

# 195826: monzogranitic gneiss, McCarthy Well

*(Davey Well Granite, Durlacher Supersuite,  
Gascoyne Province, Capricorn Orogen)*

## Location and sampling

MOUNT PHILLIPS (SG 50-2), LOCKIER (1949)  
MGA Zone 50, 372898E 7283465N

Sampled on 18 September 2009

This sample was collected from low, polished pavements on Eudamullah Station, about 7.9 km east-northeast of Crawford Well, 6.4 km southeast of Brown Well, and 3.7 km northwest of McCarthy Well.

## Tectonic unit/relations

The unit sampled is a muscovite–biotite–tourmaline monzogranitic gneiss assigned to the Davey Well Granite of the 1680–1620 Durlacher Supersuite (Sheppard et al., 2010). The Durlacher Supersuite is dominated by granites of granodioritic to monzogranitic composition, and was intruded into the Gascoyne Province during the Mangaroon Orogeny. The Davey Well Granite, part of the Durlacher Supersuite, outcrops over at least 1500 km<sup>2</sup> in the Mutherbukin Zone of the central Gascoyne Province (Sheppard et al., 2010) and also as isolated intrusions in the Mooloo, Limejuice, and Mangaroon Zones. The Davey Well Granite mainly comprises schistose, coarse-grained, strongly porphyritic biotite monzogranite, but at this locality the granite is strongly gneissic, showing development of in-situ cm-scale melt pockets (Fig. 1). Numerous samples of the Davey Well Granite have been dated from the Mutherbukin, Mooloo, and Limejuice Zones (GSWA 183215, 185944, 185945, and 195819), yielding ages between c. 1670 and c. 1648 Ma (Sheppard et al., 2010).

## Petrographic description

The sample is a medium-grained monzogranitic gneiss, composed of about 50–55% K-feldspar, 25–30% quartz, 5–8% plagioclase, 5–8% biotite, 1–2% titanite, and accessory sericite, chlorite, epidote, and zircon. K-feldspar (microcline) is mainly unaltered, and occurs as anhedral crystals, from 0.5 to 2 mm long, intergrown with quartz and plagioclase. Plagioclase is unaltered, anhedral, and unzoned and ranges from 0.5 to 2 mm long. Biotite crystals are euhedral, randomly oriented, and unaltered. Biotite is associated with colourless, anhedral, rounded titanite crystals that are up to 2 mm long and contain inclusions of apatite prisms and small biotite plates.

Granophyric intergrowths are locally developed along quartz–feldspar grain boundaries. Weak alteration is indicated by sericite in some K-feldspar crystals and minor chloritization of biotite.

## Zircon morphology

Zircons isolated from this sample are colourless to dark brown or opaque, and mainly subhedral and slightly rounded. The crystals are up to 700 µm long, and elongate, with aspect ratios up to 6:1. In cathodoluminescence (CL) images, most crystals consist of concentrically zoned cores overgrown by low-uranium rims, many of which are in turn overgrown by high-uranium rims. A CL image of representative zircons is shown in Figure 2.

## Analytical details

This sample was analysed on 10 February 2012 and 16–17 February 2012, using SHRIMP-B. Analyses 1.1 to 5.1 (spot numbers 1–6) were obtained during the first session, together with three analyses of the BR266 standard, which indicated an external spot-to-spot (reproducibility) uncertainty of 1.16% (1σ) and a <sup>238</sup>U/<sup>206</sup>Pb\* calibration uncertainty of 0.69% (1σ). Analyses 6.1 to 4.8 (spot numbers 7–43) were obtained during the second session, together with 19 analyses of the BR266 standard, of which 16 analyses indicated an external spot-to-spot (reproducibility) uncertainty of 0.72% (1σ) and a <sup>238</sup>U/<sup>206</sup>Pb\* calibration uncertainty of 0.21% (1σ). Calibration uncertainties are included in the errors of <sup>238</sup>U/<sup>206</sup>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

Forty-three analyses were obtained from 28 zircons. Results are listed in Table 1, and shown in a concordia diagram (Fig. 3).

