

Constraints on Archean tectonic processes from deep seismic reflection surveys in the Yilgarn, Pilbara, and Superior cratons

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Following seismic acquisition programs in the Yilgarn and Pilbara cratons by Geoscience Australia with the Geological Survey of Western Australia and in the Superior craton by the Canadian Lithoprobe program, these cratons are now some of the best surveyed Archean regions on Earth.

The Superior craton grew as various island arcs, oceanic plateaux, and micro-continental fragments of Meso-Neoproterozoic age were accreted to the southern margin of a pre-existing microcontinent (North Caribou superterrane) that gave rise to well-developed east-striking belts of granite-greenstone, metasedimentary, and plutonic rocks. Seismic reflection lines transect reveal a doubly-vergent orogen in the north and in the south listric north-dipping mid-crustal reflection fabrics, which were originally interpreted to represent successive episodes of underthrusting, but are also overlain by a thinned middle crust.

In the Yilgarn craton, the Youanmi terrane is characterized by a relatively non-reflective upper crust above a pervasive fabric of commonly listric east-dipping mid-crustal reflections that sole out into the upper part of a 2-3 s thick region of subhorizontal lower crustal reflections. We interpret these reflective fabrics as the result of widespread crustal flow during the late stage of craton evolution at ~2.65-2.6 Ga that also produced subsidence of the upper crust.

Seismic reflection surveys have crossed only the eastern and southwestern margins of the Pilbara craton. In the southwest, a relatively transparent upper crust is underlain by strongly reflective lower crust with the Moho at ~12 s. In contrast, the crust of the eastern Pilbara is notably less reflective, and only 10 s thick, with the highest amplitude reflectivity in the middle crust. Reverse faulting of the eastern Pilbara Moho may be due to reworking during Proterozoic collision.

Seismic lines from all Archean cratons indicate significant extension late in the craton evolution, which was extensive in the Yilgarn craton where it can be viewed as continental spreading. In the Superior craton, pervasive extension is more limited, consistent with the greater crustal thickness, and the preservation of many structures related to subduction-driven accretion.