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Thermal modeling and maturity assessment of the Columbrets Basin (south Valencia Trough, Western Mediterranean)

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The Columbrets Basin is a hyper-extended basin filled by up to 8-9 km of shallow water deposits developed during the Jurassic-Cretaceous times at the eastern Iberian margin. It formed as a ramp-syncline basin detached at Upper Triassic salt, which resulted from the extensional motion of ramp/flat extensional sub-salt crustal faults. Since its initial development at Jurassic times, the evolution of the Columbrets Basin has been controlled by three major tectonic events: a Late Jurassic-Early Cretaceous rift, a latest Cretaceous-earliest Miocene compression/inversion and an Early-Middle Miocene extensional reactivation.

Located entirely offshore, the stratigraphy of Columbrets Basin is rather unknown. Only few exploratory wells mainly located at the basin edges have been drilled. The only well that reaches the basin infill is the Ibiza Marino AN-1, which is located on the eastern flank of a major Mesozoic depocenter and displays middle Miocene strata underlaid by Upper Jurassic rocks. This unconformity that is also observed all over the area in the seismic reflection data, records the tectonic uplift and erosion of the Columbrets Basin during the Paleogene-earliest Miocene contractional stage.

In this scenario, our study shows the results of a quantitative analysis of the thermal history of the Columbrets Basin. Particular emphasis is focused on assessing regional tectonic processes that control maturity and hydrocarbon generation potential since the Jurassic. The obtained basin and petroleum systems model has been constrained and calibrated by wellbore bottom-hole temperature measurements and maturity indicators at the Ibiza Marino AN-1 well. This has allowed evaluating the thickness of Mesozoic eroded at this location during the latest Cretaceous-early Miocene basin inversion and, thus, to reconstruct the pre-contractional basin fill thickness. In this evaluation, the amount of erosion has been defined by a sensitivity analysis that uses rift-related basal heat flow values reasonably consistent with the observed Mesozoic crustal thinning.

The maximum burial depth of the source rocks and the heat flow history are major parameters controlling the maturity level and the potential hydrocarbon generation of any basin. Therefore, the results of our modeling provide very valuable data to define the hydrocarbon potential of the Columbrets Basin. In this sense, our study provides an evaluation and quantification of the three potential petroleum systems defined in the area, two in the Mesozoic basin fill and one in the unconformably overlying Miocene record.