Mantle xenoliths from Tertiary lavas and dykes on Ubekendt Ejland, West Greenland

Stefan Bernstein and C. Kent Brooks

Mantle xenoliths were found in Tertiary alkaline (basanitic) lavas on Ubekendt Ejland in West Greenland in the mid 1970s by J.G. Larsen. Microprobe analyses of olivine, pyroxene and spinel in two mantle xenoliths, suggested that the xenoliths on Ubekendt Ejland are highly depleted and have high modal olivine contents, and low modal orthopyroxene and clinopyroxene (Larsen 1982). In this respect the mantle xenoliths from Ubekendt Ejland are very similar to the spinel harzburgites from Wiedemann Fjord, in the Tertiary volcanic province of East Greenland (Brooks & Rucklidge 1973; Bernstein *et al.* 1998).

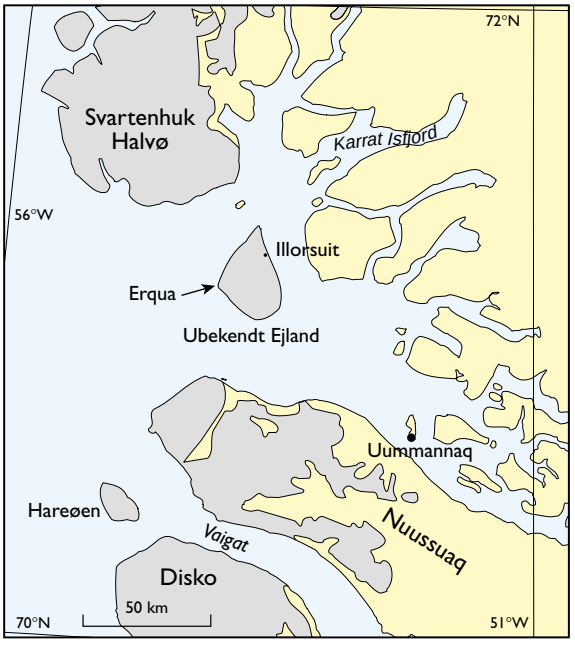

Fig. 1. Basalts (grey) on Ubekendt Ejland are part of the West Greenland Tertiary Igneous Province (e.g. Hald & Pedersen 1975). The pre-Tertiary sediments and Precambrian basement are coloured yellow. Ultramafic xenoliths were sampled from basanitic lava flows and dykes near Erqua on the west coast of Ubekendt Ejland.

Larsen (1981) also reported dykes containing mantle nodules and a varied suite of cumulates and megacrysts, one of which has subsequently been dated to 34.1 ± 0.2 Ma (Storey *et al.* 1998) The basalt flow that carries the xenoliths is from what is defined as the Erqua Formation which occurs at the top of the lava succession in western Ubekendt Ejland (Fig. 1; Drever & Game 1948; Larsen 1977a, b). The basalts have not been dated, but are younger than 52.5 Ma, which is the date obtained for the underlying formation (Storey *et al.* 1998).

During July 1997, we spent three weeks collecting xenoliths and prospecting for xenolith-bearing dykes in the Uummannaq district of central West Greenland. The field work resulted in an extensive collection of xenoliths from an alkaline basalt flow described by Larsen (1977a, b), as well as the discovery of a dyke carrying a large number of ultramafic xenoliths of various origins. The xenolith-bearing basalt flow of the Erqua Formation is exposed in the sea cliffs on the western point of Ubekendt Ejland (Fig. 1). The flow is approximately 10 m thick and xenoliths of gabbro and peridotite occur infrequently, typically spaced several metres apart. Most peridotite xenoliths are angular and between 1 and 4 cm in maximum dimension. Gabbro xenoliths are also angular and are up to 10 cm across. It proved difficult to extract samples from the well-polished surface of the basalt flow, and most had to be drilled and blasted out. A total of 25 peridotite xenoliths were retrieved. They are olivine rich, with > 80% modal olivine, 0–20% orthopyroxene and 1–2% chrome-spinel. Small amounts of clinopyroxene are present in six xenoliths only. Based on texture, mode and olivine composition, the xenoliths can be divided into two groups, a high Mg no. (= atomic Mg/(Mg + Fe) × 100) and a low Mg no. suite. The high Mg no. suite has porphyroblastic texture, with spinel grains in stringers, no

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Fig. 2. Block with ultramafic xenoliths in lamprophyre dyke 1.8 km south of Erqua, Ubekendt Ejland. Dunite xenoliths are light brown, while pyroxenite xenoliths are greenish.

clinopyroxene, and highly forsteritic olivine (> 92% Fo). The low Mg no. suite has granular texture, > 2% spinel occurring as disseminated equant grains, clinopyroxene is present, and the olivine has < 91% forsterite.

