179669: volcaniclastic sandstone, Buldania Rocks

Location and sampling

NORSEMAN (SI 51-2), BULDANIA (3333)
MGA Zone 51, 413579E 6455472N

Sampled on 2 June 2005

The sample was collected from a northwest-trending low rise, 6.7 km northeast of Buldania Rocks and the access track off the Eyre Highway.

Tectonic unit/relations

The unit sampled is a metamorphosed, poorly sorted volcaniclastic sandstone that contains sparse (<5%), fine-grained melanocratic clasts of probable mafic igneous origin. This volcaniclastic package is probably a lateral equivalent of the Black Flag Group (Hall et al., 2005) within the Norseman Domain of the Kalgoorlie Terrane, Eastern Goldfields Superterrane, Yilgarn Craton (Cassidy et al., 2006). It is locally underlain by a mafic–ultramafic succession (with subordinate metasedimentary rocks), and overlain a thick package of well-bedded siliciclastic rocks that have been metamorphosed to amphibolite facies (Hall et al., 2005), represented by GSWA 177911 (Wingate and Bodorkos, 2007).

Petrographic description

The hand specimen contains pale lenses and lamellae in a laminated grey matrix. This is a metamorphosed rock containing 14% plagioclase grains, 12% recrystallized quartz grains, and 3% polymineralic clasts comprising decussate biotite and epidote, all within a recrystallized quartzofeldspathic matrix, comprising about 25% quartz, 35–40% feldspar (20–25% plagioclase and 15% microcline), minor (7–8%) schistose biotite, and accessory magnetite, epidote, titanite, apatite, and zircon. Plagioclase crystals are mostly less than 3 mm long, partly recrystallized, and contain patches of quartz micromosaic as well as various combinations of biotite, muscovite, and epidote, with pressure shadows of K-feldspar on some grains. Quartz crystals are up to 5 mm long and anhedral, but are mostly recrystallized to relatively coarse-grained granular quartz. Biotite–epidote clasts are up to 4 mm long, but are narrow compared to the quartz aggregates. The groundmass is mostly a micromosaic of crystals up to 0.1 mm in diameter.

Initial metamorphism may have taken place under lower amphibolite facies conditions, and the partial replacement of biotite and plagioclase by muscovite and minor chlorite indicates retrogression under greenschist facies conditions. Fine-grained biotite is also partly replaced by minor pumpellyite, suggesting subsequent retrogression under sub-greenschist facies conditions.

Zircon morphology

The zircons isolated from this sample are subhedral to euhedral, and range from pale brown and transparent to dark brown and opaque. They are up to 400 µm long, with aspect ratios up to 5:1. Most zircons display concentric growth zoning. Cathodoluminescence images of representative zircons are shown in Figure 1.

Analytical details

This sample was analysed on 15 November 2005 and 16 December 2005 (using SHRIMP-A). Analyses 1.1 to 13.1 (spot numbers 1–13 inclusive) were obtained during the first session, together with 11 analyses of the CZ3 standard that indicated an external spot-to-spot (reproducibility) uncertainty of 0.00% (1σ), and a $^{238}U/^{206}Pb^*$ calibration uncertainty of 0.20% (1σ). Analyses 14.1 to 25.1 (spot numbers 14–25 inclusive) were obtained during the second session, together with seven analyses of the CZ3 standard that indicated an external spot-to-spot (reproducibility) uncertainty of 1.01% (1σ), and a $^{238}U/^{206}Pb^*$ calibration uncertainty of 0.48% (1σ). 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 common-Pb isotopic compositions determined by the method of Stacey and Kramers (1975).

Results

Twenty-five analyses were obtained from 25 zircons. Results are listed in Table 1, and shown in concordia diagrams (Figs 2 and 3).

