

# Albitised gneisses in the area between Paakitsoq and Kangerluarsuk, north-east Disko Bugt, West Greenland

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Fine-grained rutile-bearing albite-rich rocks (> 95% albite) locally replace Archaean granodioritic orthogneisses in the area between Paakitsoq and Kangerluarsuk, eastern Disko Bugt. They occur as anastomosing networks within albite-rich gneiss and as replacements along linear fracture zones. Albitisation resulted from pervasive metasomatism, but the origin and nature of the albitising fluids are uncertain. A tentative comparison is made with rutile-rich albitites ('kragerøites') in southern Norway.

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Albitised siltstones on the island Qeqertakassak, north-eastern Disko Bugt, have been described by Kalsbeek (1992). They occur within Proterozoic supracrustal rocks, the Anap nunâ Group, overlying Archaean supracrustals, granitoids and gneisses (Garde & Steenfelt 1999, this volume). Their transformation from siltstone to albitite was shown to be the result of pervasive metasomatism, possibly in two phases: one diagenetic and the other syn- or post-tectonic. Rocks comprising albite (65–75%) with quartz (10–20%) and dolomite (10–15%) were produced.

This account deals with albitised gneisses that were found during reconnaissance mapping in 1991. They occur about 45 km south of Qeqertakassak in the area between the fjords Paakitsoq and Kangerluarsuk (Fig. 1). Here distinctive, bright, white, sugary-textured, albite-rich rocks replace the pre-existing gneisses, relics of which can be seen gradually disappearing in the albitite (Fig. 2A). Rutile is a conspicuous accessory mineral in hand-samples together with apatite and zircon in thin sections.

The occurrence of albite-rich rocks was reviewed by Kalsbeek (1992) who noted that their mode of formation is not always certain. Brøgger (1935) gave the

name 'kragerøite' to rocks consisting almost entirely of albite and rutile that occur in and around the town of Kragerø on the coast of southern Norway. Here upper amphibolite facies gneisses, metavolcanic rocks and metasediments of the middle Proterozoic Bamble Formation have been intruded by a suite of gabbros with associated pneumatolitic, metasomatic NaCl-scapolite bearing rocks, apatite ± rutile bearing dykes and veins, rutile-albitites and albitised breccias. Rutile segregation produced 'rutilite' bodies of up to several hundred tons that were mined commercially earlier this century.

Although the rutile-bearing albitites of eastern Disko Bugt are far more limited in size and extent, they show some similarities with the Norwegian occurrences, particularly with respect to their mineral assemblages, but not regarding the associated rock suite.

## Field relations

The main area of albitised gneisses occurs along the northern shore of Paakitsoq and Paakitsup Ilorlia. Here they outcrop along a c. 800 m coastal section at A (Fig.

