

155504: biotite monzogranite, 30 Feet Bore

(Big Bell Suite, Austin Downs Supersuite, Murchison Domain,
Youanmi Terrane, Yilgarn Craton)

Location and sampling

KIRKALOCKA (SH 50-3), MOUNT MAGNET (2441)
MGA Zone 50, 571592E 6896880N

Sampled on 4 October 2010

This sample was collected from a large pavement outcrop (Fig. 1) on Boogardie Station, about 5.9 km east-southeast of Boogardie Homestead, 4.4 km southeast of McNab Well, and 1.7 km north of 30 Feet Bore.

Tectonic unit/relations

The unit sampled is a monzogranite assigned to the 2735–2690 Ma Big Bell Suite of the Austin Downs Supersuite (Van Kranendonk et al., 2013). The sampled pluton is part of a north-trending elongate batholith (c. 150 × 50 km) exposed west of the Meekatharra – Mount Magnet greenstone belt, and east of the Dalgarranga greenstone belt. Another sample of this granite batholith, collected 27.8 km to the northwest, yielded a magmatic crystallization age of 2706 ± 4 Ma (GSWA 155503, Wingate et al., 2014a). The monzogranite is deformed within the Wattle Creek Shear Zone (Zibra, 2012). Deformed schlieren highlight S–C fabrics and C' shear bands indicate a dextral shear sense; microstructures indicate that deformation occurred during granite crystallization. The monzogranite contains tonalite xenoliths that range in size from a few centimetres to several hundred metres (Zibra, 2012). At this locality the monzogranite is intruded by a fine-grained granodiorite dyke (Fig. 1) that yielded a maximum crystallization age of 2721 ± 8 Ma, based on analyses of xenocrystic zircons (GSWA 155505, Wingate et al., 2014b).

Petrographic description

The sample is a coarse-grained porphyritic monzogranite, composed of about 35–40% plagioclase, 30% quartz, 25% K-feldspar, 5% biotite, and accessory chlorite, muscovite, epidote, iron–titanium oxide minerals, titanite, saussurite, and sericite. Plagioclase (oligoclase, An₃₀) occurs as anhedral to subhedral prisms up to 5 mm long, but also as phenocrysts up to 15 mm long. Plagioclase exhibits saussurite and sericite clouding in the centres of crystals, suggesting an originally more calcic composition. Quartz and K-feldspar (microcline and perthite) occur as

anhedral crystals up to 4 mm across. Minor myrmekite is interstitial to K-feldspar. Biotite, chlorite, and muscovite are associated with iron–titanium oxide minerals, epidote, and titanite. Sequence of crystallization: plagioclase, biotite, microcline, quartz, epidote, saussurite, and sericite.

Zircon morphology

Zircons isolated from this sample are colourless to dark brown or opaque, and subhedral to euhedral. The crystals are up to 400 µm long, and elongate, with aspect ratios up to 5:1. In cathodoluminescence (CL) images, concentric zoning is ubiquitous, and most crystals high-uranium, metamict zones. Some crystals appear to contain older cores. A CL image of representative zircons is shown in Figure 2.

Analytical details

This sample was analysed on 20–21 September 2012, using SHRIMP-A. Nine analyses of the BR266 standard were obtained during the session, of which seven analyses indicated an external spot-to-spot (reproducibility) uncertainty of 0.56% (1σ) and a $^{238}\text{U}/^{206}\text{Pb}^*$ calibration uncertainty of 0.24% (1σ). Calibration uncertainties are included in the errors of $^{238}\text{U}/^{206}\text{Pb}^*$ ratios and dates listed in Table 1. Common-Pb corrections were applied to all analyses using contemporaneous isotopic compositions determined according to the model of Stacey and Kramers (1975).

Results

Twenty-six analyses were obtained from 25 zircons. Results are listed in Table 1, and shown in concordia diagrams (Figs 3 and 4).

Interpretation

The analyses are concordant to strongly discordant (Fig. 3). Six analyses are >5% discordant. The dates obtained from these six analyses (Group D, Table 1) are imprecise or unreliable, and considered not to be geologically significant. The remaining 20 analyses can be divided into three groups, based on their $^{207}\text{Pb}^*/^{206}\text{Pb}^*$ ratios.

