208506: foliated metamonzogranite, Gungangmura Waterhole

(Pitjantjatjarra Supersuite, Musgrave Province)

Location and sampling

Bentley (SG 52-5), Diorite (4347)
MGA Zone 52, 346858E 7207892N

Sampled on 24 September 2013

This sample was collected from a boulder on the northern side of a breakaway, located about 20.7 km west of Wanarn community, 4.8 km south of Gungarungal Hill, and 1.6 km west-northwest of Gungangmura Waterhole.

Tectonic unit/relations

The unit sampled is a foliated metamonzogranite assigned to the 1220–1150 Ma Pitjantjatjarra Supersuite of the Musgrave Province (Smithies et al., 2010, 2011). The Pitjantjatjara Supersuite accounts for a significant component of the exposed rocks in the Musgrave Province, and was generated from voluminous A-type magmas (Smithies et al., 2009), accompanied by ultra-high-temperature granulite-facies metamorphism, which lasted the duration of the Musgrave Orogeny (Smithies et al., 2011). Numerous samples of the Pitjantjatjara Supersuite have been dated previously (see Appendix 1 in Howard et al., 2015). The Musgrave Orogeny caused intense deformation and amphibolite- to granulite-facies crustal reworking.

Petrographic description

The sample is a strongly foliated to gneissic, fine- to medium-grained, inequigranular, garnet-bearing, weakly feldspar porphyritic, hornblende–biotite metamonzogranite. The rock consists of about 35–40% quartz, 25–30% K-feldspar, 10–15% plagioclase, 10–15% biotite, 5% hornblende, 3% titanite, and accessory garnet, zircon, and iron–titanium oxide minerals. Quartz and feldspars are mainly anhedral and interlocking and up to 1.5 mm across. Amphibole is partially replaced by biotite. Biotite is up to 2 mm long, and partially replaced by granular titanite.

Zircon morphology

Zircons isolated from this sample are colourless (some exhibit iron staining), and mainly subhedral to euhedral. The crystals are up to 650 μm long, and equant to elongate, with aspect ratios up to 5:1. In cathodoluminescence (CL) images, concentric zoning is ubiquitous, and sector zoning is common. A CL image of representative zircons is shown in Figure 1.

Analytical details

This sample was analysed on 14–15 August 2014, using SHRIMP-B. Thirteen analyses of the BR266 standard were obtained during the session, of which 12 analyses indicated an external spot-to-spot (reproducibility) uncertainty of 0.50% (1σ) and a $^{238}U/^{206}Pb^*$ calibration uncertainty of 0.15% (1σ). Calibration uncertainties are included in the errors of $^{238}U/^{206}Pb^*$ 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-eight analyses were obtained from 28 zircons. Results are listed in Table 1, and shown in a concordia diagram (Fig. 2).

Interpretation

The analyses are concordant to moderately discordant (Fig. 2). Dates based on 204-corrected $^{207}Pb^*/^{206}Pb^*$ ratios correlate crudely with common-Pb content ($f204$, Table 1), indicating that corrections using ^{204}Pb are inaccurate for some or all analyses. The date for this sample is therefore determined from the intersection with concordia of a regression through uncorrected data, anchored at contemporaneous initial Pb ($^{207}Pb/^{206}Pb$ = 0.9219 at 1157 Ma; Stacey and Kramers, 1975). The analyses can be divided into two groups, based on their $^{207}Pb/^{206}Pb$ and $^{238}U/^{206}Pb$ ratios.

Group I comprises 26 analyses (Table 1), for which the regression yields an intercept age of 1157 ± 9 Ma (MSWD = 1.1).

Group P comprises two analyses (Table 1), which yield 207-corrected $^{238}U/^{206}Pb^*$ dates (1σ) of 1075 ± 29 and 1074 ± 31 Ma.

The date of 1157 ± 9 Ma for the 28 analyses in Group I is interpreted as the age of magmatic crystallization of the monzogranite. The dates of 1075 and 1074 Ma for the two analyses in Group P are interpreted to reflect minor loss of radiogenic Pb.

