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The evolution of Archean cratonic roots: a geophysical perspective

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Stable continental cratons are the oldest geologic features on the planet, and have survived 3.8-2.5 billion years of Earth's evolution. It has long been recognized that the key to the preservation of cratons lies in their strong and thick lithospheric roots, which are neutrally or positively buoyant with respect to surrounding mantle. The traditional view that most Archean cratonic roots are have remained coupled with the crust since their formation, and are too viscous to be affected by mantle convection. Here we present evidence that mantle convective flow can alter the structure of the deepest portions of the "passive" cratonic roots. For the first time we show 3D image of the chemically depleted lithosphere derived from an integrative analysis of gravity, topography, crustal structure, and seismic tomography data. We find that the deepest portion of the cratonic root beneath the North American Superior Province has been shifted some 850 km to the west-southwest. Modeling of mantle convection beneath North America indicates that this shift is due to basal drag. This observation contradicts the conventional view of cratons as static, non-evolving geologic features and suggests that there is significantly more interaction (mechanical, chemical and thermal) between the convecting upper mantle and deep continental roots.