Interpretation

The analyses range from concordant to strongly discordant, and their distribution is consistent with ancient, and probably also recent, loss of radiogenic Pb from some zircons (Figs 2 and 3). Ten analyses are characterized by moderate to strong discordance (>10%). The dates

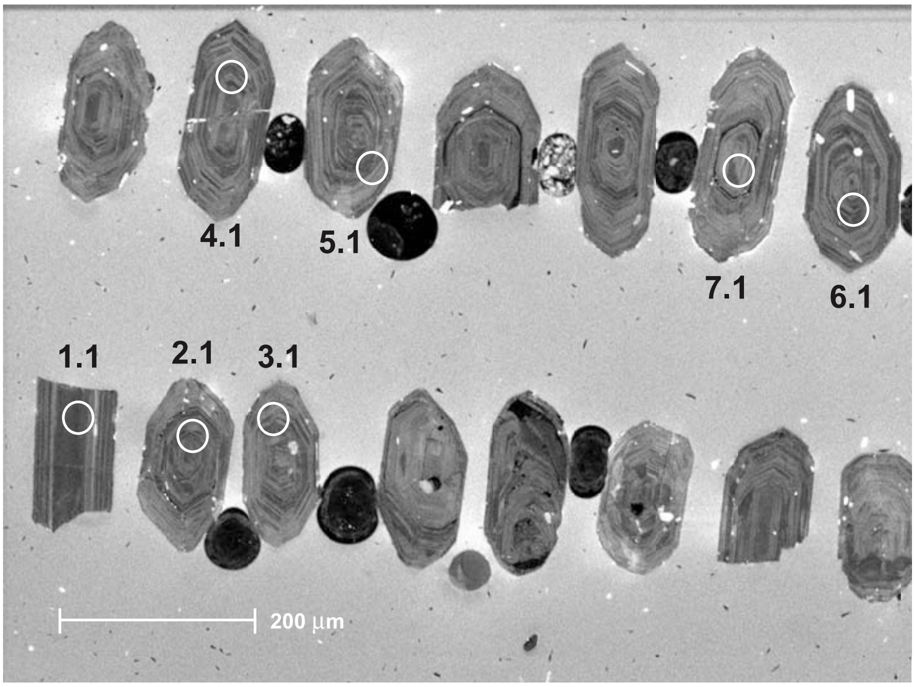

Figure 1. Cathodoluminescence image of representative zircons from sample 179669, volcaniclastic sandstone, Buldania Rocks. Numbered circles indicate approximate positions of analysis sites

obtained from these ten analyses (Group D; Table 1) are imprecise or unreliable, and are not considered geologically significant. The remaining 15 analyses can be divided into two groups, based on their $^{207}Pb^*/^{206}Pb^*$ ratios.

Group 1 comprises ten analyses of ten zircons (Table 1), which yield a weighted mean $^{207}Pb^*/^{206}Pb^*$ date of 2663 ± 3 Ma (MSWD = 0.81).

Group 2 comprises five analyses of five zircons (Table 1), which yield $^{207}Pb^*/^{206}Pb^*$ dates of 2645–2639 Ma.

All 15 zircons in Groups 1 and 2 are very similar in terms of colour, morphology and cathodoluminescence emission (Fig. 1), and display little variation in uranium content or Th/U ratio (Table 1). In combination with the distribution of the analyses, this implies that all 15 zircons were derived from a single felsic igneous source. The date of 2663 ± 3 Ma for the ten analyses in Group 1 is interpreted as the igneous crystallization age of the source rock, and is a maximum age for deposition of the volcaniclastic sandstone. The five analyses in Group 2 indicate dates that are significantly younger and slightly more discordant than those in Group 1 (Fig. 3), and are interpreted to reflect minor ancient loss of radiogenic Pb from these zircons.

