194744: mylonitic augen gneiss, Buningonia Soak

(Biranup Zone, Albany–Fraser Orogen)

Location and sampling

Zanthus (SH 51-15), Coonana (3535)
MGA Zone 51, 541365E 6531323N

Sampled on 6 October 2008

This sample was collected from a well-exposed northeasterly trending dyke or sheet within a sand plain, approximately 14.2 km northwest of Buningonia Soak, and 28.1 km east of Cherternerlynyer Lagoon.

Tectonic unit/relations

The unit sampled is a mylonitic augen gneiss 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).

This augen gneiss outcrops 1 km west of the Fraser Fault Zone, and is part of the Eddy Suite, rocks of which range from megacrystic metamonzogranite and equigranular metasyenogranitic gneiss, to rapakivi-textured metagranodiorite and metagabbronoritic rocks (Kirkland et al., 2011). This augen gneiss is the most felsic component of a large mafic dyke or sheet with dominantly gabbroic composition. This felsic component is most likely a hybrid rock, consistent with the mingling and mixing textures observed elsewhere in the Eddy Suite. Although the sample is mylonitic, the dyke or sheet is heterogeneously strained, with the more metagabbroic rocks less intensely deformed. Other samples dated from the Eddy Suite include 1665 ± 6 Ma rapakivi metadiorite (GSWA 194720, Kirkland et al., 2010a), 1659 ± 6 Ma metamonzogranite (GSWA 194723, Kirkland et al., 2010b), 1668 ± 11 Ma metasyenogranite (GSWA 194724, Kirkland et al., 2010c), and 1664 ± 7 Ma metagabbronorite (GSWA 194721, Kirkland et al., 2010d).

Petrographic description

The sample is a mylonitic augen gneiss, with a visually estimated mineralogy comprising 50% quartzofeldspathic micromosaic, 15% K-feldspar augen, 10% garnet, 10% biotite, 8% inequigranular plagioclase augen, 5% hornblende, and accessory zircon, epidote, and clay minerals. Augen of plagioclase and K-feldspar, up to 8 mm long and 4 mm wide, are abundant in this sample, and reside within a laminated mylonitic matrix. The augen are irregularly disseminated throughout the rock. Some K-feldspar augen are enclosed within plagioclase, and there is abundant perthitic orthoclase enclosing ragged residual plagioclase patches. Other augen are composed solely of plagioclase, commonly with bent twin planes. Lenses rich in biotite, microcrystalline dark-green hornblende, and limonitic clay also occur in, and adjacent to, the largest of the augen. The matrix includes rare lenses of quartz micromosaic, as well as feldspathic or quartzofeldspathic laminations composed of plagioclase, K-feldspar, biotite, hornblende, and garnet, locally with epidote. Quartz ribbons also occur parallel to the quartzofeldspathic laminations. Some of the ferromagnesian grains, especially garnet, are veined or rimmed by limonite, and there are also limonite-filled fractures parallel to the foliation.

Zircon morphology

Zircons from this sample are euhedral, up to 300 μm long, and yellow to dark brown. In cathodoluminescence (CL) images, the grains exhibit idiomorphic zoning, and several crystals contain apparently older cores. A CL image of representative zircons is shown in Figure 1.

Analytical details

This sample was analysed on 11–12 March 2011, using SHRIMP-A. Twelve analyses of the BR266 standard were obtained during the session, of 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).

