

What stable isotopes in bulk organic matter and FAMES imply about precipitation, land use, and the rise and fall of civilizations in Northern Ethiopia

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The Tigray Plateau is a pivotal region for the study of relationships between climate, land use and the rise and fall of sophisticated societies. It was the site of an origin of agriculture and a long succession of highly developed kingdoms. Its topography makes it prone to accelerated erosion and mass wasting. Location along the ITCZ and the East African rift make the region prone to climatic changes. The repetition of human history facilitates analyses of the effects of environmental change on the trajectories of complex societies. We are examining the hypothesis that climate and land use changes influenced the ascents and collapses of the kingdoms supported by the Tigray Plateau. Our proxies come from strata of ravine walls in eastern Tigray. They consist of stable isotopic analyses of carbon and nitrogen in bulk organic matter, hydrogen in long-chain Fatty Acid Methyl Esters, and ¹⁴C dating and identification of charcoal. Studies suggest that FAMES are resistant to diagenesis in drier climates and δ DFAME value record information about precipitation. The $\delta^{15}\text{N}$ values of soil organic matter are usually inversely related to precipitation but have not been used in palaeoclimatic reconstruction due to lack of knowledge about diagenetic effects. Both δ DFAME values (C26, C28, C30) and $\delta^{15}\text{N}$ values have been increasing since 5500 cal yr BP ($p < 0.0005$) and these trends may be the result of a systematic decrease in rainfall over that period. $\delta^{15}\text{N}$ values did not vary systematically with nitrogen content and so did not support the hypothesis that the trend was caused by continuous fractionations by diagenesis over time. Additionally, the δ trends in both elements would likely have been in the opposite direction had they been entirely the result of diagenesis. Vegetation changes do not necessarily indicate changes in climate. For example, $\delta^{13}\text{C}$ values suggest that relative C4 plant cover peaked at the initial ascent of the most powerful of the ancient civilisations (ca. 2600 cal yr BP). If our interpretations are correct, then present evidences suggest that human disturbances of land had a stronger association with societal developments than did climate change.