182107: quartz sandstone, Inglis Gap

(O'Donnell Formation, Speewah Group, Speewah Basin)

Location and sampling

LENNARD RIVER (SE 51-8), RICHENDA (3963)
MGA Zone 51, 731635E 8106817N

Sampled on 31 August 2007

This sample was collected from a rocky slope at Inglis Gap. The sample site is located approximately 7.2 km southwest of Mount Chalmers, 2.9 km north-northwest of Mount Hart Outcamp, and 1.0 km west of the junction of Gibb River and Mount Hart Roads.

Tectonic unit/relations

The unit sampled is a grey to brown, pebbly quartz sandstone assigned to the O'Donnell Formation (Griffin et al., 1993). The O'Donnell Formation comprises poorly sorted, coarse-grained granular quartz sandstone, with widespread conglomerate beds in the lower part of the formation, and abundant siltstone beds in the upper section. The O'Donnell Formation forms the base of the Speewah Group, and unconformably overlies the Hooper Complex and the western zone of the Lamboo Complex.

The Speewah Group is a package of siliciclastic sedimentary rocks about 1500 m thick deposited in the Speewah Basin, with minor felsic volcanic rocks included within the Valentine Siltstone in the middle of the group. The O'Donnell Formation was deposited prior to 1834 ± 3 Ma — based on the age of a felsic volcanic unit in the Valentine Siltstone (Griffin et al., 1993) higher in the Speewah Group — and after 1865–1850 Ma — based on the age of crystalline rocks of the underlying Hooper Complex. A sample of the Lansdowne Arkose, higher in the Speewah Group, was collected 9.2 km east-southeast of this locality (GSWA 182106; Kirkland et al., 2010a).

Petrographic description

The sample is poorly sorted, and consists principally of single-crystal quartz grains from 0.25 to 3 mm long, indicating medium to very coarse grained sandstone. Many quartz grains have undulose extinction, implying later deformation; stylolitic grain boundaries are also common in quartz grains. The thin section also contains a single small pebble of polycrystalline quartz, about 5 mm long. Interstitial material is sparse, but includes microcrystalline quartz, and lenses containing foliated sericite or illite–limonite.

Zircon morphology

Zircons from this sample are primarily subspherical to euhedral, and pink to dark brown. The grains are up to 300 μm long, with aspect ratios up to 5:1. Many have abraded outer surfaces or have fractured, creating angular grain margins. Cathodoluminescence (CL) images reveal a wide variety of internal textures, including idiomorphic zoning truncated at grain boundaries, features consistent with sedimentary transport. Several grains contain older zircon cores. A CL image of representative zircons is shown in Figure 1.

Analytical details

This sample was analysed over two sessions on 29–30 May 2008, using SHRIMP-B, and 31 May 2008, using SHRIMP-B. Analyses 1.1 to 56.1 (spot numbers 1–56) were obtained during the first session, together with 14 analyses of the Temora standard, which yielded an external spot-to-spot (reproducibility) uncertainty of 1.20% (1σ) and a $^{238}U/^{206}Pb^*$ calibration uncertainty of 0.43% (1σ). Analyses 57.1 to 65.1 (spot numbers 57–65) were obtained during the second session, together with six analyses of the Temora standard, which indicated an external spot-to-spot (reproducibility) uncertainty of 1.03% (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

Sixty-five analyses were obtained from 65 zircons. Results are listed in Table 1, and shown on a concordia diagram (Fig. 2) and a probability density diagram (Fig. 3).

Interpretation

The analyses are concordant to strongly discordant (Fig. 2). Thirteen analyses are >5% discordant. The dates obtained from these 13 analyses (Group D; Table 1) are imprecise or unreliable, and are not considered geologically significant. The remaining 52 analyses can be separated into two groups based on their $^{207}Pb^*/^{206}Pb^*$ ratios.

