194739: granite vein, Harris Lake

(Biranup Zone, Albany–Fraser Orogen)

Location and sampling

Zanthus (SH 51-15), Coonana (3535)
MGA Zone 51, 545937E 6534910N

Sampled on 9 December 2008

This sample was collected from a narrow gully within a rock pavement on the western bank of a dry creek bed, about 900 m west of a north-northwesterly trending track. The sample site is located approximately 8.2 km southwest of Harris Lake, 15.9 km south-southeast of Udarra Soak, and 22.2 km west of Spy Hill.

Tectonic unit/relations

The unit sampled is a granite vein assigned to the Biranup Zone, a belt of mid-crustal rocks that lie along the southern and eastern margins of the Yilgarn Craton (Myers, 1990; Spaggiari et al., 2009; Kirkland et al., 2011). The Biranup Zone is dominated by intensely deformed orthogneiss, paragneiss, and metagabbro, with ages ranging from c. 1760 to 1620 Ma. Based on Sm–Nd and Lu–Hf isotopic signatures, and on the presence of Archean granitic rocks, the Biranup Zone is interpreted to have formed autochthonously along the Yilgarn Craton margin (Kirkland et al., 2011). The Biranup Zone was deformed and metamorphosed during the Zanthus Event at c. 1680 Ma, and was later intruded by granitic rocks, and deformed and metamorphosed again, during Stages I and II of the Mesoproterozoic Albany–Fraser Orogeny (Clark et al., 2000; Kirkland et al., 2011; Spaggiari et al., 2011).

The sampled granite vein (Fig. 1) intrudes into 1665 ± 6 Ma rapakivi-textured metadiorite (GSWA 194720, Kirkland et al., 2010a), and is located about 800 m northwest of the Fraser Fault Zone, in the eastern Biranup Zone. The metadiorite is part of the Eddy Suite, which comprises metasyenogranitic, metagranodioritic, and metagabbronoritic meta-igneous rocks that are both mingled and mixed (Kirkland et al., 2011; Spaggiari et al., 2011). The granitic vein cross-cuts a steeply northwest-dipping, northeasterly trending metamorphic foliation within the host metadiorite (Fig. 1). About 50 m southwest of the sample site, the foliation becomes more intense within a high-strain zone displaying kinematics consistent with dextral movement on the nearby Fraser Fault Zone (Spaggiari et al., 2011).

Figure 1. Outcrop photograph of granite vein intruding foliated rapakivi metadiorite, Harris Lake.

Other meta-igneous rocks belonging to the Eddy Suite sampled in this area include a metamonzogranite with a magmatic crystallization age of 1660 ± 6 Ma (GSWA 194723, Kirkland et al., 2010b), metasyenogranite with a magmatic crystallization age of 1668 ± 11 Ma (GSWA 194724, Kirkland et al., 2010c), and metagabbronorite with a magmatic crystallization age of 1664 ± 7 Ma (GSWA 194721, Kirkland et al., 2010d). A siliciclastic schist outcropping 245 m southeast of the sampled granite contains a significant c. 1650 Ma zircon age component and 1300–1200 Ma metamorphic zircon rims (GSWA 194722, Kirkland et al., 2010e).

Petrographic description

The sample comprises approximately 34% plagioclase, 32% quartz, 31% microcline, 2% biotite, and accessory myrmekite, garnet, zircon, apatite, and muscovite. Two small grains of garnet occur in one corner of the thin section, and there are small patches of an unidentified phase with an acicular habit. The texture is granoblastic interlobate, with most grains less than 3 mm in maximum dimension. Some of the plagioclase is antiperthitic, and has sericite alteration in some areas. Microcline is weakly perthitic, and contains sericite patches. Quartz is anhedral and interstitial to the feldspars. Myrmekite occurs in patches up to 1 mm across, and is developed between K-feldspar and plagioclase grains. Biotite is very dark and probably iron-rich, and is up to 1.5mm long, with rare chlorite alteration.

Zircon morphology

Zircons isolated from this sample are euhedral, pale yellow to dark brown, up to 300 µm long, and have aspect ratios up to 4:1. In cathodoluminescence (CL) images, the grains exhibit oscillatory zoning. Several crystals contain apparently older cores. A CL image of representative zircons is shown in Figure 2.

Analytical details

This sample was analysed on 27–29 August 2009, using SHRIMP-B. Twelve analyses of the BR266 standard were obtained during the session, from which 11 indicated an external spot-to-spot (reproducibility) uncertainty of 1.75% (1σ) and a $^{238}U/^{206}Pb^*$ calibration uncertainty of 0.58% (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

Seventeen analyses were obtained from 16 zircons. Results are listed in Table 1, and shown in a concordia diagram (Fig. 3).

