Nucleation and growth of chrysotile nanotubes: complementary insight from macroscopic to nanoscopic measurements

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Chrysotile is one of the most studied asbestos mineral but rare studies have focussed on the nucleation and growth processes of chrysotile because batch (or discontinuous) reactors are generally used. However, various questions still remain unanswered concerning their formation in natural systems as well as their production at laboratory and industrial scales

In the present study [1], we report new insights on the nucleation and growth processes of chrysotile nanotubes [1] by using semi-continuous experiments (i.e. sampling of reacting suspension with time). From macroscopic (N_2 sorption/desorption isotherms, X-ray diffraction, infrared spectroscopy, Thermogravimetric analyses) to microscopic (FESEM, TEM) characterization, three main reaction steps were identified for chrysotile nucleation and growth at 300°C: (1) proto-serpentine precursor formation in the first 2 hours of reaction, accompanied by brucite and residual silica gel, (2) spontaneous nucleation and growth of chrysotile between about 3 and 8h of reaction via a progressive dissolution of proto-serpentine, brucite and residual silica gel and, (3) Ostwald ripening growth of chrysotile from 8 to 30h of reaction as attested by specific surface area measurements and FESEM and TEM observations. Complementary results from batch experiments have confirmed a significant influence of temperature on kinetics of chrysotile formation. Moreover, Si/Mg ratio and molality have been experienced to better characterize the stability field of chrysotile.

[1] R. Lafay, G. Montes-Hernandez *et al.*. *Chemistry – A European Journal* (**2013**) DOI: 10.1002/chem.201204105

Subsurface mineral weathering in transient layers of permafrost in the Canadian High Arctic

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Chemical weathering in high latitude regions has largely been dismissed as insignificant, as frozen soils limit weathering reaction rates for more than 8 months a year, and also the movement of weathered products within the soil profile. We present evidence that subsurface mineral weathering in the transient layers of permafrost soils results in the formation and subsequent ejection of authigenic clay, onto the surface.

Hundreds of active and dormant mud ejection features were witnessed and mapped during the summers of 2011 and 2012, on Melville Island, Nunavut, in the Canadian High Arctic. We measured the chemical composition of aqueous and mineral solid phases in material ejected from active features in order to determine the source of material and processess responsible for their formation.

Fluids from these mud ejections are enriched in nutrients (dissolved nitrogen and organic carbon) and trace metals. Stable isotope ratios of water extracted from the mud indicates that water is not from precipitation or surface runoff and is likely from thawed permafrost, or water stored in the transient layer over several melt seasons. Bulk mineralogy, and trace metal and major ion ratios of fluids and mineral solids indicate subsurface chemical weathering reactions are occuring at near freezing temperatures in the permafrost transient layer.

The results show that the material and solutions delivered to the ground surface are the products of extensive subsurface weathering of siliciclastic minerals to authigenic clays. These mud ejection features represent a mechanism that delivers fine grained material rich in dissolved metals and nutrients to the surface, where they are subject to mobilization and delivery to terrestrial and aquatic ecosystems.

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