

207259: dolerite sill, Maranoo Well

(Edmund Basin, Capricorn Orogen)

Location and sampling

EDMUND (SH 50-14), MANGAROON (2050)
MGA Zone 50, 365554E 7396984N

Sampled on 7 September 2012

This sample was collected south of an east-trending track on Maroonah Station, from loose boulders amongst outcrop on the top of a prominent scarp formed by an arcuate, northwest-trending dolerite sill (Fig. 1). The sample site is on the eastern side of the dolerite sill outcrop, about 5.3 km north-northeast of Pingagullera Well, 2.3 km southeast of East Paddock Hill, and 2.0 km west of Maranoo Well.

Tectonic unit/relations

The unit sampled is a dolerite sill intruded into carbonate rocks of the Yilgatherra Formation of the Edmund Group, at or near the contact with Gascoyne Province basement. The sill was sampled previously at this locality for paleomagnetic study (Wingate, 2002; Site 22), but yielded inconsistently directed magnetizations, possibly carried by secondary maghemite. Geochemical analysis of this sill suggests affinity with a dolerite sill dated at 1500 ± 3 Ma (GSWA 143445; Wingate et al., 2012), located about 218 km to the southeast, and intruded into siltstone of the Irregularly Formation about 2000 m above the base of the Edmund Group (Martin and Thorne, 2004). The Edmund Group unconformably overlies, and is younger than, 1680–1620 Ma granites of the Gascoyne Province, and is older than dolerite sills of the c. 1465 Ma Narimbunna Dolerite that intrude it (Wingate, 2002; Martin and Thorne, 2004; Morris and Pirajno, 2005).

Petrographic description

The sample is a very coarse-grained leucogabbro from the upper part of the dolerite sill, which elsewhere consists mainly of medium-grained dolerite. The sample is composed of about 40–45% plagioclase, 20–25% quartz–microcline granophyre and myrmekite, 15–20% epidote, 10–20% clinopyroxene (and actinolite–tremolite pseudomorphs after clinopyroxene), and minor to trace chlorite and apatite. Plagioclase (andesine, An₃₄) is subhedral, up to 10 mm long, and strongly altered to saussurite, epidote, and clinozoisite. Relict clinopyroxene (diopside: $C\hat{A}Z = 37^\circ$) and bladed actinolite–tremolite pseudomorphs after clinopyroxene are >10 mm long.

Quartz–microcline granophyre and myrmekite occur in intergranular patches up to 2 mm across. Extensive alteration is indicated by replacement of plagioclase by epidote and clinopyroxene by amphibole.

Zircon morphology

Zircons from this sample are subhedral to euhedral and colourless to dark brown or opaque. The crystals are up to 400 μm long, and mainly elongate, with aspect ratios up to 5:1. In cathodoluminescence (CL) images, colourless crystals exhibit broad concentric zoning or are internally homogeneous, whereas dark brown or opaque crystals display mottled textures and are variably metamict. A CL image of representative zircons is shown in Figure 2.

Analytical details

This sample was analysed on 30–31 May 2013, using SHRIMP-B. Thirteen analyses of the BR266 standard were obtained during the session, of which 12 indicated an external spot-to-spot (reproducibility) uncertainty of 0.82% (1σ) and a $^{238}\text{U}/^{206}\text{Pb}^*$ calibration uncertainty of 0.27% (1σ). Isotopic mass fractionation of $^{207}\text{Pb}/^{206}\text{Pb}$ ratios was corrected by reference to the OGC1 standard; measured ratios in Table 1 were increased by 0.25%. Calibration uncertainties are included in the errors of $^{238}\text{U}/^{206}\text{Pb}^*$ 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

Thirty-three analyses were obtained from 23 zircons. Results are listed in Table 1, and shown in a concordia diagram (Fig 3).

Interpretation

The analyses are concordant to slightly discordant (Fig. 3). The reverse discordance of most analyses is correlated with high uranium and thorium concentrations. This is common in ion microprobe analyses of high-uranium zircons, and reflects sputtering characteristics different to those in the lower-uranium zircon standard, but does not affect the $^{207}\text{Pb}^*/^{206}\text{Pb}^*$ ratios. The analyses define a single coherent group, based on their $^{207}\text{Pb}^*/^{206}\text{Pb}^*$ ratios.



Figure 1. Field photograph for sample 207259: dolerite sill, Maranoo Well. This view of the dolerite sill was taken towards the northeast, about 0.2 km west of the sample site, along an east-trending track.

