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Seismic structure and sources of the Antarctic continent determined from large-scale year around deployment of broadband seismographs

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The International Polar Year provided an opportunity for large-scale, year around deployment of autonomous seismographs across most of Antarctica, enabling higher resolution studies of the seismological structure of the continent and unprecedented detection of seismic sources due to both glacial and tectonic processes. The AGAP/GAMSEIS deployment consisted of 24 broadband seismographs deployed across the Gamburtsev Subglacial Mountains (GSM) in East Antarctica during 2007-2009. The POLENET/ANET deployment in West Antarctica began with a few seismographs installed during late 2007 but has now ramped up to 33 seismographs deployed across the West Antarctic Rift System, Marie Byrd Land, and surrounding regions. The seismographs operate year around even in the coldest parts of Antarctica, due to novel insulated boxes, power systems, and modified instrumentation developed in collaboration with the IRIS PASSCAL Instrument Center.

We study the surface wave phase velocity structure of Antarctica using a modified two-plane wave decomposition of teleseismic Rayleigh waves as well as noise correlation techniques and receiver functions. High mantle seismic velocities similar to Precambrian cratons elsewhere in the world are found across East Antarctica including the GSM, eliminating the possibility that the mountains formed through recent thermal or tectonic reactivation. We find that the high GSM topography is instead supported by thickened crust. The Ross Sea and West Antarctica are underlain by thinner crust and slow upper mantle velocities. The slowest upper mantle velocities seem to trend along a band adjacent to the Transantarctic mountain front, suggesting a thermal anomaly coincident with the locus of Cenozoic extension. We are also studying the distribution of seismic sources across Antarctica using both traditional high frequency (0.5 – 4 Hz) P and S wave detection as well as low frequency (0.05 – 0.01 Hz) time-reversal methods. Many seismic sources are detected by one (but not both) of these methods, suggesting distinct high frequency and low frequency source types. The geographic distribution of Antarctic seismic sources indicates that most result from glacial activity. These events may provide important constraints on the mechanics of glacial processes and future work will include better characterization and interpretation of these events.