

199418: pebbly sandstone, Mu Hills

(*Sir Frederick Conglomerate, Amadeus Basin, Centralian Superbasin*)

Location and sampling

MACDONALD (SF 52-14), EMERY (4650)
MGA Zone 52, 470636E 7353379N

Sampled on 11 September 2011

This sample was collected from low rubbly outcrop (Fig. 1) to the west of the Mu Hills, about 43 km northeast of Sheridan Rocks, 33 km east of the Maurice Hills, and 12.8 km northeast of Inarlkinj Soak.

Tectonic unit/relations

The unit sampled is a medium-grained, cross-bedded sandstone lens between conglomerate beds of the Sir Frederick Conglomerate of the Amadeus Basin (Wells et al., 1964). The unit consists of boulder, cobble, and pebble conglomerate, typically polymictic, with dominantly quartzite and sandstone clasts, and poorly exposed sandstone lenses. The Sir Frederick Conglomerate overlies the Carnegie Formation and is overlain by the Maurice Formation, with uncertain relationships, and occupies a similar stratigraphic position to the Ellis Sandstone. The Sir Frederick Conglomerate reaches an estimated 2000 m thickness in the Sir Frederick Range area and is considered to be of late Ediacaran to early Cambrian age, deposited in response to uplift during the c. 580–530 Ma Petermann Orogeny (Haines et al., 2012). A sample of the overlying Maurice Formation, collected 10.2 km to the west-southwest, yielded a maximum depositional age of 698 ± 20 Ma (GSWA 199414, Wingate et al., 2014). A sample of the underlying Carnegie Formation, collected 3.5 km to the northeast, yielded a maximum depositional age of 819 ± 13 Ma (GSWA 143783, Wingate et al., 2013).

Petrographic description

The sample is a mainly fine-grained, quartz–lithic sandstone, consisting of about 60–65% quartz grains, 25–30% microcrystalline matrix, and 7–10% chert, siltstone, and feldspar clasts, and accessory zircon. The single-crystal quartz grains are subrounded to angular and up to 0.3 mm in diameter. The matrix is ferruginous and contains grains of (texturally late) epidote 0.2–0.3 mm in diameter. Clasts of chert, siltstone, and clouded feldspar are typically 0.2–0.4 mm across.

Zircon morphology

Zircons isolated from this sample are colourless to dark brown, anhedral to subhedral, and generally strongly rounded. The crystals are up to 300 μm long, and equant to elongate, with aspect ratios up to 4:1. Many crystals have pitted outer surfaces and, in cathodoluminescence (CL) images, most exhibit concentric zoning truncated at grain edges, features consistent with abrasion during sedimentary transport. A CL image of representative zircons is shown in Figure 2.

Analytical details

This sample was analysed on 23–24 August 2012, using SHRIMP-A. Fourteen analyses of the BR266 standard were obtained during the session, of which 13 analyses indicated an external spot-to-spot (reproducibility) uncertainty of 0.61% (1σ) and a $^{238}\text{U}/^{206}\text{Pb}^*$ calibration uncertainty of 0.23% (1σ). 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). Twelve analyses are >5% discordant. The dates obtained from these 12 analyses (Group D; Table 1) are considered not to be geologically significant. The remaining 53 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 1059 ± 57 Ma (1σ).

Group S comprises 52 analyses (Table 1), which yield $^{207}\text{Pb}^*/^{206}\text{Pb}^*$ dates of 2747–1069 Ma.

