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Reservoir Development, Structure, and Hydrodynamics of Salt Dissolution and Collapse Structures: Examples from the Saskatchewan Potash Mining Belt

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Salt dissolution and collapse phenomena have been studied by numerous Williston Basin researchers. Salt collapse structures produce oil at a number of sites in the basin and have a significant impact upon the regional distribution of oil; however, there are few published studies of specific structures.

Saskatchewan potash mine operators must understand the architecture of collapse structures on their leases in order to assess the threat posed to mining operations. The authors studied a number of specific dissolution and collapse sites within the potash mining area to assess water encroachment into underground workings. These studies integrated 2D and 3D seismic, geological, and hydrodynamic datasets to determine the impact of the specific structure on mining operations.

Examples from potash collapse structures show that these features contain a variety of breccias formed by dissolution of Devonian Prairie Evaporite, Duperow, and Souris River (Davidson) salts. The breccias often possess tremendous water production potential from extremely porous and permeable zones. Evidence from mining operations that have penetrated collapse structures proves that they will produce large quantities of water, the volume being a function of fracture density and the amount of collapse breccia within the structure.

Isolated and/or small dissolution and collapse structures may deplete during water production while larger structures contain enormous water reserves capable of flooding a mine. Larger structures display more complex reservoir distribution, internal architecture, and stratigraphic variability. Faulting induced by basement-related tectonic movements may control sites of Prairie Evaporite dissolution and eventual collapse.

Collapse structures may be either sealed vertically and laterally or in communication with regional aquifers. Often collapse structures are part of larger interconnected complexes which form laterally extensive dissolution systems. Collapse structures which are laterally sealed but vertically open may act as chimneys which allow the charging of stratigraphically higher reservoirs with oil generated from stratigraphically lower source rocks. Collapse structures connected to linear basement features and laterally open may act as conduits for lateral migration of oil from the center of the basin.

Tests of structures have water production rates up to 60.5 bbls/min. (87,120 bbls/day) from relatively thin breccia zones within Upper Devonian carbonates. Much greater inflow rates of brine into mine workings have been reported. Given such productivity, a collapse-related breccia charged with oil would provide an extraordinary economic opportunity.