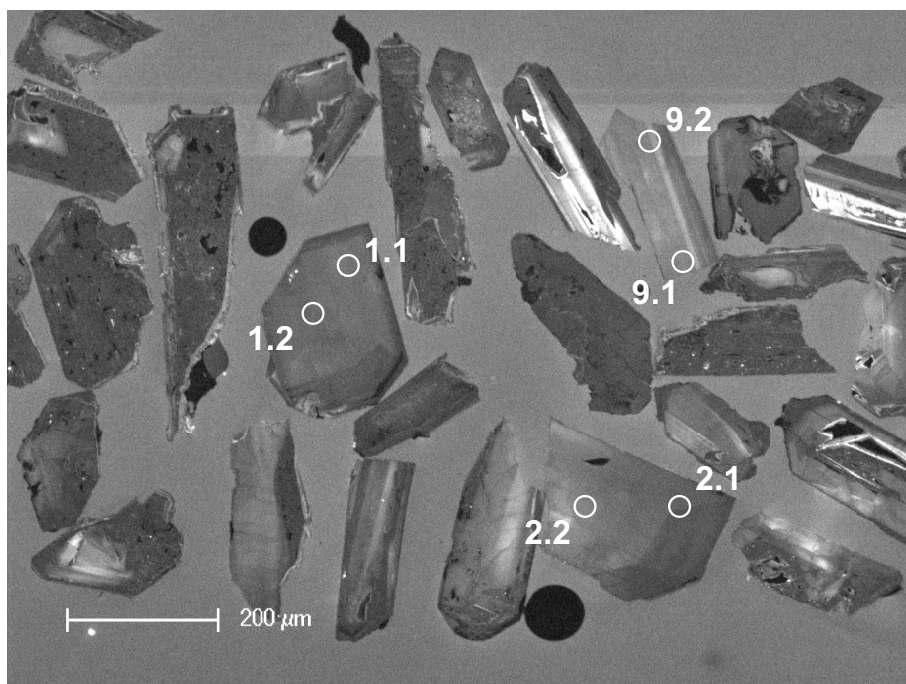


Figure 2. Cathodoluminescence image of representative zircons from sample 207259: dolerite sill, Maranoo Well. Numbered circles indicate the approximate positions of analysis sites.

Table 1. Ion microprobe analytical results for zircons from sample 207259: dolerite sill, Marano Well

