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Age and weathering status of granite tors in arctic Finland

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Cold-based ice along the Fennoscandian glacial ice divide in northern Finland allowed preservation of older landscape features. Because there was little or no movement at the ice-land surface contact, erosion was at a minimum, and relict landscape features such as tors can be found. We investigated two such granitic tors located at Pyhä-Nattanen (27° 22.207' E, 68° 07.335' N, 485 m a.s.l.) and Riestovaara (27° 09.003' E, 68° 02.613' N, 365 m a.s.l.) in subarctic Finland. At Pyhä-Nattanen, the sampling sequence included bedrock material and grus taken from within horizontal cracks, which are so prevalent at the site as to make the tor resemble a stack of pancakes. At Riestovaara, where the outcrop is more subdued, in addition to bedrock and grus samples, soil samples were also extracted from a pit dug in an embryonic soil forming on the bedrock surface.

Based on cosmogenic dating, both tors greatly predate recent glaciation. The tor at Pyhä-Nattanen, which is a more prominent landscape feature, had a longer minimum estimated total exposure age, 994 kyr, than did the tor at Riestovaara, 857 kyr. Analyses of the 10Be and 26Al cosmogenic data in accordance with marine oxygen isotope records indicates that the tors have survived at least 14–16 episodes of glaciation. Weathering, as measured by porosity determined with a microprobe, was somewhat more advanced in the Pyhä-Nattanen granite samples than in the Riestovaara granite. However, with both granites, rock porosity did not change to a depth of 4 cm below the rock surface, or vary by lichen cover/non-covered surfaces, indicating that weathering had progressed to a stage where recent lichen growth is overwhelmed by the long weathering history. Other measures of weathering, including total elemental analyses, did not detect significant differences among at-a-site samples, perhaps because all samples are highly weathered and we did not have

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a sample of unweathered granite for comparison. All samples, rock, grus and soil, were within the grus weathering range as indicated by chemical weathering indices. The soil forming adjacent to the tor at Riestovaara exhibited only slight development despite the great apparent age of the landscape. The regolith in which the soil is forming must therefore be much younger than the exposed bedrock and most likely represents a post-deglaciation accumulation of grus spanning only the last 9k years.