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3D Architecture of a Deepwater Turbidite Depositional System from Outcrop and Wells (1): Facies Distributions, High-resolution Sequence Stratigraphy and Fan Growth Mechanisms

Integration of data from outcrop DGPS mapping, logging and photogrammetry with wireline logs and 1300 m of continuous core from seven wells has enabled deterministic mapping of key surfaces and facies trends over 500 km2 of the Permian Tanqua deepwater complex, Karoo basin, South Africa. Fans 2, 3 and 4 can be divided into high-frequency sequences that control connectivity and hence fluid-flow behaviour. Fan 2 exhibits a progradational stacking pattern with additional lateral stepping while Fan 3 shows a symmetrical profile of progradation, aggradation and backstepping. Fan 4 is dominantly aggradational. Image log analysis has yielded copious paleocurrent data from climbing ripple lamination and sole structures which, when combined with similar data from outcrops, demonstrate local compensational shifts between high frequency sequences, driven by depositional and intrabasinal topography. These stacking patterns, visible in outcrop, core and well logs, produce complex regional time-stratigraphic relationships. For example, in Fans 2 and 3, the lowermost sandstone unit belongs to high frequency intra-fan sequence 1 in proximal areas, but to younger sequences further basinward (north), giving a progradational stacking pattern. In distal areas of Fan 3, the top fan contact is a sharp break from sandstone to shale but the lower few metres of this shale is time-equivalent to backstepping, sand-prone units in more proximal areas. Channel types within the intra-fan sequences show a predictable down-fan evolution from erosionally confined channels with evidence for initial bypass and later backfill, through a characteristic 'poorly-confined' type in midfan areas to 'pinchout' channels at distal fan margins.