INTRUSIONS OF MIXED ORIGIN MIGMATISING EARLY ARCHAEAN CRUST IN NORTHERN LABRADOR, CANADA.

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In the Saglek-Hebron area of northern Labrador, Canada, old-Archaean ($\gtrsim$3.6 Ga) gneisses and supracrustals are migmatised by late-Archaean granites and trondhjemites.

A simplified chronological scheme of the geological evolution in the area compared to Godthaabsfjord, West Greenland is shown in Table 1. In the early Archaean the evolution of the Labradorian Uivak continent has much in common with the evolution of the Greenlandic Amitsoq continent. In the later Archaean, however, remelting and reworking of the already existing continent plays a more important role in Labrador, than is described from the type area of the Amitsoq gneisses between Godthaabsfjord and Ameralik (1). Conversely the equivalent of the ca. 3000 Ma Nûk gneiss (s.s.) which is dominated by rocks formed from protoliths with a short crustal history, has only

Table 1.

Simplified geological table of events for the Archaean of the Saglek-Hebron area and outer Godthaabsfjord.

Age	Saglek-Hebron:	Godthaabsfjord:
$\gtrsim$3600 Ma	Uivak continent established (incl. rafts of Nulliak supracrustals).	Amitsoq continent established (incl. rafts of Isua/Akilia supracrustals).
	Saglek dyke swarm.	Ameralik dyke swarm.
	Deposition of Upernavik supracrustals.	Deposition of Malene supracrustals.
~3000 Ma	Intrusion of Lister gneiss, restricted extent.	Intrusion of anorthosite followed by wide spread Nûk gneisses.
	Tectonic intercalation of gneisses and Upernavik supracrustals.	Tectonic intercalation of gneisses, anorthosites and Malene supracrustals.
~2800 Ma	Wide spread granulite facies metamorphism, partial melting of continent. Granitic-trondhjemitic migmatising sheets.	Granulite facies metamorphism.
	Emplacement of discrete pink-grey granitic sheets.	Emplacement of Qârusuk dykes. (Wide spread granite sheeting in inner Godthaabsfjord).
~2500 Ma	Formation of post-tectonic K-feldspar rich granite.	Formation of post-tectonic Qôrqut granite.

Data from (2-5)

got a very restricted extent.

Late-Archaean sheets which migmatise the old-Archaean rocks, are intruded during the waning stages of high-grade metamorphism. Different crustal levels of the late-Archaean migmatite complex are seen at the present level of erosion, due to post-Archaean faulting of the Saglek-Hebron area. In the deepest crustal levels the migmatising sheets crystallised in granulite facies. At intermediate levels the granulite facies conditions had ceased at the time of intrusion, and migmatisation is locally related to retrogression. At the highest crustal levels represented, the migmatising sheets cut gneisses which did not reach granulite facies during the late-Archaean.

The sheets are leucocratic with very restricted amounts of mafic minerals (opx and gar in granulite facies, biot and occasional gar in amphibolite facies). K_2O/Na_2O ratios show a large spread, even within one intrusion. Absolute contents of REE are generally low (fig. 1), with prominent positive Eu-anomalies. LREE are in most cases highly enriched relative to HREE, that is $(Ce/Yb)_N$ 50-250. A garnet-bearing K-feldspar rich pegmatite (fig. 1), however, shows a concave REE-pattern.

These REE-patterns are difficult to explain in terms of simple magma differentiation from trondhjemite to granite (which would mainly be a matter of plagioclase fractionation), and we interpret the variable K_2O/Na_2O ratios as due to alkali exchange with fluids within the sheets and the surrounding gneisses. We suggest that REE and other trace elements usually considered immobile were involved in this interchange. The main factor controlling REE distribution in these fluid-rich environments is thought to be the stability of the main REE bearing phases (allanite, zircon, apatite and garnet). Eu could always easily be accomodated by the very feldspathic rock itself whilst allanite grown in the Uivak gneiss adjacent to migmatising sheets, suggests LREE enrichment by interchange across the contact. The concave REE-pattern displayed by one sample in fig. 1 is accounted for by HREE incorporation in garnet.

