Formation of magnesium silicate hydrate cement in the weathering zone of ultramafites

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Magnesium silicate hydrate (MSH) cement has been formed as a result of weathering of serpentinized ultramafic material in the presence of felsic glacial deposits. This unique process takes place at the Feragen Ultramafic Body in Eastern Norway and results in the cementation of till, forming tillite. As ultramafic material is far out of equilibrium when emplaced at the Earth's surface it is prone to weathering. This is associated with the dissolution of brucite and consequently the release of Mg and the formation of a high pH (>9) fluid which dissolves the quartz grains of the glacial deposits. Evaporation of this fluid leads to the precipitation of a nanocrystalline magnesium silicate hydrate phase with the approximate composition $Mg_8Si_8O_{20}(OH)_8 \cdot 6H_2O$. The resulting cemented rock is characterised by disintegrated and parlty dissolved quartz grains that are surrounded by the MSH cement. This process occurs at surface conditions in a subarctic climate and is known to take place on the timescale of a few decades, as constrained by mining activities.

Magnesium based cement is currently of high interest as the search for environmentally friendly cement is a pressing task considering that the widely used Portland cement accounts for about 7% of the worldwide anthropogenic CO_2 emission. As this study provides new key insights in the formation process of natural CO_2-neutral magnesium cement on the micro- and nanoscale, it could contribute in the development of a new sustainable construction material. Experiments show that mixing brucite and silicic acid results in cement that hardens in a few days and has an X-ray diffraction pattern that is very similar to that of the natural cement.