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Environmental asbestos contamination in an abandoned chrysotile mining site

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The Valmalenco area (central Alps, northern Italy) is located at the Penninic to Austroalpine boundary zone, and the most important tectonic unit is the Malenco-Forno nappe, a huge ultramafic body interpreted as a sub-continental mantle fragment. The most common lithotype is represented by schistose serpentinites, quarried as valuable dimension stone and marketed worldwide. On the other hand, the serpentinites host different ore and industrial minerals deposits, ranging from talc veins up to long-fibre chrysotile asbestos. Asbestos, which occurs in discrete cross-fibre and slip-fibre veins, gave rise in the past to widespread mining activity, particularly between the end of the XIX century and 1975 and was used mainly for weaving tablecloths or for wicks. A big boost to the mining activity occurred during World War II and the immediately following years, with annual production up to 670 tons with more than 400 workers employed, until it ended completely in 1975, leaving huge amounts of mining waste and tailings. In recent times, part of the tailing fans have been stabilized and reclaimed, covered with soil and planted. Extensive sampling of mine tailings, soils and alluvial sediments was performed all over the valley, to quantify environmental asbestos contamination (portable Raman, XRPD, SEM, TEM). Huge amounts of chrysotile are still present in mine tailings ($>$ 5 wt.%), whereas soil and sediment samples were mostly below the 1000 ppm threshold; chrysotile is widespread almost in every part of the valley. In some areas, relatively small amounts ($<$ 500 ppm) of asbestiform tremolite were detected, probably linked to talc – carbonate lodes and veins. Portable Raman device (532-nm laser at maximum output power of 30 mW, in the extended wavenumber range 120-4000 cm^{-1}, with a spectral resolution of 8 cm^{-1}) was a user-friendly efficient analytical strategy, able to discriminate the potential asbestiform fibres from non-harmful fragments, especially for preliminary evaluation of rock debris and veins. The quantitative analysis of “massive” samples (SEM) requires special care, especially for sample preparation (representative sample!) and discrimination between asbestiform minerals and non-asbestiform polymorphs (e.g. pseudo-fibrous antigorite splinters). Airborne asbestos was evaluated by environmental monitoring on polycarbonate filters (SEM and TEM): most of the samples were below the PEL of 2ff/l for living environments, with some peaks close to active serpentine quarries. Some fibrous antigorite was detected in many airborne samples. These preliminary data show a relatively “quiet” situation, but the presence of asbestiform tremolite, never reported in literature, needs special attention. Another critical issue is represented by the huge volumes of highly contaminated mining tailings and debris, sometimes with dangerous instability and possibility of landslide. The main purpose of this work is the definition of effective strategies in asbestos identification and quantification in the “natural” environment.