Organic Matter Preservation in clays from the Basal 'Hot Shale' of the Arthur Creek Formation within the Georgina Basin, Australia

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TITLE

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ABSTRACT

Organic matter (OM) preservation in sedimentary basins has been the focus of studies since the turn of the century; however, a single unifying mechanism is yet to be accepted. Multiple hypotheses have been proposed regarding mechanisms governing OM preservation, one of which is physical protection through clay mineral adsorption. The working hypothesis for this study was that OM concentrations (total organic carbon, TOC) scale with total mineral surface area (MSA) and that without clay minerals OM is not preserved. In this study the relationship was tested with swelling clays, such as smectite, known for extremely high MSA. The observed relationship between MSA and TOC partially supports this hypothesis via a positive linear relationship between TOC and MSA, as well as the scaling of TOC to MSA when plotted against depth. Significantly however, smectite was not identified by X-ray diffraction, yet samples displayed organic carbon loadings almost double that of previous studies conducted on smectitic clays. Comparison of the MSA/TOC slope to that of measured organic carbon monolayer equivalent loading (MEL) of standards led to the conclusion the relationship is relict from depositional association which has been modified by diagenesis. Despite illitization, this relationship indicates that MSA has a significant control on OM content even after diagenesis, hydrocarbon generation, migration and degradation have occurred. It seems possible that illitization enhances the protection of OM, possibly through intragranular porosity within quartz cement. This study showed that the MSA-TOC relationship commonly observed in thermally immature modern (and some ancient) sediments extends to thermally mature illitized sediments of Mid-Cambrian age (520Ma). Evidence of biodegraded hydrocarbons, identified by GC-MS (gas chromatography-mass spectrometry), provides evidence that thermally mature clays are able to absorb migrating hydrocarbons and become associated with organic carbon in the deep burial environment.

KEYWORDS

Organic matter, Preservation, Illite, Illitization, Mineral surface area, MSA, Arthur Creek Formation, Hot Shale, Georgina Basin, Mid-Cambrian.

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