185923: biotite–hornblende tonalite gneiss, Granite Rock

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

Location and sampling

CUE (SG 50-15), CUE (2443)
MGA Zone 50, 568818E 6967748N

Sampled on 4 October 2007

This sample was collected from a large outcrop area southeast of Walga Rock Road on Austin Downs Station, about 5.7 km southwest of Austin Downs Homestead, 2.7 km west-southwest of Lakeside Bore, and 1.0 km southeast of Granite Rock.

Tectonic unit/relations

The unit sampled is a strongly foliated granite gneiss, known as the Crossroads Granodiorite, which is assigned to the 2735–2690 Ma Big Bell Suite of foliated tonalitic to monzogranitic rocks (Van Kranendonk et al., in press), within the Murchison Domain of the Youanmi Terrane. At this locality, the gneiss consists of alternating mafic and felsic sheets; the mafic phase was sampled for geochronology. The Crossroads Granodiorite crosscuts interlayered and highly strained mafic and felsic volcanic rocks about 11 km to the north of the present locality, near the Big Bell Mine.

Petrographic description

The sample is a mafic tonalite gneiss, which consists of approximately 55% plagioclase, 22% quartz, 11% hornblende, 11% biotite, and accessory epidote, allanite, apatite, and zircon. Anhedral plagioclase and quartz are 0.5 to 4 mm across. Lenses of weakly foliated hornblende and moderately foliated biotite, up to 7 mm long, are subparallel to the foliation and contain individual grains up to 2 mm long. Some grains are poorly oriented or suggest a second, oblique foliation. Some mafic lenses contain epidote and apatite, although apatite is particularly abundant in poorly defined, foliation-parallel zones up to 7 mm long and 2 mm wide. Epidote locally mantles altered allanite. Plagioclase exhibits weak sericite alteration.

Zircon morphology

Zircons isolated from this sample are pale- to dark-brown, and subhedral to euhedral. Most crystals exhibit concentric growth zoning, which is faded or overprinted by reprecipitation fronts. The crystals are up to 600 µm long, and elongate, with aspect ratios up to 6:1. A cathodoluminescence image of representative zircons is shown in Figure 1.

Analytical details

This sample was analysed on 22–23 May 2009, using SHRIMP-B. Eleven analyses of the BR266 standard were obtained during the session, of which nine indicated an external spot-to-spot (reproducibility) uncertainty of 0.64% (1σ) and a $^{238}U/^{206}Pb^*$ calibration uncertainty of 0.25% (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

Eighteen analyses were obtained from 18 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), and can be divided into two groups, based on their $^{207}Pb^*/^{206}Pb^*$ ratios and uranium contents.

Group I comprises 16 analyses (Table 1), which yield a weighted mean $^{207}Pb^*/^{206}Pb^*$ date of 2724 ± 2 Ma (MSWD = 1.07). The analyses indicate moderate uranium contents (138–562 ppm).

Group P comprises two analyses (Table 1), which yield $^{207}Pb^*/^{206}Pb^*$ dates of 2710 and 2702 Ma. These analyses indicate high uranium contents (1009 and 929 ppm, respectively).

The date of 2724 ± 2 Ma for the 16 analyses in Group I is interpreted as the magmatic crystallization age of the tonalite. The dates of 2710 and 2702 Ma for the two analyses in Group P are interpreted to reflect minor ancient loss of radiogenic Pb.