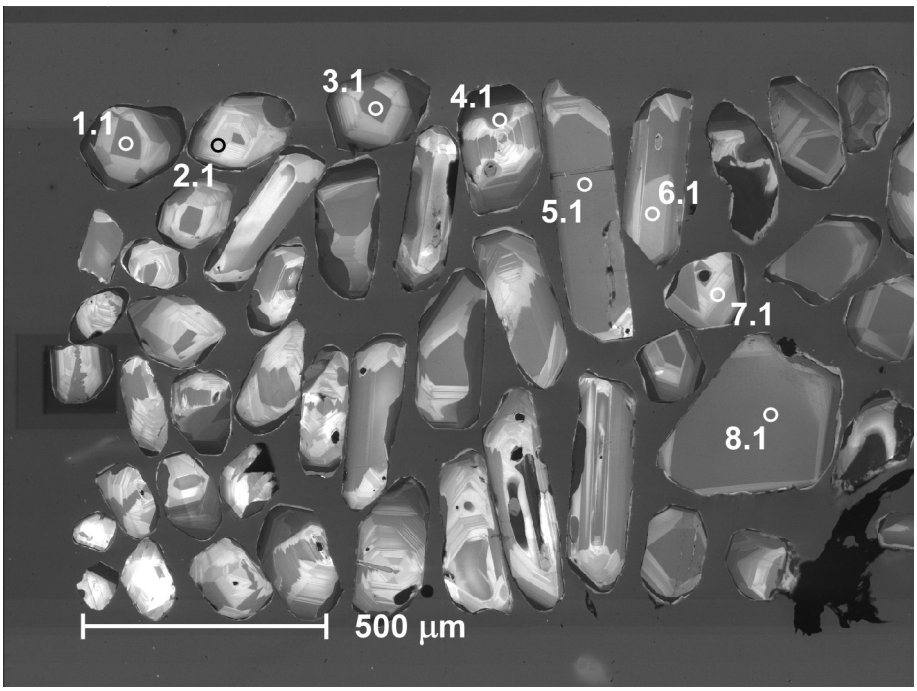

Figure 1. Cathodoluminescence image of representative zircons from sample 208506: foliated metamonzogranite, Gungangmura Waterhole. Numbered circles indicate the approximate positions of analysis sites.

