# A minimum age of 2944 ± 7 Ma for the Tartoq Group, South-West Greenland

*Allen P. Nutman and Feiko Kalsbeek*

SHRIMP zircon U-Pb data for a tonalite intruding greenschists of the Tartoq Group have yielded an age of 2944 ± 7 Ma. This date is interpreted as giving the time of igneous crystallisation of the tonalite, and provides a minimum age for deposition of the Tartoq Group.

*A. P. N., Research School of Earth Sciences, Australian National University, G. P. O. Box 4, Canberra A. C. T. 2601, Australia.*
*F. K., Geological Survey of Greenland, Øster Voldgade 10, DK- 1350 Copenhagen K, Denmark.*

The Tartoq Group (Higgins & Bondesen, 1966; Higgins, 1968; Berthelsen & Henriksen, 1975; Evans & King, 1993) is a several kilometres thick greenstone belt which forms major outcrops on both sides of Sermiligaarsuk fjord north-west of Ivittuut in South-West Greenland (Fig. 1). It consists of strongly deformed basic volcanic rocks and sediments at relatively low metamorphic grade: greenschist to low amphibolite facies. Several minor occurrences of gold as well as sulphide showings with both stratiform and vein-type mineralisation have been documented (Appel, 1984; Appel & Secher, 1984; Erfurt, 1990; Evans & King, 1993).

The age of the Tartoq Group is not known. Initially it was considered to be a continuation of the early Proterozoic (Ketilidian) volcanic rocks and sediments of Midternæs and Grænseland (e.g. Berthelsen, 1960), but in 1965 a pronounced angular unconformity was found to exist between rocks belonging to the Tartoq Group and overlying Ketilidian strata on Midternæs (Fig. 1; Higgins & Bondesen, 1966). Subsequently it has generally been assumed that the Tartoq Group is of late Archaean age (e.g. Bridgwater *et al.*, 1976) although no isotopic age determinations to confirm this were available.

Relationships between the Tartoq Group and the sur-

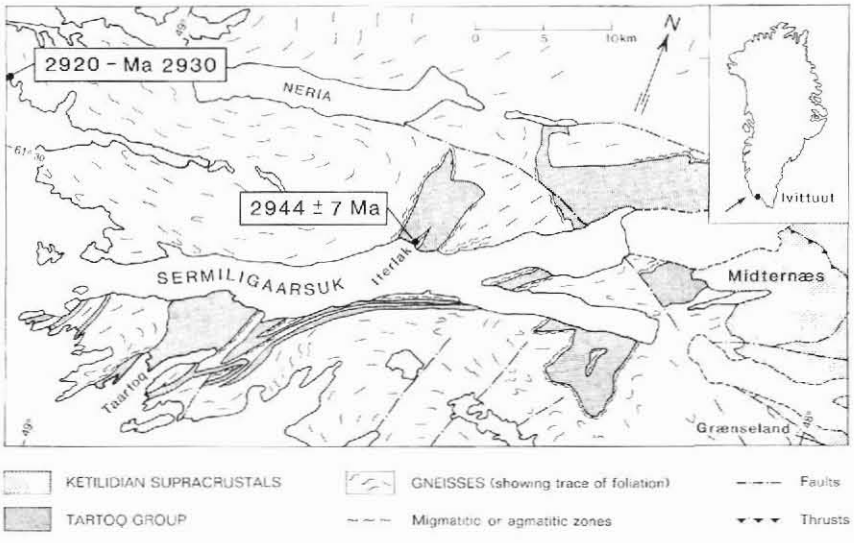


Fig. 1. Tartoq Group outcrops in the Sermiligaarsuk–Midternæs region in South-West Greenland with the locality of tonalite sample 256839 for which an age of 2944 ± 7 Ma was obtained. An age of 2920–2930 Ma has been found for a tonalite collected at the locality shown about 30 km further west.

