169042: biotite granodiorite, Wilina Well

Location and sampling

NULLAGINE (SF 51-5), MOUNT EDGAR (2955)
MGA Zone 51, 211150E 7631920N

Sampled on 15 September 2000

The sample was taken from a 0.5 m-high, 1 m-diameter boulder located in an area of low scattered boulders and weathered pavements, 150 m west of the access track and 1.4 km southwest of Wilina Well.

Tectonic unit/relations

The sample is from a pale pink-grey, medium-grained, weakly foliated biotite granodiorite of the Wilina Granodiorite, which has intruded the southestern margin of the Mount Edgar Granitoid Complex and Warrawoona Group, East Pilbara Granite–Greenstone Terrane. The granodiorite contains hexagonal plates of biotite up to 1 cm in diameter. The sample is free of obvious dykes and veins, and was dated to determine the age of the Wilina Granodiorite, a discrete pluton on the southeastern margin of the Mount Edgar Granitoid Complex (Williams and Bagas, in prep.).

Petrographic description

The principal minerals in this sample are plagioclase (55 vol.%), quartz (25–30 vol.%), microcline (10–15 vol.%), biotite (4 vol.%), and magnetite and titanite (1 vol.%), with accessory muscovite (trace), epidote (trace), allanite (trace), apatite (trace), and zircon (trace). It is a weakly foliated biotite granodiorite, with weak low temperature alteration. Irregularly disseminated mafic clots of biotite, up to 8 mm long, are relatively sparse and define a weak foliation. In thin section, there are flakes of biotite, to 6 mm in length, with smaller flakes both adjacent to the larger flakes and separate. The biotite defines a weak foliation, with magnetite, apatite, and titanite in and adjacent to the biotite. The biotite is also intergrown with quartz and plagioclase, and is partly altered to chlorite and epidote with or without muscovite. Plagioclase is abundant as subhedral grains, to 5 mm in length, with zones clouded by sericite and clinozoisite. Crystals of muscovite and epidote occur locally. Quartz forms lenses up to 10 mm long, roughly parallel to the foliation, with ragged grains to 3 mm in length, but it is not highly deformed. Microcline is not abundant and can form highly irregular grains to 3 mm in diameter, some of which have replaced plagioclase. There are also lenses of recrystallized feldspars, with both plagioclase and microcline. Myrmekite is common in the recrystallized lenses and adjacent to the larger microcline grains, occurring not only between microcline and plagioclase, but also between microcline and quartz. Rare grains of altered allanite occur, to 1 mm in length, with partial rims of epidote. Accessory magnetite, titanite, and apatite are common, partly in and adjacent to the biotite, as indicated above, and partly in quartzofeldspathic areas. The biotite contains rare small zircon crystals with pleochroic haloes.

Zircon morphology

There are several morphological types of zircons isolated from this sample. Most are typically dark greenish-brown, dark brown or black with mottled interiors, irregularly shaped or slightly elongate with subrounded terminations, between 45 × 80 µm and 160 × 280 µm in size, and metamict. A minority of grains are colourless or pale yellowish-green, euhedral, multifacetted, cracked and internally structureless or with zoned rims, and between 45 × 80 µm and 100 × 160 µm in size. Cathodoluminescence images of representative zircons are given in Figure 1.

Analytical details

This sample was analysed on 2 February 2002. The counter deadtime during the analysis session was 32 ns. Ten analyses of the CZ3 standard obtained during the analysis session indicated a Pb*/U calibration uncertainty of 2.39% (1σ). Common-Pb corrections were applied assuming Broken Hill common-Pb isotopic compositions for all analyses, with the exception of analyses 8.1, 10.1, 13.2, and 15.1, for which isotopic compositions determined using the method of Cumming and Richards (1975) were assumed.

Results

Twenty-six analyses were obtained from 21 zircons. Results are given in Table 1 and shown on a concordia plot in Figure 2.

