182477: mafic granulite, Big Red prospect

(Nornalup Zone, Albany–Fraser Orogen)

Location and sampling

SEEMORE (SH 51-12), CLAYPAN (3837)
MGA Zone 51, 688400E 6649200N

Sampled on 17 August 2010

This sample was collected from diamond drillcore from hole BRDDH002, located on the Big Red prospect, at a depth of 125.4 – 126.4 m. The hole was drilled by Teck Australia Pty Ltd, and was co-funded through the Exploration Incentive Scheme. The drillhole is located on the Nullarbor Plain, approximately 16.4 km south of Fifty Mile Claypan, 36.2 km northeast of Native Willow Bore (Kananda Station), and 57.5 km west of radio mast R204 on the Rawlinna–Warburton Road (Connie Sue Highway).

Tectonic unit/relations

The sample is from drillhole BRDDH002, which intersected Precambrian basement rocks beneath the Mesozoic–Cenozoic Eucla Basin at a depth of 102.2 m; the total depth of the hole was 147.6 m. BRDDH002 was drilled to investigate a subcircular gravity high, located approximately 2 km west of a magnetic high interpreted from detailed aeromagnetic data as a potential magnetite-bearing stratigraphic iron-formation, possibly associated with copper–gold mineralization (Tillick, 2010). This magnetic anomaly is located within the eastern Nornalup Zone of the Albany–Fraser Orogen, which contains 1800–1760 Ma metagranitic rocks similar in age to some metagranitic rocks in the Biranup Zone, overlain by metasedimentary rocks of the Arid Basin (Spaggiari et al., 2011). The Nornalup Zone is intruded by rocks of the Mesoproterozoic Recherche and Esperance Supersuites (Nelson et al., 1995).

The Precambrian rocks in BRDDH002 comprise strongly deformed and metamorphosed rocks, including foliated, garnet-bearing amphibolite and mafic granulite (up to 5 m thick), of which the present sample is representative; coarse-grained K-feldspar–quartz–biotite granitic gneiss; and folded, garnet-bearing psammitic gneiss (see also Tillick, 2010). These rocks represent a succession of migmatitic paragneissic and metagranitic rocks, with possible mafic sills. A sample of granitic gneiss (GSWA 182476, Kirkland et al., 2012d) from this same drillhole yielded a crystallization age of 1326 ± 6 Ma and an age of metamorphism of 1187 ± 9 Ma.

Three additional samples at the Big Red prospect were dated from drillhole BRDDH001, located 2.1 km to the east of BRDDH002. Two samples of migmatitic gneiss (GSWA 182473, Kirkland et al., 2012a; GSWA 182475, Kirkland et al., 2012c) yielded maximum depositional ages (1σ) of 1729 ± 27 and 1685 ± 11 Ma, respectively. These rocks are intruded by veins of granite pegmatite, one of which (GSWA 182474, Kirkland et al., 2012b) provided a crystallization age of 1167 ± 2 Ma.

Petrographic description

The sample is a medium-grained mafic granulite composed of 49% amphibole, 30% plagioclase, 15% clinopyroxene, 5% biotite, and minor apatite, zircon, garnet, and opaque oxide minerals. Granular anhedral clinopyroxene is a non-pleochroic diopside partly replaced by hornblende and biotite. Plagioclase crystals (andesine, An42–50) are inclusion-free, albite-twinned, and anhedral. Hornblende is strongly pleochroic, green-brown, and is partially altered to biotite, which itself is weakly altered and associated with iron-oxide minerals. Anhedral garnets, partially replaced by amphibole and biotite, are distributed throughout the rock, and are typically surrounded by plagioclase. Apatite occurs as inclusions within amphibole.

Zircon morphology

Zircons isolated from this sample are anhedral to subhedral, generally rounded, colourless, and transparent to translucent. The crystals are up to 300 μm long, and mainly equant, with aspect ratios up to 2.5:1. Most zircons are dark and homogeneous in cathodoluminescence (CL) images, exhibiting few distinctive internal features, although a few low-uranium crystals luminesce brightly. A CL image of representative zircons is shown in Figure 1.

Analytical details

This sample was analysed on 6–7 September 2011, using SHRIMP-B. Fourteen analyses of the BR266 standard were obtained during the session, and indicated an external spot-to-spot (reproducibility) uncertainty of 0.50% (1σ) and a $^{238}U/^{206}Pb^*$ calibration uncertainty of 0.12% (1σ). Calibration uncertainties are included in the

