184367: metagranodiorite, Dwarf Well

(Aileron Province, West Arunta Orogen)

Location and sampling

WEBB (SF 52-10), DWARF WELL (4553)
MGA Zone 52, 407460E 7529811N

Sampled on 12 August 2007

The sample was taken from one of a series of low, scattered boulders in scrub within sand plains, 8.8 km southeast of Dwarf Well, in the southwestern part of the DWARF WELL 1:100 000 map sheet. The sample site is located approximately 51 km north-northeast of Elizabeth Hills and 96 km south of Warri Peak.

Tectonic unit/relations

The unit sampled is a coarse-grained, strongly foliated metagranodiorite transected by localized shear zones with S–C fabrics showing a dextral shear sense. The metagranodiorite outcrops about 18 km northeast of GSWA 184341 (unnamed quartzite, west of Lake Mackay, Aileron Province), which is interpreted to overlie the metamonzogranite. The unnamed quartzite has a maximum depositional age of 1750 ± 19 Ma, and includes a significant component of zircons dated at 1775 ± 7 Ma (Kirkland et al., 2009).

Petrographic description

This sample is a recrystallized metagranodiorite with a visually estimated primary mineralogy consisting of 35% quartz, 30% microcline, 25% plagioclase, 10% biotite, and <5% muscovite. Anhedral microcline is up to 6 mm in size and is more abundant than saussuritized plagioclase, which reaches 4 mm in size. Quartz occurs as both discrete grains with undulose extinction, and as smaller recrystallized grains. Biotite, up to 4 mm across, occurs as discrete grains or in polycrystalline aggregates, which are up to 5 mm long. Fine-grained zones of recrystallized biotite, muscovite, epidote, and secondary ilmenite transect the specimen. A weak foliation is defined by biotite. Apatite and zircon are accessory phases. Myrmekite is common between microcline and plagioclase and may be of metamorphic origin. The mineralogy indicates amphibolite facies metamorphism and subsequent low-temperature alteration.

Zircon morphology

This sample yielded abundant euhedral zircons, which are pink to brown, up to 300 μm long, and have aspect ratios up to 5:1. Cathodoluminescence (CL) images reveal well-defined idiomorphic zoning and, in some grains, older cores with variable CL response. A CL image of representative zircons is shown in Figure 1.

Analytical details

This sample was analyzed over three sessions, the first on 28–29 March 2009, using SHRIMP-B, and both the second and third sessions on 7–8 April 2008, using SHRIMP-B. Analyses 1.1 to 14.1 (spot numbers 1–14) were obtained during the first session, together with 13 analyses of the Temora standard, which indicated an external spot-to-spot (reproducibility) uncertainty of 1.65% (1σ) and a $^{238}U/^{206}Pb^*$ calibration uncertainty of 0.52% (1σ). Analyses 15.1 to 17.1 (spot numbers 15–18) were obtained during the second session, together with four analyses of the Temora standard, which indicated an external spot-to-spot (reproducibility) uncertainty of 1.13% (1σ) and a $^{238}U/^{206}Pb^*$ calibration uncertainty of 0.63% (1σ). Analyses 18.1 to 36.1 (spot numbers 19–37) were obtained during the third session, together with eight analyses of the Temora standard, which indicated an external spot-to-spot (reproducibility) uncertainty of 2.78% (1σ) and a $^{238}U/^{206}Pb^*$ calibration uncertainty of 1.02% (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 common-Pb isotopic compositions determined according to the model of Stacey and Kramers (1975).

Results

Thirty-seven analyses were obtained from 36 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). Six analyses are characterized by >5% discordance,

