219544: altered dolerite dyke, Belvedere mine

(dyke within Mount Roe Basalt, Fortescue Group, Capricorn Orogen)

Location and sampling

WYLOO (SF 50-10), WYLOO (2152)
MGA Zone 50, 427093E 7498864N

Sampled on 26 June 2015

This sample was collected from the 54.3 – 54.6 m depth interval of diamond drillcore PBERCD0045, drilled in 2014 by Northern Star Resources Limited at the Belvedere gold mine (Fielding et al., 2018). The drillhole is located on Mount Stuart Station, about 8.8 km east of Tin Hut Bore, 6.4 km west of Billaroo Bore, and 6.4 km southeast of Paulsens gold mine. This sample was collected and analysed as part of a PhD research project completed in 2018 at Curtin University (Fielding, 2019).

Geological context

The unit sampled is a north-trending, altered dolerite dyke (Fig. 1) that is not assigned to a formal rock unit. The dyke is intruded into vesicular basalt and siliciclastic sedimentary rocks of the Mount Roe Basalt (Thorne and Trendall, 2001; Hickman et al., 2010). The Mount Roe Basalt is dated at about 2775–2772 Ma, based on U–Pb geochronology of the lower Mount Roe Basalt and dykes of the Black Range Dolerite (Arndt et al., 1991; Wingate et al., 1999). The dyke of which the present sample is representative is the host rock to gold-mineralized quartz veins at the Belvedere mine, which were sampled lower in this drillhole and yielded xenotime crystallization ages of c. 1680 Ma (GSWA 219549, Fielding and Wingate, 2021a; GSWA 219551, Fielding and Wingate, 2021b).

Petrographic description

The sample is a massive, medium-grained, strongly altered dolerite, consisting of about 35% plagioclase, 35% actinolite, 12% quartz, 10% undifferentiated feldspar, 8% opaque minerals, and minor chlorite. Actinolite and minor chlorite form pseudomorphs, that are subhedral, equant, up to 3 mm long, and probably represent former pyroxene and ferromagnesian minerals. Plagioclase is anhedral to subhedral, up to 2 mm long, and altered to epidote. Quartz is anhedral, up to 3 mm in diameter, and intergrown with clay-altered feldspar. Opaque grains include skeletal titanite grains up to 2 mm in size that may have replaced titanomagnetite. The rock is not obviously deformed or metamorphosed.

Baddeleyite morphology

Baddeleyite in this sample is pale brown to dark brown and subhedral to euhedral. The crystals are up to 100 µm long, and equant to acicular, with aspect ratios up to 9:1. Many baddeleyite crystals are altered and their outer surfaces are partially replaced by polycrystalline zircon. A backscattered electron (BSE) image of representative baddeleyites is shown in Figure 2.

Analytical details

This sample was analysed on 15–16 May 2017, using SHRIMP-B. Baddeleyite was analysed in plugs cut from polished thin sections following procedures described by Fielding (2019). During the analytical session, a 50 µm Köhler aperture was used to obtain a primary beam diameter of ~10 µm. Seven analyses of the c. 2060 Ma Phalaborwa baddeleyite standard obtained during the session indicated an external spot-to-spot (reproducibility) uncertainty of 5.66% (1σ) and a ^{238}U/^{206}Pb* calibration uncertainty of 2.26% (1σ). Isotopic mass fractionation of ^{207}Pb/^{206}Pb ratios during the session was corrected by reference to the OGC1 standard; measured ratios were increased by 0.62%. 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

Fifteen analyses were obtained from 10 baddeleyites. Results are listed in Table 1, and shown in a concordia diagram (Fig. 3).

Interpretation

The analyses are concordant to strongly discordant (Fig. 3). As is the case with analyses of the baddeleyite standard, the discordance is attributed to crystal orientation effects that bias ^{238}U/^{206}Pb* ratios, but do not affect ^{207}Pb*/^{206}Pb* ratios (Wingate and Compston, 2000). Six analyses indicate high common Pb (f_{204} >1%). The dates obtained from these six analyses (Group D, Table 1) are unreliable, and considered not to be geologically significant. The remaining nine analyses form a single group, based on their ^{207}Pb*/^{206}Pb* ratios.

