194718: mafic granulite, American Granulite Quarry

(Fraser Range Metamorphics, Albany–Fraser Orogen)

Location and sampling

WIDGIEMOOLTHA (SH 51-14), YARDILLA (3433)
MGA Zone 51, 489105E 6462896N

Sampled on 30 June 2008

This sample was collected from the American Granulite dimension stone quarry on Fraser Range Station, approximately 430 m north of Peters Dam, 6.5 km southwest of Yardilla Bore, and 10.6 km northeast of Fraser Range Homestead.

Tectonic unit/relations

The unit sampled is a mafic granulite assigned to the Fraser Range Metamorphics of the Fraser Zone (Spaggiari et al., 2009), a suite of interleaved, thin slivers of granitic gneiss, metasedimentary rocks, and mafic rocks that are now mostly pyroxene granulites or mafic amphibolites (Myers, 1985; Clark et al., 1999; De Waele and Pisarevsky, 2008). Magmatic crystallization of a gabbro within the Fraser Zone is dated at 1291 ± 8 Ma using U–Pb analyses on zircon (De Waele and Pisarevsky, 2008). Early metamorphism in the Fraser Zone, at 1304 ± 7 Ma, is recorded by zircon rims developed within a quartz metasandstone, which also yields a maximum depositional age of 1466 ± 17 Ma (Wingate and Bodorkos, 2007). Myers (1985) interpreted the mafic rocks in the Fraser Zone as part of a large layered mafic intrusion, whereas Condie and Myers (1999) argued that they represent remnants of multiple magmatic arcs. Doepel (1975) interpreted both the metagranitic and metamafic components of the Fraser Zone as an exhumed block of lower crust.

This mafic granulite contains two generations of leucosome: one parallel to the foliation, and a younger leucosome, which is crosscutting and garnet-bearing. The younger leucosome is more diffuse and has no sharp contacts with the melanosome. The granulite has a strong, northeasterly trending foliation, and moderate lineation.

Petrographic description

The sample is a mafic granulite, and contains approximately 50% plagioclase, 45% pyroxene, 3% biotite, 1% opaque oxide minerals, and accessory apatite and zircon. Clinopyroxene appears to be more dominant than orthopyroxene. The texture is predominantly granoblastic, with grains about 1 mm long. Biotite is foliated and much of the plagioclase has (010) planes at a low angle to the biotite foliation. The plagioclase contains antiperthitic domains, and in places contains patches of secondary carbonate.

Zircon morphology

Zircons isolated from this sample are subhedral, rounded, up to 300 μm long, have aspect ratios up to 5:1, and are light yellow to brown. In cathodoluminescence (CL) images, some zircons display broad sector zoning, whereas others are homogeneous or contain homogeneous domains. Contacts between these domains are generally sharp with curved interfaces; similar characteristics have been described as nebulous zoning, and are characteristic of granulite-facies metamorphism (Vavra et al., 1996). There is no evidence of older zircon cores. A CL image of representative zircons is shown in Figure 1.

Analytical details

This sample was analysed over two sessions on 27–28 August, 2010, using SHRIMP-A. Analyses 1.1 to 5.1 (spot numbers 1–5) were obtained during the first session, together with three analyses of the BR266 standard, which indicated an external spot-to-spot (reproducibility) uncertainty of 1.22% and a $^{238}U/^{206}Pb^*$ calibration uncertainty of 0.76% (1σ). Analyses 6.1 to 20.1 (spot numbers 6–20) were obtained during the second session, together with ten analyses of the Temora standard, which indicated an external spot-to-spot (reproducibility) uncertainty of 1.62% and a $^{238}U/^{206}Pb^*$ calibration uncertainty of 0.60% (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 isotopic compositions determined according to the model of Stacey and Kramers (1975).

Results

Twenty analyses were obtained from 20 zircons. Results are listed in Table 1, and shown in a concordia diagram (Fig. 2).

