Experimental crystallization of trioctahedral smectites under hydrothermal conditions. Implication for alkaline hydrothermal vents

F.J. Huertas[1*], M.J. Bentabol[2], A.E.S. Van Driesche[1]

1. Instituto Andaluz de Ciencias de la Tierra (CSIC-University of Granada), 18100 Armilla, Granada, Spain
2. Departamento de Química Inorgánica, Cristalografía y Mineralogía. University of Málaga. Campus de Teatinos. 29071 Málaga (Spain)

*javier.huertas@csic.es

Present day hydrothermal vents are considered as plausible analogues of sites where live could have emerged on primitive earth. Strýtan (Iceland) is a shallow hydrothermal system composed mainly of vertical silico-magnesium structures, whose mineral association corresponds to a low crystallinity silica, trioctahedral smectites and smaller amounts of carbonates. To better understand mineral formation in such vent systems we have synthesized trioctahedral smectites in the kerolite-stevensite-saponite series using hydrothermal conditions in slightly alkaline solutions from amorphous hydrous Mg-Al silicates. The starting material consisted of coprecipitated gels with the following chemical composition (Si/Mg/Al/Na atomic ratios): Gel 1: 4.0/2.97/0/0.48, Gel 2: 4.0/2.69/0.17/0.63, Gel 3: 4.0/2.43/0.34/0.69. Gels (250 mg) were aged with 30 mL of water for 60 days at 150, 175, 200 and 225 °C in Teflon lined reactors. The formed solid was repeatedly washed with distilled water by centrifugation, saturated overnight in $CaCl_2$ (1 M) and washed again with distilled water. The solid samples were characterized by XRD, DTA-TG, FTIR and TEM.

XRD revealed the formation of low crystallinity phyllosilicates. The 001 reflection (absent in most of the samples) evolved with increasing temperature and Al from 9.7, to 12 and 14.5 Å. The patterns contained peaks corresponding to kerolite (Krl) and stevensite/saponite (Stv/Sap). In oriented mounts, solvation with ethylene glycol shifted the 001 peak to 17.4 Å in gels 2 and 3, whereas in Gel 1 it remained at 9.7 Å with a shoulder at 17.2 Å. FTIR bands were also associated to trioctahedral phyllosilicates, talc-Krl and Stv-Sap. TEM images of samples obtained at 225°C from Gel 1 showed unresolved aggregates of tiny crystals of tens of nanometer, with turbostratic structures. Gel 3 produced layered crystals containing numerous defects and with spacings of 10-11 Å, typical of trioctahedral smectite.

Thus, aging treatment transformed Si/Mg/Al/Na gels into Krl-Sme interstratified minerals and trioctahedral smectites. Temperature increased the conversion rate from 40 to 75% at 150°C to 225°, respectively. Magnesium silicate (Gel 1) produced a 20-80% Stv-Krl interstratified mineral, composed of tiny crystals. Increasing Al content improved the crystallinity and the proportion of the smectite. Gel 2 consisted of a Sme-Krl interstratified mineral richer in smectite, while Gel 3 is fully transformed into smectite. The smectite synthesized in gels 2 and 3 is likely Saponite with Al in the tetrahedral positions.

Acknowledgements. This research was funded by FEDER/Junta de Andalucía-Consejería de Economía y Conocimiento (PY20_01389) “a way of making Europe”.

Preferred format: Poster

Session number and name: TS31 Clays and the molecules of life