Archaean U-Pb zircon ages from the Scoresby Sund region, East Greenland

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Abstract

U-Pb analyses on zircons are reported for two rock collections from infracrustal complexes within the East Greenland Caledonian fold belt in the Scoresby Sund region. Calculated minimum ages range from 2800 to 2965 Ma, and are the oldest ages obtained in the region using this method.

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Introduction

Exposures of gneissic infracrustal complexes are widespread in the western part of the Scoresby Sund region (fig. 1), and make up the oldest rock units within the southern part of the East Greenland Caledonian fold belt. In some areas the rocks of the infracrustal complexes give Archaean isotopic ages and appear to have been relatively unaffected by younger events, whereas elsewhere they have been strongly deformed by Grenville (*c.* 1100 Ma) or Caledonian orogenic events.

The most widespread infracrustal unit in the Scoresby Sund region is known as the Flyverfjord infracrustal complex (Henriksen & Higgins, 1976; Henriksen *et al.* 1980; Higgins, 1982). It is dominated by strongly folded, banded gneisses with abundant amphibolite bands and ultrabasic lenses and with, characteristically, discordant amphibolitic dykes. A variety of foliated granites and migmatitic granites are associated with the gneisses and are folded together with them; they are interpreted as an early phase of intrusions.

One of the earliest isotopic ages reported from the Flyverfjord infracrustal complex was a Rb-Sr whole rock isochron age of 2935 Ma on leucocratic gneisses from Flyverfjord (Rex & Gledhill, 1974). Subsequently, Steiger *et al.* (1979) reported a zircon age of 2300 Ma on a foliated granite north of Nordvestfjord, a zircon age of 2520 Ma on granitic augen gneiss around Harefjord, and a K-Ar hornblende age of 2511 Ma from a discordant amphibolite south of Flyverfjord.

Sampling and analytical procedure

Sample collections, on which the new zircon analyses were performed, were taken from infracrustal complexes at two localities, one in Charcot Land and the other at the head of Harefjord (fig. 1). Fresh and homogeneous material was obtained by drilling and blasting, and in each case about 100 kg of rock was collected.

The U-Pb analyses were performed according to the procedure described by Persson *et al.* (1973). Age calculations were made using the constants recommended by the IUGS Subcommission (Steiger & Jäger, 1977). Errors based on replicate analyses are 0.7% for the $^{207}Pb/^{235}U$ ratio and 0.4% for the $^{206}Pb/^{235}U$ and $^{207}Pb/^{206}Pb$ ratios. Regression lines were calculated according to the least squares method of York (1969). Errors quoted are 2σ of the mean.

