Seismic Refraction Tomography and Stratigraphic Variability of Upper Holocene Coastal Deposits Along the Al Qahmah Coast, Red Sea, Saudi Arabia

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Abstract

Subsurface stratigraphic records and seismic refraction tomographic data were acquired along three parallel SE-NW transacts perpendicular to the shoreline in an area of 4 km2 along the southern Red Sea coast, Saudi Arabia. Each transect is 950 m long, starts 5.5 m from the shoreline, and extends inland. The acquisition was conducted using a 96-channel Geode Ultra-Light Exploration Seismograph controlled by the Siesmodule Controller Software with 40-Hz vertically polarized geophones. Acquisition parameters include a stack of 12 for each record, a geophone spacing of 10 m, and a source spacing of 10 m. The raw seismic refraction data were processed using SeisImager/2D of Geometric Inc., v. 2009. There is a significant variation in the thickness and depths of the stratigraphic units and seismic velocity represented by four stratigraphic units and three velocity layers in the study area. The data was interpreted as a regressive surface at the top of the limestone with an average P-wave velocity of 3000 m/s. The limestone base is not identified on the seismic profiles, indicating it is too deep to be imaged. Siliciclastic deposits overlying the limestone are represented by three lithostratigraphic units: shelly muddy sand, gravels, and sand. Shelly muddy sands and gravels units develop with a velocity ranging from 1500 to 450 m/s and depth from 1-20 m. Sand has an average velocity of 450 m/s and ranges from 1 to 15 m in thickness. Four normal faults are interpreted in the three sections. They control the undulating morphology of the upper surface. The overlying saturated and dry sands thicken in the down-thrown hanging wall and thin over the up-thrown footwall of the faults. This thickness variation across the faults suggests that faulting was synchronous with the deposition of sediments overlying the limestone bedrock. The series of seaward stepping faults may also have caused the overall seaward deepening of the upper surface. Normal faulting may have caused the variable depth of the top surface of the limestone layer. Moreover, limestone was detected at a shallow depth at the landward end of the sections, which is interpreted as a slight uplift. Finally, the seismic interpretations indicate that the stratigraphic variability is not random and has a regular pattern of a simultaneous increase in thickness in the depressed area along and behind the coast. This is controlled by episodic syndepositional faulting during the deposition of lithostratigraphic units of carbonate and siliciclastic sediments along the rifted coast during Late Holocene.