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Neogene Paleosols in Cappadocia – Archives of Global Changes in Climate and Vegetation in the Late Neogene

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In the late Neogene (11-3 Ma, [1]) about 9 catastrophic ultraplinian eruptions resulted in voluminous ignimbrites which cover an area of at least 10.000 km^2 called the Nevsehir Plateau in Cappadocia, Central Anatolia. The wide-spread ignmibrites and pumice fall-out layers are interlayered with lacustrine sediments and sequences of lahars with a variable paleopedogenic overprint. As the volcaniclastics conserved the terrestrial landscape in situ within seconds to minutes, they (a) allow to correlate soil and lacustrine sediment profiles over tens of kilometers apart because each unit is distinct in lithology, mineralogy and chemistry, (b) serve as excellent marker horizons within Central Anatolia as they contain datable mineral phases as phenocrysts (e.g. mica, amphibole, feldspar and zircon). The conserved paleosols are thus archives of changes in paleoclimate and vegetation, that can be deciphered by mineralogical and chemical analyses.

The stratigraphic intervall is of special interest as it includes the Late Miocene phase of extreme aridity (the “Messian crisis”). While this is represented by widespread salt deposits in the Mediterranean Sea (5.5 – 4.8 Ma) it is indicated in the sediment section of Cappadocia by an intervall of Aridisols that contain palygorskite, gypsum pseudomycelia and calcretes. This intervall is embedded in a succession of Inceptisols and Entisols with characteristics indicating a more humid semi-arid seasonal climate. Using whole rock geochemical analyses we are able to describe the intensity of pedogenic processes (oxidation, hydrolysis, drainage, clay formation, calcification or salinization) by molecular weathering ratios as indicators for paleoclimatic conditions, e.g. the amount of precipitation.

The paleosols also conserve the last major global ecosystematic change from a paleovegetation that was dominated by C3 plants (e.g. brush/tree-steppes) to the modern vegetation that is characterized by dominance of C4 plants (e.g. grass-steppes). As in other Aridisols of late Miocene to early Pliocene age (8 – 4 Ma) in Kenya, Pakistan, the badlands of North America, and China, this last major global ecosystem change is conserved within the δ^{13}C isotope shift from –10 to +/-0 ‰ in their pedogenic calcretes [2,3,4,5]. This change is documented between 8 and 5 Ma, however, with differences in timing and duration [3,5,6]. In Cappadocia, the necessary temporal constraints can be provided by Ar/Ar dating of the ignimbrites and fall-out tephra layers as well as the biostratigraphy of mammalia fossil bones and teeth embedded in lahars, paleosols and reworked sections of ignimbrite units.

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