附表 1 西藏帮布勒矿床石英斑岩主量元素(%)与微量元素(10^{-6})分析结果

Appendix table 1 Major oxides (%) and trace elements (10^{-6}) of the quartz porphyry in Bangbule deposit

样品	BBL-YT1-b1	BBL-YT 1-b2	BBL-YT 1-b3	BBL-YT 1-b4	BBL-YT 3-b1	BBL-YT 3-b3	BBL-YT 3-b4	BBL-YT 4-b1	BBL-YT 4-b2	BBL-YT 4-b4	BBL-18 17-b1
SiO_2	73.67	74.61	75.54	74.94	77.12	77.03	76.70	72.78	73.70	73.53	74.53
TiO_2	0.19	0.18	0.19	0.19	0.13	0.12	0.14	0.29	0.27	0.28	0.26
Al_2O_3	12.38	12.18	12.08	11.90	12.37	12.45	12.76	13.37	13.01	13.81	12.52
Fe_2O_3	0.31	0.18	0.14	0.39	0.09	0.03	0.01	0.89	0.67	0.55	0.76
FeO	0.52	0.57	0.43	0.40	0.57	0.42	0.52	0.77	1.20	1.13	0.63
MnO	0.06	0.05	0.09	0.14	0.03	0.03	0.04	0.12	0.12	0.11	0.13
MgO	0.96	0.79	0.59	0.68	0.35	0.25	0.28	0.56	0.61	0.64	0.62
CaO	2.44	2.38	1.93	2.70	0.61	0.40	0.52	3.64	2.98	2.95	2.64
Na_2O	2.44	2.57	2.26	1.85	2.79	2.47	2.57	1.57	1.58	1.40	1.16
K_2O	5.10	4.92	5.07	4.86	4.64	5.55	5.25	4.62	4.34	3.80	5.32
P_2O_5	0.04	0.04	0.04	0.05	0.03	0.03	0.03	0.07	0.06	0.06	0.07
LOI	1.54	1.16	1.28	1.58	1.01	0.98	0.93	0.96	1.09	1.36	1.09
Total	99.65	99.64	99.64	99.69	99.73	99.76	99.73	99.64	99.62	99.62	99.73
$Mg^{\#}$	68.36	65.88	65.36	61.70	49.24	49.98	48.70	39.07	37.57	41.21	45.83
A/NK	1.30	1.28	1.31	1.43	1.29	1.24	1.29	1.76	1.78	2.15	1.63
A/CNK	0.89	0.88	0.95	0.90	1.15	1.15	1.18	0.94	1.02	1.17	1.00
Na_2O+K_2O	7.54	7.49	7.33	6.71	7.43	8.02	7.81	6.20	5.92	5.20	6.48
K_2O/Na_2O	2.09	1.92	2.24	2.62	1.66	2.24	2.05	2.93	2.75	2.71	4.59
Li	36.47	22.58	33.07	29.10	20.55	20.60	20.37	22.45	27.14	25.97	19.24
Be	2.13	2.38	2.43	2.47	2.66	2.25	2.60	2.83	2.57	3.07	1.91
Sc	3.25	3.75	3.53	3.31	5.16	5.18	4.41	5.64	5.24	7.37	4.74
V	10.89	10.42	9.13	10.56	3.03	2.72	3.98	21.62	18.30	20.78	17.15
Cr	3.28	1.07	3.62	2.16	1.16	1.32	0.58	6.90	4.83	6.26	6.59
Co	1.24	1.28	0.69	0.76	0.69	0.41	0.64	2.02	2.27	1.99	1.87
Ni	2.57	2.47	1.98	1.94	1.69	0.81	1.49	3.45	4.13	5.52	4.34
Cu	394.8	667.8	328.0	155.5	42.6	16.2	23.4	20.7	29.7	16.8	3.4
Zn	231.60	54.36	300.60	148.10	80.05	69.88	95.79	182.80	108.40	184.50	135.50
Ga	14.00	13.12	11.90	12.18	16.84	14.57	14.31	15.39	14.87	16.85	12.23
Rb	166.6	164.7	185.8	183.2	145.8	199.4	201.3	188.5	172.5	174.4	227.4
Sr	189.0	206.7	205.4	196.9	87.9	59.9	93.3	234.0	222.1	204.3	221.1
Y	22.12	24.19	21.63	20.07	29.19	33.66	34.59	27.62	25.23	32.97	24.19
Zr	118.78	115.25	117.01	118.68	87.71	86.44	89.57	170.52	158.76	156.60	153.40
Nb	11.54	11.96	11.88	12.29	17.93	19.69	19.11	14.78	13.67	15.74	13.95
Cs	5.76	4.91	7.99	7.91	4.99	5.08	4.46	6.41	6.64	13.27	6.32
Ba	559	659	640	652	413	391	461	789	612	550	727
Hf	3.23	3.32	2.98	3.23	2.30	2.04	2.04	4.34	4.08	4.08	5.98
Ta	1.15	1.25	1.36	1.28	2.10	2.24	2.23	1.41	1.44	1.44	0.63