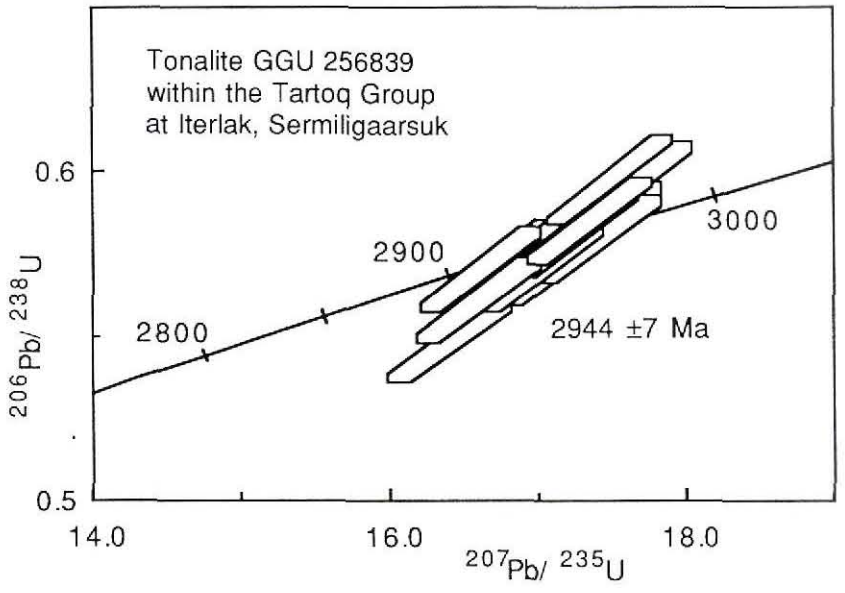


Fig. 2. U-Pb concordia diagram for GGU 256839, an intrusive tonalite within greenschists of the Tartoq Group. Error boxes for individual analyses represent the analytical precision at 1 $\sigma$ level. The analysis of site 12–1 on a coloured grain (see text) is not shown.

rounding gneisses are commonly obscured by strong deformation and retrogression along their mutual boundaries. Structural evidence suggested that the Tartoq Group might be younger than the gneisses because the gneisses appeared to have undergone a longer and more complex history of deformation (Higgins, 1968; Berthelsen & Henriksen, 1975). Moreover, a detailed structural analysis indicated that the Tartoq Group occupies the cores of synclines in a basement that was folded prior to deposition of the Tartoq Group (fig. 9 in Berthelsen & Henriksen, 1975). Locally, however, gneissic rocks display clear intrusive relationships with Tartoq Group metavolcanics, and it would appear that at least some of the gneisses were emplaced after deposition of the Tartoq Group (e.g. Higgins, 1968). Commonly there is a gradational transition between Tartoq Group rocks and the surrounding gneisses; sheets and veins of quartzofeldspathic granitoid rocks are common near the margins of the Tartoq Group, and enclaves of Tartoq Group material are common in the surrounding gneisses.

An attempt to date samples from the Tartoq Goup by the Rb-Sr whole rock method by one of us (F. K.) was

*Table 1. Shrimp zircon U-Pb data for GGU 256839*

| Site | U (ppm) | Th (ppm) | Th/U | $^{204}Pb$ (ppb) | Common $^{206}Pb$(%) | $\frac{^{206}Pb}{^{238}U}$ | $\frac{^{207}Pb}{^{235}U}$ | $\frac{^{207}Pb}{^{206}Pb}$ | Age (Ma)[a] | Disc[b] (%) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1–1 | 72 | 86 | 1.20 | 5 | 0.20 | 0.573±13 | 17.16±0.44 | 0.2172±18 | 2960±13 | –1 |
| 2–1 | 97 | 127 | 1.31 | 7 | 0.18 | 0.585±13 | 17.35±0.43 | 0.2151±14 | 2945±11 | 1 |
| 3–1 | 81 | 99 | 1.21 | 5 | 0.17 | 0.571±13 | 17.00±0.43 | 0.2162±17 | 2952±12 | –1 |
| 4–1 | 79 | 95 | 1.20 | 12 | 0.42 | 0.572±13 | 16.76±0.44 | 0.2125±20 | 2924±15 | 0 |
| 5–1 | 87 | 101 | 1.15 | 5 | 0.15 | 0581±13 | 17.24±0.43 | 0.2151±16 | 2945±16 | 0 |
| 6–1 | 88 | 105 | 1.20 | 9 | 0.28 | 0.579±13 | 16.97±0.43 | 0.2132±17 | 2930±13 | 0 |
| 7–1 | 90 | 85 | 0.95 | 7 | 0.20 | 0.560±13 | 16.60±0.42 | 0.2148±16 | 2942±12 | –3 |
| 8–1 | 128 | 188 | 1.46 | 4 | 0.08 | 0.597±14 | 17.48±0.42 | 0.2123±12 | 2923±09 | 3 |
| 9–1 | 59 | 68 | 1.14 | 4 | 0.20 | 0.583±14 | 17.38±0.46 | 0.2162±20 | 2953±15 | 0 |
| 10–1 | 80 | 94 | 1.78 | 8 | 0.26 | 0.579±13 | 17.39±0.44 | 0.2177±17 | 2964±13 | –1 |
| 10–2 | 77 | 88 | 1.14 | 7 | 0.24 | 0.548±13 | 16.40±0.41 | 0.2171±17 | 2959±12 | –5 |
| 11–1* | 136 | 139 | 1.02 | 15 | 0.29 | 0.570±13 | 16.61±0.40 | 0.2114±14 | 2916±10 | 0 |
| 12–1* | 503 | 78 | 0.16 | 259 | 1.98 | 0.391±07 | 9.71±0.23 | 0.1803±11 | 2655±12 | –20 |
| 13–1 | 91 | 105 | 1.15 | 16 | 0.46 | 0.596±13 | 17.62±0.43 | 0.2146±17 | 2939±13 | 2 |

