A new model for cold climate source rock preservation in the Arckaringa Basin

Thesis submitted in accordance with the requirements of the University of Adelaide for an Honours Degree in Geology

Natalie Debenham

November 2014

THE UNIVERSITY of ADELAIDE

TITLE

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ABSTRACT

The controls on organic carbon preservation in sediments are poorly understood, however there is a first order association between high total organic carbon concentration (TOC), warm climates and fine grained sediments with mature mineralogy in the geologic record. Permo-Carboniferous marine sediments in the Arckaringa Basin, however, present an exception with anomalous organic carbon concentration (<11% TOC) occurring within mineralogically immature siltstones deposited in deep, narrow (marine) fjords during glacial conditions. Organic matter (OM) is not refractory terrigenous material, but rather hydrogen-rich and labile, thus identifying an active preservational mechanism that differs from conventional organic carbon enrichment controlled by mineral preservation effects. Energy Dispersive Spectrometry (EDS) reveal an association between labile OM and high sulphur concentrations, and EDS mineral mapping identifies a cyclic millimetre alteration between sulphur/OM rich laminae and manganese carbonate (kutnohorite) laminae, identifying oscillating benthic redox conditions similar to annual varves in proglacial environments. Framboidal pyrite (<5 µm) is abundant only within organic-rich laminae, indicating sulphate reduction in euxinic conditions resulting from restricted sea water exchange and the development of strong density stratification. Seisimic profiles indicate that deposition occurred in fjord-shaped troughs, with restriction resulting from end moraines acting as sills to the open ocean. Thus, organic carbon enrichment is attributed to restriction in the ancient fjords, leading to periods of hydrogen sulphide build up within the water column that were annually flushed with seasonal change in temperature and runoff. The reducing conditions of the fjord provided a chemical trap for S leading to its enrichment in organic matter. Similarly, Mn within carbonates was enriched in the same manner. Excess dissolved sulphur build up in the water column and sediments resulted in vulcanization (sulfurization) reactions polymerizing labile organic compounds (lipids and carbohydrates) and their preservation as organosulphur compounds during early diagenesis.

KEYWORDS

Arckaringa Basin, organic carbon, preservation, vulcanization, icehouse, source rock

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