

192557: metagabbro, Haig Cave

(Madura Province)

Location and sampling

LOONGANA (SH 52-9), TURNER (4136)
MGA Zone 52, 253880E 6589700N

Sampled on 6 January 2012

This sample was collected from diamond core in drillhole LNGD0002, located on the Loongana prospect, at a depth of 371.0 – 371.5 m. The hole was drilled by Helix Resources Limited. The drillhole is located on the Nullarbor Plain, about 23.5 km northwest of Nurina, on the Trans-Australian Railway line, 17.4 km east of Family Dam, and 7.3 km south-southeast of Haig Cave.

Tectonic unit/relations

The unit sampled is a metagabbro of the Loongana intrusion within the Madura Province, the area of basement beneath the Eucla Basin bounded by the Rodona Shear Zone to the west and the Mundrabilla Shear Zone to the east. Geophysical datasets reveal a complex structural architecture for the Madura Province, with a dominant northeasterly regional trend (Spaggiari et al., 2012).

Geochronology of basement rocks of the Madura Province is sparse due to the complete cover. At the Loongana prospect, the sampled metagabbro occurs with metagranitic rocks in drillhole LNGD0002, and ultramafic rocks occur with metagabbro and metagranite in drillhole LNGD0001, approximately 2.5 km to the southwest. Metagranite from drillhole LNGD0002 yielded igneous crystallization ages of 1415 ± 7 Ma (GSWA 178070, Nelson et al., 2005a) and 1411 ± 6 Ma (GSWA 192558, Kirkland et al., 2013), whereas microtonalite from drillhole LNGD0001 yielded an igneous crystallization age of 1408 ± 7 Ma (GSWA 178071, Nelson et al., 2005b), and tonalite gneiss from the same core yielded an igneous crystallization age of 1407 ± 7 Ma (GSWA 178072, Nelson et al., 2005c).

Bunting and McIntyre (2003) reported that drillhole LNGD0002 is dominated by gabbro, with minor orthopyroxene-bearing gabbro and gabbro-norite. These gabbros are interlayered with granitic rocks. Possible chilled contacts between gabbro units have been interpreted at 410.4, 413.25, 549, and 562.5 m, and inclusions of an older doleritic phase have also been reported. Such features suggest that the drillcore comprises numerous intrusive phases (Bunting and McIntyre, 2003). However, other contacts are diffuse, and

the presence of back-veining textures and possible hybrid phases suggest mingling and coeval intrusive relationships. Granodiorite and tonalite intrusive rocks occur at 580.74 and 594.3 m, respectively, and are locally associated with inferred contact-metamorphic assemblages in the gabbro, including ferroactinolite and blue-green hornblende (Bunting and McIntyre, 2003).

Petrographic description

The sample is an unfoliated metagabbro comprising about 60% amphibole, 30% chlorite, 5% plagioclase (andesine), and 4% clinozoisite, with accessory epidote, opaque oxide minerals, and zircon. Plagioclase contains inclusions of fine granular clinozoisite and epidote and is in places replaced by fibrous Mg–chlorite aggregates. Amphibole (tremolite or actinolite) is developed as anhedral to bladed aggregates, which have completely replaced clinopyroxene. Fine-grained anhedral pyrite is associated with the amphibole aggregates and locally exhibits intergrowths with chalcopyrite. Opaque oxide minerals include anhedral magnetite. Detailed petrographic observations of the entire drillcore were reported by Bunting and McIntyre (2003).

Zircon morphology

Zircons isolated from this sample are colourless, anhedral to subhedral, and generally spherical. The crystals are up to 250 μm long, equant, and have aspect ratios up to 4:1. In cathodoluminescence (CL) images, the crystals display ubiquitous sector zoning. A CL image of representative zircons is shown in Figure 1.

