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Appendix DR1. Tables DR1–DR4, SHRIMP data presentation.

Testing ore deposit models using in situ U–Pb geochronology of hydrothermal monazite: Paleoproterozoic gold mineralization in northern Australia

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SHRIMP Analytical Procedures

Zircon data were acquired following standard analytical procedures (Smith et al., 1998 and references therein).

Monazite analytical procedures can be found in Foster et al. (2000) and Rasmussen et al. (2001). Analysis areas on monazite from the stockwork samples (mount C-104) were ~10 μm, with a primary O_2^- ion current ~0.4 nA. For the Tom's Gully reef monazites (mount 05-27) and Mount Goyder Syenite (03-82) the spots were <10 μm and current ~0.15 nA. The primary standard used for monazite was MAD-1 (Foster et al., 2000; also known in-house as French). Matrix effects from U and Th were determined using PD-95 (high U; Th generally higher than MAD; provided by J. Aleinikoff) and QMa28-1 (U similar to MAD but lower Th; provided by F. Henjes-Kunst). PD-95 also provides a monitor for $^{207}Pb/^{206}Pb$. Typically, each analytical session includes 6–8 analyses of both MAD-1 and PD-95, and 2–3 analyses Qma28-1.

In some cases, data were collected for sequential analyses on a single location. When this is done, there can be a significant drift in Pb/U calibration between the sequential analyses – typically ~5% for small-spot analyses of xenotime (Fletcher et al., 2000); the drift in Pb/U was smaller for most of the monazite analyses presented here. Although it is possible to calibrate the time-drift with additional (sequential) analyses of the standard(s), this was considered unjustified for this project because of the cost in sample analytical time. Sequential analyses have been assessed on the basis of average drift rates in the session and the concordance of the corresponding first analyses, which represent immediately adjacent sample material.

Data Presentation

For zircon (Table DR1) the analyses are identified by mount number (all 03-15) and grain number. One analysis was made on each grain.

For monazite, (Tables DR2–DR4), the analyses are identified as NNNNA.p-qx,
where NNNN is the mount number,
A is the fragment of polished thin section in mount NNNN,
p is the grain within fragment A,
q is the analysis area in grain p, and
x (a or b) is the sequential analysis at site p. This is omitted in tables where only single analyses were recorded.

For monazite, U and Th abundances are determined relative to the homogeneous MAD standard from raw UO_2^+/ $CePO_2^+$ and $ThO_2^+/CePO_2^+$ data. The U and Th concentrations are considered accurate to ± ~20%. Th/U is more accurate than the separate abundances

All tabulated Pb data are corrected for common Pb on the basis of measured ^{204}Pb, assuming a common Pb composition equivalent to Broken Hill galena. Any differences between this assumed composition and the actual common Pb composition are almost certainly insignificant for the data used to define ages. The magnitude of the common-Pb correction is listed as 4f206, the proportion of ^{206}Pb determined to be common Pb.

The U–Pb concordance ("conc.", as percent) is defined as $100\{t[^{206}Pb/^{238}U]/t[^{207}Pb/^{206}Pb]\}$.

Data are listed with 1σ uncertainties. These include sources of random error such as counting statistics and primary ion beam noise, propagated through data reduction. Pb/U and Pb/Th include external variance (reproducibility) assessed from the replicate data for standards. Other systematic factors, such as matrix correction parameters and inter-mount effects (standards on separate mounts) for monazite, are not included. The uncertainty in ^{207}Pb/^{206}Pb renormalisation for monazite was applied to the individual analyses listed (but was applied to grouped analyses for the means used in the main text).

The data for second analyses in single locations, although not fully calibrated, are listed for completeness and identified by italic font in reduced size.

