184125: orthopyroxene-bearing dioritic gneiss, Observatory Point

(Recherche Granite, Albany–Fraser Orogen)

Location and sampling

ESPERANCE (SI 51-6), ESPERANCE (3230)
MGA Zone 51, 388659E 6247378N

Sampled on 22 May 2006

The sample originated from a large, southward-sloping rock platform that is part of the coastal exposure at Observatory Point. The sample was collected from a point about 300 m west of the base of the access stairs, which corresponds to the location of GSWA 83659 (Nelson, 1995; Nelson et al., 1995).

Tectonic unit/relations

The unit sampled is a dark grey, coarse-grained, orthopyroxene-bearing dioritic gneiss with well-developed differentiated layering. It is attributed to the Recherche Granite, within the Biranup Complex of the Albany–Fraser Orogen (Myers, 1995). The dioritic gneiss is intruded at this locality by homogeneous foliated leucogranite, of which GSWA 83659 is representative (Nelson, 1995), that has not undergone the same degree of deformation, and both rock types are cross-cut by pegmatitic segregations.

Petrographic description

This sample is characterised by well-developed differentiated layering, defined by alternating plagioclase-rich and orthoclase-rich zones. Plagioclase-rich zones contain about 85% plagioclase (some of which is antiperthitic), 5% orthoclase, 5% quartz, 2–3% orthopyroxene, 1–2% opaque oxide minerals, and accessory hornblende, biotite, apatite, and zircon (as grains 30–100 µm in length). Orthoclase-rich zones contain 45% orthoclase, 35% plagioclase, 10–15% quartz, 3–5% hornblende, 2–3% orthopyroxene, and 1% biotite. Myrmekite is common along orthoclase-plagioclase grain boundaries in both zones.

The overall texture is granuloblastic, with quartz and feldspars ranging up to 4 mm in diameter, and finer-grained ferromagnesian minerals that rarely reach 2 mm in length. The foliation is defined by oriented biotite in association with lamellae of orthopyroxene and hornblende. Most hornblende displays brown pleochroism, characteristic of formation under granulite facies metamorphic conditions, although sparse bluish-green hornblende of possible retrograde origin is also present. Minor alteration of feldspars, orthopyroxene, and biotite to clay minerals is probably indicative of incipient weathering.

Zircon morphology

Zircons isolated from this sample are mainly euhedral to slightly rounded. Most are clear and colourless, but some are pale brown and translucent, and others are dark brown and opaque. They are up to 400 µm long, with aspect ratios up to 4:1, and many grains are strongly fractured. A cathodoluminescence (CL) image of representative zircons is shown in Figure 1. Most zircon cores exhibit low to moderate CL emission and low-contrast concentric oscillatory zoning or banded zoning, both of which are characteristically terminated by a thin zone of zircon with very high CL emission (Fig. 1). In most crystals, the high-CL zone is overgrown by rims of variable thickness, predominantly as rounded pyramidal terminations, that have very low CL emission (Fig. 1).

Analytical details

This sample was analysed on 25–26 October 2006, using SHRIMP-B. Twenty-three analyses of the Temora standard were obtained during the session, and indicated an external spot-to-spot (reproducibility) uncertainty of 1.12% (1σ) and a $^{238}U/^{206}Pb^*$ calibration uncertainty of 0.34% (1σ). Common-Pb corrections were applied to all analyses using contemporaneous common-Pb isotopic compositions determined according to the model of Stacey and Kramers (1975).

Results

Forty-four analyses were obtained from 43 zircons, with one grain (43) analysed twice. Results are listed in Table 1, and shown in a concordia diagram (Fig. 2).

Interpretation

The analyses range from slightly to moderately discordant (Fig. 2). Four analyses are moderately discordant (>5%). The dates obtained from these four analyses (Group D; Table 1) are imprecise or unreliable, and are not considered geologically significant. The remaining 40 analyses can be divided into three groups based on their analytical position, uranium content, and Th/U and $^{207}Pb^*/^{206}Pb^*$ ratios.

Group 1 comprises 22 analyses of 22 zircon cores (Table 1) with low to moderate uranium content (123–263 ppm) and moderate Th/U (0.46 – 0.79),which yield a $^{207}Pb^*/^{206}Pb^*$ date of 1322 ± 11 Ma (MSWD = 1.3).

