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The Messinian evaporites in the Levant Basin: lithology, deformation and its evolution

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The lithological composition of the Messinian evaporite in the Levant Basin remains controversial and salt deformation mechanisms are still not fully understood, due to the lack of high resolution 3D depth seismic data and well logs that record the entire evaporite sequence. We demonstrate how 3D Pre-stack depth migration (PSDM) and intra-salt tomography can lead to improved salt imaging. Using 3D PSDM seismic data with great coverage and deepwater well log data from recently drilled boreholes, we reveal intra-salt reflective units associated with thin clastic layers and a seismic transparent background consisting of uniform pure halite. Structural maps of all internal reflectors are generated for stratigraphy and attributes analysis. High amplitude fan structures in the lowermost intra-salt reflector are observed, which may indicate the source of the clastic formation during the Messinian Salinity Crisis (MSC). The Messinian evaporite in the Levant Basin comprises six units; the uppermost unit thickens towards the northwest, whereas the other units are uniform in thickness. The top of salt (TS) horizon is relatively horizontal, while all other intra-salt reflectors and base of salt (BS) dip towards the northwest. Different seismic attributes are used for identification of intra-salt deformation patterns. Maximum curvature maps show NW-striking thrust faults on the TS and upper intra-salt units, and dip azimuth maps are used to show different fold orientations between the TS and intra-salt units, which indicate a two-phase deformation mechanism: basin NW tilting as syn-depositional phase and NNE spreading of Plio-Pleistocene overburden as post-depositional phase. RMS amplitude maps are used to identify a channelized system on the TS. An evaporite evolution model during the MSC of the Levant Basin is therefore established based on all the observations. Finally the mechanical properties of the salts will be utilized to explore salt deformation in the Levant Basin.

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