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Influence of temperature and salt concentration on the salt weathering of sedimentary stones

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Salts, and particularly sodium sulphate, are known to be a very destructive agent for all type of masonries (brick, concrete, stone…). Nevertheless the mechanism of this damage is not yet fully understood. Recent researches on the subject have shown that the weathering processes are governed by porometric and mechanical properties of the stones as well as the characteristics of the salt. The aim of this study is to evaluate how the ambient temperature and the salt concentration affect the salt decay of sedimentary stones.

The stone used in this study is a detritic limestone from the Parisian basin: the “roche fine”. Its porosity is very high (36%) and its tensile strength low (1.5MPa). This stone has been chosen because it has several advantages: its detritic structure with unimodal porosity is much simpler to study than other bioconstructed or crystallized limestones; it has been demonstrated in previous tests that it is not very resistant to salt decay hence the tests are quite fast; it is very regular and homogeneous, which allows a very good reproductibility of the tests.

Cubic samples of 7cm edges have been experimentally weathered by cycles of imbibition-evaporation with a sodium sulphate solution. This accelerated weathering is composed of 15 cycles of 24h: 2h of imbibition with a sodium sulphate solution at a fixed concentration and at ambient temperature; 16h of drying at 105˚C; 6h of cooling at ambient temperature. These tests have been performed for three different sodium sulphate concentration (5, 12 and 25% in weight of Na_2SO_4) and three different ambient temperatures (5, 25 and 50˚C). The weight of the samples has been monitored three times during each cycle (before imbibition, after imbibition, after drying), and the pieces torn off during the cycles were weighed every cycle.

The results show that ambient temperature has a big influence on the decay. First of all, as expected by the phase diagram, the damage is more important at 5˚C than at 25˚C. The samples at 50˚C were intact at the end of the test. The second important feature is that the size of the pieces torn off the samples is significantly smaller for low temperatures: at 5˚C, the decay produces a mud that turns into a fine powder when dried; at 25˚C, the pieces torn off are millimetric to centimetric: the mechanisms at stake are thus different at these two temperatures. Concerning the salt concentration, the salt uptake seems quite similar for a given concentration whatever the temperature. The decay seems also to be of a different kind for each concentration. It seems that the crystallization takes place more deeply inside the stone when there is more salt in the sample. This suggests that the presence of salts has an influence on the drying velocity of the sample.