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Palaeoenvironmental insights into Pliocene palaeosols of Tuscany (Italy).

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Pliocene has a key role in assessing future climate impact and specifically, the mid-Piacenzian is considered the most recent period in Earth's history in which temperatures reached values similar to those predicted for the end of the 21st century, about 2°–3°C warmer globally on average than today. Palaeopedology offers a great potential for elucidating high resolution, deep time palaeoclimate records. Thus, we aimed to investigate palaeosols as suitable archives for reconstructing surface processes, paleo-ecosystem structures and local- to global-scale paleoclimate patterns in the Pliocene.

A favourable opportunity to study soils developed in the Early and in the Late Pliocene was provided on two alluvial sediments in Tuscany (Central Italy). Piacenzian palaeosol-stratigraphic sequences were compared with previously known Zanclean stratigraphic records. A multi-proxy approach, combining stratigraphic and paleopedological evidence, was adopted to produce more robust palaeoenvironmental insights. Field observations were related with quantitative techniques based on geochemical and isotopic analysis, to evaluate pedogenic processes, past-climate and palaeovegetation.

Pedological evidence of two contrasting environments were present at the two sequences. Strong redoximorphic features such as low-grade plinthite were observed in the Zanclean-age soil, suggesting that these soils evolved in humid palaeoclimate in a time span of a few thousand years. On the other hand, the Piacenzian-age soils of central Tuscany represented rhythmic and short intervals of pedogenesis, connected with sea level highstands. The best developed palaeosols show very well-expressed Calcic horizon. Pedogenic carbonates are typically associated with well-drained soil profiles in sub-humid, semi-arid and arid climates characterized by relatively low rainfall and high evapotranspiration. This suggest that Mediterranean-type rainfall patterns may have prevailed in the warmest intervals of Late Pliocene. The studied Piacenzian soils with carbonates were weak- to moderated-developed based on the characteristics of carbonate accumulation that are II and III stage moving from the ancient to the recent ones, suggesting a range of development from 10^3 to 10^4 years.

The estimates of the mean annual precipitation (MAP), based on weathering indices (CIA-K) and geochemical climofunctions, further allowed us to solidly inferred that substantial differences in climate conditions leaded to the divergent pedogenesis pathways, even considering the large difference in time as a factor (about one order of magnitude) between the two outcrops.