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Ilmo Kukkonen, Suvi Heinonen, Kati Oinonen, Katriina Arhe, Olav Eklund, Fredrik Karell, Elena Kozlovskaya, Arto Luttinen, Raimo Lahtinen, Juha Lunkka, Vesa Nykänen, Markku Poutanen, Eija Tanskanen and Timo Tiira

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A shoshonitic dyke in Lohja, southern Finland

Marek Lehtinen[1], Markku Väisänen[1], Jaakko Kara[1], Hugh O'Brien[2] and Marja Lehtonen[2]

[1]Department of Geography and Geology, 20014 University of Turku, Finland
[2]Geological Survey of Finland, 02151 Espoo, Finland
E-mail: mmtleh@utu.fi

We describe here a newly discovered cross-cutting mafic dyke in the vicinity of Lohja, southern Finland. The dyke is E-W trending and about 6 m in width. Only a few zircons were recovered from the dyke despite the high Zr contents and they all were inherited. Therefore, the crystallisation age remains uncertain. The dyke is shoshonitic in composition and the closest analogues are the Åva lamprophyre dykes in SW Finland.

Keywords: postorogenic, dyke, enriched mantle, Fennoscandia, Lohja

1. Introduction

Post-tectonic mafic dykes of different ages and compositional groups cross-cut sharply the Svecofennian bedrock in central and southern Finland and Russian Karelia (Figure 1). The main groups from oldest to youngest are:

a) 1.84-1.83 Ga lamprophyre dykes of eastern Finland (Neuvonen et al. 1981, Laukkanen 1983, O'Brien et al. 2005)
b) 1.79-1.78 Ga lamprophyre dykes of SW Finland and Russian Karelia (Eklund et al. 1998, Andersson et al. 2006, Woodard et al. 2014)
c) 1.65-1.54 Ga diabase dykes related to rapakivi granite magmatism (Rämö and Haapala 2005)
d) 1.26 Ga diabase dykes of the Satakunta area (Suominen 1991, Kohonen and Rämö 2005)

In Uusimaa, southern Finland, several diabase dykes cut the Svecofennian host rock (Figure 1). To the west of the 1.65 Ga Bodom and Obbnäs rapakivi granite intrusions is the Lohja diabase swarm, where the largest estimated dyke is 30 km long and 10 m wide (Vaasjoki 1977, Laitala 1987, 1994).

A newly discovered dyke from the Lohja area apparently belongs to the Lohja swarm. We compare the geochemistry of this dyke with data from the above-mentioned main groups to estimate whether it belongs to some of them. We also present a preliminary U/Pb age dating of the dyke.

2. The Lohja dyke

The studied mafic dyke is located about 25 km NW from the town of Lohja in a road cut of the E18 Turku-Helsinki motorway (Figure 1). The dyke is E-W-trending, 5-6 m in width and sharply cross-cuts the surrounding Svecofennian migmatitic garnet-cordierite mica gneiss. The inner parts of the dyke are fine to medium-grained and show an ophitic texture, whereas the contact to the country rock shows a chilled margin with aphanitic, almost glassy texture. On a fresh surface the rock is dark grey, and it contains rounded xenoliths of varying colour and size. The main minerals are plagioclase, hornblende, brown mica with secondary carbonate and chlorite. The EDS-analyses with FE-SEM also identified rutile, titanite, galena, sphalerite, apatite, baryte, epidote, allanite and bastnäsite in the same heavy mineral fraction that contained the zircons. The reddish xenoliths are less than 5 mm wide and the light-coloured are larger, ~ 20 mm wide. There are also ~ 5 mm wide amygdales, filled with carbonate and chlorite (Figure 2).