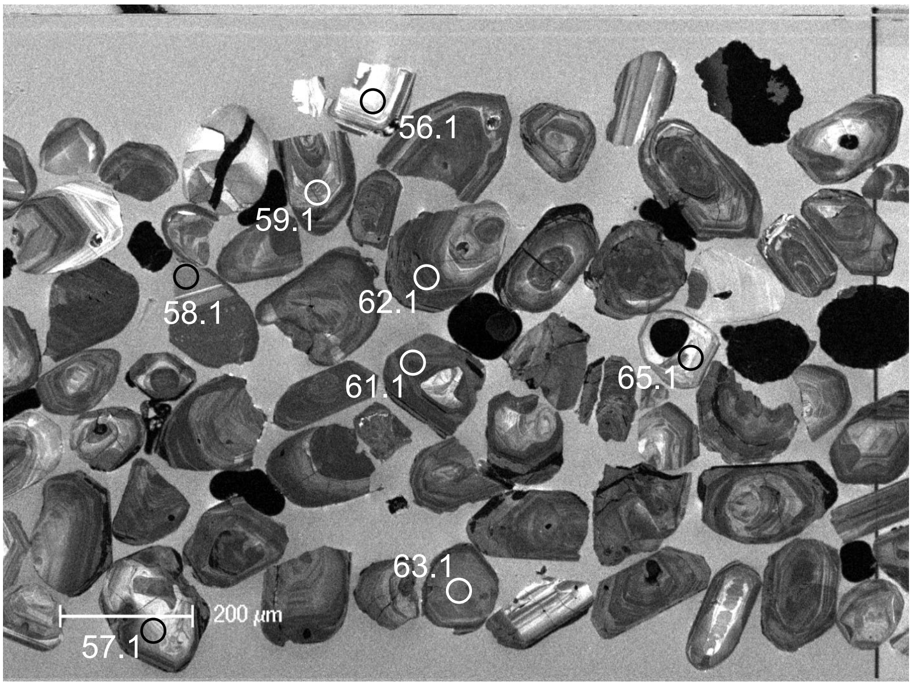

Figure 1. Cathodoluminescence image of representative zircons from sample 182107: quartz sandstone, Inglis Gap. Numbered circles indicate the approximate positions of analysis sites.

Group Y comprises a single analysis (26.1, Table 1), which yields a $^{207}Pb^{*}/^{206}Pb^{*}$ date of 1841 ± 17 Ma (1σ).

Group S comprises 51 analyses (Table 1), which yield $^{207}Pb^{*}/^{206}Pb^{*}$ dates of 2718–1842 Ma.

It is possible that all of the analyses in Groups Y and S represent unmodified detrital zircons, in which case the date of 1841 ± 17 Ma (1σ) for the single analysis (26.1) in Group Y represents a maximum age of deposition. A more conservative estimate of the maximum depositional age can be based on the weighted mean $^{207}Pb^{*}/^{206}Pb^{*}$ date of 1864 ± 4 Ma (MSWD = 1.01) for the youngest 28 analyses in Groups Y and S.

The 52 analyses in combined Groups Y and S indicate dates that define a significant age component at c. 1882 Ma, defined by 38 analyses, and several minor components between 2700 and 2400 Ma (Fig. 3). These are interpreted as the ages of zircon-crystallizing rocks in the detrital source region(s), or the ages of detrital components within sediments that have been reworked into this rock.

Age components at c. 1950–1800 and 2550–2450 Ma have been reported from the overlying Kimberley Group (McNaughton et al., 1999; Kirkland et al., 2010b), although this sample from the underlying Speewah Group appears strongly dominated by late Paleoproterozoic detrital zircons. Based on the age of the youngest detritus in the O'Donnell Formation (this sample), and the 1834 ± 3 Ma age for volcanic rocks in the Valentine Sandstone of the middle Speewah Group, the lower Speewah Group (O'Donnell and Tunganary Formations) was deposited between c. 1858 and 1834 Ma.

References

Griffin, TJ, Tyler, IM and Playford, PE 1993, Lennard River, Western Australia (3rd edition): Geological Survey of Western Australia, 1:250 000 Geological Series Explanatory Notes, 56p.

Kirkland, CL, Wingate, MTD and Tyler, IM 2010a, 182106: feldspathic sandstone, Mount Vincent; Geochronology Record 887: Geological Survey of Western Australia, 6p.

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McNaughton, NJ, Rasmussen, B and Fletcher, IR 1999, SHRIMP uranium–lead dating of diagenetic xenotime in siliciclastic sedimentary rocks. Science, v. 285, p. 78–80.

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.

Recommended reference for this publication

Kirkland, CL, Wingate, MTD and Tyler, IM 2010, 182107: quartz sandstone, Inglis Gap; Geochronology Record 888: Geological Survey of Western Australia, 5p.

