RESULTS OF INVESTIGATION OF TERTIARY VOLCANIC BRECCIA SOUTH OF NIAQORNAT, NÛGSSUAQ, WEST GREENLAND, 1971

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Introduction

On the Nûgssuaq peninsula, south of Niaqornat village and east from the northerly extension of the Itivdle valley, there lies an area in which Cretaceous and Danian sediments are overlain by igneous rocks. These rocks in the main are highly altered, ultrabasic breccias. Further east basalt flows cap the high ridges. The area visited was the high ridge between the valley Tunorssuaq and the north coast, east and west of Niaqornat village. In particular considerable attention was given to the area described by Arnold Heim (1910, p. 209) 4 km south-west of Niaqornat village. Heim was the first to discover these rocks and classified them as intrusive mainly because of the graphitisation of some of the shales nearby. This idea was continued by Rosenkrantz (*in* Birkelund, 1965, plate 49), Rosenkrantz & Pulvertaft (1969, p. 892) and Henderson (1969 a, p. 20; 1969 b, p. 25).

Rock types and field relationships

The major rock type in the area is a highly altered green breccia containing inclusions of vesicular basalt, olivine basalt, coarse-grained picrite, and shale (as concretions). The breccia shows layering on a massive scale with some cross-bedding. The direction of cross-bedding indicates derivation from a western source. Between many of the massive layers there are thin layers of tuffaceous shaly material. In one locality a pure shale band 0.5 m thick can be followed for 150 m before it disappears from view.

The inclusions are found at all outcrops of the breccia with the exception of the coarse-grained picrite which has a very restricted occurrence (see below). However at many localities inclusion-free homogeneous breccia is seen to grade into breccia rich in inclusions, there being no sharp boundaries.

Inclusions of picrite are restricted to an area above that described by Heim. They occur in varying sizes from 5 cm to 2 m in diameter. The large blocks are found in a line of 20 m which suggest they are intrusive but there is no evidence of chilled margins and the blocks are quite separate. Also one particular block (1 m

wide) consists of a block of vesicular basalt intruded by coarse picrite. The larger blocks of the other types of inclusions are also confined to this area.

In some of the layers which consist of only inclusion-free homogeneous rock the alteration is less intense. Whether this is due to a change in the chemistry of the rock or to variation in the altering medium is not known.

The green breccia is substantially veined by N-S and E-W trending veins. The vein material is normally calcite but the mineral xonotlite has a restricted occurrence.

The second major rock type is an altered brown breccia consisting of blocks of a single rock type in a highly altered matrix. This rock often occurs as a series of small cubical blocks quite close together with the junction between block and matrix as a vertical plane. Inclusions of graphite are also found in this rock as also are layers of homogeneous tuffaceous, glassy matrix. There are occurrences of randomly orientated blocks but they are the exception to the normal. The blocks, while comparatively fresh, have no glassy margins.

This breccia also shows massive sub-horizontal layering but no interbedded shales were found.

Below each of these major rock types there are outcrops of tuff. Below the brown breccias they extend vertically for some 50 m, although interspersed with layers of inclusions. It is in these lower layers that most random orientation of the blocks occurs.

Below the green breccia layers of tuff extend only for about 10 m before passing down into shale.

As mentioned above the tuffs always occur below the breccias. The two breccias interdigitate with each other in the area of the graphite pits. Sometimes the boundary is concordant with the layering so that in a vertical section one would pass from brown breccia into green breccia and back into brown breccia but 30 m further east the brown breccia (with tuff layers) is truncated by the green breccia which in this case has no layering. This is also in the area where large blocks occur. Generally the brown breccia occurs only below, above and to the west of the graphite pits while the green breccias predominate east of that point.

Petrography

Green breccia

The homogeneous parts of the green breccia when fresh consist of glass fragments with interstitial carbonate and serpentine minerals. When highly altered there is an increase in carbonate material.

The glass fragments (especially the larger ones) often contain pseudomorphs of olivine crystals in their centres now replaced by serpentine and carbonate. Occasionally small laths of plagioclase can also be found.

