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Anomalous Features within the Mantle Transition Zone of Antarctica and their Relationship to Volcanism and Surface Topography

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Prominent volcanoes and the presence of anomalously seismically-slow (warm) material within the upper mantle beneath West Antarctica have led to the suggestion that there may be one or more plumes rising from the lower mantle. Recent results from both seismic tomography studies (sensitive to velocity changes) and receiver functions analysis (sensitive to mantle discontinuities) lend support to these arguments in several distinct regions beneath the Marie Byrd Land and the West Antarctic Rift System [1,2]. However, results from prior tomographic and receiver function studies of the Mt. Erebus region suggest that the anomalies in this area are constrained to the upper mantle [3,4]. Across East Antarctica, it has been suggested that the anomalously high topography is caused by dynamic uplift of the thick continental lithosphere, similar to models proposed for the African Superswell [5]. However, significant slow anomalies have not been detected within the upper mantle beneath East Antarctica suggesting that any warm, buoyant material beneath the uplifted continent should be located deeper, within the mantle transition zone or in the lower mantle.

Using data from several permanent and temporary seismic deployments, including the 2000-2003 TAMSEIS, 2007-2009 GAMSEIS, 2007-2017 ANET, and 2012-2015 TAMNNET arrays, we have computed P-wave receiver functions (PRFs) to examine the mantle transition zone structure beneath Antarctica. Earthquakes located at distances of 30-90^o with magnitudes of Mb>5.5 were processed using an iterative time-domain deconvolution method [6]. PRFs were used to generate common conversion point stacks, which were migrated to depth assuming the ak135 1-D velocity model. Initial results indicate that the mantle transition zone beneath the East Antarctic Gamburtsev Mountains does not vary appreciably (±10 km). Initial results from the McMurdo-Transantarctic Mountains region are similar, showing little perturbation to the mantle transition zone, although some thinning may exist south of Mt. Erebus. This possibly thinned mantle transition zone is detected in the region beneath the Transantarctic Mountains where upper mantle shear velocities change greatly over a short distance (about -5% to +5% relative to the global average) [7]. Additional stacking and migration using a 3-D velocity model is in progress and will provide confidence in this observation.

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