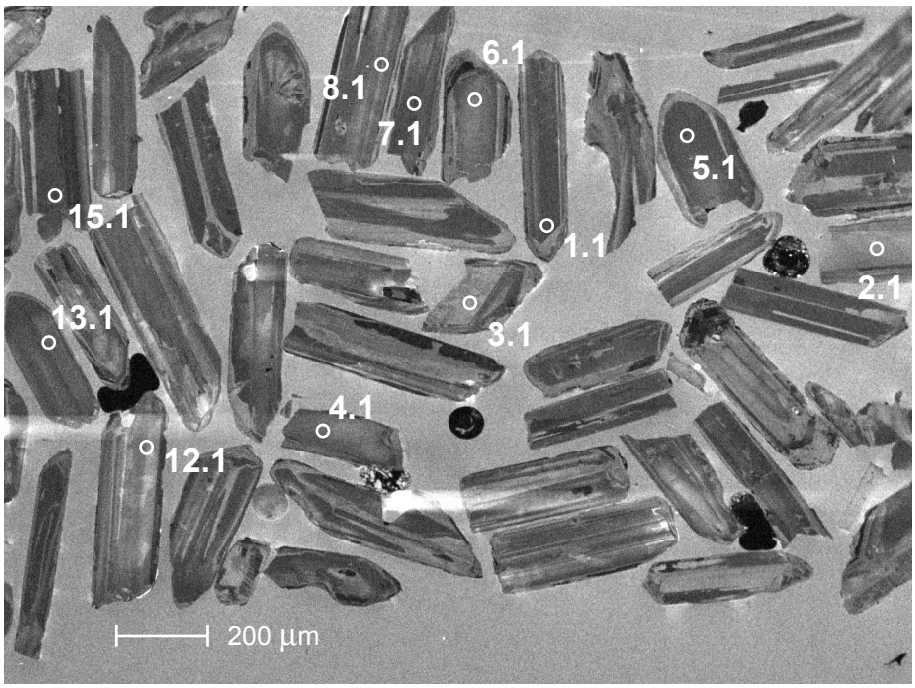

Figure 1. Cathodoluminescence image of representative zircons from sample 185923: biotite–hornblende tonalite gneiss, Granite Rock. Numbered circles indicate the approximate locations of analysis sites.

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 in press, Long-lived, autochthonous development of the Archean Murchison Domain, Yilgarn Craton: Precambrian Research.

Recommended reference for this publication

Wingate, MTD, Kirkland, CL and Van Kranendonk, MJ 2011, 185923: biotite–hornblende tonalite gneiss, Granite Rock; Geochronology Record 970: Geological Survey of Western Australia, 4p.

Data obtained: 23 May 2009
Data released: 30 June 2011

Table 1. Ion microprobe analytical results for zircons from sample 185923: biotite–hornblende tonalite gneiss, Granite Rock

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	11	11.1	324	178	0.57	0.022	1.920	0.017	0.18740	0.00048	1.920	0.017	0.18721	0.00049	2703	19	2718	4	0.6
I	14	14.1	371	102	0.29	0.075	2.004	0.020	0.18800	0.00097	2.005	0.020	0.18733	0.00099	2608	21	2719	9	4.1
I	15	15.1	562	140	0.26	0.021	1.925	0.013	0.18761	0.00037	1.925	0.013	0.18743	0.00038	2697	15	2720	3	0.9
I	17	17.1	382	70	0.19	0.085	1.842	0.013	0.18823	0.00045	1.843	0.013	0.18747	0.00047	2794	16	2720	4	-2.7
I	8	8.1	281	147	0.54	0.020	1.964	0.015	0.18766	0.00052	1.964	0.015	0.18748	0.00052	2653	16	2720	5	2.5
I	13	13.1	357	115	0.33	0.024	1.926	0.016	0.18778	0.00047	1.927	0.016	0.18757	0.00050	2695	18	2721	4	1.0
I	9	9.1	353	95	0.28	0.035	1.962	0.014	0.18802	0.00048	1.963	0.014	0.18771	0.00049	2654	16	2722	4	2.5
I	18	18.1	469	302	0.66	0.014	1.931	0.014	0.18818	0.00041	1.932	0.014	0.18805	0.00042	2689	16	2725	4	1.3
I	16	16.1	451	99	0.23	0.010	1.902	0.014	0.18809	0.00041	1.903	0.014	0.18800	0.00042	2723	16	2725	4	0.1
I	4	4.1	269	59	0.23	-0.031	1.921	0.014	0.18773	0.00052	1.921	0.014	0.18801	0.00054	2702	16	2725	5	0.8
I	1	1.1	525	132	0.26	-0.003	1.919	0.013	0.18806	0.00038	1.919	0.013	0.18809	0.00038	2703	15	2726	3	0.8
I	5	5.1	427	115	0.28	-0.005	1.938	0.014	0.18814	0.00042	1.938	0.014	0.18819	0.00042	2682	16	2726	4	1.6
I	12	12.1	138	36	0.27	0.024	1.882	0.022	0.18831	0.00074	1.882	0.022	0.18810	0.00076	2747	26	2726	7	-0.8
I	7	7.1	374	81	0.22	0.064	1.911	0.014	0.18911	0.00045	1.912	0.014	0.18854	0.00048	2712	16	2729	4	0.6
I	6	6.1	195	45	0.24	-0.021	1.938	0.015	0.18887	0.00063	1.938	0.015	0.18906	0.00063	2683	17	2734	6	1.9
I	2	2.1	170	56	0.34	-0.013	1.928	0.015	0.18908	0.00065	1.928	0.015	0.18919	0.00066	2694	18	2735	6	1.5
P	10	10.1	929	345	0.38	0.081	2.064	0.014	0.18618	0.00030	2.066	0.014	0.18546	0.00032	2545	14	2702	3	5.8
P	3	3.1	1009	928	0.95	0.005	2.009	0.014	0.18633	0.00028	2.009	0.014	0.18629	0.00028	2604	14	2710	2	3.9