Pb	169	40	237	122	81	44	81	44	29	100	71
U	1.64	1.83	4.91	2.95	4.37	3.62	3.68	1.73	1.66	1.45	1.63
La	44.43	43.62	41.91	41.87	28.75	33.08	35.03	48.65	49.32	56.26	47.83
Ce	84.18	83.24	79.70	80.58	56.97	68.37	65.21	91.22	93.41	103.50	89.72
Pr	10.65	10.52	10.07	10.13	7.68	8.85	8.95	11.37	11.65	13.00	10.51
Nd	36.80	37.07	35.16	35.39	27.18	31.37	31.81	39.37	40.42	42.65	37.33
Sm	6.21	6.35	5.86	5.90	5.56	6.48	6.26	6.62	6.67	7.65	6.39
Eu	1.08	1.06	1.04	1.01	0.66	0.73	0.89	1.29	1.20	1.33	1.14
Gd	5.34	5.67	5.02	4.79	5.27	6.35	6.07	5.83	5.67	6.85	5.22
Tb	0.83	0.88	0.80	0.76	0.93	1.10	1.10	0.95	0.91	1.16	0.83
Dy	4.49	4.75	4.29	3.96	5.37	6.21	6.25	5.17	4.72	6.34	4.55
Ho	0.86	0.94	0.83	0.77	1.07	1.25	1.29	1.03	0.94	1.25	0.90
Er	2.40	2.60	2.38	2.21	3.18	3.53	3.76	2.83	2.67	3.44	2.59
Tm	0.37	0.40	0.37	0.34	0.49	0.57	0.57	0.44	0.41	0.53	0.40
Yb	2.38	2.55	2.42	2.25	3.27	3.68	3.68	2.82	2.72	3.42	2.59
Lu	0.36	0.39	0.36	0.34	0.51	0.55	0.57	0.42	0.42	0.50	0.39
ΣREE	200.37	200.02	190.22	190.29	146.89	172.12	171.44	218.00	221.14	247.89	210.39
LREE	183.35	181.85	173.75	174.88	126.81	148.88	148.14	198.52	202.67	224.39	192.92
HREE	17.03	18.17	16.48	15.41	20.08	23.24	23.29	19.48	18.47	23.50	17.47
LREE /HRE											
E	10.77	10.01	10.54	11.35	6.32	6.41	6.36	10.19	10.97	9.55	11.04
Sr/Y	8.54	8.54	9.49	9.81	3.01	1.78	2.70	8.47	8.80	6.20	9.14
(La/Y											
$b)_N$	13.41	12.29	12.41	13.36	6.32	6.45	6.83	12.37	13.02	11.79	13.25
δEu	0.56	0.53	0.57	0.56	0.37	0.34	0.43	0.62	0.58	0.55	0.59
δCe	0.92	0.92	0.92	0.93	0.92	0.96	0.88	0.92	0.92	0.90	0.94

注.A/CNK.molar $Al_2O_3/(CaO+Na_2O+K_2O)$，A/NK.molar $Al_2O_3/(Na_2O+K_2O)$，$Mg^{\#}$=100*(MgO/40.305)/(MgO/40.305+ FeO /71.845+ 0.89 * Fe_2O_3/ 71.845)，δEu=2*Eu_N/(Sm_N +Gd_N)，δCe=2*Ce_N/(La_N +Pr_N)，$(La/Yb)_N$.球粒陨石标准化；球粒陨石标准化数据引自 Sun and McDonoug(1989)

附表 2 西藏帮布勒矿床石英斑岩 LA-ICP-MS 锆石 U-Pb 年代学分析

Appendix table 2 LA-ICP-MS zircon U-Pb analytical data quartz porphyry from the Bangbule deposit

