EU - LIFE Project
Filtering of **A**sbestos fibres in **L**eachate from hazardous waste **L**andfills
(LIFE03 ENV/IT/323-FALL)

UNIVERSITÀ CA' FOSCARI VENEZIA

ISPESL
Istituto Superiore per la Prevenzione e la Sicurezza del Lavoro

SI
Sviluppo Italia
Aree Produttive

European Conference on

Asbestos Risks and Management

Rome, 4-6 December 2006

ISPESL
Istituto Superiore per la Prevenzione
e la Sicurezza del Lavoro

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Presentazione

L'amianto è una sostanza che ha avuto, negli anni passati, numerose applicazioni sia industriali che civili e pertanto risulta ampiamente diffuso su tutto il territorio nazionale. In Italia costituisce un problema estremamente complesso che coinvolge aspetti economici, previdenziali, sanitari ed ambientali.

Sebbene la normativa italiana in materia sia tra le più restrittive in ambito europeo ed internazionale, giova ricordare che a distanza di quattordici anni dall'introduzione della Legge 257 del 27 Marzo 1992 che stabilisce la "cessazione dell'impiego dell'amianto", sono ancora presenti sul territorio nazionale circa 32 milioni di tonnellate di materiali contenenti tale sostanza in matrice compatta e molte altre tonnellate in matrice friabile.

Il totale di amianto puro si stima intorno a 8 milioni di metri cubi ripartiti in tutto il territorio nazionale tra siti industriali e quelli civili (pubblici e privati).

L'amianto è definito come sostanza cancerogena dallo IARC (International Agency for Research on Cancer) ed i materiali che lo contengono sono classificati dal CER (Catalogo Europeo dei Rifiuti) come rifiuti pericolosi.

E' necessario pertanto che la bonifica dei siti contaminati e la messa in discarica del materiale contenente amianto siano realizzate operando con le opportune cautele nel rispetto delle norme di prevenzione e sicurezza degli ambienti di lavoro e di vita e della tutela dell'ambiente.

Le indicazioni sulla presenza di amianto in Italia vengono riportate dall'ISPESL su scala europea ed internazionale partecipando ad organizzazioni e programmi di ricerca in collaborazione con numerosi paesi.

Tenuto conto che con il passare degli anni lo stato di degrado dei materiali contenente amianto comporta un notevole incremento del rilascio di tali fibre pericolose nell'ambiente, al fine di evitare esposizioni indebite dei lavoratori o della popolazione, in Italia si sta procedendo con attività di messa in sicurezza di emergenza e bonifica di siti di rilevanza nazionale contaminati da amianto. In particolare la Legge 9 Dicembre 1998, n.426, il Decreto 18 Settembre 2001, n.468 e la Legge n. 179 del 2001 individuano numerosi siti di interesse nazionale che debbono essere bonificati anche e soprattutto rispetto all'amianto che può essere presente sia come fonte di contaminazione primaria che come fonte secondaria ed assicurano una prima copertura finanziaria per gli interventi di messa in sicurezza d'emergenza per le situazioni di inquinamento ritenute più pericolose ed acute.

Oltre ai siti sopra citati, sono presenti sul territorio nazionale molte altre aree contaminate da amianto. Pertanto attraverso la Legge 93/2001 ed il relativo D.M. 101/2003, lo Stato ha previsto ulteriori finanziamenti per la realizzazione di una mappatura completa della presenza di amianto sul territorio nazionale e degli interventi di bonifica urgenti.

A tale scopo l'ISPESL, in collaborazione con il Ministero dell'Ambiente e della Tutela del Territorio (MATT), sta approntando un Sistema Informatico Territoriale (SIT) che consentirà di ottenere una corretta interpretazione delle reali situazioni di rischio amianto presenti su tutto il territorio nazionale.

L'ISPESL, infatti, si occupa da anni della sicurezza e prevenzione dei rischi derivanti dall'inquinamento delle matrici ambientali aria, acqua e suolo dovuto all'impiego dell'amianto e ciò sia sotto il profilo sanitario, che di tutela dei lavoratori e della popolazione esposta a tale sostanza cancerogena.

L'ISPESL svolge tra l'altro attività di formazione sulle tematiche connesse all'amianto e recentemente ha partecipato, in qualità di Ente scientifico coordinatore, al "Corso di formazione permanente per la lotta all'amianto" organizzato dal MATT per il personale delle pubbliche amministrazioni nazionale (AUSL, ARPA, Comuni, Province, Regioni, Sindacati etc.) che si occupa delle problematiche relative alla dismissione e messa in sicurezza dell'amianto.

Inoltre l'ISPESL partecipa come partner al Progetto di Ricerca Europeo LIFE -FALL (*F*iltering of *A*sbestos fibres in *L*eachate from hazardous waste *L*andfills) per il quale ha già organizzato l'European Conference on Asbestos Monitoring and Analytical Methods (AMAM 2005), tenutosi a Venezia dal 5-7 Dicembre 2005 ed organizza la presente European Conference on Asbestos Risk and Management (ARAM 2006), Roma 4-6 Dicembre 2006.

L'ISPESL, certo dell'elevato spessore scientifico del Convegno di Roma appena citato, augura ai partecipanti all'ARAM 2006 un caloroso benvenuto ed auspica che le memorie presentate ed il confronto tra gli esperti del settore, provenienti da numerose nazioni, possano contribuire alla elaborazione di un documento finale scientificamente rilevante e tale da poter essere adottato dalle competenti Autorità nazionali ed internazionali per diffondere la cultura della prevenzione e della lotta all'amianto sia in ambienti di vita che di lavoro.

Il Presidente
Prof. Antonio Moccaldi

Prefazione

L'ISPESL (Istituto Superiore per la Prevenzione e la Sicurezza del Lavoro) nasce con il DPR 619/80 e, pertanto, da ventisei anni si colloca all'interno del comparto della ricerca pubblica.

L' Istituto è organo tecnico –scientifico del Servizio Sanitario Nazionale ed è sottoposto alla vigilanza del Ministero della Salute.

Precipuo obiettivo dell'ISPESL, attraverso la sua variegata attività istituzionale di ricerca, studio, sperimentazione, controllo, formazione, informazione, consulenza, certificazione ed omologazione di impianti ed attrezzature, è la tutela del cittadino e del lavoratore nei rispettivi ambienti di vita e di lavoro, creando altresì, attraverso adeguata attività di comunicazione e di diffusione, i necessari presupposti perché siano, quanto più possibile, recepite ed assimilate la conoscenza, la responsabilità e la consapevolezza da parte dei cittadini e dei lavoratori in ordine alla prevenzione dei rischi connessi alla presenza crescente di tecnologie complesse e potenzialmente pericolose sia sui posti di lavoro sia usufruite direttamente dai cittadini.

L'ISPESL, mediante le proprie strutture tecnico-scientifiche centrali e territoriali è, pertanto, fortemente impegnato per il raggiungimento del predetto obiettivo al fine di concorrere alla riduzione degli incidenti sul lavoro e negli ambienti di vita, limitare le malattie professionali, diffondere la cultura della sicurezza, contribuendo infine a migliorare la qualità della vita e del lavoro nel nostro Paese.

In particolare l'ISPESL annovera i seguenti compiti istituzionali:

- Ricerca, studio, sperimentazione ed elaborazione dei criteri e delle metodologie per la prevenzione degli infortuni e delle malattie professionali con particolare riguardo all'evoluzione tecnologica degli impianti, dei materiali, delle attrezzature e dei processi produttivi.
- Individuazione dei criteri di sicurezza e dei relativi metodi di rilevazione ai fini dell'omologazione di macchine, componenti di impianti, apparecchi, strumenti e mezzi personali di protezione, nonché ai fini delle specifiche tecniche applicative.
- Prevenzione dei lavoratori contro i rischi di incidenti rilevanti connessi a determinate attività industriali.
- Protezione dei lavoratori contro i rischi derivanti da esposizione ad agenti chimici, fisici e biologici durante il lavoro.
- Consulenza nella elaborazione dei Piani sanitari nazionale e regionale e nella predisposizione della relazione sullo stato sanitario del paese, nonché consulenza tecnica ai presidi multizonali di prevenzione e, su richiesta, ad organismi pubblici e privati.
- Standardizzazione tecnico-scientifica delle metodiche e delle procedure di valutazione dei rischi per la salute e la sicurezza di lavoratori.
- Svolgimento di attività di ricerca, didattica e di formazione, di perfezionamento e di aggiornamento professionali rivolti al personale del Servizio Sanitario Nazionale in materia di

prevenzione salute e sicurezza negli ambienti di lavoro ai fini dell'accesso ai ruoli dirigenziali del Servizio Sanitario Nazionale.

- Consulenza ed assistenza alle imprese.

L'ISPESL si articola, a livello centrale, su 5 Dipartimenti tecnico-scientifici ed, a livello territoriale, su 20 agenzie ed annovera tre centri di ricerca di eccellenza; pertanto una peculiarità dell'ISPESL è quella di essere vicino alle esigenze di prevenzione e sicurezza che riguardano i cittadini e le imprese.

Infine l'ISPESL opera attraverso gruppi multidisciplinari e ciò rappresenta la garanzia di un approccio d'intervento di elevato profilo tecnico-scientifico.

Il Direttore Generale
Dott. Umberto Sacerdote

Introduzione

L'ISPESL (Istituto Superiore per la Prevenzione e la Sicurezza del Lavoro) è costituito da 5 dipartimenti tecnico-scientifici fra i quali si annovera il Dipartimento Installazioni di Produzione ed Insediamenti Antropici. (DIPIA)

Il DIPIA in particolare, svolge compiti di studio, ricerca, sperimentazione, consulenza, assistenza alle imprese, proposta normativa, controllo, standardizzazione delle metodiche e delle procedure di valutazione, ai fini della sicurezza e della compatibilità ambientale in connessione con la presenza sul territorio di installazioni di produzione insediamenti antropici, in particolare c on riferimento agli stabilimenti a rischio di incidenti rilevanti di cui al decreto legislativo 17 agosto 1999 n.334 e alle installazioni di cui al decreto legislativo 18 febbraio 2005,n.59.

Inoltre il Dipartimento fornisce supporto tecnico-scientifico ai Ministeri della Salute, dell'Ambiente e Tutela del Territorio (MATT) in merito alla bonifica di siti contaminati di interesse nazionale (DM del 25.10.99 n. 471 e Legge 31 luglio 2002 n. 179.

Molti di questi siti risultano contaminati da amianto ed in particolare in una decina di essi detto agente cancerogeno risulta essere il principale contaminante.

Il DIPIA nell'ambito della propria attività di ricerca e consulenza fornisce indicazioni e linee guida per gli Organi di controllo locali e formula pareri tecnici sulla tematica che vengono acquisiti come prescrizioni nei verbali delle Conferenze di Servizi decisorie del MATT.

Effettua inoltre sopralluoghi in situ per le campagne di monitoraggio ambientale ed allo scopo dispone di un laboratorio specificatamente attrezzato al controllo ed alle analisi delle matrici ambientali aria, acqua e suolo contaminate da amianto.

Il DIPIA infine partecipa a progetti europei quale quello presente , LIFE-FALL, ed organizza corsi di formazione per le amministrazioni pubbliche nazionali e locali specifici sulla tematica della prevenzione e sicurezza dal rischio amianto.

Si ringrazia per la fattiva collaborazione alla realizzazione dell'attuale Convegno la Direzione Qualità della Vita del MATT ed in particolare il Direttore Generale Dr. Gianfranco Mascazzini e l'Ing. Marco Giangrasso.

Il Direttore del DIPIA
Dott. Ing. Mario Mariani

Session 1

Compensation for damages due to asbestos and legal aspect; work of asbestos victim groups; municipalities' role

ASBESTOS DAMAGE COMPENSATION IN THE UNITED STATES, SPAIN AND FRANCE

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In the USA, it is estimated that manufacturing companies have spent 70 billion dollars on asbestos exposure victims[1]. Similarly, in Europe, a recent research situates the asbestos-related diseases among the most expensive for the insurance providers[2].

Leaving these revealing numbers aside, one of the major issues arising from asbestos-related damages compensation is who should bear the costs. The goal is to identify the responsible party for the damage caused and provide a full compensation for the victim. The approach to this ideal model of compensation requests a brief analysis of the different systems applied in developed countries. This analysis attempts to identify the failures of the main damage compensation systems and propose improvements to attain adequate damage compensation and equitable distribution of the responsibilities.

In the United States, the first claims against asbestos manufacturers were filed around the '30s and gradually, a strong case law established that the manufacture constituted the principal and sole responsible for asbestos caused damages[3]. One of the landmark cases is *Borel v. Fibreboard Corporation,* where it was stated that the manufacturer of asbestos-containing products has the duty to warn the hazards linked to its use. The failure to warn makes the manufacturer liable for any damage that the user may suffer. The doctrine established by this judgement encouraged new lawsuits against manufacturers. It is estimated that 16,000 complaints were filed against asbestos manufacturers in the 10 following years. One judgement known for the severeness applied on the manufacturer and the unavoidable financial crisis that lead the company into bankruptcy is *Beshada v. Johns-Manville Products*. In this case, Manville, the manufacturer, alleged that at the moment the products were marketed, it ignored the dangers of asbestos, regardless this fact, the court found that the manufacturer was in a better position to support damage compensation costs caused by their products. Recently, a group of workers from Alabama filed a complaint against the manufacturer that sold the asbestos containing products to their employer. The court found against the manufacturer for selling products without the proper hazard warnings, in the amount of 130 million dollars[4].

The severe assessment of manufacturer's responsibilities, together with the large number of individuals suffering from asbestos diseases, has increased the claims, conducting several companies into bankruptcy. Besides this matter which will be addressed later on, what is revealing in the American system is that all of the claims are filed against the manufacturer who is, in the end,

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[1] S. Carroll, D. Hensler, J. Gross, Elizabeth M. Sloss, M. Schonlau, A. Abrahamse, J. Scott Ashwood RAND Institute for Civil Justice, *Asbestos Litigation.* 2005.

[2] *Cout et financement des maladies professionnelles en Europe,* EUROGIP, 2004, págs. 12 y ss.

[3] *Un repaso de la principal jurisprudencia norteamericana y también la española en la materia en* A. AZAGRA MALO, M. GILI SALDAÑA: "Guía InDret Civil de *jurisprudencia sobre responsabilidad civil por daños del amianto"*, *InDret,* núm. 277, 2005. Vid. *También un resumen de los referentes jurisprudenciales americanos* http://www.asbestosresource.com/litigation/

[4] Caso Bell v. Dresser Industries Inc.

the responsible for asbestos-related damages. This is different in the European systems, as we will point out, where the employer is the main responsible for the damages suffered by workers during the course of their activities. This principle is applied as well to the damages caused by professional asbestos exposure.

The reason why in the American scheme the responsibility is focused on the manufacturer has its grounds in the limitations of the worker's insurance for damages occurred during labor. While different from the models adopted by European countries, in the USA, there is no universal system to guarantee workers compensation for the damages suffered as a consequence of their job. There are funds reserved for workers who suffer job-related accidents, but these funds do not cover all of the workers and do not fully compensate the damages suffered. Furthermore, the existence of these reserve funds precludes workers from filing a claim against their employer. In other words, any worker that receives compensation based on work-related damages from the Workers Compensation funds, even if insufficient to fully cover the damage, will be prevented from claiming the uncompensated portion from the employer. This is known as the employers' immunity principle, by which it is implied that if the employer has made financial contributions to the Worker's Compensation fund, should not pay also for civil compensation.

The limited coverage provided by the compensation funds encourage workers to seek alternative ways to get compensation for job-related damages. Considering the cited precedents addressing manufacturers' responsibility, it is obvious that the most secure way to assure the claim's success and satisfactory compensation, is to direct the claim against the manufacturer of the product used at work, clearly, limited to those cases where the damage was caused by such products.

Under these rules, workers may get fully compensated for the damages. However, the American system does not guarantee an automatic compensation of the damage, because the worker needs to wait until judgement is rendered. Also, no consideration is given to any eventual responsibility of the employer that could or should have known the risks of the products used by its employees.

The absence of other mechanisms to compensate damages caused by accidents and the legal precedents, increase the number of lawsuits against manufacturers, heading the manufacturing industry to the boundaries of bankruptcy.

This situation has forced the United States to reconsider the asbestos damage compensation system. In the last few years, efforts have been undertaken to create a Special Fund to compensate asbestos' victims. Several bills known as "Fairness in Asbestos Injury Resolution Act" have been introduced, although, up to this date, none has passed[5]. The delay in the enactment of this law is based in the difficulties to reconcile the conflicting interests involved, specially the resistance of the victims that prefer to get substantial compensations from the manufacturers.

In summary, the purpose of this fund is to ensure automatic compensation of the damage for those who proved to suffer an asbestos-related disease. The compensation amounts are fixed and may vary according to the type of disease suffered. Any amount awarded from this fund is deductible when calculating other compensations that the victim could have claimed from the manufacturer in alternative procedures. This deduction rule does not apply to other amounts the victim could be entitled, as long as they do not come from the manufacturing company; for example, amounts granted by worker's compensation funds. The rationale lays in the aim that the special compensation fund for asbestos-related damages be financed by State and manufacturers'

[5] Las diferentes versiones de la norma se pueden encontrar en http://www.cnie.org/NLE/CRS/detail.cfm

contributions. Therefore, it is reasonable to deduct any sums already contributed by the manufacturers when seeking other possible accessory compensations from them.

In a different but not particularly efficient manner, the Spanish system burdens the Social Security and the employer with the responsibility for asbestos-related damages compensation.[6]

In Spain, there is a specific list of occupational diseases which automatically includes illnesses caused by asbestos-related activities. Therefore, in order to collect due compensation from the Social Security system, the worker must prove asbestos-exposure in conducting any of the legally recognized activities.

Usually, the compensation consists in a pension to cover the worker for the lost earnings within the convalescence period. Furthermore, in the event of death due to the illness, the worker's family would receive a legally established compensation.

The costs of these benefits are financed by the employers through their monthly contribution which is calculated per each worker, in relation with the company's risks.

To the extent that it guarantees automatic damage compensation, the Spanish Social Security system is satisfactory. However, it does not provide a complete relief since it only covers workers for the lost earnings while other eventual damages such as psychological and physical sufferings, remain uncompensated. Somehow, the Spanish legislator amended the limitations in the Social Security system by an expressed provision (Art. 127.3 Social Security Law). This rule states that the reception of benefits from Social Security does not preclude the victim from seeking civil compensation from the responsible party. In conclusion, the worker victim of an asbestos exposure disease will receive the benefits provided by the Social Security, and also will be entitled to claim civil compensation from the party responsible for such exposure. At this stage, the questions arising are against whom should the worker file his claim, and how will the benefits received from the Social Security affect the calculation of an eventual compensation.

After outlining the American compensation system, we could forecast that workers would direct their claims against the asbestos-containing product manufacturer. Specially considering that the Spanish Statute 22/1994 from July 6, resultant from the transposition of the communitarian regulation 85/374 from July 25, establishes product manufacturer's objective responsibility for the damages caused by defective products. Nonetheless, it is interesting to remark that so far no worker in Spain has directed his claim against the asbestos-product manufacturer. All of the civil complaints for asbestos-related damages have been filed against the employer.[7] The Supreme Court, the highest jurisdictional body in Spain, has had only one opportunity to pronounce its opinion on this matters. The judgement dated September 30, 1997, dismissed the worker's claim on the basis that the employer had taken all of the required security measures and thus, was not to be held liable.

In addition, as mentioned before, the Spanish legislative system allows the accumulation of civil compensation with benefits from social security. The issue is whether this accumulation is unlimited, meaning that civil compensation will be calculated without consideration of the social

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[6] MERCADER UGUINA, J.: *Indemnizaciones derivadas de acidentes de trabajo*, La Ley, Madrid, 2001 RODRÍGUEZ SANZ DE GALDEANO, B.: *Resposabilidades de los fabricantes en materia de prevención de riesgos laborales,* Lex Nova, Valladolid, 2005.

[7] AZAGRA MALO, M. GILI SALDAÑA: *"Guía InDret de jurisprudencia sobre responsabilidad civil por daños del amianto"*, *InDret,* núm. 277, 2005.

security benefits already received by the worker or, to the contrary, the Social Security benefits that the worker is entitled to, need to be deducted from civil compensation.

There is no uniform case law in Spanish courts on this matter. Therefore, the Social and Labor Matters Courts understand that civil compensation owed by the employer should be reduced proportionally by the amount received from social security benefits. While the Civil Courts, in an opposite position, compute the worker's right to compensation independently of any benefits received from the Social Security.

The Chamber of Social and Labor Matters of the Supreme Court formulated what seems to be the most appropriate view on this subject: When the worker is receiving Social Security benefits for the lost earnings, clearly civil compensation should not redress worker for equal damages but only for those consequences suffered and not yet repaired such as the physical or psychological sufferings. Also, to state otherwise, would force the employer to repair the same damage twice, given that he would be liable for civil compensation payments while obliged to contribute to Social Security funds.

In conclusion, in Spain, the worker victim of asbestos-exposure related damages is entitled to Social Security benefits and also, has the right to seek damage compensation from the responsible party. The total amount of the compensation granted will differ whether the jurisdictional body is a civil or a social and labor court. In the Spanish practice contrary to that in the United States, the employer is the target of all worker's claims. Even though manufacturers could be held responsible for the damages suffered by workers, there is a lack of tradition in suing third parties irrelevant in the employment relationship for work related damages.

None of the analyzed systems fully satisfies the two major goals that a damage compensation system should pursue: full compensation for the victim and attribution of responsibility for the damage caused. For instance, the Spanish system guarantees worker an automatic but limited compensation financed by the employer. However, the statutes do not contemplate the possibility that the manufacture could contribute to the Social Security funds. It is not provided that the Social Security could seek indemnification for the benefits paid to the worker when the manufacturer is found responsible for the damage caused. Only the worker or the employer would be entitled to civil compensation from the manufacturer, but in the practice, neither of them exercise those rights.

Apparently, the American system is closer than the Spanish to attaining the goals pursued. Certainly in America the manufacturer bears the responsibility for asbestos-related-damages and the worker receives a satisfactory compensation, however, it takes long years of litigation. Notwithstanding, it appears that the manufacturer is assuming an excessive responsibility facing alone the burdensome compensations when surely the employer is also responsible for the damages suffered by the workers. Also, it would be appropriate to debate whether the American case law, in its efforts to compensate the victim, is being overly severe in the assessment of the manufacturer's responsibility.

The French legislator embraces a more equitable approach in the Statute number 2000-1257 of December, 23, creating a specific Fund to compensate the asbestos-exposure victims, known as the Compensation Fund for Asbestos-Victims (FIVA)[8].

This specific system is based on two basic purposes, the guarantee of a full damage compensation and equal treatment of asbestos-victims. In order to accomplish these aims, compensation is available for economic and non-economic damages. The compensation amount is

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[8] Existe un sitio específico en internet con toda la información sobre la regulación de estos Fondos: http://www.fiva.fr/

computed attending to each victim's situation based on fixed criteria according to standards specially prepared for that use.

Among the economic damages subject to relief are included: (1) The physical disability, meaning, the diminished physical, sensorial, or intellectual capacity of the person, (2) the lost earnings, or the professional impairment and (3) other accessory costs such as, those incurred in adjusting the regular vehicle to fit the victim's requirements or the need of hiring special care for the victim. The physical disability will be valued according to the victim's age and the gravity of the disease, determined by medical standards which differentiate less serious respiratory affections such as fibrosis from those that carry a higher risk for health like cancer.

Along with the economic damages, the Funds repair also non-economic damages, meaning, psychological, physical and aesthetics damages caused by asbestos exposure.

Moreover, the Funds not only compensate the victim for the damage suffered but also the economic detriment and psychological suffering of the victim's family in the case of death. In the calculation of economic damages are considered the number of family members in charge of the victim and the home income before his death.

In order to receive the fixed compensation benefits from the Funds the victim must file the proper application before the administrative authority who verifies whether the established requirements are met and sets the corresponding amount.

The FIVA compensation is compatible with benefits granted by other organisms, in particular the Social Security, but they may not be accumulated. Hence, those benefits should be deducted from the compensation established by the fund known as FIVA, with the aim of preventing the victim from getting double compensation for the same damage.

The finance of these Funds is a duty of the Estate and the Social Security, the organism in charge of managing work-related accidents and professional diseases and also, beneficiary of the employer's contributions. In an initial stage, the Estate and the Social Security undertake the responsibility for compensation payments to the victims while they subrogate on victim's causes of action against the responsible party with the purpose of recovering the amounts paid.

Out of the three compensation systems briefly outlined, the French is certainly the one that better accomplishes the double purpose: full damage compensation and equitable distribution of the responsibility. Under this system, the victim receives relief for economic and non-economic damages caused by asbestos-exposure. The compensation payments are financed by the Estate and the employers trough their contributions to the Social Security. Notwithstanding, when there is a responsible third party involved such as the manufacturer, or the damage was caused by the employer's negligence, the Funds are entitled to indemnity actions for the amounts paid. Differing from the USA scheme, the public insurance system and the employers bear a great portion of the compensation costs to the manufacturers' benefit. In order to counterbalance this system, the Funds may recover from the third party responsible, such as the manufacturer, a portion of the amounts paid. Perhaps the perfect solution lays in the creation of an automatic and integrated system of compensation financed by contributions of the Estate, employers and manufacturers. Resulting in a combination of the Funds created in France, and the project drafted in the USA. Still, the difficult tasks would be reaching a fair calculation of the compensation to which the worker is entitled and determining the contributions that each individual should make.

THE CASE ON ASSOCIAZIONE ESPOSTI AMIANTO REGIONE FRIULI VENEZIA GIULIA

R. Fonda

A.E.A. regione Friuli Venezia Giulia (o.n.l.u.s.) - Trieste Italy

About ten years ago, and to be more precise in September 1997, this thanks to the determinant interest of a group of about eighty widows of workers and retired persons of the port of Trieste who asked themselves why so many people had died for lung cancer in the last seven years, a new painful chapter regarding sanitary carelessness was opened. A problem – asbestos – which was 'scientifically' well known since long ago and had to be finally evidenced. Circa six hundred thousand tons of hazardous goods such as 'Cape blue 35' asbestos have transited through the port of Trieste from 1960 to 1996, together with semi-manufactured products such as eternit, cords and cardboards, insulating ceramics, fire-bricks and so on. Together with the routes connecting the Central –and northern Europe countries, there are to be considered the historical ones, those that lead to the Mediterranean regions and South – East Asia via Suez. The documents gathered in those years are quite many and particularly significant, such as the Italian national railroad company (Ferrovie dello Stato) ones. It is established that damages caused by eventual dispersion of 'Cape blue 35' asbestos during the transport by train will be entirely charged to the customer, since this material is considered very hazardous.The sanitary authorities are finally alerted, but the most important thing is that the public opinion is informed in a better way about such terrible calamity, that is asbestos. Conferences, debates, conventions on social welfare, medical, and environmental themes are held. Medias talk more about asbestos, this time without too many obstacles. Medical –and epidemiological science-experts are activated in order to investigate adequately, although evident omissions in the reports.

Mr. Roberto Riverso, an italian jurist, is convinced that some public institutions are not very interested in informing workers of their rights (i.e. law nr. 257/92 for the compensation of damages deriving from asbestos diseases). The Associazione Esposti Amianto Friuli Venezia Giulia (AEA), an independent and non-profit association which keeps contacts and collaborates with the other associations of Italy and the ones of bordering countries, have put pressure to the politicians of Regione Friuli Venezia Giulia in order to obtain finally in 2001 the publication of a new important regional law against asbestos, together with the institution of the Register of asbestos-exposed workers and important economic contributions for the prosecution of the association's activities. Problems unfortunately are endless, although thanks to the solidarity of the association's members – nowadays their number has increased up to 1500 persons – the Associazione Esposti Amianto has obtained the esteem of local, regional, national and international institutions, and are becoming one of the most important landmarks in this field. The policy of the association nowadays deals with prevention and scientific research. Priority is given to obtain compensation of damages for the widows of workers, legal protection, environmental guardianship. All this is considered by Associazione Esposti Amianto in an European context, in order to consent the EU government to express itself with a loud voice on a world-known and still unsolved problem, the asbestos.

L'IMPORTANZA DELLE ASSOCIAZIONI DI TUTELA DEGLI ESPOSTI AD AMIANTO

Virgili A.M.

Associazione Italiano Esposti Amianto (AIEA)

The Italian Association of Asbestos-Exposed (A.I.E.A.) has replaced, for legislative and statutory reasons, the Association of Asbestos-Exposed established in 1989 by "Medicina Democratica" (Democratic Medicine), a movement for health.

Today A.I.E.A. is a partner of the international network Ban Asbestos based in London.

Its main purposes are:

1. Abolition of asbestos and of other toxic carcinogenic agents, for which there must be no limit value;
2. Knowledge and study of the so-called asbestos substitutes;
3. Scientific information about the damages and hazards caused by asbestos;
4. Divulgation of struggle experiences lived by workers and population exposed to asbestos;
5. Protection of workers' and citizens' environment and health;
6. Promotion of regional and national initiatives for sites decontamination;
7. Promotion of sanitary overseeing, treatment and rehabilitation of those citizens struck by asbestos related illnesses;
8. Enforcement of law 257/92, which banned asbestos in Italy.

As we know, April 28th is the World Day for Asbestos Victims: celebrations are not the mere commemoration of the thousands of victims caused by asbestos but a call for justice for them and their families; a demand to the establishment for law enforcement in order to forbid the extraction, production and sale of asbestos; a request for environmental decontamination and for a fund that could indemnify the damages to the people exposed to asbestos.

Every day workers and people still dies for asbestos in Europe and in the World.

We demand the suspension of asbestos mining on the territories of China, Russia, Canada and Brazil, being the main producers worldwide.

In Italy, the asbestos problem is still a sanitary and environmental emergency of the highest importance. We have organized press conferences and national meetings with the participation of European Parliament members, Italian Parliament delegates, local administrators, social forces; demonstrations in front of the Italian Parliament to remind the government to bring the asbestos issue to the Parliament's attention; request to local administrations to introduce the asbestos issue in their schedules.

Session 2

Diagnosis of asbestos related damage; medical treatments; medical research; epidemiological studies

IL TRATTAMENTO CURATIVO DEL MESOTELIOMA PLEURICO: ASPETTI CHIRURGICI

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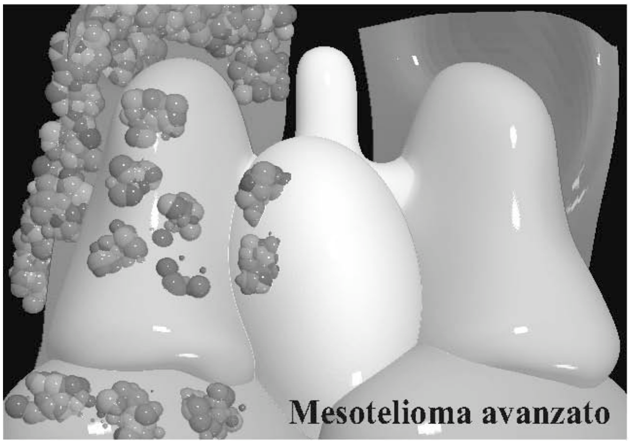
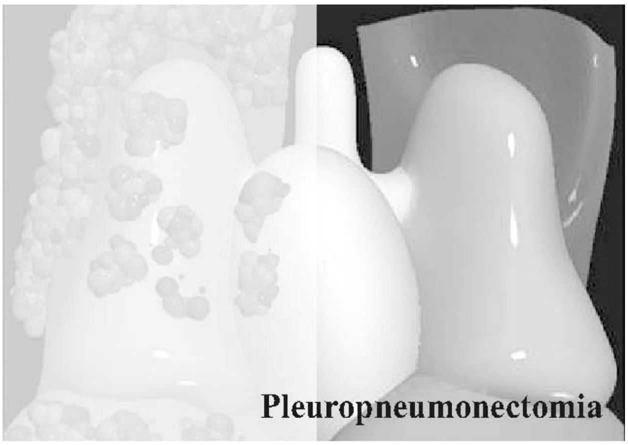
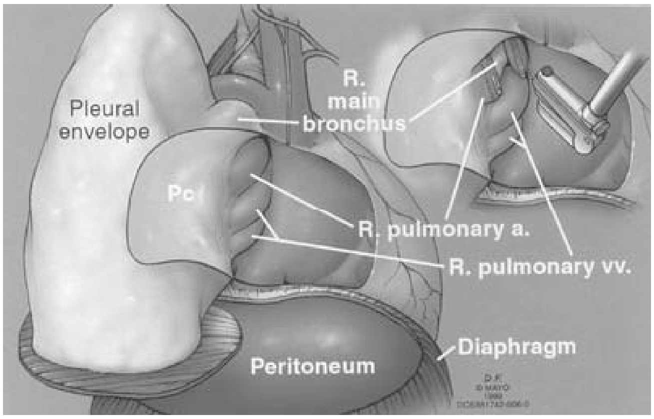
La tecnica della pleuropneuctomia fu descritta per la prima volta da Sarot nel 1950 a proposito del trattamento dell'empiema tubercolare. Solo a partire dagli anni '70 l'intervento ha trovato applicazione nella terapia del mesotelioma pleurico, mentre all'inizio degli anni '90 è stata pubblicata da Sugarbaker *et al*. la prima casistica di pazienti sottoposti a pleuropneumonectomia nell'ambito di un trattamento multimodale, in cui l'intervento è stato associato a chemio- e radio-terapia adiuvanti.

Malgrado i significativi incrementi della sopravvivenza ottenuti mediante questo approccio multimodale rispetto alle terapie mono- o bi-modali, a tutt'oggi non esiste ancora una modalità di trattamento univocamente accettata dai vari autori. Attualmente le due alternative terapeutiche per un approccio curativo al mesotelioma pleurico sono per l'appunto il trattamento trimodale secondo Sugarbaker e la pleurectomia/decorticazione, anch'essa associata a chemio- e radioterapia adiuvanti e/o neoadiuvanti. Il razionale dell'uso della pleuropmeumonectomia sta nella maggiore radicalità chirurgica (l'intervento viene comunque in genere considerato citoriduttivo) che consentirebbe di ottimizzare l'efficacia delle terapie adiuvanti su un residuo minimo di malattia e di somministrare dosi più elevate di radiazioni senza il rischio di indurre una polmonite da raggi. La pleurectomia/decorticazione d'altra parte è associata ad più basse mortalità e morbilità operatorie e, pur essendo le sue finalità curative limitate allo stadio I IMIG della malattia, non è gravata dai problemi inerenti alla ricostruzione del diaframma e del pericardio; la tecnica può peraltro essere applicata ai pazienti che non possiedono tutti i requisiti di eligibilità alla pleuropneumonectomia (oltre







ad essere comunque foriera di un'efficace palliazione anche negli stadi avanzati). Non sono comunque a tutt'oggi stati pubblicati trials clinici randomizzati che mettano a confronto i risultati delle due tecniche nell'ambito di gestioni multimodali.

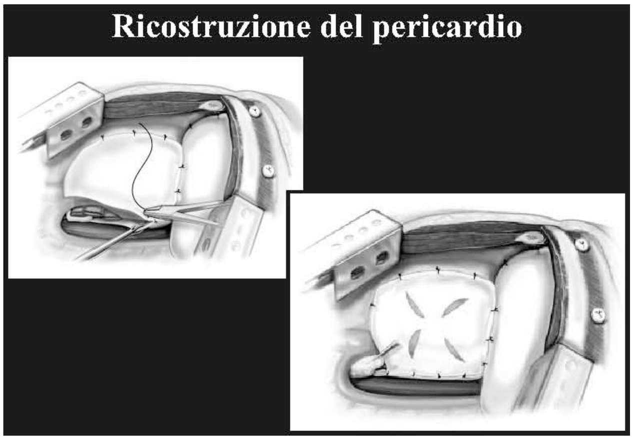
Un primo criterio di eligibilità all'intervento di pleuropneumonectomia è costituito da un'istologia tumorale di tipo epiteliale o misto (bifasico), accertata con esame istologico su biopsia pleurica.

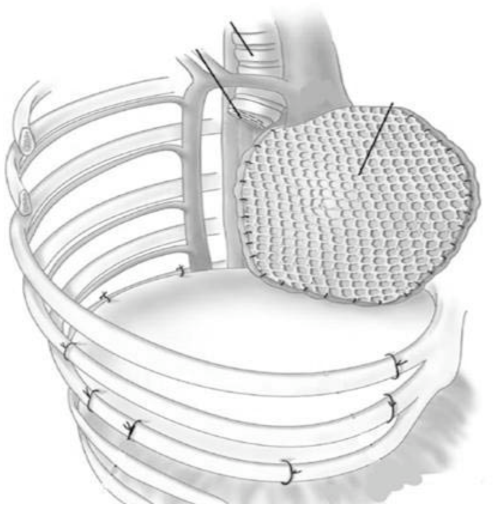
Viene in genere considerata suscettibile di trattamento multimodale con pleuropneumonectomia la malattia confinata ad un emitorace, completamente resecabile: stadi I e II IMIG o stadio I di Butchart. È ammesso anche un limitato coinvolgimento linfonodale: stadi I, II e III-nonN2 IMIG o stadi I e II Brigham. Tali criteri restano validi anche per la ristadiazione post-chemioterapia neoadiuvante.

Tra le procedure per la stadiazione trovano largo impiego la TC e la RMN del torace (quest'ultima con un maggior potere di risoluzione soprattutto nella valutazione dell'interessamento diaframmatico e della fascia endotoracica), la PET (utile soprattutto nell'individuazione di metastasi extratoraciche) e la TC-PET (superiore alle altre tecniche nella rilevazione di un coinvolgimento linfonodale mediastinico).

Meno diffuso è l'uso di metodiche stadiative invasive come l'agoaspirato transbroncchiale o le tecniche di stadiazione chirurgica estesa comprendenti la mediastinoscopia e la laparoscopia (per l'esecuzione di biopsie del peritoneo sottodiaframmatico e del lavaggio addominale per esame citologico).

Il paziente candidabile al trattamento trimodale con pleuropneumonectomia deve avere un'età inferiore ai 75 anni ed essere inoltre in buone condizioni generali: assenza di gravi dismetabolismi, indici di funzionalità epatica nella norma, creatininemia < 2mg/dl, indice di Karnofsky > 70, buona funzionalità cardiaca con frazione di eiezione > 45%, pO_2 > 75 mmHg e pCO_2 < 45 mmHg. Per quanto riguarda gli indici di funzionalità respiratoria Sugarbaker considera eligibili i pazienti con FEV1 > 2 L/s e consiglia per i casi con FEV1 < a 2 L/s l'esecuzione di una scintigrafia ventilo-perfusoria e la candidabilità all'intervento per i pazienti con FEV1 residuo > 0,8 L/s. Pagan





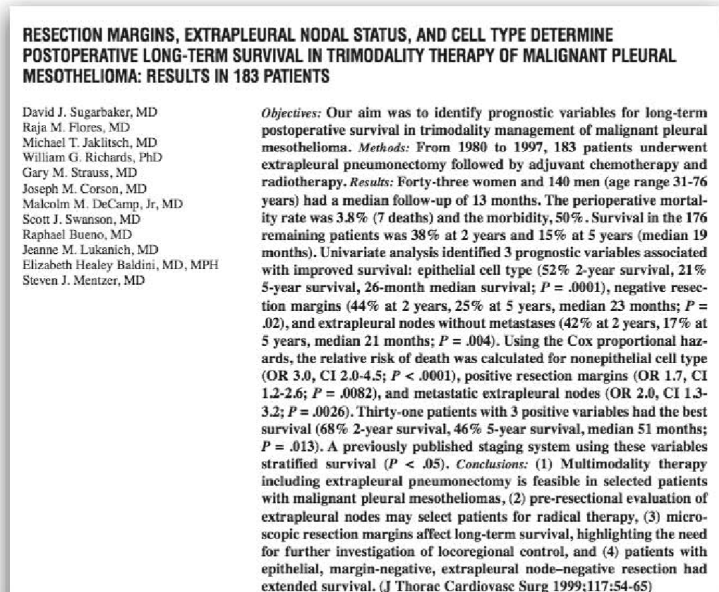
considera candidabili alla pleuropneumonectomia i pazienti con FEV1 e DLCO residui non inferiori alla metà del teorico. Infine, la pressione arteriosa polmonare dev'essere nella norma; essa può essere stimata mediante l'ecocardiografia e nei casi sospetti, si può ricorrere alla cateterizzazione cardiaca con misurazione diretta ed eventuale monitoraggio della stabilità emodinamica nel corso di simulazione della pneumonectomia mediante occlusione dell'arteria polmonare con palloncino.

L'intervento di pleuropneumonectomia inizia con l'escissione dei tramiti parietali di precedenti toraco-tomie e può procedere con un'incisione posterolaterale o verticale sull'ascellare media, seguite da un accesso in 5°-6° spazio intercostale per il tempo dissettivo principale. Per il tempo diaframmatico può rendersi necessaria una seconda incisione intercostale più bassa (9°-10° spazio).

Prima di accedere al torace si può procedere ad un'esplorazione diaframmatica addominale mediante un piccolo accesso sottopostale o un tempo laparoscopico.

Per ottenere una migliore esposizione della pleura parietale, dopo lo stipping periostale la costa sottostante allo spazio scelto per la toracotomia può essere resecata. La dissezione extrapleurica viene condotta a seconda delle necessità alternando la via smussa a quella tagliente ed all'uso del bisturi elettrico, procedendo sia in basso che in alto. Lo stripping pleurico viene accompagnato dal packing del cavo che si va aprendo onde minimizzare le perdite ematiche. Ottenuta un'adeguata esposizione iniziale, si posiziona allora un retrattore costale e si prosegue la dissezione dapprima anteriormente e poi posterior-mente. Particolare attenzione va posta nell'evitare danneggiamenti dei vasi mammari interni anteriormente, dei vasi succlavi all'apice, delle vene cava ed azigos a destra, dei vas i intervostali all'origine dall'aorta e del nervo ricorrente a sinistra. L'identificazione dell'esofago può essere facilitata dal posizionamento di un sondino nasogastrico.

Si apre quindi il pericardio anteriormente e dopo aver escluso la presenza di segni di non resecabilità, si procede alla dissezione diaframmatica iniziando anteriormente (a livello dell'incisione pericardica) e proseguendo lateralmente e posteriormente lungo l'inserzione muscolare mediante elettrobistuti o con l'avulsione dell'inserzione stessa, lasciando un margine muscolare di 2 cm a ridosso



RESECTION MARGINS, EXTRAPLEURAL NODAL STATUS, AND CELL TYPE DETERMINE POSTOPERATIVE LONG-TERM SURVIVAL IN TRIMODALITY THERAPY OF MALIGNANT PLEURAL MESOTHELIOMA: RESULTS IN 183 PATIENTS

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Objectives: Our aim was to identify prognostic variables for long-term postoperative survival in trimodality management of malignant pleural mesothelioma. *Methods:* From 1980 to 1997, 183 patients underwent extrapleural pneumonectomy followed by adjuvant chemotherapy and radiotherapy. *Results:* Forty-three women and 140 men (age range 31-76 years) had a median follow-up of 13 months. The perioperative mortality rate was 3.8% (7 deaths) and the morbidity, 50%. Survival in the 176 remaining patients was 38% at 2 years and 15% at 5 years (median 19 months). Univariate analysis identified 3 prognostic variables associated with improved survival: epithelial cell type (52% 2-year survival, 21% 5-year survival, 26-month median survival; $P = .0001$), negative resection margins (44% at 2 years, 25% at 5 years, median 23 months; $P = .02$), and extrapleural nodes without metastases (42% at 2 years, 17% at 5 years, median 21 months; $P = .004$). Using the Cox proportional hazards, the relative risk of death was calculated for nonepithelial cell type (OR 3.0, CI 2.0-4.5; $P < .0001$), positive resection margins (OR 1.7, CI 1.2-2.6; $P = .0082$), and metastatic extrapleural nodes (OR 2.0, CI 1.3-3.2; $P = .0026$). Thirty-one patients with 3 positive variables had the best survival (68% 2-year survival, 46% 5-year survival, median 51 months; $P = .013$). A previously published staging system using these variables stratified survival ($P < .05$). *Conclusions:* (1) Multimodality therapy including extrapleural pneumonectomy is feasible in selected patients with malignant pleural mesotheliomas, (2) pre-resectional evaluation of extrapleural nodes may select patients for radical therapy, (3) microscopic resection margins affect long-term survival, highlighting the need for further investigation of locoregional control, and (4) patients with epithelial, margin-negative, extrapleural node–negative resection had extended survival. (J Thorac Cardiovasc Surg 1999;117:54-65) dell'esofago che verrà utilizzato per la ricostruzione protesica. La separazione del diaframma dal peritoneo viene ottenuta per via smussa con l'aiuto di un tampone montato. Si completa infine l'incisione pericardica posteriormente.

I vasi polmonari vengono in genere sezionati e suturati intrapericardici con uno stapler vascolare; a sinistra l'arteria polmonare viene comunemente preparata e sezionata sul piano extrapericardico, extrapleurico. L'introduzione dello stapler può essere agevolata dall'uso di un endolider. Si esegue quindi posteriormente la sezione del bronco con la tecnica preferita (manuale o meccanica) e l'eventuale protezione del moncone con lembi autologhi. La ricostruzione del diaframma e del pericardio può essere confezionata con mesh in vari materiali (Gore-Tex, PTFE o rete poliglicolica). La protesi diaframmatica viene fissata circonferenzialmente alla parete toracica con punti staccati non riassorbibili; Sugarbaker consiglia l'uso di bottoni in polipropilene da posizionare come contrafforti all'esterno della parete e l'uso di due patches parzialmente sovrapposti ed uniti con due colpi di stapler onde ottenere una protesi dinamica (riduzione della tensione sui punti di fissaggio circonferenziali).

È consigliata infi ne la fenestrazione della protesi pericardica per la prevenzione del tamponamento cardiaco.

CASES OF MALIGNANT MESOTHELIOMA AND OCCUPATIONAL EXPOSURES TO ASBESTOS IN AGRICULTURAL SECTOR: CONSIDERATIONS AND ANALYSIS OF THE ReNaM DATA

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**COR Toscana

Introduction

From the analysis of the risk profile in agricultural sector a series of not negligible risks able to cause damages to health emerges. Among the most common risk factors there is the use of pesticides, the exposure to ultraviolet radiation and the dust exposure often containing crystalline silica. With regard to asbestos, exposures different from the use of asbestos filters have been unknown since recent times. Some cases of mesotelioma reported just the use of asbestos in filters. However in the years numerous cases in farmers-breeders often have been classified as "unknown asbestos exposure" (UAE) with the consequence that the exposures to asbestos have been only assumed according to information collected in several occasions, but often difficult to verify.

Among the hypotheses of asbestos use and consequent exposure we remember the asbestos matrix for pesticides, the "dusts" from Balangero mine used in chicken food and in litter for great stables, etc., but this information has never been proved by written documentation Other exposures might have been occurred during tractors or other machines maintenance.. These activities have been described directly during the interviews. During the last few years another condition emerged as a possible source of exposure: the recycling of second hand jute bags previously containing asbestos.. Until the first half of the seventies asbestos fibres came transported in bags of textile fiber, mainly jute, but also linen. Companies using asbestos in the production process directly recycled these bags yielding them to employees and bags manufacturers. A recent study on UAE cases has evidenced and proven such activity and it is available on the ISPESL website . http://www.ispesl.it/ispesl/sitorenam/ricerca/Relazione_conclusiva_ignoti.pdf.)

Mesotelioma in agriculture

The incidence of malignant mesothelioma (1993-2001) with UAE has reached a total of 87 cases. 53 of them (out of the 87) had professional history exclusively in agriculture;

The table 1 shows the distribution of the cases for incidence year and region of residence.

The regions with the highest incidence are Liguria and Tuscany; The distribution for gender is 61 cases in males (70.1%) vs. 26 (29.9%) of female with a relationship between gender of approximately 3/1. If the observation restricts to the 53 just agricultural workers the differences on gender is reduced (33 males vs.20 female) (table2).

Table 1 -Distribution of the UAE cases of mesotelioma for year of incidence and region of residence

	YEAR OF INCIDENCE									
REGION	***1993***	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***Total***
Basilicata									1	**1**
Emilia Romagna		1	1		1		3	1		**7**
Liguria				4	6	2		2	1	**15**
Lombardy								4	3	**7**
Marches				1	2	1	2		2	**8**
Piedmont	1					1	1	1	1	**5**
Puglia		1				2	5	3		**11**
Sicily						3		6	2	**11**
Tuscany		2	1	3		3	3	1	2	**15**
Veneto			1	1				5		**7**
Total	**1**	**4**	**3**	**9**	**9**	**12**	**14**	**23**	**12**	**87**

Table 2. Distribution for sex and site

	SITE		
SEX	**PLEURA**	**PERITONEUM**	**TOTAL**
Female	25	1	26
Males	60	1	61
Total	**85**	**2**	**87**

In respect of diagnosis 51 (58.6%) are defined as "certain" (histological) the remaining 36 cases (41.4%) are comprised between "mesothelioma probable" (23 cases) and "mesothelioma possible" (13 cases). The distribution for age shows a range between 75 and 84 years for the 40% of the cases.The advanced age at diagnosis might explain the fairly low number of histological definitions.

Modality of the interview and classification of the exposure

The distribution for modality of interview puts in evidence (table 3) that more than 60% are submitted to proxies. The direct interviews are 30% of the totalsand this fact, in a sector notspecific for asbestos use of, does not help to reconstruct eventual past exposure

Table 3. Distribution for interview modality

INTERVIEWS		
	Freq.	**Percent**
NOT PERFORMED	3	3.45
TO THE SUBJECT	30	34.48
TO THE PARENTS	54	62.07
TOTAL	**87**	**100.00**

If the level of the exposure (table.4) is considered we can deduce that almost 60% of the cases don't have a definite exposure.

Table.4 Distribution for level of exposure

EXPOSURE LEVEL	FREQ	PERCENT
Occupational exposure	13	14.94
Probable exposure	4	4.60
Possible exposure	16	18.39
Improbable exposure	2	2.30
Unknown exposure	52	59.77
Total	**87**	**100.00**

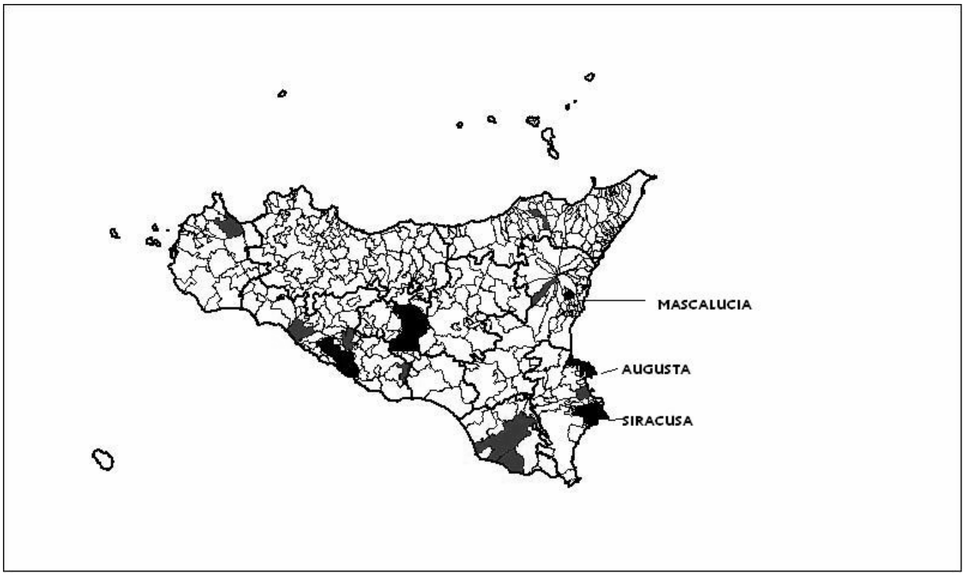
Sicily Mesothelioma Registry

The Mesothelioma Registry of Sicily (COR Sicily), collected information on the use of recycled jute bags in the agricultural sector and managed to single out a circuit of this sort of recycling with bags coming from the east Europe. In particular one trade company located in Catania declared this type of commercial circuit.

In Sicily numerous industries have produced asbestos cement for a long time and direct information obtained by ex workers has proven that the bags were sold or just given away for free to the workers . The industries were located in San Filippo del Mela, province of Messina (Nuova Sacelit), San Cataldo, province of Caltanissetta (3 companies) and Priolo, province of Siracusa (Eternit) .

The figure 1 shows the distribution of the cases of malignant mesothelioma in farmers (gray) and the location of the asbestos cement industries (black).

Figure 1 -Location of cases of malignant mesothelioma (gray), and the sites were asbestos was used (black).



Mesothelioma Registry of Tuscany

At the present the recorded cases in the tuscan archive as agriculturalist for at least one period of their working life in agriculture are 98. For 67 of them (68.4%) the exposure happened in other productive sectors. Of the remaining 31 (31.6%) 5 cases (16.1%) have been exposed (1 certain 4 possible) in agriculture while 26 (83.9%) are still classified as UAEand all these cases have worked for the whole their life in the agricultural sector.The males are 24 against 7 females. As far as the diagnosis is concerned 22 have histologicalcertificate, 4 have cytology and 5 only clinical diagnosis. The more important period of incidence goes from 1996 to 1999 with 9 cases (29%) while during the last few years a decrease in incidence is observed. The tuscan Mesothelioma Registry is proceeding to trace and to document the iter of the juta bags . In the area of Pistoia it is well documented a massive use of jute either in bags or just fabric by plant and flower nurseries. Some of the traced bags came from the province of Reggio Emilia (famous for the presence of several asbestos cement manufacturers .

Jute fabric, being biodegradable, has large use on the plant radical apparatus bondage during transplantation.

Mesothelioma registry of Brescia

The province of Brescia is an important agricultural area with remarkable cultivations of cereals.

During the period 1978-2005, 370 malignant mesothelioma cases were recorded in Registry of the province of Brescia. Information on occupational history was collected for 352 of these (95%). 24 cases (6.8%) had at least a working period (longer than 1 year) in agriculture. Exposure assessment according to the National Mesothelioma Registry Re.Na.M. 2003 Guidelines classifiedthese cases as UAE. . The cases with “unknown” exposure in agriculture represent the 22% of the cases included in this category. These agricultural workers were mainly labourers in farms of small dimensions or just self employed; 20 over 24 worked in the countryside. between the provinces of Brescia and Bergamo, where was active in the past (from 1930 until 1980) the most important Italian Manufacture of asbestos packings and ropes ; the crude mineral coming from from the mines of Balangero and Val Malenco was chrisotile and was transported in jute bags, the crocidolite came probably from South Africa transported in the same way.

In the Comune of Calcio (BG) operated the bag manufacture Vezzoli, it was specialized in recycling the jute bags then used for transporting food in grains (cereals, soya-bean, coffee, flours etc). The bags to recycle came from several Italian provinces including harbours and industrial areas like Balangero Asbestos Mine and Casale Monferrato where the biggest Eternit plant operated since 1983. The period of greater bag recycling is indicated around the sixties. Many cases of malignant mesotelioma have been taken place among the workers and the residents in proximity of such industries.

Just after the Second World War the Vezzoli family extended this activity in other small plants in the city of Calcio (BG) and province of Brescia. In the 1950 the Vezzoli Company opened a plant also in the city of Rovato (BS), employing approximately 20 women laborers. They were appointed to on jute bags fixingafter pulling the inside out, shaking them manually and repairing by sewing machine. Two cases of mesothelioma (pleural and and peritoneal) have been collected in this company, each one sewed approximately 60 bags per day. They reported not knowing whether the bags had previously contained asbestos or not, the only thing they remembered was visible residual of agricultural origin. At the end of the fifties `the Vezzoli family' opened a third plant in the Comune of Pontevico (BS), in proximity of "Amiantit" asbestos cement producer since 1962; the employer's wife and daughter, that had been working in the bag factory and living in the proximity of the small factory, both developed mesothelioma. The jute bags were sold to the farmers, at a low cost, directly from the factory. Another company recycling jute bags was opened in the commune of Provaglio (BS) in proximity of an industrial area where asbestos ropes and the packings where manufactured .

Mesotheliomas and pleural plaques have been developed within this cohort of workers. These workers had reported not to know whether in the bags there had been asbestos or not , the majority reported just agricultural products. In conclusion:

1) the presence of asbestos manufacturing plants has involved also the parallel activity of small factories specialized in jute bags recycling.

2) sufficient evidences that these bags had contained asbestos and that have been widely recycled in agriculture have been found. This happened after the second world war in coincidence with an important growth of asbestos consumption in some geographical areas. This second use of jute bags has represented a possible source of asbestos exposure for farmers not excluding other categories ;

Discussion

The collection of useful information outside the interviewing of the cases in particular on the possible recycling of jute bags in agriculture has made an important turn out on asbestos exposure assessment and it is important that the this methodology will continue also in other regional centres. Further deepening should localize the cases in agriculture in order to cross information on the localization of the asbestos industries, mainly asbestos cement. Meanwhile the reconstruction of the residential history (space/time) of the single cases might help. The mapping of the factories will have to include, beyond to the asbestos cement, also the industrial division of bags manufacturers. Other activities within the agricultural sector, like tractors maintenance and repairing, should be allocated in different sectors with different risk profile in order to avoid misclassification. During the interviews the answers to the questions about the use of bags are vague. The interviewed don't remember the meaning of the writing on the bags or just if the bags were recycled or not. In our opinion information should be collected on the type of harvest in order to understand the necessity of bags. At the same time information about the period appears to be fundamental: jute bags for transporting asbestos have been used just until the first half of the seventies. Information matching the presence of asbestos cement industries, period and type of harvest might be sufficient to classify mesothelioma cases in farmers and agricultural workers as “possibly exposed to asbestos”.

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ASBESTOSIS AND GSTM1 AND GSTT1 POLYMORPHISMS

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Introduction

It has become increasingly obvious that both environmental and genetic factors may influence the development of disease [1]. The interaction between genes and environment is defined as co-participation in the same causal mechanism leading to disease [2]. Primary candidates for gene-environment interactions studies have been mostly genes coding for enzymes that are involved in the metabolism of xenobiotics [1]. In populations variant forms of these genes exist, many of which may alter metabolism of xenobiotics and thus modify the individual susceptibility to the development of disease.

Many of these variant gene forms are relatively common, therefore interactions between metabolizing enzymes coded by these genes and environmental factors, such as asbestos, may have an important influence on the development of disease. According to the model of causation, different causes, that is events, conditions or characteristics, play a role in producing an occurrence of the disease [3]. In the case of asbestos-related diseases these causes could be: asbestos exposure, time of exposure, genetic factors and also unknown causes (Figure 1).

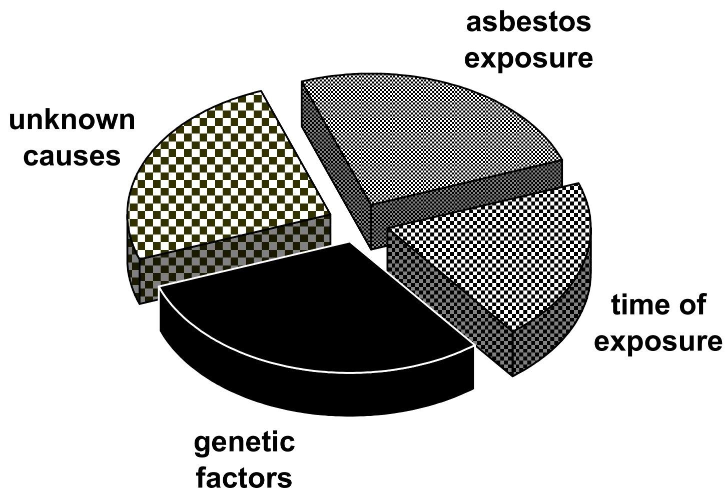

Figure 1 - Causal factors for the development of asbestosis

Asbestos is known to have certain toxic properties such as the ability to produce inflammation, fibrous scarring and cancer [4, 5] and is known to be associated with the development of asbestosis, pleural diseases such as pleural plaques, and several types of cancer [6, 7, 8, 9, 10, 11, 12, 13, 14, 15]. Asbestosis is among the most frequent diseases caused by asbestos. After a long latency period, this interstitial pulmonary process slowly develops into diffuse pulmonary fibrosis [16, 17]. The disease continues to progress even after the cessation of exposure and the process is irreversible.

Although asbestos-related diseases are among the most extensively studied occupational diseases, relatively little is known about the genetic factors that might modify an individual's susceptibility [16]. The results of the studies suggest that asbestos induces an inflammatory cascade by stimulating the production of reactive oxygen species (ROS), nitric oxide and cytokines [18, 19, 20].

Glutathione S-transferases (GST) are important enzymes involved in the detoxification process. They inactivate the electrophiles produced by ROS and nitric oxide [21, 22, 23] (Figure 2). GSTs participate in the direct inactivation of peroxidized lipids and DNA produced by ROS and nitric oxide and thus protect from oxidative stress [21, 22]. In mammalian species seven classes of cytosolic GST isoenzymes have been recognized [24, 25]. The genes coding for GSTs of different classes are polymorphic [13, 25, 26, 27, 28]. The GSTM1 and GSTT1 genes are known to exhibit null polymorphism (GSTM1 or GSTT1-null genotype) in individuals homozygous for deletion of these genes [25, 28]. In carriers of GSTM1 or GSTT1-null genotype both gene copies are lost and the particular detoxification enzyme cannot be produced [28].

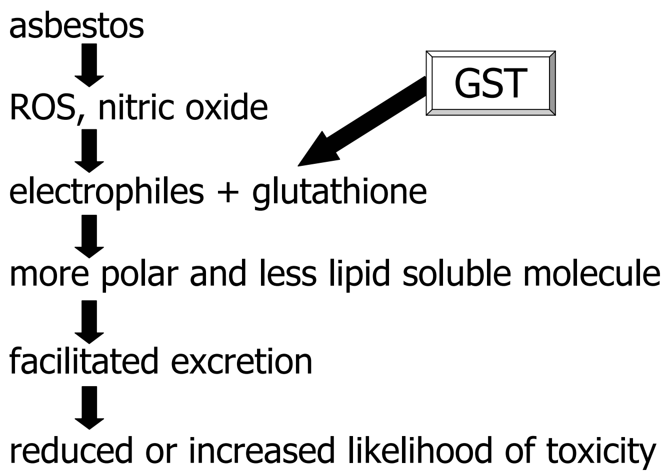

Figure 2 – Conjugation of asbestos toxic products by glutathione S-transferases (GST)

The aim of the present study is to investigate whether the genetic polymorphism of GSTM1 and GSTT1 represents a risk of developing asbestosis.

Methods

The study population comprised 262 cases with asbestosis and 265 subjects with no asbestos disease as controls. The study subjects were selected from the cohort of 2080 people exposed to asbestos who asked the Board for the Recognition of Occupational Asbestos Diseases to verify an occupational disease in the period from 1 January 1998 to 31 December 2003. All the subjects included in the study were employed in the asbestos cement manufacturing plant of Salonit Anhovo, Slovenia. Production in this factory began in 1921 and lasted till the end of 1996 when asbestos was banned by law in Slovenia [15].

Cumulative exposure for each subject was available from the previous study [15]. The duration of exposure was calculated for each subject and was defined as a month of actual exposure to asbestos. The periods when the subjects were in the workplace with no asbestos exposure, worked in other companies or were absent because of army training were considered and deducted from the sum.

The data on smoking were registered in all subjects using a standardized questionnaire at the interview [15].

The diagnosis of asbestosis was established by experts of the Board for the Recognition of Occupational Asbestos Diseases at the Clinical Institute of Occupational Medicine and was based on the Helsinki Criteria for diagnosis and attribution of asbestos diseases (1997) [29].

For the isolation of DNA and genotyping capillary blood samples from the finger tips of all subjects were collected on FTA Mini Cards (Whatmann Bioscience). FTA cards are designed for room temperature collection, shipment, archiving and purification of nucleic acids from a wide variety of biological samples for a PCR analysis. The deletions of GSTM1 and GSTT1 genes (GSTM1 and GSTT1-null genotypes) were identified using multiplex PCR. Both genes were simultaneously amplified in a single-step PCR reaction together with the beta-globin gene as the internal positive control [30].

Results

The average duration of exposure to asbestos was 267.62 months in the cases and 229.80 months in the controls and the mean cumulative exposure to asbestos was 37.67 fibres/cm^3-years in the workers with asbestosis and 11.23 fibres/cm^3-years in the controls. The duration of exposure ($t = 3.65$, $p = 0.001$) and the cumulative dose ($t = 4.78$, $p = 0.001$) were significantly higher in workers with asbestosis than in those without the disease.

GSTM1 null genotype was detected in 60.4 % of cases and in 60.6 % of controls ($\chi^2 = 0.003$, $p = 0.96$) and the GSTT1 null genotype was observed in 17.3 % of cases and in 25.4 % of controls ($\chi^2 = 5.08$, $p = 0.02$).

Conclusions

As expected the workers with asbestosis were exposed to higher levels of asbestos compared to those without asbestosis. The duration of exposure was also significantly longer in the subjects with asbestosis than in the controls.

No difference was found in GSTM1 null genotype frequency between the cases and controls. On the other hand the frequency of GSTT1 null genotype was significantly lower in workers with asbestosis compared to subjects who were occupationally exposed to asbestos but did not develop any of asbestos-related diseases.

The results of our study give some indication that the GSTT1 gene deletion and consequently the absent enzyme activity may be important for the development of asbestosis.

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IN VITRO ASSESSMENT OF FIBROUS MINERALS ON CELLULAR SYSTEMS

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In this study, we dealt with some mechanisms involved in the arising of lung disease and cancer induced by asbestiform fibrous minerals. Asbestos is the name given to a number of naturally occurring hydrated inorganic mineral silicates possessing a crystalline structure and known for their properties of high tensile strength and heat resistance. They are sub-grouped as serpentine (chrysotile) and amphibole (amosite, crocidolite, anthophyllite, tremolite and actinolite) based on their chemistry and morphology. The harmful effects of asbestos fibers have been known for a long time, both as regards serpentine and amphibole fibers, which cause pulmonary pathologies after occupational exposure for long or short periods including lung cancer, asbestosis, and mesothelioma. Extensive investigations have identified some but not all of the pathogenic mechanisms of asbestos diseases.

Over the last few years, the awareness of possible health hazards not related to professional exposure to asbestos, but related instead to the back ground of such fibers generated both by natural and anthropic events has been increasing. Cases of environmental pollution by mineral fibres not classified as asbestos are becoming more frequent, in Italy and in foreign countries, and natural and synthetic fibers are becoming a group of substances of potential toxicological and public health concern. According to the data "in vitro" and "in vivo", most natural fibers show only low levels of cytotoxicity. However, some of them are reported to show high levels of cytotoxicity. Thus, certain types of fibers originating from natural sources such as asbestos can cause a wide variety of respiratory diseases ranging from inflammation and fibrosis to highly malignant forms of cancers. Today, fibrous minerals are represented by approximately 500 mineral species and every year new species are discovered. The risk of developing breathable mineral-related lung diseases or cancer varies between fiber types, because the various physiochemical properties such as fiber dimensions, fiber structure, surface charge, ability to generate reactive oxygen species and biopersistance have been implicated in inducing diseases. Moreover, understanding how asbestos-like fibers interact with target cells of disease, i.e. epithelial, mesothelial, macrophage and fibroblastic cells, and how these events contribute to the pathogenesis of fiber-associated fibroproliferative and malignant diseases are critical to designing preventive and therapeutic approaches to lung and pleural disorders.

Recently, in an epidemiological study on mortality from malignant pleural neoplasms in Italy, it was found that some subjects who resided in Biancavilla, a town in eastern Sicily located in the Etna volcanic area, were diagnosed with malignant pleural mesothelioma [1]. The residents, for whom a diagnosis of pleural mesothelioma had been made, never had any relevant exposure to asbestos during their professional life. The results of an environmental survey, which was preliminarily conducted by the Istituto Superiore di Sanità and by Department of Earth Sciences of University of Rome "La Sapienza", suggested that a possible cause for fibrous mineral exposure of Biancavilla population was the stone quarries present in Monte Calvario [1,2]. It is located on the south-west side of the Etnean volcanic complex, south-east of Biancavilla (Catania). The materials extracted from the quarries are widely used in the local building industry and contain large quantities of fibrous amphibole. A detailed crystal-chemical investigation on the amphibole found in Biancavilla allowed to better define it as the new fibrous amphibole fluoro-edenite [ideal formula: $NaCa_2Mg_5(Si_7Al)O_{22}F_2$] [2]. This fibre has been found in a case of cytological examination of a woman, resident in Biancavilla, dead from malignant pleural mesothelioma, evidencing a tight correlation between the incidence of mesothelioma and the exposure to fibrous materials.

In the same time, in the veins of serpentinite rocks outcropping in the Western Alps (Piemonte, Italy), the asbestiform minerals, carlosturanite, balangeroite, antigorite, diopside, olivine, brugnatellite, brucite and the chrysotile, tremolite, and actinolite asbestos, were found by a research group of Turin and Alessandria, probably involved in lung disease risk or development [3]. Among these inhalable mineral fibres, the harmfulness of chrysotile is known, whereas nothing is recognized about fibrous antigorite, although it is very abundant in serpentinite rocks of the Western Alps. Antigorite is a silicate mineral very similar in chemical composition to chrysotile but fairly different in atomic arrangements.

Thus, our research group has started a study the aims of which are: i) to understand how asbestos-like fluoro-edenite and/or antigorite fibres interact with target cells of lung disease, ii) how these events contribute to the pathogenesis of fibre-associated fibroproliferative and malignant diseases, and iii) to evaluate the possible use of the some parameters as a biomarker of fibrous minerals exposure.

For this purpose, it was used normal human lung fibroblasts, human lung alveolar epithelial A549 and MeT-5A cell lines, and mouse monocyte-macrophage J774 cell line, frequently employed in the evaluation of the degree of cytotoxicity of various silica dusts. Following exposure of cells to fluoro-edenite fibers at the concentrations of 5, 50 and 100 micrograms/ml (corresponding to 1.06, 10.6, and 21.2 $\mu g/cm^2$) for 24, 48 and 72 h, several significant biofunctional parameters were examined.

Cell viability was evaluated by performing 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyl test (MTT) and cell cytotoxicty by measuring lactic dehydrogenase (LDH) release. MTT assay and LDH release analysis are useful tools to observe the influence of fluoro-edenite on cell viability and membrane integrity, respectively. Tetrazolium salts are metabolised by various mitochondrial dehydrogenase enzymes and reduced to a blue formazan by living cell only; whereas the presence of LDH release in the culture medium is a marker of membrane breakdown.