## Interpretation

The analyses are concordant to strongly discordant (Fig. 3). Eight analyses are >10% discordant or indicate high common Pb (*f*<sub>204</sub> >1%), and one analysis is

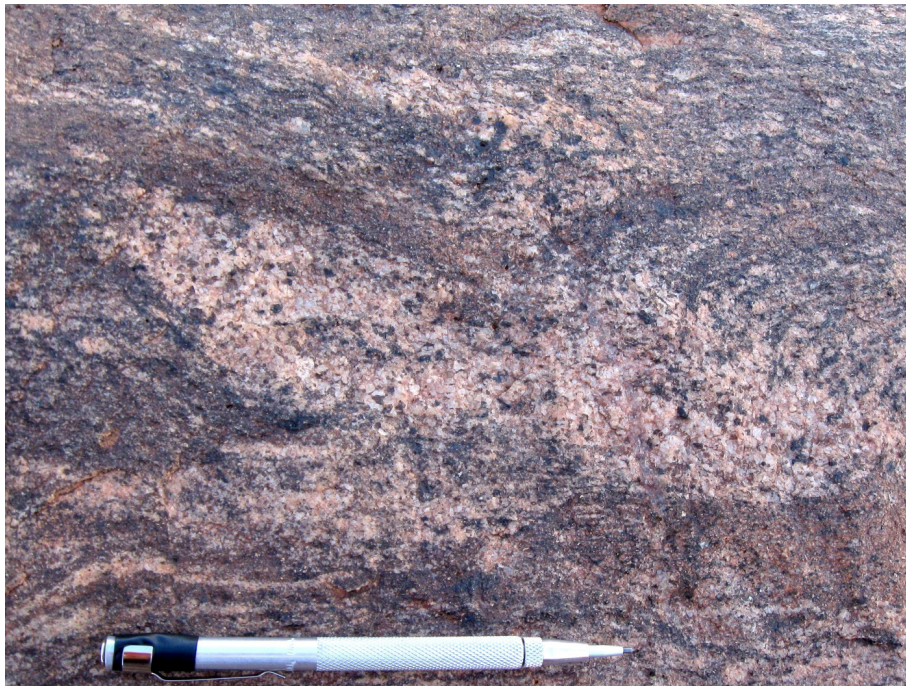


Figure 1. Outcrop photograph of sample 195826: monzogranitic gneiss, McCarthy Well.

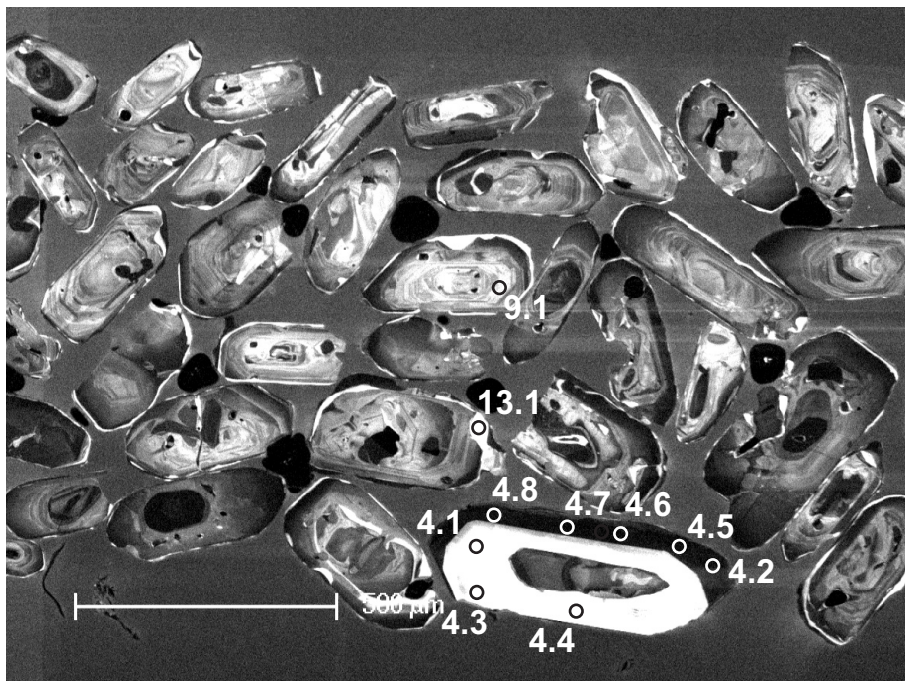
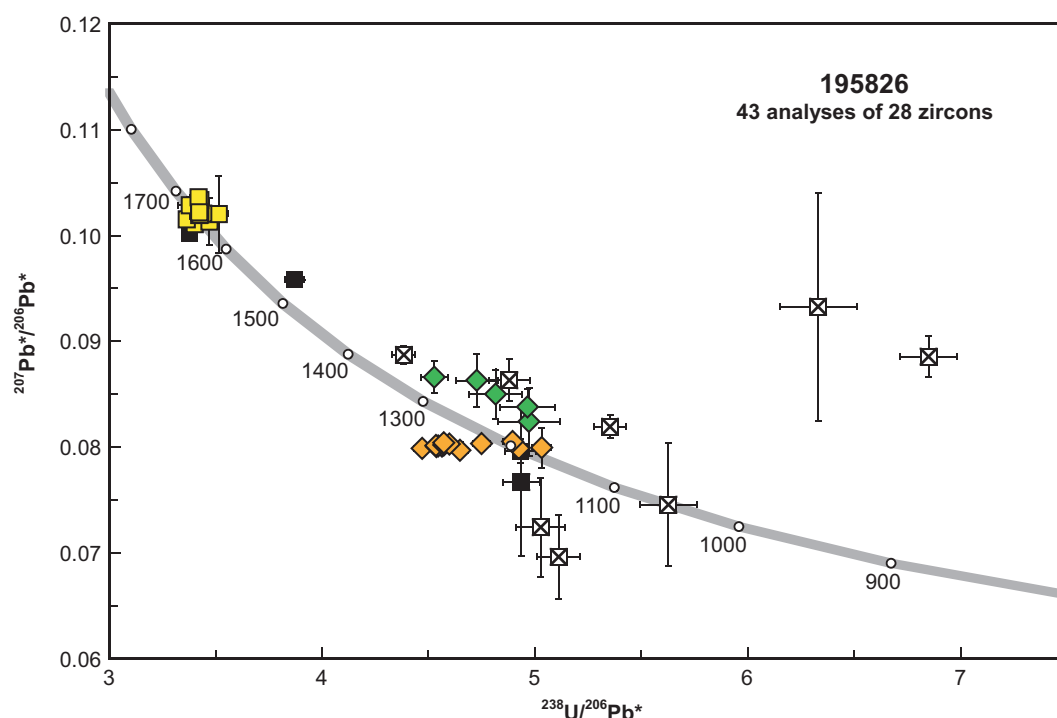


