

# 178014: biotite monzogranite, Quartz Hill

## Location and sampling

NULLAGINE (SF 51-5), NULLAGINE (2954)  
MGA Zone 51, 220170E 7566020N

Sampled on 27 May 2002

The sample was taken from a low rounded outcrop at the base of the southern side of a prominent tor- and boulder-covered hill, 250 m east of the access track and 6 km east-southeast of Quartz Hill.

## Tectonic unit/relations

The sample is a pale pinkish-grey, medium- and even-grained, unfoliated biotite monzogranite from a large, locally weakly foliated granite body in the Bonney Downs Granite of the Kurrana Granitoid Complex, Kurrana Terrane (Bagas, 2005). The sample contains at least two igneous phases — a coarse-grained pegmatite and an even-grained granitic phase — and was collected to determine whether the Bonney Downs Granite is similar in age to the post-tectonic, Sn-bearing granites in the East Pilbara Granite–Greenstone Terrane.

## Petrographic description

The principal minerals in the sample are K-feldspar (35 vol.%), plagioclase (andesine–oligoclase; 30–35 vol.%), quartz (30 vol.%), and altered biotite (3 vol.%), with trace amounts of accessory opaque oxide, chlorite, clay, epidote, sericite, clinozoisite, titanite, leucoxene, fluorite, and zircon. This is an undeformed biotite monzogranite with chlorite–clay–epidote–sericite–titanite alteration. The rock has abundant pale pink feldspar that is mostly K-feldspar. Plagioclase occurs as anhedral to subhedral grains and crystals up to 6 mm long, which are dusted commonly with sericite and clinozoisite, locally with coarser grained muscovite with or without epidote, and rarely with fluorite. Some of the more anhedral grains have been partly replaced by microcline during crystallization. The microcline is inequigranular, with larger grains up to 8 mm long, anhedral to subhedral, and containing oriented small inclusions of plagioclase as euhedral laths less than 0.5 mm long. Smaller, mostly anhedral microcline grains are commonly moulded onto, and apparently replace, earlier plagioclase. Locally, there are large patches of myrmekite, mostly as optically continuous overgrowths on plagioclase. Quartz occurs as anhedral, partly interstitial grains up to 4 mm long, mostly undeformed with rare undulose extinction. Biotite, up to 1 mm in grain size, is completely altered to chlorite, clay (?vermiculite), or both, with minor to abundant granular

epidote and lamellae of titanite, leucoxene, or both. Some of the altered biotite is interlaminated with muscovite. Large masses, up to 1 mm in diameter, of opaque oxide are present, with apatite, altered biotite, and rare zircon in and adjacent to the oxide. Strongly zoned zircon crystals, up to 0.15 mm in length, are most common in the altered biotite, and rarer within quartz, but there are also zoned crystals that could be allanite, rather than zircon, and have epidote overgrowths away from the oxide masses. There are small prisms of apatite. The sample is an undeformed, but altered, monzogranite with low-temperature hydrothermal alteration to chlorite (clay–epidote–secondary titanite – sericite–muscovite).

## Zircon morphology

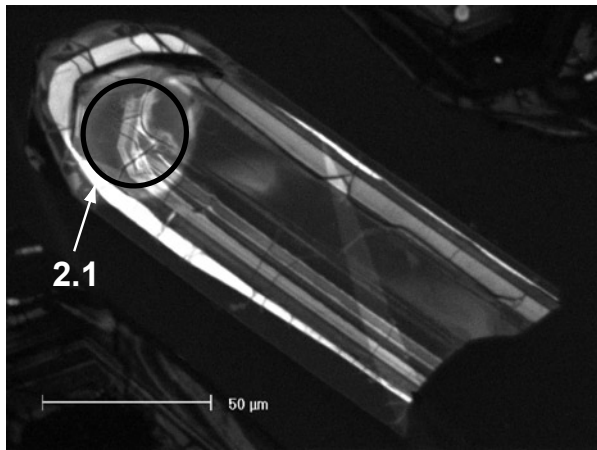
The zircons isolated from this sample are typically colourless, pale yellowish-brown or dark brown, between  $60 \times 140 \mu\text{m}$  and  $160 \times 280 \mu\text{m}$  in size, and elongate and euhedral or subhedral. Most grains have faint internal zonation, but a minority are structureless and unzoned with abundant fluid and mineral inclusions. Cathodoluminescence images of representative zircons are given in Figure 1.

