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The thermal state of the Arabian plate derived from heat flow measurements in Oman and Yemen

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The dynamics of the Afar plume and the rifting of the Red Sea and the Gulf of Aden affect the present-day thermal regime of the Arabian plate. However, the Arabian plate is a Precambrian shield covered on its eastern part by a Phanerozoic platform and its thermal regime, before the plume and rifting activities, should be similar to that of other Precambrian shields with a thick and stable lithosphere. The first heat flow measurements in the shield, in Saudi Arabia, yielded low values (35-44 mW/m2), similar to the typical shields values. Recent heat flow measurements in Jordan indicate higher values (56-66 mW/m2). As part of the YOCMAL project (YOung Conjugate MArgins Laboratory), we have conducted heat flow measurements in southern and northern Oman to obtain 10 new heat flux values in the eastern Arabian plate. We also derived 20 heat flux values in Yemen and Oman by processing thermal data from oil exploration wells. The surface heat flux in these different locations is uniformly low (45 mW/m2). The heat production in samples from the Dhofar and Socotra Precambrian basement is also low (0.7 μW/m3). Differences in heat flow between the eastern (60 mW/m2) and the western (45 mW/m2) parts of Arabia reflect differences in crustal heat production as well as a higher mantle heat flux in the west. We have calculated a steady state geotherm for the Arabian platform that intersects the isentropic temperature profile at a depth of about 150 km, consistent with the seismic observations. Seismic tomography studies of the mantle beneath Arabia also show this east-west contrast. Seismic studies have shown that the lithosphere is rather thin, 100 km or less below the shield and 150 km below the platform. The lithospheric thickness for the Arabian plate is 150 km, and the progressive thinning near the Red Sea, caused by the thermal erosion of the plume material, is too recent to be detected at the surface. The Afar plume mostly affects the base of the Arabian lithosphere along the Red Sea and the western part of the Gulf of Aden. The extent of this effect is explained by channeling of the asthenospheric magma by the rift. The subdued penetration into the Gulf of Aden is probably due to the important segmentation of the rift. The continental domain is not affected by rifting in the Gulf of Aden. The main thermal effect of the Arabian plate is probably the channeling of the Afar plume to the North.