

206121: metasandstone, Sophie Downs homestead

(Biscay Formation, Halls Creek Group, Eastern Zone, Lamboo Province, Halls Creek Orogen)

Location and sampling

GORDON DOWNS (SE 52-10), HALLS CREEK (4461)
MGA Zone 52, 377812E 7988258N

Sampled on 22 June 2012

This sample was collected from an area of pavement outcrop (Fig. 1) on Sophie Downs station, about 7.4 km southwest of The Brim Rockhole, 5.9 km northeast of Mount Pandora, and 3.2 km east of Sophie Downs homestead, near the southern end of the Sophie Downs Dome.

Tectonic unit/relations

The unit sampled is the lower Biscay Formation of the Halls Creek Group (Blake et al., 1999). The Halls Creek Group consists of 1880–1845 Ma metasedimentary and volcanic rocks within the Eastern Zone of the 1910–1805 Ma Lamboo Province (Griffin and Tyler, 1992; Tyler et al., 1995; Hollis et al., 2014). The sample collected is from a succession of upper greenschist facies laminated pelitic and psammitic rocks that fine upward into locally graphitic pelitic rocks. Within the sampled succession, garnet is particularly developed in the more pelitic layers. Bedding is isoclinally folded with a foliation developed parallel to bedding. The mineralogy of this unit and the presence of graded beds suggests that these rocks were derived either by airfall (i.e. tuffs) or, perhaps more likely, by sedimentary reworking of at least some component of volcanic rocks. The Biscay Formation is overlain, probably disconformably, by the Olympio Formation, and conformably overlies quartzite of the Saunders Creek Formation.

A maximum depositional age of 1868 ± 3 Ma, as well as a discrete provenance component at 1907 ± 3 Ma, have been reported for a tuffaceous metasandstone of the Biscay Formation (GA sample 87598022, unpublished). A depositional age of 1870 ± 4 Ma for the Biscay Formation was determined from U–Pb zircon dating of a felsic metavolcaniclastic rock in the lower Biscay Formation (GA sample 87598001, unpublished). A metasandstone of the Biscay Formation, collected about 31 km southwest of the present sample site, yielded a conservative maximum depositional age of 1861 ± 3 Ma (GSWA 206187, Kirkland et al., 2015).

Petrographic description

This sample is a fine-grained metasandstone, composed of about 40% hornblende, 25% quartz, 20% plagioclase and microcline, 5% epidote, 5% iron oxide minerals, <5% poikiloblastic garnet, and accessory zircon. Many feldspars exhibit concentric zoning, interpreted as primary igneous in origin. The rock holds only a weak tectonic fabric, particularly in fine-grained layers, defined by elongation of hornblende. Coarser-grained layers contain randomly oriented hornblende laths. Poikiloblastic garnets contain weakly elongate quartz inclusions parallel to the foliation, consistent with garnet–greenschist facies metamorphism during deformation.

Zircon morphology

Zircons isolated from this sample are colourless to dark brown, anhedral to euhedral, and variably rounded. The crystals are up to 200 μm long, and equant to elongate, with aspect ratios up to 4:1. In cathodoluminescence (CL) images, most zircons exhibit concentric zoning, although this is very indistinct in some crystals. Some crystals have pitted outer surfaces and concentric zoning truncated at grain boundaries, features consistent with sedimentary transport. A CL image of representative zircons is shown in Figure 2.

Analytical details

This sample was analysed on 4–5 April and 10–11 April 2014, using SHRIMP-A. Analyses 1.1 to 27.1 (spot numbers 1–27) were obtained during the first session, together with eight analyses of the BR266 standard, of which seven analyses indicated an external spot-to-spot (reproducibility) uncertainty of 0.52% (1σ) and a $^{238}\text{U}/^{206}\text{Pb}^*$ calibration uncertainty of 0.27% (1σ). Analyses 28.1 to 65.1 (spot numbers 28–65) were obtained during the second session, together with 15 analyses of the BR266 standard. Significant drift of standard $^{238}\text{U}/^{206}\text{Pb}^*$ dates during the second session was addressed by fitting a LOWESS curve, (Cleveland, 1979) with a smoothing window of five analyses, implemented using the program Isoplot 2.50 (Ludwig, 2009; Wingate and Kirkland, 2014). During this session, 13 standard analyses indicated an external spot-to-spot (reproducibility) uncertainty of 1.34 (1σ).



