Chemical weathering, erosion, and CO_2 consumption in the southern Tibetan Plateau and Eastern Syntaxis of the Himalaya

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The Yarlung Tsangpo-Brahmaputra River drains a large portion of the Himalaya and southern Tibetan plateau, including the eastern Himalayan syntaxis, one of the most tectonically active regions on the globe. We measured the solute chemistry of 161 streams and major tributaries of the Tsangpo-Brahmaputra to examine the effect of tectonic, climatic, and geologic factors on chemical weathering rates. Specifically, we quantify chemical weathering fluxes and CO_2 consumption by silicate weathering in southern Tibet and the eastern syntaxis of the Himalaya, examine the major chemical weathering reactions in the tributaries of the Tsangpo-Brahmaputra, and determine the total weathering flux from carbonate and silicate weathering processes in this region. We show that high precipitation, rapid tectonic uplift, steep channel slopes, and high stream power generates high rates of chemical weathering in the eastern syntaxis. The total dissolved solids (TDS) flux from the this area is greater than 520 t km^{-2} yr^{-1} and the silicate cation flux more than 34 tons km^{-2} yr^{-1}. In total, chemical weathering in this area consumes 15.2 x 10^5 mol CO_2 km^{-2} yr^{-1}, which is twice the Brahmaputra average. These data show that 15-20% of the total CO_2 consumption by silicate weathering in the Brahmaputra catchment is derived from only 4% of the total land area of the basin. Hot springs and evaporite weathering provide significant contributions to dissolved Na^+ and Cl^- fluxes throughout southern Tibet, comprising more than 50% of all Na^+ in some stream systems. Carbonate weathering generates 80 to 90% of all dissolved Ca^{2+} and Mg^{2+} cations in much of the Yarlung Tsangpo catchment.

Precipitation and aggregation of ZnS nanoparticles in the presence of low-molecular weight organic acids

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Introduction

ZnS and other metal-sulfide nanoparticles are known to exist as intermediates during precipitation and dissolution of their respective bulk mineral phases [1, 2]. However, the mechanisms that enable these nanoparticles to persist in surface waters and sediment porewaters are unknown. Humic substances and other hydrophilic organics can stabilize metal-oxide colloids in solution by adsorbing to particle surfaces and preventing aggregation [3]. This study seeks to identify whether similar processes occur for nanocolloidal ZnS.

Experimental Methods

The stability of aqueous ZnS nanoparticles was investigated by assessing the role of low-molecular weight organic ligands (oxalate, serine, cysteine, thioglycolate, and glycolate) during precipitation of ZnS. $Zn(NO_3)_2$ and Na_2S were dissolved (2 uM each) in laboratory aqueous solutions buffered at pH 7.5 and containing one of the organic ligands. Particle formation and size was monitored over time by dynamic light scattering. Zn speciation was measured in filtered (<0.2 μm) ZnS solutions by anodic stripping voltammetry to confirm that Zn was coordinated to sulfide during the aggregation experiments and not in the form of dissolved Zn-organic complexes.

Results and Discussion

Observed growth rates of ZnS aggregates varied by orders of magnitude, depending on the type and concentration of organic ligand in solution. Growth rates were slowest in the presence of thiol-containing ligands: cysteine and mercaptoacetate. In contrast, ZnS aggregation rates were generally not affected by oxalate, serine and glycolate. These compounds contain hydroxyl, carboxylate, and/or amine functional groups. Thermodynamic stability constants for the Zn-thiol complexes are greater that those for the other Zn-organic complexes. Thus, slow aggregation of ZnS nanoparticles may be caused by specific attachment of the thiol on surface Zn sites. These results demonstrate a possible mechanism that stabilizes nanocolloidal metal-sulfides in the aquatic environment.

References

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