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THE GEOCHRONOLOGY OF THE SCORESBY SUND AREA

Progress report 3: Zircon ages

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Introduction

The crystalline complex around Nordvestfjord was mapped in 1968 and 1969 (Henriksen & Higgins, 1969, 1970) and a number of geological key samples from this area were collected for zircon age determinations. In order to avoid polymetamorphic rocks, mainly granites were collected for this purpose. Up to now more than 15 zircon fractions from four localities have been analysed and the preliminary results for three of these are discussed in this report. The actual age determinations have been carried out at the "Institut für Kristallographie und Petrographie" of the "Eidg. Technische Hochschule" in Zürich.

In order to extrapolate the age of crystallisation, or last major recrystallisation, of a zircon suite, data points are plotted in a coupled parent-daughter (concordia) diagram. The "concordia" curve is the locus for which the ages calculated from Pb^{206}/U^{238} and Pb^{207}/U^{235} ratios are identical. Data points normally plot on the concave side of the concordia curve indicating partial Pb loss, or U addition. Zircon fractions subdivided according to physical properties usually form a linear array. The upper intersection of the extrapolated linear array with the concordia curve is generally interpreted as the time of crystallisation; the significance of the lower intersection is still disputed. There are at least three valid explanations for the linear arrangement of zircon data points: 1) episodic loss of Pb, or U addition; 2) mixing of zircons of different generations, and; 3) continuous Pb loss. For a detailed discussion and additional references see Steiger & Wasserburg (1969).

Results

The preliminary results obtained from the zircon age determinations of these samples are indicated on the concordia diagram (fig. 17). The analysed samples are given in table 7.

Table 7. Location of analysed samples

GGU No/Collector	Rock type	Location (latitude/longitude)
103873/Henriksen	Foliated biotite granite	North side of inner Nordvestfjord 71° 46′ N/27° 23′ W
103779/Henriksen	Hornblende-biotite quartz diorite	Tillite Nunatak, west Charcot Land 71° 54′ N/29° 47′ W
103811/Henriksen	Biotite and garnet bearing foliated augen granite	North coast Nordvestfjord, east of Borgbjerg Gletscher 71° 31′ N/25° 44′ W

Discussion of results

GGU 103873. Foliated granite from the Flyverfjord infracrustal basement complex. The sample was collected in an area mapped by F. Keller in 1968. It represents a foliated granite which occurs in the central part of a minor domal structure cut by the north wall of Nordvestfjord. The granite dips north-east beneath a series of banded gneisses, and a continuous amphibolite horizon with associated pegmatites and marble lenses occurs between the granite and the banded gneiss. These rocks form part of the Flyverfjord infracrustal complex, which is interpreted as predominantly reactivated basement (Henriksen & Higgins, 1969). It includes banded-veined hornblende and biotite gneisses, often with amphibolite bands and ultramafic inclusions; foliated granites occur locally. The infracrustal basement rocks are found below the younger supracrustal Krummedal sequence.

The sample was collected from a fairly homogeneous part of the granite showing a slight foliation. Occasional steeply inclined pegmatitic veins were avoided. The rock is a reddish, leucocratic, medium-grained, quartz-rich, biotite-microline granite, with some plagioclase.

The zircons in the sample are morphologically rather inhomogeneous; they rarely show any but prismatic faces, the terminations are mostly rounded, and all zircons are short and stubby. Three major populations may be distinguished: 1) fairly transparent crystals of intermediate size, with a reddish brownish tinge; 2) smaller crystals, clear and transparent, often completely rounded; 3) large brown crystals, sometimes with dark cores.

Four zircon fractions have been analysed from this rock. The data points are somewhat discordant, but form a linear array. The upper extension of the straight line through the data array intersects with the concordia curve at 2345 m.y., indicating the time of crystallisation. The lower extension of the line through the data point intersects the concordia at 600 m.y.. Without additional information it is not possible to give a valid interpretation of the meaning of the lower intersection. It is however interesting to note that ages of 615-630 m.y. have been found in the