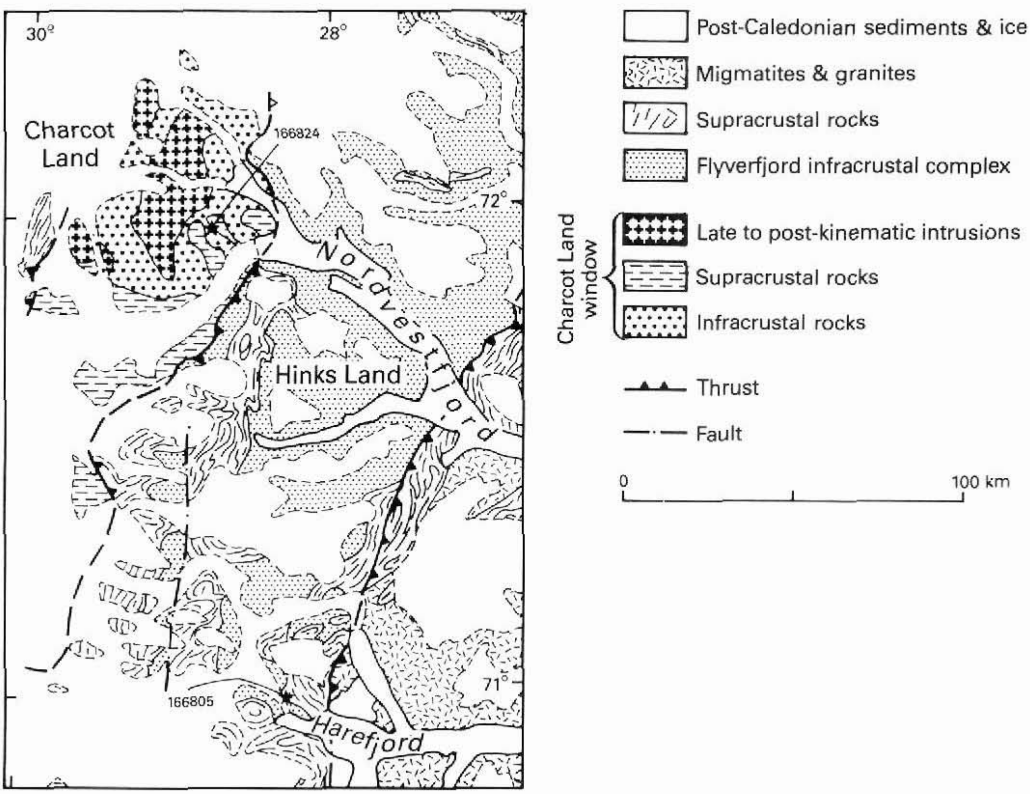

Fig. 1. Simplified geological map of the area between Charcot Land and Harefjord, showing sample localities.

Charcot Land

Most of Charcot Land, together with adjacent nunataks and part of western Hinks Land, occur in a tectonic window below an arch-shaped thrust with a westward displacement of at least 40 km. The rock units within the window include: (1) an infracrustal complex of gneisses and granites, (2) the Charcot Land supracrustal sequence, (3) late to post-kinematic intrusions, and (4) a small occurrence of tillite. The general geology of the region is described by Henriksen & Higgins (1976) and Higgins (1982), and a study of metamorphism of the supracrustal rocks by Steck (1971).

Previous isotopic studies (Hansen *et al.*, 1981) led to the following chronology for the rock units of the Charcot Land window. The infracrustal complex has yielded K-Ar hornblende ages of 2855 Ma, 2097 Ma, 2075 Ma, 1750 Ma and 642 Ma; some of these ages reflect metamorphic overprinting, and it was concluded that the age of the complex was greater than 2100 Ma and probably Archaean. It was compared in general terms to the Flyverfjord infracrustal complex. U-Pb studies on zircons from a metagabbro body of the Charcot Land supracrustal sequence suggest a main metamorphic event probably 1900-1850 Ma ago. A Rb-Sr whole rock isochron age on a pegmatite granite suggests probable intrusion 1850 Ma ago, while a similar age (*c.* 1840 Ma) was obtained by U-Pb analyses on zircons from a hornblende-biotite quartz diorite intrusion. There is no isotopic or fossil evidence for the age of the tillite, which overlies 1840 Ma intrusions and lies beneath a Caledonian thrust, but it is thought likely to be latest Precambrian (Henriksen, 1981).

Table 1. U-Pb analytical data on zircons from the Scoresby Sund region

GGU sample No & sieve fraction in μm	mg sample analysed	Observed atomic ratios $^{208}Pb/^{206}Pb$	$^{207}Pb/^{206}Pb$	$^{206}Pb/^{204}Pb$	U ppm	Pb_{rad} ppm	$^{206}Pb_{rad}$ n mol/g	Atomic ratios corrected for blank* and common Pb $^{206}Pb/^{238}U$	$^{207}Pb/^{235}U$	$^{207}Pb/^{206}Pb$
GGU 166805										
< 40	2.2	0.06901	0.19536	1718	650	315	1236	0.45550	11.8254	0.18829
40 – 63	6.85	0.03474	0.19319	7874	854	324	1286	0.36086	9.5361	0.19166
63 – 80	5.0	0.03436	0.19257	8065	882	329	1306	0.35484	9.3478	0.19106
80 – 125	6.7	0.03131	0.18266	5155	1117	349	1403	0.30101	7.4912	0.18050
> 125	6.65	0.02715	0.16526	2801	1828	455	1875	0.24589	5.4502	0.16076
GGU 166824 > 75μ										
grey, round	1.1	0.56893	0.20744	70	2106	131	591	0.06686	0.58304	0.06325
milky, prism.	0.1	0.25253	0.15224	178	4167	288	1300	0.07176	0.71060	0.07182
clear, idiom.	0.25	0.17134	0.12901	251	1552	118	520	0.08103	0.80334	0.07190
milky, round	0.5	0.16086	0.11994	265	2995	191	860	0.06829	0.61806	0.06564
green, prism.	0.7	0.18489	0.11842	279	2592	175	757	0.07004	0.64614	0.06691

* Composition of lead used for blank correction $^{206}Pb/^{204}Pb$ = 18.7, $^{208}Pb/^{204}Pb$ = 15.63, $^{208}Pb/^{204}Pb$ = 38.63
The composition of common lead used for correction accords to the model of Stacey & Kramers (1975).

