143800: sandstone, Dinner Hill

(Ellis Sandstone, Amadeus Basin, Centralian Superbasin)

Location and sampling

Rawlinson (SG 52-2), Wallace (4549)
MGA Zone 52, 424306E 7322366N

Sampled on 26 September 2009

This sample was collected from a low outcrop of sandstone (Fig. 1) about 31.4 km west of the Sandy Blight Junction Track, 13 km northwest of the Ellis Range, and 9.5 km southeast of Dinner Hill.

Tectonic unit/relations

The unit sampled is sandstone-dominated sequence up to 1000 m thick (typically c. 500 m) assigned to the Ellis Sandstone (Wells et al., 1964; Haines et al., 2012). Cross-bedding and ripple marks indicate deposition in a shallow-water environment, probably fluvial to deltaic, with sediment derivation from the south and southwest. The Ellis Sandstone overlies the Carnegie Formation with uncertain contact relationships, and is inferred to interfinger with the Sir Frederick Conglomerate. Regional relationships indicate that it was deposited synchronously with the c. 580–530 Ma Petermann Orogeny (Haines et al., 2012). The time of deposition is thus constrained between late Ediacaran and early Cambrian. At this locality, the rock is a medium-grained, thick- to medium-bedded, blocky, silicified sandstone, with medium to large trough cross-beds, common current lineations, sparse poorly sorted coarse beds, rare fine-grained ferruginous beds, and rare rounded pebbles and cobbles of quartzite. A sample from the overlying Maurice Formation was collected 1.2 km to the north-northeast (GSWA 143799, Wingate et al., 2013) and yielded a maximum depositional age of 831 ± 13 Ma (1σ).

Petrographic description

The sample is a fine- to coarse-grained lithic quartz sandstone, consisting of 75–80% single-crystal quartz grains, 20–25% lithic grains, and 2–3% pore space. The grains vary from 0.1 to 0.7 mm in diameter, indicating fine to coarse sand, and are subrounded to angular. Many single-crystal quartz grains are clouded and may partly represent altered felsic volcanics, although others appear to possess deformation lamellae. Optically continuous overgrowths are rare. Lithic grains are mostly quartz-rich to sericite-rich or kaolinized and may represent chert, siltstone, and very fine grained sandstone, with minor leucoxene and possible hematite in some grains. Pore spaces are mostly less than 0.5 mm in diameter.

Zircon morphology

Zircons isolated from this sample are colourless to dark brown, anhedral to euhedral, and strongly rounded. The crystals are up to 200 μm long, and equant to slightly elongate, with aspect ratios up to 3:1. Some crystals have pitted outer surfaces and, in cathodoluminescence (CL) images, many 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 18–19 April and 19–20 April 2011, using SHRIMP-B. Analyses 1.1 to 35.1 (spot numbers 1–35) were obtained during the first session, together with nine analyses of the BR266 standard, which indicated an external spot-to-spot (reproducibility) uncertainty of 0.51% (1σ) and a $^{238}U/^{206}Pb^*$ calibration uncertainty of 0.22% (1σ). Analyses 36.1 to 84.1 (spot numbers 36–84) were obtained during the second session, together with 10 analyses of the BR266 standard, which indicated an external spot-to-spot (reproducibility) uncertainty of 0.58% (1σ) and a $^{238}U/^{206}Pb^*$ calibration uncertainty of 0.24% (1σ). Calibration uncertainties are included in the errors of $^{238}U/^{206}Pb^*$ ratios and dates listed in Table 1. Isotopic mass fractionation of $^{207}Pb/^{206}Pb$ ratios during the two sessions was corrected by reference to the OGC1 standard; measured ratios were increased by 0.61%. Common-Pb corrections were applied to all analyses using contemporaneous isotopic compositions determined according to the model of Stacey and Kramers (1975). Dates from analyses for which 204-corrected $^{238}U/^{206}Pb^*$ ratios indicate ages <1300 Ma are based on 207-corrected $^{238}U/^{206}Pb^*$ ratios; those >1300 Ma are based on 204-corrected $^{207}Pb^*/^{206}Pb^*$ ratios.

