Upper Mantle Velocity Structure Beneath the TAMSEIS Network, Antarctica

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The Transantarctic Mountains (TAM), extending more than 3500 km in length and reaching heights of 4500m, are characterized by gently tilted fault blocks resulting from vertical crustal movement in the Cenozoic. Paralleling much of the West Antarctic Rift System (WARS), the TAM is considered by many to be a classic example of rift flank uplift, however evidence supporting a clear uplift mechanism has yet to be provided. Thus the PASSCAL Transantarctic Mountain Seismic Experiment (TAMSEIS) was conducted to investigate the crustal and upper mantle structure beneath the TAM as well as the adjacent East Antarctic craton and WARS in the vicinity of Ross Island. TAMSEIS consisted of 41 temporary broadband seismometers deployed between December, 2000, and December, 2003, in three arrays (Figure 1a).

Utilizing the TAMSEIS data as well as data from 3 Global Seismic Network stations (SBA, VNDA, & TNV), body-wave tomography was conducted to estimate the upper mantle velocity structure beneath the stations. In total, 3934 P-waves were picked from 324 events (Figure 1b) and 2244 S-waves were picked from 174 events. Both P and S wave tomography results reveal a low-velocity anomaly in the upper mantle extending 200 km beneath the TAM in the vicinity of McMurdo Sound. The low-velocity anomaly extends NNE with depth beneath the Ross Sea. At its western boundary, the low-velocity anomaly makes a sharp contact with the faster velocities that accompany the upper mantle beneath the East Antarctic Craton (Figure 2d,f).

Figure 1. a) An elevation map of the TAM in the Ross Sea region displaying the TAMSEIS network. The blue circles mark the N-S Array stations (80 km station spacing), the red triangles mark the E-W array stations (20 km station spacing), the yellow squares mark the Coastal Array stations (variable distances), and the black triangles mark the GSN station locations. b) An earthquake distribution map displaying the locations of the 324 events used in the P-wave tomography study.

Figure 2. a) 150 km depth slice through the P-wave model b) 300 km depth slice through the P-wave model. c) Transect key d-f) Cross sections A-A’, B-B’, & C-C’ respectively, through the P-wave model from 100 – 400 km depth.