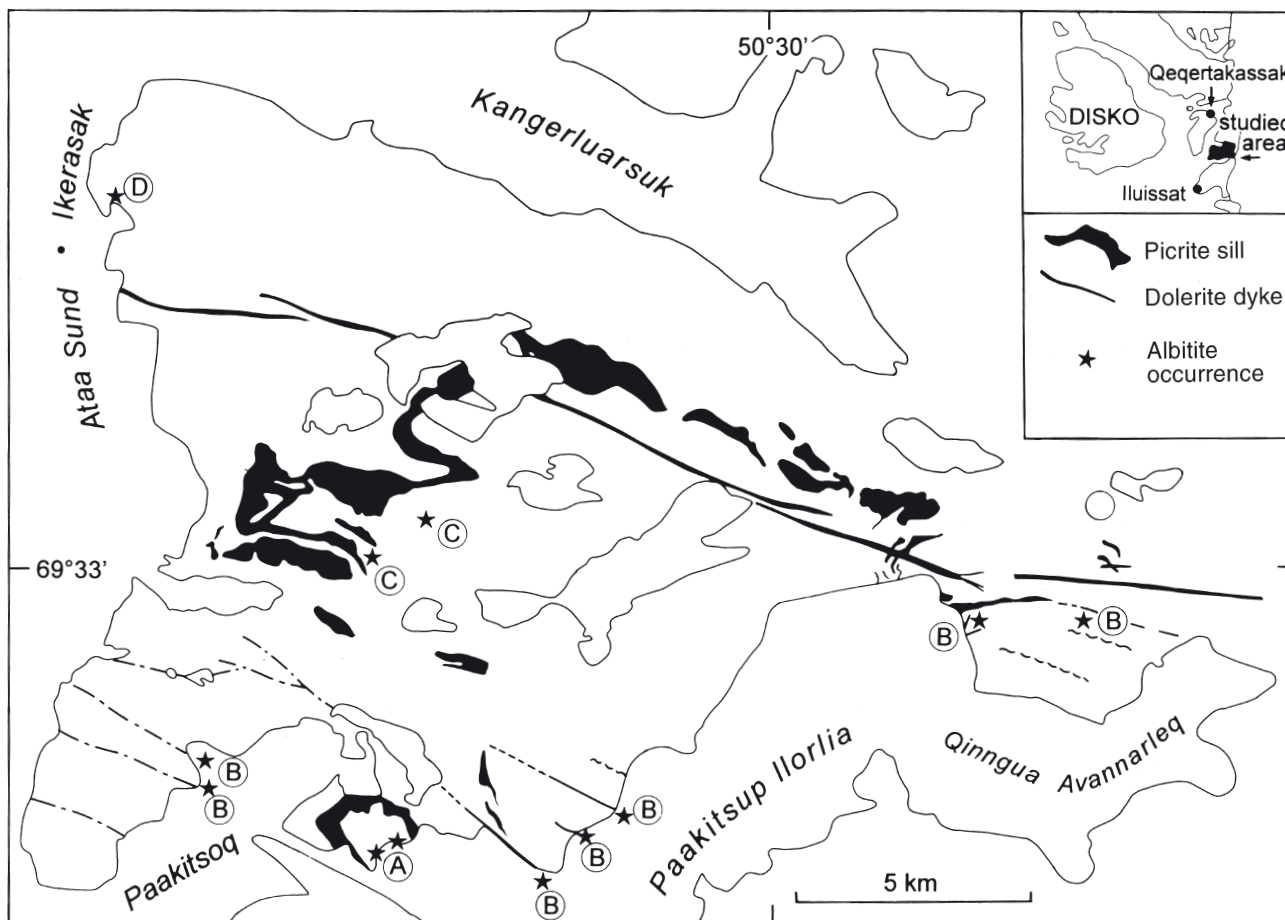


Fig. 1. Map showing localities of albitised gneisses (stars marked A–C) between Paakitsup and Kangerluarsuk, eastern Disko Bugt. For explanation of A, B, etc. see text.

1); their inland extent is not known. To the east and west, linear fracture zones are albitised and reddened (B) and *c.* 7 km to the north of A there are two seemingly isolated areas of albitite (C), also of unknown extent. A thin albitised zone outcrops in the walls of Ataa Sund (D).

The main occurrence (A) lies close to a major zone of augen gneisses, cataclasites and mylonites that runs WNW–ESE along the narrow channel entrance to Paakitsup Ilorlia (Fig. 1). The western margin of this albitised zone is a rapid transition from unaltered gneiss through albitised gneiss with relict schlieren of gneiss (Fig. 2A) to almost pure, white albitite, over a distance of 5–10 m. At least two phases of albitisation can be recognised in the field (Fig. 2B) and at one location a small, millimetre-scale veinlet of rutile provides evidence of small-scale rutile segregation. Figure 2C shows a thin, pink albitite vein cross-cutting the gneiss foliation. The vein has a gradational contact, albeit rapid

gradational over a few centimetres, and it appears to be a non-dilational vein of replacement type. To the east the albitites are in contact with an ultramafic sill which is not albitised and, therefore, could be presumed to be younger than the albitisation event. On the other hand, the fact that in most cases the albitites lie close to, and structurally above, the extensive sill complex (see Fig. 1) might indicate that they are related genetically, with the sill providing the heat for a hot brines ‘*per descensum*’ model (see p. 117).

Of the three linear zones (B) outcropping in the north-western wall of Paakitsup Ilorlia, the western one contains both white albitite and a massive, reddened, epidotised rock. The middle zone consists of 15 m of white albitite and the eastern one has a massive, pinkish-grey, homogeneous, partly brecciated ‘gneiss’ adjacent to massive, white albitite, 15–20 m wide.

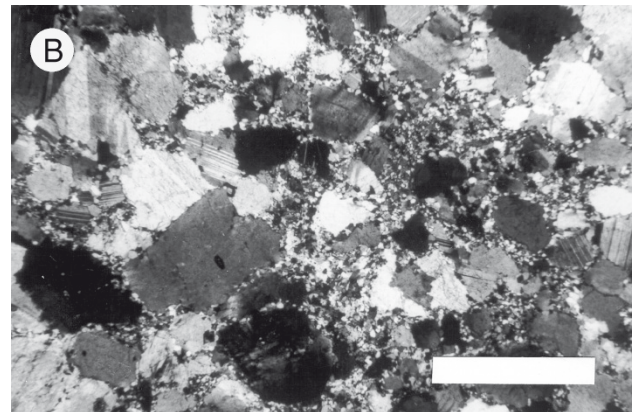
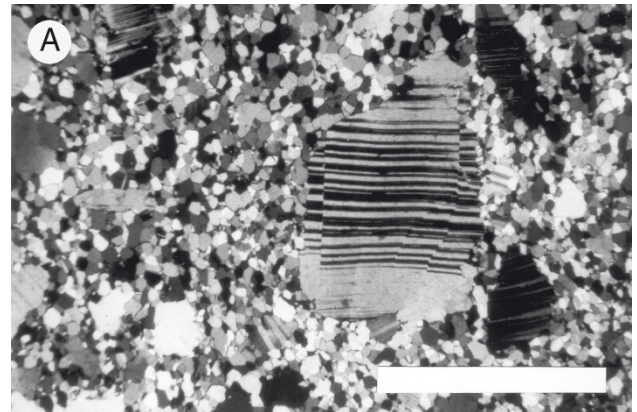


