THE OHIO STATE UNIVERSITY

2019 Birdsall-Dreiss Distinguished Lecture

High Latitude Hydrology: Water in a Changing World

Dr. Jonathan B. Martin, Professor,
Geological Sciences, University of Florida

ABSTRACT. Retreat of continental ice sheets has exposed ~15% of Earth's surface since the Last Glacial Maximum (LGM) and deposited fine-grained sediments in "deglaciated" watersheds. These sediments are susceptible to enhanced chemical weathering, which may vary in intensity and reaction mechanisms depending on exposure times and precipitation. Thus, ice retreat should alter solute fluxes to the ocean and gas exchange with the atmosphere as reflected by the rise in seawater Pb isotopes following the LGM. Solute and gas fluxes will depend on both riverine concentrations and discharges. Although discharge may be orders of magnitude greater for individual proglacial than non-glacial streams, their specific discharge (normalized to drainage area) is similar in western and southern Greenland. However, chemical compositions are distinct between proglacial and deglaciated watersheds and among deglaciated watersheds depending on their exposure ages and precipitation. Newly deglaciated watersheds have dissolved $^{87}Sr/^{86}Sr$ ratios that are 0.003 greater than bedload values but this difference decreases to near zero in watersheds with longer exposure ages, reflecting greater chemical weathering. The dominant weathering reactions shift with exposure age from carbonic acid weathering of carbonate minerals to sulfuric acid weathering of silicate minerals, thereby altering CO_2 consumption and production. Compared to proglacial watersheds, deglaciated watersheds have enhanced dissolved organic carbon (DOC) specific yields but the DOC is more recalcitrant than proglacial DOC. Among proglacial watersheds CO_2 and CH_4 fluxes vary, depending on magnitudes of subglacial mineral weathering and organic matter contents. These results indicate ice retreat is an important control on mass fluxes from periglacial environments. Understanding causes of these differences could improve analyses of how past ice retreat altered ocean and atmospheric chemistry and provide predictive capability for changes in fluxes with continued ice retreat in a future warmer world.

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