Prediction of Sediment Distribution and Stratigraphic Traps along Salt Structures: A Review and Insights from Field Cases

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Abstract

Stratigraphic traps in salt controlled minibasins are attractive exploration targets for the hydrocarbon industry and for Carbon Capture Storage projects. However, predicting sediment dispersal patterns and thus, stratigraphic traps along salt structures is a major challenge. In addition to classic controlling factors for sediment supply and distribution (eustasy, tectonics, climate) the interplay with growing salt structures adds another level of complexity. Drastic spatial facies change very often occur at very small distances (<250m), especially near the salt structure. Here a compilation is presented of the most relevant outcrop analogs of salt-controlled sedimentary successions. A new model is proposed with improved prediction capacity of sediment distribution and stratigraphic trap occurrence using diagnostic halokinetic geometries.

Halokinetic geometries result from horizontal to gently dipping depositional surfaces due to differential evacuation/inflation of an underlaying salt layer, exhibiting diverse shapes across varying scales. The most extensive halokinetic geometry referred here, is the “mini-basin tectonostratigraphic unit (MTS)” (i.e. Rowan & Giles, 2022), involving sedimentary strata extending over multiple kilometers and reaching thicknesses of thousands of meters. Such large scale halokinetic geometries are clearly imaged by seismic and can be used as a tool to predict facies distribution. In order to characterize in great detail reservoir facies distribution inside MTS, we have compiled and synthetized sedimentological and stratigraphical data from world-class outcrop analogs (i.e. Sivas basin, Turkey; the Paradox basin, United States; the southern Pyrenees, Spain; La Popa basin, Mexico). This study highlights remarkable tendencies that enable us to link specific MTS types with a typical sediment distribution. (i) The layer-type MTS, with strata maintaining their thickness approaching the salt-structure. (ii) The thinning-wedge MTS, in which the bounding surfaces converge toward the salt-structure. (iii) The thickening- wedge MTS, where strata expand toward the salt-structure. A quantification of the facies and thickness variations (i.e. distances and reservoir facies percentage) is provided in the model. Key parameters such as the impact of the salt topography, of smallest scale halokinetic geometries (i.e. HS and CHS) or the salt-structure roof thickness are also discussed in our model.

This study is a first step in developing a comprehensive generic model that may serve as a valuable guideline for interpreting seismic data of MTS in undrilled zones.