TABLE DR1. SHRIMP U-Pb DATA FOR ZIRCON IN MOUNT BUNDEY GRANITE

Analysis spot	U (ppm)	Th (ppm)	Th/U	f206 (%)	$^{207}Pb^*/^{206}Pb^*$	±	$^{206}Pb^*/^{238}U$	±	$^{207}Pb^*/^{235}U$	±	$^{208}Pb^*/^{232}Th$	±	conc. (%)	$^{207}Pb^*/^{206}Pb^*$ Age (Ma)	± (Ma)
Main magmatic data group, in $^{207}Pb/^{206}Pb$ sequence															
0315.2-1	320	302	0.97	0.066	0.1116	0.0005	0.3166	0.0044	4.873	0.071	0.0922	0.0013	97	1826	9
0315.25-1	482	588	1.26	0.041	0.1114	0.0006	0.3172	0.0043	4.873	0.071	0.0913	0.0013	97	1823	10
0315.20-1	476	333	0.72	0.038	0.1113	0.0005	0.3063	0.0041	4.702	0.066	0.0902	0.0013	95	1821	7
0315.9-1	663	731	1.14	0.060	0.1113	0.0005	0.3130	0.0042	4.802	0.068	0.0915	0.0013	96	1820	8
0315.6-1	815	1015	1.29	0.042	0.1112	0.0003	0.3219	0.0043	4.936	0.067	0.0933	0.0014	99	1819	6
0315.7-1	390	439	1.16	-0.016	0.1112	0.0005	0.3139	0.0043	4.812	0.069	0.0909	0.0013	97	1819	8
0315.15-1	208	238	1.18	0.108	0.1111	0.0009	0.3141	0.0045	4.812	0.079	0.0906	0.0014	97	1818	14
0315.12-1	494	468	0.98	-0.007	0.1110	0.0004	0.3158	0.0043	4.832	0.068	0.0919	0.0013	97	1816	7
0315.14-1	653	395	0.63	0.125	0.1109	0.0005	0.3116	0.0044	4.763	0.071	0.0914	0.0014	96	1813	9
0315.4-1	862	941	1.13	0.009	0.1108	0.0003	0.3094	0.0041	4.727	0.065	0.0900	0.0012	96	1813	6
0315.28-1	302	321	1.10	0.020	0.1106	0.0006	0.3131	0.0043	4.774	0.071	0.0920	0.0018	97	1809	9
0315.18-1	245	232	0.98	0.088	0.1106	0.0007	0.3207	0.0045	4.889	0.075	0.0933	0.0014	99	1809	12
0315.26-1	59	67	1.18	0.000	0.1106	0.0012	0.3205	0.0056	4.887	0.101	0.0936	0.0019	99	1809	20
0315.23-1	419	435	1.07	0.029	0.1105	0.0005	0.3238	0.0045	4.935	0.072	0.0930	0.0014	100	1808	9
0315.16-1	612	782	1.32	0.027	0.1104	0.0004	0.3073	0.0041	4.679	0.065	0.0892	0.0012	96	1806	7
0315.13-1	436	481	1.14	0.038	0.1103	0.0005	0.3180	0.0043	4.837	0.069	0.0922	0.0013	99	1805	8
0315.10-1	508	465	0.94	0.100	0.1102	0.0005	0.3067	0.0041	4.659	0.066	0.0933	0.0013	96	1802	8
0315.8-1	465	539	1.20	0.312	0.1102	0.0007	0.3134	0.0043	4.760	0.071	0.0905	0.0014	98	1802	11
0315.22-1	506	481	0.98	0.585	0.1100	0.0010	0.3189	0.0044	4.834	0.079	0.1001	0.0017	99	1799	17
0315.17-1	511	442	0.89	0.136	0.1090	0.0006	0.3061	0.0042	4.603	0.067	0.0945	0.0014	97	1784	9
0315.29-1	48	57	1.21	0.599	0.1085	0.0022	0.3178	0.0056	4.754	0.127	0.0911	0.0022	100	1774	37
Young outlier															
0315.27-1	700	566	0.84	0.264	0.1076	0.0006	0.3025	0.0040	4.486	0.065	0.1069	0.0015	97	1759	11
Near-concordant magmatic grains with low common Pb															
0315.11-1	404	663	1.70	0.000	0.1123	0.0006	0.3078	0.0045	4.766	0.074	0.0907	0.0014	94	1837	9
0315.24-1	573	461	0.83	0.024	0.1110	0.0005	0.3010	0.0040	4.607	0.065	0.0877	0.0012	93	1816	8
0315.1-1	224	254	1.17	0.462	0.1101	0.0011	0.2908	0.0041	4.417	0.076	0.0923	0.0015	91	1802	18
Young or strongly discordant data with low common Pb															
0315.3-1	455	336	0.76	0.021	0.1106	0.0010	0.2667	0.0037	4.067	0.067	0.0623	0.0011	84	1809	16
0315.19-1	352	381	1.12	0.076	0.1090	0.0006	0.2700	0.0037	4.058	0.060	0.0879	0.0014	86	1783	10
0315.5-1	189	119	0.65	0.510	0.1084	0.0015	0.2010	0.0031	3.004	0.062	0.0930	0.0018	67	1772	25
0315.30-1	1048	817	0.81	0.222	0.1050	0.0005	0.2353	0.0031	3.407	0.048	0.0634	0.0009	79	1715	9
0315.21-1	552	518	0.97	0.083	0.1049	0.0006	0.2420	0.0033	3.501	0.052	0.0746	0.0011	82	1713	10