Figure 1. Outcrop photograph for sample 206121: metasandstone, Sophie Downs homestead. Note hand lens for scale.

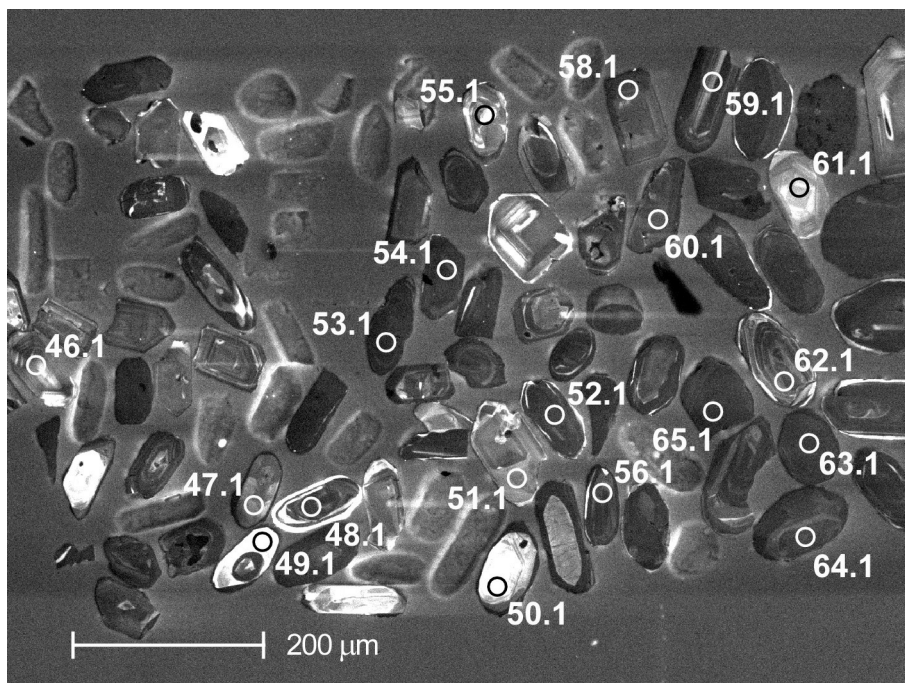


Figure 2. Cathodoluminescence image of representative zircons from sample 206121: metasandstone, Sophie Downs homestead. Numbered circles indicate the approximate locations of analysis sites.

Table 1. Ion microprobe analytical results for zircons from sample 206121: metasandstone, Sophie Downs Homestead

