Goldschmidt 2000
September 3rd–8th, 2000
Oxford, UK.

Journal of Conference Abstracts
Volume 5(2), 579

Biomarker Constraints on Water Column Structure and Oceanographic Circulation in an Epeiric Sea (Callovian, Jurassic, North-Western Europe)

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Molecular fossils (biomarkers) provide a tool for water column structure reconstruction when associated with paleontological data. In turn, water column structure and it evolution with time provide strong constraints on paleoceanographic circulation. Water column structure is defined for an epeiric sea that joins the Arctic Mediterranean to the Tethyan ocean during the opening of the North Atlantic (Callovian, Jurassic).

Callovian samples, stratigraphic equivalent to the Peterborough Member of the Oxford Clay (Callovian, Central England) were collected from the Isle of Skye (Scotland) to Boulogne (France) for organic geochemical analysis. A particular attention was given to isorenieratene derivatives. Isorenieratene is a molecule synthesized by the brown strain of the green sulfur bacteria *Chlorobiaceae*. The presence of *Chlorobiaceae* in the environment of deposition is an unambiguous indicator of water column stratification, with anoxic bottom waters reaching into the photic zone (e.g. Summons and Powell, 1986; Kenig et al., 1995). Stratigraphic and geographic distribution of isorenieratene derivatives within the Callovian seaway is compared to palaeontological and sedimentological data, such as benthic biofacies assemblages and extent of bioturbation. This permits to determine that: 1- A stratified water column with anoxic bottom waters was a permanent feature in Skye (Scotland) where sediments are organic carbon-rich, laminated, and contain isorenieratene derivatives including isoreniaratane; 2- High-frequency intermittent anoxic events characterize the environment of deposition of the organic carbon-rich (marine algal organic matter), argillaceous, fossil-lagerstaetten of the Peterborough Member (Oxford Clay, Callovian, Central England) where sediments are burrowed, contain benthic fossil assemblages and isorenieratane; 3- Stratification of the water column was a rare event in Northern France where sediments are organic carbon poor (with altered algal organic matter) but still contain isorenieratane. In such a paleogeographic context, it can be hypothesized that water column stratification resulted from fresh water discharge within the epeiric sea from the large landmasses bordering the seaway. The permanent stratification of the water column in Scotland indicates its proximity to fresh water discharge. The fresh water lid was recurrently covering Central England, but only reached Northern France in rare occasions resulting in poor preservation of organic matter. This can be explained by the morphology of the seaway which was relatively narrow at the latitude of Skye but broadened Southward toward France where it opened on the Tethyan ocean. The fresh water discharge in the seaway was rarely large enough to result in stratification of the broad seaway in Northern France.

This paleoceanographic reconstruction is supported by other geochemical evidence. The Callovian sediments of Skye contain more pyrite than sediments of Central England (Fisher and Hudson, 1987) but do only contain trace amounts of sulfurized organic compounds. On the contrary, Central England sediments contain a polysulphide bound macromolecule suggesting that sulfurization of organic matter occurred. This implies that the supply of reactive iron must have been higher in Skye than in Central England, suggesting that fresh water input in the seaway occurred north of Skye. This is also supported by decreasing relative concentration of land-plant derived biomarkers from Skye to Boulogne. The exact location of fresh water discharge within the seaway cannot be determined but the East coast of Greenland is a good candidate with its Callovian marine sandstones (e.g. Petersen et al., 1998).

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