All 25 analyses define a poorly fitted discordia (MSWD = 11.6) with upper and lower concordia intercept dates of 2669 ± 15 Ma and 742 ± 69 Ma respectively (Figs 2 and 3). The data display a crude inverse correlation between apparent age and uranium content (Fig. 2), which indicates that the degree of discordance probably reflects loss of radiogenic Pb related to radiation damage of the zircon lattices as a consequence of elevated uranium contents. The upper concordia intercept is not significantly different from date of 2663 ± 3 Ma indicated by Group 1, so if the discordia mainly reflects a single episode of radiogenic-Pb loss, then the regression indicates that this episode took place at c. 740 Ma.

References

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Table 1. Ion microprobe analytical results for zircons from sample 179669: volcaniclastic sandstone, Buldania Rocks

Grp no.	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 (%)
1	10	10.1	298	143	0.50	0.068	2.010 ± 0.010	0.18079 ± 0.00059	2.011 ± 0.010	0.18018 ± 0.00061	2602 ± 11	2655 ± 6	2.0
1	23	23.1	416	265	0.66	0.095	2.017 ± 0.024	0.18123 ± 0.00046	2.019 ± 0.024	0.18038 ± 0.00051	2593 ± 25	2656 ± 5	2.4
1	1	1.1	309	364	1.22	0.027	1.972 ± 0.012	0.18127 ± 0.00060	1.972 ± 0.012	0.18103 ± 0.00063	2644 ± 13	2662 ± 6	0.7
1	11	11.1	108	112	1.08	0.164	1.971 ± 0.021	0.18266 ± 0.00098	1.974 ± 0.021	0.18119 ± 0.00107	2642 ± 23	2664 ± 10	0.8
1	24	24.1	546	368	0.70	0.013	1.941 ± 0.023	0.18135 ± 0.00040	1.942 ± 0.023	0.18123 ± 0.00041	2678 ± 26	2664 ± 4	–0.5
1	9	9.1	378	315	0.86	0.025	2.018 ± 0.010	0.18145 ± 0.00056	2.018 ± 0.010	0.18123 ± 0.00056	2595 ± 10	2664 ± 5	2.6
1	8	8.1	549	280	0.53	0.059	2.021 ± 0.009	0.18178 ± 0.00047	2.022 ± 0.009	0.18126 ± 0.00049	2590 ± 10	2664 ± 5	2.8
1	4	4.1	446	215	0.50	0.049	2.032 ± 0.016	0.18181 ± 0.00050	2.033 ± 0.016	0.18137 ± 0.00052	2579 ± 17	2665 ± 5	3.2
