Naturally Occurring Asbestos: the problem of quantification

Doctoral Dissertation
Doctoral Program in Energy Engineering (30th Cycle)

NATURALLY OCCURRING ASBESTOS: THE PROBLEM OF QUANTIFICATION

Oliviero Baietto

* * * * * *

Supervisors
Prof. Paola Marini

Doctoral Examination Committee:

Politecnico di Torino
March, 19, 2019

Summary

Asbestos is a known human carcinogen and this is the reason why it is considered one of the most dangerous and complex factors to face during underground excavations and quarries exploitation in ophiolitic rocks, both for workers' safety and for the disposal of contaminated excavated material. The quantitative determination of the content of asbestos in rock matrices is a complex operation that is susceptible to significant errors.

The purpose of this work is to investigate the problem concerning the quantification of the content of Naturally Occurring Asbestos (NOA) within massive samples deriving from excavation activities.

The current regulations do not fully satisfy the analytical requirements and do not propose an unambiguous procedure regarding NOA.

The principal instruments used for the analysis are the Scanning Electron Microscope (SEM) and the Phase Contrast Optical Microscope (PCOM). PCOM is usually considered as a technique useful only for the recognition of asbestiform minerals. This work, in the first part, evaluates the potential use of PCOM also for the quantification of asbestos content. In this thesis the PCOM methodology is validated through repeated analyzes and statistical evaluations. The major criticism attributed to optical microscopy is that of the lower resolution and the consequent possibility of not detecting the finest asbestos fibers. In order to evaluate the effectiveness of the technique even in samples with low concentrations of asbestos 150 samples are analyzed, both with the PCOM and with the Scanning Electron Microscopy (SEM), which is a technology capable of better resolution. Pros and cons of the various technologies and the main sources of analysis errors, such as the discrimination between antigorite and chrysotile and the presence of out of scale objects, are discussed.

One of the topic deeply investigated is the behaviour of tremolite if subjected to grinding. Tremolite crystal habit can be described as asbestiform (fibrous) for longer and thinner fibers or non-asbestiform (prismatic) for prismatic fragments. The analysis carried out showed that there is not a formation of fibers from a sample with prismatic habit subjected to a grinding process. Moreover, there is a decrease of its fibrousness if the grinding is carried out on a fibrous tremolite sample. This is an interesting theme focused on the relationship between the crystalline particle breaking methods and their impact on the respiratory system.

Finally, different kind of natural samples are described and the best methodology for the analysis is suggested.