

# 179239: porphyritic metadacite, Montague Well

## Location and sampling

SANDSTONE (SG50-16), MONTAGU (2843)  
MGA Zone 50, 753308E 6968162N

Sampled on 12 June 2003

The sample was taken from a low, bouldery outcrop at the base of a low rise, about 2.7 km northeast of Montague Well.

## Tectonic unit/relations

The unit sampled is a massive to weakly foliated, dark grey porphyritic felsic volcanic rock that contains plagioclase (and possibly minor quartz) phenocrysts up to 2 mm in length. The felsic volcanic rock is part of the Gum Creek greenstone belt, in the Southern Cross Domain of the Youanmi Terrane in the Yilgarn Craton (Cassidy et al., 2006). It lies structurally above a succession comprising mafic-ultramafic volcanic rocks, and associated banded iron-formation, that marks the eastern margin of the greenstone belt (Wyche and Doyle, in prep.). Stratigraphic relationships are unclear owing to poor outcrop, although the presence of widespread siliciclastic sedimentary rocks in the eastern part of the Gum Creek greenstone belt suggests an association similar to that noted in other greenstone belts of the central Yilgarn Craton, such as the Marda-Diemals greenstone belt (Chen et al., 2003), where felsic volcanic and clastic sedimentary rocks unconformably overlie a substantially older succession containing mafic and ultramafic volcanic and intrusive rocks, and banded iron-formation.

## Petrographic description

This sample is foliated and fine-grained, and the primary mineralogy was visually estimated from a stained offcut, as well as thin section. The thin section shows 1% quartz phenocrysts, 10–15% phenocryst-like aggregates (K-feldspar-plagioclase-biotite-epidote in various proportions), 20% groundmass quartz, 55% fine-grained groundmass plagioclase, 7% fine-grained biotite, 4% groundmass K-feldspar, and 1% fine-grained chlorite. Quartz phenocrysts are rounded or bipyramidal, and mostly less than 1 mm in diameter. The phenocryst-like aggregates are up to 4 mm in length, and vary from rounded to elongate. Some are largely composed of single K-feldspar or plagioclase grains, but most are at least partly fine-grained with a recrystallized, micromosaic texture. Aggregates are dominated by plagioclase and microcline with biotite, epidote, chlorite, and calcite also present. The groundmass contains a plagioclase-rich quartzofeldspathic micromosaic, with minor quartz and less abundant K-feldspar. Fine-grained biotite commonly

lies in parallel lamellae, but individual flakes are decussate or define a weak schistosity at a high angle to the lamellae. Small lenses of carbonate minerals are associated with epidote and rare muscovite, and patches of titanite enclose opaque oxide minerals that have been altered to leucoxene. Slender crystals of zircon and apatite up to 0.15 mm long were also observed.

The mineralogy and texture indicates metamorphism of a porphyritic dacite, possibly under greenschist or lower amphibolite facies conditions, followed by annealing of the groundmass. Some plagioclase grains are partly replaced by sericite and clay minerals, indicating very low temperature alteration.

## Zircon morphology

Zircons isolated from this sample are euhedral to subhedral, and range from clear and colourless to dark brown and turbid. Larger crystals tend to be darker and more cracked. The grains are up to 400  $\mu\text{m}$  long, mostly elongate, with aspect ratios up to 6:1. Concentric growth zoning is common and many zircons contain central channels and inclusions of other minerals. A cathodoluminescence image of representative zircons is shown in Figure 1.