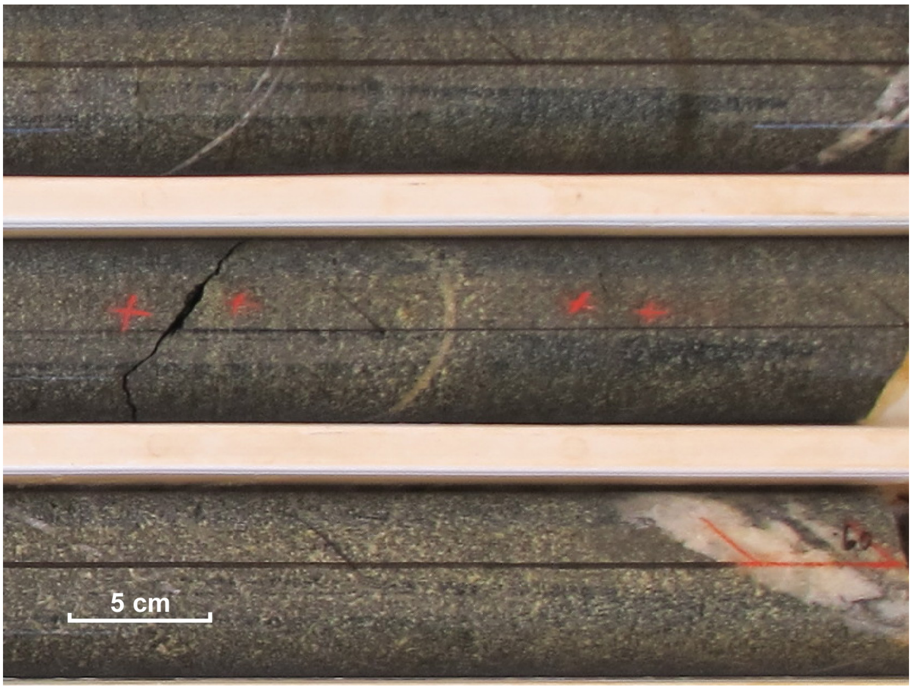

Figure 1. Drillcore image for sample 219544: altered dolerite dyke, Belvedere mine

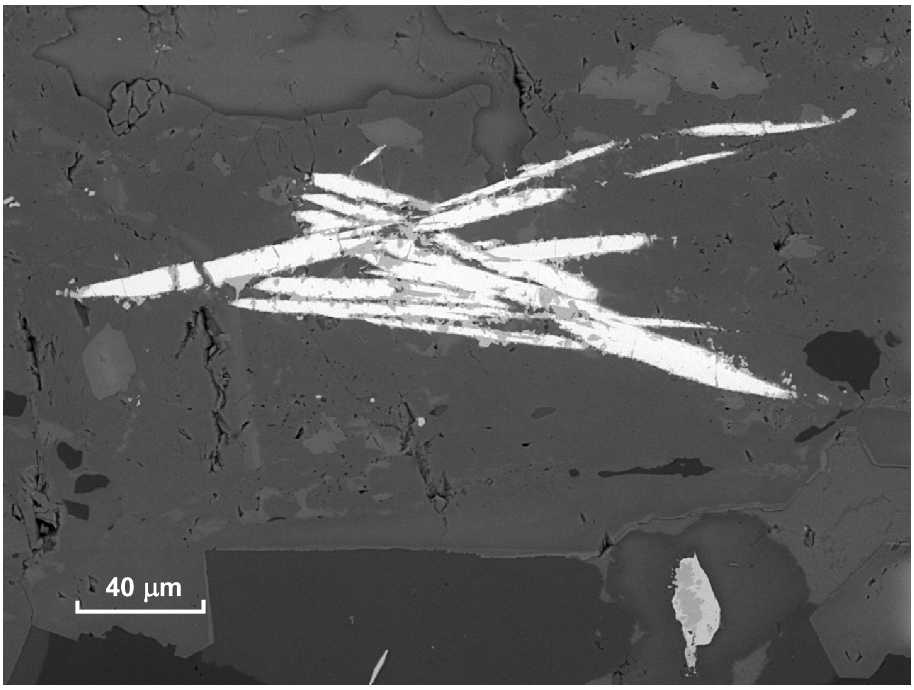

Figure 2. BSE image of representative baddeleyites from 219544: altered dolerite dyke, Belvedere mine

Table 1. Ion microprobe analytical results for baddeleyites from sample 219544: altered dolerite dyke, Belvedere mine