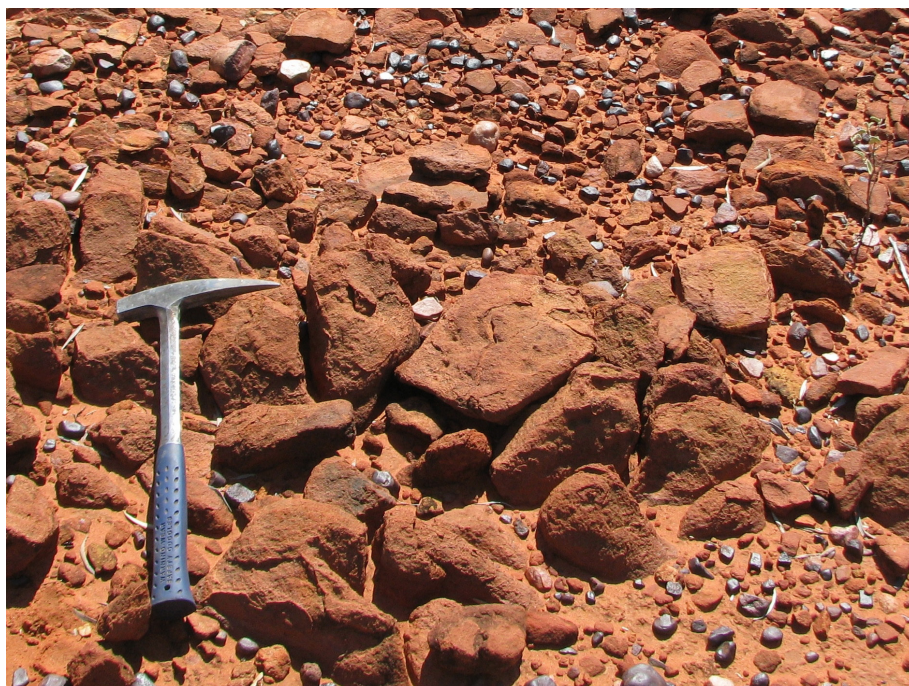


Figure 1. Outcrop photograph for sample 199418: sandstone, Mu Hills.

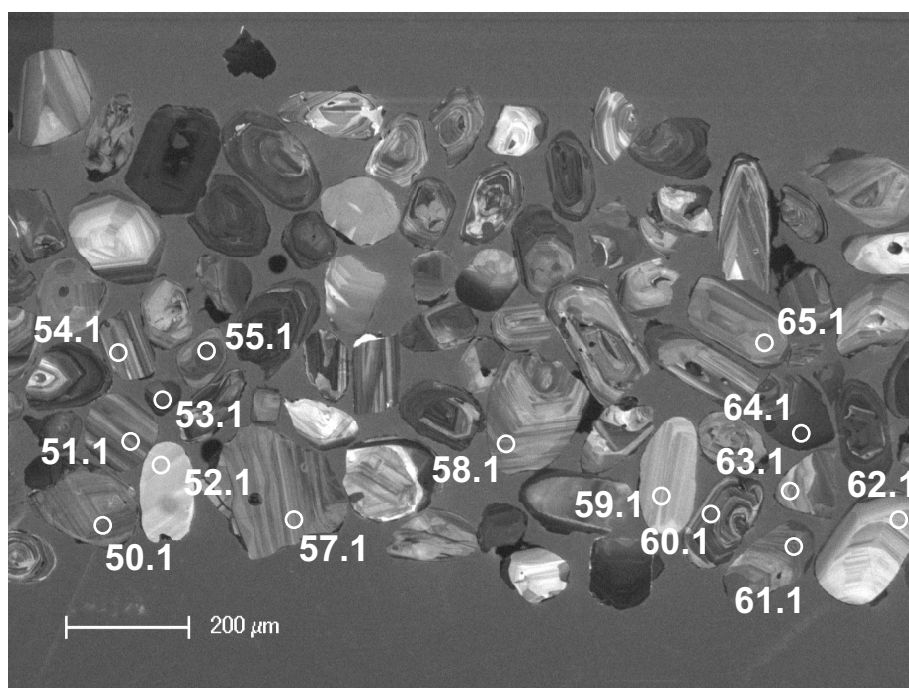


Figure 2. Cathodoluminescence image of representative zircons from sample 199418: sandstone, Mu Hills. Numbered circles indicate the approximate locations of analysis sites.

Table 1. Ion microprobe analytical results for zircons from sample 199418: sandstone, Mu Hills