## Analytical details

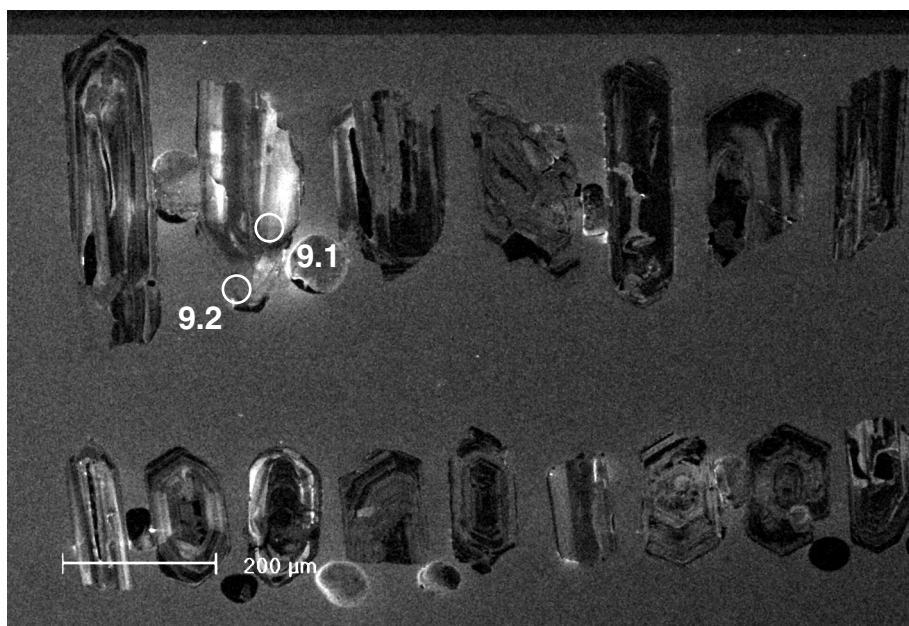
This sample was analysed on 24 April 2004, using SHRIMP-A. Twelve analyses of the CZ3 standard were obtained during the session, and following the deletion of one analysis as an outlier, the remaining 11 analyses indicated a  $^{238}\text{U}/^{206}\text{Pb}$ \* calibration uncertainty of 2.67% ( $1\sigma$ ). Common-Pb corrections were applied using Broken Hill common-Pb isotopic compositions for all analyses except 18 (4.1, 5.1, 6.1, 7.1, 8.1, 9.2, 11.1, 13.1, 14.1, 18.1, 21.1, 22.1, 23.1, 27.1, 29.1, 30.1, 31.1, and 32.1), which used compositions determined using the method of Stacey and Kramers (1975).

## Results

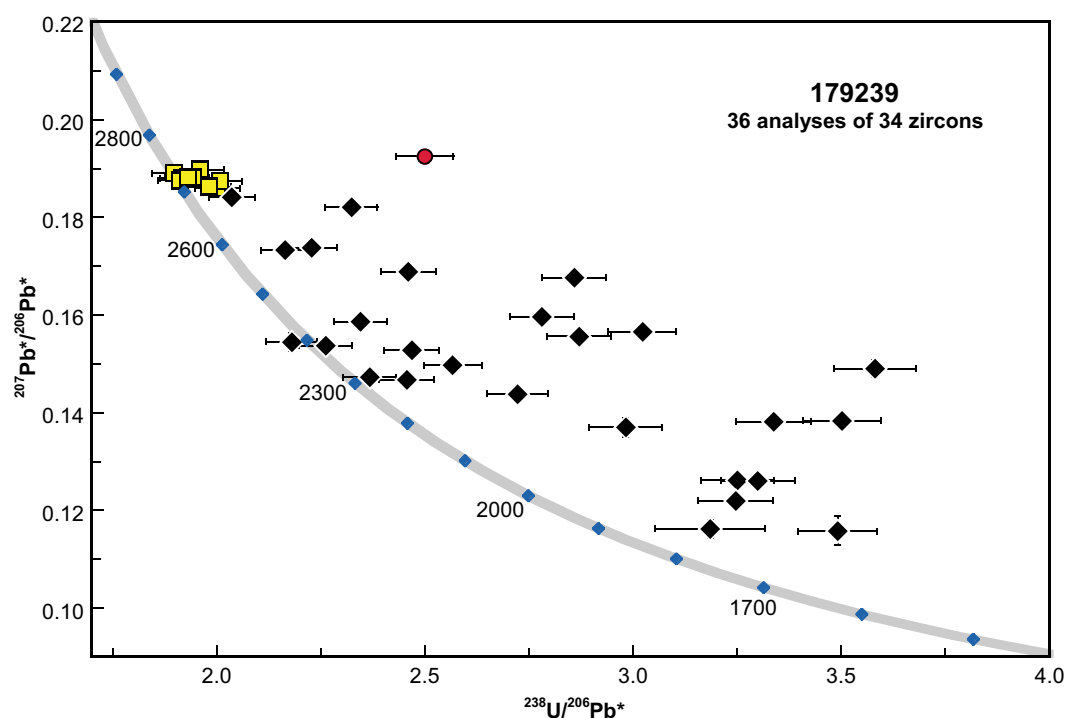
Thirty-six analyses were obtained from 34 zircons, with two grains (9 and 10) each analysed twice. Results are listed in Table 1, and shown in Figure 2.