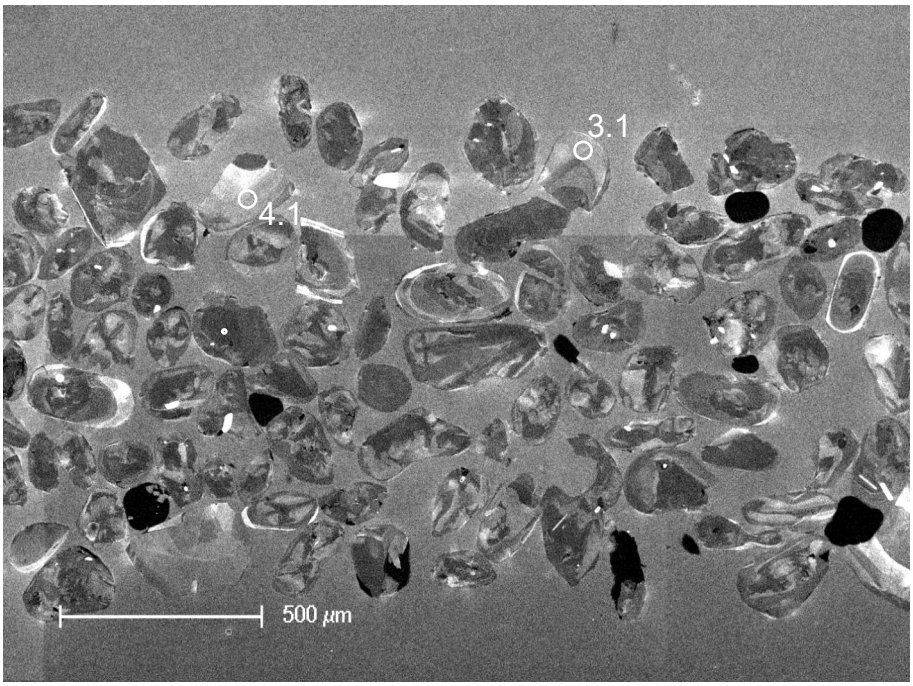

Figure 1. Cathodoluminescence image of representative zircons from sample 194718: mafic granulite, American Granulite Quarry. Numbered circles indicate the approximate positions of analysis sites.

Interpretation

The analyses are concordant (Fig. 2), and define one coherent group based on their $^{207}Pb^*/^{206}Pb^*$ and $^{238}U^*/^{206}Pb^*$ ratios.

Group M comprises 20 analyses (Table 1), which yield a concordia age of 1292 ± 6 Ma (MSWD = 0.81).

The date of 1292 ± 6 Ma for the 20 analyses in Group M is interpreted as the age of granulite-facies metamorphism. Emplacement of the igneous protolith may have been coeval with this metamorphism, or alternatively, the zircons may have been completely reset during this metamorphic event. In either case, 1292 Ma is a minimum age for the protolith.

References

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Recommended reference for this publication

Kirkland, CL, Wingate, MTD and Spaggiari, CV 2011, 194718: mafic granulite, American Granulite Quarry; Geochronology Record 993: Geological Survey of Western Australia, 4p.

Data obtained: 28 August 2010
Data released: 30 June 2011

Table 1. Ion microprobe analytical results for zircons from sample 194718: mafic granulite, American Granulite Quarry

Group ID	Spot no.	Grain spot	^{238}U (ppm)	^{232}Th (ppm)	$^{232}Th/^{238}U$	f204 (%)	$^{238}U/^{206}Pb$	± 1 σ	$^{207}Pb/^{206}Pb$	± 1 σ	$^{238}U/^{206}Pb^*$	± 1 σ	$^{207}Pb^*/^{206}Pb^*$	± 1 σ	$^{238}U/^{206}Pb^*$ date (Ma)	± 1 σ	$^{207}Pb^*/^{206}Pb^*$ date (Ma)	± 1 σ	Disc. (%)
M	1	1.1	139	67	0.49	0.481	4.625	0.080	0.08552	0.00082	4.648	0.080	0.08144	0.00131	1256	20	1232	32	-2.0
M	2	2.1	168	106	0.65	0.307	4.567	0.076	0.08465	0.00322	4.581	0.076	0.08205	0.00332	1273	19	1247	79	-2.1
M	8	8.1	44	15	0.37	0.083	4.420	0.099	0.08319	0.00136	4.424	0.100	0.08249	0.00153	1314	27	1257	36	-4.5
M	5	5.1	428	202	0.49	0.061	4.615	0.071	0.08326	0.00366	4.618	0.071	0.08274	0.00367	1264	18	1263	87	0.0
M	6	6.1	390	193	0.51	0.000	4.542	0.082	0.08344	0.00048	4.542	0.082	0.08344	0.00048	1283	21	1280	11	-0.2
M	11	11.1	506	247	0.50	0.054	4.550	0.082	0.08391	0.00041	4.552	0.082	0.08346	0.00045	1280	21	1280	10	0.0
M	18	18.1	426	201	0.49	0.018	4.532	0.082	0.08375	0.00179	4.532	0.082	0.08360	0.00179	1285	21	1283	42	-0.2
M	16	16.1	408	208	0.53	0.027	4.516	0.082	0.08392	0.00045	4.517	0.082	0.08369	0.00047	1289	21	1285	11	-0.3
M	13	13.1	196	123	0.65	0.080	4.446	0.083	0.08452	0.00356	4.450	0.084	0.08384	0.00358	1307	23	1289	83	-1.4
M	4	4.1	123	59	0.49	0.033	4.611	0.266	0.08424	0.00085	4.613	0.266	0.08396	0.00089	1265	70	1292	21	2.1
M	14	14.1	245	177	0.75	0.031	4.502	0.083	0.08438	0.00059	4.503	0.083	0.08411	0.00062	1293	22	1295	14	0.2
M	9	9.1	93	39	0.44	-0.121	4.470	0.090	0.08309	0.00093	4.465	0.090	0.08412	0.00110	1303	24	1295	26	-0.6
M	12	12.1	568	672	1.22	-0.006	4.460	0.080	0.08423	0.00038	4.460	0.080	0.08429	0.00038	1304	21	1299	9	-0.4
M	19	19.1	416	204	0.51	0.000	4.598	0.083	0.08445	0.00044	4.598	0.083	0.08445	0.00044	1269	21	1303	10	2.6
M	15	15.1	426	252	0.61	-0.035	4.563	0.082	0.08421	0.00044	4.562	0.082	0.08451	0.00046	1278	21	1304	11	2.0
M	17	17.1	345	257	0.77	0.062	4.432	0.081	0.08525	0.00048	4.435	0.081	0.08472	0.00053	1311	22	1309	12	-0.1
M	7	7.1	251	115	0.47	-0.048	4.473	0.083	0.08433	0.00060	4.470	0.083	0.08474	0.00064	1301	22	1310	15	0.6
M	10	10.1	90	39	0.45	-0.170	4.566	0.092	0.08330	0.00096	4.558	0.092	0.08474	0.00120	1279	24	1310	27	2.4
M	3	3.1	150	60	0.41	-0.060	4.598	0.077	0.08481	0.00082	4.595	0.077	0.08532	0.00089	1269	20	1323	20	4.0
M	20	20.1	562	481	0.88	-0.007	4.495	0.081	0.08528	0.00161	4.495	0.081	0.08533	0.00161	1295	21	1323	36	2.1

