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Chemical weathering of volcanic tephra and their impact on pedogenesis in Icelandic soils

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Iceland offers a rare opportunity to investigate the impact of explosive volcanic eruptions on soil formation, soil weathering processes and soil quality. The volcanically active Vatnajökull area has received numerous tephra deposits of varying thicknesses during Holocene. The presence of the light coloured rhyolitic tephra from the Öræfajökull eruption in AD 1362 and a black coloured basaltic Veiðivötn tephra from AD 1477 in the research area in SE Iceland enables comparison between the weathering behaviour of tephra of different chemical composition, examination of their contrasting mineralogy and how they impact soil development in both, wetland and dryland soils.

Icelandic soils are unique. They are characterized by repeated input of tephra and a steady flux of aeolian material. Even high organic soils show an appreciable amount of inorganic material (leading to andic properties). Weathering rates in Iceland are usually considerable in spite of the predominant cold climate. Amorphous secondary minerals (e.g. allophane and imogolite) and poorly crystalline ferrihydrite are the dominant phases while layer silicates are not present or just minor components of the clay fraction of Icelandic soils.

Our investigation on histosols in SE Iceland showed that the mineralogy of the rhyolitic tephra was almost entirely comprised of quartz, suggesting that it hardly altered since its deposition in AD 1362. In contrast, the basaltic tephra showed more signs of weathering, even though it is younger and therefore exposed to soil forming processes for a shorter period of time. We found that the weathering behaviour and the alteration products formed in the soils are insignificantly controlled by the chemical composition of the parent glass, but may be enhanced by the local conditions. A prevailing low pH and the high SOM content inhibited clay formation in the soils. The presence of amorphous secondary clay minerals can be explained by aeolian deposition of allophanic material. In the clay fraction we identified 2:1 layer silicates (e.g. smectite and hydroxy interlayered minerals).

A complimentary study of dryland soils (andosols) in SE Iceland is now advanced. We will compare the weathering behaviour of tephra deposits in wetland and dryland conditions, reveal the role of the chemical composition of the tephra for pedogenesis and highlight the mineral transformation in tephra and Icelandic soils.