178187: dolerite sill, Reid Bore

(Warakurna Supersuite, Pilbara region)

Location and sampling

YARRIE (SF 51-1), MUCCAN (2956)
MGA Zone 51, 217594E 7726283N

Sampled on 9 September 2006

This sample was collected from a low bouldery outcrop on the east side of a creek and 50 m west of a prominent hill, on Yarrie Station. The outcrop is about 4.7 km northeast of Lake Bore, 3.7 km southeast of Cattle Gorge Bore, and 2.1 km west of Reid Bore.

Tectonic unit/relations

The unit sampled is a dolerite sill of the Warakurna Supersuite, which is intruded into the Eel Creek Formation in the eastern Pilbara region (Hickman, 1983; Williams, 1999). The Eel Creek Formation consists of basal conglomerate, shale, mudstone, siltstone, sandstone, and minor felsic volcanic rocks (Williams, 1999). The sedimentary rocks dip to the north and east, overlie Archean rocks of the eastern Pilbara Craton along an angular unconformity, and are overlain unconformably by the Permian Paterson Formation or the Jurassic–Cretaceous Callawa Formation (Williams, 1999). Prior to the results described in this report, the Eel Creek Formation was thought to represent a westward extension of the mid-Neoproterozoic Tarcunyah Group (Williams, 1999). The Tarcunyah Group was deposited after c. 840 Ma but prior to the 750–720 Ma Miles Orogeny (Grey et al., 2005). The geochronology in this report establishes that the Eel Creek Formation belongs to an older siliciclastic succession than the Tarcunyah Group.

The Warakurna Supersuite consists of mafic and felsic extrusive rocks, layered mafic–ultramafic intrusions, gabbros, granites, and mafic dykes that collectively form the Warakurna Large Igneous Province (LIP), which has an areal extent of at least 1.5 million km^2 in central and western Australia (Wingate et al., 2004; Morris and Pirajno, 2005). In the Capricorn and eastern Pilbara regions, the Warakurna Supersuite consists mainly of dolerite sills and dykes (Wingate, 2002, 2003; Wingate et al., 2004). Recent geochronology, including that for the present sample, shows that the Warakurna LIP extends northward into the Eel Creek area east of the Pilbara Craton, and also southward into the central Yilgarn Craton (fig. 9 of Howard et al., 2011). Dates of 1064 ± 14 and 1077 ± 9 Ma, also for a dolerite sill within the Eel Creek Formation, were previously reported by Rasmussen et al. (2012) for tranquillityite and zirconolite, respectively.

Petrographic description

The sample is a medium-grained dolerite comprising approximately 35–40% plagioclase, 30–40% clinopyroxene, 10–15% quartz–feldspar myrmekite, 10% opaque oxide minerals, 5–8% olivine, 2–3% hornblende, and minor chlorite, apatite, baddeleyite, and zircon. The dolerite has a subophitic texture, with randomly oriented plagioclase laths and interstitial clinopyroxene. Plagioclase is up to 3 mm long, and is slightly altered to sericite. Clinopyroxene (augite) is up to 2 mm long, pink in plane-polarized light, typically twinned, and locally exhibits minor alteration to amphibole. Olivine is anhedral, strongly fractured, and up to 1.5 mm across. Myrmekitic intergrowths are interstitial to plagioclase.

Baddeleyite morphology

Baddeleyites isolated from this sample are dark brown, subhedral to euhedral, and up to 120 µm long. A transmitted-light image of representative baddeleyites is shown in Figure 1.

Analytical details

This sample was analysed on 13–14 April 2007, using SHRIMP-B. Ten analyses of the Phalaborwa standard obtained during the session indicated an external spot-to-spot (reproducibility) uncertainty of 5.41% (1σ) and a $^{238}U/^{206}Pb^*$ calibration uncertainty of 1.70% (1σ). Dispersion in $^{238}U/^{206}Pb^*$ data for baddeleyite is due mainly to crystal orientation effects (Wingate and Compston, 2000). 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 24 baddeleyites. Results are listed in Table 1, and shown in a concordia diagram (Fig. 2).

