Environmental Air Monitoring in areas with Natural Occurring
Asbestos

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Abstract: - Italy ban asbestos in 1992. The legislation on asbestos in the last 20 years has so focused primarily
on occupational aspects. The topic of asbestos environmental remediation has never been treated in a
systematic. Until now main remediations involved buildings and facilities (mainly in confined area, indoor). To
date the problems have moved on the environmental side (outdoor remediation around asbestos contaminated
factories, facilities, building, etc.) with shortcomings concerning working procedures and analysis, as well as
the definition of threshold limits compatible with the environmental asbestos content in air, soil and water,
exposure, and the instrumental detection limits. In particular are analyzed those factors that most affect the
dispersion of hazardous fibers in areas under land reclamation and in urban areas. Concentrations of total and
asbestos fibers have been so determined, measuring them both in SEM and PCOM. These data were then
compared with the work processes and weather condition at the time of sampling, in order to study better
solutions for environmental management in polluted areas.

Key-Words: - Asbestos, environment, NOA, Superfund, air monitoring, remediation,

1 Introduction
Italy is a country covering a surface area of 301,340
km², with 60,626,442 inhabitants and a population
density of 201 inhab./km². It is thus a very densely
populated country, with much of its territory
urbanised and requiring the protection of valuable
cultural or natural assets.
This Country has been one of the biggest producers
of asbestos ore and Asbestos Containing Material
(ACM), with a double production than importation
(fig. 1). Consequently are registered more than 1000
death/year due to asbestos related disease, with an
increasing trend at least until 2018 (fig.2-3) [1].

The Italian National Mesothelioma Register reports
that more than 70% of the disease are due to
occupational exposure to asbestos, and 4% to
environmental exposure, as well as 20% is of
unkown origin (tab.1) [2,3].

Fig.1 – Asbestos production in Italy

Fig.2 – Italian raw asbestos consumption and
mesothelioma deaths observed and predicted

2 Methodology
In Italy, the asbestos, was extracted, used in the
primary production of asbestos-containing products,
sold, widely used in all its forms throughout the country, exported. In Italy asbestos ore and ACM production, import and exportation has been banned in 1992, but not its use. Considering the data reported in Table 1 in which 70% of exposures is due to occupational origin, the first measures were addressed in employment.

During the last 20 years from the ban Italy has adopted a legislation wide and varied, covering all major aspects in occupational field such as personal and work environment exposure, threshold limits values (sampling, analysis, etc.), technical standards for remediation, mapping, classification of Asbestos Containing Waste (ACW), landfill management, inertization, etc. [4]. Only in 1996 was enacted the first decree on environmental issues related to NOA, but always in relation to work activities carried out (mainly "green-stones" quarries). The topic of asbestos environmental remediation, already occurred and faced with the first significant remediations, has never been treated in a systematic. They still miss specific guidelines, risk assessments and threshold limit relating to the living environments.

In this context, to fill this gap, INAIL DIPIA asbestos team has issued the “Guidelines for asbestos remediation at italian Superfund sites” The Italian Environmental Ministry, has prescribed their use in all Italian Superfunds but now they are also applied in the main local remediations. Those Guidelines agree with and adopt the threshold limit of 1 f/l in living environment, cited by WHO-European guidelines for ambient air [5]. It should be noted that until now main remediations involved buildings and facilities (mainly confined area, indoor). To date the problems have moved on the environmental side (outdoor remediation around asbestos contaminated factories, facilities, building, etc.) with shortcomings concerning working procedures and analysis, as well as the definition of threshold limit compatible with the environmental asbestos content in air, soil and water, exposure, and the instrumental detection limits. Moreover in Italy we are mapping now a wide presence of Natural Occurring Asbestos (NOA), both exploited in the past for the extraction of raw ore, both simply with outcrops in inhabited areas (sometimes also involved in local works), sources of expositions potentially hazardous for surrounding people and environment. It should be emphasized that in these areas the registered mortality for environmental exposure is about 4% on total death (tab 1). Therefore we highlight the importance of specific monitoring campaigns in high-risk areas to assess the exposure of workers both during remediation or simply during excavations, constructions, agricultural works, etc. in contaminated areas[6].

In this paper we describe the importance of environmental air monitoring in two italian Superfund NOA. Specifically, here we analyze available monitoring data measured in Balangero.