TABLE DR2. SHRIMP U–Pb DATA FOR MONAZITE IN THE MOUNT GOYDER SYENITE

Analysis spot	U (ppm)	Th (ppm)	Th/U	f206 (%)	$^{207}Pb^*/^{206}Pb^*$	±	$^{206}Pb^*/^{238}U$	±	$^{207}Pb^*/^{235}U$	±	$^{208}Pb^*/^{232}Th$	±	conc. (%)	$^{207}Pb^*/^{206}Pb^*$ Age (Ma)	± (Ma)
0382B.1-2	172	936	5.4	0.078	0.1100	0.0020	0.3109	0.0082	4.716	0.154	0.0929	0.0027	97	1799	32
0382B.1-3	144	837	5.8	0.089	0.1128	0.0021	0.3333	0.0091	5.183	0.175	0.0998	0.0028	101	1845	33
0382B.1-4a	157	870	5.6	0.000	0.1116	0.0017	0.3324	0.0090	5.116	0.163	0.0930	0.0026	101	1826	27
0382B.1-4b	*109*	*542*	*5.0*	0.079	0.1139	0.0026	*0.3207*	*0.0083*	*5.037*	*0.177*	*0.0993*	*0.0027*	*96*	1863	41
Age outlier; marginally discordant, higher common Pb.															
0382B.1-3b	*104*	*505*	*4.9*	0.528	0.1054	0.0027	*0.3264*	*0.0088*	*4.742*	*0.178*	*0.0998*	*0.0031*	*106*	1721	47