Figure 2. Cathodoluminescence image of representative zircons from sample 195826: monzogranitic gneiss, McCarthy Well. Numbered circles indicate the approximate locations of analysis sites.

Table 1. Ion microprobe analytical results for zircons from sample 195826: monzogranitic gneiss, McCarthy Well

Group ID	Spot no.	Grain spot	$^{238}\text{U}$ (ppm)	$^{232}\text{Th}$ (ppm)	$\frac{^{232}\text{Th}}{^{238}\text{U}}$ (%)	$f_{204}$ (%)	$^{238}\text{U}/^{206}\text{Pb} \pm 1\sigma$	$^{207}\text{Pb}/^{206}\text{Pb} \pm 1\sigma$	$^{238}\text{U}/^{206}\text{Pb}^* \pm 1\sigma$	$^{207}\text{Pb}^*/^{206}\text{Pb}^* \pm 1\sigma$	$^{238}\text{U}/^{206}\text{Pb}^* \text{ date (Ma)} \pm 1\sigma$	$^{207}\text{Pb}^*/^{206}\text{Pb}^* \text{ date (Ma)} \pm 1\sigma$	Disc. (%)
I	27	22.1	150	130	0.90	-0.016	3.402 0.039	0.10093 0.00062	3.402 0.039	0.10107 0.00063	1661 17	1644 12	-1.1
I	28	23.1	197	162	0.85	0.103	3.468 0.038	0.10223 0.00219	3.471 0.038	0.10133 0.00222	1632 16	1649 41	1.0
I	31	25.1	385	2	0.01	-0.007	3.365 0.032	0.10147 0.00040	3.364 0.032	0.10153 0.00041	1678 14	1652 7	-1.5
I	15	12.1	221	231	1.08	0.050	3.421 0.035	0.10238 0.00049	3.423 0.035	0.10195 0.00052	1652 15	1660 10	0.5
I	26	21.1	100	82	0.85	0.069	3.426 0.044	0.10259 0.00074	3.428 0.044	0.10199 0.00082	1650 19	1661 15	0.6
I	21	17.1	129	97	0.77	0.037	3.513 0.042	0.10236 0.00362	3.515 0.042	0.10204 0.00363	1614 17	1662 66	2.9
I	9	8.1	285	280	1.01	0.032	3.440 0.034	0.10237 0.00046	3.441 0.034	0.10209 0.00048	1645 14	1662 9	1.1
I	14	11.1	231	222	0.99	0.038	3.422 0.034	0.10253 0.00048	3.423 0.035	0.10220 0.00050	1652 15	1664 9	0.7
I	19	15.1	363	256	0.73	0.020	3.418 0.031	0.10251 0.00040	3.418 0.031	0.10234 0.00041	1654 14	1667 7	0.8
I	1	1.1	141	114	0.83	-0.059	3.381 0.055	0.10235 0.00076	3.379 0.055	0.10286 0.00081	1671 24	1676 15	0.3
I	11	9.1	138	155	1.16	0.032	3.427 0.039	0.10363 0.00062	3.428 0.039	0.10336 0.00065	1650 17	1685 12	2.1
I	24	19.1	136	110	0.84	0.000	3.420 0.040	0.10362 0.00065	3.420 0.040	0.10362 0.00065	1653 17	1690 12	2.2
P	12	4.4	42	0	0.00	0.549	4.910 0.086	0.08131 0.00667	4.937 0.087	0.07669 0.00697	1189 19	1113 181	-6.8