Analytical details

This sample was analysed on 15–16 November 2012, using SHRIMP-A. Fourteen analyses of the BR266 standard were obtained during the session, of which 12 indicated an external spot-to-spot (reproducibility) uncertainty of 1.05% (1σ), and a $^{238}\text{U}/^{206}\text{Pb}^*$ calibration uncertainty of 0.32% (1σ). Calibration uncertainties are included in the errors of $^{238}\text{U}/^{206}\text{Pb}^*$ 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).

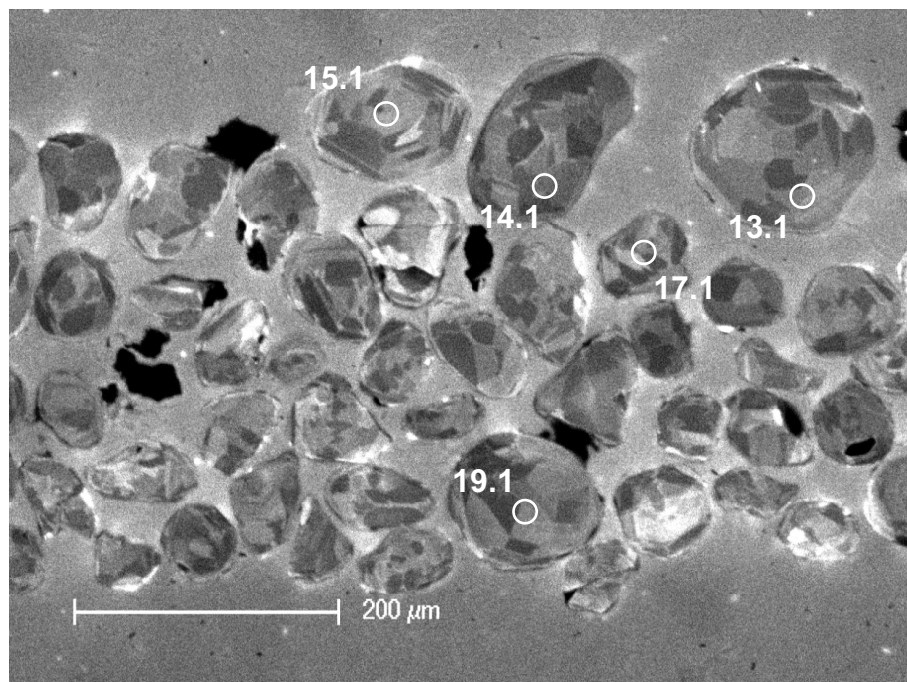


Figure 1. Cathodoluminescence image of representative zircons from 192557: metagabbro, Haig Cave. Numbered circles indicate the approximate positions of analysis sites