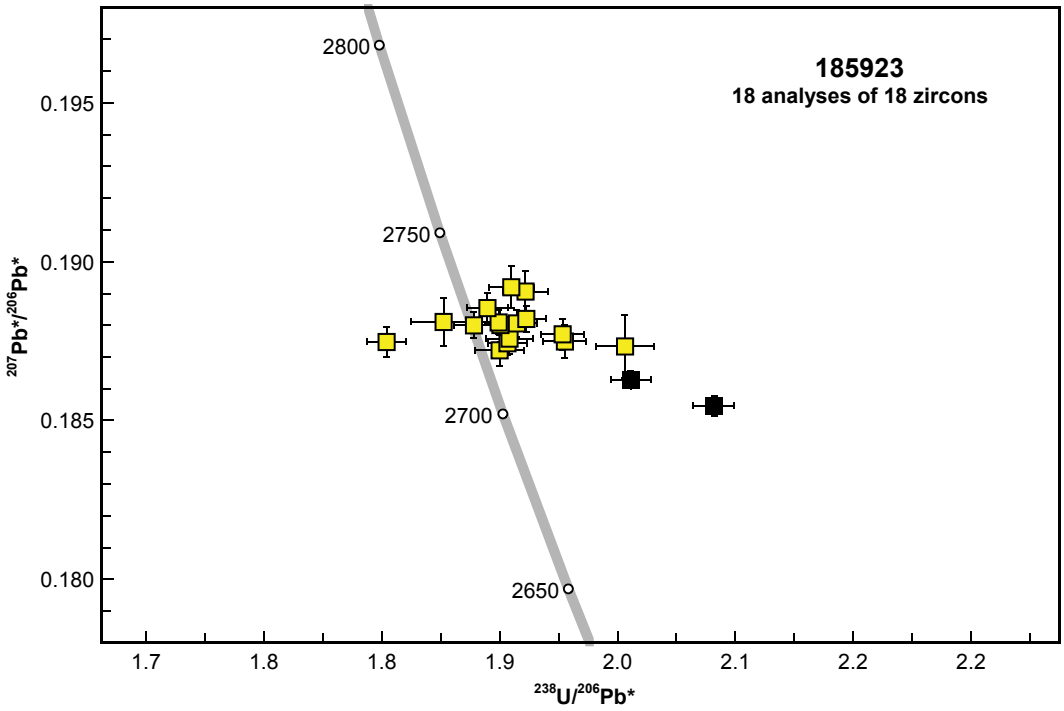

Figure 2. **U–Pb analytical data for sample 185923: biotite–hornblende tonalite gneiss, Granite Rock. Yellow squares indicate Group I (magmatic zircons); black squares indicate Group P (radiogenic-Pb loss).**