

184339: sandstone, Pollock Hills

(Heavitree Quartzite, Amadeus Basin)

Location and sampling

WEBB (SF 52-10), POLLOCK (4452)
MGA Zone 52, 347508E 7476842N

Sampled on 31 July 2007

The sample was collected from a coarse-grained to pebbly sandstone bed in an outcrop of intercalated sandstone and minor siltstone, exposed in a series of low, rugged hills, in the western Pollock Hills. The sample site is located about 1 km southwest of the Kiwirrkurra–Gary Junction Road, 1.5 km east of the western boundary of the WEBB 1:250 000 map sheet, and about 25.8 km west of the Kiwirrkurra town site.

Tectonic unit/relations

The unit sampled is the Heavitree Quartzite, commonly the basal unit of the Amadeus Basin succession. The quartzite consists of silicified sandstone with discontinuous units of siltstone, shale, and conglomerate at its base. Silty conglomerate units are found in the middle of the formation, and well-sorted sandstone and minor siltstone near the top (Vanderhor et al., 2006). The Heavitree Quartzite is equivalent to the Dean Quartzite, and the Vaughan Springs Quartzite of the Ngalia Basin. The Heavitree Quartzite unconformably overlies the Kiwirrkurra Formation, of which sample 184336 is representative (Kirkland et al., 2009). The sample comes from an outcrop near the base of the Heavitree Quartzite, close to the unconformity with the Kiwirrkurra Formation. Well-developed, large-scale cross-stratification indicates paleocurrent directions to the west and, from slightly higher in the stratigraphy, to the northwest.

Petrographic description

This sample is dominated by single-crystal quartz grains from 0.25 to 1.5 mm in diameter, indicating medium- to very-coarse-grained sandstone. Varied diagenetic effects are seen, with detrital cores defined by hematite or fluid-inclusion trails and optically continuous overgrowths. Stylolitic grain boundaries and areas with interstitial patches of decussate sericite or illite are also present. Minor tourmaline, up to 0.4 mm in size and partly fragmented, is disseminated throughout the rock. Some quartz grains contain inclusions of biotite or apatite.

Zircon morphology

Zircons from this sample show a diverse range of grain morphologies. Most are clear and colourless, and some are pale brown, and others are black. The crystals range from subhedral and variably rounded to euhedral and well faceted, and are up to 150 μm long with aspect ratios up to 4:1. Most crystals exhibit oscillatory growth zoning which is truncated at abraded grain margins, consistent with sedimentary transport. Some zircons show core and overgrowth relationships testifying to a history of growth and regrowth. A cathodoluminescence image of representative zircons is shown in Figure 1.

Analytical details

This sample was analysed over two sessions, on 27–28 November 2008, using SHRIMP-A. Analyses 1.1 to 60.1 (spot numbers 1–60) were obtained during the first session, together with 16 analyses of the Temora standard. Following rejection of three analyses as outliers, the remaining 13 analyses indicated an external spot-to-spot (reproducibility) uncertainty of 0.01% (1σ), and a $^{238}\text{U}/^{206}\text{Pb}^*$ calibration uncertainty of 0.17% (1σ). Analyses 61.1 to 66.1 (spot numbers 61–66) were obtained during the second session, together with 14 analyses of the Temora standard. Following rejection of one analysis as an outlier, the remaining 13 analyses indicated an external spot-to-spot (reproducibility) uncertainty of 0.93% (1σ), and a $^{238}\text{U}/^{206}\text{Pb}^*$ calibration uncertainty of 0.33% (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 common-Pb isotopic compositions determined according to the Pb isotopic model of Stacey and Kramers (1975).

Results

Sixty-six analyses were obtained from 66 zircons. Results are listed in Table 1, and shown in a concordia diagram (Fig. 2) and a probability density diagram (Fig. 3).