## Analytical details

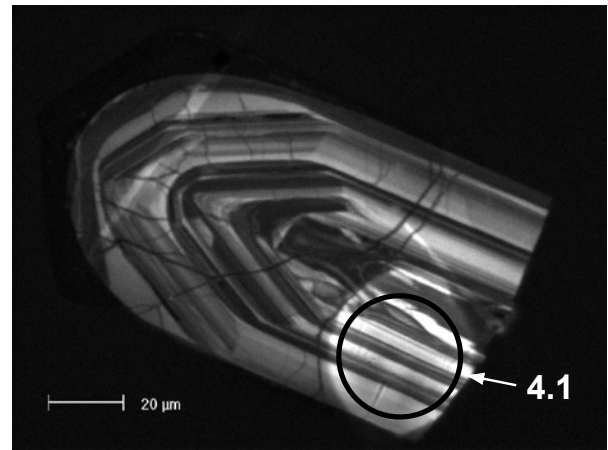
This sample was analysed on 10 and 26 February 2003. The counter deadtime during both analysis sessions was 24 ns. During the first analysis session, seven analyses of the CZ3 standard were obtained. Following deletion of one standard analysis as an outlier, the remaining six standard analyses indicated a Pb\*/U calibration uncertainty of 2.46% ( $1\sigma$ ). Analyses 1.1 to 12.1 were obtained during the first analysis session. During the second analysis session, six analyses of the CZ3 standard indicated a Pb\*/U calibration uncertainty of 0.685% ( $1\sigma$ ). A calibration uncertainty of 1.0% ( $1\sigma$ ) was applied to analyses of unknowns obtained during this analysis session. Common-Pb corrections were applied assuming Broken Hill common-Pb isotopic compositions for all analyses, with the exception of analyses 1.1, 2.1, 3.1, 4.1, 5.1, 7.4, 8.1, 8.3, 9.3, 10.1, and 11.1, for which isotopic compositions determined using the method of Cumming and Richards (1975) were assumed.

## Results

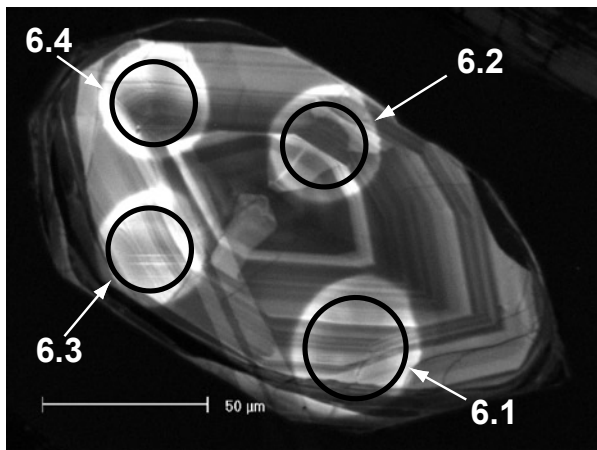
Twenty-two analyses were obtained from 11 zircons. Results are given in Table 1 and shown on a concordia plot in Figure 1.



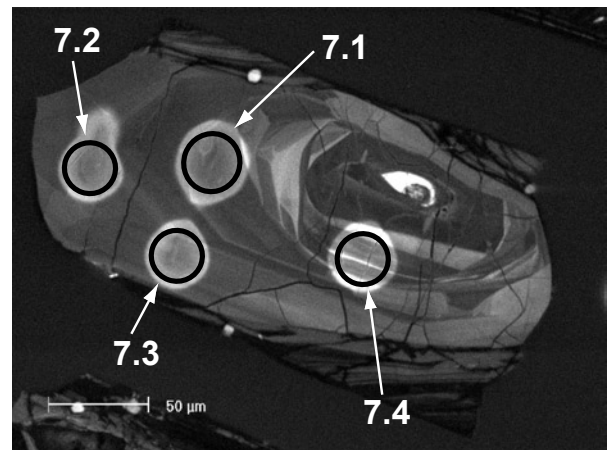
(a)