## Interpretation

The analyses range from concordant to strongly discordant, and the discordance pattern is consistent with the combined effects of ancient and recent loss of radiogenic Pb from most of the analysed sites. The analyses can be



**Figure 1.** Cathodoluminescence image of representative zircons from sample 179239: porphyritic metadacite, Montague Well. Numbered circles represent approximate positions of analysis sites



**Figure 2.** U-Pb analytical data for sample 179239: porphyritic metadacite, Montague Well. Squares denote Group 1 (igneous crystallization); filled circle denotes analysis 2.1 (xenocrystic zircon); filled diamonds indicate Group 2 (affected by ancient and recent radiogenic-Pb loss events)

Table 1. Ion microprobe analytical results for zircons from sample 179239: porphyritic metadacite, Montague Well

Grain spot	U (ppm)	Th (ppm)	Th/U	f <sub>204</sub> (%)	$^{238}\text{U}/^{206}\text{Pb}$ $\pm 1\sigma$	$^{207}\text{Pb}/^{206}\text{Pb}$ $\pm 1\sigma$	$^{238}\text{U}/^{206}\text{Pb}^*$ $\pm 1\sigma$	$^{207}\text{Pb}/^{206}\text{Pb}^*$ $\pm 1\sigma$	$^{238}\text{U}/^{206}\text{Pb}^*$ age (Ma) $\pm 1\sigma$	$^{207}\text{Pb}/^{206}\text{Pb}^*$ age (Ma) $\pm 1\sigma$	Disc (%)
1.1	92	97	1.09	0.347	1.954 $\pm$ 0.055	0.19238 $\pm$ 0.00127	1.961 $\pm$ 0.056	0.18970 $\pm$ 0.00153	2656 $\pm$ 62	2740 $\pm$ 13	3.0
2.1	196	168	0.89	0.567	2.486 $\pm$ 0.068	0.19681 $\pm$ 0.00101	2.500 $\pm$ 0.069	0.19246 $\pm$ 0.00125	2169 $\pm$ 51	2763 $\pm$ 11	21.5
3.1	303	545	1.86	0.401	1.994 $\pm$ 0.054	0.18909 $\pm$ 0.00078	2.002 $\pm$ 0.055	0.18598 $\pm$ 0.00090	2612 $\pm$ 59	2707 $\pm$ 8	3.5
4.1	680	1 527	2.32	0.647	3.316 $\pm$ 0.089	0.14388 $\pm$ 0.00063	3.338 $\pm$ 0.090	0.13816 $\pm$ 0.00090	1689 $\pm$ 40	2204 $\pm$ 11	23.4
5.1	390	688	1.82	1.585	2.526 $\pm$ 0.068	0.16383 $\pm$ 0.00057	2.567 $\pm$ 0.070	0.14974 $\pm$ 0.00139	2121 $\pm$ 49	2343 $\pm$ 16	9.5
6.1	1 440	1 311	0.94	0.820	2.347 $\pm$ 0.063	0.15456 $\pm$ 0.00032	2.367 $\pm$ 0.063	0.14727 $\pm$ 0.00069	2272 $\pm$ 51	2315 $\pm$ 8	1.8
7.1	1 123	944	0.87	0.686	2.165 $\pm$ 0.062	0.16058 $\pm$ 0.00175	2.180 $\pm$ 0.062	0.15448 $\pm$ 0.00184	2434 $\pm$ 58	2396 $\pm$ 20	-1.6
8.1	1 284	2 318	1.87	0.429	3.285 $\pm$ 0.088	0.12981 $\pm$ 0.00063	3.299 $\pm$ 0.089	0.12604 $\pm$ 0.00074	1707 $\pm$ 40	2043 $\pm$ 10	16.5
9.1	175	166	0.98	0.138	1.895 $\pm$ 0.052	0.19009 $\pm$ 0.00089	1.898 $\pm$ 0.052	0.18903 $\pm$ 0.00094	2729 $\pm$ 61	2734 $\pm$ 8	0.2
9.2	1 567	2 350	1.55	0.552	3.233 $\pm$ 0.087	0.13097 $\pm$ 0.00033	3.251 $\pm$ 0.087	0.12612 $\pm$ 0.00055	1729 $\pm$ 41	2045 $\pm$ 8	15.4
10.1	163	254	1.61	0.154	1.914 $\pm$ 0.053	0.18922 $\pm$ 0.00092	1.917 $\pm$ 0.053	0.18803 $\pm$ 0.00104	2706 $\pm$ 61	2725 $\pm$ 9	0.7
10.2	154	285	1.92	0.236	1.976 $\pm$ 0.055	0.18806 $\pm$ 0.00101	1.981 $\pm$ 0.055	0.18624 $\pm$ 0.00125	2635 $\pm$ 60	2709 $\pm$ 11	2.7
11.1	1 219	1 470	1.25	0.729	2.439 $\pm$ 0.065	0.15322 $\pm$ 0.00131	2.457 $\pm$ 0.066	0.14675 $\pm$ 0.00143	2201 $\pm$ 50	2308 $\pm$ 17	4.6
12.1	314	581	1.91	0.274	2.001 $\pm$ 0.054	0.18954 $\pm$ 0.00069	2.007 $\pm$ 0.054	0.18742 $\pm$ 0.00078	2606 $\pm$ 58	2720 $\pm$ 7	4.2