Interpretation

Most analyses are concordant to slightly discordant (Fig. 2). Four analyses are characterized by slight to

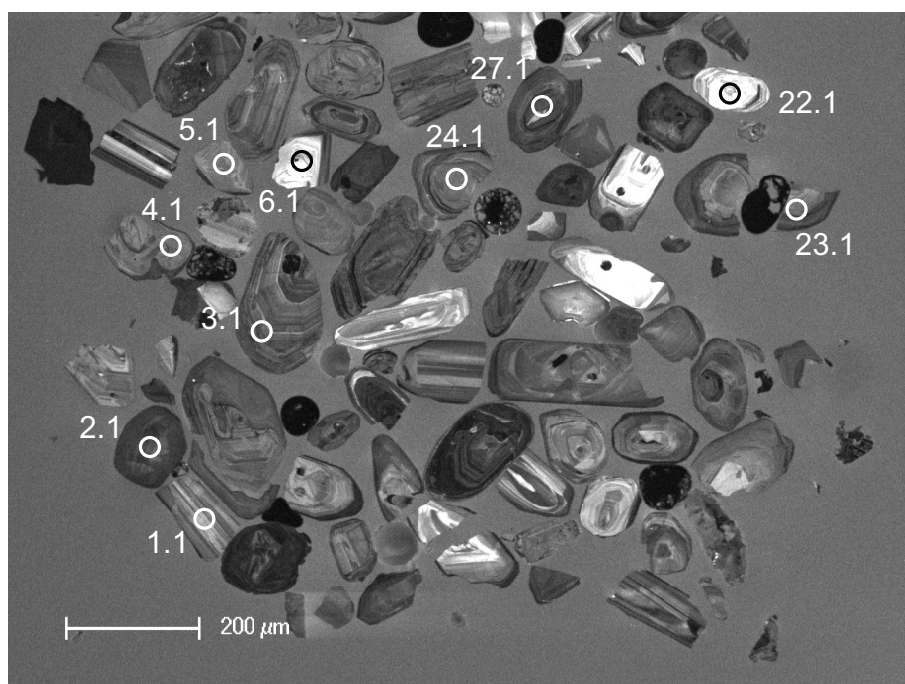


Figure 1. Cathodoluminescence image of representative zircons from sample 184339: sandstone, Pollock Hills. Numbered circles indicate approximate locations of analysis sites.

moderate discordance (>5%). The dates obtained from these four analyses (Group D; Table 1) are unreliable, and are not considered geologically significant. The remaining 62 analyses can be divided into two groups.

Group Y comprises a single analysis (19.1; Table 1), which yields a $^{207}\text{Pb}^*/^{206}\text{Pb}^*$ date of 1198 ± 24 Ma (1σ).

Group S comprises 61 analyses (Table 1) which yield $^{207}\text{Pb}^*/^{206}\text{Pb}^*$ dates of 3173–1597 Ma.

It is possible that all of the analyses are of unmodified detrital zircons, in which case the date of 1198 ± 24 Ma (1σ) for the single analysis in Group Y can be interpreted as the maximum age of deposition for the sandstone. A more conservative estimate of the maximum age of deposition is provided by the weighted mean $^{207}\text{Pb}^*/^{206}\text{Pb}^*$ date of 1625 ± 36 Ma (MSWD = 1.3) for the youngest four analyses in Group S.

The 62 analyses in combined Groups Y and S indicate dates that define significant age components at c. 1625, 1774, 1837, and 1884 Ma (by contributions from 4, 24, 11, and 16 grains, respectively), and several minor components in the range 3173–1198 Ma. These are interpreted as the ages of zircon-crystallizing rocks in the detrital source region of the sandstone, or the ages of detrital components within sediments which have been reworked.

References

- Kirkland, CL, Wingate, MTD, Spaggiari CV and Tyler, IM 2009, 184336: sandstone, Pollock Hills; Geochronology Record 816: Geological Survey of Western Australia, 5p.
- Stacey, JS and Kramers, JD 1975, Approximation of terrestrial lead isotope evolution by a two-stage model: *Earth and Planetary Science Letters*, v. 26, p. 207–221.
- Vanderhor, F, Flint, RB, Tyler, IM and Hocking, RM 2006, 1:500 000 interpreted bedrock geology of Western Australia, 2006 update. Dataset within GeoVIEW.WA (interactive geological map): Geological Survey of Western Australia.

