

## 160498: hornblende–biotite granodiorite, Geemas Well

### Location and sampling

ROEBOURNE (SF 50–3)

AMG Zone 50, 580510E 7678990N

Sampled on 17 September 1998

The sample was taken from an isolated bouldery outcrop located about 4 km north-northeast of Geemas Well.

### Tectonic unit/relations

This sample is of a hornblende–biotite granodiorite that has intruded sedimentary rocks assigned to the Mallina Formation.

### Petrographic description

The principal minerals present in this sample are plagioclase (55 vol.%), quartz (25 vol.%), orthoclase (7–8 vol.%), amphibole (6 vol.%), biotite (4 vol.%), opaque oxide (2–3 vol.%), hydrogarnet (trace), apatite (trace), biotite (trace), chlorite (trace), titanite (trace), albite (trace), sericite (trace), clinozoisite (trace), and zircon (trace). This is an altered, shallowly emplaced tonalite or granodiorite with hornblende and altered biotite, accessory magnetite, apatite and titanite, and rare zircon. It contains 7–8 vol.% K-feldspar and is relatively quartz-poor but with abundant ferromagnesian silicates. The thin section shows abundant plagioclase  $\leq 6$  mm in grain size, with alteration of the cores to albite, sericite, and clinozoisite and sodic rims. Quartz  $\leq 1.5$  mm in grain size is rarely bipyramidal, suggesting a shallow emplacement level. This is supported by the presence of interstitial orthoclase rather than microcline. Pale green amphibole, the main ferromagnesian mineral, forms prisms  $\leq 3$  mm long, with inclusions of opaque oxide. Slightly less abundant biotite  $\leq 2$  mm in size has been replaced by chlorite and an isotropic mineral, possibly hydrogarnet. The altered biotite also encloses opaque oxide  $\leq 0.1$  mm in grain size, and apatite and some biotite has been replaced by chlorite, titanite, and K-feldspar. Small xenoliths with or without glomeroporphyritic aggregates of decussate amphibole and altered biotite are present. Apatite and lesser titanite preferentially accompany opaque oxide grains. Zircon is rare, to 60  $\mu\text{m}$  in grain size, and is seen in hornblende. This rock has a composition transitional between tonalite and granodiorite.

### Zircon morphology

The zircons isolated from this sample are commonly yellow-brown to dark brown, euhedral in shape and between  $40 \times 60 \mu\text{m}$  and  $120 \times 250 \mu\text{m}$  in size. Internal zonation is common. Many grains are black and metamict.

### Analytical details

This sample was analysed on 11 December 1999. The counter deadtime was 32 ns. Eleven analyses of the CZ3 standard obtained during the analysis session indicated a  $\text{Pb}^*/\text{U}$  calibration

