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Damage induced by salt crystallization in heterogeneous porous media in the context of the erosion of the French Basque Coast and the damage of protective buildings

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Coastal erosion is a growing concern for many coastal regions worldwide, and salt weathering has been identified as a contributing factor to this phenomenon. This research focuses on the ongoing erosion of the French Basque Country coastline, particularly between the connecting sections of Saint-Jean-de-Luz and Hendaye which are characterized by Santonian flysch rock cliffs.
The objective of the global project is to investigate the role of salt weathering and its impact in the mechanical weakening of both the tight and low-porosity flysch rocks with rhythmic alternations of heterogeneity and the concrete material used for the protective blocs of the Artha dam located in Saint-Jean-de-Luz. Particularly, this study focuses on the gathering of reliable and fine experimental data allowing the calibration and the validation of predictive numerical tools developed besides.
For this purpose, a novel accelerated salt weathering protocol has been developed, involving the continuous partial immersion of test samples in a 3 molal concentration of sodium sulfate solution at a controlled temperature of 34 ◦C, while maintaining room temperature at 20 ◦C. Non-destructive acquisition techniques, including acoustic emission analysis and time-lapse photography or quasi-simultaneous neutron and x-ray tomography (Institut Laue-Langevin) –coupled with digital image correlation –were employed to gather reliable experimental data for validating the weathering protocol and for further numerical analysis. The effectiveness of the protocol was confirmed through numerous tests conducted on the two targeted materials (flysch rocks and Artha dam concrete) but also on Vosges sandstones, which are less heterogeneous and widely studied in the literature.
Central to this study, the unique application of quasi-simultaneous neutron and x-ray imaging provided a comprehensive understanding of the role of salt crystallization in damaging porous rock materials with encouraging experimental data acquired to enable the observation and quantification of fracture formation and hydrated salt content in the samples. The results gathered indicate that salt crystallization is a crucial factor in the observed damage of flysch rock, Vosges sandstone, and concrete samples, with heterogeneity playing a significant role in the deformation and failure.
The findings of this study contribute valuable insights into the phenomenon of crystallization-induced damage by salt, which has practical applications in building engineering, materials science, and environmental science. The collected experimental database, especially on Vosges Sandstone, can be directly used for numerical model calibration and validation.
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References

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