Hatiba to Port Sudan Deep (Red Sea) Imaging a growing Ocean

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The current knowledge of the bathymetry of one of the youngest oceans on earth, the Red Sea, and its spreading centres is poor and mainly based on several low resolution maps of a few deeps of higher interest, like the Atlantis II Deep [e.g., 1, 2]. During the RV Poseidon cruise 408 we collected a continuous bathymetric dataset of Red Sea deeps from the Hatiba Deep via Atlantis II Deep to the Port Sudan Deep over a total N-S distance of 300 km between 22°28´N and 19°59´N along the Red Sea rift with a resolution of 25-30 m.

The bathymetric data visualize very well tectonic features (complex fault and rift structures) and related volcanic edifices, in Hatiba, Atlantis II as well as Port Sudan Deep. The position of the rift axis can be determined for the Hatiba Deep and Atlantis II Deep based on graben fault symmetry and slope angle calculations, together with the recovery of fresh basalts. The models demonstrate that especially the tectonic setting of the comparatively large Hatiba Deep is much more complex than previously thought and reveal evidence for a rift-axis-jump to the south. Basalts with characteristic flow textures and enclosed sediments, recovered from the southwestern Hatiba basin, give strong indications for rupturing in an environment, where possibly magma interacted with wet sediments. Thermobarometry calculations based on geochemical analyses (EMP, FTIR) of basalt glass from Hatiba deep reveal generally variable depths of last equilibration with a gabbroic mineral assemblage of about 6 to 14 km for samples from different locations in the deep, whereas samples from the assumed actual spreading center point to a crystalization depth of about 8 km at 1170°C.

Distinct tectonic features as visible in the Hatiba Deep become less prominent to the south. Therefore, the bathymetry of the Port Sudan Deep marks the changeover from the rifting in the northern Red Sea to the drifting in the southern Red Sea. For all mapped deeps, the bathymetric data show strong influence of salt/sediment flow as well as land slides into the deeps, which in some cases cover large parts of the graben structures. Due to sedimentation, indications of ridge offsets between the deeps are covered by sediments and the tectonics of ridge transition are not visible in the recently available dataset.

We present a unique collection of bathymetric models and volcanic/tectonic interpretations. Combined with data about ground truthing, geological mapping and geochemical data this work provides a detailed look into the structure, tectonics, magmatic centres and evolution of Red Sea deeps in larger detail than observed before.

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Siderophile element redistribution during mantle metasomatism

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During subduction zone processing, highly siderophile elements (HSE) including Re-Os may be mobilised differentially from different parts of the slab, with consequences for their transfer into the mantle wedge and retention in deeply subducted residual eclogites [e.g. 1]. The Slave craton in northern Canada was affected by Paleoproterozoic subduction, leading to emplacement of gabbroic materials, eclogitisation during interaction with deserpentinisation fluids and associated diamond formation [2]. Pristine sulphide inclusions in these 1.9 Ga eclogitic diamonds have HSE and other trace metal concentrations attesting to conservative behaviour during dehydration-induced metasomatism and metamorphism of their subduction-related gabbroic source rocks. This is taken to indicate that the fluids involved were reducing and Cl-poor, and therefore unable to mobilise HSE from the gabbroic portion of the slab into the supra-subduction zone.

Contrary to sulphide included in diamond, sulphide of the same composition and inferred age in eclogite xenoliths have been exposed to mantle metasomatic processes since their 1.9 Ga emplacement into the cratonic lithosphere. Such metasomatism may lead to introduction and/or remobilisation of HSE, either as sulphide melts or dissolved along with oxidised S species in silicate or carbonate melts or related fluids [e.g. 3]. Earlier investigation of sulphide minerals in these eclogite xenoliths has revealed three of five samples to be too Ni-rich to be in equilibrium with a meta-basaltic source, and to have disturbed Re-Os isotope systematics. By contrast, the silicate portion of the eclogites does not show evidence for metasomatic overprint. This may indicate introduction of mobile Ni-rich sulphide melts derived from surrounding mantle peridotite [4].

We are in the process of measuring HSE and other trace metal contents of sulphide minerals in these rocks, and in a pyroxenite giving a 1.9 Ga sulphide-derived Re-Os isochron age. This will enable us to compare HSE signatures of sulphide in eclogite xenoliths with corrupted Re-Os isotope systematics to primary sulphide included in diamond and in the pyroxenite. We anticipate there will be differences in HSE abundances and/or ratios that will afford insights into the nature and effects of mantle metasomatic agents that lead to redistribution of HSE and disturbance of primary Re-Os isotope signatures.

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