Interpretation

The analyses are concordant to discordant (Fig. 3). One analysis is >5% discordant. The date obtained from this analysis (Group D; Table 1) is unreliable, and is considered not geologically significant. The remaining 16 analyses define two groups, based on their $^{207}Pb^*/^{206}Pb^*$ ratios.

Group I comprises 15 analyses of 15 grains (Table 1), which yield a concordia age of 1671 ± 8 Ma (MSWD = 1.5).

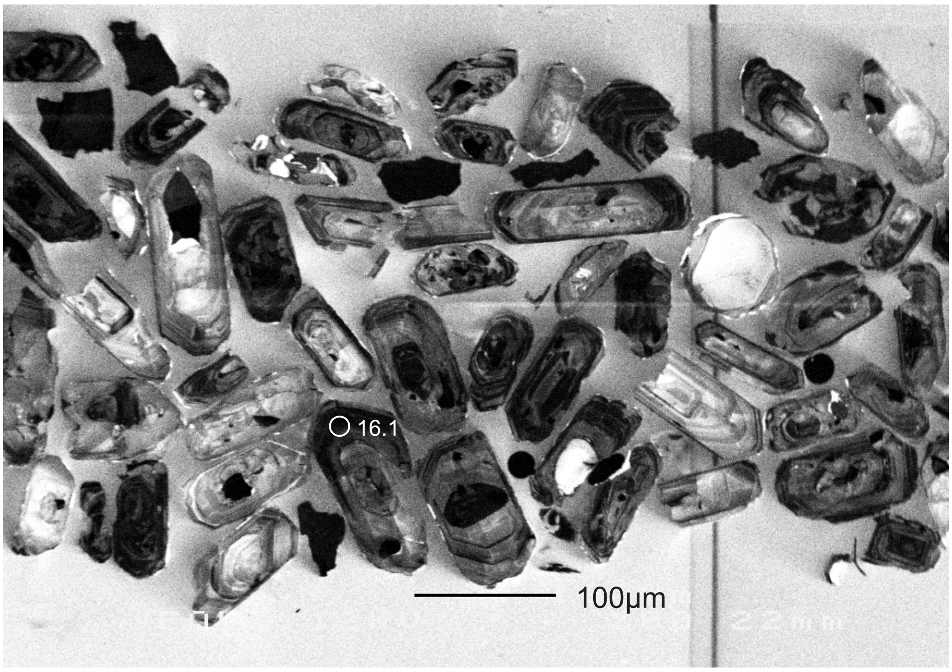

Figure 2. Cathodoluminescence image of representative zircons from sample 194739: granite vein, Harris Lake. Numbered circle indicates the approximate position of an analysis site.

Table 1. Ion microprobe analytical results for zircons from sample 194739: granite vein, Harris Lake

Group ID	Spot no.	Grain. spot	^{238}U (ppm)	^{232}Th (ppm)	$\frac{^{232}Th}{^{238}U}$	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. (%)
I	11	10.1	213	96	0.46	0.239	3.558	0.070	0.10324	0.00064	3.567	0.070	0.10117	0.00082	1593	28	1646	15	3.2
I	10	9.1	199	95	0.49	0.042	3.411	0.067	0.10241	0.00064	3.412	0.067	0.10205	0.00067	1657	29	1662	12	0.3
I	4	3.2	267	104	0.40	0.162	3.492	0.068	0.10356	0.00053	3.498	0.068	0.10215	0.00063	1621	28	1664	11	2.6
I	12	11.1	94	96	1.05	0.335	3.362	0.071	0.10507	0.00091	3.373	0.071	0.10217	0.00124	1674	32	1664	23	0.6
I	6	5.1	263	124	0.49	0.082	3.393	0.066	0.10299	0.00059	3.396	0.066	0.10228	0.00065	1664	29	1666	12	0.1
I	17	16.1	224	56	0.26	0.117	3.403	0.067	0.10364	0.00062	3.407	0.067	0.10263	0.00071	1659	29	1672	13	0.8
I	7	6.1	131	79	0.62	0.231	3.500	0.071	0.10467	0.00080	3.508	0.072	0.10266	0.00100	1617	30	1673	18	3.3
I	5	4.1	142	111	0.81	0.112	3.368	0.069	0.10378	0.00082	3.372	0.069	0.10280	0.00093	1674	31	1675	17	0.1
I	9	8.1	216	114	0.54	0.077	3.345	0.066	0.10352	0.00061	3.347	0.066	0.10286	0.00067	1685	30	1676	12	0.5
I	8	7.1	54	50	0.95	0.340	3.444	0.079	0.10608	0.00122	3.456	0.079	0.10314	0.00166	1638	34	1681	30	2.6
I	1	1.1	345	184	0.55	0.265	3.536	0.068	0.10545	0.00048	3.545	0.068	0.10315	0.00067	1602	28	1682	12	4.7
I	2	2.1	147	64	0.45	0.052	3.402	0.068	0.10418	0.00072	3.404	0.068	0.10373	0.00077	1660	30	1692	14	1.9
I	14	13.1	165	181	1.13	0.182	3.353	0.067	0.10537	0.00071	3.359	0.067	0.10379	0.00085	1680	30	1693	15	0.8
I	16	15.1	169	123	0.75	0.239	3.444	0.069	0.10595	0.00069	3.452	0.069	0.10388	0.00088	1640	30	1695	16	3.2
I	13	12.1	142	61	0.44	0.057	3.436	0.070	0.10451	0.00076	3.434	0.070	0.10500	0.00081	1647	30	1714	14	3.9
X	3	3.1	130	93	0.74	0.104	2.772	0.056	0.12664	0.00077	2.775	0.056	0.12573	0.00084	1984	35	2039	12	2.7
D	15	14.1	205	90	0.45	0.246	3.570	0.071	0.10511	0.00068	3.579	0.072	0.10298	0.00087	1588	29	1679	16	5.4