Many authors [4,5] reported that free radicals and other reactive oxygen species (ROS) play a pivotal role in the tissue damage mediated by asbestos fibres. Fibrous minerals, in fact, may be capable of inducing cellular response after inhalation showing production of reactive oxygen species (ROS) and reactive nitrogen species (RNS), that can alter biological macromolecules and cause genetic mutations. In this study, the possible induction of oxidative stress was examined both performing a fluorescent analysis of intracellular ROS production, and evaluating the amount of nitrite/nitrate ($NO^{\cdot}$, nitric oxide) in culture medium by colorimetric assay based on the Griess reaction and the expression of inducible nitric oxide synthase (iNOS) by Western blotting. In addition, in order to study the possible involvement of fluoro-edenite in DNA damage, we chose to perform Single Cell Gel Electrophoresis (Comet assay), which, within the last decade, has been used to investigate the level of DNA damage in terms of strand breaks and alkaline labile sites. The data obtained with fluoro-edenite were compared with those obtained with crocidolite that, due to its high toxicity, is one of the most studied asbestos amphiboles.

The results of MTT assay, LDH release and ROS production, with respect to untreated control cells, demonstrated a concentration- and time-dependent decrease in cell viability, and an increase in LDH release and ROS production. Concerning crocidolite, we observed a more drastic effects. In all experimental cultures $NO^{\cdot}$ synthesis and iNOS expression were increased after crocidolite fibers treatment. By contrast, the treatment with fluoro-edenite did not modify, in our experimental conditions, the level of $NO^{\cdot}$ determined both by Griess assay and immunocytochemistry method. NO and iNOS increase were observed in the J774 cells treated with 50 or 100 μg/ml of fluoro-edenite for 96 h. The results of Comet assay showed the same concentration and time dependent behaviour as ROS production: at high fluoro-edenite and crocidolite concentrations DNA damage was much dramatic.

Moreover, in this study, we investigated the response of A549 and MeT-5A cells after fluoro-edenite exposure, focusing on the synthesis of Vascular Endothelial Growth Factor (VEGF) and ß-catenin, two critical steps of epithelial cell activation pathways. Since blood vessels are critical for tumour survival, VEGF has an important role. Without new blood vessels, in fact, a carcinoma cannot grow beyond a very small size, nor can it metastasise to distant organs. The action of ß-catenin is another significant step in neoplastic transformation, since activation of the Wnt-ß-catenin pathway is a signalling cascade closely involved in the activation of transcription processes during cancer development. We determined also the expression of cyclooxygenase (COX)-2 by Western blot analysis and the level of prostaglandins (PG)E_2 by enzyme-linked immunosorbent assay (ELISA) in fluoro-edenite treated J774 monocyte-macrophage cell line. These parameters are critical participants in the development of inflammatory responses after infection or tissue injury and are up-regulated in several human tumours. Prostaglandin E_2 (PGE_2) is one of the most studied mediators of this process. A comparison between control and fluoro-edenite treated cells demonstrated that since at 24 hr, treated A549 cells displayed an increased number of cells expressing VEGF and ß-catenin and increased staining intensity of both markers both in the cytoplasm and in the peripheral membranous protrusions. Treated MeT-5A cells showed a stronger expression both of VEGF and ß-catenin in cytoplasm and plasma membrane compared to controls, whereas at 48 h they showed an increased number of cells expressing VEGF and ß-catenin and a stronger intensity in the expression of both molecules (greater for ß-catenin) only in the cytoplasmic compartment and at membrane junctional levels.

As expected, basal COX-2 and PGE_2 levels of untreated control cultures were low. On the contrary, fluoro-edenite has significantly demonstrated an increase in COX-2 and PGE_2 productions in a concentration- and time-dependent manner.

Our results show that fluoro-edenite, as well as crocidolite, may induce functional modifications and affect some biochemical parameters in lung fibroblasts in a concentration and time dependent manner, though these two fibres seem to be differently harmful. As a matter of fact, all the observed cell functional modifications induced by fluoro-edenite, in our experimental conditions, are generally less dramatic than those induced by crocidolite on a per weight basis. These results provide convincing evidence that fluoro-edenite fibers are capable to induce “in vitro” functional modifications of some parameters playing a essential role in the development and progression of cancer. According to our findings, we confirmed the hypothesis that inhaled fluoro-edenite fibers can induce mesothelioma.

This is a typical example of non-occupational exposure of an environmental nature caused by natural fluoro-edenite fibrous amphiboles.

To examine the behaviour of fibrous antigorite with chemical formula $(Mg_{11.05}Fe_{0.53}Al_{0.21})_{12.00}(Si_{7.98}Al_{0.02})_{8.00}O_{20}(OH)_{16}$, collected from serpentinite rock outcropping at Blue Lake near St. Jacques – Aosta (Italy), the study was performed using Met-5A, and J774 cells.

Antigorite determined an antiproliferative effect and an induction of LDH release and an increase in ROS and NO productions. Generation of $NO^{\bullet}$ was assessed by measuring the amount of NO_2^- in the culture medium of Met-5A and J774 cells exposed to fibrous antigorite. In Met-5A, the maximum value of PGE_2 reached at 100 μg/ml was about 11 times higher than the control; in J774 cells, the maximal PGE_2 production generated by 100 μg/ml antigorite treatment was about 2 times higher compared to control. Antigorite treated A549 cells at 24 and 48 hours resulted in up-regulation of metabolic processes leading to increased synthesis of VEGF, β-catenin and Cdc42. Cdc42, one of the Rho protein family members, regulates many functions related to cell shape, proliferation, movement, and cell death and is known to be involved in lung tumour progression [6], even if its contribution to cancer development is still incompletely clear. All the observed cell functional modifications induced by antigorite, in our experimental conditions, were generally less dramatic than those induced by crocidolite on a per weight basis.

In conclusion, it is possible to affirm that mineralogical characterization of rocks mined from specific deposits helps determine the presence, form, abundance, and morphology of potential toxicants, and can be used to develop predictive models of mineral deposit types where such components may be present. *In vitro* toxicity tests of well-characterized ore can help the understanding of toxicity effects of potential toxicants upon exposure present in rocks, soils, dusts, and water as a result of natural erosion and weathering of mineral deposits and host rocks.

Therefore, it is important to investigate *in vitro* in order to determine the degree of cell damage induced by the environmental exposure to single breathable inorganic fibers.

Our results have been helpful in revealing the properties of some asbestiform fibers important in toxicity, inflammation, and disease, and provided information on the reactivity in fibrous minerals-induced biological and pathological responses.

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MALIGNANT MESOTHELIOMA SURVEILLANCE IN ITALY: INCIDENCE AND ASBESTOS EXPOSURE BY ITALIAN REGISTER (RENAM).

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Occupational exposures to asbestos dust have been widespread in all industrialized countries and continue as a consequence of "in place" material. Cumulative world production of asbestos between 1900 and 2000 was about 173 million tons. In Western Europe, Scandinavia, North America and Australia the manufacture and use of asbestos products experienced its greatest expansion between 1950 and 1960 and peaked in the 1970s. Millions of worldwide workers for these reasons have been exposed to asbestos in the workplace most often during maintainance, repair and replacement of asbestos-containing materials. As a consequence of the strong cause-effect relationship and the long latency for the development of mesothelioma, it is estimated that about 10,000 new cases of mesothelioma are annually diagnosed in North America, in Western and Northern Europe, in Japan and in Australia. With these concerns about the health risks, it is important to set up a systematic collection and analysis of mesothelioma cases to be used for immediate primary prevention action, program planning and evaluation. Knowledge about national mesothelioma pattern, trends and asbestos exposures is a priority setting for cancer prevention. The prevention strategies for mesothelioma cases could be based on the identification of exposure sources.

Taking into account that the situation in Italy has become particularly alarming, the Italian National Mesothelioma Registry (ReNaM) was set up at the National Institute for Occupational Safety and Health (ISPESL) in accordance with Art. 36 of Italian Legislative Decree N. 277 passed in 1991.

The ReNaM's main objectives are: to estimate the incidence of malignant mesothelioma in Italy, to define and record exposures to asbestos, to assess the impact and diffusion of the pathology in the population, and to identify underestimated (or unknown) sources of environmental contamination with asbestos or other potential causes of mesothelioma. Regional Operating Centers (CORs) in 18

Italian regions have been set up to identify and to investigate on all cases of malignant mesothelioma diagnosed in each region, applying national guidelines. The ReNaM currently covers more than 90% of Italian population and accounts, in terms of mortality from malignant pleural mesothelioma, for about 95% of the national case-list.

Each COR directly collects cases in regional health care institutions that diagnose and treat mesothelioma. These include pathology and histology units, lung diseases and chest surgery wards. Hospital discharge records and death certificates are also examined to check if all available information has been collected. Guidelines are used to standardize the diagnostic criteria for mesothelioma, and cases are classified as definite, probable, possible and non-mesothelioma, depending on the level of diagnostic confidence achieved. Occupational history, lifestyle habits and areas of residence for each case are obtained by direct interview using a standard questionnaire, administered by a trained interviewer. When a subject is not available, next-of-kins who can provide information on the case's work and life history can be interviewed (indirect interview). To obtain information on occupational and/or residential exposure, each COR can also consult local health and public hygiene offices, and regional occupational prevention, hygiene and safety agencies. Exposure is then classified by an industrial hygienist, checking the available documents and applying his own knowledge of industrial conditions to establish whether the subject's work, private life or any particular environmental conditions could have involved exposure to asbestos.

Descriptive analyses and exposure modalities have been performed on the entire ReNaM caselist for the period of incidence 1993-2001: 5,173 cases of malignant mesothelioma (3,746 males and 1,427 females) have been diagnosed in 9 Italian regions in different periods between 1993 and 2001 (Table 1). Regional Operating Centers (CORs) have been established in the following regions: Piemonte, Valle d'Aosta, Lombardia, autonomous province of Trento, Veneto, Friuli-Venezia Giulia, Liguria, Emilia-Romagna, Toscana, Marche, Umbria, Abruzzo, Campania, Puglia, Basilicata, Calabria and Sicilia. Dataset transmission to the National Register from other recently established CORs has not been yet achieved. Cases of not- mesothelioma or benign mesothelioma have been excluded. Certain asbestos exposure has been diagnosed in 3945 cases (76,3%), probable in 777 (15%) and possible in 451 (8,7%). Males:females ratio is 2,6:1, but is strongly related to geographical patterns: in fact the female proportion, which is 27,6% at national level, ranges from 8% in Friuli-Venezia Giulia to 37% in Piemonte. Among anatomical sites, pleura is the most frequent (93%), followed by peritoneum (6,4%), pericardium (0,3%) and tunica vaginalis of the testis (0,3%). Peritoneal cases appear significantly higher among females (41,6%). The proportion of diagnosed cases aged less than 35 is extremely low (28 cases, that is 0,6% of total cases), while more than 50% have been diagnosed in a range of 55-74 years. Mean age at diagnosis is 67,4 years, with an increasing trend for the diagnostic certainty (65,5 years for "certain" cases, 72,7 for "probable" cases and 74,4 for "possible" cases) and anatomical sites (67,6 years for pleural site, 64,2 for the peritoneal, 61,6 for pericardium and 58,9 for the tunica vaginalis of the testis). Regarding the morphology 50,1% of cases were detected in the epithelioid, 12% in the fibrous and 7% in the bifasic pattern, with an homogeneous distribution among gender and no relevant differences by anatomical site.

Latency period of mesothelioma, defined as the time elapsing from the beginning of exposure to the causative agents and the manifestation of the disease, has been detected for 2544 cases, whose data about the first exposure to asbestos were available. Latency period is not significantly related to gender, exposure modalities and anatomical sites.

Standardized incidence rate of pleural mesothelioma (certain, probable and possible) in 2001 is 2,98 (in 100.000 inhabitants) for males and 0,98 for females, in the regional pool. Rates for the peritoneal site are 0,18 and 0,06 for males and females respectively (Table 2). These figures might be reduced by around 20% as only "certain" malignant mesothelioma cases are selected, and "possible" and "probable" cases are excluded (diagnostic ascertainment is coded according to ReNaM guidelines). In addition, a wide geographical variability is observed, especially regarding the pleural site: in fact incidence rates for males range from 1,05 in Puglia to 10,4 in Liguria [11]. Time-trend analysis over longer time-periods will be performed, given the present differences among geographical patterns. Exposure modalities have been defined for 3552 cases out of 5173 (68,7%) and for 1621 (31,3%) are on going (or cannot be identified).

History of exposure modalities is generally obtained by a direct interview to the subject or next-of-kin (in 46,8% and 45,6% of cases respectively). Exposure modalities have been identified for 68,7% of "definite" exposure cases: 67,4% had professional (certain, probable, possible), 4,3% domestic, 4,2% environmental, 1,3% extra-working exposure. The proportion of female cases with professional exposure (compared with definite cases) decreases to 30,1%. Unlikely or unknown exposure is detected for 22,8% of cases.

According to recent issues [12] unknown or unlikely exposures occur in 22,8% of cases, so that an exposure is ascertained for 77,2% of all cases. However, this figure might be reduced as the documentation of past patterns of asbestos exposure in non-asbestos industries increases, as recently occurred with the use of friction materials in the textile industry.

Epidemiological surveillance of mesothelioma with reliable modalities of data collecting (active cases detection and analysis of exposure modalities with an individual questionnaire) in Italy provide an advanced system, also in the comparison with similar current or experimental procedures in other industrialized countries. However there are some limitations, mainly due to the incomplete territorial covering, the dishomogeneous data detection and coding, the less interest to extra-pleural mesotheliomas, and the relevant quota of cases for which exposure modalities are not identifiable by the Register, because of objective conditions or lack of devices and resources.

In spite of that, the active detection of the mesothelioma incident cases is a relevant tool in public health and prevention of asbestos-related diseases. A limited risk has been found for employers in mineral processing sectors, while an higher risk is observed in sectors with a secondary use of asbestos, as in the building and construction industries, metallurgic and steel, shipbuilding and railway stock. However the whole pattern of exposures is extremely wide and professional exposures are present in many other sectors, mainly because of asbestos used for cohibentation in the workplaces (sugar refineries, chemical and vitreous industry, petroleum extraction and refining, electrical power production).

Table 1. Italian Mesothelioma Register (ReNaM). Number of collected malignant mesothelioma cases by gender, site, diagnosis, asbestos exposure modalities, morphology, year of incidence.

		Uomini	Donne
Anatomical sites	Pleura	3,527	1,283
	Peritoneum	195	139
	Pericardium	10	5
	Testis	14	-
Year at diagnosis	≤ 54 years	481	174
	55-64	993	315
	65-74	1,308	473
	≥ 75	964	465
Diagnosis certainty level*	MM histologically confirmed	2,904	1.041
	MM suspected	842	386
Asbestos exposure modalities*	Professional	2,139	255
	Household	24	128
	Environmental	73	77
	Hobbies related	29	18
	On going (or unknown)	1,407	882
Morphology	Epithelioid	1,686	668
	Bifasic	418	139
	Fibrous	260	79
	Undefinied	1,382	541
Incidence period	1993-1997	1,379	527
	1998-2001	2,367	900
Overall		3,746	1,427

* Diagnosis and asbestos exposure classification and coding criteria are described in : Nesti M, Adamoli S, Ammirabile F, et al (eds). "Linee guida per la rilevazione e la definizione dei casi di mesotelioma maligno e la trasmissione delle informazioni all'ISPESL da parte dei Centri Operativi Regionali". Monografia ISPESL, Roma 2003.
Available at website: http://www.ispesl.it/ispesl/sitorenam/index.asp.

Tabella 2. Malignant mesothelioma standardized incidence rates (x 100.000 inhabitants) by gender, anatomical sites. Italian mesothelioma register (ReNaM), year of incidence 2001.

Anatomical sites	Gender	Standardized incidence rates (*100,000)
Pleura	Men	2.98
	Women	0.98
Peritoneum	Men	0.18
	Women	0.06
Pericardium	Men	0.01
	Women	-
Testis	Men	0.01

TREMOLITE: ENVIRONMENTAL EXPOSURE IN BASILICATA REGION

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Introduction: In the Mesothelioma Register (ReNaM) of the Basilicata region, 12 cases of malignant mesothelioma (MM) were registered among the residents in the Lagonegro area (ASL 3) in the years 1989-2005. In the 1999 Regional Asbestos Plan 7 towns with presence of "green stones" are listed in this area. MM cases occurring among residents in this area were investigated for the possible etiologic role of outcropping green rocks with the certain presence of asbestos minerals: tremolite. (1)

[1] R. Pasetto et al, Mesotelioma Pleurico ed esposizione ambientale a fibre minerali: il caso di un'area rurale in Basilicata, Ann Ist Super Sanità, 40,2, 251/265, 2004

Materials and Methods: In accordance with Renam procedures (2), for all detected cases the clinical and exposure history was investigated.

[2] M.Nesti et al, Linee Guida per la rilevazione e la definizione dei casi di mesotelioma e la trasmissione delle informazioni all'Ispesl da parte dei Centri Operativi Regionali, 2,ed, Roma, Ispesl, 2003

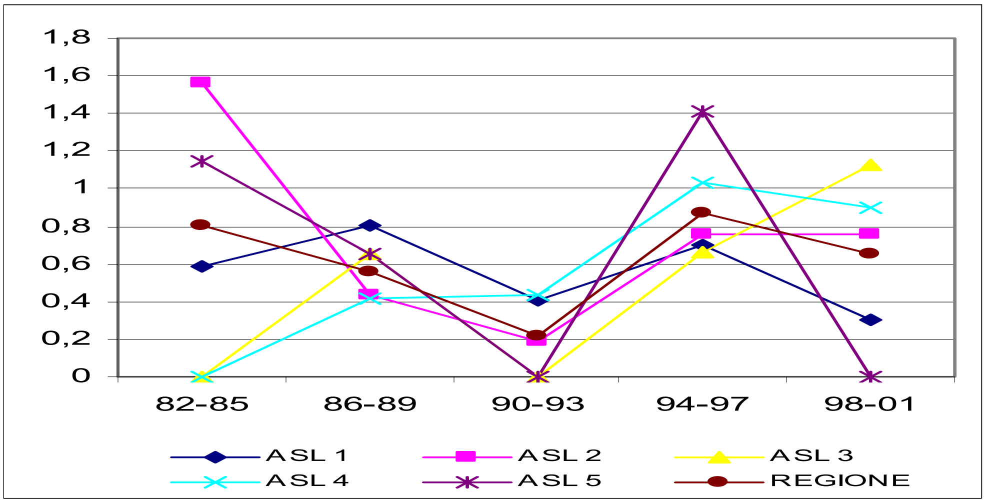
Results: The ASL3 crude mortality rate, reported in Basilicata Mortality Atlas (1982-2001), ICD 163-163.9 was 1.28 x 100.000, the same rate calculated for the seven towns of the ASL3, where was registered these 12 cases, is 3.12 x 100.000 (1989/2004). Among 12 cases, 2 females and 10 males: 5 cases were resident in towns with the presence of green stones: 4 men have an exposure classified as possible employment and all of them also did farming (woodcutting, breeding), the woman's exposure was classified as environmental, she lived in an area where outcropping tremolite was detected but she also did farming and breeding. Interestingly, for 3 of these subjects the search for tremolite fibers in the lung was positive, at post mortem examination or in biopsy samples. As to the exposure of the other 7 cases not resident in towns with the presence of green stones: 3 cases have an exposure classified as probable employment (building, railroads, sugar refinery), 4 an exposure classified as possible employment (1 tyre repairer and 3 farmers).

Discussion: The presence of 4 cases of MM in subjects resident in towns with the presence of green stones emphasized the etiologic role of tremolite contained in the outcropping green rocks of the area, geologically characterized as argilloscisti. This underlines the role of the mesothelioma register as a system of epidemiological surveillance and an instrument for promoting public health and scientific research. The ReNaM COR Basilicata activities have introduced the requirement to adopt the earliest protective measures for public health: plan of health-epidemiological surveillance of exposed population, counselling programs to help quit smoking, evaluation of fibers exposure of residents. (3)

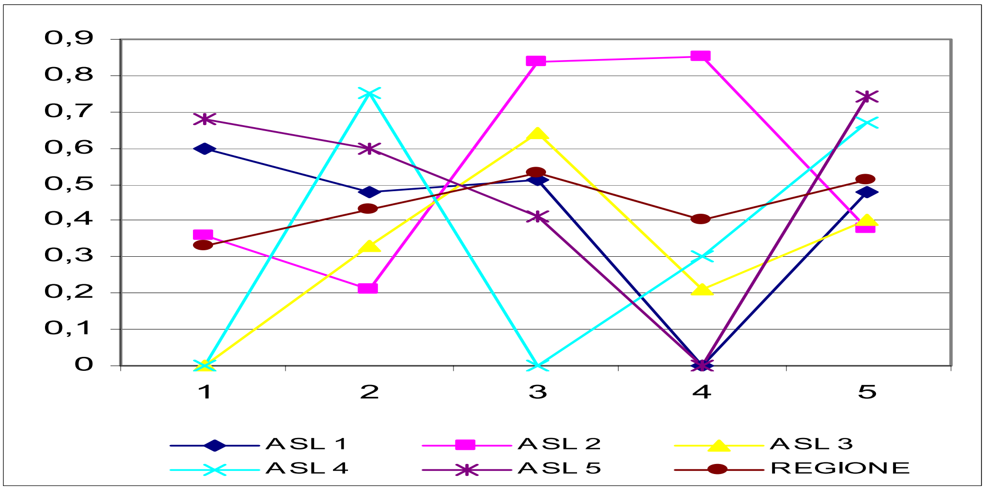
[3] M. Musti et al, Consensus Conference Sorveglianza Sanitaria delle popolazioni esposte a fibre di tremolite nel territorio della Asl 3 Lagonegro (Pz), Roma 22/23 febbraio 2005, Ann Ist Super Sanità, 2006, in press

ASL MORTALITY 1982-2001 STANDARDISED RATES (x 100.000 INHABITANTS)

MESOTHELIOMA (ICD 163-163.9) MEN



MESOTHELIOMA (ICD 163-163.9) WOMEN



MALIGNANT MESOTHELIOMA IN LEGHORN, ITALY

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The Province of Leghorn, Central Italy, is located along the coast of the Ligurian Sea. It covers an area of 1,213 sq km, with a population of 336,759 inhabitants. Studies on mortality from pleural cancer in Italy showed that in the period 1988-1997, the Province of Leghorn had the highest mortality rates among men in Central Italy[1]. Mesothelioma in Leghorn and surrounding area has been the object of previous investigations[2]. In the present study, a series of malignant mesotheliomas, diagnosed in Leghorn municipality, were reviewed, in order to characterize the sources and the features of asbestos exposure, occurred in these cases.

Leghorn (about 155,000 inhabitants), the capital of the Province, is one of the principal sea-ports in Italy. Leghorn is also the site of important industries, including shipbuilding, metallurgical plants, steel works, chemical manufacturers.

Methods

Mesothelioma registration started in Leghorn in 1980. Very few cases were notified in the early period of activity. Sufficiently complete data are available since 1988. Mesothelioma registration in Leghorn has been conducted following the rules of the Italian National Mesothelioma Registry[3].

We reviewed a series of 149 cases, registered in Leghorn in the period Jan 1988-June 2006. The diagnosis of mesothelioma was based on clinical, radiological, and cytological findings in 38 cases, and on histological examination in 111 cases. Occupational data were obtained from the patients themselves or from their relatives, by personal or telephone interviews.

Results

Pleura was the primary site of the tumor in 141 cases, and peritoneum in 8. Twenty-six cases were registered in the period 1988-1993, 54 cases in the period 1994-1999, and 61 cases in the period 2000-2005. The series included 130 men and 19 women, aged between 46 and 89 years (mean 68 years, median 68). The sex and age distribution of the cases are reported in Table 1. Sufficient occupational data were available in 128 cases (Table 2). Of the persons classified under the term maritime trades, three had been employed as engineer in merchant marine, two had served in the Italian Navy (one officer, one engine department officer), and one had served as marine engineer in Financial Police. The cases classified as “other” included maintenance workers (5 cases), tailors (3 cases), car repair workers (2 cases), telephone cables workers (2 cases), a baker, a fireman, a joiner, a printer, a talc manufacture worker, a warehouse man, a welder. In the remaining 21 cases occupational histories were insufficient or negative.

Table 1 - Sex and age distribution in 149 malignant mesotheliomas, Leghorn, Jan 1988-June 2006								
Age groups (years)	Pleura				Peritoneum			
	Men		Women		Men		Women	
	No.	%	No.	%	No.	%	No.	%
45-49	3	2.01	-	-	-	-	-	-
50-54	11	7.38	-	-	1	0.67	-	-
55-59	13	8.72	2	1.34	-	-	-	-
60-64	19	12.75	4	2.68	4	2.68	-	-
65-69	25	16.79	4	2.68	-	-	-	-
70-74	22	14.77	1	0.67	2	1.34	-	-
75-79	23	15.45	5	3.36	1	0.67	-	-
80-84	5	3.36	2	1.34	-	-	-	-
85-89	1	0.67	1	0.67	-	-	-	-

Table 2 – Occupational data in 128 cases of malignant mesothelioma, Leghorn, Jan 1988-June 2006								
Category	Pleura				Peritoneum			
	Men		Women		Men		Women	
	No.	%	No.	%	No.	%	No.	%
Ship construction	26	20.31	-	-	3	2.35	-	-
Ship repairs	15	11.72	-	-	-	-	-	-
Port work	10	7.81	-	-	-	-	-	-
Maritime trades	6	4.69	-	-	-	-	-	-
Cement asbestos	6	4.69	1	0.78	2	1.56	-	-
Metal industry	8	6.25	-	-	1	0.78	-	-
Chemical industry	8	6.25	-	-	-	-	-	-
Glassworks	8	6.25	-	-	-	-	-	-
Construction	6	4.69	-	-	-	-	-	-
Railway	4	3.12	-	-	-	-	-	-
Domestic	-	-	5	3.90	-	-	-	-
Other	14	10.94	3	2.35	2	1.56	-	-

A majority of the patients had their first exposure to asbestos after 1950 (Figure 1). The duration of exposure ranged from some months to over 40 years (Figure 2). The latency periods, defined as time intervals elapsed between first exposure to asbestos and diagnosis of the tumor, ranged from 22 to 64 years (mean 42 years, median 41) (Figure 3).

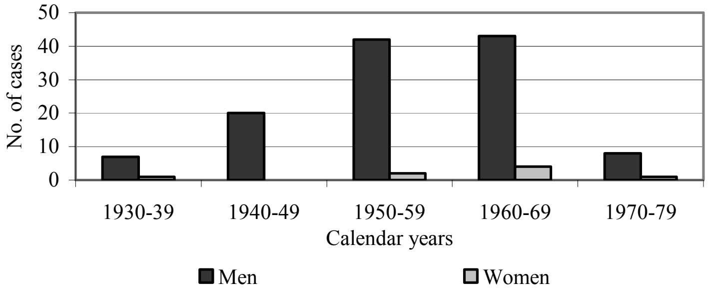

Figure 1 - First exposure to asbestos in 128 cases of malignant mesothelioma, Leghorn, Jan 1988-June 2006

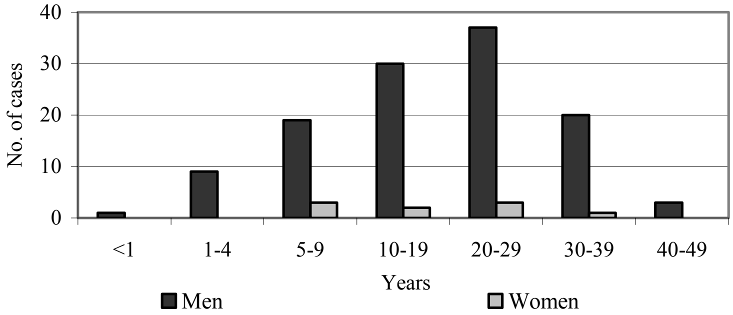

Figure 2 - Duration of exposure to asbestos in 128 cases of malignant mesothelioma, Leghorn, Jan 1988-June 2006

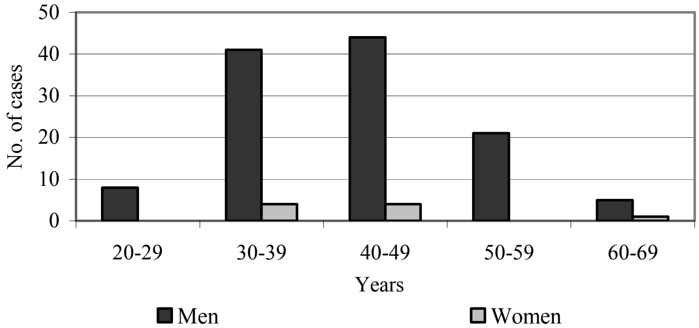

Figure 3 - Latency periods in 128 cases of malignant mesothelioma, Leghorn, Jan 1988-June 2006

Discussion

The present data show that malignant mesothelioma in Leghorn is a condition, mostly affecting men aged between 60 and 80 years. The number of registered cases has increased from the period 1988-1993 to the following years. It remains uncertain if such an increase reflects a real rise in incidence, or a higher attention for this cancer, as well as better diagnostic procedures.

The association between mesothelioma and ship construction and repair represents one of the most typical facts in mesothelioma epidemiology[4]. In the present series, one third of men had been employed in this branch. This is not an unexpected finding, since the Leghorn shipyards have a long history dating back to 19th century. Port work was another occupation at high risk in the past, when asbestos was transported by paper or jute sacks[5]. The sacks often broke, resulting in severe pollution. The relevance of asbestos exposure among seafarers has for long time neglected[6]. The amounts of asbestos used in the ship construction were so high, that it was difficult to find an area on the ship, in which asbestos was not present[7]. Continuous vibrations on the ship may cause significant fibre release. Obviously, if the sailor is engaged in inspection, maintenance, repair work of structures containing asbestos, the risk is substantially higher. Of the six seafarers observed in the present series, five had been employed in the engine room.

Apart from naval activities, various workplaces were the source of exposure to asbestos in Leghorn series. Among the non-naval occupations, some deserve particular attention. Despite numerous studies on asbestos exposure and asbestos-related mesothelioma, many risks remain unrecognized or underestimated. The Leghorn series includes, for instance, two telephone workers. Sometimes, this occupation is not recognized as a work at risk for asbestos disease. However, some telephone technicians appear in the Australian Mesothelioma Register[8] and single cases were reported in other series[3]. The use of talc in preparing telephone cables is the plausible source of exposure in this branch.

In the Leghorn series, over 90% of the patients had been exposed for five years or more, and 75% for ten years or more. The relevance of exposure duration in the genesis of asbestos-related mesothelioma has generally been neglected. Some recent studies clearly showed that the risk for mesothelioma among asbestos exposed people increases with the duration of exposure[9-11].

A point to emphasize is also the length of the latency periods. Although the figures of 20-40 years are frequently reported in the literature, nearly 60% of mesotheliomas in the present series showed latency periods of 40 years or more.

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PREDICTED INCIDENCE OF MESOTHELIOMA IN SLOVENIA

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Background

In Slovenia, the use of asbestos was banned by law in 1996. At that time the Ministry of Health set itself the task to draw up national guidelines for asbestos. As a basis for the guidelines, the Ministry sponsored a study, which was to provide answers to the following questions:

- How much asbestos was imported into Slovenia over the past 35 years?
- How many workers were either directly or potentially exposed to asbestos during that period?
- How many asbestos products were manufactured and used in the country, how many were exported and how many are still in use at present?
- How many workers developed occupational asbestos disease? [1].

The Ministry of Health also established the Board for the Recognition of Occupational Asbestos Diseases. The Board operates at the Clinical Institute of Occupational Medicine in Ljubljana. It consists of two teams. Each team includes an occupational physician, pulmologist and radiologist. The criteria for the recognition of asbestos-related diseases have been based on the Helsinki Criteria for diagnosis and attribution of asbestos diseases (1997) and on the proposal of the American Thoracic Society [2, 3].

The following occupational diseases have been recognized in Slovenia: asbestosis, pleural diseases: pleural plaques, pleural effusion and diffuse pleural thickening, lung cancer and malignant mesothelioma of the pleura and peritoneum [4].

In the period from 1 January 1998 to 31 December 2003 the Board recognized 1426 cases of pleural disease, 398 cases of asbestosis, 25 cases of lung cancer and 25 cases of mesothelioma.

The aim of this study was to:

- locate all mesothelioma cases diagnosed from 1964 to 2002 in relation to their permanent address;
- compare the locations of mesothelioma cases diagnosed from 1964 to 1994 with - mesothelioma cases diagnosed from 1995 to 2002 and following the incidence curve from 1964 to 2002
- predict the incidence of mesothelioma in the next 15–20 years.

Methodology

The authors used the following data from the previous study:

- the numbers and addresses of directly and potentially exposed workers,
- the information about total asbestos consumption,
- the mesothelioma cohort from 1964 to 1994,
- the location of industrial and municipal dumping sites and
- the location of plants which used asbestos in the past.

For this study we obtained the data about:

- names and addresses of new mesothelioma cases (from1995 to 2002) from the Cancer Register,
- the improved GIS program showing the locations of streets and buildings and
- aerial photographs of cities/villages where mesotelioma cases were located.

The regression analysis was used and several models were constructed to find the best model to predict the future trend of mesothelioma.

Results

In the past about 1500 workers were directly exposed to asbestos and 22,500 workers were potentially exposed to asbestos in Slovenia. These were the workers from about 30 companies from electronics and electrical industry, ship-building, construction, manufacture of household appliances, oil refinery, car workshops where brakes and clutches were repaired, etc.

The information about total asbestos consumption showed that approximately 700,000 tons of asbestos were used from 1947 to 1997. The separate data on chrysotile and amphiboles were available only for the asbestos cement manufacturing plant Salonit Anhovo, which imported most of the above quantity, i.e. about 600,000 tons, including more than 70,000 tons of amphiboles. It is evident from the total quantity of asbestos imported into Slovenia that about 85 % of all asbestos was used in this factory. The information about asbestos consumption from this industry showed that the consumption increased from 1946 when only 28 tons of chrysotile asbestos were imported to 1987 when 4151 tons of chrysotile were imported. After this year, the quantity of imported asbestos was rapidly declining until 1997 when only 1688 tons of asbestos were used. Slovenian factories manufactured a variety of asbestos products: corrugated sheets, sheets for gaskets, asbestos millboard, pipes, plasters, pastes, glues, etc. Asbestos was used as a construction and insulation material, asbestos textiles, engine gaskets, industrial gaskets, filters and insulation tapes; it was built into rail cars, boilers and brake linings, etc.

SMR of the cohort of 22,500 workers was calculated. For all cancers and/or cancer of gastrointestinal tract and lung cancer the risk of dying was close to 1 showing the influence of a healthy worker effect. When SMR for lung cancer was limited to the age group of 35 to 49 years, the risk of dying for lung cancer was twofold higher if compared with the general Slovenian population at the same age [1].

The incidence of mesothelioma cases was presented by geographical regions. The data on the mesothelioma incidence were obtained from the Cancer Register which first provided the data for mesothelioma cases for the period from 1964 to 1994 and later for the period from 1995 to 2002. According to these data a total of 365 cases were found, mostly in the direct vicinity of the sources of asbestos pollution. More than 90 % of all cases lived in the diameter of 2 km from the asbestos companies.

By using the geographical information system (GIS), it was possible to locate each case on the map of Slovenia, the map of a city/village and in a building/street (Figures 1 and 2). The picture showed the same location of clusters as were already presented from the first mesothelioma cohort (1994–1996). There were 4 clusters: the expected one in the vicinity of cement-asbestos factory, around shipyard, in the capital Ljubljana where several smaller asbestos industries were located, and in the second biggest industrial town Maribor, where mostly the train and car industries were located.

The mesothelioma cases were further located in streets and buildings inside the clusters showing some interesting patterns: there are some micro-locations (streets or buildings) where a group of mesothelioma cases appeared (Figure 2). These patterns need more research.

A comparison of two mesothelioma cohorts (1964 to 1994 and 1995 to 2002) showed an exponential threefold increase after 1994. Several regression equations were used to calculate the trend of mesotheliomas in the next years. The one where the fit was the best and the standard error the smallest was: $y = 1.5536x^2 - 0.45x + 0.02$ ($R^2 = 0.96$) showing the exponential shape (Figure 3).

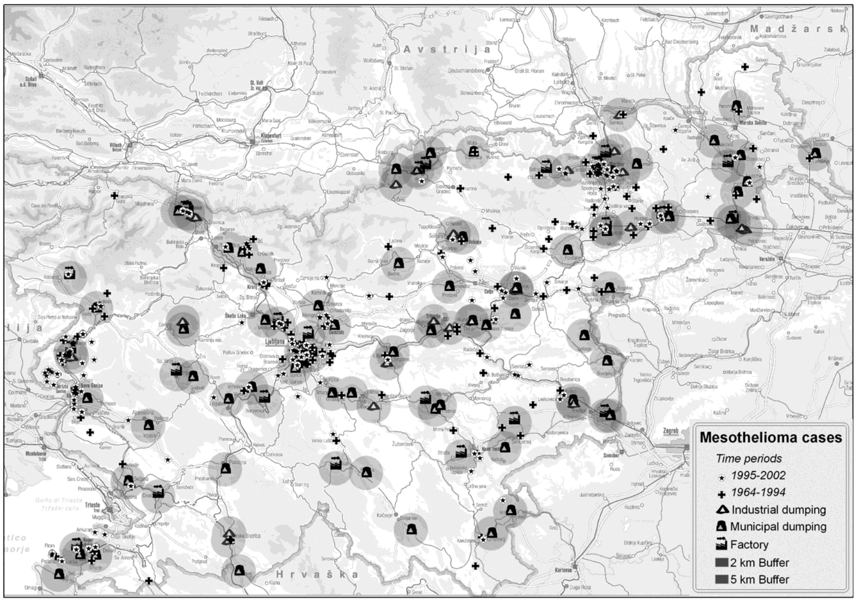

Figure 1 - Mesothelioma and sources of asbestos exposure: factories, industrial dumping and municipal dumping located within a distance of 2 to 5 km. Each star and cross represents one case of mesothelioma

Figure 2 - Cluster of mesothelioma cases in Anhovo. Each dot and star represents one case of mesothelioma

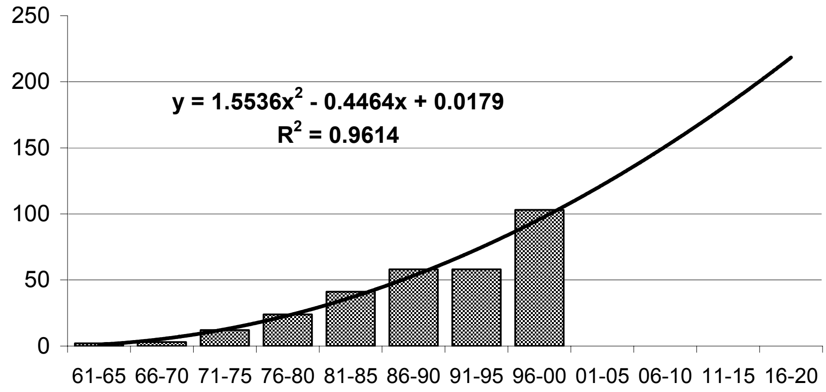

Figure 3 - Predicted trend of mesothelioma in Slovenia, 1964–2020

Conclusion

The number of mesothelioma cases in Slovenia has been increasing since 1964, first linearly, and after 1994, exponentially. Considering the long latency period, the fact that the consumption of asbestos in Slovenia reached its peak in the mid-1980s and that asbestos was banned by law in 1996, the increase in new cases of mesothelioma is not expected to stabilize before the period between 2020 and 2025. When bearing in mind that:

- some asbestos-containing materials are permanently installed in buildings,
- most asbestos products have a lifetime of 1 to 45 years, which means that most of these products are still in use at present, although their lifetime is running out and
- that approximately the same quantities of asbestos will soon land on refuse dumps

it is possible that the peak of the mesothelioma incidence could be postponed after 2025.

The geographical presentation of the mesothelioma clearly shows four larger clusters in Slovenia, looking at the micro-region (streets) we also found some micro clusters. For some of them we have found a possible explanation, for some further investigation is needed. In the region around cement-asbestos factory, two micro clusters were found, one in a small street and group of buildings in nearby village Deskle, another in Nova Gorica. The plausible explanation is that the factory built these buildings for its workers. They lived there and the number of occupationally exposed workers was the largest there. The same explanation also holds true for a group of buildings in Nova Gorica. A micro-cluster was also found in Ljubljana along one street: we do not have any possible explanation for this yet.

The results are important enough to rethink the quality of cleaning the environment polluted by asbestos and to intensively research the causes of yet unexplained micro-clusters. In future research also the cohort of directly exposed and potentially exposed workers will be followed.

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CRITICAL ELEMENTS IN THE DIAGNOSIS OF DISEASES CAUSED BY ASBESTOS

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Asbestos has been used, and in some countries is still being used, to manufacture a wide range of Asbestos Containing Materials (ACM), thanks to its unique chemical and physical properties. The ubiquitous use of ACM has created a problem due to the enormous quantity of contaminated waste created by the disposal of end-of-life ACMs. Collaborative efforts are being made to eliminate the risks caused by the widespread use of asbestos.

Asbestos-related diseases are a living matter, especially with reference to asbestos environmental exposure. In asbestos-related disease lawsuits and in epidemiological studies, special attention must be assigned to pathologist’s report (available to the patients too).

The pathologist should declare his opinion with “reasonable medical certainty” acquired from the available data of the subject and subsequent comparison with the literature knowledge.

Several information must be put together for an accurate diagnosis in asbestos-related disease:

- pertinent and appropriate clinical and radiographic data;
- histological diagnoses;
- quantitative data on ferruginous bodies (FB) and asbestos fibres detected in lung tissue or other biological materials;
- micro-analytic studies and their interpretation;
- evidence of clinical, smoking history and other social habits that may be relevant;
- possible occupational and environmental exposure:
  - information on first exposure to asbestos
  - type of exposure: occupational or para-occupational
  - type of asbestos involved in the exposure (chrysotile, crocidolite, amosite)
  - duration of exposure in year
  - intensity of the exposure in hours/day or hours/week
  - latency period (the time that has elapsed since first exposure)
  - level of exposure (for example a worker is potentially exposed when the concentration of asbestos fibres, measured in relation to a reference period of 8 hours/day and 40 hours/week, is 0.25 ff/cm^3 or greater, or when the accumulate dose measured or calculated over a continuous period of 3 months is 15 ff/days/ cm^3 or more)
- mineralogist and industrial hygienist opinion;
- prove or disprove a causal relationship between the significant pathology and impairment or death.

In this work we will discuss 6 cases of probably asbestos-diseases with the intention to show the difficult diagnoses in Asbestos Small Airway disease, Asbestosis, Mesotelioma and Lung Cancer due to Occupational/Environmental Asbestos Exposure (in human and animals). Our goal was to provide an advanced level of diagnostic information covering a broad range of cito-histological material (clinical, surgery or autoptical) see in general practices by pathologists and mineralogists:

1) Male of 65 years old with probable asbestos occupational exposure. He was operated to larynx cancer and died for tumor of the chest wall. Autopsy showed infiltration of the chest wall and lung by undifferentiated tumor (mesothelioma? carcinoma?). Some morphological aspects were similar in the chest wall neoplasia and larynx cancer.
   Is it possible an association with asbestos exposure?
2) Male of 35 years old with probable anthropic asbestos exposure and no occupational asbestos exposure known. He died for malignant mesothelioma of the pleura with infiltration of controlateral lung, diaphragm muscle, adrenal gland, kidney and lymph nodes.
   This malignant mesothelioma can be imputed to asbestos?
3) Male of 74 years old, smoker with occupational asbestos exposure for 1 year (Eternit). He was operated to upper lobotomy for anaplastic large cell cancer.
   Is it possible to define an association between lung cancer and asbestos?
4) Male of 67 years old with real occupational asbestos exposure (Eternit). There was a chronic lower lung infiltrates on chest radiograph and a bilateral, diffuse areas of ground glass attenuation on high-resolution CT scan.
   There are some analyses, without open lung biopsy, capable to define this disease an asbestosis?
5) Lion with pleural mesotelioma due to probably environmental asbestos exposure: it lived in a Safari Park with an asbestos cement shelter.
   There is an association? This is very important to determine an eventual risk for the human population worked in the same place.
6) Cat with respiratory distress syndrome: it lived near a plant of serpentinitic rocks crushing.
   There is an association? This is an example of a study about the assessment of the possible environmental risk of the human population that live around this area.

The presence of ferruginous bodies and asbestos fibres in the lung or other biological materials (e.g. BAL, broncoscopy etc) can confirm the possible occupational asbestos-related etiology where there is the slight suspect of occupational exposure in patients who have been operated for lung cancer, mesothelioma or other cancer or affected by interstitial fibrosis.

These analyses are performed on histological sections and/or digested materials, using optical and electron microscopy, complementary investigations.

These investigations are possible also on animals (System Sentinel Animals) and are useful to identify a geographic areas with probably environmental asbestos exposure.

A good interpretation of these data is very important to identify the real asbestos disease.

For this reason we would proposed a diagnostic approach for asbestos-related disease in humans and animals based on synergic pathologists and mineralogists working process.

THE ANALYSIS OF MESOTHELIOMA CASES WITHOUT ASBESTOS OCCUPATIONAL EXPOSURE AS A PRELIMINARY CONTRIBUTION FOR THE RISK ASSESSMENT WITHIN THE GENERAL POPULATION IN TUSCANY

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Introduction

The recording of malignant mesothelioma in Tuscany is active since 1988 conducted by the Regional Reference Centre (COR), part of the National Registry of Malignant Mesotheliomas (RENAM). To date (2005) this registry has collected 892 cases of mesothelioma in tuscan residents, of which 687 with histological diagnosis. The procedures of collection, recording and exposure assessment of the cases are those codified in the National Guidelines published in the 2003 by ISPESL, that manages and coordinates the activities of the RENAM[1]. To every case for which sufficient information is available on the exposure history, a type of exposure to asbestos, either in occupational environment or not, is assigned. The data of the archive allow to characterize the situations at risk that after many years cause the development of the disease. Indirect information derives also from the analysis of the cases classified as "unknown asbestos exposure" (UAE). This work aims to give a contribution to the understanding of the asbestos risk for the general population not professionally exposed supplying a preliminary crude estimate of the phenomenon in Tuscany Region.

Methods and materials

The cases with histological diagnosis recorded in the period 1988 - 2005 are 892, mostly males (78.8%). In the Tuscan Registry exposure to asbestos at different certainty degrees is assigned to approximately three cases of mesothelioma over four[2]. It is important to emphasize that the exposures (612 cases) mostly happened in occupational settings (584 cases, 95.4%) and most of the cases began to work from 1950 to 1965 (Figure 1). The remaining 4.6% are subdivided among "familiar" (17 cases, 2.8%), "environmental" (5 cases, 0.8%) "extraprofessional" (6 cases, 1%). When the information collected during the interview is not sufficient, the cases are recorded as UAE. A recent study on these cases, probing their work histories, has allowed the reclassification of 1 case over 4. It has been proved in this way that beyond the interview, the gathering of information about the industrial division can turn out very important for the past exposures reconstruction. It is well known moreover, that top quality information is obtained during "direct" interviews, thus when questions are asked directly to the cases. In this analysis we took into account the diagnostic level, thus including only the cases with histological certificate, and the type of interview. An extraction of the cases with exclusion of exposure above the background level, based on reliable information, has been performed. To these subjects, assuming asbestos as the sole etiological agent for mesothelioma, a generic environmental exposure, although at very low levels, could be assigned. In order to improve this classification further geographical information should be collected; to date the entire residential history of the cases is available and reliable only for few cases. The crude incidence rate for the entire region, considering the years of observation and the consistency of the Tuscany population, has been estimated.

Results

Among the cases, better defined from a diagnostic point of view (histological), 73.5% presents an exposure to asbestos, at various levels of certainty (Table 1). Most of them (95.2%) had occupational exposure during working activities performed in companies well recorded in the archive. To date “familiar”, “environmental” and “extra professional” exposures are assigned to 24 cases (4.8%). The mean age at diagnosis turns out to be 65,6 years while the mean latency is 42,3 years. Since 1998 a plateu of incident cases with asbestos exposure has been observed with maximum annual peak in 2002 (54 cases); the number is slowly decreasing in the last three years (Graph 2). Still 126 UAE cases (18.3%) with histological diagnosis are moreover present in the archive. Among these cases the gender distribution is quite levelled (49,2% male vs. 50.8% females). This data becomes unbalanced when a job-based selection is operated. Those to whom a possible occupational exposure could be assigned were 65,7% males and 34,3% females, while among the remaining 91 cases, 57.1% were females vs. 42,9% males. Among this group, a further selection based on the type of interview, (44 cases) (36.4% men vs 63.6% women) emerges (Table 2). Considering the reliability of information (direct interview), the hypothesis that these subjects undergone a generic environmental exposure has been formulated, although not yet well defined or known. Therefore 44 cases recorded in 17 years of epidemiological surveillance would produce a crude rate of approximately 0,7 cases on million inhabitants.

Discussion

The slight observable decreasing number of cases in last the 3 years can be compatible with the events that characterized the exposures in the remote past for quality and amount, although this data could be partially attenuated by the eventual rescue of cases still not identified. The assertion that approximately one case over four reports not having undergone asbestos exposures above the so-called “natural background” could be due, in reality, to the insufficient sensibility of gathering information method: the interview. This sensibility decreases when information is supplied by someone different from the case (proxy), due to the fast worsening of the health conditions or to the bad functioning of the archive network system for signalling the cases. Improvement of the collected data quality needs the contribution of expert industrial hygienists or occupational medical doctors in order to reach an accurate exposure assessment. In total or nearly absence of outdoor pollution data, a generic assignment of “environmental” exposure could lead to misclassification with negative influences to public health strategic policies. Further research is needed in order to establish and assess eventual present sources of pollution that could still involve exposure risk. Particular attention should be taken on waterborne asbestos fibres in city-waters[3] and how much they might contribute to indoor airborne fibre pollution. Nevertheless attention should be paid to the environment through monitoring campaigns 15 years after the banning of asbestos in Italy. Once available these information should be crossed with the UAE geographical localization.

Conclusions

Active epidemiological surveillance of the malignant mesothelioma, beyond the analytical description of the epidemic course of this high aetiological fraction neoplastic pathology, represents a useful tool in order to assume important decisions of public health policy in the field of the primary prevention. The distribution of the cases, in relation to the exposure modalities, clearly indicates the link between the mesothelioma and asbestos industrial usage, including the cohabitation with asbestos workers and the living near companies producing outdoor pollution. At the same time the study of the occupational and life anamnesis of the UAE cases can supply important indications on the possibility that risks, generically defined as "environmental" could still affect the general population not professionally exposed. However the calculation of the annual crude rate in the Tuscany population ($0,7 \times 10^6$), if confirmed by information on the complete residential life history of the UAE cases crossed with airborne asbestos fibre monitoring, indicates that this pollution would rather bring a contained risk. Moreover it should be considered that due to the long latency the present new cases should have been exposed at least 40 years ago, a period in which asbestos was certainly more diffused than now.

Figure 1 - Periods of beginning work

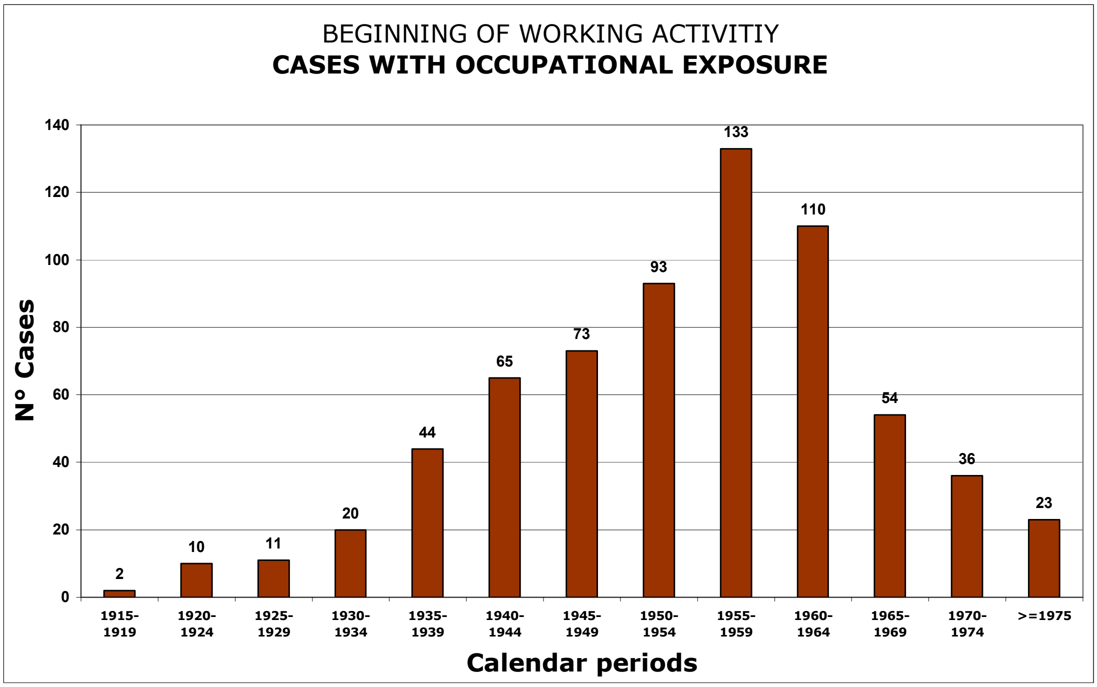


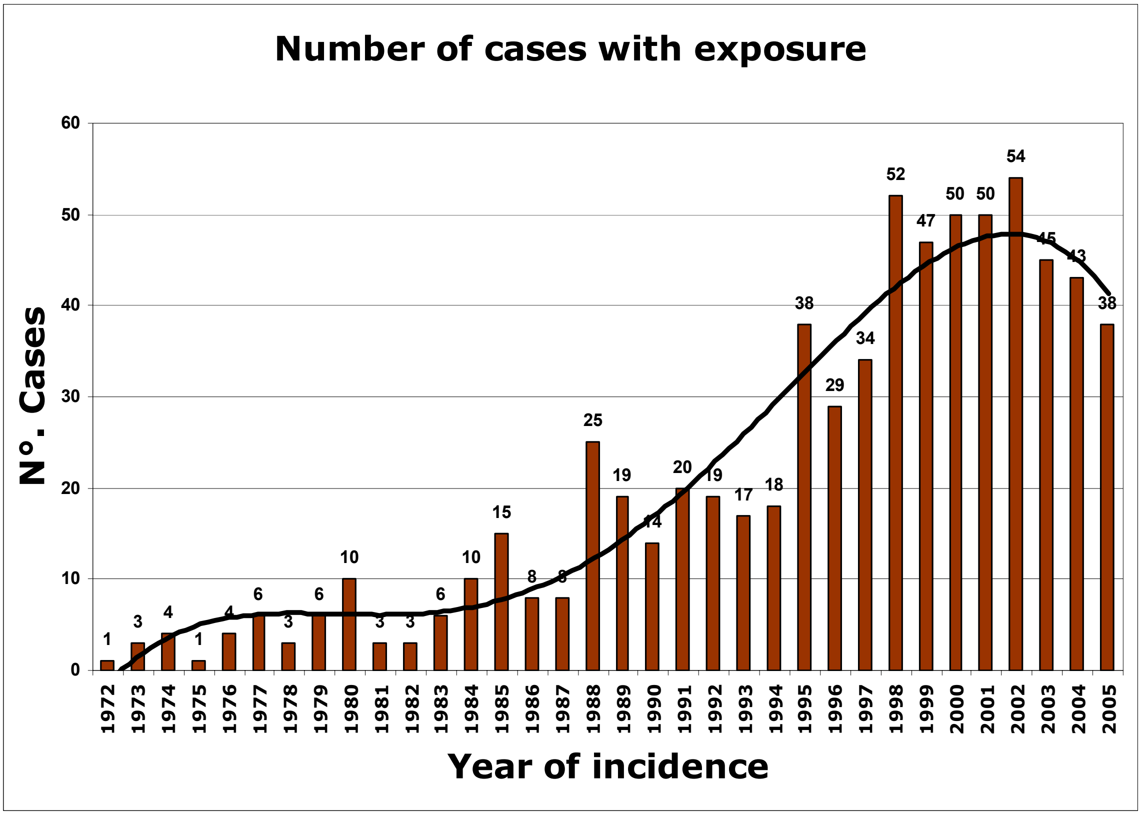
Table 1 - Type of exposure and diagnostic level

Exposure	All diagnosis					Histological only					% Histological		
	Male	%	Fem	%	Both	Male	%	Fem	%	Both	Male	Fem	Both
All registered cases	703	78,8	189	21,2	892	557	81,1	130	18,9	687	79,2	68,8	77
Occupational	546	93,5	38	6,5	584	449	93,3	32	6,7	481	82,2	84	82,4
Non occupational	9	32,1	19	67,9	28	9	37,5	15	63	24	100	78,9	85,7
All	555	90,7	57	9,3	612	458	90,7	47	9,3	505	82,5	82,5	82,5
Unknown	74	46,0	87	54,0	161	62	49,2	64	51	126	83,8	73,6	78,3

Table 2 - Unknown asbestos exposure and type of interview

Type of interview	All cases					Job based possible exp					Job based unprobable exp				
	Male	%	Fem	%	Both	Male	%	Fem	%	Both	Male	%	Fem	%	Both
Direct	26	44,1	33	55,9	59	10	66,7	5	33,3	15	16	36,4	28	63,6	44
Proxy	36	53,7	31	46,3	67	13	65	7	35	20	23	48,9	24	51,1	47
All	62	49,2	64	50,8	126	23	65,7	12	34,3	35	39	42,9	52	57,1	91

Figure 2 - Cases with asbestos exposure



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MALIGNANT MESOTHELIOMA IN MONFALCONE, ITALY

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The Trieste-Monfalcone district is a narrow coastal strip, located in north-eastern Italy, with a population of about 300,000 inhabitants. This district has been characterized as an area at high incidence of asbestos-related mesothelioma[1, 2]. Shipbuilding industry has been the principal source of exposure to asbestos in the area[1, 3]. In the course of a study on mesothelioma in Trieste-Monfalcone, we reviewed 54 mesothelioma cases observed in Monfalcone in the period 2001-2006.

Methods

In 41 cases the diagnosis of mesothelioma was made or confirmed at necropsy, in 12 cases mesothelioma was diagnosed on material obtained at thoracoscopy or surgery, and in one case on cytology of pleural fluid. Occupational data were obtained from the patients themselves, or from their relatives, by personal or telephone interviews. In 21 cases asbestos bodies were isolated after chemical digestion of lung samples, after the Smith-Naylor method[4]. In 20 cases the lung samples were obtained at necropsy (right base), and in one case at surgery. Pleural plaques were classified in three classes on the basis of their size: unilateral or bilateral plaques, not larger than 4 cm across the major axis were classified as class 1 (small); plaques larger than 4 cm but involving less than 50% of the thoracic cavity, were defined as class 2 (intermediate); plaques involving more than 50% of the thoracic cavity were labelled class 3 (large).

Results

The group included 49 men, and 5 women, aged between 46-89 years (mean 69 years, median 72). In nearly 70% of the cases, the age at diagnosis was comprised between 60 and 79 years. The primary site of the tumor was pleura in 53 cases, and peritoneum in one case. All the cases were asbestos-related. A majority of patients had worked in the shipyards (Table 1). Of the 42 people classified as shipyard workers, some had worked for short periods in insulation.

Table 1 - Occupational data in 54 cases of malignant mesothelioma, Monfalcone, Jan 2001-May 2006

Category	*Men*	*Women*	*Total*	*%*
Shipbulding	40	2	42	77.78
Various industries	3	3	6	11.11
Insulation	3		3	5.56
Seafarers	2		2	3.70
Construction industry	1		1	1.85
Total	49	5	54	100.00

Of 49 patients, for whom detailed chronological data were available, 15 persons had their first exposure before 1950, 17 in 1950s, 12 in 1960s, and 5 in 1970s. The duration of exposure, calculated in 34 cases, was generally longer than 10 years (Figure 1). The latency periods, defined as time intervals elapsing between first exposure to asbestos and diagnosis of mesothelioma, calculated in 47 cases, ranged from 28 to 67 years (mean 48 years, median 47) (Figure 2). The three insulation workers showed latency periods of 35, 47, and 49 years respectively.

Figure 1 – Duration of exposure to asbestos in 34 cases of malignant mesothelioma, Monfalcone, Jan 2001-May 2006

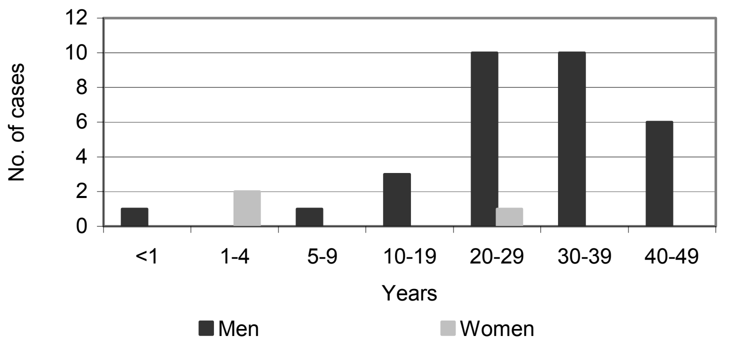
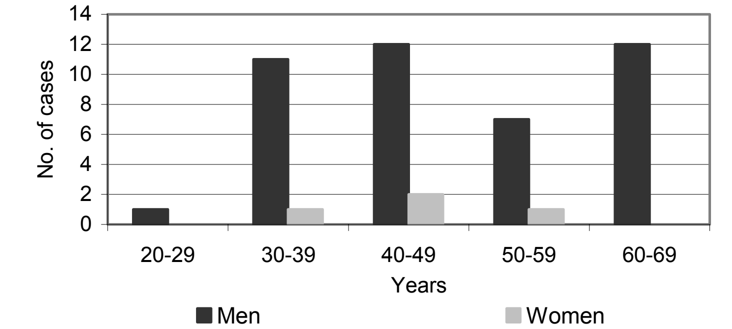


Figure 2 - Latency periods in 47 cases of malignant mesothelioma, Monfalcone, Jan 2001-May 2006



Pleural plaques were reported in 35 cases; in 5 cases the plaques had not been classified; in the others the plaques were classified as class 1 in 4 cases, as class 2 in 21, and as class 3 in 5 cases. The amounts of lung asbestos bodies ranged between 50 and 380,000 bodies/g dried tissue; the highest values were found among some shipyard workers (Table 2).

Table 2 - Lung asbestos body counts in 21 cases of malignant mesothelioma by category of exposure, Monfalcone, Jan 2001-May 2006

Category	*No. of cases*	*Asbestos bodies x 1,000/g dried tissue*			
		<1	*1-10*	*10-100*	*>100*
Shipbulding	12		3	3	6
Insulation	2			2	
Seafarer	2	1	1		
Other	5	1	3	1	

Discussion

Extensive research on mesothelioma has been conducted during the last decades. Nevertheless, the monitoring of the tumor remains problematic. Firstly, the diagnosis of mesothelioma is not rarely difficult[5]. In the frame of the France National Mesothelioma Surveillance Program[6], it has recently been seen that in a relevant percentage of cases, the initial diagnosis of mesothelioma, made by the pathologist, was not confirmed. Moreover, a not neglectable number of cases remained undefined. In the present series, the diagnosis of mesothelioma was made or confirmed on the basis of necropsy findings in 75% of the cases. However, this represents an exception rather than the rule. Necropsy practice is progressively declining everywhere[7]. Apart from diagnosis, registration of mesothelioma at the time of death may present major difficulties[8]. The result of this situation is that, sometimes, the epidemiological data don't have a high degree of reliability.

Malignant mesothelioma in Monfalcone is characterized by the absolute prevalence of shipyard workers. The Monfalcone shipyards began their activity in 1908. In the following decades, they became the most important shipbuilding installation in the Mediterranean region. The work-force of the Monfalcone shipyards reached a peak in the late 1930s with some 6,000 workers. Moreover, at that time, about 4-5,000 workers were employed in the aeronautic works and in electro-mechanic shops, included in the shipyards. A series of studies showed the relevance of asbestos exposure occurred in the Monfalcone shipyards[3]. The fact that in the past asbestos fibres might reach very high levels in the shipyards, is also demonstrated by the exceedingly large amounts of asbestos bodies found in the lung tissue, in some of the present cases.

Investigations on the presence and amounts of asbestos bodies (or asbestos fibres) in the lung, should be performed in all the cases of mesothelioma, but in particular in the cases in which occupational and residential histories are not defined, or negative. In Australia, the lungs were examined for asbestos fibres in the mesothelioma cases with negative histories. It has been found that 80% of these cases, apparently negative, showed high amounts of asbestos fibres[9]. This clearly indicates that, on the only basis of occupational, social, and residential data, not always one can distinguish asbestos-related mesotheliomas from non asbestos-related ones.

In this context, pleural plaques has also to be considered as a very precious marker of asbestos exposure. Even if small and unilateral, pleural plaque generally indicates a not trivial exposure to asbestos[3].

In the studies conducted in the Trieste-Monfalcone area, the latency periods, elapsing between first exposure to asbestos and diagnosis of mesothelioma, were far longer[1, 10, 11]than those currently reported in the literature[12]. In the Trieste-Monfalcone area it has also been observed that latency periods were shorter among insulators (about 30 years) than in other categories, and longer in maritime trades (mean 55 years)[1, 10, 11]. This indicates that an inverse relationship exists between intensity of exposure and length of the latency period. On the contrary, in the present series some mesotheliomas in insulation workers with longer latency periods (47 and 49 years respectively) were observed. The reasons for this fact are not clear (less heavy exposure? higher resistance?).

The natural history of mesothelioma raises some important questions about the pathogenesis of this tumor. In more than 40% of the current cases, the tumor has developed after 50-60 years or more since first exposure. In these cases with latency periods very long, it is not plausible that the oncogenic effect of asbestos has started since the first exposure, and that it has remained silent for decades. However, it seems logic to admit, that for a long period asbestos effects are neutralized by the defence mechanisms of the host. If this is true, it is necessary to distinguish between latency period (the entire period in which contact between asbestos fibres and host occurs), and induction period (the period in which the first stages of the neoplasia start and tumor progression occurs). This distinction has already been proposed both for cancer in general as well as for mesothelioma[13]. Probably, various factors can induce the transition through the induction period, including both cumulative dose as well as host factors.

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TRENDS OF PLEURAL CANCER MORTALITY IN A COHORT OF ASBESTOS WORKERS AFTER A LONG LATENCY: EVALUATION OF THE POSSIBLE ROLE OF ASBESTOS CLEARANCE.

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The importance of time-related factors in the development of asbestos-related diseases has been recognized for decades. In particular, the time elapsed since first exposure (TSFE) to asbestos is related to the rate of mesothelioma. On the basis of the multistage model of tumour induction, in 1976 Newhouse and Berry [1] suggested that the risk of mesothelioma increases at a rate proportional to a power of TSFE, according to:

$$I(T)= C(T-W)^K \quad ,$$

Where I is the incidence rate; C is the cumulative exposure; T is TSFE; W is time interval after the start of the exposure in which it is assumed that the incidence of mesothelioma does not increase (usually 5 or 10 years); K is a constant. This model predicts that the rate of mesothelioma keeps increasing over time after first exposure, and provided a good fit to available data from several epidemiological studies. However, during the 1980s some authors [2] suggested that the increasing incidence trend of mesothelioma with TSFE was not monotonic and that incidence rates could eventually start to decline many years after the first exposure. In a modified model proposed by Berry in 1991, the increase in mesothelioma rate with time since first exposure was attenuated by a factor which represents a decline in risk due to the clearance of the asbestos fibers from the lung [3]. In the "elimination " model

$$I(T)= C(T-W)^{K} \exp(-\lambda T)$$

the elimination of fibers was taken into account by assuming a first order kinetic model in which the elimination rate λ was constant.

In order to test the Berry's hypothesis we used data from a cohort of workers formerly employed at the Eternit asbestos cement plant in Casale Monferrato (Piedmont region, N-W Italy), one of the most important European plants specialized in the production of asbestos cement. We compared the observed mortality rates for pleural and peritoneal cancer with the rates expected by the elimination model, in order to evaluate if it fitted the data better than the traditional model of Newhouse.

Methods

The Eternit asbestos cement plant of Casale Monferrato was active in the production of asbestos cement from 1907 to 1986. It produced plain and corrugated sheets, chimney tubes and high-pressure pipes. Raw material included both chrysotile and crocidolite but not amosite. During the

1970s, the consumption of crocidolite decreased rapidly and was mainly limited to the production of high-pressure pipes [4].

The cohort included 3443 blue collar workers (2663 men and 780 women) active on 1st January 1950 or hired between 1950-1984. Nine subjects were excluded because of lack of data. Dates of birth and employment were obtained from personnel records at the factory. The follow-up took place between 1/11/2001 and 30/4/2003 and vital status at follow-up was ascertained for 99% of the subjects. Local registry offices provided the vital status and the cause of death for each member of the cohort. The underlying cause of death was coded according to the International Classification of Disease (9th revision). Each member of the cohort contributed to the computation of person-years at risk (pyr) since hiring (or January, 1st, 1950, if hired previously) until either death, migration abroad, loss to follow-up or end of follow-up.

Statistical analysis

Different Poisson regression models were fitted to data to estimate mortality rates for pleural cancer (ICD-IX 163) and peritoneal cancer (ICD-IX 158). We used three approaches to model TSFE. Firstly, we modelled TSFE as a categorical variable. Secondly we used linear splines (with a unique knot at 40 years since first exposure) to investigate late changes in the temporal distribution of pleural and peritoneal cancer. Thirdly, Berry's model was compared with the traditional one which does not include a parameter for the elimination of asbestos from the lung. We set W equal to 5 years in both the traditional and the elimination model. The parameters K and λ were estimated from the data. The Likelihood ratio test was used to compare the elimination model with 3 parameters (K, λ and the intercept) with the traditional model with 2 parameters (K and the intercept). In all the analyses time since start of the employment in Eternit was used as a proxy of time since first exposure. Duration of the employment at the Eternit plant (computed summing up all separate intervals) was used as a proxy of the cumulative exposure.