To establish better age control for the infracrustal rocks, U-Pb analyses have been carried out on zircons from a large sample of quartzo-feldspathic gneiss (GGU sample no. 166824); the small proportion of mafic minerals comprise mainly biotite. Five zircon fractions, all from the sieve fraction > 75 μ, have been analysed; the data are given in Table 1 and plotted in fig. 2. The zircons show a variety of habits and colour, including clear idiomorphic, milky prismatic, light green prismatic, grey rounded and milky rounded. Four fractions (excluding the clear idiomorphic zircons) define a discordia with a lower intercept at 403 Ma and an upper intercept at 2813 Ma (fig. 2). Because of the extended extrapolation and the very low $^{206}Pb/^{204}Pb$ ratios (70 – 300, Table 1) the older age is uncertain. However, an age of about 2800 Ma is in agreement with the K-Ar hornblende age on an amphibolite from the Charcot Land infracrustal complex (Hansen *et al.*, 1981), as well as with ages obtained on the similar rocks of the Flyverfjord infracrustal complex (Rex & Gledhill, 1974; Steiger *et al.*, 1979). The high discordancy is probably related to episodic lead loss due to tectonic overprinting during

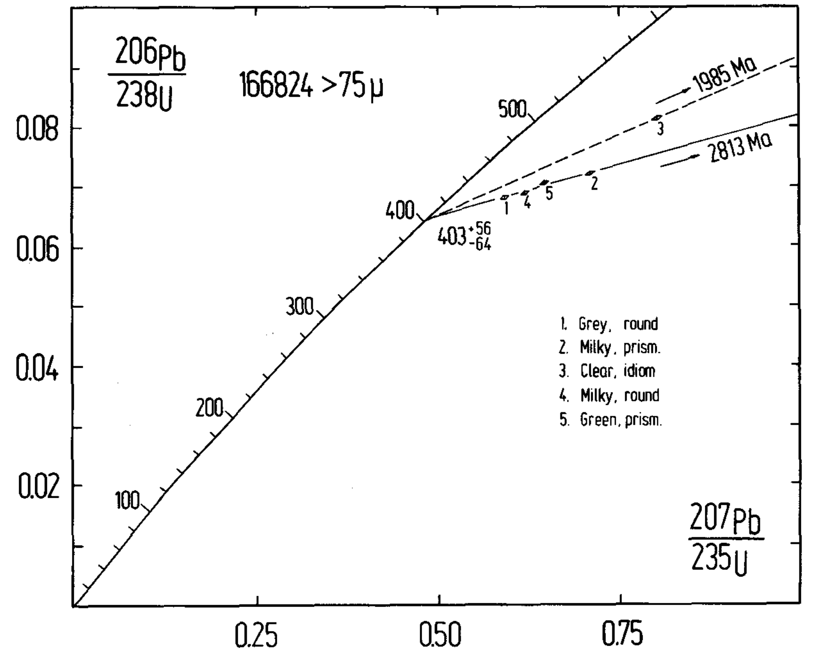

Fig. 2. Concordia plot of zircons from sample 166824, Charcot Land.

the Caledonian orogeny rather than to new growth, as Caledonian metamorphism was only of retrogressive character in the Charcot Land window.

The data point for the clear idiomorphic zircon fraction falls clearly above the discordia defined by the other four fractions (fig. 2). A tieline between this point and 400 Ma gives an upper intercept of 1985 Ma. This age is coincident with the age for the main regional metamorphism of the Charcot Land supracrustal sequence (*c.* 1850-1900 Ma; Hansen *et al.*, 1981) and could be explained by new zircons grown during this event suffering episodic lead loss during Caledonian time. If new zircon growth did take place at this time then the discordia age of 2800 Ma deduced from the other four zircon fractions is a minimum age, as all fractions would have been displaced towards the discordia by new growth during the 1900 Ma event. While this interpretation is speculative in view of the high discordance of the analysed fractions, it is of interest that the upper intercept ages agree with known events in the area.