Spot No.	Th	U	Th/U	$^{207}Pb/^{235}U$	1σ	$^{206}Pb/^{238}U$	1σ	$^{207}Pb/^{235}U$	1σ	$^{206}Pb/^{238}U$	1σ
	10^{-6}							Age (Ma)			
BBL-1817-B1，77.20 ± 0.81 Ma (MSWD=0.35，N=16)											
01	253.698	186.958	1.357	0.0791	0.0079	0.0116	0.0002	77.3	7.4	74.4	1.5
02	283.747	214.446	1.323	0.0794	0.0131	0.0121	0.0003	77.6	12.4	77.3	1.8
03	351.990	205.917	1.709	0.0826	0.0094	0.0123	0.0003	80.6	8.8	78.8	1.7
04	247.905	192.048	1.291	0.0780	0.0077	0.0121	0.0003	76.3	7.3	77.6	1.8
05	360.150	307.983	1.169	0.0808	0.0065	0.0121	0.0002	78.9	6.1	77.3	1.3
06	123.847	93.967	1.318	0.0834	0.0192	0.0122	0.0003	81.3	18.0	78.0	2.0
07	111.896	93.489	1.197	0.0840	0.0130	0.0120	0.0003	81.9	12.1	77.1	2.2

08	276.671	337.040	0.821	0.0799	0.0064	0.0121	0.0002	78.1	6.1	77.4	1.3
09	669.466	390.460	1.715	0.0788	0.0062	0.0119	0.0002	77.0	5.8	76.4	1.2
10	283.142	184.961	1.531	0.0871	0.0095	0.0121	0.0003	84.8	8.9	77.7	1.9
11	369.458	296.055	1.248	0.0796	0.0072	0.0121	0.0002	77.8	6.8	77.3	1.2
12	217.513	144.836	1.502	0.0827	0.0121	0.0122	0.0003	80.7	11.3	78.2	2.0
13	109.262	69.625	1.569	0.0771	0.0143	0.0121	0.0004	75.4	13.4	77.4	2.8
14	152.499	118.248	1.290	0.0791	0.0140	0.0121	0.0003	77.3	13.1	77.7	2.1
15	280.916	250.258	1.123	0.0790	0.0074	0.0121	0.0003	77.2	6.9	77.4	1.6
16	174.907	105.253	1.662	0.0811	0.0147	0.0121	0.0004	79.1	13.8	77.2	2.4
BBL-YT4，77.31 ± 0.74 Ma (MSWD=0.63，N=20)											
01	93.996	70.295	1.337	0.0816	0.0074	0.0123	0.0003	79.7	6.9	78.9	2.2
02	108.552	85.404	1.271	0.0794	0.0092	0.0121	0.0003	77.6	8.7	77.4	1.8
03	621.577	483.765	1.285	0.0813	0.0036	0.0124	0.0002	79.3	3.4	79.3	1.1
04	99.503	78.110	1.274	0.0814	0.0080	0.0123	0.0003	79.5	7.5	79.0	2.2
05	112.328	84.300	1.332	0.0778	0.0080	0.0119	0.0004	76.1	7.5	76.1	2.3
06	158.639	88.985	1.783	0.0796	0.0070	0.0121	0.0003	77.8	6.6	77.3	2.1
07	164.879	79.396	2.077	0.0816	0.0104	0.0122	0.0004	79.6	9.7	78.3	2.3
08	58.861	51.698	1.139	0.0864	0.0107	0.0123	0.0004	84.1	10.0	78.7	2.4
09	129.444	81.151	1.595	0.0806	0.0068	0.0123	0.0003	78.7	6.4	78.7	2.1
10	135.816	110.990	1.224	0.0790	0.0071	0.0120	0.0003	77.2	6.7	76.9	1.8
11	182.184	113.744	1.602	0.0775	0.0085	0.0119	0.0003	75.8	8.0	76.1	2.0
12	89.010	69.802	1.275	0.0807	0.0090	0.0121	0.0004	78.8	8.5	77.7	2.6
13	256.700	241.197	1.064	0.0789	0.0048	0.0121	0.0002	77.1	4.5	77.3	1.3
14	108.047	88.310	1.224	0.0809	0.0090	0.0123	0.0004	79.0	8.5	78.8	2.3
15	293.251	222.776	1.316	0.0793	0.0049	0.0121	0.0002	77.5	4.6	77.5	1.4
16	302.510	193.158	1.566	0.0761	0.0053	0.0117	0.0002	74.5	5.0	74.7	1.4
17	318.600	187.969	1.695	0.0782	0.0049	0.0119	0.0002	76.4	4.6	76.4	1.5
18	273.326	190.937	1.431	0.0793	0.0056	0.0120	0.0002	77.5	5.3	77.0	1.5
19	357.994	312.498	1.146	0.0793	0.0041	0.0118	0.0002	77.5	3.9	75.6	1.3
20	225.635	176.080	1.281	0.0792	0.0052	0.0121	0.0003	77.4	4.9	77.5	1.6