Interpretation

The analyses are concordant to highly discordant, with the discordance pattern consistent with several recent episodes of radiogenic-Pb loss. On the basis of their $^{207}Pb/^{206}Pb$ ratios, many analyses can be assigned to one of three groups. Concordant and near-concordant analyses 7.1, 16.1, and 17.1, assigned to Group 1, have $^{207}Pb/^{206}Pb$ ratios defining a single population and indicating a weighted mean $^{207}Pb/^{206}Pb$ date of 3310 ± 8 Ma (chi-squared = 0.80). Concordant and slightly discordant analyses 1.1, 13.1, and 21.1, assigned to Group 2, have $^{207}Pb/^{206}Pb$ ratios defining a single population and indicating a weighted mean $^{207}Pb/^{206}Pb$ date of 3323 ± 9 Ma (chi-squared = 0.62). Ten analyses of ten zircons (2.1, 4.1, 5.1, 6.1, 9.1, 11.1, 12.1, 14.1, 19.1, 20.1), assigned to Group 3, have $^{207}Pb/^{206}Pb$ ratios defining a single population and indicating a weighted mean $^{207}Pb/^{206}Pb$ date of 3464 ± 3 Ma (chi-squared = 1.57). Concordant analysis

15.2 indicates a slightly younger $^{207}Pb/^{206}Pb$ date than those of Group 3, whereas the remaining analyses are slightly or highly discordant and cannot be confidently grouped.

Analyses 15.1 and 15.2 were obtained on a straw-coloured, euhedral, structureless grain. Concordant analysis 15.2 was obtained from the centre of grain 15. Although there is no morphological evidence of a core or overgrowth within this grain, the disparity between the $^{207}Pb/^{206}Pb$ dates indicated by these two analyses suggests that patchy within-grain recrystallization or new rim zircon growth on older (Group 3) cores was possible during at least one of the younger (Group 1 or 2) events.

Several interpretations of these results are possible. The date of 3310 ± 8 Ma indicated by the weighted mean $^{207}Pb/^{206}Pb$ ratio of the three concordant and near-concordant analyses 7.1, 16.1, and 17.1 of Group 1 could be interpreted as the time of igneous crystallization of the granodiorite, with the older dates indicated by the analyses of Groups 2 and 3 attributed to the presence of xenocryst zircons. Alternatively, the date of 3323 ± 9 Ma indicated by the analyses of Group 2 could provide the age of igneous crystallization of the granodiorite, with the younger analyses of Group 1 due to either the presence of indistinct veins or dykes in the sample, or an ancient radiogenic-Pb redistribution event. The analyses of Group 3, which indicated an older $^{207}Pb/^{206}Pb$ date than those of Groups 1 and 2, are interpreted to be of xenocryst zircons. The remaining discordant analyses are interpreted to be of analysis sites that have undergone radiogenic-Pb loss during several recent disturbance events.

Recommended reference for this publication:

NELSON, D. R., 2004, 169042: biotite granodiorite, Wilina Well; Geochronology dataset 40; in Compilation of geochronology data, June 2006 update: Western Australia Geological Survey.

