

135965: phyllitic metasandstone, Acacia 2

(Basement to Canning Basin succession)

Location and sampling

CROSSLAND (SE 51-16), BARBWIRE RANGE (3959)
MGA Zone 51, 709776E 7861635N

Sampled on 24 May 2005

The sample was obtained from core 5 of petroleum well Acacia 2 (Watson and Derrington, 1982), from depth interval 1570.9–1571.5 m.

Tectonic unit/relations

This sandstone forms basement to the Canning Basin succession. As such, it is pre-Ordovician and probably Proterozoic in age (Watson and Derrington, 1982).

Petrographic description

The unit sampled is a finely laminated quartz-sericite phyllite. It contains 20–35% sericite in different layers and abundant quartz to 0.15 mm in diameter, suggesting that the protolith was a siltstone or very fine-grained sandstone. Some sericite-rich lamellae also contain carbonaceous matter and have a crenulation cleavage at 20–60° to the main schistosity. Rare chlorite occurs in quartz-rich lenses, commonly enclosing flakes of possibly detrital muscovite, and is aligned at a high angle to the schistosity. Very minor carbonate and leucoxene are disseminated as well as accessory tourmaline and zircon up to 70 µm long. The sample was metamorphosed under greenschist facies conditions.

Zircon morphology

Zircons from this sample are anhedral to euhedral, variably rounded to subspherical, and most are clear and colourless. Grains are up to 200 µm long, with aspect ratios up to 6:1. Some have pitted outer surfaces and growth zoning truncated at (abraded) grain boundaries, consistent with sedimentary transport. A cathodoluminescence image of representative zircons is shown in Figure 1.

Analytical details

This sample was analysed over two sessions on 17–18 January 2008 and 7–8 February 2008, using

SHRIMP-A. Analyses 1.1 to 33.1 (spot numbers 1–33) were obtained during the first session, together with 15 analyses of the Temora standard which indicated an external spot-to-spot (reproducibility) uncertainty of 1.84% (1σ), and a $^{238}\text{U}/^{206}\text{Pb}^*$ calibration uncertainty of 0.54% (1σ). Analyses 34.1 to 69.1 (spot numbers 34–69) were obtained during the second session, together with 14 analyses of the Temora standard that indicated an external spot-to-spot (reproducibility) uncertainty of 0.88% (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 model of Stacey and Kramers (1975).

Results

Sixty-nine analyses were obtained from 69 zircons. Results are listed in Table 1 and shown on a concordia diagram (Fig. 2) and a probability density plot (Fig. 3).

Interpretation

Most analyses are concordant to slightly discordant (Fig. 2). Eleven analyses are characterized by slight to moderate discordance (>5%). The dates obtained from these 11 analyses (Group D; Table 1) are imprecise or unreliable, and are not considered geologically significant. The remaining 58 analyses can be divided into two groups, based on their $^{207}\text{Pb}^*/^{206}\text{Pb}^*$ and $^{238}\text{U}/^{206}\text{Pb}^*$ ratios.

Group Y comprises a single analysis (17.1; Table 1), which yields a $^{207}\text{Pb}^*/^{206}\text{Pb}^*$ date of 961 ± 29 Ma (1σ).

Group S comprises 57 analyses of 57 zircons (Table 1) which yield $^{207}\text{Pb}^*/^{206}\text{Pb}^*$ and $^{238}\text{U}/^{206}\text{Pb}^*$ dates of 3380–1030 Ma.

It is possible that all of the analyses are of unmodified detrital zircons, in which case the $^{238}\text{U}/^{206}\text{Pb}^*$ date of 961 ± 29 Ma (1σ) for analysis 17.1 represents a maximum depositional age for the sandstone protolith. A more conservative estimate of the maximum depositional age can be based on the weighted mean $^{207}\text{Pb}^*/^{206}\text{Pb}^*$ date of 1074 ± 12 Ma (MSWD = 0.79) for the seven youngest analyses in Group S.

