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Thermal and Maturation Histories in the Saharan Basins

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Quasi two-dimensional numerical analysis of burial and thermal histories of the basins together with assessment of thermal maturation of their organic matter were carried out along eight profiles for sedimentary sections in 32 wells of the East Algerian basins and 24 wells of the southern and western Saharan basins. The numerical results were obtained with the aid of one-dimensional non-steady numerical reconstructions in the framework of the basin modeling system GALO. The modeling supposed that the highest thermal activation in the history of the Saharan basins with the heat flow more than 100 mW/m² and thinnest lithosphere in the order of 25 to 35 km took place during the Late Carboniferous- Permian in the Dahar and Oued Mya basins. The uplift responsible for this activation caused erosion of 2000-3000 m of the Early Carboniferous, Devonian, Silurian and even Ordovician sediments. This activation was more moderate in the western basins. In particular, heat flow in the Timimoun basin and the northern part of the Ahnet and Mouydir basins during the Permian- Triassic-Jurassic amounted to around 70-80 mW/m² and a lithosphere thickness to 40-50 km, whereas in the Sabaa sub-basin and Reggane basin it was around 63-67 mW/m² with lithosphere thickness of about 55-60 km. The present-day thermal regime of the Ahnet and Reggane basins and the central part of the Timimoun basin is rather high and comparable to that of the Illizi basin, where heat flow reaches 100 mW/m², the present-day lithosphere is as thin as 25 km and recent volcanism has taken place. Moderate extension of the lithosphere with maximal total amplitude of about 1.16 during the Cenozoic is assumed in our modeling in the Reggane basin and the southern half of the Timimoun basin as well as the central and eastern part of the Illizi basin. In the northern and especially north-eastern basins (the Trias basin and northern half of the Oued Mya), the present-day thermal regime of the lithosphere is considerably lower than in the southern areas and thickness of the lithosphere here reaches 80 km.

The variation in the thermal regime of southern and northern areas of the region results in significant rheological weakening of the lithosphere in the western and southern areas as compared to the north-eastern ones. We analyze sepecially the rheological behavior of the lithosphere with the strain rate $=10^{-12}$-10^{-14} l/sec and present-day temperature distribution describing the upper continental crust by rheology of wet quartz, the lower continental crust by rheology of dry anortosite and the mantle by dry dunite. In all areas, the brittle layers in the upper and lower crust are underlined by rather thick ductile zones at the base of which yield stresses decrease almost to zero. A rather strong and thick brittle layer is typical for the uppermost mantle of the north-eastern areas, but it disappears totally in the hot southern and western areas (Illizi, Timimoun, Reggane, and Ahnet depressions).
Thermal and maturation analysis of the Saharan basins has shown that the Hercynian erosion can account only for a minor part of the Ro jumps observed in vitrinite profiles. Intrusive activity and the associated hydrothermal heat transfer during the Triassic and Lower Jurassic accurately explain the step-like character of maturation profiles in the Saharan basins.