Results and conclusions

Tables 1 and 2 show the results from fitting the Poisson regression models. In the categorical model, the rate ratios for pleural cancer showed a steep increase in the first categories of TSFE and reached a plateau after 40 years since the first exposure (table 1). On the other side, the rate ratios for peritoneal cancer monotonically increased over all the categories of TSFE (table1). Different patterns of pleural and peritoneal cancer were also evident in the linear spline models, where there was a statistically significant change ($p=0.02$) in the slope after 40 years of TSFE for pleural cancer but not for peritoneal cancer ($p=0.66$) (results not shown). Table 2 presents the elimination model compared with the traditional model. The likelihood ratio test suggested that the elimination model fitted the data better than the traditional model ($p=0.02$) for pleural cancer. The maximum likelihood estimate (MLE) of K in the elimination model was 2.95 for pleural cancer, in good agreement with the figures reported in other studies [5,6]. On the other hand, MLE of K in the traditional model for pleural cancer (K=1.27), which was below the values reported in literature, suggested that this model is not appropriate to describe the data. The elimination model estimated an asbestos elimination rate of 6% per year, corresponding to a half-life of 11 years, similar to the figures suggested by Berry and in good agreement with the results of some experimental studies [7,8]. Regarding to peritoneal cancer, the elimination model did not fit the data better than the traditional model (Likelihood Ratio test $p=0.22$). Moreover the estimated parameter values in the elimination model ($K=0.74$; $\lambda= -0.05$) for peritoneal cancer are not biologically sensible (a negative value for the clearance rate is not interpretable and the estimated value of K is very low) and suggested that this model does not describe well the data. Figure 1 shows observed rates of pleural cancer and expected rates according to both elimination and traditional models vs.TSFE. When the traditional model was used to fit the data up to 40 years of TSFE (dotted line), it predicted a steep increase with TSFE, and the fit was excellent. On the other hand, the observed rates after 40 years of TSFE fell far from the expected values. When the observations after 40 years of latency were included in the analysis, the global fit of the traditional model was worse (solid line). The elimination model (dashed line) gave very similar results to the traditional model up to 40 years, but diverged thereafter, describing well the plateau of the rates in the last categories of TSFE. These results suggest the possibility that the pleural cancer risk, rather than showing an indefinite increase, could reach a plateau when a sufficiently long time has elapsed since the start of the exposure. These findings are consistent with the results of other studies on asbestos workers [9,10,11]. There is some evidence that the such a pleural cancer trend could be related to the clearance of the asbestos from the workers' lungs. Should this be the case, the number of pleural cancers caused by asbestos exposure predicted by currently used models could be overestimated. The peritoneal cancer showed a different trend, with a monotonic increase over time, suggesting no fiber clearance from the peritoneum. Beside possible biological explanations, the different behavour of pleural and peritoneal cancer mortality suggests that the time trends of these two neoplasms should be analysed separately.

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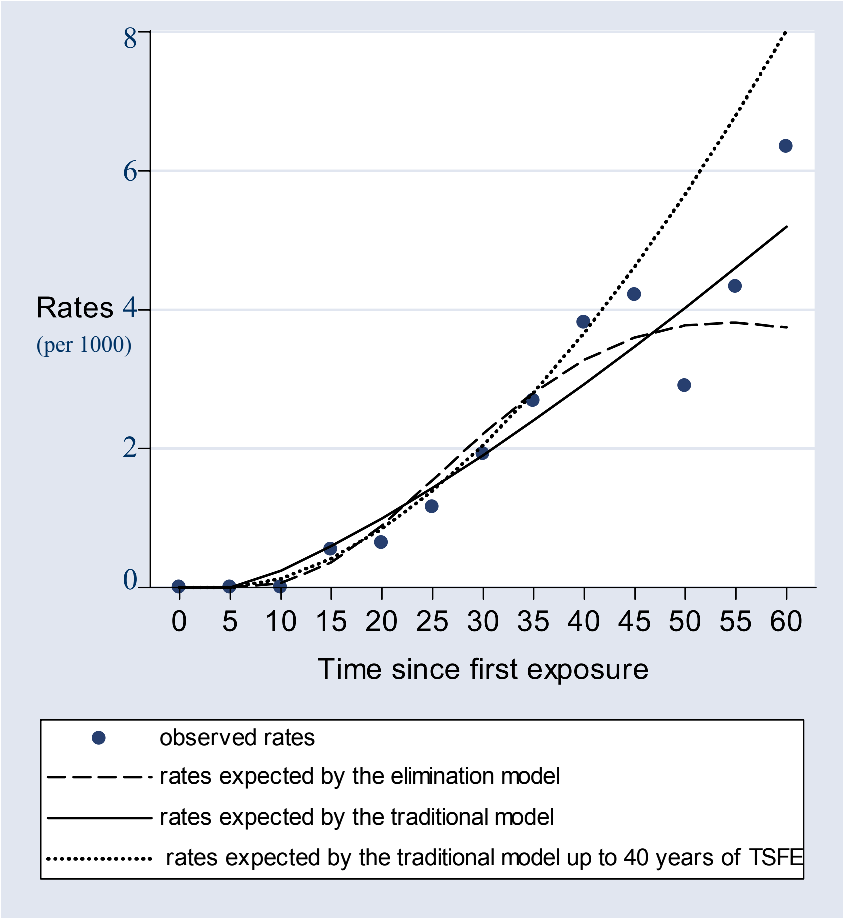
Table 1 – Poisson regression models. Rate Ratios and 95% confidence intervals for pleural and peritoneal cancer by time since first exposure. Results adjusted for age, sex, calendar year.

Time since first exposure (years)	Pleural cancer		Peritoneal cancer	
	Cases	Rate Ratio (95% CI)	Cases	Rate Ratio (95% CI)
< 20	8	0.36 (0.16 ; 0.83)	1	0.07 (0.01 ; 0.88)
20-29	24	0.61 (0.36 ; 1.04)	5	0.42 (0.15 ; 1.22)
30-39	48	1 (reference)	17	1 (reference)
40-49	40	1.51 (0.97 ; 2.37)	15	1.97 (0.93 ; 4.17)
At least 50	19	1.23 (0.65 ; 2.37)	18	5.06 (2.13 ; 11.9)

Table 2 – Comparison between the elimination model and the traditional model. Estimated parameter values and their 95% confidence intervals for pleural and peritoneal cancer.

	Parameter	Pleural cancer Estimated value (95% CI)	Peritoneal cancer Estimated value (95% CI)
Elimination model	K	2.95 (1.23 ; 4.67)	0.74(-1.28 ; 2.76)
	λ	0.06 (0 ; 0.12)	-0.05 (-0.11 ; 0.02)
	Intercept	-16.9 (-20.7 ; -13.1)	-14.3 (-18.9 ; -9.73)
Traditional model	K	1.27 (0.89 ; 1.64)	2.12 (1.40 ; 2.83)
	Intercept	-13.4 (-14.7 ; -12.1)	-17.3 (-19.9 ; -14.8)
Comparison between the two models (Likelihood Ratio test)		p= 0.02	p=0.22

Figure 1 – Mortality for pleural cancer. Observed and expected rates by different models, vs. time since first exposure (TSFE).



Session 3

Workers protection in asbestos remediation activities; watchdog bodies' role and experiences

LE AZIONI DI BONIFICA DELLA PRESENZA DI AMIANTO: TUTELA DELLA PERSONA E DELL'AMBIENTE ATTRAVERSO UNA COERENTE PREPARAZIONE PROFESSIONALE DELL'OPERATORE

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Il tema delle bonifiche da amianto offre innumerevoli spunti di approfondimento per chiunque debba o abbia necessità di confrontarsi con esse.

L'occasione rappresentata da questa Conferenza Europea che tratta della problematica amianto nei suoi vari aspetti di gestione del rischio, offre l'opportunità di svilupparne uno che è sicuramente importante sia per coloro che detengono materiali contenenti amianto, sia per coloro che lo bonificano: l'idonea ed adeguata formazione per coloro che manipolano materiali contenenti amianto che, peraltro, non può prescindere dalla conoscenza, conseguita attraverso una corretta e coerente informazione, riguardante anche la gestione di questa presenza.

Ciò che segue, in forma descrittiva, rappresenta una occasione di riflessione su questa tematica ma anche opportunità di approfondimento e spunto, per ulteriori occasioni di crescita collettiva nella strategia di indirizzo formativo, nell'ambito della quale che la Regione Liguria ha da tempo avviato esperienze proficue ed interessanti.

Le azioni di bonifica da amianto presuppongano che tutti coloro che sono coinvolti nel processo svolgano un ruolo attivo e responsabile finalizzato alla tutela della persona e dell'ambiente.

Rilevante è quindi l'aspetto della consapevolezza che si acquisisce con la crescita professionale, attraverso iniziative mirate di formazione che, sempre più e meglio debbono cercare di corrispondere al progredire, in termini culturali, scientifici e tecnologici, delle conoscenze in tema di amianto.

Sulla base di questo presupposto vengono programmate ed attuate le iniziative formative di volta in volta necessarie, verificandone l'efficacia e la coerenza con l'evolversi dell'esigenza.

È evidente che, parlando di tutti coloro che sono coinvolti, si annoverano tra essi i detentori, i responsabili per la gestione della presenza, i bonificatori e gli incaricati delle indagini analitiche oltre che coloro che sono chiamati a svolgere azioni di controllo e vigilanza.

Uno spettro ampio, dunque, con differenti esigenze e motivazioni, portatore di istanze anche particolari che tutte però convergono e vengono coniugate nell'unico ed onnicomprensivo concetto di prevenzione.

La Regione Liguria, come del resto tutte le Regioni e Province Autonome che con la presenza di manufatti e siti inquinati contenenti amianto si confrontano quotidianamente, mantenendo nel tempo una attenta strategia volta a corrispondere con tempestività alle istanze condivisibili, ha sempre posto attenzione alle problematiche proprie della materia o che da essa derivano anche in conseguenza di specifiche condizioni del contesto ambientale o, ancora, della specifica condizione della presenza.

Ha inoltre coltivato con impegno, all'interno delle proprie azioni di Piano, la formazione quale strumento di prevenzione attiva e responsabile.

Destinatari di questa azione articolata e differenziata in parte nei contenuti e, per taluni aspetti, negli aspetti metodologici, sono state nel tempo, continuando ad esserlo, tutte le figure sopra individuate.

Partecipazione e consapevolezza sono le principali finalità di questa azione, perseguite attraverso conversazioni e sperimentazioni gestite da personale professionalmente idoneo e qualificato ed in grado di trasmettere ciò che è a sua conoscenza ed è il suo sentire.

Fondamentali le collaborazioni e le interazioni di volta in volta cercate ed attuate con l'Università degli Studi di Genova, le Unità Operative di Igiene e Sanità Pubblica e di Prevenzione e Sicurezza negli Ambienti di Lavoro, delle Aziende Unità Sanitarie Locali della Liguria, le quattro Province liguri ed alcuni Centri di Formazione Professionale, opportunamente individuati e localizzati strategicamente sul territorio per corrispondere alle istanze dell'utenza, per le varie iniziative poste in atto.

L'azione concreta, cioè la formazione iniziale (avviata già a partire dal 1997 a favore di un gruppo di LSU inseriti in un progetto regionale finalizzato al censimento della presenza di materiali con amianto friabile/compatto) del personale delle AUSL e dal 1998 a favore del personale titolare o dipendente da imprese che attuavano o intendevano attuare bonifica da amianto) ed i successivi periodici aggiornamenti legati alla socializzazione delle nuove norme intervenute nel frattempo o delle più attuali strategie di intervento (corsi brevi, seminari, incontri, avviati a partire dal 2003), si è basata sul rapporto con il cantiere, sulla corretta e coerente metodologia di attuazione degli interventi, sulla idoneità del monitoraggio ambientale e dell'efficacia del controllo e della valutazione delle indagini analitiche.

L'orientamento che ha indirizzato l'azione è stato quello di privilegiare l'approfondimento immediato e partecipato delle tematiche di volta in volta oggetto delle informazioni; in questo modo si è ritenuto di riuscire meglio ad evidenziarne la significatività ed a corrispondere più puntualmente alle istanze di chiarezza.

Il risultato più evidente oggi riscontrabile dall'esame delle iniziative svolte, è la progressiva crescita della qualità operativa presente in ciascuno degli ambiti sopra descritti e, spesso, nei casi in cui il presupposto aveva motivo di esistere ed è stato sviluppato e perseguito in modo condiviso, la finalizzazione al conseguimento della certificazione ambientale.

Diversi i passaggi che hanno caratterizzato il percorso che ha permesso il raggiungimento (formalizzato nei suoi diversi aspetti a partire dalle attività promosse nel 2002) dell'attuale livello di efficacia: l'introduzione di una verifica iniziale sui livelli di conoscenza per cercare di rendere omogenei i gruppi di partecipanti e stabilire la soglia formativa di partenza del corso, l'implementazione delle argomentazioni trattate o il loro maggiore grado di approfondimento con dilatazione dei tempi di formazione, l'esposizione dei contenuti formativi in forma semplice e chiara comunque accessibile al fruitore che ne deve ricavare chiaramente i concetti di prevenzione e sicurezza, l'ammissione all'accertamento finale su istanza dell'interessato e la verifica, propedeutica all'accertamento, del raggiungimento di uno standard adeguato per poter affrontare l'accertamento finale con possibilità di successo, la compilazione di un questionario di gradimento finale per lo studio e la possibile introduzione di migliorie organizzative, di metodo o di contenuto, che spesso sono sfociate in incontri di approfondimento.

Già dalle prime esperienze formative, peraltro, la Regione Liguria ha scelto la strada della partecipazione consapevole e condivisa dei partecipanti ai corsi, prevedendo che ogni iniziativa corsuale, che le singole Amministrazioni Provinciali svolgono attraverso i Centri di formazione professionale gestiti direttamente o con esse convenzionati, deve essere preceduta da un incontro introduttivo, svolto direttamente dall'organo che presiede allo svolgimento dell'intero Piano, che ha il fine di inquadrare l'attività formativa nel contesto del Piano Regionale Amianto mettendola in relazione con le finalità dal medesimo e con gli aspetti di tutela della persona e dell'ambiente.

È altresì utile precisare che l'odierno indirizzo tende a privilegiare una sede di livello provinciale, compresa una nell'area del chiavarese (che rappresenta, per estensione territoriale e per popolazione, una realtà di dimensione assimilabile al livello provinciale), in grado di disporre di uno spazio dedicato all'interno del quale è ricavata un'area confinata attrezzata e dotata di unità di decontaminazione.

In particolare, per gli aspetti di tutela citati in precedenza, è fondamentale riuscire a far emergere ed a far condividere l'attenzione al reale contenuto delle azioni che si compiono, a volte non sufficientemente analizzate e valutate.

Causa di ciò è spesso la superficialità ed il sommario esame di fatti e circostanze in conseguenza di atteggiamenti personali di scarsa disponibilità a mettersi in discussione per la convinzione di avere già conoscenza del necessario.

Da questa premessa, certo stimolante ma non unica nel panorama complessivo, dovrebbe potersi derivare l'importanza di crescere in consapevolezza per assicurare lo svolgimento di reali e concrete azioni integrate di prevenzione, connesse alla conoscenza ed alla comunicazione in tema di amianto, finalizzate alla promozione ed alla protezione della salute e dell'ambiente.

La situazione ambientale esistente, caratterizzata da un reale e diversificato inquinamento da fibre di amianto, deve fare sempre e comunque riflettere anche sull'importanza della valutazione del rischio, elemento di indagine fondamentale prima di avviare una qualsiasi azione di rimozione e più in generale di bonifica con disturbo della matrice contenente fibre di amianto, degli effetti dei determinanti ambientali sulla salute umana nonché sul ruolo che hanno e sempre più dovranno avere gli organismi responsabili della protezione di salute ed ambiente.

In maniera sempre più marcata deve essere presa consapevolezza della necessità di incidere su questa situazione attraverso la costruzione di un sistema che sia capace di sostenere le molteplici azioni che si intraprendono ed al tempo stesso possieda quella flessibilità necessaria per essere in grado di adattarsi con tempestività alle modificazioni che intervengono in materia.

Mutamenti che il tempo ha insegnato ad attendere con pazienza ma anche con pervicacia ed accettare sempre con rispetto ed attenzione perché frutto delle conoscenze scientifiche in costante evoluzione e della altrettanto sistematica ricerca di migliore corresponsione ai fini di tutela.

In definitiva, la conoscenza in tema di amianto intesa come sistema, che si colloca all'interno della nostra quotidianità e si rapporta con la nostra realtà di vita, per consentire una efficace azione di prevenzione attraverso la reale conoscenza che trasmette consapevolezza.

Oggi le problematiche che maggiormente si affacciano, in relazione anche alle obbligatorietà introdotte dal nuovo decreto legislativo 25 luglio 2006 numero 257 di attuazione della direttiva 2003/18/CE relativa alla protezione dei lavoratori dai rischi derivanti dall'esposizione all'amianto (pubblicato sulla Gazzetta Ufficiale dell'11 settembre 2006 numero 211 ed entrato in vigore lo scorso 26 settembre), riguardano la giusta obbligatorietà di tutti coloro che sono a diretto contatto con la manipolazione dei materiali contenenti amianto, ad aver assolto all'obbligo formativo finalizzato al conseguimento dell'abilitazione a svolgere detta attività.

L'organizzazione delle attuali ed ancor più delle future attività non può prescindere dalla evidenza che a questa tipologia lavorativa vengono sempre più spesso avviati operatori provenienti da Paesi comunitari o anche extra comunitari che sono carenti o privi non solo di specifiche conoscenze tecnico operative, ma presentano difficoltà linguistiche che possono significare un ostacolo insormontabile alla corretta comprensione dei contenuti corsali o, nelle migliori condizioni, una riduzione del livello conoscitivo dovendo più frequentemente ritornare su argomenti oggetto di precedenti trattazioni.

Occorre una attenta riflessione su quanto esposto perché il testo del decreto legislativo 257/2006 attribuisce ai datori di lavoro il compito di prevedere una sufficiente ed adeguata formazione per tutti i lavoratori esposti o potenzialmente esposti alle fibre di amianto (conseguimento dell'abilitazione ad Addetto o Dirigente delle attività di bonifica), precisando che la formazione, sufficiente ed adeguata, deve essere svolta ad intervalli regolari (periodica frequenza a corsi di aggiornamento) e sviluppare in modo sempre più puntuale le tematiche di prevenzione e sicurezza.

A fine ottobre 2006, la Regione Liguria ha provveduto a fornire, alle imprese iscritte nella Categoria 10 dell'Albo Nazionale dei Gestori Ambientali ed alle imprese inserite nell'Elenco Regionale delle ditte che hanno in organico personale abilitato alla bonifica da amianto, tra le prime indicazioni circa i contenuti del già citato decreto legislativo 257/2006, anche quelle riguardanti l'obbligatorietà dell'abilitazione degli operatori.

RESTITUTION PROCEDURE IN THE COURSE OF FRIABLE ASBESTOS RECLAMATION: EXPERIENCE IN A THERMO-ELECTRIC STATION

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Introduction: the typology of reclamation procedures on asbestos containing materials, contemplated specifically in a series of technical prescription, as it is well known, differs with regard to the kind of material one operates upon and to the environment in which the reclamation is carried out.(1)

In particular, for the removal of materials that contain asbestos in friable matrix, it is necessary for the performing firm to adopt a series of technical, procedural and organizing measures of high complexity that are essential for workers and environment protection, measures that must be necessarily reported in a work plan to transmit in advance to the services of vigilance of territory health structures. (2,3).

The control function of these services develops through the different execution phases of the reclamation, and terminates with a final "restitution" of reclaimed areas, whose criteria and methods, indicated carefully by the M.D. (ministerial decree) 9/6/94, must be applied by qualified personnel, with adequate equipment, and with a scrupulous respect for safety standards. (1,2).

During the fulfilment of a work program of removal of isolating material inside a thermo-electric station, the operative Unit of Prevention, Hygiene and Working Sites Safety performed a series of final "restitution" controls, through numerous investigations on the spot and samplings inside the reclaimed surroundings, as reported below.

Materials and Methods: The evaluation of the restitution, conducted according to the technical indications of the M.D. 09/06/94, regarded all single areas inside the thermo-electric station, isolated with a static and dynamic confinement. As the structures were progressively reclaimed with the removal of the material that contained asbestos, at the end of the cleaning and decontaminating operations of the building site, we performed inside the yet confined area 2 visual inspections (one after the first cleaning operations of the area and one after the end of the treatment of the reclaimed surfaces with a sealing product) and following samplings of the area to measure the concentration of asbestos fibres dispersed in the air.

The visual inspections concerned all surfaces, with particular regard to hanging pipes and to the points of difficult access: in case of identification of areas yet visibly contaminated by little fragments or debris of remaining asbestos containing material, we asked the performing firm for a new and more accurate cleaning, repeating a new visual inspection; once obtained a favourable result, we proceeded with the atomising of the area and of all surfaces inside it with appropriate sealing material. After that we performed a series of air samplings, using portable automated environment samplers and appropriate cellulose filters: the number of samplings and the position of the samplers was established in function of the dimensions of the area of work and of its structural characteristics, so that they were representative of the conditions of the full area under examination.

For environment samplings we used portable samplers with constant flux and electronic input control. The range of fluxes we used, have taken into consideration the level of dust supposed from the values obtained from different environments of observation, and however they never exceeded 12 litres/m. The sampling modalities sought to simulate, as much as possible, the dynamic environmental conditions that can be find during work and life activities.

The volume sampled through membranes of cellulose ester with 0.8 micron pores, was 3000 litres.

Those filters were analysed on electronic microscopy by the laboratory of Electronic Microscopy and microanalysis of the Province Department of ARPACAL.

The analytical applications for the classification and the determination of the concentration of asbestos fibres dispersed in the air, perfectly in line with the protocols indicated by the laws in force, were performed through scan electronic microscopy and energy dispersion mycroanalysis.

The analysis proceeded through the following phases:

1) calibration of the instrument chain
2) characterization of the massive material object of reclaiming with the aim to classify the mineralogical phases that were present. The species we found were represented by amphibolic phases (amosite and subordinately crocidolite) and sporadically chrysotile.

The calculation of concentration occurred through the analysis of membranes with normalized fibre counts, as to say, fibres with a more than 5 micron length and with a diameter never exceeding 3 microns, with a 3:1 ratio. The observations involved 400 fields at 2000x. The analytical calculation was made according to Poisson's distribution with indication of a higher and lower limit of concentration (2,3,4).

Results: In the course of a year we performed, on a total of 39 building sites, nr.50 visual inspections e nr 146 samplings. The preliminary results of visual inspections and the values we found in the following analysis, never put into evidence, in our experience, discrepancies form the criteria of the 6th article of the M.D. 09/06/94 or the overcoming of the limits imposed by the aforementioned Decree. To certify the possibility of restitution of an area, that limit is 2 fibres/litre, as an average of asbestos fibres concentration found in every sample.

As evidenced in the enclosed table the concentration values of asbestos fibres ranged from 0,000 fibres/litres, to a maximal value of 1,767 fibres/litre and middle value 0,210 (Tab. 1 e 2); the variability we found and in particular the peaks can correlate with the different articulations of the areas of work, which in the specific cases were occupied by pipes and equipments that could not be removed, and whose cleaning was particularly complicated, with a consequent residual, albeit minimal, contamination of asbestos fibres.

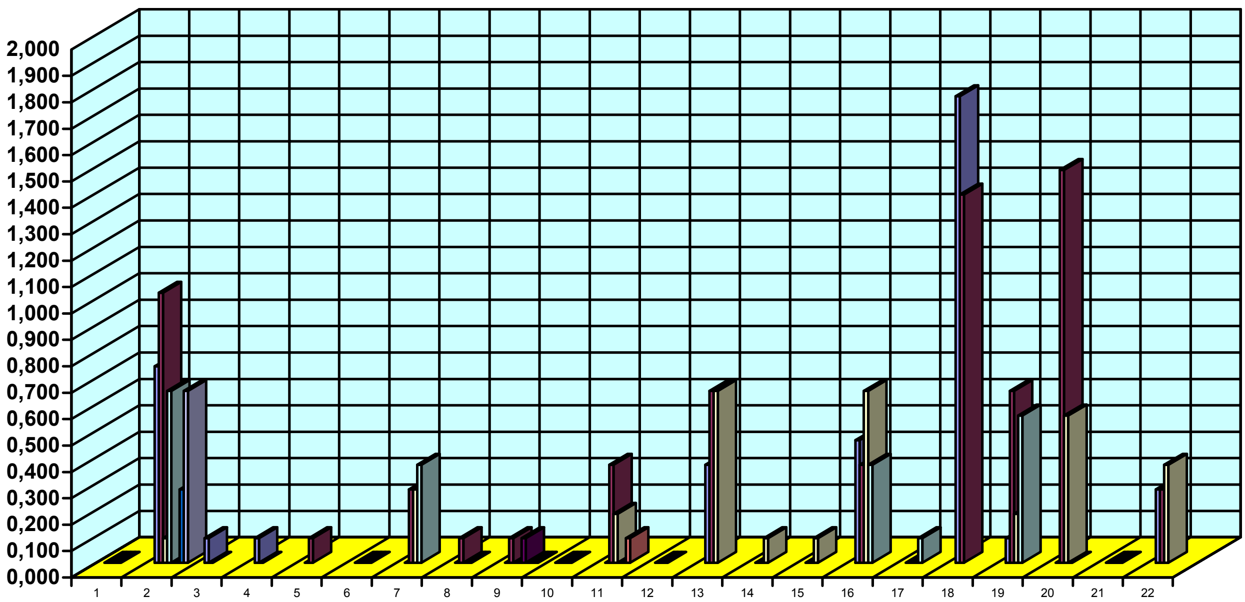
As in these cases, as in the generality of cases, we could find a strict correlation between the final cleaning accuracy of the building site and the concentration of the fibres dispersed in the air: these concentrations, however, never exceeded the limit values of 2 fibres/litre (in which case the Service ought to impose a further decontamination of the entire area up to the achievement of stable lower concentrations).

In all controlled building sites, having found asbestos fibre concentrations lower than limit values, it was possible to declare that the reclaimed area was devoid of residual asbestos contamination, and the performing firm was allowed to remove confinement barriers, extracting equipment and decontamination units, and the customer was authorized to use again and freely the abovementioned areas.

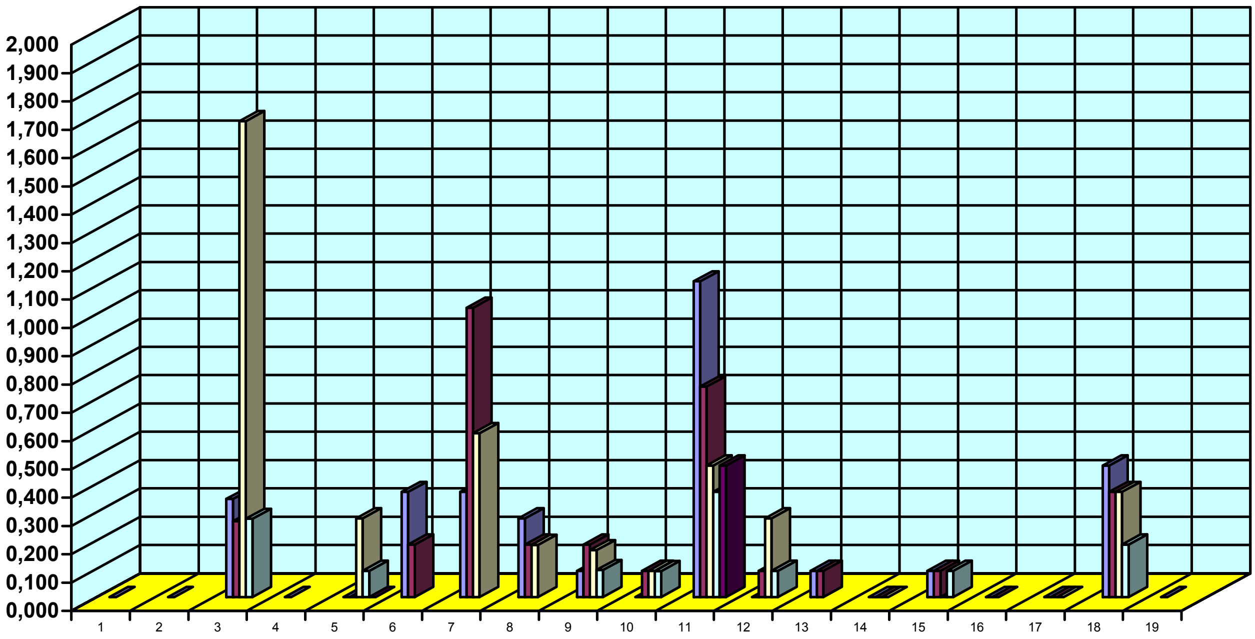
Conclusions: The procedure of visual inspection and sampling constitute the final and integrated act of a check process on removal interventions of friable asbestos that, beginning from the preventive evaluation of the work plan, proceeds through a test phase of the building site, a visual and documental check on the correct execution of the works, to end with a final "accessibility" verification of the reclaimed area.

In these procedures, taken into consideration the complexity and the necessary commitment, emerges the skill requested for medical operators and technicians to execute the tasks imposed by the laws in force and the specific contribution to the functions of health protection of the workers and of the population at risk with asbestos.

Asbestos fibre concentration for restitution procedure in Group 1 and 2 of Thermo-electric station



Tab. 1



Tab. 2

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LUNG FIBER BURDEN AMONG ITALIAN SUBJECTS OCCUPATIONALLY EXPOSED TO ASBESTOS SUFFERING FROM MESOTHELIOMAS

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INTRODUCTION AND AIMS

In Italy consumption of raw asbestos has been high, and picked between 1976 and 1979. Limitations to the use of crocidolite were introduced since 1986 and asbestos was banned effectively in 1994. Past occupational exposure has been poorly characterized.

The study by Electron Microscopy (EM) of the asbestos fibres retained in the lung of exposed subjects has reached some conclusions: the results provide data to supplement the occupational history; increasing risks of Malignant Mesothelioma (MM) are observed with increasing amount of retained fibres; amphibole fibres are more bio-persistent although they are eliminated at some rates; chrysotile fibres are much less bio-persistent so that the amount, if any, of these retained fibres do not appear to be proportional to cumulative exposures but reflect recent exposures.

Finding a lung concentration of asbestos fibres of about 500,000 total amphibole/g dry lung establishes a history of asbestos exposure in subjects for whom no history is available or for whom it is denied [1]. A consensus document suggests that over 1,000,000 million of amphibole fibres dry tissue greater than 1 μm detected through an EM by a qualified laboratory defines a previous occupational exposure to asbestos [2].

Less than a dozen of lung fibres analyses among asbestos-diseased Italian subjects has been so far published.

The study was designed to assess the lung fibre load through a Scan EM among mesothelioma patients, investigated by the Occupational Health Units of some areas of Northern Italy (residents in the Province of Brescia, Mantua and the Veneto Region, Northern Italy), in the frame of population-based mesothelioma registries [3].

We report on the first 34 mesothelioma patients defined as having had an occupationally exposed to asbestos, before the results were known.

MATERIALS AND METHODS

Study population

Fresh lung tissue samples were obtained from mesothelioma cases occurred after 2001. Diagnoses had to be based on histological examination supplemented by immuno-phenotipical characterization.

Information on asbestos exposure was derived from interviews, mostly face-to-face, or from relatives, supplemented by additional information (employment cards, historical data on the use of asbestos at the workplaces, etc.). Past occupational exposure to asbestos was graded as certain, probable, possible according to the criteria used by the National mesothelioma Registry [2]**.** The definition was done before the results were known.

Analysis of lung tissue fibre

All analyses were carried out at the Centre of Electronic Microscopy, ARPA, Milan blindly to the information on exposure.

Lung fragments of about 1 cm^3 were processed through phases [4]:

1. dehydration;
2. removal of organic compounds: by oxygen plasma asher (Plasma Asher Emitech mod. K 1050X);
3. ash dissolving
4. filtering: a growing quantity of the suspension of ash corresponding to a defined lung tissue dry weigh, filtered through polycarbonate membranes (Millipore Isopore Type GTTP).
5. the analysis used a Scan Electronic Microscope (Stereoscan 420 Leica), equipped with X-ray fluorescence microanalyzer (Oxford EXL) at 12000X magnification, comparing peak ratios to X-ray standard spettra.

Fibres with length more than 1 μ, diameter less than 3 μ and length to diameter ratio more than 3 were detected and counted, and expressed as total number of asbestos fibres for 1 gram of dry tissue.

RESULTS

The first 34 subjects fulfilling the inclusion criteria were 30 males, and 3 females (mean age 64,7 ys, range 49-81) all pleural mesothelioma, except a peritoneal. Lung samples were collected because of pulmectomy (16 cases), or at autopsies (18 cases).

28 subjects have been classified to have had a “certain” occupational exposure to asbestos, 2 and 4, a “probable” or “possible” occupational exposures. Overall, occupational exposure to asbestos lasted 20 ± 11.6 ys; in 15% (n=5) it lasted less than 5 ys. In 59 % (n= 17) occupational exposure began after the sixties.

None had a pulmonary asbestosis, pleural plaques observed in some.

Fibre type and burden

Among 60% (n=20), only amphibole fibres were detected, both amphibole and chrysotile in 36% (n=13); among 3 subjects chrysotile was prevalent over amphibole. In no one was chrysotile the only one component in the lungs.

A wide variation of fibre burden was observed (range: 0.25 - 400 millions), but a large majority of subjects (68%, n= 23) had values over 1,000,000 f/g of dry tissue.

Highest values were detected among subjects classified as having had a certain occupational exposure, compared with those classified as probably or possibly exposed. 8 subjects had values less than 1.000.000, 4 less than 500.000 f/g dry tissue.

Highest values

Values over 200 million fi/g dry tissue, all amphibole, were detected in two women, one employed for 25 yrs in a small shop recycling jute sacks, the second in a factory producing asbestos textiles (strings, gaskets, etc). These high values confirm that mesothelioma occurring among women in Italy may be due to occupational exposures [5]. One of these two high values was in a woman suffering from a peritoneal mesothelioma.

Values over 30 and up to 110 million f/g dry tissue were detected: in a man involved in handling asbestos bags, and performing mechanical work, inclusive of plumbing, in a factory deriving oil from soya beans; among three subjects who worked at cement-asbestos factories; in a mechanic, who occasionally repaired the equipments inside a cement-asbestos factory; in a man who worked from 1980 to 1990 in a factory where railroad coaches were renewed.

The latter result confirms that exposure to crocidolite in these factories could have been heavy and explain why a huge number of mesotheliomas are occurring in Italy, because of the decision to insulate with sprayed crocidolite all the carriages and coaches of the public railroad system, and then to de-insulate them [6].

Values over 2 millions f/g dry tissue have been detected in subjects exposed at dockyards, in petrochemical work (because of welding, plumbing or inspecting), in iron foundry workers, and in masons, the later now expressing the highest number of mesothelioma occurring in Italy [7,3].

Finally, we want to drew attention to the results in a subject who worked in Venice in a private business, selling and preparing small objects in glass by blowing and shaping heated glass wires. The activity was performed over a bench, covered with an asbestos cardboard, probably of chrysotile. The cart-board was shaped and frequently cleaned using mechanical tools. He should have been exposed to the inhalation of fibres up to ten years before the lung fibres count. The "low" amount of only amphibole fibres (0.45 millions) may be explained by the short bio-persistence of chrysotile fibres [1].

CONCLUSIONS

We confirm that high concentrations of amphibole fibres detected as pulmonary load help in establishing a history of occupational exposure asbestos exposure and to give appreciation on the intensity of exposure that have occurred at workplaces. The high values we observed among subjects who worked at some jobs and tasks can provide indications for classifying as exposed and estimate the intensity of exposure subjects without analyses of lung fibre burden.

The large majority of subjects we have defined as having had an occupational exposure had predominantly amphibole fibres over 1 million f/g dry tissue.

This should be interpreted as a consequence of: a) the diffuse and uncontrolled use of asbestos fibres at workplaces in Italy; b) the large use of a mixture of fibres, inclusive of amphibole, lasting since recently.

We definitively agree that mineralogical analyses are not of diminishing interest [8], especially in Italy, where these measures have seldom be performed.

Negative results cannot defeat a clear exposure history, especially where exposure to chrysotile has occurred.

ACKNOWLEDGMENTS

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TABLES

Table 1. Fibre concentration (in f/g dry tissue) of mesothelioma cases by exposure probability

Exposure	N.	Fibre concentration and range	% exceeding 1.000.000
1. definite	27	47.8 (0.42-400)	75
2. probable	3	1.0 (0.41-1.9)	33
3. possible	4	1.7 (0.55-2.9)	68

Table 2. Duration (in ys) of asbestos exposure and lung fibre load (in f/g dry tissue)

years	N	mean ±SD	range
5	7	2,4 ±1.6	0.6-5.2
6-15	6	30.3±47.5	0.5-115
15-29	10	74.8±116.8	0.4-400
30	11	36.3±87.2	0.4-286

SETTING UP A JOB/ASBESTOS EXPOSURE MATRIX IN A RAILWAY STOCK CONSTRUCTION INDUSTRY

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Introduction

Parallel to a mortality study of a cohort composed by 3700 workers employed by a construction railway stock industry, a job/asbestos exposure matrix has been elaborated, relating to a period of approximately 25 years during which the material used for carriages insulations was sprayed asbestos. This will concur to proceed on the analysis of mortality aiming to find a correlation with the levels of exposure. The originality of the present job consists in having developed one new technique for the quantitative past exposure levels estimate in absence of environmental monitoring.

Aims

To attribute a quantitative level of exposure, expressed in number of fibres/volume unit, for each workshop/job for each year of activity during the considered period.

Materials and methods

Through documents and information gathered from workers an historical reconstruction of the production process and the relative hygienic conditions, with particular attention to the tasks involving asbestos use during railway carriages and engines, has been performed. Dust control and personal protection has been traced through the same period too. In order to estimate the intensity of exposure we referred to the literature describing similar conditions. On this base the absolute number of fibres inside the carriages under construction during the asbestos spraying has been calculated, being known the internal volume. Assuming a fibre migration through the windows and doors and a uniform dispersion of the fibres within the workshop, the new and diluted concentration, subdivided in “near” and “far” field has been obtained dividing the absolute number of fibres by a virtual volume around the carriage (near field) and by the volume of the whole workshop (far field). Frequency of “dusty” operations has been assessed and modelled with the annual sprayed asbestos quantities. For the calculation of the time weighted average (TWA) asbestos concentrations have been differentiated taking into account the residual pollution during the days following the spraying (residual pollution). The estimate of this TWA has been used for the “indirect” exposure assessment. As far as the “direct” exposure assessment is concerned an estimate of intensity for three jobs during the furniture, wiring and technical accessories assembling of the carriages has been performed. The time of exposure for these three jobs has been modelled over the number of carriages annually produced. Still for the same jobs the overall exposure was computed by summing the indirect and direct exposures. Indirect levels of exposures only have been assigned to all the other jobs operating in the same workshop.

Results

A job/exposure matrix for the period 1956 – 1979 has been compiled. The years go from 1956 (beginning of spraying) to the end of 1979. The three jobs included are: electrician, tube welder, assembler. All the other jobs operating in the same workshop of the spraying are indicated as "Others". Concentrations are expressed in fibres/cc and have to be intended as TWA in one singular year. Cumulative exposures for each worker with known work history are calculated by summing the TWA concentrations for each year of work.

Discussion

The calculate cumulative exposure values appear to be compatible with asbestos related pathologies found in company (excess of mesothelioma and pleural plaques, but not meaningful presence of parenchimal asbestosis). The course of exposure intensity is, in some periods, inverse to the asbestos consumption, since during the seventies dust control programs were established up to reach the physical separation of the spraying workshop. These occupational hygiene measures considerably reduced the asbestos contamination within the premises.

Conclusions

The calculation of cumulative exposure for all the subjects with available entire work history will allow a new analysis of the occurred mortality differentiated by level of cumulative exposure. It will be possible to produce a better estimate of the lung tumours already highlighted in excess in the first cohort study. In particular it will be possible to understand if this excess derives from asbestos or other carcinogenic agents (e.g. heavy metals). The inverse proportionality between exposure and asbestos consumption demonstrate the insufficient usefulness of this last parameter, alone, like proxy of exposure.

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Session 4

Assessment and mapping of large asbestos contaminated areas; fibrous mineral in natural environments: prevention and eco- compatibility

MINERAL FIBRES MEASUREMENTS IN THE URBAN ENVIRONMENT.

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INTRODUCTION

Russia is the largest asbestos producer and consumer in the world. In Russia only chrysotile is produced and used in civil purposes in contrast to the widespread, past usage of crocidolite or amosite asbestos in Western Europe, United States and Australia. Over 50 percent of chrysotile production was and is used now for inner consumption (predominantly for asbestos cement production). The amphibole content in Russian chrysotile is minimal [1].

Amphiboles (anthophylite and crocidolite) were produced from 1947 until 1994 in small amounts (about 12 thousand tons for all history of production) for special non-civil purposes at two deposits in Sverdlovsk region [2].

Chrysotile containing materials allowed for use in the Russian Federation according to: 2.1.2/2.2.1.1009–00 State Standard "List of asbestos-cement products recommended for use"; Letter no. 1100/3232-1-110 of Chief Hygienist of the Russian Federation from 9.11.2001 "Asbestos products recommended for production and use at transport, equipment, industrial and common life commodities". Safety measures in use of these materials are determined by 2.2.3.757 – 99 State Sanitary Regulations "Use of asbestos and asbestos-containing materials". On April 8, 2000 ILO Convention 162 was ratified in Russia by Federal Act 50-FZ "About the ratification of Convention on Safety in the use of asbestos from 1986".

Chrysotile is used in a broad variety of building materials. Typical examples include asbestos cement products such as wall panels, roofing plates, water tubes and sewage pipes. In Russia friable, low-density chrysotile containing insulation materials are usually present only in technical areas, heating and water supply systems but not in public working or living areas.

Recently man-made mineral fibres (MMMF) have found common applications as insulation wools and other construction materials.

This study was conducted to estimate the concentrations of respirable fibres in indoor and outdoor air as a source of nonoccupational exposure to asbestos and other fibrous particles. The results of phase-contrast optical microscopy (PCOM) were confirmed with fibre identification by scanning and transmission electron microscopy (SEM/TEM).

METHODS

The survey included a total of twenty buildings in Moscow:

1. Fourteen residential houses
   (three 5-storey panel buildings from the 1950's and 1960's, four 12-storey panel buildings from the 1970's, three 16-storey panel buildings from the 1980's, three high-rise brick buildings from the 1950's and one 9-storey panel building from the 1970's)
2. Six public buildings
   (one hospital, one covered stadium, one theatre and three office buildings)

In residential houses, dust samples were taken from entrance areas on the ground floor, near waste ducts and fire staircases on upper floors with direct air connection to flat areas and from indoor air of ordinary flats. In two residential houses and three public buildings (theatre, two offices), the sampling was made during the period of large renovations but without ongoing working activities. All the buildings contained some asbestos materials, most often asbestos cement panels and pipes in dwelling areas or thermal insulations in heating rooms at the technical stores. At visual inspection, the technical condition and housekeeping ranged from poor to satisfactory.

Because chrysotile fibres may also originate from traffic emissions, fibre concentrations were measured at five locations near Moscow motorways (North, East, South, West and Center). A series of measurements were made near a thermal power plant where large quantities of asbestos and MMMF insulations were removed, repaired and installed.

Also five points where technical maintenance of motorcars is provided were examined: one private garage, where individual technical service for domestic and old imported cars is provided; two car-repair shops situated on highways for domestic and imported cars; authorized service center for cars produced by VAZ factory; department of technical services for small lorries, produced by domestic industry consists of two big free connected departments: garage and repair department (repair department is subdivided into three parts: unit repair section, mechanical section and turnery section; works with asbestos containing friction materials using high speed processing equipment are performed in turnery section).

The dust samples were collected onto cellulose ester membrane filters (diameter 25 mm, pore size 0.8 μm) for phase-contrast optical microscopy (PCOM) and onto polycarbonate filters (diameter 25 mm, pore size 0.1 μm) for electron microscopy (SEM/TEM). The flow rate was 2 L/min, with a minimum volume of 250 L for PCOM samples and 1000 L for SEM/TEM. All respirable fibres (>5 μm in length, <3 μm in diameter, aspect ratio >3 to 1) were enumerated at 450 X magnification. The definition of respirable fibres equals to the counting rules of the WHO Recommended Method for phase-contrast optical microscopy (World Health Organization 1997) [3]. Scanning electron microscopy and X-ray microanalysis were used to identify and count different fibrous particles at 1500X. The concentration of short chrysotile fibres was also verified by transmission electron microscopy at higher magnifications. The detection limit of the measurements was about 0,001 f/ml.

RESULTS

The measurements of all respirable fibres by PCOM and chrysotile fibres by SEM can be divided into three categories. In the first group of eight residential buildings, a city hospital and a two-storey office building, the dwelling areas were being kept in a satisfactory technical condition. Cleaning was regular, and at visual inspection, no surface damages of asbestos-containing materials or MMMF products were observed. The airborne concentration of all respirable fibres, as determined by PCOM, did not exceed the Russian limit of 0,06 f/ml for environmental air of occupied spaces. By SEM analysis, a majority of the particles were organic fibres, soot, plaster, gypsum, MMMF and other inorganic particles of various origins. The mean concentration of chrysotile fibres (>5 μm) was below 0,001 f/ml.

In the second group of buildings, the technical condition of asbestos and MMMF materials was not properly maintained in general or partly. At some places, manifest damage was observed. The concentration of all respirable fibres was about 2 to 3-fold higher than in the first group. The chrysotile concentration was about 0,004 f/L. Other inorganic fibres including MMMF were also more common in these samples.

The third group consists of two residential houses, a theatre and two office buildings which were under large renovation. In some occasions, work operations were executed without any precautions that are required by the national sanitary rules. The mean chrysotile concentration was 0,125 f/ml in ten samples which were taken during weekends without ongoing work activities. Thus the mean level was higher than the hygienic limit of 0,1 f/ml stipulated for workplace air in many countries. Without proper cleaning, the chrysotile concentration remained as high as 0,053 f/ml one day after the demolition of old water supply systems in residential houses. In a renovated office building, the mean level of all respirable fibres was 0,011 f/ml before reconstruction, 0,015 f/ml after primary operations and 0,007 f/ml after full completion. Simultaneously the airborne concentration of chrysotile fibres decreased from 0,005 f/ml to below the detection limit of 0,001 f/ml.

The concentration of all respirable fibres (>5 μm) ranged from <0,001 to 0,058 f/L in fifteen residential and public buildings which were sampled without ongoing renovation. By SEM analyses, the fibrous particles consisted of organic fibres (55%), chrysotile (7%) and other inorganic fibres (38%). In contrast, the mean concentration of all respirable fibres was 0,087 (range 0,002-0,57) f/ml in 77 samples which were taken from five renovated buildings. About 52 % of these fibres (>5 μm) were chrysotile (n=28). Gypsum and MMMF fibres were identified in some samples but no amphibole asbestos was detected.

In summertime samples, low concentrations of all fibres (> 5μm) and chrysotile (>1 μm) were found at five locations near Moscow motorways. The mean concentrations were 0,002 f/ml and below 0,001 f/ml, respectively. Exceptionally high levels of chrysotile, up to 0,009 f/ml (>1 μm) were measured near a power station which was under extensive reconstruction.

Analysis of samples taken at automotive service departments also did not show risk of exposure to unacceptable high concentrations of chrysotile fibres for workers occupied with cars equipped with chrysotile containing friction materials. All fibre concentrations was from 0,004 to 0,008 f/ml and chrysotile fibres concentrations was less than 0,001 f/ml. The exception was one car repair station where chrysotile-containing brakes were worked up by high-speed tool without even the simplest safety measures (local and area ventilation systems also did not present). Concentrations of all fibres (PCOM) was from 0,013 to 3,1 f/ml, concentrations of chrysotile fibers longer that 1 μm (SEM) was up to 20,2 f/ml and longer than 5 μm – up to 2,4 f/ml.

In general, the results of this study in Moscow are consistent with measurements of nonoccupational exposure to fibrous particles in other urban areas in Russia. In two large industrial centers the ambient concentrations of respirable fibres (>5 mm) ranged from 0,001 to 0,06 f/ml [4].

These samples were taken from public buildings, urban environments and above an asbestos cement roof for the estimation of fibre emissions from asbestos products, which are permitted for use in civil engineering according to the Russian standards. From the total number of airborne fibres, chrysotile formed 1,8 – 5,5 % when the particles were classified by electron microscopy.

DISCUSSION AND CONCLUSION

According to our survey results in outdoor samples, the background level of chrysotile fibres was below 0,001 f/ml (>1 mm), which indicated only minimal environmental exposure originating from the friction materials of motor vehicles. Local emissions from industrial activities may occasionally contribute to the air contamination of nearby residential areas.

At most sampling points in civil buildings and car repair stations in our studies the concentration of asbestos fibres was below the limit of 0,06 f/ml that was established in Russia for atmospheric air of occupied places (measured by PCOM).

Exceptions were cases when friable asbestos and MMMF containing materials were destroyed without any precautions.

On the average, only 7 % of the counted by PCOM fibres were chrysotile (by electron microscopy analyses). During renovation the dust concentrations were much higher and about one half of all respirable fibres were chrysotile. This indicates that without knowledge on the dust composition PCOM can produce reliable results for total respirable fibres (>5 μm) but not for asbestos fibre concentrations. A recommended method for nonoccupational purposes should include the additional confirmation of fibre type by electron microscopy.

Asbestos cement materials and other asbestos containing construction materials when used with ordinary precautions without intensive destruction are not source of release asbestos fibers into the environment in significant amounts.

Uncontrolled demolition and repair of friable asbestos and MMMF materials can be an important source of occupational and nonoccupational exposure to mineral fibres. New national safety regulations were prepared for the use of natural and synthetic fibres in nonindustrial applications as well as for the measurements of ambient air contamination.

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ENVIRONMENTAL POLLUTION FROM AIRBORNE ASBESTIFORM FIBRES: DEVELOPMENT OF FIBRE PROPAGATION MAPS (final paper)

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Environmental exposure to low concentrations of asbestiform fibres can create, as a consequence, a higher incidence of pleural mesothelioma in populations living in areas which present a natural presence of these minerale [1,2,3] Various areas in Italy (Basilicata[4,5], Sicilia[6]), France (Corse[7], New Caledonia[8]), Turkey[9] and Greece[10] share this context. In this paper we present the results of our research: we pointed out the presence of tremolite amphibole, whose carcinogenic potential is though to be similar to crocidolite.[11,12] In dealing with environmental exposure, we must face several problems: historic estimates are very problematic to assess, and measuring average concentrations and estimating risk levels is a tricky task, too[5]. The aim of this paper is to achieve a better analytical sensitivity in counting and estimating airborne fibres concentration with Phase Contrast Light Microscopy (PCLM). We will obtain such an improvement increasing the examined area of filters[13,14] in order to improve in this way the measurements of environmental concentration of fibrous minerals; these estimates will be used to assess cumulative exposure and under the assumption of a direct proportionality between cumulative exposure and relative risk for residential exposures[15] to asses the number of asbestos related diseases in an area with a natural presence of asbestiform minerals. In a recent paper the authors emphasized the difficulties arising from estimation of the average concentration of airborne fibres in PCLM in living areas; in the same paper they stressed out the point that the standard methodology, which has been developed for working environment, is not appropriate for living areas for its low sensitivity. The only way to increase the sensitivity of this methodology by at least an order of magnitude is to extend the percentage of examined area; the standard methodology only look at the 0,4% of total area when examining 200 fields (or a little less of 1% of total area when examining 400 fields). Theoretically, we can extend the percentage of examined area by at least an order of magnitude both increasing the number of analyzed fields and increasing the radius of inspected fields, but the first strategy is unfeasible for practical reasons. Obviously, we can choose to use every graticule whose area is greater (by at least an order of magnitude) than the Walton-Beckett graticule area. We choose to look at the whole area of every field (the diameter of every field is 500 micron) for its simplicity. When looking at the whole area of every field, we multiply the examined area by a factor of 25, and we reduce the detection limit by the same factor of 25 (if we don't change the number of inspected fields). In the following example we consider the counting of 200 fields over a single filter. We can easily calculate the sensitivity of the counting methodology, which is equal to 0,004 ff/L for the "whole area" graticule compared to 0,11 ff/L for the WB graticule. These different sensitivities are equivalent to the assessment of 4 and 110 fibers on the filter.

Filter radius mm	Filter area mm2	WB area mm2	R WB	WF area mm2	R WF	area of 200 fields mm2		% analyzed area	
						WB	TC	WB	TC
11	380,12	0,007854	**48400**	0,196344	**1936**	1,57	39,27	**0,41**	**10,33**

Total Number of ff	Total Number of fields	air (liters)	concentration ff/L		ff per filter	
1	200	1000	0,009	0,22	9	221
0,5	200	1000	0,004	0,11	4	110

The errors made in estimating the number of fibres on a filter depend on the number of fibres actually counted, and this number can be modeled as a random Poisson variable whose parameter λ is

$\lambda = a \times \frac{r^2}{R^2}$ if we only look at a single field and $\lambda = c \times a \times \frac{r^2}{R^2}$ if we look at *c* fields, where *a* is the *true number of fibres on the filter,* r^2 is the field radius and R^2 is the filter radius. These relations tell us that the errors made in estimating the number of fibres are a random variable which depends on the actual number of fibres on the filter *a* and depends on the percentage of examined area $c\, r^2/R^2$. At the present time, error estimates are carried out calculating confidence intervals for the number of observed fibres using the χ^2 approximation for the Poisson distribution (Fig. 1): if we count *c* fibres on a set of filters, we can approximate the Poisson distribution with a χ^2 distribution with *2c* or *2(c+1)* degrees of freedom. We can therefore take as a confidence interval: [quantile (2c, α/2) / 2, quantile(2 (c+1), 1-α/2) / 2] where *quantile(n, d)* is the *d*-th quantile for the χ^2 distribution with *n* degrees of freedom and a certainty of *(1-α)*. We can apply the same argument to use the gaussian approximation instead of the χ^2 approximation: the Poisson distribution with parameter λ can be acceptably approximated by a gaussian distribution with mean and variance both equal to λ when λ > 10. In this case, confidence intervals are calculated in the standard way: the confidence interval (with 95% probability) for the mean after the observation of *c* fibres is given by *[c – σ*z, c + σ*z]*, where *z* is the *d/2*-th quantile for the standardized gaussian

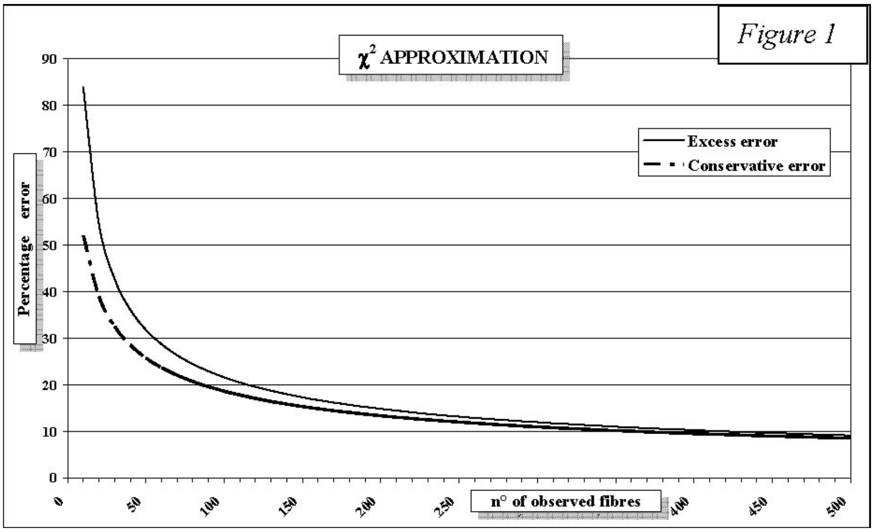

Figure 1

distribution (if d = 0,05, z = 1,96) and σ can be easily estimated from c, since for Poisson distributions mean and variance have the same value. This gaussian approximation and the χ^2 approximation lead us to similar confidence intervals, especially then the observed number of fibres is bigger. We notice that, using the χ^2 approximation, we found the same confidence intervals which are reported in DM 6/9/94 for SEM counting (DM 6/9/94 does not contain confidence interval for PCLM observations). When we deal with airborne asbestos concentrations as low as those arising from natural outcrops, we expect to count a very low number of fibres: this would bring us to make huge errors in the estimate of fibres concentration. Actually, what is useful to know is the average concentration of airborne fibres within a small error, so if we fix the error we choose to be acceptable we can calculate the minimum number of fibres that we should count (on one or more filter) to be in the choosen error range. Since the number of fibres counted on a filter is a Poisson variable with parameter λ ,

$\lambda = a \times \frac{r^2}{R^2}$ the number of fibres observed on a set of more filters will be given by a sum of Poisson variables and therefore it will be itself a Poisson variable whose final parameter λ is given by the sum of the previous λ : $\lambda = [a_1 + a_2 + ... + a_n] \times c \times \frac{r^2}{R^2}$

Now we can handle the problem of estimating the number of samplings needed to calculate the average atmospheric concentration of fibres, with a prearranged maximum error. This concentration can be roughly estimated thanks to pre existing informations, or by analogy with different situations, or with explorative samplings and can lead us to assume a possible range $\lambda_{min} \leq \lambda \leq \lambda_{max}$ for fibres concentration. As an example, we report a table with the number of filters we need to examine to have a maximum fixed error with probability equal to 95%, under the only assumption that the average number of fibers per filter is ≥ 50. We can retreive the same information from the plot of maximum relative errors as a function of λ, which is always equal to *average number of fibres on filters × N¡ of filters × % analyzed area = total number of fibres on filters × % analyzed area* (Fig. 2).

50 fibres on filters

Fixed error with probability equal to 95%	**N¡ filters need**	
	WB	**TC**
5%		**298**
10%	**1857**	**76**
15%	**843**	**34**
20%	**481**	**21**
25%	**319**	**13**
30%	**230**	**10**
35%	**180**	**8**
40%	**141**	**7**

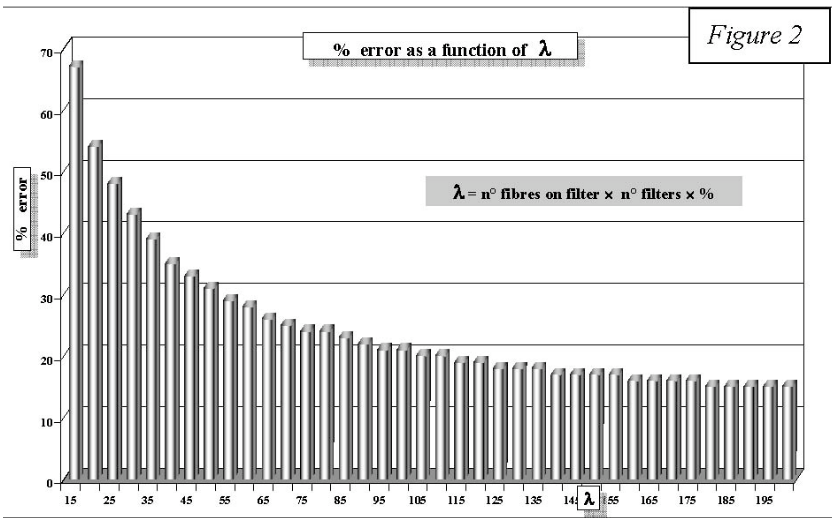

Figure 2

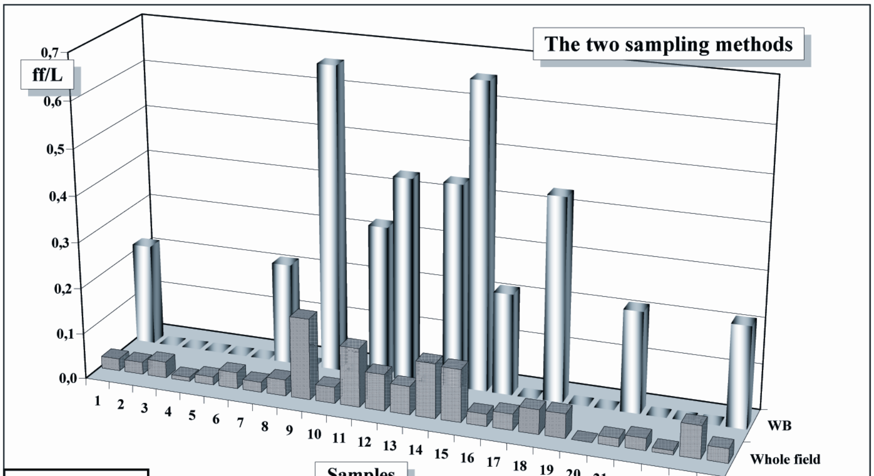

Figure 3

In our case, the histogram of concentrations obtained from 25 samplings with the two different counting methods (Fig. 3) shows a big difference. When we examine the whole field area, we estimate an average concentration of 0,05 ff/L ± 20%. This is equivalent to say that, with probability 95%, the true concentration is between 0,04 ff/L and 0,06 ff/L. If we try to use the WB method we estimate an average concentration of 0,16 ff/L ± 16%: we can say that, with probability 95%, the average concentration is greater than 0,06 ff/L and smaller than 0,27 ff/L. These two estimations are extremely different: to achieve a relative error lower than 20% with the WB graticule it would have been necessary to analyze approximately 480 filters. In figure 4 we show 2000 simulations of examinations of filters with 50 fibres (which is approximately the number of fibres on filter we estimated for our 25 samples); we can see how random oscillations around the estimated value rapidly decrease, and we can see that stability for estimated concentrations is reached only after about 1000 filters.

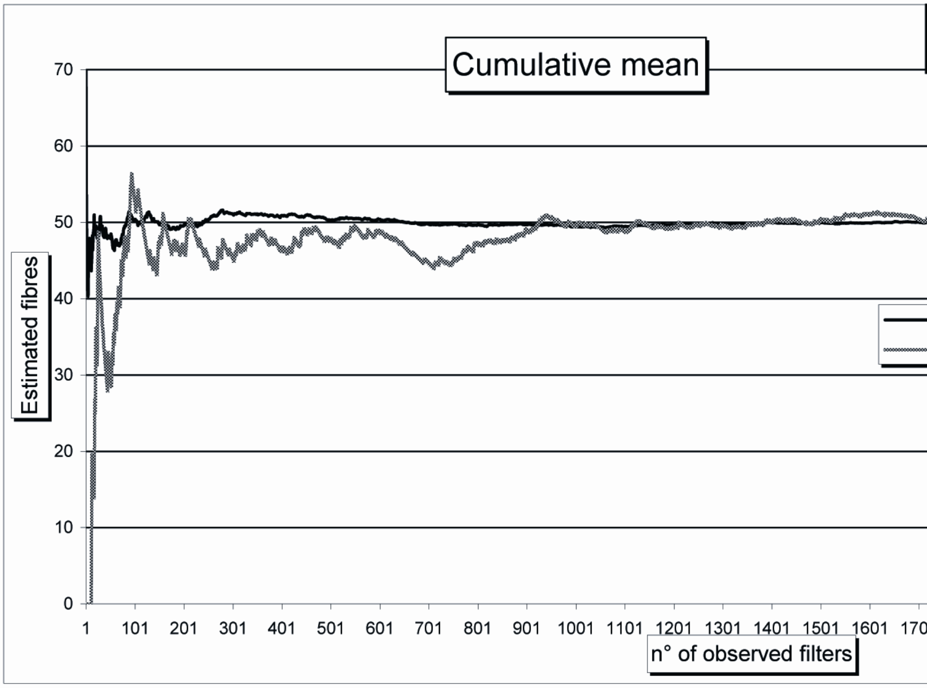

Figure 4

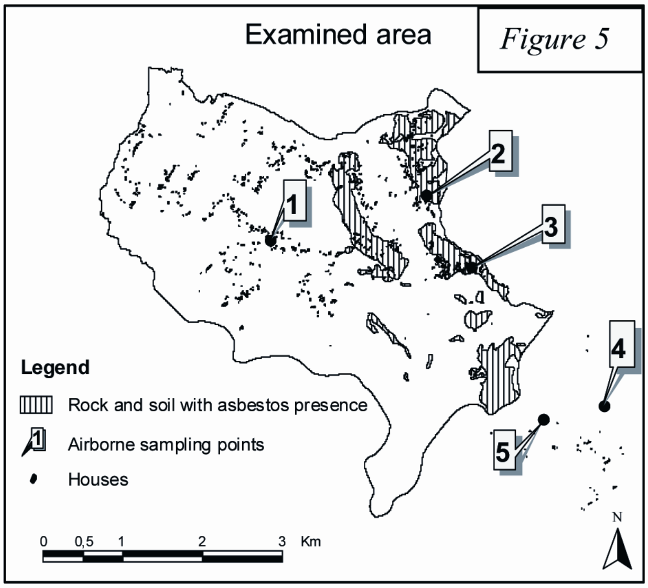

Figure 5

Using these technique we estimate the average concentration of airborne fibres (**0,05** ± 20% ff/L) in an area of Basilicata between Lauria, Castelluccio Superiore and Latronico (Fig. 5). Locations of these five sampling points have been chosen according to GIS techniques of spatial analysis based on:

- the realization of a geographic mapping (rock and soil) of areas where mineralogical and petrographich analysis detected the presence of asbestiform minerals (tremolite and subordinately chrysotile);
- the spatial distribution of residential areas. Samplings have been carried out from november to july. It will be possible to use the estimated average concentrations of airborne asbestos fibres to calculate the cumulative exposure; furthermore an integrated analysis of cumulative exposure and of the exposure which is due to agricultural and domestic work will make it possible to calculate risk levels for populations.

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ASBESTOS AS FAR AS THE EYE CAN SEE

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Background

The commercial mining of asbestos occurred in four Provinces of South Africa (Northern Cape, North West, Limpopo and Mpumalanga). It was initiated in the late 1800's and lasted for over a hundred years into the beginning of this century. From a production standpoint, South Africa rivaled Russia, China and Canada with a maximum output of 379 000 tons in 1977 falling to 163 000 tons in 1985. As a producer of amphibole asbestos, South Africa far outpaced every other country being responsible for 97% of global production. The last crocidolite mine closed in 1996 and by 2000, production of chrysotile had fallen to 12 500 tons per year, ceasing entirely by 2002. Manufacturing consumption in South Africa decreased by 39% from 12,689 tons in 2000 to 7,744 tons in 2002 (the last year of production). This decrease was largely the result of switching to asbestos alternatives in the construction materials industry (primarily asbestos cement) and a decline in local and international demand. Milled fiber stockpiles were estimated to have been exhausted by 2003. However, according to industry representatives, the milled stockpile of asbestos cement products has been substantially reduced but remains available to consumers (both locally and internationally). Everite, the leading supplier of asbestos cement products in South Africa divested itself of all stocks as of 2003, though imports from Zimbabwe and Mozambique have continued coming into South Africa throughout 2004 (Brian Gibson, personal communication)[1].

Asbestos consumption in South Africa was ranked 20th out of a list of the 25 top consuming countries with an estimated consumption of 12,500 tons per year. However, it matched the worldwide average on a per capita basis with consumption of 0.3 kg/year (rank of 15th [range = 3.7-0.1 kg/capita/yr]) in 2000[2]. These statistics do not take into account the quantity of asbestos not formally traded as a commodity but instead used locally in the construction of roads, buildings and as common fill. Nor does it take into account those fugitive emissions of fibers from stockpiles, mills, and wastage from tailings dumps and losses from transport. These statistics do not provide the full picture of asbestos use and abuse within the environment surrounding the mining regions.

Anecdotal information concerning environmental contamination as a result of the former mining activities, and the improper disposal of mine waste tailings has been reported by a variety of authors[3-8]. Considerable interests and controversy exists as to the true extent and severity of environmental contamination in South Africa. Articles in the popular press with titles of, *Horror find at Prieska*,[9] *Asbestos in river raises fears for SA*,[10] *Asbestosis casts its long shadow*,[11] *Cloud of asbestos dust blanketed Gencor plants*,[12] and *Asbestos doesn't rot, it will be there forever*,[13] among others, fuels the debate over the true extent of environmental contamination. According to the Minister of the South African Department of Environmental Affairs and Tourism (DEAT), "We also know that it is because of old roads, old buildings, old mines, and cheap construction… that this airborne threat hangs like a cloud over our families."[14]

Few comprehensive or systematic surveys have been conducted to date to document this issue and very little quantifiable research has been completed on the communities located in close proximity to the former mine sites. A 1998 study of the Prieska area found high rates of asbestos related diseases

(ARD) and documented significant environmental exposures in inhabited areas such as schools, playgrounds and homes[5]. Felix similarly documented high rates of ARD in the environmentally exposed population in Ga-Mafefe (Limpopo Province) and documented extensive environmental contamination[6]. According to McCulloch little research has been done in South Africa on the effects of environmental exposure upon health[8]. In addition, with the exception of Felix's work in Ga-Mafefe, the extent of secondary contamination of the environment, in particular, the use of waste asbestos in the construction of homes, schools, roads, and other areas in the vicinity of the mines and mills and to what extent this use is increasing the potential for secondary exposure has not been researched.

Methods

In 2004 and 2005 DEAT sponsored a community asbestos survey in the former asbestos mining regions. The location of the existing mine sites within South Africa were obtained from the South African Department of Minerals and Energy (DME). From this data information on known sites and sources of contamination such as dumps and other source potentials were identified. A series of geographic information system (GIS) location analyses was performed using GIS software to determine those villages at the greatest risk for potential exposures. The locations of known source areas (mines and mine dumps) was converted to a data layer and was overlain onto the base information showing village locations, topography, and census data. A series of concentric circles, extending out to 5 kilometers was drawn from a point within each identified source. The number of villages, inhabited dwellings, and land uses was ascertained for the area within the concentric circles. Predominant wind direction, slope, water courses and other topographic features were also noted. The resulting GIS maps provided the starting point for survey work to be completed in the next phase. A series of 46 maps were generated for the Northern Cape and North West Province depicting the 79 known locations of asbestos mines and dumps as previously identified by DME. A series of 28 maps were generated for the Limpopo and Mpumalanga Provinces depicting the 58 known mines and dumpsites. The villages and communities that fell within the 5 kilometer radius of the DME mapped mine site centre point were then ranked for their priority for community survey efforts. The ranking was based on the following rationale.

High Priority: Mapped villages and communities within 1-2 kilometers of at least one known area source

Moderate Priority: Mapped villages and communities within 5 kilometers of one known area source and that are within the predominant wind direction or that have an identified watercourse or road access linking the point source to the community

Low Priority: Areas of very low population density within a 5 kilometer radius but upwind of the source area and/or communities outside of the 5 km radius of area sources

Note: This initial assessment was used to guide the preliminary selection of communities to be surveyed. However, additional communities were also selected based on the prior knowledge of local facilitators and by field judgment.

A training program was developed for the community facilitators involved in this assessment work. Eight facilitators were recruited to participate in the field assessment and received training as to the nature of asbestos, its potential health affects, the purpose of the DEAT sponsored survey, the field methods to be utilized and the necessity of health and safety measures to be employed during the investigation. Training was delivered by the Project Manager and monitored by a representative of

Nelson Mandela Metropolitan University, (NMMU) Department of Environmental and Occupational Health.

The facilitators reviewed the previously prepared Preliminary Risk Assessment and Priority Mapping to compare their knowledge of local conditions to that represented by the GIS analysis. A community survey program was developed and areas thought to be representative of the conditions experienced in the majority of the communities were identified as a priority for sampling. It is recognized that the community sampling program could not sample all known or suspected areas of contamination within the study area. Therefore, the following protocol was developed to establish where sampling would take place.