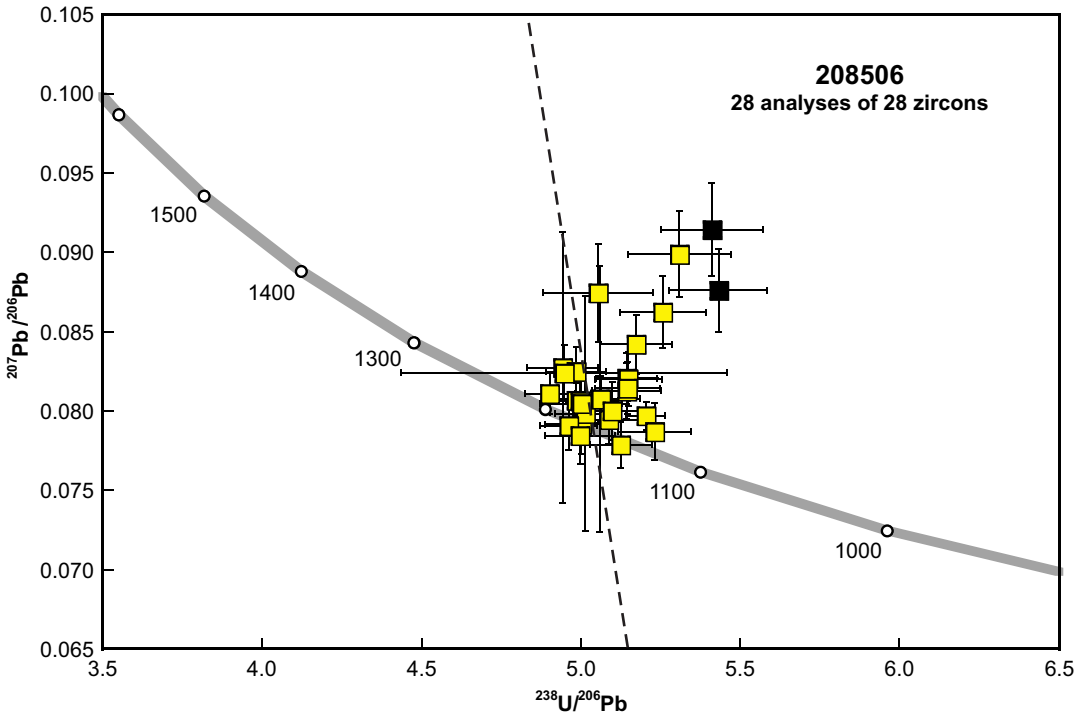

Figure 2. U–Pb analytical data, not corrected for common Pb, for sample 208506: foliated metamonzogranite, Gungangmura Waterhole. Yellow squares indicate Group I (magmatic zircons). The dashed line indicates a regression from initial Pb through data in Group I.

Table 1. Ion microprobe analytical results for zircons from sample 208506: foliated metamonzogranite, Gungangmura Waterhole

Group ID	Spot no.	Grain. spot	^{238}U (ppm)	^{232}Th (ppm)	$\frac{^{232}Th}{^{238}U}$	f204 (%)	$^{238}U/^{206}Pb$ ± 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	7	7.1	42	45	1.11	1.516	5.232	0.114	0.07871	0.00181	5.313	0.119	0.06617	0.00463	1112	23	812	146	-36.9
I	23	23.1	42	64	1.58	0.896	5.002	0.113	0.07919	0.00188	5.047	0.115	0.07170	0.00387	1165	25	978	110	-19.2
I	25	25.1	32	42	1.35	1.051	5.059	0.127	0.08077	0.00838	5.113	0.131	0.07199	0.00936	1152	28	986	265	-16.8
I	10	10.1	64	58	0.93	0.944	5.064	0.092	0.08078	0.00146	5.113	0.094	0.07288	0.00304	1152	20	1011	85	-13.9
I	5	5.1	44	66	1.57	0.614	4.998	0.108	0.07845	0.00175	5.029	0.109	0.07331	0.00313	1169	24	1023	86	-14.3
I	8	8.1	62	75	1.26	0.664	4.962	0.091	0.07906	0.00148	4.995	0.093	0.07350	0.00273	1176	20	1028	75	-14.5
I	26	26.1	54	70	1.34	0.698	5.087	0.095	0.07945	0.00152	5.123	0.097	0.07361	0.00285	1150	20	1031	78	-11.5
I	1	1.1	47	57	1.26	1.027	4.948	0.509	0.08240	0.00177	4.999	0.515	0.07379	0.00374	1175	122	1036	102	-13.5
I	4	4.1	55	40	0.75	0.448	5.125	0.096	0.07788	0.00148	5.148	0.097	0.07413	0.00240	1144	20	1045	65	-9.5
I	20	20.1	55	81	1.51	0.917	5.145	0.096	0.08207	0.00158	5.193	0.099	0.07438	0.00317	1135	20	1052	86	-7.9
I	22	22.1	38	56	1.53	0.848	4.943	0.112	0.08274	0.00854	4.985	0.114	0.07562	0.00919	1178	25	1085	244	-8.6
I	27	27.1	42	72	1.79	0.602	5.145	0.109	0.08126	0.00176	5.176	0.111	0.07619	0.00310	1139	23	1100	81	-3.5
I	2	2.1	30	37	1.27	0.445	5.002	0.128	0.08047	0.00218	5.024	0.129	0.07673	0.00345	1170	28	1114	90	-5.0
I	16	16.1	21	23	1.13	1.561	5.310	0.162	0.08990	0.00273	5.394	0.169	0.07676	0.00658	1096	32	1115	171	1.7
I	12	12.1	87	80	0.95	0.496	4.903	0.078	0.08110	0.00130	4.927	0.079	0.07693	0.00216	1191	18	1119	56	-6.4
I	28	28.1	39	70	1.87	0.797	5.173	0.114	0.08422	0.00186	5.215	0.116	0.07750	0.00356	1131	24	1134	91	0.3
I	24	24.1	163	131	0.83	0.244	5.205	0.062	0.07970	0.00091	5.217	0.062	0.07764	0.00124	1130	13	1138	32	0.6
I	9	9.1	43	57	1.37	0.158	5.098	0.111	0.08002	0.00182	5.106	0.111	0.07869	0.00226	1153	24	1164	57	1.0
I	15	15.1	61	84	1.41	0.117	5.015	0.093	0.07984	0.00738	5.021	0.094	0.07885	0.00745	1171	20	1168	187	-0.2
I	17	17.1	114	86	0.79	0.115	4.986	0.069	0.08070	0.00109	4.992	0.070	0.07973	0.00129	1177	15	1190	32	1.1
I	11	11.1	52	84	1.65	0.129	5.146	0.102	0.08142	0.00164	5.153	0.103	0.08033	0.00198	1143	21	1205	48	5.1
I	3	3.1	37	38	1.08	-0.180	4.999	0.116	0.08062	0.00194	4.990	0.116	0.08215	0.00246	1178	26	1249	59	5.7
I	6	6.1	28	35	1.29	0.441	5.258	0.135	0.08625	0.00223	5.282	0.137	0.08251	0.00348	1118	27	1258	82	11.1
I	21	21.1	57	87	1.59	-0.222	4.986	0.094	0.08250	0.00155	4.975	0.094	0.08438	0.00204	1181	21	1301	47	9.3
I	18	18.1	16	17	1.10	0.000	5.055	0.171	0.08745	0.00309	5.055	0.171	0.08745	0.00309	1164	37	1370	68	15.1
I	19	19.1	47	78	1.72	-0.691	5.149	0.106	0.08202	0.00173	5.113	0.106	0.08792	0.00314	1151	22	1381	69	16.6
P	14	14.1	25	26	1.05	1.463	5.432	0.154	0.08762	0.00261	5.513	0.160	0.07533	0.00618	1075	30	1077	165	0.3
P	13	13.1	23	24	1.05	0.644	5.411	0.160	0.09145	0.00291	5.446	0.163	0.08596	0.00488	1087	31	1337	110	18.7