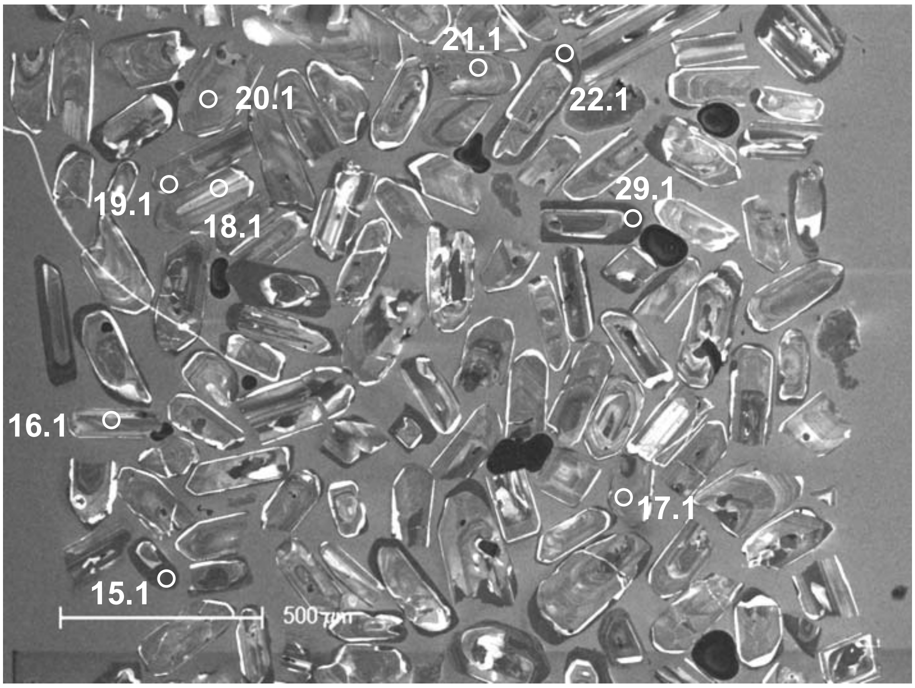

Figure 1. Cathodoluminescence image of representative zircons from sample 184125: orthopyroxene-bearing dioritic gneiss, Observatory Point. Numbered circles indicate the approximate positions of analysis sites

Group 2 comprises 13 analyses of 13 zircon rims (Table 1) with high uranium content (538–2524 ppm) and low but variable Th/U (0.02 – 0.32), which yield a weighted mean $^{207}Pb^{*}/^{206}Pb^{*}$ date of 1195 ± 4 Ma (MSWD = 1.08).

Group 3 comprises five analyses of five zircon cores (Table 1) with high uranium content (870–1761 ppm) and low Th/U (0.09 – 0.17), which yield $^{207}Pb^{*}/^{206}Pb^{*}$ dates of 1171–1158 Ma.

The date of 1322 ± 11 Ma for the 22 analyses in Group 1 is interpreted as the age of igneous crystallization of the dioritic protolith to the orthopyroxene-bearing gneiss. The date of 1195 ± 4 Ma for the 13 rim analyses in Group 2 is interpreted the age of the high-grade metamorphic event responsible for zircon rim growth in the orthopyroxene-bearing dioritic gneiss. The five analyses in Group 3 are interpreted to be metamorphic zircon rims affected by minor ancient loss of radiogenic Pb, possibly facilitated by radiation damage to the zircon lattice as a consequence of their elevated uranium contents.

The igneous crystallization age of 1322 ± 11 Ma for the diorite is significantly older than the igneous crystallization age of 1288 ± 12 Ma determined by Nelson (1995) for the leucogranite that intrudes it, although both were emplaced during Stage I of the Albany–Fraser Orogeny (Nelson et al., 1995; Clark et al., 2000). The latter date therefore provides a minimum age for the gneissosity-forming event that affected the diorite. The high-grade metamorphic event interpreted to have affected this rock at 1195 ± 4 Ma reflects tectonothermal activity associated with Stage II of the Albany–Fraser Orogeny (Clark et al., 2000).

References

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Recommended reference for this publication

Bodorkos, S, and Wingate, MTD, 2008, 184125: orthopyroxene-bearing dioritic gneiss, Observatory Point; Geochronology dataset 703, *in* Compilation of geochronology data: Geological Survey of Western Australia.

