Polarforschung 60 (2): 101–106, 1990 (erschienen 1992)

9. Age Relations of the High Grade Metamorphic Rocks in the Terra Nova Bay Area, North Victoria Land, Antarctica: a Preliminary Report

By Susanne Klee*, Albrecht Baumann* and Friedhelm Thiedig*

Samples of high grade metamorphic basement rocks of Wilson Terrane cropping out in the Deep Freeze Range and on Kay Island (Fig. 1) were collected during GANOVEX VI to study their isotopic evolution. The age and origin of granulite facies gneisses and of their migmatite host rocks are especially of interest for the interpretation of the geological and tectonic development of North Victoria Land. Another important research aspect is the influence of the polyphase metamorphic evolution on the isotopic systems of whole rocks and minerals like zircon, garnet, orthopyroxene, amphibole and feldspar.

Two samples of paragneisses collected nearly 500 m northeast of Gondwana Station (74° 36' S, 164° 13' E) were analyzed up to present. They are part of the high grade basement complex. Sample ANT 102 is a medium grained biotite-feldspar-gneiss, sample ANT 104 is a fine grained garnet-biotite-gneiss. Both samples contain zircons and monazites as accessory minerals which were analyzed by conventional U-Pb-method of dating.

The data of six distinct fractions (Table 1) of ANT 102 plot on a discordia line which intersects the concordia in two points (Fig. 2) with ages of 2028 +34/-33 Ma and 488 +/- 9 Ma. The data of three quasi concordant zircon fractions (Table 1) of ANT 104 plot at about 485 Ma in accordance with three monazite fractions of ANT 102 and 104 (Fig. 3). Concordant zircons are usually not typical of paragneisses. The concordance could be explained with one homogeneous source area from which zircons of ANT 104 originated. The first data consistently point to an event which affected the isotopic systems of the minerals ± 480 Ma ago. Obviously they fall within time interval of the Ross orogeny. In detail they are consistent with Rb-Sr- and K-Ar-data of the Granite Harbour Intrusives between 500 and 450 Ma which were interpreted as emplacement ages by BORSI et al. (1989) and KREUZER et al. (1987). However, correlation with one distinct evolution phase of the Ross event requires more detailed petrographic and isotopic analyses.

About 450 samples including 10 large samples for zircon dating have been collected from granulite facies gneisses and migmatite host rocks (Fig. 1).

Kay Island

The small island (74° 04' S, 160° 19' E) situated between tongues of the Aviator and Tinker Glacier mainly consists of garnet-biotite- ± cordierite-bearing stromatic and nebulitic migmatites including up to decameter large massive bodies of enderbitic orthogneisses and up to meter large fine grained biotite-rich, garnet-bearing gneissic bodies which in places occur as boudins.

Following questions should be answered:

- Which correlation does exist between the migmatites, the enderbitic orthogneisses and the fine-grained garnet-bearing gneisses?

* Susanne Klee, Albrecht Baumann and Prof. Dr. Friedhelm Thiedig, Geol.-Paläont. Institut, Universität Münster, Corrensstraße 24, D-4400 Münster, FRG

