LAWRENCE
LIVERMORE
NATIONAL
LABORATORY

UCRL-CONF-227105

Structure of the Lithosphere and Upper Mantle Across the Arabian Peninsula

A. Al-Amri, A. Rodgers

January 5, 2007

2007 Gulf Seismic Forum
Kuwait City, Kuwait
March 24, 2007 through March 27, 2007

Structure of the Lithosphere and Upper Mantle Across the Arabian Peninsula

Abdullah Al-Amri
Seismic Studies Center and Geology Department, King Saud University
Riyadh, SAUDI ARABIA
and
Arthur Rodgers
Seismology Group, Energy and Environment Directorate,
Lawrence Livermore National Laboratory, Livermore CA USA

Analysis of modern broadband (BB) waveform data allows for the inference of seismic velocity structure of the crust and upper mantle using a variety of techniques. This presentation will report inferences of seismic structure of the Arabian Plate using BB data from various networks. Most data were recorded by the Saudi Arabian National Digital Seismic Network (SANDSN) which consists of 38 (26 BB, 11 SP) stations, mostly located on the Arabian Shield. Additional data were taken from the 1995-7 Saudi Arabian IRIS-PASSCAL Deployment (9 BB stations) and other stations across the Peninsula. Crustal structure, inferred from teleseismic P-wave receiver functions, reveals thicker crust in the Arabian Platform (40-45 km) and the interior of the Arabian Shield (35-40 km) and thinner crust along the Red Sea coast. Lithospheric thickness inferred from teleseismic S-wave receiver functions reveals very thin lithosphere (40-80 km) along the Red Sea coast which thickens rapidly toward the interior of the Arabian Shield (100-120 km). We also observe a step of 20-40 km in lithospheric thickness across the Shield-Platform boundary. Seismic velocity structure of the upper mantle inferred from teleseismic P- and S-wave travel time tomography reveals large differences between the Shield and Platform, with the Shield being underlain by slower velocities, ±3% for P-waves and ±6% for S-waves. Seismic anisotropy was inferred from shear-wave splitting, using teleseismic SKS waveforms. Results reveal a splitting time of approximately 1.4 seconds, with the fast axis slightly east of north. The shear-wave splitting results are consistent across the Peninsula, with a slight clockwise rotation parallel for stations near the Gulf of Aqaba. In summary, these results allow us to make several conclusions about the tectonic evolution and current state of the Arabian Plate. Lithospheric thickness implies that thinning near the Red Sea has accompanied the rupturing of the Arabian-Nubian continental lithosphere. The step in the lithospheric thickness across the Shield-Platform boundary likely reveals a pre-existing difference in the lithospheric structure prior to accretion of the terranes composing the eastern Arabian Shield. Tomographic imaging of upper mantle velocities implies a single large-scale thermal anomaly underlies the Arabian Shield and is associated with Cenozoic uplift and volcanism.

This work was performed under the auspices of the U. S. Department of Energy by University of California, Lawrence Livermore National Laboratory under contract W-7405-Eng-48.