Abstract

Climatic Controls on Deposition in Syn-Rift Sequences: A Case Study of Cambrian–Ordovician Siliciclastics Tasmania, Australia.

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The Late Cambrian–Early Ordovician siliciclastic sequences in northern and western Tasmania, Australia, represent an excellent analogue for understanding the climatic controls on the processes active during syn-rift deposition. The paper presents and discusses the role of palaeogeography, and climatic conditions on the depositional processes and styles in a broad range of depositional settings including alluvial fans, braided fluvial, intertidal and shallow marine environments. The research also looks into micro-nano scale reservoir characteristics of sandstones deposited in pre-vegetation, warm, humid climatic setting conducive to the development of extensive, sheet braided geometries.

Although the exact position of Tasmania in the Late Cambrian remains debateable (Berry and Bull, 2012), broad palaeogeographical reconstructions indicate that it was located on the eastern margin of the Gondwana landmass (Achab and Paris, 2007; Baillie et al., 1989; Cocks, 2001; Cocks and Torsvik, 2002; Fortey and Cocks, 2003; Li et al., 1997; Li and Powell, 2001; Rowland and Shapiro, 2002), and situated north of the palaeoequator between 10° to 20° latitude. The Late Cambrian palaeoclimate reconstruction is complicated due to large uncertainties regarding atmospheric composition, palaeogeography, and terrestrial conditions (Kononen, 2013; Runkel et al., 2010),but it can be inferred that in the Late Cambrian through much of the Ordovician the climate was tropical with warm sea waters (Trotter et al., 2008) and was influenced by an extended greenhouse period (Frakes et al., 2005; Munnecke et al., 2010), with rising and considerably high sea level through out the Palaeozoic Era (Haq and Schutter, 2008).

This research was undertaken using conventional sedimentary facies analysis technique, in which several lithofacies were identified and facies associations were analysed to evaluate depositional processes and environments (Collinson, 1969; Miall, 1990; Reading, 2009). The project involved detailed field mapping of the litho facies, measurement of several stratigraphic sections, sedimentological features including palaeocurrent directions and structural analysis, in the southern West Coast Range, Tasmania.

Five broad facies associations have been identified, these include alluvial fans, braided fluvial, intertidal, shallow marine and sheet flows. There is a strong influence of palaeoclimate on the depositional processes and resulting stratigraphic build-ups. The depositional styles of similar aged sediments studied globally, are also markedly different from their present day depositional analogues, mainly due to unique parameters controlling the overall depositional style, such as climate, vegetation state and global sea level conditions (Cotter, 1977; Davies and Gibling, 2010; Fuller, 1985; Long, 1977).

Reservoir characteristics of selected sandstone sample were analysed using standard thin section petrography, and state of the art Scanning Electron Microscopy along with Energy Dispersive X-ray Spectroscopy. The sandstones are mainly comprised of quartz, mica, lithic grains, clays, zircon, tourmaline, leucoxene, rutile, glauconite and chert grains. These were supplied by a Proterozoic metamorphic and a Middle Cambrian volcanic provenance. The sediments have undergone severe diagenesis, including quartz overgrowth, iron coating, and haematite, chlorite and sericite alteration. Multi-phase haematite-related diagenesis is common and late stage hydrothermal fluid alteration assemblages have severely altered the sediments. The exceptionally quartz-rich provenance along with warm and humid climatic conditions have given rise to a compositionally unusual example of a syntectonic (or active margin) deposit, rather than a typical passive margin quartzarenite.

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