[a]U-Pb ages are corrected for very small amounts of common lead. Uncertainties are given at the 1σ level.
[b]Disc. is the degree of discordance (%) of the analysis. It is calculated as $100 \times [(^{206}Pb/^{238}U \text{ age})/(^{207}Pb/^{206}Pb \text{ age}) - 1]$.
*Analyses excluded from the calculated weighted mean $^{207}Pb/^{206}Pb$ age.

not successful: data points showed a very wide scatter in an isochron diagram. Samples from a tonalite body within Tartoq Group metavolcanic rocks at Iterlak in Sermiligaarsuk (61° 32'N, 48° 36'W, Fig. 1) yielded a poorly fitted Pb-Pb isochron, and a late Archaean age of 2550 ± 170 Ma was obtained after omitting 3 out of 18 analysed samples from the isochron calculation (P. N. Taylor and F. Kalsbeek, unpublished data).

In this note we report a zircon U-Pb age determination for a sample of the above mentioned tonalite body at Iterlak. On the 1:100 000 geological map, sheet 61 V1 N Neria (Jensen, 1973), this tonalite is shown as 'pegmatite'. It is intrusive into greenschists of the Tartoq Group. Tonalite dykes, up to several metres wide, run from the central tonalite body into the country rock. Although the tonalites are not strongly deformed, they have been pervasively affected by low grade alteration: plagioclase is sericitised, biotite chloritised and hornblende replaced by actinolitic amphibole. Magmatic textures, however, are commonly preserved; subhedral plagioclase crystals up to *c.* 5 mm occur in a finer grained matrix of quartz and plagioclase.

## Analytical data and results

GGU sample 256839 from the tonalite body yielded prismatic zircons typically 200 to 300 $\mu$m long. Most of the grains are structureless or very faintly zoned, colourless or very pale yellow, with only a few inclusions of other mineral phases. A few grains are darker brown in colour. Neither inherited older cores nor younger metamorphic overgrowths were detected in any of the grains. Most of the grains are perfectly euhedral. For Archaean zircons they are remarkably well preserved.

Analysis with the ion microprobe SHRIMP 1 followed routine analytical procedures (e.g. Compston *et al.*, 1984; Williams & Claesson, 1987). Fourteen analyses were undertaken on thirteen grains (Table 1, Fig. 2). The analysed sites were of the dominant type of colourless or very weakly coloured zircon, except for a single analysis of a more strongly coloured grain (grain 12). The dominant type has U abundances of < 200 ppm, rather high Th/U ratios of 0.95 to 1.31, and concordant or almost concordant U-Pb ages. After rejection of sites 11–1 and 12–1 (the latter in the coloured grain), the analyses have indistinguishable $^{207}Pb/^{206}Pb$ ratios, with a weighted mean age of 2944 ± 7 Ma (2 $\sigma$). The single analysis of coloured grain 12 indicated a high U content, lower Th/U ratio, higher content of common Pb, and was strongly discordant with a $^{207}Pb/^{206}Pb$ age of 2655 Ma (Table 1). The mean age of 2944 ± 7 Ma obtained for the zircons is interpreted as giving the time of crystallisation of the tonalitic protolith of GGU 256839.

