GLOEOCAPSOMORPHA PRISCA AND ITS INFLUENCE ON THE ORGANIC d13C RECORD IN THE LATE MIDDLE ORDOVICIAN, CENTRAL UNITED STATES

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Organic matter in the Decorah Formation (Middle Caradocian, Central United States) records a 7‰ positive carbon isotope excursion (Hatch et al., 1987) associated with a pronounced increase in the abundance of the organic microfossil, Gloeocapsomorpha prisca (Jacobsen et al., 1988). This organism is abundant in Ordovician units, yet its physiology and habitat remain controversial. To understand the nature of G. prisca and whether or not it contributed to the expression of an isotope excursion in the Decorah, we performed molecular and isotopic analyses on a continuous section of rocks from the Decorah and the underlying Platteville Formation. We collected thirty samples spanning the Middle Caradocian from the Cominco SS-9 core, drilled in Jackson County, Iowa and archived at the Iowa State Geological Survey. Total lipid extracts were obtained and fractions isolated using standard techniques, and isotope ratios were determined by irm-GC/MS using a Finnigan MAT252. Saturate and aromatic fractions were characterized using a HP GC/MS (5972MSD) operating in selective ion monitoring mode.

In the SS-9 core, the n-alkane distribution varies with the proportional abundance of G. prisca as determined using petrographic techniques by Jacobsen et al. (1988). In particular, n-alkanes with less than 20 carbon atoms are more abundant relative to higher-molecular weight homologues and exhibit a strong odd-over-even dominance when the proportional abundance of G. prisca is high. This relationship is common in other G. prisca-rich rocks, and we use n-alkane distributions as a first-order proxy for the relative contribution of G. prisca in these samples. Samples containing abundant contributions from G. prisca are characterized by significantly lower sterane:hopane ratios (Fig.1), high n-alkane:isoprenoid ratios, and elevated abundances of tetracyclic relative to tricyclic terpanes. We also observed several homologous series of n-alkylated cyclohexanes (Fowler et al., 1986) and benzenes.

Highest concentrations of G. prisca occur in the Guttenberg Member of the Decorah Formation and lowest concentrations occur in the uppermost Platteville Formation and the Spechts Ferry and Ion Members of the Decorah. The Guttenberg Member was deposited below storm wave base at depths of several tens of meters to perhaps 100 meters (Ludvigson et al., 1996) and under conditions that were relatively oxidizing (as determined by a range of biomarker proxies). The other units were deposited in relatively shallower waters, under more reducing conditions and contained a series of aryl isoprenoids similar to those reported by Summons and Powell (1987) and attributed to green photosynthetic bacteria.

Proportionally greater quantities of low-molecular weight n-alkanes (<C20) are associated with G. prisca, and therefore, we expect contributions from G. prisca to the n-alkane pool to decrease with increasing molecular weight. If the 7‰ positive excursion in (13CTOC is partially or wholly caused by a transition from G. prisca-poor to G. prisca-rich organic matter, higher molecular-weight n-alkanes should exhibit a smaller excursion. We observe this in the Guttenberg (Fig. 1B) and suggest that G. prisca is enriched in 13C relative to other sources of organic matter. Isotopic analyses of n-alkylated cyclohexanes and benzenes are consistent with this interpretation.

Based upon the relationships between G. prisca abundance and compound distributions we propose that this organism was a photosynthetic, planktonic prokaryote. Coastal upwelling in this region may have caused G. prisca in the Guttenberg to be further enriched; high nutrients could cause elevated growth rates and decreased fractionation during photosynthesis. Thus, extensive production and burial of G. prisca may impact the (13CTOC record. Here, increased contributions from G. prisca have amplified an important regional carbon isotope excursion from approximately 3‰ to 7‰.

References

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