Data obtained: 26 October 2006
Data released: 31 July 2008

Table 1. Ion microprobe analytical results for zircons from sample 184125: orthopyroxene-bearing dioritic gneiss, Observatory Point

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	3	3.1	138	73	0.55	–0.188	4.437 ± 0.071	0.08575 ± 0.00092	4.429 ±0.071	0.08736 ± 0.00114	1312 ± 19	1368 ± 25	4.1
1	11	11.1	209	111	0.55	–0.113	4.361 ± 0.056	0.08619 ± 0.00072	4.356 ±0.056	0.08715 ± 0.00093	1332 ± 16	1364 ± 21	2.3
1	8	8.1	130	66	0.53	–0.086	4.441 ± 0.062	0.08576 ± 0.00091	4.437 ±0.062	0.08649 ± 0.00118	1310 ± 16	1349 ± 26	2.9
1	13	13.1	168	118	0.72	–0.001	4.492 ± 0.060	0.08615 ± 0.00081	4.492 ±0.060	0.08616 ± 0.00081	1296 ± 16	1342 ± 18	3.4
1	17	17.1	170	87	0.53	0.021	4.479 ± 0.066	0.08614 ± 0.00081	4.480 ±0.066	0.08596 ± 0.00086	1299 ± 17	1337 ± 19	2.9
1	16	16.1	193	162	0.87	–0.111	4.347 ± 0.057	0.08498 ± 0.00076	4.343 ±0.057	0.08593 ± 0.00091	1336 ± 16	1337 ± 21	0.0
1	2	2.1	193	98	0.52	–0.082	4.348 ± 0.068	0.08518 ± 0.00078	4.345 ±0.068	0.08588 ± 0.00088	1335 ± 19	1336 ± 20	0.0
1	10	10.1	188	95	0.52	–0.047	4.414 ± 0.058	0.08545 ± 0.00076	4.412 ±0.058	0.08584 ± 0.00086	1317 ± 16	1335 ± 19	1.3
1	19	19.1	198	100	0.52	–0.049	4.362 ± 0.058	0.08537 ± 0.00080	4.360 ±0.058	0.08579 ± 0.00085	1331 ± 16	1333 ± 19	0.2
1	14	14.1	148	74	0.51	0.215	4.485 ± 0.061	0.08697 ± 0.00086	4.495 ±0.061	0.08514 ± 0.00127	1295 ± 16	1319 ± 29	1.8
1	25	25.1	154	79	0.53	–0.045	4.317 ± 0.058	0.08471 ± 0.00084	4.315 ±0.058	0.08509 ± 0.00094	1344 ± 16	1318 ± 21	–2.0
1	40	40.1	168	84	0.51	0.065	4.388 ± 0.058	0.08558 ± 0.00102	4.391 ±0.059	0.08502 ± 0.00112	1323 ± 16	1316 ± 25	–0.5
1	34	34.1	180	99	0.57	0.086	4.420 ± 0.071	0.08570 ± 0.00117	4.424 ±0.071	0.08497 ± 0.00126	1314 ± 19	1315 ± 29	0.1
1	7	7.1	133	69	0.54	0.095	4.473 ± 0.084	0.08575 ± 0.00093	4.478 ±0.084	0.08494 ± 0.00105	1299 ± 22	1314 ± 24	1.1
1	20	20.1	161	79	0.51	0.026	4.361 ± 0.058	0.08478 ± 0.00081	4.362 ±0.058	0.08456 ± 0.00084	1330 ± 16	1306 ± 19	–1.9
1	35	35.1	158	84	0.55	0.134	4.430 ± 0.060	0.08549 ± 0.00084	4.436 ±0.060	0.08434 ± 0.00102	1310 ± 16	1300 ± 23	–0.8
1	38	38.1	237	182	0.79	0.039	4.517 ± 0.058	0.08458 ± 0.00075	4.519 ±0.058	0.08425 ± 0.00100	1289 ± 15	1298 ± 23	0.7
1	9	9.1	123	55	0.46	–0.012	4.377 ± 0.061	0.08390 ± 0.00092	4.377 ±0.061	0.08401 ± 0.00092	1327 ± 17	1293 ± 21	–2.6
1	12	12.1	263	165	0.65	0.074	4.461 ± 0.059	0.08457 ± 0.00064	4.464 ±0.059	0.08394 ± 0.00075	1303 ± 16	1291 ± 17	–0.9
1	1	1.1	198	107	0.56	0.240	4.348 ± 0.061	0.08556 ± 0.00090	4.359 ±0.061	0.08353 ± 0.00142	1332 ± 17	1282 ± 33	–3.9
1	33	33.1	132	62	0.49	0.216	4.401 ± 0.064	0.08487 ± 0.00155	4.410 ±0.064	0.08303 ± 0.00178	1317 ± 17	1270 ± 42	–3.7