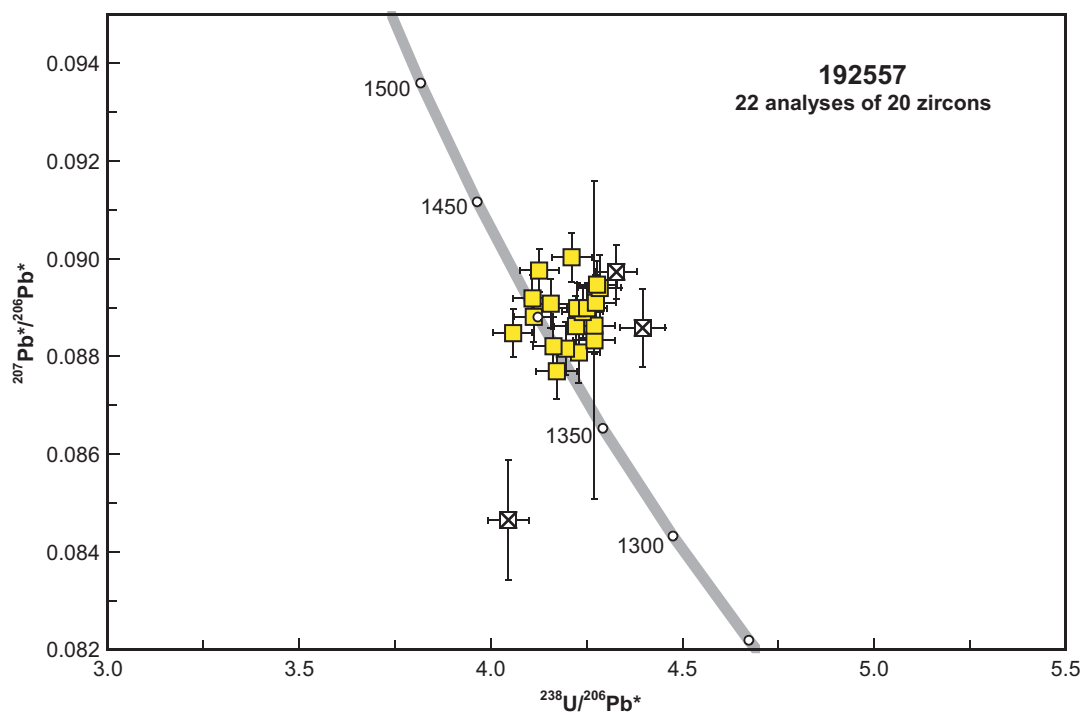


Figure 2. U-Pb analytical data for sample 192557: metagabbro, Haig Cave. Yellow squares indicate Group I (magmatic zircons); crossed squares indicate Group D (discordance >5%).

Table 1. Ion microprobe analytical results for zircons from sample 192557: metagabbro, Haig Cave

Group ID	Spot no.	Grain. spot	^{238}U (ppm)	^{232}Th (ppm)	$\frac{^{232}\text{Th}}{^{238}\text{U}}$	f_{204} (%)	$^{238}\text{U}/^{206}\text{Pb} \pm 1\sigma$	$^{207}\text{Pb}/^{206}\text{Pb} \pm 1\sigma$	$^{238}\text{U}/^{206}\text{Pb}^* \pm 1\sigma$	$^{207}\text{Pb}^*/^{206}\text{Pb}^* \pm 1\sigma$	$^{238}\text{U}/^{206}\text{Pb}^*$ date (Ma) $\pm 1\sigma$	$^{207}\text{Pb}^*/^{206}\text{Pb}^*$ date (Ma) $\pm 1\sigma$	Disc. (%)
I	18	18.1	194	128	0.68	0.054	4.169 0.053	0.08817 0.00053	4.172 0.053	0.08770 0.00057	1385 16	1376 13	-0.7
I	13	13.1	153	106	0.72	0.031	4.229 0.055	0.08834 0.00061	4.230 0.055	0.08808 0.00063	1368 16	1384 14	1.2
I	15	15.1	215	181	0.87	0.070	4.193 0.052	0.08876 0.00049	4.196 0.052	0.08816 0.00054	1378 16	1386 12	0.6
I	6	6.1	198	125	0.65	0.040	4.161 0.053	0.08855 0.00057	4.163 0.053	0.08821 0.00060	1388 16	1387 13	-0.1
I	10	10.1	214	175	0.85	0.117	4.265 0.054	0.08933 0.00325	4.270 0.054	0.08833 0.00326	1357 16	1390 71	2.4
I	21	21.1	231	169	0.76	0.010	4.058 0.051	0.08857 0.00049	4.058 0.051	0.08848 0.00050	1420 16	1393 11	-1.9
I	2	2.1	171	109	0.66	0.000	4.222 0.056	0.08862 0.00061	4.222 0.056	0.08862 0.00061	1370 16	1396 13	1.8
I	3	3.1	206	167	0.84	0.071	4.267 0.054	0.08924 0.00054	4.270 0.054	0.08863 0.00059	1356 16	1396 13	2.9
I	19	19.1	259	198	0.79	0.064	4.109 0.051	0.08936 0.00047	4.112 0.051	0.08881 0.00051	1403 16	1400 11	-0.2
I	16	16.1	216	209	1.00	0.051	4.238 0.053	0.08934 0.00050	4.240 0.053	0.08891 0.00053	1365 15	1402 12	2.6
I	11	11.1	242	161	0.69	-0.050	4.227 0.053	0.08856 0.00049	4.225 0.053	0.08899 0.00052	1369 16	1404 11	2.5
I	4	4.1	243	187	0.80	0.030	4.250 0.053	0.08925 0.00049	4.251 0.053	0.08899 0.00052	1362 15	1404 11	3.0
I	12	12.1	246	209	0.88	-0.021	4.157 0.052	0.08890 0.00050	4.156 0.052	0.08908 0.00051	1390 16	1406 11	1.1
I	14	14.1	247	290	1.21	0.080	4.271 0.053	0.08978 0.00052	4.274 0.053	0.08910 0.00057	1355 15	1406 12	3.6
I	22	22.1	268	343	1.32	0.027	4.108 0.051	0.08942 0.00046	4.109 0.051	0.08919 0.00048	1404 16	1408 10	0.3
I	8	8.1	136	88	0.66	-0.017	4.285 0.057	0.08925 0.00065	4.284 0.057	0.08940 0.00067	1352 16	1413 14	4.3
I	7	7.1	251	174	0.72	-0.015	4.277 0.053	0.08934 0.00047	4.277 0.053	0.08947 0.00048	1354 15	1414 10	4.2
I	20	20.1	282	290	1.06	-0.016	4.126 0.051	0.08962 0.00043	4.126 0.051	0.08976 0.00044	1399 16	1420 9	1.5
I	17	17.1	232	256	1.14	-0.053	4.214 0.052	0.08958 0.00047	4.211 0.052	0.09003 0.00050	1373 16	1426 11	3.7
D	5	5.1	160	115	0.74	0.611	4.021 0.054	0.08986 0.00073	4.046 0.054	0.08465 0.00123	1424 17	1308 28	-8.9
D	1	1.1	154	113	0.76	0.098	4.392 0.059	0.08942 0.00070	4.396 0.060	0.08858 0.00079	1321 16	1395 17	5.3
D	9	9.1	221	140	0.65	-0.072	4.331 0.054	0.08911 0.00050	4.328 0.054	0.08973 0.00055	1340 15	1420 12	5.6

