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BOOK OF ABSTRACTS

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QUANTITATIVE DETERMINATION OF ASBESTOS IN ROCKS AND SOILS BY OPTICAL MICROSCOPY: ANALYTICAL METHODS AND EXAMPLES OF APPLICATION

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Another paper presented at this congress explains the operational principles and the analytical methods for the quantitative determination of the asbestos content in rocks. This paper represent a further contribution to this topic, as it illustrates a method based on optical microscopy with which semiquantitative results can be obtained.
The quantitative analysis of the asbestos content in rocks and soils is more and more required, even when this content is extremely low. For instance according to an Italian law concerning polluted soils (L. 471/99) it must be established if the asbestos content (free fibres) is higher or lower than 0,1%. In these cases optical microscopy can be useful, even if it has been criticized for being a subjective and impossible to standardize method.
On the other hand, optical microscopy has the following benefits:

- it is not influenced by interference between fibrous and non fibrous asbestos minerals;
- it is possible to distinguish between free fibres and fibres included in a matrix;
- even very low asbestos contents can be detected with a sensitivity which is not attained by other analytical methods.

The difficulties encountered in transforming into content by mass the results obtained by counting the particles, which are inherent in all microscopic methods (including electron microscopy) can be – at least partly – overcome using the analytical method here described .
The following operational principles are assumed as a basis.

1) For a microscopical analysis one must see the particle. Therefore if the asbestos fibres are included in a matrix the sample must be ground to a size at which the liberation of the asbestos fibres from the matrix is attained. That means that the comminution product must be formed either by asbestos particles or matrix particles, without middlings. If the aim of the analysis is to determine "free" fibres, no grinding is performed, otherwise the degree of liberation of the components and therefore also of the asbestos will increase.
2) The comminution product is then classified into close size ranges by means of wet screening. This will make easier the analysis, as each class is formed by particles having similar sizes. Wet sieving is used for the following aims:
    - to obtain a well classified product;
    - to prevent dispersion of fibres in the air.

The number of classes and the limiting sizes of the classes are chosen taking into account the nature of the material and the aim of the analysis.
Each class is examined under the optical microscope, using different methods as a function of the size:

a) for the coarse classes the fibres are sorted using a stereomicroscope and the sorted product is examined using phase contrast microscopy with chromatic dispersion (PCOM) in order to verify if all the sorted fibres are asbestos fibres; the asbestos content by mass of each class can be obtained by weighing the sorted products;
b) for the intermediate classes the fibres are counted using an optical microscope both in polarized light and in phase contrast (the number of asbestos tufts is given as a percentage of the total number of particles). To obtain the asbestos content by mass the volume of the asbestos tufts can be evaluated by comparison with nearby non-asbestos particles. By the use of polarized light optical microscopy (PLOM) it's also possible to determine the particle thickness by inserting the analyzer and observing the birefringence phenomenon, which gives a rough estimate of the particle thickness. In conclusion it is possible to say that an asbestos tuft has the same mass as two non fibrous particles or a particle, or half a particle;
c) for the finest class (e.g. < 400 mesh) the procedure is more difficult because there is no lower limit to the particle size. Also in this case the asbestos fibres are identified in PCOM and counted. The volume of each fibre is determined by using an eyepiece micrometer. To obtain the asbestos content by mass the microscope specimens are previously weighted on an analytical balance.

An as example the analytical results obtained on a sample of a slurry produced by washing aggregates in a crushing plant of serpentine rocks are given in table 1.
The sample has been sieved with 28,48,100,200 and 400 mesh sieves; due to the high content of fine particles also a sieving with a 20 micrometers mesh sieve has been performed.
Figures from 1 to 5 show examples of microscopic fields: figures from 1 to 4 are in PLOM (analyzer inserted) while figure 5 is in PCOM.
The average asbestos content in the sample is given by the weighted mean of the contents in the size classes. The table also shows the asbestos distribution in the different classes. It is therefore possible to find out in which classes most of the asbestos minerals as present. Deeper analysis, if needed, will be carried out only on these classes.

size classes	mass (%)	asbestos content (mg/kg)	asbestos distribution (%)	type of asbestos
> 28 mesh	17.54	0	0	-
28 – 48	1.55	0	0	-
48 – 100	1.82	100	0,4	Chrysotile
100 – 200	2.22	353	1,9	Chrysotile
200 – 400	6.81	1775	29,5	Chrysotile
400 – 20 µm	26.02	508	32,2	chrysotile , tremolite
<20 µm	44.04	334	36,0	Chrysotile

Table 1- Analytical results on a slurry sample.

The figures show how it is easy to detect at a glance fibrous tufts or isolated fibres in PLOM by inserting the analyser; if the same field is afterwards observed in PCOM the nature of the fibres can be determined through the chromatic dispersion phenomenon. Also the shape can be easily detected and this is useful for the evaluation of the particles mass.

Photo 1. 48 - 100 mesh class. A frayed chrysotile tuft (at the centre) and an organic fibre (below). Short side of the photogram 0,94 mm.

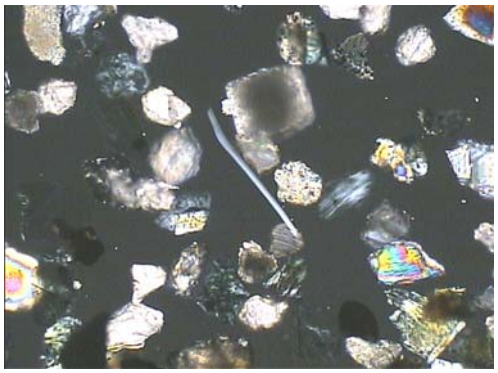

Photo 2. 100 - 200 mesh class. A thin chrysotile tuft at the centre. Short side of the photogram 0,94 mm.

Photo 3. 200 – 400 mesh class. Chrysotile tufts and an organic fibre (at the centre and below). Short side of the photogram 0,94 mm.

Photo 4. 400 mesh – 20 micrometers class. A partly frayed chrysotile tuft. Short side of the photogram 0,47 mm.

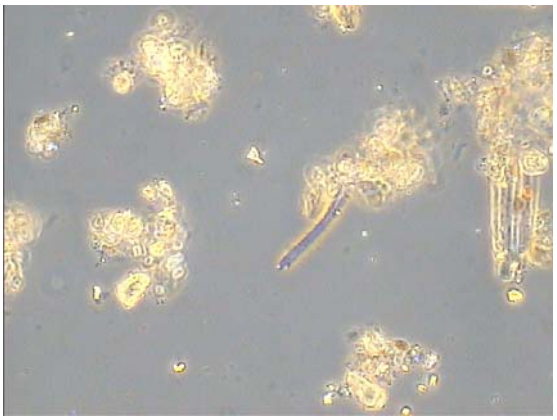

Photo 5. < 20 micrometers class. At the centre a chrysotile tuft (blue with an orange halo). Short side of the photogram 0,235 mm.