

A novel technique for F/OH apatite series synthesis and early results on thermodynamic mixing properties of fluor-hydroxylapatite solid solutions

GUY L. HOVIS

Department of Geology & Environmental Geosciences,
Lafayette College, Easton, PA 18042 USA
(*correspondence: hovisguy@lafayette.edu)

Synthesis and Unit-Cell Data

We have used a novel technique, to be described at the Goldschmidt Conference, to synthesize fluorapatite from a hydroxylapatite end member. In turn, these F and OH apatite end members have been utilized to synthesize multiple intermediate compositions along the F-OH apatite join. Employing NIST 640a Si as an internal standard, X-ray powder diffraction data were collected for all series members and, with the software of Holland and Redfern [1], utilized to refine unit-cell dimensions. The resulting data for these hexagonal crystalline solutions indicate that the “a” unit-cell dimension decreases linearly across the series as fluorine content increases, while the “c” dimension is nearly constant. Unit-cell volumes are linear, or nearly so, with composition, indicating volumes of mixing that are either small or non-existent.

Solution Calorimetric Results

Heats of solution have been measured at 50 °C in 20.0 wt% HCl under isoperibolic conditions for all F-OH apatite series members. Utilizing a 50-mg sample size in all experiments, calorimetric data collected prior to the abstract deadline for this conference show enthalpies of solution that behave linearly with composition for the F-rich half of the series, while data for OH-rich compositions appear to show small negative enthalpies of mixing. Overall, calorimetric results indicate that there is no enthalpy barrier to complete mixing between the hydroxylapatite and fluorapatite end members. We anticipate completion of the calorimetric study prior to the Goldschmidt Conference, but even at this time the nearly ideal thermodynamic behaviour of both volume and enthalpy is clear. Present results extend the thermodynamic data base for the apatite system $[\text{Ca}_5(\text{PO}_4)_3(\text{F,Cl,OH},0.5\text{CO}_3)]$ to compositions beyond the F-Cl apatite binary (Hovis and Harlov [2]; Schettler, Gottschalk and Harlov [3]).

[1] Holland and Redfern (1997) *Mineralogical Magazine* **61**, 65–77. [2] Hovis and Harlov (2010) *American Mineralogist* **95**, 946–952. [3] Schettler, Gottschalk and Harlov (2011) *American Mineralogist* **96**, 138–152.

Efficient cycling of Particulate Organic Carbon through orogenic systems

N. HOVIUS¹, A. GALY¹, R.G. HILTON², R.B. SPARKES¹,
S.-J. KAO³, AND J. LIU⁴

¹Department of Earth Sciences, University of Cambridge, UK.
(nhovius@esc.cam.ac.uk)

²Department of Geography, Durham University, UK.
(r.g.hilton@durham.ac.uk)

³Research Center for Environmental Changes, Academia Sinica, Taipei, Taiwan. (s.j.kao@gate.sinica.edu.tw)

⁴Institute of Marine Geology and Chemistry, National Sun Yat-Sen University, Kaohsiung, Taiwan.

High erosion rates on convergent margins drive a transfer of Particulate Organic Carbon (POC) from standing biomass and soils into sedimentary basins. These basins are prone to rapid tectonic recycling, entraining buried POC in mountain building, exhumation and renewed erosion. The role of mountain building in the global carbon cycle depends, in part, on the rate of remineralization of entrained or fossil POC during exhumation and erosion. We have determined the geological resilience of POC in Taiwan, a small and fast eroding mountain belt in the west Pacific rim.

The flux weighted average of POC in 11 Taiwanese comprises a mixture of ~70% fossil POC and ~30% recently photosynthesised POC from the terrestrial biosphere. Measured fossil POC yields from Taiwan ranged from about 10 to 250 tC km²yr⁻¹. Efficient transfer of this material involved supply of about 1.3×10^6 t yr⁻¹ of fossil POC exhumed in Taiwan to the ocean, with <15% loss due to weathering in transit. Nearby marine sediments show a positive trend between $\Delta^{14}\text{C}_{\text{org}}$ and $\delta^{13}\text{C}_{\text{org}}$ which is consistent with a mixture of the known terrestrial input and recent marine organic carbon. This indicates that fossil and non-fossil terrestrial POC is efficiently buried offshore Taiwan.

Plio-Pleistocene marine sediments have been exhumed in the frontal ranges of west Taiwan. These sediments contain first cycle fossil POC and graphitized carbon harvested from bedrock of the Taiwan Central Range. Peak metamorphic conditions in the Taiwan orogen have been insufficient to form highly ordered graphite found in the frontal ranges. Instead, this may have originated in an older orogeny elsewhere in east Asia before entrainment in Taiwan. Presence of this graphite in recent hyperpycnal deposits off SW Taiwan suggests that POC can survive multiple cycles of burial, exhumation and erosion. Resilience of fossil organic carbon during orogenic cycling in coastal mountain belts may enhance long-term storage of carbon in Earth's lithosphere.