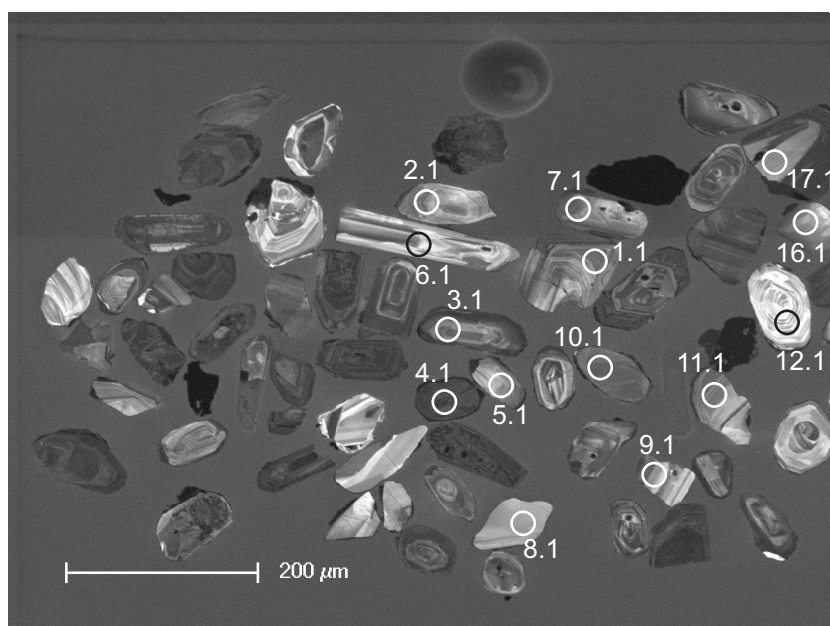


Figure 1. Cathodoluminescence image of representative zircons from sample 135965: phyllitic metasandstone, Acacia 2. Numbered circles indicate approximate positions of analysis sites.

The 58 analyses in combined Groups Y and S indicate dates that define significant age components at c. 1079, 1223, 1343, 1414, 1579, and 1610–1790 Ma, and several minor components spanning the range 3380–961 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 which have been reworked.

References

- Watson, S and Derrington, S 1982, Acacia No. 2 well completion report, Canning Basin: Geological Survey of Western Australia, Statutory petroleum exploration report, S2161 A2 (unpublished).
- 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

Wingate, MTD and Haines, PW 2009, 135965: phyllitic metasandstone, Acacia 2; *Geochronology Record 780*: Geological Survey of Western Australia, 5p.

Data obtained: 7 February 2008

Data released: 30 June 2009

Table 1. Ion microprobe analytical results for zircons from sample 135965: phyllitic metasandstone, Acacia 2