<table>
<thead>
<tr>
<th>Exposure type</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Occupational exposure</td>
<td>70%</td>
</tr>
<tr>
<td>Familiar Exposure</td>
<td>4.4%</td>
</tr>
<tr>
<td>Environmental exposure</td>
<td>4.4%</td>
</tr>
<tr>
<td>Exposure to hobby activities</td>
<td>1.5%</td>
</tr>
<tr>
<td>Unknown/Unlikely Exposure</td>
<td>19.7%</td>
</tr>
</tbody>
</table>

Table 1 – Mesothelioma cases related to exposure type
(Piedmont) and Biancavilla (Sicily). We compare the values of observed airborne fibers concentrations with the climate weather data (when available) and the ongoing works at the time of sampling. From these two experiences it’s possible to extract the common procedures which in author’s opinion should be applied in all situations.

2.1 Balangero mine (Turin, Piedmont)
The Balangero mine is the largest chrysotile former mine in Europe. Starting from 1992 (asbestos ban in Italy) the Ministry of the Environment funded “environmental reclamation of the asbestos mines in Balangero and Corio”.

The terrains in Superfund perimeter have an asbestos levels between 6 and 9%. The remediation activities are going on concerning several and different aspects, proper of a great asbestos mine. The adopted interventions have concerned:

- Initial interventions for emergency situations;
- Interventions for the hydro-geological stabilization of the inert landfills with naturalistic engineering technics;
- Hydro-geological maintenance and requalification of the vegetal coverage;
- Removal of abandoned production area structures (still in progress);
- Removal of contaminated sludge from the mine lake (still in progress).

The monitoring campaigns have foreseen several sampling points distributed in Superfund area and in the adjacent Balangero and Corio towns. The main sampled parameters concern:

- Fibers concentrations calculated in Phase Contrast Optical Microscopy (PCOM) and Scanning Electron Microscopy (SEM) with Energy Dispersive Spectrometer (EDS);
- Meteorological parameters such as temperature, rainfall, humidity, wind direction and speed, etc.;
- Ongoing activity.

From 2003 to 2012, about 10 environmental sampling points have been identified at the site, and thousands daily samples of air-borne particles have been taken for environmental monitoring. This sampling has been conducted by RSA (Governmental society for Balangero and Corio mine remediation) and local health and environmental Authority [7]. The samples, both for personal and environmental monitoring (indoor and outdoor), were collected according to the guidelines written by INAIL-DIPIA for remediation measures in Superfund [8].

2.2 Biancavilla town (Catania, Sicily, Italy)
Among the most famous Superfund in Italy there is the town of Biancavilla Etna (Catana - Sicily), an urban area of 23,000 inhabitants on the slopes of Etna, where has been discovered a volcanic fibrous amphibole called Fluoro-edenite. The area of Biancavilla Etna is located on the south-west side of the Etna volcano and geologically has volcanic products belonging to the Ancient Mongibello phase (40 KY-14 KY). The asbestos occurrence, discovered in two Biancavilla quarries, mined for inert production (local use), is really a particular case worldwide because is the first case of asbestos related minerals in volcanic terrains.

The main source of pollution has been discovered to be the volcanic breccia quarried until 2000 in the quarry of Mount Calvario, but all Biancavilla soils are contaminated with different concentrations. Following first monitoring results which showed more than 150 f/l near the rock mills and about 10 f/l in town, quarrying activities have been stopped and emergency safety measures implemented to reduce the dispersion of hazardous fibers [9].

The remediation activities foreseen:

- Contamination sources identification (quarries in the town perimeter);
- First Emergency Situations Measures (ESM);
- Monitoring campaigns;
- Authorization and management of a specific landfill located inside the quarries areas;
- Environmental restoration (still in progress).

The monitoring campaigns have foreseen several sampling points distributed in town and in the adjacent quarry. Other following monitoring campaigns have been also associated to tunneling works for completion of circum-etnea railway [10]. The main sampled parameters concern:

- Fibers concentrations calculated in Phase Contrast Optical Microscopy (PCOM) and Scanning Electron Microscopy (SEM) with Energy Dispersive Spectrometer (EDS);
- Meteorological parameters such as temperature, rainfall, humidity, wind direction and speed, etc.;
- Ongoing activity.