Recommended reference for this publication

- Kirkland, CL, Wingate, MTD, Spaggiari CV and Tyler, IM 2009, 184339: sandstone, Pollock Hills; Geochronology Record 817: Geological Survey of Western Australia, 5p.

Data obtained: 28 November 2008
Data released: 30 June 2009

Table 1. Ion microprobe analytical results for zircons from sample 184339: sandstone, Pollock Hills

Group ID.	Spot no.	Grain. spot	²³⁸ U (ppm)	²³² Th (ppm)	²³² Th/ ²³⁸ U	f ₂₀₄ (%)	²³⁸ U/ ²⁰⁶ Pb ± 1 σ	²⁰⁷ Pb/ ²⁰⁶ Pb ± 1 σ	²³⁸ U/ ²⁰⁶ Pb* ± 1 σ	²⁰⁷ Pb/ ²⁰⁶ Pb* ± 1 σ	²³⁸ U/ ²⁰⁶ Pb* date (Ma) ± 1 σ	²⁰⁷ Pb/ ²⁰⁶ Pb* date (Ma) ± 1 σ	Disc. (%)				
Y	19	19.1	242	195	0.83	0.084	4.859	0.020	4.863	0.022	0.08004	0.00099	1206	6	1198	24	-0.6
S	40	40.1	104	70	0.69	-0.122	3.564	0.023	3.560	0.023	0.09856	0.00143	1596	12	1597	27	0.1
S	17	17.1	163	114	0.72	0.082	3.482	0.017	3.485	0.018	0.09915	0.00115	1626	10	1608	22	-1.1
S	21	21.1	312	65	0.21	0.016	3.460	0.013	3.461	0.014	0.10007	0.00080	1636	8	1625	15	-0.7
S	5	5.1	163	113	0.71	-0.087	3.450	0.018	3.447	0.019	0.10180	0.00118	1642	10	1657	22	0.9
S	49	49.1	118	90	0.79	0.169	3.174	0.021	3.179	0.022	0.10497	0.00152	1763	14	1714	27	-2.9
S	14	14.1	132	204	1.60	0.133	3.261	0.019	3.266	0.019	0.10497	0.00135	1722	12	1714	24	-0.5
S	60	60.1	80	92	1.19	0.136	3.200	0.025	3.204	0.026	0.10611	0.00125	1751	16	1734	22	-1.0
S	56	56.1	251	71	0.29	0.038	3.237	0.020	3.238	0.020	0.10694	0.00096	1735	13	1748	16	0.7
S	10	10.1	138	60	0.45	0.032	3.184	0.025	3.185	0.025	0.10721	0.00123	1760	16	1753	21	-0.4
S	1	1.1	198	200	1.04	0.389	3.218	0.015	3.231	0.017	0.10730	0.00159	1738	11	1754	27	0.9
S	32	32.1	256	139	0.56	0.024	3.286	0.013	3.286	0.015	0.10771	0.00091	1712	9	1761	15	2.8
S	45	45.1	222	53	0.25	0.081	3.156	0.015	3.159	0.016	0.10773	0.00106	1773	10	1761	18	-0.7
S	62	62.1	196	93	0.49	0.115	3.182	0.034	3.186	0.036	0.10778	0.00079	1760	23	1762	13	0.1
S	15	15.1	156	37	0.25	-0.025	3.153	0.016	3.153	0.017	0.10815	0.00115	1776	11	1768	19	-0.4
S	55	55.1	169	89	0.55	0.102	3.209	0.017	3.212	0.018	0.10820	0.00183	1747	11	1769	31	1.3
S	43	43.1	173	68	0.41	0.052	3.197	0.017	3.199	0.017	0.10821	0.00113	1754	11	1769	19	0.9