Results

Eighty-four analyses were obtained from 84 zircons. Results are listed in Table 1, and shown in a concordia diagram (Fig. 3), and a probability density diagram (Fig. 4).

Figure 1. Outcrop photograph for sample 143800: sandstone, Dinner Hill.

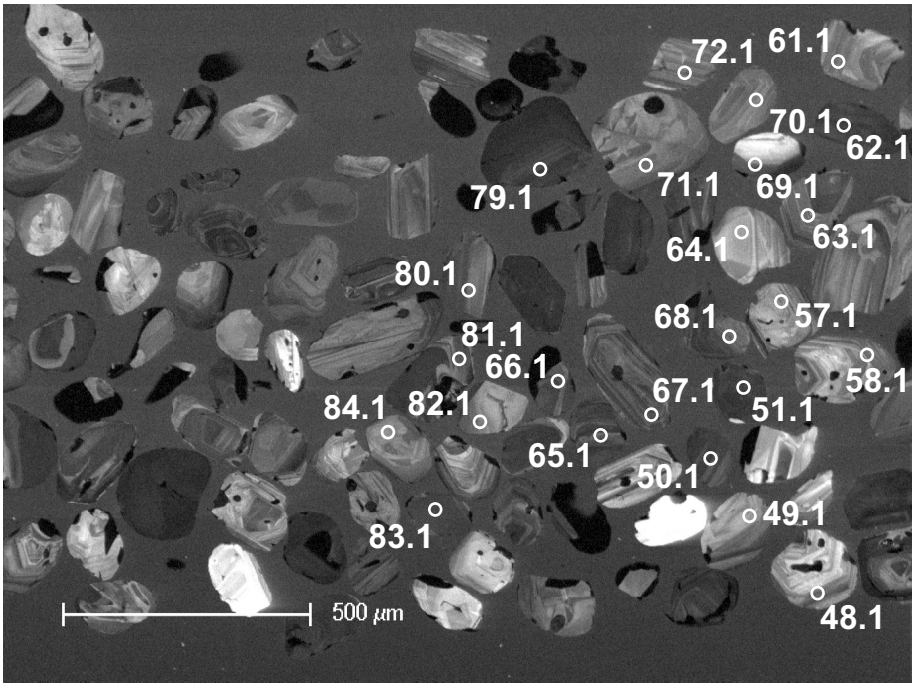

Figure 2. Cathodoluminescence image of representative zircons from sample 143800: sandstone, Dinner Hill. Numbered circles indicate the approximate locations of analysis sites.

Table 1. Ion microprobe analytical results for zircons from sample 143800: sandstone, Dinner Hill