Group ID	Spot no.	Grain. spot	^{238}U (ppm)	^{232}Th (ppm)	$\frac{^{232}\text{Th}}{^{238}\text{U}}$	f^{204} (%)	$^{238}\text{U}/^{206}\text{Pb} \pm 1\sigma$	$^{207}\text{Pb}/^{206}\text{Pb} \pm 1\sigma$	$^{238}\text{U}/^{206}\text{Pb} \pm 1\sigma$	$^{207}\text{Pb}/^{206}\text{Pb} \pm 1\sigma$	$^{238}\text{U}/^{206}\text{Pb} \pm 1\sigma$	$^{207}\text{Pb}/^{206}\text{Pb} \pm 1\sigma$	date (Ma)	$^{238}\text{U}/^{206}\text{Pb} \pm 1\sigma$	date (Ma)	$^{207}\text{Pb}/^{206}\text{Pb} \pm 1\sigma$	Disc. (%)		
Y	17	17.1	213	109	0.53	0.105	6.203	0.117	0.07201	0.00061	6.209	0.122	0.07114	0.00101	963	20	961	29	-0.1
S	59	59.1	238	199	0.86	0.457	5.721	0.059	0.07740	0.00069	5.747	0.094	0.07357	0.00118	1034	18	1030	32	-0.4
S	53	53.1	291	129	0.46	0.206	5.539	0.065	0.07645	0.00058	5.550	0.096	0.07472	0.00079	1068	20	1061	21	-0.6
S	46	46.1	579	339	0.60	0.091	5.651	0.053	0.07557	0.00041	5.656	0.089	0.07480	0.00066	1050	18	1063	18	1.3
S	21	21.1	393	219	0.58	0.076	5.693	0.106	0.07544	0.00045	5.697	0.111	0.07481	0.00058	1043	22	1063	16	2.0
S	43	43.1	244	132	0.56	0.224	5.496	0.056	0.07714	0.00093	5.508	0.090	0.07526	0.00113	1075	19	1076	30	0.0
S	56	56.1	320	160	0.52	0.116	5.436	0.053	0.07635	0.00055	5.442	0.088	0.07537	0.00066	1087	19	1078	17	-0.8
S	14	14.1	747	101	0.14	0.044	5.449	0.101	0.07603	0.00033	5.451	0.105	0.07567	0.00036	1086	23	1086	10	0.0
S	3	3.1	385	281	0.75	0.048	5.236	0.100	0.07736	0.00045	5.239	0.104	0.07696	0.00048	1126	24	1120	13	-0.5
S	10	10.1	418	316	0.78	0.216	5.300	0.099	0.07979	0.00048	5.311	0.103	0.07797	0.00088	1112	24	1146	22	3.0
S	58	58.1	117	82	0.72	0.355	4.946	0.056	0.08205	0.00089	4.964	0.085	0.07905	0.00134	1183	22	1173	34	-0.8
S	8	8.1	121	116	0.99	0.081	4.947	0.096	0.07980	0.00081	4.951	0.100	0.07912	0.00084	1186	26	1175	21	-0.9
S	34	34.1	196	93	0.49	0.200	4.701	0.048	0.08208	0.00064	4.711	0.077	0.08039	0.00102	1241	22	1207	25	-2.8
S	41	41.1	253	184	0.75	0.239	4.684	0.047	0.08288	0.00059	4.695	0.076	0.08085	0.00081	1245	22	1218	20	-2.2
S	33	33.1	307	305	1.02	-0.050	4.859	0.091	0.08045	0.00049	4.857	0.095	0.08087	0.00050	1207	26	1218	12	0.9
S	1	1.1	255	116	0.47	0.165	4.617	0.087	0.08238	0.00056	4.625	0.091	0.08098	0.00080	1262	27	1221	19	-3.4
S	2	2.1	250	218	0.90	-0.018	4.763	0.090	0.08099	0.00055	4.762	0.094	0.08114	0.00056	1229	27	1225	14	-0.3