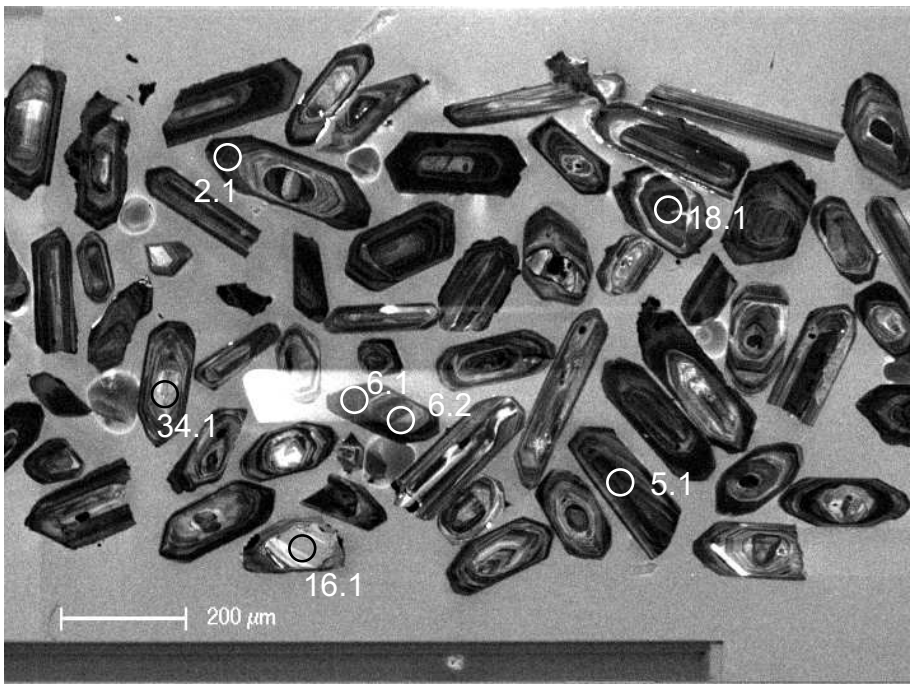

Figure 1. Cathodoluminescence image of representative zircons from sample 184367: metagranodiorite, Dwarf Well. Numbered circles indicate the approximate positions of analysis sites.

and two analyses (9.1 and 19.1) are interpreted as mixtures between cores and rims. The dates from these eight analyses (Group D; Table 1) are imprecise or unreliable, and are not considered geologically significant. The remaining 29 analyses can be divided into two groups, based on their positions within the crystals and $^{207}Pb^*/^{206}Pb^*$ ratios.

Group I comprises 18 analyses of 18 zircons (Table 1), which yield a weighted mean $^{207}Pb^*/^{206}Pb^*$ date of 1773 ± 6 Ma (MSWD = 1.7). These analyses were located on idiomorphically zoned zircon forming both rims and discrete grains. These analyses have variable U contents (1224–135 ppm) and moderate Th/U ratios (0.727–0.169).

Group X comprises 11 analyses of 11 cores (Table 1), which yield $^{207}Pb^*/^{206}Pb^*$ dates of 2488–1841 Ma. These analyses have both variable U contents (525–36 ppm) and variable Th/U ratios (1.66–0.062).

The date of 1773 ± 6 Ma for the 18 analyses in Group I is interpreted as the age of magmatic crystallization of the metagranodiorite. This date is within the age range of granitic rocks belonging to the c. 1805–1770 Ma Carrington Suite (Edgoose et al., 2005). The sample is also temporally related to, and likely deformed during, the c. 1780–1770 Ma Yambah Event (Scrimgeour, 2006). The dates of 2488–1841 Ma for 11 analyses in Group X indicate significant age components at 1860 Ma and 1882 Ma, defined by contributions from three and four grains, respectively. These dates are interpreted as the ages of material inherited from older rocks. Erosion of metagranodiorite (GSWA 184367) likely provided c. 1775 Ma detritus into the overlying quartzite (GSWA 184341).

References

Edgoose, CJ, Close, DF and Scrimgeour, IR 2006, Lake MacKay, Northern Territory (Second Edition), 1:250 000 geological map series, SF 52-11: Northern Territory Geological Survey, Darwin.

Kirkland, CL, Wingate, MTD, Spaggiari, CV and Tyler, IM 2009, 184341: quartzite, Lake Mackay; Geochronology Record 818: Geological Survey of Western Australia, 5p.

Scrimgeour, IR 2006, The Arunta Region: Links between tectonics and mineralisation: AGES Abstracts, Northern Territory Geological Survey, Record 2006-002, p. 7–10.

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

Kirkland, CL, Wingate, MTD, Tyler, IM and Spaggiari, CV 2009, 184367: metagranodiorite, Dwarf Well; Geochronology Record 846: Geological Survey of Western Australia, 4p.

Data obtained: 8 April 2008
Data released: 10 November 2009

Table 1. Ion microprobe analytical results for zircons from sample 184367: metagranodiorite, Dwarf Well