From 2000 to 2012, 260 environmental sampling points have been identified at the site, and over 1.900 samples of air-borne particles have been taken
for the environmental and personal monitoring. This sampling has been conducted by INAIL– DIPIA, the University of Catania, Regional Agency for Environmental Protection (ARPA Sicily), private laboratories commissioned by the municipal authorities and Circum-Etna Railway [10]. The samples both for personal and environmental monitoring (indoor and outdoor) were collected according to the guidelines written by INAIL-DIPIA for remediation measures in Superfund [8].

3 Data Analysis

Were examined data sets from 2001 to 2012 for both sites. The set of data is highly significant and it is possible to distinguish them into two main categories namely:

- Samples in urban areas outside the Superfund remediation site perimeter;
- Samples inside the Superfund perimeter.

Samplers and analysts were both public Body (Local Health, local environmental agency, INAIL - former ISPESL asbestos team, Universities) and private laboratory. The samples have been analyzed by SEM and PCOM.

Analysis of data shows clearly the correspondence of total fibers concentrations examined via SEM or PCOM. The PCOM values are always lower than the SEM due to the worst analytical sensitivity; this ratio can be considered about 1:2 as stated by Italian law.

This leads us to consider reliable analytical results both in PCOM and SEM and their concentration trend usually corresponds. It also should be noted that the trend of total fibers concentration is similar to the asbestos fibers one (the latter in concentrations always lower).

This fact allows us to say, in a Superfund in which the main contamination is recognized due to asbestos fibers, that the trend to the uplift is affected by the specific event that has determined it, (work or meteorological), albeit with distinctly different concentrations of total and asbestos fibers.

The study of weather maps and work plans, compared with the fibers concentration, confirmed such hypothesis.

It is important to reassess the fiber counting criteria, considering the importance of the fibers bundles and aggregates in outdoor.

Both of them, in fact, do not contribute to the breathable fraction, usually considered in an indoor counting analysis by international Law. However they have to be considered in outdoor living areas or environmental context because subject to inevitable further degradation with comminution by land use in fibers of breathable size.

![Image](image1.png)

Fig.4 – Biancavilla (Sicily) 2010. Samplings in town and quarry area (asbestos fibers, SEM analysis)

![Image](image2.png)

Fig.5 – Balangero (Piedmont) 2011 samplings in town and quarry area (total fibers, PCOM analysis)

On the other hand it is demonstrated that low concentrations in total asbestos (also not yet reduced in fibers and neglecting the mineralogical problem of non-fibrous habitus) are difficult to measure, both for the low sensitivity of quantitative instrumental techniques (XRD, FTIR = 1%) and for the difficulty to "weight" localized asbestos in amount of rock.
The evaluations carried out show so clearly to focus on:

- Preliminary geological survey and mineral-petrographic detailed survey (scale 1:1,000-1:5,000) to identify and foresee the potential sources of airborne diffusion.
- Acquisition and management of monitoring data related to historical and current trend about fiber concentrations, wind speed, humidity, etc.
- Proper positioning of sampling points.
- the need of sample pre-treatment in order to improve the analytical sensitivity, considering very low concentrations;
- GIS assistance for mapping of spatial and measured parameters also for the identification in real time of critical situations, their sources and causes.
- Formal acts by public authorities which restrict the land use and/or special activities to avoid in areas identified at increased risk (digging, farming, animal breeding, etc.).

4 Conclusion
Two real cases related to NOA have been compared. At these sites INAIL-DIPIA asbestos group has carried out environmental sampling as well as having acquired hundreds of analytical results from further sampling campaigns. The examined analysis are related to concentrations in total fibers and asbestos fibers and have been conducted both in sem that in MOCF. From the comparisons have emerged clear correspondences between the concentrations in total fibers and asbestos fibers, so like between the concentrations observed via SEM and PCOM. Moreover, the recorded results in the inland areas to Superfund are also comparable to those in living environment in town. The examination of all these comparisons clearly showed a relationship between causes of airborne diffusion and exceedings the threshold limits. From these observations it follows the need from one side to refine the technical problems through e.g. a better positioning of the sampling points (that significantly affect the results), pretreatment of the samples, etc., on the other hand to build a culture of environmental management also through indispensable acts carried out, case by case, by those public Bodies that govern such territories.

References:
[1] Italian Health Ministry, State of art and future prospects in contrasting the asbestos-related diseases, Papers of the , ISSN 2038-5293, No. 15, May-June 2012.