- Those areas identified as a high priority based on the initial GIS mapping
- Those areas outside of the five kilometer radius that are locally known or suspected to contain dumps, mines or mills and/or where asbestos waste was purposely used as a building material, ground cover, common fill or was inadvertently placed
- Those sites that are representative of a particular community, land use or condition

Each team conducted an interview with local residents during the community surveying program. The purpose of the interviews was to gain additional understanding about the potential for asbestos contamination in the area and to explain the reasons for the community surveying effort. At each site sampled, the facilitator team completed a sample data form designed to capture information relative to the use of asbestos on the premises, the conditions of the contaminated area and its potential for exposure to residents or other individuals. Additional information included the sample locations, site address, ownership and date of construction.

A total of 2,059 samples of soil and building materials were collected during the community survey work in the four Provinces. Each discrete sample collected in the field was logged into a project database. It was then placed against a white background (in its container) and the material spread to a thin even layer. It was then initially assessed by a trained technician to ascertain if visible fibers are present in the media. Material that is fibrous (greater than 3:1 aspect) and has the physical characteristics of asbestos (primarily shape and color) is noted as, "visible fibers present" and recorded on the database and sample data sheet. This crude form of initial assessment was conducted in order to test the validity of using visual assessment techniques for the identification of asbestos fibers in soil and building material. This is an appropriate test given the current use by DME of a visual assessment method to determine the extent of rehabilitation efforts under their jurisdiction. Samples with no visible fibers WERE NOT considered free of asbestos contamination.

Each discrete sample was then analyzed under a stereomicroscope at a magnification of 20x to 60x to discern if fibers are visible at that magnification. Those samples with fibers visible under stereomicroscopy that were not seen under the visual assessment are noted. Ninety-three samples were randomly selected from the total set for confirmatory testing by stereomicroscopy and polarized light microscopy (PLM) with dispersion staining by an outside independent laboratory. The sample protocol employed in this study is depicted in Figure 1. Each sample with asbestos fibers identified was then classified based on the concentration. For the purposes of the assessment methodology, the asbestos concentrations are reported as NAD, Trace (both defined below), 1-3%, 3-5%, 5-10%, then in 10% classes up to 50%, and >50%.

NAD: No asbestos detected (this does not mean that asbestos is not present in some small amount, but that the level of detection employed in the analysis could not ascertain the presence of regulated asbestos fibers, fiber bundles or cleavage fragments).

Trace: Amounts of asbestos less than 1% by area coverage on a given preparation are considered trace. This may equal one or more fibers, fiber bundles, or fibrous cleavage fragments in a given sample preparation. Trace levels of contamination are not considered safe in that airborne concentrations can still be generated under certain conditions. However, for the purposes of this assessment protocol, they are considered less hazardous than the higher concentrations.
Note: Quantification of percentages is approximate and is determined through stereomicroscopy analysis. The definition of asbestos used above should not be confused with the definition of a, "regulated asbestos fiber" per the OHSA Asbestos Regulations (2001). The definition provided by OHSA relates to airborne occupational exposures and does not account for the variety and condition of asbestos structures encountered in the environment surrounding the former mining areas. For instance, fibrous cleavage fragments do not meet the definition of a regulated asbestos fiber, but upon pressure to the fibrous portion of the fragment, fibers can be released. For instance, the mechanical abrasion caused by a vehicle driving on a gravel road surface contaminated with asbestos cleavage fragments can easily dislodge individual fibers from the structure leading to airborne exposure. It is for this reason that the term asbestos, as applied to this investigation, includes regulated asbestos fibers as well as those structures with the potential to release regulated asbestos fibers into the environment.

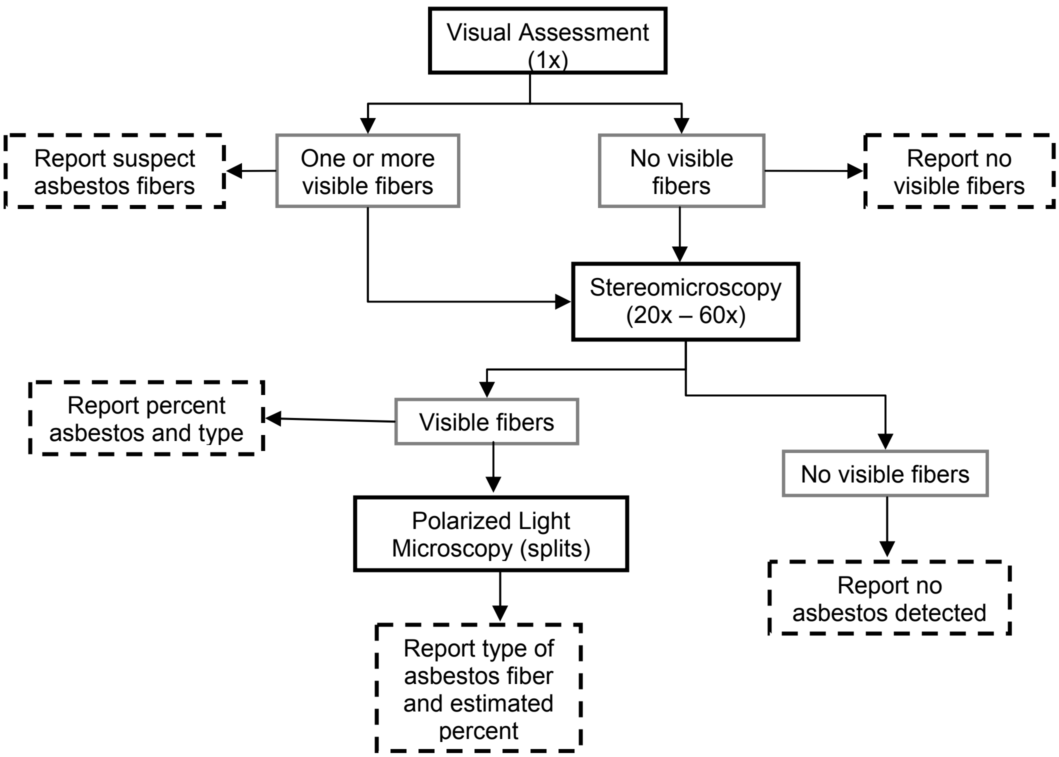

Figure 1: Sample Analysis Protocol

Results

The survey found a high rate of contamination of locally constructed homes, schools, roads and open spaces extending out to within five kilometres of the former mine sites (but occasionally further). Roads were found to be contaminated with asbestos fibers at a rate of 53% (n=51), public spaces (identified as churches, open space, public buildings and parks/playgrounds) at a rate of 56% (n=73), a total of 55% (n=66) of the schools were found to contain either contaminated building material, soil or both and homes were contaminated at a rate of 82% (n=295) (see Figure 2).

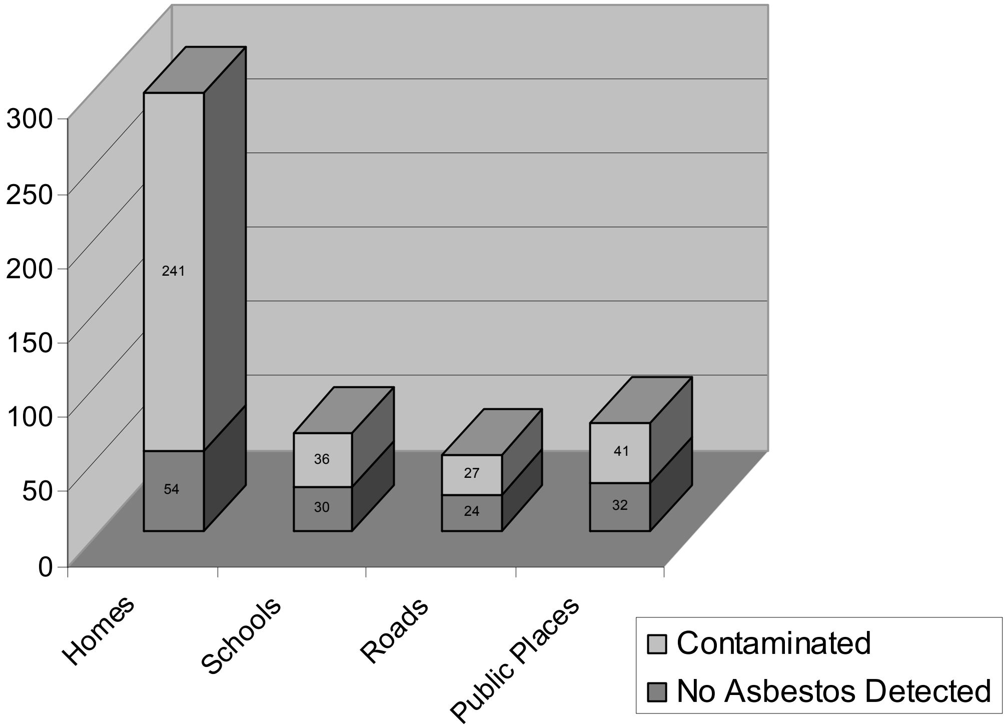

Figure 2: Summary of Results by Land Use

The results indicate that contamination is primarily a factor of human influences and is not necessarily related to prevailing wind directions, runoff or other physical or climatologic factors such as distance to the nearest mine site. The use of asbestos waste material in the construction of homes, schools, playgrounds and roads was found to be the primary agent of contamination. In most cases, building material is of local origin and was made by mixing waste asbestos tailings into mortar, plaster and concrete. Given the dry and dusty environment, the potential for fiber release is considerable. In other cases, asbestos contaminated building material was recently broken down on site and replaced with asbestos free alternatives. Unfortunately, the contaminated debris was either left on site or not properly disposed of. The report estimates a total of 3,882 homes, 36 schools and 432 kilometres of roads are contaminated with asbestos within a total area of 6,667 square kilometers. This estimate excludes the prevalence of asbestos cement building materials (corrugated and flat roof panels are common) within the country (there are an estimated one million low-cost homes constructed with asbestos roofs).

The data was used to develop a risk based corrective action strategy to guide mitigation efforts. The risk model is a seven step process that looks at the condition of the building material, the concentration of asbestos contamination, the exposure potential based on the land use, if soil contamination is also present and the potential for childhood exposure. The model identified those sites that warrant immediate remediation efforts along with more detailed site specific investigations. These actions are currently being considered by the national and provincial governments.

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NATURE AND EXTENT OF THE EXPOSURE TO FIBROUS AMPHIBOLES IN BIANCAVILLA

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An epidemiological study on the mortality from malignant pleural mesothelioma was conducted in Italy between 1988 and 1992 [1]. The study evidenced a high and unusual cluster of malignant mesothelioma cases among the people living in Biancavilla, a 30.000 inhabitant town located on the south-western side of the Etnean volcanic area in Sicily.

Mesothelioma is considered a marker pointing to an occupational or environmental asbestos exposure. Environmental and mineralogical surveys in Biancavilla showed no asbestos exposure either from occupational activities or from the use of asbestos-containing manufactured products [2]. However, they allowed finding some sites which resulted to be the sources of the environmental diffusion of some amphibole minerals with fibrous habit [2,3]. Such fibres were also detected in the lung parenchyma of the only mesothelioma case of which it was possible to study the mineral fibre burden in the lungs: an 86-year-old woman ever resident in Biancavilla whose deadly disease had been diagnosed as pleural mesothelioma [2]. *In vivo* toxicological investigations on rats were subsequently carried out and evidenced the high potential to induce mesothelioma of the amphibole fibres [4]. On the basis of all these results, referred and discussed on the mentioned works, it was suggested [5] that the unusual cluster of mesotheliomas in Biancavilla might be caused by the exposure to the detected fibrous amphiboles.

The mineralogical and crystal-chemical studies carried out so far with specific methodologies on the fibrous amphiboles from Biancavilla have evidenced that their compositions and crystal morphologies can be related to those of the prismatic fluoro-edenite [3¸6]. However, the fibres present also a moderate compositional variability, so that some of them appear to be similar to calcic amphiboles like tremolite, winchite and richterite.

The aim of this study is to describe the diffusion of these fibrous amphiboles in the Biancavilla area and identify their sources. The obtained data may allow defining the health risk related to the past exposure to the detected amphibole fibres of the Biancavilla population.

Different Occurrences of the Amphibole Fibres

Concerning the "in situ" host material, amphibole fibres were detected in the friable volcanic products of the Etnean volcanic complex. Three main sites characterized by an abundant presence of mineral fibres were detected after sampling all around Biancavilla (figure 1). The fibres showed diameters in the submicron range. The three sites were designated as "Monte Calvario", "Poggio Mottese", "Freeway area" (Table 1).

- <u>The Monte Calvario</u> area (Fig 1: ①) is the area all around an old quarry located south-east of Biancavilla. The quarry had been widely exploited for the extraction of sand and rubble by the local building industry. The quarrying activities had altered the morphology of the region by pulling down a hill called Monte Calvario. An abundant presence of altered incoherent and very friable materials was found in the area. Their sources were both the brecciated benmoreitic lavas and piroclastic deposits. Previous mineralogical studies allowed detecting in these materials a fluorine amphibole with acicular and prismatic habit. Later it was identified as fluoro-edenite [6], a new end-member of the calcic amphibole series. Some amphibole fibres (identified as "sample 19") were also found in this area, particularly in the samples collected within the incoherent deposits located on the north perimeter of the quarry (Fig 1 ④). The fibres have a 0.33 µm mean diameter .

Figure 1- The map shows Biancavilla and the areas where the fibrous amphiboles were found

- The Poggio Mottese area (Fig 1 ②) is located north-east of Biancavilla and north of the Monte Calvario quarry. It is a rural area where there are both dwellings and tilled lands. The Poggio Mottese samples were taken from incoherent piroclastic deposits. Amphibole fibres with 0.43 µm mean diameter were found in this material.
- The rural area neighbouring the new freeway (Fig 1 ③) is located to the east of Biancavilla and north-east of the other two areas. There are neither dwellings nor tilled lands. Some minor caves had been occasionally exploited also in this area. Samples from this area consisted of very friable grey-whitish piroclastic material in which amphibole fibres (identified as "freeway fibre") with a 0.30 µm mean diameter were found.

Plaster/mortar samples (Table 1) were collected from thirty-eight buildings along an axis going from the old town centre of Biancavilla to its north built-up area. All the building materials used by the local building industry came from the Monte Calvario quarries. The search for the presence of the amphibole fibre contents in the building industry materials such as friable plaster, mortar etc., was focused on the buildings built from the Fifties to the end of the Nineties. During this period the most incoherent material had been quarried and used, and it was probably richer in amphibole fibres than the stones later mined. An abundant presence of amphibole fibres was found in the and their concentrations ranged from a few thousands up to $40x10^3$ fibres/mg of plaster. In total the 71% of the friable plaster samples resulted to be contaminated by amphibole fibres. The mean diameter of the detected fibres was 0.47 µm.

In March and April 2000 the municipality of Biancavilla had airborne particulate samples collected in areas with high dust emissions due mainly to unpaved roads. The samples were collected according to the national law guidelines on the evaluation of asbestos exposure. The urban area was divided into five parts. Each of them was searched for the most significant sites for sampling, with special care over those with buildings under construction and/or unpaved roads. Twenty-seven polycarbonate membrane filters on which the airborne particulate had been collected (Table 1) were analysed with scanning electron microscopy. Amphibole fibres were detected in twenty of them. The atmospheric fibre concentration calculated on the basis of the sampling conditions ranged from 1 up to 20 fibre/litre. The sites where the twenty samples had been collected were located prevalently in the areas north/north-east (Fig 1:**C,A,D)** and south/south-east (Fig 1: **B,E)** of the town. These areas were characterized by the presence of unpaved roads covered with inert material which had the same provenance of the material used by the local building industry and therefore abundantly polluted by fibres. The mean diameter of the detected airborne fibres was 0.46 µm.

Mineral fibres were also recovered from a sample taken from the lung parenchyma (Table 1) of a woman who died of pleural mesothelioma at the age of 86. It was reported that the woman was a housewife married to a farmer and that she had lived in Biancavilla for all her lifetime. A number of amphibole fibres and various “asbestos bodies” were detected in these samples. The mean diameter of such fibres was 0.52 µm.

TABLE 1: Sites and contexts in which amphibole fibres could be detected

CONTEXT	LOCALIZATION	CATEGORY
{1}Monte Calvario and neighbouring areas	South-East urban area	Old quarries
{2} Poggio Mottese	North-East urban area	Area neighbouring cultivated lands and dwellings
{3} Freeway area	East urban area	Uncultivated areas and old quarries
{4} Site 19	East Monte Calvario	Site on a steep escarpment
{5} Building plasters and mortars	Urban area (several sites)	Products from '50-'90 buildings
{6} Airborne particulate	Several sites North /North-East and South/South-East in the urban area	Airborne particulate sampled near unpaved roads
{7} Lung parenchima from a mesothelioma case		Autopsy sample from lung tissue

Chemistry of the fibrous amphiboles

In order to evaluate the nature and extent of the amphibole fibre diffusion in the Biancavilla area it is important to define the compositional relationships both of the prismatic fluoro-edenite to every fibrous amphibole and of every fibrous amphibole to the others. The amphibole and the fluoro-edenite compositions were compared after being determined with the analytical electron microscopy technique. The oxide concentrations in the fibrous amphiboles vs the oxide concentrations in the fluoro-edenite are reported in table 2 (where the fluoro-edenite values are the reference values).

The results evidenced that the fibres considered in this study present a moderate compositional variability. This is confirmed by the correlation coefficients of the fibrous amphibole compositions. On the other hand the differences between the fibres and the fluoro-edenite are more significant, especially with regard to the abundance of the Si, Mg, Ca and Fe oxides. The data show higher Mg and Ca contents in the prismatic fluoro-edenite, while Si and Fe contents are higher in the fibres.

TABLE 2: Oxide concentrations in amphibole fibres vs oxide concentrations in fluoro-edenite

ELEMENTS	FLUORO EDENITE {1}	POGGIO MOTTESE FIBRES {2}	FREEWAY FIBRES {3}	SITE 19 FIBRES {4}	PLASTER FIBRES {5}	AIRBORNE FIBRES {6}	LUNG PARENCHIMA FIBRES {7}
Na2O	1.0000	0.7415	0.9073	0.9073	0.7537	0.8707	0.9244
MgO	1.0000	0.7623	0.8148	0.9319	0.7721	0.7252	0.7937
Al2O3	1.0000	1.0833	1.0500	0.7292	1.1208	1.1771	1.2667
SiO2	1.0000	1.0319	1.0457	1.0296	1.0147	1.0122	0.9683
K2O	1.0000	0.8125	1.1146	0.8646	0.9792	1.0521	1.0625
CaO	1.0000	0.7778	0.7749	0.7585	0.8048	0.8309	0.8899
TiO2	1.0000	1.6867	1.6265	1.0482	1.6506	1.9157	1.8554
MnO	1.0000	1.6667	2.8462	1.1667	2.3333	1.7179	1.5385
FeO	1.0000	3.0903	1.8403	2.4653	2.9167	3.0590	2.8785

On the basis of the chemical differences in Table 2, a hierarchical tree was obtained in which the compositional relationships among the fibrous minerals are shown (figure 2).

The close affinities among the airborne particulate fibres {*6*}, the building material fibres {*5*} and the lung parenchyma fibres {*7*} are evident. Moreover all these fibres appear to be very close to the Poggio Mottese {*2*} amphibole phase. These data seem to suggest that the same amphibole fibre typology may be present in the four contexts just listed above. The little compositional variability among the fibre typologies ({*6*}, {*5*}, {*7*} and {*2*}) may be due to various reasons, first of all to the different "stories" of the fibres, i.e. the different compositions of the matrixes in which they were found.

On the other hand the fibrous phases recovered from Site 19 {4} and the Freeway Area {3} present a chemistry which is slightly different from that of the fibrous phases from the building plasters, the airborne and the lung parenchyma samples.

The phases {3} and {4} seem to be closer to the fluoro-edenite chemistry. Moreover the granulometry of these fibres, which present about 0.30 µm mean diameters, is different from that of the other detected fibres, which present mean diameters greater than 0.40 µm.

Conclusions

The finding of amphibole fibres in different areas near the town of Biancavilla (figure 1) points up their wide environmental diffusion. It is likely that the Biancavilla population had been exposed both to the fibres produced by the quarrying and use of volcanic material by the local building industry (building construction, road surface settling etc.) and to the fibres coming from the naturally contaminated areas. The use of the Monte Calvario sand and rubble involved the spreading of volcanic material containing dangerous fibres and is documented starting from the Fifties till the closing of the quarries in 2001. The results of this study suggest that the amphibole fibre diffusion in the Biancavilla environment had been maximum during the Sixties and the Seventies with the uncontrolled development of the local building industry. The fibres can be found not only in the old buildings but also in the unpaved roads, from which the airborne particulate fibres were collected.

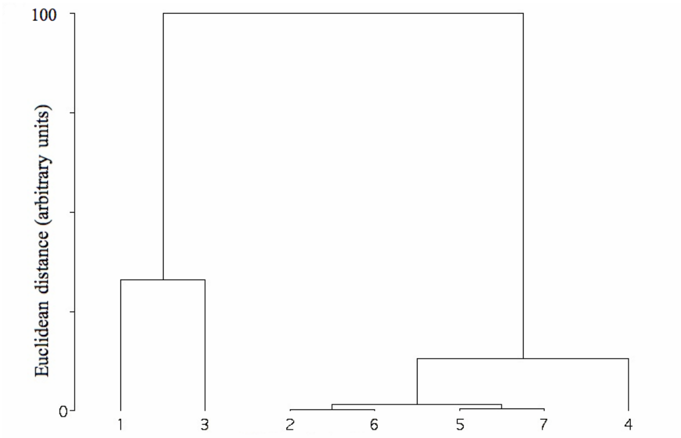

Figure 2 - Hierarchical tree obtained on the basis of the compositional data

The hierarchical tree in figure 2 shows that the fibres involved in the mesothelioma case are the same present in the environment, i.e. in plasters and airborne particulates from high dust emission areas. On the whole the obtained data show the extent and continuity in the time of the amphibole fibre diffusion in the Biancavilla environment and account for the unusual cluster of mesothelioma cases observed starting from the eighties. Today the environmental situation results to be changed following both the closing of the Monte Calvario quarries and the urbanization works after 2001, above all the asphalting of dusty roads. Anyway, considering the long mesothelioma latency period, some sporadic mesothelioma cases among the people who had lived in the Biancavilla area between 1960 and 1990 are very likely to occur in the next years.

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UNDERGROUND RECLAIMING FROM ASBESTOS. A CASE STUDY: ETERNIT INDUSTRIAL AREA IN BAGNOLI (NAPLES)

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In the last century Bagnoli industrial area was one of the most important metallurgic site in Italy, where the Eternit industry represented the materials primary source for the flanking iron and steel industry. At beginning of 90's the Italian authorities established the stop of industrial activities and the start of Bagnoli reclaiming operations in order to turn this area into a tourist and cultural place.

The asbestos removal from underground and its disposal is still one of the most problematic issues in Bagnoli.

This work describes the planned operations for the asbestos removal, mainly focusing on an efficient soil sampling during the initial characterization phase, so to define a detailed mapping about the compact and friable asbestos distribution and on the asbestos removal operations by the dynamic confining activities on the basis of the previous characterization results. Particularly, this paper contains also all the safety procedures performed in order to protect the close city centre, the local environment and the workers health and safety during the reclaiming activities.

The 150,000 m^2 of Eternit area extension was divided into main box units of 10,000 m^2, successively divided into subunits of 625 m^2 examined by an accuracy of 64 m^2. For each 64 m^2 subunit was indicated a single sampling point, where a particular sampling method has been performed, so that the sampling total number was about 1200.

This procedure led us to make a detailed map containing all the data about XY distribution, depth, thickness and the kind of the revealed asbestos. So, on the basis of such results the definition of operative sub-areas has been performed.

Finally, the asbestos removal activities have begun by dynamic confining for each defined sub-area, starting from critically regions where the friable asbestos has been found.

ASBESTOS FIBRES RELEASE FROM SERPENTINITES DURING QUARRY OPERATIONS: CASE STUDIES FROM EASTERN LIGURIAN OPHIOLITES

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1) Introduction

Asbestos-bearing rocks, such as serpentinites, can be a significant source of fibres release into the air, water and soils during quarry operations, which comprise several extraction procedures and the stacking, storing, depositing and/or treatment of excavated materials.

We have investigated three serpentinite quarries located in the "Torrente Petronio" Valley (Casarza Ligure, eastern Liguria, Italy) that were dismissed from less than one, five and about ten years, respectively.

The serpentinites of the studied area belong to the Bargonasco-Val Graveglia Massif and occur within the Northern Apennines ophiolitic sequences (Val di Vara Supergroup, Bracco-Graveglia Unit) that were affected by polyphase ductile and brittle deformations associated both with ocean floor and orogenic tectono-metamorphic events. The serpentinites of the investigated outcrops are extensively tectonised with several generations of faults and fractures.

2) Geological field observations and sampling

The exposed outcrops of the three quarries have been characterised following the scheme of the UNI EN ISO 14689-1 ("Indagini e prove geotecniche – Identificazione e classificazione delle rocce") modified and adapted for the specific case of the asbestos-bearing serpentinites.

On the basis of the field evidences, the outcropping rocks have been classified and mapped in the following four groups: A) massive serpentinites, B) fractured serpentinites, C) cataclastic serpentinites, and D) unconsolidated sediments.

A) Massive serpentinites represent 20-25% of the volume of the quarry fronts and occurs as subspheroidal or irregular shaped metric to decametric lenses that show a relatively low degree of fracturing. The fractures are pervasive and characterised by a mean (600-200 mm) or wide (2000-600 mm) spacing. The main systems are interconnected and form a network that subdivide the massive bodies in polyhedric blocks varying in size from 2000 to 200 mm. Fractures vary in thickness from 100 to 10 mm and are partially or completely filled by light green to whitish serpentine minerals generally with a macroscopic fibrous and/or columnar appearance.

B) Fractured serpentinites generally represent more than 70% of the volume of the quarry fronts. Serpentinites of this group show a high degree of fracturing and are subdivided in polyhedric to irregular blocks varying in size from 600 to 60 mm. They are characterised by two main sets of conjugated fractures (with a spacing of 600-200 mm and a thickness varying from 100 to 10 mm) and several irregularly distributed and less pervasive fracture systems, mainly related to local stresses. The fractures (see chapter 5) are partially to completely filled with whitish to light green serpentine minerals often with a well visible fibrous habit. In the thickest fractures the fibres are soft and friable and clearly tend to detach as a consequence of water flow or other erosion processes (Fig. 1a).

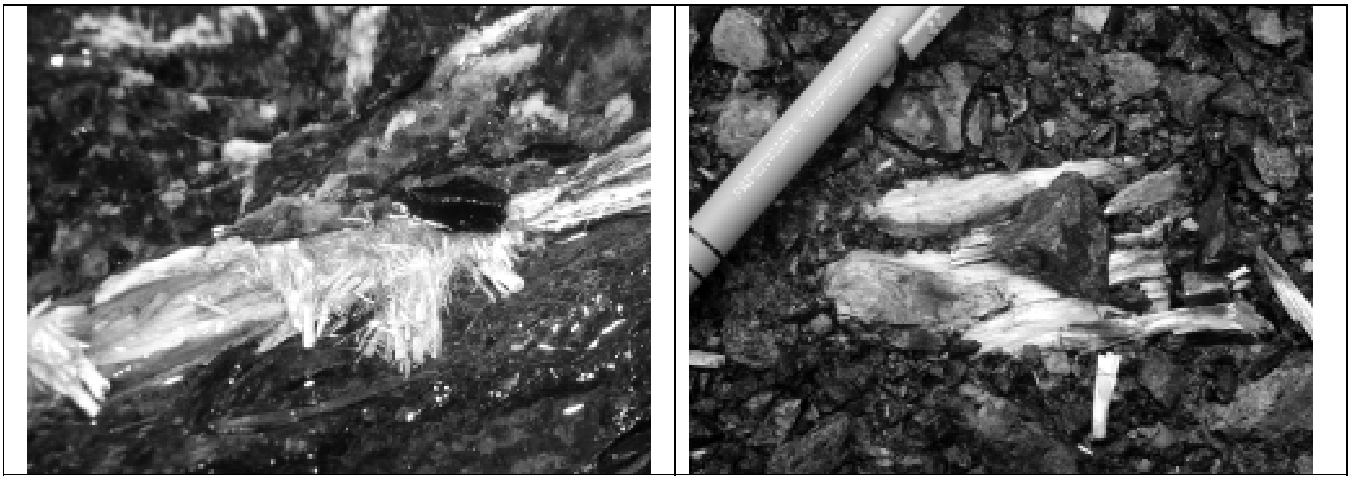

Fig.1: a) soft and friable fibres bundles partially detached from an outcropping fracture (fracture thickness = 1 cm); b) free rigid fibres bundles on the sediment of a quarry floor

C) Cataclastic serpentinites are ubiquitous but generally represent less than 5-10% of the volume of the quarry fronts. They occur along fault zones and typically enclose the massive serpentinite lenses. They are characterised by a very high degree of fracturing that often determine the development of cohesive cataclasites and sometimes of poorly cohesive fault breccias. The fractures have a narrow (220-60 mm) or a very narrow (<60 mm) spacing and a thickness varying from 2.5 to 0.1 mm; they are partially or completely filled by light green and/or whitish minerals with massive and sometimes fibrous macroscopic appearance.

Erosion due to water circulation within fractures commonly determines the release of fibres and fibres bundles and sheaves, which progressively accumulate in the sediments of the quarry floors (Fig. 1b).

D) Unconsolidated sediments derive from erosion processes, landslides and rock falls as well as from extraction procedures and treatment of excavated materials. They are characterised by the presence of free fibres bundles over the entire quarry areas, in particular close to the vertical cuttings and in the stockpile areas.

On the basis of these evidences every group have been mapped and sampled. Over 100 hundred samples have been recovered in the three quarries. For the unconsolidated sediments, about 5 kg of sample have been collected after quartering. Moreover every occurrence of free or easily releasable macroscopic fibres have been described, mapped and sampled.

3) Analytical methods

All samples have been analysed by a combination of optical (stereoscopic and transmitted transmitted light microscopy) and X-ray powder diffraction (XRPD) techniques.

For the optical microscopy analyses all rocks and unconsolidated sediment samples were preliminary embedded in epoxy resin and then prepared for standard thin sections.

Qualitative and quantitative analyses have been performed using a Leica Polarizing Microscope equipped with an electronic point counter.

Macroscopic fibrous minerals, covering the sample surfaces or filling open fractures, veins, and voids, have been scraped and prepared both for the XRPD and optical microscopy analyses.

XRPD analyses were carried out using a Philips PW1140-X-CHANGE diffractometer (CuKα radiation; current 30 mA, voltage 40 kV, scan speed, 0.5°2θ/min; scan interval, 3-70° 2θ.) and interfaced with PC-APD software for data acquisition and processing.

4) Mineralogy and petrography of serpentinites

Serpentinites of the four groups mainly differ for the degree of fracturing and for the deformation intensity and style but are quite homogeneous for mineralogical composition as well as for their textural features. The main mineral phases, in order of decreasing abundance, are lizardite, chrysotile, magnetite and other spinels, and chlorite. Subordinate amounts of calcite, dolomite, talc, tremolite, and clay minerals, are almost ubiquitous in all samples

Serpentinites are typically characterised by mesh textures and bastites, deriving by the pseudomorphic replacement of olivine and pyroxene, respectively (Fig. 2a-b)

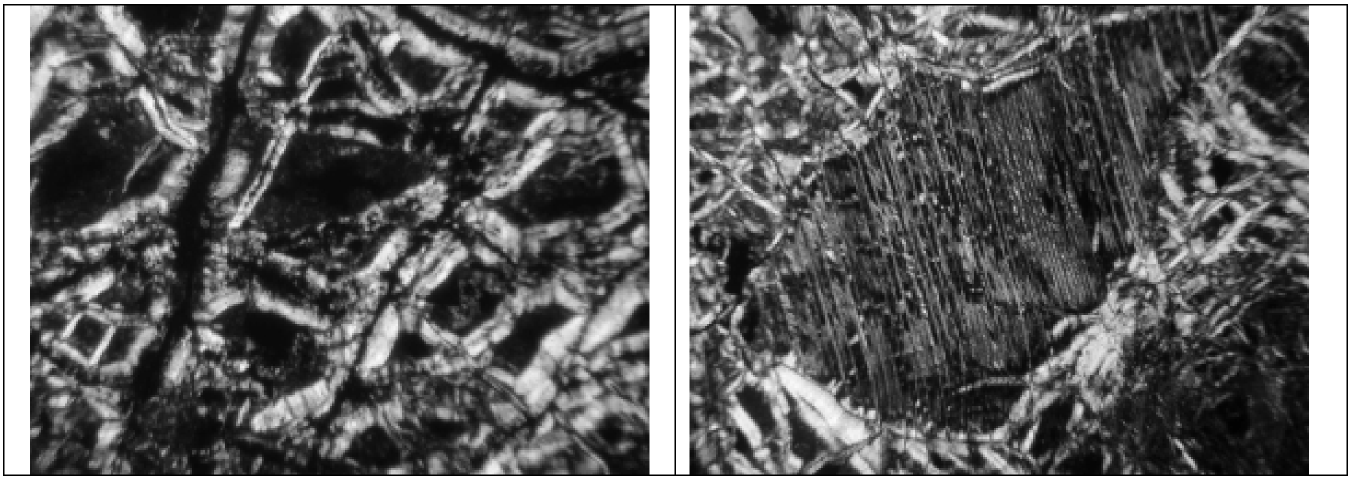

Fig.2: transmitted light microphotographs of a) mesh texture (crossed polars; field of view = 2.5 mm); b) bastite pseudomorph (crossed polars; field of view = 5 mm)

Mesh textures are characterised by fibrous chrysotile, forming the mesh rim, and lizardite, representing the "holes" of the mesh. Usually magnetite forms elongated fine-grained aggregates along the mesh rims, sometimes associated with chlorite patches. Locally euhedral magnetite crystals occur within the lizardite mesh cores. Chrysotile fibres in this texture vary from 0.3 to 0.1 mm in length and have a diameter <0.05 mm.

Locally mesh textures are deformed and appear as elongated irregular bands centered by lamellar lizardite and rimmed by tiny and short chrysotile fibres (ribbon textures).

Bastite pseudomorphs after pyroxene are mostly composed of lizardite lamellae with fibrous chrysotile (generally < 10 μm in length) along the cleavage planes.

Most of the serpentinite samples are characterised by the presence of different types of microfractures (<0.2 mm in thickness) that have been distinguished on the basis of the mineral filling: a) chrysotile; b) chrysotile + lizardite ± magnetite; c) lizardite + calcite ± chrysotile ± chlorite; d) calcite ± dolomite. Fibrous chrysotile-bearing microfractures represent more than 50% of the total. Chrysotile fibres within these microfractures are generally < 0.2 mm in length and < 0.01 mm in diameter.

On the basis of visual estimation and point counting results the modal abundance of fibrous chrysotile occurring in massive textures and microfractures varies from 25 to 35%.

5) Chrysotile-bearing fracture and veins

Chrysotile-bearing macrofractures and veins, thicker than 1mm, are ubiquitous over the fronts of the three studied quarries. They are either single or show connectivities ranging from branched to nonbranched. On the basis of the potential asbestos risk assessment (i.e., chrysotile fibres releasability), textural features and mineral filling, the following types can be distinguished: A) serrate chrysotile-bearing veins; B) composite chrystotile ± lizardite veins with soft fibres sheaves; C) chrysotile coatings. A) Serrate chrysotile veins are generally monomineralic and range in colour from white through light to dark green. They mostly vary in thickness from 1 mm up to 1 cm and consist of parallel aggregates of rigid fibres. Commonly, when these veins outcrop, single fibres or fibres bundles are partially detached. Most of these veins correspond to the syntaxial and antitaxial veins described in [1]. B) Composite chrysotile ± lizardite veins are characterised by various and complex textural features. The veins of this type are generally characterised by the presence of chrysotile fibres sheaves (up to tens of millimeters in length) with different orientation. Every time these veins intercept the surface of the quarry fronts, several centimetric soft and friable bundles of fibres outcrop (fig. 1a). C) Chrysotile coatings are widespread over the three quarry fronts and are particularly abundant in fractured and cataclastic serpentinites. Most of these coatings represent the exposed surface of slip-fibre veins [2] that are characterised by the near-parallel orientation of the fibres and the edge of the vein. Within these coatings fibres are generally rigids, and occurs as parallels aggregates that form elongated tabular and columnar sheaves, generally light green to whitish in colour. Also in this case any superficial erosive process may trigger significant fibres release.

6) Unconsolidated sediments

The presence of abundant unconsolidated sediments is a common feature of the three quarries. They may derive either from physical erosion of the outcropping rocks and form several quarry operations, which include all the extraction procedures and the stacking, storing, depositing and/or treatment of excavated materials. Comparative analyses of the two sediment types evidenced strong enrichment (up to 1-2 order of magnitude) in free or easily releasable fibres in all sediments produced during quarry operations. The highest enrichments were detected close to the more recent quarry cuts and in all the sand and gravel piles derived from milling. These evidences can be explained if we consider that mechanical excavation and milling are fast processes that act preferentially along vein and fracture surfaces. Optical microscopy analyses evidences that all sediment types are almost exclusively composed (90-95%) by serpentinite grains. These grains can be further subdivided in massive serpentinite fragments (mainly characterised by mesh textures and bastites) and fragments of fibrous chrysotile-bearing veins (Fig 3a). Fibrous fragments generally represent 6 to 10 % of the sediment grains and reach the maximum values in the milled piles (up to 20-25%). Moreover within sediments several free fibres (100-10 µm in length and < 10 µm in diameter) have been observed (Fig. 3b). Quantitative XRD analyses evidences chrysotile concentration in sediments variable from 467 mg/kg (natural sediments) to more than 25000 mg/kg (recent quarry-derived sediments).

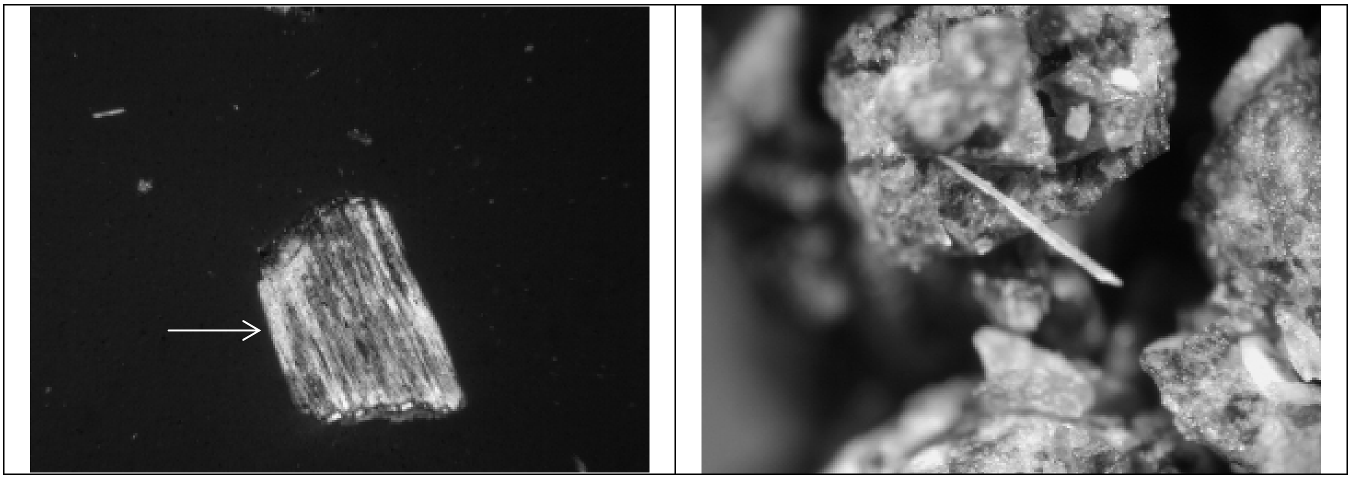

Fig.2: a) sediment grain entirely composed of chrysotile fibres (transmitted light microphotographs, crossed polars; field of view = 5 mm); b) stereomicrophotograph of a free chrysotile fibre within milled sediments (fibre length = 40 μm)

7) Conclusion

- Serpentinites of the studied quarries contain abundant chrysotile (up to 20-25% of the total mineral species) occurring in a variety of pseudomorphic and nonpseudomorphic textures [2]. The chrysotile fibres in these massive textures are to be considered not easily releasable during erosion processes or quarry operations.
- On the contrary, all the different chrysotile-bearing vein types represent the major potential source of asbestos fibres release into the air, water, and soils in all the studied quarry fronts. For these reason their occurrences must be always carefully researched, pointed out, mapped, and quantitatively estimated to prevent potentially hazardous quarry operations.
- Sediments as well as crushing muds derived from quarry operations or stacked in piles after millings are strongly enriched in free chrysotile fibres or fibrous bundle. Any disturbance of these fibres-rich sediments has the potential to release asbestos into the ambient air.
- An effective evaluation of the asbestos risk before quarry authorization cannot only be based on the analytical procedures scheduled on the D.M. 14.05.1996 of the Italian Normative, but should be performed through a systematic geological, mineralogical and petrographical study of the area that must comprise a) geological field observation, b) definition of a sampling strategy, c) characterization of outcropping rocks by means of mineralogical, petrographical and geotechnical analyses, d) quantitative determination of asbestos in bulk samples, and e) estimation of the amount of asbestos effectively released not only in ambient air but also in sediments and crushing muds.

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IL RISCHIO DA ROCCE AMIANTIFERE NELL'AMBIENTE NATURALE: CORRELAZIONE TRA GRADO DI EROSIONE E DISPERSIONE A DISTANZA

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Il recente interesse sull' approfondimento della composizione geologica degli Appennini ha messo in luce la frequente reperibilità di rocce amiantifere. Questo lavoro relaziona sul reperimento di tremolite in affioramenti diffusi nel territorio dei contrafforti presilani, oltre che nell'Appenino Lucano, già noto.

È stato monitorato il grado di diffusione di fibre libere dalle rocce prive di vegetazione spontanea, sia sopra vento che sottovento, a distanze variabili tra i m.10 e i m.100 circa in linea d'aria, oltre che a distanza ravvicinata, con campionature eseguite in doppio per permettere lettura dei filtri sia in MOCF che in SEM.

Sui siti è stata anche eseguita determinazione dell'indice di rilascio delle rocce oggetto di monitoraggio, e valutato il tenore del contenuto di amianto in comparazione con tecniche differenti (FTIR e MOCF e SEM) contro standards puri.

I valori di dispersione, valutati in fibre/mc, sono stati quindi relazionati alla natura mineralogico-petrografica, al contenuto relativo di materiali amiantiferi, e alla loro compattezza, al fine di poter prevedere statisticamente la disperdibilità di materiali fibrosi naturali nell'ambiente naturale.

È stata quindi comparata la dispersione naturale ambientale ai livelli di dispersione indotta dalle attività di coltivazione delle rocce a fini commerciali.

L'esito di queste comparazioni, seppur rassicurante alla luce delle vigenti normative, evidenzia la assoluta necessità di piena osservanza della classificazione sistematica sul territorio delle pietre verdi, nonché di quelle geomorfologicamente assimilabili, e tanto in via preliminare al rilascio di autorizzazione alla coltivazione, così come l'opportunità di confinamento naturale mediante piantumazione/ forestazione, ove possibile, dei materiali fibrosi affioranti.

Materiali e Metodi

Nel corso del 2006 è stata eseguita ricerca specifica sui minerali naturali presenti in un sito dei preappennini calabro-tirrenici, già identificati come materiali anfibolici mineralogicamente affini al tipo *tremolite* negli anni addietro. [1, 2]; il sito è caratterizzato da una pregressa attività di coltivazione di cava provvista di propria viabilità interna, non asfaltata, in adiacenza ad una strada provinciale, e sul fronte opposto dal restante complesso collinare - montuoso (altezza s.l.m. ca 650 m.) ove sono chiaramente visibili affioramenti di "pietre verdi", così come identificabili nel D.M. 14 maggio 1996, n.178,

Sono stati eseguiti prelievi di campioni massivi sia sul fronte di cava che dai residui di lavorazione o comunque presenti, nonché da tre distinti affioramenti altrove presenti nelle vicinanze ma fuori dall'ex area di cava. Su questi campioni è stata eseguita analisi per la ricerca di materiali asbestosici sia con tecnica MOCF che in FTIR, nonché in SEM+EDS.

È stata altresì eseguita prova oggettiva di degrado superficiale così come descritta dalla Norma UNI EN 10608 sulle superfici piane reperibili ed idonee allo scopo, il cui risultato è stato espresso in mg/cm^2.

Nelle quattro aree come sopra indicate, inoltre, sono stati eseguiti monitoraggi ambientali per la verifica di dispersione di polveri e fibre dai minerali in situ; segnatamente – trattandosi di materiali con andamento grossolanamente parallelo al piano di campagna circostante – si è proceduto al campionamento di aria a circa m.1,50 dal piano di campagna relativo in sopravento, in sottovento nonché, dove possibile, anche a 90° e 270° dalla direzione del vento.

Delle quattro aree prescelte, due sono state selezionate a maggiore distanza dalla strada provinciale, discretamente trafficata, di accesso al sito, mentre le due rimanenti si trovano a distanza dalla strada stessa sufficiente a far ritenere del tutto ininfluente il transito veicolare.

Resta inteso che, poiché nel corso dei rilevamenti, la condizione di vento prevalente è risultata variabile nell'arco della giornata, i risultati sono successivamente stati aggregati rispetto non alla posizione assoluta bensì rispetto alla direzione del vento stesso al momento di esecuzione dei campionamenti. I campionamenti sono stati eseguiti in più giornate con condizioni metereologiche simili (vento leggero tra 0,8 e 1,2 m/s, umidità relativa compresa tra 30% e 40%, temperature variabili tra i 28°C e i 35 °C) in numero di 7 ripetizioni per ognuna delle 12 postazioni fissate, per complessivi 72 campionamenti relativi alle 4 descritte postazioni sorvegliate. I monitoraggi ambientali , eseguiti mediante campionatori del tipo personale su idonei supporti, sono stati parzialmente effettuati in doppio sia su membrana di estere di cellulosa che su policarbonato, onde consentire la successiva analisi comparativa con tecnica MOCF + dispersione cromatica in liquidi ad alta densità che in Microscopia Elettronica a Scansione + EDS.

Descrizione dei risultati

Complessivamente, gli 8 campioni, indicati con lettere dalla A alla H, raccolti ed analizzati corrispondono a due tipologie prevalenti, la prima come minerale di tipo compatto (di tipo simile ai graniti), la seconda come minerale con aspetto più friabile (di tipo scistoso), e sono stati identificati con lettere dalla A alla H.

Essi hanno presentato tutti alla microscopia ottica in contrasto di fase, dopo blanda macinazione in mortaio a pestello d'agata, la presenza di fibre, fibrille ed acidule; sotto posti ad indagine analitica quantitativa, hanno rivelato la presenza di amianto del tipo tremolite in percentuali variabili dal 33% al 95%, come indicato nella fig. 1:

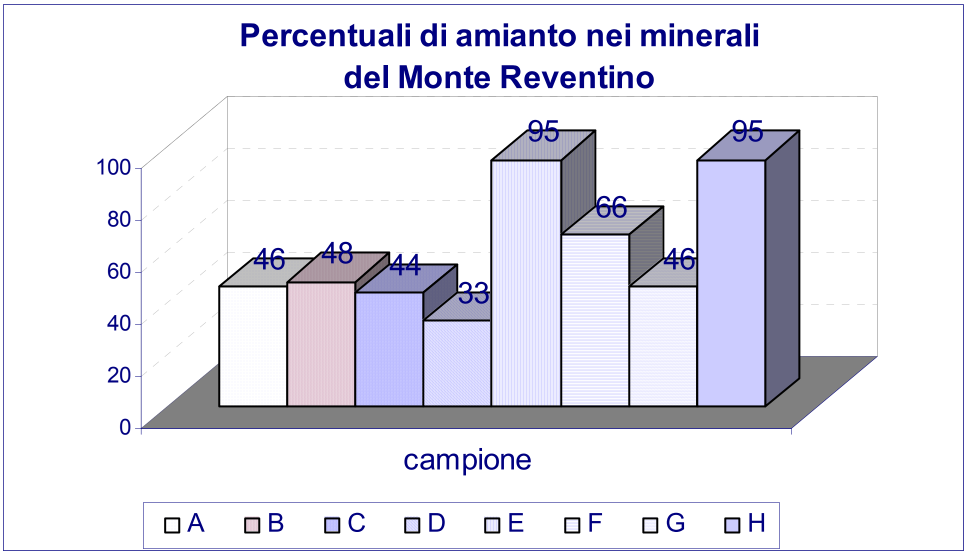

Figura 1

L'indice di rilascio, calcolato secondo i dettami del D.Lgs. 258/05, sono risultati compresi tra 0,35 e 1,29, come da figura 2:

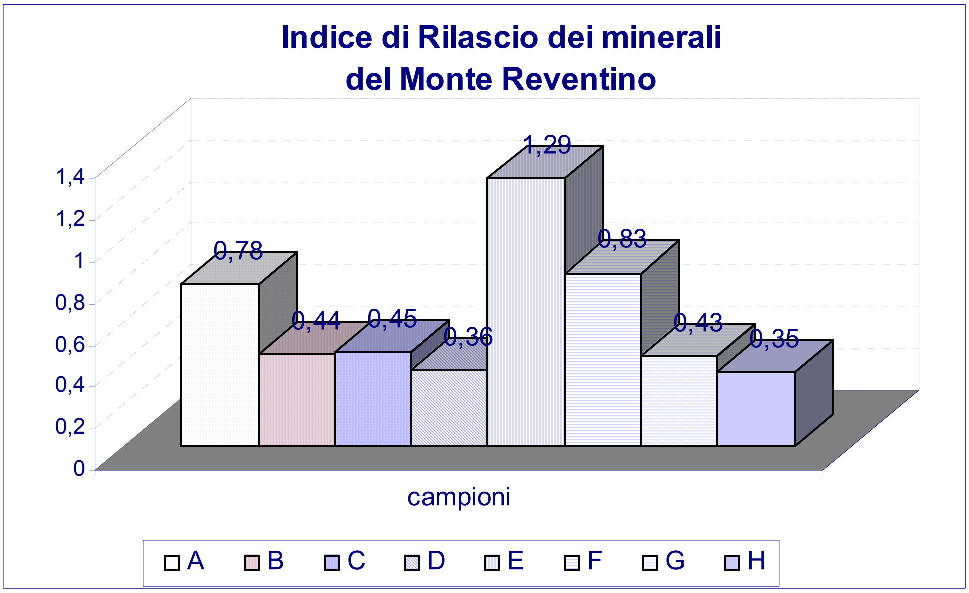

Figura 2

Ancora, su 3 postazioni dei minerali in situ da cui sono stati raccolti i campioni sono state eseguite prove di degrado superficiale, per verificare la capacità di dispersione di materiali dagli stessi.

Al merito, si segnala che la prova I si riferisce alla porzione di roccia da cui è stato prelevato il campione D, sul fronte di cava dismessa, mentre la prova II si riferisce agli affioramenti di minerale con caratteristiche scistose presenti lungo la strada provinciale di accesso al sito.

Descrizione area	Condizioni di degrado superficiale in mg/cm^2
I . Minerale da ex-fronte di cava	**0,65**
II . Roccia affiorante libera	***108,87***

Tabella 1

Come si può notare dai dati emersi, le rocce affioranti di tipo scistoso tendono a perdere considerevolmente masse superficiali, così come consueto in queste conformazioni di per sé poco compatte, ed è per questo motivo che questa conformazione mineralogica viene difficilmente sfruttata per l'impiego commerciale in lastre ornamentali, mentre talvolta è ritenuta motivo di appetibilità per lo sfruttamento come cava di materiali inerti da riporto e riempimento.

Nella pagina che segue si riportano infine i risultati del monitoraggio di fibre aerodisperse che sono stati eseguiti in prossimità dei punti di attenzione oggetto del presente studio. Si segnala, per comodità di lettura, che alla posizione rispetto ai venti presenti al momento dei vari campionamenti (72 complessivamente) è stato assegnata simbologia in gradi "°", intendendosi riferimento a 0° per la posizione sopra vento del campionatore rispetto al minerale, 180° per la posizione sottovento ed a seguire 90° e 270° per le rimanenti postazioni.

Postazione minerali affioranti sparsi				
	1°giorno	2°giorno	3°giorno	**Media 3 gg**
Direzione del vento	**ff/mc**	**ff/mc**	**ff/mc**	**ff/mc**
0°	372	1089	730	730
90°	631	2542	1345	1506
180°	728	2424	1947	1699
270°	0	1104	1201	768
Postazione minerali affioranti massicci				
	1°giorno	2°giorno	3°giorno	**Media 3 gg**
Direzione del vento	**ff/mc**	**ff/mc**	**ff/mc**	**ff/mc**
0°	1323	2161	3233	2239
90°	1781	7371	4298	4483
180°	1876	3484	5447	3602
270°	1964	3253	3113	2776
Postazione lungo strada c/o minerali affioranti massicci (ex area cava)				
	1°giorno	2°giorno	3°giorno	**Media 3 gg**
Direzione del vento	**ff/mc**	**ff/mc**	**ff/mc**	**ff/mc**
0° (lato strada)	3976	6098	4493	4856
180°	863	2941	2471	2091
Postazione lungo strada c/o minerali affioranti sparsi				
	1°giorno	2°giorno	3°giorno	**Media 3 gg**
Direzione del vento	**ff/mc**	**ff/mc**	**ff/mc**	**ff/mc**
0° (lato strada)	1233	711	510	818
180°	0	1169	386	518

Tabella 2

Si può notare che le posizioni sottovento presentano concentrazione prevalentemente maggiore rispetto alle omologhe sopravento, tranne che per le zone in immediata prossimità della strada dove il transito veicolare evidentemente smuove le sedimentazioni formatisi con l'erosione eolica ed il dilavamento meteorico.

Per quanto i dati sopra riportati debbano intendersi, comunque, approssimati al centinaio (le decine e le unità si ottengono per conversione del risultato da ff/lt a ff/m^3), emerge chiaramente che la concentrazione di fibre aerodisperse nell'ex area di cava è sensibilmente superiore che nelle zone non coltivate, in buon accordo all'esito sia delle prove di degrado superficiale che degli Indici di Rilascio misurati.

In particolare, si nota che la concentrazione apparentemente più bassa di fibre aerodisperse è da intendersi correlata più al minor tenore in materiali asbestosici degli affioramenti definiti "sparsi" che non all'Indice di Rilascio, mentre per contro risulta direttamente proporzionale all'intrinseca caratteristica di degradabilità superficiale dei minerali oggetto di studio. I risultati di aerodispersione naturale rendono ragione dei risultati di monitoraggi eseguiti da altri autori per le attività di lavorazione delle rocce verdi in questione, che riportano dati di esposizione sempre inferiori a 60 ff/lt (e quindi a 60000 ff/m^3) per gli operatori addetti.

Conclusioni

Nelle rocce costituenti i preappennini calabri sono presenti quantità significative di tremolite, che rendono opportuna ed anzi necessaria un'attenta valutazione del tenore di materiali asbestosici nelle rocce medesime, sia in occasione della concessione di sfruttamento minerario che in occasione dell'esecuzione di Grandi Opere Pubbliche che incidano distruttivamente sui minerali stessi, in particolare per quanto attiene la produzione di sterili, nel caso dello sfruttamento minerario, ovvero la aerodispersione di polveri dalla movimentazione dello smarino, per le Grandi Opere Pubbliche.

AIRBORNE POLLUTION AT BIANCAVILLA (CATANIA, SICILY, ITALY) – NATIONAL INTEREST SITE – BEFORE AND AFTER REMEDIATION: AREAL DISTRIBUTION OF ASBESTOS-LIKE PARTICULATE MATTER.

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** ISPESL- Higher Italian Institute for Occupational Health and Safety- Department for Production Facilities and Human Settlements (DIPIA) - Research Assignment

Introduction

In the municipality of Biancavilla, in the province of Catania, Sicily, high concentrations of asbestos-like fibers have been detected deriving from the fluoro-edenite coming from two sites where volcanic material had been quarried to be used for buildings, fillings in road construction, public works, etc.

Such material did not fall under Act 257/92 on asbestos, and yet its behaviour is comparable to asbestos so much so that it could be considered – as stated later – as a highly carcinogenic pollutant.

The dispersion of volcanic material throughout the city area and the closeness to the quarrying sites - currently inside the urban area – caused a wide dissemination of risk and high concentration of asbestos-like airborne fibers throughout the city; thus exposing to this carcinogenic agent non only the people entering the quarrying sites but everybody living and working in the municipality.

The Department for Production Facilities and Human Settlements of ISPESL (DIPIA) being the National Scientific and Technical Agency, upon request of the Italian Ministry for the Environment and Territory Protection – the institution for emergency containment and subsequent remediation of contaminated sites – carried out an investigation monitoring the environment to assess the severity of pollution in various urban areas to identify indications to draft adequate prevention measures to safeguard citizens and environment health and safety.

The paper will present the results of monitoring campaigns before and after the emergency containment actions envisaged, to assess their effectiveness.

Investigations before remediation actions.

A number of papers by the Italian High Institute for Health, on the both epidemiology and mineralogy, referred in the past of a higher than normal death rates in Biancavilla for pleural mesothelioma and lung cancer.

Early analytical tests (X-ray diffraction and microanalysis) detected a polluting mineral whose characteristics were similar to tremolite (Ca and Mg silicates) and/or actinolite (Ca, Mg and Fe silicates) with variable Al, Na and F presence.

More accurate studies carried out by Dr. Gianfagna from the Rome University showed that at crystallization - in the mineral formation stage – fluorine had replaced the -OH groups of edenite giving rise to a new mineral defined as fluoro-edenite by the “Commission on New Mineral and New Mineral Names” (CNMMN).

This mineral had already been identified as a synthetic material but it had never been found in nature.

The morphology and chemical composition of fluoro-edenite resembles those of amphibole asbestos. Like asbestos, it causes respiratory illnesses as acknowledged by Act 257/92, hence the Conference of Services at the Ministry for the Environment, in agreement with national scientific agencies, decided that safety measures had to be adopted for the population and remediation actions had to be implemented as for asbestos.

The Italian Ministry for the Environment and Territory Protection commissioned ISPESL an early environmental investigation in urban areas, detecting very high concentration of asbestos-like fibers at the two quarrying sites in Biancavilla and very alarming levels were detected near quarrying crushing units (60-80ff/l) and loading areas. Similarly alarming concentration were detected for garbage collectors (60-70 ff/l) and close to municipal areas with dirt roads.

Based on these preliminary analytical results, the Italian Ministry for the Environment decided a number of actions among which the closing down of two quarrying sites and the starting off of the procedure for emergency containment and the widening up of environmental investigation to include the whole municipal area.

ISPESL, following up on the Ministry request, carried out a number of environmental monitoring campaigns to identify the source of contamination and the concentration of fibres in bulk material and airborne particles at the quarrying sites and in the whole residential area.

In particular, various samples of lava rock have been taken in the two quarrying sites in the Monte Calvario area, together with samples of particulate matter around the crushing unit, along the conveyor belt and the loading area in front of the excavation facing.

Furthermore, additional samples of bulk excavation material have been collected where the underground around the Etna is being built, between Biancavilla and Catania to assess whether they complied with the features of the material collected at the above-mentioned quarrying sites, which they did.

The results of sample analyses identified a very large area polluted by asbestos-like fibres.

The analysis of hundreds of core samples taken from different spots within the Biancavilla municipality proved the soil to be polluted with fluoro-edenite at variable concentrations and a wide area being at risk.

To monitor air pollution in the residential area and next to the quarrying sites, samples were taken at the crushing units and in the loading areas of the quarry, in different parts of the city - 4 of which in correspondence with the urban areas involved with remediation actions (North, East, South and West) presented by the Biancavilla local authority and 1 downtown.

In table 1, average values are recorded as measured in the 5 above-mentioned areas in the residential parts of the city. The areas had been chosen by the remediation project as indicative of the living and working conditions in town.

Table 1 – Biancavilla: environmental samples in town: environmental monitoring March-April 2000

Area	sample location	Camp.	SEM Results (ff/l)	Camp.	Results PCM (ff/l)
A	Via Vittorio Emanuele 467 (pressi Comune) (1)			A 90	< 1
B	Via dell'Edera, uscita scuola Don Bosco (2)	E 24	3,2		
C	Via dell'Oste n.1 (vicino-interno cava) (3)	C 155-156	1,2	C 42	1
D	Via Ravenna (4)	D 20	7,8		
E	Via Norvegia (5)	B1	8,2		

(1) Paved-road in the residential area
(2) Dirt road used by school bus
(3) Dirt road next to and inside quarrying site
(4) High traffic dirt road (close to supermarket)
(5) High traffic dirt road

The results highlighted the constant presence of airborne fluoro-edenite all over the urban area, always exceeding the threshold value of 1f/l as set by the WHO document "Air Quality Guidelines for Europe", 1987 in nearly all selected areas in the city environment.
Highest levels were recorded close to dirt roads, urban traffic and next to the quarrying sites. Indeed there is a difference in the samples from the dirt roads with heavy traffic and the paved roads downtown with heavy traffic as well.
Based on these records and thanks to the financing granted by the Italian Ministry for the Environment and the Extraordinary Commissioner for the Waste Emergency in Sicily, emergency containment measures have been adopted and implemented at the following sites:

Emergency containment measures
Environmental surveys carried out by the Higher Institute for Health and ISPELS in particular lead to the identification of polluting sources, assessment of contamination level and pinpoint the emergency containment measures subsequently implemented:

- closing down quarrying sites and paving dirt roads
- Disposal of filling material, rubble and dusts often to be found in heaps at the edge of dirt roads in adequate bags after wetting or treatment with encapsulating products.
- Landfilling debris deriving form urbanization works and the excavation of metropolitan tunnel
- Special precautions during street sweeping (masks with P3 filters to be used by garbage collectors)
- Replacing the sweeper in use by the local authority with asbestos specific equipment
- All wet cleaning operations also at home and no sweeping by citizens of dirt areas in front of the buildings
- avoiding whenever possible the use in public and domestic buildings of forced air systems without specific filters (fans, air conditioners)
- Laying down that school buses should stop the engine when making stops along paved roads
- Resurfacing the area of the contaminated sports ground with grassy layer or other off-the-shelf option

City roads before and after
emergency containment measures

Post Emergency Containment sampling procedures

After the adoption of the above-mentioned Emergency Containment measures, ISPESL carried out an additional environmental survey to assess their effectiveness, in April 2006, monitoring the airborne concentration in various urban neighbourhoods.

To obtain comparable results, measurements were performed on the same locations (or close to in the case of D in the following table 2) of the 5 area subdivisions where earlier measurements had been taken.

Unlike with the first campaign, two samples were taken at each station, one to be analyzed at SEM and the other at Phase Contrast Optic Microscope.

Samples of airborne dusts for Phase Contrast Optic Microscope analysis were obtained after filtration through mixed ester cellulose filters with a 25mm diameter and 0,8 μm porosity, using high flow environmental sample taking equipment (10 l/m) by Analitica Strumenti, Air-cube model for a volume of 3,000 liters.

Filter readings were performed, after adequate filter preparation, in compliance with Ministerial Decree 6/9/94, Annex 2.

All standard measure fibers were counted (length over 5μm, diameter < 3μm and diameter/length ratio>1:3) that were present in 200 reading fields per each sample.

During microscope analysis, attention was devoted also to micronized fibers. For SEM analysis and Energy Dispersive X-Ray Analysis (EDXA), air samples were obtained by filtration through 25 mm diameter and 0.4μm porosity polycarbonate membrane, using a high flow environmental sampler (10 l/m) Air-cube l by Analitica Strumenti, for a volume of 3,000 liters.

After adequate filter preparation, the filters used for the sampling were analyzed using Leo 1430 SEM by Assing, equipped with EDXA;
The analysis was performed at 2,000 x magnification, on at least 94 fields, that were considered as sufficient in view of the microscope in use and its selected magnification power, for a 1 mm^2 area per filter as laid down in Min. Dec. No. 288 of 6/9/1994
On each filter, fibres longer than 5µm, with diameter ≤ 3µm and diameter/length ratio 1:3 were counted, and the presence of microfibers in the fields of analysis was recorded.

Results of the sampling after the Emergency Containment

Table 2 shows asbestos-like fiber concentration obtained with SEM and PCOM of the samples taken in various urban areas as previously described.

Table 2-Biancavilla: environmental samples in town- environmental monitoring of April 4-5-6, 2006

Area	Sampling station	Camp.	SEM Results (ff/l)	Microfibres present	Camp.	PCM Results (ff/l)	Microfibres present
A	Comune: Via Vittorio Emanuele 467	A 9	0,1	some	A 1	0,6	numerous in few fields
B	Via dell'Edera, uscita scuola Don Bosco	A 8	0,19		A 2	0,33	some in few filds
C	Via dell'Oste n.9	A 3	0,56		A 7	0,26	some iin few fields
sD	Via Filippo Turati151 (pressi v. Ravenna)	A 10	0,17	some	A 4	0,27	
E	Via Norvegia 19	A 6	0,34		A 5	0,4	few

The results confirmed the presence in all samples of amphibolic fluoro-edenite type mineral fibres similar to those identified by previous sampling in the urban area, never exceeding the threshold for urban environments of 1f/l as set by the WHO document "Air Quality Guidelines for Europe", 1987.
Among all samples, only those comparable for logistic (same station) and environmental (same season) reasons were analysed. The analysis evidenced a dissemination of fibres all over the town, with the highest concentration recorded at the station closest to the quarrying sites (C area) and higher concentrations in the various neighbourhoods in the E area, in the outskirts, marked by the presence of dirt roads.
The comparison between the two analysis methods (SEM and PCOM) was successful as despite the obvious difference in figures, in fact they lead to the same conclusions.
Microfibres were included into the analysis after the detection in various filters used for the 2005 sampling of high concentrations of very thin and short fibrils (at PCOM > 10 ff in just one Walton-Beckett field) of about 5 µm in length.
The analyses evidenced a presence of such fibrils in a number of samples that were representative of all areas examined in variable and non homogenous quantities in the filter
At PCOM, higher fibril concentrations in a larger number of filters than at SEM were detected due to the difference between the two methods (one basically with a quantitative approach and the other also with a qualitative approach).

Comparison between pollution levels before and after the implementation of measures

The comparison between the results of sampling performed before and after the implementation of emergency containment measures highlights that concentrations of airborne fibers recorded after are remarkably lower than before, thus confirming the effectiveness of remediation actions and in particular:

- the closing down of quarrying activities, removal of contaminated material and use of mechanical sweeper equipped with absolute filters contributing first and foremost to the reduction in fibre concentration in the residential area
- the paving of previously dirt roads contributing mainly to the lowering, well below threshold limits, of concentration peaks on heavy traffic roads. It is to be recalled that previous surveys performed on dirt roads –now covered with asphalt –had detected levels as high as 8,2ff/l.

Conclusions

The paper presents the procedure followed by the Municipality of Biancavilla for the emergency containment actions that are still under way.

The paper highlights the important role of the monitoring campaigns carried out to identify the most adequate remediation actions.

The actions taken proved to be successful – at least as emergency measures –reducing airborne pollutant concentrations remarkably, below the levels set by WHO.

Further studies are still necessary to follow remediation actions still to be implemented (remediation of quarrying sites, metropolitan tunnel, etc)

The risk potential due to the presence of microfibres should be the subject of further investigation to assess epidemiology and patogenicity, and threshold exposures.

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VALUTAZIONE DELLO STATO DI CONSERVAZIONE DI MATERIALI CONTENENTI AMIANTO IN MATRICE COMPATTA

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Nell'ambito delle azioni programmatiche previste dal Piano Regionale Amianto la Liguria ha realizzato il censimento di tutti i materiali contenenti amianto sia in matrice compatta, sia in matrice friabile presenti in edifici ed impianti, in ambienti di vita e di lavoro. I dati contenuti nelle schede di autonotifica pervenute sono stati inseriti in un database appositamente predisposto denominato "Censam" e sono stati successivamente elaborati per ottenere informazioni in merito alla localizzazione geografica dei materiali contenenti amianto, al loro quantitativo, tipologia e destinazione d'uso. Riscontrata la notevole diffusione sul territorio della ASL 4 di materiali contenenti amianto in matrice compatta sotto forma di coperture esterne (sono l' 80% del totale delle localizzazioni censite, corrispondenti a circa 500.000 mq) e le numerose richieste dell'utenza in merito alla valutazione del loro degrado, la S.S. Amianto della ASL4 ha ritenuto utile sviluppare un piano di azione triennale con i seguenti obiettivi:

- individuare le situazioni che maggiormente possono costituire un rischio per la salute pubblica e su di esse programmare la sorveglianza;
- effettuare la taratura di un metodo che consenta di uniformare e rendere il più possibile oggettivo il giudizio sullo stato di conservazione dei materiali in matrice compatta ed i successivi provvedimenti da intraprendere;
- verificare la corrispondenza tra quanto dichiarato nelle schede di autonotifica e l'esito dei nostri accertamenti.

Per l'avvio del progetto è stata effettuata una serie di elaborazioni sui dati contenuti nell'archivio informatico applicando un metodo standard USA denominato "Versar" opportunamente calibrato sulla base dei parametri correlati al danneggiamento contenuti nelle autonotifiche.

Per materiali compatti i dati disponibili nella scheda per l'elaborazione del punteggio erano:

- l'estensione della superficie
- lo stato di conservazione
- l'anno di installazione

Il metodo Versar ha individuato 3 zone di azione, ognuna delle quali è associata ad un determinato livello di gravità potenziale del rischio e pertanto comporta una diversa tipologia d'intervento.

Si è così ottenuta una scala di priorità che ha evidenziato le situazioni a maggiore degrado sulle quali programmare le verifiche. In particolare, sono state individuate 70 strutture presenti in ambienti di vita e di lavoro. In base al metodo Versar la maggior parte di esse si sono classificate come localizzazioni da bonificare.

Il protocollo operativo, elaborato dal gruppo di lavoro ASL4 - ARPAL, ha fissato quindi la seguente procedura di intervento:

- ispezione visiva con relativa documentazione fotografica
- compilazione di modulo valutativo di sopralluogo definito in base alle linee guida contenute nel Piano Regionale amianto dell'Emilia Romagna

- prelievo di frammento di lastra per la valutazione della compattezza del materiale e per l'osservazione allo stereomicroscopio
- applicazione del metodo UNI 10608 definito "a strappo"
- formulazione di un giudizio complessivo sulla base di tutti i rilievi effettuati e indicazione delle conseguenti azioni da intraprendere (richiesta di bonifica, aumento della frequenza nella periodicità dei controlli o mantenimento del programma di controllo).

