

185990: metagabbro, Grass Flat Bore

(Grass Flat Gabbro, Southern Cross Domain, Youanmi Terrane, Yilgarn Craton)

Location and sampling

BARLEE (SH 50-8), JOHNSTON RANGE (2738)
MGA Zone 50, 705789E 6731086N

Sampled on 17 October 2008

This sample was collected from an area of low outcrop west of Diemals Homestead, about 3.3 km south of Grass Flat Bore, 2.9 km north-northwest of Watch Bore, and 350 m west of a north-trending track.

Tectonic unit/relations

The unit sampled is a leucocratic metagabbro of the Grass Flat Gabbro (Riganti et al., 2010). The gabbro consists of two major layered sills, each up to 1 km thick, exposed on the limbs of the Watch Bore Syncline in the Marda-Diemals greenstone belt (Wyche et al., 2001). The lower sill intruded between chert and banded iron-formation, and contains felsic zones with sparse acicular clinopyroxene crystals up to 20 cm long, in a medium- to coarse-grained plagioclase-rich matrix. Igneous layering, defined by differentiation of leucocratic and melanocratic gabbro, is locally preserved, and is concordant with bedding in the underlying shale. The upper sill, from which the geochronology sample was collected, is concordant with both underlying and overlying spinifex-textured komatiitic basalts. The gabbroic rocks may be co-magmatic intrusive equivalents of the mafic volcanic rocks they intrude, although this has not been demonstrated. The greenstones are unconformably overlain by the felsic to intermediate Marda Complex, in which greenstone-derived basal conglomerates and sandstones are overlain by felsic volcanic rocks dated at c. 2732 Ma (GSWA 168960, Nelson, 2001).

Petrographic description

The sample is a coarse-grained to pegmatitic leucocratic metagabbro, composed of about 35–40% altered plagioclase, 30% uralitized pyroxene, 25% interstitial granophyre and quartz, 7% opaque oxide minerals, and accessory titanite, apatite, and zircon. Plagioclase is albitized, and both plagioclase and pyroxene are strongly overgrown by needles and tufts of fibrous amphibole. Skeletal opaque oxide minerals are largely altered to leucoxene and microcrystalline titanite.

Zircon morphology

Zircons isolated from this sample are mainly dark brown or opaque, and subhedral to euhedral. The crystals are up to 300 μm long, and equant to slightly elongate, with aspect ratios up to 4:1. The zircons are variably metamict, very strongly altered, and contain abundant minute inclusions. In cathodoluminescence (CL) images, most zircons are partially replaced by a luminescent material (not identified). A CL image of representative zircons is shown in Figure 1.

Analytical details

This sample was analysed on 21–22 January 2010, using SHRIMP-B. Eleven analyses of the BR266 standard were obtained during the session, of which ten indicated an external spot-to-spot (reproducibility) uncertainty of 2.31% and a $^{238}\text{U}/^{206}\text{Pb}^*$ calibration uncertainty of 0.89% (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-two analyses were obtained from 20 zircons. Results are listed in Table 1, and shown in a concordia diagram (Fig. 2).

Interpretation

The analyses are concordant to strongly discordant (Fig. 2). Fifteen analyses are >5% discordant. The dates obtained from these 15 analyses (Group D; Table 1) are imprecise or unreliable, and are not considered geologically significant. The remaining seven analyses can be divided into two groups, based on their $^{207}\text{Pb}^*/^{206}\text{Pb}^*$ ratios.

Group I comprises four analyses of four zircons (Table 1), which yield a weighted mean $^{207}\text{Pb}^*/^{206}\text{Pb}^*$ date of 2796 ± 6 Ma (MSWD = 0.21).

Group P comprises three analyses of three zircons (Table 1), which yield $^{207}\text{Pb}^*/^{206}\text{Pb}^*$ dates of 2776–2647 Ma.