附表 3 西藏帮布勒矿床石英斑岩(BBL-1817-b1)锆石 Hf 同位素分析

Appendix table 3 Hf isotopic compositions of zircons from the quartz porphyry (BBL-1817-b1) in the Bangbule deposit

Spot no.	Age	$^{176}Yb/^{177}Hf$	$^{176}Lu/^{177}Hf$	$^{176}Hf/^{177}Hf$	1σ	$(^{176}Hf/^{177}Hf)_i$	$\varepsilon_{Hf(0)}$	$\varepsilon_{Hf(t)}$	T_{DM}	T_{DMc}	T_{chur}	$f_{Lu/Hf}$
1	74.4	0.033701	0.001236	0.282563	0.000011	0.282561	-7.39	-5.83	981	1514	349	-0.96
2	77.3	0.024962	0.001040	0.282736	0.000010	0.282735	-1.26	0.39	731	1121	59	-0.97
3	78.8	0.034559	0.001421	0.282561	0.000011	0.282558	-7.48	-5.84	990	1519	355	-0.96
4	77.6	0.027155	0.001090	0.282538	0.000011	0.282537	-8.27	-6.61	1012	1567	389	-0.97
6	78	0.035467	0.001382	0.282534	0.000011	0.282532	-8.41	-6.78	1026	1578	399	-0.96
7	77.1	0.098611	0.003833	0.282524	0.000012	0.282518	-8.78	-7.29	1114	1609	451	-0.88

8	77.4	0.030628	0.001211	0.282536	0.000011	0.282534	-8.36	-6.72	1019	1574	395	-0.96
9	76.4	0.039995	0.001591	0.282534	0.000012	0.282531	-8.43	-6.85	1033	1581	403	-0.95
10	77.7	0.028191	0.001172	0.282720	0.000011	0.282718	-1.84	-0.21	757	1158	87	-0.96
11	77.3	0.035138	0.001397	0.282564	0.000016	0.282562	-7.34	-5.73	983	1510	348	-0.96
13	77.4	0.033390	0.001343	0.282543	0.000011	0.282541	-8.09	-6.47	1012	1557	383	-0.96
14	77.7	0.020567	0.000852	0.282501	0.000012	0.282500	-9.59	-7.92	1058	1651	447	-0.97
15	77.4	0.003895	0.001547	0.282534	0.000011	0.282532	-8.43	-6.79	1031	1579	402	-0.95
16	77.2	0.030040	0.001270	0.282564	0.000009	0.282562	-7.36	-5.73	981	1511	348	-0.96

注.$\varepsilon_{Hf(0)}=[(^{176}Hf/^{177}Hf)s/(^{176}Hf/^{177}Hf)_{CHUR,0}-1]\times10000$；$\varepsilon_{Hf}(t)=[((^{176}Hf/^{177}Hf)s-(^{176}Lu/^{177}Hf)s\ (e^{\lambda t}-1))/((^{176}Hf/^{177}Hf)_{CHUR,0}-(^{176}Lu/^{177}Hf)_{CHUR}\ (e^{\lambda t}-1))\ -1]\times10000$；$T_{DM}$ (Ma) 和 T_{DMC} (Ma) 分别代表亏损地幔一阶段和二阶段模式年龄 $T_{DM1}=1/\lambda\times\ln(1+((^{176}Hf/^{177}Hf)_S-(^{176}Hf/^{177}Hf)_{DM})/((^{176}Lu/^{177}Hf)_S-(^{176}Lu/^{177}Hf)_{DM}))$；$T_{DMC}=1/\lambda\times\ln(1+((^{176}Hf/^{177}Hf)_{S,t}-(^{176}Hf/^{177}Hf)_{DM,t})/((^{176}Lu/^{177}Hf)c\ (^{176}Lu/^{177}Hf)_{DM}))+t$；$f_{Lu/Hf}=(^{176}Lu/^{177}Hf)_S/(^{176}Hf/^{177}Hf)_{CHUR}-1$，where $(^{176}Lu/^{177}Hf)_S$ 和$(^{176}Hf/^{177}Hf)_S$为样品测定值，$(^{176}Lu/^{177}Hf)_{CHUR}=0.0332$ 和 $(^{176}Hf/^{177}Hf)_{CHUR,0}=0.282772$ (Blichert-Toft and Albarède, 1997)；$(^{176}Lu/^{177}Hf)_{DM}=0.0384$ and $(^{176}Hf/^{177}Hf)_{DM}=0.28325$ (Griffin *et al.*, 2000)，$(^{176}Lu/^{177}Hf)c=0.015$，t=样品形成时间，$\lambda=1.867\times10^{-5}$ Ma.