TABLE DR3. SHRIMP U-Pb DATA FOR MONAZITE IN SHALE WITH QUARTZ-PYRITE STOCKWORK

Analysis spot	U (ppm)	Th (ppm)	Th/U	f206 (%)	^{207}Pb*/^{206}Pb*	±	^{206}Pb*/^{238}U	±	^{207}Pb*/^{235}U	±	^{208}Pb*/^{232}Th	±	conc. (%)	^{207}Pb*/^{206}Pb* Age (Ma)	± (Ma)
C104E.1-2a	266	7481	28.2	1.289	0.1147	0.0022	0.3224	0.0041	5.096	0.117	0.0933	0.0017	96	1875	35
C104F.1-3a	208	6404	30.8	0.501	0.1138	0.0018	0.3435	0.0070	5.391	0.145	0.1028	0.0029	102	1862	29
C104F.3-1b	*266*	*3045*	*11.4*	1.172	0.1125	0.0019	*0.3189*	*0.0059*	*4.945*	*0.127*	*0.0927*	*0.0026*	*97*	1840	30
C104F.7-2b	*434*	*8977*	*20.7*	0.121	0.1123	0.0011	*0.3238*	*0.0054*	*5.014*	*0.101*	*0.0936*	*0.0025*	*98*	1837	17
C104F.3-1	285	3516	12.4	0.573	0.1122	0.0014	0.3292	0.0058	5.090	0.116	0.0945	0.0026	100	1835	23
C104F.1-1a	294	3430	11.7	0.118	0.1119	0.0010	0.3281	0.0035	5.064	0.070	0.0908	0.0014	100	1831	16
C104F.1-2a	300	6058	20.2	0.174	0.1118	0.0011	0.3349	0.0059	5.163	0.107	0.0992	0.0027	102	1829	17
C104F.1-3b	*169*	*4387*	*26.0*	0.395	0.1116	0.0016	*0.3248*	*0.0063*	*4.999*	*0.125*	*0.1023*	*0.0028*	*99*	1826	26
C104E.1-2	172	4158	24.1	1.252	0.1116	0.0029	0.3338	0.0076	5.134	0.183	0.0951	0.0027	102	1825	47
C104E.3-1b	*1640*	*7178*	*4.4*	0.483	0.1115	0.0007	*0.3176*	*0.0048*	*4.882*	*0.083*	*0.0947*	*0.0027*	*98*	1824	12
C104E.3-1	2016	9438	4.7	0.526	0.1113	0.0010	0.3354	0.0060	5.148	0.107	0.0959	0.0028	102	1821	17
C104F.1-2b	*205*	*3112*	*15.2*	0.140	0.1112	0.0011	*0.3223*	*0.0059*	*4.944*	*0.107*	*0.0958*	*0.0026*	*99*	1820	18
C104F.7-2a	606	10052	16.6	0.164	0.1108	0.0009	0.3337	0.0057	5.099	0.100	0.0934	0.0026	102	1813	16
Discordant or high common Pb															
C104F.7-1b	*694*	*12388*	*17.8*	0.604	0.1125	0.0013	*0.2619*	*0.0047*	*4.061*	*0.090*	*0.0755*	*0.0020*	*82*	1840	21
C104F.6-1a	448	17920	40.0	0.542	0.1158	0.0017	0.2765	0.0056	4.415	0.115	0.0760	0.0022	83	1893	26
C104F.7-1a	533	19908	37.3	0.521	0.1139	0.0017	0.2816	0.0060	4.424	0.119	0.0771	0.0021	86	1863	27
C104F.1-1b	*290*	*4400*	*15.2*	0.457	0.1144	0.0016	*0.2849*	*0.0038*	*4.494*	*0.086*	*0.0873*	*0.0017*	*86*	1870	25
C104E.1-3a	482	5921	12.3	2.691	0.1113	0.0024	0.3229	0.0040	4.953	0.122	0.0911	0.0017	99	1820	40
C104E.1-2b	*208*	*3476*	*16.7*	3.228	0.1168	0.0042	*0.2540*	*0.0039*	*4.091*	*0.153*	*0.0965*	*0.0018*	*76*	1908	65
C104F.5-1a	1068	6307	5.9	3.327	0.1106	0.0017	0.2861	0.0053	4.364	0.108	0.0684	0.0020	90	1810	28
C104F.8-1a	328	4831	14.7	5.055	0.1125	0.0029	0.3385	0.0058	5.252	0.164	0.0928	0.0025	102	1841	46
C104E.1-1a	1356	4732	3.5	6.262	0.0860	0.0078	0.3141	0.0073	3.726	0.327	0.0945	0.0019	132	1339	176
C104E.1-1a	251	6995	27.9	9.201	0.1097	0.0093	0.3413	0.0075	5.162	0.441	0.0922	0.0026	106	1794	154