P	16	4.5	67	2	0.02	0.104	4.928 0.072	0.08051 0.00093	4.933 0.072	0.07963 0.00112	1190 16	1188 28	-0.2
P	23	18.1	119	91	0.79	0.000	3.871 0.047	0.09583 0.00070	3.871 0.047	0.09583 0.00070	1481 16	1544 14	4.1
P	25	20.1	162	121	0.77	0.059	3.375 0.038	0.10074 0.00058	3.376 0.038	0.10023 0.00064	1672 17	1628 12	-2.7
M	32	26.1	15	1	0.05	0.270	4.960 0.144	0.08471 0.00222	4.973 0.145	0.08241 0.00320	1181 32	1255 76	5.9
M	4	4.1	23	0	0.00	0.000	4.966 0.130	0.08378 0.00173	4.966 0.130	0.08378 0.00173	1183 29	1287 40	8.1
M	2	2.1	26	0	0.01	-0.159	4.825 0.124	0.08365 0.00188	4.817 0.124	0.08500 0.00232	1216 29	1316 53	7.6
M	8	7.1	28	0	0.00	-0.479	4.751 0.100	0.08222 0.00145	4.728 0.100	0.08630 0.00249	1237 24	1345 56	8.0
M	18	14.1	96	7	0.08	0.412	4.510 0.064	0.09010 0.00094	4.529 0.064	0.08659 0.00151	1286 17	1351 34	4.8
M2	33	27.1	3796	23	0.01	0.016	4.647 0.039	0.07983 0.00016	4.648 0.039	0.07969 0.00017	1256 10	1189 4	-5.6
M2	39	28.3	3380	14	0.00	0.027	4.470 0.038	0.08011 0.00018	4.471 0.038	0.07988 0.00019	1301 10	1194 5	-9.0
M2	40	4.9	1195	3	0.00	0.043	4.923 0.044	0.08025 0.00030	4.925 0.044	0.07989 0.00033	1192 10	1194 8	0.2
M2	35	27.2	1086	5	0.01	0.242	5.020 0.046	0.08200 0.00185	5.032 0.046	0.07995 0.00189	1169 10	1196 47	2.3
M2	34	28.1	4179	22	0.01	0.010	4.538 0.038	0.08012 0.00016	4.538 0.038	0.08004 0.00016	1284 10	1198 4	-7.2
M2	6	5.1	3710	17	0.00	0.011	4.564 0.064	0.08019 0.00016	4.564 0.064	0.08009 0.00016	1277 16	1199 4	-6.5
M2	42	4.7	4157	19	0.00	0.021	4.545 0.038	0.08028 0.00016	4.546 0.038	0.08010 0.00016	1282 10	1200 4	-6.8
M2	43	4.8	3850	18	0.00	0.011	4.535 0.038	0.08024 0.00016	4.536 0.038	0.08015 0.00017	1284 10	1201 4	-7.0
M2	36	28.2	3824	17	0.00	0.009	4.572 0.038	0.08029 0.00016	4.572 0.038	0.08021 0.00017	1275 10	1202 4	-6.1
M2	5	4.2	2682	8	0.00	0.012	4.598 0.063	0.08039 0.00015	4.598 0.063	0.08029 0.00015	1269 16	1204 4	-5.4
M2	37	27.3	2565	18	0.01	0.009	4.750 0.040	0.08042 0.00020	4.750 0.040	0.08034 0.00020	1232 10	1205 5	-2.2
M2	41	4.6	3093	16	0.01	0.012	4.572 0.038	0.08051 0.00018	4.572 0.038	0.08041 0.00018	1275 10	1207 4	-5.6
M2	38	27.4	1292	13	0.01	0.134	4.890 0.044	0.08165 0.00030	4.896 0.044	0.08052 0.00038	1198 10	1210 9	1.0