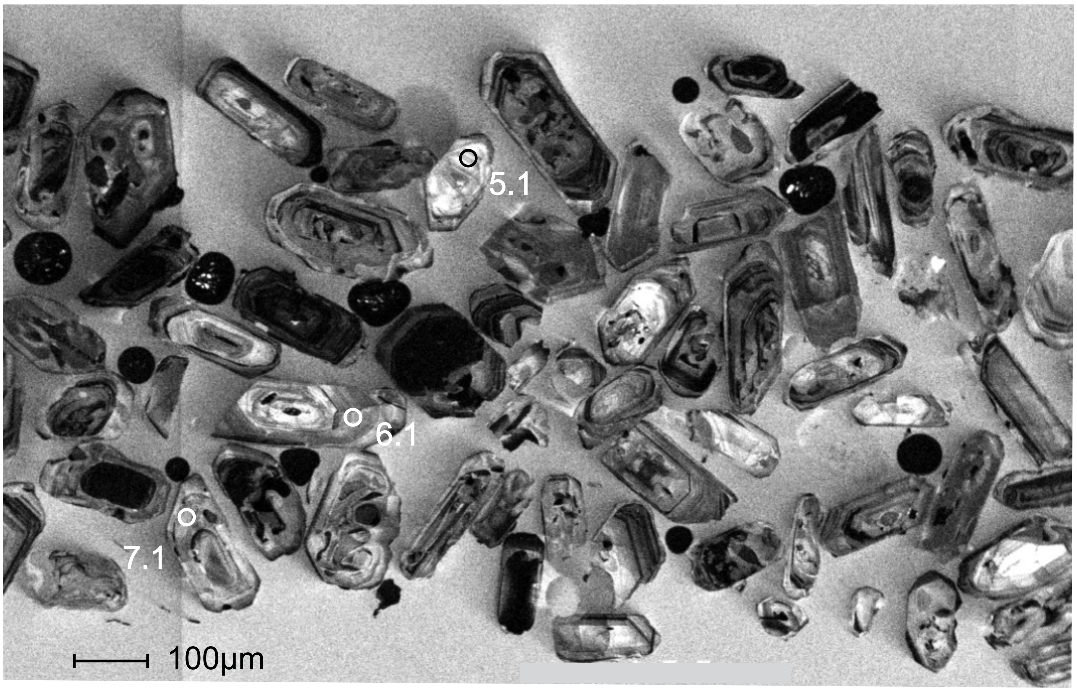

Figure 1. Cathodoluminescence image of representative zircons from sample 194744: mylonitic augen gneiss, Buningonia Soak. Numbered circles indicate the approximate positions of analysis sites.

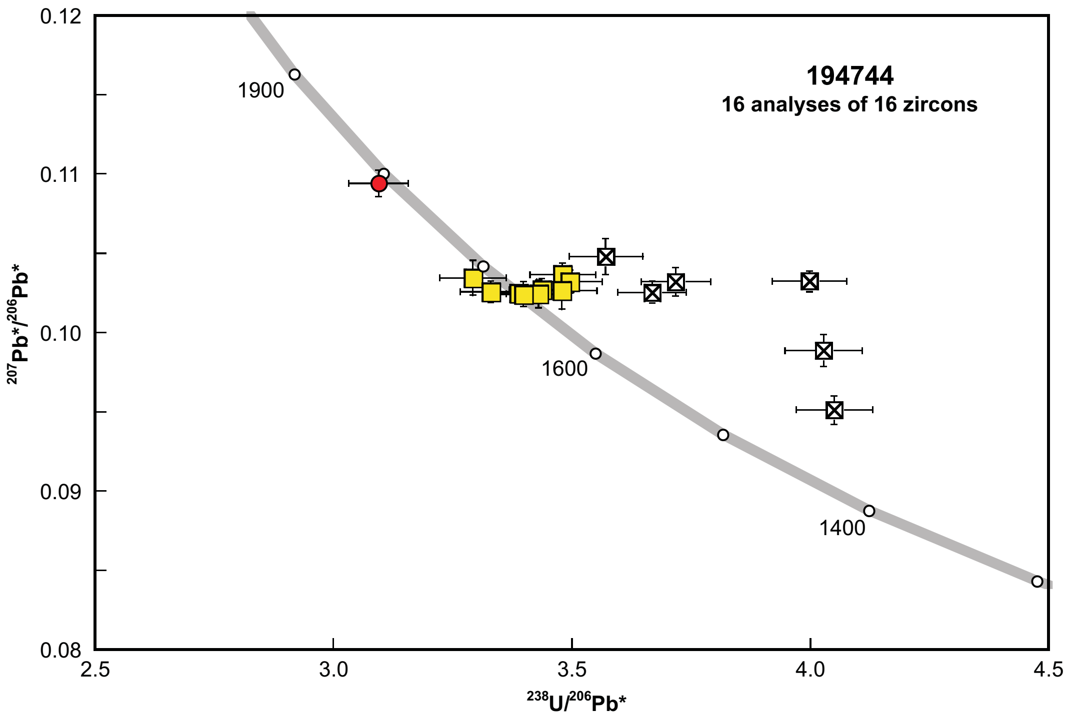

Figure 2. U–Pb analytical data for sample 194744: mylonitic augen gneiss, Buningonia Soak. Yellow squares indicate Group I (magmatic zircons); red circle indicates Group X (inherited zircon); crossed squares indicate Group D (discordance >5%).