Group ID	Spot no.	Grain. spot	^{238}U (ppm)	^{232}Th (ppm)	$\frac{^{232}\text{Th}}{^{238}\text{U}}$	r_{204} (%)	$^{238}\text{U}/^{206}\text{Pb} \pm 1\sigma$	$^{207}\text{Pb}/^{206}\text{Pb} \pm 1\sigma$	$^{238}\text{U}/^{206}\text{Pb}^* \pm 1\sigma$	$^{207}\text{Pb}^*/^{206}\text{Pb}^* \pm 1\sigma$	$^{238}\text{U}/^{206}\text{Pb}^*$ date (Ma) $\pm 1\sigma$	$^{207}\text{Pb}^*/^{206}\text{Pb}^*$ date (Ma) $\pm 1\sigma$	Disc. (%)						
I	14	13.1	374	482	1.33	0.057	3.689	0.040	0.09356	0.00100	3.691	0.040	0.09307	0.00102	1546	15	1489	21	-3.8
I	29	9.2	260	300	1.19	0.088	3.798	0.045	0.09392	0.00107	3.801	0.045	0.09316	0.00111	1506	16	1491	23	-1.0
I	22	21.1	213	1254	6.08	0.063	3.747	0.045	0.09399	0.00108	3.750	0.045	0.09344	0.00111	1524	17	1497	23	-1.8
I	24	23.1	884	1684	1.97	0.076	3.452	0.034	0.09607	0.00093	3.454	0.034	0.09542	0.00095	1639	14	1536	19	-6.7
I	16	15.1	793	2180	2.84	0.024	3.529	0.035	0.09460	0.00093	3.530	0.035	0.09439	0.00094	1608	14	1516	19	-6.1
I	19	18.1	1207	3544	3.03	0.035	3.585	0.034	0.09427	0.00092	3.586	0.034	0.09397	0.00092	1586	14	1508	19	-5.2
I	15	14.1	1608	2468	1.59	0.032	3.607	0.034	0.09486	0.00091	3.608	0.034	0.09458	0.00091	1577	13	1520	18	-3.8
I	1	1.1	592	1102	1.92	-0.006	3.659	0.038	0.09379	0.00096	3.659	0.038	0.09384	0.00096	1557	14	1505	19	-3.5
I	5	5.1	1502	3706	2.55	0.025	3.662	0.035	0.09404	0.00092	3.663	0.035	0.09383	0.00092	1556	13	1505	19	-3.4
I	26	3.2	452	611	1.40	-0.023	3.643	0.039	0.09411	0.00098	3.642	0.039	0.09431	0.00099	1564	15	1514	20	-3.3
I	25	7.2	483	669	1.43	0.030	3.687	0.039	0.09412	0.00098	3.688	0.039	0.09386	0.00099	1547	15	1505	20	-2.8
I	2	2.1	627	1264	2.08	0.017	3.705	0.038	0.09381	0.00095	3.706	0.038	0.09367	0.00096	1540	14	1501	19	-2.6
I	7	7.1	388	565	1.50	0.029	3.713	0.041	0.09403	0.00100	3.714	0.041	0.09378	0.00102	1537	15	1504	20	-2.2
I	30	1.2	528	899	1.76	0.007	3.710	0.039	0.09401	0.00097	3.710	0.039	0.09395	0.00097	1538	14	1507	19	-2.1
I	28	6.2	1296	3655	2.91	0.023	3.704	0.035	0.09437	0.00169	3.705	0.035	0.09416	0.00169	1540	13	1511	34	-1.9
I	32	10.2	757	1507	2.06	0.132	3.691	0.037	0.09546	0.00094	3.695	0.037	0.09432	0.00097	1544	14	1515	19	-1.9
I	3	3.1	377	483	1.32	0.000	3.701	0.041	0.09430	0.00100	3.701	0.041	0.09430	0.00100	1542	15	1514	20	-1.8
I	9	9.1	271	310	1.18	-0.014	3.714	0.044	0.09404	0.00105	3.713	0.044	0.09416	0.00106	1537	16	1511	21	-1.7
I	11	10.1	426	689	1.67	0.026	3.714	0.040	0.09445	0.00099	3.715	0.040	0.09422	0.00100	1537	15	1513	20	-1.6
I	31	11.2	241	276	1.19	0.016	3.752	0.045	0.09389	0.00108	3.753	0.045	0.09375	0.00109	1523	16	1503	22	-1.3
I	20	19.1	398	530	1.38	0.017	3.665	0.040	0.09569	0.00099	3.665	0.040	0.09555	0.00100	1555	15	1539	20	-1.0
I	13	12.1	300	310	1.07	0.037	3.770	0.043	0.09395	0.00104	3.772	0.043	0.09363	0.00105	1516	15	1501	21	-1.0
I	33	13.2	421	580	1.42	0.042	3.750	0.040	0.09461	0.00099	3.751	0.040	0.09424	0.00100	1523	15	1513	20	-0.7
I	27	4.2	347	344	1.02	0.011	3.721	0.041	0.09488	0.00102	3.722	0.042	0.09478	0.00103	1534	15	1524	20	-0.7
I	4	4.1	135	147	1.13	0.027	3.774	0.053	0.09414	0.00121	3.775	0.053	0.09391	0.00123	1515	19	1506	25	-0.6
I	8	8.1	265	673	2.62	-0.014	3.702	0.044	0.09543	0.00106	3.702	0.044	0.09555	0.00107	1542	16	1539	21	-0.2
I	6	6.1	349	581	1.72	0.031	3.738	0.042	0.09515	0.00102	3.739	0.042	0.09488	0.00103	1528	15	1526	20	-0.1
I	12	11.1	200	211	1.09	0.092	3.775	0.047	0.09530	0.00111	3.779	0.047	0.09451	0.00117	1514	17	1518	23	0.3
I	23	22.1	221	250	1.17	-0.033	3.794	0.046	0.09397	0.00109	3.792	0.046	0.09425	0.00111	1509	16	1513	22	0.3
I	17	16.1	299	386	1.33	0.050	3.835	0.125	0.09433	0.00244	3.837	0.125	0.09390	0.00245	1493	45	1506	49	0.9
I	21	20.1	413	411	1.03	-0.009	3.811	0.041	0.09432	0.00099	3.810	0.041	0.09440	0.00100	1502	15	1516	20	0.9
I	18	17.1	249	292	1.21	0.049	3.868	0.046	0.09431	0.00109	3.870	0.046	0.09389	0.00111	1482	16	1506	22	1.6
I	10	2.2	269	313	1.20	-0.124	3.765	0.044	0.09496	0.00106	3.760	0.044	0.09603	0.00112	1520	16	1548	22	1.8

