

## Genesis and depositional history of Late Jurassic back-bulge sandstone reservoir in southwestern Saskatchewan: The Roseray Formation

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### Abstract

The Jurassic strata of southern Saskatchewan consist of Triassic? to Middle Jurassic red sandstone beds of Watrus Formation, Middle Jurassic clastic-carbonate-evaporite strata of Gravelburg and Chaunavon formations and late Middle to Late Jurassic calstics of the Vanguard Group. The Vanguard Group is dominated by siliciclastic rocks that subcrop in southwestern Saskatachewan and lies conformably above the Bathonian Shaunavon Formation and unconformably under Kimmeridgian Success 1 (S1) Formation. The Vanguard Group is dominated by shale lithology (Reirdon, Rush Lake and Masefield formations) and one sandstone-dominated unit (Roseray Formation) which accumulated in intracratonic Williston Basin. The Roseray Formation was deposited on the northwestern margin of the Williston Basin and forms a wedge-shaped sandstone interval separating older Rush Lake shales from younger Masefield shales. Where the latter is missing, the formation is unconformably succeeded by Late Jurassic Success Formation or Cretaceous Cantaur Formation. The Roseray Formation is an excellent hydrocarbon reservoir in southwestern Saskatchewan; it is dominated by porous sandstone lithology of shallow marine origin. Six lithofacies units were determined: poorly-cemented quartz arenite, kaolinite-bearing sandstone, cross-bedded glauconitic sandstone, bioturbated sandstone, fissile shale, and massive mudstones. Sedimentary structures in the sandstone lithofacies include flaser and lenticular bedding, low angle cross-laminations, and horizontal burrows. Glauconite grains and rip-up clasts are locally common. These sedimentary structures suggest moderate to high energy shallow marine (shoreface) depositional environment with intermittent flooding events represented by the shaly lithofacies followed by progradation of the sandy lithofacies. Deposition of the Roseray Formation was influenced by the paleogeographic setting during the early stage of foreland basin evolution. The Columbian Orogeny resulted in the Alberta Trough bounded to the east by the Sweetgrass Arch. The later separated the Williston Basin to the east from the Alberta Trough to the west. The uplifting of the Sweetgrass Arch is attributed to the rejuvenation of old structural discontinuities by the convergent tectonics and formation of a peripheral bulge. The bulge separated fore-bulge basin (Alberta Trough) from back-bulge basin (Williston Basin). The latter existed much earlier than the onset of the peripheral bulge but uplifting of the basin's western boundary (i.e., Sweetgrass Arch) was further enhanced by the orogen-related uplifting of the peripheral bulge. The highlands of the Sweetgrass Arch sourced the siliciclastic influx into the Willistone Basin and deposition of the Roseray Formation, as well as correlative Swift Formation of the Alberta Trough. The Roseray Formation is a wedge-shaped stratigraphic unit that gradually onlaps older rocks the form the eastern flank of the Sweetgrass Arch and pinches-out eastward giving way fossiliferous basinal shales of the Reirdon Formation. The latter accumulated in the depocentral area of the basin located in southern Saskatchewan and farther south in to the USA. The genesis of the stratigraphic architecture of the Vanguard Group can be visualized within a tectono-eustatic context. The onset of the Cordilleran (Columbian) Orogeny caused the formation of a peripheral

bulge. The bulge was not initially well-elevated and the foreland basin remained under water resulting in deposition of the Rush Lake and lower Reirdon shales. This was followed by an intensive uplifting and exposure of the bulging area (Sweetgrass Arch), separating the foreland basin into back-bulge and fore-bulge depressions. Coarse detrital grains eroded from the uplifted and exposed land filled the proximal areas of the depressions (i.e., Roseway Formation and coeval Swift Formation). This was followed by erosion of the exposed area resulting in lowered relief. Tectonic relaxation may have caused further loss of relief accompanied by a (relative) sea level rise which heralded cessation of the coarse siliciclastic influx and deposition of the shales of the Masefield Formation throughout the region.