Fig. 3. Photomicrographs of albitised gneiss. A: Albite porphyroclast set in fine-grained anhedral albitite matrix; scale bar 5 mm. B: Fine-grained albitite matrix; scale bar 0.5 mm.

### Petrography

The albitites consist of > 95% albite with significant rutile and apatite. Zircon is always present, quartz either absent or present in very small amounts. Carbonate is not present in the albitites and is only a very minor component in the massive, epidotised rock mentioned above.

Typically, the albitites exhibit classic mortar textures: strained, undulose, bent, microfractured albite porphyroclasts set in a mosaic of fine-grained, anhedral, polygonal, unstrained albitite (Fig. 3A, B). They have a bimodal grain size: porphyroclasts are 2–4 mm, occa-

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Fig. 2. Field occurrence of albitites. A: Gneiss remnants within white sugary-textured albitite. B: Partially albitised gneiss with an anastomosing replacement-type network of albitite, formed in two successive phases of albitisation. C: Albitite vein (c. 20 cm thick) formed by replacement along a fracture cutting the gneiss foliation.

sionally 5 mm in a matrix of 0.1–0.2 mm albite grains. Rutile and apatite are often found closely associated as anhedral grains, 0.5–1.0 mm across, and in elongate clusters up to 5 mm. The rutile and apatite are neither strained nor fractured. Generally the apatite has clear cores and cloudy margins, possibly suggestive of alteration to oxy- or hydroxyl-apatite around the edges. Occasional, very minor, radiating clusters of chlorite and muscovite are found.

Samples from area C (Fig. 1) also show the typical mortar texture and contain sphene in addition to rutile. The matrix consists of albite and a little quartz with a ‘dust’ of tiny grains of rutile, sphene and epidote. Aggregates of chlorite with a little muscovite contain tiny rutile needles.

Reddened rocks associated with the albitites in the linear zones (B) contain abundant epidote and orange-brown biotite. The epidote is either concentrated in plagioclase cores or clustered throughout the rock, concentrated in layers and schlieren. Minor quartz, carbonate and sphene also occur.

The gneisses on either side of the main albitised zone (A) are variable quartz-dioritic to granodioritic in composition, occasionally with enough K-feldspar to be monzogranitic. They show the beginnings of a mortar texture.

## Chemistry

Table 1 shows analyses of six albitites from areas A and C and one unaltered gneiss from just east of the main albitised zone at A (Fig. 1, for comparison, pure albite,  $\text{NaAlSi}_3\text{O}_8$ , contains 68.7%  $\text{SiO}_2$ , 19.4%  $\text{Al}_2\text{O}_3$  and 11.8%  $\text{Na}_2\text{O}$ ).

It can be seen that all six analysed albitites are very similar chemically; GGU 293844 and -863 from areas A and C respectively are almost identical. Compared with the unaltered gneiss (GGU 293845) the albitised rocks expectedly show big increases in  $\text{Na}_2\text{O}$  and  $\text{Al}_2\text{O}_3$  and strong depletion in  $\text{FeO}$ ,  $\text{MgO}$  and  $\text{K}_2\text{O}$ .  $\text{TiO}_2$  is surprisingly low in GGU 293842, -844 and -863, and con-

