

Probing the Lithosphere of the Wopmay Orogen

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The Lithoprobe SNORCLE (Slave Northern Cordillera Lithospheric Evolution) transect across the Mesoproterozoic (ca. 1.92-1.84 Ga) Wopmay orogen in northwestern Canada has produced some of the most detailed images of the lithosphere that are available anywhere in the world. Because the orogen was built on the western margin of the Archean Slave province, it forms the crust and lithosphere beneath much of northwestern Canada. Accordingly, the transect provides both a spatial and a temporal link between the Archean Slave Province and the Phanerozoic Cordillera and therefore addresses how northwestern North America has evolved since the early history of the Earth. Lithoprobe work was designed to establish the processes of Mesoproterozoic accretion as well as how the associated structures influenced later development of the Cordillera and the Western Canada sedimentary basin.

Orogenic activity took place during at least two major stages of collision and accretion of arc terranes: the Hottah terrane (age: 1.9-2.3 Ga; accretion: 1.90-1.88 Ga) and the Nahanni-Fort Simpson terrane (age: ~1.845 Ga; accretion: ~1.84 Ga). As a result, the orogen consists of five distinctive tectonic domains from east to west: Coronation margin, Hottah terrane, Great Bear magmatic arc, Fort Simpson- Nahanni terrane and Fort Simpson basin. The Coronation margin consists of westward thickening supracrustal rocks that were deposited on the margin of the Slave craton and that were collapsed and thrust eastward during 1.90-1.88 Ga accretion of the meta-supracrustal and magmatic rocks of the Hottah terrane (Calderian orogeny). The Great Bear magmatic arc, an extensive continental arc that formed on the previously amalgamated Hottah-Slave continent, was active between 1.88-1.84 Ga and was probably formed by eastward subduction of a basin that separated the Hottah from the outboard Nahanni-Fort Simpson terrane. The Nahanni-Fort Simpson terrane accreted to the western Hottah some time after 1.84 Ga because Great Bear magmatism ceased at that time. Post-orogenic extension and subsidence produced the Fort Simpson basin on the west and initiated the post-ca. 1.8 Ga western margin of proto-North America that truncated regional trends of the Canadian Shield (e.g., structural, potential field, etc).

The Coronation margin, Hottah terrane, Great Bear magmatic arc and Nahanni-Fort Simpson terrane all strike north-south and project from outcrop southward beneath the Western Canada Sedimentary basin where Lithoprobe recorded seismic reflection, seismic refraction and electromagnetic profiles. The geophysical data have clear images of Mesoproterozoic subduction surfaces to ~100 km depth, lithospheric wedging that formed during terrane accretion, and the base of the subduction-related Great Bear magmatic arc. Intracrustal deformation appears to have taken place by low-angle contraction that was listric into, or slightly above, the Moho, which in turn underlies nearly the entire orogen at ~35 km. The Fort Simpson basin is up to 25 km deep, but is largely buried beneath the thin Western Canada sedimentary basin. Some of the shallow Proterozoic strata within the Fort Simpson basin outcrop in thrust uplifts near the Cordilleran deformation front in northeastern British Columbia.

These results provide strong evidence that Mesoproterozoic accretion and orogenesis took place by subduction of lithosphere, the remnants of which are still visible today as seismic reflection and refraction surfaces that dip from the crust to ~100 km depth. Detailed images of structures within the upper mantle attest to its complex developmental history as well as its highly variable lithological properties in this region.