Results

Twenty-two analyses were obtained from 22 zircons. Results are listed in Table 1, and shown in a concordia diagram (Fig 2).

Interpretation

The analyses are concordant to slightly discordant (Fig. 2). Three analyses are >5% discordant. The dates obtained from these three analyses (Group D; Table 1) are considered not to be geologically significant. The remaining 19 analyses define a coherent group, based on their $^{207}\text{Pb}^*/^{206}\text{Pb}^*$ ratios.

Group I comprises 19 analyses (Table 1), which yield a weighted mean $^{207}\text{Pb}^*/^{206}\text{Pb}^*$ date of 1403 ± 6 Ma (MSWD = 1.2).

The date of 1403 ± 6 Ma for the 19 analyses in Group I is tentatively interpreted as the magmatic crystallization age of the gabbro. Although the strongly rounded shapes are not typical of primary zircons in mafic intrusions (e.g. Wingate et al., 1998), the moderate to high Th/U ratios (0.66 – 1.32) are consistent with increasing magma temperature, promoting higher Th contents relative to U contents, in conditions closer approximating equilibrium crystallization. Such crystallization processes result in higher Th/U ratios for zircon grown during magmatic crystallization in a mafic rock (Wang et al., 2011).

An alternative interpretation, that the zircons are metamorphic in origin, is feasible. The sector zoning in these zircons implies slow crystal growth and has been reported for both plutonic and metamorphic zircons (Watson and Liang, 1995).

A third possible interpretation is that the zircons in the metagabbro are inherited from older rocks, which themselves were mafic in composition, in which case the date of 1403 ± 6 Ma is a maximum age for crystallization of the gabbro.

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Recommended reference for this publication

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