Halite Crystallization on Interior Tunnel Walls at the University of Western Ontario

Roberta L. Flemming* and Syed J. Ali
Department of Earth Sciences, The University of Western Ontario, London, ON, N6A 5B7,
rflemmin@uwo.ca

Abstract

We present textural observations and X-ray diffraction data for crystalline solids forming on the interior walls of the pedestrian underground tunnel system at the University of Western Ontario. At several locations in the tunnel system, interior walls have been penetrated by leakage from exterior surface water. After prolonged exposure to leakage, efflorescences and precipitates have formed on the walls, ceiling, and floor of affected areas. These deposits demonstrate a variety of morphologies, including 'fluffy' white fibrous masses, irregular 'popcorn-like' aggregates (white or with varying degrees of orange-brown staining) as well as continuous sheet-like white to gray encrustations or 'crusts' on floors and walls, and white to yellow-brown stalactites on the ceiling. X-ray diffraction of this material reveals all forms to be halite (NaCl) sometimes with traces of associated building materials (e.g. paint chips contain the white pigment rutile (TiO_2)). Other physical properties are also consistent with halite: It is soluble in water and it tastes salty.

The fibrous morphology is rare in the tunnels, being found only at one location. Fibrous halite has been previously reported to have lengths on the sub-millimeter scale, inside pore spaces of building materials (Gomez-Heras and Fort 2007, Lubelli and Rooij 2009), whereas the halite observed here protrudes horizontally outward from the wall to lengths on the order of ~1 cm. The popcorn morphology is most common morphology found in the tunnels. The crusts, where found, are the most extensive, and can be continuous for several cm. Horn-like stalactites varying in length from 1 to 10 cm extend downward from the ceiling. Shorter ones (< 3 cm) tend to be tubular or hollow, and can exhibit a ring-like pattern which is interpreted to be consecutive growth.

Micro X-ray diffraction on whole specimens using a Bruker D8 Discover microdiffractometer indicates that the fibers are single crystals (or bundles) elongate along the a_1 axis, while the popcorn morphology is polycrystalline. Translucent gray crusts and stalactites are massive crystals of single orientation, while white (or sometimes coloured) areas on crusts and stalactites are coarsely polycrystalline. Iron oxidation of metal building materials likely contributes to the yellow-orange to brown colouration of some of the halite deposits; colouration is generally not associated with additional mineral phases.

Morphology appears to be correlated with amount of brine influx, where the fibrous morphology is associated with the lowest influx (no visible signs of water flow). The popcorn morphology is associated with moderate influx (distinct water staining indicates periodic flow) and the crusts are associated with the highest influx (visible water flow). Identification of this material as halite explains the aggressive deleterious physical and chemical weathering of the building materials due to surface brines, formed by the dissolution of road salt into surface melt water, occurring above the tunnels.

References

Gomez-Heras, M. and Fort, R. ,2007, Patterns of halite (NaCl) crystallization in building stone conditioned by laboratory heating regimes: Environmental Geology, 52, 259–267.

Lubelli, B. and de Rooij, M. R., 2009, NaCl crystallization in restoration plasters: Construction and Building Materials, 23, 1736–1742.