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Reconstructing the evolution of Earth's sub-tropical critical zones using supergene Fe-minerals (U-Th)/He geochronology

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The Earth's continental crust surface, i.e. critical zone, responds to geodynamical and climatic changes through dynamic organic and inorganic chemical exchanges, participating in the dissolution of primary minerals and the subsequent precipitation or rejuvenation of secondary supergene minerals (e.g. Fe-minerals, clays). Understanding the formation and evolution of the Earth's surface, the natural accumulation of potentially toxic metals, past and present hydrology, landscape changes, or biodiversity adaptation in relation to climate oscillations is crucial for assessing Earth's habitability. This is particularly important for sub-tropical regions, where the high rate of weathering of parent rocks and natural accumulation of toxic metals are accentuated by hot, humid climate. In this contribution, we employ (U-Th)/He geochronology on supergene Fe-minerals like hematite and goethite formed during the Cenozoic. The application of the (U-Th)/He technique to these minerals, coupled with a detailed understanding of their helium retention and mineral properties, enables precise dating over million-year timescales. We present data from lateritic Fe-duricrusts in French Guiana and ore deposits in Morocco, highlighting the potential of the (U-Th)/He method, and examining the significance of age dispersion in those samples. These examples shed light on the paleoclimatic influences on Earth's critical zone particularly through the weathering and precipitation of Fe-minerals.