

## **Identification of fossil worm tubes from Phanerozoic hydrothermal vents and cold seeps**

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One of the main limitations to understanding the evolutionary history of hydrothermal vents and cold seep communities is the identification of tube fossils from ancient deposits. Tube-dwelling annelids are some of the most conspicuous inhabitants of modern vent and seep ecosystems, and ancient vent and seep tubular fossils are usually considered to have been made by annelids. However, the taxonomic affinities of many tube fossils from vents and seeps are contentious, or have remained largely undetermined due to difficulties in identification. In this study, we employ a detailed chemical and morphological assessment of modern annelid tubes from six families, and fossil tubes (seven tube types from the Cenozoic, 12 Mesozoic, and four Palaeozoic) from hydrothermal vent and cold seep environments. Characters identified from the above investigations were used to, for the first time, explore the systematics of ancient vent and seep tubes within a cladistic framework. Results reveal details of the compositions and ultrastructure of modern tubes, and also provide vital insights into whether tubes possess sufficient diagnostic characters to allow discrimination between different annelid lineages, as well as into the evolutionary history of annelids within vent and seep environments.