1	21	21.1	191	110	0.59	0.282	4.528 ± 0.059	0.08497 ± 0.00076	4.541 ±0.060	0.08258 ± 0.00135	1283 ± 15	1259 ± 32	–1.9
2	4	4.1	899	156	0.18	–0.010	4.973 ± 0.059	0.08027 ± 0.00035	4.973 ±0.059	0.08035 ± 0.00036	1181 ± 13	1206 ± 9	2.0
2	44	43.1	2091	46	0.02	0.165	4.881 ± 0.056	0.08165 ± 0.00032	4.889 ±0.056	0.08026 ± 0.00040	1200 ± 13	1203 ± 10	0.3
2	26	26.1	2524	128	0.05	0.008	4.828 ± 0.055	0.08021 ± 0.00021	4.828 ±0.055	0.08014 ± 0.00022	1213 ± 13	1200 ± 5	–1.1
2	15	15.1	1013	197	0.20	0.031	4.957 ± 0.058	0.08038 ± 0.00033	4.959 ±0.058	0.08012 ± 0.00034	1184 ± 13	1200 ± 8	1.3
2	27	27.1	1634	141	0.09	–0.016	4.940 ± 0.058	0.07995 ± 0.00026	4.939 ±0.058	0.08008 ± 0.00028	1189 ± 13	1199 ± 7	0.9
2	28	28.1	1366	249	0.19	–0.003	5.010 ± 0.058	0.08002 ± 0.00029	5.010 ±0.058	0.08005 ± 0.00029	1173 ± 12	1198 ± 7	2.1
2	23	23.1	748	138	0.19	–0.002	4.959 ± 0.070	0.07999 ± 0.00039	4.959 ±0.070	0.08000 ± 0.00039	1184 ± 15	1197 ± 10	1.1
2	22	22.1	2224	102	0.05	0.047	4.952 ± 0.057	0.08040 ± 0.00024	4.954 ±0.057	0.08000 ± 0.00027	1185 ± 12	1197 ± 7	1.0
2	6	6.1	1721	183	0.11	0.088	5.169 ± 0.060	0.08053 ± 0.00025	5.174 ±0.060	0.07979 ± 0.00030	1139 ± 12	1192 ± 7	4.4
2	29	29.1	1476	234	0.16	–0.013	4.950 ± 0.057	0.07944 ± 0.00027	4.950 ±0.057	0.07955 ± 0.00028	1186 ± 13	1186 ± 7	0.0
2	41	41.1	1034	181	0.18	0.048	4.969 ± 0.065	0.07991 ± 0.00035	4.971 ±0.065	0.07950 ± 0.00039	1182 ± 14	1185 ± 10	0.3
2	37	37.1	1230	202	0.17	0.012	4.995 ± 0.058	0.07949 ± 0.00030	4.996 ±0.058	0.07938 ± 0.00031	1176 ± 13	1182 ± 8	0.5
2	39	39.1	538	168	0.32	0.076	4.997 ± 0.060	0.07977 ± 0.00045	5.001 ±0.060	0.07913 ± 0.00049	1175 ± 13	1175 ± 12	0.0
3	43	42.1	1195	201	0.17	0.012	5.139 ± 0.063	0.07904 ± 0.00033	5.140 ±0.063	0.07894 ± 0.00034	1146 ± 13	1171 ± 8	2.1
3	24	24.1	1761	210	0.12	0.069	5.314 ± 0.064	0.07940 ± 0.00027	5.317 ±0.064	0.07881 ± 0.00032	1111 ± 12	1167 ± 8	4.8
3	36	36.1	1570	132	0.09	0.025	4.935 ± 0.057	0.07902 ± 0.00027	4.937 ±0.057	0.07880 ± 0.00029	1189 ± 13	1167 ± 7	–1.9
3	5	5.1	1518	232	0.16	0.042	5.071 ± 0.059	0.07908 ± 0.00027	5.073 ±0.059	0.07873 ± 0.00032	1160 ± 12	1165 ± 8	0.5
3	32	32.1	870	141	0.17	0.059	4.972 ± 0.058	0.07899 ± 0.00036	4.975 ±0.058	0.07849 ± 0.00042	1181 ± 13	1159 ± 11	–1.8
D	18	18.1	82	38	0.47	0.220	4.321 ± 0.065	0.08395 ± 0.00112	4.331 ±0.066	0.08208 ± 0.00196	1339 ± 18	1248 ± 47	–7.4
D	42	41.2	301	21	0.07	0.444	5.480 ± 0.069	0.08279 ± 0.00112	5.504 ±0.070	0.07904 ± 0.00146	1076 ± 13	1173 ± 37	8.3
D	31	31.1	2138	188	0.09	0.139	6.021 ± 0.069	0.07793 ± 0.00033	6.030 ±0.070	0.07676 ± 0.00039	989 ± 11	1115 ± 10	11.3
D	30	30.1	2123	328	0.16	0.189	7.130 ± 0.082	0.07417 ± 0.00026	7.144 ±0.083	0.07259 ± 0.00038	845 ± 9	1003 ± 10	15.8

