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Asbestos exposure during quarrying and processing of serpentinites: a case study in Valmalenco, Central Alps, Northern Italy

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Serpentinites are metamorphic rocks derived from ultramafics such as peridotites (lherzolites and/or harzburgites), with a typical mineralogical assemblage of antigorite, olivine, diopside and minor magnetite, chlorite and chrysotile. If the rock mass has good geotechnical properties, these stones are quarried because of their wide variety of green shades and outstanding technical properties. Excellent stones are produced in the Malenco Valley, Central Alps (northern Italy, Sondrio): here the geological set-up is dominated by the ultramafic Malenco massif (lower crust-mantle complex), exposed at the Penninic to Austroalpine boundary zone. Different processing operations give origin to valuable products like stoves, funeral monuments, design home appliances; important building element as roof slabs, tiles for floor and wall coverings constitute the main commercial line of production. In this area, good quality long fibre chrysotile asbestos was mined since the XIX century, till the seventies. The asbestos fissures (mostly slip-fiber) are well known in Valmalenco, associated to an important ENE-WSW striking fracture and hydrothermal vein system. Some actual serpentinite quarries "cross" at times tunnels of the old asbestos mines, because the fracture and vein system "guides" the extraction. At present time, this area represents an excellent example of naturally occurring asbestos (NOA). For these reasons, workers' exposure to asbestos during quarrying and processing cannot be ruled out, and must be assessed according to national laws. From 2004 to nowadays, the INAIL Regional Management of Lombardia, with the collaboration of University of Milan-Bicocca, carried out extensive monitoring campaigns both in quarries and in processing laboratories. More than 300 massive samples (rocks and veins) and 250 airborne dust samples were collected during the surveys. One of the main problems in the study of massive serpentinites is the accurate identification of the different serpentine minerals due to the close resemblance of their basic structures. For this reason, the massive samples were studied by combined use of optical microscopy, SEM-EDS, X-ray powder diffraction and FT-IR. Geological and geostructural mapping of the chrysotile veins was also performed by the University, in order to characterize and quantify the "asbestos content" in each quarry. The analyses performed on massive samples showed that chrysotile asbestos is concentrated only along fissures and veins, and is not "dispersed" in the rock. Airborne personal and environmental samples (performed both in quarries and laboratories), were analyzed by means of phase-contrast microscopy (PCM) and SEM-EDS. The exposure values were extremely variable, and mostly below the permissible exposure level. The airborne samples revealed some critical details: the extreme fineness of chrysotile fibers (not detectable by PCM), the presence of chrysotile "aggregates", the difficulty to distinguish between chrysotile and splintery antigorite fragments (produced by mechanical fragmentation during quarrying and processing). Prevention actions were planned on the basis of the analytical results, and are still in progress: preliminary geological surveys (in order to avoid mineralized fissures), drilling technologies, dust suction and water abatement were tested in the field, procedural and organizational solutions are implemented both in the quarries and in the processing sites. Employers and workers are trained appropriately according to the law. A specific method for monitoring NOA exposure in these workplaces will be soon released.