AMAGMATIC EXTENSION AND THICK OCEANIC CRUST IN THE EASTERN BLACK SEA

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Volcanic rifted margins exhibit extensive syn-rift magmatism during extension and produce thick ocean crust during initial spreading, whilst magma-poor margins are characterised by limited syn-rift magmatism, highly stretched continental crust and areas of exhumed mantle. Often these two types of rifting can be seen along the same margin (e.g., Gulf of California and eastern Canada), but the nature of the transition from one to the other is poorly understood. New seismic refraction data collected in the Eastern Black Sea (EBS) provide provocative new constraints on this type of transition. The Black Sea can be divided into two sub-basins that have distinct tectonic histories. The EBS is thought to have opened by rotation of the Shatsky Ridge away from the Mid Black Sea High, with rifting culminating in the early Cenozoic. Previous studies have revealed a thick sedimentary package (8-9 km) underlain by thin crust in the centre of the basin, but the nature of the crust has remained controversial. In spring 2005, we collected four wide-angle seismic profiles in the EBS basin as shown in figure 1. Lines 2 and 3 are approximately orientated parallel to the inferred direction of extension and located ~ 200 km apart. Line 1 connects these lines, traversing the centre of the basin and sampling some of the thinnest crust.

![Figure 1. The Eastern Black Sea basin and the location of our 2005 survey lines. Each white dot represents an OBS location and each black triangle is a land station.](image)
Along Line 3, the crust thins abruptly from ~ 32 km to ~ 7-9 km in the centre of the basin. Within the thin crust the velocity increases along a shallow velocity gradient of ~ 0.35 s\(^{-1}\) from 5 km/s at the top to 6.5 km/s over a depth of ~ 5 km. The lower crust has a fairly constant velocity of 6.5-6.75 km/s. This velocity structure indicates that the crust along Line 3 is most likely highly stretched continental material. Mantle velocities beneath the crust are ~ 8.0 km/s, and there is no evidence for extensive syn-rift magmatism.

Further southeast, the crust along Line 2 is ~ 13 km thick and has two distinct seismic velocity gradients. The top 4 km has a high velocity gradient from 4.25 km/s to 6.0 km/s. The velocity gradient gradually shallows to reach seismic velocities of 7.2-7.5 km/s at the base of the crust. This velocity structure is too fast to be continental crust and the velocity gradient structure is best interpreted as thick oceanic crust.

At the eastern end of Line 1, where it crosses Line 2, the velocity structure also indicates thick oceanic crust extending for ~ 150 km along the line. A transition from oceanic to continental crust appears to occur ~ 60 km to the west of the intersection with Line 2 and coincides with a crustal fault (Ordu Fault) imaged in seismic reflection data and inferred from shipboard gravity data. To the west of this fault the crust is ~ 6 km thick with a constant velocity gradient of ~ 0.35 s\(^{-1}\). The thickness of the crust is fairly constant over a distance of ~ 60 km before thickening slightly and decreasing again to ~ 7 km over a distance of 80 km. Line 3 intersects Line 1 at the western edge of this crustal thickening.

Our data suggest that the extension of the EBS basin is greater in the SE than the NW such that rifting in the SE culminated with the onset of seafloor spreading. This supports previous hypotheses that the rift opened by rotation of the Shatsky Ridge away from the Mid Black Sea High. A remarkable feature of the observed crustal configuration is the existence of highly thinned continental crust immediately adjacent to thick oceanic crust. These two crustal domains are separated by an interpreted transform fault, implying that rift segmentation exerts control over the expression of magmatism in the rift (as seen along the east Africa rift system) or that there were significant along margin changes in mantle temperature and/or composition at the time of rifting.