Tectonics of the Northern Red Sea, insights from multibeam bathymetric mapping of Mabahiss Deep.

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The Red Sea is a unique place to study the birth of an oceanic rift basin and the interplay between magma and tectonics at a young divergent plate boundary. The Red Sea is a NNW-SSE oriented and 2000 km long rift system with a spreading rate decreasing from ~16 mm/yr in the south to ~7 mm/yr in the north. The morphology also changes along the rift axis: the south portion is a continuous and well-developed rift, clearly exposing oceanic crust, the central portion is characterized by deeps made by oceanic crust separated by shallower inter-trough zones, and the northern part contains more widely spaced and less obvious deeps with the transition to the continental crust not well defined. While the central Red Sea morphology has been extensively studied, the structure of the northern Red Sea and its link to the central Red Sea are still unclear. Indeed, the northern Red Sea rift is offset by 100 km to the central Red Sea axis by the still poorly understood Zabargad fracture zone.

Here we aim at improving the understanding of the volcano-tectonic structure of the axial part of the southern tip of the northern Red Sea that corresponds to the Mabahiss Deep. To this aim, we carried out multiple multibeam surveys with R/V Thuwal and R/V Kobi Ruegg to map the sea bottom to add to what had been done in earlier surveys. In addition, we obtained several sub-bottom profiling lines across and along the deep to better constrain the shallow sedimentary structure.

Our results show that the 15 km long, 9 km wide and 2250 m deep Mabahiss Deep along with the 800 m high and 5 km wide central volcano are the key prominent structures of the area. The deep is bordered by a series of Red Sea parallel normal faults on two sides forming a graben-like structure and thus suggesting a rift-like morphology. The central volcano is well preserved and has a 2 km wide summit caldera containing several volcanic cones and thus suggesting a permanent magmatic source underneath of a relatively young age. The ocean floor outside the deep and the volcanic edifice is mostly covered by salt flows, limiting structural analysis of the surrounding areas.

A comparison between the northern and central Red Sea suggests, although in both areas thick salt covers most of the ocean floor, that the axes have similar rift-like structures with stable axial
volcanism. However, in the central Red Sea larger portions of the oceanic crust are free of salt and the deformation seems larger with more prominent faults that also affect the floor of the deeps and split apart volcanic edifices, enhancing the occurrence of diffused monogenic volcanic cones. Therefore, this might suggest, despite the central and northern Red Sea sharing the same structure and evolution, that the less volcanic and tectonic activity in the north probably reflects the decreasing spreading rate from south to north along the Red Sea.