## Discussion

The age of 2944 Ma represents a minimum age for deposition for the Tartoq Group. This is much older than anticipated. The age of deposition of the Tartoq Group and its relationships with the surrounding gneisses remain unknown. A sample of a late leucocratic tonalitic gneiss, similar in appearance to the analysed rock, collected some 30 km further to the west (Fig. 1), has yielded a SHRIMP U-Pb zircon age of 2920–2930 Ma, but also contains a younger zircon component with an age of 2820–2830 Ma (A. P. Nutman, unpublished data). This rock is intrusive into older migmatitic grey gneisses which form the bulk of the gneisses in that area (Kalsbeek, 1970). Thus, both the Tartoq Group and most of the gneisses appear to be older than about 2940 Ma, and the grey gneisses may or may not have been the basement onto which the Tartoq Group was deposited.

## References


Appel, P. W. U. 1984: An iron-formation in the Precambrian Tartoq Group, South-West Greenland. *Rapp. Grønlands geol. Unders.* **120,** 74–78.

Appel, P. W. U. & Secher, K. 1984: On a gold mineralization in the Precambrian Tartoq Group, South-West Greenland. *J. geol. Soc. Lond.* **141,** 273–278.

Berthelsen, A. 1960: An example of a structural approach to the migmatite problem. *Rep. 21st int. geol. Congr. Norden, 1960* **14,** 149–157.

Berthelsen, A. & Henriksen, N. 1975: Geological map of Greenland 1:100 000, Ivigtut 61 V 1. Syd, descriptive text. The orogenic and cratogenic geology of a Precambrian shield area. Copenhagen: Grønlands Geologiske Undersøgelse (also *Meddr Grønland* **186,**1), 169 pp.

Bridgwater, D., Keto, L., McGregor, V. R. & Myers, J. S. 1976: Archaean gneiss complex of Greenland. *In* Escher, A. & Watt, W. S. (ed.) *Geology of Greenland,* 19–75. Copenhagen: Geol. Surv. Greenland.

Compston, W., Williams, I. S. & Meyer, C. 1984: U-Pb geochronology of zircons from Lunar Breccia 73217 using a sensitive high mass-resolution microprobe. *Proc. 14th Lunar Planet. Sci. Conf. J. Geophys. Res. Suppl.* **89,** B525–534.

Erfurt, P. 1990: Reconnaissance and exploration for gold and base metals in the area between Arsuk and Neria Fjords, South- West Greenland. Work performed 1971 to 1985: results and discussion. *Open File Ser. Grønlands geol. Unders.* **90/10,** 30 pp.

Evans, D. M. & King, A. R. 1993: Sediment and shear-hosted gold mineralization of the Tartoq Group supracrustals, southwest Greenland. *Precambrian Res.* **62,** 61–82.

Higgins, A. K. 1968: The Tartoq Group on Nuna qaqortoq and in the Iterdlak area, South-West Greenland. *Rapp. Grønlands geol. Unders.* **17,** 17 pp.

Higgins A. K. & Bondesen, E. 1966: Supracrustals of pre-Ketilidian age (the Tartoq Group) and their relationships with

Ketilidian supracrustals in the Ivigtut region, South-West Greenland. *Rapp. Grønlands geol. Unders.* **8,** 21 pp.

Jensen, S. B. (compiler) 1973: Geological map of Greenland 1:100 000, 61 V1 N, Neria. Copenhagen: Grønlands Geologiske Undersøgelse.

Kalsbeek, F. 1970: The petrography and origin of gneisses, amphibolites and migmatites in the Qasigialik area, South-West Greenland. *Bull. Grønlands geol. Unders.* **83** (also *Meddr Grønland* **189,** 1), 70 pp.

Williams, I. S. & Claesson, S. 1987: Isotopic evidence for the Precambrian provenance and Caledonian metamorphism of the high-grade paragneisses from the Seve Nappes, Scandinavian Caledonides, II. Ion microprobe zircon U-Th-Pb. *Contr. Mineral. Petrol.* **97,** 205–217.