13.1	656	725	1.14	0.577	2.446 $\pm$ 0.066	0.17401 $\pm$ 0.00050	2.460 $\pm$ 0.066	0.16887 $\pm$ 0.00074	2199 $\pm$ 50	2546 $\pm$ 7	13.6
14.1	1 169	2 135	1.89	0.295	3.237 $\pm$ 0.091	0.12452 $\pm$ 0.00118	3.246 $\pm$ 0.091	0.12193 $\pm$ 0.00127	1731 $\pm$ 42	1985 $\pm$ 18	12.8
15.1	580	536	0.96	0.251	2.159 $\pm$ 0.058	0.17527 $\pm$ 0.00050	2.165 $\pm$ 0.058	0.17329 $\pm$ 0.00058	2448 $\pm$ 55	2590 $\pm$ 6	5.5
16.1	155	147	0.98	0.097	1.940 $\pm$ 0.054	0.18882 $\pm$ 0.00095	1.942 $\pm$ 0.054	0.18806 $\pm$ 0.00102	2678 $\pm$ 60	2725 $\pm$ 9	1.7
17.1	489	441	0.93	0.284	2.030 $\pm$ 0.055	0.18633 $\pm$ 0.00070	2.036 $\pm$ 0.055	0.18412 $\pm$ 0.00077	2576 $\pm$ 57	2690 $\pm$ 7	4.3
18.1	610	652	1.11	0.377	2.220 $\pm$ 0.060	0.17712 $\pm$ 0.00059	2.228 $\pm$ 0.060	0.17375 $\pm$ 0.00070	2390 $\pm$ 54	2594 $\pm$ 7	7.9
19.1	541	563	1.07	0.149	2.855 $\pm$ 0.077	0.16880 $\pm$ 0.00058	2.859 $\pm$ 0.077	0.16762 $\pm$ 0.00063	1934 $\pm$ 45	2534 $\pm$ 6	23.7
20.1	390	387	1.03	0.045	2.323 $\pm$ 0.063	0.18248 $\pm$ 0.00099	2.324 $\pm$ 0.063	0.18213 $\pm$ 0.00102	2307 $\pm$ 52	2672 $\pm$ 9	13.7
21.1	550	757	1.42	0.395	2.770 $\pm$ 0.076	0.16312 $\pm$ 0.00072	2.781 $\pm$ 0.076	0.15960 $\pm$ 0.00085	1980 $\pm$ 47	2451 $\pm$ 9	19.2
22.1	642	2 469	3.97	2.106	3.506 $\pm$ 0.095	0.16772 $\pm$ 0.00059	3.581 $\pm$ 0.097	0.14901 $\pm$ 0.00172	1588 $\pm$ 38	2335 $\pm$ 20	32.0
23.1	530	1 664	3.24	0.442	2.858 $\pm$ 0.077	0.15957 $\pm$ 0.00097	2.871 $\pm$ 0.077	0.15563 $\pm$ 0.00111	1927 $\pm$ 45	2409 $\pm$ 12	20.0
24.1	101	70	0.72	0.029	1.911 $\pm$ 0.054	0.18779 $\pm$ 0.00114	1.912 $\pm$ 0.054	0.18757 $\pm$ 0.00118	2712 $\pm$ 62	2721 $\pm$ 10	0.3
25.1	901	1 055	1.21	0.123	3.497 $\pm$ 0.094	0.13931 $\pm$ 0.00105	3.502 $\pm$ 0.094	0.13830 $\pm$ 0.00108	1619 $\pm$ 38	2206 $\pm$ 13	26.6
26.1	195	154	0.81	0.096	1.928 $\pm$ 0.053	0.18880 $\pm$ 0.00091	1.930 $\pm$ 0.053	0.18806 $\pm$ 0.00096	2691 $\pm$ 61	2725 $\pm$ 8	1.2
27.1	1 568	2 470	1.63	0.852	2.700 $\pm$ 0.073	0.15139 $\pm$ 0.00055	2.723 $\pm$ 0.073	0.14384 $\pm$ 0.00084	2017 $\pm$ 47	2274 $\pm$ 10	11.3
28.1	2 162	3 629	1.73	1.212	3.449 $\pm$ 0.092	0.12642 $\pm$ 0.00228	3.491 $\pm$ 0.094	0.11581 $\pm$ 0.00300	1624 $\pm$ 39	1892 $\pm$ 47	14.2
29.1	740	732	1.02	0.628	2.964 $\pm$ 0.087	0.14254 $\pm$ 0.00174	2.982 $\pm$ 0.088	0.13698 $\pm$ 0.00187	1864 $\pm$ 48	2189 $\pm$ 24	14.9
30.1	1 416	1 025	0.75	0.822	2.243 $\pm$ 0.062	0.16104 $\pm$ 0.00035	2.262 $\pm$ 0.063	0.15372 $\pm$ 0.00071	2360 $\pm$ 55	2388 $\pm$ 8	1.2
31.1	723	1 130	1.62	1.773	2.969 $\pm$ 0.080	0.17235 $\pm$ 0.00049	3.023 $\pm$ 0.081	0.15657 $\pm$ 0.00143	1842 $\pm$ 43	2419 $\pm$ 16	23.8
32.1	2 247	2 270	1.04	0.444	3.171 $\pm$ 0.131	0.12011 $\pm$ 0.00170	3.185 $\pm$ 0.132	0.11622 $\pm$ 0.00181	1760 $\pm$ 64	1899 $\pm$ 28	7.3
33.1	1 272	2 927	2.38	1.117	2.319 $\pm$ 0.062	0.16855 $\pm$ 0.00053	2.345 $\pm$ 0.063	0.15860 $\pm$ 0.00097	2290 $\pm$ 52	2441 $\pm$ 10	6.2
34.1	1 745	2 456	1.45	1.198	2.439 $\pm$ 0.065	0.16346 $\pm$ 0.00061	2.469 $\pm$ 0.066	0.15280 $\pm$ 0.00104	2192 $\pm$ 50	2378 $\pm$ 12	7.8

