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Iron-rich authigenic minerals in Lower Cretaceous transgressive shallow marine greensands, NW Shelf, Western Australia: an integrated diagenetic, ichnological and sedimentological analysis.

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The Lower Cretaceous Mardie Greensand in the Carnarvon Basin, Western Australia is a regionally extensive, highly condensed, transgressive shallow marine succession characterised by glaucony-rich sandstones and mudstones containing abundant, and often intense, siderite cementation. The aim of the research presented here is to determine, through the integration of stratigraphic, sedimentological and diagenetic analysis, the controls on early diagenetic cementation and resulting patterns of cement distribution within the Mardie Greensand.

Diagenetic phases in the Mardie Greensand are complex and dominated by iron-rich mineral cements. Abundant glaucony grains take the form of regular to irregular pellets. Grain-rimming and pervasive pore-filling siderite cement (δ^{13}C = –5.3 to –12.6$^{o}/_{oo}$ VPDB, δ^{18}O = -5.5 to –9.30$^{o}/_{oo}$ VPDB) is abundant, with pervasive cement being prevalent in the lowermost part of the succession forming siderite beds. Late-stage ankerite (δ^{13}C = -8.5 and δ^{18}O = -10.2$^{o}/_{oo}$ VPDB respectively) occurs as a replacive phase in glaucony and siderite beds, or as a poikilotopic cement in coarser units, post-dating quartz cement. Minor early diagenetic pyrite is present throughout glaucony beds, but within siderite beds, pyrite is almost invariably late in origin. Deposition within the upper part of the Mardie succession occurred within a well oxygenated, low energy, gently dipping inner shelf setting. Trace fossil diversity is high, and dominated by '*Teichichnus zigzag*', *Skolithos*, *Diplocraterion habichi*, *Planolites* and ?*Macronichnus*. Complex cross-cutting and tier development are characteristic. Within the lower part of the succession in the southernmost part of the study area,

trace fossil diversity and intensity are significantly reduced (diversity=1-2, BI=1-3). *Thalassinoides* are dominant, with minor *Skolithos*, and *Ophiomorpha irregulaire*.

The glaucony facies in the upper parts of the succession, which represents deposition within well oxygenated, open marine shelfal conditions, reveals good to moderate reservoir quality. The glaucony grains, which formed either *in situ* or were reworked from further inshore, are poorly cemented by siderite resulting is relatively high primary porosity. The presence of early diagenetic pyrite and minor siderite suggests that sulphate reduction and iron reduction were important during early diagenesis. The low diversity trace fossil assemblages in the lower part of the succession are thought to represent deposition under restricted and periodically stressed marine conditions. Extensive siderite cementation is thought to be a consequence of low net sediment accumulation rates and low accommodation space in nearshore protected embayments during the earliest stages of transgression, resulting in greater sediment condensation. This led to early diagenesis being dominated by bacterial iron reduction (sub-oxic diagenesis), and the resulting precipitation of extensive grain-rimming and pore-filling siderite cement, and a substantial reduction in reservoir quality in this part of the succession.