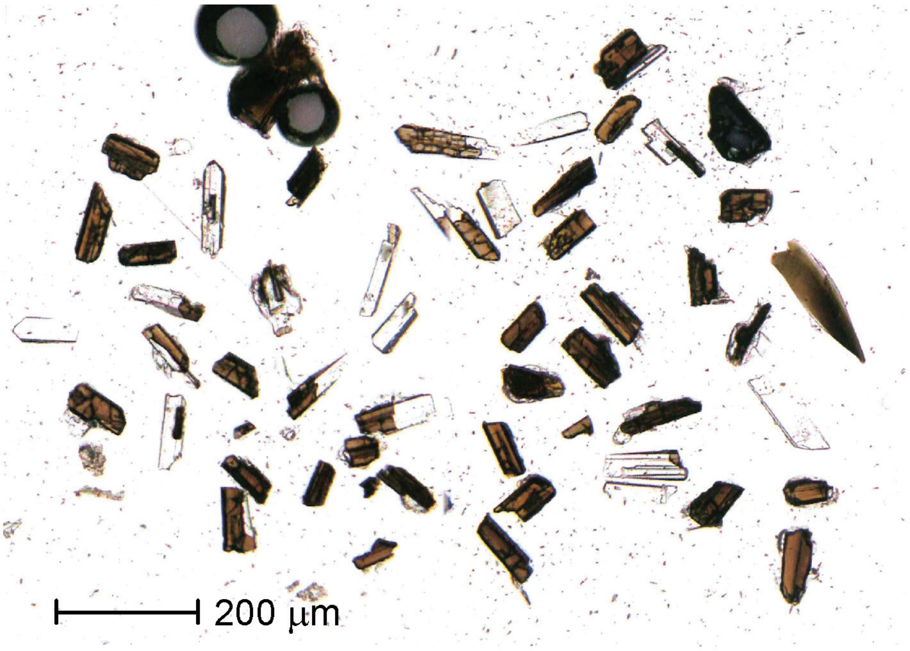

Figure 1. **Transmitted-light image of representative baddeleyites from sample 178187: dolerite sill, Reid Bore. Colourless crystal outlines represent baddeleyites that were dislodged from the epoxy resin during polishing.**

