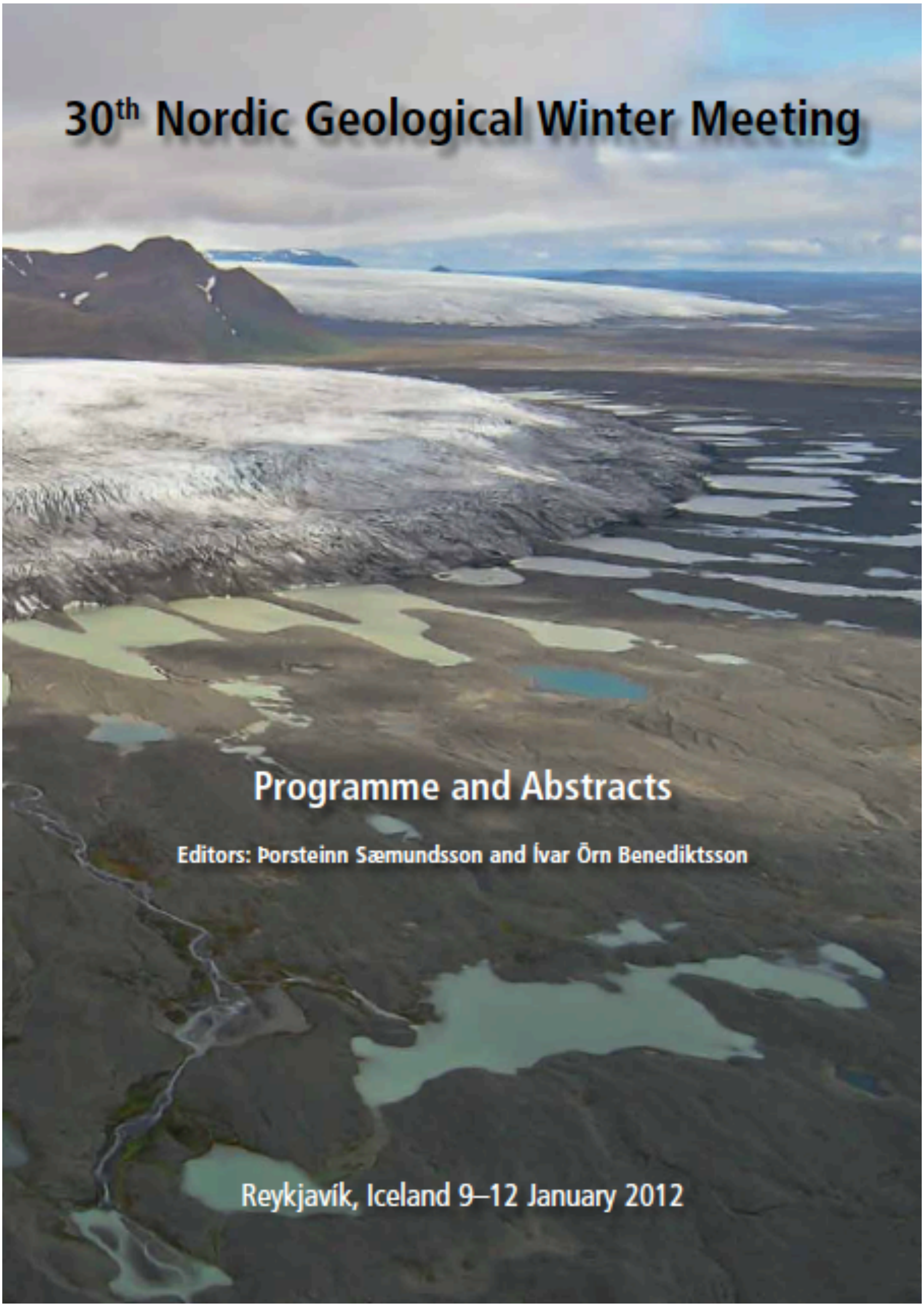

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Igneous and ore-forming events at the roots of a giant magmatic plumbing system: the Seiland Igneous Province (SIP)

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SIP covers an area of 5500 km^2 in N. Norway. 50 % of the volume comprises mafic layered or homogenous plg+px+Fe-Ti±ol gabbros. 25 % of the area consist of ultramafic intrusions, mostly peridotite and subsidiary pyroxenite and hornblendite and the final 25 % is dominated by calc-alkaline and alkaline plutons, respectively.

Ultramafic plutons intersect gabbros and calc-alkaline plutons. Recent zircon U/Pb geochronology imply that SIP formed at 560-570 Ma, with mafic- and ultramafic rocks emplaced in <4 Ma (Roberts et al., Geol. Mag, 2007).

Geothermobarometry of contact metamorphic mineral assemblages, implies minimum depth of 20-30 kilometres. Accordingly, the Seiland province arguably provides a unique cross section through the deep-seated parts of a large magmatic plumbing system.

Sulphide Cu-Ni-(PGE) deposits are intimately associated with the ultramafic rock suite. One deposit is known from Stjernøy where sulphide dissiminations occur at the floor of a peridotitic pluton, another deposit occur at the floor of the Reinfjord ultramafic layered complex in the far West of SIP and the third deposit comprises vertical sulphide dykes in the interior of a hornblendite on the Øksfjord peninsula. Currently, only the Reinfjord deposit is studied in detail. Previous studies (Søyland Hansen, 1971, unpub. MSc thesis, NTNU) and our preliminary work document dissiminated Cu-Ni sulphides in a 10-20 m's thick and two km's long deposit at the lower contacts of the Reinfjord intrusion. Hansen and NGU reports 0.15 wt% for both Ni and Cu. The sulphide assemblage is pentlandite, chalcopyrite, pyrrhotite and minor pyrite. Most of the pentlandite is bravoitised, hence c. 50 % of the Ni at the surface is lost to weathering. Most Ni occurs in isolated pentlandite grains whereas pyrrhotite is Ni-poor. The sulphide assemblage is interstitial amongst olivine and pyroxene primocrysts.

The Reinfjord intrusions is layered and develops from olivine clinopyroxenites in the lower part to wherlite and dunite in the upper part. Earlier studies suggest that the parental melts comprise olivine pyroxenites whereas dunites and wherlites formed by fractional crystallization (Bennet et al., Bull. NGU, 405, 1-41). During our fieldwork we observed spectacular examples of cumulus structures, not previously reported, and including modally layered and modally graded dunite/wherlite, cross-bedding, slumping and mush-diapirs. Finally we saw an example of magma-replenishment an irregular olivine pyroxenitic dike was emplaced and mixed with the olivine/wherlite mushes!

Along the contacts, it was observed that the country rock gabbros were partially melted and assimilated during the emplacement of the ultramafic magma, in a zone extending tens of metres in to the gabbros. Interestingly, uneconomic sulphide dissiminations are common throughout the gabbros and may have provided the sulphide liquids required in ore-formation.

In conclusion, the high proportion of ultramafic intrusions in SIP provides a rare insight in to the roots of giant magmatic plumbing system. Voluminous emplacement of ultramafic magmas in the deep-seated Reinford intrusion, featuring convection, slumping, replenishment, massive assimilations of sulphide bearing gabbros and de facto sulphide deposits, imply large-scale ore-forming processes at work throughout the SIP.