Provisional Sm-Nd isotopic measurements of the migmatising sheets show negative, though numerically small e_{Nd} (2800 Ma)-values, ranging from -2 to -4. Since e_{Nd} (2800 Ma)-values for Uivak gneisses and Nulliak supracrustals are strongly negative (-5 to -10), this suggests a mixed origin for the migmatising sheets with both crustal and mantle like components. If REE exchange with the surrounding rocks took place, the Uivak gneisses (and Nulliak supracrustals) would have been contaminated with an abnormally radiogenic Nd in the late Archaean, in which case previously reported (6) positive e_{Nd} (3665 Ma)-values of Uivak gneisses could be an artifact and not necessarilly indicative of derivation from a depleted mantle source.

Pb-Pb results also indicate that upper crustal levels were contaminated with Pb of abnormal isotopic composition during the late-Archaean migmatisation. In fig. 2 granulite and amphibolite facies Uivak gneisses reveal a difference in Pb-radiogeneity which is not explicable in terms of U-loss from granulite grade areas at 2800 Ma. If U-loss and partial isotopic homogenisation were the only disturbing factors, the only systematic variation between amphibolite and granulite facies rocks would fall along a line with 2800 Ma slope. From fig. 2 it can be seen that amphibolite facies rocks have radiogenic Pb with an abnormally high $^{207}Pb/^{206}Pb$-ratio (that is radiogenic Pb developed before 2800 Ma). If Uivak gneisses do not have different histories between the early Archaean and the late-Archaean high-grade metamorphism on different sides of the facies boundaries, the easiest explanation is that amphibolite facies gneisses were contaminated with radiogenic Pb at 2800 Ma.

The granitic-trondhjemitic migmatising sheets have suitable Pb-compositions for being the contaminating agents. (Direct evidence of Pb mobility is seen in local galena mineralisations of probable late-Archaean age in the area).

The main conclusion is that granitic-trondhjemitic sheets and their related fluid phases acted as vehicles for element transport from one crustal level to another. This caused isotopic anomalies in the Pb-Pb and possibly also the Sm-Nd systems. Both isotopic systems indicate a mixed origin for the migmatising sheets, with crustal as well as mantle components. From their general geochemistry and mineralogy the most probable origin of the migmatising sheets was melting of sialic crust. The mantle component may either have been introduced by fluid metasomatism directly from the mantle, or alternatively by derivation from adjacent Upernavik supracrustals if these had a short crustal history.

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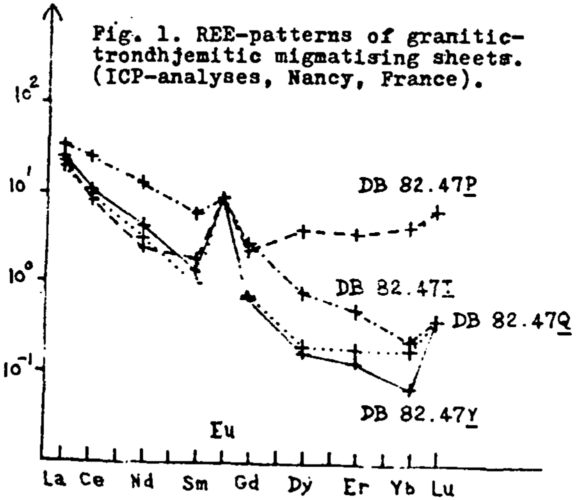

Fig. 1. REE-patterns of granitic-trondhjemitic migmatising sheets. (ICP-analyses, Nancy, France).