Data obtained: 31 May 2008
Data released: 30 June 2010

Table 1. Ion microprobe analytical results for zircons from sample 182107: quartz sandstone, Inglis Gap

Group ID	*Spot no.*	*Grain. spot*	*^{238}U (ppm)*	*^{232}Th (ppm)*	*$^{232}Th/^{238}U$*	*f204 (%)*	*$^{238}U/^{206}Pb$*	*±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	26	26.1	149	53	0.36	0.256	2.978	0.043	0.11477	0.00083	2.986	0.043	0.11253	0.00106	1862	24	1841	17	-1.2
S	10	10.1	176	90	0.53	0.080	2.975	0.042	0.11328	0.00104	2.978	0.043	0.11258	0.00178	1867	24	1842	29	-1.4
S	57	57.1	188	48	0.26	0.286	3.055	0.041	0.11534	0.00077	3.064	0.041	0.11283	0.00102	1821	22	1846	16	1.3
S	55	55.1	135	59	0.45	0.430	3.007	0.044	0.11690	0.00093	3.020	0.045	0.11315	0.00139	1844	24	1851	22	0.4
S	22	22.1	205	112	0.56	0.143	2.929	0.041	0.11450	0.00073	2.933	0.041	0.11325	0.00086	1891	23	1852	14	-2.1
S	24	24.1	329	163	0.51	0.037	2.898	0.039	0.11359	0.00056	2.899	0.039	0.11326	0.00068	1910	23	1852	11	-3.1
S	1	1.1	1245	185	0.15	0.053	3.099	0.041	0.11373	0.00028	3.100	0.041	0.11327	0.00030	1802	21	1852	5	2.7
S	56	56.1	140	127	0.94	0.114	2.909	0.043	0.11430	0.00092	2.913	0.044	0.11330	0.00267	1903	25	1853	43	-2.7
S	17	17.1	311	82	0.27	0.173	2.979	0.041	0.11495	0.00059	2.985	0.041	0.11344	0.00071	1863	22	1855	11	-0.4
S	64	64.1	240	241	1.04	0.170	2.983	0.039	0.11502	0.00070	2.988	0.039	0.11354	0.00085	1861	21	1857	13	-0.2
S	30	30.1	323	167	0.53	0.188	3.138	0.043	0.11521	0.00059	3.144	0.043	0.11357	0.00087	1780	21	1857	14	4.1
S	12	12.1	985	27	0.03	0.076	3.013	0.039	0.11441	0.00033	3.016	0.039	0.11375	0.00037	1846	21	1860	6	0.8
S	6	6.1	989	85	0.09	0.056	2.999	0.039	0.11443	0.00033	3.000	0.039	0.11394	0.00035	1854	21	1863	6	0.5
S	62	62.1	928	224	0.25	0.088	3.063	0.038	0.11483	0.00035	3.065	0.038	0.11406	0.00046	1820	20	1865	7	2.4
S	36	36.1	184	66	0.37	0.102	2.882	0.041	0.11512	0.00075	2.885	0.041	0.11423	0.00078	1919	24	1868	12	-2.7
S	47	47.1	286	91	0.33	0.156	2.968	0.041	0.11579	0.00061	2.972	0.041	0.11443	0.00076	1869	23	1871	12	0.1
S	31	31.1	194	112	0.60	0.145	2.952	0.042	0.11580	0.00074	2.957	0.042	0.11453	0.00080	1878	23	1873	13	-0.3
S	53	53.1	126	80	0.66	0.207	2.952	0.044	0.11635	0.00093	2.958	0.044	0.11454	0.00116	1878	24	1873	18	-0.3
S	8	8.1	177	99	0.58	0.042	2.940	0.042	0.11492	0.00079	2.941	0.042	0.11455	0.00084	1887	24	1873	13	-0.7
