

Application of isotope-geology to ichnology: paleoecology of the Phymatoderma-producer based on carbon-isotope analysis

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The present study shows a case study that applies isotopic analysis to ichnology. The ichnogenus *Phymatoderma* is a subhorizontal branching burrow system consisting of radiating tunnels filled with fecal pellets. This ichnogenus has been interpreted as a product of a deposit-feeding organism, but the question of whether the *Phymatoderma*-producer was a subsurface deposit feeder or a surface deposit feeder is still a topic of controversy. Here I present evidence for the surface deposit-feeder hypothesis, based on carbon-isotope analyses, for the trace fossil *Phymatoderma granulata* from the lower Toarcian black shale in southern Germany. Carbon-isotope ratios of organic carbon in the pelletal infill of *P. granulata*, the surrounding black shale, and the overlying gray mudstone are -26.64 permil, -28.49 permil, and -26.27 permil, respectively. The difference between the pelletal infill and overlying mudstone in terms of C-isotope ratio is much smaller than that between the fillings and black shale; therefore, these data clearly indicate that the *Phymatoderma*-producer ingested the surface sediments and subsequently excreted fecal pellets into the subsurface sediments. Such a surface deposit-feeding style would be an effective way of absorbing nutrients, because surface sediments contain much fresh organic material, whereas organic matter in subsurface deposits consists mostly of refractory material that is poorly utilized by most marine benthos.