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Archean Oceanic Crust and Boninitic Magmatism in the Norwegian Craton: Geochemical Affinities and Preliminary Geodynamic Interpretations

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The Archean (3.7-2.5 Ga) Norwegian Craton is composed of several granulite-gneiss and amphibolite-mica schist complexes separated from other cratonic terranes (Kola-Murmansk and Karelian) of the Scandinavian Shield by Proterozoic (2.1-1.7 Ga) greenstone belts (Pasvik-Pechenga) and Archean-Proterozoic (3.0-1.8 Ga) mobile belts (Lapland Granulite Belt, Inari Composite Terrane). Archean (2.98-2.75 Ga) gneisses in the Kirkenes-Neiden-Bugoyfjord area contain ultramafic-mafic rocks that structurally and geochemically resemble fragments of oceanic crust accreted within Phanerozoic mobile belts. Although these rock associations are highly fragmented and at best can be described as dismembered oceanic complexes, they are present at least within four locations in the Norwegian Craton: 1) Pasvik Valley – serpentinized peridotites and layered utramafic cumulates; 2) Neiden – sheeted dykes with massive and pillow lavas; 3) Kirkenes – gabbroic rocks and low-level dykes and 4) Bugoyfjord – sheeted dikes. Gneisses hosting ultramafic-mafic rocks yield U-Pb zircon ages of 2.75-2.98 Ga with inherited zircon cores dated at 3.2 and 3.69 Ga which represent the oldest crustal ages reported for the Norwegian segment of Scandinavian shield. Serpentinized peridotites display geochemical characteristics (elevated Nb and LREE concentrations coupled with depletions in Rb and Ba relative to U ratios and weak positive Eu anomalies) typical of refertilized oceanic serpentinites. Basaltic (plagioclase- and plagioclase-olivine-phyric) rocks that form sheeted dyke complex near Bugoyfjord display high TiO_2 (1.75-2.01 wt.%), Zr (117-151 ppm), Y (35-38 ppm) and V (384-408 ppm) contents and plot in MORB compositional field in common geochemical discrimination diagrams (Ti-V, Cr-Y, Zr/Y-Zr, Zr-Ti). Fine-grained gabbros and lower dyke screens exposed near Kirkenes are also characterized by MORB-like geochemistry (TiO_2 = 1.5-2.24 wt.%, Y =37-40 ppm, Zr = 124-161 ppm, V = 327-434 ppm) and are compositionally similar to Bugoyfjord sheeted dykes. Volcanic rocks that form sheeted dyke complex near Neiden contain olivine-orthopyrone-minor clinopyroxene phenocryst assemblages and are characterized by high SiO_2 (52-57 wt.%), MgO (13-24 wt.%), Cr (1500-2800 ppm), Ni (470-1240 ppm) contents coupled with low TiO_2 (under 0.3 wt.%), Y (4-10 ppm), and Zr (4-45 ppm) concentrations. These rocks plot in boninite compositional field in all tectonic diiscrimination diagrams and are chemically and mineralogically similar to Cenozoic boninites from Cape Vogel (PNG), Bonin Islands and Tonga Trench as well as to Phanerozoic boninites from Troodos, Betts Cove and Pindos ophiolites and Archean boninites from Isua (West Greenland), Abitibi (Canada) and Pilbara (West Australia) cratonic terranes. Based on our preliminary geochemical data, gabbroic and sheeted dyke complexes exposed at Bugoyfjord and Kirkenes are best interpreted as fragments of Archean (> 3 Ga) oceanic crust incorporated (together with re-fertilized oceanic serpentinites from Pasvik Valley) into the Norwegian Craton upon its final assembly at around 2.5 Ga. Boninites from Neiden dyke complex are interpreted here as representing

nascent oceanic arc magmatism that followed the development of an oceanic basin. Existing geological, structural and geochemical data do not preclude interpretation of fragments of Archean oceanic and supra-subduction crust with MORB- and boninite-like geochemical affinities as formed within the Belomorian-Lapland Oceanic Basin (BLOB) which was separating Norwegian and Karelian cratonic terranes in Mesoarchean to Neoarchean time. Within this geotectonic context, Neiden boninites may represent development of an early-stage oceanic subduction zone which was later accreted, together with BLOB fragments, to the Eoarchean-Neoarchean continental crustal terranes.