Group ID	Spot no.	Grain. spot	^{238}U (ppm)	^{232}Th (ppm)	$^{232}Th/^{238}U$	f204 (%)	$^{238}U/^{206}Pb$ ± 1 σ		$^{207}Pb/^{206}Pb$ ± 1 σ		$^{238}U/^{206}Pb^*$ ± 1 σ		$^{207}Pb^*/^{206}Pb^*$ ± 1 σ		$^{238}U/^{206}Pb^*$ date (Ma) ± 1 σ		$^{207}Pb^*/^{206}Pb^*$ date (Ma) ± 1 σ		Disc. (%)
I	36	35.1	179	51	0.29	0.206	3.101	0.088	0.10830	0.00066	3.107	0.094	0.10651	0.00080	1799	62	1741	14	-3.3
I	35	34.1	146	64	0.45	0.528	3.257	0.092	0.11150	0.00072	3.274	0.098	0.10691	0.00120	1718	59	1747	21	1.7
I	27	26.1	248	131	0.54	-0.021	3.063	0.086	0.10742	0.00046	3.062	0.091	0.10761	0.00047	1822	63	1759	8	-3.6
I	4	4.1	248	116	0.48	0.033	3.246	0.056	0.10806	0.00047	3.247	0.058	0.10777	0.00052	1731	35	1762	9	1.8
I	14	14.1	372	149	0.41	0.012	3.121	0.052	0.10791	0.00038	3.122	0.055	0.10780	0.00039	1791	36	1763	7	-1.6
I	25	24.1	180	67	0.39	0.028	3.139	0.095	0.10807	0.00054	3.140	0.100	0.10782	0.00055	1782	65	1763	9	-1.1
I	3	3.1	503	139	0.28	0.026	3.150	0.053	0.10842	0.00035	3.151	0.055	0.10819	0.00038	1777	36	1769	6	-0.4
I	7	7.1	140	52	0.38	-0.037	3.177	0.055	0.10801	0.00062	3.176	0.057	0.10833	0.00065	1765	36	1772	11	0.4
I	10	10.1	199	93	0.48	0.048	3.198	0.054	0.10896	0.00051	3.199	0.057	0.10855	0.00057	1753	36	1775	10	1.2
I	30	29.1	328	160	0.50	0.027	3.032	0.086	0.10884	0.00043	3.033	0.091	0.10860	0.00044	1837	64	1776	7	-3.4
I	1	1.1	314	73	0.24	0.000	3.073	0.052	0.10868	0.00039	3.073	0.054	0.10868	0.00039	1816	37	1777	7	-2.2
I	8	8.1	301	87	0.30	0.020	3.183	0.054	0.10889	0.00043	3.183	0.057	0.10872	0.00045	1761	36	1778	8	1.0
I	12	12.1	331	202	0.63	0.042	3.047	0.057	0.10924	0.00043	3.048	0.059	0.10887	0.00045	1829	41	1781	8	-2.7
I	13	13.1	502	353	0.73	-0.001	3.148	0.053	0.10889	0.00034	3.148	0.055	0.10890	0.00035	1778	36	1781	6	0.1
I	6	6.1	1224	201	0.17	0.014	3.096	0.052	0.10922	0.00095	3.097	0.054	0.10910	0.00095	1804	36	1784	16	-1.1
I	23	22.1	205	112	0.56	0.064	2.977	0.087	0.10980	0.00104	2.979	0.092	0.10924	0.00105	1866	67	1787	18	-4.4
I	11	11.1	220	74	0.35	-0.032	3.209	0.055	0.10941	0.00055	3.208	0.057	0.10969	0.00056	1749	36	1794	9	2.5
I	33	32.1	135	74	0.57	0.118	3.070	0.087	0.11081	0.00078	3.073	0.093	0.10978	0.00090	1816	63	1796	15	-1.1
X	32	31.1	379	168	0.46	0.288	3.185	0.089	0.11504	0.00042	3.194	0.095	0.11253	0.00057	1756	60	1841	9	4.6
X	19	18.1	364	99	0.28	0.107	2.934	0.083	0.11450	0.00044	2.937	0.089	0.11356	0.00053	1889	66	1857	8	-1.7
X	37	36.1	164	43	0.27	0.123	2.915	0.103	0.11487	0.00063	2.919	0.108	0.11379	0.00072	1899	81	1861	11	-2.1
X	22	21.1	203	25	0.13	0.031	2.870	0.082	0.11441	0.00058	2.871	0.087	0.11414	0.00059	1927	68	1866	9	-3.2
X	31	30.1	524	82	0.16	-0.020	2.871	0.080	0.11500	0.00031	2.870	0.085	0.11518	0.00031	1927	66	1883	5	-2.4
X	5	5.1	373	42	0.12	-0.032	2.951	0.052	0.11528	0.00042	2.950	0.055	0.11556	0.00049	1882	40	1889	8	0.4
X	18	17.1	525	162	0.32	0.148	2.854	0.033	0.12080	0.00035	2.858	0.038	0.11950	0.00041	1934	30	1949	6	0.8
X	34	33.1	84	95	1.17	0.060	2.554	0.075	0.13417	0.00091	2.555	0.080	0.13364	0.00122	2129	78	2146	16	0.8
X	24	23.1	103	90	0.90	0.098	2.456	0.076	0.13573	0.00082	2.458	0.081	0.13487	0.00106	2200	85	2162	14	-1.8
X	28	27.1	36	2	0.06	-0.200	2.448	0.072	0.14479	0.00222	2.443	0.076	0.14657	0.00229	2212	82	2306	27	4.1
X	17	16.1	83	49	0.61	0.008	2.149	0.028	0.16315	0.00093	2.149	0.031	0.16308	0.00119	2463	43	2488	12	1.0
D	2	2.1	277	108	0.40	0.427	3.868	0.065	0.11081	0.00048	3.884	0.068	0.10709	0.00075	1477	29	1751	13	15.6
D	21	20.1	377	72	0.20	1.012	7.094	0.199	0.11622	0.00088	7.167	0.215	0.10742	0.00152	842	27	1756	26	52.1
D	29	28.1	322	113	0.36	0.393	4.829	0.136	0.11171	0.00062	4.848	0.145	0.10829	0.00096	1209	40	1771	16	31.7
D	16	6.2	473	388	0.85	1.449	3.949	0.066	0.12154	0.00046	4.007	0.072	0.10892	0.00097	1436	29	1781	16	19.4
D	9	9.1	136	77	0.58	-0.127	3.149	0.054	0.10965	0.00067	3.145	0.057	0.11076	0.00087	1780	37	1812	14	1.8
D	20	19.1	241	62	0.27	0.115	3.050	0.086	0.11196	0.00053	3.053	0.091	0.11096	0.00062	1826	63	1815	10	-0.6
D	15	15.1	328	396	1.25	1.272	3.233	0.043	0.13619	0.00064	3.275	0.048	0.12500	0.00104	1718	29	2029	15	15.3
D	26	25.1	253	193	0.79	0.204	2.868	0.081	0.12968	0.00053	2.874	0.086	0.12789	0.00066	1925	67	2069	9	7.0

