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ABSTRACTS VOLUME

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THE THERMAL HISTORY OF THE MESOZOIC ALGARVE BASIN (SOUTH PORTUGAL) AND ITS IMPLICATIONS FOR HYDROCARBON EXPLORATION

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The Algarve Basin is the southernmost geological province of mainland Portugal, outcropping along the entire south coast area and extending offshore, where it is recognised on seismic lines and in hydrocarbon exploration wells. It mainly comprises Jurassic and Lower Cretaceous limestones and marls making a succession over 3 km thick. This sedimentary basin belongs to a series of basins that were initiated by rifting associated with the opening of the North and Central Atlantic Ocean, following the breakup of Pangaea.

Sedimentation in the Algarve Basin commenced with Upper Triassic continental red beds and evaporites which unconformably overlie folded and faulted Carboniferous strata. These strata are overlain by Early Jurassic (Hettangian) volcanic rocks associated with the Central Atlantic Magmatic Province (CAMP). After this important magmatic episode, Sinemurian to Tithonian marine carbonate sedimentation became well-established across the Algarve Basin. During this period, lateral facies changes observed in the limestone lithologies across the basin allow its division into the Western (Sagres), the Budens-Lagoa, and the Eastern (Faro) sub-basins. These sub-basins are separated by major north-south trending faults, which were probably active during deposition.

Three main sedimentary cycles separated by regional unconformities are recognised in the Sinemurian to Tithonian marine carbonates. These cycles consist mainly of shallow water limestones, sometimes with reef facies and alternations of marls with pelagic limestones, which are related to sea level variations or regional tectonic events. The first cycle extends from the Sinemurian to early Toarcian, the second from the Aalenian to Callovian and the third from the mid Oxfordian to Tithonian.

The Lower Cretaceous is represented by a carbonate and siliciclastic succession, deposited in nearshore and continental settings. During the Late Cretaceous a major uplift episode occurred, related to Alpine tectonism and the emplacement of the Late Cretaceous (Campanian, ca. 72 Ma) syenite of Monchique. Therefore, no Upper Cretaceous to Palaeogene strata are found in the exhumed Algarve Basin. After this event, sedimentation only resumed during the Miocene, with bioclastic limestones and silts which unconformably overlie the Jurassic and Lower Cretaceous succession.

Investigation of almost 200 samples of mudrocks and marls by means of vitrinite reflectance, spore fluorescence and colour, indicates that the Mesozoic stratigraphic succession of the Algarve Basin is within the oil-window. Vitrinite reflectance values increase with the age of the sedimentary rocks from: 1 – 1.2% R_r in the top Triassic – Hettangian, 0.8 – 0.9% R_r in the Middle Jurassic, 0.7 – 0.9% R_r in the Upper Jurassic and 0.5 – 0.6% R_r in the Lower Cretaceous. These results suggest that subsidence under normal burial conditions was the main mechanism of organic maturation.

Four maturation profiles (R_r vs. depth) were constructed across the basin for the Sagres – Lagos, Albufeira, Faro and Tavira regions. These profiles are linear with good correlation factors. Palaeogeothermal gradients ranging from 23.5 – 39°C/km were calculated for the eastern sub-basin, whereas a higher palaeogeothermal gradient of 62°C/km was calculated for the western sub-basin. The palaeogeothermal gradients indicate that a 2.2 – 2.7 km thick succession of post-Aptian age in the eastern sub-basin, and a 1.22 km thick succession of post Albian age, was necessary to account for the measured maturation levels. The most likely age for this eroded sedimentary cover is Upper Cretaceous – Lower Tertiary, suggesting that sedimentation in the Algarve Basin continued through this time period and did not end in the early Cretaceous. Upper Cretaceous to Lower Tertiary sediments could be preserved in non-inverted or less exhumed areas located in the offshore part of the basin. The offshore Mesozoic succession penetrated by the Ruivo and Corvina wells is also within the oil-window.

The organic maturation results from the Miocene sediments in the Tavira region (Cacela) and in the offshore Ruivo and Corvina wells, indicates that this part of the succession is immature regarding the oil-window, with vitrinite reflectance ranging from 0.3 to 0.45% R_r . The presence of reworked vitrinite and Mesozoic palynomorphs in the Miocene sediments with organic maturation levels which match the levels measured for the onshore Upper Jurassic – Lower Cretaceous sediments is significant. This implies that part of the Mesozoic succession of the Algarve Basin was exposed and being eroded during Miocene times and it also constrains the timing of the maturation for the Mesozoic succession to the Late Cretaceous – Early Tertiary interval.

Further evidence of the timing of the maturation is provided by the maturation levels of the diapirs in Loulé and Albufeira and the adjacent sedimentary rocks. The age of the evaporites in the two diapirs is Hettangian. In Loulé a value of ca. 1.1% R_r was measured in clay rich beds within the diapir, whereas values of ca. 0.7 – 0.8% R_r were obtained from for Late Upper Jurassic beds intruded by the evaporites. In Albufeira, the movements of the evaporites tilted the Late Jurassic and Early Cretaceous beds closed to the diapir walls to vertical. A value of 1.13% R_r was measured for the diapir and a value of 0.6% R_r was measured for the vertical Early Cretaceous beds close to the diapir wall. This implies that peak temperatures related to the maturation levels in the Algarve Basin were achieved prior to the salt movements of both diapirs, probably during Late Cretaceous (Early Tertiary?) times.



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