S	23	23.1	180	182	1.04	0.065	4.760	0.091	0.08210	0.00066	4.764	0.094	0.08155	0.00068	1228	27	1235	16	0.5
S	51	51.1	115	165	1.48	0.488	4.484	0.084	0.08611	0.00089	4.506	0.103	0.08198	0.00133	1292	32	1245	32	-3.8
S	12	12.1	106	31	0.30	0.137	4.724	0.101	0.08334	0.00087	4.731	0.105	0.08218	0.00098	1236	30	1250	23	1.1
S	31	31.1	324	140	0.45	0.060	4.423	0.083	0.08333	0.00046	4.425	0.086	0.08283	0.00047	1313	28	1265	11	-3.8
S	60	60.1	189	209	1.14	0.188	4.596	0.055	0.08726	0.00075	4.605	0.080	0.08565	0.00086	1267	24	1330	19	4.8
S	11	11.1	243	94	0.40	0.048	4.239	0.080	0.08664	0.00055	4.241	0.083	0.08623	0.00086	1365	30	1343	19	-1.6
S	40	40.1	235	150	0.66	0.184	4.435	0.044	0.08806	0.00059	4.443	0.072	0.08650	0.00073	1309	23	1349	16	3.0
S	64	64.1	185	77	0.43	0.026	4.022	0.042	0.08920	0.00073	4.023	0.067	0.08898	0.00075	1431	26	1404	16	-1.9
S	30	30.1	633	198	0.32	0.108	4.050	0.076	0.09036	0.00034	4.054	0.079	0.08944	0.00040	1421	31	1414	9	-0.5
S	54	54.1	96	50	0.54	0.130	3.830	0.045	0.09129	0.00094	3.835	0.067	0.09017	0.00102	1494	29	1429	22	-4.5
S	37	37.1	56	33	0.61	0.196	3.840	0.050	0.09238	0.00112	3.847	0.070	0.09071	0.00120	1489	30	1440	25	-3.4
S	27	27.1	196	113	0.60	0.092	3.846	0.073	0.09527	0.00061	3.850	0.076	0.09448	0.00074	1489	33	1518	15	1.9
S	66	66.1	193	105	0.56	0.104	3.781	0.040	0.09542	0.00070	3.785	0.063	0.09453	0.00080	1511	28	1519	16	0.5
S	63	63.1	153	143	0.97	0.086	3.724	0.041	0.09713	0.00080	3.727	0.063	0.09639	0.00082	1532	29	1555	16	1.5
S	5	5.1	209	175	0.87	0.068	3.600	0.069	0.09766	0.00062	3.602	0.071	0.09708	0.00088	1579	35	1569	17	-0.7
S	25	25.1	298	132	0.46	0.087	3.754	0.071	0.09824	0.00050	3.757	0.074	0.09749	0.00061	1521	33	1577	12	3.5
S	47	47.1	76	48	0.65	0.382	3.589	0.045	0.10158	0.00110	3.602	0.064	0.09828	0.00161	1579	32	1592	31	0.8
S	36	36.1	245	271	1.14	0.112	3.469	0.034	0.09929	0.00055	3.473	0.056	0.09832	0.00062	1631	30	1593	12	-2.4
S	52	52.1	278	304	1.13	0.084	3.506	0.035	0.10012	0.00057	3.509	0.057	0.09940	0.00061	1616	30	1613	11	-0.2
S	49	49.1	176	113	0.66	0.179	3.460	0.036	0.10163	0.00070	3.467	0.057	0.10008	0.00089	1634	31	1626	17	-0.5
S	22	22.1	153	164	1.11	0.201	3.474	0.066	0.10252	0.00066	3.481	0.069	0.10078	0.00087	1628	37	1639	16	0.6

