



Gneiss wastes as secondary raw material for the ceramic industry: an example from the Verbano Cusio Ossola district (Piedmont, north-western Alps, Italy)

Alessandro Cavallo

University of Milano-Bicocca, Department of Earth and Environmental Sciences, Department of Earth and Environmental Sciences, Milano, Italy (alessandro.cavallo@unimib.it)

The Verbano Cusio Ossola province (VCO, Piedmont, north-western Italy) is one of the most important Italian quarrying districts, due to the peculiarity and variety of its exploited rock types, mainly orthogneisses such as Serizzo and Beola, and subordinately granites, marbles and other rocks. The most important and extensively exploited ornamental stone from the VCO province is surely the Serizzo, commercialized in four main varieties, and representing about 70% of all the stone production from the VCO area. The protholith of the Serizzo is a Permian granite - granodiorite metamorphosed during the alpine events, and the rock-forming minerals are mainly quartz, K-feldspar, plagioclase (andesine), biotite, with variable amounts of muscovite and epidote (allanite). The other important ornamental stone of the VCO province is the Beola, a series of heterogeneous materials (mainly orthogneisses) with marked (mylonitic) foliation and strong mineralogical lineation, occurring in the median Ossola Valley; its production (15% of the whole stones of the VCO) is subordinated with respect to that of Serizzo. The mineralogical composition of the Beola varieties is similar to Serizzo, consisting of quite homogeneous quartz, K-feldspar (orthoclase or microcline), plagioclase, biotite and muscovite. The main differences relate to the grain size, the rock fabric (generally mylonitic) and to the presence of accessory/secondary minerals. Recent regulatory developments and the growing environmental awareness, require an increasing reuse of wastes deriving from the extraction and processing of dimension stones (up to 50 % of the extracted gross volume). Granite wastes from the VCO (Baveno pink granite and Montorfano white granite), after specific industrial treatments (crushing, sieving, drying, magnetic separation of biotite and hornblende), are used successfully as quartz-feldspars mix in the ceramic industry, with very low FeOtot content. On the other hand, other quartzose-feldspathic rocks (i.e. Serizzo and Beola), are potential sources of secondary raw materials for the ceramic industry. To assess the feasibility of a reuse of these waste materials, an extensive sampling was performed on the main quarry dumps. The waste rocks were characterized by polarized light optical microscopy (OM) on thin sections, scanning electron microscopy (SEM), quantitative X-ray powder diffraction (XRD-QPA with the Rietveld method), electron microprobe (WDS and EDS) and whole-rock geochemistry (ICP-AES, ICP-MS and LECO[®]). The performed analyzes show a marked mineralogical and chemical heterogeneity (e.g. highly variable content of phyllosilicates, FeOtot content between 0.39 and 6.99 wt.%), as well as important textural and granulometric differences. On the other hand, the composition of feldspars is quite homogeneous, with the plagioclase ranging from almost pure albite to oligoclase (An 25 – 30%). Some varieties of Serizzo and Beola (Serizzo Sempione, Serizzo Formazza and Beola Bianca) are preferable because of their relatively low FeOtot content, but granulometric and textural factors should never be overlooked, as they have an important feedback in the efficiency and feasibility of the industrial treatments (e.g. magnetic separation). Specifically, some Beola varieties with particularly fine grain size and mylonitic texture, are poorly-suited to industrial ore treatments. On the contrary, the Serizzo varieties, although with a generally higher FeOtot content, have a coarser and homogeneous (and therefore preferable) grain size. Waste materials with different composition could be mixed properly until reaching the desired “ideal” compositions for the following industrial treatments. In any case, an accurate characterization of the waste materials from each of quarry dump is of fundamental importance.