Cosmogenic 32-Si reveals extent of reverse weathering in tropical deltas

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Cosmogenic ^{32}Si ($t_{1/2}$ ~ 140 yrs) was used in a novel way to constrain the quantity of reactive Si storage and early diagenetic reactions of Si in the highly mobile deltaic sediments along the coast of French Guiana, representative of sediments along the ~1600 km Amazon – Guianas coastline downdrift of the Amazon delta. A sequential leach was developed to extract and purify SiO_2 from different operational pools in large samples of surface sediments (0 – 10cm). This methodology, a hot 1% Na_2CO_3 leach followed by a hot 4M NaOH leach, was adapted from the existing leaches widely used to estimate biogenic Si (bSi) content in marine sediments, and ultimately to constrain the global oceanic Si budget. ^{32}Si activity was determined in each pool via its daughter product ^{32}P [1, 2]. Initial results from several sites in coastal mudbanks near Kourou and Sinnamary indicate no detectable ^{32}Si activity in the bSi fraction, whereas ^{32}Si was detected in the Si-NaOH fraction *after* removal of bSi. The lack of detectable activity in the 1% Na_2CO_3 leach and its detection in the NaOH fraction (0.2 – 0.35 dpm) indicate that the method widely used to determine biogenic Si content recovers only a minor fraction of the originally deposited reactive Si in these deposits. The results are consistent with rapid alteration of biogenic silica and clay authigenesis or reverse weathering. They also demonstrate that the current estimate of biogenic silica storage in tropical deltaic sediments is significantly underestimated by at least one order of magnitude. Assuming an initial diatom specific activity of ~40 dpm/kg SiO_2 [3], the ^{32}Si activity in the NaOH fraction corresponds to a reactive Si storage of ~150 – 300 μmol Si/g sediment. This magnitude is consistent with estimates of reactive Si storage in the Amazon delta based on modified operational leach techniques that target poorly crystalline clays and with diagenetic modeling of pore water K^+, F^-, and $Si(OH)_4$ [4], likely exceeding ~25% of annual Amazon riverine Si supply or ~1.7 x 10^{11} mol/y.

[1] Lal *et al* (1960) *Phys. Rev.* **118**, 1626–1632. [2] Demaster (1979) Yale University. [3] Craig *et al* (2000) *EPS* **175**, 297–308. [4] Michalopoulos and Aller (2004) *GCA* **68**, 1061–1085.