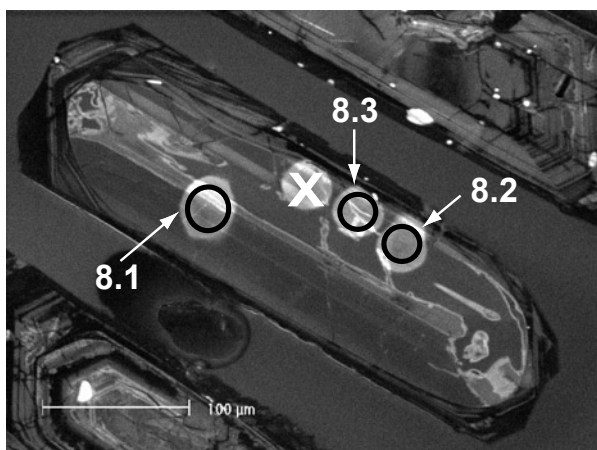
(b)



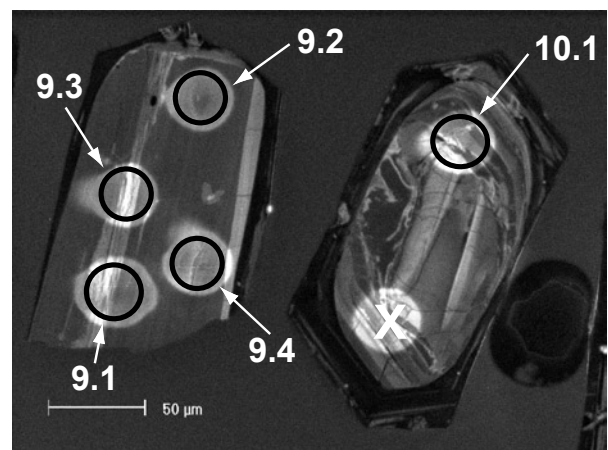
(c)



(d)



(e)



(f)

Figure 1. Cathodoluminescence images of representative zircons from sample 178014: biotite monzogranite, Quartz Hill

Table 1. Ion microprobe analytical results for zircons from sample 178014: biotite monzogranite, Quartz Hill