Nella tabella sottostante sono riportati i risultati emersi dai rilievi effettuati in 3 anni di attività:

Casi esaminati	Provvedimenti
60 %	Bonifica del materiale
10 %	Aumentare la frequenza nella periodicità dei controlli
30 %	Mantenere il programma di controllo triennale

Dall'applicazione sistematica del metodo UNI 10608 si è potuto notare che esiste una relazione ben precisa tra il grado di affioramento superficiale delle fibre di amianto, valutabile in modo grossolano con una lente durante il sopralluogo e con maggiore definizione in laboratorio allo stereomicroscopio, e la classificazione delle condizioni del materiale definita dal metodo:

Osservazioni allo stereomicroscopio	Giudizio ottenuto dal metodo UNI 10608
Fibre completamente inglobate	Ottimo
Fibre parzialmente affioranti	Buono
Fibre quasi totalmente distaccate dalla matrice e/o fibre libere	Scadente - Pessimo

Si sottolinea che tali corrispondenze si ottengono adottando particolari accortezze operative:

- effettuare campionature su tutti i lati della copertura in caso di superficie non omogenea;
- prelevare almeno cinque spezzoni di nastro in ogni zona campionata;
- ripulire le forbici dal collante con solvente a base chetonica;
- non applicare in presenza di muschi e licheni.

Per contro si è notato che il metodo non fornisce risultati correlabili alla compattezza del materiale e si ritiene pertanto che, pur essendo attualmente l'unico riferimento standardizzato in materia, non può costituire da solo l'elemento discriminante per un giudizio complessivo sulle condizioni dei materiali. Si ribadisce quindi l'importanza del sopralluogo visivo con la rilevazione di tutti i parametri previsti nella scheda valutativa e di una accurata osservazione allo stereomicroscopio.

LA MAPPATURA DELL'AMIANTO PRESENTE SUL TERRITORIO ITALIANO

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SIAP c/o Ministero dell'Ambiente e della Tutela del Territorio e del Mare - DG per la Qualità della Vita - Divisione VIII

Introduzione

L'art. 20 ("Censimento dell'amianto e interventi di bonifica") della legge n. 93 del 23 marzo 2001 "Disposizioni in campo ambientale" ha introdotto il concetto di "mappatura delle zone del territorio nazionale interessate dalla presenza di amianto". La mappatura dell'amianto, così come indicato dal successivo decreto di attuazione (D.M. 101 del 18 marzo 2003 "Regolamento per la realizzazione di una mappatura delle zone del territorio nazionale interessate dalla presenza di amianto, ai sensi dell'articolo 20 della legge 23 marzo 2001, n. 93"), ha come finalità il rilevamento delle contaminazioni da amianto (impianti industriali attivi o dimessi, edifici pubblici e privati, siti interessati da presenza naturale di amianto, presenza di amianto dovuta ad attività antropica) che costituiscono un elevato rischio potenziale per l'uomo e l'ambiente e la definizione di tutte le misure necessarie per prevenire, contenere o eliminare tale rischio.

La mappatura, così come previsto dall'art. 1 comma 1 del D.M. 101/2003, può essere realizzata anche sulla base dei dati raccolti nelle attività di monitoraggio ai sensi della L. 257/1992 ("Norme relative alla cessazione dell'impiego di amianto") e deve avvalersi di Sistemi informativi impostati su base territoriale (SIT), integrati da software specifico per le elaborazioni e le interrogazioni, secondo gli standard del Sistema informativo nazionale ambientale (art. 3 comma 1).

Per la valutazione del rischio associato ai siti con amianto, così come richiesto dall'art. 1 comma 2 del D.M. 101/2003 e su forte sollecitazione del Ministero dell'Ambiente e della Tutela del Territorio e del Mare (MATTM), il Comitato Interregionale Ambiente e Sanità ha definito la Procedura per la determinazione degli interventi di bonifica urgenti, approvata nel 2004 dalla Conferenza dei Presidenti delle Regioni e delle Province Autonome. Tale procedura consiste nell'applicazione, per ciascun sito rilevato, di un algoritmo (figura 1) che consente di associare al sito un punteggio rappresentativo del grado di rischio (a punteggio più alto corrisponde un rischio maggiore), in modo da definire una graduatoria dei siti mappati con relative priorità di intervento.

Stante la rilevanza del progetto in atto, il MATTM con D.M. 771/1994 ha finanziato le attività di mappatura dell'amianto, trasferendo alle Regioni e province Autonome di Trento e Bolzano il 50% della disponibilità totale delle somme indicate dall'art. 20 della L. 93/2001, destinando il restante 50% al finanziamento di interventi di bonifica urgenti (Area industriale della Val Basento, Stabilimenti ex Fibronit ed ex Ecored di Broni, Canolo Nuova, Valle del Belice, Comune di Messina, Careggi nel Comune di Firenze).

La finalità del presente lavoro è quella di illustrare in forma sintetica i risultati delle attività di mappatura condotte dalle 21 Regioni italiane.

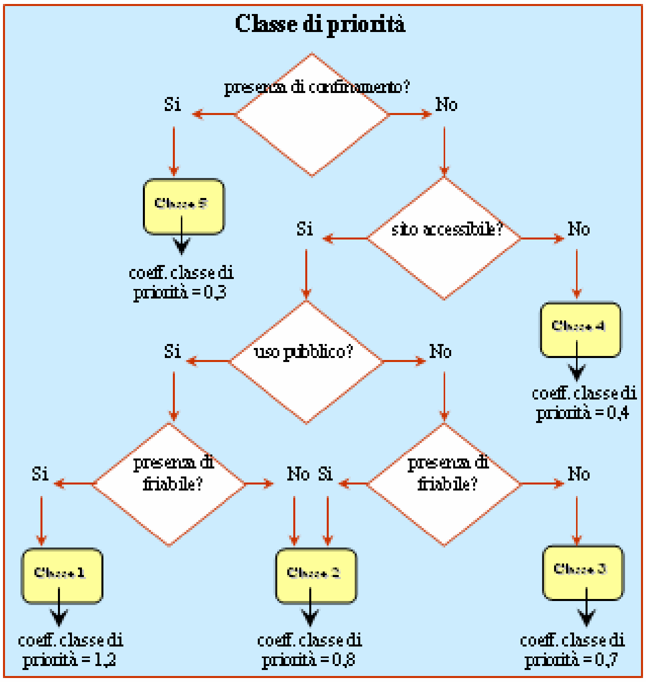
A tal fine sono stati analizzati i dati di mappatura che le Regioni, in ottemperanza al D.M. 101/2003, inviano entro il 30 giugno di ogni anno, al MATTM.

Nei casi in cui le Regioni non abbiano ancora trasmesso i risultati della mappatura si è tenuto conto di quanto indicato nel Piano Regionale Amianto (realizzato dalle Regioni ai sensi dell'art. 10 della L. 257/1992) e documenti correlati.

Figura 1 - Procedura per la determinazione degli interventi urgenti di bonifica da amianto (categoria 1: impianti industriali attivi o dimessi; categoria 2: edifici pubblici e privati; categoria 3: presenza naturale; categoria 4: altra presenza di amianto da attività antropica)

- Calcolo del punteggio per i siti della mappatura delle categorie 1, 2 e 4

Punteggio = $D*(i_1+i_6+i_7+i_{11}+(i_{14}*i_{15})))+(C*(i_1+i_2+i_4+i_9+i_{12}+i_{13}+i_{16}))+(B*(i_9+i_4+i_7+i_{10}+i_{13}+(i_{15}*i_{14})+i_{16})+(A*(i_2+i_6+i_8+i_{10})))*(i_5+i_3)*$
$*$coeff. classe di priorità



i_1 = Quantità di materiale stimato (kg)
i_2 = Presenza di programma di controllo e manutenzione
i_3 = Attività (attiva-dismessa)
i_4 = Presenza di cause che creano o favoriscono la dispersione di fibre
i_5 = Concentrazione di fibre aerodisperse (ff/l)
i_6 = Area di estensione del sito (mq)
i_7 = Superficie esposta all'aria (mq)
i_8 = Previsione documentata in lavori di urbanizzazione
i_9 = Stato di conservazione delle strutture edili
i_{10} = Tempo trascorso dalla dismissione (aa)
i_{11} = Tipologia di amianto presente
i_{12} = dati epidemiologici (mesotelioma)
i_{13} = Frequenza di utilizzo
i_{14} = Distanza dal centro abitato (m)
i_{15} = Densità di popolazione interessata
i_{16} = Età media soggetti frequentatori (aa)

A (tipologia di MCA) = 2 se friabile; 1 se non friabile
B (tipologia attività) = 2,5 se uso pubblico; 1 se non pubblico
C (accessibilità) = 2,5 se accessibile; 1 se non accessibile
D (presenza di confinamento) = 2,5 se non confinato; 1 se confinato

- Calcolo del punteggio per i siti della mappatura della categoria 3

Punteggio = $(in_1+in_4+in_3+in_5+in_6)*in_2$

in_1 = Materiale costituente gli affioramenti rocciosi contenenti amianto
in_2 = Presenza di affioramenti entro 50 m di area abitata o con frequenza abituale
in_3 = Fibre aerodisperse in prossimità del recettore (ff/l)
in_4 = Estensione degli affioramenti contenenti amianto
in_5 = Coinvolgimento del sito in lavori di urbanizzazione
in_6 = Dati epidemiologici riferiti a casi di mesoteliomi

Risultati

Nella figura 2 sono riportati i dati relativi alla presenza di amianto in Italia disponibili presso il MATTM alla data del 31/10/06.

La Regione Abruzzo ha individuato 2.375 siti (1.900 edifici pubblici e 475 siti industriali) con amianto. L'indagine volta all'accertamento della presenza naturale di amianto (cave di pietre verdi) ha invece escluso l'esistenza di siti di categoria 3. Non sono ancora state indicate le priorità di intervento.

La Regione Basilicata ha rilevato la presenza, nei 354 edifici civili ed industriali censiti nel Piano Regionale Amianto (PRA) e non ancora bonificati, di circa 5 milioni di chili di amianto. Dal lavoro è inoltre emerso la prioritaria necessità di intervenire, nell'ambito delle sorgenti di natura antropica censite, sui siti da bonificare di interesse nazionale: Val Basento e Tito.

La Regione Campania ha comunicato di aver ricevuto, prevalentemente da parte di Enti locali, diverse richieste di finanziamento per la bonifica di siti di categoria 2 e 4 e che, "sulla scorta di segnalazioni di fonte ufficiosa, è ragionevole supporre una presenza di MCA sul territorio regionale, prevalentemente in matrice compatta e/o resinoide, abbastanza consistente, sia relativamente alla categoria 2 (edilizia privata), sia relativamente alle categorie 1 (impianti industriali dismessi di Bagnoli, Napoli Orientale, Litorale vesuviano, ecc.) e 4 (principalmente abbandono di rifiuti e/o discariche abusive)". Non sono ancora state indicate priorità di intervento.

La Regione Emilia Romagna ha rilevato la presenza di 1.198 siti con amianto (141 impianti attivi o dismessi; 1.037 edifici pubblici e 20 cave di Pietre Verdi) caratterizzati da un punteggio medio-basso (il 40% dei siti ha punteggio compreso tra 501 e 1.500).

Tali dati sono stati aggiornati nel 2006, tenendo conto dei 118 interventi di bonifica eseguiti: al 31/05/2006 i siti non ancora bonificati risultano essere 1.080.

La Regione Friuli Venezia Giulia ha trasmesso i primi dati relativi alla localizzazione dei siti contenenti amianto individuati con la tecnica di ripresa iperspettrale da piattaforma aerea (MIVIS).

La Regione ha inoltre comunicato di aver effettuato, con l'attuazione del PRA (approvato nel 1996), diversi censimenti i cui dati saranno utilizzati per realizzare la mappatura dei siti con amianto.

In prima istanza sono stati presentati i risultati del "Censimento e mappatura delle pensiline delle stazioni ferroviarie, dei capannoni, o strutture similari, di tipo industriale, artigianale o agricolo, utilizzati o dismessi, localizzati sul territorio regionale, con tipologie di materiali contenenti amianto": sono state individuate 752 strutture in eternit, corrispondenti ad una superficie di 1.064.317 mq. Non sono ancora state indicate priorità di intervento.

La Regione Liguria ha presentato la mappatura dei 2 siti con amianto ritenuti maggiormente a rischio: si tratta di due edifici pubblici.

La Regione Lombardia ha trasmesso i dati relativi ad una prima valutazione della pericolosità dei siti con amianto, eseguita dalle AA.SS.LL. utilizzando la procedura del Comitato Interregionale. Il lavoro ha portato alla individuazione di 70 siti di cui 4 maggiormente a rischio. I dati sono stati aggiornati nel 2006, tenendo conto degli interventi di bonifica eseguiti: sul territorio regionale sono attualmente presenti 67 siti non ancora bonificati (16 siti di categoria 1; 45 di categoria 2 ed 1 di categoria 4).

La Regione Marche ha trasmesso la mappatura del territorio regionale, ottenuta attraverso l'elaborazione dei dati del censimento amianto degli edifici e delle unità produttive, eseguito nell'ambito del PRA (approvato nel 1997) e del relativo Piano Operativo. Il lavoro di mappatura ha riguardato le categorie di ricerca 1, 2 e 4 ed ha consentito di rilevare la presenza di 15.012 siti con amianto con punteggio non elevato (punteggio massimo registrato: 769).

La Regione Molise ha trasmesso i risultati della mappatura dell'amianto sul territorio regionale: sono stati identificati 666 siti di categoria 2, sui quali è stato applicato l'algoritmo indicato nella procedura per la determinazione degli interventi urgenti di bonifica (punteggio massimo: 2.202).

La Regione Piemonte ha rilevato la presenza, sul territorio regionale, di quattro gruppi litologici principali: serpentiniti ofiolitiche, metabasiti, calcestisti e micascisti e successioni terziarie derivanti dallo smantellamento di rocce basiche ed ultrabasiche. Sono stati censiti 153 siti oggetto di permesso di ricerca, 5 concessioni minerarie (tra cui la miniera di San Vittore a Balangero) e 31 siti estrattivi di cui 3 attivi. Inoltre, sulla base dell'analisi dei siti con presenza accertata di amianto e della loro collocazione/possibile interferenza con le entità esposte (popolazione, beni, infrastrutture), è stata effettuata una prima selezione di 13 situazioni "critiche" in termini di rischio (5 affioramenti, 4 cave inattive, 2 miniere e 2 miniere-discariche), per le quali è stata applicata la procedura per la determinazione delle priorità di intervento. I punteggi calcolati variano da un minimo di 54 ad un massimo di 185.

La Provincia Autonoma di Bolzano ha trasmesso i dati relativi al censimento amianto realizzato nel periodo 1991-2000: sono stati identificati circa 400 siti contaminati. Non sono stati indicate priorità di intervento.

La Regione Puglia ha trasmesso i dati di mappatura dei tetti in cemento amianto, ottenuti attraverso l'elaborazione delle immagini iperspettrali acquisite da piattaforma aerea con il sensore MIVIS. Sono stati identificati e georiferiti circa 5.000 tetti in amianto, di cui 2.751 con dimensioni superiori a 200 mq e 1.706 con dimensioni superiori a 500 mq. Non sono state indicate priorità di intervento.

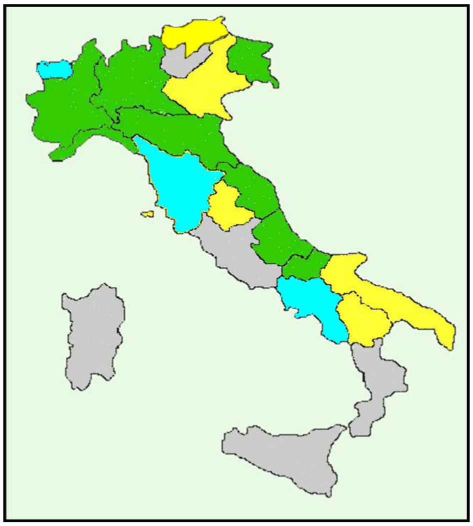
La Regione Toscana, nell'ambito del PRA, approvato nel 1997, ha eseguito il censimento: dei siti interessati da attività di estrazione dell'amianto; delle imprese che utilizzano o hanno utilizzato amianto nelle attività produttive; degli edifici nei quali sono presenti materiali o prodotti contenenti amianto libero o in matrice friabile. Dalle prime indagini è emersa la presenza, sul territorio regionale, di una serie di affioramenti naturali generalmente di piccole dimensioni ed estremamente discontinui, in genere sfruttati per il reperimento di materiale da utilizzare nella realizzazione di massicciate di rilevati stradali, ecc. Il censimento delle attività estrattive ricadenti all'interno dei siti di affioramento individuati (1993) ha identificato 17 cave attive di rocce verdi, di cui 3 in fase di ripristino ambientale. Il censimento delle imprese con amianto (1988-1991, 1993) non ha fornito risultati attendibili essendo stato eseguito con lo strumento dell'autonotifica: solo il 30% delle aziende contattate ha risposto; la percentuale di risposte positive sul totale di quelle ricevute è risultata pari al 6%. Non sono state indicate priorità di intervento.

La Regione Umbria ha trasmesso l'elenco dei siti di proprietà pubblica nei quali è stata riscontrata presenza di amianto, ritenuti di prioritaria pericolosità in relazione a: quantità e stato di conservazione dell'amianto; accessibilità e vicinanza del sito a centri abitati. I dati sono stati ricavati dal censimento effettuato in ottemperanza alla L. 257/1992 ed hanno evidenziato la presenza di ca. 70 di categoria 2 e 3 di categoria 1, per circa la metà dei quali è disponibile il dato di estensione superficiale (superficie totale: 46.124,71 mq). Non sono ancora state indicate priorità di intervento.

La Regione Valle d'Aosta non risulta aver ancora avviato le attività di mappatura se non per il sito di bonifica di interesse nazionale di Emarese, interessato, fino agli anni '70, da attività estrattiva dell'amianto.

La Regione Veneto ha trasmesso un primo report sulla mappatura delle zone del territorio regionale interessate dalla presenza di amianto, contenente i risultati, aggiornati al 2000, del censimento dell'amianto nelle scuole, negli ospedali e negli stabilimenti dimessi: è stata registrata una contaminazione da amianto in 204 delle 734 scuole indagate (su un totale regionale di 3.684 strutture scolastiche) ed in 16 dei 22 ospedali censiti (su un totale di 66 strutture ospedaliere regionali). Sono stati inoltre censiti: 159 mezzi rotabili (tutti messi in sicurezza e periodicamente controllati) ed 11 stabilimenti dismessi di produzione di MCA. Non sono state indicate priorità di intervento.

Figura 2 - Stato dell'arte della consegna dei dati relativi alla presenza di amianto in Italia, aggiornato al 31/10/06



Regioni che hanno presentato:

- dati con l'applicazione dell'algoritmo
- dati senza l'applicazione dell'algoritmo
- dati provvisori
- nessun dato

Conclusioni

Il lavoro di mappatura ha consentito di disporre, ad oggi, dei dati relativi alla presenza di amianto di 13 Regioni e Provincia Autonoma di Bolzano (figura 2).

Nel confrontare le diverse situazioni regionali occorre tener presente che le attività di mappatura in alcuni casi non hanno interessato tutte e quattro le categorie di ricerca indicate dal D.M. 101/2003 e che, in altri casi, le Regioni hanno ritenuto opportuno segnalare solo i casi ritenuti maggiormente critici. Sarà necessaria una verifica periodica per l'individuazione di siti "sfuggiti" ai precedenti controlli ed un aggiornamento che tenga conto dei siti nel frattempo bonificati.

In generale, i risultati ad oggi pervenuti evidenziano una rilevante presenza di amianto sul territorio nazionale e, conseguentemente, tenuto conto dell'elevato rischio ambientale e sanitario ad esso correlato, la necessità di attuare importanti interventi di bonifica.

Il Ministero dell'Ambiente e della Tutela del Territorio e del Mare - Direzione Generale per Qualità della Vita sta implementando i dati regionali di mappatura in un apposito SIT che consente la gestione di tutte le informazioni disponibili sulla presenza di amianto. Sulla base di tali informazioni è possibile procedere a valutazioni organiche e razionali delle situazioni di contaminazione che rappresentano un rischio più elevato, anche dove le Regioni non hanno indicato priorità di intervento. Tale attività, con l'aiuto delle Regioni, consentirà di armonizzare i dati forniti con il fine ultimo di individuare le situazioni più a rischio che, come detto, necessitano di urgenti interventi di bonifica.

Il MATTM ha fortemente promosso e sollecitato le attività di mappatura nella convinzione che la precisa conoscenza della situazione reale possa consentire al Legislatore l'assunzione di adeguate iniziative, sia normative che finanziarie.

Ringraziamenti

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NATURALLY OCCURRING ASBESTOS MAPPING PROJECT: THE EXPERIENCE OF REGIONE PIEMONTE

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INTRODUCTION

Today for most people of Piemonte the term "asbestos" is bound to Casale Monferrato (AL), famous for the presence of the biggest asbestos-cement plant in Italy, "Eternit", which has been working since 1906 to 1986, and that is dramatically still conditioning the lives of inhabitants of surrounding areas.

From Casale M.to our thought goes to Balangero, located in Lanzo Valley 30 km NW of Turin, where we find S. Vittore Mine, the most important open-pit of chrysotile in Europe, active till 1990, when political pressures, due to the raising consciousness of health problems connected to asbestos, caused the mine's closure. Since 1995 the plant is under the control of RSA S.r.l., responsible of remediation works as established by a national programme regulated by Italian Law 09.12.1998, n. 426.

More recently, since 2002, asbestos has come on the scene again, as many outcrops of serpentinite bodies and ophicalcites containing asbestos-tremolite veins were evidenced on the site selected for Bobsleigh, Luge and Skeleton Venues of Torino 2006 Olympic Winter Games. The planned vast works of excavation and construction would have caused a non acceptable fibres' release in atmosphere, very close to populated areas, requiring strict, complex and too expensive dust control systems, so another place in the High Susa Valley was chosen.

This occasion highlighted a problem that could affect many small villages in the NW Alps, with a strong tourist development, and that we should soon to cope with. Due to the geological and structural characteristics of their territory, tremolite-actinolite or chrysotile asbestos are more likely to be found, and so we have to be aware (in NW Italy, as in some other countries with similar geologic characteristics) that if in an undisturbed natural environment, these fibres are locked in place within the rock and represent no health hazard, however, when disturbed, such as during construction, these fibres are released as a fine dust. Dry, windy conditions could carry this hazardous dust beyond the boundaries of a construction site.

We have also to mention the International Railway Turin-Lyon (TAV), because the possible asbestos occurrence along the planned tracing is one of the main critical aspects.

That is why in Piemonte the approach to the requests of Italian law D.M. 18/3/2001 n° 101 concerning natural occurring asbestos has been quite different from that adopted in other Italian regions.

1. ITALIAN LAW D.M. 18/3/2001, N° 101 AND NATURALLY OCCURRING ASBESTOS MAPPING PROJECT IN PIEMONTE

Italian Law D.M. 18/3/2001, n° 101 contains a set of rules and regulations aimed at mapping areas with asbestos' occurrences on the whole national territory, as required by the art. 20 of Law 23/3/2001 n° 93.

In particular it requires:

as first step, identification and characterization of all sites with asbestos occurrence both in anthropic and in the natural environment,

as second step, a selection of the worst situations among previously individuated sites, in terms of hazard and risk, where it is urgent and necessary to plan and finance corrective actions and remediation works.

Referring to category 3 - Natural occurrences of asbestos - the regional administration (Direzione regionale Tutela e Risanamento Ambientale) and the regional environmental protection agency (ARPA Piemonte) developed a research project, whose first phase was completed in July 2006.

First we tried to identify at regional scale the geological and structural setting in which asbestos natural occurrence is more likely, using official geological and structural maps at regional scale and more detailed maps when available, evidencing the distribution of lithotypes more likely asbestos bearing, as reported in regulations in force and asbestos related bibliography.

Then we carried out a collection and organization with GIS techniques of all information referring to verified and classified asbestos occurrences. These information, often very heterogeneous and deriving from different sources, generally are represented by local data.

In the same time a wide and detailed bibliographic review has been carried on, in order to compare different approaches to the problem, at national as well as international level.

An epidemiological descriptive analysis has been conducted, with the aim to evidence, if possible, a correlation between natural asbestos occurrences and epidemiological data, trying to distinguish environmental exposure from professional one.

On the basis of the first results, some sites have been selected as “critical”: the procedure and algorithm established in 2004 by the conference of the Councillorships to the Health and the Environment and the Conference of the Regions’ Presidents to determine the necessary and urgent corrective actions have been experimentally applied to each site.

Besides, some operational instructions for a geologic site characterization at different scales, in areas affected by asbestos’ natural occurrence, have been drawn up.

2. THE NATURALLY OCCURRING ASBESTOS DATA BASE IMPLEMENTATION

Geologic-structural framework

The regional distribution of potential asbestos bearing lithologies has been drawn from the official geologic cartography at scale 1:100.000 (Carta Geologica d’Italia – Geologic Map of Italy). It is a set of geologic maps which represents the most complete and homogeneous information at regional scale even if it was published during a long period of time (the oldest maps date back to the end of nineteenth century and the last 2^{nd} edition maps date back to the seventieth). Geologic maps and information at best scale are available but they are made for different purposes and they refer to limited areas as the new “Progetto CARG” (National Geologic Cartography Project at scale 1:50.000) that is actually at the beginning and incomplete (3 sheets completed, 5 in progress, 1 just started).

Almost all of the ore studies on asbestos mineralization state that high concentrations of asbestos minerals develop along fractures and veins related to shear zone and tectonic stress. Asbestos minerals are not homogeneously spread within the potential asbestos bearing rocks (mainly serpentinite rocks) but they concentrate along faults and shear zones.

Therefore, in order to obtain a much complete regional framework of the areas where asbestos mineralizations are more likely, the main regional structural elements have been derived from the Structural Model of Italy at scale 1:500.000 (CNR, 1990).

Along shear zones permeability increases and, in basic or ultramafic rocks, under particular pressure and temperature conditions, fluids can crystallize in huge concentration or as ore deposits of asbestos. Fibres could grew in different and complex geometries along shear surfaces or within fractures linked to them.

Surveys made during the project confirm that asbestos mineralizations have been observed almost always in strongly deformed zones. At mesoscopic scale asbestos–bearing structures are characterized by very irregular frequency: high concentrations of asbestos can be observed in small portions of rock mass (some meters of thickness) next to huge volumes of massive basic and ultrabasic rocks without visible asbestos bearing veins.

Comparing the regional lithologic and structural framework (major structural elements and potential asbestos bearing lithologies) with location of ore research permits for asbestos confirmed that areas with a high tectonic complexity could be interested by important deposits of asbestos.

Local data

A further step is represented by superimposing the data layer of the points referred to real or highly suspected presence of asbestos on the regional geologic and structural layer described above.

As the goal was to produce the regional framework of the critical areas for asbestos, it has been taken in account all kind of information even if they are different for scale, date, purpose:

points referred to outcrops or sampling of asbestos investigated in mineralogical and petrographic research studies (by professors and researchers of the Turin University);

ore deposits researches made in the past for asbestos, which was a very important mineral for industry and economy until ‘80th all over the world;

geologic-technical investigation supporting studies for important infrastructures and

generic information on asbestos outcropping

As requested by law, information about “Pietre Verdi” (Green Stones) quarrying sites have been collected also, specially referring to serpentinite quarries. Information come from regional and county digital archives related to extractive activities, but also from bibliography or cartographic sources.

A specific data collection on asbestos mines in Piemonte has been done. It refers to asbestos research permits and asbestos mining carried out during the 20th century. Major asbestos mining works have been identified and localized, defining the regional framework on asbestos works. Each site has been classified by an “asbestos occurring index” which represents a qualitative parameter linked to qualitative presence and quantity of asbestos and to the lasting of the mining works in the site. More than one hundred mining sites have been identified but only in a few of them there were ore deposits of asbestos with an economic importance. Much of them refers to ore deposits of local extension and to mineralization in rock masses in association with other minerals of industrial interest.

Other information coming from specific and detailed studies carried out on local areas have been acquired, for example it is worth to mention a specific project of Risk Evaluation in Lemme Valley (Province of Alessandria), with geological detailed mapping of asbestos outcrops, massive, air and liquid sampling and laboratory analyses, or geological investigations addressed to feasibility analysis of Lyon-Turin Railway in Susa Valley (Province of Turin).

Procedures and regulations are necessary for a correct and safe use of territory and technical guidelines are needed for planning and construction (for example operational protocols, personal protective equipment to protect the health of workers on streets, railways, buildings); a framework on naturally occurring asbestos such the one above described is a starting point and a base of working going to that direction.

3. ANALYTICAL METHODS

Analytical activities represent a small, even if fundamental, part of the investigations conducted for this project: 58 qualitative determinations of asbestos in rocks (46) and air (12) have been carried out. It is worth to remember that analytical results are always related to single point, more or less significant or representative according to the "geological model" available for the considered site (for bulk materials) and to meteoclimatic conditions during air sampling.

As the primary aim of this project was to furnish a general framework about the distribution of asbestos minerals on the whole regional territory, during the field surveys planned to verify bibliographic or external sources of information, a series of targeted bulk samples has been collected. They were examined using stereomicroscope and Phase Contrast Microscopy with Chromatic Dispersion (as provided by DM 6/9/1994 - annex 3), considering sufficient a qualitative response, which could confirming the massive presence of "regulated" minerals or only as trace.

When the analytical result adopting this method is not clear (as it happened for some bulk samples collected in Varaita Valley – Province of Cuneo, near "Auriol" asbestos Mine), it is necessary to complete the analysis with other methods, such as Scanning Electron Microscopy accomplished with energy-dispersed X-ray fluorescence Spectrometry (SEM-EDS) or Infrared Spectroscopy (FT-IR), which unfortunately is the method

As regarding airborne fibres monitoring, it has to be underlined that the analytical result is related to meteoclimatic conditions and to possible external sources of disturbance registered during air sampling: so that every measure has to be evaluated together with the other observations derived from site characterization. According Italian law in force, fibres counting can be performed by Phase Contrast Microscopy (PCOM) or by energy-dispersed X-ray fluorescence Spectrometry (SEM-EDS).

During environmental monitoring surveys, even close to asbestos-bearing outcrops and in absence of external/anthropic disturbance, asbestos fibres generally represent only a small part of the total amount of fibrous material, or they are absent, while organic fibres strongly prevail. As they appear "countable" using PCOM, an overestimation of air pollution can be inferred: as already confirmed by many researchers and technicians, during environmental investigations it is therefore necessary to adopt only SEM-EDS method.

4. FIRST CRITICAL SITUATIONS

On the basis of the knowledge framework available, some field investigation have been conducted in order to collect other information and to do some sample analyses. The most critical situations for human health have been selected taking in account the results of the analyses, the presence of asbestos (hazard – probability of asbestos fibres scattering in the air) and the human presence (risk – nearby presence of people, buildings, infrastructures). Some hypotheses of remediation works are proposed and some other deepening and analyses are suggested.

A specific Microsoft Access database linked to the GIS ESRI ArcView software has been implemented, in order to geocode and to gather meaningful parameters of the selected sites.

As indicated by the above quoted DM it has been done an evaluation of feasibility and costs of remediation works; regional administration, through "Direzione Tutela e Risanamento Ambientale", applied to Environment Ministry for funding these works.

In some cases, where it is urgent to act, regional and local administrations will adopt first urgent precautions both as structural measures (e.g. ri-naturalization/reclamation works on asbestos rocks outcropping), or not-structural measures (e.g. forbidden entrance to sites, restrictions on land use, guidelines on event of works).

CONCLUSION

The complexity of the argument we are dealing with made clear that a lot of aspects and competencies are involved, requiring the contribution of different experts and professionals operating as a multidisciplinary workgroup.

In order to give the problem a proper dimension, actions of formation and information have to be developed, addressed both to people living close to naturally occurring asbestos and to technicians, professionals and public officers involved in land planning and management.

It has to be kept in mind that, at present, operational instructions to conduct planning stages and to manage the construction of great infrastructures already exist, even if not totally shared and standardized, while for other construction activities, of smaller importance and dimensions, awareness of health risk for employees and inhabitants as well as rules for investigations and working procedures are still lacking.

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STRUCTURAL AND MICROSTRUCTURAL CONTROL ON CHRYSOTILE DISTRIBUTION IN SERPENTINITES FROM EASTERN LIGURIAN OPHIOLITES

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INTRODUCTION

Several outcrops of serpentinites, from the very-low grade metamorphic ophiolites of the Northern Apennine in eastern Liguria (Italy), were selected to carry out pilot studies based on microstructural and mineralogical investigations, to assess the distribution and approximate volumes of asbestos minerals and their potential airborne fibre contribution. We focused on quarry activity, firstly because the related asbestos hazard was brought into evidence by judicial proceedings and because the quarry areas, representing a total rock exposure, can be assumed as the worst-case scenario to evaluate the global asbestos diffusion over ophiolitic districts.

The study areas consist in 1) three serpentinite quarries located in the Petronio Valley (Bargonasco village north of Sestri Levante) that were dismissed from less than one, five and about ten years, respectively and 2) the Ponte Nuovo serpentinite – chert quarry in the lower Vara Valley. At present, only cherts are exploited. At all sites, the serpentinite was exploited to obtain concrete aggregates.

The quarried serpentinites were affected by several deformational events associated with recrystallisation during their geodynamic evolution from the Jurassic to present; as a consequence, a complex fabric (i.e. geometric) pattern results in the rock, and different serpentine group minerals were developed in different textural position.

STRUCTURAL, PETROGRAPHIC, MINERALOGICAL FRAME

Massive serpentinite

The serpentinite occurs as massive rock bodies (western side of the Ponte Nuovo quarry with relic lherzolite, restricted volumes at Bargonasco). The pristine texture of the lherzolite ranging from granular to porphyroclastic tectonitic is overprinted by the metamorphic serpentinisation phase. The latter produces pseudomorphic growth of serpentine on pristine olivine or pyroxene, developing bastite porphyroblasts. A fine-grained aggregate of prevailing lizardite minor chrysotile + magnetite developing mesh (Plate 1a) and ribbon textures (Plate 1b) overgrows the groundmass olivine.

Fractured serpentinite

Several generation of crosscutting fractures associated with more or less significant growth of fibrous phases were recognised in the studied outcrops. Their frequency is variable between <1 and 30% of the rock volume.

The brittle deformation in the serpentinite developed through the complex ocean floor and orogenic evolution of the ultramafic rocks. At the outcrop scale, brittle structures are associated with kinematic indicators that allow to infer the direction or relative sense of shear within the rock body.

Brittle structures without significant mineral recrystallisation were grouped in A) structures such as slickenside, elongated mineral fibres, intersection lineations between S-C surfaces that give indications of the direction of tectonic movement, and B) structures such as stepwise fibre growth, sigmoids and rotation of a pre-existing foliation, that are kinematic indicators of the direction and sense of movement. Rock fracturing is accompanied by mere recrystallisation of the massive lizardite, to produce slickenside surfaces (Plate 1c).

Geometry of veins

The main types of vein are fibrous veins, mostly composite fibres veins, but both syntaxial and antitaxial patterns of fibre growth [1] occur as well. The thickness of the veins ranges between few mm to some cm. Some veins developed along reactivated joint surfaces.

In **syntaxial** veins the filling fibrous chrysotile nucleated from the host rock. Fibres are perpendicular to the rockwall of the vein and bend to the centre; this indicates that the oldest fibres are at the selvedge, without important compositional discontinuity between the host rock and the early vein-filling mineral.

Antitaxial veins have straight chrysotile fibres in the middle of the vein, grading to bent fibres close to the wallrock; this growth pattern suggests that the filling derives from exotic input and that the fibres at the centres are older than onea at the selvedge. The "crack and seal" mechanism can account for this geometry.

The most common veins are **composite** fibre veins and host both inward and outward fibre growth (Plate 1d, e). The geometry of the fibres indicates that the fracture was filled during extension (syntaxial growth) and shearing (crack and seal). Also the intersection relationships between older and younger vein and the optical continuity among fibres support that extension and shearing was simultaneous, i.e. occurred under the same kinematic regime.

Finally, an extensional phase occurred, characterised by the development of cm thick veins. This phase is scarcely represented at Ponte Nuovo, but is widespread in the Bargonasco quarries.

Vein filling minerals

We carried out optical analyses with the transmitted light polarising microscope, XR powder diffraction on minerals extracted from veins or separated by magnetic methods, and quantitative in situ electron microprobe analyses by SEM-EDS on selected massive samples.

The pervasive fracture networks are characterised by polyphase growth of chrysotile. Locally the development of calcite suggests metastable equilibrium and stepwise fracture opening. The late veining phase is dominated by development of cm-long linear fibres of chrysotile and intergrown chrysotile + tremolite (Plate 1f). Irregularly distributed veins dominantly made of calcic amphiboles (mostly tremolite – actinolite) are not related with the tectonic phases, but represent metamorphosed basic dikelets (gabbro or basalt).

Cataclastic serpentinite

The most representative rock volumes of cataclastic serpentinites are in the Bargonasco quarries. The massive serpentinite is turned to a fine-grained matrix with small relic volumes of the massive rock. The veins filled with chrysotile, both irregularly distributed and organised in conjugate networks easily disperse their content. In case of cataclastic incoherent matrix, the fibres are to be considered free.

MECHANISMS OF FIBRE CONCENTRATION

The non-asbestiform amphibole of the fibrous species is dependably differentiated under microscopic investigation, as two populations result sharply distinguished although scant splinters or slivers can develop with length: width ratios >3:1; few of them however, shows the critical dimension of fibres (> 5 μm in length and < 3 μm in diameter) [2]. Conversely, the milling of fibrous chrysotile increases the percentage of fibres, due to the perfect lengthwise cleavage of the fibre. This supports that milling, i.e. size reduction between few mm to some cm of lizardite serpentinite pieces, releases scarce fibrous minerals if the material is devoid of filled veins.

In syntaxial veins, the chrysotile fibres grow consistently with the host serpentinite and can thus be assumed as a mechanically continuous material at the microscale.

Conversely, in the antitaxial veins and in the more widespread composite veins, characterised by disjunction between wall-rock and vein, and by contrasting fibre orientation along a lateral cross section, fibrous chrysotile under mechanical stress results more liable to be released.

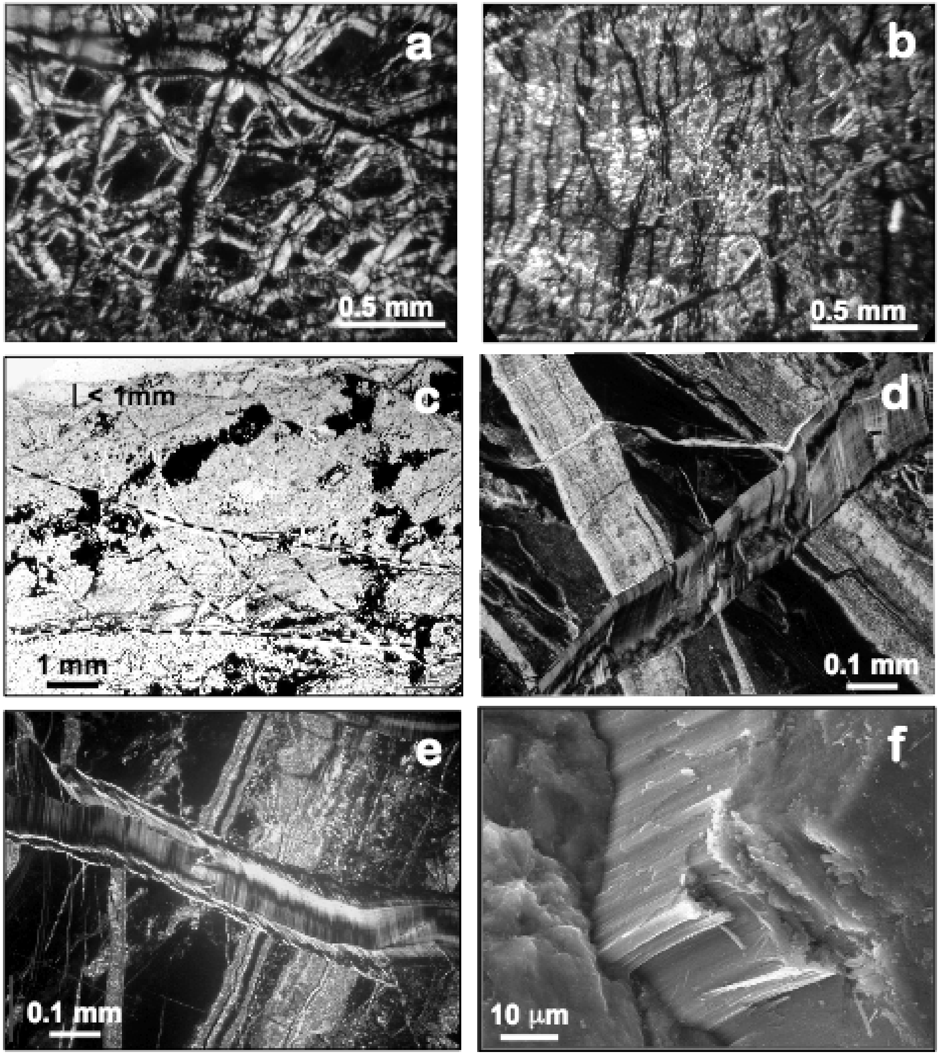

Plate 1: Transmitted light microphotographs. Scale bar in photo. a) Crossed polars. Mesh texture in massive lizardite – bearing serpentinite. b) Crossed polars. Ribbon texture in massive lizardite – bearing serpentinite. c) Plane polarised light. Slickenside surface. The thickness of the "polished" film (lizardite) is < 1 mm; thick dashed lines: domino structures, shear surfaces, and the sense of movement. d) Polarised light, crossed polars. Composite vertical veins filled by chrysotile cut an

oblique syntaxial vein filled by the same mineral. e) Polarised light, crossed polars. Composite oblique vein filled by chrysotile cut a high angle trending syntaxial veins filled by fine grained and fibrous chrysotile. f) Tremolite + chrysotile fibres filling the late phase fractures.

The cataclastic event, corresponding to the latest phases of deformation and resulting in the cataclastic texture, both concentrates and allows fibre release.

ANALYTICAL PROTOCOL

The D.M. 14/5/1996 indicates the analytical procedures for synthetic materials and quarried blocks and aggregates, to be carried out on materials already extracted. Up to now no particular attention was paid to outcrops potentially releasing asbestos fibres; as a consequence the D.M. 14/5/1996 is the reference normative in case of evaluation of the potential cession. The main inconsistency to be faced in applying the existing normative is that rock volumes show a farther wide range of textures and the frequency and distribution of potential asbestos sources is variable and dependent of the tectonic style. The second observation is that geologic systems are time-variable and that natural weathering on the rock surface or runoff over the detrital stone heaps can enhance or inhibit the fibre dispersion.

As a whole, our investigation integrated the following procedures:

I) **Field survey** and characterisation according to the scheme of UNI EN ISO 14689-1 (“Indagini e prove geotecniche – Identificazione e classificazione delle rocce”) adapted to asbestos-bearing serpentinites. The direction and dip of vein families was measured over the quarry front, and plotted as stereonets. However, this phase could be further improved by introducing a high-resolution image analysis of the quarry front, as already in use in the evaluation of stability.

II) On this basis, sampling is strategic I) to result representative of the vein population II) to carry out mineralogical analyses of vein filling. The **identification** of the fractured samples and of vein minerals was done by optical (stereoscopic and transmitted light microscopy) techniques on rock chips and incoherent detrital heaps, consolidated by epoxy resin then processed to thin section. **Modal analysis** of the serpentinite and of unconsolidated sediments was carried out on thin sections and by quantitative point counting [3].

III) Fibrous minerals, scraped from the veins, then manually and magnetically separated, were analysed by X-ray powder diffraction (XRPD) The technique, effective for univocal **determination** of mineral mixtures, was carried out using a Philips PW1140-X-CHANGE diffractometer (CuKα radiation; current 30 mA, voltage 40 kV, scan speed, 0.5°2θ/min; scan interval, 3-70° 2θ.) and interfaced with PC-APD software for data acquisition and processing. Selected samples (very thin veins or tremolite-chrysotile mixtures) were further investigated by the Philips SEM 515 scanning electron microscope, equipped with an EDAX PV9100 spectrometer in the energy dispersive mode. Operating conditions were 15 kV accelerating voltage and 2.1 nA of beam current. The natural standards were analysed by WDS microprobe at Modena University. Raw data were reduced using the ZAF algorithm and the standard software of the EDAX PV9100. Both facilities are available at the Dip.Te.Ris, University of Genoa.

However, an analytical bias resides I) in the approximation to extend the modal abundances obtained in 2D from meso- to microscale, to the rock volume at 3D and mostly II) in the analysis of the quarry front, that is operator-dependent.

DISCUSSION

It must be stated that problems of accuracy in evaluating asbestos in the natural background arise for Regions as Liguria or Piedmont, where significant volumes of ophiolitic lithologies outcrop. Although restricted to selected Regions, the need for a proper methodological approach integrating quantitative field survey and laboratory investigations is assessed. Thus, we integrated the conventional methods of earth science investigations (i.e. structural, petrographic and mineralogical analysis at meso- and microscale) in a flow-chart procedure, able to produce the assessment of the fracture volume, the volume of infilling minerals and the definition of cessible and free fibres of the observed rock volume.

In the perspective of hazard evaluation, it is fundamental to define and quantify firstly the amount of fibrous minerals associated with the serpentinite, provided that only a risible amount of microfibrous chrysotile is therein included. For this reason we assumed the lizardite – bearing, porphyroclastic, mesh- or ribbon-textured serpentinite as *massive*.

The *cessible* fibres, i.e. the amount of asbestos minerals enclosed in the host rock under different textures and liable to be loosed for natural or anthropic friction and/or comminution, are subject to local tectonic and mineralogical factors. Their quantification should take into account the mesoscale to microscopic data. The application of UNI EN ISO 14689-1 ("Indagini e prove geotecniche – Identificazione e classificazione delle rocce") modified and adapted to asbestos-bearing serpentinites is based on the structural analysis of disjunctive tectonics in the rock and provides the geometric relationships among vein networks and their modal abundance (frequency) vs. the undisturbed rock volume. However, the arrangement of mineral fibres and their nature within veins needs also to be investigated.

The *free* fibres can be defined as the fibrous minerals already detached from the rock or the host vein, and liable to enter the sedimentary cycle, hydrosphere, atmosphere or biosphere [3].

CONCLUSIONS

- Massive ultramafic rocks under low-grade metamorphism are mainly composed of fine-grained, though not fibrous, lizardite with minor magnetite and chrysotile. Therefore the general term "ophiolite", aside its geological and petrological significance, should refer to asbestos-bearing rocks with different fibre "dilution".
- The origin of asbestiform phases occurred under brittle deformation regime and was associated with development of vein filling minerals. Rock fracturing is therefore critical for the origin and concentration of asbestos. Open or filled fractures act as discontinuities and disrupt the rock body; the earliest fracture nets are easily reactivated under the late cataclastic tectonic events or during quarry operations.
- Fibres unlikely originate from the corresponding massive mineral or mineral-bearing rock body [2]. The milling (i.e. quarry operations) to aggregates of a massive serpentinite produces scarce fibre -shaped and -sized particles; it rather tends on average to dilute the asbestos fibres eventually dispersed in the rock.

- The fibre concentration mostly occurs by natural processes (cataclasis, detrital aprons, pedogenesis) starting from a veined rock body. Airborne fibre dispersion is both natural and anthropic.

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ASBESTOS MONITORING IN CIVIL AND INDUSTRIAL ENVIRONMENTS OF SELECTED ITALIAN SITES. THE CASE OF A CERAMIC FACTORY

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Abstract

This paper presents the results of an intensive monitoring activity of the air, fall-out and soil of a Ceramic factory in Sassuolo (Modena, Italy) with sheds made of cement-asbestos. The monitoring protocol accomplished a 1 week long collection time performed during each season. Filters and samples of fall-out and soils were analysed with XRPD, electron and optical microscopy, and FTIR. The surprising outcome of this work is that the calculated amount of dispersed asbestos fibers is practically null. with a minor concentration during the autumn season.

Introduction

Air-dispersed particulate, and especially asbestos fibres may represent a serious hazard for the human health. It originates from different media (bulk materials such as ACM=asbestos containing materials in civil or industrial buildings, quarries or mines, work or life private/public buildings, soils, water, etc). It is of critical importance to monitor the presence of particulate not only in air but also in water and soils (the so called *fall-out* particulate) to carefully assess the real levels of exposure risk in life and work environment. The aim of this project, granted by the Fondazione Cassa di Risparmio di Modena, is the long-term asbestos and inorganic particulate (with a special care to PM10 particulate) monitoring in civil and industrial environments of selected Italian sites. The selection embraced environments with different characteristics: typology of the asbestos material and associated level of risk, geographical position, activity within and nearby the monitored site, closeness to public buildings, etc. Selected sites are within the Bologna, Modena and Reggio Emilia Provinces (Italy) and were kept monitored for 1 year to investigate the activity of the asbestos fibres and other inorganic particulate during different seasons and environmental/climate conditions. Monitoring was conducted for 1 week and repeated during each season. For the production sites, the monitoring spot was located very close to the dispersions source (such as the cement-asbestos roof) and about 50 m away from it. In this contribution, we present a selection of the results of the monitoring of a Ceramic factory in Sassuolo (Modena, Italy) whose production sheds have cement-asbestos roofs, and the relative blank site, a civil building about 1 Km away from the production site. The results are discussed in the light of existing literature data.

Experimental part

The monitoring of the Ceramic factory in Sassuolo (Modena, Italy) was conducted in continuous mode for 1 week and repeated 4 times a year (spring, summer, autumn, and winter shifts). The monitoring spots are located very close to the dispersions source (the cement-asbestos roof) and about 50 m away from it to assess, if any correlation between the particulate concentration/nature and the distance from the dispersion source exists. The monitoring of the airborne dispersed particulate was possible using an especially modified high flux volumetric (ca. 1 m^3 per min) area sampler and large cellulose filters (A4 paper size). Given the high flux, filters tend to be quickly over-saturated and have to be changed every second day. The fall out particulate is collected in a 1 m^2 wide collector filled with water to simulate a water source (collection of the *fall out* material). Water samples are then filtered to separate the solid fraction and dried for the lab investigation. Samples of the surface soil are also collected in the proximity of the monitoring sites to assess the nature and concentration of the particulate deposited in a long term. The analysis of the collected samples was possible using bulk (quali-quantitative X-Ray powder diffraction with the Rietveld method [1-3] and FTIR) and microscopic techniques (SEM, TEM; optical microscopy) in the attempt to determine the nature, meso-microstructure and density of the inorganic particles. The analytical protocol accomplishes different steps:

- Thermal treatment at 500 °C for 1 h of all the filters, raw soils and fall out samples for the decomposition of clay minerals such as kaolinite (which gives interference with chrysotile in diffraction), organic matter and the cellulose filter
- Quali-quantitative XRPD, SEM, TEM and optical microscopy (MOLP) of all the thermally treated residue of the filters, raw soils and water fall out samples
- Wet separation/enrichment of asbestos using the Appiani levigator method [1] of all the thermally treated residue of the filters
- Quali-quantitative XRPD, SEM and optical microscopy (MOLP) of asbestos residue obtained by the wet treatment using the Appiani levigator method
- DSC+TA, FTIR analyses on selected samples which require further inspection
- Collection of the environmental and weather condition reports during the monitoring shift

Results and Discussion

It is not possible to discuss hereby all the details of the outcome of this project. Thus, we will present the phase composition of the various collected specimen and focus on the concentration of asbestos fibres. It is important to remark that the physical state of the cement-asbestos shed was fairly good (damage percentage < 10%) and not necessarily subject to abatement procedure. The analytical protocol developed for this project allowed to reveal the nature of the crystalline phases present in the various media (air, fall-out, soil: see Table 1) and relative origin during the four monitoring shifts. Some of these phases are considered carcinogenic (see quartz), others have clearly a fibrous habit (see the anatase fibre in the TEM image of Figure 1) although their are not considered hazardous. Despite the nature of the collected sample, a clear result of this study is that the concentration of asbestos fibres is practically zero. Only in the airborne dispersed and fall-out materials collected during the fall shift, bundles of asbestos fibres were detected. As an example, Figure 2 and 3 report the experimental evidence (MOLP and SEM, respectively) of the presence of fibre bundles in the fall-out and airborne materials collected during the this season. If we consider the plentiful of literature data on the dispersion of asbestos fibres in air in urban and industrial areas, the results are quite surprising because the calculated amount of asbestos fibre is practically null: an estimate of 0.0008(4) ff/l (and in any case, lower than 0.001 ff/l) was determined for the airborne particulate. On the other hand, although not fully consistent, literature data seems to point to a generalized high concentrations of airborne (asbestos?). As an example, the average concentration of asbestos fibres in industrial and/or urban sites nearby old asbestos productive site point to significant to very high concentrations from 0 to 257 ff/l [4]. Although we have investigated outdoor working and life sites, the comparison with the allowed concentration of asbestos fibres in working environment (100 ff/l according to the recent law Decreto 257/2006) indicates that the concentration found in this work are by far much lower than the concentration limits imposed by the law.

ORIGIN	AIRBORNE	FALL-OUT	SOIL
CERAMIC RAW MATERIALS	quartz, plagioclase, zircon, mica, Kfeldspar, mullite, kaolinite, chlorite, wollastonite, Ba-sulphate**, Pb, Pboxides**	quartz, plagioclase, mica, anatase, rutile	quartz, plagioclase, K-feldspar, mica, anatase, rutile, chlorite, illite, interlaminated, amphibole
CEMENT ASBESTOS	calcite, dolomite, anhidrite*	chrysotile, calcite, anhydrite	calcite, dolomite
SUB-AERIAL ALTERATION	calcite, anhydrite*, hematite, Fe and Mn-oxides	anhydrite, calcite	calcite
SECONDARY PROCESSES	fluorite***	cristobalite****	
AIR POLLUTION	Pb and Pb-oxides		
CHEMICAL PRECIPITATION		halite, carobbiite	

Table 1 - Crystalline phases present in the various media and origin. Legend: *Original gypsum transformed at 500°C into anhydrite; **Frits raw material; ***Formed during the process of industrial volatile fluorine abatement with CaO; ****Formed during the tyles firing processes and/or tyles waste (chamotte)

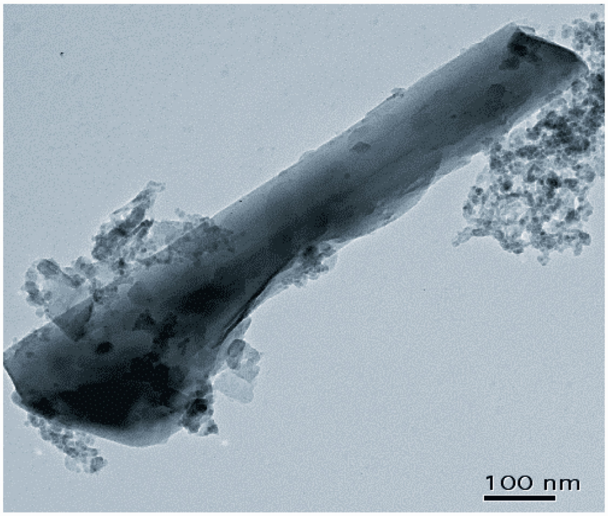

Figure 1 – TEM image of a fibre of titanium oxide discovered in the airborne dispersed specimen collected during the fall season.

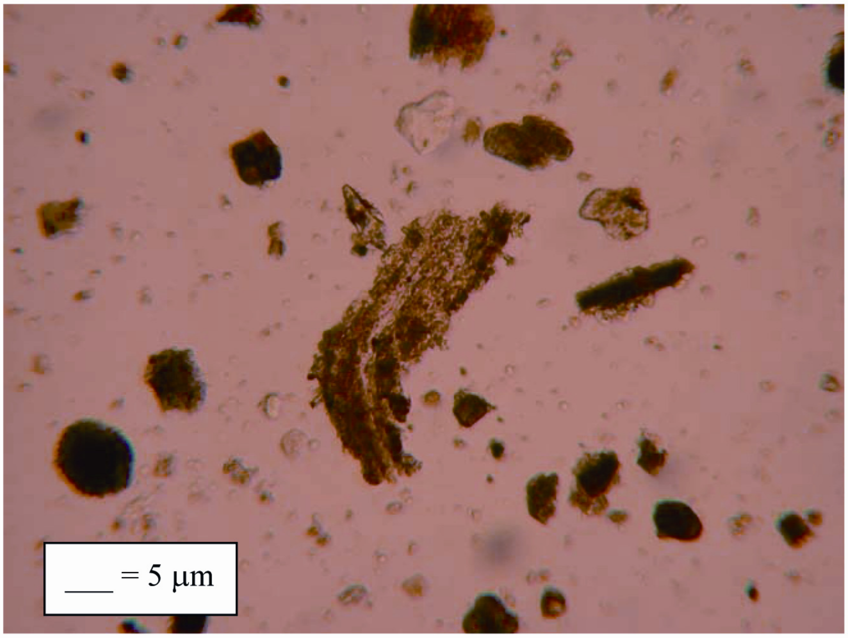

Figure 2 – Bundle of asbestos fibres found in the fall-out specimen collected during the fall session revealed by the MOLP analysis (100x).

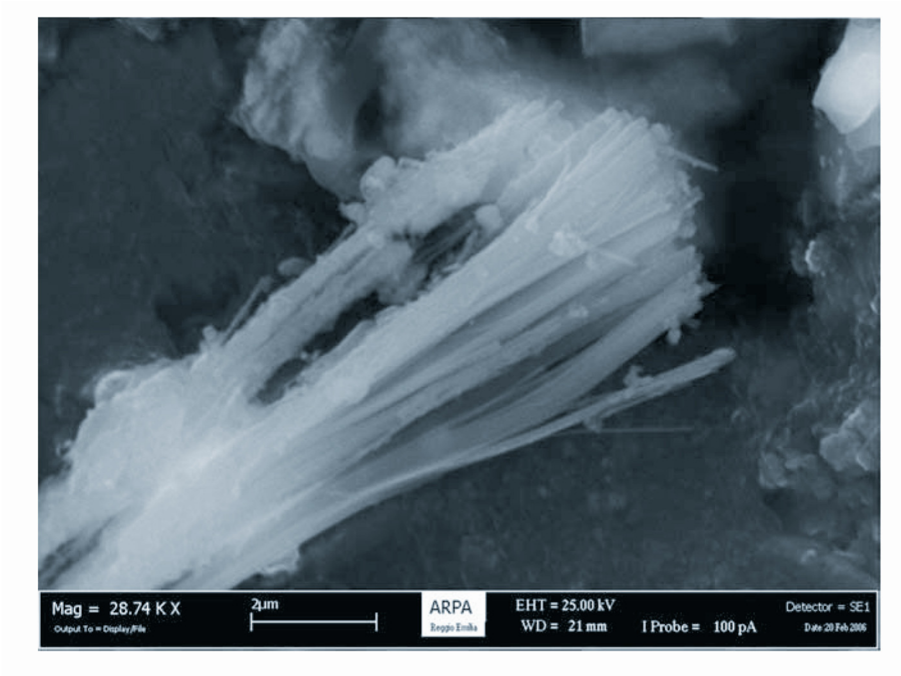

Figure 3 – SEM image of a bundle of asbestos fibres found in the airborne dispersed material collected during the third monitoring shift.

It is difficult to deal our results with the literature data. In general, we have seen that the concentration of asbestos or asbestos-like fibres in air is remarkably higher than that reported in our study. How to explain such inconsistency? There are two possible provisos: to assume that our results are affected by an undefined bias or to assume that our results are accurate and that the bias resides in the literature data. The following causes may plausibly explain the inconsistency: (i) lack of statistical significance due to the monitoring of only one site; (ii) nature of the investigate monitoring site; (iii) unpredictable random causes; (iiii) lack of accuracy of the analytical protocol. The issue is still open to us but it should be remarked that the literature itself proposes a number of unexplained issues such as the high concentration of asbestos fibres in monitoring sites which apparently should be considered as blank (with zero fibres concentration). These inconsistencies have already been underlined and the reliability of the determination of some high concentrations has been considered suspicious [4]. Extreme cases of concentration of asbestos fibres observed in a Pacific Ocean island and in the ice from Anctartica [5] appear open to criticism. The observed concentration of the asbestos fibres in the airborne and fall-out samples collected in the blank site (a civil building about 1 Km away from the Ceramic factory) for all the seasons was zero indicating that far away from the source of dispersion the risk of exposure is practically null. Surprisingly, fibre bundles were found in the samples of soil (see the example of the fibres observed with TEM in Figure 4). This may be indicative of past activity involving the removal of asbestos containing materials and eventual widespread dispersion in air, and concentration of the particulate in the soil.

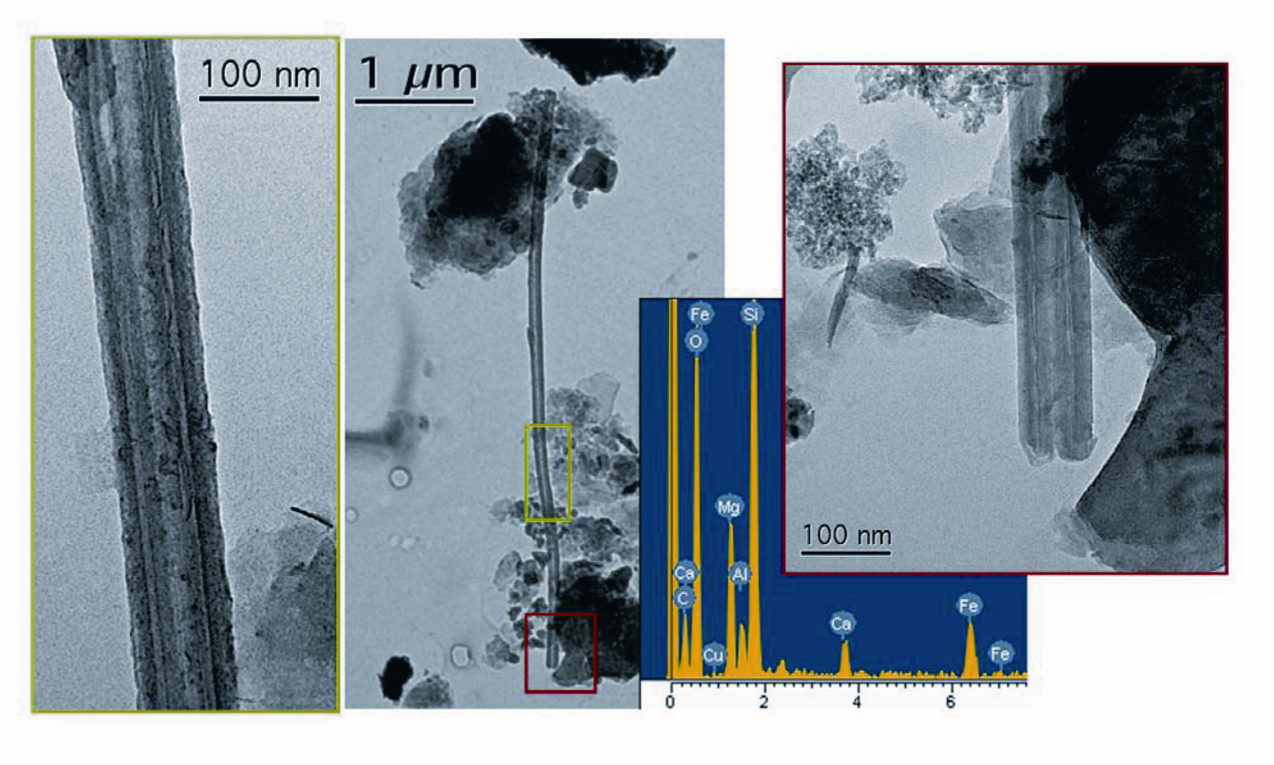

Figure 4 – TEM image of an (amphibole?) asbestos fibre discovered in the soil of the blank site.

Conclusions

In spite of the general report of remarkable concentration of asbestos fibres in air in urban and industrial sites worldwide, the results of this study point to a nearly zero concentration of dispersed asbestos fibers in the surrounding of a Ceramic factory (source of dispersion) whose production sheds are made of cement-asbestos.

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Session 5

Asbestos removal or management: techniques and case studies

RISK ASSESSMENT TOOLS FOR ASBESTOS CONTAINING MATERIALS

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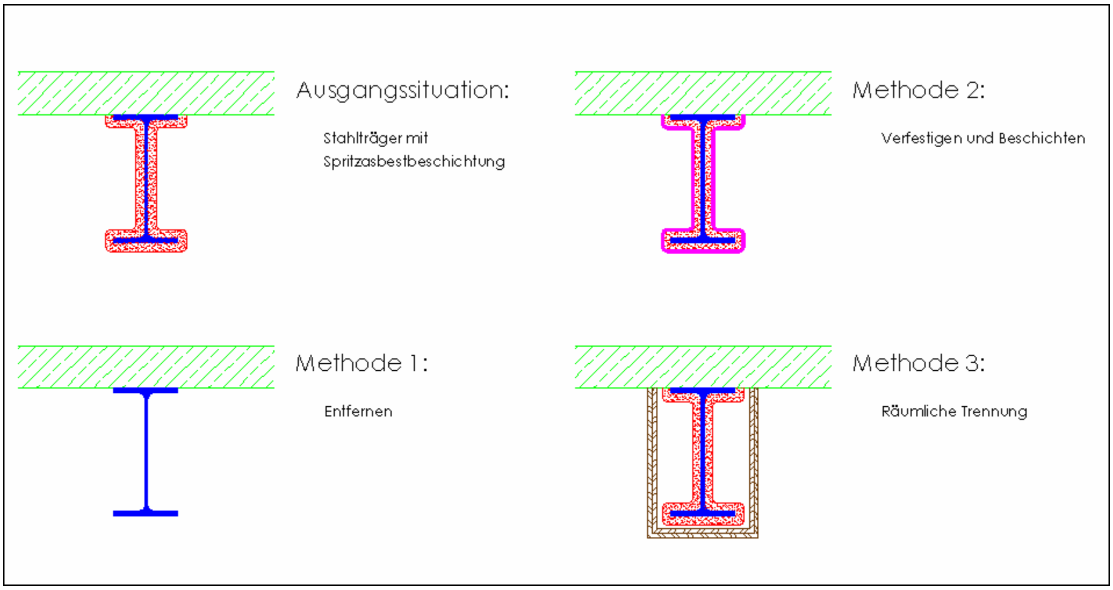
1. Introduction

Asbestos containing materials (ACM) in buildings can cause airborne asbestos fiber concentrations in case of ageing or external derogations like airflow, vibrations, changes in temperature and mechanical influence. The release of fibers to the indoor air increases with worsening of constructional conditions of ACM year by year.

Airborne asbestos fibers can be inhaled and cause serious human diseases. As it is not possible to determine any level of airborne asbestos fiber concentration that could be recognized as safe or harmless for humans, any asbestos fiber concentration has to be minimized or avoided at all. Three possible methods how to deal with ACM in order to reach this aim and are shown in picture 1.



Picture 1 – Methods for managing ACM

Picture 1 contains a sketch in the left above corner showing a steel beam with sprayed on asbestos as an initial situation, the following sketches symbolize the 3 methods:

- Method 1: Removal of ACM
- Method 2: Tightening and Sealing of ACM
- Method 3: Covering of ACM

The risk for humans increases with the level of airborne asbestos fiber concentration, the period of exposure and the life expectancy.

To minimize such risks, these aspects as well as constructional and operational ones have to be taken into consideration when a risk assessment on ACM should be outlined.

2. Austrian/German/Swiss Approach for Risk Assessment on ACM

There is a wide field of international approaches for risk assessment on ACM. Most of these approaches recommend a combination of visual and monitoring assessing. Some approaches are pointing out, that the composition and condition of all ACM in a building should be assessed for its potential to release fibers into the indoor air.

Though all these risk assessments should be executed by competent and experienced people, there might be difficult to set up the results upon a comparable basis. To realize this makes it necessary to use an evaluation standard on a semi-numerical standard at least.

Austria, Germany and Switzerland are practicing an approach that has been developed about 18 years ago and is still in use, covering weakly bound ACM. There might occur, that in each of the three countries the results of the common risk assessment approach can lead to slightly different conclusions. In that case, this paper covers only the Austrian specifics. However, the main philosophy on how to generate the decision basics is the same.

The main tool for this risk assessment approach on ACM is an assessment form respectively questionnaire as shown by the picture 2 next side. For every finding or source of ACM within a building this assessment form should be prepared carefully, covering questions or facts according the following groups I to VII:

I category of ACM
II type of asbestos
III surface condition of ACM concerning the structure
IV surface condition of ACM concerning damages
V external derogation of ACM
VI occupancy of the room containing ACM
VII position of ACM within the room

For each of these 7 groups, the assessment form proposes different possibilities according to the visual or analytical findings on site. The 30 possibilities in sum, that have to be answered like a multiple-choice-form, are associated with a certain assessment figure in the right column. Finally, the assessment figures have to be summed up according to certain rules. The result of the sum of the assessment figures – 98 at maximum – leads to 3 possible measures:

- Result ≥ 80: immediate measures required
- Result between 70 and 79: repeat of visual assessment at a 2-yearly interval
- Result < 70: repeat of visual assessment at a 5-yearly interval

For Austria, immediate measures mean, that the occupancy of the assessed room has to be stopped immediately, if a measurement of airborne asbestos fibers does not prove a result of less than 1.000 fibres/m³ of air (0,001 f/cc = 0,001 f/ml), conducted by a scanning electron microscopy method.

If the result of such measurement or monitoring program does not exceed 1.000 f/m³, occupancy can be continued under the conditions, that the same monitoring program has to be repeated within

3 months each, while a comprehensive management plan covering the focused ACM has to be prepared within 1 year at least.

It is important to stress, that this approach for risk assessment on ACM may not be applied by amateurs on the one hand, and that it does not exempt the professional from his responsibility on the other hand.

This risk assessment form has to be taken as a tool and a support for the professional on asbestos issues in order to work out a risk assessment statement on ACM within his unrestricted responsibility and without leaving any experience and know how beside.

3. Summary

A risk assessment standard for ACM should fulfill transparency, comparability and the possibility of verifying the results, if it shall meet a minimum requirement of objectivity.

It must be applicable in any situation and circumstance and may not claim to deliver statements without need of explanation through professionals.

The risk assessment approach on ACM as practicing in Austria, Germany and Switzerland is approved for about 18 years and has to be seen as a tool for the professional in conducting his job in elaborating risk assessment statements on ACM.

