Gravity-Driven Deformation of a Youthful Saline Giant: The Interplay Between Gliding and Spreading in the Messinian Basins of the Eastern Mediterranean

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ABSTRACT

The triggers and drivers for salt-related deformation on continental margins are intensely debated, reflecting uncertainties related to: (i) the diagnostic value of certain structural styles; and (ii) the precise mechanics associated with the two principal mechanisms (gravity gliding and spreading). Determining the triggers and drivers for salt-related deformation is important because they provide insights into continent-scale geodynamic processes, the regional kinematics of salt-related deformation, and the hydrocarbon prospectivity of salt-bearing sedimentary basins. The processes associated with and the timing of deformation of Messinian salt in the offshore Eastern Mediterranean are uncertain, and thus so is our understanding of the geodynamic evolution of this tectonically complex region. We here use an extensive 2D and 3D seismic reflection dataset to test models for the salt-tectonic development of Messinian salt. Our data suggest that Plio-Pleistocene salt flow along the eastern, western and northern margins of the Levant Basin was triggered by gravity gliding caused by thick-skinned tectonic uplift of the basin margins. Along the Levantine margin, however, spreading, driven by the progradation of margin-attached deltas, started to play an increasingly important role in driving basinward salt flow. Spreading, in this case driven by progradation of the Nile Delta, was the main process causing salt flow along the northern coast of Egypt. Locally, however, base salt still dips seaward, despite the crust being loaded by a relatively thick pile of Nile Delta-related sediment. We speculate this records an earlier phase of basinwards tilting of the margin due to differential basin subsidence and consequent gliding-induced deformation of the margin, prior to the main phase of Nile Delta progradation and associated spreading. Our study indicates that gliding and spreading are not mutually exclusive, but may overlap in time and space, being driven by a combination of local and far-field tectonics (gliding), and differential overburden loading (spreading). We also argue that intrasalt strain and seismic-stratigraphic patterns can be explained by a model invoking a single, post-Messinian period of salt-related deformation, rather than a more complex model involving two separate deformation events that occurred during and after salt deposition.