divided into three groups based on their  $^{207}\text{Pb}^*/^{206}\text{Pb}^*$  ratios, uranium contents, and discordance values.

Group 1 comprises nine concordant analyses of eight zircons (1.1, 3.1, 9.1, 10.1, 10.2, 12.1, 16.1, 24.1, and 26.1) with low to moderate uranium contents (92–314 ppm), and  $^{207}\text{Pb}^*/^{206}\text{Pb}^*$  ratios that define a single population, and indicate a weighted mean date of  $2722 \pm 6$  Ma (MSWD = 1.15).

Group 2 comprises 26 concordant to strongly discordant analyses of 26 zircons with moderate to very high uranium contents (390–2247 ppm), and  $^{207}\text{Pb}^*/^{206}\text{Pb}^*$  dates of 2690–1892 Ma.

The remaining analysis (2.1) is strongly discordant, with a moderate uranium content (196 ppm), and a  $^{207}\text{Pb}^*/^{206}\text{Pb}^*$  date of  $2763 \pm 11$  Ma ( $1\sigma$ ).

The date of  $2722 \pm 6$  Ma indicated by the nine analyses in Group 1 is interpreted as the age of igneous crystallization of the precursor dacite. Analysis 2.1 is interpreted to be of a xenocrystic zircon. The 26 analyses in Group 2 are highly dispersed (Fig. 2), and are interpreted to reflect a combination of ancient and recent radiogenic-Pb loss events.

## References

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## Recommended reference for this publication

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Data obtained: 24 April 2004  
Data released: 30 June 2006