Group ID	Spot no.	Grain. spot	^{238}U (ppm)	^{232}Th (ppm)	$\frac{^{232}\text{Th}}{^{238}\text{U}}$	f_{204} (%)	$^{238}\text{U}/^{206}\text{Pb} \pm 1\sigma$	$^{207}\text{Pb}/^{206}\text{Pb} \pm 1\sigma$	$^{238}\text{U}/^{206}\text{Pb}^* \pm 1\sigma$	$^{207}\text{Pb}^*/^{206}\text{Pb}^* \pm 1\sigma$	$^{238}\text{U}/^{206}\text{Pb}^* \pm 1\sigma$	$^{207}\text{Pb}^*/^{206}\text{Pb}^* \pm 1\sigma$	$^{238}\text{U}/^{206}\text{Pb}^* \pm 1\sigma$	$^{207}\text{Pb}^*/^{206}\text{Pb}^* \pm 1\sigma$	date (Ma) $\pm 1\sigma$	date (Ma) $\pm 1\sigma$	Disc. (%)		
Y	21	21.1	298	278	0.96	0.188	2.920	0.029	0.11755	0.00068	2.926	0.029	0.11590	0.00080	1895	16	1894	12	-0.1
S	1	1.1	201	220	1.13	0.299	2.957	0.033	0.11911	0.00084	2.966	0.033	0.11650	0.00107	1873	18	1903	17	1.6
S	57	57.1	281	202	0.74	0.018	2.977	0.049	0.11677	0.00082	2.978	0.049	0.11661	0.00084	1866	27	1905	13	2.0
S	33	33.1	149	168	1.17	0.020	2.911	0.050	0.11685	0.00087	2.911	0.050	0.11667	0.00089	1903	28	1906	14	0.1
S	58	58.1	324	228	0.73	0.090	2.870	0.044	0.11812	0.00062	2.872	0.044	0.11733	0.00068	1926	26	1916	10	-0.5
S	36	36.1	211	200	0.98	0.093	2.994	0.047	0.11840	0.00071	2.997	0.047	0.11759	0.00077	1856	26	1920	12	3.3
S	54	54.1	377	475	1.30	0.038	2.841	0.043	0.11859	0.00299	2.842	0.043	0.11826	0.00299	1943	26	1930	45	-0.7
S	6	6.1	151	153	1.05	0.416	2.207	0.028	0.16374	0.00106	2.217	0.028	0.16003	0.00131	2400	26	2456	14	2.3
S	47	47.1	96	56	0.60	-0.022	2.029	0.039	0.16065	0.00146	2.029	0.039	0.16085	0.00148	2583	41	2465	16	-4.8
S	43	43.1	46	34	0.76	0.233	2.101	0.049	0.16311	0.00170	2.106	0.049	0.16104	0.00194	2505	50	2467	20	-1.6
S	8	8.1	140	86	0.64	0.191	2.146	0.028	0.16357	0.00108	2.150	0.028	0.16187	0.00121	2462	27	2475	13	0.5
S	45	45.1	253	388	1.58	0.186	2.210	0.037	0.16418	0.00090	2.214	0.037	0.16253	0.00101	2402	34	2482	10	3.2
S	38	38.1	75	60	0.82	0.110	2.213	0.043	0.16460	0.00133	2.216	0.043	0.16362	0.00142	2401	40	2493	15	3.7
S	25	25.1	229	269	1.21	0.065	2.129	0.023	0.16429	0.00082	2.130	0.023	0.16371	0.00085	2481	23	2494	9	0.5
S	41	41.1	74	59	0.83	0.129	2.127	0.042	0.16494	0.00127	2.130	0.042	0.16379	0.00138	2482	41	2495	14	0.5
S	9	9.1	1343	261	0.20	0.027	2.123	0.016	0.16415	0.00035	2.124	0.016	0.16391	0.00036	2487	15	2496	4	0.4