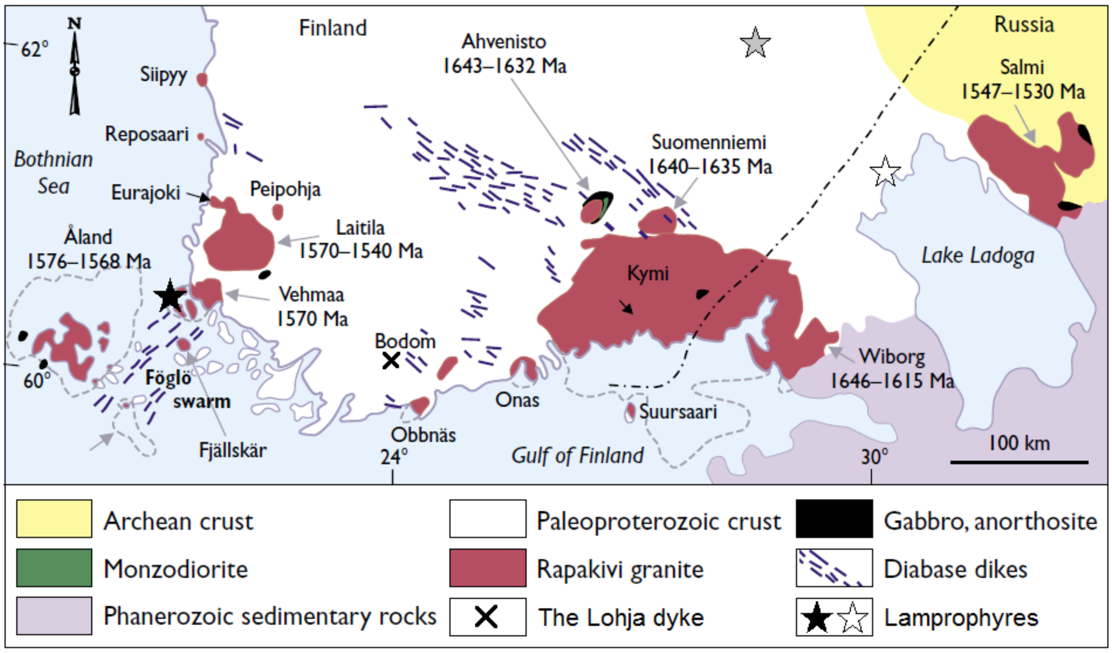

Figure 1. Geological map of southern Finland focusing on diabase dykes and rapakivi granites. Stars indicate lamprophyres: black for Åva (Andersson et al. 2006), grey for eastern Finland (Laukkanen 1983) and white for Russian Karelia (Woodard et al. 2014). Cross indicates the Lohja dyke (modified after Rämö and Haapala 2005).