Data obtained: 02/02/2002; Data released: 06/12/2004

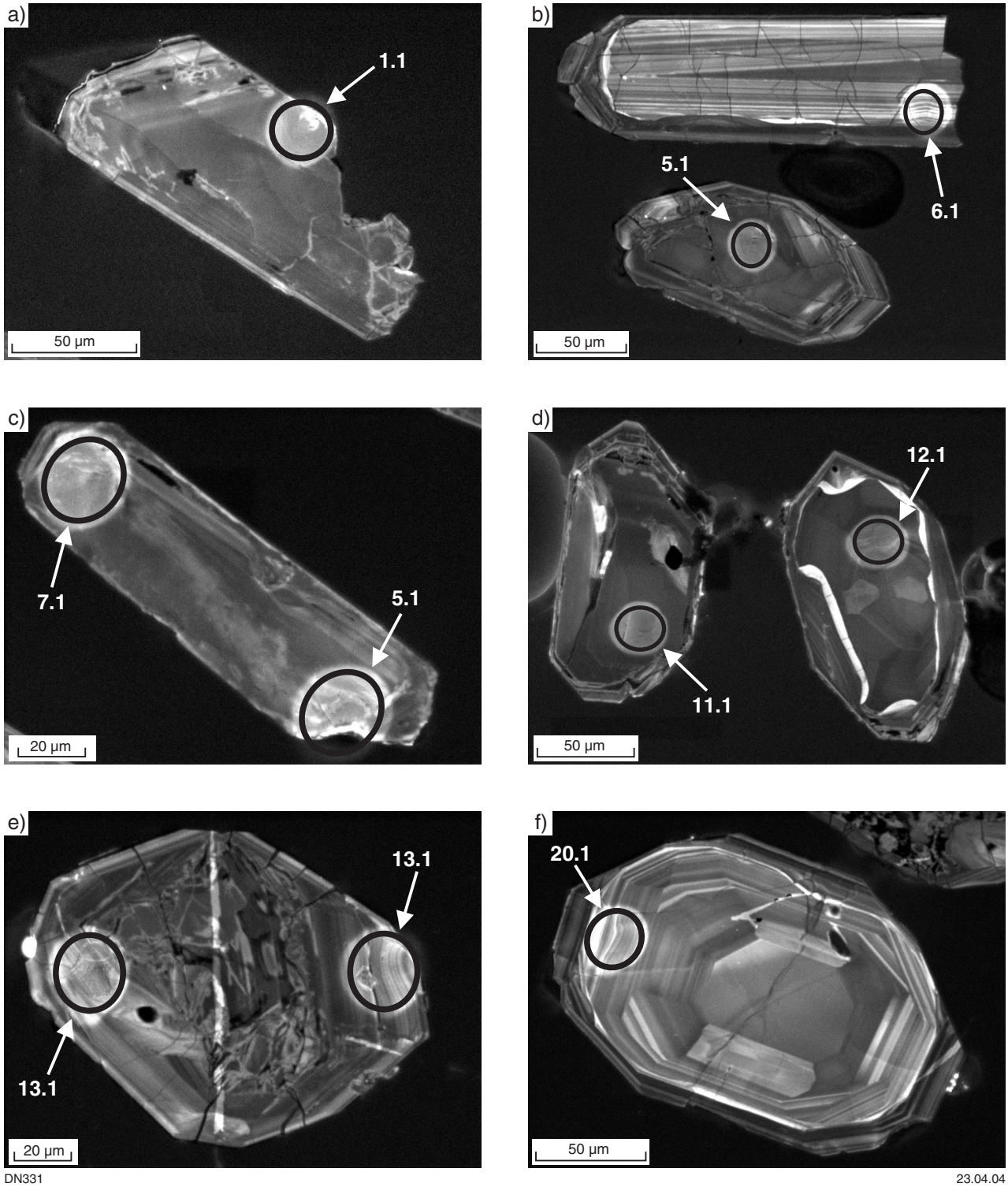

Figure 1. Cathodoluminescence images of representative zircons from sample 169042: biotite granodiorite, Wilina Well

Table 1. Ion microprobe analytical results for sample 169042: biotite granodiorite, Wilina Well