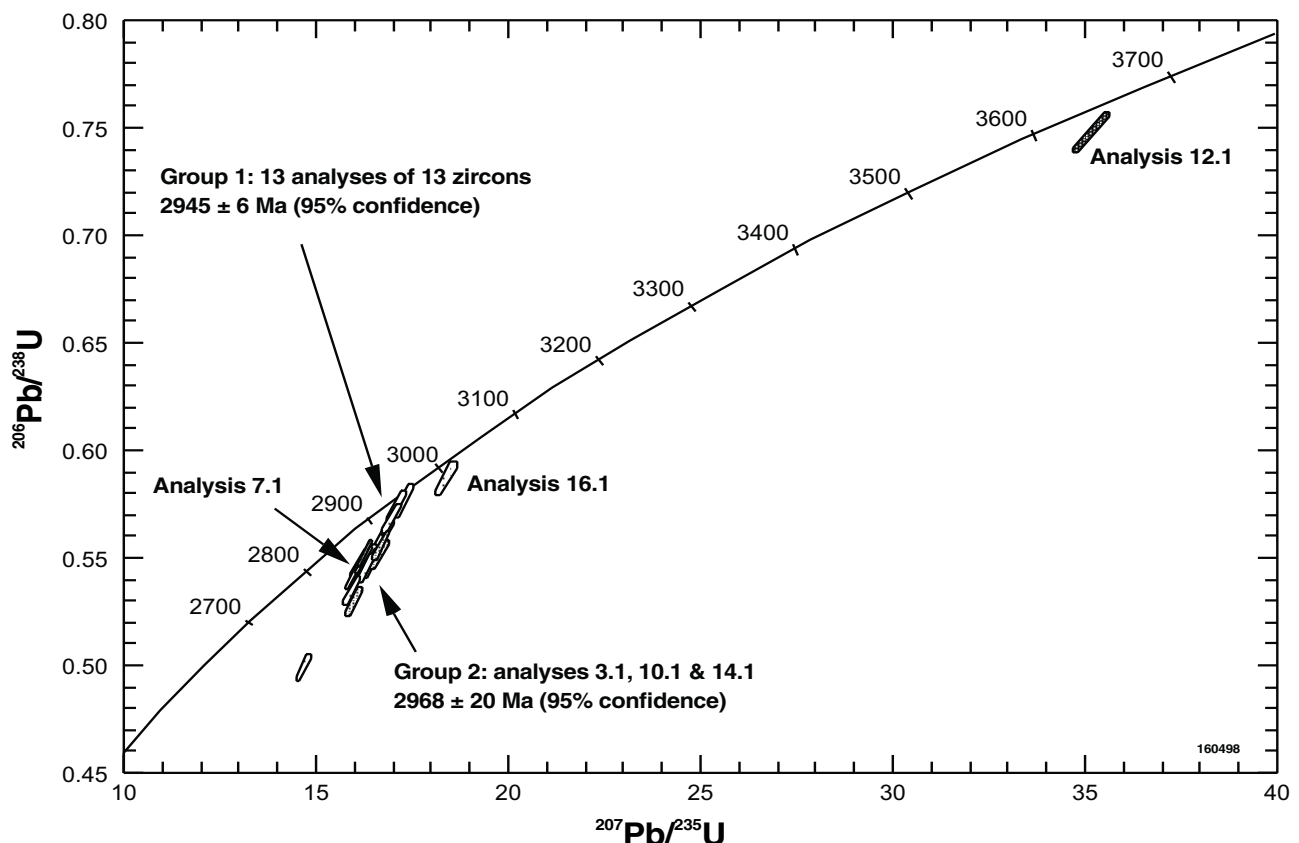
error of 1.12 (1 $\sigma$ %). Common-Pb corrections were applied assuming Broken Hill common-Pb isotopic compositions for all analyses.

## Results

Nineteen analyses were obtained from 19 zircons. Results are given in Table 52 and shown on a concordia plot in Figure 58.

## Interpretation

All analyses are concordant to highly discordant, with the discordance pattern consistent with several recent episodes of radiogenic-Pb redistribution. On the basis of their  $^{207}\text{Pb}/^{206}\text{Pb}$  ratios, many analyses may be assigned to 2 main groups. Thirteen concordant and near-concordant analyses (1.1, 2.1, 4.1, 5.1, 6.1, 8.1, 9.1, 11.1, 13.1, 15.1, 17.1 and 19.1), assigned to Group 1, have  $^{207}\text{Pb}/^{206}\text{Pb}$  ratios defining a single population and indicating a weighted mean date of  $2945 \pm 6$  Ma (chi-squared = 1.64). Three discordant analyses (3.1, 10.1 and 14.1), assigned to Group 2, have  $^{207}\text{Pb}/^{206}\text{Pb}$  ratios defining a single population and indicating a weighted mean date of  $2968 \pm 20$  Ma (chi-squared = 1.32). The remaining analyses (7.1, 12.1 and 16.1) cannot be assigned to discrete groups.