S	59	59.1	182	109	0.62	-0.017	3.180	0.017	3.179	0.018	0.10838	0.00211	1763	11	1772	35	0.5
S	66	66.1	128	62	0.50	0.067	3.100	0.035	3.102	0.036	0.10848	0.00091	1801	24	1774	15	-1.5
S	18	18.1	361	240	0.69	0.033	3.221	0.011	3.222	0.012	0.10880	0.00075	1743	8	1779	13	2.1
S	4	4.1	207	125	0.62	-0.019	3.172	0.014	3.171	0.015	0.10885	0.00100	1767	10	1780	17	0.7
S	28	28.1	145	98	0.70	-0.080	3.238	0.017	3.236	0.018	0.10885	0.00112	1736	11	1780	19	2.5
S	12	12.1	309	201	0.67	0.061	3.271	0.017	3.273	0.018	0.10897	0.00087	1719	11	1782	14	3.6
S	46	46.1	187	153	0.85	-0.031	3.203	0.017	3.202	0.017	0.10901	0.00111	1752	11	1783	19	1.7
S	50	50.1	134	75	0.57	0.114	3.206	0.019	3.210	0.020	0.10959	0.00132	1748	12	1793	22	2.5
S	29	29.1	100	50	0.52	-0.109	3.122	0.020	3.119	0.021	0.11027	0.00145	1793	14	1804	24	0.6
S	42	42.1	185	90	0.50	0.043	3.104	0.016	3.105	0.016	0.11060	0.00110	1800	11	1809	18	0.5
S	53	53.1	167	85	0.53	-0.039	3.193	0.017	3.191	0.018	0.11203	0.00114	1757	11	1833	18	4.1
S	13	13.1	196	103	0.54	0.031	3.216	0.016	3.217	0.016	0.11208	0.00105	1745	10	1833	17	4.8
S	30	30.1	47	34	0.74	0.055	3.120	0.029	3.122	0.030	0.11234	0.00205	1791	20	1838	33	2.5
S	8	8.1	407	129	0.33	0.013	2.992	0.010	2.992	0.011	0.11243	0.00071	1859	8	1839	11	-1.1
S	31	31.1	215	77	0.37	0.014	3.015	0.013	3.015	0.014	0.11301	0.00139	1846	10	1848	22	0.1
S	23	23.1	181	81	0.46	0.045	3.027	0.015	3.029	0.016	0.11302	0.00114	1839	11	1849	18	0.5
S	57	57.1	360	375	1.08	0.027	3.035	0.011	3.035	0.013	0.11456	0.00081	1836	9	1873	13	2.0
S	2	2.1	474	56	0.12	0.036	3.075	0.009	3.077	0.011	0.11494	0.00067	1814	7	1879	10	3.4
S	41	41.1	245	59	0.25	0.052	3.072	0.014	3.073	0.015	0.11500	0.00101	1816	10	1880	16	3.4
S	47	47.1	224	55	0.25	0.073	3.022	0.014	3.024	0.015	0.11502	0.00175	1841	11	1880	27	2.1
S	9	9.1	269	108	0.41	0.075	2.959	0.012	2.962	0.013	0.11505	0.00090	1875	10	1881	14	0.3
S	24	24.1	165	47	0.30	0.042	2.997	0.015	2.999	0.016	0.11505	0.00115	1855	11	1881	18	1.4
S	35	35.1	336	45	0.14	-0.059	2.933	0.014	2.931	0.015	0.11530	0.00080	1892	11	1885	12	-0.4
S	51	51.1	362	97	0.28	0.081	2.998	0.011	3.001	0.012	0.11544	0.00080	1854	9	1887	13	1.7

