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The climosequence approach: Experiences from three continents, lessons learned and future challenges

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Soil climosequences are, by definition, sequences of soils whose variations are caused by differences in climatic conditions. In the real world, vegetation almost always co-varies along climatic gradients. Therefore, most soil climosequences are implicitly also vegetation-sequences. Here, we report results from three soil climosequence studies along altitudinal / climatic gradients in South America, Asia and Europe. On 3000-yr-old volcanic parent material in Ecuador, we observed precipitation of amorphous materials and accumulation of organic matter at high elevations, whereas halloysite dominated the clay mineralogy at low elevations. The different pedogenic pathways strongly affect the soils' present fertility and erodibility. On 200,000-yr-old volcanic deposits in Taiwan, the high-elevation soils also contained high amounts of amorphous materials and organic matter, whereas the low-elevation soils were dominated by gibbsite, kaolinite and hematite. On both volcanic climosequences, "andic" soil properties increased with elevation, resulting in taxonomic sequences from low-elevation Cambisols to high-elevation Andosols. In the Austrian Limestone Alps, we studied a climosequence of organic matter-dominated soils (Histosols) and found altitudinal trends in organic carbon stocks, organic matter quality as well as microbial community composition. Despite the wealth of information we can obtain from soil climosequence studies, this approach faces several challenges that need to be tackled by the scientific community in the future.