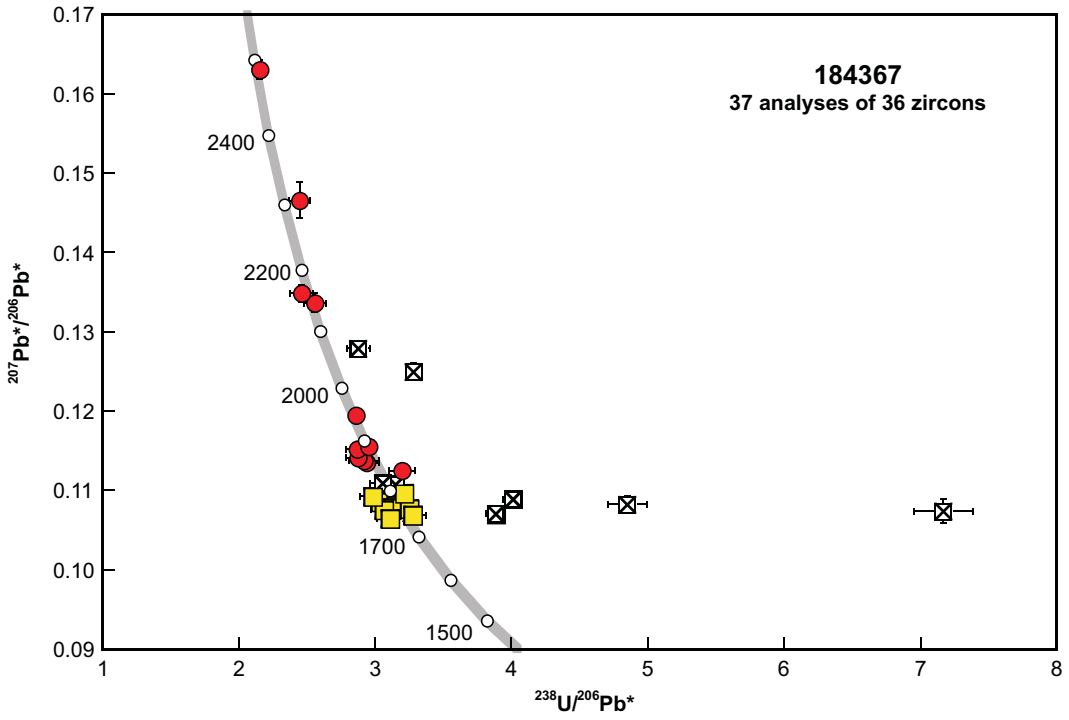

Figure 2. **U–Pb analytical data for sample 184367: metagranodiorite, Dwarf Well. Yellow squares indicate Group I (magmatic zircons); red circles indicate Group X (xenocrystic zircons); crossed squares indicate Group D (discordance >5% or core–rim mixture).**