S	31	31.1	46	45	1.02	0.316	2.061	0.047	0.16690	0.00169	2.068	0.047	0.16409	0.00200	2543	49	2498	21	-1.8
S	7	7.1	184	135	0.76	0.119	2.114	0.025	0.16515	0.00096	2.117	0.025	0.16409	0.00104	2494	25	2498	11	0.2
S	40	40.1	152	108	0.73	0.112	2.162	0.036	0.16597	0.00089	2.164	0.036	0.16498	0.00095	2448	34	2507	10	2.3
S	39	39.1	1080	22	0.02	0.020	2.024	0.028	0.16544	0.00031	2.025	0.028	0.16527	0.00032	2588	30	2510	3	-3.1
S	26	26.1	435	205	0.49	0.283	2.219	0.020	0.16802	0.00064	2.225	0.020	0.16549	0.00078	2393	18	2513	8	4.8
S	50	50.1	90	53	0.60	0.096	2.129	0.042	0.16684	0.00143	2.131	0.042	0.16599	0.00151	2480	42	2518	15	1.5
S	37	37.1	77	90	1.20	0.027	2.205	0.043	0.16627	0.00130	2.205	0.043	0.16604	0.00133	2411	40	2518	13	4.3
S	44	44.1	208	122	0.60	0.057	2.140	0.035	0.16697	0.00077	2.141	0.035	0.16647	0.00080	2470	34	2522	8	2.1
S	17	17.1	1392	1170	0.87	0.026	2.122	0.016	0.16679	0.00034	2.122	0.016	0.16656	0.00034	2489	15	2523	3	1.4
S	4	4.1	547	367	0.69	0.051	2.123	0.019	0.16715	0.00069	2.124	0.019	0.16670	0.00070	2487	19	2525	7	1.5
S	63	63.1	433	250	0.60	0.017	2.135	0.032	0.16696	0.00062	2.136	0.032	0.16681	0.00063	2476	32	2526	6	2.0
S	5	5.1	284	175	0.64	0.028	2.151	0.022	0.16742	0.00078	2.151	0.022	0.16717	0.00079	2461	21	2530	8	2.7
S	59	59.1	199	189	0.98	0.077	2.122	0.035	0.16789	0.00083	2.123	0.035	0.16721	0.00087	2488	35	2530	9	1.7
S	64	64.1	351	222	0.65	0.097	2.099	0.032	0.16841	0.00067	2.101	0.032	0.16755	0.00071	2509	33	2533	7	0.9
S	32	32.1	566	561	1.02	0.030	2.056	0.030	0.16815	0.00046	2.057	0.030	0.16789	0.00047	2554	31	2537	5	-0.7
S	55	55.1	133	29	0.22	0.034	2.112	0.038	0.16919	0.00105	2.113	0.038	0.16889	0.00107	2498	37	2547	11	1.9
S	53	53.1	1131	105	0.10	0.159	2.158	0.031	0.17222	0.00045	2.162	0.031	0.17080	0.00051	2451	29	2566	5	4.5
S	2	2.1	636	296	0.48	0.088	2.059	0.017	0.17863	0.00053	2.061	0.017	0.17784	0.00055	2550	18	2633	5	3.1
S	48	48.1	291	92	0.33	0.000	2.013	0.033	0.18690	0.00117	2.013	0.033	0.18690	0.00117	2600	35	2715	10	4.2
S	42	42.1	1219	39	0.03	0.013	1.732	0.024	0.22003	0.00047	1.733	0.024	0.21991	0.00047	2937	34	2980	3	1.4
S	52	52.1	777	120	0.16	0.014	1.670	0.072	0.24279	0.00831	1.670	0.072	0.24267	0.00831	3025	107	3138	54	3.6