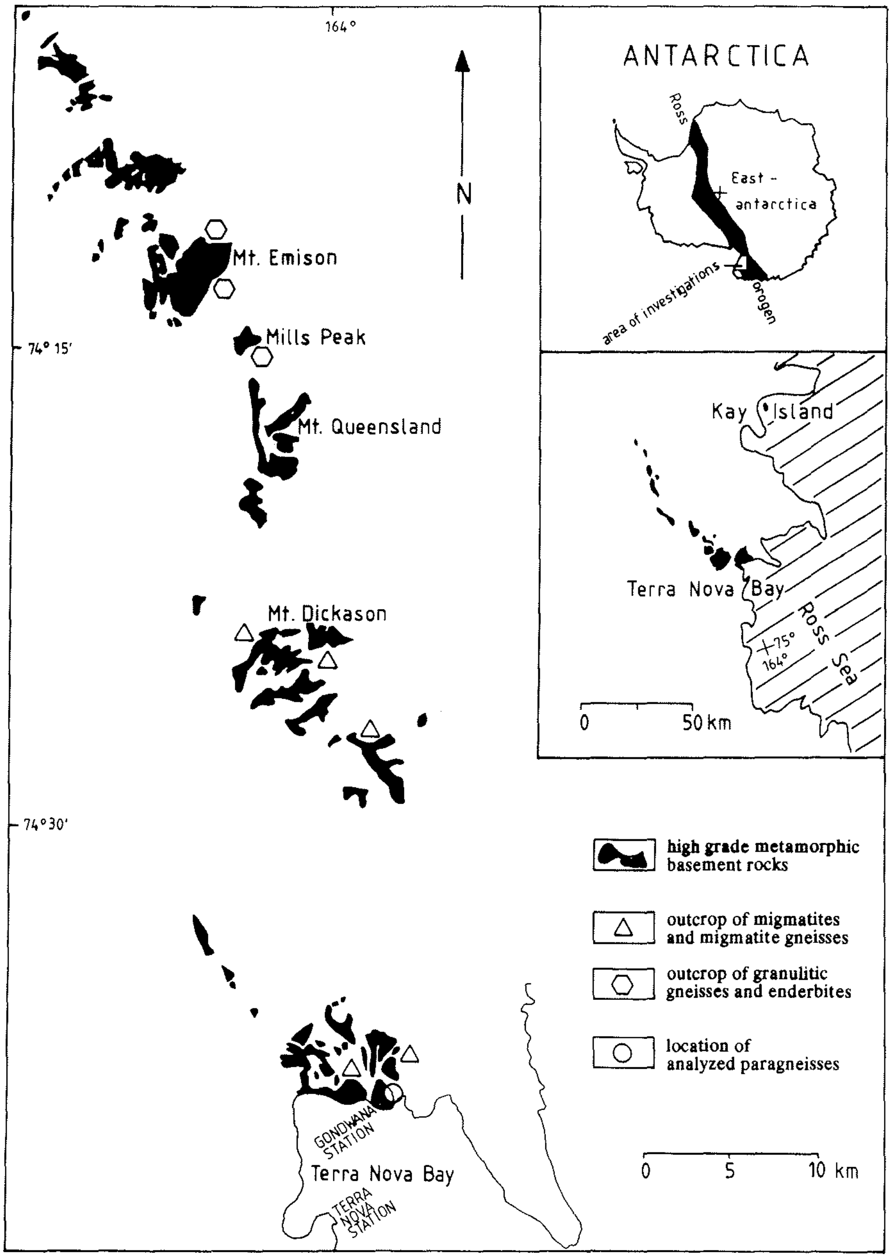

Fig. 1: Sample localities in the Terra Nova Bay area, North Victoria Land, Antarctica.

Abb. 1: Probenpunkte im Terra-Nova-Bay-Gebiet, Nordviktorialand, Antarktis.
Schwarz = hochgradig metamorphes Grundgebirge, Dreiecke = Vorkommen von Migmatiten und Gneisen, Sechsecke = Vorkommen granulitischer Gneise und Enderbite, Kreise = analysierte Paragneise.