Group ID	Spot no.	Grain. spot	^{238}U (ppm)	^{232}Th (ppm)	$\frac{^{232}\text{Th}}{^{238}\text{U}}$	f_{204} (%)	$^{238}\text{U}/^{206}\text{Pb} \pm 1\sigma$	$^{207}\text{Pb}/^{206}\text{Pb} \pm 1\sigma$	$^{238}\text{U}/^{206}\text{Pb}^* \pm 1\sigma$	$^{207}\text{Pb}^*/^{206}\text{Pb}^* \pm 1\sigma$	$^{238}\text{U}/^{206}\text{Pb}^*$ date (Ma) $\pm 1\sigma$	$^{207}\text{Pb}^*/^{206}\text{Pb}^*$ date (Ma) $\pm 1\sigma$	Disc. (%)						
Y	6	6.1	54	43	0.83	0.490	5.347	0.085	0.07878	0.00130	5.374	0.086	0.07486	0.00213	1100	16	1059	57	-3.8
S	2	2.1	86	98	1.17	0.393	5.276	0.069	0.07832	0.00101	5.297	0.069	0.07502	0.00155	1115	14	1069	42	-4.3
S	8	8.1	505	64	0.13	0.009	5.488	0.046	0.07512	0.00043	5.489	0.046	0.07504	0.00043	1079	8	1070	12	-0.9
S	9	9.1	88	129	1.50	-0.214	5.699	0.075	0.07340	0.00101	5.687	0.075	0.07520	0.00135	1044	13	1074	36	2.8
S	50	50.1	194	67	0.36	0.025	5.554	0.058	0.07564	0.00069	5.555	0.058	0.07543	0.00072	1067	10	1080	19	1.2
S	21	21.1	125	65	0.54	0.148	5.554	0.256	0.07729	0.00086	5.563	0.256	0.07605	0.00106	1066	47	1096	28	2.8
S	63	63.1	144	71	0.51	0.000	5.220	0.062	0.07696	0.00085	5.220	0.062	0.07696	0.00085	1130	12	1120	22	-0.9
S	7	7.1	186	113	0.63	0.238	5.207	0.055	0.07936	0.00070	5.219	0.055	0.07736	0.00095	1130	11	1131	24	0.0
S	54	54.1	200	161	0.83	0.072	5.463	0.060	0.07818	0.00070	5.467	0.060	0.07758	0.00078	1083	11	1136	20	4.7
S	24	24.1	152	79	0.54	0.000	5.484	0.061	0.07758	0.00080	5.484	0.061	0.07758	0.00080	1080	11	1136	20	5.0
S	20	20.1	108	79	0.75	0.216	4.964	0.060	0.07980	0.00087	4.975	0.061	0.07798	0.00114	1181	13	1146	29	-3.0
S	12	12.1	200	158	0.82	0.042	5.076	0.052	0.07882	0.00083	5.078	0.052	0.07847	0.00086	1159	11	1159	22	0.0
S	16	16.1	90	106	1.21	0.000	5.170	0.068	0.07848	0.00102	5.170	0.068	0.07848	0.00102	1140	14	1159	26	1.6
S	61	61.1	180	108	0.62	0.150	4.943	0.053	0.07995	0.00072	4.950	0.054	0.07868	0.00089	1186	12	1164	22	-1.9
S	18	18.1	223	211	0.98	0.058	5.098	0.051	0.07918	0.00065	5.100	0.051	0.07869	0.00071	1154	11	1164	18	0.9
S	26	26.1	73	67	0.96	0.182	5.120	0.073	0.08033	0.00114	5.129	0.073	0.07879	0.00145	1148	15	1167	36	1.6