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. (%)
Y	44	44.1	136	135	1.02	0.513	6.162	0.071	0.07373	0.00176	6.194	0.072	0.06944	0.00215	965	10	912	64	-5.8
S	74	74.1	44	31	0.72	2.488	5.699	0.099	0.07655	0.00212	5.845	0.106	0.05627	0.00500	1018	17	463	197	-119.9
S	61	61.1	111	65	0.60	0.140	5.650	0.069	0.07615	0.00179	5.658	0.069	0.07497	0.00191	1049	12	1068	51	1.8
S	33	33.1	101	64	0.66	0.712	5.636	0.069	0.07669	0.00195	5.676	0.070	0.07072	0.00249	1046	12	949	72	-10.2
S	81	81.1	173	105	0.63	0.238	5.652	0.059	0.07417	0.00169	5.665	0.060	0.07218	0.00183	1048	10	991	52	-5.8
S	78	78.1	116	69	0.61	0.090	5.634	0.068	0.07587	0.00178	5.639	0.068	0.07511	0.00186	1052	12	1071	50	1.8
S	19	19.1	34	33	0.98	1.261	5.594	0.099	0.08117	0.00235	5.666	0.103	0.07060	0.00411	1048	18	946	119	-10.8
S	63	63.1	122	76	0.64	0.299	5.613	0.066	0.07652	0.00177	5.629	0.067	0.07400	0.00201	1054	12	1042	55	-1.2
S	56	56.1	111	64	0.60	0.741	5.607	0.091	0.07642	0.00180	5.649	0.092	0.07021	0.00242	1051	16	934	71	-12.5
S	53	53.1	117	66	0.58	0.510	5.607	0.068	0.07456	0.00178	5.636	0.069	0.07029	0.00220	1053	12	937	64	-12.4
S	48	48.1	105	72	0.71	0.354	5.568	0.068	0.07471	0.00178	5.588	0.069	0.07173	0.00209	1061	12	978	59	-8.5
S	32	32.1	40	24	0.62	1.537	5.450	0.096	0.07416	0.00223	5.535	0.100	0.06149	0.00418	1071	18	657	146	-63.0
S	37	37.1	307	171	0.58	0.272	5.292	0.048	0.07699	0.00161	5.306	0.048	0.07469	0.00169	1113	9	1060	46	-5.0
S	8	8.1	167	100	0.62	0.841	5.244	0.061	0.07502	0.00188	5.288	0.062	0.06801	0.00237	1116	12	869	72	-28.4
S	59	59.1	57	53	0.96	0.895	5.174	0.083	0.07866	0.00202	5.221	0.085	0.07116	0.00313	1130	17	962	90	-17.5
S	29	29.1	244	187	0.79	0.351	5.149	0.046	0.07777	0.00179	5.167	0.046	0.07480	0.00191	1140	9	1063	51	-7.2
S	12	12.1	85	73	0.89	0.440	5.111	0.068	0.08185	0.00201	5.133	0.069	0.07812	0.00241	1147	14	1150	61	0.3
S	38	38.1	292	239	0.84	0.267	5.117	0.052	0.07769	0.00161	5.131	0.052	0.07543	0.00170	1148	11	1080	45	-6.3
S	75	75.1	126	132	1.09	0.395	5.092	0.060	0.08072	0.00175	5.112	0.060	0.07737	0.00202	1152	13	1131	52	-1.9
S	21	21.1	107	116	1.11	0.458	5.078	0.058	0.08068	0.00190	5.101	0.058	0.07680	0.00219	1154	12	1116	57	-3.4
S	43	43.1	76	64	0.87	0.461	5.047	0.071	0.08460	0.00190	5.070	0.072	0.08068	0.00235	1160	15	1214	57	4.4
S	68	68.1	135	109	0.83	0.266	5.038	0.058	0.08107	0.00173	5.051	0.058	0.07881	0.00191	1164	12	1167	48	0.3
S	30	30.1	105	125	1.24	0.435	5.031	0.060	0.08192	0.00193	5.053	0.060	0.07823	0.00223	1164	13	1153	57	-1.0
S	62	62.1	349	164	0.49	0.185	5.032	0.044	0.07982	0.00296	5.041	0.044	0.07825	0.00299	1167	9	1153	76	-1.2
S	79	79.1	287	265	0.95	0.212	5.022	0.046	0.07979	0.00162	5.032	0.046	0.07799	0.00169	1168	10	1147	43	-1.8
S	82	82.1	83	116	1.45	0.467	5.020	0.067	0.08005	0.00184	5.043	0.068	0.07610	0.00226	1166	15	1098	59	-6.2
S	76	76.1	49	45	0.95	1.276	4.979	0.083	0.08257	0.00206	5.043	0.086	0.07186	0.00355	1166	18	982	101	-18.7
S	60	60.1	352	279	0.82	0.258	4.983	0.044	0.08071	0.00286	4.996	0.044	0.07852	0.00291	1176	10	1160	74	-1.4
S	36	36.1	178	130	0.75	0.565	4.984	0.052	0.07967	0.00167	5.013	0.052	0.07490	0.00195	1173	11	1066	52	-10.0
S	45	45.1	37	58	1.61	3.312	4.952	0.094	0.08499	0.00225	5.122	0.103	0.05789	0.00597	1150	22	526	226	-118.6
S	15	15.1	131	119	0.94	0.804	4.962	0.066	0.08213	0.00190	5.002	0.067	0.07534	0.00235	1175	15	1078	63	-9.0
S	13	32.1	128	92	0.75	0.552	4.953	0.056	0.08133	0.00190	4.980	0.057	0.07666	0.00223	1180	12	1112	58	-6.1
S	23	23.1	55	101	1.90	1.558	4.931	0.073	0.08300	0.00208	5.009	0.076	0.06995	0.00345	1173	16	927	101	-26.5
S	3	3.1	150	167	1.16	0.813	4.949	0.054	0.07971	0.00188	4.990	0.055	0.07287	0.00233	1177	12	1010	65	-16.5
S	6	6.1	160	114	0.73	0.473	4.941	0.053	0.08034	0.00187	4.964	0.053	0.07634	0.00212	1183	12	1104	56	-7.2
S	65	65.1	272	221	0.84	0.286	4.933	0.046	0.08150	0.00163	4.948	0.047	0.07907	0.00173	1187	10	1174	43	-1.1
S	66	66.1	218	132	0.63	0.211	4.940	0.049	0.07971	0.00166	4.951	0.050	0.07792	0.00175	1186	11	1145	45	-3.6
S	70	70.1	76	78	1.07	1.088	4.929	0.070	0.08158	0.00189	4.983	0.072	0.07244	0.00288	1179	16	998	81	-18.1
S	2	2.1	111	88	0.82	0.830	4.936	0.060	0.08019	0.00193	4.978	0.061	0.07320	0.00249	1180	13	1020	69	-15.7
S	83	83.1	183	581	3.28	0.074	4.915	0.051	0.08089	0.00168	4.919	0.051	0.08026	0.00172	1193	11	1203	42	0.8