[1] Austrian Standards Institute, *ONORM M 9406, Handling of products containing weakly bound asbestos,* 01 08 2001

[2] Ministerialblatt für das Land Nordrhein-Westfalen, *Richtlinie für die Bewertung und Sanierung schwach gebundener Asbestprodukte in Gebäuden* (*Asbest-Richtlinie),* 01 1996

[3] EKAS, *Spritzasbest und andere schwach gebundene asbesthaltige Materialien (SG-Asbest),* 01 2000

Assessment form on construction and operational aspects in accordance with ONORM M 9406

groups	line	Finding/Source: **Building:** .... **Room:** .... **Construction part:**	Sign 1)	Assessment figure	
I		**Category of ACM**			
	1	Sprayed on asbestos	O	20	
	2	Asbestos containing plaster	O	10	
	3	Asbestos containing panels	O	10	
	4	Other ACM	O	5 to 20	**2)**
II		**Type of asbestos**			
	5	Amphibole (Crocydolite, etc.)	O	2	
	6	Chrysotile	O	0	
III		**Surface condition of ACM - Structure**			
	7	Loose fiber structure	O	10	
	8	Close fiber structure without or with insufficient tight surface coating	O	4	
	9	Coated and tight surface	O	0	
IV		**Surface condition of ACM - Damage**			
	10	Heavy damages	O	6	
	11	Slight damages	O	3	
	12	No damages	O	0	
V		**External Derogation of ACM**			
	13	ACM can be damaged directly (situation within handle height)	O	10	
	14	ACM is exposed to occasional works	O	10	
	15	ACM is exposed to mechanical influence	O	10	
	16	ACM is exposed to vibrations	O	10	
	17	ACM is exposed to strong alternating stress due to temperature	O	10	
	18	ACM is exposed to strong ventilations	O	10	
	19	ACM is exposed to strong airflow within the room	O	7	
	20	ACM can be released due to improper operation	O	3	
	21	No external derogation from ACM	O	0	
VI		**Room with ACM - Occupancy**			
	22	Regularly occupied room by children, teens and athletes	O	25	
	23	Permanent occupied or often used room by other persons	O	20	
	24	Temporary occupied room	O	15	
	25	Rarely occupied room	O	8	
VII		**Room with ACM - Position of ACM**			
	26	Directly within the room	O	25	
	27	Within the ventilation for the room (lining or covering of leaky ducts)	O	25	
	28	Behind a leaky, suspended ceiling or paneling	O	25	
	29	Behind a tight, suspended ceiling or paneling, outside of tight ducts	O	0	
	30	**Sum of assessment figures**			
		Measures in accordance with ONORM M 9406:2001-08, chapter 10			
	31	Immediate measures	O	≥ 80	
	32	Interval 2 years	O	70 to 79	
	33	Interval 5 years	O	< 70	

1) Please tick all appropriate boxes. When signing more than one line within one group, please consider only the highest assessment figure for summing up.

2) e.g.: AC mastic (5), AC knifing filler (5), AC foam (10), AC board (10), AC tissues (15), AC rope (15), loose AC insulating materials (20)

Picture 2 – Risk Assessment Form according to ONORM M 9406

ASBESTOS REMOVAL AT THE VIENNA INTERNATIONAL CENTRE

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1. Introduction

Vienna with the Vienna International Center – VIC is together with New York, Geneva and Nairobi one of the 4 headquarters of the United Nations. The buildings of the VIC have been erected between 1973 and 1979 by the Republic of Austria who is still the owner of the facility. Just in the year of completion and opening of the complex, sprayed on asbestos has been banned in Austria. However, sprayed on asbestos and some other asbestos containing materials have been used in the construction of the VIC as fire insulations before.

Picture 1 – Vienna International Centre, Construction Site 1974

The VIC complex consists of 7 buildings, 4 of them office towers, 2 buildings for common services and 1 conference building. The gross floor area of the whole complex is about 340.000 m², the enclosed volume makes about 1.400.000 m³. Today more than 4000 people are working in this

VIC complex. It is not only the headquarter of the UN in Vienna, but also of the International Atomic Energy Agency IAEA, of the United Nations Industrial Development Organization UNIDO and the Preparatory commission for the Comprehensive Nuclear-Test-Ban Treaty Organization CTBTO.

Due to the existence of various partly hidden asbestos containing materials in the VIC, the big size of the complex and the very high level of safety and security regulations it took some years to develop an asbestos management plan and to implement it into the ongoing operation and facility management of the building.

In any case, the main challenge is that any health risks have to be kept away from VIC staff during the entire project, both in the phase of regular operation before asbestos removal and in the asbestos removal phase itself. This aim could be guaranteed by several investigations and well prepared measures within the asbestos management plan.

The asbestos management plan for the VIC can be seen as a prototype of how to deal with the problem of asbestos containing materials in big, complex and sensitive premises without causing any risks for the users at all.

Picture 2 – Vienna International Centre, 1988

2. Development of the Asbestos Management Plan for the VIC

Within the structure of the VIC, asbestos containing materials have been used as fire insulations in breakthroughs and fire walls, in fire protection doors and on some air ducts in the technical floors and other applications.

In the mid of the 1990s the first large-scale modifications of technical facilities had to be undertaken. Due to this fact it became necessary to touch areas where asbestos containing materials were present. Consequently the first asbestos removal requirements came up and they had to be settled within the given time frames and technical requirements. At that time the International Organizations as well as the Austrian Government became aware of the need of setting up a Management Plan for the further handling with the asbestos issue in the buildings of the VIC.

The initial investigation on this issue was undertaken in the period from 1997 to 1998 in order to get an overview of the whole matter. After completion of this investigation - internally indicated as "Status-Report" – the Austrian Government decided to start a program to become the VIC an asbestos free environment, though the results of the Status-Report, that were verified by external consultants, did not indicate any health hazards for the VIC staff at all.

The next steps were: to work out a Draft Masterplan for asbestos removal from the VIC in the period 1999 - 2000, to seek a general consultant for outlining Final Masterplans based on this by the beginning of 2001and finally to execute these Masterplans step by step.

Initial small-scale asbestos removal exercises took place in 2003, but the start of operations oft the main project commenced in November 2004.

3. Elements of the Asbestos Management Plan for the VIC

The Asbestos Management Plan for the VIC in its present form has grown step by step during the period from 1997 to 2002. It is, of course, a living plan to be continued and, if necessary also adapted according to upcoming requirements until the presumed finish of the whole asbestos removal project is reached, presumably by 2010.

The main supports of this Asbestos Management Plan are the Status-Report, the Draft Masterplan and the Final Masterplans for each of the sections of the overall project. The elements of the existing Asbestos Management Plan have been defined, outlined and detailed within the three supports. The structure and content of these elements as well as their chronological sequence is shown in the following descriptions.

3.1 Status-Report

The aim of the Status-Report was to set up a general plan on how to operate the buildings taking in account the existing asbestos issue and how to deal with this issue in case of touching effected areas during buildings management operations.

The elements of the Status-Report were:

- setting up a general inventory and systematization of asbestos containing,
- working out an overall risk assessment scheme,
- developing of instructions for buildings management services and maintenance staff,
- working out of asbestos related terms of contract for external contractors,
- setting up of technical, logistical and safety principles on asbestos issues and
- defining a minimum standard on air monitoring of airborne asbestos fibres.

3.2 Draft Masterplan

The aim of the Draft Masterplan was to define, to analyze and to specify all technical, logistical and economical requirements to be met for executing an overall asbestos removal program for the buildings of the VIC. It was also the base for main decisions for both partners, the International Organizations as well as the Republic of Austria, to enable the project to be realizable.

The elements of the Draft Masterplan were:

- working out a detailed asbestos register on an individually created database,
- working out a model for removal priorities for all the buildings of the VIC,
- undertaking a pilot removal project in one of approximately 100 regular floors,
- working out an outline for installing substitute materials instead of asbestos,
- developing an optimal logistical option of asbestos removal and upgrading works due to the fact that the VIC has to stay in operation for the whole period of the project and
- setting up an estimate for the cost and time frame of the overall project.

3.3 Final Masterplans

The Final Masterplans are based directly on the Draft Masterplan and are developed in sufficient detail to make the project ready for realization. As pre-condition, a project organization for the asbestos removal and upgrading works had to be developed, covering all relevant parties (users and the owner of the VIC, consultants and contractors for all the different tasks) as well as different project ateas and sections according to the size and structure of the building concerned. For each of these project sections an own Final Masterplan must be elaborated.

The elements of these Final Masterplans are:

- detailed surveys of all areas within each section, covering non moveable furniture and installations, special requirements concerning security and technical issues and the individual level of upgrading demands after the asbestos removal,
- definition and preparation of all types of relevant works to be executed,
- setting up technical and logistical operational procedure plans for each section,
- elaboration of all work flow plans and move plans for each floor,
- approval of all the plans by the relevant authorities,
- standard specifications and bills of quantities for each of the required works,
- execution of tendering procedures to select the best bids for contracts and materials,
- implementing a site supervision and monitoring team to secure the quality of all works and services and the time and cost frame as fixed in contracts,
- implementing of a cost and time management level within the project team

4. Execution of the Asbestos Management Plan for the VIC

The execution of the asbestos management plan for the VIC – consisting of the Status-Report, the Draft Masterplan and the Final Masterplans – started already in 1998 with realization of the proposals and recommendations given within the Status-Report.

The Draft Masterplan has been an interim step, the next execution measures was completion of the first of the Final Masterplans in 2003, covering a part of the first project section.

The biggest project section I, the asbestos removal from the 4 office-block-towers, started in November 2004. According to the existing time schedules this project section should be finished within the third quarter of the year 2007.

The project section II covering the 2 buildings of the common services is actually in the phase of the tendering procedure and will start with execution within the first quarter 2007. As this project section II seems to become the most difficult ones, it will need the same time as the project section I, that is about 3 years.

Asbestos removal from the conference building, the project section III will not start before the year 2008, till a new conference building, actually under construction, will be ready for operation. The finish of project section III should be in the year 2010.

The time span from the first beginnings of the asbestos management plan of the VIC to the presumed state of an asbestos free environment in the VIC will last about 13 years. This period may seem relatively long, but it is to be taken into consideration the big size of the building, the execution of the asbestos removal exercise during full operation of the VIC, the execution of upgrading works in parallel to the asbestos removal works and a very careful preparation of all safety and security related work-flow plans. However, this would not be possible if there were even a slight health hazard for the VIC staff at large caused by the existing asbestos containing materials indicated in the regularly taken air measurements.

According to the present plans, an average 150 to 200 workers, supervisors and consultants are involved in this asbestos removal project for about 7-8 years. A laboratory equipped with two scanning electron microscopes is situated on site to undertake all measurements that are prescribed in Austria on a SEM-basis, with minimal delay.

EXAMINATION OF PHYSICAL PROPERTIES OF A CHRYSOTILE ROPE SATURATED WITH ASF WETTING AND ENCAPSULATING PREPARATION

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Ph.D. Sc. Andrzej Obmiński – Construction Technology Institute, Warsaw, Poland

1. Objectives of the research work

The research project carried out by the authors had two research objectives:

1. to obtain air which includes a small amount of respirable fibres of chrysotile. The air should be free from other organic (cellulose) respirable fibres. From the point of view of fibres' concentration, the obtained air should be similar to the environment inside buildings where asbestos-containing products are used or to the atmospheric air with a low concentration of asbestos fibres.
2. to examine the ability of ASF preparation to impregnate asbestos soft products in a durable and deep way. This refers to woven and plaited products (asbestos rope).

2. History of test preparations which impregnate asbestos-containing products in Poland

The methodology of examinations is based on a concept [1] developed by A. Obmiński in 1997. The concept enables "assessment of an impregnating agent's efficiency in relation to asbestos products through the assessment of bonding of asbestos fibres by layers which secure asbestos-cement products". This concept consists in comparing the number of respirable asbestos fibres released during mechanical destruction (polishing) of surfaces of asbestos-cement boards before they are impregnated and after having applied an impregnating agent.

An asbestos-cement board is polished inside a testing device, and the destruction of its surface is performed in repeatable conditions. At the same time, a set amount of the air from the space located above the polished sample is collected and blown through filters made of nitrocellulose ester. Air filtering through nitrocellulose ester filters takes place at specified speed. Fig. 1 shows a scheme of the device.

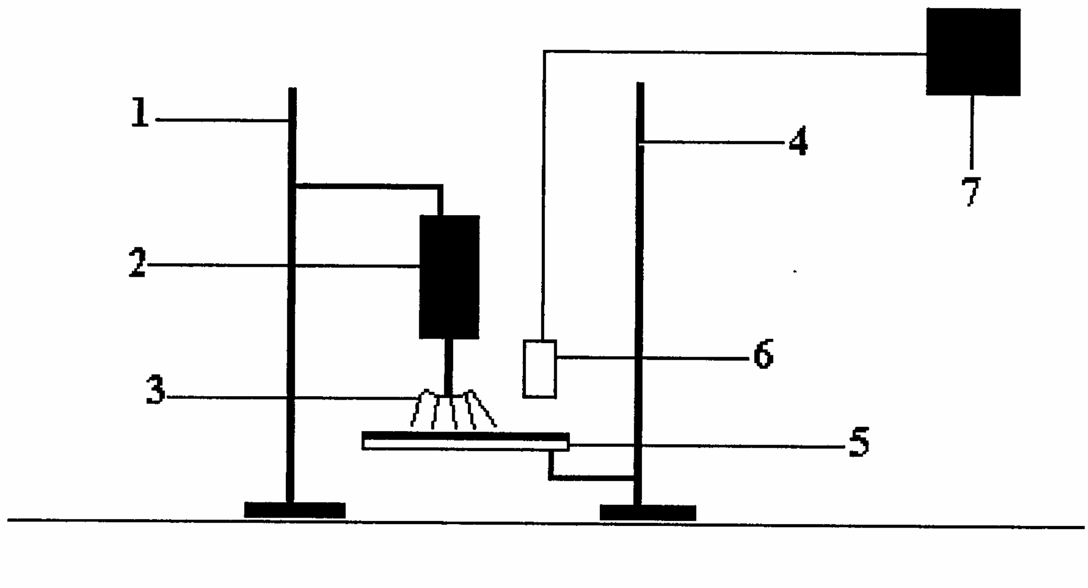

Fig.1.

1. boring machine holder
2. boring machine exerting constant pressure on tested tile
3. rotating steel wire brush
4. tested tile fixing holder
5. tested tile (plate, board)
6. probe with membrane filter
7. respirator

Fig. 1 Schematic view of testing assembly for examination of asbestos fibre emission from impregnated asbestos-cement tiles

In line with the requirement of phase-contrast methodology (PCM) Asbestos and other fibres by PCM method 7400, 15/08/1994; NIOSH Manual of Analysed methods 8/15/94, laboratory-processed filters are subjected to microscope analysis focused on respirable fibres. The said fibres are analysed in terms of their quantity and quality. The quantity analysis is conducted in the phase contrast. The quality analysis is based on optical features of examined fibres by registering them in polarised light under a microscope (PLM, i.e. Polarised Light Method).

In the year 2002, the Construction Technology Institute (ITB) developed "Recommendations for Issuing Technical Approvals by ITB" (zuat-15/vi. 12/2002) for products designed to secure façade and roofing asbestos-cement panels in existing buildings. In the said document one of several examinations was a microscopic examination of a change in the number of respirable asbestos fibres released from mechanically damaged asbestos-cement boards, when the said change was attributable to applying securing layers. In the "Recommendations" requirements, besides the said examination, other types of examinations are also applied, that is:

- standard-based methods: examinations of density, viscosity, adhesiveness, layers' flexibility;

– other than standard-based methods: laboratory procedures of establishing: the period of product's effective usefulness, drying (hardening) time on the cement base of painting coats, adhesiveness of coating complex, diffusion resistance for steam, water permeability, layers' flexibility, chemical resistance of a coating, flexibility and permeability of layers after self-induced ageing.

It was assumed that a securing product which obtained ITB's technical approval [2] has the efficiency of bonding asbestos fibres not lower than two, and the said efficiency is expressed by the proportion between the number of fibres released by an asbestos-cement board which is not secured with an impregnating agent and the number of fibres released by the board which is secured with an impregnating agent.

Table 1 presents exemplary values of the efficiency of bonding asbestos fibres by agents examined in the process of obtaining ITB's technical approval.

Table 1

Preparation's No.	Number of fibres released from a product not having any securing coating	Number of fibres released from a product secured with a protective coating	How many times the number of released respirable asbestos fibres decreased after the protective coating had been applied
1	7900	3800	2
2	7900	5100	1,5
3	7900	3100	2,5
4	7900	4000	1,97
5	7900	1400	5,6
6	7900	1600	4,9
7	34020	17208	2
8	34020	19472	1,7
9	34020	10706	3,1
10	29640	8084	3,7
11	5002	505	9,9

In the above table the shaded agents are the ones which do not meet the requirements for obtaining ITB's technical approval.

2. Examination of bonding asbestos fibres being released by soft asbestos products impregnated by wetting or encapsulating agent.

The above-described device and examination methodology refers to asbestos-cement products. It cannot be used to soft asbestos products, and in particular to those which do not contain a bonding matrix, impregnated by wetting or encapsulating agents. There was not such a device in Poland so far. There is also no information about such a device anywhere abroad [3]which could serve while testing materials of such a type. Owing to this fact, M. Foltyn designed and constructed a device to examine soft, flexible goods containing asbestos, e.g. a sample of asbestos rope. The device is characterised by the fact that release of asbestos fibres from this rope takes place due to simultaneous both-sides bending and both-sides twisting of the rope. An air inflow from a fan is an additional factor which increases release. In order to prevent any influence of the surrounding environment on the fibres' release, and in particular on their composition, the device was placed in a hermetic chamber. A HEPA filter, used in protective equipment for breathing system, was placed on the air inflow to the chamber. The air for analysing fibres is collected via the aspirator's sampler, placed in the outflow opening. Schematic view of a rope – end motion is presented in Fig No. 2, photo No. 2 presents how the device looks like.

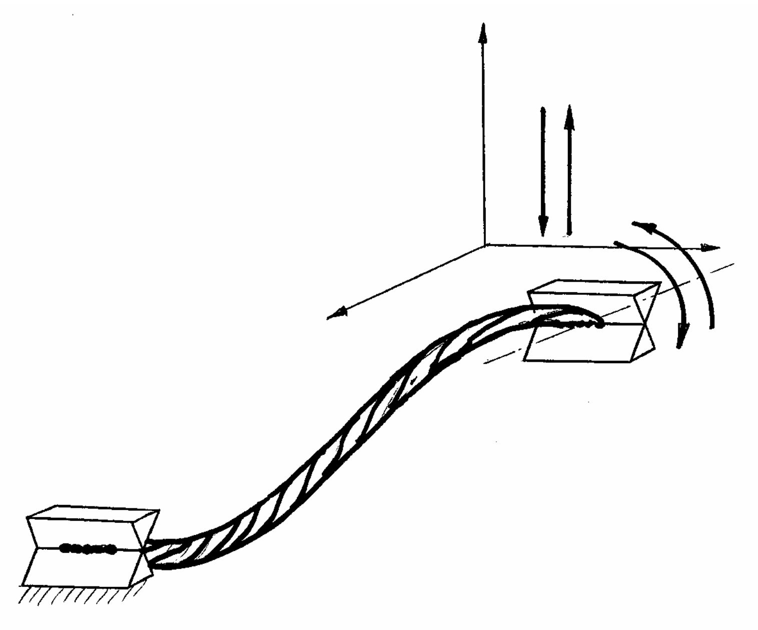

Fig. 2.
Schematic view of a rope – end motion

Photo 3. PA 23 1350
Side view of the device

The chamber's capacity is 0.14 m^3. The rope's bending and twisting is achieved with the help of a mechanism propelled by a micro-engine. A full cycle of bending and twisting of the rope in the range $\underline{+}90^o$ lasts 1.0 seconds, the ventilator's efficiency is about 0.2 m^3/min.

3. The process of examination of physical properties of a rope made of chrysotile and saturated with wetting and encapsulating preparation.

The subject of examinations was a sample – a piece of chrysotile rope, about 100 mm long and 8 mm in diameter (a 8 strand rope).

The objective of examinations was to assess efficiency of bonding asbestos fibres emitted from a sample of asbestos rope which had been impregnated with a wetting and encapsulating agent (ASF). The efficiency of bonding asbestos fibres by the said preparation was specified as a proportion between the concentration of fibres emitted by a rope which had not been subject to any wetting and encapsulating actions and the concentration of fibres emitted by a rope saturated with the preparation.

Two series of examinations were carried out.
In the first series the examination covered: contamination of the chamber caused by emission of asbestos fibres during both sides bending and both sides twisting of an impregnated sample (sample No. 2) and contamination of that chamber caused by the emission coming from a rope not-secured with an impregnating agent (sample No. 1). In the said series the time of each testing (emission and air sampling with an aspirator AF 50 whose efficiency was up to 50 dm^3/min) lasted 0.5 hours.

In the second series (sample No. 3, impregnated and No. 4 tested 24 hours after wetting with water only) velocity of the air-flow through the filter was reduced and simultaneously the length of testing was extended to about 1 hour (emission and air sampling). Examination of the same sample was repeated after 24 and 48 hours counting from the moment of sample impregnation with ASF preparation. Results of tests are presented in table No. 2.

The measurement of asbestos fibre concentation in the contaminated air was made with the help of a BIOLAR microscope with 600 times zoom.

Table 2. Results of the tests

Samples of tested asbestos ropes	Velocity of air-flow through the examined filter [dm^3/min]	Time length of testing (emission and air sampling) [min]	Calculated density of asbestos fibres in 1m^3 fibres/m^3	How many times the emission was reduced after having used ASF preparation
No. 1(without ASF)	17,8	25	230 000	-
No. 2	18	37	4 570	50
No. 3	10	45	1 200	191
No. 3 after 24 hours	10	45	2 500	92
No. 3 after 48 hours	11	65	16 000	14
No. 4 after 24 hours	11	65	24 500	9.4

4. Conclusions

a) conclusions on the ASF preparation

1.Impregnation of a chrysotile rope with ASF preparation significantly reduces the amount of asbestos fibres released from that rope. Obtained during on-site examinations, the concentration of released asbestos fibres ranged from 50 to 190 times lower in relation to the values of concentration of asbestos fibres released from the rope not subjected to impregnation.

2.The said preparation retains its good properties of bonding asbestos fibres in the period lasting at least 24 hours and thus it can be applied during work connected with removal of asbestos-containing products in order to reduce exposure to asbestos fibres.

3.Gelling of the preparation and the change of its form from liquid to gel-like substance, which binds asbestos fibres, enables its application as an encapsulating agent, thanks to which removal of asbestos, and particularly its remnants present in the gel-like substance is much easier.

b) Conclusions concerning the testing device

1. The device produces fibres depending on the source of emission, e.g. chrysotile fibres if chrysotile rope is being tested.
2. The produced fibrous dust is free of cellulose, organic, ceramic and glass fibres.
3. The device can produce fibres of specific concentration, it is also useful for emission of a specific type of fibres.
4.

5. References

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2. Polish Standard PN-88/Z-04202/02; Air Purity Protection. Examination of asbestos content. Determination of asbestos fiber concentration at working sites aided with the optical microscopy.
3. IR/L/MF/95/08; Wet Removal of Asbestos: Final Report; G. Burdett and G. Revell, HSE Research and Laboratory Services Division, Sheffield, April 1995.

FILTERING OF ASBESTOS FIBERS FROM HAZARDOUS WASTE LANDFILL LEACHATE (FALL PROJECT): A FIRST PRELIMINARY BALANCE

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[4] *Barricalla Spa*

Asbestos is introduced into water from a number of sources, including erosion of asbestos bearing rocks, erosion of natural deposits, corrosion from asbestos-cement pipes in the distribution systems, and disintegration of asbestos roofing materials with subsequent transport via rainwater into cisterns, and the like. Wastewater from asbestos mining activities and asbestos-related industries as well as atmospheric input also carry significant burdens of asbestos fibers in liquid.
The asbestos containing liquid can be divided into the following categories:

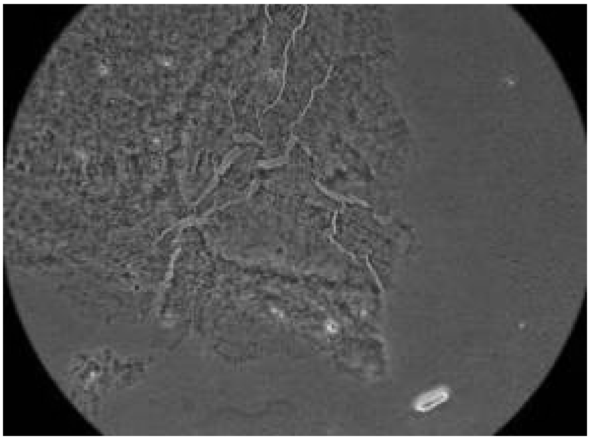
- Drinking Water
- Liquid from industrial activities and remediation
- Natural water (groundwater, river draining natural asbestos occurrences)

The Council of European Communities adopted in 1987 a Directive on the prevention and reduction of environmental pollution by asbestos (87/217/EEC). The Directive controls emissions of asbestos to air and water. Regarding aqueous effluents, the limit value is 30 g total suspended matter per m^3 of effluent, with a conversion factor of two fibres/ml to 0,1 mg/m^3 of asbestos dust, corresponding to $600*10^6$ fibers/liter (a fibre is defined as any object of length greater than 5 μm, breadth less than 3 μm, and having a length/breadth ratio greater than 3/1), which is countable by phase contrast optical microscopy using the European reference method defined in Annex I of Directive 83/477/EEC. Competent authorities must specify the maximum volume of discharge into water of the total quantity of suspended matter per tonne of products.
The promulgation of the European Community directive 1999/31/CE have lead to the set up of special landfill areas exclusively dedicated asbestos, leading to a large increase in the concentration of these carcinogenic fibres in liquid deposits (leachates). The dispersion of such leachates in the environment during some of the treatment process phases (air) or after disposal (water and/or soil) poses a serious environmental and sanitary risk.
European regulations do not foresee appropriate systems for the elimination of asbestos fibres from such leachates.
The LIFE-FALL"Filtering of Asbestos fibres in Leachates from hazardous waste Landfill" project (LIFE03 ENV/IT/00323), stemmed from the need to verify the possible environmental risk that could be generated by the presence of asbestos fibres in landfill leachates, an occurrence already pointed out in a preliminary study carried out in 2001 by the University of Venice in collaboration with ISPESL.

The project, now towards its end, had three main objectives:

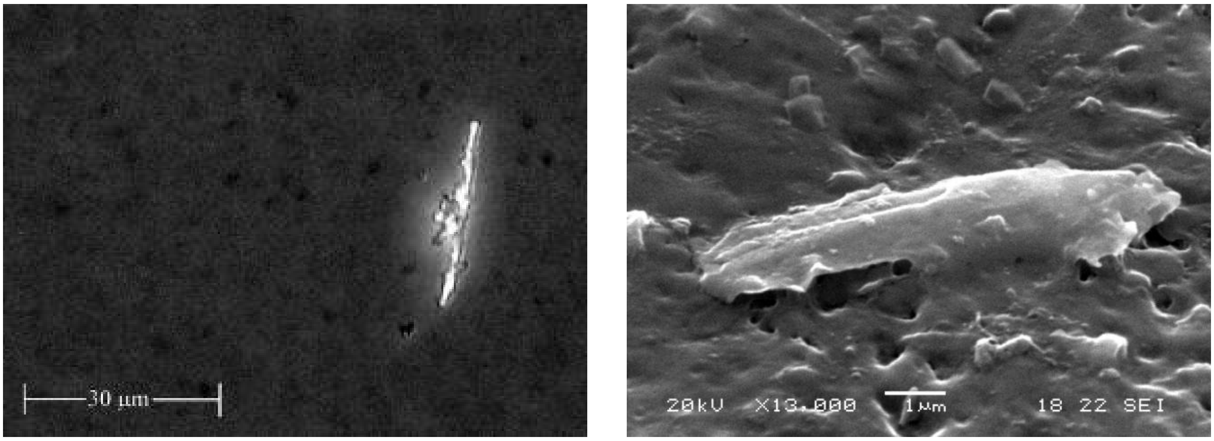
1. to develop a methodology for monitoring asbestos fibres in leachates (that can be helpful to the definition of a community protocol aiming at the regulation of the subject)
2. to monitor the leachates produced by the Barricalla (TO) landfill
3. engineering and construct a prototype plant for filtering asbestos fibres.

The filtering process of asbestos microfibres needs low porosity filters, which can be easily clogged by the presence of organic matter and other materials dispersed in the leachates. This calls for a treatment to reduce the organic load before filtration. A pre-treatment is also needed for the analytical process, in order to allow the observation of asbestos fibres otherwise embedded into organic matter. The project foresees the experimentation with treatments which could be able to reduce the organic matter load in the leachates.
The reduction of the organic content is performed in a batch-reactor by chemical oxidation under microwave irradiation. Filtration occurs both before the oxidation process, for clusters of larger dimension, and after it, for the smallest particles. The treatment target is the reduction of the 99% of the hazardous fibers in the leachate.



PCM Photograph: organic layer (250X)

SEM Photograph: organic layer (2000X)



Fibers embedded in organic layer (PCM Photograph: 500X and SEM Photograph: 9000X)

The key outputs are:

1. the analytical protocol
2. the analytical data obtained from the samples collected at the Barricalla landfill
3. the prototype

The analytical protocol task was completed in 2005. It consists of a collection of procedures for the analytical determination of asbestos fibres in liquids with a high content of organic matter. From sample collection to fibres observation, the most important features for routine analyses with the most used microscopy techniques (PCM, SEM and TEM) have been investigated and reported.
The analytical protocol have underlined that:

- » The reactant acidity in the prototype damaged the filter surface
- » Asbestos fibers tend to aggregate with organics
- » Fibers embedded in organics are not visible in SEM and PCM analysis
- » Fibers embedded in organics are not transferred to the TEM specimen
- » Necessity of a sample pre-treatment (Microwave assisted acid digestion)
- » Analytical method has been successfully adopted for samples with an organic load lower than 15000 mgO2/L COD
- » Elemental analysis is necessary to differentiate asbestos fibers
- » The small SEM investigated area couldn't be representative of the total filter surface
- » Other mineral fibres and microfibers (sulfate, titanium, etc.) observed, sometimes in a large amount, in SEM and TEM analysis, are hardly distinguishable in PCM; the presence in asbestos-like fibers may induce to an overestimation in the counting
- » The micro-fibers (fibers shorter than 5µm) content in leachate is not negligible for the total content in liquids

The landfill monitoring was completed in May 2006. Samples have been analyzed by PCM (144 analysis), SEM (46) and TEM (26). Furthermore some cross analyses have been made, in order to compare results obtained by different techniques.
Data processing is currently in progress. Preliminary results will be shown at the conference.

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RISK ASSESSMENT AND REMEDIATION PRIORITIZATION FOR ASBESTOS-CONTAINING MATERIALS

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Introduction

The health effects of breathing asbestos fibers are so well known that they need not be documented in this paper. Historically, the affected individuals have mostly included workers in the mines, mills and factories where the fiber and numerous products were produced, as well as those who installed the products in buildings and facilities. More recently, attention has been focused on those who work around asbestos-containing materials (ACM) as part of construction or maintenance activities.

The management of ACM in buildings and facilities consists of an on-going Operations and Maintenance (O&M) program and abatement when necessary, usually by removal. Assessing the risk of exposure to airborne asbestos fibers involves several factors, as does estimating the costs associated with managing the installed materials and their eventual removal.

This paper describes an approach to assessing the risk posed by ACM on the basis of its Current Condition and Potential for Disturbance. A graphical presentation of the assessments for all ACM in a building or facility allows one to prioritize response actions and decide which materials to remove and which to continue managing in place. The *Customized Compliance Program for Asbestos* software applies unit costs for removal to calculate the cost of the risk-based decisions for abatement and displays these costs in tabular and graphical formats.

Assessing asbestos-containing materials

The protocol for assessing the Current Condition and Potential for Disturbance of ACM appears in ASTM E2356 Standard Practice for Comprehensive Building Asbestos Surveys. [ASTM 2004; Oberta, 2005] Those who are familiar with inspection and assessment protocols developed for compliance with the U.S. Environmental Protection Agency (AHERA) regulations issued under the Asbestos Hazards Emergency Response Act [EPA, 1987] will find that the methodology in E2356 yields a greater amount of more usable information. The *Customized Compliance Program for Asbestos* software [Environment-i-media, Inc., 2004] further improves on the E2356 protocol.

In addition to taking bulk samples of materials that may contain asbestos for analysis in a laboratory, the inspector assesses the Current Condition and Potential for Disturbance of different types of ACM in various locations. Based on his visual observation, the *Current Condition* (CC) of each material is categorized as shown below: A rating of "1" represents the low end of "Poor" and "10" represents the high end of "Good," i.e. completely intact material.

Qualitative Ranking	Numerical Ratings	Description of ACM
Poor	1, 2 or 3	Extensive damage and/or visible debris
Fair	4, 5, 6 or 7	Moderate amounts of damage and/or visible debris
Good	8, 9 or 10	Little or no damage or visible debris

Anticipating what might happen to suspect ACM in the future – its *Potential for Disturbance* (PFD) -- is more complex. A regulatory definition of "Disturbance" is "...activities that disrupt the matrix of ACM or PACM, crumble or pulverize ACM or PACM, or generate visible debris from ACM or PACM."[OSHA 1994] The inspector assesses each material based on one or more of the factors shown below:

Qualitative Ranking	Numerical Ratings	Assessment factors					
		Physical disturbance		Environmental disturbance			
Low	1, 2 or 3	*accessibility*	*activities*	*vibration*	*air / dust*	*water damage*	*corrosive*
Medium	4, 5, 6 or 7						
High	8, 9 or 10						

Physical disturbance considers the *accessibility* of the material by workers during normal facility operations, including maintenance and repair, and the *activities* performed near the material - what people do and how often they do it. *Environmental disturbance* considers sources of *vibration*, such as operating machinery, HVAC equipment, whether *air currents* are strong enough to dislodge loose ACM or if *airborne dust* can erode the material. *Water* from a leaking roof or pipe may have damaged the material. The material may be subjected to a *corrosive atmosphere or liquids* that can erode the matrix and expose asbestos fibers.

Assessment tables and charts

Table 1 contains survey and assessment data for a small boiler plant. The table has been sorted to place the materials in the worst condition (lowest CC rating) at the top, and if there are two or more materials with the same CC rating, a second sort was performed to rank these materials according to the highest PFD rating (most accessible). A glance at the table shows which materials in what locations are the most in need of attention. This is the first step in deciding which ones to remove and which to keep managing in place.

NOTE: This is not an algorithm! The ratings are not added, multiplied or arithmetically combined in any manner. They are tabulated and plotted as shown below.

E2356 describes a two-dimensional chart called the Abatement vs O&M Decision Chart on which these ratings are plotted. The left side of Figure 1 shows such a chart for the boiler plant example in Table 1. The closer to the upper left corner the rating for a particular ACM is plotted, the greater the risk of exposure to asbestos fibers and consequently the higher the priority is for removing the ACM. The area above the curved line is called the Abatement region. Below the line is the O&M region, and the closer to the bottom right corner the rating for a particular ACM is plotted, the lower the risk of exposure and managing it in place is more feasible.

Location	Area	Asbestos-Containing Materials	Quantity	Assessment			
				Current Condition		Potential for Disturbance	
				Rating	Based on	Rating	Based on
G	Boilers #1, #2 & #3	Insulation covering top of boilers #1, #2 & #3	500 ft²	1	Damage & debris	7	Frequent access
D	Southwest corner	Tank & fittings insulation	120 ft²	2	Damage & debris	9	Frequent access
C	Southwest corner	Pipe insulation	150 ft	3	Damage & debris	8	Frequent access
E	Boilers #1, #2 & #3	Steam drum insulation	250 ft²	3	Missing covering	7	Elevated location
F	Boiler #4	Steam drum insulation	100 ft²	7	No visible damage	5	Elevated location
B	East aisle and southeast corner	Pipe insulation	440 ft	9	No visible damage	5	Elevated location
A	East aisle and northeast corner	Breeching insulation	1500 ft²	9	No visible damage	4	Elevated location

Table 1. Assessment ratings and quantities of asbestos-containing materials in boiler plant

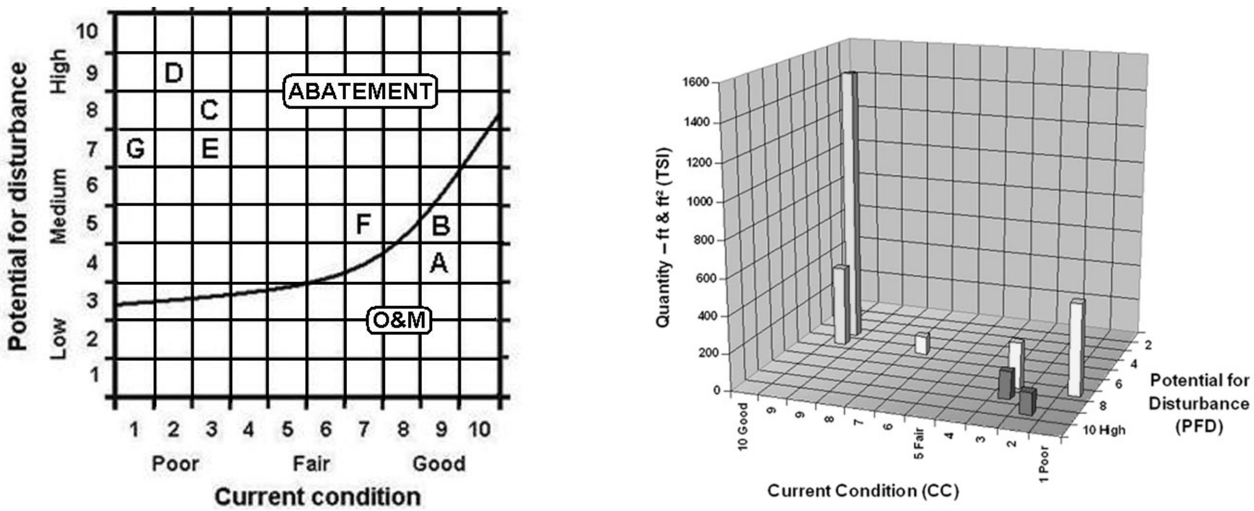

Figure 1. Two and three dimensional Abatement vs O&M Decision Charts for boiler plant

The position and shape of the line in Figure 1 biases decisions toward abatement, which occupies more area of the chart than O&M. One reason is that O&M tasks for remaining ACM in this boiler plant would be of more-than-average complexity and frequency. In this example, the insulation covering the top of boilers #1, #2 & #3 and the steam drum insulation on these boilers are clear candidates for removal, as is the pipe insulation in the southwest corner. The remaining ACM is close to the line and whether to remove it or leave it in place is a matter deserving consideration of other factors. These might include the proficiency of the O&M crew (in-house or contractor) and whether including these items in an abatement project for other ACM is cost-effective.

Making decisions about removing ACM or managing it in place is not a simple matter of drawing a line on a chart. The benefit of doing so is to encourage an honest evaluation of the overall asbestos management program as part of the decision-making process. The risks associated with ACM should be viewed as a continuum of severity that can be more realistically represented by using color and a three-dimensional chart. The *Customized Compliance Program for Asbestos* software displays the Current Condition and Potential for Disturbance ratings on the "floor" of a three-dimensional chart, with the vertical axis representing the amount of each ACM. The three-dimensional chart for the boiler plant is shown on the right side of Figure 1.

The horizontal axes have been arranged so that the ACM in the poorest Current Condition and the highest Potential for Disturbance are in the right front corner of the "floor." Also, the color of the "floor" goes from green in the left rear corner to red in the right front corner. The further into the green area the ACM is located, the more amenable it is to being managed in place. The further the ACM is into the red area, the higher the priority for abatement. The three-dimensional chart visually separates the ACM in the boiler plant into two items in the green area that are clearly amenable to O&M, four clear candidates for removal in the red area and one in between for which either option may be acceptable. The vertical axis shows the quantities of each of these items of ACM. Even though the breeching and some pipe insulation in the left rear corner constitute the largest amounts of ACM, they are also the most amenable to being managed in place.

The Abatement vs O&M Decision Chart supports the process of making asbestos management decisions on the basis of the exposure risk associated with the ACM, and the three-dimensional representation introduces the quantities of the ACM into the process. The *Customized Compliance Program for Asbestos* software also determines the costs of implementing the decisions.

Potential and probable costs

Many asbestos survey reports include an estimate of cost for removing ACM based on unit costs for each type of material found. If not, typical values can be used in preparing Table 2, using data from the same boiler plant as in Table 1. The column titled "Potential Cost" is the amount that would be spent *if* the material was removed. It is the cost of abatement, for example, that would be incurred if that renovation or demolition required prior removal of ACM that might be disturbed by construction activities. (EPA, 1990) However, the probability that the material would be removed *based solely on its Current Condition and Potential for Disturbance ratings* is almost certainly less than one, and is actually a function of those ratings.

The *Customized Compliance Program for Asbestos* software contains a "probability matrix" for all combinations of Current Condition and Potential for Disturbance. At one extreme, material in perfect condition with almost no chance of disturbance (mastic under intact non-asbestos floor tile is a good example) is found at CC=10 and PFD=1; therefore the probability of removal equals 0.01. On the other hand, it is quite certain that heavily-damaged pipe insulation close to the floor in a high-traffic area with ratings of CC=1 and PFD=10 would be removed; hence a probability of removal of 1.0. In between are 98 other combinations of ratings and their associated probabilities of removal *based solely on the Current Condition and Potential for Disturbance of the ACM.*

Location	Area	Asbestos-Containing Materials	Quantity	Ratings		Removal costs ($US)		
				CC	PFD	Unit cost	Potential cost	Probable Cost
G	Boilers #1, #2 & #3	Roofing	500 ft²	1	7	$15	$7,500	$5,250
D	Southwest corner	Tank & fittings insulation	120 ft²	2	9	$10	$1,200	$972
C	Southwest corner	Pipe insulation	150 ft	3	8	$10	$1,500	$960
E	Boilers #1, #2 & #3	Steam drum insulation	250 ft²	3	7	$15	$3,750	$2,100
F	Boiler #4	Steam drum insulation	100 ft²	7	5	$15	$1,500	$300
B	East aisle and southeast corner	Pipe insulation	440 ft	9	5	$15	$6,600	$660
A	East aisle and northeast corner	Breeching insulation	1500 ft²	9	4	$20	$30,000	$2,400
Total							**$52,050**	**$12,642**

Table 2. Potential and probable removal costs for asbestos-containing materials in boiler plant

The last column in Table 2 applies these probabilities to the Potential Costs for each material to create a set of values called the Probable Costs. By summing the Potential Cost and Probable Cost columns, Table 2 shows that the expected abatement costs for the facility are reduced significantly by taking into account the fact that relatively intact, inaccessible asbestos-containing materials will continue to be managed in place as long as they stay that way. Consequently, the amount that must be budgeted for removal under these circumstances (absent any planned renovation or demolition) is a fraction of what could (and eventually will) be spent.

The same three-dimensional format as in Figure 1 can be used to illustrate the Potential Cost and Probable Cost of implementing risk-based decisions made with the assistance of the Abatement vs O&M Decision Chart.

Conclusion – Part One

The assessment protocol for asbestos-containing materials in ASTM E2356 provides risk-based information with which to prioritize decisions as to whether the ACM should be removed or managed in place. The *Customized Compliance Program for Asbestos* software allows the user to visualize these priorities in color and three dimensions, and also estimates the costs associated with the decisions. These tools complement the skills of a trained professional – they are not a substitute for his judgment and experience – and are to be used in the context of other factors affecting asbestos management decisions.

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A MICROWAVE-ASSISTED PILOT PLANT FOR PRE-TREATMENT OF HAZARDOUS WASTE LANDFILL LEACHATE: THE PROTOTYPE OF THE LIFE-FALL PROJECT

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In the frame of the EU-LIFE project "Filtering of Asbestos fibres in Leachates from hazardous waste Landfill", acronym FALL (LIFE03 ENV/IT/00323), we engineered a pilot plant (prototype), which is designed to digest the organic component contained in landfill leachates, as a pre-step for efficient filtering of dangerous fibres, possibly present in the leachate. In fact, the filtering process of microfibres needs low porosity filters, which can be easily clogged by the presence of organic matter and other materials dispersed in the leachates. This calls for a treatment to reduce the organic load before filtration. In our prototype this digestion process is carried out in a acid/oxidizing environment under MW irradiation.

The aim of the treatment is the filtration of the micrometric asbestos fibers potentially dispersed in landfill leachates and in general in liquids with high content of organic matter, using a multistage filtering process associated with a reduction of the organic load of the liquids.

The reduction of the organic content is performed in a batch-reactor by chemical oxidation under microwave irradiation. Filtration occurs both before the oxidation process, for clusters of larger dimension, and after it, for the smallest particles. The treatment target is the reduction of the 99% of the hazardous fibers in the leachate. Processed liquid could be refinished on-site to meet normative limits for discharge or could be transported off-site to a dedicated treatment plant.

The pilot-scale plant for filtering asbestos fibers on landfill site is composed of a 220 μm pre-filter device acting as screen at the inlet, followed by a 100 L closed-tank microwave batch-reactor (2x8 kW magnetrons at 2,45 GHz), which can operate up to 6 bar/120°C. From the second batch on, a heat exchanger allows the liquid entering the reactor to be pre-heated by the digested liquid, thus increasing the energy efficiency of the apparatus. A dedicated software controls the process through temperature and pressure sensors and a number of electro-valves placed along the liquid pathway. An filtering unit has been devised for the out-gas.

Oxidation of the leachate is obtained by adding an appropriate mixture of H_2SO_4 and H_2O_2 to the raw leachate and then rapidly heating the solution to ca.120°C, using the extremely efficient microwave radiation. We aim to obtain a charge of liquid poor in organic compounds and suspended solids, so that the effectiveness of the asbestos fibers retention by the following two-step 25/0.5 μm filtration step will be increased. A reverse osmosis unit could be integrated in the plant as a final treatment, so that the liquid could be securely discharged without the need of further off-site treatment.

The leachate pumped from the landfill cell is temporarily stored in a feeding-tank from where the reactor is fed. Before entering the reactor the leachate is forced through the first filtration unit (220 micron) for the organic clusters blockage. The first charge of a cycle is pumped directly to the reactor, since no heat exchange is possible. Reactants are fed and the reaction performed. The hot liquid mixture is then spilled from the bottom of the reactor and pumped into the heat exchanger, where the liquid for the second batch is thus pre-heated. In the meanwhile, another fresh charge is being directly processed in the reactor as the first cycle charge. As soon this 3rd charge has been processed the complete automated cycle can be started. So during the routine working cycle of the pilot plant there will be a charge in processing and in the meantime two charges exchanging heat. After the heat-exchanging step, the cooled processed mixture is neutralized with a basic component (NaOH) in the neutralization tank (N).

The neutralized-fresh liquid is then pumped through the last filtration units (25µm and 0,5µm) for fibers blockage and separately stored to be transported off-site. In order to prevent local atmospheric pollution, reaction out-gas is first convoyed through a filtering unit and then bubbled into a water tank.

The plant has been constructed and assembled in a compact flexible modular set, easy to transport and arranged as shown in Fig. 1. From the image the positioning of the four magnetrons on the reactor can be noticed. The filtration system is located on the rear, beneath the heat-exchangers and it shown in the inset on the top-right side of the figure.

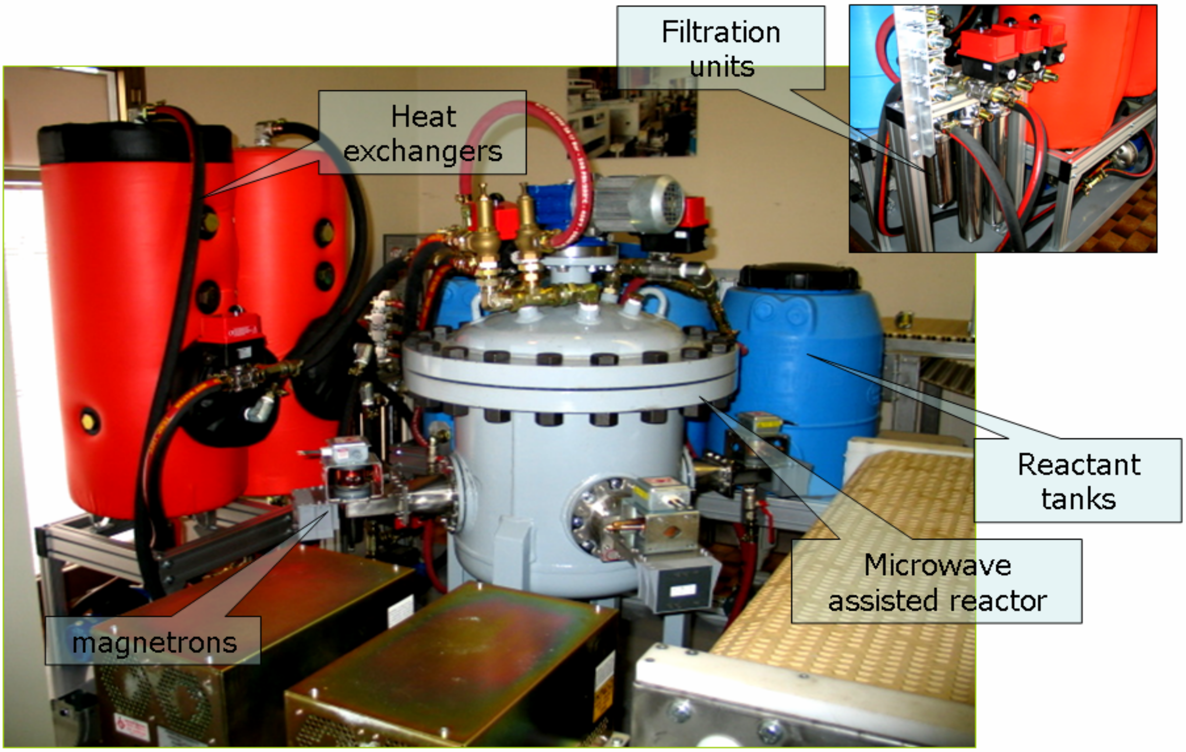


Fig. 1 – A photo of the plant during assembling.

The apparatus is housed in a protective transparent box with a semi-moveable roof. A software controlled synoptic diagram provides for real time monitoring and control of cycle parameters.

For further details on the pilot plant please refer to the FALL project web site (www.unive.it/fall).

ACKNOWLEDGMENTS

The financial support of the European Community (LIFE03 ENV/IT/00323) is greatly acknowledged.

THE COMBINATION OF THE MECHANICAL SEPARATOR AND THE EXTRACTION CLEANER CAN PROCESS THE COMPLETE ASBESTOSCONTAINING WASTE-STREAM AND MAKE IT SUITABLE FOR REUSE.

ing. A.M. Boer[1], drs.ir. L.A. Daal[1], J.L.A. de Groot[1], ir. J.G. Cuperus[1]

[1] Verwerking van asbesthoudende reststromen

Up to 1991 asbestos has been used frequently in The Netherlands. Asbestos is especially found in roofing on sheds and outbuildings. These buildings are often found in the countryside. Until the use of asbestos was forbidden in The Netherlands in 1991, the old sheets were carried off together with the rubble to the rubble crushers. The sheets that were still in one piece, were reused. If sheets broke, they were usually used as gravel on the roads. Also sawdust and remnants were used to fill the holes in the roads at the surrounding ground. Remnants from asbestos could also be picked up for free from the asbestos factories.

Because of these applications many roads in the countryside as well as yard-hardenings are contaminated with asbestos. This form of asbestos-contamination is estimated at 400.000 million tons of soil and rubble a year, for the years to come. This is also caused by the fact that before 1991 asbestos was supplied to the rubble crushers and this rubble is sold as granulate for gravel in the road-building. That's why the Dutch government has set up a concentration at which asbestos has to be removed. The soil standard is

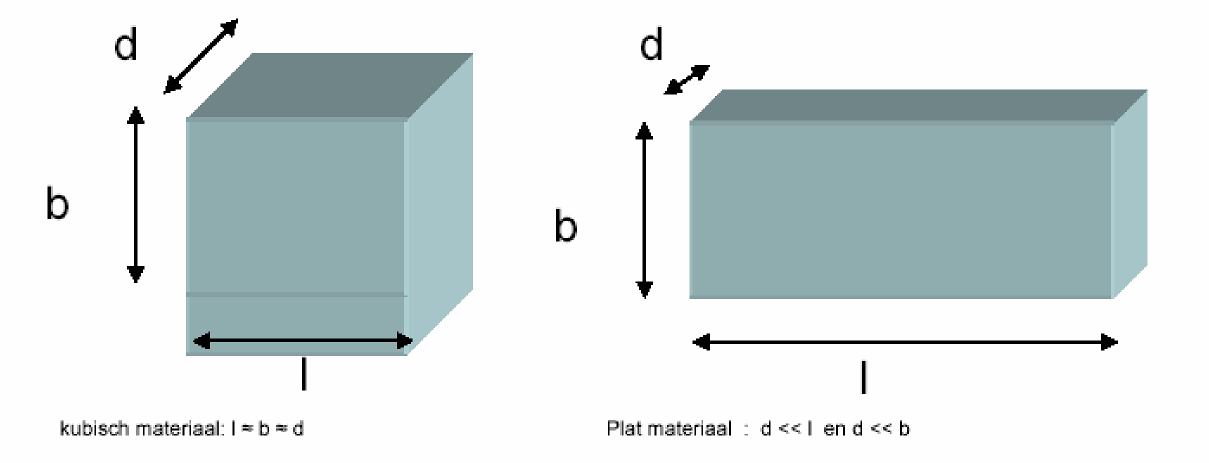
100 mg/kg asbestos. If the concentration of asbestos is higher than 100 mg/kg, reconstruction has to take place. If the most dangerous type of asbestos, amphibole, is found, this standard is 10 x more severe.

For the last few years it is obliged in The Netherlands, to produce a "clean soil certificate" at the sale of real estate. If asbestos is found in the soil at a visual check, it is also necessary to check on asbestos in the further course of the examination.

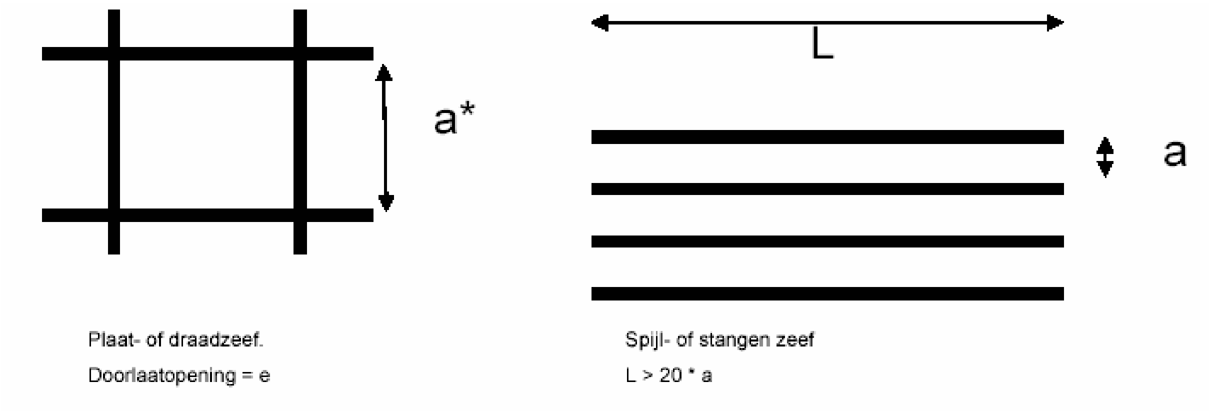
Both soil and rubble are reused in The Netherlands. Because the asbestos-sheets in the ground are broken into small pieces, it is very difficult to separate these. A much used method was to screen the soil as well as the rubble to 60 and 10 mm. The soil of up to 10 mm is usually clean and the rubble bigger than 60 mm can be cleaned easily through handpicking. The inter-fraction with a lot of asbestos and rubble is then dumped in a landfill. VAR has developed a mechanical asbestos separator, which can separate asbestos mechanically. Mechanical separation is possible at a fraction of 10 till 80 mm.

ASBESTOS-SEPARATOR

The principle of separation is based on the fact that asbestos exists from flat parts. Granulated material has a length (l), a width (w) and a depth (b). A flat piece is characterized by a depth (d) which is smaller than the length (l) and the width (w). The depth (d) is the determining dimension in the separation process.



To separate the sheets a mechanical separator is used. This separator exists from a special bar-screen and a flat-screen, which are placed on top of each other. The openings in the screen deck (a) determine the maximum dimension of a granulate piece that falls through this screen. Bigger parts remain on the deck. Sheets with a depth < a and cubical or globular parts with a diameter < a will also fall through the bar-screen. These last-mentioned parts are not flat. Screening by the bar screen is being followed by the second step in the screening; the flat screen. The openings in this deck have a measurement of a*. The globular and cubical parts fall through this. The measurements “b” and “l” are mostly > a*, so they remain laying flat on this deck and are removed separately.



On the basis of tests which have been carried out, it appeared that 88 to 98% of the asbestos which is supplied, was removed. The tests are carried out in a “worst-case” scenario. In practice it appears that the fraction 10-80 mm at sandy material the asbestos found has been removed for more than 96% from the rubble-stream.

From the fraction bigger than 80 mm the asbestos and any other contaminations can be removed through handpicking, so also the granulated rubble is made suitable for reuse.

EXTRACTION CLEANER

Apart from asbestos-sheets/plates, also soil and rubble is often contaminated with asbestos fibres. These fibres are often present in combination with rubble and asbestos-sheets. By screening the soil at 10 mm, this can be cleaned with an extraction ground-cleaner. This ground-cleaner is normally used for the cleaning of chemical contaminated soil like for instance soil with oil or metals. It was expected that asbestos fibres in a extraction cleaner would get attached to organic material (sludge). This proved to be the case. In the extraction cleaner the sand is wet-screened (0-4 mm) and separated through cyclones at 63 um. The fraction < 63 um is sludge and has to be dumped. The fraction 4-10 mm is non-separable with the present techniques and is dumped as well. After testing it appeared that asbestos fibres are found in sludge, not in sand and water.

Conclusion:

When in soil and rubble asbestos sheets are found > 10 mm, it is possible by means of screening and mechanical separation, to clean the soil and rubble until far below the current standard of 100 mg/kg and only a minimum amount of residue has to be dumped. If there are also fibres in the soil, this soil can be cleaned by means of an extraction cleaner.

Session 6

Management and treatment of asbestos waste: european and italian legislation and applications

ANALITICAL EVALUATION OF WASTES CONTAINING ASBESTOS AFTER INERTIZATION TREATMENT BY PYROLITIC PROCESS

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Wastes recovery efficiency have been slightly improved by Decree n.248 of 29/7/2004 on" Rules on determination and disciplines of recovery activities of products and goods of asbestos and containing asbestos" by defining processes and treatment able to bring to a complete transformation of crystallochemical features of asbestos.

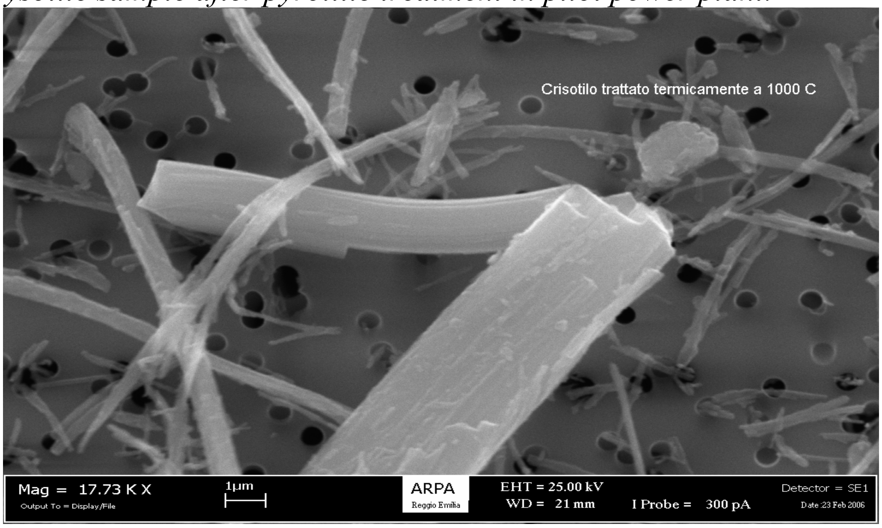
Such treatments if properly applied allows to avoid the disposal of wastes in dumps. They also allow the reutilization of processed wastes. No adequate power plants suitable for the mentioned treatment presently exist in Italy.

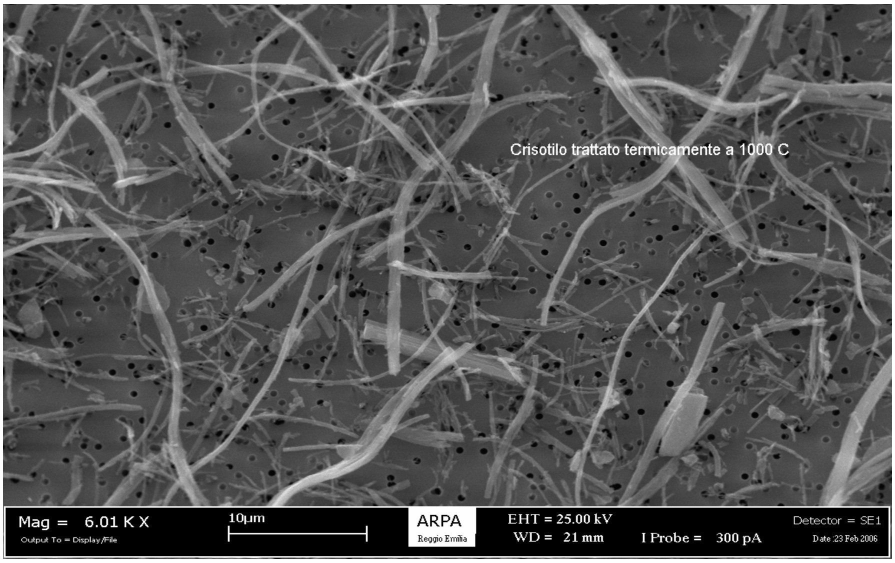
Intense research activity is devoted to the start up of pyrolitic processes applied to wastes deriving from concrete/asbestos to be reutilized in environmental recovery. Decree n.248 reports characteristics of processed material which must be asbestos free and accompanied by mineralogical composition of final product.

Present paper propose an analytical protocol suitable for law need and able to guarantee safety conditions of wastes after crystallochemical transformation.

In order to verify such transformations analytical procedures adopted in qualified laboratories on asbestos analysis have been utilized. Pure chrysotile and concrete/asbestos samples have been analyzed by MOCF, DRX, SEM and FTIR after 2 hours heating at 600-700-800-900-1000 °C in muffle furnace. Some samples processed by pilot power plant by Aspireco have also been analyzed.

Figures 1-2. Chrysotile sample after pyrolitic treatment in pilot power plant.





Main high temperature transformations of asbestos containing materials are described as solid state deoxydrilization and recrystallizations (Gualtieri and Tartaglia, 2000). Thermal treatment of pure chrysotile evidences that after deoxydrilization at 800 °C starts a solid state transformation which brings to a complete recrystallization into silicatic-magnesiac phases (forsterite and enstatite). After this transformation chrysotile loses fiber-asbestos characteristic and is not dangerous for health. Asbestos by pure tremolithic amphibole thermally processed at 1100 °C after deoxydrilization is completely tranformed in diopside, enstatite and cristobalite. Flaked asbestos represented by chrysotile and processed at 1000 °C show that asbestos original characteristic is completely decomposed and three new phases of gehlenite, diopside and iron forsterite are cristallized. X ray diffractometry of concrete/asbestos constituted by prevailing chrysotile processed at 1100 °C evidence new phases deriving from chrysotile transformation such as prevailing gehlenite and diopside in a less extent. Quartz and hematite have also been found as residuals. SEM analysis of obtained materials evidence the inertization of fibrous phases which are transformed into irregular aggregates of neoformation crystals accompanied by loss of original dangerous character.

MOLP

Is the simplest technique which enables to verify optical properties of asbestos crystals.

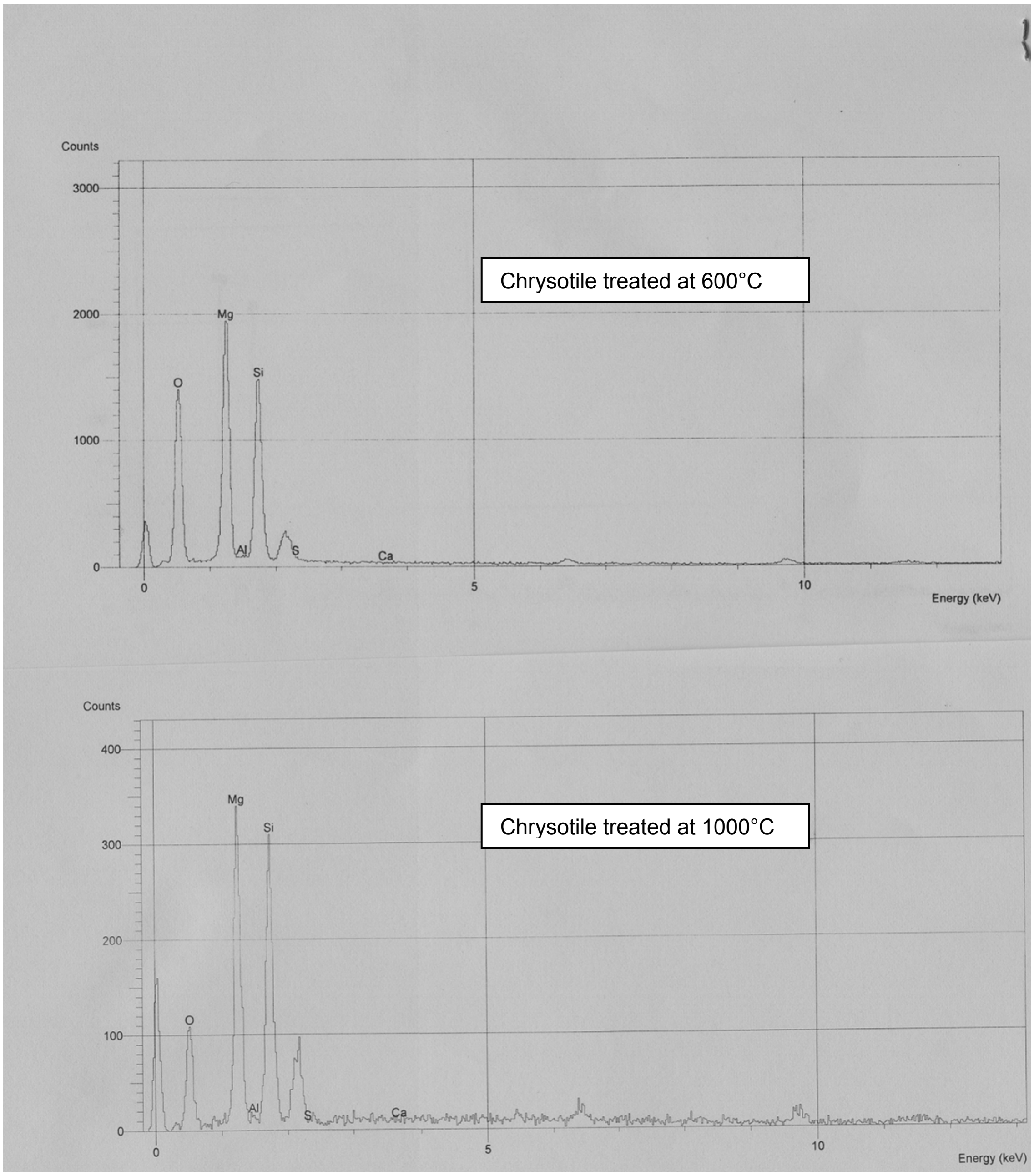
Chrysotile processed at relatively low temperatures (600-700 °C) is still characterized by original colour and colour changes which completely disappear at higher temperatures evidencing the complete crystalline structure tranformation.

DRX

Main (12.1°) and secondary (24.3°) reflexed rays expressed as 2 Theta are recognizable on chrysotile and concrete/asbestos samples processed at 600-700 °C while are not visible on samples processed at temperatures higher than 800 °C. A detailed study on diffractogram allows to recognize new recrystallization phases.

SEM

Chrysotile fibers morphology tends to modify loosing characteristic flexuous curves of chrisotile and assuming a rigid character closer to artificial mineral fibers. New recrystallized fibers tend to broke transverally differently to asbestos ones. Qualitative analysis of EDX spectra evidences an increasing oxygen loss related to increasing temperature of the sample.



FTIR

FT-IR spectrophotometry is a highly sensitive analytical method which allows to analyze samples in relatively short times and good repetivity. Samples of KBr, chrysotile and concrete/asbestos have been grinded , tranformed into tablets and analyzed. A decreasing of characteristic peak in chrysotile speactra related to increasing processing temperature was detected. The peak completely disappeared on samples processed at temperatures higher than 800 °C evidencing the complete transformation of chrysotile.

In conclusion the contemporary study of the same samples with all listed methods allows sure diagnosis on processed wastes.

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UNDERSTANDING THE HIGH TEMPERATURE REACTION SEQUENCE DURING THE THERMAL TREATMENT OF CEMENT-ASBESTOS SLATES

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Abstract

This paper reports the description of the reaction path taking place during the firing of cement-asbestos slates followed using different experimental techniques (optical microscopy, SEM, TEM , quali- quantitative X-Ray powder diffraction, FTIR). It will be demonstrated that only an interplay of different experimental techniques (mainly diffraction end electron microscopy) can lead to a safe verification of the yield of thermal transformation of asbestos minerals. The understanding of the complex temperature induced reaction path is of paramount importance for the optimization of industrial heating processes to yield a safe transformed product to be eventually recycled.

Introduction

After a long *incubation* time, the promulgation of the law D.M. 19/07/2004, nr. 248 opened a new scenario in the management and treatment of asbestos waste. Because of the scantiness of waste plants devoted to the confinement of asbestos containing materials (ACM) on the Italian territory, and the reorganization of the existing ones in a more restrictive legislative scheme, the promulgation of this law was a prompt to solve this critical and urgent issue. An alternative way to handle and treat the asbestos waste is proposed. Such an alternative solution is likely a great chance to move the first steps towards the conclusive solution of the asbestos problem in Italy. The importance of alternative ways of treating ACM is witnessed by the number of existing research (lab, industrial, semi-industrial) projects (see for example CORDIAM; mechanical-chemical treatment of MCS, etc) that have been developed in Italy in the last decade but never applied to an industrial scale because of the lack of a regulation act. At a European level, although the Italian projects were the first to be chronologically conceived, neighbour countries such as France and Germany were faster in converting ideas into industrial plants.

In this scenario, we are in the process to explore the viability of developing an industrial heating process to transform the cement-asbestos slates, as an alternative to their confinement in waste plants.

Basically a study of the thermal transformation of cement-asbestos slates must consider the complexity of the system and the fact that the high temperature reactions taking place within that system greatly differ from the reaction path of the pure asbestos minerals.