The picrite inclusions consist of phenocrysts of olivine in an ophitic groundmass of pyroxene and plagioclase. The olivine (26 per cent) has a composition of Fo_{90}. The pyroxene (46 per cent) and plagioclase (22 per cent) are undetermined. The remainder consists of ore minerals.

Alteration of the olivine to serpentine and ore minerals is quite considerable.

Brown breccia

The blocks in the brown breccia consist of olivine phenocrysts (largely replaced by carbonate and serpentine) in a fine-grained groundmass of plagioclase and carbonate. The presence of the carbonate in the groundmass makes it impossible to say whether there was any original pyroxene or olivine. No glass can be seen in thin section. The proportions are olivine pseudomorphs 10 per cent, plagioclase 45 per cent, carbonate 45 per cent.

Tuffs

Besides showing glass fragments and some carbonate material the basal tuffs show fragments of quartz and shale.

Chemistry

Four of the samples collected from the green breccias have been chemically analyzed. The results are given in Table 1.

Table 1. Analyses of samples from the green breccias

	139858	139872	139872G	139890
SiO_2	40.75	32.42	54.75	50.22
TiO_2	0.63	0.70	1.05	1.00
Al_2O_3	7.67	8.59	10.91	14.64
Fe_2O_3	3.35	2.85	1.42	2.35
MgO	20.14	14.55	6.20	5.39
FeO	9.36	5.34	5.91	2.75
MnO	0.28	0.13	0.07	0.11
CaO	5.62	9.24	4.55	4.36
Na_2O	2.44	2.47	5.06	7.70
K_2O	n.d.	n.d.	n.d.	n.a.
P_2O_5	n.d.	n.d.	n.d.	n.a.
H_2O^+	4.61	4.83	7.08	10.17
H_2O^-	4.1	2.84	3.76	
CO_2	0.2	16.4	1.2	n.a.
	99.12	100.36	101.96	98.69

n.d. not determinable with method used.
n.a. not analysed for.

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139858 coarse-grained picrite.
139872 comparatively unaltered layer of inclusion-free green breccia (glass fragments in matrix of carbonate and serpentine minerals).
139872G glass from above.
139890 unserpentinised glass fragments from fresh glass breccias.

Graphite

The reason for the formation of graphite at the graphite pits is not certain but the pits do occur within the area of outcrop of the brown breccia and small fragments of graphite are found elsewhere in this rock. The physico-chemical conditions for the formation of graphite are not generally agreed upon, so it is not possible to be certain that the graphite indicates a higher temperature within the brown breccia than within the green breccia in which only shale is found. Scree unfortunately obscures the contact relations of the graphite pits.

Summary and conclusions

The brown and green breccias, both at least 250 m thick at Heim's locality are distinctly different rocks. The green breccia is certainly extrusive and likely of an explosive nature giving rise to a concentration of large blocks and the truncation of the basal components of the brown breccia. The brown breccia is probably extrusive but may well be the result of exploitation of the cooling cracks of lava flows by altering fluids but with some disturbed breccias in the lower part.

The intensity of alteration does not change within the area studied but on the south coast of Nûgssuaq east of the Itivdle valley a gradation change can be seen in rocks of the same character. Further mapping over a large area may reveal a relationship between the alteration and the Itivdle valley fault system.

References

Birkelund, T. 1965: Ammonites from the Upper Cretaceous of West Greenland. *Bull. Grønlands geol. Unders.* **56** (also *Meddr Grønland* **179**, 7), 192 pp.

Heim, A. 1910: Über die Petrographie und Geologie der Umgebungen von Karsuarsuk, Nordseite der Halbinsel Nugsuak, W. Grönland. *Meddr Grønland* **47**, 175–228.

Henderson, G. 1969 a: Field work supplementing photogeological interpretation of Nûgssuaq. *Rapp. Grønlands geol. Unders.* **19**, 18–21.

Henderson, G. 1969 b: Oil and gas prospects in the Cretaceous-Tertiary basin of West Greenland. *Rapp. Grønlands geol. Unders.* **22**, 63 pp.

Rosenkrantz, A. & Pulvertaft, T. C. R. 1969: Cretaceous-Tertiary stratigraphy and tectonics in northern West Grønland. *Mem. Am. Ass. Petrol. Geol.* **12**, 883–898