CO_2 evasion from the Greenland Ice Sheet: A new carbon-climate feedback

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Rising greenhouse gas levels may increase global surface temperatures between 1 and 6°C by 2100. Even greater increases are expected for the Arctic, where sea ice reduction, organic matter decomposition in lakes and thawed permafrost, and other positive feedbacks can potentially amplify the global trend. Melting of the Greenland Ice Sheet (GIS) figures prominently in climate change predictions because it will impact albedo, sea level, and possibly, ocean circulation. However, direct carbon cycle feedbacks are poorly constrained. Here, we show that melting of the GIS yields a previously unknown flux of CO_2 that will likely increase in a warmer world. Water emerges from the Russell Glacier in West Greenland with CO_2 partial pressures (pCO_2) 3 – 10X supersaturated with respect to atmospheric equilibrium. This CO_2 likely originates from microbial respiration beneath the GIS. During downstream transport, the chemical weathering of glacial till sequesters 70% of the excess CO_2 as HCO_3 – a carbon sink on human timescales – and the remaining 30% evades to the atmosphere. Scaled to all rivers draining the GIS, the evasion flux of 0.13 Tg C/yr is small by comparison to other atmospheric CO_2 inputs; however, we hypothesize that significant increases could occur as retreat of the ice sheet margin and expansion of moulins exposes meltwater to basal ice with pCO_2 values up to 340X higher than the current atmospheric value. Worst-case model predictions yield evasion fluxes of 100 – 180 Tg C/yr by 2100 depending whether melting increases linearly or exponentially with time. These CO_2 fluxes surpass those reported for Arctic Lakes (20 Tg C/yr) and would increase by 23% those predicted for permafrost thaw (800 – 1100 Tg C/yr). Our findings suggest that Arctic climate change could have a more significant feedback on global climate than currently anticipated.

Along-arc geochemical variations in the Southern Volcanic Zone, Chile

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The origin of enriched isotopic signatures in volcanic rocks from the northern segment of the Southern Volcanic Zone (SVZ) in Chile is controversial. Hildreth and Moorbath [1] argued for crustal assimilation in the context of their MASH model. Stern [2] and recently Kay *et al.* [3], however, proposed that subduction erosion can best explain the increasing enrichment of the magmas from the Miocene to present. We present new trace element and isotope data from young olivine-bearing volcanic rocks along the volcanic front of the SVZ in Chile. We observe systematic spatial variations in Sr, Nd, Hf and Pb isotopic compositions along the arc with the northern part of the Southern Volcanic Zone (NSVZ) having the most enriched signatures. Oxygen isotope data, with one exception, show uniform compositions, close to that expected for the upper mantle. Mixing calculations using O and Sr isotope ratios suggest that the enriched signature of the NSVZ lavas is primarily acquired in the mantle, favoring the subduction erosion model. Crustal assimilation, however, could also affect the composition of these lavas.

[1] Hildreth & Moorbath, (1988) *Contrib. to Mineralogy & Petrology* **98**, 455–489. [2] Stern, C.R. (1991) *Geology* **19**, 78–81. [3] Kay *et al.* (2005) *GSA Bulletin* **117**, 67–88.