Table 1. (continued)

Group ID	Spot no.	Grain spot	^{238}U (ppm)	^{232}Th (ppm)	$^{232}\text{Th}/^{238}\text{U}$	f_{204} (%)	$^{238}\text{U}/^{206}\text{Pb} \pm 1\sigma$	$^{207}\text{Pb}/^{206}\text{Pb} \pm 1\sigma$	$^{238}\text{U}/^{206}\text{Pb}^* \pm 1\sigma$	$^{207}\text{Pb}/^{206}\text{Pb}^* \pm 1\sigma$	$^{238}\text{U}/^{206}\text{Pb}^* \text{ date (Ma)} \pm 1\sigma$	$^{207}\text{Pb}/^{206}\text{Pb}^* \text{ date (Ma)} \pm 1\sigma$	Disc. (%)
S	7	7.1	397	228	0.59	0.006	3.009	0.010	3.009	0.011	1850	1888	2.0
S	34	34.1	536	86	0.17	-0.029	2.996	0.009	2.996	0.010	1857	1896	2.1
S	44	44.1	195	49	0.26	0.000	2.951	0.014	2.951	0.015	1881	1905	1.3
S	38	38.1	51	46	0.92	-0.393	3.005	0.043	2.994	0.044	1858	1906	2.5
S	52	52.1	173	49	0.29	0.140	2.978	0.016	2.983	0.017	1864	1916	2.7
S	27	27.1	226	80	0.37	-0.035	2.869	0.012	2.868	0.013	1928	1955	1.4
S	33	33.1	221	116	0.54	0.042	2.784	0.012	2.785	0.013	1978	2037	2.9
S	64	64.1	148	97	0.67	0.063	2.706	0.030	2.708	0.031	2026	2044	0.9
S	26	26.1	471	93	0.20	0.025	2.675	0.011	2.676	0.012	2047	2070	1.1
S	37	37.1	97	52	0.55	0.046	2.572	0.017	2.573	0.017	2116	2113	-0.1
S	16	16.1	154	56	0.38	0.037	2.641	0.013	2.642	0.014	2069	2116	2.2
S	39	39.1	259	147	0.59	0.041	2.534	0.019	2.535	0.019	2143	2172	1.3
S	58	58.1	183	79	0.45	0.022	2.407	0.013	2.408	0.013	2239	2189	-2.3
S	63	63.1	111	81	0.76	0.044	2.476	0.028	2.477	0.030	2186	2204	0.8
S	36	36.1	195	242	1.28	0.065	2.349	0.015	2.351	0.015	2285	2364	3.3
S	11	11.1	90	132	1.52	0.050	2.333	0.016	2.334	0.017	2298	2367	2.9
S	54	54.1	423	268	0.66	-0.013	2.213	0.008	2.213	0.008	2404	2450	1.9
S	22	22.1	79	61	0.79	-0.020	2.250	0.017	2.249	0.018	2371	2457	3.5
S	61	61.1	168	92	0.57	-0.024	2.173	0.025	2.172	0.026	2441	2494	2.1
S	65	65.1	90	65	0.75	0.075	1.794	0.021	1.795	0.022	2854	2863	0.3
S	20	20.1	59	57	0.99	-0.027	1.595	0.013	1.594	0.014	3139	3173	1.1
D	6	6.1	79	69	0.90	0.245	2.994	0.030	3.002	0.031	1854	1753	-5.7
D	25	25.1	321	118	0.38	0.239	3.501	0.013	3.510	0.014	1616	1796	10.0
D	48	48.1	433	491	1.17	0.206	3.143	0.011	3.149	0.012	1778	1995	10.9
D	3	3.1	496	280	0.58	0.347	4.068	0.012	4.082	0.014	1413	1800	21.5

