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A deltaic-sediment gravity flow depositional system in the Upper Triassic Yanchang Formation, Southwest Ordos Basin, China

Yi Gao (1,2), Zaixing Jiang (1,2), Shengqian Liu (1,2)

(1) College of Energy, China University of Geosciences, Beijing 100083, China, (2) Institute of Earth Sciences, China University of Geosciences, Beijing 100083, China

The Ordos Basin, located in central China, is a large-scale residual Mesozoic intracratonic down-warped basin. It is the second largest and the most productive oil-gas-bearing basin in China. The Upper Triassic Yanchang Formation is characterized by fluvial-lacustrine facies. It can be subdivided into 10 stratigraphic sublayers (Ch1-Ch10 from top to bottom), and the Ch81 interval is an important oil-gas reservoir in this basin. For a long time, sandstones in this interval are interpreted to be deposited in a shallow water braided delta sedimentary system in the southwest of the basin. During deposition of this interval, the water is quite shallow, and there are no sediment gravity flow deposits. In this research, based mainly on core observation and description, as well as well logging and seismic data, we proposed that sediment gravity flow deposits are well-developed in the study area in the southwestern Ordos Basin. Four lithofacies assemblages have been recognized: (i) thick-bedded sandstone with abundant lamination structures as channelized sandy deposits in braided delta; (ii) thick-bedded chaotically contorted sandstone as sandy slump; (iii) thick-bedded structureless sandstone with floating mudstone clasts as sandy debrite, or with spaced planar lamination as high-density turbidite; (iv) thin-bedded ripple cross-laminated sandstone as low-density turbidite. On the basis of core evidence of a sedimentary cross-section along flow direction with six cored wells, the most possible trigger of sediment gravity flow is delta-front collapsing. Through downslope transportation, one type of gravity flow can transform to another type. Deltaic channelized sandstones are dominant in the proximal area. Sandy slumps are dominant in the middle area, which is formed by collapsing of deltaic deposits and transform to high density turbidite and sandy debrite in the distal area. Few low-density turbidite is shown. With additional geochemical evidence, it can be confidently determined that the study area is in a transitional environment in lacustrine basin between marginal delta and distal basin plain. The water during deposition is deep enough to preserve sediment gravity flow deposits, which is quite opposite to previous interpretation that this is a shallow-water braided delta and no sediment gravity flow deposition. A depositional model is proposed with deltaic deposits in the proximal and sediment gravity flow deposits in the middle and distal area, showing non-channelized subaqueous sediment gravity flow depositional system. Furthermore, the porosity and permeability data indicate that different types of deposits have varying reservoir quality, especially for permeability. The Ordos Basin is famous for its tight sandstone oil-gas reservoir in China, and distinguishing high-permeability sandstone is vital for oil-production in these reservoirs. Therefore, this research shines light on a new perspective based on delicate sedimentary research for future oil exploration and development in the most productive Ordos Basin.