Geochemistry and Sm-Nd Isotope Studies of a 2.45 Ga Dyke Swarm: Hints at Parental Magma Composition and PGE Potential to Fennoscandian Layered Intrusions?

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Introduction

Mafic dyke swarms are exceptional geological time markers that often punctuate major episodes of crustal rifting. A knowledge of the timing of dyke emplacement is essential for understanding the tectonic evolution of rift-related environments and for the regional correlation of igneous activity. Dyke swarms are important in continental environments as they are often the only surviving evidence of quite considerable geological events (e.g. rifting, mantle plumes, plate subductions, or crustal "break-up") and can be used to monitor the geological history of the continents over long periods of time. Dykes are the primary channel for mafic magma transport into the crust from a source area in the mantle and thus they can also provide data on the parent magma of volcanics and major intrusions.

Paleoproterozoic Dyke Swarms

Several dyke swarms comprising a voluminous number of dykes are visible in the eastern and northern parts of the Fennoscandian Shield, and thus Finland, Russian Karelia and the Kola Peninsula provide a good area for research into the formation of Palaeoproterozoic dykes in particular (Fig 1.).

Integrated studies of the geochronology, geochemistry and palaeomagnetism of Palaeoproterozoic dyke swarms are aimed at identifying various dyking events in the eastern Fennoscandian Shield and their relationship to economically important layered intrusions, and at establishing the earliest part of the Proterozoic apparent polar wander path for Fennoscandia. Dykes were sampled in areas belonging to the Karelian and Kola Provinces where overprinting by the 1.8 Ga Svecofennian orogen is thought to be minimal, i.e. in the Taivalkoski and Suomussalmi areas of eastern Finland, Suoperä and Lake Pääjärvi near the Burakovsky Intrusion in Russian Karelia, and the mid-Kola Peninsula. Together with previous zircon ages, the results indicate that there were several dyke intrusion events in the eastern Fennoscandian Shield between 2.5 Ga and 1.97 Ga. These dykes can be divided into at least five main groups in terms of their geochemical composition, absolute age criteria and occurrence, dated to 2.5, 2.45, 2.33, 2.1 and 1.97 Ga. The first one, 2.5 Ga, is seen only on the Kola Peninsula, but the others are visible throughout the Karelian Province.

2.45 Ga Dyke Swarms and Layered Intrusions

The 2.45 Ga episode is now well documented and includes both dykes and layered intrusions. Our results clearly show that in Archaean craton there is a real dyke swarm of age 2.45 Ga which is closely connected with layered intrusions in the eastern Fennoscandian Shield (Fig.1A.) and that data from dykes can be used to estimate the composition of their parent magmas. The dyke system is also quite similar to those previously described in the Bushveld and Stillwater complexes. The 2.45 Ga dyke swarm can be divided into five subgroups in terms of their field relations, geochemistry and isotope findings: 1) NE-trending boninitic-noritic dykes, 2) NW-trending gabbro norite dykes, 3) NW-trending tholeiitic dykes, 4) NW-trending Fe-tholeiitic dykes and finally 5) E-W-trending plagioclase porphyry dykes. Groups 1, 2 and 5 have their own geochemical trends, showing slight calc-alkaline affinity, while groups 3 and 4 have a normal tholeiitic trend. Sm-Nd isotope studies carried out on groups 1-4 have shown that groups 1 and 2 clearly represent a (boninitic) magma type which has negative initial ε_{Nd} values consistent with those recorded previously in layered intrusions. The data on groups 3 and 4 (tholeiitic magma type) point to positive ε_{Nd} values and give new information on the magmatic evolution of the 2.45 Ga event. These results indicate that the dykes are coeval with 2.45 Ga intrusions and thus could be candidates for the parent magma of the layered intrusions of this age.

Preliminary PGE Studies

It has been presented previously that the first magma type (boninitic) is PGE-enriched compared with second one (tholeiitic). We have started to study general distribution of PGE in 2.45 Ga dyke swarms to get some new light on PGE potential to different magma types. So far our studies have not shown clear evidence to this but further expanding works will give some signs to PGE potential for different magma types?