Grain .spot	*U (ppm)*	*Th (ppm)*	*Pb (ppm)*	*f206%*	$^{207}Pb/^{206}Pb$	*±1σ*	$^{208}Pb/^{206}Pb$	*±1σ*	$^{206}Pb/^{238}U$	*±1σ*	$^{207}Pb/^{235}U$	*±1σ*	*% concordance*	$^{207}Pb/^{206}Pb$ *Age*	*±1σ*
1.1	328	108	251	0.222	0.27311	0.00061	0.09348	0.00066	0.6463	0.0155	24.339	0.592	97	3 324	3
2.1	114	44	96	0.084	0.29753	0.00103	0.10886	0.00103	0.6926	0.0167	28.411	0.704	98	3 457	5
3.1	404	201	289	0.303	0.26598	0.00055	0.13309	0.00068	0.5894	0.0141	21.614	0.524	91	3 282	3
4.1	463	395	443	0.056	0.29954	0.00050	0.23284	0.00058	0.7243	0.0173	29.915	0.724	101	3 468	3
5.1	259	199	234	0.065	0.29757	0.00070	0.21435	0.00081	0.6929	0.0166	28.428	0.693	98	3 458	4
6.1	107	54	87	0.110	0.29630	0.00118	0.15663	0.00136	0.6427	0.0155	26.257	0.656	93	3 451	6
7.1	368	180	297	0.095	0.27071	0.00055	0.13639	0.00058	0.6630	0.0159	24.748	0.601	99	3 310	3
8.1	487	205	336	0.894	0.25923	0.00062	0.12243	0.00103	0.5653	0.0135	20.207	0.492	89	3 242	4
9.1	199	148	190	0.040	0.29912	0.00080	0.20358	0.00090	0.7343	0.0176	30.283	0.742	102	3 466	4
10.1	425	156	296	0.231	0.26729	0.00058	0.10646	0.00068	0.5853	0.0140	21.570	0.524	90	3 290	3
11.1	360	282	347	0.061	0.29844	0.00055	0.21297	0.00063	0.7383	0.0177	30.379	0.737	103	3 462	3
12.1	223	213	222	0.045	0.29844	0.00073	0.25718	0.00091	0.7396	0.0178	30.435	0.744	103	3 462	4
13.1	151	36	111	0.590	0.27171	0.00104	0.07112	0.00143	0.6209	0.0149	23.261	0.578	94	3 316	6
14.1	463	399	416	0.046	0.29875	0.00048	0.23757	0.00057	0.6775	0.0162	27.907	0.675	96	3 464	3
15.1	499	190	396	0.533	0.27405	0.00053	0.10399	0.00074	0.6577	0.0157	24.854	0.602	98	3 329	3
16.1	597	313	469	0.096	0.27021	0.00044	0.14426	0.00047	0.6425	0.0154	23.937	0.578	97	3 307	3
17.1	399	159	310	0.235	0.27124	0.00055	0.10989	0.00063	0.6487	0.0155	24.262	0.589	97	3 313	3
18.1	357	137	236	0.401	0.26423	0.00063	0.10852	0.00083	0.5510	0.0132	20.073	0.489	86	3 272	4
19.1	194	108	171	0.107	0.29901	0.00079	0.14938	0.00082	0.7051	0.0169	29.068	0.712	99	3 465	4
20.1	83	33	71	0.166	0.30103	0.00125	0.11225	0.00141	0.7014	0.0170	29.112	0.730	99	3 476	6
21.1	467	183	362	0.031	0.27294	0.00047	0.10869	0.00040	0.6515	0.0156	24.519	0.593	97	3 323	3
7.2	332	128	248	0.497	0.27831	0.00077	0.11777	0.00105	0.6122	0.0147	23.491	0.575	92	3 353	4
10.2	446	153	290	0.519	0.26676	0.00063	0.09772	0.00087	0.5459	0.0131	20.077	0.488	85	3 287	4
15.2	219	149	195	0.119	0.29696	0.00075	0.18871	0.00086	0.6933	0.0166	28.387	0.694	98	3 454	4
13.2	218	75	120	1.320	0.26809	0.00106	0.09975	0.00184	0.4504	0.0108	16.647	0.413	73	3 295	6
16.2	519	200	400	0.204	0.27463	0.00049	0.10699	0.00054	0.6444	0.0154	24.399	0.590	96	3 333	3