Table 1. continued

Group ID	Spot no.	Grain. spot	^{238}U (ppm)	^{232}Th (ppm)	$\frac{^{232}\text{Th}}{^{238}\text{U}}$	f_{204} (%)	$\frac{^{238}\text{U}}{^{206}\text{Pb}} \pm 1\sigma$	$\frac{^{207}\text{Pb}}{^{206}\text{Pb}} \pm 1\sigma$	$\frac{^{238}\text{U}}{^{208}\text{Pb}^*} \pm 1\sigma$	$\frac{^{207}\text{Pb}^*}{^{208}\text{Pb}^*} \pm 1\sigma$	$\frac{^{238}\text{U}}{^{206}\text{Pb}^*} \text{ date (Ma)} \pm 1\sigma$	$\frac{^{207}\text{Pb}^*}{^{206}\text{Pb}^*} \text{ date (Ma)} \pm 1\sigma$	Disc. (%)						
S	23	23.1	237	90	0.39	0.047	1.496	0.016	0.27041	0.00099	1.497	0.016	0.27000	0.00100	3299	28	3306	6	0.2
S	15	15.1	213	189	0.91	0.101	1.525	0.017	0.27128	0.00129	1.526	0.017	0.27040	0.00132	3248	29	3308	8	1.8
S	14	14.1	588	242	0.42	0.015	1.485	0.012	0.27070	0.00061	1.485	0.012	0.27058	0.00061	3319	22	3309	4	-0.3
S	16	16.1	337	15	0.05	0.038	1.514	0.015	0.27121	0.00083	1.515	0.015	0.27089	0.00084	3268	25	3311	5	1.3
S	10	10.1	379	132	0.36	0.107	1.509	0.014	0.28077	0.00082	1.511	0.014	0.27985	0.00084	3274	24	3362	5	2.6
S	49	49.1	282	29	0.10	0.031	1.489	0.023	0.28283	0.00089	1.490	0.023	0.28256	0.00090	3311	41	3377	5	2.0
S	28	28.1	587	104	0.18	0.070	1.489	0.022	0.28335	0.00064	1.490	0.022	0.28275	0.00065	3311	38	3378	4	2.0
S	13	13.1	1236	398	0.33	0.023	1.486	0.035	0.28951	0.00043	1.487	0.035	0.28931	0.00043	3316	63	3414	2	2.9
S	22	22.1	888	74	0.09	0.011	1.463	0.011	0.29463	0.00056	1.463	0.011	0.29453	0.00056	3358	20	3442	3	2.4
S	11	11.1	540	357	0.68	0.026	1.420	0.012	0.29725	0.00068	1.420	0.012	0.29703	0.00068	3437	23	3455	4	0.5
S	19	19.1	817	666	0.84	0.024	1.410	0.011	0.29761	0.00051	1.410	0.011	0.29741	0.00052	3456	21	3457	3	0.0
S	27	27.1	339	383	1.17	0.035	1.401	0.014	0.29890	0.00087	1.401	0.014	0.29860	0.00088	3472	26	3463	5	-0.3
S	18	18.1	131	49	0.38	0.000	1.424	0.019	0.31002	0.00755	1.424	0.019	0.31002	0.00755	3428	35	3521	38	2.6
S	34	34.1	228	14	0.07	0.005	1.394	0.023	0.31163	0.00101	1.395	0.023	0.31159	0.00101	3485	44	3529	5	1.2
S	29	29.1	371	136	0.38	0.000	1.441	0.023	0.31504	0.00592	1.441	0.023	0.31504	0.00592	3398	44	3546	29	4.2
S	62	62.1	193	84	0.45	0.065	1.398	0.024	0.31647	0.00658	1.399	0.024	0.31593	0.00659	3477	46	3550	32	2.1
S	12	12.1	448	257	0.59	0.017	1.360	0.012	0.32808	0.00078	1.360	0.012	0.32794	0.00078	3552	25	3607	4	1.5
S	30	30.1	737	96	0.14	0.008	1.333	0.019	0.32927	0.00060	1.333	0.019	0.32920	0.00060	3608	40	3613	3	0.1
S	3	3.1	98	67	0.71	0.054	1.333	0.020	0.33073	0.00167	1.334	0.020	0.33028	0.00169	3606	42	3618	8	0.3
S	56	56.1	692	53	0.08	0.024	1.328	0.020	0.33864	0.00769	1.328	0.020	0.33844	0.00769	3618	43	3656	35	1.0
D	51	51.1	114	98	0.90	0.071	2.603	0.047	0.11598	0.00112	2.604	0.047	0.11536	0.00118	2095	33	1886	18	-11.1
D	46	46.1	156	165	1.09	0.079	2.908	0.201	0.11738	0.00100	2.910	0.201	0.11669	0.00108	1904	121	1906	17	0.1
D	35	35.1	62	55	0.91	0.230	2.336	0.052	0.16206	0.00167	2.341	0.052	0.16001	0.00191	2293	44	2456	20	6.6
D	24	24.1	107	273	2.64	0.371	2.409	0.034	0.16847	0.00131	2.418	0.034	0.16516	0.00159	2232	27	2509	16	11.1
D	65	65.1	990	71	0.07	0.037	2.218	0.032	0.16714	0.00044	2.219	0.032	0.16681	0.00045	2398	29	2526	4	5.0
D	61	61.1	86	100	1.20	0.028	2.220	0.044	0.16888	0.00134	2.221	0.044	0.16864	0.00136	2397	40	2544	14	5.8
D	60	60.1	996	132	0.14	0.051	1.878	0.027	0.21042	0.00047	1.879	0.027	0.20996	0.00048	2750	32	2905	4	5.3
D	20	20.1	547	345	0.65	1.631	1.765	0.015	0.30300	0.00071	1.795	0.015	0.28900	0.00097	2855	19	3412	5	16.3