Table 1. (continued)

Group ID.	Spot no.	Grain. spot	^{238}U (ppm)	^{232}Th (ppm)	$^{232}\text{Th}/^{238}\text{U}$	$f^{204}\text{Pb}$ (%)	$^{238}\text{U}/^{206}\text{Pb} \pm 1\sigma$	$^{207}\text{Pb}/^{206}\text{Pb} \pm 1\sigma$	$^{238}\text{U}/^{206}\text{Pb}^* \pm 1\sigma$	$^{207}\text{Pb}/^{206}\text{Pb}^* \pm 1\sigma$	$^{238}\text{U}/^{206}\text{Pb}^* \text{ date (Ma)} \pm 1\sigma$	$^{207}\text{Pb}/^{206}\text{Pb}^* \text{ date (Ma)} \pm 1\sigma$	Disc. (%)
S	32	32.1	174	104	0.62	0.047	3.381	0.10333	3.382	0.10292	1670	1677	0.5
S	19	19.1	420	299	0.74	0.035	3.428	0.10358	3.429	0.10328	1650	1684	2.0
S	69	69.1	391	50	0.13	0.041	3.467	0.10425	3.468	0.10389	1633	1695	3.6
S	55	55.1	137	77	0.58	0.209	3.404	0.10590	3.411	0.10408	1657	1698	2.4
S	61	61.1	210	172	0.85	0.095	3.291	0.10615	3.294	0.10533	1709	1720	0.6
S	35	35.1	155	158	1.05	0.100	3.301	0.10706	3.304	0.10619	1705	1735	1.8
S	7	7.1	242	93	0.40	0.047	3.148	0.10705	3.149	0.10664	1778	1743	-2.0
S	68	68.1	248	142	0.59	0.079	3.263	0.10738	3.266	0.10669	1722	1744	1.2
S	29	29.1	134	140	1.08	0.340	3.292	0.11119	3.304	0.10822	1705	1770	3.7
S	16	16.1	130	110	0.87	0.122	3.146	0.10991	3.150	0.10885	1777	1780	0.2
S	20	20.1	89	188	2.18	0.041	3.079	0.10969	3.081	0.10933	1812	1788	-1.3
S	13	13.1	144	146	1.05	0.029	3.186	0.11048	3.187	0.11023	1759	1803	2.4
S	48	48.1	177	315	1.84	0.197	3.013	0.11410	3.019	0.11238	1844	1838	-0.3
S	44	44.1	111	91	0.85	0.163	2.873	0.11608	2.877	0.11465	1923	1874	-2.6
S	39	39.1	87	64	0.77	0.215	2.755	0.12446	2.761	0.12257	1992	1994	0.1
S	50	50.1	441	27	0.06	0.059	2.829	0.12416	2.831	0.12364	1950	2009	3.0
S	62	62.1	137	45	0.34	0.093	1.912	0.18086	1.914	0.18004	2710	2653	-2.1
S	9	9.1	193	64	0.34	0.066	1.952	0.18077	1.954	0.18018	2664	2655	-0.4
S	15	15.1	436	232	0.55	0.077	1.974	0.18320	1.975	0.18251	2641	2676	1.3
S	57	57.1	147	91	0.64	0.039	1.521	0.28337	1.521	0.28303	3257	3380	3.6
D	67	67.1	22	30	1.43	1.342	5.042	0.08435	5.110	0.07312	1152	1017	-13.2
D	6	6.1	89	111	1.29	0.673	4.888	0.08148	4.921	0.07582	1193	1090	-9.4
D	42	42.1	192	53	0.29	0.360	5.317	0.07677	5.337	0.07375	1107	1035	-7.0
D	65	65.1	184	173	0.97	0.326	4.382	0.08512	4.397	0.08236	1321	1254	-5.4
D	24	24.1	294	210	0.74	0.314	4.959	0.07977	4.974	0.07712	1181	1124	-5.0
D	18	18.1	335	265	0.82	0.071	3.495	0.10620	3.497	0.10559	1621	1725	6.0
D	38	38.1	458	251	0.57	0.030	5.308	0.08026	5.310	0.08001	1112	1197	7.1
D	45	45.1	241	172	0.74	0.156	5.206	0.08243	5.214	0.08111	1131	1224	3.0
D	28	28.1	241	113	0.49	-0.040	6.866	0.07149	6.863	0.07182	877	981	10.6
D	26	26.1	45	48	1.09	0.118	6.031	0.07853	6.039	0.07753	988	1135	13.0
D	4	4.1	1314	462	0.36	0.087	6.889	0.07468	6.895	0.07395	873	1040	16.1