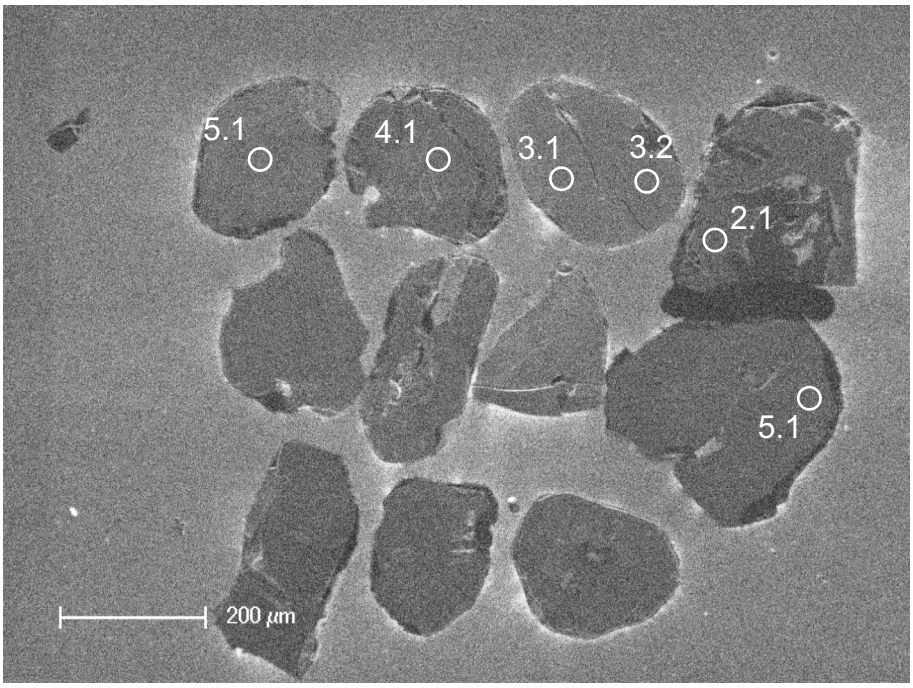

Figure 1. Cathodoluminescence image of representative zircons from sample 182477: mafic granulite, Big Red prospect. Numbered circles indicate the approximate positions of analysis sites.

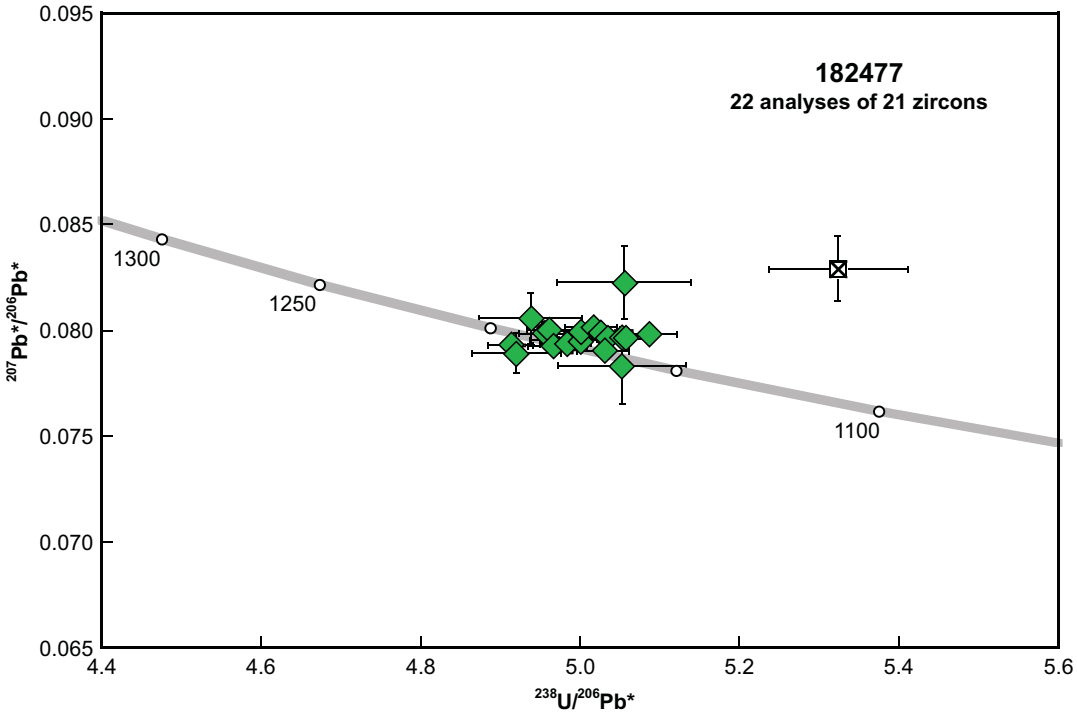

Figure 2. U–Pb analytical data for sample 182477: mafic granulite, Big Red prospect. Green diamonds indicate Group M (metamorphic zircons); crossed square indicates Group D (discordance >5%).