Grain -spot	U (ppm)	Th (ppm)	Pb (ppm)	f <sup>206</sup> %	$^{207}\text{Pb}/^{206}\text{Pb}$	$\pm 1\sigma$	$^{208}\text{Pb}/^{206}\text{Pb}$	$\pm 1\sigma$	$^{206}\text{Pb}/^{238}\text{U}$	$\pm 1\sigma$	$^{207}\text{Pb}/^{235}\text{U}$	$\pm 1\sigma$	% concordance	$^{207}\text{Pb}/^{206}\text{Pb}$ Age	$\pm 1\sigma$
1.1	538	157	261	0.890	0.22017	0.00063	0.10085	0.00103	0.4139	0.0102	12.563	0.316	75	2 982	5
2.1	343	93	225	2.334	0.24537	0.00096	0.13564	0.00184	0.5093	0.0126	17.229	0.439	84	3 155	6
3.1	450	289	372	0.795	0.25524	0.00058	0.17708	0.00096	0.6532	0.0161	22.986	0.577	101	3 218	4
4.1	196	181	158	0.555	0.26796	0.00081	0.25667	0.00134	0.6031	0.0149	22.282	0.564	92	3 294	5
5.1	211	79	95	4.410	0.22637	0.00189	0.30515	0.00403	0.2994	0.0074	9.344	0.253	56	3 027	13
6.1	87	38	64	0.124	0.25587	0.00113	0.12836	0.00132	0.6104	0.0152	21.534	0.556	95	3 221	7
7.1	264	138	170	0.037	0.20442	0.00055	0.14254	0.00069	0.5555	0.0137	15.657	0.395	100	2 862	4
8.1	442	611	280	0.271	0.19743	0.00051	0.38189	0.00104	0.4622	0.0114	12.581	0.316	87	2 805	4
9.1	430	557	296	0.104	0.20042	0.00044	0.35149	0.00084	0.5127	0.0127	14.167	0.355	94	2 830	4
7.2	212	130	132	0.173	0.20191	0.00071	0.17059	0.00109	0.5236	0.0054	14.576	0.166	96	2 842	6
7.3	173	86	107	0.088	0.20394	0.00079	0.13522	0.00113	0.5372	0.0056	15.104	0.176	97	2 858	6
8.2	414	600	302	0.052	0.20201	0.00048	0.39341	0.00096	0.5295	0.0054	14.749	0.159	96	2 842	4
9.2	284	268	193	0.104	0.20180	0.00059	0.25177	0.00100	0.5406	0.0056	15.042	0.166	98	2 841	5
10.1	393	80	240	0.730	0.24599	0.00068	0.08334	0.00110	0.5191	0.0053	17.606	0.192	85	3 159	4
9.3	407	551	263	0.925	0.19531	0.00071	0.39465	0.00153	0.4582	0.0047	12.339	0.139	87	2 787	6
9.4	249	191	156	0.090	0.20162	0.00067	0.21518	0.00111	0.5122	0.0053	14.238	0.160	94	2 839	5
8.3	508	608	340	0.453	0.19749	0.00055	0.36743	0.00113	0.4900	0.0050	13.342	0.146	92	2 806	5
11.1	538	200	310	0.447	0.23225	0.00059	0.09984	0.00088	0.4945	0.0050	15.837	0.171	84	3 068	4
6.2	95	79	80	0.160	0.25564	0.00112	0.22651	0.00171	0.6589	0.0073	23.224	0.287	101	3 220	7
6.3	47	25	36	0.543	0.25657	0.00190	0.14179	0.00316	0.6280	0.0075	22.216	0.328	97	3 226	12
6.4	86	50	68	0.140	0.25665	0.00117	0.15845	0.00160	0.6470	0.0072	22.894	0.287	100	3 226	7
7.4	245	138	149	0.658	0.20154	0.00086	0.18537	0.00159	0.4993	0.0052	13.875	0.162	92	2 839	7

