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# Thermal state of the upper mantle beneath the Northern Cordilleran Volcanic Province (NCVP), British Columbia, Canada

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**Abstract**

Data are presented for a suite of peridotitic mantle-derived xenoliths collected from basanite lavas within the Llangorse volcanic field, northwest British Columbia. The xenoliths comprise spinel lherzolite and subordinate spinel harzburgite. Two-pyroxene thermometry based on the Brey and Köhler (1990) [Brey, G.P., Köhler, T., 1990. Geothermobarometry in four-phase lherzolites II. New thermobarometers, and practical assessment of existing thermobarometers. Journal of Petrology, 31, 1353–1378.] calibration was applied to 44 xenolith samples. The resulting geothermometry define minimum (800–850 °C) and maximum (1050–1100 °C) temperatures of equilibration for the xenolith suite which are estimates of thermal conditions in the underlying lithospheric mantle. We take the minimum temperatures as indicative of the maximum MOHO temperature; the maximum xenolith temperatures provide a minimum temperature for the transition from lithospheric to asthenospheric mantle. The geothermometry data are combined with published heat flow data to produce a set of model geotherms for this portion of the northern Cordillera. The model geotherms constrain the thickness of the mantle lithosphere in the northern Canadian Cordillera to between 16 and 30 km, corresponding to depths to the lithosphere/asthenosphere boundary of 52–66 km. We show that this model is consistent with an underlying convecting asthenospheric mantle with an average temperature and viscosity of 1210–1250 °C and $10^{19.4}$ Pa s, respectively. We conclude by exploring the implications this model has for the source regions of alkaline magmas erupted over this portion of the northern Cordilleran volcanic province.
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*Keywords:* Mantle lithosphere; Canadian Cordillera; Geothermometry; Peridotite; Xenolith; Northern Cordilleran volcanic province

## 1. Introduction

The mantle lithosphere underlying the northern Canadian Cordillera has been the focus of geophysical and petrological research aimed at understanding the physical and chemical character of the Cordilleran lithosphere, the origins of the underlying mantle lithosphere and, ultimately, the mechanisms of crustal amalgamation (Clowes et al., 1999; Hyndman and Lewis, 1999; Hammer et al., 2000; Snyder et al., 2002; Lewis et al., 2003; Hammer and Clowes, 2004). For example, the northern Canadian Cordillera became welded to the western margin of North Amer-

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ica beginning in the Middle Jurassic (Coney et al., 1980; Monger et al., 1982), yet the nature and origin of the lithospheric mantle underlying these amalgamated crustal terranes remains a major uncertainty.

The Canadian Cordillera is ideal for direct study of the mantle lithosphere because of the presence of Miocene to Holocene mafic alkaline volcanic rocks (Fig. 1; Edwards and Russell, 1999, 2000). Lavas from these volcanic centres commonly contain peridotite xenoliths, providing primary samples of the mantle lithosphere underlying the northern Cordillera. Numerous previous workers have taken advantage of these occurrences of mantle xenoliths within Miocene to Holocene volcanic rocks distributed across the

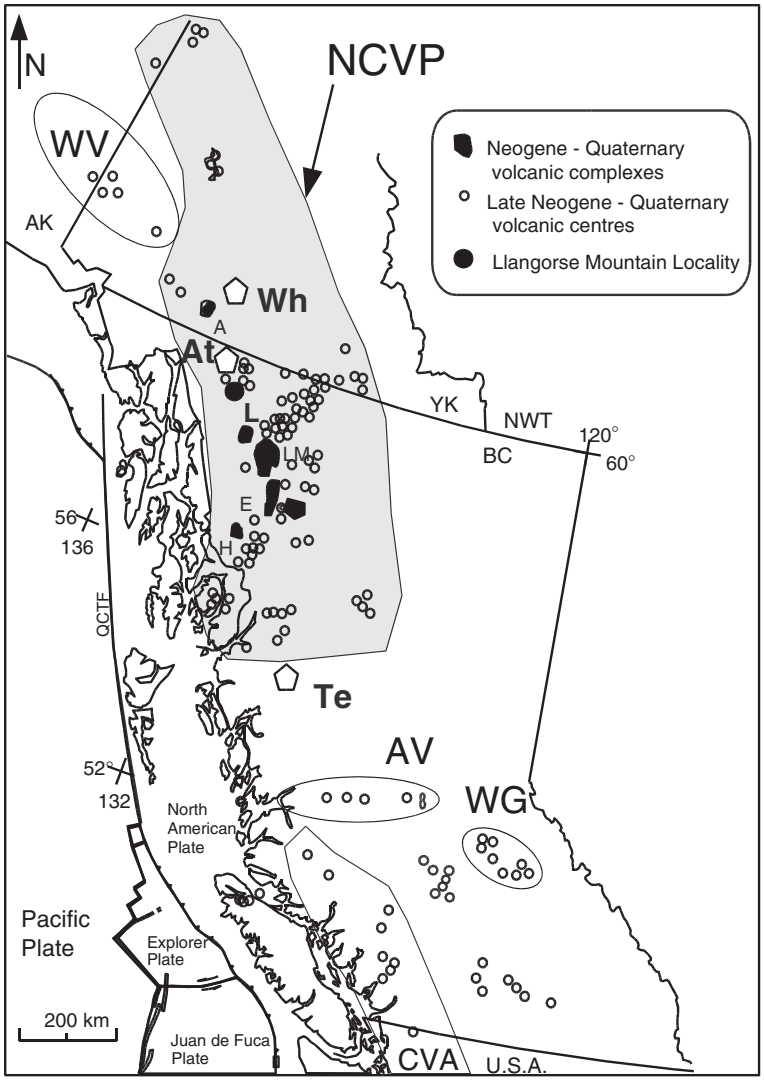


Fig. 1. The northern Cordilleran volcanic province (NCVP) comprises Miocene and younger volcanic rocks distributed across northern British Columbia (BC), the Yukon territory (YK) and easternmost Alaska (AK) (Edwards and Russell, 2000). Other major volcanic provinces include: Wrangell volcanics (WV), Anaheim volcanic belt (AV), Wells–Grey volcanic field (WG), and Cascade volcanic arc (CVA). Major centres include Hoodoo Mountain (H), Mount Edziza (E), Alligator Lake (A), and Level Mountain (LM). Small black circles represent individual occurrences of Miocene to Holocene volcanic rocks. This study involves volcanic rocks from near Llangorse Mountain (L) immediately southeast of Atlin (At). Other population centers include Whitehorse (Wh) and Terrace (Te). The Queen Charlotte transform fault (QCTF) defines the boundary between the Pacific and North American plates.

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