1	2	2.1	548	414	0.78	0.038	2.037 ± 0.009	0.18192 ± 0.00046	2.038 ± 0.009	0.18158 ± 0.00047	2574 ± 9	2667 ± 4	3.5
1	13	13.1	87	113	1.35	–0.069	1.985 ± 0.017	0.18185 ± 0.00109	1.983 ± 0.017	0.18247 ± 0.00112	2632 ± 19	2675 ± 10	1.6
2	6	6.1	471	322	0.71	0.061	2.050 ± 0.009	0.17900 ± 0.00048	2.051 ± 0.009	0.17846 ± 0.00051	2560 ± 9	2639 ± 5	3.0
2	5	5.1	365	225	0.64	0.049	2.082 ± 0.010	0.17829 ± 0.00055	2.083 ± 0.010	0.17785 ± 0.00058	2528 ± 10	2633 ± 5	4.0
2	18	18.1	570	504	0.91	0.094	2.098 ± 0.024	0.17754 ± 0.00040	2.100 ± 0.024	0.17670 ± 0.00043	2511 ± 24	2622 ± 4	4.3
2	22	22.1	414	208	0.52	0.054	2.095 ± 0.025	0.17855 ± 0.00048	2.097 ± 0.025	0.17806 ± 0.00050	2514 ± 25	2635 ± 5	4.6
2	19	19.1	471	1022	2.24	0.019	2.113 ± 0.025	0.17937 ± 0.00044	2.114 ± 0.025	0.17920 ± 0.00045	2497 ± 24	2645 ± 4	5.6
D	12	12.1	532	374	0.73	0.083	2.279 ± 0.010	0.17646 ± 0.00046	2.281 ± 0.010	0.17572 ± 0.00050	2343 ± 8	2613 ± 5	10.3
D	25	25.1	921	339	0.38	0.144	2.248 ± 0.026	0.18187 ± 0.00033	2.251 ± 0.026	0.18058 ± 0.00037	2370 ± 23	2658 ± 3	10.8
D	3	3.1	688	355	0.53	0.134	2.465 ± 0.010	0.17033 ± 0.00044	2.468 ± 0.010	0.16913 ± 0.00048	2193 ± 8	2549 ± 5	14.0
D	7	7.1	565	436	0.80	0.158	2.435 ± 0.010	0.17692 ± 0.00083	2.439 ± 0.010	0.17551 ± 0.00086	2215 ± 8	2611 ± 8	15.2
D	20	20.1	729	557	0.79	0.131	2.642 ± 0.031	0.16302 ± 0.00037	2.646 ± 0.031	0.16186 ± 0.00041	2067 ± 20	2475 ± 4	16.5
D	16	16.1	513	292	0.59	0.175	2.846 ± 0.033	0.16258 ± 0.00048	2.851 ± 0.033	0.16102 ± 0.00056	1938 ± 20	2466 ± 6	21.4
D	14	14.1	590	298	0.52	0.082	2.808 ± 0.033	0.16560 ± 0.00044	2.811 ± 0.033	0.16487 ± 0.00048	1962 ± 20	2506 ± 5	21.7
D	21	21.1	726	640	0.91	0.087	3.180 ± 0.037	0.15890 ± 0.00049	3.183 ± 0.037	0.15812 ± 0.00052	1761 ± 18	2436 ± 6	27.7
D	15	15.1	599	758	1.31	0.107	3.442 ± 0.040	0.15643 ± 0.00058	3.446 ± 0.040	0.15548 ± 0.00062	1642 ± 17	2407 ± 7	31.8
D	17	17.1	540	277	0.53	0.084	3.580 ± 0.042	0.15693 ± 0.00071	3.583 ± 0.042	0.15618 ± 0.00075	1587 ± 16	2415 ± 8	34.3