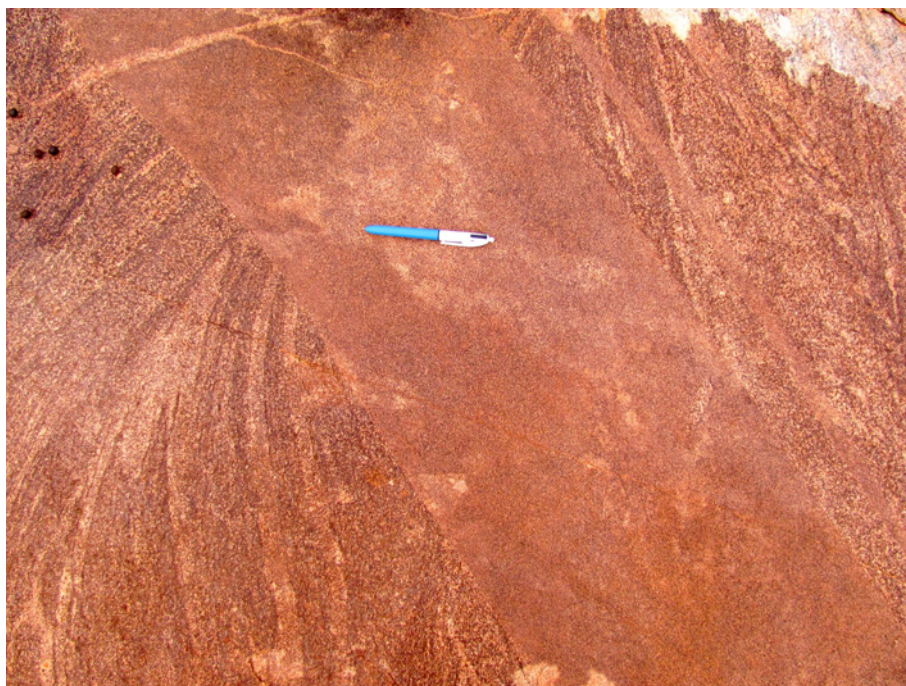


Figure 1. Outcrop image of sample 155504: biotite monzogranite, 30 Feet Bore. The monzogranite is intruded by a non-deformed granodiorite dyke (GSWA 155505, Wingate et al., 2014b).

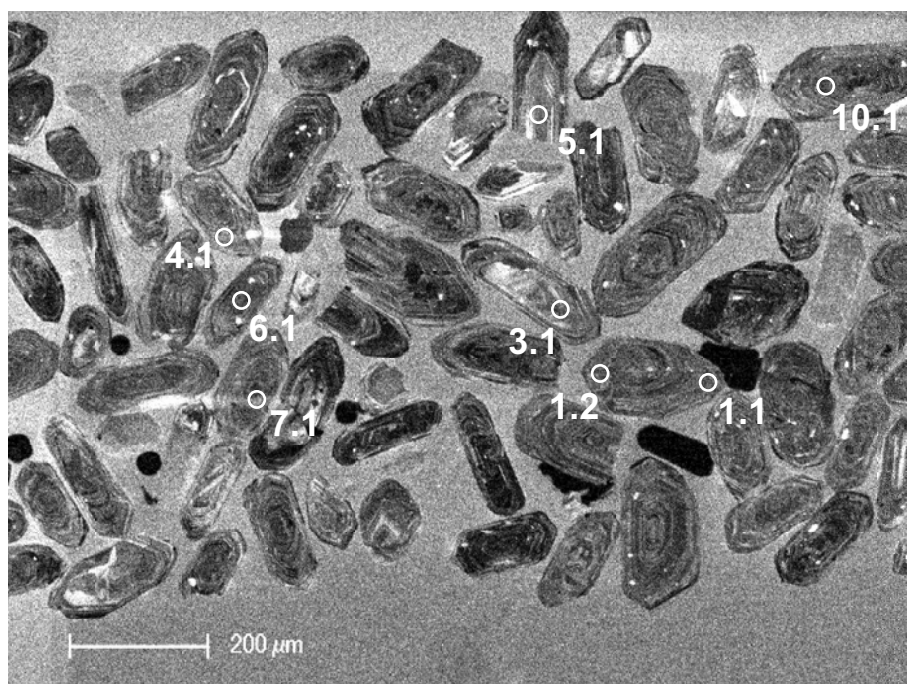


Figure 2. Cathodoluminescence image of representative zircons from sample 155504: biotite monzogranite, 30 Feet Bore. Numbered circles indicate the approximate locations of analysis sites.