TABLE DR4. SHRIMP U-Pb DATA FOR HYDROTHERMAL MONAZITE IN TOM'S GULLY QUARTZ REEF

Analysis spot	U (ppm)	Th (ppm)	Th/U	f206 (%)	$^{207}Pb^*/^{206}Pb^*$	±	$^{206}Pb^*/^{238}U$	±	$^{207}Pb^*/^{235}U$	±	$^{208}Pb^*/^{232}Th$	±	conc. (%)	$^{207}Pb^*/^{206}Pb^*$ Age (Ma)	± (Ma)
0527A.1-1a	767	3616	4.7	0.904	0.1092	0.0016	0.3273	0.0064	4.928	0.123	0.0962	0.0020	102	1786	27
0527A.1-1b	590	2313	3.9	1.077	0.1092	0.0017	0.3020	0.0060	4.547	0.118	0.0961	0.0019	95	1786	29
0527A.1-3a	880	5956	6.8	0.506	0.1104	0.0012	0.3270	0.0064	4.978	0.113	0.0943	0.0016	101	1806	19
0527A.2-1a	2518	11088	4.4	0.049	0.1086	0.0008	0.3389	0.0061	5.075	0.098	0.0981	0.0016	106	1776	13
0527A.2-1b	1645	7684	4.7	0.032	0.1089	0.0007	0.3065	0.0055	4.601	0.089	0.0963	0.0017	97	1780	12
0527A.2-2a	1931	11399	5.9	0.058	0.1091	0.0009	0.3368	0.0064	5.067	0.108	0.1008	0.0017	105	1784	16
0527A.2-2b	1615	10480	6.5	0.912	0.1081	0.0012	0.2927	0.0054	4.365	0.095	0.0983	0.0017	94	1768	20
0527A.2-4a	1072	7668	7.1	0.223	0.1085	0.0010	0.3373	0.0068	5.047	0.114	0.1014	0.0019	106	1775	17
0527A.2-4b	699	3802	5.4	0.040	0.1098	0.0013	0.3243	0.0067	4.911	0.118	0.1020	0.0020	101	1796	21
0527A.2-5a	2029	12402	6.1	0.101	0.1080	0.0008	0.3459	0.0064	5.152	0.105	0.1044	0.0020	108	1767	14
0527A.2-5b	1744	9147	5.2	0.099	0.1088	0.0008	0.3262	0.0064	4.893	0.103	0.1026	0.0018	102	1779	13
0527A.3-1a	1309	6097	4.7	0.037	0.1079	0.0009	0.3422	0.0064	5.090	0.106	0.1011	0.0019	108	1764	15
0527A.3-1b	1820	5605	3.1	0.009	0.1094	0.0007	0.3122	0.0057	4.711	0.093	0.0998	0.0018	98	1790	12
0527A.3-2a	1034	4739	4.6	1.100	0.1108	0.0015	0.3366	0.0071	5.143	0.132	0.0974	0.0019	103	1813	25
0527A.3-2b	746	3230	4.3	1.091	0.1092	0.0015	0.3179	0.0060	4.786	0.115	0.0945	0.0017	100	1786	26
0527C.1-1a	586	6563	11.2	0.214	0.1081	0.0012	0.3413	0.0074	5.088	0.126	0.0975	0.0019	107	1768	20
0527C.1-1b	209	4233	20.3	0.637	0.1061	0.0023	0.3183	0.0081	4.658	0.159	0.0951	0.0018	103	1734	39
Common ^{206}Pb >1.5%															
0527A.1-3b	720	5177	7.2	3.024	0.1081	0.0023	0.2839	0.0057	4.231	0.127	0.0883	0.0015	91	1767	40
0527A.2-3a	43	4705	110.3	4.046	0.1316	0.0101	0.3212	0.0139	5.830	0.511	0.0903	0.0016	85	2120	134
0527A.2-3b	30	3046	101.7	4.782	0.1354	0.0154	0.3166	0.0145	5.909	0.708	0.0942	0.0017	82	2169	199

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