S	11	11.1	280	128	0.47	0.189	3.109	0.043	0.11622	0.00064	3.115	0.043	0.11457	0.00080	1795	22	1873	13	4.2
S	35	35.1	492	100	0.21	0.034	2.884	0.038	0.11490	0.00045	2.885	0.038	0.11460	0.00046	1919	22	1874	7	-2.4
S	45	45.1	234	77	0.34	0.181	2.989	0.042	0.11628	0.00069	2.995	0.042	0.11469	0.00082	1857	23	1875	13	0.9
S	33	33.1	175	67	0.40	0.211	2.983	0.043	0.11656	0.00077	2.990	0.043	0.11472	0.00112	1860	23	1875	18	0.8
S	49	49.1	211	131	0.64	0.061	2.985	0.042	0.11527	0.00075	2.986	0.042	0.11474	0.00079	1862	23	1876	12	0.7
S	63	63.1	304	139	0.47	0.023	3.010	0.039	0.11509	0.00064	3.011	0.039	0.11489	0.00065	1849	21	1878	10	1.6
S	34	34.1	328	68	0.21	0.058	2.930	0.040	0.11543	0.00056	2.932	0.040	0.11492	0.00067	1892	23	1879	10	-0.7
S	38	38.1	416	64	0.16	0.043	2.938	0.039	0.11530	0.00051	2.940	0.040	0.11492	0.00057	1888	22	1879	9	-0.5
S	4	4.1	230	224	1.00	0.151	3.039	0.043	0.11632	0.00061	3.044	0.043	0.11500	0.00084	1831	23	1880	13	2.6
S	3	3.1	287	93	0.34	0.115	2.933	0.041	0.11612	0.00055	2.936	0.041	0.11511	0.00082	1889	23	1882	13	-0.4
S	39	39.1	398	508	1.32	0.055	2.989	0.040	0.11564	0.00054	2.990	0.040	0.11516	0.00062	1860	22	1882	10	1.2
S	15	15.1	175	81	0.48	0.068	2.971	0.043	0.11578	0.00080	2.973	0.043	0.11518	0.00083	1869	24	1883	13	0.7
S	32	32.1	167	115	0.71	0.087	2.947	0.042	0.11605	0.00080	2.950	0.042	0.11528	0.00086	1882	24	1884	13	0.1
S	27	27.1	226	127	0.58	0.128	2.909	0.040	0.11641	0.00070	2.913	0.041	0.11529	0.00074	1903	23	1884	12	-1.0
S	54	54.1	181	87	0.49	0.249	2.940	0.042	0.11748	0.00081	2.947	0.042	0.11531	0.00111	1883	24	1885	17	0.1
S	25	25.1	132	57	0.45	0.174	2.898	0.043	0.11693	0.00090	2.903	0.043	0.11541	0.00107	1908	25	1886	17	-1.2
S	60	60.1	857	92	0.11	0.033	2.971	0.036	0.11577	0.00038	2.972	0.036	0.11549	0.00042	1870	20	1888	7	0.9
S	21	21.1	338	226	0.69	0.052	2.972	0.040	0.11598	0.00061	2.973	0.040	0.11552	0.00064	1869	22	1888	10	1.0
S	48	48.1	345	55	0.16	0.129	2.938	0.040	0.11667	0.00056	2.942	0.040	0.11554	0.00065	1886	22	1888	10	0.1
S	37	37.1	208	56	0.28	0.031	2.950	0.041	0.11582	0.00070	2.951	0.041	0.11555	0.00074	1881	23	1889	11	0.4
S	20	20.1	392	103	0.27	0.044	2.962	0.040	0.11597	0.00053	2.963	0.040	0.11559	0.00082	1875	22	1889	13	0.8
S	23	23.1	165	58	0.36	-0.012	2.891	0.042	0.11551	0.00082	2.890	0.041	0.11562	0.00082	1915	24	1889	13	-1.4

