Chemical weathering in King George Island, Antarctica

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King George island, Antarctica, is mostly covered by ice sheet and glaciers, but the land area is locally exposed for several thousand years after deglaciation. For a mineralogical study of chemical weathering in the polar environment, glacial debris was sampled at the well-developed patterned ground which was formed by long periglacial process. As fresh equivalents, recently exposed tills were sampled at the base of ice cliff of outlet glaciers and at the melting margin of ice cap together with fresh bedrock samples.

Fresh tills are mostly composed of quartz, plagioclase, chlorite, and illite, but those derived from hydrothermal alteration zone contain smectite and illite-smectite. In bedrocks, chlorite was the major clay minerals in most samples with minor illite near hydrothermal alteration zone and interstratified chlorite-smectite in some samples. Smectite closely associated with eolian volcanic glass was assigned to alteration in their source region. Blocks with rough surface due to chemical disintegration showed weathering rinds of several millimeter thick. Comparision between inner fresh and outer altered zones did not show notable change in clay mineralogy except dissolution of calcite and some plagioclase. Most significant weathering was observed in the biotite flakes, eolian volcanic glass, sulfides, and carbonates in the debris. Biotite flakes derived from granodiorite were altered to hydrobiotite and vermiculite of yellow brown color. Minor epitactic kaolinite and gibbsite were formed in the cleaved flakes of weathered biotite. Pyrite was replaced by iron oxides. Calcite was congruently dissolved. Volcanic glass of basaltic andesite composition showed alteration rim of several micrometer thick or completely dissolved leaving mesh of plagioclase laths. In the alteration rim, Si, Na, Mg, and Ca were depleted, whereas Al, Ti, and Fe were relatively enriched. Mineralization of lichen and moss debris is of much interest. They are rich of Al and Si roughly in the ratio of 2:1 to 3:1 typical of allophane. In some case, Fe and Ti are enriched in addition to Al and Si. Transmission electron microscopy of the samples rich of volcanic glass showed abundant amorphous aluminosilicates, which are interpreted as allophane.

Chemical weathering in the King George Island is dominated by the leaching of primary phyllosilicates, carbonates, eolian volcanic glass, and minor sulfides. Authigenesis of clay minerals is less active. Absence of a positive evidence of significant authigenic smectite formation suggests that its contribution to the clay mineralogy of marine sediments are doutful even near the maritime Antarctica undergoing a more rapid and intenser chemical weathering under more humid and milder climate.