Table 1. Ion microprobe analytical results for zircons from sample 194744: mylonitic augen gneiss, Buningonia Soak

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	11.1	208	105	0.52	0.233	3.391	0.067	0.10442	0.00062	3.399	0.067	0.10240	0.00078	1663	29	1668	14	0.3
I	6	6.1	184	81	0.46	0.192	3.423	0.068	0.10409	0.00072	3.430	0.068	0.10243	0.00088	1649	29	1669	16	1.2
I	2	2.1	1259	1747	1.43	0.002	3.389	0.063	0.10249	0.00024	3.389	0.063	0.10250	0.00024	1667	28	1670	4	0.2
I	9	9.1	239	121	0.52	0.094	3.328	0.065	0.10338	0.00059	3.331	0.065	0.10257	0.00066	1692	30	1671	12	1.3
I	13	13.1	88	42	0.49	0.139	3.474	0.074	0.10384	0.00102	3.479	0.074	0.10264	0.00118	1629	31	1672	21	2.6
I	7	7.1	218	129	0.61	0.077	3.434	0.068	0.10335	0.00067	3.437	0.068	0.10268	0.00074	1646	29	1673	13	1.6
I	1	1.1	215	73	0.35	0.150	3.491	0.069	0.10452	0.00064	3.496	0.069	0.10322	0.00075	1622	29	1683	13	3.6
I	5	5.1	90	47	0.54	0.094	3.290	0.070	0.10428	0.00097	3.293	0.070	0.10346	0.00108	1709	33	1687	19	1.3
I	12	12.1	210	92	0.45	0.069	3.479	0.069	0.10426	0.00064	3.481	0.069	0.10366	0.00070	1628	29	1691	12	3.7
X	16	16.1	152	123	0.84	0.121	3.092	0.062	0.11049	0.00075	3.095	0.063	0.10943	0.00085	1805	32	1790	14	0.8
D	14	14.1	214	108	0.52	0.182	4.044	0.080	0.09668	0.00073	4.051	0.080	0.09512	0.00090	1422	26	1530	18	7.1
D	8	8.1	146	76	0.54	0.241	4.019	0.081	0.10096	0.00079	4.028	0.081	0.09888	0.00101	1429	26	1603	19	10.8
D	3	3.1	240	85	0.37	0.081	3.665	0.072	0.10324	0.00063	3.668	0.072	0.10254	0.00069	1554	27	1671	13	7.0
D	4	4.1	277	156	0.58	0.092	3.995	0.077	0.10402	0.00059	3.999	0.078	0.10323	0.00065	1439	25	1683	12	14.5
D	15	15.1	207	67	0.33	0.288	3.707	0.073	0.10570	0.00066	3.718	0.073	0.10320	0.00087	1536	27	1683	16	8.7
D	10	10.1	86	113	1.35	0.104	3.568	0.076	0.10569	0.00103	3.572	0.077	0.10479	0.00115	1591	31	1711	20	7.0

Results

Sixteen analyses were obtained from 16 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). Six analyses are >5% discordant. The dates obtained from these six analyses (Group D, Table 1) are unreliable, and are considered not geologically significant. The remaining ten analyses define two groups, based on their $^{207}Pb^*/^{206}Pb^*$ ratios.

Group I comprises nine analyses (Table 1), which yield a concordia age of 1671 ± 6 Ma (MSWD = 0.85).

Group X comprises one analysis (Table 1), which yields a $^{207}Pb^*/^{206}Pb^*$ date of 1790 ± 14 Ma (1σ).

The date of 1671 ± 6 Ma for the nine analyses in Group I is interpreted as the magmatic crystallization age of the igneous protolith to the gneiss. If the field observation of mixing seen between this rock and the gabbroic component of the dyke or sheet is correct, then this date is also a maximum age for the magmatic crystallization of the dyke or sheet. The date of 1790 ± 14 Ma for the single analysis in Group X is interpreted as the age of an inherited component.

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