Table 1. continued

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. (%)
S	26	26.1	190	150	0.81	0.042	4.915	0.047	0.08064	0.00182	4.917	0.047	0.08029	0.00184	1193	10	1204	45	0.9
S	52	52.1	83	76	0.94	0.714	4.913	0.068	0.08072	0.00204	4.948	0.069	0.07469	0.00264	1187	15	1060	71	-12.0
S	80	80.1	103	74	0.74	0.297	4.911	0.062	0.08065	0.00178	4.926	0.062	0.07814	0.00202	1191	14	1150	51	-3.6
S	46	46.1	290	183	0.65	0.359	4.884	0.045	0.08081	0.00162	4.901	0.045	0.07777	0.00174	1197	10	1141	44	-4.9
S	7	7.1	151	81	0.55	0.589	4.879	0.053	0.08162	0.00188	4.908	0.054	0.07664	0.00220	1195	12	1112	57	-7.5
S	54	54.1	254	180	0.73	0.329	4.882	0.195	0.07920	0.00163	4.898	0.195	0.07642	0.00175	1198	45	1106	46	-8.3
S	22	22.1	95	72	0.78	0.844	4.867	0.058	0.08163	0.00193	4.908	0.059	0.07451	0.00248	1195	13	1055	67	-13.3
S	24	24.1	138	89	0.67	0.582	4.858	0.051	0.08194	0.00186	4.887	0.052	0.07701	0.00215	1200	12	1121	56	-7.0
S	69	69.1	44	46	1.09	1.189	4.864	0.085	0.08006	0.00869	4.922	0.087	0.07010	0.00926	1192	20	931	271	-28.0
S	49	49.1	53	59	1.13	2.065	4.836	0.079	0.08420	0.00203	4.938	0.084	0.06701	0.00411	1189	19	838	128	-41.9
S	58	58.1	201	138	0.71	0.389	4.846	0.050	0.08094	0.00167	4.865	0.050	0.07765	0.00185	1205	11	1138	47	-5.9
S	42	42.1	127	102	0.83	0.327	4.853	0.056	0.07959	0.00173	4.869	0.057	0.07681	0.00194	1204	13	1116	50	-7.9
S	67	67.1	210	149	0.73	0.325	4.843	0.049	0.08082	0.00166	4.859	0.049	0.07807	0.00181	1206	11	1149	46	-5.0
S	34	34.1	225	159	0.73	0.212	4.849	0.051	0.07928	0.00187	4.859	0.051	0.07749	0.00195	1206	12	1134	50	-6.3
S	18	18.1	141	125	0.92	0.408	4.835	0.049	0.08108	0.00185	4.855	0.049	0.07763	0.00204	1207	11	1137	52	-6.2
S	39	39.1	172	118	0.71	0.327	4.821	0.051	0.08146	0.00168	4.837	0.051	0.07869	0.00185	1211	12	1164	47	-4.0
S	20	20.1	81	61	0.78	0.182	4.804	0.060	0.08132	0.00196	4.812	0.060	0.07977	0.00211	1217	14	1191	52	-2.2
S	77	77.1	79	58	0.75	0.702	4.800	0.068	0.07984	0.00207	4.834	0.069	0.07393	0.00269	1212	16	1039	73	-16.7
S	72	72.1	125	140	1.15	0.633	4.771	0.073	0.08038	0.00175	4.801	0.074	0.07504	0.00218	1220	17	1069	58	-14.1
S	73	73.1	117	70	0.62	0.604	4.690	0.074	0.08064	0.00176	4.719	0.074	0.07554	0.00217	1239	18	1083	58	-14.4
S	35	35.1	367	43	0.12	0.149	4.609	0.046	0.08184	0.00176	4.616	0.046	0.08058	0.00179	1264	12	1211	44	-4.4
S	57	57.1	239	424	1.83	0.331	4.351	0.212	0.08662	0.00164	4.365	0.213	0.08379	0.00177	1330	61	1288	41	-3.3
