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Mediterranean Heat-Flow Prediction Using Gravity Inversion

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Abstract

Predicting heat-flow for petroleum systems modeling in the offshore basins of the Mediterranean presents a significant exploration challenge; the Mediterranean consists of a complex mosaic of ocean basins of different age and origin. We use gravity-anomaly inversion, to determine top basement heat-flow history including both transient and continental radiogenic heat productivity components. The methodology uses 3-D spectral domain gravity inversion to determine Moho depth, crustal-basement thickness and continental lithosphere thinning factor, and incorporates corrections for lithosphere thermal gravity anomaly and magmatic addition from decompression melting. Lithosphere thinning from gravity inversion is used to determine the thickness of continental radiogenic crust and its heat-flow contribution, and the transient heat-flow component for oceanic and thinned rifted continental margin lithosphere. The radiogenic and transient heat-flow components, together with the background asthenosphere derived heat-flow are used to predict heat-flow history. For each oceanic sub-basin of the Mediterranean, we explore a range of rift and sea-floor spreading ages to determine top basement heat-flow history and its sensitivity. Maps of crustal thickness and continental thinning factor from gravity inversion show the distribution of ocean lithosphere and continental-ocean boundary location. Crustal cross-sections, with Moho depth determined from gravity inversion, show ocean-continent transition structure, magmatic type (magma poor, normal or magma rich) and the possible existence of hyper-extended continental crust. Digital grids of continental-lithosphere thinning and residual continental radiogenic heat productivity, produced by gravity inversion, provide valuable input to petroleum systems and basin modeling, while delimiting the crustal type reduces some of the uncertainty associated with such modeling.