sample no. $^{208}Pb/^{206}Pb$	grain type	grain size	sample weight (µm)	concentrations U_{tot} (mg)	Pb_{tot} (ppm)	$^{206}Pb_r$ (ppm)	measured atomic ratios (µmol/g)	$^{206}Pb/^{204}Pb$	$^{207}Pb/^{206}Pb$
ANT102									
1	xenomorphic⁺	- 100	0.1	3911	892	1504	2940	0.07393	1.78135
2	rounded⁺	- 100	0.2	2170	448	844	4344	0.07315	1.47978
3	short prisms⁺	- 100	0.4	1891	330	865	4995	0.08472	0.76145
4	long prisms⁺	- 100	0.3	1837	278	944	6207	0.09044	0.33379
5	prisms with pyramidal ends⁺	125 - 100	0.61	593	84	332	6910	0.09528	0.13223
6	rounded⁺	125 - 100	0.5	488	73	295	8906	0.09769	0.10570
7	platy*	125 - 100	0.62	9193	2276	3009	4640	0.05987	2.57281
ANT104									
3	rounded⁺	- 180	1.0	917	74	296	2861	0.06233	0.15648
4	short prisms⁺	- 180	0.4	803	66	262	4844	0.06031	0.15795
5	long prisms⁺	- 180	1.4	1350	113	442	7634	0.05891	0.17767
1	platy*	62 - 50	0.52	3910	1235	1268	728	0.07684	3.57223
2	platy*	90 - 80	0.99	4940	1642	1608	807	0.07499	3.73747

sample no.	grain type	grain size (µm)	atomic ratios corrected for common Pb and blank $^{206}Pb/^{238}U$	$^{207}Pb/^{235}U$	$^{207}Pb/^{206}Pb$	apparent ages (Ma) $^{206}Pb/^{238}U$	$^{207}Pb/^{235}U$	$^{207}Pb/^{206}Pb$
ANT102								
1	xenomorphic⁺	- 100	0.09219	0.87779	0.06906	568	640	900
2	rounded⁺	- 100	0.09329	0.89844	0.06985	575	651	924
3	short prisms⁺	- 100	0.10967	1.23847	0.08190	671	818	1243
4	long prisms⁺	- 100	0.12319	1.49792	0.08819	749	930	1387
5	prisms with pyramidal ends⁺	125 - 100	0.13426	1.72651	0.09326	812	1018	1493
6	rounded⁺	125 - 100	0.14504	1.92057	0.09604	873	1088	1548
7	platy*	125 - 100	0.07848	0.61393	0.05673	487	486	481
ANT104								
3	rounded⁺	- 180	0.07744	0.61132	0.05725	481	484	501
4	short prisms⁺	- 180	0.07818	0.61769	0.05731	485	488	503
5	long prisms⁺	- 180	0.07849	0.61694	0.05701	487	488	492
1	platy*	62 - 50	0.07775	0.60914	0.05682	483	483	485
2	platy*	90 - 80	0.07804	0.61259	0.05693	484	485	489

Table 1: U-Pb data of zircons and monazites of paragneisses which belong to the high grade metamorphic basement of Wilson Terrane. Zircon ages vary between 480 Ma and 488 Ma, monazites yield ages between 482 Ma and 485 Ma (*monazite, ⁺zircon).

Tabelle 1: U-Pb-Daten für Zirkone und Monazite aus Paragneisen des hochgradig metamorphen Wilson-Terrane-Basement. Die Zirkon-Alter variieren zwischen 480 und 488 Ma; die Monazite ergeben Alter zwischen 482 und 485 Ma. (* = Monazite, ⁺ = Zirkone)

- Which rock types could be the protoliths of the enderbitic orthogneisses and the fine-grained garnet-bearing gneisses?
- Which rock types could be the protoliths of the enderbitic gneisses: (a)The basic members of a suite of magmatic charnockites? (b) Magmatites recrystallized under granulite facies conditions? (c) Relic bodies developed in a way quite different from the protoliths of the migmatites? (d) Intrusives of the migmatized originally magmatic or metamorphic complex?