表 4 西藏帮布勒矿床石英斑岩全岩 Rb-Sr 及 Sm-Nd 同位素特征

Appendix table 4 Rb‑Sr and Sm‑Nd isotopic compositions of whole rocks from the Late Cretaceous quartz porphyry in the Bangbule deposit

Sample No.	Rb (10^{-6})	Sr (10^{-6})	$^{87}Rb/^{86}Sr$	$^{87}Sr/^{86}Sr$	2σ	$(^{87}Sr/^{86}Sr)_i$	Sm (10^{-6})	Nd (10^{-6})	$^{147}Sm/^{144}Nd$	$^{143}Nd/^{144}Nd$	2σ	$(^{143}Nd/^{144}Nd)_i$	εNd(t)	$T_{DM}{}^1$ (Ma)	$T_{DM}{}^2$ (Ma)
BBL-YT1-b1	200	202	2.8710	0.717892	0.000014	0.7148	6.63	36.00	0.1112	0.512176	0.000013	0.5121	-8.17	1449	1547
BBL-YT1-b2	198	216	2.6517	0.718105	0.000013	0.7152	6.59	35.10	0.1133	0.512209	0.000013	0.5122	-7.55	1429	1495
BBL-YT1-b3	218	210	3.0107	0.719082	0.000012	0.7158	6.12	33.30	0.1112	0.512220	0.000012	0.5122	-7.32	1384	1477
BBL-YT3-b1	174	88.8	5.6709	0.731767	0.000013	0.7256	5.85	26.40	0.1342	0.512145	0.000009	0.5121	-9.01	1925	1612
BBL-YT3-b3	237	59.6	11.4966	0.731311	0.000015	0.7187	6.68	29.40	0.1373	0.512187	0.000008	0.5121	-8.21	1920	1548
BBL-YT3-b4	231	94	7.1188	0.729434	0.000017	0.7217	6.32	29.00	0.1318	0.512196	0.000009	0.5121	-7.98	1775	1530
BBL-YT4-b1	226	247	2.6456	0.721510	0.000014	0.7186	7.00	38.20	0.1108	0.512205	0.000011	0.5121	-7.61	1401	1501
BBL-YT4-b2	199	234	2.4687	0.720487	0.000017	0.7178	6.87	37.90	0.1095	0.512136	0.000009	0.5121	-8.93	1484	1609
BBL-YT4-b4	206	208	2.8644	0.720158	0.000012	0.7170	7.39	39.80	0.1123	0.512168	0.000009	0.5121	-8.35	1477	1560

备注: $^{87}Sr/^{86}Sr_{(i)}=(^{87}Sr/^{86}Sr)-(^{87}Rb/^{86}Sr)\times(e^{\lambda t}-1)$，where $\lambda=1.42\times10^{-11}$；$\varepsilon_{Nd(t)}=[(^{143}Nd/^{144}Nd)_t/(^{143}Nd/^{144}Nd)_{CHUR,t}-1]\times10000$，$(^{143}Nd/^{144}Nd)_{CHUR,t}=(^{143}Nd/^{144}Nd)_{CHUR,0}-(^{147}Sm/^{144}Nd)_{CHUR,0\times}(e^{\lambda t}-1)$，$(^{143}Nd/^{144}Nd)_t=(^{143}Nd/^{144}Nd)_0-(^{147}Sm/^{144}Nd)_0\times(e\lambda t-1)$.$(^{143}Nd/^{144}Nd)_{CHUR,0}=0.512638$，$(^{147}Sm/^{144}Nd)_{CHUR,0}=0.1967$，$\lambda=6.54\times10^{-12}$.二阶段 Nd 模式年龄($T_{DM}{}^2$)的计算根据 Keto and Jacobsen (1987).