Geophysical Research Abstracts,
Vol. 10, EGU2008-A-10771, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-10771
EGU General Assembly 2008

Formation of Thaumasite by Sulphate Attack (TSA) – Application of Stable Isotopes

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The formation of Thaumasite from Sulphate Attack (TSA) is known to damage concrete buildings especially at low temperature(e.g. Lee et al., 2008). Most common sulphate attack e.g. by the formation of ettringite can be significantly reduced using sulphate-resistant cements, whereas TSA even appears in concretes with negligible aluminium content by consuming calcium silicate hydrate phases (Bellmann and Stark 2007). The formation of TSA may result in a significant decrease of the concrete stability.

A case study has been carried out at the Bosruck railway tunnel in Austria to decipher the mechanisms of shotcrete damaging during the last 50 years after construction. At several locations pieces of shotcrete (0.1 to 1.0 m^2) were falling down and caused safety risks for the highly frequented railway tunnel. The interlayer between the sooty brick wall lining and the shotcrete show intense sulphate attack. The damaged horizon is composed of white fine grained material which mainly consists of thaumasite with small amounts of gypsum and ettringite. Thaumasite occurs as needles with a few microns in size and can be distinguished from ettringite e.g. by Raman Spectroscopy.

The analysed local ground water is highly enriched in sulphate (> 6 mM SO_4^{2-}) due to the dissolution of local marine evaporites. The sulphate minerals of the damaged horizons and local evaporites show $\delta^{34}S_{CD}$ values from 14.8 to 22.2 and from 10 to 27

‰ (Spötl and Pak 1996), respectively. Thus, the sulphate minerals from the damaged horizons display sulphate from local ground water. Soot relicts as a potential source of sulphur can be ruled out as the respective analysed $\delta^{34}S_{CD}$ values lay between 3.4 and 4.1 ‰. Accordingly, the destruction of the shotcrete by sulphate attack comprises a dynamic and ongoing process due to the quasi infinite source of ground water sulphate. The investigations will be expanded to $^{12}C/^{13}C$ and $^{18}O/^{16}O$ signatures of SO_4^{2-} and CO_3^{2-} to provide further insight to the origin of the components and the atmospheric impact on the formation of TSA.

References

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