Ultramafic xenoliths were also found in an approximately 60 cm wide lamprophyre dyke, which is vertical and strikes N–S. The dyke crops out in a stream bed, some 100 m from the shore and about 1.8 km south of Erqua. The basalt that hosts the dyke at this locality is believed to be the next flow overlying the basalt flow with xenoliths described above. About 500 m separates the two xenolith localities. The xenoliths found in the lamprophyre dyke are mainly rounded and from a few centimetres to about 20 cm in maximum dimensions (Fig. 2). Most of the xenoliths are peridotites, i. e. olivine rich with > 90% olivine, 5–10% clinopyroxene and 1–3% chrome-spinel. The peridotite xenoliths have a granular and sometimes cumulate texture, and olivine has forsterite contents in the range 84–88%. Other xenoliths include clinopyroxenites and clinopyroxene-rich peridotites in which the olivines in general have lower forsterite contents (77–84%).

Three other xenolith-bearing localities (two dykes and a small plug), as well as float blocks with ultramafic, mafic and felsic inclusions, together with various megacrysts, were also found but have not yet been subjected to detailed examination.

Preliminary electron microprobe data on olivine compositions are summarised in Figure 3, which shows that there is some overlap between the low Mg no. suite from the basalt flow and the olivine rich (peridotite) xenoliths from the lamprophyre dyke. Olivines from the clinopyroxene-rich xenoliths have lower forsterite contents than olivines from the peridotite xenoliths from both localities. The xenoliths which have olivine with less than 91% forsterite are thought to be cumulates which may have formed in magma chambers during the waning stages of continental rifting in this area. The high Mg no. suite of xenoliths from the basalt flow has olivine

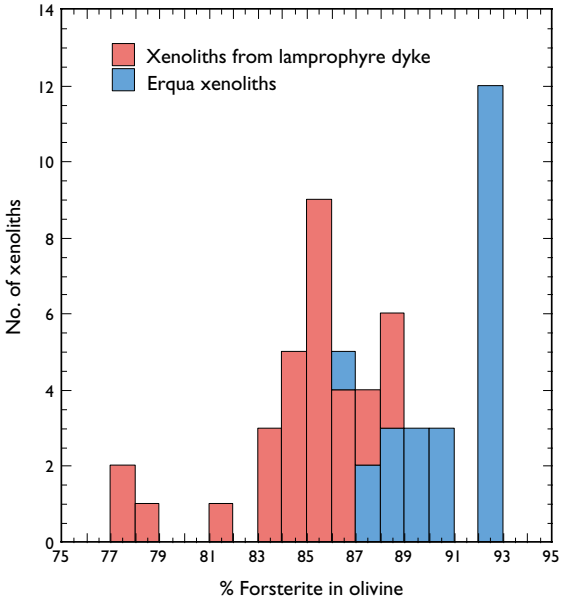

Fig. 3. Forsterite (atomic Mg/(Mg + Fe) × 100) in xenoliths from near Erqua, Ubekendt Ejland (basanite flow) and the nearby lamprophyre dyke. Each sample represents the average of 2–25 microprobe analyses in olivine grains. The variation in forsterite content within single xenolith samples is typically less than 0.5% (relative).

with distinctly higher forsterite contents than other peridotite xenoliths from both localities. Their average olivine has 92.6% forsterite. This is remarkably similar to other refractory spinel peridotites from Kaapvaal, South Africa (Fo = 92.8: Boyd 1989), Udachnaya, Siberia (Fo = 92.8: Boyd *et al.* 1997), Lac de Gras, Canada (Fo = 92.7: Boyd & Canil 1997), and Wiedemann Fjord, East Greenland (Fo = 92.7: Bernstein *et al.* 1998). The depleted harzburgite xenoliths from Wiedemann Fjord, East Greenland can be modelled as the residue after 40% melt extraction at low pressures (20–30 kbar), producing a melt similar to Munro-type komatiites (Bernstein *et al.* 1998). We speculate that the closely similar forsterite content of olivines from these depleted mantle xenoliths reflects extensive melt extraction in the Archaean, with termination of the melting process at the exhaustion of orthopyroxene from the source.

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Authors' addresses:

S.B., *Danish Lithosphere Centre, Øster Voldgade 10, DK-1350 Copenhagen K, Denmark.*

C.K.B., *Danish Lithosphere Centre* and *Geological Institute, University of Copenhagen, Øster Voldgade 10, DK-1350 Copenhagen K, Denmark.*