Table 1. (continued)

Group ID	Spot no.	Grain. spot	^{238}U (ppm)	^{232}Th (ppm)	^{232}Th/^{238}U	f204 (%)	$^{238}U/^{206}Pb$	±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. (%)
S	29	29.1	483	171	0.37	0.000	2.978	0.040	0.11575	0.00052	2.978	0.040	0.11575	0.00052	1866	22	1892	8	1.3
S	2	2.1	259	126	0.50	-0.003	2.957	0.042	0.11581	0.00057	2.957	0.042	0.11584	0.00084	1878	23	1893	13	0.8
S	65	65.1	173	72	0.43	0.321	3.077	0.042	0.11865	0.00082	3.087	0.042	0.11584	0.00126	1809	22	1893	20	4.4
S	44	44.1	471	494	1.08	0.081	2.970	0.040	0.11668	0.00049	2.973	0.040	0.11597	0.00057	1869	22	1895	9	1.4
S	18	18.1	236	47	0.21	0.041	2.881	0.040	0.11653	0.00067	2.882	0.040	0.11617	0.00068	1920	23	1898	11	-1.2
S	5	5.1	230	79	0.35	0.081	2.975	0.042	0.11704	0.00060	2.977	0.042	0.11633	0.00079	1867	23	1901	12	1.8
S	16	16.1	185	71	0.40	0.142	2.295	0.033	0.15030	0.00079	2.298	0.033	0.14904	0.00088	2329	28	2335	10	0.3
S	13	13.1	342	252	0.76	-0.073	2.103	0.036	0.16318	0.00057	2.102	0.036	0.16382	0.00064	2509	36	2495	7	-0.5
S	9	9.1	94	79	0.87	0.198	2.072	0.032	0.16729	0.00111	2.076	0.032	0.16553	0.00119	2534	33	2513	12	-0.9
S	41	41.1	108	36	0.34	0.198	2.020	0.031	0.17638	0.00112	2.024	0.031	0.17461	0.00128	2588	33	2602	12	0.5
S	19	19.1	229	108	0.49	0.032	1.858	0.029	0.18754	0.00074	1.859	0.029	0.18725	0.00079	2775	35	2718	7	-2.1
D	46	46.1	247	53	0.22	0.510	3.472	0.048	0.11573	0.00072	3.490	0.048	0.11127	0.00108	1624	20	1820	18	10.8
D	40	40.1	188	49	0.27	0.704	3.435	0.054	0.12002	0.00091	3.459	0.054	0.11387	0.00164	1637	23	1862	26	12.1
D	61	61.1	448	146	0.34	0.102	3.232	0.040	0.11518	0.00052	3.235	0.040	0.11428	0.00059	1736	19	1869	9	7.1
D	51	51.1	176	125	0.73	0.397	3.322	0.047	0.11864	0.00085	3.335	0.048	0.11517	0.00143	1691	22	1883	22	10.2
D	7	7.1	288	121	0.43	0.212	3.329	0.046	0.11715	0.00064	3.336	0.046	0.11529	0.00079	1690	21	1884	12	10.3
D	42	42.1	578	53	0.10	0.102	3.309	0.044	0.11650	0.00049	3.312	0.044	0.11561	0.00061	1701	20	1889	9	10.0
D	28	28.1	93	34	0.38	0.077	3.120	0.048	0.11707	0.00108	3.122	0.048	0.11639	0.00110	1791	24	1902	17	5.8
D	14	14.1	290	61	0.22	0.053	3.207	0.044	0.11793	0.00063	3.209	0.044	0.11747	0.00102	1749	21	1918	16	8.8
D	59	59.1	382	203	0.55	0.310	2.930	0.037	0.12490	0.00060	2.939	0.037	0.12218	0.00079	1888	21	1988	12	5.0
D	52	52.1	734	82	0.12	0.159	2.837	0.038	0.14249	0.00045	2.842	0.038	0.14108	0.00053	1944	23	2241	6	13.2
D	58	58.1	223	158	0.73	0.135	2.506	0.033	0.14569	0.00076	2.510	0.033	0.14450	0.00100	2162	25	2282	12	5.3
D	50	50.1	132	68	0.53	0.796	3.394	0.050	0.16061	0.00113	3.421	0.050	0.15353	0.00186	1653	22	2386	21	30.7
D	43	43.1	358	73	0.21	0.076	1.908	0.026	0.17284	0.00163	1.910	0.026	0.17216	0.00165	2715	31	2579	16	-5.3