Table 1. Ion microprobe analytical results for zircons from sample 155504: metamonzogranite, 30 Feet Bore

Group ID	Spot no.	Grain. spot	^{238}U (ppm)	^{232}Th (ppm)	$\frac{^{232}\text{Th}}{^{238}\text{U}}$	f_{204} (%)	$^{238}\text{U}/^{206}\text{Pb} \pm 1\sigma$	$^{207}\text{Pb}/^{206}\text{Pb} \pm 1\sigma$	$^{238}\text{U}/^{206}\text{Pb}^* \pm 1\sigma$	$^{207}\text{Pb}^*/^{206}\text{Pb}^* \pm 1\sigma$	$^{238}\text{U}/^{206}\text{Pb}^* \text{ date (Ma)} \pm 1\sigma$	$^{207}\text{Pb}^*/^{206}\text{Pb}^* \text{ date (Ma)} \pm 1\sigma$	Disc. (%)
I	24	23.1	129	51	0.41	0.036	1.933 0.019	0.18478 0.00073	1.933 0.019	0.18446 0.00074	2687 22	2693 7	0.2
I	20	19.1	250	225	0.93	0.107	1.934 0.016	0.18591 0.00053	1.936 0.016	0.18496 0.00056	2684 19	2698 5	0.5
I	10	9.1	437	212	0.50	0.042	1.967 0.015	0.18586 0.00043	1.967 0.015	0.18549 0.00044	2649 17	2703 4	2.0
I	4	4.1	708	439	0.64	0.063	1.959 0.014	0.18613 0.00033	1.960 0.014	0.18557 0.00035	2657 16	2703 3	1.7
I	14	13.1	339	373	1.13	0.058	1.935 0.016	0.18610 0.00048	1.937 0.016	0.18559 0.00049	2684 18	2703 4	0.7
I	22	21.1	247	41	0.17	0.024	1.933 0.016	0.18585 0.00054	1.934 0.016	0.18564 0.00055	2687 19	2704 5	0.6
I	18	17.1	396	309	0.81	0.043	1.912 0.015	0.18616 0.00043	1.913 0.015	0.18578 0.00044	2711 17	2705 4	-0.2
I	19	18.1	340	112	0.34	0.066	1.930 0.015	0.18699 0.00047	1.931 0.015	0.18641 0.00049	2690 18	2711 4	0.8
I	2	2.1	143	88	0.64	0.272	1.984 0.020	0.18908 0.00078	1.989 0.020	0.18666 0.00090	2625 22	2713 8	3.2
I	5	5.1	213	319	1.55	0.105	1.954 0.017	0.18762 0.00060	1.956 0.017	0.18668 0.00063	2662 20	2713 6	1.9
I	3	3.1	145	91	0.65	0.238	1.976 0.019	0.18884 0.00072	1.980 0.019	0.18672 0.00082	2635 21	2713 7	2.9
I	25	24.1	79	66	0.87	0.564	1.877 0.022	0.19191 0.00094	1.887 0.022	0.18687 0.00120	2741 26	2715 11	-1.0
I	12	11.1	556	285	0.53	0.068	1.968 0.015	0.18749 0.00037	1.969 0.015	0.18688 0.00039	2647 16	2715 3	2.5
X	7	6.1	546	295	0.56	0.015	1.993 0.015	0.18957 0.00037	1.993 0.015	0.18944 0.00037	2621 16	2737 3	4.2
X	8	7.1	565	58	0.11	0.022	1.903 0.014	0.19284 0.00036	1.903 0.014	0.19265 0.00036	2722 16	2765 3	1.5
X	26	25.1	231	125	0.56	0.078	1.779 0.015	0.20708 0.00055	1.780 0.015	0.20638 0.00057	2874 20	2877 5	0.1
X	21	20.1	265	143	0.56	0.044	1.784 0.015	0.20894 0.00209	1.784 0.015	0.20855 0.00209	2868 20	2894 16	0.9
X	13	12.1	137	100	0.76	0.000	1.776 0.018	0.21130 0.00077	1.776 0.018	0.21130 0.00077	2879 23	2916 6	1.3
P	9	8.1	420	165	0.41	0.126	2.068 0.016	0.18052 0.00045	2.071 0.016	0.17939 0.00048	2540 16	2647 4	4.1
P	16	15.1	864	494	0.59	0.020	2.043 0.014	0.18039 0.00028	2.044 0.014	0.18021 0.00029	2567 15	2655 3	3.3
D	15	14.1	917	52	0.06	0.080	4.879 0.034	0.12915 0.00036	4.883 0.034	0.12844 0.00039	1201 8	2077 5	42.2
D	1	1.1	755	413	0.57	0.022	2.701 0.019	0.16562 0.00034	2.701 0.019	0.16543 0.00034	2030 13	2512 3	19.2
D	6	1.2	738	35	0.05	0.028	2.884 0.021	0.17054 0.00036	2.885 0.021	0.17029 0.00037	1919 12	2560 4	25.1
D	23	22.1	912	451	0.51	0.072	2.483 0.017	0.17526 0.00030	2.485 0.017	0.17462 0.00046	2180 13	2602 4	16.2
D	17	16.1	800	357	0.46	0.082	2.225 0.109	0.17951 0.00133	2.226 0.109	0.17877 0.00134	2392 102	2642 12	9.5
D	11	10.1	630	364	0.60	0.067	2.082 0.015	0.18243 0.00042	2.083 0.015	0.18184 0.00043	2528 15	2670 4	5.3