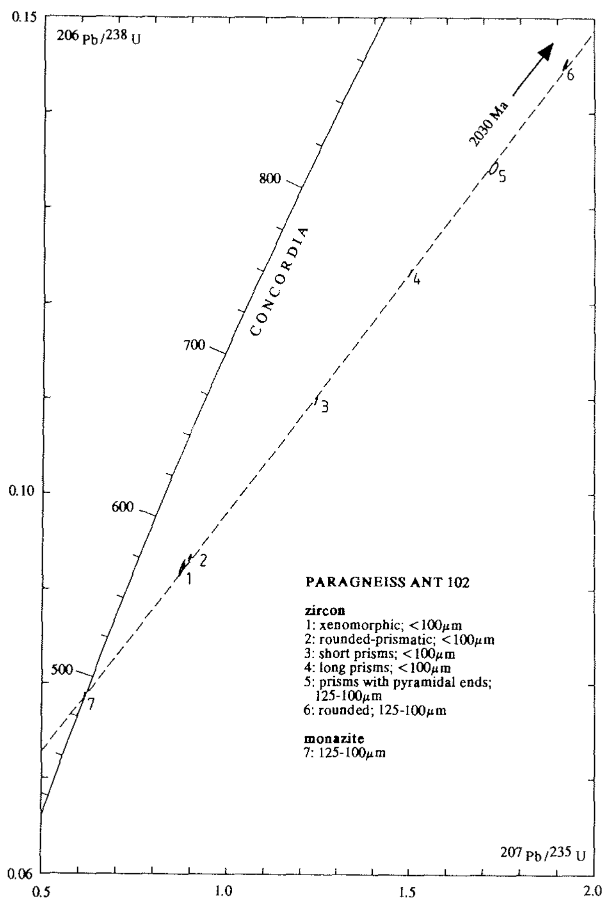

Fig. 2: Concordia diagram with U-Pb data for zircon and monazite of biotite-feldspar-gneiss (ANT 102). The discordia line is defined by 6 zircon fractions. The lower intercept point yields an age of 488 ± 9 Ma, the upper intercept age is 2028 + 30 / - 38 Ma.

Abb. 2: Concordia-Diagramm mit U-Pb-Daten für Zirkon und Monazit aus Biotit-Feldspat-Gneis (ANT102). Die Diskordia-Linie ist definiert durch 6 Zirkon Fraktionen. Der untere Schnittpunkt ergibt ein Alter von 488 ± 9 Ma, der obere Schnittpunkt 2028 + 30 / - 38 Ma.

MT. EMISON

Well preserved granulitic assemblages - for example garnet + quartz + plagioclase + orthopyroxene + k-feldspar + sillimanite are not very common since most of the granulite facies rock types show the strong influence of the thermal overprinting affected by the emplacement of the Granite Harbour Intrusives in a late phase of the Ross tectogenesis. This thermal event produced amphibolite facies retrogressive mineral assemblages. On the base of the field observations the rocks bearing granulitic mineral assemblages are difficult to recognize. Rock types with assumed well preserved granulite facies paragenesis are collected at the Mt. Emison (74° 12' S, 163° 44' E, Fig. 9-1).

With respect to the deformation grade two main granulite facies rock types could be distinguished: (1) foliated granulitic gneisses characterized by layering and banding of feldspar-orthopyroxene-leucosomes; (2) granulitic rocks with irregularly oriented feldspar-orthopyroxene-leucosomes.

The sequence is thought to be an originally sedimentary series which has been subjected to migmatization, granulite facies metamorphism, amphibolite facies overprinting and cutting by pegmatites. An idea about the temporary development of the rock forming processes is: (i) Migmatization of the granulitic protoliths and forming of the feldspar-orthopyroxene-leucosomes. (ii) Granulite facies events as proposed by LOMBARDO et al. (1989) and TALARICO et al. (1990). (iii) Retrograde amphibolite facies overprinting. Orthopyroxene or altered

