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Climate, time, or diagenesis? Exploring geochemical and mineralogical pedo-signatures in soils and paleosols.

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The objective of this presentation is to discuss geochemical and mineralogical pedo-signatures in soils and paleosols. A major challenge in paleosols studies is to disentangle the influence of the length of the soil-forming interval, the intensity of pedogenesis, and the potential effects of post-burial diagenesis. Here, I present examples of common pedo-signatures used in pedology and paleopedology to assess (paleo-)climatic conditions, namely morphology, geochemistry, and clay mineralogy. The first example explores a paleosol between basalt flows dated between 48 and 51 Ma in Antarctica. Despite the long hiatus between the basalt flows (approx. 3 Ma), the moderate/weak weathering degree suggested a short soil-forming interval and/or a not intense weathering environment. The presence of soil horizons, plant fossils, bioturbation features, and weak Fe mottles indicated a moist and biologically active environment. However, the presence of smectite and hematite suggested a more advanced weathering degree under a seasonally dry paleoenvironment. The combination of mineralogical and micromorphological techniques demonstrated that smectite was inherited from the parent material and hematite was formed due to long-term burial. The modern soil example presents a chronosequence study in the coastal temperate rainforest of southeast Alaska where soils belonging to the same taxonomic order (i.e., Spodosols), formed under similar parent material, forest type, and climatic conditions, have contrasting geochemical properties due to different soil-forming intervals. The suitability of weathering indices using Al as an immobile element (e.g., CIA) in forested environments is also discussed, and a modified version of CIA using Ti as an immobile element and including Mg is presented. These two examples highlight the challenges of interpreting (paleo-)climate using geochemical and mineralogical pedo-signatures in soils and paleosols. More research is necessary to distinguish the role of length, the intensity of soil formation, and diagenesis on pedo-signatures in paleosols. Detailed field morphology and micromorphology descriptions combined with the use of soil chronofunctions could provide a suitable approach to assess the length of soil-forming interval and intensity of weathering processes. The identification of diagenetic features, especially in pre-Quaternary paleosols, can also provide a more informed interpretation of paleoclimatic conditions.