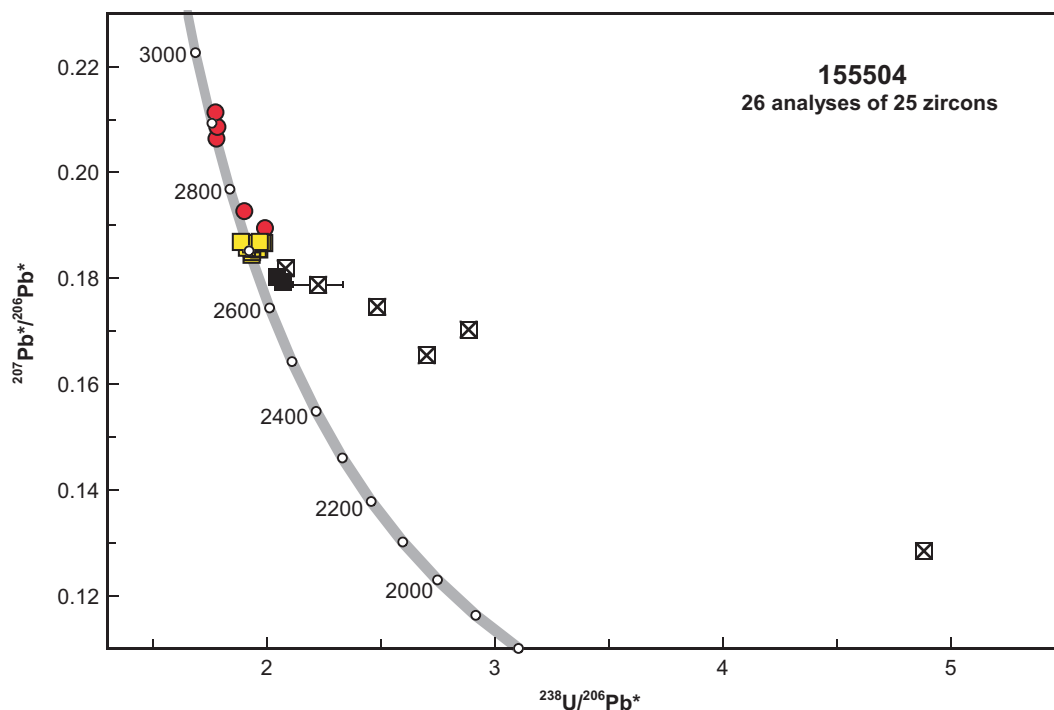


Figure 3. U–Pb analytical data for sample 155504: biotite monzogranite, 30 Feet Bore. Yellow squares indicate Group I (magmatic zircons); red circles indicate Group X (xenocrystic zircons); black squares indicate Group P (radiogenic-Pb loss); crossed squares indicate Group D (discordance >5%).