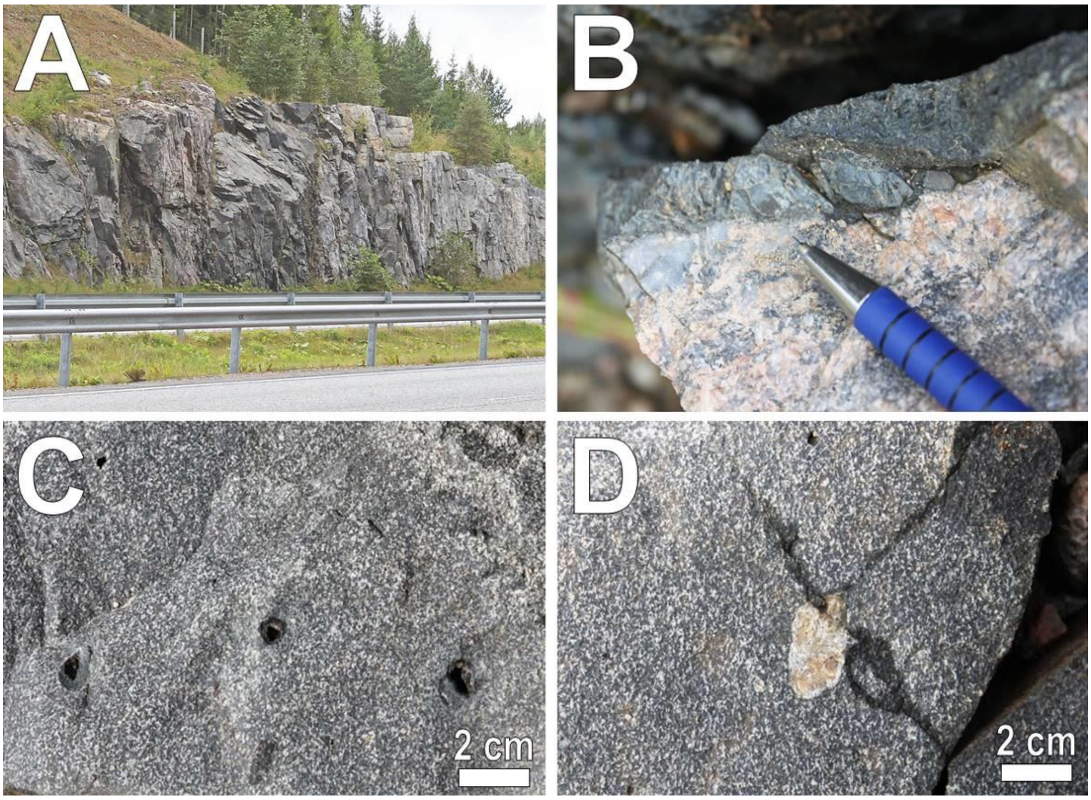

Figure 2. Outcrop photographs of the Lohja dyke. (A) Road cut of the E18 motorway showing the 5.5 m wide cross-cutting mafic dyke. (B) Sharp contact with a chilled margin. (C) Carbonate- and chlorite-filled amygdales. (D) Light-coloured felsic xenolith. Ophitic texture is visible in the mafic dyke.

3. U/Pb age dating and geochemistry

From quite a big sample (~ 6 kg), only 10 zircons were recovered after the standard heavy mineral separation process. The BSE-imaging and isotopic analyses were performed in the Finnish Geosciences Research Laboratory (GTK, Espoo, Finland) using the FE-SEM and LA-SC-ICPMS for imaging and isotope analyses, respectively. The U/Pb analyses were performed in two steps. Firstly, one spot was placed on each zircon. These showed a range of $^{207}Pb/^{206}Pb$ ages between 1.52-1.86 Ga. Therefore, the two youngest zircons were selected for additional analyses. All combined the results show three groups: (i) 20 analyses with ages between 1.80-1.86 Ga, (ii) a cluster of 7 analyses with a concordia age of c. 1.78 Ga and (iii) a cluster of 5 analyses with a concordia age of c. 1.68 Ga. We also tested U-Pb dating on rutile and titanite. The rutile was devoid of radiogenic Pb and was discarded. The titanite contained some radiogenic Pb but 30 analyses nevertheless showed too low contents of radiogenic Pb and gave geologically meaningless results.

Three samples were collected for geochemical analyses; two from the centre of the dyke and one from the chilled margin. They all have very similar compositions and form a tight cluster in most diagrams. The dyke shows high content of Fe_2O_3 but very low MgO, CaO and Mg-number along with low ferromagnesian trace element contents (Ni, Cr, Co). The dyke is enriched in Rb, Ba, Y and especially in Zr, and shows a fractionated REE pattern. High K_2O content, K_2O/Na_2O and Ce/Yb vs. Ta/Yb ratios show that the composition is shoshonitic.

4. Discussion and conclusions

Despite the high Zr content, very few zircons were recovered and their U/Pb analyses showed that they were inherited from older rocks. Zircons either did not crystallize from such a melt or they were too small and were lost during the separation. Many of the zircons had been heterogeneously affected by some later geological event. The 1.78 Ga age might readily correlate with the well-documented post-orogenic magmatism which includes lamprophyre dykes. The 1.68 Ga age is unclear as no such a geological event is known in southern Finland. Those ages might represent incomplete resetting during the 1.65 Ga magmatic pulse represented by the Bodom and Obbnäs rapakivi plutons. In summary, the crystallisation age of the Lohja dyke remains uncertain.

The composition of the dyke is more enriched than the rapakivi-related dykes or the 1.26 Ga dykes, but less enriched than the lamprophyre dykes in the reference data set (Savolahti 1964, Laitakari 1969, Laukkanen 1983, Rämö 1990, 1991, Suominen 1991, Lindberg and Bergman 1993, Väisänen 2004, Luttinen and Kosunen 2006, Woodard et al. 2014). The closest analogue is the Åva lamprophyre dykes with partially overlapping geochemical characteristics (Hollsten 1997, Eklund et al. 1998, Andersson et al. 2006). However, the Åva data is more enriched, e.g., in LREE, Ba, Sr and F. Therefore, we prefer to call the Lohja dyke a shoshonitic dyke rather than a lamprophyre dyke.

5. Acknowledgements

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