



Dolomite Dissolution in Alkaline Cementitious Media

Florian Mittermayr (1), Dietmar Klammer (1), Stephan Köhler (2), and Martin Dietzel (1)

(1) Graz University of Technology, Department of Applied Geosciences, Graz, Austria, (2) Swedish University of Agricultural Sciences, Uppsala, Sweden

Chemical alteration of concrete has gained much attention over the past years as many cases of deterioration due to sulphate attack, thaumasite formation (TSA) or alkali silica reactions (ASR) have been reported in various constructions (Schmidt et al, 2009). Much less is known about the so called alkali carbonate reaction (ACR). It is believed that dolomite aggregates can react with the alkalis from the cement, dissolve and form calcite and brucite (Katayama, 2004). Due to very low solubility of dolomite in alkaline solutions this reaction seems doubtful. In this study we are trying to gain new insights about the conditions that can lead to the dissolution of dolomite in concrete. Therefore we investigated concrete samples from Austrian tunnels that show partially dissolved dolomite aggregates. Petrological analysis such as microprobe, SEM and Raman spectroscopy as well as a hydrochemical analysis of interstitial solutions and ground water and modelling with PhreeqC (Parkhurst and Appelo, 1999) are carried out. In addition a series of batch experiments is set up. Modelling approaches by PhreeqC show a thermodynamically possibility in the alkaline range when additional Ca^{2+} in solution causes dolomite to become more and more undersaturated as calcite gets supersaturated. Interacting ground water is enriched in Ca^{2+} and saturated with respect to gypsum as marine evaporites are found in situ rocks. Furthermore it is more likely that Portlandite ($\text{Ca}(\text{OH})_2$) plays a more important role than Na and K in the cement. Portlandite acts as an additional Ca^{2+} source and is much more abundant than the alkalies. Some interstitial solutions are dominated mainly by Na^+ and SO_4^{2-} and reach concentrations up to 30 g/l TDS. It is believed that solutions can even reach thenardite saturation as efflorescences are found on the tunnel walls. In consequence dolomite solubility increases with increasing ionic strength. $\text{pH} > 11$ further accelerate the process of dedolomitization by the removal of Mg^{2+} as brucite ($\text{Mg}(\text{OH})_2$) precipitates. Brucite and calcite were detected insitu by Raman spectroscopy surrounding partially dissolved dolomite grains. Dolomite dissolution under alkaline condition is a dynamic process of dissolution and precipitation stimulated by high Ca^{2+} content, high ionic strength, low temperature and high pH with the consequence of low Mg^{2+} concentration.

References:

- Katayama, T., 2004. How to identify carbonate rock reactions in concrete. *Materials Characterization* 53, 85-104.
- Parkhurst, D. L., Appelo, C. A. J. 1999. User's guide to PHREEQC. U.S. Geol. Sur.: 312.
- Schmidt, T., Lothenbach, B., Romer, M., Neuenschwander, J., Scrivener K., 2009. Physical and microstructural aspects of sulfate attack on ordinary and limestone blended Portland cements. *Cement and Concrete Research* 39, 1111-1121.