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Serpentinitic waste materials: possible reuses and critical issues

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The extraction and processing of marbles, rocks and granites produces a significant amount of waste materials, in the form of shapeless blocks, scraps, gravel and sludge. Current regulations and a greater concern to the environment promote the reuse of these wastes: quartz-feldspathic materials are successfully used for ceramics, crushed porphyry as track ballast, whereas carbonatic wastes for lime, cement and fillers. However, there are currently no reuses for serpentinitic materials: a striking example is represented by the Valmalenco area (central Alps, northern Italy), a relatively small productive district. In this area 22 different enterprises operate in the quarrying and/or processing of serpentinites with various textures, schistose to massive, and color shades; the commercial products are used all over the world and are known with many commercial names. The total volume extracted in the quarries is estimated around 68000 m^3/yr. and the resulting commercial blocks and products can be estimated around the 40 - 50 % of the extracted material. The processing wastes can vary significantly according to the finished product: 35 % of waste can be estimated in the case of slab production, whereas 50 % can be estimated in the case of gang-saw cutting of massive serpentinite blocks. The total estimate of the processing rock waste in the Valmalenco area is about 12700 m^3/yr; together with the quarry waste, the total amount of waste produced in the area is more than 43000 m^3/yr. The sludge (approximately 12000 m^3/yr, more than 95 % has grain size $<$ 50 micron) mainly derives from the cutting (by diamond disk and gang-saw) and polishing of massive serpentinites; it is filter-pressed before disposal (water content ranging from 11.5 to 19.4 wt. %). All the different waste materials (85 samples) were characterized by quantitative XRPD (FULLPAT software), whole-rock geochemistry (ICP-AES, ICP-MS and Leco®) and SEM-EDS. The mineralogical composition is quite variable from quarry to quarry, with abundant antigorite (up to 90 wt. %) and olivine (up to 38 wt. %), and variable contents of diopside, chlorite, magnetite, chromite and brucite. The chemical composition reflects the protolith: MgO 35.1 – 42.7 wt. %, SiO_2 38.8 – 42.3 wt. %, Fe_2O_3 7.1 – 8.8 wt. %, Al_2O_3 0.9 – 2.8 wt. %, CaO 0.2 – 3.1 wt. %, Cr_2O_3 0.26 – 0.35 wt. %, Ni 1800 – 2100 ppm; little differences can be observed in trace elements. SEM-EDS investigations evidenced little amounts of chrysotile asbestos fibers (generally $<$ 1000 ppm, mean values 200 – 400 ppm), deriving from cracks, fissures and veins of the waste blocks. Very few published studies on the reuse of serpentinitic wastes can be found. Finely ground antigorite-rich materials could be used as filler for plastics (instead of talc), whereas olivine-rich wastes as a reactive fixing carbon dioxide (as carbonates) released during the use of fossil fuels. In the ceramic industry, the most promising target is represented by forsterite and/or high-MgO ceramics and forsterite refractories (with periclase addition), but also by cordierite ceramics (adding kaolin) and high-hardness vitroceramics. The real possibility of an industrial use of serpentinitic materials will require much more experimental work, because no relevant previous studies are available. Special care must be taken to avoid chrysotile asbestos contamination.