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Asbestos and other fibrous minerals in the serpentinites of the Gimigliano-Mount Reventino Unit (Calabria, South-Italy)

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The study concerns the investigation of fibrous minerals contained in serpentinitic rocks from meta-ophiolite sequence belonging to the Gimigliano-Mount Reventino Unit (GMRU). The GMRU consists of serpentinites, meta-basalts, meta-gabbros/meta-dolerites with a sedimentary cover made up of marble alternating with calceschists and quarzites. Previous studies on the possible presence of fibrous minerals (comprising asbestos) are not detailed and all referred to several working quarries, but the asbestos detection and their quantification are important not only from the scientific point of view, but also to give to the administrative agencies the knowledge useful to take decision for the realization of works (as the road yards) health protecting.
To this target, 14 serpentinite rock samples have been collected from meta-ophiolite sequence belonging to GMRU and in detail characterized by polarized light microscopy (PLM), XRPD, SEM/EDS, TEM/EDS, TG/DSC, XRF and micro-Raman investigations.
Serpentinites, observed under PLM, show pseudomorphic mesh texture and bastite replacing olivine and pyroxene respectively with some very rare relicts of these silicates. Results from XRPD show that the most abundant minerals in all serpentinitic rocks are serpentine minerals. Variable amounts of tremolite asbestos, clinochlore, chamosite, quartz, magnesite, calcite, chromium-oxide and clay minerals were also detected, but not in all samples.
TEM investigations show four varieties of serpentine minerals: antigorite, lizardite, polygonal serpentine and chrysotile (in order of decreasing abundance). Chrysotile shows the classical cylinder fibers and rarely proto-cylindrical; antigorite was detected both with bladed prismatic and fibrous shape; lizardite exhibits its plate-like morphology. In order to describe the size of the serpentine minerals, several hundred TEM micrographs were recorded and for each serpentine fibrous mineral, about 440 single fibres were measured. The results from all sample indicate that chrysotile fibres width ranges from 0.01 to 0.76 μm (0.07 μm in average) and the 95.4 % of them have a width less than 0.25 μm and therefore they are potentially carcinogenic according to the Stanton's hypothesis (Stanton et al., 1981). TEM-EDS analyses revealed that serpentine minerals composition deviates slightly from the ideal formula of Mg end-members, with a few percent substitution of Si and Mg by Al and Fe respectively. In many samples low amount of Cr was also detected. Thermal analyses (TG, DSC) indicate that there are some general features shared by all the serpentinite samples. TG curves display a total weight losses of about 12-14 % at 1000 °C with a marked weight loss in the 700-800 °C range. The DSC patterns show an endothermic peak at about 630-650 °C related to the dehydroxylation reaction of chrysotile and a sharp exothermic peak at about 820-826 °C which indicates the crystallization of forsterite and enstatite.
These new data could be used i) as markers of specific environmental conditions during asbestos minerals formation, ii) to identify eventually health hazard areas owing to asbestos fibers presence, iii) to provide data for compulsory Italian mapping.