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Crustal structure of the southern Dead Sea basin derived from project DESIRE wide-angle seismic data

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SUMMARY

As part of the DEad Sea Integrated REsearch project (DESIRE) a 235 km long seismic wide-angle reflection/refraction (WRR) profile was completed in spring 2006 across the Dead Sea Transform (DST) in the region of the southern Dead Sea basin (DSB). The DST with a total of about 107 km multi-stage left-lateral shear since about 18 Ma ago, accommodates the movement between the Arabian and African plates. It connects the spreading centre in the Red Sea with the Taurus collision zone in Turkey over a length of about 1 100 km. With a sedimentary infill of about 10 km in places, the southern DSB is the largest pull-apart basin along the DST and one of the largest pull-apart basins on Earth. The WRR measurements comprised 11 shots recorded by 200 three-component and 400 one-component instruments spaced 300 m to 1.2 km apart along the whole length of the E–W trending profile. Models of the *P*-wave velocity structure derived from the WRR data show that the sedimentary infill associated with the formation of the southern DSB is about 8.5 km thick beneath the profile. With around an additional 2 km of older sediments, the depth to the seismic basement beneath the southern DSB is about 11 km below sea level beneath the profile. Seismic refraction data from an earlier experiment suggest that the seismic basement continues to deepen to a maximum depth of about 14 km, about 10 km south of the DESIRE profile. In contrast, the interfaces below about 20 km depth, including the top of the lower crust and the Moho, probably show less than 3 km variation in depth beneath the profile as it crosses the southern DSB. Thus the Dead Sea pull-apart basin may be essentially an upper crustal feature with upper crustal extension associated with the left-lateral motion along the DST. The boundary between the upper and lower crust at about 20 km depth might act as a decoupling zone. Below this boundary the two plates move past each other in what is essentially a shearing motion. Thermo-mechanical modelling of the DSB supports such a scenario. As the DESIRE seismic profile crosses the DST about 100 km north of where the DESERT seismic profile crosses the DST, it has been possible to construct a crustal cross-section of the region before the 107 km left-lateral shear on the DST occurred.

Key words: Controlled source seismology; Transform faults.

INTRODUCTION

The Dead Sea Transform (DST) forms the boundary between the African and Arabian plates at the northwestern flank of the Nubo-Arabian Shield (Fig. 1). It trends N-NNE for about 1 100 km from the northern Red Sea in the south to the collision zone at the Taurus mountains in the north. Since its inception about 18 Ma ago it has accommodated about 107 km of left-lateral movement between the two plates (Quennell 1958; Freund *et al*. 1970; Garfunkel 1981, 1997). Along its southern portion huge pull-apart basins, for example the Dead Sea basin (DSB), Gulf of Aqaba/Elat, alternate with strands of strike-slip dominated, relatively simple shear zones, for example the Arava/Araba valley. The DSB is the largest pull-apart basin along the DST and one of the largest such features on Earth.