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Grenville-Sveconorwegian detrital zircon signatures in the High Arctic, from East Greenland to Severnaya Zemlya

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Research during the last two decades has documented detrital zircon age signatures in the Eurasian high Arctic, providing unambiguous evidence that Mesoproterozoic basement, apparently similar to that in the Grenville-Sveconorwegian Orogen, is well represented in the vast continental shelves of the Kara, Barents and Norwegian seas. Its provenance age signatures are present in both Neoproterozoic and Palaeozoic successions within the Timanide, Caledonide and Uralide (including Novaya Zemlya) orogens, and the Taimyr and Severnaya Zemlya fold belts.

On Svalbard, all Caledonian provinces provide evidence of Grenville-age source terrains. The oldest metasediments on Nordaustlandet (Brennevinsfjorden and Helvetesflya groups) yielded Mesoproterozoic detrital zircon ages of 1.05 Ga and older. They are intruded by c. 0.95 Ga granites and unconformably overlain by Murchisonfjorden Supergroup sediments, containing 0.95 Ga zircons. Johansson et al. (2005) reported inherited zircons of similar age in Caledonian granites. All these relationships are remarkably similar to those reported from East Greenland (Strachan et al. 1995). In Ny Friesland, the Planetfjella Group had a Mesoproterozoic sediment source as young as 0.95 Ga and, deeper in the Caledonian thrust stack, the Smutsbreen Formation is characterised by Mesoproterozoic (c. 1.2 Ga) to late Palaeoproterozoic (c. 1.73 Ga) detrital zircons populations (Gee and Hellman 1996). In northwestern Svalbard, the Krossfjorden Group bears evidence of Mesoproterozoic detrital zircons as young as 1.0 Ga (Ohta & Larionov 1998, Pettersson et al. 2009) and metasediments in the paleosome of migmatites yield c. 1.05 Ga detrital zircons (Ohta et al. 2002). In southwestern Svalbard, 1.0-0.9 Ga zircon populations were reported from the Neoproterozoic Isbjørnhamna Group (Larionov et al. 2010), and voluminous populations of 1.2-0.9 Ga detrital monazites from the early Neoproterozoic Deilegga and late Neoproterozoic Sofiebogen groups (Czerny et al. 2010).

On Franz Joseph Land, turbidites in drill core samples from the basement beneath Alexandra island yielded unambiguous Mesoproterozoic signatures (Pease et al. 2001), indicating a sedimentation age younger than 1 Ga.

On Novaya Zemlya, Permo-Triassic deformation is superimposed on a Timanide basement. In southern parts, only latest Cambrian and earliest Ordovician strata were analysed (Pease & Scott 2009), providing very little evidence of late Mesoproterozoic sediment input. However, the Cambrian to Permian successions of northern Novaya Zemlya reveal Grenville basement as a major sediment source. Late Mesoproterozoic and earliest Neoproterozoic detrital zircons constitute only minor populations before the Late Ordovician. Then the frequency of Proterozoic zircon ages, including 0.95-1.05 Ga, 1.1 Ga and 1.2-1.25 Ga assemblages, increases to dominate throughout the Silurian and Devonian and fall back to the earlier, late Neoproterozoic signature in the Carboniferous. The dominance of detritus from early Neoproterozoic and older basement is interpreted as an effect of Caledonian orogeny. In the Urals, 500 km to the south, Mesoproterozoic detrital zircon signatures are prominent in paragneisses in the core of the Lapinskaya anticlinorium, where metamorphic rims yield Timanian (c. 630 Ma) ages, along with 580-600 Ma granites (Gee et al 2007).

In Tajmyr, Mesoproterozoic basement (Mamont-Shrenk region) is intruded by c. 0.9 Ga granites (Pease et al 2001). Along the northern coast, detrital zircon ages from early Cambrian turbidites are mid to mainly late Neoproterozoic in age (Pease & Scott 2009). Also the Palaeozoic successions of Severnaya Zemlya, just north of Tajmyr, are dominated by this Timanian population; but 0.95-1.25 Ga and older zircons are present, and prominent in late Cambrian turbidites and Devonian Old Red Sandstones (Lorenz et al. 2008).

The data summarised above suggest that the Grenville-Sveconorwegian Orogen may well have continued northwards through what are now the continental shelves of the North Atlantic and into the high Arctic, implying that the Neoproterozoic relationships between Laurentia and Baltica were more simple than is generally accepted today (cf. recent reconstructions of Rodinia) and did not involve significant rotations of either continent, or sinistral strike-slip displacements of thousands of kilometres between them.