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The Paleoproterozoic Wernecke Supergroup of Yukon, Canada: Relationships to orogeny in northwestern Laurentia and basins in North America, East Australia, and China

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ABSTRACT

The Paleoproterozoic Wernecke Supergroup of Yukon was deposited when the northwestern margin of Laurentia was undergoing major adjustments related to the assembly of the supercontinent Columbia (Nuna) from 1.75 to 1.60 Ga. U–Pb detrital zircon geochronology coupled with Nd isotope geochemistry and major and trace element geochemistry are used to characterize the evolution of the Wernecke basin. The maximum depositional age of the Wernecke Supergroup is reevaluated and is estimated at 1649 ± 14 Ma. Detrital zircon age spectra show a bimodal age distribution that reflects derivation from cratonic Laurentia, with a prominent peak at 1900 Ma. Going upsection, the late Paleoproterozoic peak shifts from 1900 Ma to 1850–1800 Ma, and the proportion of Archean and early Paleoproterozoic zircon decreases. These modifications are a consequence of a change in the drainage system in western Laurentia caused by early phase of the Forward orogeny, several hundred km to the east. The exposed lower and middle parts of the Wernecke Supergroup are correlated with the Hornby Bay Group. Zircon younger than 1.75 Ga appear throughout the sedimentary succession and may have originated from small igneous suites in northern Laurentia, larger source regions such as magmatic arc terranes of the Yavapai and early Mazatzal orogenies in southern Laurentia, and possible arc complexes such as Bonnetia that may have flanked the eastern margin of East Australia. Basins with similar age and character include the Tarcoola Formation (Gawler Craton) and the Willyama Supergroup (Curnamona Province) of South Australia, the Isan Supergroup of North Australia, and the Dongchuan–Dahongshan–Hondo successions of southeast Yangtze Craton (South China). Nd isotope ratios of the Wernecke Supergroup are comparable with values from Proterozoic Laurentia, the Isan and Curnamona assemblages of east Australia, the Gawler Craton, and the Dahongshan–Dongchuan–Hondo successions of the Yangtze Craton of South China. These similarities are compelling evidence for a shared depositional system among these successions. Western Columbia in the Late Paleoproterozoic may have had a dynamic SWEAT-like configuration involving Australia, East Antarctica and South China moving along western Laurentia.

1. Introduction

The formation and break-up of supercontinents is a cyclical process that has strongly influenced Earth evolution (Hoffman, 1989a, 1989b; Rogers and Santosh, 2002; Murphy and Nance, 2013). Several Precambrian supercontinents involving Laurentia have been proposed, including Kenorland in the Archean (Williams et al., 1991; Aspler and Chiarenzelli, 1998), Columbia (and similar configurations named Nuna and Nena) in the Paleoproterozoic to early Mesoproterozoic (Hoffman, 1988, 1989a, 1989b; Gower et al., 1990; Meert, 2002; Rogers and Santosh, 2002; Zhao et al., 2004; Meert, 2012) and Rodinia in the Neoproterozoic (McMenamin and McMenamin, 1990; Dalziel, 1991; Hoffman, 1991; Moores, 1991; Li et al., 2008). For the Paleo–Mesoproterozoic supercontinent of, Columbia, the reconstruction remains a work in progress. Johansson (2009) proposed a SAMBA configuration for the east side of Columbia (current coordinates) with Laurentia joined to Baltica, West Africa and Amazonia. This reconstruction however is challenged by Bogdanova et al. (2015) and Pisarevsky et al. (2014) on the basis of geological and paleomagnetic data. Siberia has been placed against northern or western Laurentia (Rainbird et al., 1998; Sears and Price, 2000, 2003), although the latter configuration is incompatible with recent paleomagnetic interpretations (Evans and Mitchell, 2011; Buchan, 2014; Pisarevsky et al., 2014) for the late Paleoproterozoic. On the western side of Laurentia, Australia, East Antarctica, Yangtze and Cathaysia of South China, North China, and India and Siberia are present in various configurations (Condie and Rosen, 1994; Rainbird et al., 1998; Zhang et al., 2009; Pisarevsky et al., 2014).

