that the distribution 'gap' in fig. 20 is spurious and due to the lack of coastal sections in that area. Several of the easternmost dykes localised in 1979 (fig. 20) indeed have the east–west strike directions characteristic of the coastal dykes (Escher & Watterson, 1973; Scott, 1977; J. Korstgård, personal communication). The Sarfartôq cone sheet swarm may thus be interfering with a larger swarm of east–west trending dykes, possibly centred on the Ikertoq shear zone (Bak *et al.,* 1975).

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An ultrabasic pipe in the eastern Sukkertoppen region, southern West Greenland

R. P. Hall

An unusual occurrence of ultrabasic material was located in the eastern Sukkertoppen region during the reconnaissance mapping programme of 1977, the findings of which were described by Allaart *et al.* (1978). It occurs on a small exposure on the west side of a north-pointing peninsula in the middle of the large nunatak Majorqap alángua (65°53′N, 50°40′W), to the north-east of the Majorqaq valley (Hall, 1978, fig. 21). The area is composed predominantly of a suite of granulite facies granitic gneisses which contain numerous enclaves of pyroxene-bearing amphibolites, and locally anorthositic and gabbroic rocks similar to those seen in the Fiskenæsset anorthosite complex (Myers, 1975). The

Fig. 22. Xenoliths of granulite facies amphibolite, banded gneiss, anorthosite, leucogabbro and ultrabasic material (dunite) within the pyroxenite pipe matrix. The xenoliths are well rounded and range in size from approximately 1 cm to 5 m in diameter. The proportion of rock types of the xenoliths does not correspond to that of the surrounding gneisses, indicating a certain degree of transport.

gneisses in the centre of the nunatak are highly irregular in orientation, occupying the complex intersection of closures of at least two major fold phases. A belt of amphibolites forms the cliff at the south-west tip of Majorqap alángua. Related rocks occur in amphibolite facies in the area around the lake Qardlît taserssuat immediately to the south (Hall, 1978).

The ultrabasic material is believed to form a pipe and is clearly discordant to the granulite facies gneisses and enclaves. The margins of the body are not sharp but form an intricate network of thin irregular veins into the surrounding gneisses, although some of the marginal rocks are masked by ice cover. The centre of the pipe contains abundant xenoliths (fig. 22) which are principally pyroxene-amphibolites with fewer leucogabbroic, ultrabasic (dunitic) and banded gneiss blocks. Angular and rounded xenoliths are juxtaposed although elongate but well rounded ones predominate. The proportions of the composite xenolithic rock types are not comparable to those of the surrounding gneisses which are mainly granitic. This feature together with the well rounded shape of many of the xenoliths implies a certain degree of xenolith transportation. The incorporated blocks form approximately 60 per cent of the volume of the pipe and the total exposure is of the order of 100 metres in diameter.

The ultrabasic matric of the pipe is a homogeneous and massive dark brown-green pyroxenite which is equigranular and has a grain size of approximately 1 mm. It consists of equal proportions of hypersthene (En_{62}) and salite ($Wo_{47}En_{39}Fs_{14}$) (fig. 23), the texture of which is generally granoblastic with numerous triple points between individual grains although locally clinopyroxene partially encloses orthopyroxene in an apparently relict igneous relationship. Both pyroxenes occur as single discrete grains and not as recrystallized polygonal mozaics while their chemistry indicates that no original igneous pyroxenes are preserved.

The hypersthenes commonly contain poorly developed exsolution lamellae of salite and both the clino- and orthopyroxene are overprinted by minute flakes of biotite. Electron microprobe analyses of the component mineral phases of the matrix pyroxenite and one of the basic xenoliths are presented in Table 3. This xenolith is a homogeneous, fine-grained granoblastic hypersthene-salite-andesine (An_{42}) rock containing minor biotite and has a colour index of about 40. It is interpreted as a granulite facies equivalent to the widespread supracrustal amphibolites. The pyroxenes from this xenolith are similar to those of the pyroxenite matrix, being slightly more Fe-rich (fig. 23). The coexisting pyroxene pairs of the matrix and xenolith have Mg-Fe distribution coefficients (K_D) of 0.57 and 0.58 respectively, where

$$K_D = (X^o_{Mg}(1-X^c_{Mg}))/((1-X^o_{Mg})X^c_{Mg})$$

and X is the mol. fraction and the superscripts o and c refer to ortho- and clinopyroxene, respectively. These values are close to those accepted for metamorphic rocks in general (cf. 0.73 for igneous rocks, Kretz, 1963) and for granulite facies rocks in the Buksefjorden region to the south of Godthåb (Wells, 1976a).

The temperatures of the coexisting pyroxenes in both the matrix and the analysed xenolith have been estimated using the two pyroxene thermometer of Wood & Banno (1973, equation 27) and Wells (1977, equation 5). These equations give temperatures of 885°C and 917°C, respectively, for the coexisting matrix pyroxenes and 859°C and 894°C for those in the xenolith. These temperatures correspond to high granulite facies conditions and are slightly higher than those found for the granulite grade rocks of the Buksefjorden region (Wells, 1976b).

