Integrated Stratigraphic and Thermal/Burial Modeling of the Levant Basin (East-Mediterranean Region): Implications on Thermogenic and Biogenic Petroleum Systems Assessment

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Abstract

More than 60TCF of gas have been recently discovered in the Levant Basin within a few producing and upraised fields (e.g. Tamar, Leviathan, Aphrodite, Zohr, Calypso, Glaucus). All these discoveries are reported to relate to biogenic gas, sourced in Oligo-Miocene clastics, while some new findings (e.g. Karish field, offshore Israel) may suggest the viability of thermogenic petroleum systems. Still, the Levant Basin is characterized by a lack of data, a complex geodynamic history, and high exploration costs. This hampers the predictive assessment and de-risking of the overall exploration potential. Crucial questions pertaining to precise estimation of the biogenic gas accumulations across the basin, and to infer about other potential thermogenic hydrocarbon occurrences are still un-answered. This contribution attempts to provide new ideas and possible answers to the above cited questions. An integrated workflow for modeling sedimentary basins including source to sink stratigraphic forward simulations as well as thermal/burial evolution has been designed and applied on the Levant Basin to answer these questions. The model covers around 200,000 sq. km, with horizontal cells grid resolution of 5 sq. km and a vertical resolution of less than 50m. This workflow integrated a variety of problem-dedicated numerical tools in a unique software platform (as well as concept-driven thinking). The following steps were achieved: i) characterization and integration of geological, geophysical and geochemical data (leading to the geological

conceptual models); ii) sedimentary facies modeling using numerical forward stratigraphic approaches (testing multi-scenario GDE maps, play fairways); iii) structural characterization and modeling; and iv) burial/thermal and petroleum systems modeling - with a new, specific approach for simulating biogenic gas generation, expulsion and accumulation. In conclusion, the integrated workflow proved to be a reliable tool for de-risking exploration in typical frontier provinces such as the Levant Basin. It highlighted the following emergent ideas: i) potential accumulations of biogenic gas as well as thermogenic oil/gas mix in central and northern Levant Basin (offshore Lebanon and Cyprus); ii) possibility for mixing Mesozoic thermogenic systems and Cenozoic biogenic systems due to overpressure hydrofracturing; and iii) the role of Messinian Salinity Crisis (MSC) on the migration/trapping of biogenic gas.