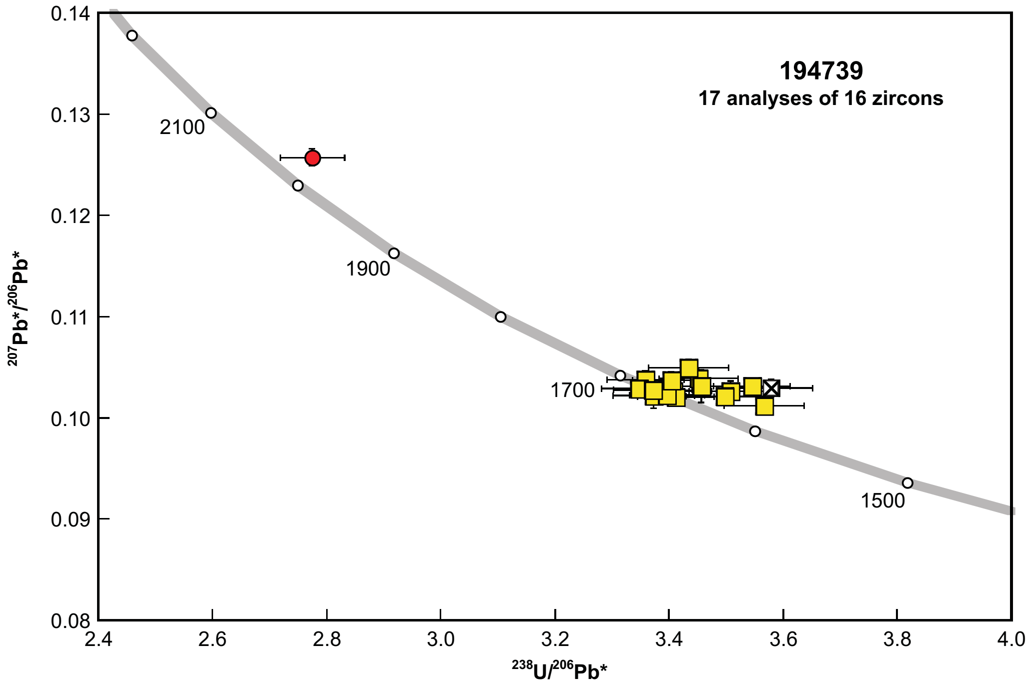

Figure 3. U–Pb analytical data for sample 194739: granite vein, Harris Lake. Yellow squares indicate Group I (magmatic zircons); red circle indicates Group X (inherited zircon); crossed square indicates Group D (discordance >5%).

Group X comprises one core analysis (Table 1), which yields a $^{207}Pb^*/^{206}Pb^*$ date of 2039 ± 12 Ma (1σ).

The date of 1671 ± 8 Ma for the 15 analyses in Group I is interpreted as the magmatic crystallization age of the igneous host rock to the granite vein, with no new zircon growth within the granite vein during its crystallization. The maximum age of crystallization for the granite vein is therefore 1671 ± 8 Ma. The alternative, that Group I reflects magmatic zircons crystallized within the granite vein, is not feasible, because it would imply that a solid-state foliation formed in the 1665 ± 6 Ma rapakivi metadiorite host rock (GSWA 194720, Kirkland et al., 2010a) prior to intrusion of the granitic vein. As the metadiorite crystallization age is within uncertainty of Group I from this sample, this would require rapid or syn-magmatic fabric formation. However, this is not consistent with field relationships, which indicate foliation development during dextral movement along the adjacent Mesoproterozoic Fraser Fault Zone (Spaggiari et al., 2011). The interpretation of Mesoproterozoic fabric development is more consistent with the presence of Stage I and II metamorphic zircons in nearby siliciclastic schist (GSWA 194722, Kirkland et al., 2010e).

The date of 2039 ± 12 Ma (1σ) for the single analysis in Group X is interpreted as the age of an inherited component, incorporated into this granite vein on its emplacement pathway.

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