

Facies of deep-water sand-prone fan lobes at Klęczany, the Cergowa Beds (Oligocene), Polish Outer Carpathians



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In the Klęczany Quarry, almost 200 m thick section of the Cergowa Beds deep-water succession documents vertical and lateral facies changes in the sand-prone lobe complex over a lateral distance of 900 m. Three main facies associations have been distinguished: (A) very thick- and extremely thick-bedded, amalgamated, massive, normally graded or subordinately plane-stratified and plane-parallel laminated medium-, fine- or coarse-grained sandstones and pebbly sandstones, which form composed beds, up to 9 m thick; locally with mudstone clasts or rafted fragments of mudstone beds and associated slumped beds; (B) thick-, very thick- to medium-bedded, massive, normally graded fine-, medium- or coarse-grained sandstones, often topped with thin, laminated siltstones or silty mudstones, commonly rich in coalified plant detritus; plane-parallel or ripple-cross lamination is occasionally found at the bed top, and, less frequently, in the basal part of bed; mudstone clasts are present, especially in upper part of beds; (C) thick- to thin-bedded, plane-parallel, wavy or ripple cross-laminated, subordinately massive and plane-stratified fine- and very fine-grained sandstones topped with laminated siltstone and massive/graded mudstones, intercalated with thin- and very thin-bedded rippled siltstones coupled with mudstones; single medium-bedded hybrid sandstones and debrites occur; laminated sand beds are interbedded with packages of very thin- and thin-bedded ripple cross- or parallel-laminated siltstones coupled with mudstones (C1), up to 25 beds in one set.

These facies cover a wide range of density flow deposits. The thick- and very thick-bedded, massive and normally graded sandstones represent the product of high density turbidity currents (or in some instances – sandy debris flows). Complexes of amalgamated sandstones may overlie scour surfaces or deformed sandstone and mudstone beds, suggesting high energy of the overriding high-density flows. The thick- and medium-bedded, graded to laminated sand beds were deposited from high- to moderate-density turbidity currents and diluted, residual turbidity currents. The wide range of laminated fine-grained sandstones and siltstones coupled with mudstones are the product of moderate- to low density waning or quasi-steady turbidity currents.

It can be inferred that the succession at Klęczany represents a part of basin-floor lobe system of turbidite fan developed in the Fore-Magura Basin. The section reflects gradual transition from: 1) lobe axis channels filled with amalgamated, massive and normally graded sandstones (facies associations A and B) representing 4 or 5 stacked lobes separated with 1–7 m thick complexes of heterogeneous associations which may represent lobe off-axis (facies association B), and lobe fringe or lobe distal fringe settings (facies associations C and C1), to 2) lobe fringe settings with laminated sandstones intercalated with silt-mud bedsets (facies associations C and C1) stacked in positive sequences, and with single outcrop-scale, lenticular, up to 11m thick sand bodies of thick-bedded amalgamated sandstones. The whole succession may represent the retrogradational stacking pattern beginning with the fan related to the initial uplift of the basin and source area activation followed by the subsequent gradual subsidence and source area drowning and decline in sediment supply, which correspond to the pattern of evolution of the Carpathian subbasins during early Oligocene.

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