

Quartz dissolution and M-S-H cement precipitation in a high pH ultramafic system

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Quartz is known as one of the most insoluble minerals at Earth's surface. However, at the Feragen Ultramafic Body in SE Norway we observe that complete quartz grains of ~100 µm are dissolved and replaced by magnesium silicate hydrate (M-S-H) cement in less than a century. This implies dissolution rates that are several orders of magnitude higher than indicated by experimental studies.

Weathering of serpentinitized ultramafic rock leads to the formation of high pH (> 9), Mg-rich fluids. The ultramafic body is covered with quartz-rich felsic glacial deposits which, under such high pH conditions, are far out of equilibrium. As a result, quartz grains are partly dissolved and M-S-H cement, a nanocrystalline phyllosilicate phase, is precipitated, leading to a concrete-like rock containing ultramafic and felsic clasts. The quartz dissolution is associated with etch pits and remarkable honeycomb structured cement as a result of disintegration and subsequent dissolution of recrystallized quartz. TEM revealed an amorphous silica layer of ~100 nm on the quartz surface of partly dissolved grains. It is likely that this layer is the result of dissolution-reprecipitation and subsequently reacts with the high pH, Mg-rich fluid to form M-S-H cement, allowing for further quartz dissolution and the complete replacement of quartz by cement.

This natural cement is similar to man-made M-S-H cement, which is currently of interest as a potential CO₂-neutral alternative for Portland cement and also for the encapsulation of nuclear waste. However, fundamental information is lacking and considerably more research is required to be able to produce this cement on a large scale. We therefore aim to provide new insights and knowledge about M-S-H formation that could inspire the cement industry. Furthermore, our findings shed new light on chemical weathering of quartz and the associated precipitation of amorphous silica and subsequent Mg-silicate phases at high pH surface conditions.