Geochemical and environmental importance of marine archaea

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Molecular biological analyses have revealed over the last decade or so that archaea, one of the three kingdoms of life, are not restricted to extreme environments like volcanic hot springs, brines or anoxic conditions, but also thrive in more temperate environments such as oceans, lakes and soils. In fact, one specific clade within the crenarchaeota is even thought to make up 20% of the picoplankton in the world's oceans (Karner et al., 2001). These findings indicate the abundance of a completely new and important group of microbes in the marine water column. However, their physiology and role in the carbon cycle is presently enigmatic.

We recently showed that the abundant "cold" crenarchaeota from the marine water column make glycerol dialkyl glycerol tetraethers (GDGTs) similar as those encountered in cultured hyperthermophilic organisms with the exception of one GDGT, "crenarchaeol", which is uniquely characterized by the presence of a cyclohexane ring (Schouten et al., 2000). This specific lipid not only allows us to trace the presence and environmental abundance of these microbes in present day oceans but also enables the reconstruction of their evolutionary history and provides us with information on their role in the global carbon cycle. Furthermore, using these lipids several new organic geochemical proxies were developed among which a new proxy for reconstructing ancient sea surface temperatures.

References

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Carbon isotope stratigraphy of Middle Cambrian to Lower Silurian shales from Baltoscandia: implications for presumed climatic stability

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A 120 million years record of the isotopic composition of organic matter has been constructed for Scandinavia. The isotope curve is based on a regional survey of samples from shallow to deep-water environments and through a range of different thermal ranks (immature to low metamorphic). In the Cambrian, a +5‰ shift in carbon isotopic compositions takes place through the basal Middle Cambrian to lowermost Upper Cambrian. The rate of changes in the carbon isotopic composition accelerate, however, in the basal Upper Cambrian where a +2‰ excursion is located in the *H. obesus* and *G. reticulatus* bearing part of the *Olenus* Zone. This excursion seems to correlate with the Steptoean positive carbon isotope excursion (SPICE) and hence confirms that a major global change in carbon cycling took place in the world's oceans during the earliest Late Cambrian.

During the Ordovician and Silurian, the carbon isotopic composition fluctuates with a higher frequency compared to those of the Cambrian interval. The most prominent feature is a +3‰ excursion in the upper Ashgill (lower Hirnantian Stage) confirming the both inorganic and organic carbon isotopic signature of the Hirnantian glaciation. A pre-Hirnantian carbon excursion (+2‰) is located across the *foliaceus/clingani* boundary (mid to late Caradoc) that might prove coeval with the Guttenberg carbon isotopic excursion. A +2‰ shift in carbon isotopes is seen in the uppermost Ordovician (*N. persculptus* Zone) extending into the middle Llandovery (Lower Silurian). No data are currently available from the Late Llandovery or younger levels.

The carbon isotopic composition provides additional ties useful for intercontinental correlation and may act as a robust chemostratigraphical tool even in metamorphic sections. Furthermore, the identification of isotopic excursions within the inorganic and organic carbon reservoirs allows evaluation of the mechanisms behind carbon cycling and its relationship to global climatic changes. The variable carbon isotopic composition recorded in the Ordovician and Silurian compared to those in the Middle and Upper Cambrian might thus reflect differences in climatic stability perhaps related to fluctuating CO_2 levels. Accordingly, the Mid Cambrian to Early Ordovician may have been characterised by higher levels of CO_2 compared to the remainder of the Ordovician and Silurian.

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