S	50	50.1	222	92	0.43	0.246	4.439	0.044	0.08593	0.00165	4.450	0.044	0.08383	0.00175	1307	12	1289	41	-1.4
S	27	27.1	99	40	0.42	0.561	4.508	0.053	0.08488	0.00192	4.533	0.054	0.08011	0.00226	1285	14	1200	56	-7.1
S	47	47.1	148	188	1.31	0.369	4.340	0.049	0.08710	0.00172	4.356	0.050	0.08395	0.00193	1332	14	1291	45	-3.2
S	4	4.1	68	68	1.03	0.735	4.481	0.066	0.08772	0.00208	4.514	0.067	0.08145	0.00276	1290	18	1232	66	-4.7
S	51	51.1	225	307	1.41	0.316	4.202	0.041	0.08836	0.00164	4.215	0.041	0.08566	0.00176	1372	12	1330	40	-3.2
S	1	1.1	140	71	0.52	0.250	4.064	0.045	0.09143	0.00187	4.074	0.045	0.08928	0.00199	1415	14	1410	43	-0.4
S	28	28.1	195	144	0.76	0.107	3.904	0.037	0.09493	0.00181	3.908	0.037	0.09401	0.00185	1469	13	1508	37	2.6
S	25	25.1	131	98	0.77	0.190	3.658	0.039	0.09654	0.00186	3.665	0.039	0.09490	0.00194	1555	15	1526	38	-1.9
S	84	84.1	73	39	0.55	0.203	3.490	0.050	0.09975	0.00186	3.497	0.050	0.09799	0.00202	1621	21	1586	38	-2.2
S	16	16.1	179	75	0.43	0.219	3.538	0.032	0.10090	0.00180	3.546	0.033	0.09900	0.00186	1601	13	1605	35	0.2
S	55	55.1	141	180	1.32	0.255	3.389	0.039	0.10165	0.00171	3.397	0.039	0.09943	0.00183	1663	17	1613	34	-3.1
S	40	40.1	188	86	0.47	0.212	3.161	0.041	0.10580	0.00324	3.167	0.041	0.10395	0.00328	1769	20	1696	58	-4.3
S	31	31.1	101	179	1.84	0.281	3.328	0.040	0.10726	0.00192	3.337	0.040	0.10480	0.00206	1690	18	1711	36	1.2
S	71	71.1	88	52	0.61	0.160	3.158	0.042	0.10726	0.00182	3.163	0.042	0.10586	0.00193	1771	21	1729	33	-2.4
S	5	5.1	277	144	0.54	0.133	2.934	0.026	0.11742	0.00183	2.938	0.026	0.11626	0.00185	1888	15	1899	29	0.6
D	64	64.1	47	31	0.69	0.663	3.779	0.065	0.09312	0.00205	3.805	0.066	0.08744	0.00280	1504	24	1370	62	-9.8
D	11	11.1	43	24	0.57	1.255	3.407	0.061	0.10264	0.00222	3.450	0.063	0.09182	0.00340	1641	27	1464	70	-12.1
D	41	41.1	36	53	1.51	1.271	3.154	0.060	0.10628	0.00214	3.195	0.062	0.09528	0.00345	1755	30	1534	68	-14.4
D	9	9.1	38	76	2.05	1.306	3.047	0.057	0.11248	0.00230	3.088	0.059	0.10111	0.00356	1809	31	1645	65	-10.0
D	10	10.1	56	51	0.93	0.739	3.074	0.048	0.11032	0.00209	3.097	0.049	0.10387	0.00265	1804	25	1694	47	-6.5
D	17	17.1	50	39	0.80	0.512	2.993	0.044	0.10950	0.00204	3.009	0.045	0.10503	0.00239	1850	24	1715	42	-7.9
D	14	14.1	67	87	1.34	0.504	1.872	0.028	0.18071	0.00573	1.881	0.028	0.17619	0.00583	2748	34	2617	55	-5.0