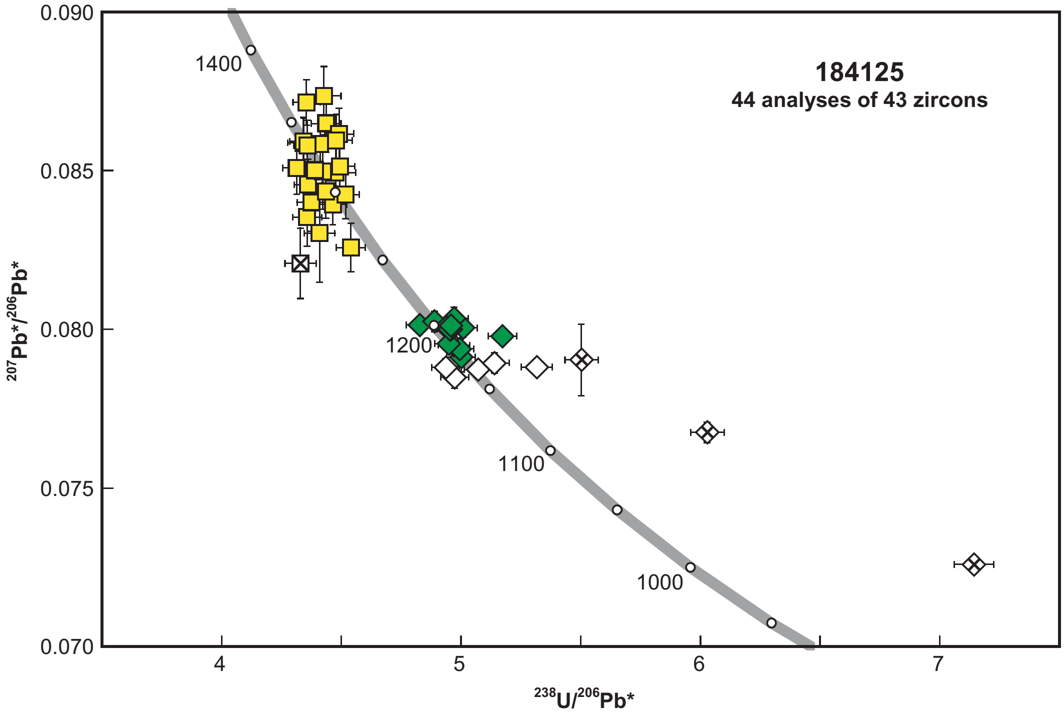

Figure 2. **U–Pb analytical data for sample 184125: orthopyroxene-bearing dioritic gneiss, Observatory Point. Yellow squares denote Group 1 (igneous zircon cores); green diamonds denote Group 2 (metamorphic zircon rims); white diamonds denote Group 3 (metamorphic zircon rims affected by minor ancient loss of radiogenic Pb); crossed squares and diamonds indicate ungrouped core and rim analyses respectively (discordance >5%)**