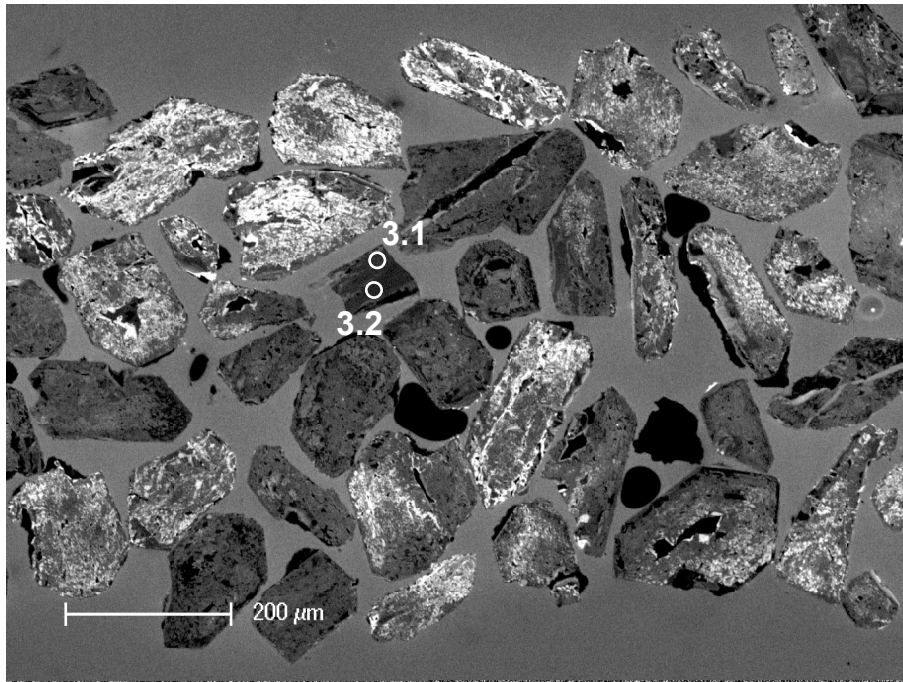


Figure 1. Cathodoluminescence image of representative zircons from sample 185990: metagabbro, Grass Flat Bore. Numbered circles indicate the approximate locations of analysis sites.

The date of 2796 ± 6 Ma for the four analyses in Group I is interpreted as the magmatic crystallization age of the gabbro. This interpretation is supported by the euhedral morphology of the zircons, and their high and variable uranium and thorium values, and Th/U ratios (1.2–15.0), all features typical of primary zircons in differentiated mafic intrusions (e.g. Wingate et al., 1998). The dates of 2776–2647 Ma for the three analyses in Group P are interpreted to reflect ancient loss of radiogenic Pb.

References

- Nelson, DR 2001, 168960: meta-ignimbrite, Marda Tank; Geochronology Record 194, Geological Survey of Western Australia, 4p.
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- 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.
- Wingate, MTD, Campbell, IH, Compston, W and Gibson, GM 1998, Ion microprobe U–Pb ages for Neoproterozoic basaltic magmatism in south-central Australia and implications for the breakup of Rodinia: Precambrian Research, v. 87, p. 135–159.
- Wyche, S, Chen, SF, Greenfield, JE and Riganti, A 2001, Geology of the Johnston Range 1:100 000 sheet Geological Survey of Western Australia, 1:100 000 Geological Series Explanatory Notes, 31p.

Recommended reference for this publication

Wingate, MTD, Kirkland, CL, Riganti, A and Wyche, S 2011, 185990: metagabbro, Grass Flat Bore; Geochronology Record 868: Geological Survey of Western Australia, 4p.

Data obtained: 22 January 2010

Data released: 30 June 2011

Table 1. Ion microprobe analytical results for zircons from sample 185990: metagabbro, Grass Flat Bore

Group ID	Spot no.	Grain spot	²³⁸ U (ppm)	²³² Th (ppm)	²³² Th/ ²³⁸ U	f ₂₀₄ (%)	²³⁸ U/ ²⁰⁶ Pb ± 1σ	²⁰⁷ Pb/ ²⁰⁶ Pb ± 1σ	²³⁸ U/ ²⁰⁶ Pb* ± 1σ	²⁰⁷ Pb*/ ²⁰⁶ Pb* ± 1σ	²³⁸ U/ ²⁰⁶ Pb* date (Ma) ± 1σ	²⁰⁷ Pb*/ ²⁰⁶ Pb* date (Ma) ± 1σ	Disc. (%)
I	3	3.1	376	435	1.20	0.034	1.868 0.048	0.19644 0.00063	1.869 0.048	0.19613 0.00065	2763 59	2794 5	1.1
I	8	7.1	387	995	2.66	-0.004	1.881 0.048	0.19613 0.00057	1.881 0.048	0.19616 0.00057	2749 58	2795 5	1.6
I	12	11.1	138	236	1.76	-0.037	1.886 0.051	0.19628 0.00099	1.886 0.051	0.19661 0.00101	2743 62	2798 8	2.0
I	19	18.1	156	233	1.54	-0.010	1.913 0.051	0.19679 0.00091	1.912 0.051	0.19688 0.00092	2711 61	2801 8	3.2
P	14	13.1	258	3420	13.69	0.392	2.003 0.053	0.18289 0.00075	2.011 0.054	0.17939 0.00276	2602 59	2647 26	1.7
P	10	9.1	461	1387	3.11	0.108	2.085 0.081	0.18092 0.00057	2.087 0.081	0.17996 0.00060	2524 84	2653 6	4.9
P	9	8.1	348	1097	3.26	0.054	1.862 0.048	0.19439 0.00060	1.863 0.048	0.19390 0.00062	2769 59	2776 5	0.2
D	1	1.1	1601	3779	2.44	0.720	3.217 0.080	0.14887 0.00034	3.240 0.081	0.14248 0.00052	1734 39	2258 6	23.2
D	22	20.1	1075	3729	3.58	0.085	2.613 0.065	0.16778 0.00037	2.616 0.065	0.16702 0.00040	2087 46	2528 4	17.4
D	7	6.1	156	2263	14.97	0.614	2.570 0.068	0.17553 0.00502	2.586 0.068	0.17006 0.00515	2108 49	2558 51	17.6
D	13	12.1	252	2095	8.60	0.039	2.559 0.066	0.17427 0.00072	2.560 0.066	0.17392 0.00073	2126 48	2596 7	18.1
D	15	14.1	631	2741	4.48	0.085	2.517 0.064	0.17676 0.00050	2.519 0.064	0.17600 0.00053	2155 47	2616 5	17.6
D	17	16.1	258	3495	13.98	0.171	2.343 0.061	0.17823 0.00079	2.347 0.061	0.17670 0.00087	2288 51	2622 8	12.7
D	18	17.1	398	1968	5.11	0.132	2.644 0.127	0.17806 0.00068	2.648 0.127	0.17688 0.00073	2065 88	2624 7	21.3
D	11	10.1	190	1576	8.59	0.243	2.157 0.057	0.17932 0.00086	2.163 0.057	0.17715 0.00097	2450 55	2626 9	6.7
D	5	5.1	771	1845	2.47	0.008	2.144 0.055	0.17809 0.00042	2.144 0.055	0.17802 0.00042	2468 54	2635 4	6.3
D	4	4.1	175	1688	9.97	0.209	2.407 0.064	0.18097 0.00097	2.412 0.064	0.17911 0.00108	2236 52	2645 10	15.5
D	20	18.2	394	1596	4.18	0.262	2.229 0.057	0.18624 0.00059	2.235 0.057	0.18390 0.00070	2384 52	2688 6	11.3
D	16	15.1	558	1557	2.88	0.061	2.153 0.055	0.18771 0.00052	2.154 0.055	0.18717 0.00054	2458 53	2717 5	9.5
D	2	2.1	430	1505	3.61	0.151	2.058 0.053	0.18905 0.00064	2.062 0.053	0.18770 0.00072	2549 55	2722 6	6.3
D	21	19.1	255	642	2.60	0.110	2.103 0.054	0.18917 0.00070	2.105 0.055	0.18819 0.00074	2505 55	2726 6	8.1
D	6	3.2	577	763	1.36	0.065	2.253 0.057	0.19017 0.00058	2.254 0.057	0.18959 0.00060	2367 52	2739 5	13.6