**Figure 3.** U–Pb analytical data for zircons from sample 195826: monzogranitic gneiss, McCarthy Well. Yellow squares indicate Group I (magmatic zircons); green diamonds indicate Group M (metamorphic zircon rims); orange diamonds indicate Group M2 (younger metamorphic rims); black squares indicate Group P (radiogenic Pb-loss); crossed squares indicate Group D (discordance >10%, high common Pb ( $f_{204} > 1\%$ ), or core-rim mixture). One highly discordant and imprecise analysis in Group D is not shown.

interpreted to represent a mixture of core and rim material. The dates obtained from these nine analyses (Group D, Table 1) are imprecise or unreliable, and considered not to be geologically significant. The remaining 34 analyses can be divided into four groups, based on their uranium and thorium contents, Th/U ratios,  $^{207}\text{Pb}^*/^{206}\text{Pb}^*$  ratios, and locations within the crystals.

Group I comprises 12 analyses of 12 zircon cores (Table 1), which yield a weighted mean  $^{207}\text{Pb}^*/^{206}\text{Pb}^*$  date of  $1664 \pm 8$  Ma (MSWD = 1.4). These analyses indicate mainly moderate uranium and thorium concentrations and moderate Th/U ratios.

Group M comprises five analyses of five low-uranium zircon rims (Table 1), which yield a weighted mean  $^{207}\text{Pb}^*/^{206}\text{Pb}^*$  date of  $1321 \pm 40$  Ma (MSWD = 0.61). These analyses indicate low uranium and thorium concentrations and very low Th/U ratios.

Group M2 comprises 13 analyses of four high-uranium zircon rims (Table 1), which yield a weighted mean  $^{207}\text{Pb}^*/^{206}\text{Pb}^*$  date of  $1200 \pm 3$  Ma (MSWD = 1.3). These analyses are in part slightly reversely discordant, and indicate very high uranium concentrations, very low thorium concentrations, and very low Th/U ratios.

Group P comprises four analyses of three zircons (Table 1). Two analyses of a low-uranium rim yield  $^{207}\text{Pb}^*/^{206}\text{Pb}^*$  dates of 1188 and 1113 Ma, and two analyses of two zircon cores yield dates of 1628 and 1544 Ma. These four analyses (Group P) are interpreted to reflect ancient loss of radiogenic Pb.

The date of  $1803 \pm 3$  Ma for the 16 analyses in Group I is interpreted as the magmatic crystallization age of the monzogranite protolith. The date of  $1321 \pm 40$  Ma for the five analyses in Group M is interpreted as the age of a metamorphic event. The date of  $1200 \pm 3$  Ma for the 13 analyses in Group M2 is interpreted as the age of a second metamorphic event. The slight reverse discordance of Group M2 analyses is probably due to matrix effects, which are common in ion microprobe analyses of high-uranium zircons, and do not affect  $^{207}\text{Pb}^*/^{206}\text{Pb}^*$  ratios. The dates of 1628–1113 Ma for the four analyses in Group P are interpreted to reflect ancient loss of radiogenic Pb.

## References

- Sheppard, S, Johnson, SP, Groenewald, PB and Farrell, TR 2008, Yinnetharra, WA Sheet 2148: Geological Survey of Western Australia, 1:100 000 Geological Series.

Sheppard, S, Johnson, SP, Wingate, MTD, Kirkland, CL and Pirajno, F 2010, Explanatory Notes for the Gascoyne Province: Geological Survey of Western Australia, Perth, Western Australia, 336p.

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.

## **Recommended reference for this publication**

Wingate, MTD, Kirkland, CL and Johnson, SP 2013, 195826: monzogranitic gneiss, McCarthy Well; Geochronology Record 1104: Geological Survey of Western Australia, 5p.

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