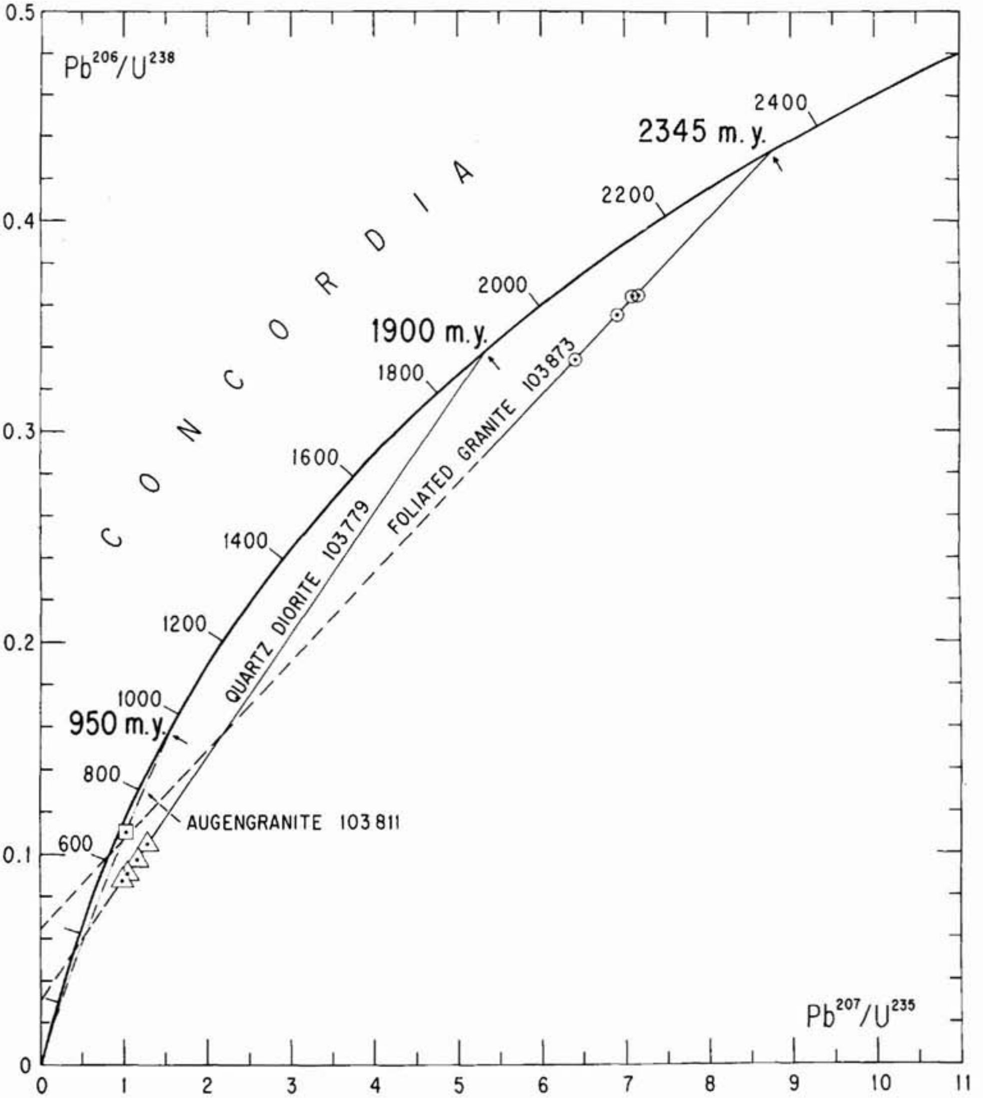

Fig. 17. Coupled parent-daughter ("concordia") diagram showing results on zircon fractions from three different rocks. GGU 103873 (open circles) represents the Flyverfjord infracrustal basement complex, GGU 103779 (open triangles) is the rock underlying the Tillite Nunatak from Charcot Land. The extrapolated ages of crystallisation are 2345 and 1900 m.y., respectively. The dashed extensions of the straight lines drawn through the respective data points intersect the concordia curve at 600 and 370 m.y. If these extensions were mixing lines between different generations of zircons the lower ages may determine the age of the younger generation. If the zircons are cogenetic and suffered lead loss during a specific metamorphic event, the lower ages may date the time of metamorphism. The straight line extensions may also be interpreted as tangents to the upper linear region of continuous diffusion curves. In that case the lower intersections with concordia do not date any geological event. Sample GGU 103811 (open square) shows no spread in the U/Pb ratios of the zircon fractions. The open square representing three data points fits on a continuous diffusion trajectory for zircons that crystallised some 950 m.y. ago.

Stauning Alper (Hansen, Steiger & Henriksen, this report) and in Gåseland (Larsen, 1969). On the other hand a continuous diffusion curve for the age of 2345 m.y. will have a tangent of similar slope intersecting with concordia at about 600 m.y. The fact that the zircon fractions are only moderately discordant may indicate that they had a rather simple history after their crystallisation.

The age of 2345 m.y. is interpreted as the age of intrusion, or the time of a major reactivation of the granite. This age is consistent with a Rb/Sr K-feldspar age of 2290 m.y. obtained from the autochthonous basement granite in Gåseland (Haller & Kulp, 1962). At the same time it indicates a maximum age for the overlying Krummedal supracrustal sequence.

GGU 103779. Homogeneous hornblende-biotite quartz diorite from west Charcot Land. The sample represents a plutonic body which forms the northern part of the Tillite Nunatak. According to Steck (1971) this body comprises a coarse-grained meta-granodiorite with red K-feldspar and green plagioclase, but quartz dioritic and granitic types have also been recorded. It is unconformably overlain by a tillite, containing amongst others boulders of the granodiorite. Along its southern border greenschists of the Charcot Land Series are found in contact with the granodiorite. Steck (1971) states that offshoots from the granodiorite cut the supracrustals. He also observes that all rocks in the immediate area are overprinted by a low-grade regional metamorphism. At the collection site of the zircon sample, the quartz dioritic rock is completely homogeneous, but in other places it can be somewhat foliated and includes gneissic and amphibolitic inclusions indicating the existense of older elements.