The age of the pipe remains uncertain. The granulite facies pyroxene assemblage suggests that it was intruded during the widespread high grade metamorphism at *c.* 2850 m.y. (Black

Table 3. Representative analyses of the component phases of the pyroxenite pipe matrix and one of the basic xenoliths

	Matrix		Xenolith			
	Opx(7)	Cpx(6)	Opx(6)	Cpx(7)		Plag(4)
SiO_2	52.85	52.17	52.44	52.49	SiO_2	58.56
TiO_2	-	0.36	-	0.25	Al_2O_3	26.57
Al_2O_3	1.10	2.24	0.64	1.59	CaO	8.65
Cr_2O_3	-	0.32	-	0.14	Na_2O	6.14
FeO ★	23.12	9.04	25.16	9.57	K_2O	0.29
MnO	0.52	-	0.38	0.16		100.21
MgO	21.99	13.47	20.54	13.21		
CaO	0.68	22.03	0.45	21.86		
	100.25	99.62	99.62	99.29		
Si	1.97	1.95	1.99	1.97	Si	10.44
Ti	-	0.01	-	0.01	Al	5.58
Al	0.05	0.10	0.03	0.07	Ca	1.65
Cr	-	0.01	-	-	Na	2.12
Fe	0.72	0.28	0.80	0.30	K	0.07
Mn	0.02	-	0.01	0.01		
Mg	1.22	0.75	1.16	0.74		
Ca	0.03	0.88	0.02	0.88		
En	62.04	39.17	58.70	38.52	Ab	55.25
Wo	1.37	46.08	0.93	45.83	Or	1.69
Fs	36.59	14.75	40.36	15.66	An	43.06

★ All iron presented as FeO. The ionic proportions of the pyroxenes and feldspar are calculated on the basis of 6 and 32 oxygens respectively. The number of analyses of each phase is bracketed.

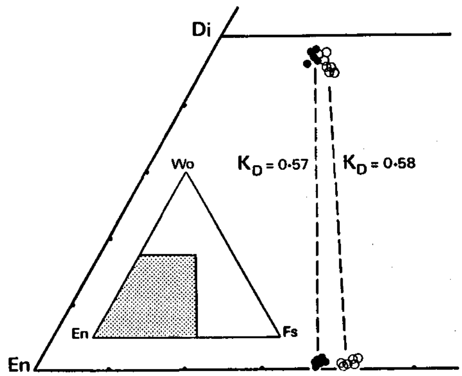

Fig. 23. En–Wo–Fs plot showing the composition of the co-existing pyroxene pairs from the pyroxenite pipe matrix (dots) and one of the basic xenoliths (open circles) and the corresponding Fe–Mg distribution coefficients (K_D).

et al., 1973; Chessex *et al.,* 1973). The minute flakes of biotite which pervade the matrix probably developed during the phase of post-granulite facies retrogression. However, the pipe is clearly younger than the deformation of the host rocks as it veins the neighbouring banded and folded gneisses and contains abundant xenoliths of the same lithologies, but is itself completely undeformed and without a recognizable fabric. Similar bodies occur as a collection of diatreme-like veins in South-East Greenland (Bridgwater, personal communication, 1979) although these are thought to be of Proterozoic age. No other such rocks have been recorded from the Archaean of West Greenland.

The mineral compositions were determined by electron microprobe analysis at the Department of Mineralogy and Petrology, Cambridge University under the guidance of J. V. P. Long and N. R. Charnley whose help is gratefully acknowledged.

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Evidence of mid-Proterozoic granite formation in the Isua area

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A 1.5–2 m wide fine-grained undeformed acid dyke, cutting the Early Archaean Isua supracrustal succession, was found in 1978 (D.B., J.B.). Preliminary Rb-Sr isotope measurements (F.K.) of small hand samples suggested an unexpected mid-Proterozoic age. Additional material was collected in 1979 (J.B.). Owing to weight restrictions in the helicopter, some of the samples are smaller (100–500 g) than we would normally use, but we feel justified in presenting the results since they suggest Proterozoic granitic activity in the area, which has implications for the later history of the Archaean block.

The dyke outcrops on a small knoll in the supracrustal belt 3.5 km due SW of the Kryolitselskabet's camp at Isukasia. It has a slightly irregular strike trending approximately N–S vertical and is sharply discordant to the NE–SW vertical trend of the country rocks. The dyke can be followed for 20–30 m before being covered by snow and gravel; no continuation is seen along strike. We have not noted other examples of such dykes in the area. No intersections with the major Proterozoic basic dykes are seen.

The country rocks to the dyke are inhomogeneous amphibolite and chlorite schists with local calcareous units, one of which forms the knoll on which the dyke occurs. There are occasional thin biotite-rich layers in the amphibolite. The margins to the dyke are sharp and slightly finer grained than the dyke centres with small fragments of country rock enclosed locally in the marginal few centimetres. Although the margins are chilled there is local reaction between dyke and country rock on a microscopic scale, so at the actual contact there is a mixed zone 2–3 mm wide with fragments of biotite-rich country rock forming recrystallised patches in dyke matrix. Away from the marginal 3–4 cm there are no inclusions.

The dyke rock is very dark purple-brown at the margins becoming slightly lighter in colour near the centre. It breaks like flint and shows plagioclase phenocrysts 1–2 mm in diameter, which are more noticable near the margin due to the contrast with the finer grained matrix. In section the dyke consists of fine-grained (0.05 mm) quartz, biotite, muscovite and both plagioclase and K-feldspar with accessory zircon and sphene. There are phenocrysts and aggregates of oligoclase and partly resorbed quartz and occasional biotite aggregates. The centre of the dyke contains some opaque minerals, partly replaced by sphene. The pheno-