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Mass-balance of 42 elements in a periglacial lake catchment in West Greenland

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Considering the projected warming of the Arctic region, it is critical that we have a thorough understanding regarding the biogeochemical cycling of different elements in high latitudes. However, few studies have assessed the behavior of multiple elements on the landscape scale. We have developed a whole-catchment mass-balance budget for a periglacial catchment in West Greenland using site specific data for 42 elements in un-frozen soils, groundwater, permafrost soils, lake water, lake sediments, and terrestrial and aquatic biota. Based on their sources, behavior and fate in the lake catchment, the elements can be grouped into different categories. Weathering resistant elements associated with mineral grains (e.g., Zr, Al, Ti, Si) are predominately transported by eolian processes. Elements more prone to weathering (e.g., V, Ce, La, Th, U) are transported to the lake by water. In the lake, these dissolved elements either re-precipitate, absorb to mineral grains, or are incorporated in organic matter before being deposited in the lake sediment. Wet deposition is a dominant source for halogens (Br, Cl, I), elements that are abundant in sea water (e.g., K, Ca, Mg) and some transition metals (e.g., Mo, Bi, Sb, Sn). Because of the limited flow of water through the landscape, these elements are enriched in both soils and lake water. For elements where anthropogenic pollution has decreased in recent decades (i.e. Pb and S), there is a release from terrestrial soils to the aquatic system. Overall, the results show a landscape where eolian processes dominate over hydrological transport. Another major difference from many temperate systems is the limited outflow from the lake, which gives a very long residence time for all elements entering the aquatic system. Together this indicates that changes in effective precipitation is an important factor when predicting the future effect of global warming on the biogeochemical cycling in dry periglacial systems.