Li diagenesis in tropical sediments

SHAILY RAHMAN[1,2*], ROBERT C. ALLER[2], AND J. KIRK COCHRAN

[1]Department of Geological Sci., Univ. of Florida, Gainesville, FL, USA (*corresponding author: s.rahman@ufl.edu)
[2]School of Marine and Atmospheric Sci., Stony Brook Univ., Stony Brook, NY, USA (robert.aller@stonybrook.edu; kirk.cochran@stonybrook.edu)

Authigenic clay formation and sequestration by Fe – bearing phases have been suggested as major sinks for lithium in the global ocean. Sediment extractions were performed on several archived cores from mobile mudbanks in coastal French Guiana and topset deposits in the Gulf of Papua, tropical deltaic systems with extensive authigenic clay formation and reactive Fe cycling. Iron – oxides were targeted using several HCl – based extractions in both regions. In French Guiana, unaltered biogenic silica and highly reactive Si, which includes diagenetically altered products of biogenic silica, were targeted using an established mild alkaline leach [1] or a two step mild acid+mild alkaline leach [2]. Li contents in these solid phases, as well as a suite of other elements, were analyzed via ICP – OES.

Li contents in leaches targeting reactive Fe in French Guiana are lower than in the Gulf of Papua. This may reflect lithology of initial weathering products or early diagenetic processes which may preferentially concentrate these elements into particular phases. Average Li contents in these phases (1N HCl extraction) of Gulf of Papua topset sediment were 1.2 ± 0.4 (1σ) μmol g^{-1} (total Li contents ~ 6.3 – 11.2 μmol g^{-1} in source sediments [3]). In French Guiana, Li contents in similar leaches were 5 – 10X lower.

In French Guiana, the operationally defined unaltered biogenic silica pool had Li concentrations which were undetectable for the solid to solution ratios used in the leaches. In sharp contrast, Li contents in highly reactive Si leaches, all in the initial mild acid extraction, were 310 ± 30 (1σ) nmol g^{-1} (average Li content of upper continental crust ~ 2.9 – 5 μmol g^{-1}) . Correlations between Li and Si ranged from 0.19 – 0.71. Average Si/Al ratios (~1.6 mol mol^{-1}) imply this highly reactive Si phase is an authigenically formed aluminosilicate. These amorphous clay phases are more likely to constitute a permanent sink than reactive Fe oxides. By using Li/Si mole ratios, preliminary estimates of Li sequestration via reverse weathering reactions were ~7 x 10^8 mol Li y^{-1} along the Guainas coast (assuming reverse weathering sink of ~0.3Tmol Si y^{-1}).

[1] DeMaster (1981), GCA 45, 1715–1732. [2] Michalopoulos & Aller (2004), GCA 68, 1061–1085. [3] Brunskill, Zagorski, & Pfitzner (2003), GCA 67, 3365–3383.