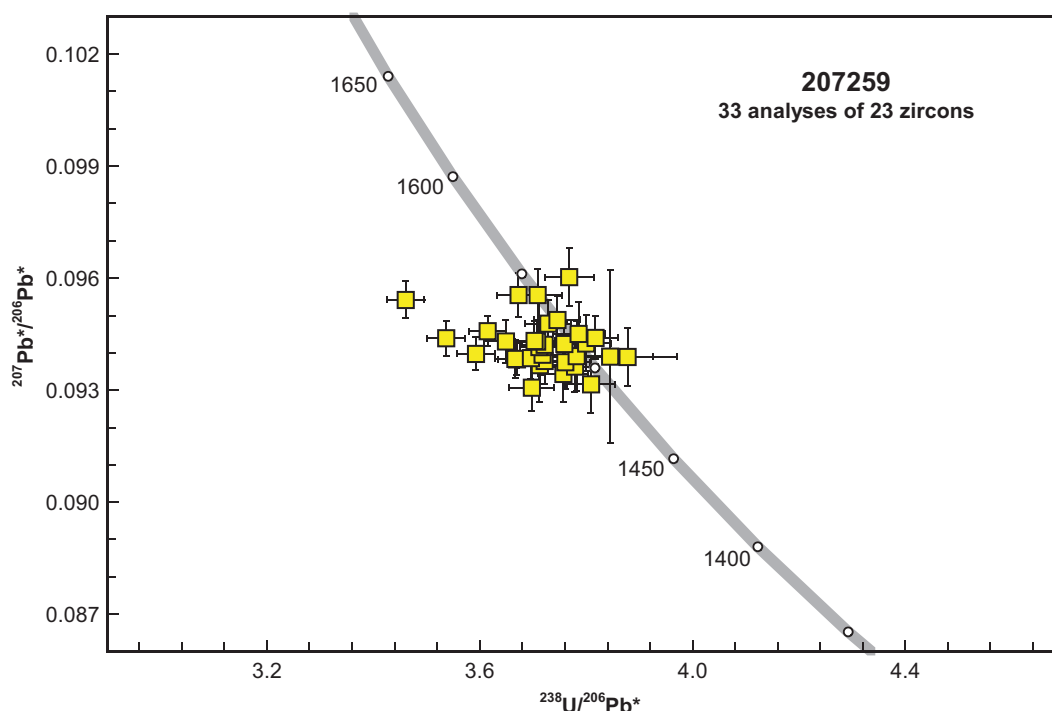


Figure 3. U–Pb analytical data for sample 207259: dolerite sill, Maranoo Well. Yellow squares indicate Group I (magmatic zircons).

Group I comprises 33 analyses of 23 zircons (Table 1), which yield a $^{207}\text{Pb}^*/^{206}\text{Pb}^*$ date of 1513 ± 4 Ma (MSWD = 1.1).

The date of 1513 ± 4 Ma for the 33 analyses in Group I is interpreted as the igneous crystallization age of the dolerite sill. Together with the date of 1500 ± 3 Ma for a dolerite sill located about 218 km to the southeast (GSWA 143445; Wingate et al., 2012), and with geochemical information, this result is evidence that the Edmund Group is intruded by dolerite sills significantly older than the c. 1465 Ma Narimbunna Dolerite.

References

- Martin, DM and Thorne, AM 2004, Tectonic setting and basin evolution of the Bangemall Supergroup in the northwestern Capricorn Orogen: *Precambrian Research*, v. 128, p. 385–409.
- Morris, PA and Pirajno, F 2005, Mesoproterozoic sill complexes in the Bangemall Supergroup, Western Australia: geology, geochemistry, and mineralization potential: Western Australia Geological Survey, Report 99, 75p.
- 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.
- Wingate, MTD 2002, Age and palaeomagnetism of dolerite sills intruded into the Bangemall Supergroup on the Edmund 1:250 000 map sheet, Western Australia: Western Australia Geological Survey, Record 2002/4, 48p.

Wingate, MTD, Kirkland, CL, Cutten, HN and Thorne, AM 2012, 143445: dolerite sill, Waldburg Homestead; *Geochronology Record* 1077: Geological Survey of Western Australia, 4p.

Recommended reference for this publication

Wingate, MTD, Kirkland, CL, Blay, O and Johnson, SP 2013, 207259: dolerite sill, Maranoo Well; *Geochronology Record* 1123: Geological Survey of Western Australia, 4p.

Data obtained: 31 May 2013

Data released: 30 June 2013