AAPG Search and Discovery Article #90024©2000 AAPG Regional International Conference, Istanbul, Turkey, July 9-12, 2000 (2004)

CRUSTAL-SCALE IMAGING OF THE ABSHERON RIDGE (SOUTH CASPIAN SEA) REVEALED BY DEEP SEISMIC REFLECTION PROFILING

Camelia C. Diaconescu1; James H. Knapp2; and John Connor3
1 Department of Geological Sciences, Cornell University, Ithaca, NY 14853
2 Department of Geological Sciences, University of South Carolina, Columbia, SC 29208
3 Chevron Overseas Petroleum Azerbaijan Ltd., 17 Tagiev Kuçesi, 370000 Baku, Azerbaijan

The crustal structure of the South Caspian Basin is for the first time imaged with normal-incidence seismic reflection techniques to depths in excess of 50 km, as part of a 1998 acquisition program directed by Chevron Overseas Petroleum Inc. Two roughly perpendicular deep seismic reflection profiles, each –70 km in length and recorded to 20 s, were acquired offshore Azerbaijan, in a key area for understanding the regional tectonics of the enigmatic Caspian Basin system. The main aim of collecting deep seismic data in this important petroliferous basin was to: (1) reveal the deep structure and tectonics of the Alpine-Himalayan continent-continent collisional zone beneath the South to Central Caspian Sea, (2) portray the full Mesozoic (?)-Quaternary section of the sedimentary basin that is inferred to be, in places, thicker than 20 km, and (3) elucidate the thickness and nature of the crust, providing critical information for subsidence and thermal modeling with implication for source rock maturation. With previous efforts to image the shallow South Caspian Sea, provision of a crustal-scale image represents a compelling opportunity to link active upper crustal deformation with deep lower crustal-mantle processes. These new reflaction data provide a pseudo 3-D architecture of the South Caspian basin in the vicinity of the Absheron Ridge. Although recorded with standart industry parameters (airgun source of 3180 cm3 at 1900 psi, 25 m hydrophone spacing, 50 m shot spacing, 5400 m streamer lentgh, 4 ms sample rate), the two deep seismic lines provide an image of the basin down to upper mantle depths.

Reliminary processing of these profiles, including predictive deconvolution, T-p filtering, and a time-variant gain function, was focused on removal of abundant multiple energy and enhancement of low signal-to-noise deep reflections. The time section was subsequently converted to depth using the stacking velocities and information provided by earlier seismic refraction profiles. The following significant features can be seen on the profiles. (1) a series of high-amplitude folds, developed within the thick Tertiary-Quaternary portion of the section, (2) a prominent, strongly reflective horizon at ~26 km (12.8 s) on the southern part of the profile, (3) an underlying layered interval down to ~34-38 km (16-16.5 s) with discernible lower frequency reflections, and (4) a noticeable decrease in reflectivity below ~34 km (~16 s).

As has been observed on numerous dep seismic reflection profiles, we interpret the bright reflection at ~26-28 km depth as the basement/cover contact. The overlying section shows no obvious change in amplitude and frequency of reflections, while below this horizon, reflectivity is noticeably of lower frequency and higher amplitude. In addition, previous velocity models from both DSS (Deep Seismic Sounding) and teleseismic studies in the South Caspian suggest a minimum sedimentary thickness of 20 km. precluding a shallower basement/cover contact. Although laterally discontinuous, this bright reflector can be traced toward the Absheron Ridge, exhibiting a gentle northward dip. This geometry suggests deepening of the crust from south to north, which could be interpreted as evidence for northward subduction of the South Caspian lithosphere beneath the Absheron Ridge. If correct, these observations imply that the sedimentary fill of the South Casian in the vicinity of the Absheron Ridge is ~26-28 km in thickness, making this the deepest sedimentary basin in the world, to our knowledge. The more highly reflective portion of the section below ~28 km is interpreted as the crystalline basement. Downward termination of reflectivity is thought to represent the Moho, despite the absence of a clearly reflective horizon, making for a composite crustal thickness in this portion of the basin of ~34-38 km. The apparent ~8 km thickness of the crystalline crust is consistent with an oceanic affinity for this part of the basin. The overlying section is dominated by large, S-vergent fault-propagation(?) folds that root into a relatively “shallow” detachment, dipping northward from ~14 to 20 km. The Plio-Pleistocene section reaches thicknesses approaching ~10 km in the southern part of the study area. Discordance of axial surfaces in folds developed within the sedimentary section shows clear evidence for at least two distinct stages of deformation in Tertiary time.