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Cratons forged by large igneous provinces: Evidence from the Siberian and Yangtze Cratons

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Since the Archean mantle plumes can produce a high-degree melting in the lithospheric mantle and may generate large igneous provinces (LIPs). Although magmatism-related thermal erosion has been regarded as an important mechanism for the lithospheric thinning and craton destruction, it is noteworthy that many cratons containing LIPs are still keeping their long-live stability, e.g., the Siberian Craton with the Siberian Traps erupted at ~250 Ma, or the Yangtze Craton with the Emeishan Flood Basalt Province erupted at ~260 Ma, the Kapvaal Craton with the Bushveld Complex at ~2055-2060 Ma and the Karoo LIP at ~183 Ma, and the Indian Craton with the Deccan Traps erupted at ~66 Ma. Therefore, mantle plumes do not necessarily completely destroy cratons.

Both the Siberian and Yangtze cratons are characterized by a low heat flow, rather thick and stable lithosphere, relatively high velocity layers in the lowermost crust and high velocity anomaly in the upper mantle [1, 2]. Combined with the studies of lower crustal and lithospheric mantle xenoliths and rock physics, we reinterpret the seismic profiles and MT data across the Siberian and Yangtze cratons. New results indicate that the elevated Vp (>7.2 km/s) in the lowermost crust can correspond to a mixture of garnet granulites, two-pyroxene granulites, and garnet gabbros as a results of magma underplating at Moho boundary. The high velocity anomaly in the upper mantle (Vp = 8.3-8.6 km/s) can be interpreted as a mixture of eclogites and spinel/garnet peridotites. The comparison between MT data [3, 4] and measurements of electrical conductivity of mantle rocks reveals that the high resistive lithosphere corresponds to the depleted, extremely dry peridotite residues resulted from a high-degree melting. Therefore, the formation of LIPs produced more dehydrated, and rheologically stronger subcontinental lithosphere beneath the Siberian and Yangtze Cratons.

We propose that the interconnection between magmatism-induced heating and dehydration has strongly influenced the long-live stability of cratons or its destruction process. If mantle plumes could not break up the cratonic lithosphere, magmatism and subsequent metamorphism will forge cratons due to a strong coupling of the crust-mantle boundary and increasing viscosity of the subcontinental lithospheric mantle beneath cratons.

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