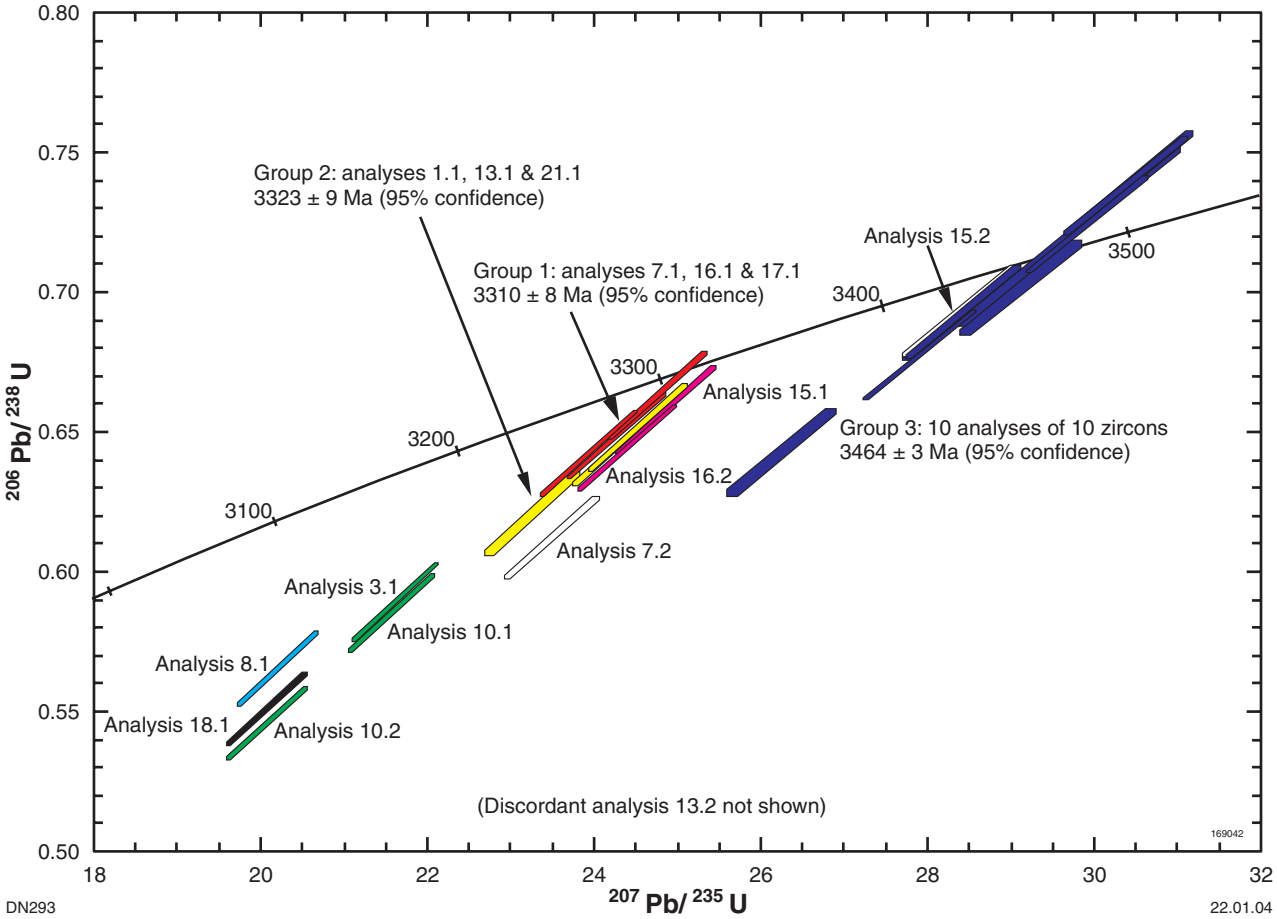

Figure 2. Concordia plot for sample 169042: biotite granodiorite, Wilina Well