Table 1. Chemical analyses of albitised gneisses

GGU no Locality	293935 A	293841 A	293842 A	293844 A	293863 C	293864 C	293845 A
$\text{SiO}_2$	64.94	64.71	70.44	67.81	67.49	67.46	71.93
$\text{TiO}_2$	1.34	0.73	0.21	0.28	0.20	0.43	0.24
$\text{Al}_2\text{O}_3$	20.24	19.91	17.15	19.24	19.60	19.39	14.96
$\text{Fe}_2\text{O}_3$	0.41	0.30	0.40	0.09	0.10	0.12	0.55
$\text{FeO}$	0.18	0.17	0.17	0.32	0.21	0.19	1.36
$\text{MnO}$	0.00	0.01	0.00	0.01	0.01	0.01	0.03
$\text{MgO}$	0.24	0.36	0.24	0.07	0.07	0.08	0.69
$\text{CaO}$	0.90	1.81	0.55	0.43	0.44	0.52	2.78
$\text{Na}_2\text{O}$	10.42	10.21	9.13	11.43	11.44	11.17	4.38
$\text{K}_2\text{O}$	0.26	0.63	0.21	0.16	0.31	0.42	2.26
$\text{P}_2\text{O}_5$	0.03	0.52	0.08	0.09	0.02	0.08	0.06
Volat.	0.20	0.17	0.10	0.06	0.09	0.04	0.33
Sum	99.16	99.53	98.68	99.99	99.98	99.91	99.57
V	–	56	–	18	18	27	27
Cr	16	–	–	–	3	–	–
Ni	–	46	–	43	46	44	37
Cu	2	5	2	4	4	5	18
Zn	–	–	–	5	–	72	31
Rb	–	25	–	16	24	24	46
Sr	124	279	49	127	148	131	376
Zr	662	295	143	200	294	266	47
Ba	–	203	–	53	51	124	772

A and C denote sample localities (Fig. 1).

GGU 293845 is a non-albitised gneiss from locality A for comparison. Analyses by GGU. Most major and trace elements from XRF on glass discs; Na and Cu by AAS. Trace element data are reconnaissance values.

sidering the amount of apatite in thin sections, so is  $P_2O_5$ . Among the trace elements, high levels of Zr reflect the frequent occurrence of zircon seen in thin section. Depletion of Sr mirrors the disappearance of CaO.  $Na_2O/K_2O$  ratios range from 16 to 71 in the albitites, compared with 2 in the unaltered gneiss.

## Origin of the albitites

The field evidence in the main albitite zone (A), where the transition from unaltered gneiss to pure white albitite and the replacement veins of albitite are well exposed along the coast, indicates that the albitites originated by metasomatic alteration of quartz-dioritic to granodioritic gneisses. Petrographically, the virtually monomineralic character of the albitites, > 95% albite with accessory rutile, apatite and zircon, is also consistent with a metasomatic origin.

The albitisation process apparently involved a sequence of events. Original oligoclase-andesine of the gneissic protoliths was hydrothermally altered to produce epidote and albite, with addition of OH and Na. Ferromagnesian minerals, quartz and epidote were then broken down and removed with further influx of Na and Al and removal of Fe, Mg, Ca and K. The early-formed albite porphyroblasts were then strained, bent and microfractured by a cataclasis event, followed by recrystallisation of the fine-grained, granoblastic albitic matrix to produce the mortar texture. Rutile and apatite (and possibly zircon) appear to have crystallised at this late stage, with a final segregation of rutile to produce elongate clusters and the small rutile vein.

The origin and nature of the albitising fluid are uncertain. With large-scale albitisation of siltstones on Qeqertakassak, 45 km to the north, an obvious source of fluids would be the same percolating brines proposed by Kalsbeek (1992) – the ‘*per descensum*’ model.

The albite-rich rocks on Qeqertakassak include quartz and dolomite among their major minerals with small clusters of tiny rutile needles in all samples and hematite and biotite sometimes present. The albitites of the present study contain little or no quartz, no dolomite, large rutile crystals up to 2 mm and in clusters, apatite and zircon. Kalsbeek’s analyses of dolerites and altered dolerites and dark siltstones and albite-rich rocks show the same depletion in Rb, Ba, Sr and increase in Zr in the albitised rocks as in the present study. If the same percolating brines were responsible for the albitisation in this southern area, presumably the greater depths below the Proterozoic supracrustal

rocks could account for the differences in mineralogy, with higher temperatures involved. An obvious source of heat to produce hot brines is the thick, extensive picritic sills in this area. Kalsbeek (1992) also proposed a similar model for Qeqertakassak where dolerites intrude the sediments. He noted that the Anap nunâ Group sediments may have contained evaporite minerals as the source of the Na-rich brines.

Alternatively, if the rutile-bearing albitites compare with the kragerøites of southern Norway, a ‘*per ascensum*’ origin could be invoked. However, kragerøites characteristically form part of a suite comprising gabbros, scapolitised rocks, apatite + phlogopite + enstatite mineralisation, hornblende-apatite and rutile dykes etc., which have not been found in eastern Disko Bugt.

It is well known that albitites may be the products of feldspathic fenitisation around carbonatite centres (Garson *et al.* 1984) and carbonate-lamprophyre dykes are widespread in the area around Kangerluarsuk (Escher *et al.* 1999, this volume). Thus it could be that these albitised gneisses are associated with further (earlier) carbonatitic magmatism in the area, which would make them useful guides in prospecting. In that regard, the major zone of cataclasites containing the main albitite occurrence (A) would be of interest.

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