

Tectono-eustatic Controls on the Depositional Setting and Stratigraphic Evolution of the Late Jurassic Vanguard Group, SW Saskatchewan

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Abstract

The Vanguard Group is a Late Jurassic lithostratigraphic unit that subcrops in southern Saskatchewan. The group conformably overlies Bathonian Shaunavon Formation and unconformably lies under either Kimmeridgian Success-1 Formation or younger Cretaceous strata. The Vanguard Group consists of shale-dominated Rierdon, Rush Lake and Masefield formations, and sandstone-dominated Roseray Formation. The group accumulated in the intracratonic Williston Basin with the influence of the Columbian convergent tectonics encroaching from the west. The Rush Lake and overlying Roseray formations occur in the southwestern part of the Province and laterally (eastward) merge with the Rierdon Formation. The Masefield Formation succeeds Rierdon and Roseray formations. The Rierdon Formation consists of dark to medium greenish-grey shale grading to light grey (locally rusty) shale/mudrock. The Rush Lake Formation is lithologically comparable with the Rierdon Formation; both contain crinoids, brachiopods, ammonites and horizontal ichnofossils. The two formations are interpreted as low energy, outer to middle shelf deposits. The Roseray Formation is dominated by well- to poorly-cemented quartz arenite, kaolinite-rich sandstone, kaolinitic shales and laminated to massive sandy mudrocks. Subordinate glauconitic, bioclastic and bioturbated sandstone units also occur. Sedimentary structures in the sandstone lithofacies include flaser and lenticular bedding, low angle cross-laminations, and burrows. These structures suggest medium to high energy shoreface depositional environment. The Masefield Formation consists of medium greyish-green to light-grey calcareous shale. Presence of bivalves and belemnites has been reported in the literature. The formation contains horizontal burrows and laminations, suggesting a quiet, subtidal depositional environment. The lithostratigraphic stacking nature of the Vanguard Group reflects the interplay among tectonics, relative sea level changes and sedimentation at an early stage of foreland basin development. The Columbian Orogeny resulted in the Alberta Trough bounded to the east by the uplifting of the Sweetgrass Arch. The later separated the Williston Basin from the Alberta Trough. An initial phase of subdued Sweetgrass Arch along with high sea level resulted in deposition of the Rierdon-Rush Lake shales in a deep shelf setting. This was followed by uplifting of the Sweetgrass Arch most likely due to rejuvenation of old structural lineaments and establishment of a prominent peripheral bulge. The exposed Sweetgrass Arch sourced the clastic influx of the Roseray Formation in the Williston Basin (back-bulge basin). Paleotopographic lowering of the Arch by erosion and tectonic relaxation accompanied by Late Jurassic sea level rise culminated in inundation across the Sweetgrass Arch and deposition of the Masefield Formation.

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