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Accelerated chemical weathering in Kärkevagge Swedish Lapland: the pyrite connection

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In his seminal publication on landscape denudation in Kärkevagge, Swedish Lapland, Rapp (1960) made the startling discovery that chemical weathering exceeded any measured physical process of denudation. This counterintuitive finding called attention to the conventional lack of emphasis placed on chemical processes in cold environments. His interpretation was based on limited observations of soil and water chemistry and on some landscape features including “poisonous rocks” and “lime coated stream channels.” While insightful, Rapp offered no mechanism to explain these findings. Our subsequent work in Kärkevagge has revealed the driving mechanism of chemical weathering - acid production from pyrite oxidation. We have determined that pyrite occurs in some of the rock units in the valley and its oxidation produces sulfuric acid, H_2SO_4, which accelerates weathering. Along with Rapp, we have found that SO_4^{-2} is abundant in some water sources in the valley. We have determined that the poison in the “poison rocks” is sulfuric acid leachate that lowers the pH of surrounding soil and kills adjacent vegetation. The “lime coats” are primarily an amorphous aluminum sulfate which coats surfaces it contacts. That this is an active feature is demonstrated by efflorescence on actively growing seasonal vegetation in stream channels. Other secondary sulfate minerals associated with pyrite oxidation include yellowish coatings of jarosite, $KFe_3(SO_4)_2(OH)_6$, and rust-colored ferrihydrite, $Fe_2^{+3}O_3{\cdot}0.5(H_2O)$, or other iron oxides on local rocks. We believe that pyrite oxidation may be an important first step in weathering in many environments but largely goes unrecognized because it occurs rapidly and typically is only identified in highly disturbed landscapes associated

with mining and other large-scale earth-moving activities.