CRUSTAL SHORTENING ALONG THE CRETAN ARC OBTAINED BY ACTIVE SEISMIC EXPERIMENTS

Jannis Makris*, Marco Brönner
Institute for Geophysics, Hamburg University, Hamburg, Germany - makris@dkrz.de

Keywords: crustal mapping, tectonics, Crete, Libyan and Cretan seas

The crust and upper mantle structure of Crete, the Cretan and Libyan Seas were obtained by two onshore-offshore seismic experiments performed in 1997 and 1999. Onshore we deployed up to 100 stand alone digital seismic stations and offshore 67 OBS. They were used to record seismic energy generated by a 3050 cubic inch airgun array. Six seismic profiles were recorded and approx. 700 locations were occupied by the onshore-offshore seismic stations (Figure 1). Technical details of both experiments have been described obtained at Bohnhoff *et al.*[1] and Broenner and Makris [2].

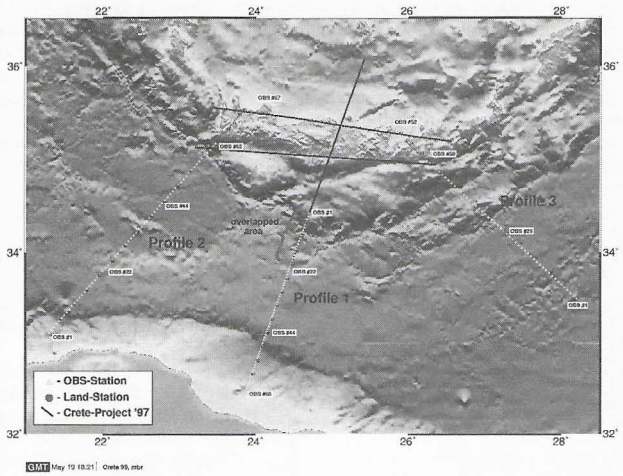

Figure 1: Crete -Projekt, Distribution of OBS- and Land- Stations.

Crustal structure on Crete proved to be laterally very variably. At the central part of Crete the crustal thickness exceeds 30 km whereas to the east and west the continental crust thins to approx. 26 km and to the east 22 km. In general the southern part of the island is thinner than the northern part of it and even at central Crete obtains values of the order of 29 km. To the north of Crete (Cretan sea) the continental crust does not exceed 16 km at its thinnest part and seems to be associated with transtensional processes that created pull apart basins (see also [3]). The sediments in the Cretan sea do not exceed 5000m and high velocity metamorphic limestones partly exposed on Crete do not seem to be present. On Crete the metamorphic limestone formations (Plattenkalk) have variable thicknesses ranging between 3 and 5 km. Their compressional velocities have values between 5.7 and 6.0 km/s. Below Crete we could identify in western and central Crete a second crustal layer of 5 to 6 km thickness which is clearly separated by the continental crust by first order discontinuity mapped due its good reflectivity. This layer was interpreted as oceanic crust of the Ionian domaine which is presently subducted below Crete. The decoupling of this layer from the continental crust occurs at the north-eastern part of Crete and the decoupling front is northwest-southeast oriented. It delineates the down dipping slab of oceanic lithosphere that generates the volcanic arc of the southern Aegean sea (Figure 2).

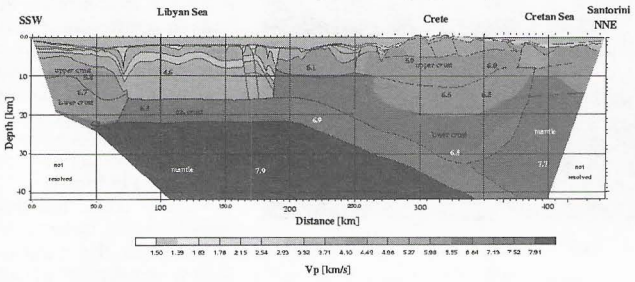

Figure 2: 2D Velocity- Depth model from the rim of Africa across Crete to Santorini, vertical exaggeration: 3.0

South of Crete the continental crust extends 100 - 150 km south and southwest of the Cretan coast and has been partly tectonized by the Ptolomeus and Pliny fault systems which are also associated with extensional structures. These propably involve strike slip as well as normal faulting. The crust of the Libyan sea which was mapped south of the Pliny fault is composed of oceanic crust and covered by thick sediments. Along the Mediterranean Ridge they exceed in some areas 12 km in thickness. This part of the Libyan sea is very strongly folded and faulted, expressing the intense tectonic deformation ongoing at present. In this part of the Mediterranean Ridge we have not identified high velocity limestones of the Plattenkalk type as those exposed on Crete or other Parts of the Hellenic Arc. Compressional wave velocities of 4.5 - 4.8 km/s denote the existence formations that have not been subjected to significant metamorphism. In most of the Libyan sea we identified one inversion zone of 3.0 -3.2 km/s underlying the 4.2 km/s limestones. In some parts two inversion zones have been mapped.

The African continental crust extends north to northeast for more than 100 km off the Libyan coast. This part of the crust is strongly thinned (25 -22 km thickness) and covered by thick sediments which are more intensely deformed to the west than to the east of Cyrenaica. Along our western profile we identified thick sedimental basins at the Libyan offshore areas that contain more than 8000m of sediments and are truncated to the northeast by intense faulting. By comparing the eastern profiles with the western line described above, we see that the intense tectonization is closer to the eastern Cretan coast than to its western side. In general whereas south of Crete the continent- ocean collision is oblique, to the west the subduction is oriented parallel to the Hellenides and of northeast- southwest orientation.

References:

1 - Bohnhoff *et al.*, 2000, Crustal investigation of the hellenic subduction zone using wide aperture seismic data, in Press
2 - Broenner M. and Makris J., 2000. Crustal structure of the Libyan margin. *CIESM Workshop Series*, 13: 63- 66
3 - Goetz L.G., 1996, Beschreibung und Vergleich der Tektonik pazifischer und mediterraner Back- arc Becken hergeleitet aus echographischen und bathymetrischen Vermessungen, Bericht aus dem ZMK, Reihe C: *Geophysik*, Nr. 9