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Broadband Array Seismic Studies of Lithospheric Structure Beneath Southern Africa: Implications for the Formation and Evolution of Cratons

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The Kaapvaal Project is a multidisciplinary and multinational investigation into early continental formation in southern Africa. The Project included a two year deployment of 55 broadband seismic stations deployed at 82 sites in a swath 1800 km long by about 600 km wide. Tomographic analysis of the seismic data reveals that high velocity tectospheric roots extend at least locally to depths as great as 250 and perhaps 300 km beneath undisturbed Archean craton. No comparable root structures are observed beneath post-Archean terranes. The Kaapvaal craton was disrupted over a wide swath about 2.05 Ga by the Bushveld magmatic event, beneath which mantle velocities are distinctly lower. The mantle beneath the Archean Limpopo Belt suture is cratonic in character. Tomographic results indicate the presence of a large low velocity region in the deep mantle, possibly the upper reaches of the African superswell.

The crust beneath southern Africa exhibits significant regional variations that have implications for crustal formation in Archean time. Receiver function analysis of seismic records from 81 broadband stations reveals that both crustal thickness and the character of the P- to S-wave Moho conversions correlate remarkably well with geologic terrane. The crust beneath undisturbed Archean craton is relatively thin (~35-40 km), unlayered, and characterized by a strong velocity contrast across a simple Moho. Complex Moho signatures and thicker (~45-55 km) crustal sections characterize both the intracratonic region of the Bushveld layered intrusion and the Proterozoic mobile belts adjoining the cratons. These results indicate that the processes which separated crust from mantle were highly efficient in the Archean and that the crust/mantle interface has been stable since that time. Thicker crust, weak Moho signatures and mafic lower crust characterize post-Archean terranes and Archean regions disrupted by large-scale Proterozoic magmatic or tectonic activity.