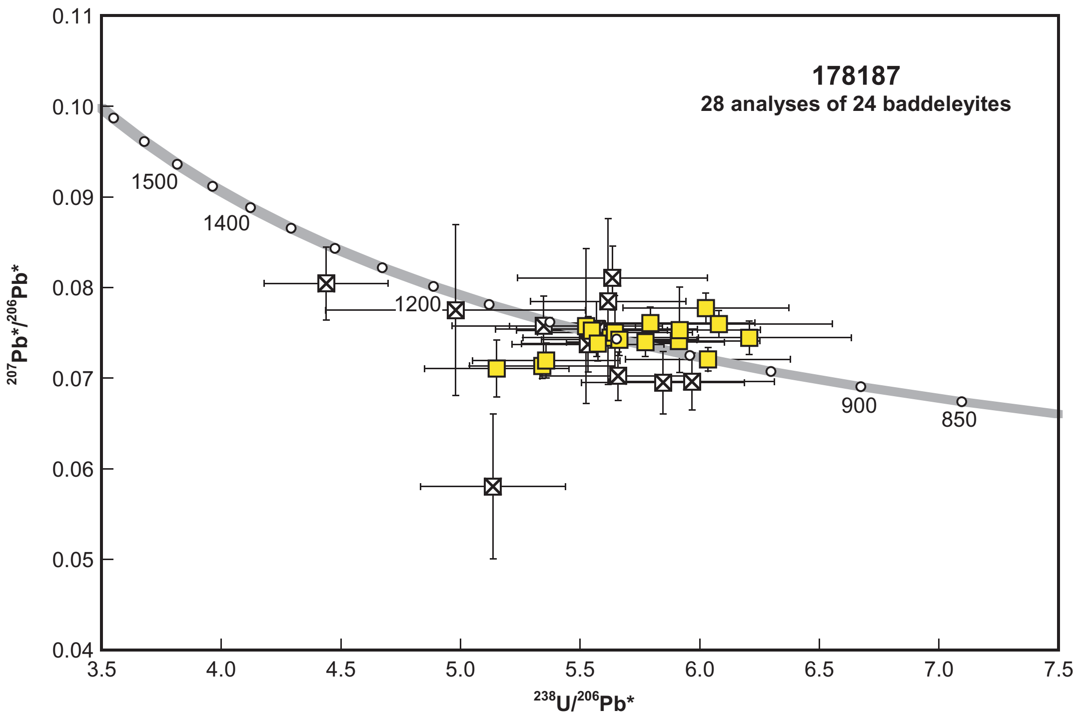

Figure 2. **U–Pb analytical data for sample 178187: dolerite sill, Reid Bore. Yellow squares indicate Group I (magmatic zircons); crossed squares indicate Group D (*f*204 >1%).**

Table 1. Ion microprobe analytical results for baddeleyites from sample 178187: dolerite sill, Reid Bore

Group ID	Spot no.	Grain. spot	^{238}U (ppm)	^{232}Th (ppm)	$^{232}Th/^{238}U$	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	1	1.1	43	3	0.07	0.622	5.120	0.300	0.07624	0.00175	5.152	0.302	0.07106	0.00315	1144	65	959	90	-19.2
I	20	20.1	181	30	0.17	0.570	5.311	0.304	0.07610	0.00079	5.342	0.305	0.07134	0.00139	1106	61	967	40	-14.4
I	23	23.1	123	11	0.09	0.696	5.321	0.305	0.07776	0.00104	5.358	0.308	0.07194	0.00193	1103	61	984	55	-12.1
I	25	2.2	150	15	0.10	0.239	6.021	0.344	0.07407	0.00095	6.035	0.345	0.07207	0.00131	988	55	988	37	0.0
I	6	6.1	152	19	0.13	0.744	5.533	0.317	0.08006	0.00100	5.574	0.319	0.07382	0.00191	1064	59	1037	52	-2.6
I	8	8.1	106	16	0.16	0.523	5.743	0.329	0.07835	0.00093	5.773	0.330	0.07397	0.00158	1030	58	1041	43	1.0
I	3	3.1	104	7	0.07	0.255	5.898	0.338	0.07624	0.00111	5.913	0.339	0.07411	0.00155	1007	57	1044	42	3.6
I	5	5.1	212	34	0.17	0.854	5.616	0.321	0.08141	0.00088	5.664	0.324	0.07425	0.00175	1048	58	1048	47	0.0
I	10	10.1	99	9	0.10	0.492	6.177	0.424	0.07856	0.00110	6.207	0.426	0.07444	0.00184	963	66	1053	50	8.6
I	27	8.2	219	30	0.14	0.555	5.597	0.365	0.07914	0.00069	5.628	0.367	0.07449	0.00117	1054	67	1055	32	0.0
I	18	18.1	132	16	0.13	0.590	5.612	0.321	0.07999	0.00387	5.646	0.323	0.07503	0.00407	1051	59	1069	109	1.7
I	4	4.1	328	69	0.22	0.570	5.518	0.314	0.08004	0.00056	5.550	0.316	0.07526	0.00105	1068	59	1075	28	0.7
I	21	21.1	147	31	0.22	0.944	5.860	0.335	0.08324	0.00442	5.916	0.338	0.07531	0.00472	1007	56	1077	126	6.5
I	15	15.1	56	5	0.09	0.237	5.512	0.318	0.07772	0.00847	5.525	0.319	0.07574	0.00855	1072	60	1088	226	1.4
I	26	10.2	113	12	0.11	0.348	6.059	0.472	0.07891	0.00100	6.080	0.474	0.07598	0.00150	982	76	1095	40	10.3
I	17	17.1	147	18	0.13	0.838	5.745	0.433	0.08314	0.00089	5.794	0.437	0.07609	0.00174	1026	77	1097	46	6.5
I	2	2.1	108	8	0.07	0.220	6.012	0.345	0.07958	0.00124	6.026	0.346	0.07773	0.00164	990	56	1140	42	13.2
D	11	11.1	80	4	0.05	4.452	4.907	0.285	0.09435	0.00180	5.136	0.302	0.05803	0.00800	1147	65	531	302	-116.0
D	13	13.1	53	6	0.11	1.334	5.769	0.336	0.08061	0.00144	5.847	0.341	0.06950	0.00345	1018	58	914	102	-11.4
D	24	24.1	67	7	0.11	1.357	5.887	0.339	0.08092	0.00132	5.968	0.345	0.06962	0.00316	999	56	917	93	-8.9
D	9	9.1	65	4	0.06	1.090	5.597	0.323	0.07932	0.00121	5.659	0.327	0.07023	0.00267	1049	59	935	78	-12.2
D	14	14.1	124	12	0.10	1.839	5.431	0.311	0.08915	0.00101	5.533	0.317	0.07374	0.00306	1071	60	1034	84	-3.6
D	7	7.1	145	14	0.10	1.479	5.487	0.415	0.08785	0.00128	5.569	0.421	0.07542	0.00302	1065	80	1080	80	1.4
D	12	12.1	73	4	0.05	1.674	5.258	0.376	0.08983	0.00134	5.348	0.383	0.07575	0.00334	1105	78	1088	88	-1.5
D	19	19.1	66	9	0.13	2.406	4.860	0.529	0.09779	0.00845	4.980	0.543	0.07751	0.00944	1180	131	1134	242	-4.0
D	22	22.1	67	4	0.06	3.345	5.430	0.313	0.10670	0.00716	5.618	0.326	0.07845	0.00912	1056	60	1158	231	8.8
D	16	16.1	110	9	0.08	1.515	4.371	0.254	0.09327	0.00172	4.439	0.259	0.08044	0.00401	1310	73	1208	98	-8.4
D	28	14.2	156	102	0.68	1.008	5.579	0.392	0.08960	0.00313	5.636	0.396	0.08106	0.00353	1053	73	1223	86	13.9

