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An astronomically-tuned climate framework for hominins in the Turkana Basin

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Understanding the influence of orbital climate cycles on hominin evolution in Africa remains a key challenge in paleoanthropology. Many hypotheses have been put forward to link climate and environmental change with important junctions in the evolution of the human lineage. However, in order to test these hypotheses (or to generate new ones) high-resolution temporal synchronicity of climatic and evolutionary events needs to be demonstrated. The two major unresolved issues are the paucity of relevant high-resolution terrestrial climate records, and the lack of age control on hominin fossil occurrences at sufficiently high resolution. Here we present a novel climate proxy, strontium isotope ratios (87Sr/86Sr) of lacustrine fish fossils from the Turkana Basin (Kenya, Ethiopia), that solves these issues by capturing orbitally forced variation in summer monsoon intensity over the Ethiopian Highlands. We applied the proxy to a $\sim$ 130 ky time interval of $\sim$2 million year old paleolake deposits containing important fossils of early Homo and Paranthropus. Age control is ensured by the well-dated KBS Tuff at the top of the sequence and by a new high-resolution magnetostratigraphic record that pins down the base of the Olduvai subchron near the bottom of the sequence. Spectral analysis reveals that 87Sr/86Sr variability is primarily determined by precession, which enables us for the first time to place hominin fossils in an astronomically-tuned climate framework. Our results show that between $\sim$ 2 and 1.87 Ma the Turkana Basin remained well-watered and inhabited by hominins even during dry periods of precession maxima configurations. This is in contrast to other basins in the East African Rift System (EARS) that were impacted heavily by precession-forced droughts. We conclude that during lake phases, the Turkana Basin could function as an aridity refugium for hominins over the precessional climate cycles. The Sr climate proxy constitutes an innovative approach that yields exceptionally detailed terrestrial climate information at precession timescales. It can be applied in all hominin-bearing lake deposits in the Turkana Basin, ranging in age from $\sim$ 4.2 to 0.8 Ma and covering key events in evolution of the human lineage. Hence, it serves as a powerful tool for testing and generating of climate-evolution hypotheses.