Harefjord

Infracrustal rocks outcropping around the head of Harefjord include banded gneisses with amphibolite layers and lenses, and a homogeneous biotite augen gneiss with sharp boundaries to the banded gneisses and probably of igneous origin. These infracrustal rocks can be traced discontinuously northwards into the more extensive exposures of infracrustal rocks around Flyverfjord (fig. 1), and may be viewed as part of the same complex.

Analyses of zircons from the homogeneous augen gneiss by Steiger *et al.* (1979) suggest an age of formation (or intrusion) at 2510 Ma. Additional analyses, reported here, have been

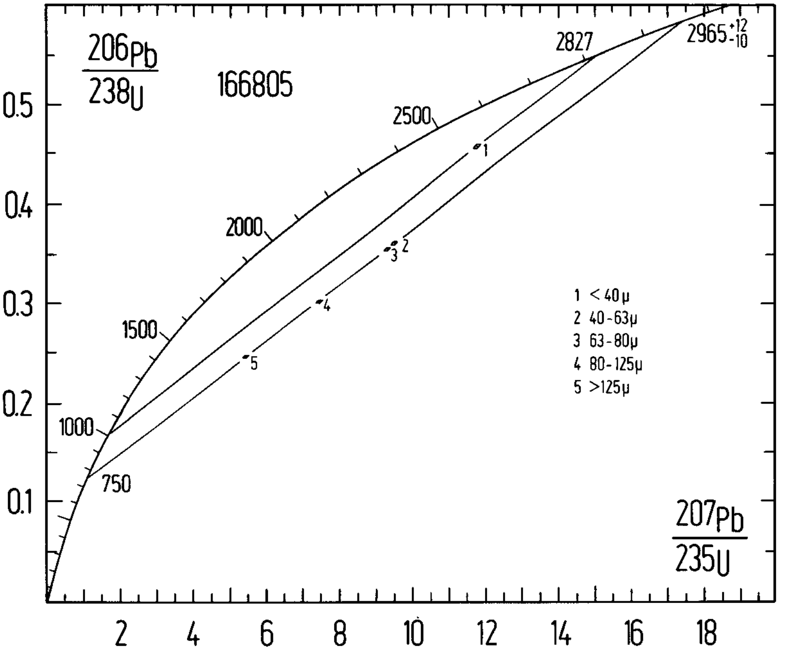

Fig. 3. Concordia plot of zircons from sample 166805, west of Harefjord.

carried out on a sample of the banded gneisses forming the country rock surrounding the augen gneiss in the same area.

Five zircon sieve fractions from the rock (GGU sample no 166805) have been analysed (Table 1), and the data are plotted in fig. 3. The data for the five sieve fractions show a systematic relationship between grain size and uranium concentration, the finest grain size having the lowest U concentration, as is often characteristic for Archaean zircons. The four coarsest fractions form a discordia with intercepts at 750 Ma and 2965 Ma. Although the four fractions show a considerable spread, the lower intercept age of 750 Ma has no apparent geological significance, and the upper intercept age must therefore be regarded as a minimum age. An indication of a disturbed system is given by the data point for the sieve fraction <40 μm, which plots clearly above the discordia defined by the other points suggesting a different evolution. If these zircons were formed during the main regional metamorphism, which in this area is considered to have taken place during a mid-Proterozoic (Grenville – *c.* 1100 Ma) orogenic event (Hansen *et al.*, 1978; Henriksen, 1982) then a minimum age of at least 2825 Ma is obtained (fig. 3); the area was also subsequently affected by Caledonian metamorphism, and a new growth or episodic lead loss might have been superimposed on the zircons moving the data points to younger ages.

The deduced minimum ages for the zircons in the banded gneisses at Harefjord fall in the range 2825-2965 Ma, which supports the field evidence that the infracrustal rock units around Harefjord are part of the Flyverfjord complex.

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