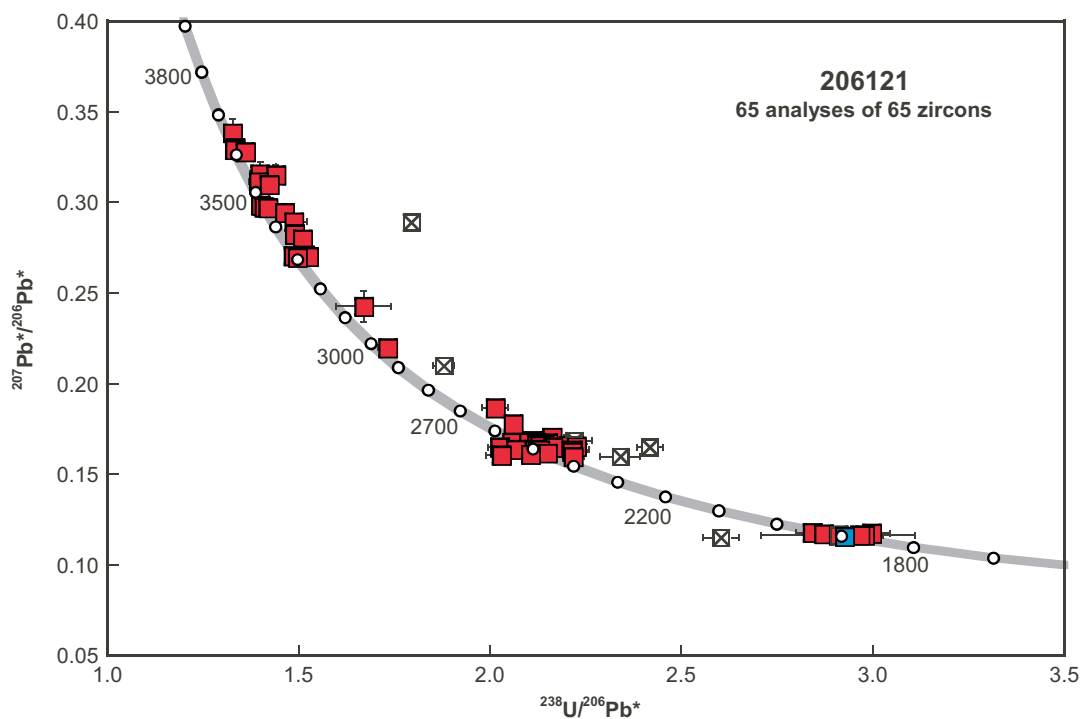


Figure 3. U-Pb analytical data for zircons from sample 206121: metasandstone, Sophie Downs homestead. Blue square indicates Group Y (youngest detrital zircon); red squares indicate Group S (older detrital zircons); crossed squares indicate Group D (discordance >5%).