Group ID	Spot no.	Grain. spot	^{238}U (ppm)	^{232}Th (ppm)	$\frac{^{232}Th}{^{238}U}$	ƒ204 (%)	$^{238}U/^{206}Pb$	± 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	14	B.2-3	215	7	0.033	0.415	2.632	0.167	0.12449	0.00211	2.643	0.168	0.12083	0.00268	2069	115	1968	40	-5.1
I	5	E.1-1	152	6	0.039	0.957	2.139	0.149	0.13073	0.00264	2.160	0.151	0.12227	0.00417	2453	146	1990	61	-23.3
I	4	D.1-1	231	46	0.200	0.747	2.539	0.158	0.13351	0.00241	2.558	0.160	0.12689	0.00349	2127	116	2055	48	-3.5
I	1	A.1-1	251	8	0.032	0.101	2.451	0.152	0.12870	0.00235	2.453	0.153	0.12781	0.00252	2204	119	2068	35	-6.6
I	13	B.2-2	132	3	0.023	0.524	2.743	0.172	0.13246	0.00264	2.757	0.173	0.12781	0.00352	1995	110	2068	49	3.5
I	7	G.1-2	129	3	0.025	0.454	2.750	0.175	0.13221	0.00334	2.762	0.176	0.12818	0.00439	1992	111	2073	60	3.9
I	9	G.1-3	107	6	0.058	-0.218	2.798	0.201	0.12931	0.00324	2.791	0.201	0.13124	0.00376	1974	124	2115	50	6.7
I	6	G.1-1	124	5	0.042	-0.096	2.708	0.199	0.13093	0.00347	2.705	0.199	0.13179	0.00349	2028	130	2122	46	4.4
I	3	B.2-1	158	4	0.023	-0.158	2.789	0.176	0.13198	0.00284	2.785	0.176	0.13339	0.00316	1978	110	2143	41	7.7
D	10	H.1-1	101	5	0.048	2.441	2.341	0.149	0.13149	0.00287	2.399	0.153	0.11009	0.00653	2246	124	1801	108	-24.7
D	15	E.1-2	158	8	0.048	1.092	2.471	0.159	0.13039	0.00218	2.499	0.160	0.12075	0.00347	2170	121	1967	51	-10.3
D	12	J.1-1	118	4	0.034	1.522	2.391	0.151	0.13586	0.00271	2.428	0.153	0.12240	0.00493	2224	122	1992	72	-11.7
D	2	B.1-1	209	16	0.079	1.272	2.757	0.173	0.13926	0.00609	2.793	0.175	0.12798	0.00736	1973	109	2070	101	4.7
D	11	I.1-1	73	8	0.114	2.634	2.318	0.152	0.15298	0.00354	2.381	0.158	0.12962	0.00734	2261	129	2093	100	-8.0
D	8	G.2-1	118	5	0.038	1.042	2.389	0.155	0.14451	0.00286	2.414	0.157	0.13524	0.00438	2234	126	2167	56	-3.1

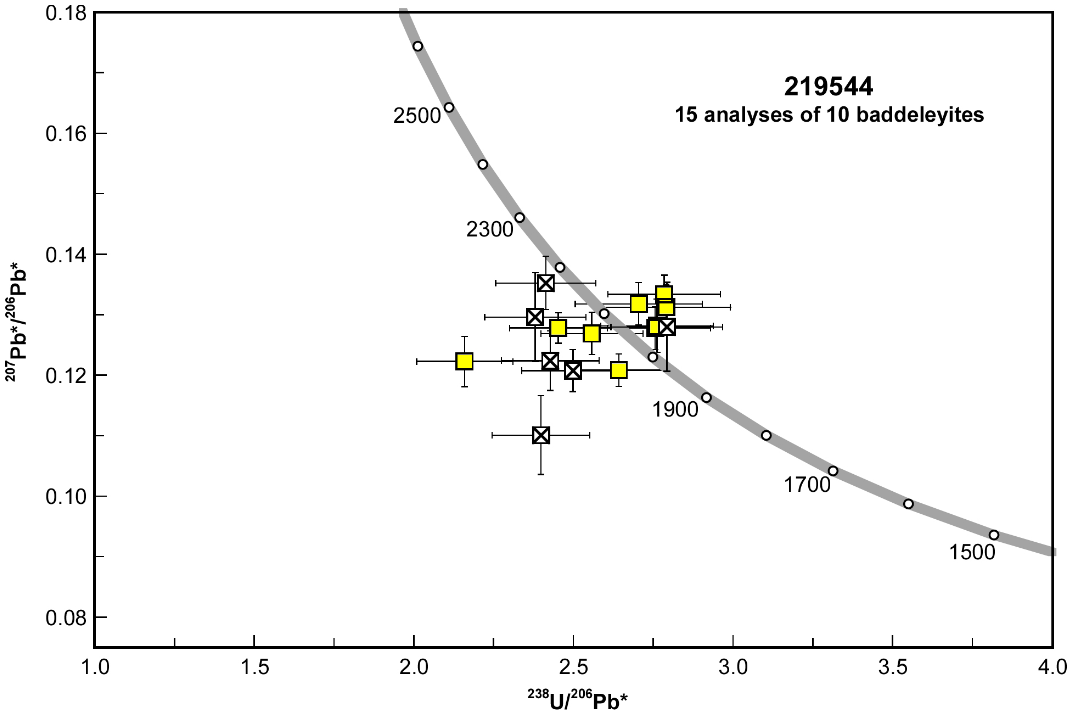

Figure 3. U–Pb analytical data for baddeleyites from sample 219544: altered dolerite dyke, Belvedere mine. Yellow squares indicate Group I (magmatic baddeleyites); crossed squares indicate Group D (high common Pb)

Group I comprises nine analyses of five baddeleyites (Table 1), which yield a weighted mean ^{207}Pb*/^{206}Pb* date of 2068 ± 46 Ma (MSWD = 1.7).

The date 2068 ± 46 Ma for the nine analyses in Group I is interpreted as the magmatic crystallization age of the dolerite dyke.

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Recommended reference for this publication

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