S	58	58.1	155	170	1.13	0.000	5.114	0.057	0.07887	0.00078	5.114	0.057	0.07887	0.00078	1151	12	1169	20	1.5
S	29	29.1	134	275	2.12	-0.034	5.113	0.059	0.07862	0.00083	5.111	0.059	0.07891	0.00088	1152	12	1170	22	1.5
S	13	13.1	151	181	1.24	-0.029	4.916	0.055	0.07866	0.00078	4.915	0.055	0.07891	0.00082	1194	12	1170	21	-2.0
S	42	42.1	257	191	0.77	0.069	4.997	0.049	0.07968	0.00060	5.001	0.049	0.07909	0.00067	1175	11	1175	17	-0.1
S	64	64.1	537	433	0.83	0.071	5.270	0.045	0.07974	0.00043	5.274	0.045	0.07914	0.00048	1119	9	1176	12	4.8
S	30	30.1	126	115	0.94	0.000	5.144	0.060	0.07916	0.00086	5.144	0.060	0.07916	0.00086	1145	12	1176	22	2.6
S	55	55.1	353	33	0.10	0.013	5.083	0.047	0.07931	0.00054	5.084	0.047	0.07920	0.00055	1158	10	1177	14	1.7
S	35	35.1	116	137	1.22	0.144	5.012	0.277	0.08074	0.00087	5.019	0.278	0.07953	0.00106	1171	62	1185	26	1.2
S	56	56.1	101	128	1.31	-0.043	5.086	0.065	0.07918	0.00095	5.083	0.065	0.07954	0.00101	1158	14	1186	25	2.4
S	23	23.1	208	147	0.73	0.081	5.078	0.051	0.08025	0.00066	5.082	0.051	0.07957	0.00074	1158	11	1186	18	2.4
S	28	28.1	222	244	1.14	0.073	5.024	0.050	0.08035	0.00062	5.028	0.050	0.07973	0.00070	1169	11	1190	17	1.8
S	44	44.1	135	111	0.85	-0.099	4.978	0.058	0.07908	0.00083	4.974	0.058	0.07992	0.00096	1181	13	1195	24	1.2
S	51	51.1	142	143	1.04	-0.029	4.932	0.057	0.08027	0.00078	4.930	0.057	0.08052	0.00082	1190	13	1210	20	1.6
S	11	11.1	277	229	0.86	-0.074	5.056	0.048	0.07991	0.00056	5.053	0.048	0.08054	0.00063	1164	10	1210	15	3.8
S	17	17.1	72	88	1.26	0.000	5.005	0.093	0.08124	0.00111	5.005	0.093	0.08124	0.00111	1174	20	1227	27	4.3
S	45	45.1	196	68	0.36	0.042	4.592	0.048	0.08288	0.00068	4.594	0.048	0.08253	0.00072	1270	12	1258	17	-0.9
S	41	41.1	108	122	1.17	0.247	4.472	0.055	0.08496	0.00090	4.483	0.056	0.08286	0.00120	1298	15	1266	28	-2.5
S	38	38.1	160	127	0.82	-0.045	4.422	0.048	0.08429	0.00072	4.420	0.048	0.08467	0.00077	1315	13	1308	18	-0.5
S	27	27.1	113	89	0.81	0.000	4.449	0.216	0.08469	0.00111	4.449	0.216	0.08469	0.00111	1307	60	1308	25	0.1
S	60	60.1	199	257	1.33	-0.019	4.412	0.046	0.08578	0.00067	4.411	0.046	0.08595	0.00069	1317	13	1337	16	1.5