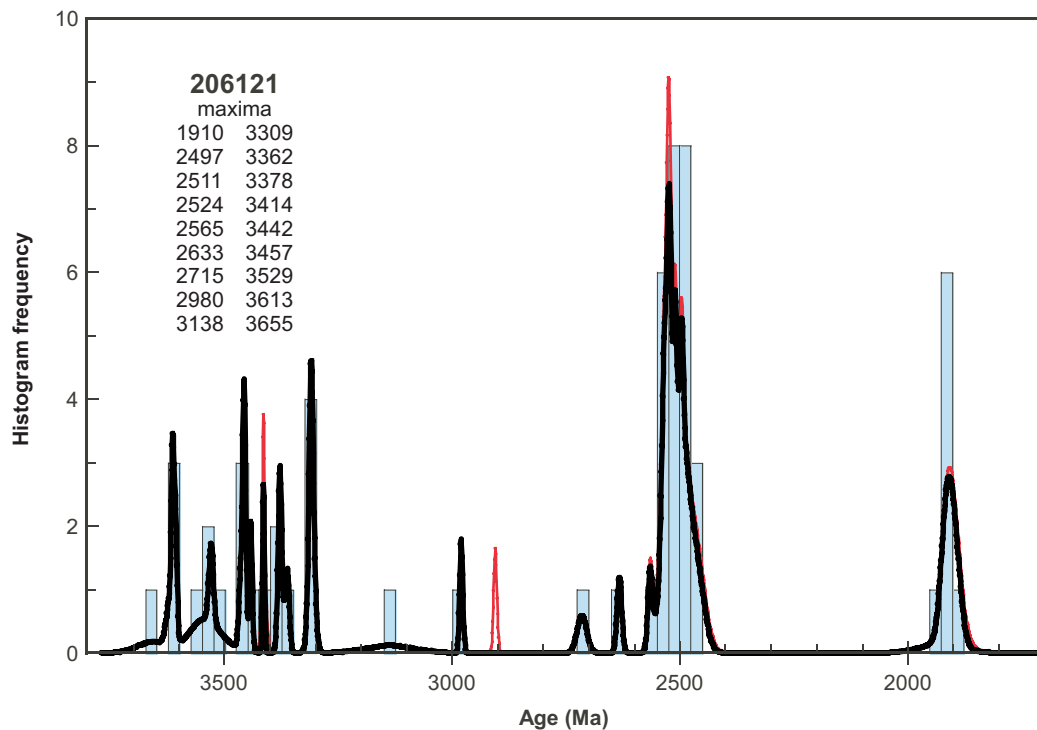


Figure 4. Probability density diagram and histogram for sample 206121: metasandstone, Sophie Downs homestead. Thick curve, maxima values, and frequency histogram (bin width 25 Ma) include only accepted data (57 analyses of 57 zircons). Thin curve includes all data (65 analyses of 65 zircons).

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).

Results

Sixty-five analyses were obtained from 65 zircons. Results are listed in Table 1, and shown in a concordia diagram (Fig. 3), and a probability density diagram (Fig. 4).

Interpretation

The analyses are concordant to strongly discordant (Fig. 3). Seven analyses are >5% discordant and one analysis exhibits high within-run variation of isotope ratios. The dates obtained from these eight analyses (Group D; Table 1) are unreliable, and are considered not to be geologically significant. The remaining 57 analyses can be divided into two groups, based on their $^{207}\text{Pb}^*/^{206}\text{Pb}^*$ ratios.

Group Y comprises one analysis (Table 1), which yields a $^{207}\text{Pb}/^{206}\text{Pb}^*$ date of 1894 ± 12 Ma (1σ).

Group S comprises 56 analyses (Table 1), which yield $^{207}\text{Pb}/^{206}\text{Pb}^*$ dates of 3656–1903 Ma.

It is possible that all of the analyses in Groups Y and S are of unmodified detrital zircons, in which case the date of 1894 ± 12 Ma (1σ) for the single analysis in Group Y represents a maximum depositional age for the sandstone. A more conservative estimate of the maximum depositional age can be based on the weighted mean $^{207}\text{Pb}^*/^{206}\text{Pb}^*$ date of 1909 ± 10 Ma (MSWD = 0.54) for the seven youngest analyses in Groups Y and S.

The data for Groups Y and S indicate significant age components at c. 3613, 3528, 3456, 3309, 2523, 2510, 2496, and 1909 Ma, based on contributions from approximately 5, 4, 4, 4, 13, 12, 12, and 7 analyses, respectively (Fig. 4). These are interpreted as the ages of zircon-crystallizing rocks in the detrital source region(s), or as the ages of detrital components within sediments that have been reworked into this rock.

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Recommended reference for this publication

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Data released: 28 February 2015