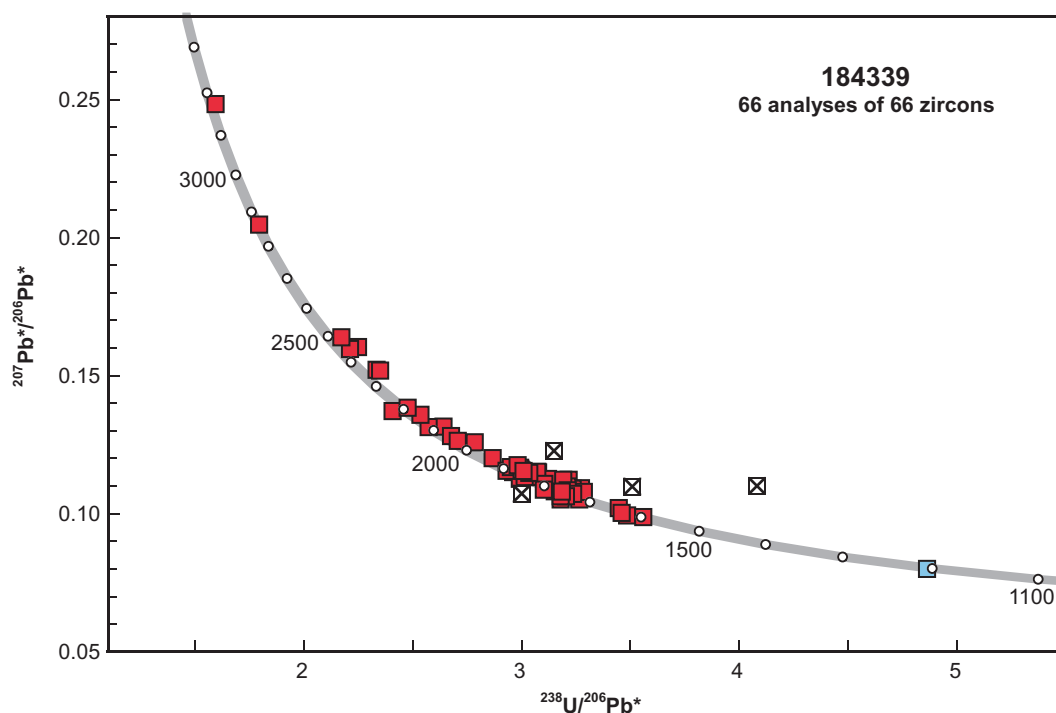


Figure 2. U-Pb analytical data for zircons from sample 184339: sandstone, Pollock Hills. Blue square indicates Group Y (youngest detrital zircon); red squares indicate Group S (older detrital zircons); crossed squares indicate Group D (discordance >5%).

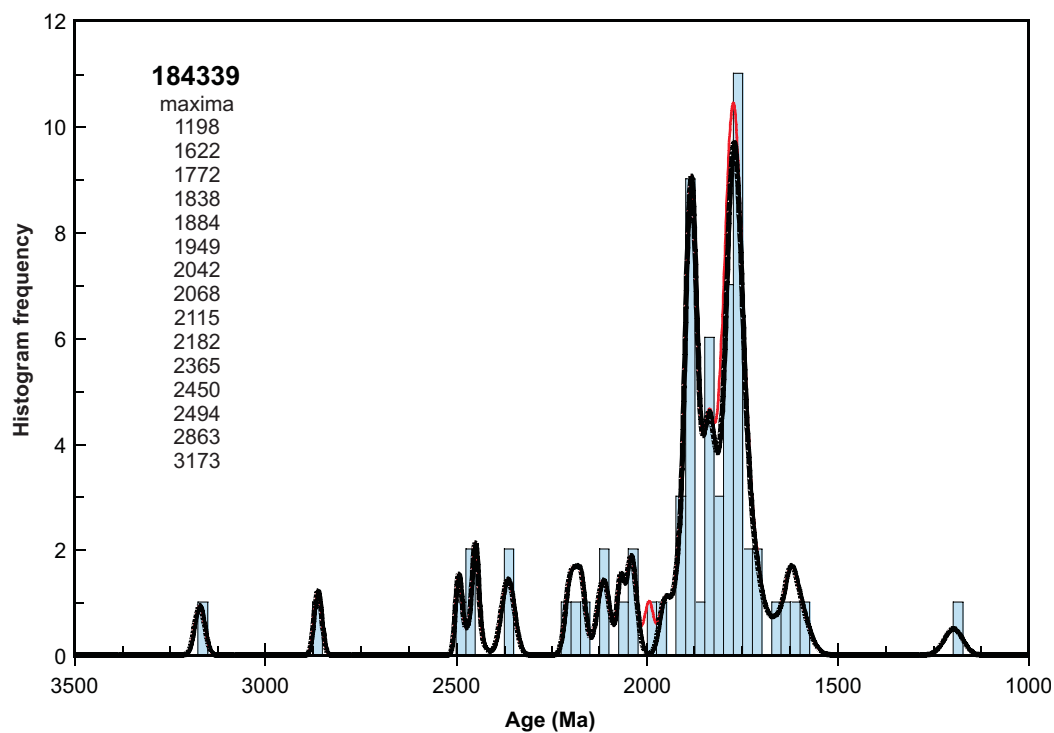


Figure 3. Probability density diagram and histogram for sample 184339: sandstone, Western Pollock Hills. Heavy curve, maxima values, and frequency histogram (bin width 25 Ma) includes only concordant data (62 analyses of 62 zircons). Light curve includes all data (66 analyses of 66 zircons).