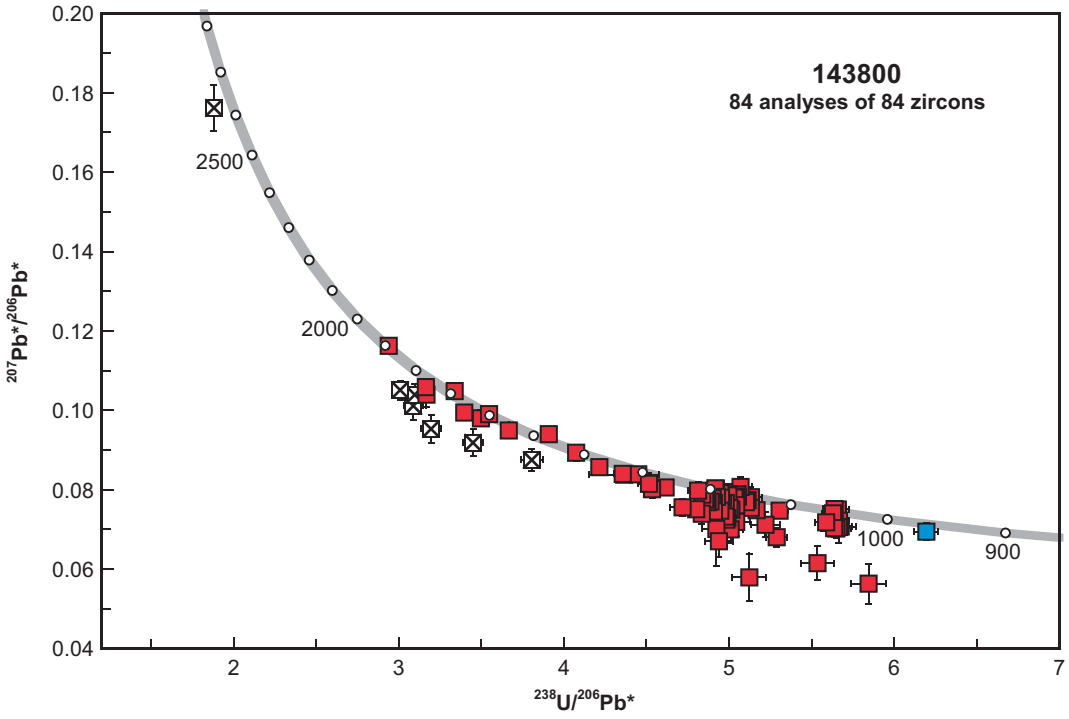

Figure 3. **U–Pb analytical data for zircons from sample 143800: sandstone, Dinner Hill. Data are corrected for common Pb using measured $^{204}Pb/^{206}Pb$. Blue square indicates Group Y (youngest detrital zircon); red squares indicate Group S (older detrital zircons); crossed squares indicate Group D (U/Pb date >1300 Ma and discordance >5%).**