References

Howard, HM, Smithies, RH, Kirkland, CL, Kelsey, DE, Aitken, A, Wingate, MTD, Quentin De Gromard, R, Spaggiari, CV and Maier, WD 2015, The burning heart — The Proterozoic geology and geological evolution of the west Musgrave Region, central Australia: Gondwana Research, v. 27, no. 1, p. 64–94.

Smithies, RH, Howard, HM, Evins, PM, Kirkland, CL, Bodorkos, S and Wingate, MTD 2009, The west Musgrave Complex — new geological insights from recent mapping, geochronology, and geochemical studies: Geological Survey of Western Australia, Record 2008/19, 20p.

Smithies, RH, Howard, HM, Evins, PM, Kirkland, CL, Kelsey, DE, Hand, M, Wingate, MTD, Collins, AS, Belousova, E and Allchurch, S 2010, Geochemistry, geochronology, and petrogenesis of Mesoproterozoic felsic rocks in the west Musgrave Province, central Australia, and implications for the Mesoproterozoic tectonic evolution of the region: Geological Survey of Western Australia, Report 106, 73p.

Smithies, RH, Howard, HM, Evins, PM, Kirkland, CL, Kelsey, DE, Hand, M, Wingate, MTD, Collins, AS and Belousova, E 2011, High-temperature granite magmatism, crust-mantle interaction and the Mesoproterozoic intracontinental evolution of the Musgrave Province, central Australia: Journal of Petrology, v. 52, p. 931–958.

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.

Recommended reference for this publication

Wingate, MTD, Kirkland, CL, Howard, HM, Quentin De Gromard, R and Smithies, RH 2015, 208506: foliated metamonzogranite, Gungangmura Waterhole; Geochronology Record 1255: Geological Survey of Western Australia, 4p.

Data obtained: 15 August 2014

Data released: 31 May 2015