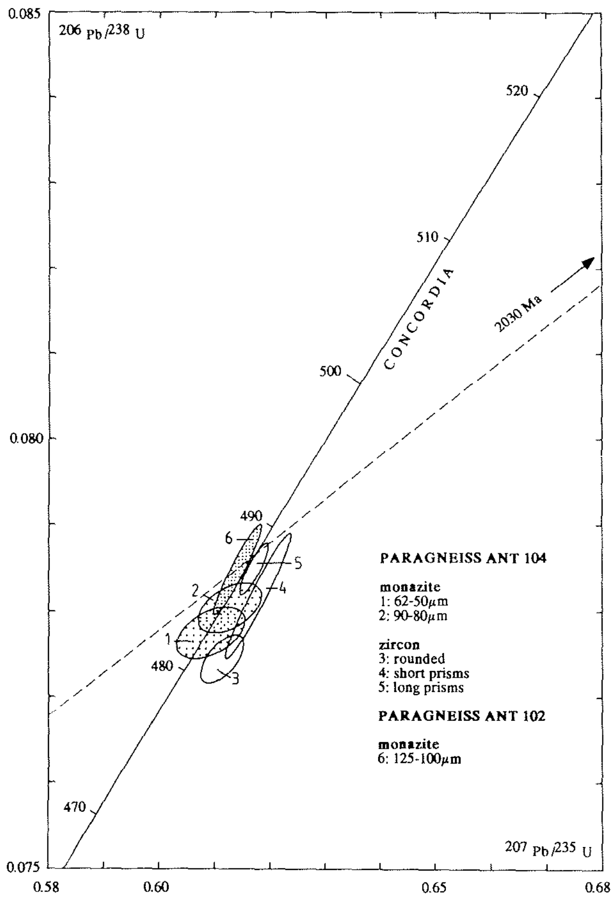

Fig. 3: Concordia diagram with U-Pb data for zircon and monazite of garnet-biotite-gneiss (ANT 104) and monazite of biotite-feldspar-gneiss (ANT 102). Error ellipses demonstrate the analytical uncertainty.

Abb. 3: Concordia-Diagramm mit U-Pb-Daten für Zirkon und Monazit aus Granat-Biotit-Gneis (ANT104) und für Monazit aus Biotit-Feldspat-Gneis (ANT102). Die Ellipsen zeigen die mögliche analytische Streuung.

orthopyroxene bearing leucosomes of granulite facies gneisses seem to indicate that migmatization probably preceded granulite facies metamorphism.

Following problems must be clarified:

- Influence of the rock forming processes on the isotopic systems of the granulites;
- Chronology of the metamorphic events;
- Is the migmatization event subjected to the granulitic protoliths temporally related to the development of the Deep Freeze Range migmatites, synchronous evolution or temporally different events?

ACKNOWLEDGMENTS

The authors wish to thank the Italian colleagues especially F. Talarico for helpful informations about the petrography and petrology of the Deep Freeze Range metamorphics and for support during joint fieldwork. We are thankful to the BGR, the DFG and the Progetto Nazionale di Richerche for the logistic and financial support.

References

Borsi, L., Ferrada, G., Tonarini, S. (1989): Rb-Sr and K-Ar-data on Granite Harbour Intrusives from Terra Nova Bay and Priestley Glacier (Victoria Land, Antarctica) - Mem. Soc. Geol. Italiana 33: 161-170, Siena.

Kreuzer, H., Höhndorf, A., Lenz, H., Müller, P., Vetter, U. (1987): Radiometric ages of pre-mesozoic rocks from Northern Victoria Land, Antarctica.- In. McKenzie, G.D. (ed.), Gondwana six: Structure, Tectonics and Geophysics.- Geophys. Monogr. 40: 31-48, AGU, Washington.

Lombardo, B., Cappelli, B., Carmignani, L., Gosso, G., Memmi, I., Montrasio, A., Palmeri, R., Panutti, F., Pertusati, P.C., Ricci, C.A., Salvini, F. & Talarico, F. (1989): The metamorphic rocks of the Wilson Terrane between David and Mariner Glaciers, North Victoria Land, Antarctica.- Mem. Soc. Geol. Itatiana 33: 99-130, Siena.

Talarico, F. (1990): Reaction textures and metamorphic evolution of aluminous garnet granulites from the Wilson Terrane (Deep Freeze Range, North Victoria Land, Antarctica).- Mem. Soc. Geol. Italiana 43: 49-58, Siena.