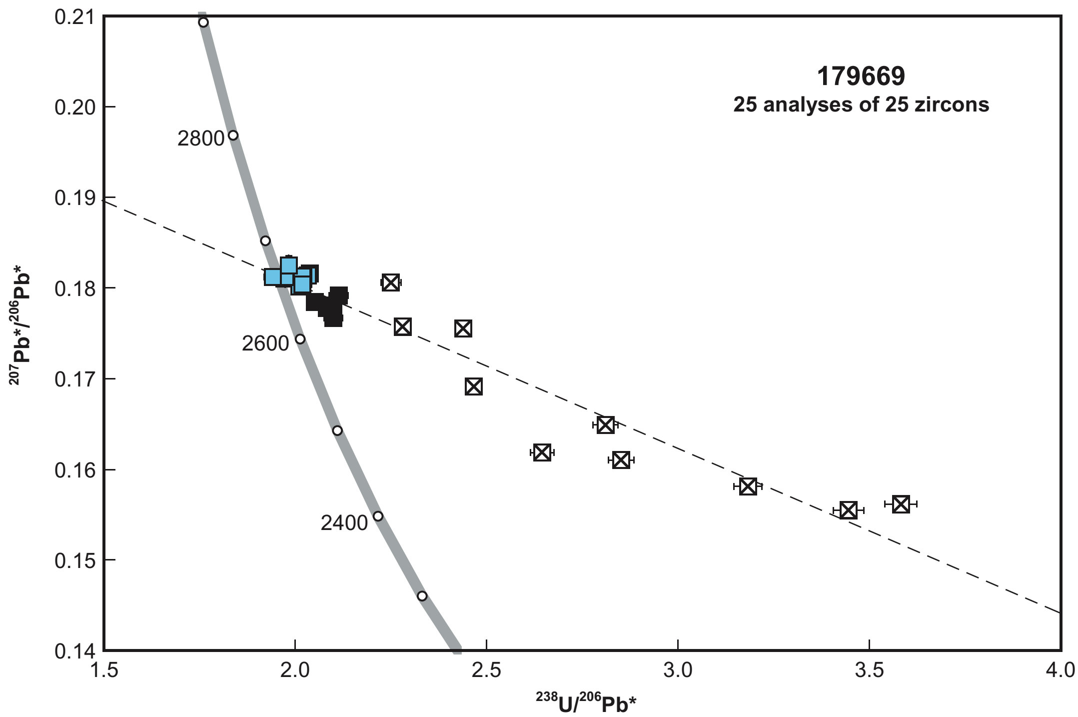

Figure 2. **U–Pb analytical data for sample 179669: volcaniclastic sandstone, Buldania Rocks. Blue squares indicate Group 1 (youngest detrital zircons); black squares indicate Group 2 (minor radiogenic Pb loss); crossed white squares indicate ungrouped analyses (discordance >10%). The dashed line shows a discordia regression through all data**

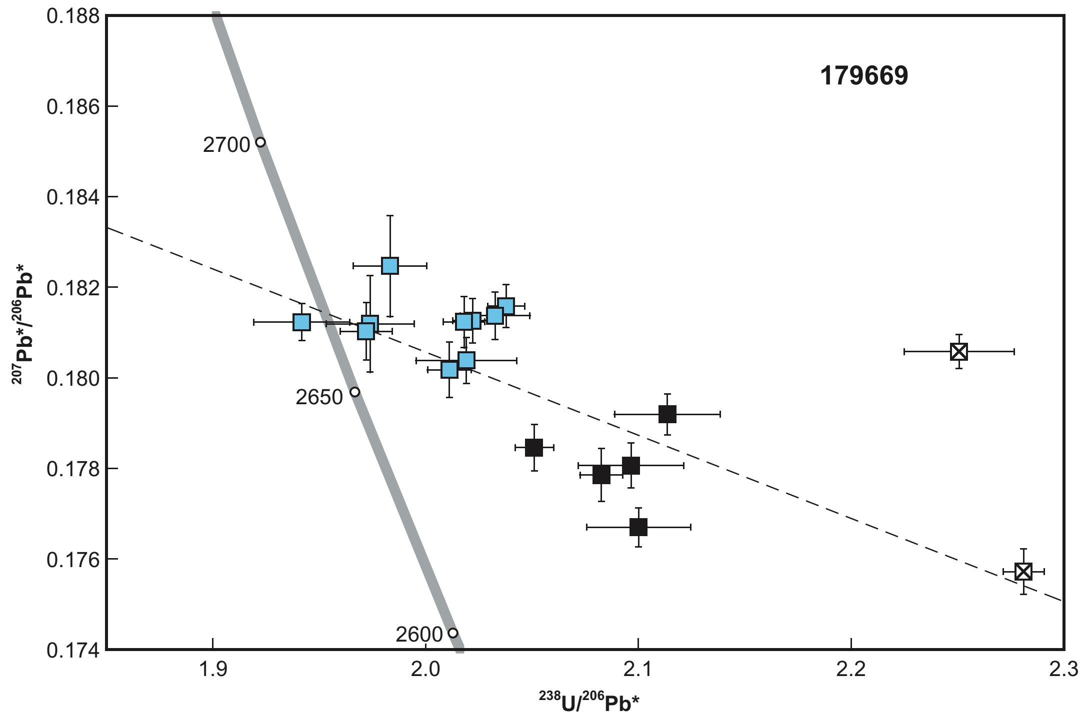

Figure 3. **Expanded view of U–Pb analytical data for sample 179669: volcaniclastic sandstone, Buldania Rocks. Symbols as in Figure 2**

Recommended reference for this publication

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