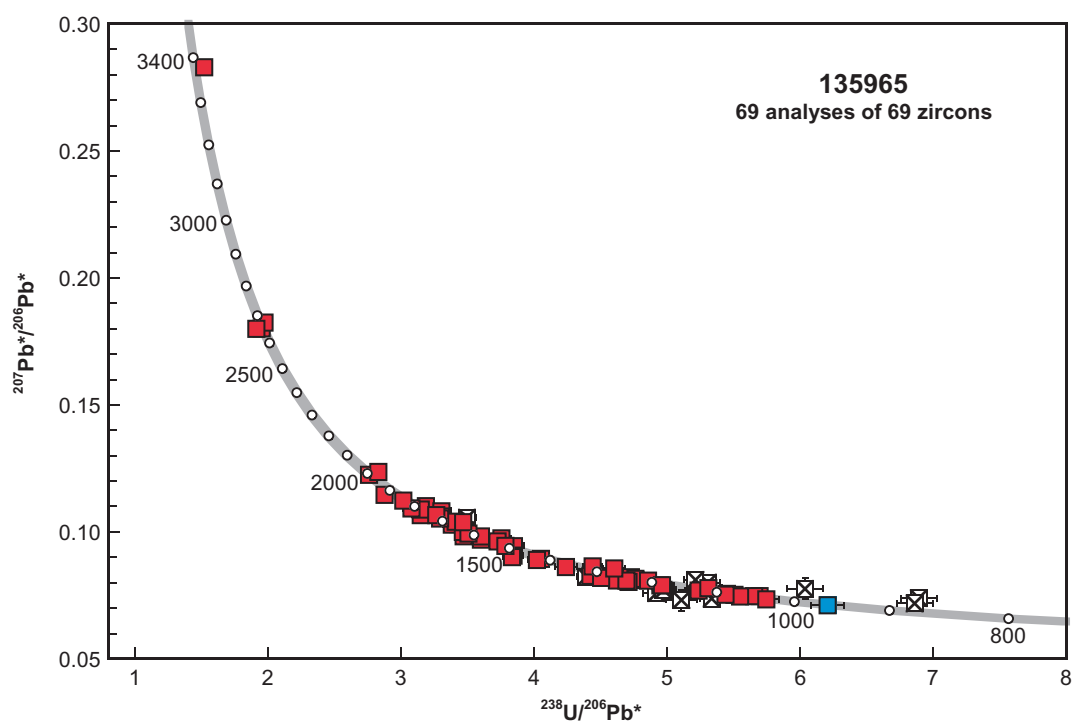


Figure 2. U-Pb analytical data for sample 135965: phyllitic metasandstone, Acacia 2. Blue square indicates Group Y (youngest detrital zircon); red squares indicate Group S (older detrital zircons); crossed squares indicate Group D (discordance > 5%).

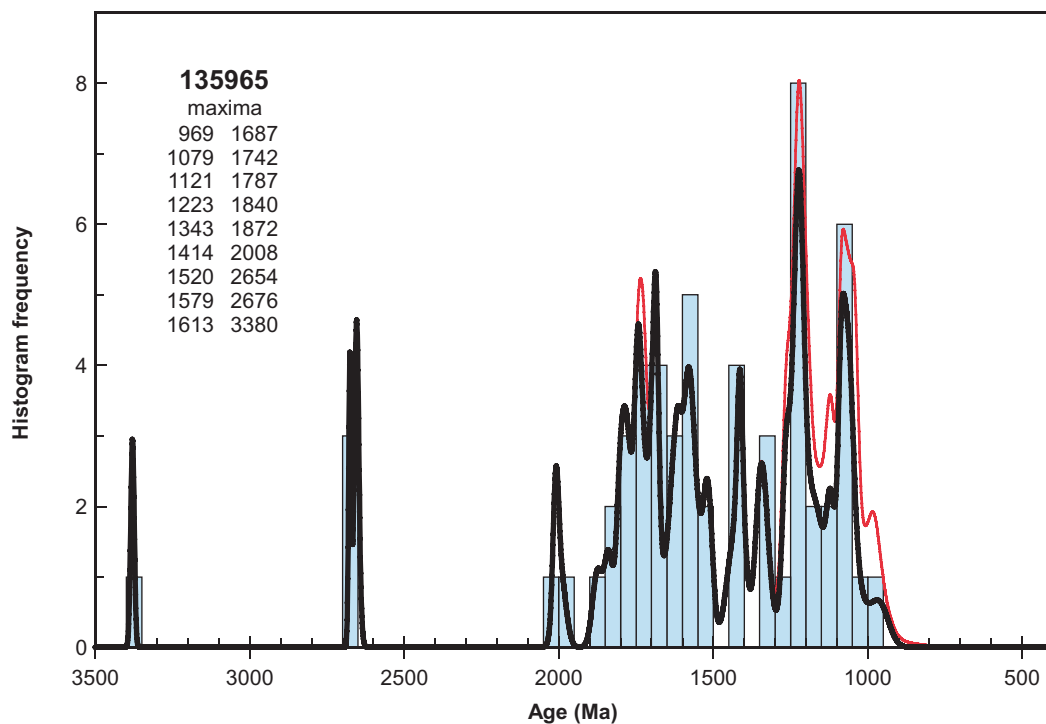


Figure 3. Probability density diagram for sample 135965: phyllitic metasandstone, Acacia 2. Heavy curve, maxima values, and frequency histogram (bin width 50 Ma) include only data with discordance < 5% (58 analyses of 58 zircons). Lighter curve includes all data (69 analyses of 69 zircons).