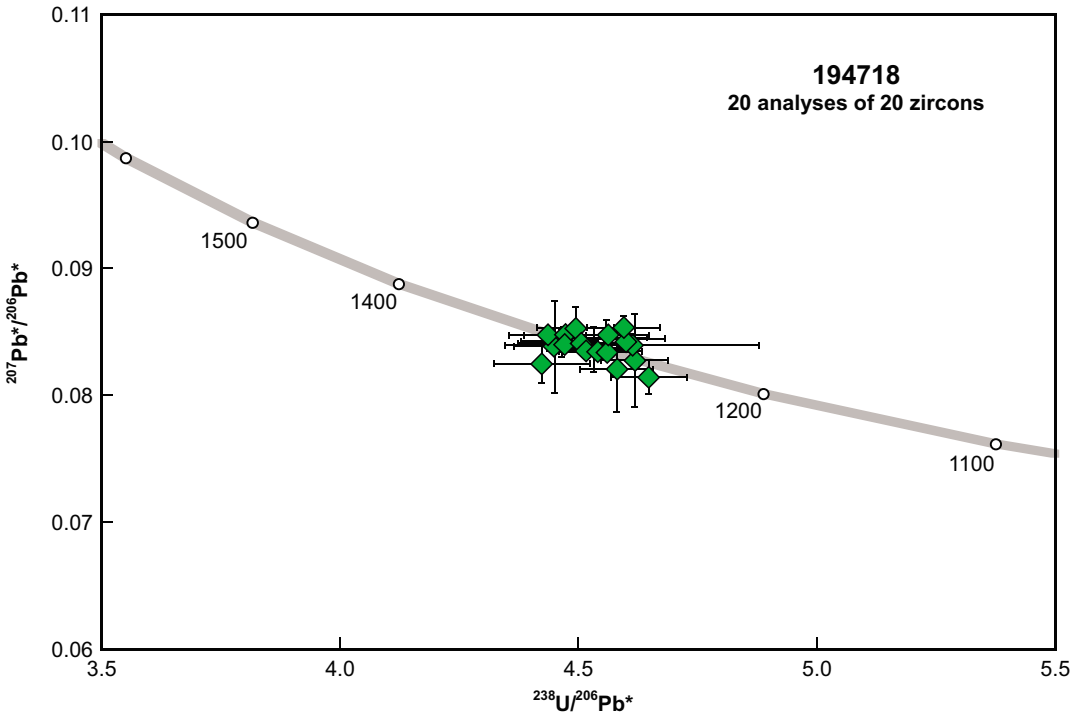

Figure 2. U–Pb analytical data for sample 194718: mafic granulite, American Granulite Quarry. Green diamonds indicates Group M (metamorphic zircons).