ELEMENTAL, ISOTOPIC AND MOLECULAR SIGNATURES OF EARLY CAMBRIAN MARINE SEDIMENTS AND A PHANTOM PETROLEUM SYSTEM IN SOUTH AUSTRALIA

By

Philip Anthony Hall

M.Phil. Environmental and Geographical Sciences, Manchester Metropolitan University, U.K.
B.Sc. Hons. Geology and Petroleum Geology, University of Aberdeen, U.K.

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School of Earth and Environmental Science
Faculty of Science
University of Adelaide

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Palaeoredox status and thermal alteration of the lower Cambrian (Series 2) Emu Bay Shale Lagerstätte, South Australia. Australian Journal of Earth Sciences 58 (2011) 259-272. doi: 10.1080/08120099.2011.557439

Biomarker and isotopic signatures of an early Cambrian Lagerstätte in the Stansbury Basin, South Australia. Organic Geochemistry 42 (2011) 1324-1330. doi:10.1016/j.orggeochem.2011.09.003

Signed..... Date.....

ABSTRACT

The aim of the research study is to apply mass spectrometric geochemical techniques to the investigation of palaeoenvironmental, chemostratigraphic and provenance questions from several South Australian Phanerozoic basins.

Results of a multi-pronged palaeoenvironmental investigation of Early Cambrian marine sediments, employing trace and REE abundances, TOC and stable isotopes (C, S) are reported from three formations in the Stansbury Basins; Heatherdale Shale, Emu Bay Shale and Talisker Formation. The multiproxy approach in conjunction with sedimentological information provides a powerful tool for interpreting palaeoenvironmental conditions. Prevalent palaeoredox conditions of the Heatherdale Shale and Talisker Formation were dysoxic, evolving progressively more reducing natures up section. The Emu Bay Shale conversely demonstrates consistently aerobic interpretations for the redox proxies. Comparison of trace element and REE distributions to similar sequences of the Yangtze platform, South China shows striking similarities, Analogous basinal environments and common provenance may have lead to the seawater trace element chemistry of the Palaeo Pacific & Asian oceans exhibiting a homogenous nature.

The Emu Bay Shale biota is the richest Burgess Shale-type (BST) fauna in the southern hemisphere. The implied oxic water column during accumulation appears difficult to reconcile with the exceptional preservation exhibited. Micro-scale sealed vessel (MSSV) pyrolysis of isolated kerogen and $\delta^{13}C_{org}$ values provided confirmation of its redox status and implicate cyanobacteria in the preservation mechanism. Molecular signatures diagnostic of *Gloeocapsomorpha prisca* were identified, the first indication that microbial mats were involved in the taphonomy of a BST deposit.

The biostratigraphic definition of GSSP horizons though the use of cosmopolitan taxa biohorizons is problematical for sections such as lower Cambrian deposits where few candidate fossils exist. Instead, an integrated approach comprising chemostratigraphy and/or sequence stratigraphy with the known biostratigraphy greatly increases our ability to make high-resolution correlations., $\delta\ ^{13}C_{carb}$ profiles from three South Australian basins; the Stansbury, the Arrowie and the Officer are correlated regionally with the existing data from the Flinders Ranges. Globally identified excursions such as the negative ROECE and AECE event and the positive CARE and MICE events, are recognised in the profiles. This chemostratigraphic interpretation appears to support the biostratigraphic assignment of the sections.

Asphaltic bitumens are long known to strand along coastlines of southern Australia and as far afield as New Zealand and Macquarie Island. Widely regarded as artefacts of an unidentified submarine oil seepages, a common source is interpreted from remarkably uniform compositions. An important consideration when attempting to locate their point of origin is the degree of weathering exhibited, which will reflect the residence time in the marine environment and proximity of the seep to the stranding site. Biomarker signatures and *n*-alkane C-isotopic profiles from interior and weathered exterior sub-samples of asphaltum from four localities in South Australia and New Zealand were compared. No distinction could be made between strandings despite their widely separated localities. The degree of degradation and isotopic variance suggest an origin from low intensity seeps in the western Otway Basin as strandings on the Limestone Coast and Kangaroo Island appear less weathered than those from Eyre Peninsula and New Zealand.

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.....and I'd like to thanks the late Douglas Adams for two little words inscribed in large friendly letters on the front cover of the Hitchhiker's Guide to the Galaxy:

DON'T PANIC

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