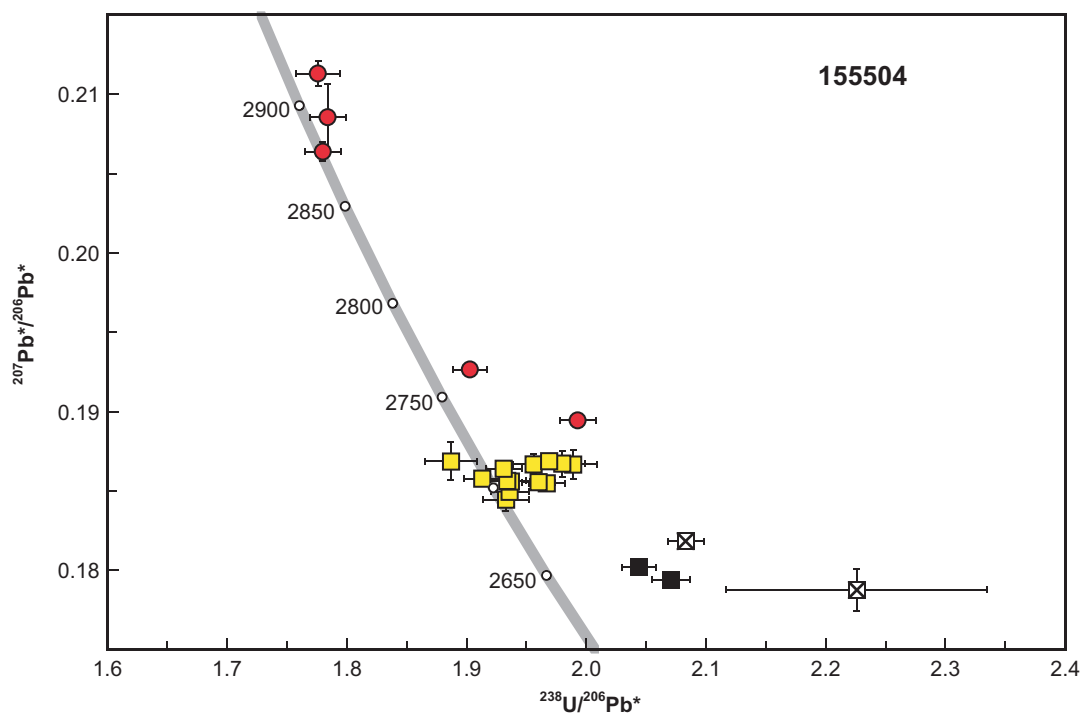


Figure 4. Expanded view of U–Pb analytical data for sample 155504: biotite monzogranite, 30 Feet Bore. Symbols as in Figure 3.

Group I comprises 13 analyses of 13 zircons (Table 1), which yield a weighted mean $^{207}\text{Pb}^*/^{206}\text{Pb}^*$ date of 2706 ± 4 Ma (MSWD = 1.7). This result includes one analysis that is $>2.5\sigma$ above the mean; exclusion of this analysis does not significantly affect the date.

Group X comprises five analyses of five zircon cores (Table 1), which yield $^{207}\text{Pb}^*/^{206}\text{Pb}^*$ dates of 2916–2737 Ma.

Group P comprises two analyses (Table 1), which yield $^{207}\text{Pb}^*/^{206}\text{Pb}^*$ dates of 2655 and 2647 Ma.

The date of 2706 ± 4 Ma for the 13 analyses in Group I is interpreted as the magmatic crystallization age of the monzogranite. The dates of 2916–2737 Ma for the five analyses in Group X are interpreted as the ages of inherited components. The dates of 2655 and 2647 Ma for the two analyses in Group P are interpreted to reflect ancient radiogenic-Pb loss.

References

- Stacey, JS and Kramers, JD 1975, Approximation of terrestrial lead isotope evolution by a two-stage model: *Earth and Planetary Science Letters*, v. 26, p. 207–221.
- Van Kranendonk, MJ, Ivanic, TJ, Wingate, MTD, Kirkland, CL and Wyche, S 2013, Long-lived, autochthonous development of the Archean Murchison Domain, and implications for Yilgarn Craton tectonics: *Precambrian Research*, v. 229, p. 49–92.
- Wingate, MTD, Kirkland, CL and Zibra, I 2014a, 155503: biotite monzogranite, Mundra Well; *Geochronology Record* 1147: Geological Survey of Western Australia, 4p.
- Wingate, MTD, Kirkland, CL and Zibra, I 2014b, 155505: granodiorite dyke, 30 Feet Bore; *Geochronology Record* 1149: Geological Survey of Western Australia, 4p.
- Zibra, I 2012, Syndeformational granite crystallisation along the Mount Magnet Greenstone Belt, Yilgarn Craton: evidence of large-scale magma-driven strain localisation during Neoproterozoic time. *Australian Journal of Earth Sciences*, v. 59, p. 793–806.

Recommended reference for this publication

Wingate, MTD, Kirkland, CL and Zibra, I 2014, 155504: biotite monzogranite, 30 Feet Bore; *Geochronology Record* 1148: Geological Survey of Western Australia, 5p.

Data obtained: 21 September 2012

Data released: 31 January 2014