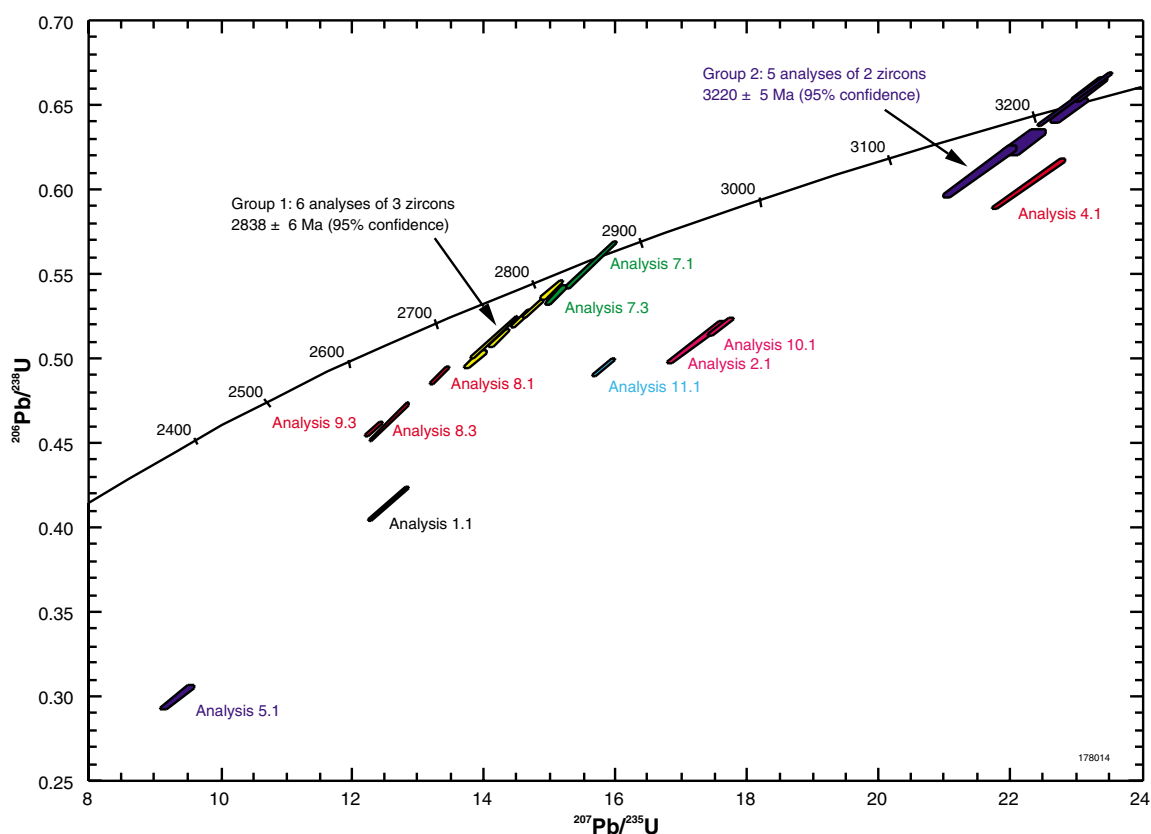


Figure 2. Concordia plot for sample 178014: biotite monzogranite, Quartz Hill

## Interpretation

The analyses are concordant to highly discordant, with the discordance pattern consistent with at least one ancient episode of radiogenic-Pb loss. On the basis of their  $^{207}\text{Pb}/^{206}\text{Pb}$  ratios, many analyses can be assigned to one of two groups. Six discordant analyses of three zircons (7.2, 7.4, 8.2, 9.1, 9.2, 9.4), assigned to Group 1, have  $^{207}\text{Pb}/^{206}\text{Pb}$  ratios defining a single population and indicating a weighted mean  $^{207}\text{Pb}/^{206}\text{Pb}$  date of  $2838 \pm 6$  Ma (chi-squared = 1.21). Five concordant and slightly discordant analyses of two zircons (3.1, 6.1, 6.2, 6.3, 6.4), assigned to Group 2, have  $^{207}\text{Pb}/^{206}\text{Pb}$  ratios defining a single population and indicating a weighted mean  $^{207}\text{Pb}/^{206}\text{Pb}$  date of  $3220 \pm 5$  Ma (chi-squared = 0.31). Highly discordant analyses 8.1, 8.3, and 9.3 indicate  $^{207}\text{Pb}/^{206}\text{Pb}$  dates that are younger than those of Group 1; concordant analysis 7.1, and near-concordant analysis 7.3 indicate  $^{207}\text{Pb}/^{206}\text{Pb}$  dates that are older than those of Group 1. Highly discordant analyses 1.1, 2.1, 5.1, and 10.1 indicate  $^{207}\text{Pb}/^{206}\text{Pb}$  dates that are intermediate between those of Groups 1 and 2; and highly discordant analysis 4.1 indicates a substantially older  $^{207}\text{Pb}/^{206}\text{Pb}$  date than those of Group 2.

The  $^{207}\text{Pb}/^{206}\text{Pb}$  dates indicated by the discordant analyses of Group 1, and of discordant analysis 9.3, are interpreted to be of analysis sites that have lost radiogenic Pb during an ancient disturbance event. Concordant analyses 7.1 and 7.3, which indicate a weighted mean

$^{207}\text{Pb}/^{206}\text{Pb}$  date of  $2861 \pm 4$  Ma ( $\pm 1\sigma$  uncertainty), are interpreted to provide the best estimate of the age of igneous crystallization of the monzogranite. The date of  $2838 \pm 6$  Ma indicated by the weighted mean  $^{207}\text{Pb}/^{206}\text{Pb}$  ratio of the six discordant analyses of three zircons of Group 1 is interpreted as a minimum age for igneous crystallization of the monzogranite. The older  $^{207}\text{Pb}/^{206}\text{Pb}$  dates indicated by the remaining analyses, including those of Group 2, are interpreted to be of xenocryst zircons.

Recommended reference for this publication:

NELSON, D. R., 2005, 178014: biotite monzogranite, Quartz Hill; Geochronology dataset 551; in Compilation of geochronology data, June 2006 update: Western Australia Geological Survey.

Data obtained: 26/02/2003; Data released: 30/06/2005