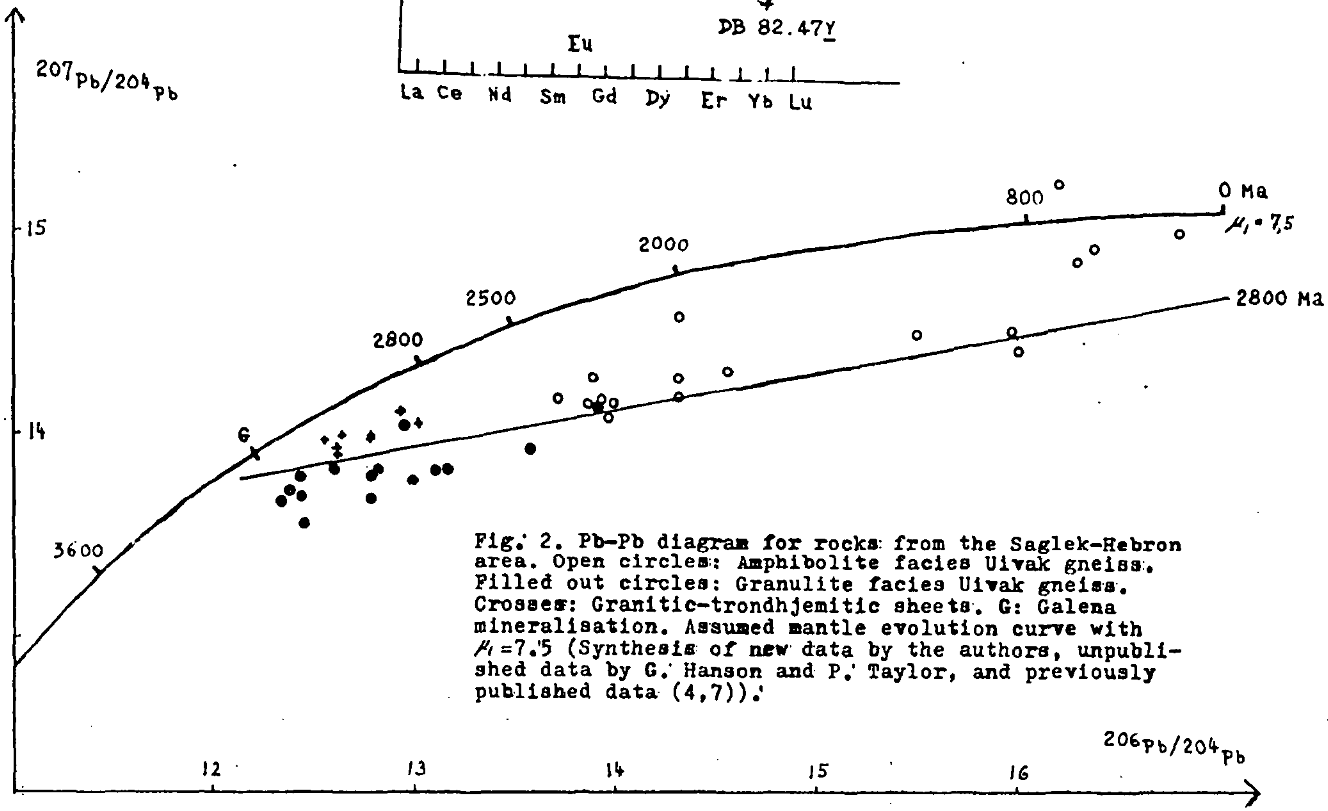

Fig. 2. Pb-Pb diagram for rocks from the Saglek-Hebron area. Open circles: Amphibolite facies Uivak gneiss. Filled out circles: Granulite facies Uivak gneiss. Crosses: Granitic-trondhjemitic sheets. G: Galena mineralisation. Assumed mantle evolution curve with $\mu_1 = 7.5$ (Synthesis of new data by the authors, unpublished data by G. Hanson and P. Taylor, and previously published data (4,7)).