

Chemical garden reaction and underground environmental science

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Our civilization is based on material science. One of the most important material created in our civilization is cement for many buildings. Cement consists of Ca(OH) (portlandite) and hydration products of calcium silicate hydrate (C-S-H) resulted from hydration of crinker minerals such as alite and belite. This hydration reaction produces function of water stopping and mechanical strength on the cement utilized for dams, urban buildings and tunnels. This function is created by nano-scale crystal growth in the cement pores. The C-S-H is not well-understood crystallographically. The latest model proposes that the structure of C-S-H includes both glass-like short-range order and crystalline features of tobermorite (Pellenq et al., 2009). During crystal growth of C-S-H, the growth form changes from layered to hollow as a function of supersaturation, which is widely known as chemical garden reaction.

This reaction occurs when the silicate solution includes Ca²⁺ or other Me²⁺ ions, and also on natural rock in the alkaline solution. If the C-S-H occurs on natural fractures in which alkaline solution flows, the solution flow can be clogged finally.

Laboratory experiment reproduced C-S-H growth on synthetic rock fracture by flow of alkaline solution at a constant pressure gradient. Nano-scale observation revealed the growth texture of C-S-H and its function. This can serve important information for prediction of our future condition of underground environment that may be affected by alkaline groundwater including cement leachates.

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