About 140 kg of sample were crushed and yielded some 1.7 gm of zircon. Several zircon fractions were analysed. They show a limited spread in U/Pb ratios and are highly discordant. The data points form a linear array and the straight-line extrapolation as shown on fig. 17 results in an upper intersection with the concordia curve around 1900 m.y. The high discordance makes the extrapolation somewhat uncertain, so an error of at least ± 10 m.y. must be assigned to this age. The data points also lie within limits of error on a 1900 m.y. continuous diffusion curve (Tilton, 1960). The lower extension of the straight line through the data points intersects the concordia curve around 370 m.y. At this stage it is not known whether the lower intersection has a geologic significance. This extrapolated age coincides with late Caledonian events observed in Caledonian mountain belts. On the other hand it coincides nicely with the tangent to the linear region of a continuous diffusion curve for 1900 m.y.

For zircons from an igneous rock the Tillite Nunatak zircons exhibit an unusually high degree of discordance. The morphology of the zircons is also very unusual. The crystals form turbid, reddish brown, rod-like to tabular fragments of irregular shape, often intercalated with layers of a milky material. Many grains exhibit good cleavage but rarely any crystal faces.

There is no evidence for the presence of more than one generation of zircons. The zircons may represent a special type which is particularly susceptible to lead loss. The fact that the zircons are strongly discordant makes it difficult to establish whether they are as uniform in age as they appear morphologically. If the granite s.l. was formed by granitisation of a metasedimentary rock, any obvious indication of the previous history is lacking from the zircon data and a rather complete resetting of the zircon clock at the time of the granitisation or anatexis must be assumed.

The minimum age for the deposition of the supracrustal Charcot Land Series hinges on the interpretation of the age of the granitic *(sensu lato)* veins cutting the supracrustals. Steck (1971) maintains that they are offshoots from the underlying granodiorite and implies that they were emplaced more or less simultaneously with the granodiorite. Although this is the most likely interpretation they could also have formed at a later time. Higgins (pers. comm.) has observed occasional thin leucocratic veins in the granodiorite stop at the contact to the tillite. Therefore, the formation of these veins must have occurred prior to deposition of the tillite. At the south-west margin of the granite *sensu lato* Henriksen has observed granite *s.l.* veins 10 to 50 cm wide which cut discordantly the foliation of the greenschists and gabbroic greenstones of the Charcot Land Series. The intrusion of the granitic *s.l.* veins therefore seems to be later than the formation of the foliation in the greenschists and the gabbro. This is in contradiction to the observations of Steck (1971) who states that in general only one principal phase of regional recrystallisation is detectable in the different rock types of the Charcot Land Series including the granite from which the analysed zircons derived. Clearly, more age work is required before the age of the Charcot Land Series can be established.

GGU 103811. Foliated augen granite,with biotite, garnet and sillimanite, from the north coast of central Nordvestfjord. The rock represents one of a series of concordant sheets of garnetiferous, foliated, gneissic augen granites up to 1000 m thick, found around the outer parts of Nordvestfjord and Øfjord, i.e. in the migmatitic central part of the Scoresby Sund region. The augen granites may have sharp or gradational boundaries with the surrounding migmatites. While essentially intrusive bodies, the age relations between their emplacement and the formation of the granitic neosome of the migmatites are not completely known, although it is apparent that some of the neosome is younger than the augen granite (Henriksen & Higgins, 1970 p. 10). In Renland the augen granites are influenced by an early phase of major isoclinal recumbent folding and by a later phase of more open folding (Chadwick, 1971). The sample for the age determination was collected from an extensive augen granite sheet in migmatitic gneissic rocks. In parts it is a very homogeneous, medium-grained granite, which passes laterally into an augen granite with visible foliation and exhibiting slight folding. In places the augen appear to be flattened parallel to the axial planes of minor folds. This phenomenon and the foliation suggest that the emplacement of the granite may have been synkinematic. The rock is composed mainly of K-feldspar (microline) and quartz, with only a little plagioclase. The mafics include a chloritised biotite, garnet and ore.

Four zircon fractions were analysed. They show almost no spread in their U/Pb ratios and plot in a cluster represented by an open square on the concordia diagram (fig. 17). A continuous diffusion curve for 950 to 1000 m.y. will pass through the data cluster, indicating that the zircons may have formed at least 950 m.y. ago. All zircons show well developed prism faces, and the terminations are mostly rounded. The population consists of all gradations between the following extreme zircon types: 1) short, stubby and transparent grains with a light reddish tinge and occasional inclusions; and 2) colourless, completely clear, needle-like crystals.

The zircon data suggest a time of intrusion or last major recrystallisation some 950 m.y. ago. If some of the zircons represent crystals that grew during a later orogeny or were overgrown by new zircon material at that time, a still higher original age is possible.

A straight line drawn through the concordia curve at the time mark for a possible metamorphism (400-500 m.y. ago) and the data cluster (i.e. assuming episodic loss of Pb or addition of U during Caledonian times) may point to an age of original crystallisation up to 1200 m.y. ago.

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