In fact, in the pure asbestos minerals, the major temperature induced transformations are dehydroxylation and recrystallization reactions [1]. The thermal treatment of pure chrysotile in the 700-800 °C range concerns dehydroxylation and subsequent recrystallization leading to the formation of Mg-rich anhydrous silicates forsterite and enstatite:

$$Mg_3(OH)_4Si_2O_5 \Rightarrow Mg_2SiO_4\ (\textit{forsterite}) + MgSiO_3\ (\textit{enstatite}) + 2H_2O$$

Similarly, pure asbestos amphibole tremolite undergoes dehydroxylation and subsequent recrystallization at higher temperature (900-1000 °C) to form diopside, enstatite e cristobalite:

$$Ca_2Mg_5Si_8O_{22}(OH)_2 \Rightarrow 2CaMgSi_2O_6\ (\textit{diopside}) + 3MgSiO_3\ (\textit{enstatite}) + SiO_2\ (\textit{cristobalite}) + H_2O$$

Finally, pure riebeckite thermally treated at 1100 °C shows a more complex reaction path which includes iron oxidation:

$$Na_2MgFe''_2Fe'''_2Si_8O_{22}(OH)_2 \Rightarrow 2NaFe'''Si_2O_6\ (\textit{pyroxene}) + MgSiO_3\ (\textit{enstatite}) + Fe_2O_3\ (\textit{hematite}) + 3SiO_2\ (\textit{cristobalite}) + H_2O$$

Such reaction paths are dramatically changed in the complex cement-asbestos system composed of Ca-rich cement phases, calcite, quartz, clay minerals and the asbestos minerals (mainly chrysotile and riebeckite)

The goal of this contribution is to describe the reaction path taking place during the firing of real samples of cement-asbestos slates followed using different experimental techniques (optical microscopy, SEM, TEM , quali- quantitative X-Ray powder diffraction, FTIR) with a special attention to the possible pitfalls evidenced by the misapplication of a specific experimental technique. The understanding of the complex high temperature reaction sequence is of paramount importance for the optimization of the heating process to yield a safe transformed and eventually recycling product.

Experimental

Samples of commercial cement-asbestos slates were used for the study. Their standard mineralogical phase compositions was verified by comparison with a number of other commercial samples and showed clinochrysotile (around 10 wt%), calcite, quartz, gypsum, illite, kaolinite, and minor CHS phases and portlandite. The low content of cement phases is due to the well known reaction of carbonation in air, a slow process which leads to the formation of calcite from portlandite and from the CHS phases.

The thermal treatments on intact commercial cement-asbestos slates were conducted using a discontinuous industrial kiln in different firing cycle up to 1200 °C. The monitoring of the phase evolution was possible on samples that experienced various temperatures and verified with different experimental techniques (optical microscopy, electron microscopy, quali- quantitative X-Ray powder diffraction, FTIR). To cross-check the results, *in situ* high temperature diffraction experiments were conducted on powdered specimen with a Panalytical X'Pert Pro Diffractometer equipped with an Anton Paar HTK16 heating chamber and a fast RTMS [2] detector.

Results and Discussion

Figure 1 reports the field of stability of the various original and newly-formed crystalline phases in the cement-asbestos slate system up to the maximum firing temperature 1200 °C obtained from the results of the diffraction experiments. The first phase to be decomposed is kaolinite which undergoes dehydroxylation in the range 400-600 °C according to the: $Al_2(OH)_4Si_2O_5 \Rightarrow Al_2Si_2O_7$ (*metakaolinite*) + $2H_2O$ [3]. Al and Si are made available for successive high temperature crystallization reactions. Chrysotile decomposes in the range 700-800 °C with a prompt crystallization to forsterite and enstatite (see above). Forsterite is stable up to the maximum firing temperature whereas the pyroxene small crystals are readily decomposed to form later Ca- and Mg-rich silicates such as merwinite and akermanite ($Ca_2MgSi_2O_7$). Calcite decomposition ($CaCO_3 \Rightarrow CaO + CO_2$) at about 900 °C is accompanied by the decomposition of minor phases such as illite and gypsum. The latter has been previously converted to anhydrite at about 350 °C. Anhydrite decomposition ($CaSO_4 \Rightarrow CaO + SO_3$) releases molecular groups useful for the formation at high temperature of the stable phase silicocarnotite ($Ca_5(SiO_4)_2SO_4$). The decomposition of minor illite makes available Al, Mg, Si, and K for the high temperature reactions. K is likely to form a very low amount of glass phase. The large amount of lime available after the decomposition of calcite combines with silica (quartz is then no longer stable at T>1000 °C), magnesium, and iron to form the typical clinker phases: C2S ($2CaO \cdot SiO_2$) with a larnite structure; ferrite (brownmillerite, $Al_2Ca_4Fe_2O_{10}$); merwinite ($Ca_3Mg(SiO_4)_2$). Only the latter is not stable up to the maximum firing temperature (1200 °C). Hence, the product of inertization has a phase composition very similar to that of a natural or a low temperature clinker [4] with an excess of iron and magnesium elements.

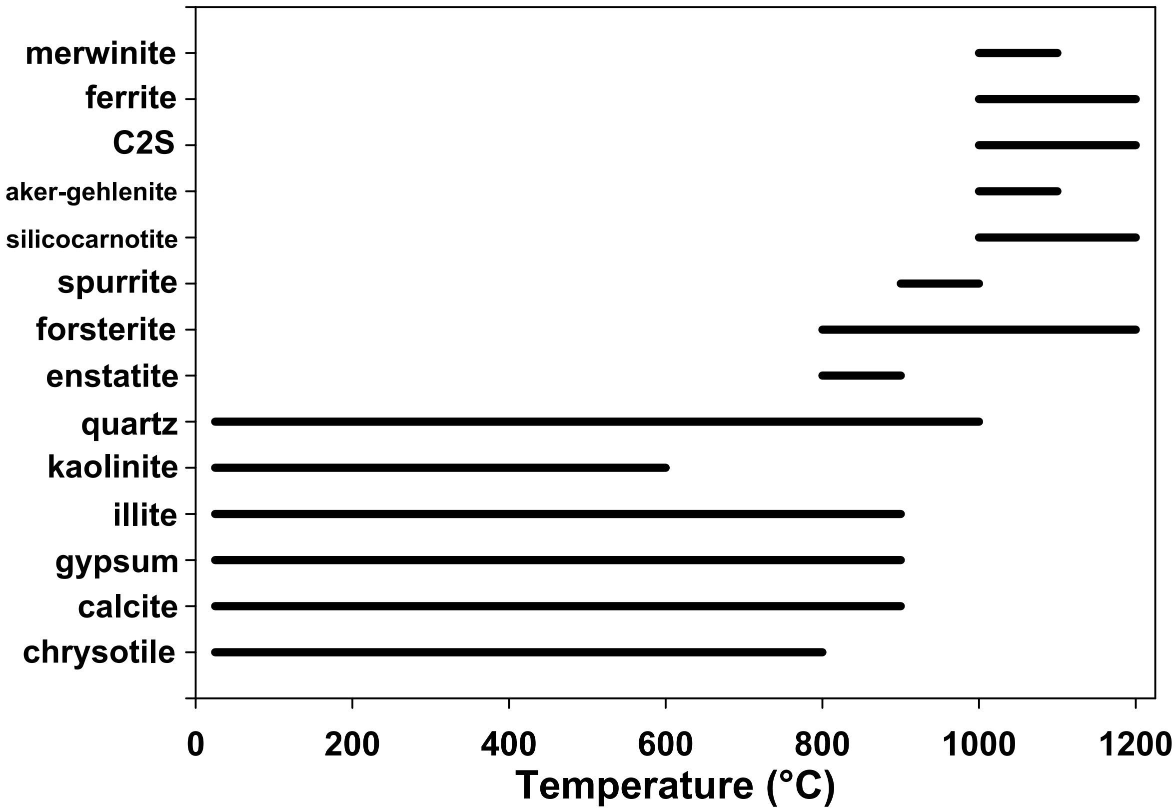

Figure 1 – The stability field of the crystalline phases in the cement-asbestos slate system

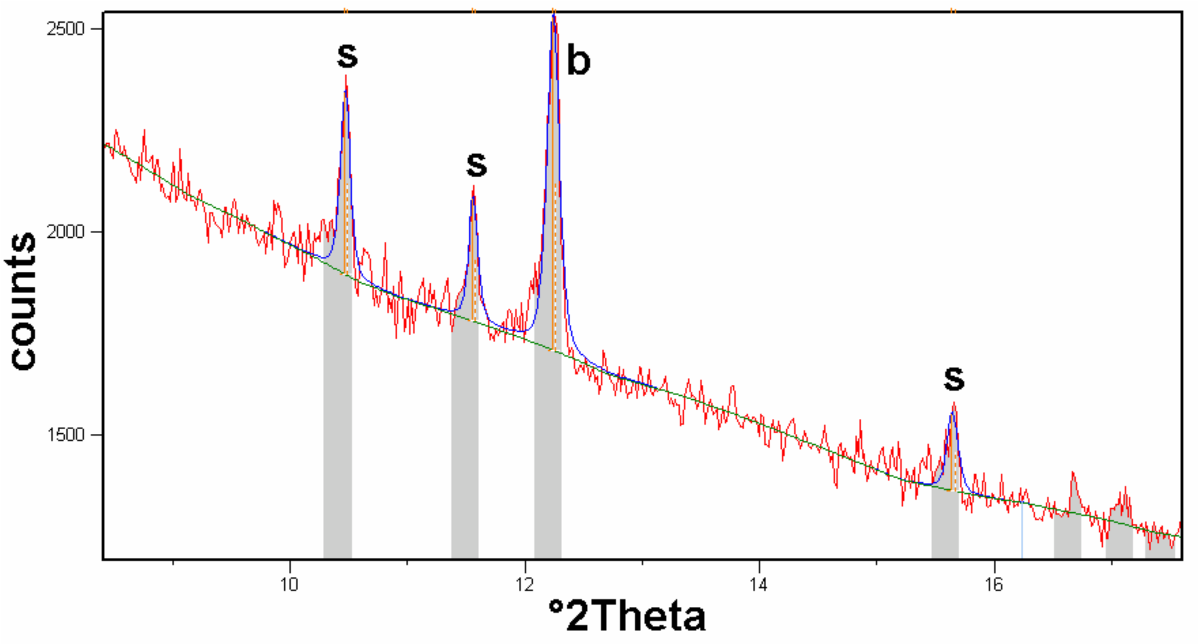

Figure 2 – Low angle region of powder pattern of a sample of cement-asbestos slate fired at 1200 °C with the presence of the brownmillerite (**b**) and silicocarnotite (**s**) peaks

Keeping in mind that the final goal of the process is the transformation of the asbestos minerals, the knowledge of the reaction sequence is very useful to determine the temperature reached by a certain thermal treatment. As a matter of fact, although reaction kinetics should not be neglected, the presence of the original or newly-formed phases in the system is indicative of the maximum temperature reached by the treatment. For example, the presence of residual calcite may be indicative that the higher temperature reached by the system is somewhat around 900 °C, plausibly not as high as to reach full destruction of the asbestos minerals (especially the amphibole species). The remarkable presence of high temperature stable phase such as ferrite and C2S is a reliable marker that the thermal treatment has reached temperature above 1000-1100 °C with a subsequent transformation of the asbestos minerals.

The determination of the mineralogical composition of a system is easily done with X-Ray powder diffraction. Notwithstanding, this experimental technique cannot be applied alone mainly because the phase detection limit is around 0.5-1 wt% but also because diffraction peaks of the high temperature phases may overlap with those of the asbestos phases and invalidate the application of this technique. The most prominent case regards brownmillerite (cement ferrite). One of its major peaks (020) occurs at about 7.2 Å and perfectly overlaps with the major peak (001) of chrysotile (invariably the only present in the powder pattern when chrysotile content is less than 5 wt%). Figure 2 shows a selected range of powder pattern of a sample of cement-asbestos slate fired at 1200 °C with the presence of the brownmillerite peak at ca. 7.2 Å (ca. 12.2 °2Theta). In such case, it is impossible to ascertain the eventual simultaneous presence of residual chrysotile.

Because powder diffraction alone is not effective, we have seen that the only experimental technique capable to safely verify if the asbestos fibres are fully transformed is electron microscopy. Only SEM imaging performed at high magnification (or TEM) may reveal the very nature of the microstructure of the thermally treated fibres. The fibres which underwent a full transformation exhibit a totally different microstructure with respect to the original one with an evident intergrowth of newly-formed crystals in place of the original (still visible) fibres. At low magnification (e.g., Figure 3a) the microstructure of a thermally treated fibre is not revealed and doubts may arise on the effectiveness of the thermal treatment. At higher magnification (e.g., Figure 3b, a magnification of the previous image) the issue may be solved.

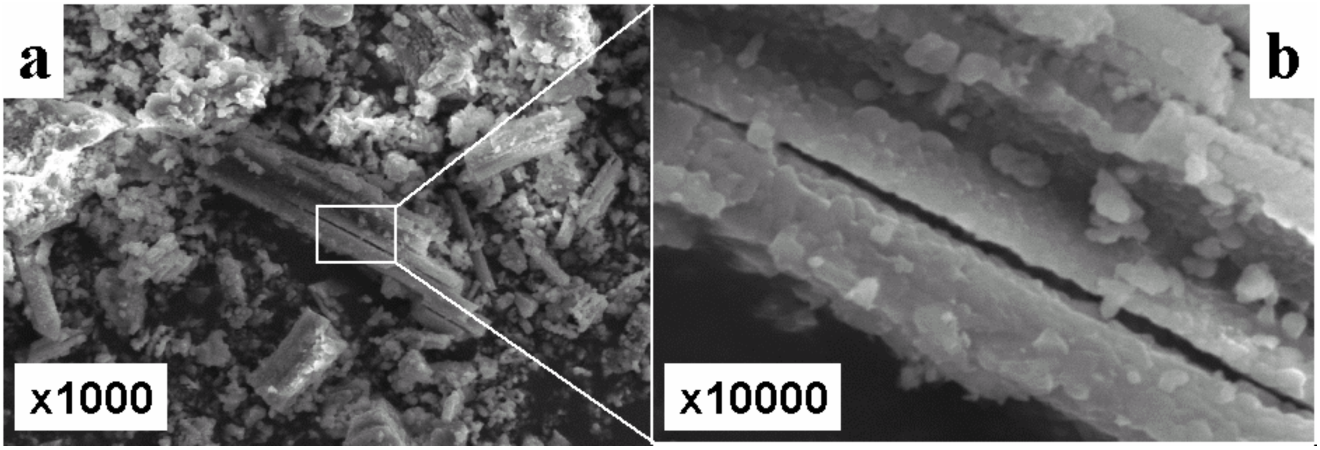

Figure 3 - (a) SEM of a thermally treated chrysotile bundle at low magnification; (b) a high magnification of part of the bundle showing a full recrystallization of the fibres

Figure 4 shows TEM images of the thermally treated chrysotile asbestos fibres which display a totally different microstructure with a clear intergrowth of newly-formed crystals. We have also discovered that TEM imaging can be effectively and quickly reveal untransformed fibres. In fact, such fibres exhibit a quick *in situ* transformation with evident bloating under the electron beam, because of the release of water during the dehydroxylation process of the untransformed fibres.

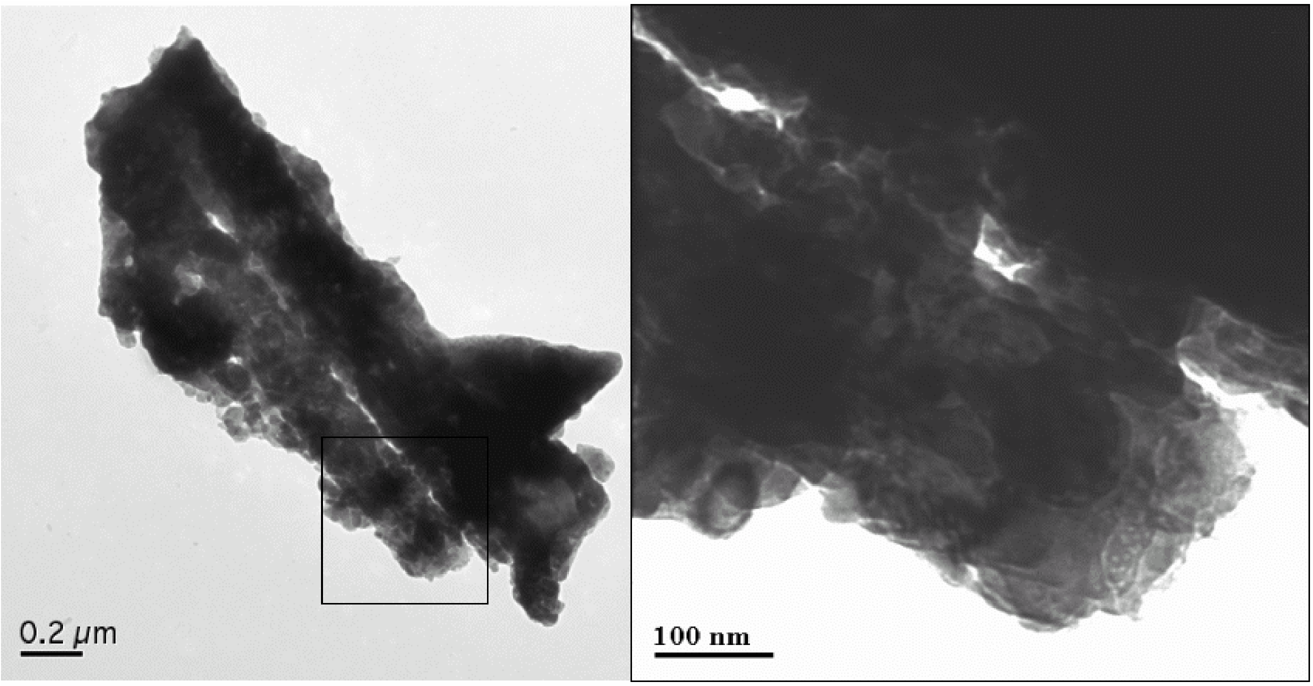

Figure 4 – TEM of a thermally treated chrysotile bundle showing a complete recrystallization of the fibres into newly-formed high temperature silicates

Conclusions

Because D.M. 19/07/2004 clearly states that the yield of transformation of asbestos minerals due to thermal treatment should be complete, that is, no residual asbestos fibres should be present in the treated material ("*I trattamenti che, come effetto, conducono alla totale trasformazione cristallochimica dell'amianto, rendono possibile il riutilizzo di questo materiale come materia prima*."), it is our believe that the analytical protocol utilized for the assessment of the yield of transformation must take advantage of a combination of different experimental techniques, principally X-ray diffraction and electron microscopy (SEM at high magnification or TEM). It was demonstrated that X-ray powder diffraction alone is clearly useless. FTIR given the detection limits (comparable to diffraction) may be just an alternative to diffraction. MOCF, because of the low resolution, has a limited use in this case because of the intrinsic difficulties to ascertain whether a fibre is transformed or not whereas MOLP may be used to ascertain extent because of the capability to verify the change of the optical properties (such as pleocroism, extinction, and dispersion) of the transformed fibres with respect to the properties of the original ones.

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AIRBORNE PARTICULATE MATTER POLLUTION: PRELIMINARY OBSERVATIONS ON VERTICAL DISTRIBUTION VARIABILITY OF ASBESTIFORM PARTICLES

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** ISPESL- Higher Italian Institute for Occupational Health and Safety- Department for Production Facilities and Human Settlements (DIPIA) - Research Assignment

Introduction

In Italy, there are 53 polluted national interest sites requiring remediation. They account for 3% of the national territory. Such sites are to be found in all Italian regions, with different risk factors for human health and the environment. Pollution is mostly caused by improper use of the land with consequent negative repercussions on the environment: water, air and soil.
Environmental monitoring activities are essential to assess risk conditions and develop adequate prevention, safety, remediation and restoration actions.
ISPELS, being the Italian National Scientific Agency, to provide adequate technical and scientific contribution to the Italian Ministry for the Environment and Land Protection (MATT), which is the authority in charge for these sites, carries out inspections and specific environmental monitoring campaigns to detect pollution sources and relative concentrations of bulk materials in the soil and wastes, in the airborne and water, at industrial sites at risk and in the neighbouring urban areas.
ISPELS-DIPIA, in its professional experience carried out environmental studies at the national interest site of Biancavilla detecting the non homogeneous vertical distribution of airborne particulate matter. ISPELS-DIPIA decided therefore to start a more indepth study to assess whether early observations did actually imply a true variability in the vertical distribution of airborne particulate matter
The correct characterization of the problem is of the utmost importance to identify the real potential risk at which both the environment and the population are exposed; thus making sure that analytical data are reliable and consequently most adequate emergency containment, remediation and restoration actions are undertaken.

Procedures and actions undertaken

ISPELS is the institutional technical and scientific advisor to MATT. In particular, ISPELS-DIPIA is actively involved in the national interest remediation procedures, participating to technical meetings and service conferences and investigating the contaminated area considered.
This paper refers to the experience earned at the Biancavilla national interest site.
Biancavilla Etnea (Catania, Sicily, Italy) is located on south-western side of the Etna volcano and, geologically is characterized by volcano products dating back to the Ancient Mongibello phase (Romano, 1982)
The Mt. Calvario formation, near the breccia mines named after it, is a characteristic finding of the local geology. The mining sites, hitherto known as a series of domes of benmoreitic autoclastic lavas are actually characterised by a sequence of volcanic deposits of both effusive and explosive nature and thus of heterogeneous composition.

The sequence is composed of basis lava terms of benmoreitic composition surmounted by the Biancavilla ignimbrite in a radial direction. This in turn is sealed by lahar deposits mainly composed of eruptive products outcropping above the area concerned.
The MATT, being the administration in charge, proceeded to fence off the area and started emergency containment procedures and remediation actions, undertaking among other things epidemiologic, health, mineralogic and environmental studies on the whole area.
The main source of pollution, as identified following the above-mentioned studies carried out by ISPELS, turned out to be the two breccia mining sites at Mt. Calvario (Fig. 1, pic. 1). The pollutant is fluoro-edenite. Its main features strongly resemble those of amphibole type asbestos, with very thin (less than 1 micron in diameter) and relatively long (up to 50-60 micron) fibres. Hence the same safety measures were implemented for the population and remediation actions as with asbestos.

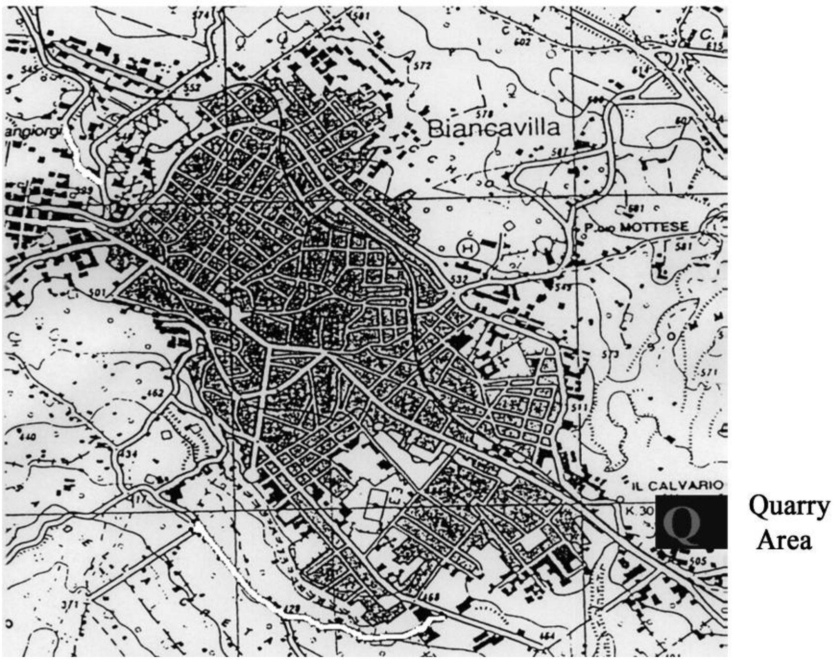


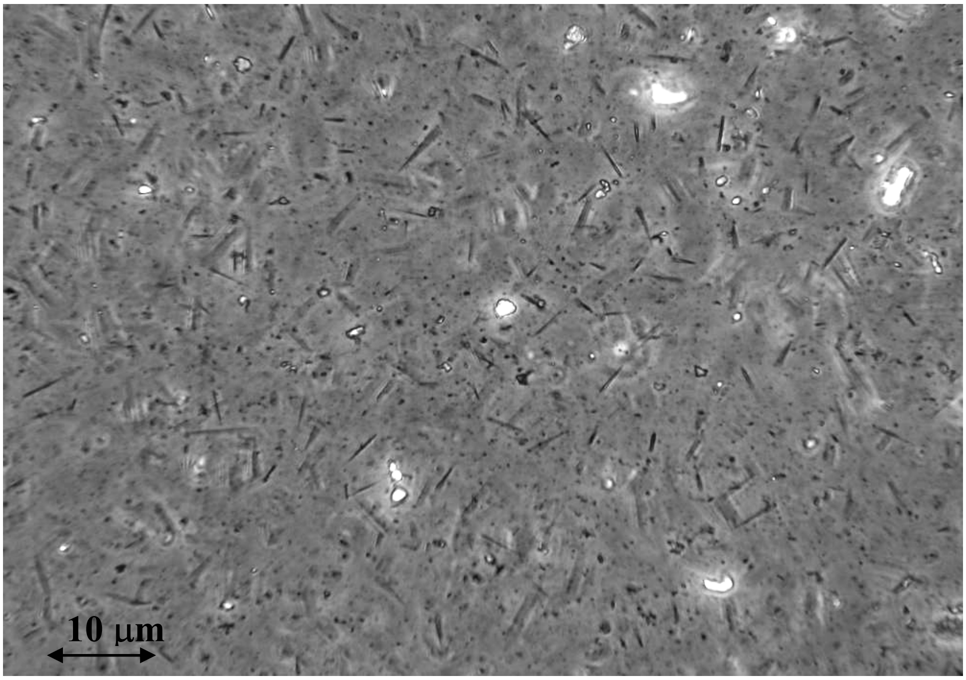
Fig 1 - Biancavilla Etnea: Map and quarry area

Pic.1 - Biancavilla Etnea

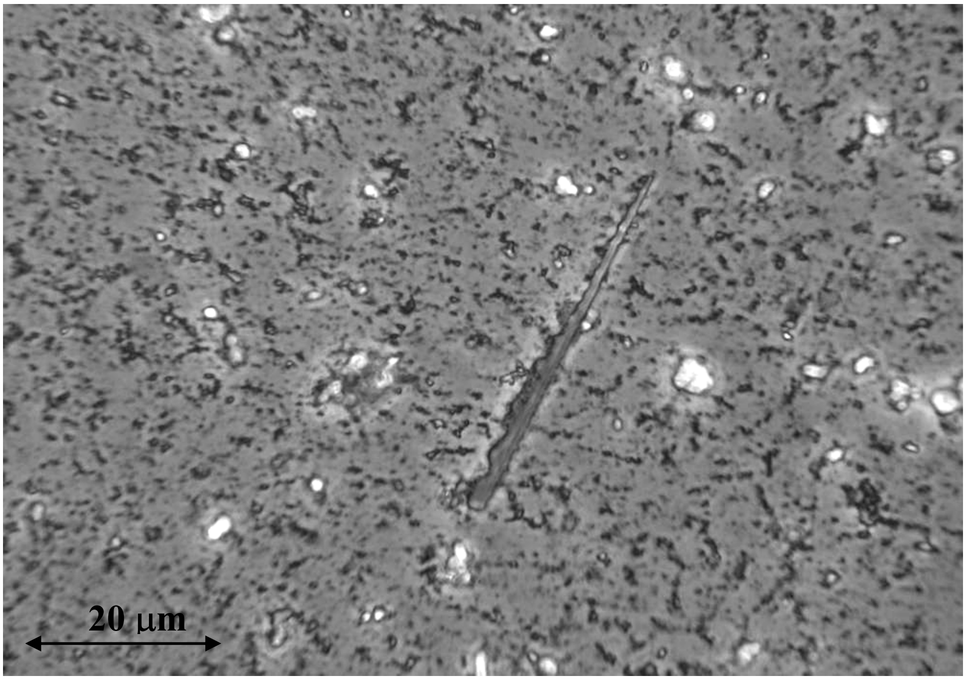
Heaps of quarry material left at the edges of dirt roads, the very presence of dirt roads and the use of a common mechanical sweeper were identified as additional risk sources. The Emergency Containment measures included the following:

- Closing down of mining activities
- Surfacing dirt roads with a bituminous coating
- Removing debris and filling material
- Adoption of specific precautions for street cleaning (street sweepers should use class P3 filter half-masks) and replacement of commonly used sweepers with asbestos specific equipment

At the end of emergency containment measures, in 2005, ISPELS carried out an air monitoring in town while streets were being swept with a mechanical sweeper equipped with absolute filters for workers' protection as well as with technical means for dust abatement.
Measurements were taken under extreme conditions to assess the impact on air, while the sweeping unit was in use, and its performance in terms of user safety.
Furthermore, to assess the potential exposure of local population, additional samples were taken at variable heights (i.e. balconies, basement floors, top floors etc.), with the objective of detecting dispersion and accumulation of minute fibres at various hights, similarly to what is envisaged by fibre dispersion models assuming a vertical distribution based on their shape, size and weight. This analysis evidenced a marked concentration abatement of airborne fibres at land surface, thus confirming the effectiveness of the containment measures undertaken, while recording for the first time an anomalous presence of fluoro-edenite fibres (sample no.3=85,2ff/l; sample no.6 = 35,2 ff/l) (pics. 2 and 3) at variable heights and above 3 m.
ISPELS-DIPIA then performed a specific monitoring campaign in April 2006 for a preliminary assessment on airborne fibre vertical distribution.



Pic.2: standard and microfibre asbestiform fluoro-edenite fibres (PCM –500X)



Pic.3: standard asbestiform fluoro-edenite fibres (PCM –500X)

Vertical monitoring results of airborne

In April 2006, environmental monitorings were carried out with SEM and PCOM to measure concentrations of hazardous inhalable standard type fibres and detect the presence of microfibres at different hights on the land surface.

Samples were taken using pumps for environmental (high flow: 10 l/m, 3,000 l) and personal measures (low flow: 2 l/m, 480l) with sampling devices at fixed stations: land surface, 1st floor, 2nd floor to obtain a preliminary assessment on air quality in urban environment and on individual exposure of citizens while performing normal daily operations.

The monitoring campaign results are presented in table A.

Area	**B**	**C**
Address	Via dell'Edera, uscita scuola Don Bosco	Via dell'Oste n.9
	No. of sample- concentration (ff/l)- Notes	**No. of sample- concentration (ff/l)- Notes**
environmental SEM results Land surface	A8 - **0,19**	A3 - **0,56**
environmental SEM results 1st floor	illegible because of excessive loading	sampler out
Environmental SEM results 2nd floor	A14 - **0,69** very many microfibres	A12 - **0,1** many microfibres
Personal SEM results 1st floor	P10 - **0**	P7 - **0,54** many microfibres
Personal SEM results 2nd floor	P12 - **0,54** some microfibres	P9 - **0**
PCM environmental results Land surface	A2 - **0,33** few microfibres in few fields	A7 - **0,26** microfibres in few fields
PCM personal results 1st floor	P1 - **11,67** very many microfibres in numerous fields	P4 - **11,25** many microfibres in numerous fields
PCM personal results 2nd floor	P2 - **9,58** many microfibres in few fields	P6 - **2,08** very many microfibres in few fields

Table A-Biancavilla: vertical environmental monitoring, April 2006

Preliminary considerations on airborne pollution at various hights.
The results of sampling performed after emergency containment actions show that fluoro-edenite fibre concentrations recorded at land surface are always below the threshold of 1f/l as set by the WHO document "Air Quality Guidelines for Europe", 1987.
Furthermore, at land surface, no relevant microfibre presence was detected, unlike what was observed with SEM and PCOM at 1st and 2nd floors, with high and low flow samplers where high standard fibres and microfibres concentrations were recorded.
In particular, in a number of samples the areal distribution of microfibres on the filters, though abundant, was not homogeneous. The which is possibly caused by the type of sampler in use (environmental/personal) and/or by electrostatic effects due to the use of plastic or metal sampling heads.
The above-mentioned considerations led to confirm preliminary data recorded in 2005, evidencing an anomalous vertical distribution of airborne particulate matter in Biancavilla and urging further studies to collect a more relevant body of data to develop vertical dispersion models of fibres based on their shape, size and weight.
ISPELS-DIPIA, in the framework of a convention with Ferrovia CircumEtnea (Etna railworks) envisaging seasonal monitorings of ambient air in town, at land surface, as laid down by the relevant regulation, will make sure that such monitorings are carried out at variable hights, better to study the above-mentioned issue to gain further insight and consequently identify further prevention measures for the population and the environment alike.
The authors believe that these studies should include other asbestos contaminated national interest sites within urban areas (Bari-Fibronit; Casale Monferrato-Eternit; Broni-Fibronit, etc.).

Conclusions

The paper identifies the issue of vertical asbestos-like fibre distribution in the airborne as evidenced by a number of environmental monitoring campaigns carried out by ISPELS-DIPIA in the national interest site requiring remediation in the municipality of Biancavilla Etnea
These results complement those of previous monitorings and identify a new strand of studies to be carried out to include all asbestos highly contaminated sites within urban areas.

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IL RISANAMENTO AMBIENTALE DELLA MINIERA DI BALANGERO E CORIO: APPROCCIO PROGETTUALE E PRINCIPALI INTERVENTI

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La ex miniera di amianto di Balangero e Corio è situata a 30 km a nord-ovest di Torino: in essa si è estratto amianto di serpentino a partire dagli anni '20 fino al fallimento della Società Amiantifera di Balangero S.p.A. nel 1990. Tale produzione ha comportato la messa a dimora nei siti limitrofi ai bacini di coltivazione di circa 30.000.000 di metri cubi di pietrisco di risulta, composti in larga parte da sterile di stabilimento (proveniente dal processo di arricchimento del minerale) ed in minor misura da sterile di cava (roccia a basso tenore di minerale e terreni di copertura).
Lo sterile di stabilimento, che rappresenta circa i ¾ del totale, ha pezzatura centimetrica/decimetrica e presenta un angolo di attrito interno decisamente inferiore rispetto allo sterile di cava la cui pezzatura, nella frazione rocciosa, varia tra il decimetro ed il metro cubo.
I primi interventi di risanamento ambientale si sono concentrati, necessariamente, su tali ammassi lapidei e su alcune aree più circoscritte ma con problematiche anche più complesse quali, ad esempio, un'area di stoccaggio fanghi di lavaggio, ove risultano depositati limi contenenti amianto al 30% (area denominata "Rio Pramollo").
In considerazione delle enormi quantità di materiali lapidei presenti, l'approccio progettuale ha visto mettere in atto il principio della messa in sicurezza *in sito* dei materiali lapidei, utilizzando in larga misura le tecniche di ingegneria naturalistica.
L'utilizzo delle tecniche dell'ingegneria naturalistica ha dimostrato di poter assolvere alle esigenze di messa in sicurezza, evidenziando negli anni una stabilizzazione e rivegetazione dinamica delle aree sottoposte ad intervento, proprio in funzione della crescita vegetazionale.
Per l'avvio degli interventi, le aree a cielo aperto sono state suddivise in lotti funzionali alla tipologia di rischio e alle tempistiche di intervento:

- **Discarica lapidea versante Balangero e canale scolmatore dell'ex bacino di coltivazione**
- **Area di accumulo fanghi "Rio Pramollo"**
- **Discarica lapidea versante Corio**

In considerazione delle grandi superfici interessate da tali interventi, le attività di cantiere sono sottoposte a specifico Piano di Monitoraggio Ambientale per le fibre aerodisperse, redatto dalla R.S.A. S.r.l., di concerto con l'Agenzia Regionale per la Protezione Ambientale. Al fine di assicurare la tempestività dei risultati delle analisi, è stato allestito da R.S.A. S.r.l., apposito laboratorio in sito per le analisi dei campioni in microscopia ottica a contrasto di fase (MOCF). Nelle situazioni individuate a maggior rischio (p.es. vento di phon), le analisi sono condotte in microscopia a scansione e relativa micro - analisi (SEM), presso il laboratorio del Polo Amianto dell'Agenzia Regionale per la Protezione Ambientale.
Riguardo alla protezione dei lavoratori, specifiche sperimentazioni sono state condotte precedentemente l'avvio degli interventi, con il fine di eseguire attenta valutazione del rischio

amianto, correlato al rischio di stress da calore indotto dall'uso di tute in materiale sintetico in condizioni di cielo aperto. Tali sperimentazioni, condotte di concerto con il Dipartimento di Medicina del Lavoro dell'Università di Torino, hanno suffragato la scelta dei più adeguati disposItivi di protezione delle vie respiratorie e l'utilizzo di tute in cotone a trama compatta, ai sensi del D.M. 06.09.1994, in sostituzione delle tute sintetiche mono-uso.

EXPERIENCES AND OPERATING MODALITIES IN RECLAMATION WORKS OF ASBESTOS-CONTAINING MATERIALS

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THE OBLIGATION OF REGISTRATION TO THE NATIONAL BULLETIN-BOARD OF THE ENTERPRISES THAT EFFECT THE ENVIRONMENTAL MANAGEMENT FOR THE ENTERPRISES OF ASBESTOS RECLAMATION

By the Deliberation n. 1 of March 30 th 2004, published on the Official Gazette n. 88 of April 15 th 2004, the Committee of the National bulletin-board of the enterprises that effect the management of the refusals has fixed the *Criterions and requisites for the registration to the bulletin-board in the category 10 - Reclamation of the goods containing asbestos.*

Particularly it has been established, that, to the goals of the registration to the bulletin-board, the activities of which to the aforesaid category 10 are divided in:

A) Activities of reclamation of goods containing asbestos effected on the material followings: material building containers tied up asbestos in cement or resin matrixes;

B. Activities of reclamation of goods containing asbestos effected on the material followings: material of attrition, insulating materials (panels, cupels, papers and cardboards, textile, material sprinkled, plasters, enamels, bitumens, hill, gaskets, other insulating materials), pressure containers, equipments out use, other materials incoherent containers asbestos. Besides, both for the category 10 A both for that 10 B is been individualized. 5 classes (in the order: "to", "b", "c", "d", "e", correspondents to amounts as decreasing of the “yard” jobs).

The least requisites have been fixed then for the enterprises that, also to the goals of the obligation of the presentation of the work plans in accordance to the Decree Legislative 15 August 1991, n. 277 (now in accordance to the Decree Legislative 25 July 2006, n. 257), they intend to enroll in the bulletin-board in the aforesaid category 10. The technical Person responsible of these enterprises can be:

- Graduated Engineer or Architect or Chemical or Geologist or Biologist or other trained subject, on the base of the relative professional arrangements, for all the five classes of the two categories 10 To and 10 Bs with a number of years of experience matured in the specific sector by 1 to 5, according to the category and of the class of registration;
- Graduated Surveyor or Perished industrial or Perished chemical or other trained subject, on the base of the relative professional arrangements, only for the classes "c", "d", "and" of the category 10 To with a number of years of experience matured in the specific sector by 2 to 5, according to the class of registration, and of 3 only for the class "and" of the category 10 Bs;
- Person, without title of specific study, that has followed and overcome the anticipated Course of formation for the technical Person responsible, for all the five classes of the two categories 10 To and 10 Bs with a number of years of experience matured in the specific sector by 2 to 7, according to the category and of the class of registration.

This Deliberation specificies then that the experience matured in the activity of reclamation of the materials of which to the category 10 A it is valid for the registration in the class "e" (the lowest in terms of amount of the jobs) related to the activities of reclamation of the materials of which to the category 10 B and that the experience matured in a class of registration is valid to the goals of the
The criterions and the formalities of carrying out of the Courses of formation for technical Persons responsible of the enterprises, held from the Region or from Corporate body and Institutes by the same one recognized, they were established from the Committee of the national bulletin-board of the enterprises that you/they effect the management of the refusals with Deliberation July 16 th 1999, n. 3. These Courses of formation are articulated in a Form Of Base, of the duration of 40 hours, obligatory for all the categories of registration and in Forms Of Specialization for the different categories of registration.
The anticipated Forms of specialization are 6, and precisely: "A", "B", "C", "D", "E", "F." Among these, the Form "F" it is that related to the technical Person responsible of the enterprises that you/they intend to enroll in the category 10. Reclamation of the goods containing asbestos and also for it you/he/she has been anticipated a duration of 40 hours.
With reference to the formation of the technical Person responsible of these enterprises, the aforesaid Deliberation n.1 of 30/03/2004 precise that the qualification achieved following the frequency to the Courses of which to the article 10, paragraph 1, letter b) of the Decree of the President of the Republic August 8 th 1994 (or rather the courses of managerial level for Coordinators asbestos, of the duration of 50 hours), it replaces the share with the Form of specialization "F" of the courses of formation for technical Persons responsible, I save the obligation of the share to the Form of base and the overcoming of the relative test, of which to the Deliberation of the Committee of July 16 th 1999.
The aforesaid Deliberation n.1 of 30/03/2004 has specified then that the charge of technical Person responsible of the enterprises in activity to the date of effectiveness of the Deliberation (April 14 th 2004) and that they have introduced question of registration within the anticipated term from the article 30, paragraph 8, of the Decree Legislative 5 February 1997, n. 22, can be assumed (or rather June 14 th 2004) by the legal representative of the enterprise, also in absence of the aforesaid requisites. In such case the interested enterprises have the obligation to satisfy such requisites within five years from the date of registration.
The on suitable Deliberation n.1 of March 30 th 2004 define besides the amounts for the attainment of the requisites of financial ability for the registration in the aforesaid category. With the Decree 5 February 2004 of the Office of the environment and the guardianship of the territory, published on the Official Gazette n. 87 of April 14 th 2004, have been established the "Formality and amounts of the financial guarantees that must be lend for the State from the enterprises that they effect the activities of reclamation of the goods containing asbestos."
For every some five anticipated (to, b, c, d, e) classes are suitable the amounts of the guarantee fidejussoria. Besides, with the Deliberation n.2 of March 30 th 2004, published on the Official Gazette n. 88 of April 15 th 2004, the Committee of the National bulletin-board of the enterprises that they effect the management of the refusals, the Modulistica has defined for the registration to the bulletin-board in the category 10 - Reclamation of the goods containing asbestos, or rather that The model of question has predisposed for the registration to the bulletin-board in the category 10, that you/he/she is attached 30/03/2004 Deliberation to this second.

Subsequently, with the Deliberation n. 2 of July 10 th 2006 from the title "*Availability least equipments for the registration in the category 9 - reclamation of the sites, and in the category 10 - reclamation of the goods containing asbestos*", published on the Official Gazette n. 211 of September 11 th 2006, the national Committee of the bulletin-board national environmental managers (already refusals managers) has brought important changes to the formalities of demonstration of the full and exclusive availability of the least equipments for the registration in the category 10 of which to the Deliberation n. 1 of March 30 th 2004, published on the Official Gazette n. 88 of April 15 th 2004, related to the *Criterions and requisites for the registration to the bulletin-board in the category 10 - Reclamation of the goods containing asbestos.*

In fact, following the new Deliberation, the bulletin-board unlike the past, allow now that the full and exclusive availability of the least equipments in endowment to the enterprises of reclamation of the goods containing asbestos can also be shown through contract of location, with the prudence that it:

- is stipulated in form writing with signatures authenticated by official public;
- has lasted not inferior to years five to elapse from the date of effectiveness of the registration to the bulletin-board of the enterprise leaseholder, or, in case of enterprise affiliate, lasted already at least equal to the residual period of validity of the registration;
- has to object the mass in full and exclusive availability of the equipments, that must be identifies in clear and univocal way, for the enterprise leaseholder;
- contains the formal declaration of the parts that the equipments are not used and they won't be used, for the whole contractual duration, for registrations to the bulletin-board different from that of the leaseholder.

The Legislative Decree n. 257/2006 has confirmed that the jobs of demolition or removal of the asbestos can be effected only by in conformity with enterprises to the requisites of which to the article 30, paragraph 4, of the Decree Legislative 5 February 1997, n. 22, or rather the enrolled enterprises to the on suitable Bulletin-board.

PROFESSIONAL REQUISITES FOR THE ACTIVITIES OF REMOVAL, DISPOSAL IS RECLAMATION OF THE ASBESTOS

The law n. 257/92 and the D.P.R. August 8 th 1994 foresee the predisposition of specific courses of professional formation with release of titles of qualification.

The courses of formation are articulated in relationship to the professional level of the personnel to which Ithey are direct:

- operational, turned to the workers employed to the activities of removal, disposal and reclamation;
- managerial, turned to whom directs on the place the activities of removal, disposal and reclamation.

The courses of operational level are contemplated to the acquisition of the sensitization to the safety and of the awareness of the risk, as well as' to the correct use of the systems of protection and the respect of the operational procedures. The Legislative Decree n. 257/2006 has specified better and integrated the matters by to treat in these progress and you/he/she has clarified that the employer must assure that all the exposed workers or potentially statements to dusts containing asbestos must receive an enough and suitable formation to regular intervals.

Besides, the content of the formation must easily be comprehensible for the workers and must allow them to acquire the knowledges and the necessary competences in subject of prevention and safety, particularly as it regards:

- the ownerships of the asbestos and its effects on the health, included the effect sinergy of the smoke;
- the types of products or material that can contain asbestos;
- the operations that can involve an exposure to the asbestos and the importance of the preventive controls to reduce to the least such exposure;
- the sure procedures of job, the controls and the equipments of protection;
- the function, the choice, the selection, the limits and the correct use of the devices of protection of the respiratory streets; . the procedures of emergency;
- the procedures of decontamination;
- the elimination of the refusals;
- the necessity of the medical overseeing.

The workers that have frequented the courses of professional formation of which to the article 10, paragraph 2, letter h), of the law March 27 th 1992, n. 257 can be employed to the removal and disposal of the asbestos and to the reclamation of the interested areas.

The courses destined to the operational level has a least duration of thirty hours.

The courses of managerial level are diversified for the employees to the activities of reclamation (removal or other formalities) of buildings, fittings, structures, etc. insulator
with asbestos and for the employees to the activities of disposal of the asbestos refusals. Such courses also include the responsibilities and the assignments of the direction of the activities, the systems of control and testing, the criterions of choice of the systems of protection. They foresee the treatment at least of the followings matters:

- risks for the health caused by the fibers asbestos exposure;
- normative for the protection of the workers and the guardianship of the environment: obligations and responsibility of the different subjects, relationships with the organ of vigilance;
- management of the anticipated informative tools from the norms in force;
- methods of measure of the asbestos fibers;
- criterions, systems and equipments for the prevention of the environmental pollution and the collective protection of the workers: isolation of the work areas, unity of decontamination, extractors and systems of depression;
- means of personal protection, inclusive ivi them control and maintenance;
- corrected procedures of job in the activities of maintenance, control, reclamation and disposal;
- prevention and management of the accidents and the situations of emergency.

The courses destined to the managerial level have a least duration of fifty hours. The release of the relative titles of qualification happens from the Regions or Provinces autonomous previous final verification of the acquisition of the elements of base related to the safety and to the prevention of the asbestos risk with specific references to the activity which the discentis will be employed.

THE TECHNIQUES OF INTERVENTION FOR THE MATERIALS CONTAINING ASBESTOS

According to the D.M. September 6 th 1994, the reclamation from the asbestos can be performed with one of the followings three interventions:

Removal: it eliminates every potential source of exposure and every necessity to effect specific cautions for the activities that develop him in the building. It behaves an extremely elevated risk for the employed workers and it produces notable quantities of dangerous refusals that must correctly be digest. It generally asks for the application of a new material in substitution of the removed asbestos.

Encapsulation: treatment of the asbestos with penetrating or covering products that (according to the type of used product) extend to englobe the asbestos fibers, to restore the adherence to the support, to constitute a film of protection on the exposed surface. It doesn't ask for the following application of a substitutive product and it doesn't produce refusals. The risk for the employed workers is generally smaller in comparison to the removal. And' the treatment of election for the a little friable materials like with cement. The asbestos remaining in the building is necessary to maintain a program of control and maintenance.
Confinement: installation of a barrier to estate that separates the asbestos from the busy areas of the building. If you/he/she is not associated to an encapsulating treatment, the release of fibers continues inside the confinement. In comparison to the encapsulation, introduces the advantage to realize a resistant barrier to the bumps. It always needs a program of control and maintenance, in how much the asbestos remains in the building; besides the installed barrier for the confinement must be maintained under good conditions. In comparison to the other two interventions introduces a more contained cost.

PREDISPOSITION OF THE WORK PLAN

According to the Legislative Decree n. 257/2006, the employer, before the beginning of jobs of demolition or removal of the asbestos or materials containing asbestos from buildings, structures, instruments and fittings, as well as from the means of transport, it is kept to predispose a work plan. Such plan must foresee the necessary measures to guarantee the safety and the health of the workers on the place of job and the protection of the external environment.
It must foresee particularly:

- the removal of the asbestos or the materials containing asbestos before the application of the techniques of demolition, less such removal cannot constitute for the workers a great risk of that represented by the fact that the asbestos or the materials containing asbestos is left on the place; . the supply to the workers of the devices of individual protection;
- the verification of the absence of due risks to the exposure to the asbestos on the place of job, at the end of the jobs of demolition or removal of the asbestos;
- you adjust measures for the protection and the decontamination of the personnel entrusted of the jobs; . you adjust measures for the third protection and for the harvest and the disposal of the materials;
- the adoption, in the case in which the overcoming of the value is anticipated limit of 0,1 fibers per cubic centimeter of the following measures:
- to furnish a suitable device of protection of the streets to the workers individual respiratory and other devices of protection and it demands the use of it during such jobs; . to handle the posting of poster to signal that the overcoming of the value limit of exposure foresees him; . to adopt the necessary measures to prevent out the dispersion of the dust of the places or places of job;
- to consult the workers or their representatives of which to the article 18 on the measures to be adopted before proceeding to such activities.
- the nature of the jobs and them presumable duration;
- the place where the jobs will be effected; . the working techniques adopted for the removal of the asbestos;
- the characteristics of the equipments or devices that they intend to use.

Copy of the work plan has to be sent to the organ of vigilance, at least thirty days before the beginning of the jobs. Finally, the employer must provide so that the workers or their representatives have access to the documentation.

THE RECLAMATION OF THE FRIABLE ASBESTOS-CONTAINING MATERIALS

You removal of the materials friable containers asbestos is generally performed through the technique of the static and dynamic confinement. If the environment in which the removal happens is not naturally confined, it is necessary to handle the realization of an artificial confinement with fit divisors.

In the case of removal of coverings from pipelines in quota it is necessary to predispose mobile scaffoldings on wheels inside the already confined yard. In the carrying out of the job all the precautions must be taked to protect the zones adjacent to the work area not interested by the dust contamination or deposits containing asbestos.

When, during the reclamation, the remaining areas of the building are busy for the carrying out of the normal activities, it is necessary to foresee a zone filter, not accessible to extraneous, between the yard and the busy areas. The zone of access in the yard must be controls with the purpose to prevent the entry to extraneous. According to the situation they must anticipate:

- safety system of signs;
- enclosure with descriptive ribbons;
- dividing with polythene.

In the work plan must be individualize the possible streets through which a dispersion of fibers can be verified to the outside of the work area, above all those that can determine an inside pollution to the building. Before beginning the interventions of reclamation, the zone must be clears away from all you furnish him and the equipments that can be moved.

In the case of limited interventions on pipelines dressed again in asbestos for the removal of small surfaces of coibentazione (to es. on pipelines or valves or junctions or on redoubts surfaces or objects to be freed for other interventions), and' usable the technique of the glove-bag (cells of polietilene, endowed with inside gloves for the execution of the job).

This technique is delicate and dangerous for:

- the discreet probability that the cell is broken off;
- the operators' scarce handly;
- taking place itself of dangerous situations during their installation and removal.

THE RESTITUTION CERTIFICATION OF THE RECLAMATIONED SPACES

At the end of the jobs of friable asbestos reclamation, the operations of certification of restitution of the of the reclamationed spaces must be perform. Such operations such operations must be paid from the buyer and must be perform at officials of the competent AS with the purpose to assure that the interested areas can be reoccupied with safety.

The expenses related to the inspection and to the determination of the concentration of fibers aerodisperses are to load of the buyer the jobs of reclamation. The principals anticipated requisites to the purpose of validare the final decontamination of the yard expressed by the certification of "restitution" are:

Absence of visible residues of asbestos within the reclamationed area: such verification involves the preventive visual inspection. Before proceeding to the visual inspection all the surfaces inside the operational area, already submitted to the final cleanings, must adequately be dry. The visual inspection must be how much more accurate possible and must not only understand the places and the surfaces to sight, but also every other place partially or completely hidden, even if of small dimensions (what angles, indentations, prominences on the walls, on the ceiling and on the floor).

Acceptable concentration of asbestos fibers in the inclusive atmosphere in the reclamationed area: It is advisable to verify the feasibility of the zone, within the 48 following hours at the end of the job, through samplings of the air. The sampling of the air that must happen disturbing in opportune way the surfaces in the interested (aggressive sampling) area. The sampling of the air can happen only if the area is it deprives of visible residues of asbestos. The middle concentration of asbestos fibers aerodisperse in the places, determined through the use of the electronic microscopy in scanning (SEM) must not be superior to the 2 fves per liter. If the measured concentration overcomes the value of reference, the area must again be cleaned until the values of concentration are not reached established. Only after the samplings have shown the accessibility of the area all the barriers of confinement can be removed, the unities of decontamination can be get off, extinguished the extractors and I removed all the cloths. The access to the area, for the possible following phases of job or for his "normal " re-use will be possible without any protection for the asbestos.

THE RECLAMATION OF THE CEMENT-ASBESTOS COVERAGES

The plates in cement-asbestos, employed for the coverage of the buildings, are constituted from material compact that, when it is new or in good state of maintenance, it hasn't the tendency to spontaneously free fibers. With the time however, these manufactured articles, the action of the atmospheric agents being exposed to, they suffer a progressive I degrade particularly for the action some sour rains, of the thermal starts, of the erosion eolica and of vegetable microorganisms.

Accordingly, after years from the installation, superficial corrosive alterations can be determined with breakthrough of the fibers and phenomena of liberation. It needs therefore to appraise the state of I degrade some coverages in cement-asbestos in relationship to the potential release of fibers.

The reclamation of these manufactured articles, the open one being performed to, you/he/she must be conducted limiting the more possible the dispersion of fibers. For the reclamation of the aforesaid coverages it is possible to apply one of the following methods:

Removal: elimination of the manufactured articles containing asbestos;

Encapsulation: treatment of the plates with imbuing products, that penetrate in the material tying the asbestos fibers among them and with the cement matrix and covering products, that form a thick membrane on the surface of the manufactured article;

Confinement: consistent in to perform a overcoverage above that in cement-asbestos, which is left in the center when the carrying structure is fit to bear an additional permanent load.

The removal must be conducted safeguarding the integrity of the material in all the phases of the intervention. Besides it involves the necessity to install a new coverage in substitution of the removed material. The plates of coverages must be treat with an encapsulating product according to what anticipated from the enclosure 2 of the D.M. 20/08/1999, as modified by the D.M. 25/07/2001.

As it regards the general prescriptions of hygiene and safety of the job during the interventions on the coverages in cement-asbestos, to proceed it is necessary first of all to the delimitation and signaling temporary of the areas in which the operations of removal of products happen in cement-

asbestos that you/they can give dispersion place of fibers.
Besides, the reclamation of the coverages in cement-asbestos involves a specific risk of fall for staving in of the plates. The measures valid anti-accident must evidently be adopted for the building yards and they will owe particularly besides to be realized fit works for the protection from the risk of fall, or adopted opportune fit shrewdness to make the coverages stamping on.
It is necessary then to limit the more possible the number of the exposed workers, which must correctly use the collective and individual means of protection. The operators employed to the intervention of reclamation must be endowed with mask hal-facial provided of respirator with filter of the type P3.
It’s necessary however to respect all the norms of hygiene and safety of the job of which to the DPR n. 164/56, 547/55 and 303/56.

INDIRECT ASSESSMENT of BREATHABLE INORGANIC FIBRES by SENTINEL ANIMALS of PIEDMONT AREAS (N-W ITALY)

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Introduction

In last decades, besides the asbestos chrysotile, also tremolite, actinolite and other fibrous minerals have been found in outcropping serpentinite rocks in Western Alps, several of them in large quantity. A big chrysotile deposit near Balangero (Piedmont Region) has been mined for a long time. It was abundantly used by local industry (with crocidolite and amosite also) in the building materials. Hence Piedmont is very rich in asbestos either from natural as anthropic sources. Weather actions, like wind and rainfall, and anthropic activities, operating both on anthropic and natural sources, give rise to dispersion of mineral fibres in the air that therefore represent a constant component of environmental background. Whereupon all people living in this area are exposed to airborne asbestos and other fibrous species. The potential effects on human health of this kind of exposition, generally at low dose, are only in recent time investigated.

Recent publications show the advantage in using animal populations called Sentinel System Animals (SSA) as indicator of environmental contaminants, as breathable fibrous minerals fraction (bfmf) too, because SSA are free from some of the confounders factors (as cigarette smoke, working activity etc.) that can make the results of human studies difficult to interpret. SSA can provide information about both exposure levels and potential adverse health effects.

This study concerns the assessment of bfmf in lungs of six animal groups selected in four Western Alps areas, where outcropping serpentinite rocks are present and abundant, and two plain areas, selected because naturally free of rocks bearing chrysotile, tremolite and actinolite.

Materials and methods

We have investigated lung samples of some animal species lived in different Piedmont areas:

- 20 lungs of cows, Susa Valley (VS), Turin;
- 19 lungs of cows, Lanzo Valleys (VL), Turin;
- 6 lungs of cows, Sesia Valley (VC), Vercelli;
- 6 lungs of wild animals, Varaita Valley (VV), Cuneo;
- 28 lungs of wild animals, Regional Park "La Mandria" (M), Turin.
- 12 lungs of cows, Asti (AT) – control group.

After chemical digestion every sample has been investigated by OM and by SEM/EDS. OM has been used to detect the ferruginous bodies (FB) that include both asbestos bodies and pseudo-asbestos bodies (when the core is not an asbestos fibre); SEM/EDS observation enable to identify and quantify the mineral fibrous species. Histological section examination has been carried out by OM to identify the elementary lesions of the lung tissues and to evaluate inorganic lung burden too.

Results

In all different animal groups there is not pulmonary fibrosis, which instead is generally present in human subjects with professional exposure to asbestos. The percentage of the cases with unspecific fibrosis has resulted different in the different animal groups studied. In particular that is more abundant in the VV animal lungs where the average value of FB is biggest.

We have observed a greater inorganic lung burden in Susa Valley (in 20 of 19 samples) and Lanzo (in 15 of 19 samples) Valley cattle in comparison to wild animals of Varaita Valley (in 2 of 6 samples) and Regional Park of "La Mandria" (in 9 of 28 samples) and Val Sesia cattle (in 1 of 6 samoles). In the Asti control group inorganic lung burden is less then all other groups (in 1 of 12 samples).

FB's have not been detected only in VC group. Their frequency is: 15.8 % in VL, 20% in VS, 32 % in M, 33% in VV and 50% in AT.

Tremolite has been found in VS, VL, VV and AT groups; actinolite, amosite and chrysotile in VS and VL ones; crocidolite in VS group only. Also many different non-asbestos fibrous species were detected.

Discussion

The present data prove that the investigation of lungs of non-experimental animals can be utilized as indicator of environmental background exposure when human samples are unavailable or poor.

In particular show that airborne asbestos and other inorganic fibres are diffused in the Piedmont Region.

With the data until now obtained it is possible begin to make a "natural environmental exposition map" for several Piedmont areas: this is the start point for a correct information program to the resident and tourist people.

ASBESTOS TRAFFIC IN THE MEDITERRANEAN REGION: THE PORT OF TRIESTE, ITALY

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Asbestos production was concentrated in a relatively low number of countries. For a large part of the past century, Soviet Union and Canada were the major producers, the production of these countries accounting for about 70% of the total. However, also other countries were relevant producers including Australia, China, Cyprus, Greece, Italy, South Africa. Transport of asbestos from the sites of production to the rest of the world was largely made by sea.

The transport of asbestos may represent a source of relevant exposure to the mineral. Epidemiological studies showed increased risk for mesothelioma in categories such as dock workers[1, 2], and truck drivers involved in asbestos transport. In the present study, available data on asbestos traffic in the port of Trieste, Italy, in the period 1960-98, were reviewed. Such period is particularly important for the history of asbestos use and commerce for two reasons: 1) world asbestos production progressively increased from about 2 million in 1960 to over 5 million tons in the late 1970s[3]; 2) in this period asbestos ban started in various countries[4]. The figures analyzed in the current study were furnished by the Authority of the Trieste port. In the period 1960-98, over 500,000 tons of asbestos passed through the port of Trieste. By sea traffic (arrivals plus departures) ranged between 558 and 18,882 tons per year in the period 1960-96 (total 257,795 tons). By railway traffic in the period 1960-94 ranged between 1464 and 17,670 tons per year (total 237,717 tons). By truck traffic was far lower (total 19,870 tons), but the data were not complete. Data about asbestos arrivals by sea and by railway are reported in Figs. 1 and 2. Until late 1970s, and partly even in 1980s, asbestos passing through the Trieste port was transported by jute or paper sacks. Such sacks often broke, resulting in high dustiness. The severity of the pollution was documented by inquiries conducted by the Occupational Medicine Unit of the Local Health Authority in 1977. Both chrysotile and amphiboles were transported[5]. In the period 1981-98, 94% of asbestos arrived by sea to the Trieste port, came from South Africa, with about 60% coming from the Durban port, and 32% from Port Elisabeth. Various asbestos-cement industries were furnished through the Trieste port, including Vöcklabruch, Wietersdorf, Guntransdorf in Austria, Oradea, and Bikaz in Romania, Broni in Italy, and Anhovo Solin in Yugoslavia. After asbestos ban adopted in Italy in 1992, substantial amounts of asbestos continued to pass through the port of Trieste. This is due to the extraterritorial rights, the port enjoys.

Some effects of asbestos exposure occurred in the port of Trieste have already been documented. Recently, a series of 23 pleural mesotheliomas diagnosed among dock workers in Trieste between 1968 and 2004, were reviewed[6]. Twenty-one patients had been employed in loading/unloading of a variety of goods, including asbestos; one had served in the port as a member of the Financial Police, and one as engineer and electrician. In comparison with other occupational categories, investigated in the Trieste-Monfalcone area[7], port workers showed shorter latency periods and higher prevalence of asbestos bodies in routine lung sections. Both the above findings indicate an exposure to asbestos heavier than in other occupational groups.

Since the transport of asbestos partly occurred in the open air, atmospheric pollution involved also urban areas surrounding the port. The effects of such pollution have not been systematically investigated. However, two cases of pleural mesothelioma, attributable to environmental exposure to asbestos in the port area, were observed. Both the patients, two women, had lived in houses facing the port (Figs. 3, 4). Their histories were negative for occupational as well as for domestic exposure to asbestos. Necropsy was performed in one of the two cases, and several asbestos bodies were seen on routine lung sections.

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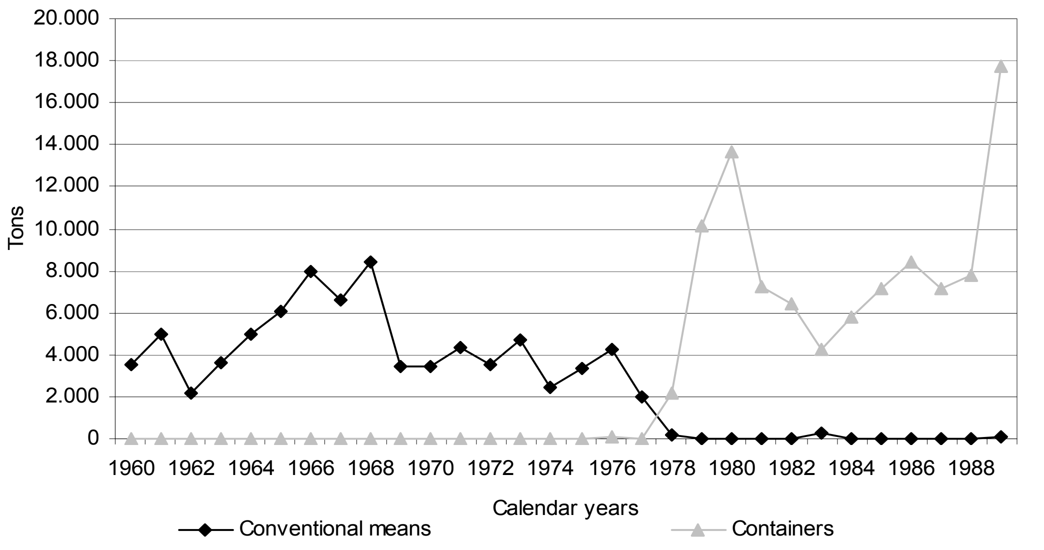
Figure 1 - Asbestos arrivals by sea in the port of Trieste, 1960-1989



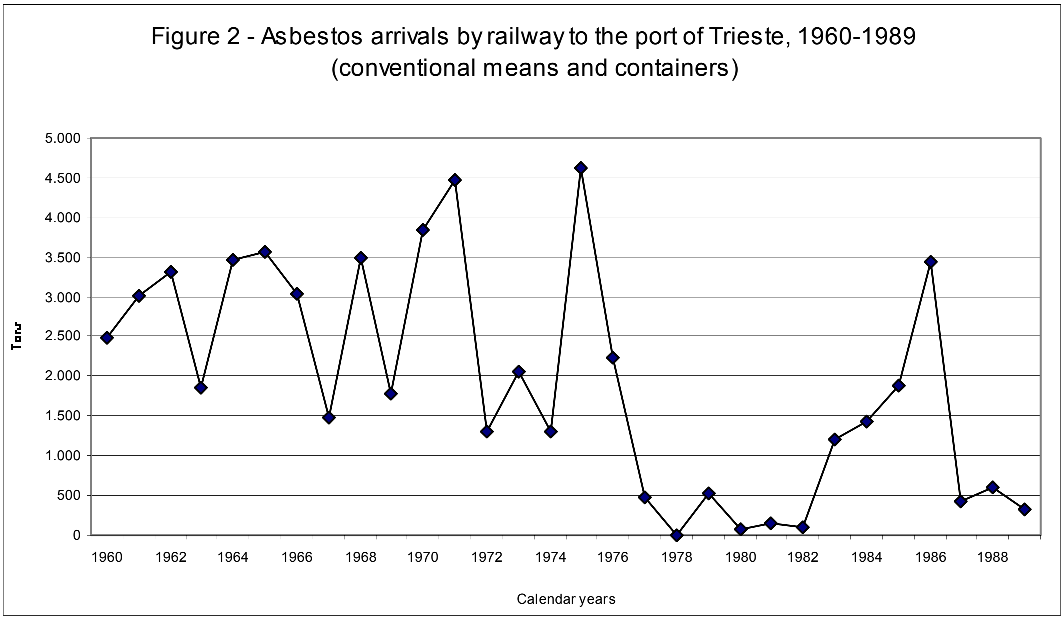


Figure 2 - Asbestos arrivals by railway to the port of Trieste, 1960-1989
(conventional means and containers)

Figure 3 - View of the Port of Trieste. The houses where lived the two women with mesothelioma are marked by white dots.

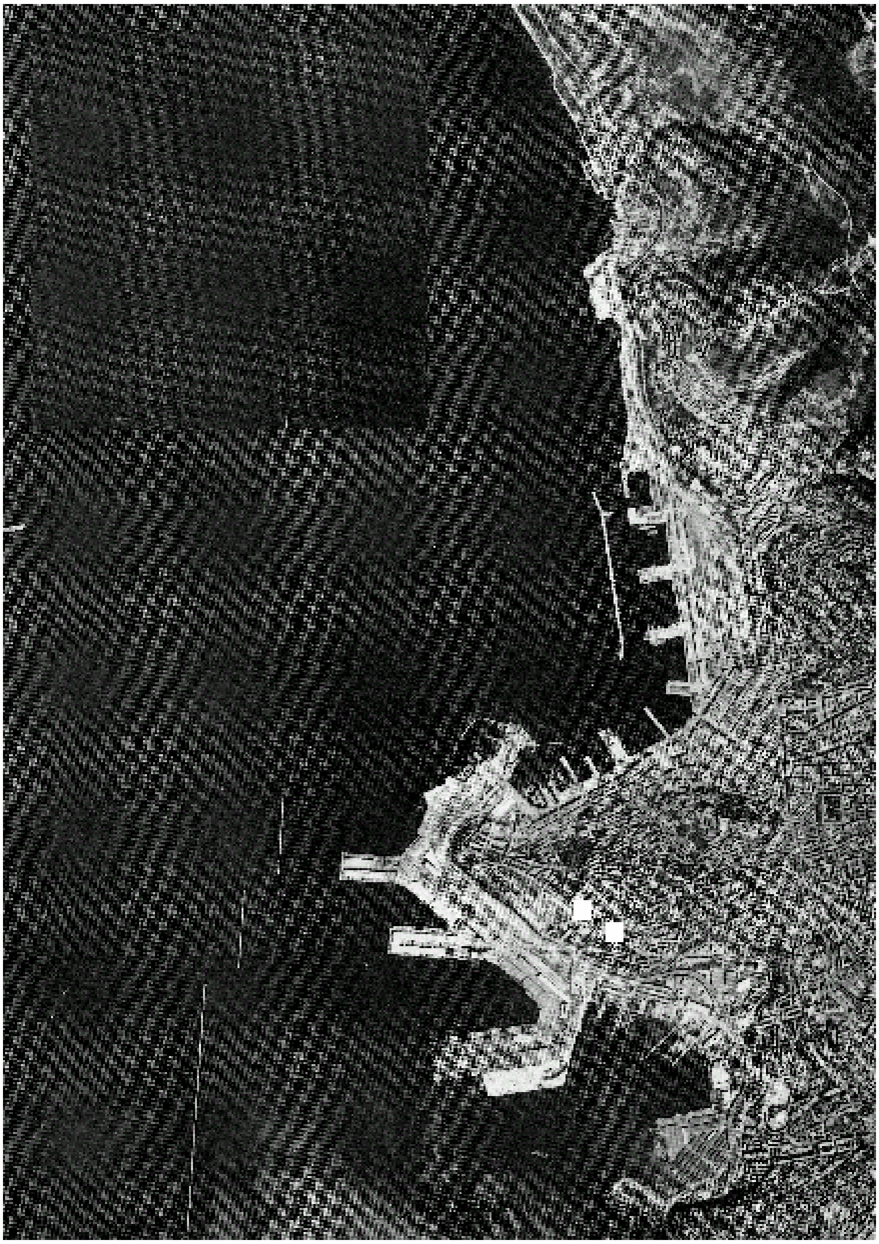


Figure 4 - Aerial view of the Port of Trieste. The houses where lived the two women with mesothelioma are marked by white dots.

MONITORING MINERAL FIBRES BACKGROUND in the BIANCAVILLA AREA (SICILY) by OM and SEM-EDS INVESTIGATION of ANIMALS LUNG

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Introduction

Some cases of environmental pollution due to asbestos fibres are known. Famous cases of epidemiological incidence of endemic mesotheliomas are known in New Caledonia, Cyprus, Greece and Turkey. In these areas a correlation has been evidenced between excess of mesothelioma and presence of tremolite deposits used as whitewashes for buildings.

