Are high-Arctic Glacial Forefields CO_2 Sinks or Sources?

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Chemical weathering, one of the major factors contributing to soil formation, regulates nutrient availability to biota and acts as an atmospheric sink or source of CO_2. Soil formation in the high Arctic, despite being the fastest changing region globally, is still poorly understood. Here we show how high Arctic glacial forefields are not just highly biogeochemically active but also play a key role in contemporary soil development over a century of weathering. Across three 113 year chronosequences in Arctic Svalbard, both total inorganic carbonate (TIC) and total sulphur (TS: expressed as sulfide) decay exponentially along the chronosequences. Our data suggest that these forefields are sources of CO_2 over the first 29 yrs of weathering and that carbonate dissolution is coupled to sulfide oxidation. Furthermore, silicate weathering, expressed as a change in the chemical index of alteration (CIA), showed that Ca-silicate weathering only becomes dominant after 40 yrs of exposure. The CIA index is the same up to 40 yrs (57±1), but increases to 66±2 at 113 yrs. Complementary microbial diversity data show the development of soil microbial communities in tandem with an increase of geochemical weathering. The implications of these findings are that predicted Arctic warming could lead to a short-term increase in CO_2 flux before long-term benefits of silicate weathering are apparent. Our work can also inform soil development models in future fast-changing Arctic scenarios and maybe even in post snowball-earth scenarios.