Quantification of amorphous content in Antarctic glacial sediments

JOSEPH GRALY[1], BRIONY HORGAN[2], DAVID BISH[3] REBECCA SMITH[4], KATHY LICHT[5],

[1]IUPUI, jgraly@iupui.edu
[2]Purdue University, briony@purdue.edu
[3]Indiana University, bish@indiana.edu
[4]Purdue University, smit3080@purdue.edu
[5]IUPUI, klicht@iupui.edu

The combination of low-temperatures, freshly crushed mineral surfaces and high water availability often causes sediments emerging from subglacial environments to contain substantial amounts of newly formed amorphous material. The chemical composition of this amorphous material is important for determining the stoichiometry of subglacial and periglacial chemical processes, but this can be difficult to assess through typical mineralogical approaches. We used 44 sediment samples from the Mt. Achernar Moraine, Transantarctic Mountains, to compare two approaches to quantifying amorphous composition. For all samples, a series of sequential extractions was employed to dissolve soluble and poorly crystalline material. The sequence consisted of water, acetic acid, HCl, and hydroxylamine hydrochloride leaches. We applied a second method to the samples, which combined X-ray diffraction with bulk elemental chemistry, subtracting mineral constituents from the bulk composition through a mass balance equation to determine the amorphous composition. A 20% corundum standard and Reitveld refinements were used to quantify the abundance and composition of the mineral and amorphous constituents.

Results from both methods showed the amorphous component to comprise 10-30% of the total mass and contain substantial amounts of Fe, Al, and Si. Ca and Mg also occur at appreciable abundances (5-10%). This composition is consistent with substantial contributions from allophane, amorphous silica, Fe oxyhydroxides, and possibly poorly crystalline clays, although the actual amorphous phases may be more complex. The composition of the amorphous component as estimated by the two methods was within uncertainties for all elements except Si, which was higher in the estimate derived from the mass balance approach. It is likely that the Si in some amorphous or poorly ordered phases was not solubilized as other elements were leached during the extraction. Compared to mass balance, sequential extractions have far higher precision, but lower accuracy, as soluble crystalline solids may also be removed. These results suggest that mass balance techniques are an effective means to assess the amorphous component composition in glacial samples.