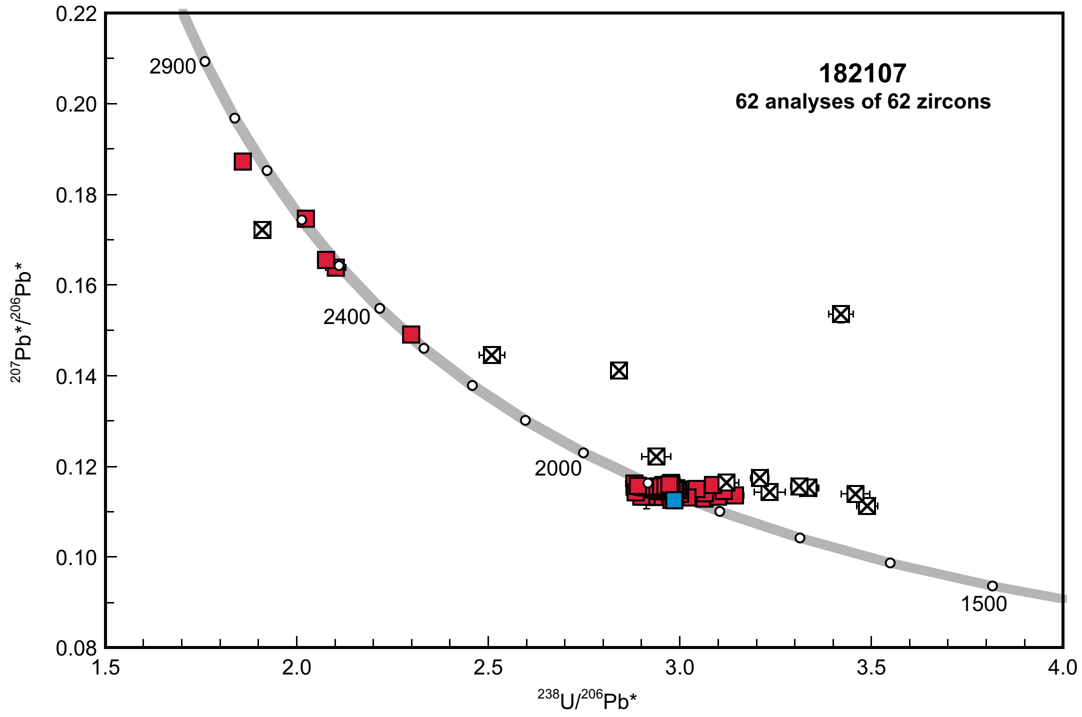

Figure 2. **U–Pb analytical data for sample 182107: quartz sandstone, Inglis Gap. Blue square indicates Group Y (youngest detrital zircon); red squares indicate Group S (older detrital zircons); crossed squares indicate Group D (discordance >5%).**

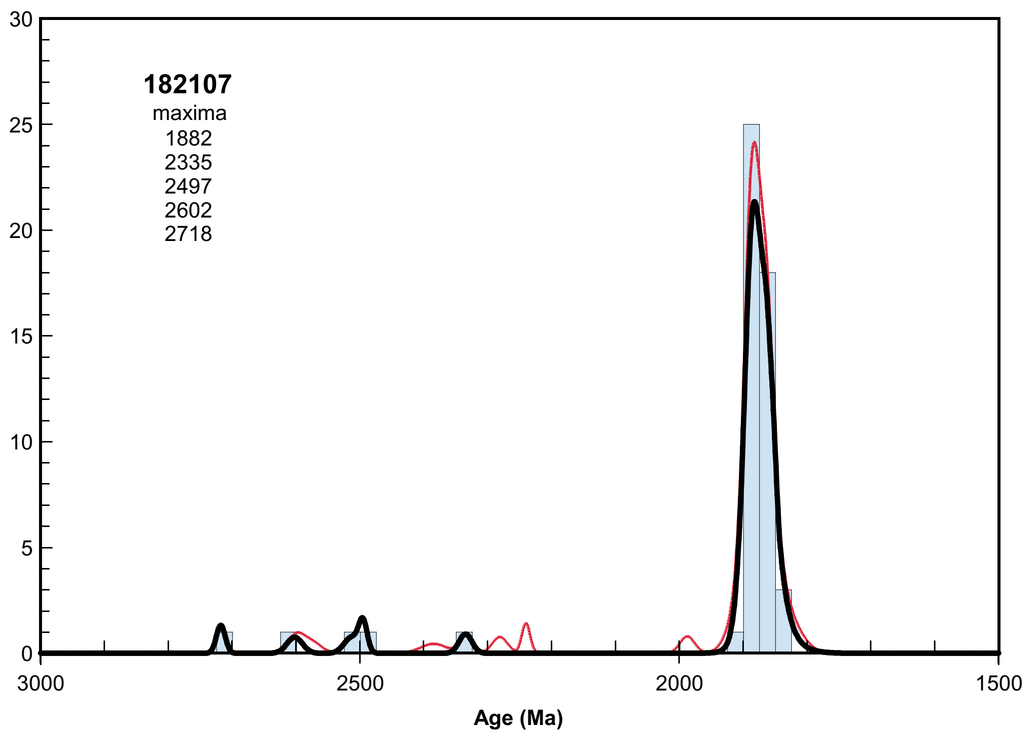

Figure 3. **Probability density diagram and histogram for sample 182107: quartz sandstone, Inglis Gap. Thick curve, maxima values, and frequency histogram (bin width 25 Ma) include only concordant data (52 analyses of 52 zircons). Thin curve includes all data (65 analyses of 65 zircons).**