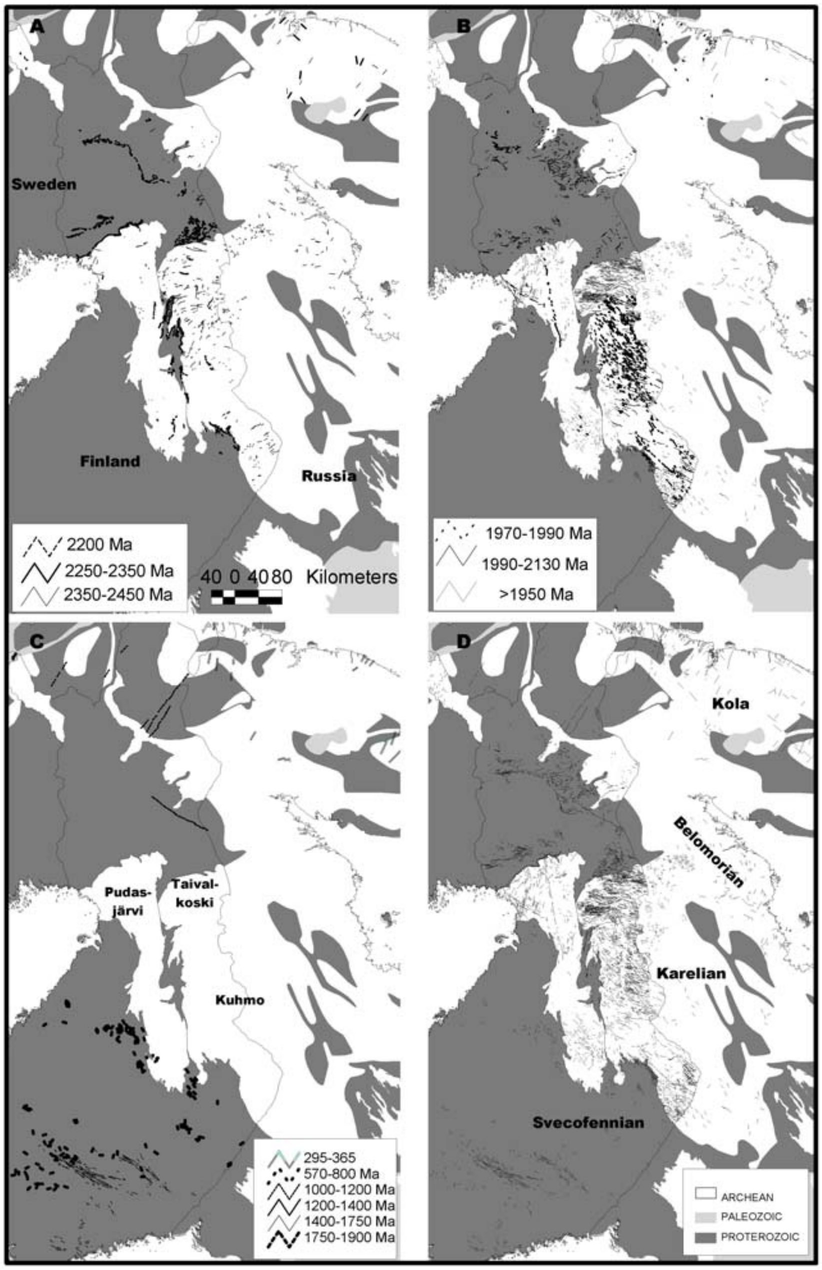

Figure 1. *Diabase dyke swarms of the Eastern Fennoscandian Shield (A to D). Dykes that can be assigned to specific swarms are shown as various line segments. Dykes that cannot presently be assigned (Fig B) to a particular Paleoproterozoic swarm (>1950 Ma) are shown as thin lines.*