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Intracrystalline Oxygen Isotope Fractionation in Clay Minerals

ELHAM ASADI MEHMANDOSTI AND FRED J LONGSTAFFE

The University of Western Ontario

We coupled a thermogravimetric analyzer (TGA) with an isotopic water analyzer (CRDS) (Oerter et al., 2017) and used this TGA-CRDS to measure hydroxyl O-isotope compositions of Clay Minerals Society (CMS) Source Clays. Samples were heated (100°C/min) from ambient to 200°C to remove adsorbed water, followed by heating (300°C/min) to 1000°C to release water via dehydroxylation; evolved gases were immediately swept by dry N_2 into the CRDS. Water standards calibrated to VSMOW were analyzed in each TGA-CRDS analytical session. Isotopic compositions of total structural oxygen prior to and following dehydroxylation were determined by fluorination.

The isotopic fractionation between non-hydroxyl oxygen (non-OH) and hydroxyl oxygen (OH) for Macon, Georgia KGa-1 kaolinite ranged from 1.02113 (<0.2 μm) to 1.02196 (0.2<2 μm). These $\alpha_{non\text{-}OH/OH}$ values lie between those reported for Macon kaolinite by Hamza & Epstein (1980) using partial fluorination (1.01973) and Girard & Savin (1996) using thermal dehydroxylation (1.02720). Single mineral O/H thermometry suggests KGa-1 formation at ~15-18°C.

Illite intracrystalline isotopic fractionation was measured for Silver Hills illite (IMt-1) using the difference between total structural oxygen and hydroxyl oxygen ($\Delta_{total\text{-}OH}$); this allowed direct application of the $\Delta_{total\text{-}OH}$ geothermometer of Bechtel & Hoernes (1990). $\Delta_{total\text{-}OH}$ for IMt-1 (<0.2 and 0.2-2 μm) = 13.93-14.12 ‰. These values yield temperatures of ~215°C following Bechtel & Hoernes (1990), consistent with sub-greenschist facies formation of this illite.

For dioctahedral smectites, $\Delta_{total\text{-}OH}$ = 18.03 ‰ for montmorillonite SAz-1 (O/H isotope thermometry = ~26°C) whereas 'nontronite' SWa-1 has much larger $\Delta_{total\text{-}OH}$ (27.76-31.85 ‰) (O/H thermometry = ~16°C). Among trioctahedral smectites, $\Delta_{total\text{-}OH}$ = 17.52-20.41‰ for saponite SapCa-1 (<2 μm) (O/H isotope thermometry = ~46°C). The $\Delta_{total\text{-}OH}$ ranges from 7.92-8.35 ‰ for Fe-rich chlorite CCa-1 (Flagstaff Hill schists, California), much lower than for Mg-rich chlorite (12.7 ‰) from Vermont schists (Hamza & Epstein, 1980). Untangling the controls of crystal-chemistry and temperature is essential for O-isotope single clay mineral geothermometers to be realized.

Bechtel A. & Hoernes S. (1990) *Contrib. Mineral. Petrol.* 140:463-470.

Girard J-P & Savin S.M. (1996) *Geochim. Cosmochim. Acta* 60:469-487.

Hamza M.S & Epstein S. (1980) *Geochim. Cosmochim. Acta* 44:173-182.

Oerter E. *et al.* (2017) *Chem. Geol.* 475:14-23.