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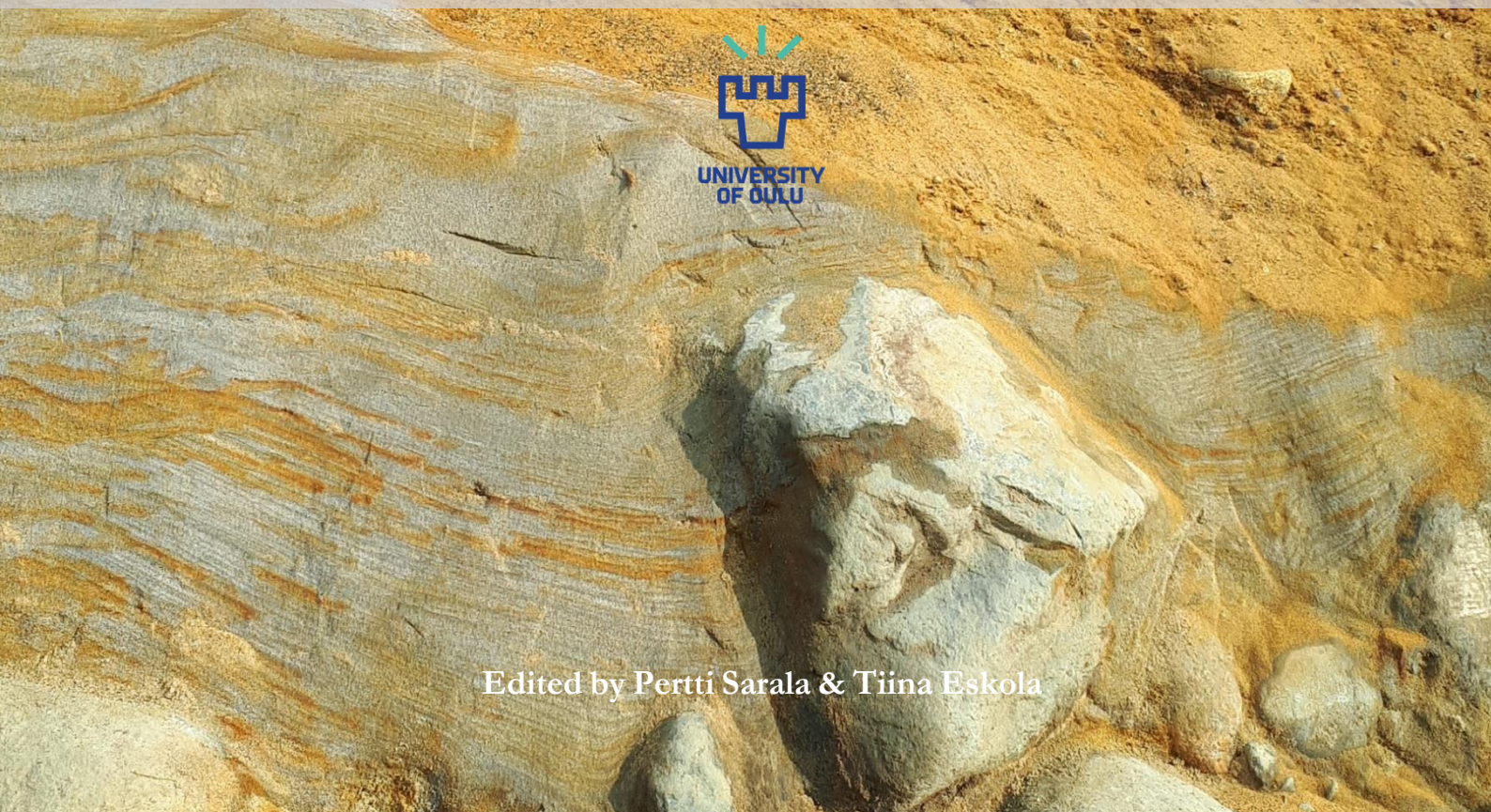

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PGE geochemistry of Palaeoproterozoic mafic and ultramafic volcanic rocks from northern Fennoscandia: implications for exploration of magmatic sulphide deposits

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The Paleoproterozoic break-up of the Kenorland supercontinent was associated with wide-spread mafic-ultramafic magmatism. Here we report on the geochemistry of mafic-ultramafic volcanic rocks from several rifting-related belts in NE Fennoscandia to constrain the platinum-group element fertility and sulphide saturation history of the magmas and their potential to form magmatic sulphide deposits. Magmatism associated with early-stage rifting (2.5–2.45 Ga) formed large layered intrusions in the Kola and Karelian cratons. The coeval volcanic formations have variable PGE contents, with Pt+Pd contents ranging from 1.3 to 15 ppb. Relatively unevolved rocks show mantle-like Cu/Pd ratios whereas more evolved rocks show elevated Cu/Pd ratios indicative of sulphide melt saturation. The middle-stage rifting event (2.2–2.1 Ga) produced volcanic rocks exposed in several belts. Some of the lavas, notably in the Peräpohja and Kuusamo belts, are unusually rich in Pt and Pd, with up to ~24 ppb Pt and up to ~36 ppb Pd. The magmas have seemingly not reached sulphide saturation, as reflected by Cu/Pd ratios below the primitive mantle value. In contrast, a relatively late-stage rifting event at 2.06–1.98 Ga formed significant Ni-Cu-(PGE) sulphide deposits at Kevitsa, Sakatti and Pechenga. We suggested that magmatic ore formation in Fennoscandia has been controlled, in part, by lithospheric structure. During the early rifting stage, the lithosphere was relatively thick and conducive to the formation of large magma chambers in which sulphide saturation occurred during advanced fractionation. This resulted in PGE reefs, and relatively low PGE levels in coeval lavas. During the middle-stage rifting, the lithosphere was weaker and thinner, preventing efficient magma storage and resulting in relatively small intrusions undergoing limited fractionation and ore formation while feeding PGE-undepleted magmas to the surface of the Earth. The late-stage rifting is also characterised by advanced lithospheric thinning facilitating magma ascent into the upper crust without intermittent storage and metal extraction. However, a key difference to earlier magmatism is that the late stage magmas could assimilate external S from sedimentary units deposited after the middle-stage rifting. Our study thus highlights the importance of holistic geochronological/ geodynamic models in magmatic ore exploration.