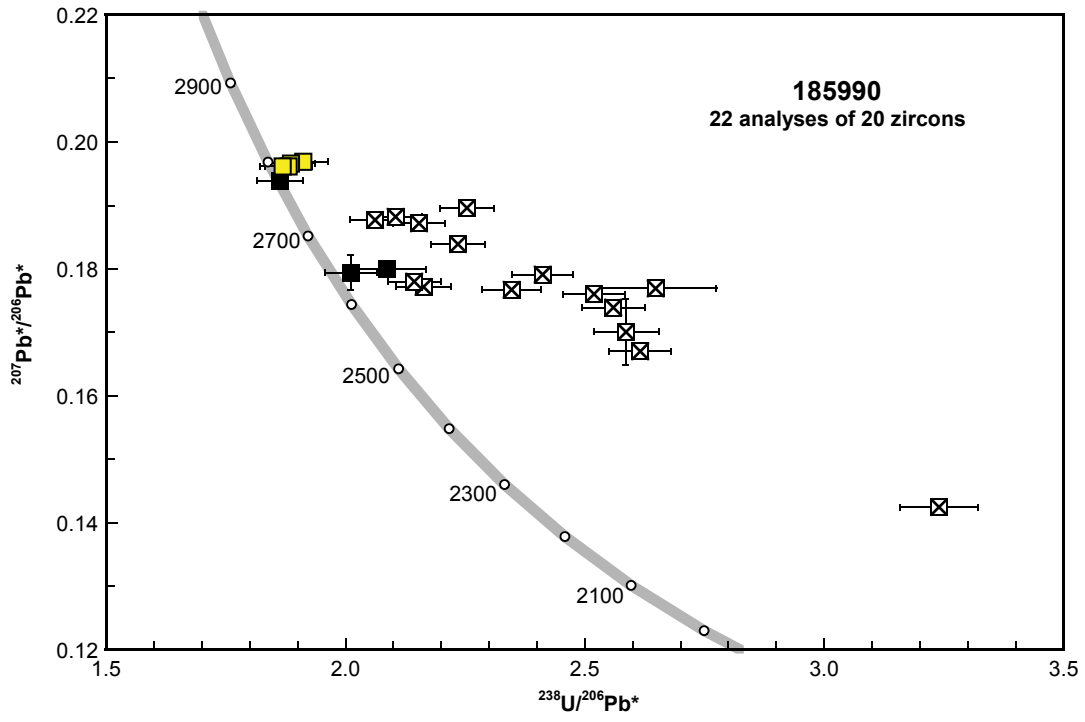


Figure 2. U–Pb analytical data for sample 185990: metagabbro, Grass Flat Bore. Yellow squares indicate Group I (magmatic zircons); black squares indicate Group P (radiogenic-Pb loss); crossed squares indicate Group D (discordance >5%).