Table 1. continued

Group ID	Spot no.	Grain. spot	^{238}U (ppm)	^{232}Th (ppm)	$\frac{^{232}\text{Th}}{^{238}\text{U}}$ (%)	$^{238}\text{U}/^{206}\text{Pb} \pm 1\sigma$	$^{207}\text{Pb}/^{206}\text{Pb} \pm 1\sigma$	$^{238}\text{U}/^{206}\text{Pb}^* \pm 1\sigma$	$^{207}\text{Pb}^*/^{206}\text{Pb}^* \pm 1\sigma$	$^{238}\text{U}/^{206}\text{Pb}^* \text{ date (Ma)} \pm 1\sigma$	$^{207}\text{Pb}^*/^{206}\text{Pb}^* \text{ date (Ma)} \pm 1\sigma$	Disc. (%)
S	33	33.1	187	56	0.31	0.000	0.08700	0.00067	0.08700	0.00067	1361	0.2
S	15	15.1	50	37	0.76	0.183	0.09323	0.00127	0.09166	0.00156	1460	-1.0
S	25	25.1	92	45	0.50	-0.153	0.09064	0.00098	0.09195	0.00118	1466	1.5
S	65	65.1	105	100	0.98	-0.072	0.09152	0.00096	0.09214	0.00106	1470	4.3
S	53	53.1	208	125	0.62	0.121	0.09644	0.00386	0.09540	0.00388	1536	2.8
S	4	4.1	309	181	0.61	0.047	0.09731	0.00051	0.09690	0.00054	1565	4.3
S	14	14.1	153	109	0.74	0.019	0.09718	0.00073	0.09701	0.00075	1567	1.3
S	43	43.1	221	207	0.97	0.026	0.09917	0.00373	0.09894	0.00373	1604	1.2
S	49	49.1	369	100	0.28	0.038	0.10435	0.00049	0.10402	0.00051	1697	3.1
S	19	19.1	162	189	1.20	0.096	0.10791	0.00087	0.10708	0.00094	1731	1.1
S	10	10.1	104	251	2.51	0.169	0.10910	0.00089	0.10763	0.00105	1760	1.4
S	37	37.1	276	222	0.83	0.035	0.10794	0.00053	0.10763	0.00055	1760	9
S	62	62.1	57	61	1.11	0.150	0.11014	0.00165	0.10883	0.00182	1780	2.6
S	40	40.1	106	158	1.54	0.137	0.11053	0.00088	0.10933	0.00100	1788	17
S	31	31.1	64	24	0.39	0.291	0.12022	0.00111	0.11766	0.00140	1921	21
S	34	34.1	32	48	1.55	0.099	0.16071	0.00171	0.15983	0.00182	2454	19
S	36	36.1	78	39	0.52	-0.045	0.19021	0.00109	0.19061	0.00111	2747	10
D	59	59.1	30	104	3.56	0.617	0.07694	0.00174	0.07179	0.00313	980	-18.6
D	47	47.1	94	166	1.82	0.335	0.07850	0.00099	0.07568	0.00146	1087	39
D	39	39.1	296	331	1.15	0.015	0.07945	0.00056	0.07932	0.00058	1180	14
D	5	5.1	471	638	1.40	0.072	0.08005	0.00044	0.07944	0.00049	1183	12
D	32	32.1	286	176	0.63	0.000	0.08035	0.00059	0.08035	0.00059	1206	14
D	57	57.1	98	110	1.16	-0.311	0.07824	0.00096	0.08087	0.00138	1218	33
D	22	22.1	567	919	1.67	0.241	0.09185	0.00043	0.08978	0.00061	1421	13
D	52	52.1	57	35	0.63	-0.058	0.09293	0.00122	0.09343	0.00132	1497	27
D	48	48.1	89	62	0.73	0.216	0.10074	0.00103	0.09888	0.00129	1603	24
D	46	46.1	144	130	0.94	0.021	0.10120	0.00079	0.10102	0.00081	1643	15
D	1	1.1	117	53	0.47	0.024	0.10918	0.00089	0.10897	0.00091	1782	15
D	3	3.1	339	193	0.59	0.018	0.13226	0.00051	0.13210	0.00052	2126	7