**Figure 58. Concordia plot for sample 160498: hornblende-biotite granodiorite, Geemas Well**

**Table 52. Ion microprobe analytical results for sample 160498: hornblende–biotite granodiorite, Geemas Well**

<i>Grain .spot</i>	<i>U (ppm)</i>	<i>Th (ppm)</i>	<i>Pb (ppm)</i>	<i>f206%</i>	<i><sup>207</sup>Pb/<sup>206</sup>Pb</i>	<i>±1σ</i>	<i><sup>208</sup>Pb/<sup>206</sup>Pb</i>	<i>±1σ</i>	<i><sup>206</sup>Pb/<sup>238</sup>U</i>	<i>±1σ</i>	<i><sup>207</sup>Pb/<sup>235</sup>U</i>	<i>±1σ</i>	<i>% concordance</i>	<i><sup>207</sup>Pb/<sup>206</sup>Pb Age</i>	<i>±1σ</i>
1.1	161	88	107	0.262	0.21660	0.00132	0.14551	0.00201	0.5617	0.0073	16.775	0.252	97	2956	10
2.1	255	146	152	0.315	0.21320	0.00111	0.16048	0.00174	0.4990	0.0061	14.670	0.203	89	2930	8
3.1	242	130	155	0.638	0.21879	0.00122	0.15799	0.00206	0.5302	0.0066	15.993	0.227	92	2972	9
4.1	320	163	215	0.526	0.21608	0.00100	0.13593	0.00162	0.5693	0.0069	16.960	0.229	98	2952	7
5.1	159	118	112	0.186	0.21549	0.00128	0.19582	0.00204	0.5744	0.0074	17.068	0.253	99	2947	10
6.1	214	105	139	0.618	0.21731	0.00126	0.13088	0.00202	0.5479	0.0068	16.415	0.236	95	2961	9
7.1	585	575	408	0.180	0.21368	0.00062	0.24412	0.00100	0.5525	0.0065	16.278	0.202	97	2934	5
8.1	245	129	160	0.768	0.21377	0.00120	0.14109	0.00203	0.5476	0.0068	16.141	0.229	96	2934	9
9.1	159	80	107	0.307	0.21714	0.00129	0.13098	0.00189	0.5774	0.0075	17.287	0.258	99	2960	10
10.1	293	151	191	0.191	0.21759	0.00093	0.13867	0.00129	0.5567	0.0068	16.703	0.224	96	2963	7
11.1	367	184	234	0.512	0.21581	0.00096	0.14511	0.00154	0.5354	0.0064	15.932	0.212	94	2950	7
13.1	292	125	186	0.462	0.21661	0.00103	0.11800	0.00160	0.5459	0.0066	16.305	0.221	95	2956	8
12.1	297	122	278	0.097	0.34021	0.00099	0.10469	0.00085	0.7496	0.0091	35.160	0.452	98	3664	4
14.1	203	126	135	0.250	0.21869	0.00113	0.16942	0.00167	0.5518	0.0069	16.639	0.235	95	2971	8
15.1	369	183	233	0.174	0.21338	0.00082	0.13125	0.00109	0.5419	0.0065	15.944	0.208	95	2931	6
16.1	128	77	90	0.137	0.22664	0.00141	0.15958	0.00200	0.5877	0.0079	18.364	0.284	98	3028	10
17.1	231	144	157	0.190	0.21618	0.00101	0.16425	0.00144	0.5682	0.0071	16.936	0.233	98	2952	8
18.1	504	338	334	0.132	0.21440	0.00067	0.17957	0.00093	0.5493	0.0065	16.239	0.204	96	2939	5
19.1	165	99	108	0.195	0.21566	0.00128	0.16071	0.00193	0.5495	0.0070	16.338	0.241	96	2949	10

The date of  $2945 \pm 6$  Ma indicated by thirteen concordant and near-concordant analyses of Group 1 is interpreted as providing the time of igneous crystallization of the granodiorite. Apart from discordant analysis 7.1, which has higher U (585 ppm) than the other analyses and which is interpreted to have lost radiogenic Pb during several disturbance episodes, the remaining analyses (including those of Group 2) are interpreted to be of xenocryst zircons.

STRATIGRAPHIC REFERENCE:

SMITHIES, R. H., and CHAMPION, D., 2000, The Archaean high-Mg diorite suite: links to tonalite–trondhjemite–granodiorite magmatism and implications for early Archaean crustal growth: *Journal of Petrology*, v. 41, p. 1653–1671.

Recommended reference for this publication:

NELSON, D. R., 2000, 160498: hornblende-biotite granodiorite, Geemas Well; in *Compilation of geochronology data, 1999*: Western Australia Geological Survey, Record 2000/2, p. 207–210.

OR

NELSON, D. R., 2000, 160498: hornblende-biotite granodiorite, Geemas Well; Geochronology dataset 240; in *Compilation of geochronology data, June 2006 update*: Western Australia Geological Survey.

Data obtained: 11/12/1999; Data released: 30/06/2000