Table 1. Ion microprobe analytical results for zircons from sample 182477: mafic granulite, Big Red prospect

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. (%)
M	10	9.1	60	30	0.51	0.314	5.038	0.080	0.08099	0.00127	5.053	0.080	0.07834	0.00184	1164	17	1156	47	-0.7
M	12	11.1	123	45	0.38	0.069	4.916	0.056	0.07952	0.00084	4.920	0.056	0.07894	0.00093	1193	13	1171	23	-1.9
M	15	14.1	1367	287	0.22	0.000	5.029	0.032	0.07904	0.00024	5.029	0.032	0.07904	0.00024	1169	7	1173	6	0.3
M	20	19.1	1227	352	0.30	0.024	4.966	0.032	0.07946	0.00027	4.967	0.032	0.07925	0.00028	1182	7	1178	7	-0.3
M	2	2.1	5878	399	0.07	0.028	4.912	0.029	0.07955	0.00015	4.913	0.029	0.07932	0.00016	1194	7	1180	4	-1.2
M	18	17.1	1982	504	0.26	0.021	4.978	0.030	0.07950	0.00021	4.979	0.030	0.07933	0.00021	1180	7	1180	5	0.0
M	5	4.1	2175	360	0.17	0.002	4.984	0.030	0.07943	0.00020	4.984	0.030	0.07942	0.00020	1179	7	1183	5	0.3
M	21	20.1	1644	593	0.37	0.005	4.968	0.031	0.07956	0.00023	4.968	0.031	0.07952	0.00023	1182	7	1185	6	0.2
M	9	8.1	1455	318	0.23	0.023	4.996	0.031	0.07974	0.00024	4.997	0.031	0.07955	0.00025	1176	7	1186	6	0.8
M	22	21.1	1733	479	0.29	0.012	4.991	0.031	0.07968	0.00023	4.991	0.031	0.07958	0.00023	1177	7	1187	6	0.8
M	14	13.1	1192	346	0.30	0.017	5.053	0.032	0.07977	0.00027	5.054	0.032	0.07962	0.00028	1164	7	1188	7	2.0
M	6	5.1	1496	417	0.29	0.000	5.060	0.032	0.07971	0.00024	5.060	0.032	0.07971	0.00024	1163	7	1190	6	2.3
M	4	3.2	1168	306	0.27	0.000	5.033	0.033	0.07971	0.00027	5.033	0.033	0.07971	0.00027	1168	7	1190	7	1.8
M	3	3.1	1466	503	0.35	0.027	5.086	0.034	0.08005	0.00028	5.088	0.034	0.07982	0.00030	1157	7	1193	7	3.0
M	17	16.1	1218	366	0.31	-0.003	4.956	0.032	0.07983	0.00026	4.956	0.032	0.07986	0.00026	1185	7	1193	7	0.7
M	1	1.1	1978	371	0.19	0.028	5.022	0.030	0.08011	0.00020	5.024	0.030	0.07988	0.00021	1170	6	1194	5	2.0
M	13	12.1	2017	413	0.21	0.008	5.000	0.030	0.08005	0.00020	5.000	0.030	0.07998	0.00020	1175	7	1197	5	1.8
M	19	18.1	2109	721	0.35	0.010	4.963	0.030	0.08014	0.00021	4.963	0.030	0.08005	0.00021	1183	7	1198	5	1.2
M	16	15.1	1424	272	0.20	0.009	5.013	0.032	0.08024	0.00025	5.014	0.032	0.08016	0.00026	1172	7	1201	6	2.4
M	11	10.1	89	43	0.50	0.139	4.931	0.065	0.08175	0.00099	4.938	0.065	0.08057	0.00120	1189	14	1211	29	1.8
M	7	6.1	55	21	0.40	-0.240	5.067	0.084	0.08023	0.00128	5.055	0.084	0.08227	0.00173	1164	18	1252	41	7.0
D	8	7.1	50	27	0.55	0.084	5.320	0.087	0.08363	0.00135	5.324	0.087	0.08292	0.00153	1110	17	1267	36	12.4

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-two analyses were obtained from 21 zircons. Results are listed in Table 1, and are shown in a concordia diagram (Fig. 2).

Interpretation

The analyses are concordant to slightly discordant (Fig. 2). One analysis is >10% discordant. The date obtained from this analysis (Group D; Table 1) is imprecise and unreliable, and is considered not geologically significant. The remaining 21 analyses define one coherent group, based on their $^{207}Pb^*/^{206}Pb^*$ ratios.

Group M comprises 21 analysis of 20 zircons (Table 1), which yield a weighted mean $^{207}Pb^*/^{206}Pb^*$ date of 1188 ± 4 Ma (MSWD = 1.7).

The date of 1188 ± 4 Ma for the 21 analyses in Group M is interpreted as the age of a high-grade metamorphic event during the 1215–1140 Ma Stage II of the Albany–Fraser Orogeny (Clark et al., 2000). The rounded forms of Group M zircons are characteristic of granulitic or eclogitic zircons, grown under high-pressure conditions (Tichomirowa et al., 2005). The homogeneous textures observed in this sample could imply near-equlibrium growth in metamorphic fluids, or else growth within a fluid whose composition did not change significantly during crystallization (Corfu et al., 2003). The date of 1188 ± 4 Ma is also a minimum crystallization age for the protolith of this rock.

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Recommended reference for this publication

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