The margin of western North America is characterized by a basement grain that has been truncated by Precambrian and early Paleozoic

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rifting (Sears and Price, 2002; Ross, 2002), and complicated by terrane accretion and stratigraphic burial (Monger and Price, 2002; Colpron et al., 2006, 2007). Consequently, the western margin of Laurentia at the time of supercontinent Columbia is difficult to restore. Fortunately, two Paleoproterozoic sedimentary successions are exposed, namely the Wernecke Supergroup in Yukon Territory (Delaney, 1981, 1985; Thorkelson et al., 2001a, 2005) and the Muskwa assemblage in northern British Columbia (Ross et al., 2001; Cook et al., 2004). Detrital zircon geochronology on the Muskwa assemblage was carried out by Ross et al. (2001), and the Wernecke Supergroup has recently been re-examined, providing new information (Furlanetto et al., 2013). The Wernecke Supergroup, and probably the Muskwa assemblage, record

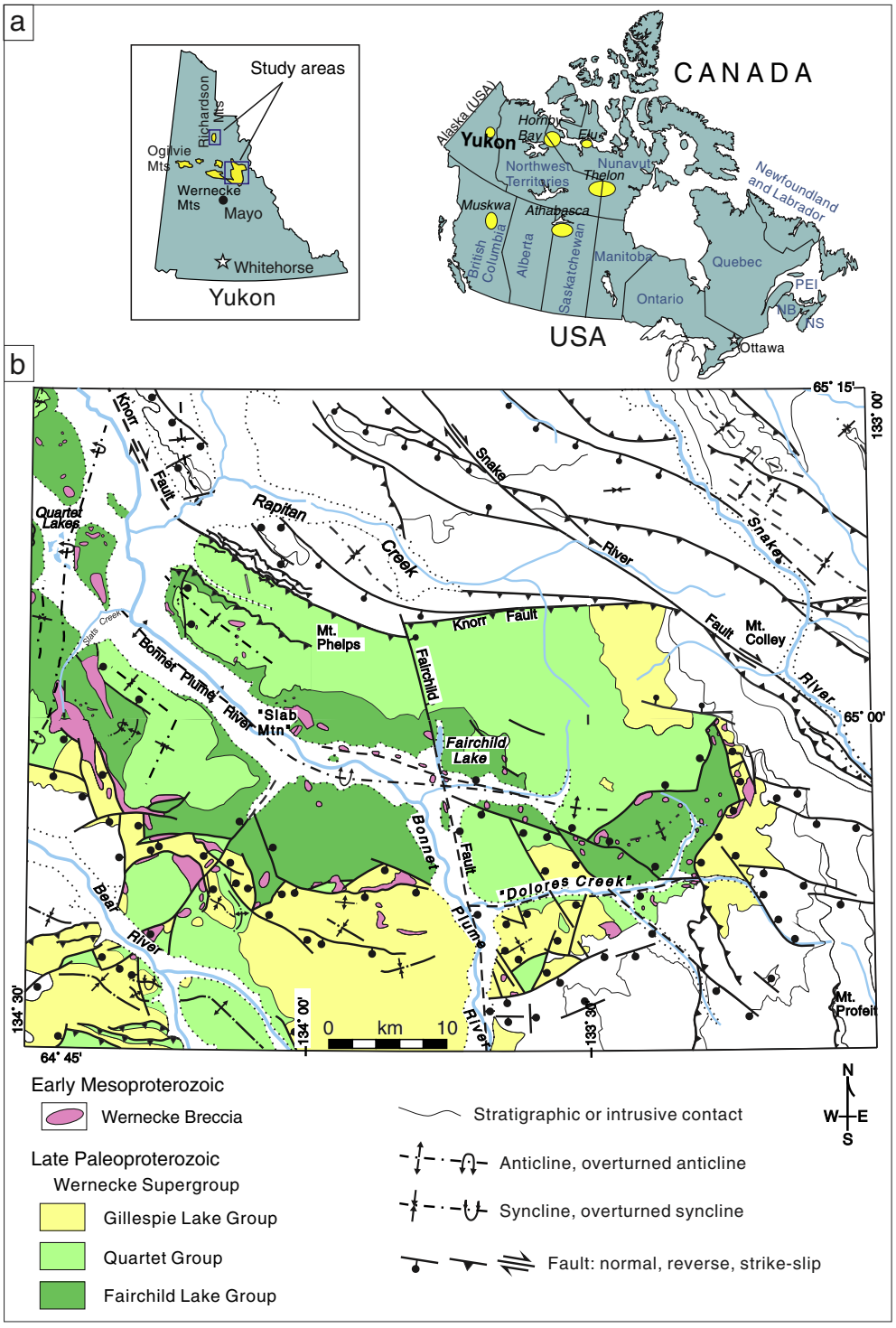

Fig. 1. a) Maps of Canada and Yukon showing exposures of the Wernecke Supergroup and other Canadian paleoproterozoic sedimentary successions (yellow), and location of study area; b) Geological map of study area (modified from Thorkelson et al., 2005) with colours limited to the Wernecke Supergroup and Wernecke Breccia lithologies.