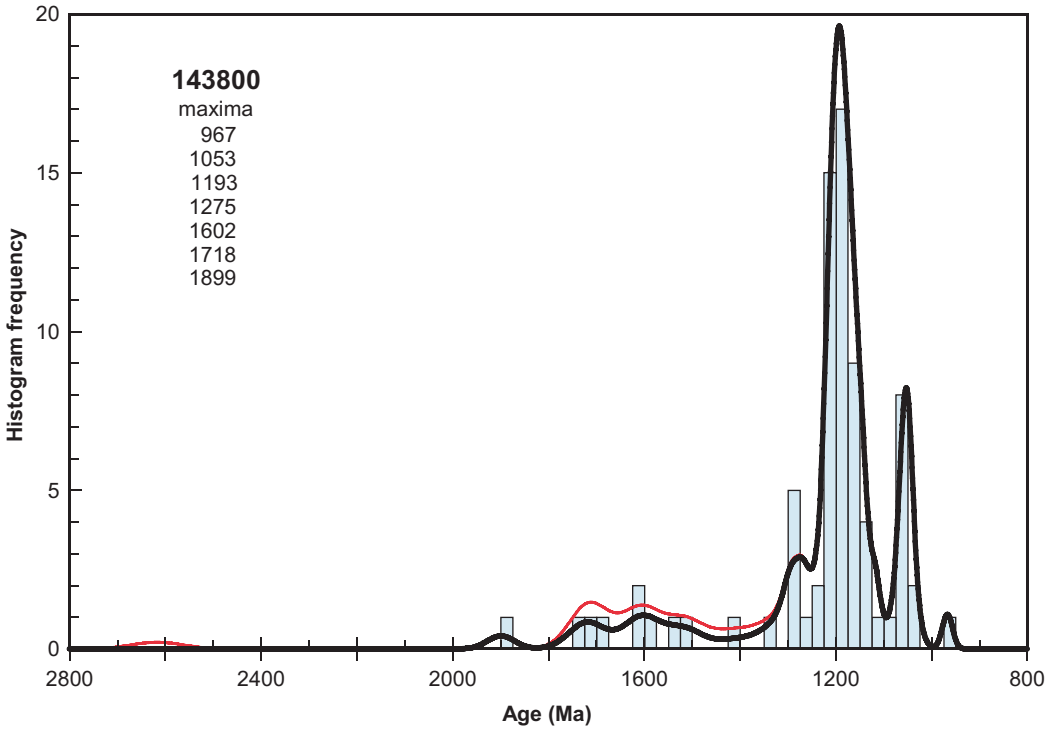

Figure 4. **Probability density diagram and histogram for sample 143800: sandstone, Dinner Hill. Dates <1300 Ma are based on 207-corrected $^{238}U/^{206}Pb^*$ ratios. Thick curve, maxima values, and frequency histogram (bin width 25 Ma) include only accepted data (77 analyses of 77 zircons). Thin curve includes all data (84 analyses of 84 zircons).**

Interpretation

Most analyses are concordant to slightly discordant (Fig. 3). Seven analyses >1300 Ma are >5% discordant. The dates obtained from these seven analyses (Group D; Table 1) are unreliable, and are considered not to be geologically significant. The remaining 77 analyses can be divided into two groups, based on their $^{207}Pb^*/^{206}Pb^*$ and $^{238}U/^{206}Pb^*$ ratios.

Group Y comprises one analysis (Table 1), which yields a 207-corrected $^{238}U/^{206}Pb^*$ date of 967 ± 11 Ma (1σ).

Group S comprises 75 analyses (Table 1), which yield $^{207}Pb^*/^{206}Pb^*$ or $^{238}U/^{206}Pb^*$ dates of 1899–1039 Ma.

It is possible that all of the analyses are of unmodified detrital zircons, in which case the date of 967 ± 11 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-corrected $^{238}U/^{206}Pb^*$ date of 1055 ± 8 Ma (MSWD = 0.53) for the youngest 11 analyses in Group S.

The data for Group S indicate significant age components at c. 1602, 1275, 1193, and 1053 Ma. 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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