High incidence of malignant mesothelioma, which has been revealed by previous epidemiological investigations, have been associated sometimes to non asbestos fibrous minerals as in Cappadocia (Turkey) and in Biancavilla (Italy). In Cappadocia a correlation has been found with the presence of erionite (a natural zeolite) contained in rocks used in local building until few years ago. In Biancavilla (Catania - Eastern Sicily) there is a similar situation, but in this case the fibrous minerals is the fluoro-edenite, a new amphibole locally abundant in autochthon lava rocks. In both cases the fibres are airborne from buildings owing to their degradation.

Our aim is to study the environmental fibre exposure under natural conditions, at low dose too, monitoring the presence of inorganic fibres in general and amphibole fluoro-edenite fibres in particular, in lungs of sentinel systems animals (SSA) living in this area.

Recent publications in fact show the advantage in using SSA as indicator of environmental contaminants, e.g. breathable fibrous minerals fraction (bfmf), because they are free from some of the confounders factors (as cigarette smoke, working activity etc.) that can make difficult to interpret the results of human studies and because sometimes human samples are unavailable or scarce.

Materials and methods

We have investigated lung samples of two animal groups detailed as follow:

- I group of 4 sheep and 1 goat coming from an area of Monte Calvario;
- II group of 8 sheep coming from an area near Biancavilla town.

Histological sections have been coloured with Hematossilin-Heosin to point out cytological characteristic. Their examination has been carried out by OM in order to:

- identify the elementary lesions of the lung tissue (fibrosis, type of inflammatory infiltrate and eventually associated infecting agents);

- evaluate dust lung burden (exogenous particles as carbon, silica, iron, ferruginous bodies etc):
  (-) no dust; (+) presence of dust with different grade (1+: focal dust in peribronchiol-bronchiolar and/or perivasal area; 2+: focal dust in peribronchial/bronchiolar/perivasal and interstitial area; 3+: moderate aggregate of dust in every tissue side; 4+: diffuse deposit of dust).

Moreover, after chemical digestion by NaClO of the organic portion and filtration of the inorganic suspension through a filter, every sample has been investigated by:

- OM to detect ferruginous bodies (FB) observing the whole membrane at 400 magnification;
- SEM/EDS to identify and quantify the mineral fibrous species and other inorganic fibres, observing a portion of filter corresponding to 800 fields at 2000 magnification.

The number of FB and fibres found has been normalized to 1 gram of dry weight (gdw), according to the international standard.

Results

First group of animals.

We have observed 2 cases of fibrosis out of 5 investigated samples.

No cases of asbestosis or other asbestos morphological lesions were observed.

About the quantification of dust lung burden:

- in 2 samples we have observed dust (-);
- in 3 samples we have observed dust at different grade: in 2 samples (+) and in 1 sample (++).

FB's have been detected in 3 cases out of 5 investigated lung samples (60%).

By SEM-EDS inorganic fibres have been detected in all the samples: inosilicates (amphiboles and pyroxenes), sheet-silicates (mainly clay minerals), feldspars and titanium dioxide.

All data are schematically reported in the following table:

samples	fibrosis	dust burden	FB/gdw	total fibres/gdw
369	no	+	101	76068
333	+	++	0	37598
331	no	+	0	11911
251	+	-	16	27122
020	no	-	128	19338

Second group of animals:

We have observed 2 cases of fibrosis out of 8 investigated samples.

No cases of asbestosis or other asbestos morphological lesions were observed.

About the quantification of dust lung burden:

- in 5 samples we have not observed dust (-);
- in 3 samples we have observed dust at different grade: in 1 sample (+), in 1 sample (++), in 1 sample (+++).

FB's have been detected in 2 cases out of 8 investigated lung samples (25%).

By SEM-EDS inorganic fibres have been detected only in 3 samples.

All data are schematically reported in the following table:

samples	fibrosis	dust burden	FB/gdw	total fibres/gdw
1	no	++	42	4273
2	no	-	0	0
3	no	-	0	0
5	no	+	0	0
7	+	+++	0	4026
8	no	-	0	0
9	+	-	25	3787
11	no	-	0	0

Discussion

To understand the environmental situation of the studied area we have compared these results with other data collected by some of the present authors on cattle lung samples from Asti (Piedmont), area geologically free of asbestos (control case) and with those collected on cattle of Susa Valley and Lanzo Valleys, areas in which many fibrous minerals, including asbestos, have been found in outcropping serpentinite rocks.

Histological examination.

Also in Biancavilla animals no cases of asbestosis or other asbestos morphological lesions have been observed as in cattle of Susa Valley, Lanzo Valleys and Asti.

We have observed the following dust lung burden in decreasing percentage: 95% (19 cases/20 samples) in Susa Valley cattle, 79% (15/19) in Lanzo Valleys cattle, 60% (3/5) in group I and in 25% (2/8) in group II of Biancavilla animals; and 8.3% (1/12) in Asti cattle.

The FB's are not present in the dust of all examined animals.

These results underline that both Biancavilla areas have a dust burden lower than Susa and Lanzo Valleys (Piedmont Valleys) but higher then Asti; Asti is therefore confirmed as a good control area.

FB's investigation by OM.

FB's have been detected in the following decreasing order: 60% (3 cases/5 samples) in group I of Biancavilla animals, 50% (6/12) in Asti cattle, 25% (2/8) in group II of Biancavilla animals; 20% (4/20) in High Susa Valley and 15,8% (3/19) in Lanzo Valleys.

FB's in fact have an iron-protein coat but the nature of core cannot be an asbestos fibre (e.g. TiO_2 fibre).

Fibre

Average concentrations of total fibres/gdw are schematically reported in the following table:

Animals provenience	Average concentration of total fibres/gdw
Alta Val di Susa	130250
Valli di Lanzo	96626
Bassa Val di Susa	75880
Biancavilla (group I)	34406
Asti	2509
Biancavilla (group II	1510

Animals coming from the area near Biancavilla town (group II) have a fibre burden comparable with the fibre burden of Asti cattle. Therefore we can affirm that airborne fibre quantity in this area is low, not detectable by SSA.
Animals coming from the area of Monte Calvario (group I) have a fibre burden representing a situation of environmental pollution from fibres in the living period of the examined animals: 1998 -2004. In spite of lung morphology differences of the animal species from Piedmont (cattle) and Sicily (sheeps and goat), it seems reasonable to conclude that the fibrous environmental pollution of the Monte Calvario, for the considered years, is much lower than in the examined area of Piedmont.

A SPATIAL CASE-CONTROL STUDY OF THE ENVIRONMENTAL ASBESTOS EXPOSURE ON MALIGNANT MESOTHELIOMA IN BARI, ITALY.

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Introduction: A geographical analysis of malignant mesothelioma occurrences among people living near an asbestos-cement factory in Bari, Apulia (Italy) was described in Bilancia et al. (2003) (1). To strengthen the aforementioned results, and to estimate the cancer risk due to environmental exposure to asbestos in people who never experienced occupational exposure, a spatial case control study was carried out.

(1) Bilancia M., Pollice A., Cavone D., Musti M. (2003) Valutazione del rischio di mesotelioma: il caso di una fabbrica per la produzione di cemento-amianto nella città di Bari, Epidemiologia e Prevenzione, 27(5), 277-284.

Materials and Methods: The study includes 48 cases of malignant mesothelioma (MM) with no apparent occupational exposure among residents in the municipality of Bari over the period 1992/2003, taken from the mesothelioma national registry -Apulia regional operative center, and 273 controls randomly selected from the municipal list of residents by date of death. Information about sex, place and date of birth, place and date of death, and the complete residential history were collected for cases and controls. Due to the lack of agreement about the dose-response relation between asbestos exposure and MM, geographical coordinates of the spatial locations of both the nearest (to the asbestos-cement factory) and the longest lasting (prevalent) residential addresses were collected from http://www.maporama.com. Metrical coordinates were retrieved by a suitable conversion software (WinDatum), and distances and angles of residential locations with respect to the putative source of risk were computed for cases and controls.

Results: for cases and controls, point process based methods have been used to estimate the risk surface (all the subsequent analyses have been replicated for both nearest and prevalent addresses). The estimated spatial distribution of cases shows a peak around the putative source of risk, and it differs considerably from the spatial distribution of controls. A confirmatory analysis has been conducted by classifying cases and controls lying within a fixed distance threshold (from the factory location) as exposed, and unexposed otherwise: spatial odds ratio as a function of the threshold are significantly greater than 1 within a radius of about 2500m centred on the factory spatial location. Within the context of spatial case-control studies, a focused analysis has been performed by modelling odds by means of a spatial logistic regression model: likelihood ratio tests shows a significant effect of the distance from the putative source of risk.

Discussion: The present work confirm the association of environmental asbestos exposure and pleural MM.

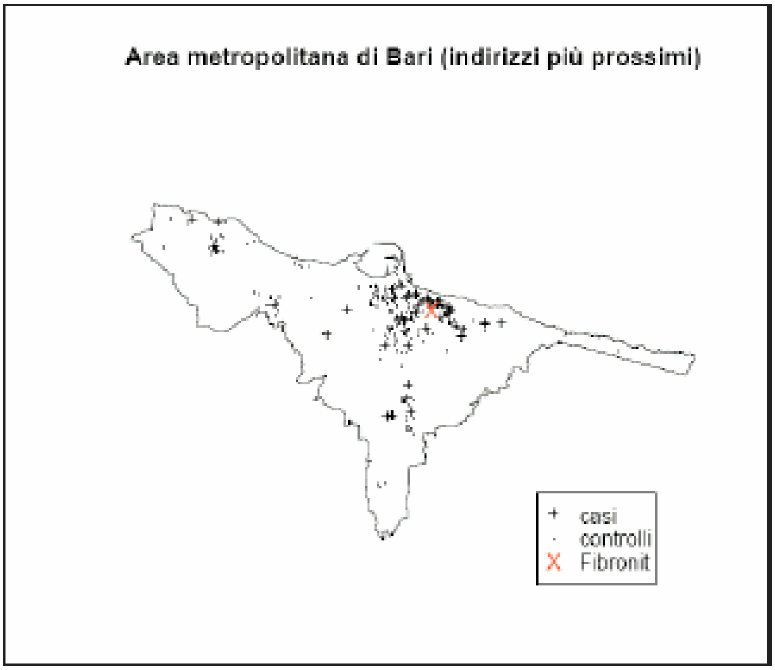

Fig. 1: Mappatura degli indirizzi di residenza di casi e controlli più prossimi allo stabilimento Fibronit.

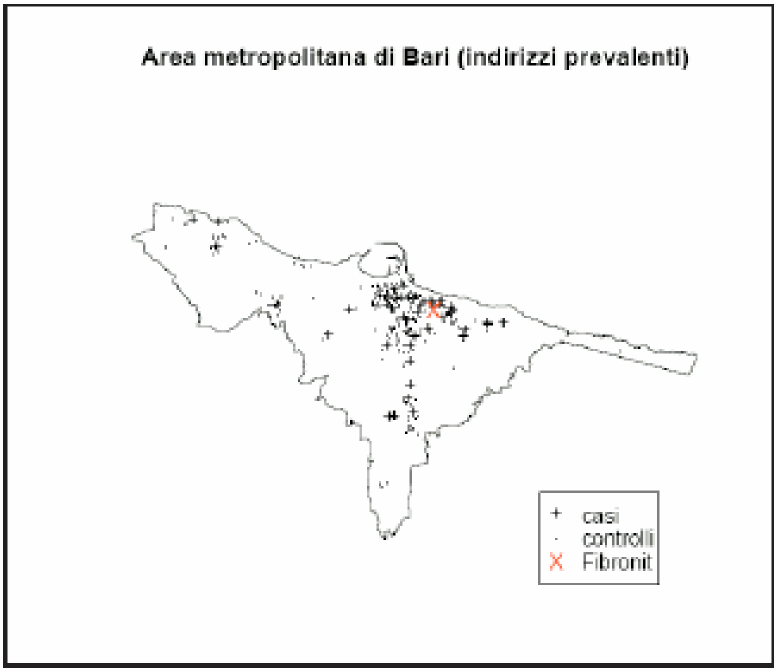

Fig. 2: Mappatura degli indirizzi di residenza prevalenti di casi e controlli.

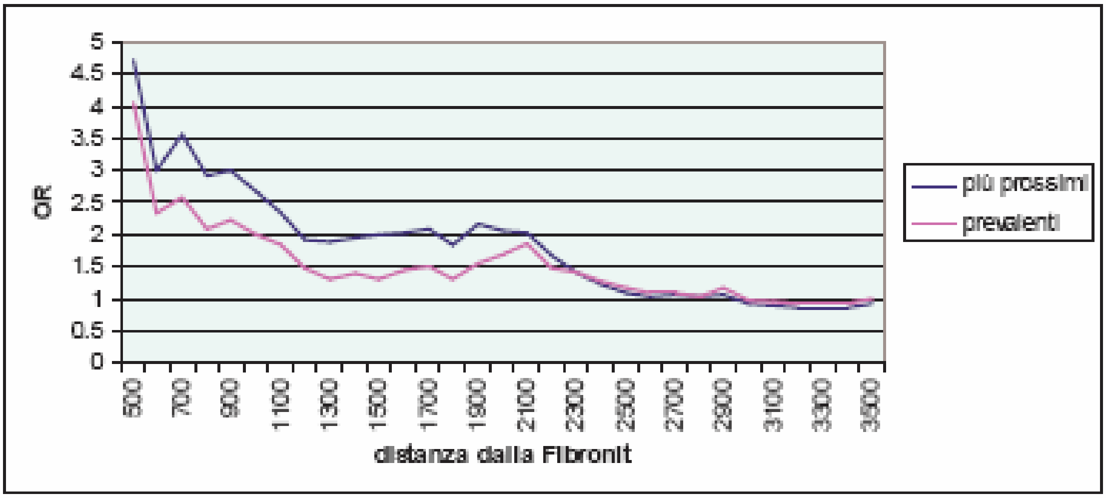

Fig. 5: Odds ratio calcolati considerando esposti gli individui residenti ad una distanza dalla Fibronit inferiore ad una soglia variabile.

PIANI REGIONALI DI PROTEZIONE DELL'AMBIENTE, DI DECONTAMINAZIONE, DI SMALTIMENTO E DI BONIFICA AL FINI DELLA DIFESA DAI PERICOLI DERIVANTI DALL'AMIANTO
(ai sensi dell'art. 10 della legge 257/92)

A. Damian[1]
[1] Sviluppo Italia Aree Produttive c/o Ministero dell'Ambiente e della Tutela del territorio e del Mare

Il massiccio impiego di amianto effettuato nel passato ha determinato l'immissione nell'ambiente di numerosi manufatti e prodotti contenenti amianto, alcuni dei quali assai duraturi, quali treni, natanti, tram e metropolitane, edifici ed impianti industriali.

In questo contesto, visto l'impiego diversificato sia nei settori industriali che civili, è nata la necessità di affrontare due tipologie di problematiche: una relativa al personale specializzato operante nel settore della dismissione e bonifica del materiale contenente amianto ed una relativa al personale che, quotidianamente, è impiegato in ambienti dove il materiale risulta comunemente presente come elemento strutturale o architettonico. Tale diversificazione si ritrova, infatti, nei contenuti dei Piani regionali Amianto che vengono analizzati in seguito.

In Italia, sebbene la legislazione abbia affrontato tale problematica già dopo la metà degli anni novanta, la normativa di settore che disciplina sia l'estrazione, l'importazione, la lavorazione, l'utilizzazione, la commercializzazione, il trattamento e lo smaltimento nel territorio nazionale sia l'esportazione dell'amianto e dei prodotti che lo contengono è la Legge 257 del 1992.

La normativa coinvolge non solo le pubbliche Amministrazioni che hanno un ruolo principale nel controllo della corretta gestione del materiale nell'intero ciclo di vita, ma anche le imprese che utilizzano amianto, direttamente o indirettamente, nei processi produttivi, o che svolgono attività di smaltimento o di bonifica dello stesso.

Inoltre, la medesima Legge prevede che, attraverso decreto del Ministro della Sanità, di concerto con il Ministro dell'industria, del Commercio e dell'Artigianato, con il Ministro dell'Ambiente e del Territorio, con il Ministro dell'Università e della Ricerca scientifica e tecnologica e con il Ministro del Lavoro e della Previdenza sociale, venga istituita la Commissione per la valutazione dei problemi ambientali e dei rischi sanitari connessi all'impiego dell'amianto.

Tale Commissione ha il compito , tra l'altro, di acquisire i dati dei censimenti, di predisporre i piani di indirizzo per la formazione professionale del personale del Servizio sanitario nazionale, di predisporre i disciplinari tecnici sulle modalità per il trasporto e il deposito dei rifiuti di amianto, di individuare i requisiti per la omologazione dei materiali sostitutivi dell'amianto e di definire i requisiti tecnici relativi ai marchi e alla denominazione di qualità dei prodotti costituiti da materiali sostitutivi dell'amianto.

Il coinvolgimento alla corretta gestione e il conseguente autocontrollo nelle attività ad essa correlate, viene esteso, come già anticipato, anche alle imprese che utilizzano amianto, direttamente o indirettamente, nei processi produttivi, o che svolgono attività di smaltimento o di bonifica dell'amianto.

Tali imprese, infatti, hanno il compito di inviare annualmente alle Regioni, alle Province autonome di Trento e di Bolzano e alle Unità Sanitarie Locali, una relazione che indichi:

- i tipi e i quantitativi di amianto utilizzati e dei rifiuti di amianto prodotti;

- le attività svolte, i procedimenti applicati, il numero e i dati anagrafici degli addetti, il carattere e la durata delle loro attività e le esposizioni all'amianto alle quali sono stati sottoposti;
- le caratteristiche degli eventuali prodotti contenenti amianto;
- le misure adottate o in via di adozione ai fini della tutela della salute dei lavoratori e della tutela dell'ambiente.

Al fine di indirizzare le Regioni ad una corretta pianificazione nelle attività di gestione e di dismissione dei materiali contenenti amianto, è stato emanato il D.P.R. 8 agosto 1994 "Atto di indirizzo e coordinamento alle regioni ed alle province autonome di Trento e di Bolzano per l'adozione di piani di protezione, di decontaminazione, di smaltimento e di bonifica dell'ambiente, ai fini della difesa dai pericoli derivanti dall'amianto" che definisce puntualmente i contenuti e le modalità operative del Piano stesso.

Con questa normativa non solo è stata disciplinata la gestione del materiale, attraverso l'individuazione dei siti interessati da attività di estrazione, la programmazione, la dismissione delle attività estrattive, la relativa bonifica dei siti e l'individuazione delle aree da utilizzare per l'attività' di smaltimento dei rifiuti di amianto, ma è stata data anche primaria importanza alla salute dei lavoratori.

È prevista, infatti, una capillare formazione e informazione degli stessi con l'ausilio di specifici corsi di formazione professionale, il rilascio di titoli di abilitazione per gli addetti alle attività di rimozione e il controllo delle condizioni di salubrità ambientale e di sicurezza del lavoro al fine di affrontare la presenza dell'amianto e le problematiche ad esso connesse in modo organico e centrale.

Al fine di comprendere meglio la complessità e l'operatività del documento programmatorio in questione, viene riportata di seguito una sintesi dei contenuti previsti in tutti Piani Regionali di bonifica amianto secondo le indicazioni del Decreto attuativo D.P.R. 8 agosto 1994 "Atto di indirizzo e coordinamento alle regioni ed alle province autonome di Trento e di Bolzano per l'adozione di piani di protezione, di decontaminazione, di smaltimento e di bonifica dell'ambiente, ai fini della difesa dai pericoli derivanti dall'amianto".

Secondo le previsioni normative, i Piani Regionali di protezione dell'ambiente, di decontaminazione, di smaltimento e di bonifica al fini della difesa dai pericoli derivanti dall'amianto devo contenere:

a) il censimento dei siti interessati da attività di estrazione dell'amianto;
b) il censimento delle imprese che utilizzano o abbiano utilizzato amianto nelle attività produttive o che operano nelle attività di smaltimento o di bonifica. Affinché le Pubbliche Amministrazioni possano uniformare le modalità di controllo delle Regioni e delle Province autonome, può essere operato, un controllo incrociato, anche grazie all'ausilio delle relazioni che le Aziende devono presentare annualmente, tramite l'individuazione dei codici ISTAT di riferimento delle attività produttive maggiormente implicate, il reperimento di informazioni tramite le Camere di Commercio e il reperimento, tramite INAIL, dell'elenco delle imprese che corrispondono il premio assicurativo per la voce "silicosi ed asbestosi".
c) la predisposizione di programmi per dismettere l'attività estrattiva dell'amianto e realizzare la relativa bonifica dei siti;
d) l'armonizzazione dei Piani di smaltimento dei rifiuti di amianto con quelli di smaltimento dei rifiuti;

e) individuazione dei siti che devono essere utilizzati per l'attività di smaltimento;
f) il controllo delle condizioni di salubrità ambientale e di sicurezza del lavoro attraverso l'intervento da parte delle strutture territoriali secondo un piano di indirizzo stabilito dalla Regione;
g) la rilevazione sistematica delle situazioni di pericolo derivanti dalla presenza di amianto attraverso un controllo periodico, stabilito in funzione di una scala di priorità, in relazione alle possibili situazioni di pericolo come ad esempio nei casi di materiale accumulato a seguito delle operazioni di bonifica su mezzi di trasporto vari (vagoni ferroviari, navi, barche, aerei, ecc.) o in corrispondenza dei capannoni utilizzati e/o dismessi con componenti in amianto/cemento;
h) il controllo delle attività di smaltimento e di bonifica relative all'amianto attraverso piani di indirizzo predisposti dalla Regione e indirizzati alle strutture territoriali;
i) la predisposizione di specifici corsi di formazione professionale e il rilascio di titoli di abilitazione per gli addetti alle attività di rimozione e di smaltimento dell'amianto e di bonifica delle aree interessate. La durata ed i contenuti della formazione professionale dipende principalmente dal ruolo operativo del professionista: sono previsti, infatti, corsi della durata di 30 ore per gli operatori addetti alle attività di rimozione amianto e corsi della durata di 50 ore per il personale che ha il compito di dirigere sul posto le attività di rimozione. Il rilascio del titolo di abilitazione e' condizionato alla frequenza di tali corsi;
j) l'assegnazione delle risorse finanziarie alle unità sanitarie locali per la dotazione della strumentazione necessaria per lo svolgimento delle attività di controllo previste dalla legge;
k) il censimento degli edifici nei quali siano presenti materiali o prodotti contenenti amianto libero o in matrice friabile. Il censimento ha carattere di obbligatorietà per gli edifici pubblici, per i locali aperti al pubblico o di utilizzazione collettiva e per i blocchi di appartamenti, mentre risulta facoltativo per le singole unità abitative.

Analizzando i singoli contenuti e le modalità operative connesse, si è potuto comprendere come lo strumento pianificatorio dei Piani regionali Amianto sia risultato di complessa realizzazione.

A livello nazionale, infatti, sebbene la maggior parte delle Regioni abbia provveduto all'adozione degli stessi, come previsto dall'art. 10, comma 1, della legge 257/92, risulta come l'operatività sia stata procrastinata con l'approvazione di successivi decreti attuativi, in modo da permetterne il perfezionamento sia attraverso l'acquisizione di informazioni di maggior dettaglio a livello territoriale sia attraverso il coordinamento e l'aggiornamento professionale dei soggetti coinvolti nel settore. Tale perfezionamento, purtroppo, non è stato raggiunto da tutte le Regioni.

Attualmente, il Ministero dell'Ambiente, della Ttutela del Territorio e del Mare sta procedendo alla disamina dei singoli Piani Regionali Amianto e dei decreti attuativi ad essi connesso, al fine di verificarne non solo la corrispondenza con quanto richiesto dalla normativa, ma anche di comprendere il livello operativo raggiunto dalle Regioni per la corretta gestione e controllo di un problema così diffuso come la presenza dell'amianto nel territorio nazionale.

MONITORAGGI AMBIENTALI DURANTE OPERAZIONI DI BONIFICA: VALUTAZIONE DELL'EFFICIENZA DEI PORTAFILTRI NEI CAMPIONAMENTI DI AERODISPERSO

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Introduzione

Il 3 % del territorio nazionale italiano, afferente ai siti inquinati da bonificare di interesse nazionale, risulta contaminato da sostanze altamente pericolose sia per la salute umana che per l'ambiente. Dette aree contaminate sono presenti in tutte le Regioni italiane con diversi fattori di rischio ed impatto ambientale. L'inquinamento ivi presente risulta provocato, per la maggior parte dei casi, da un uso improprio del territorio e dallo sviluppo di un'intensa attività industriale ad elevato rischio sia per la salute umana che per le matrici ambientali acqua, aria e suolo. Ciò comporta evidenti ricadute sulla salute dei lavoratori impegnati in dette attività industriali o nelle relative bonifiche e sulla salute della popolazione residente nelle aree limitrofe. L'acquisizione delle informazioni relative a dette aree ed alle condizioni di rischio risulta di fondamentale importanza per la corretta gestione delle attività di prevenzione, sicurezza ed attivazione degli interventi di bonifica e ripristino ambientale. Dette attività di bonifica prevedono, prima, durante e dopo gli interventi, la realizzazione di attività di monitoraggio ambientale. Tali procedure risultano necessarie per stabilire lo stato di inquinamento iniziale dei siti, l'efficienza delle operazioni di bonifica e per procedere alla restituibilità delle aree inquinate da parte degli Organi di vigilanza competenti per territorio. In particolare tutte le fasi operative degli interventi di bonifica dovranno necessariamente essere concordate con le autorità di controllo locali (AUSL e ARPA) e per i siti di interesse nazionale con gli Enti Scientifici Nazionali.

L'ISPESL, in quanto Ente Scientifico Nazionale, al fine di assicurare un contributo sia tecnico-scientifico che operativo al Ministero dell'Ambiente e Tutela del Territorio, amministrazione procedente per detti siti, realizza sopralluoghi ispettivi e specifiche campagne di monitoraggio ambientale atte ad individuare le sorgenti contaminanti, le relative concentrazioni in materiali in massa di suolo e rifiuti, nell'aerodisperso e nelle acque sia presso i siti industriali a rischio che negli abitati cittadini limitrofi. Detti monitoraggi vengono eseguiti secondo modalità previste dalle normative di settore, ma possono differire per alcuni aspetti tecnici non normati.

L'ISPESL-DIPIA, nell'ambito della propria esperienza professionale ha potuto osservare nel corso di alcune indagini ambientali che per i prelievi di aerodisperso, l'adozione di testine portafiltro in diversi materiali (plastica e metallo) determinava differenti risultati analitici in situazioni analoghe; l'ISPESL-DIPIA ha di conseguenza ritenuto opportuno avviare uno studio finalizzato ad accertare che l'utilizzo di testine a diversa conducibilità conduca a risultati tra loro confrontabili o si verifichino differenze analitiche.

La caratterizzazione dei siti, prima, durante e dopo le attività di bonifica, richiede una sempre maggiore attendibilità dei risultati analitici; pertanto diventa sempre più necessario verificare e mettere a punto le più idonee procedure di campionamento ed analisi ai fini di garantire detta attendibilità e riproducibilità attraverso una standardizzazione delle metodiche anche ai fini di poter individuare sulla base di dati certi i più idonei interventi di messa in sicurezza di emergenza, bonifica e ripristino ambientale.

Inquadramento normativo

La gestione dei siti inquinati in Italia è attualmente regolata da una legislazione poco complessa che può essere riassunta schematicamente nei seguenti documenti normativi:

- D.Lgs. n. 22 del 5/2/1997 (cosiddetto Decreto Ronchi) "Attuazione delle direttive 91/156/CEE sui rifiuti, 91/689/CEE sui rifiuti pericolosi e 94/62/CE sugli imballaggi e sui rifiuti di imballaggio". E' la legge quadro in materia di rifiuti e riporta, agli artt. 17 e 18, le prescrizioni generali in materia di bonifica di siti inquinati.
- D.Lgs. n.389 del 8/11/1997 "Modifiche ed integrazioni al decreto legislativo 5 febbraio 1997, n. 22, in materia di rifiuti, di rifiuti pericolosi, di imballaggi e di rifiuti di imballaggio". Contiene, all'art. 2 "Bonifiche", alcune modifiche e integrazioni all'art. 17 del citato D.Lgs. 22/97.
- Legge n. 426 del 9/12/1998 "Nuovi interventi in campo ambientale". Prescrive, all'art. 1 "Interventi di bonifica e ripristino ambientale dei siti inquinati", l'adozione da parte del Ministero dell'Ambiente di un programma nazionale di bonifica e ripristino ambientale dei siti inquinati. Riporta inoltre l'elenco dei primi interventi di bonifica di interesse nazionale.
- Il D.M. 16/5/99 "Criteri e le Linee Guida per la redazione dei piani di bonifica regionali" formula le indicazioni per la pianificazione regionale in materia di bonifica.
- D.M. n.471 del 25/10/1999 "Regolamento recante criteri, procedure e modalità per la messa in sicurezza, la bonifica e il ripristino ambientale dei siti inquinati, ai sensi dell'articolo 17 del decreto legislativo 5 febbraio 1997, n. 22, e successive modificazioni e integrazioni". Costituisce il decreto attuativo dell'art. 17 del D.Lgs. 22/1997 e rappresenta il riferimento fondamentale per le attività legate alla gestione dei siti inquinati.
- D.M. n. 468 del 18/9/2001 "Programma nazionale di bonifica e ripristino ambientale dei siti inquinati". E' il regolamento attuativo dell'art. 1 della Legge 426/98; individua gli interventi di interesse nazionale, riportando anche quelli già individuati nella normativa precedente; definisce gli interventi prioritari e determina i criteri per l'individuazione dei soggetti beneficiari e per il finanziamento. Disciplina inoltre le modalità per il monitoraggio e il controllo sull'attuazione degli interventi.
- L. n. 179 del 31-7-02, G.U. 13-8-02 n. 189, "Disposizioni in materia ambientale": detta legge individua ulteriori 9 siti da bonificare di interesse nazionale.
- Il D.Lgs. 3 Aprile 2006, n. 152, "Norme in materia ambientale" (Pubblicato sul Supplemento Ordinario alla Gazzetta Ufficiale n. 88 del 14 Aprile 2006).

Procedure di intervento

Il regolamento contenuto nel D.M. 471/99 stabilisce che, per ogni sito potenzialmente contaminato, venga seguito un ben preciso iter amministrativo e tecnico, fino alla verifica della mancata contaminazione o dell'avvenuta bonifica. L'obbligo di procedere alla bonifica spetta al responsabile dell'inquinamento o al proprietario del sito, o al Comune (o la Regione se il sito interessa più comuni), qualora i precedenti soggetti non siano individuabili o non provvedano. L'approvazione delle varie fasi del progetto di bonifica spettano al Comune o alla Regione (sentita una Conferenza di servizi). La Provincia controlla la conformità degli interventi al progetto e il loro completamento, rilasciando apposita certificazione.

Per i siti inquinati le cui caratteristiche richiedono interventi di interesse nazionale, l'approvazione dei progetti spetta al Ministero dell'Ambiente e Tutela del Territorio, che si avvale della consulenza tecnica degli Enti di ricerca scientifici nazionali, tra cui l'ISPESL, e degli Organi Regionali di riferimento, ai sensi dell'Art. 15 del D.M. 471/99 che rappresenta lo strumento applicativo per la redazione dei Piani di caratterizzazione e dei progetti di messa in sicurezza, di bonifica e ripristino ambientale.

Per la normativa in vigore un sito, inteso come insieme delle diverse matrici ambientali e strutture antropiche, è inquinato se anche uno solo dei valori di concentrazione delle sostanze inquinanti nel suolo, sottosuolo, acque superficiali e sotterranee risulta superiore ai valori limite accettabili stabiliti nell'allegato 1 del D.M. 471/99. Si tiene comunque conto anche di monitoraggi degli inquinanti nell'aria.

Gli interventi di bonifica devono essere preceduti da una apposita progettazione, che si articola in 4 livelli di approfondimento successivo: la messa in sicurezza di emergenza, il piano di caratterizzazione, il progetto preliminare e il progetto definitivo di bonifica, ciascuno dei quali si conclude con la presentazione di una Relazione descrittiva e di Elaborati tecnici da presentare al Ministero dell'Ambiente per la relativa approvazione. L'allegato 4 del decreto illustra criteri generali per la stesura di tali progetti, validi fino alla pubblicazione di apposite linee guida da parte delle Regioni.

La Messa In Sicurezza di Emergenza prevede tutti gli interventi di rapida esecuzione atti a bloccare la fuoriuscita di inquinanti dalle arre contaminate, al fine di impedire l'aggravamento delle situazioni di rischio.

Il Piano della Caratterizzazione descrive in dettaglio il sito e tutte le attività che si sono svolte e che ancora vi si svolgono, individua le correlazioni tra le attività svolte e la localizzazione ed estensione della possibile contaminazione, definisce un piano di investigazioni finalizzato alla ricostruzione di dettaglio dello stato di inquinamento del sito e dell'ambiente da esso influenzato e del rischio posto per l'ambiente naturale e umano.

Una volta approvato il Piano di caratterizzazione, vengono condotte le indagini programmate e sulla base di esse e di tutte le informazioni raccolte in precedenza viene definito lo stato di qualità del singolo sito, in termini di distribuzione spaziale tridimensionale delle singole sostanze inquinanti nei diversi comparti ambientali, con la valutazione di situazioni di rischio per l'ambiente e la salute umana, e la dinamica della contaminazione basata sul modello concettuale. Ciò è particolarmente importante per definire una priorità degli interventi, valutare la necessità di interventi di messa in sicurezza d'emergenza, definire gli obiettivi della caratterizzazione e della bonifica e, conseguentemente, le diverse fasi progettuali.

Il Progetto preliminare valuta le investigazioni svolte, sulla base della caratterizzazione definisce gli obiettivi per la bonifica e analizza e seleziona le tecnologie di bonifica che possono essere adottate.

Nel caso in cui i livelli di concentrazione raggiungibili a seguito della bonifica siano superiori ai livelli accettabili, in questa fase vengono definiti i livelli residui mediante metodologie di analisi del rischio. La bonifica in questo caso comprenderà misure di sicurezza per garantire con continuità la tutela dell'ambiente e della salute pubblica.
Il piano definitivo è un progetto esecutivo che determina in ogni dettaglio i lavori da realizzare e il loro costo, è corredato da un piano di manutenzione delle opere di bonifica e delle eventuali misure di sicurezza e da una definizione degli interventi necessari ad attuare eventuali prescrizioni (es. piani di monitoraggio) e limitazioni d'uso del sito.
Il D.Lgs. 3 Aprile 2006, n. 152, Norme in materia ambientale (Pubblicato sul Supplemento Ordinario alla Gazzetta Ufficiale n. 88 del 14 Aprile 2006) modifica parzialmente quanto stabilito dal D.M. 471/99 ed in particolare fornisce una serie di definizioni di seguito riportate.
Concentrazioni soglia di contaminazione (CSC): i livelli di contaminazione delle matrici ambientali che costituiscono valori al di sopra dei quali è necessaria la caratterizzazione del sito e l'analisi di rischio sito specifica. Nel caso in cui il sito potenzialmente contaminato sia ubicato in un'area interessata da fenomeni antropici o naturali che abbiano determinato il superamento di una o più concentrazioni soglia di contaminazione, queste ultime si assumono pari al valore di fondo esistente per tutti i parametri superati.
Concentrazioni soglia di rischio (CSR): i livelli di contaminazione delle matrici ambientali, da determinare caso per caso con l'applicazione della procedura di analisi di rischio sito specifica e sulla base dei risultati del piano di caratterizzazione, il cui superamento richiede la messa in sicurezza e la bonifica. I livelli di concentrazione così definiti costituiscono i livelli di accettabilità per il sito.
Sito potenzialmente contaminato: un sito nel quale uno o più valori di concentrazione delle sostanze inquinanti rilevati nelle matrici ambientali risultino superiori ai valori di concentrazione soglia di contaminazione (CSC), in attesa di espletare le operazioni di caratterizzazione e di analisi di rischio sanitario e ambientale sito specifica, che ne permettano di determinare lo stato o meno di contaminazione sulla base delle concentrazioni soglia di rischio (CSR).
Sito contaminato: un sito nel quale i valori delle concentrazioni soglia di rischio (CSR), determinati con l'applicazione della procedura di analisi di rischio sulla base dei risultati del piano di caratterizzazione, risultano superati.
sito non contaminato: un sito nel quale la contaminazione rilevata nelle matrice ambientali risulti inferiore ai valori di concentrazione soglia di contaminazione (CSC) oppure, se superiore, risulti comunque inferiore ai valori di concentrazione soglia di rischio (CSR) determinate a seguito dell'analisi di rischio sanitario e ambientale sito specifica.
Bonifica: l'insieme degli interventi atti ad eliminare le fonti di inquinamento e le sostanze inquinanti o a ridurre le concentrazioni delle stesse presenti nel suolo, nel sottosuolo e nelle acque sotterranee ad un livello uguale o inferiore ai valori delle concentrazioni soglia di rischio (CSR).
Analisi di rischio sanitario e ambientale sito specifica: analisi sito specifica degli effetti sulla salute umana derivanti dall'esposizione prolungata all'azione delle sostanze presenti nelle matrici ambientali *contaminate, condotta con i criteri indicati nell'Allegato 1.*
Il D.Lgs. 3 Aprile 2006, n. 152 modifica le fasi di intervento che conducono alla bonifica.
Nel caso in cui la concentrazione di inquinanti risulti essere minore della concentrazione soglia di contaminazione non si procede ad effettuare alcun intervento.
Se invece la concentrazione di inquinanti risulti essere maggiore della concentrazione soglia di contaminazione, si procederà prima ad una Messa in Sicurezza d'Emergenza seguita da un Piano

di Caratterizzazione e dall'Analisi di Rischio necessaria per determinare le concentrazione soglia di rischio, indice oltre il quale si procede con la Bonifica/Messa in Sicurezza (operativa o permanente). Qualora invece la concentrazione di inquinanti risulti inferiore alla concentrazione soglia di rischio la legge prevede di effettuare solo un monitoraggio costante dell'area.
Il D.Lgs. 152/06 pur modificando parzialmente le modalità di esecuzione degli interventi di bonifica previsti dal D.M. 471/99, non sminuisce l'importanza delle operazioni di monitoraggio da effettuarsi comunque durante ogni fase operativa e necessarie per effettuare una corretta analisi di rischio (fase fondamentale della bonifica come previsto dal D.Lgs. 152/06). Le autorità di controllo locali (AUSL e ARPA) e gli Enti Scientifici Nazionali (per i siti di interesse nazionale) realizzano monitoraggi all'interno delle aree inquinate atti a controllare la validità dei risultati ottenuti con i campionamenti da parte delle ditte interessate. Detti monitoraggi, pertanto, richiedono una sempre maggiore attendibilità dei risultati analitici attraverso una standardizzazione delle metodiche necessarie affinché campionamenti realizzati a parità di condizioni e negli stessi luoghi, conducano a risultati analoghi.

Indagini e risultati analitici

In particolare i campionamenti di aerodisperso possono differenziarsi per la tipologia di testine utilizzate per i campionamenti. Esistono infatti due differenti tipologie di testine realizzate rispettivamente in plastica e in metallo.
L'ISPESL nell'ambito della propria attività di ricerca all'interno di Siti di Interesse Nazionale, ha effettuato numerosi monitoraggi di acque superficiali e sotterranee, rifiuti, suoli ed aerodisperso. Nell'ambito di queste ultime indagini si è evidenziata in alcuni casi una diversa risposta analitica a seconda che fossero utilizzate testine di campionamento in plastica o in metallo.
L'ISPESL DIPIA ha pertanto ritenuto opportuno approfondire detto aspetto analitico effettuando uno specifico accertamento in merito. In particolare sono stati condotti monitoraggi sull'aereodisperso realizzati sia in MOCF che in SEM differenziati solamente per la tipologia di testine utilizzate. I prelievi dei campioni di polveri aerodisperse sono stati effettuati per filtrazione attraverso membrane in esteri misti di cellulosa aventi diametro di 25 mm e porosità di 0,8 mm, utilizzando apparecchiature di prelievo ambientali ad alto flusso (8-10 l/m) della Analitica Strumenti, modello Air-cube per un totale di 3000 l, mentre i campionamenti personali sono stati eseguiti con pompe di prelievo a basso flusso (2 l/m) della ditta SKC, modello Air-check 2000 per un totale di 480 l.

Esempio di testina in plastica (foto a destra) e in metallo (foto a sinistra).

La lettura dei filtri è stata effettuata, previa idonea preparazione degli stessi, mediante microscopia ottica in contrasto di fase (MOCF) e mediante microscopia elettronica a scansione (SEM) secondo le modalità riportate nell'Allegato 2 del D.M. 6/9/94.

I campionamenti ambientali effettuati hanno mostrato differenze non trascurabili in tutti i campioni analizzati, nei due differenti casi. Tale differenza si è riscontrata sia per quel che concerne le analisi in MOCF sia per quelle in SEM. Nella tabella riportata in seguito vengono messi a confronto i risultati analitici di tali campionamenti:

	Testine in plastica	Testine in metallo
Campione 1 (SEM)	0	2,69
Campione 2 (SEM)	0,54	1,61
Campione 3 (MOCF)	11,67	3,33
Campione 4 (MOCF)	11,25	2,29

Conclusioni

I risultati rappresentati nella precedente tabella mostrano le differenze tra i due casi. Tali differenze, però, a seconda che si consideri l'analisi in MOCF o in SEM, variano in maniera non lineare nei diversi campioni. Infatti, al SEM le testine in plastica danno valori minori rispetto a quelle in metallo, mentre alla MOCF sono le testine in metallo a dare risultati inferiori rispetto a quelle in plastica.

Questi risultati non indicano quale sia, in assoluto, il tipo di testine che conducono ad un campionamento migliore, però indicano che a parità delle altre condizioni, la scelta delle testine condiziona il risultato finale. Risulta pertanto indispensabile approfondire tale ricerca con ulteriori indagini su un numero elevato di campioni tale da ottenere risultati analitici statisticamente attendibili al fine di poter determinare quali siano le migliori condizioni operative per effettuare un corretto campionamento, e formulare linee guida univoche da applicare in tutti i siti di bonifica.

La migliore confrontabilità ed attendibilità dei risultati ottenuti consentirà una più idonea definizione degli interventi di messa in sicurezza di emergenza, bonifica e ripristino ambientale.

CASI STUDIO DI SITI DI BONIFICA D'INTERESSE NAZIONALE CONTAMINATI DA AMIANTO: BARI – FIBRONIT E BIANCAVILLA (CT)

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1. Premessa

Le attività del Ministero dell'Ambiente e della Tutela del Territorio e del Mare nel campo delle bonifiche sono essenzialmente legate alla gestione dei procedimenti di bonifica dei Siti di bonifica d'Interesse Nazionale (SIN), identificati dalla Legge 426/98 (14 SIN), dalla Legge 388/2000 (3 SIN), dal Decreto n. 468 del 18.09.01 (23 SIN), dalla Legge 179/2002 (9 SIN), dalla Legge n. 248/05 (1 SIN), dalla Legge n. 266/05 (2 SIN) e, in ultimo, dal D.Lgs. n. 152 del 3.04.06 (1 SIN).
Allo stato attuale, risultano, quindi, individuati e perimetrati cinquantaquattro Siti di bonifica d'Interesse Nazionale, dei quali i seguenti sei presentano come principale contaminazione la presenza di fibre asbestiformi: Balangero, Bari – Fibronit, Biancavilla, Broni, Casale Monferrato ed Emarese.
La presenza dell'inquinamento da fibre asbestiformi può essere ricondotta a 2 principali classi:

- ✓ Inquinamento ambientale (es. presenza nel sito di un'area di cava);
- ✓ Inquinamento antropico (es. presenza di stabilimenti dismessi).

2. Caratteristiche dei Siti di bonifica d'Interesse Nazionale (SIN) contaminati da amianto

SIN	Perimetrazione*	Superficie	Caratteristiche	Tipologia di contaminazione	Risorse assentite
Balangero (TO)	10.01.2000	310 ha	area di cava / miniera S. Vittore	polvere di amianto diffusa in tutta l'area	10 mln €
Bari - Fibronit	8.07.2002	15 ha	ex stabilimento di produzione di cemento-amianto	manufatti, rifiuti, coperture contenenti amianto	2,2 mln €
Biancavilla (CT)	18.07.2002	330 ha	area di cava di Monte Calvario / area urbana	presenza di fibre anfiboliche di fluoro-edenite diffuse	4 mln €
Broni (PV)	26.11.2002	13,5 ha	ex Fibronit / ex Ecored	Presenza di fibre di amianto diffuse	Da definire
Casale Monferrato-Al	10.01.00	738,95 km^2	stabilimento di produzione di manufatti di amianto	Polveri, sfridi e scarti di lavorazione	116 mln €
Emarese (AO)	26.11.2002	330 ha	quattro aree di cava dismesse	cumuli di materiale contenenti amianto	4 mln €

*Decreto del Ministero dell'Ambiente e della Tutela del Territorio

3. Caso studio del sito di bonifica d'interesse nazionale contaminato da amianto: Bari Fibronit

Il sito è stato inserito tra i siti da bonificare d'interesse nazionale con il Decreto n. 468 del 18 settembre 2001 ed è stato perimetrato con Decreto del Ministero dell'Ambiente e della Tutela del Territorio del 8 luglio 2002, su proposta della Regione Puglia e di concerto con il Comune di Bari. La perimetrazione riguarda l'ex stabilimento di produzione di cemento-amianto Fibronit ed aree ad esso connesse e si estende per circa 150.000 mq.

Le attività dello stabilimento di cemento amianto sono cessate nell'anno 1985 e nel 1995 l'area è stata sottoposta a sequestro giudiziario e posta sotto la tutela di una Curatela Fallimentare.
A seguito della sentenza del Tribunale di Bari è stata riconosciuta a favore del Ministero dell'Ambiente e della Tutela del Territorio una provvisionale di 5 mln di euro a titolo di anticipazione sul risarcimento complessivo (pari a circa 8 mln €) ad ha disposto la confisca dell'area, sottraendola ai privati a beneficio del patrimonio dello Stato.
Nell'area perimetrata sono presenti l'ex stabilimento Fibronit ed altre aree private industriali minori.

Area Ex Fibronit

- **Attività di Messa in Sicurezza d'emergenza**

Gli interventi di messa in sicurezza di emergenza nel sito ex Fibronit sono gestiti, in sostituzione e in danno, dal Comune di Bari e dal Commissario Delegato per l'Emergenza ambientale in Puglia.
Le attività sono finalizzate all'allontanamento di tutti i rifiuti, delle coperture in eternit, degli impianti e di tutti i materiali contenenti amianto dai capannoni presenti nel sito. In breve, sono state eseguite e sono in corso di completamento le seguenti attività:

- monitoraggi e determinazioni su rifiuti e materiali (prima, durante e post intervento);
- predisposizione della segnaletica ed idonea cartellonistica;
- messa in sicurezza di buche e cavità in aree esterne;
- rimozione delle parti pericolanti esterne ed esterne;
- rimozione della vegetazione;
- pulizia ed aspirazione di tutte le superfici pavimentate;
- bonifica dei capannoni mediante rimozione di tutti i rifiuti presenti e successiva bagnatura delle superfici con soluzione incapsulante;
- smaltimento dei materiali contenenti amianto.

Nel corso degli interventi di bonifica si sono dovute affrontare particolari criticità, così riassumibili:

- ✓ il sito si trova in pieno centro urbano e risulta, pertanto, circondato da edifici residenziali. Ciò accresce il pericolo derivante dalla potenziale diffusione di fibre, anche nel corso delle operazioni di messa in sicurezza d'emergenza;
- ✓ prima dell'inizio degli interventi di messa in sicurezza d'emergenza l'area si trovava in un stato di notevole degrado ambientale; in particolare, risultavano presenti rifiuti sparsi e materiali contenenti amianto di vario genere;
- ✓ dal punto di vista statico, alcuni dei capannoni presentano criticità (ampie aperture nelle coperture; fenomeni si ossidazione delle armature dovuti ad infiltrazioni di acque meteoriche; murature lesionate ed ammalorate; arcarecci di alcuni padiglioni in cattivo stato di conservazione; travi in legno di alcune strutture in pessimo stato di conservazione; ecc.). Il capannone D8 risulta particolarmente critico in quanto le coperture presentano segni di imminente crollo, molte parti di elementi strutturali ed elementi secondari di completamento (pluviali, gronde..) sono in fase di distacco, il probabile crollo della copertura potrebbe compromettere anche la stabilità delle murature portanti del 3° livello e, quindi, innescare eventuali possibili crolli della struttura sottostante;
- ✓ il crollo della copertura del capannone D6, verificatosi nell'agosto 2005, ha causato un ampliamento dell'area scoperta del capannone medesimo e, quindi, ha ulteriormente

complicato le operazioni di messa in sicurezza d'emergenza e di confinamento del capannone medesimo;

- ✓ è presente un cumulo di rifiuti e materiali contenenti amianto di notevoli dimensioni e con concentrazioni di amianto che raggiungono punte di 5.1 %, per il quale si rende estremamente difficoltoso l'intervento di bonifica;
- ✓ la presenza in alcuni capannoni di coperture a doppia lastra con presenza di polvere d'amianto estremamente volatile nell'intercapedine;
- ✓ nel corso delle operazioni di messa in sicurezza d'emergenza relative allo smontaggio delle coperture, sono state adottate particolari cautele; in particolare le coperture medesime sono state smontate dall'interno, utilizzando un mezzo meccanico elettrico leggero (muletto e/o trabatello), non essendo stata ritenuta adeguata la modalità manuale di passaggio delle lastre dal tetto al piano campagna.

- **Attività di Caratterizzazione**

Le indagini sono state condotte dalla Curatela Fallimentare, in contraddittorio con ARPA.
I risultati delle indagini hanno evidenziato, in sintesi, che tutta l'area in esame risulta contaminata da amianto, presente sottoforma di residui di lavorazione, cocci, materiali friabili in cemento-amianto.
In particolar modo, alcune aree presentano una contaminazione consistente e diffusa (anche al di sotto dei capannoni) che raggiunge lo spessore di 6 m dal piano campagna. Si stima una volumetria di materiale contaminato pari a circa 90.000 mc.
In merito al destino dell'area, il Comune di Bari ha predisposto una variante al Piano Regolatore Generale della destinazione di zona del sito Fibronit, che interessa le aree di proprietà Fibronit, comporta il cambio di destinazione urbanistica a "verde pubblico di tipo B".

- **Progetto di Bonifica/Messa in Sicurezza Permanente**

Per la realizzazione delle operazioni di bonifica/messa in sicurezza permanente dell'area ex Fibronit, il Commissario Delegato ha impegnato a favore della Regione Puglia la somma di 10 mln €, che vanno a sommarsi ai fondi del Piano Nazionale delle Bonifiche di cui al DM 468/01. Tali fondi saranno impiegati dal Comune di Bari per gli interventi di messa in sicurezza permanente del sito ex Fibronit, il cui progetto è in corso di predisposizione da parte del medesimo Comune di Bari.

- **Aspetti epidemiologici**

È stato condotto uno studio[1] relativo alla causa specifica di mortalità dei 233 lavoratori che operavano nello stabilimento Fibronit. La mortalità osservata risultava in contrasto rispetto a quella attesa in funzione del sesso e dell'età e rispetto alla media dei casi dei residenti in Puglia. Tutte le cause di mortalità eccedevano il valore atteso, a causa dell'incremento dei casi di pneumoconiosi e neoplasmi maligni. Tra le morti correlate ai carcinomi, si è evidenziato un incremento dei tumori a: polmone (SMR: 206, 17 osservati), pleura (SMR: 2551, 4 osservati), mediastino (SMR: 2367, 2 osservati) e peritoneo (SMR: 2877, 2 osservati). L'eccesso di mortalità dovuta ad asbestosi, cancro dei polmoni e neoplasma del peritoneo può essere attribuita all'esposizione occupazionale a fibre asbestiformi.

4. Caso studio del sito di bonifica d'interesse nazionale contaminato da fluoro-edenite: Biancavilla (CT)

Il Sito di Biancavilla è stato individuato a seguito delle risultanze di un periodico programma di sorveglianza epidemiologica[2] della mortalità per mesotelioma pleurico nei Comuni italiani. Da tali studi è emerso un incremento significativo del numero dei casi osservati di mesotelioma pleurico, rispetto al valore atteso in base ai dati regionali, nel Comune di Biancavilla. Una successiva indagine epidemiologica[3] ha consentito di confermare le diagnosi dei casi, escludere significative esposizioni professionali ad amianto e individuare, in una cava di materiale per l'edilizia, una nuova fibra anfibolica detta "fluoro-edenite".

Il sito è costituito da una cava ubicata a Monte Calvario in prossimità del centro abitato di Biancavilla, dalla quale si estraeva materiale contenente fibre di fluoro-edenite, con il quale sono stati edificati gli edifici nel centro storico di Biancavilla attraverso l'uso di malte ed intonaci prodotti dalla macinazione della roccia proveniente dalla cava e da cantieri per la realizzazione della Ferrovia Circumetnea.

La fibra estratta a Biancavilla è un anfibolo[4], ritenuto inizialmente una fase intermedia fra tremolite e actinollite, e risultato successivamente essere una specie a sé stante, denominata nel 2001 fluoro-edenite dalla Commissione Internazionale per i nuovi minerali e i nomi dei minerali. La fluoro-edenite di Biancavilla (formula ideale $NaCa_2Mg_5Si_7AlO_{22}F_2$) è un anfibolo calcico ad alto contenuto di fluoro (4% in peso), è trasparente, di colore giallo, con abito da prismatico ad aciculare, fino all'asbestiforme, e di dimensioni variabili da millimetriche a micrometriche.

Uno studio successivo, eseguito al fine di chiarire la modalità di azione di questa nuova fibra, ha evidenziato che esiste un legame tra l'esposizione alla fluoro-edenite prismatica e l'alterazione di alcune cellule. I risultati finali dimostrano che l'inalazione delle fibre di fluoro-edenite senza dubbio induce un danno nelle cellule polmonari[5].

Il sito di Biancavilla è stato perimetrato con Decreto del Ministero dell'Ambiente e della Tutela del Territorio del 18 luglio 2002. Gli interventi di bonifica sono eseguiti dal Comune di Biancavilla e dal sub-Commissario per la bonifica e Ferrovia Circumetnea.

La bonifica del sito riguarda tre aree principali:

1. Area di Cava di Monte Calvario;
2. Area Urbana;
3. Ferrovia Circumetnea.

- **Attività di messa in sicurezza d'emergenza**

✓ ***Area di Cava di Monte Calvario***

La zona di cava è posta in località Monte Calvario e ricade nella zona con destinazione d'uso "verde agricolo" ed è zona di notevole interesse pubblico del vallone S. Filippo. L'inizio delle attività di cava risale al 1950.

La situazione morfologica appare oggi dissestata e presenta scavi a gradoni multipli di altezze da 10 a 30 m. I materiali di cava, utilizzati per decenni nell'edilizia locale, sono rappresentati prevalentemente da pietrisco lavico e materiale vulcanico incoerente. I campioni raccolti nella suddetta area contengono notevoli quantità di fibre anfiboliche. Tali fibre sono state rinvenute anche negli intonaci delle abitazioni e in un campione autoptico di tessuto polmonare di una paziente deceduta per mesotelioma pleurico. Gli interventi di messa in sicurezza d'emergenza in corso d'attuazione sono:

a) sistemazione dei cumuli di materiale scavato e frantumato dispersi nell'area;

b) copertura delle superfici orizzontali con terreno idoneo e rivestimento protettivo (tipo spritz-beton armato) delle pareti a rischio d'instabilità;
c) realizzazione di una recinzione del perimetro esterno delle aree estrattive, con unico cancello di accesso;
d) bitumatura della pista d'accesso all'area di cava;
e) apposizione di una segnaletica di pericolo lungo il perimetro recintato;
f) Piano di monitoraggio contenente le prescrizioni di sicurezza.

✓ ***Area del centro urbano***

Gli interventi di messa in sicurezza d'emergenza realizzati consistono nella bitumatura delle strade e rimozione di cumuli di sabbie e detriti contaminati dalla fibra fluoro-edenite nel centro abitato.
Gli interventi di messa in sicurezza d'emergenza in corso d'opera sono completati dall'utilizzo di una spazzatrice a filtro totale per l'eliminazione delle polveri dalle strade del centro abitato e dagli interventi di messa in sicurezza d'emergenza sugli intonaci degli edifici pubblici.
Si fa notare che l'impiego della spazzatrice presenta notevoli criticità, per il fatto che nel corso dei monitoraggi condotti all'interno della cabina di manovra è stato riscontrato un eccesso di fibre. Sono, pertanto, in corso approfondimenti in merito allo studio di sistemi di filtraggio che garantiscano la tutela degli operatori nel corso degli interventi.

✓ ***Cantieri della Ferrovia Circumetnea***

Gli interventi di messa in sicurezza d'emergenza realizzati ed in corso sono: la rimozione di tutto il materiale presente nelle aree di cantiere, la chiusura dell'ingresso delle gallerie dei cantieri con teli di polietilene, dello spessore di 0.5 mm, la bitumatura di tutto il piazzale di stazione del cantiere n°2, la recinzione del perimetro esterno dei cantieri per impedire l'accesso di persone non autorizzate e di animali e la realizzazione di una pista asfaltata per consentire l'ingresso dei mezzi necessari per l'attuazione degli interventi preliminare di messa in sicurezza.

- **Attività di Caratterizzazione**

Il Piano di Caratterizzazione dell'intero sito è stato completato e sono stati presentati i risultati finali dell'area del centro urbano, le aree periferiche (compresa l'area di cava).

CONCLUSIONI

I siti di bonifica d'interesse nazionale, la cui principale problematica è costituita essenzialmente dalla presenza di fibre asbestiformi, sono circa l'11% del numero complessivo di siti d'interesse nazionale individuati dai disposti legislativi summenzionati.
Nella quasi totalità dei Siti di bonifica d'Interesse Nazionale, si ritrovano comunque situazioni di contaminazione da amianto, dovuti alla presenza di coperture e manufatti in cemento-amianto.
In merito ai due casi studio esposti, è possibile rilevare che:

a. In merito al sito di Bari Fibronit:
    i. il 95% della superficie perimetrata risulta coperta dalle indagini di caratterizzazione;
    ii. tutto il sito ex Fibronit (pari a circa l'80% dell'intera area perimetrata) risulta contaminato da amianto, anche fino a profondità di 6 m dal piano campagna;
    iii. sono in fase di conclusione le attività di messa in sicurezza d'emergenza del sito ex Fibronit di tutte le strutture soprasuolo, che hanno dovuto affrontare le specifiche problematiche sopra discusse;
    iv. con la presentazione del Progetto Preliminare/Definitivo di bonifica dei suoli e della falda da parte del Comune di Bari si chiuderà l'iter amministrativo sulla bonifica del Sito d'Interesse Nazionale di Bari Fibronit.

b. In merito al sito di Biancavilla:
    i. il 100% della superficie perimetrata risulta coperta dalle indagini di caratterizzazione, il 50% è completa dei relativi risultati (area di competenza Comunale e del sub-Commissario per la bonifica);
    ii. i risultati del Piano di Caratterizzazione evidenziano che il 100 % del suolo indagato risulta contaminato da fluoro-edenite sino alla profondità di 50 cm; tale fibra è stata riscontrata con alti valori anche nelle altre matrici ambientali (aria ed acqua);
    iii. le attività di messa in sicurezza d'emergenza dell'intero sito sono in corso d'attuazione;
    iv. sulla base delle attività della "Fondazione Ramazzini", che ha valutato la pericolosità della nuova fibra fluoro-edenite, attribuendole un valore almeno pari a quello della pericolosità associata alla fibra d'amianto, si è convenuto di applicare la normativa specifica per l'amianto anche alla nuova fibra.

Per la conclusione dell'iter amministrativo sulla bonifica del Sito d'Interesse Nazionale di Biancavilla sono necessari i risultati definitivi della Caratterizzazione della Ferrovia Circumetnea, la conclusione delle attività di messa in sicurezza d'emergenza, attualmente in corso, e la presentazione del Progetto Preliminare/Definitivo di bonifica dei suoli e della falda da parte del Comune di Biancavilla e della Ferrovia Circumetnea.

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PARAMETERS WHOSE INFLUENCE THE COUNTING OF AIRBORNE ASBESTOS FIBRES BY SCANNING ELECTRON MICROSCOPY

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Introduction

Asbestos can be found in the atmosphere under very fine fibres. In the particular event of airborne fibres, we need microscope techniques to their quantification. The Italian law provide that determination of fibres collected by air filtration, could happen by the use of SEM, at 2000x.

Operating at the same magnification is not sufficient to guarantee the reproducibility of the fibres counting, because there are other factors that can influence the perception of fibre thinner than 0,2 μm. The purpose of the studies is to identify factors whose influence the perception of fibres deposited on filter and estimating the effect on the final count.

With the intention to obtain images, at 2000X, sufficiently clear to permit the operator to characterise the greatest asbestos fibres number, has been reproduced images obtained with different SEM parameters and visually compared.

For the tests has been used a SEM working with tungsten filament and digital images.

SEM operations

The main components of the SEM are: the source of electrons, the column with electromagnetic lenses and the sample chamber.

By a catode, electrons are generated at the top of the column, and then accelerated down it by application of potential difference. The probe of electrons is passing through a combination of lenses and apertures to produce a fine beam, the position of the electron beam on sample is controlled by scan coils.

Interaction between electron probe and sample produce secondary electrons. These secondary electrons, collected and accelerated by a secondary electron collector, goes to a scintillator and a multiplier phototube; the electrical signal is converted from analog to digital signal and sent to video board to the obtaining of image on screen.

When using a tungsten hairpin filament source, we need at least 10-3 Pa vacuum.

Parameters that influence the image SEM quality

The 06/09/94 “Decreto Ministeriale” annex 2) letter B) indicates the method to determine indoor environment of airborne asbestos fibres concentration through scanning electron microscopy (SEM). This method provide the airborne asbestos fibres counting, collected on a polycarbonate filter. The filter characteristics are: 0,8 microns of porosity, diameter 25 millimetres and effective diameter is between 20 and 22 millimetres. The surface to explore must be approximately 1 mm^2 and the reading fields must be observe at 2000X.

Some parameters of observing can influence the visibility of thinnest asbestos fibres: the accelerating voltage, the working distance, the diameter of the electronic beam, the objective aperture, the alignment of the beam, the astigmatism, the contrast and the brightness of the screen, the vacuum in column, the position of the Wehnelt, the pixel width of scan, the signal/noise ratio of the image, the room lights, the scan speed, the visual acuity, the level of attention, and the experience of the operator.

Effect of the accelerating voltage
As we increase the accelerating voltage the diameter of the electron beam become smaller and resolution theoretically increasing. In reality this not always happens, because the electron beam penetrating more in depth in the sample and could produce a worsening of image quality.

Effect of the diameter of the beam
Can be regulated modifying the current of the beam. “Spot size” low: the current is low and the electron beam became smaller and is obtaining more resolution power, but produce minor number of electrons and worst signal/noise ratio, therefore noisy images (grainy).
Another factor that influencing the diameter of the electron beam are the apertures.

Effect of working distance
Working distance (WD) is the distance between the surface of the sample and the lower end of the column. We also use X-ray microanalysis so it isn’t possible change to much the WD.
With a short “working distance”, high-resolution images can be obtained.

Effect of the diameter of the objective aperture
Normally in the SEM it is possible to choose which objective aperture to use, theoretically small aperture improve the resolution, but reduce the signal, consequently we obtain, a noisier image (grainy).

Effect of the scan speed.
The scan speed has affects on the image quality . If the scan speed is high we obtain noisier images. If the scan speed is reduce we obtain images with a better signal/noise ratio. Normally the filters under investigation can “charge it self” then, with a too slow scan speeds we could obtain distorted images.

Effect of the pixel width of scan.
The pixel width of scan on the sample and the diameter of the electron beam determine the resolution of the SEM.
To obtain good visibility of 0,2 microns fibres is necessary that the dimension of the pixels does not exceed this value.

Effect of the magnification
The method provide to operate to 2000X, this reduce the possibility to visualise the thinnest fibres.

Effect of SEM performances
With aging, SEM performances could decrease; are important periodic maintenance of the instrument and a periodically SEM resolution test.

Effect of operator experience

The operator needs to takes confidence with the parameters that regulate the SEM, which centring of objective aperture, alignment of the filament, adjustment of focus fire and correction of the astigmatism.

Effect of the visual acuity and the degree of attention

The visual acuity associated to other variable which the visual distance from the screen, the room lights, the brightness and the contrast of the screen is different for every operator.
In particular conditions the attention level could decrease and bring the operator to a “visual loss” of thinnest fibres.

Experimental part

The scope of test is to obtain a “ good quality SEM images ”, for this reason does not considered other important factors which sampling, preparation, conductive coating, and X-ray microanalysis.
The Italian law DM 06/09/94 provide that SEM have to be adjusted in such a way that chrysotile fibres with a width of 0,2 microns are visible at the counting magnification of 2000x .
Before carrying out the tests we have verified, with an internal procedure, that the SEM resolution (operating at 20kV with objective aperture 30 microns and WD 15 mm) was at least 30 nm
From a filter on which where deposited chrysotile fibres, we have reproduced images in six different conditions of observation.
1° condition – WD 16 mm, 20kV e objective aperture 30 microns
2° condition – WD 16 mm, 20kV e objective aperture 20 microns
3° condition – WD 16 mm, 30kV e objective aperture 30 microns
4° condition – WD 16 mm, 30kV e objective aperture 20 microns
5° condition – WD 25 mm, 20kV e objective aperture 30 microns
6° condition – WD 11 mm, 20kV e objective aperture 30 microns

For every condition the values of “spot size 1-99” have been regulated (from 35 to 42) to obtain on the screen a good signal/noise ratio; the scan modalities were: speed 10 s, resolution 640x480 (dimension pixels approximately 0,15 micrometers), “everaging” 1.
The three SEM operators that observed image at 2000x in all the above conditions have seen chrysotile fibres until 0,15 micron width, while fibres of inferior diameter could be only found to greater magnification.
From the images, takes at 7500X, of fibres from 0,05 and 0,2 micrometers, we have observed that such as variations of accelerating voltage, diameter of the objective aperture and working distance don’t have visible effect.
Using a small objective aperture has been reduced the diameter of the electron beam, but in order to reduce the noise it has been necessary to increase, by “spot size”, the beam current, in this way, the diameter of the beam will be larger.
Using a higher accelerating voltage (30kV) it has been reduced the diameter of the electron beam, but due the increasing of beam penetration in the sample, we don’t observe a better image

Conclusions
This work have demonstrated that although has been change the most important SEM parameter there is non evidence of better SEM image quality.
Not significant differences has been found between the counting operated by three SEM expert operators.
In the conditions described in DM 06/09/94 to 2000x are visible fibres of chrysotile with diameter until 0,15 micrometers.
To count fibres with a smaller diameter we must explore the filter at greater magnification.

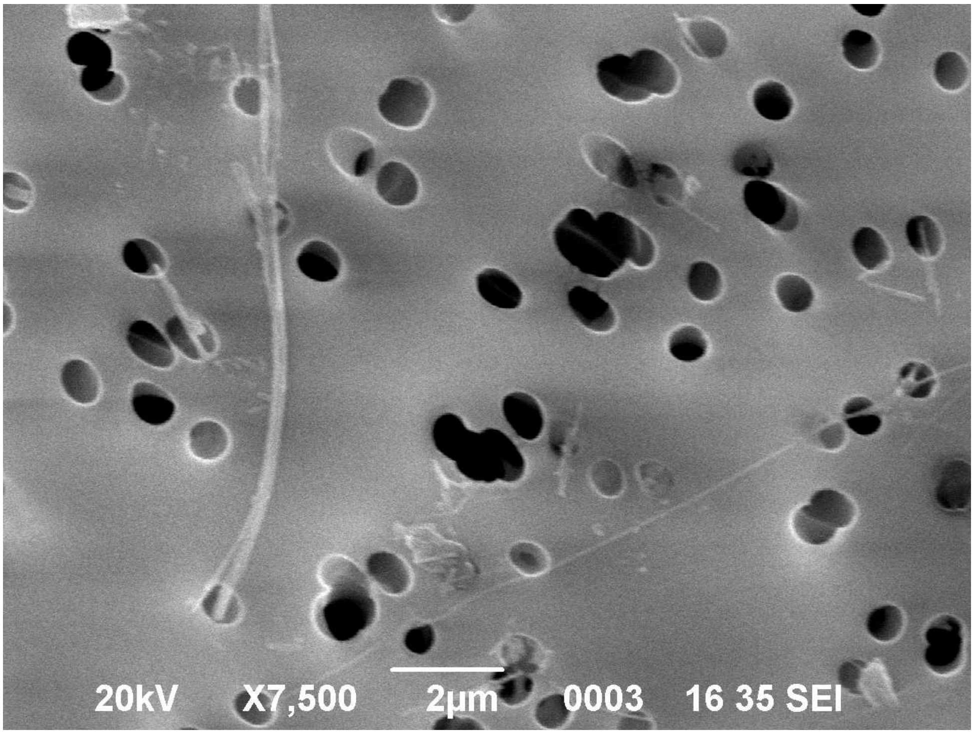

Fig.1 Image SEM of 0,05 microns and 0,3 microns chrysotile fibres deposited on polycarbonate filter 0,8 microns porosity

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USE RESTRICTIONS, REMOVAL AND RECLAIMING FROM ASBESTOS: ITALIAN LEGISLATIVE MODEL TO EXPORT.

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In the last forty years the European Economic Community established several framework directives for use restrictions, removal and reclaiming from asbestos.
Italian laws ensemble perhaps better fit European directions; in fact, one of the first Italian laws, derived from EEC directives (67/548/CE), dealt with dangerous substances labelling.
Lombardia regional directive (n. 41/1985) about the first guidelines for the individuation and reclaiming from asbestos in public buildings was the starting point for the next Italian Ministerial Order about crocidolite use restrictions, published in 1986, followed by the prohibition of crysotile, amosite and tremolite use by means of the Decree n.215/88. The workers health and safety protection from asbestos exposure was assimilated only in 1991 by Decree n.277 (reception of 80/1107/CE, 82/605/CE, 83/477/CE, 86/188/CE, 86/642/CE). Actually, such Decree, for the first time, compels employers to make environmental monitoring of air free asbestos fibres, health surveillance of exposed workers and Risk Assessment and establishes the limit value of 0.1 fibres/cm^3 in air. The following Decree n.257/92 established a main obligation such as the asbestos census in order to take under control asbestos diffusion all over our country and also corrects the exposure previous limit values.
It's now time to give technical details about the guidelines for asbestos removal and fixing activities planning and all the methods about asbestos reclaiming and the air free fibres monitoring and analysis: new decrees were born (September 6th 1994 and May 14th, 1996), defining also the friable and compact asbestos.
In the end, this work focuses on the waste sphere, which the asbestos disposal is included in, aligned to EEC laws (91/689/CE, 94/62/CE) and also the innovative procedures for little asbestos removal activities with the new Decree 257/06 (reception of 2003/18/CE).

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