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Earthworm secreted calcium carbonate: a new palaeothermometer

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Oxygen and carbon isotope ratios of calcium carbonate skeletons, produced by a range of aquatic and terrestrial organisms, have often been found to be useful proxies for environmental variability. Although they do not form skeletons, many earthworm species are true biomineralisers, secreting granules of intricately zoned calcite. These granules are frequently found in archaeological finds and buried soils. We investigated the utility of stable isotope compositions of earthworm secreted calcite granules for reconstructing past environments.

Experiments were designed in which individual earthworms (Lumbricus terrestris) were kept in bags of soil for up to four months. Two different types of soil (C3 and C4 vegetation) were used, which were air-dried and then moistened with three isotopically different types of mineral water. The experiment was performed at three different temperatures. δ13C and δ18O values were measured for the soil organic matter, soil pore water, food (manure), soil air, earthworm tissues and $CaCO_3$ granules. Results show that the δ18O values of the granules accurately reflect temperature and δ18O values of pore water, enriched by $\sim$1.5 ‰ in comparison to inorganically precipitated calcite. δ13C values appear to reflect those of food offered to the earthworms.

In combination with U/Th dating, the stable isotope composition of earthworm secreted calcite granules will enable the reconstruction of past temperatures, and probably vegetation and soil organic matter composition. As such it provides a useful new terrestrial proxy for the reconstruction of past environments in archaeological and geological contexts.