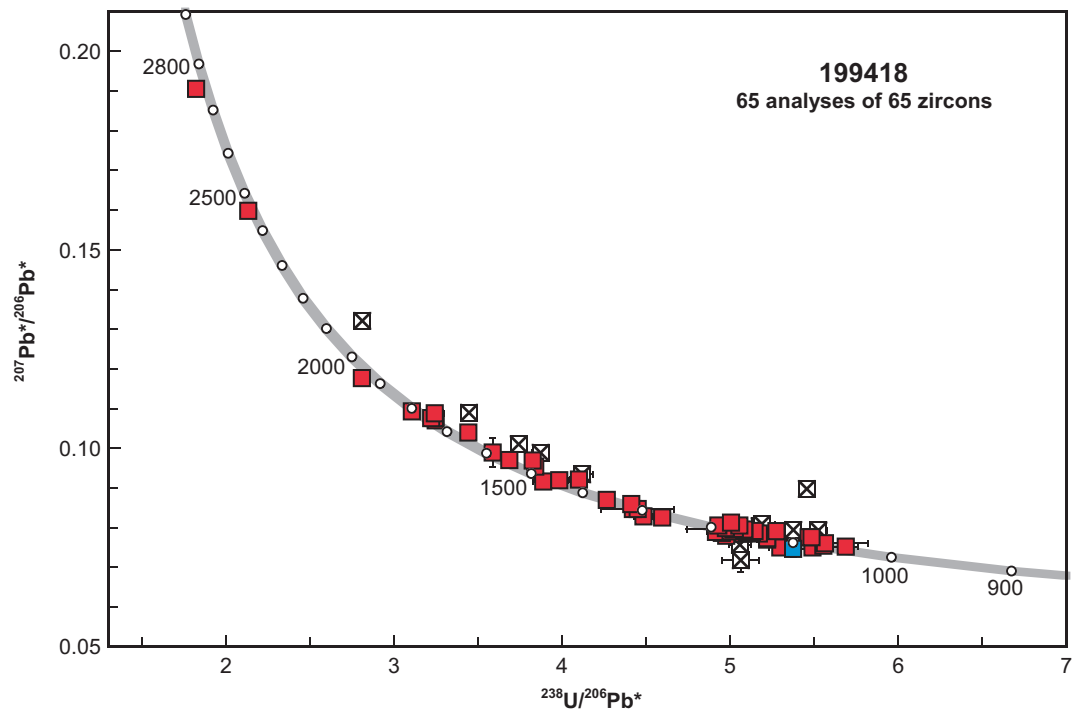


Figure 3. U-Pb analytical data for zircons from sample 199418: sandstone, Mu Hills. Blue squares indicate Group Y (youngest detrital zircon); red squares indicate Group S (older detrital zircons); crossed squares indicate Group D (discordance >5%).

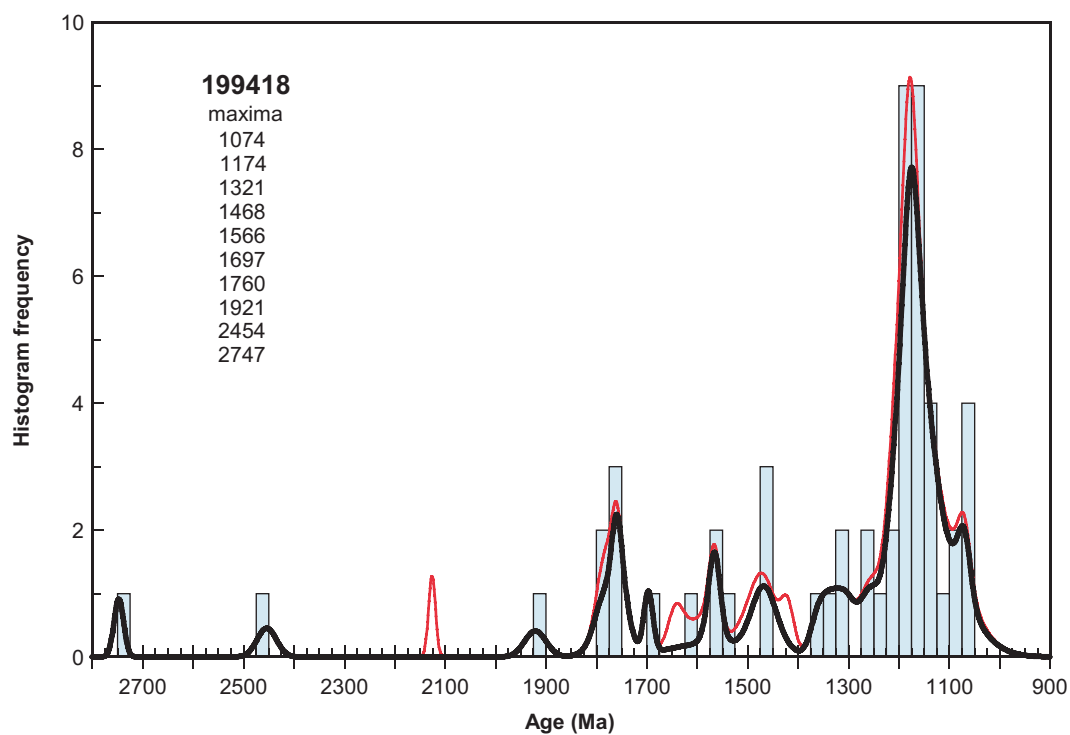


Figure 4. Probability density diagram and histogram for sample 199418: sandstone, Mu Hills. Thick curve, maxima values, and frequency histogram (bin width 25 Ma) only include accepted data (53 analyses of 53 zircons). Thin curve includes all data (65 analyses of 65 zircons).

It is possible that all of the analyses are of unmodified detrital zircons, in which case the date of 1059 ± 57 Ma (1 σ) 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 1097 ± 22 Ma (MSWD = 2.0) for the 10 youngest analyses in Groups Y and S.

The data for combined Groups Y and S indicate significant age components at c. 1760, 1566, 1468, 1321, 1174, and 1074 Ma, based on contributions from 5, 4, 5, 4, 22, and 6 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.

References

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Recommended reference for this publication

Wingate, MTD, Kirkland, CL and Haines, PW 2014, 199418: sandstone, Mu Hills; *Geochronology Record 1191*: Geological Survey of Western Australia, 6p.

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