Interpretation

The analyses are concordant to slightly discordant (Fig. 2). As is the case with analyses of the baddeleyite standard, the discordance is interpreted to reflect crystal orientation effects that bias $^{238}U/^{206}Pb^*$ ratios, but do not affect $^{207}Pb^*/^{206}Pb^*$ ratios (Wingate and Compston, 2000). Eleven analyses indicate high common Pb (*f*204 >1%). The dates obtained from these 11 analyses are imprecise or unreliable, and are considered not to be geologically significant. The remaining 17 analyses form a single group, based on their $^{207}Pb^*/^{206}Pb^*$ ratios.

Group I comprises 17 analyses (Table 1), which yield a weighted mean $^{207}Pb^*/^{206}Pb^*$ date of 1050 ± 22 Ma (MSWD = 1.10).

The date of 1050 ± 22 Ma for the 17 analyses in Group I is interpreted as the magmatic crystallization age of the dolerite sill. This result is within uncertainty of tranquillityite and zirconolite ages reported by Rasmussen et al. (2012) for a separate dolerite sill also intruded into the Eel Creek Formation. The result is also consistent with baddeleyite and zircon ages for Warakurna Supersuite dolerite sills in the Capricorn Orogen and Yilgarn Craton (Wingate, 2002, 2003; Wingate et al., 2008), and with the ages of mafic to felsic igneous rocks in the Musgrave Province (e.g. Evins et al., 2010).

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