Tomographic Imaging of Upper Mantle P-wave Velocity Heterogeneity Beneath the Arabian Peninsula

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We report preliminary estimates of three-dimensional P-wave velocity structure beneath the Arabian Peninsula estimated from travel time delay tomography. We have completed travel time measurement and inversion of a partial data set provided by King Abdulaziz City for Science and Technology (KACST). This study builds on previous work by Benoit et al. (2003) following the methods of Van der Carr and Crosson (1990) and Van der Carr (1990). Data were collected from the Saudi Arabian National Digital Seismic Network (SANDSN) operated by KACST. The network consists of 38 stations (27 broadband and 11 short-period). We augmented the KACST data with delay times measured from permanent Incorporated Research Institutions for Seismology (IRIS) stations in the region (RAYN, EIL and MRNI). Travel time delay data from Benoit et al. (2003) was not included in the inversions discussed below, but will be included in future analysis.

For the KACST data, we used 131 earthquakes with P-wave arrivals in the distance range 30°-90°, resulting in 1716 ray paths. The data from Benoit et al., (2003) included 178 earthquakes and 792 rays. Figure 1 shows the earthquake distributions for the two data sets. Natural seismicity observed in Arabia in this distance range results in many events from the northeastern azimuths and very few events from southern and western azimuths.

The inversion procedure consists of four steps. First, the P-wave travel time delays were measured from large teleseismic earthquakes using the Multi-Channel Cross-Correlation method of (Van der Carr and Crosson, 1990). Second, the ray paths and travel time residuals are computed. Residuals are formed by subtracting the theoretical travel time predicted from the global average one-dimensional velocity model *iasp91* (Kennett and Engdahl, 1991) from the observed travel time. Third, the partial derivatives of the ray paths are computed for the gridded upper mantle model. Then the travel time residuals are inverted for upper mantle velocity structure. The method uses an iterative non-linear ray tracing algorithm to allow for ray bending by three-dimensional structure.

The models reveal lateral variations in P-wave velocity of ±1%. The most striking features of these images are the strong low velocities beneath the southern Arabian Shield (Asir Province) and Red Sea and the eastern edge of the Arabian Shield. We infer low velocities beneath the Dead Sea Transform and Gulf of Aqaba at depths below 200 km. A broad region of low velocities is inferred beneath the northern Arabian Shield below 200 km. Results from the combined KACST and IRIS data are broadly consistent with the results of Benoit et al. (2003) with the exception of velocities in the northern Arabian Shield. Benoit et al. (2003) inferred high velocities beneath the northern Arabian Shield and the KACST data results in lower than average velocities.