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Weathering and deterioration of volcanic tuff rocks used as natural building stone caused by moisture expansion

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Volcanic tuff rocks are one of the most frequently used natural building rocks. Tuff rocks show great assortment in composition, grain size, sorting and textures, however scaling, flaking and cracking mostly affect all of them. Diverse authors suggest, that the swelling ability of clay minerals provoke moisture expansion contributing for the weathering and deterioration of the rocks and finally for the construction.
Fourteen building volcanic tuff rocks from Germany, Hungary and Mexico of different ages, with diverse compositions and weathering conditions were studied in order to determine the influence of the moisture content regarding their deterioration.
Hydric (water saturated) and hygric (related to the relative humidity) wetting experiments realized on the tuffs show that the phenomenon of the expansion certainly can be related to the content on clay minerals, which were clearly identified by XRD analysis. The moisture contents also dependents on the porosity, principally effective porosity and the radii distribution of the pores, because more water can be adsorbed and transported into the rock. However, there are tuff samples, which show a moderate or none expansion, although they have an important amount of clay minerals. Petrographic and geochemical analysis show, that the presence of other phyillosilicate minerals, like muscovite (sericite) and biotite, plays likewise an important role during the moisture expansion. On the other hand we identified a tuff type rich in clay minerals, which shows important hygric expansion but it is not so clear by the hydric water immersion experiment, because this tuff contains a high amount of calcium carbonate, principally in the fine grained matrix causing dissolution of the matrix and crumbling of the non-soluble particles including the clay-silt fraction. In this case it seems to be that the dissolution of the carbonate matrix causes a secondary porosity, which accelerates and favors the expansion and in consequent the deterioration of the rock.
Further studies, mainly about the clay-fraction (e.g. the total amount of swellable clay minerals, XRD of oriented slides and CEC-analysis), will help us to clarify which role plays the presence of 1:1 or 2:1 layered clay minerals in determinate tuff and its relationship with the moisture expansion.