Anomalous water absorption in low-grade serpentinites: more water than space?

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Abstract: Serpentinites used as decorative stones in the Siena Cathedral, as well as in several historical buildings in Central Italy, show water saturation indices greater than the maximal theoretical value of 100 percent. Namely, the volume of absorbed water is larger than the volume of absorbed helium. Whereas anomalous saturation indices are common in low-grade lizardite + chrysotile serpentinites, normal saturation indices occur in metamorphosed antigorite serpentinites.

Based upon chemical and physical tests, we conclude that the mechanism of excess water uptake in serpentinites may be explained by chemically induced permeability through pre-existing barriers. These barriers normally prevent the entrance of gases into pre-existing, but closed-off pore spaces; the barriers are located along the numerous grain boundaries and are thought to have composition close to MgSi₂O₅, that is the serpentine residue left after acidic treatment.

The pore-filling barrier material is formed by weathering processes on a short time scale (from a few centuries for the historical buildings to perhaps one century for old quarry outcrops). It does not occur in very fresh specimens, which show normal water absorption properties (i.e., saturation indices less than 100 percent).

Key-words: serpentinites, water absorption, porosity, weathering, alteration.

Introduction

Serpentinites have been used for decorative purposes ("green stones") for at least twenty centuries, e.g. from the "opus reticulatum" of Roman buildings to the recent front of Florence Cathedral. In particular, the decorative hangings of medieval churches in Tuscany often consist of white marble strips alternating with dark green serpentinite strips.

Unfortunately, serpentinites undergo rapid alteration, mostly by a disintegration process that releases centimeter-sized rock chips and crusts. Rec- ords of poor mechanical behaviour go back quite far (Targioni Tozzetti, 1768; Repetti, 1839). Serpentinit- ites have therefore often been used just as an outer skin or wall-hanging, that was expected to be periodically replaced.

In a study of the altered wall-hangings of the Siena Cathedral (Ceccherini, 1989), anomalous water absorption properties were repeatedly observed. In particular, saturation indices (i.e. the percentage porosity available to water uptake) were systematically larger than the 100 percent maximum theoretical value. Similar results were reported also for the serpentinite hangings of other coeval buildings (e.g., Florence Cathedral; Tiano et al., 1984; Fratini et al., 1987; De Vecchi et al., 1991).

As the ultimate nature of weathering may be fundamentally connected with water exchange mechanisms, we thought it useful to investigate further water absorption and desorption processes in selected serpentinitic rocks.