

**Table S1.** H and O isotope data for quartz in the Heihaibei gold deposit and some typical gold deposits in the EKO from the literature.  $\delta D$  was measured in fluid inclusions;  $\delta^{18}O$  was measured in quartz;  $\delta^{18}O$  of water in equilibrium with quartz was calculated at the temperature indicated by Th [23] using the equation of  $1000\ln\alpha = 3.38 \times 10^6/T^2 - 3.4$  [55].

No.	Sample Name	Rock Type	Ore Type	Mineral	$\Delta d_{vsmow}$	$\Delta^{18}O_{vsmow}$	$\Delta^{18}d_{h2o}$ ‰	$\Delta^{18}O_{h2o}$ ‰	Average Th	Ore District	References
1	HHBZK06-02-B2	brecciated white quartz vein	Qv1	Quartz	-97.2	13.4	-97.2	7.8	340.0	Heihaibei	this study
2	HHBZK06-02-B3	smoky grey quartz vein	Qv2	Quartz	-91.0	12.1	-91.0	2.7	241.0	Heihaibei	this study
3	HHBZK06-03-B2	smoky grey quartz vein	Qv2	Quartz	-101.8	12.6	-101.8	3.2	241.0	Heihaibei	this study
4	HHBZK06-03-B3	brecciated smoky grey quartz vein	Qv2	Quartz	-97.7	12.8	-97.7	3.4	241.0	Heihaibei	this study
5	HHBZK06-03-B5	brecciated smoky grey quartz vein	Qv2	Quartz	-102.3	13.3	-102.3	3.9	241.0	Heihaibei	this study
6	HHB08-JK01	white quartz vein	Qv1	Quartz	-81.1	9.2	-81.1	3.6	340.0	Heihaibei	this study
7	HHB08-JK02-1	smoky grey quartz vein	Qv2	Quartz	-94.1	13.7	-94.1	4.3	241.0	Heihaibei	this study
8	HHB08-JK02-2	smoky grey quartz vein	Qv2	Quartz	-94.6	13.7	-94.6	4.3	241.0	Heihaibei	this study
9	HHB08-JK03	smoky grey quartz vein	Qv2	Quartz	-89.9	11.3	-89.9	1.9	241.0	Heihaibei	this study
10	HHB08-JK05	smoky grey quartz vein	Qv2	Quartz	-90.4	13.6	-90.4	4.2	241.0	Heihaibei	this study
11	HHB08-JK08	smoky grey quartz vein	Qv2	Quartz	-97.4	11.6	-97.4	2.2	241.0	Heihaibei	this study
12	HHB08-JK10	white quartz vein	Qv1	Quartz	-92.8	13.9	-92.8	8.3	340.0	Heihaibei	this study
13	HHB08-JK15	smoky grey quartz vein	Qv2	Quartz	-97.6	11.6	-97.6	2.2	241.0	Heihaibei	this study
14	HHB08-JK17	white quartz vein	Qv1	Quartz	-96.8	11.0	-96.8	5.4	340.0	Heihaibei	this study
15	HHB08-JK18	smoky grey quartz vein	Qv2	Quartz	-104.2	13.0	-104.2	3.6	241.0	Heihaibei	this study
16	HHB08-JK19	smoky grey quartz vein	Qv2	Quartz	-101.5	11.0	-101.5	1.6	241.0	Heihaibei	this study
17	K1	silicificated monzogranite	Qv1+wall rocks	Quartz	-84.1	15.1	-84.1	9.5	340	Heihaibei	[23]
18	K5	smoky grey quartz vein	Qv2	Quartz	-81.1	14.1	-81.1	4.7	241	Heihaibei	[23]
19	K7	smoky grey quartz vein	Qv2	Quartz	-84	14	-84	4.6	241	Heihaibei	[23]
20	ZK0709-6	phyllitic rock		Quartz	-62.4	16.5	-62.4	6.1	222	Dazaohuo	[29]
21	ZK1609-10	phyllitic rock		Quartz	-69.1	16.4	-69.1	6.0	222	Dazaohuo	[29]
22	ZK2417-17	phyllitic rock		Quartz	-64.6	17	-64.6	6.6	222	Dazaohuo	[29]
23	ZK5601-13	phyllitic rock		Quartz	-64.6	15.7	-64.6	5.3	222	Dazaohuo	[29]
24	TC25-1	quartz vein		Quartz	-55	15.6	-55	5.5	227	Heicigou	[29]
25	TC25-3	quartz vein		Quartz	-59	15.7	-59	5.6	227	Heicigou	[29]
26	TC20-2	quartz vein		Quartz	-56	15.9	-56	5.8	227	Heicigou	[29]
27	TC20-3	quartz vein		Quartz	-51	16.1	-51	6.0	227	Heicigou	[29]
28	ZK001-7	quartz vein		Quartz	-85	11.4	-85	1.3	227	Heicigou	[29]
29	ZK001-8	quartz vein		Quartz	-97	10.6	-97	0.5	227	Heicigou	[29]

30	XI- 3390NCM 7-B1	phyllic rock	quartz	-110.6	4.6	-110.6	-3.8	262	Shenshuit an	[4]
31	XI- 3390NCM 7-B2	phyllic rock	quartz	-112.4	10.7	-112.4	2.3	262	Shenshuit an	[4]
32	XI- 3390NCM 7-B3	phyllic rock	quartz	-112.3	12.0	-112.3	3.6	262	Shenshuit an	[4]
33	XI- 3390NCM 11-B1	phyllic rock	quartz	-103.6	11.2	-103.6	2.8	262	Shenshuit an	[4]
34	XI- 3390NCM 11-B3	phyllic rock	quartz	-113.9	11.3	-113.9	2.9	262	Shenshuit an	[4]
35	XI- 3390NCM 17-B2	phyllic rock	sericite	-93.1	5.5	-73.1	0.9	262	Shenshuit an	[4]
36	XI- SDNCM3- B2-1	phyllic rock	sericite	-89.7	7.6	-69.7	3.0	262	Shenshuit an	[10]
37	XI- SDNCM3- B7	phyllic rock	sericite	-88.3	5.9	-68.3	1.3	262	Shenshuit an	[10]
38	XI- SDNCM3- B8A	phyllic rock	sericite	-94.5	5.7	-74.5	1.1	262	Shenshuit an	[10]
39	WL23-5	phyllic rock	quartz	-87.0	15.1	-87.0	6.7	262	Shenshuit an	[8]
40	WL29-5	phyllic rock	quartz	-90.0	11.6	-90.0	3.2	262	Shenshuit an	[8]
41	WL26-4-1	phyllic rock	quartz	-107.0	11.3	-107.0	2.9	262	Shenshuit an	[8]
42	WL26-4-2	phyllic rock	quartz	-82.0	11.7	-82.0	3.3	262	Shenshuit an	[8]
43	WL43-1	phyllic rock	quartz	-97.0	10.8	-97.0	2.4	262	Shenshuit an	[8]
44	WL44-1	phyllic rock	quartz	-63.0	13.2	-63.0	4.8	262	Shenshuit an	[8]
45	SZDG- ZK9302- OH1	phyllic rock	quartz	-93.6	12.0	-93.6	3.6	262	Shenshuit an	[9]
46	SZDG- 3270-CO1	phyllic rock	quartz	-97.2	11.9	-97.2	3.5	262	Shenshuit an	[9]
47	SZDG- 3270-CO4	phyllic rock	quartz	-105.7	13.1	-105.7	4.7	262	Shenshuit an	[9]
48	SZDG- 3270-CO5	phyllic rock	quartz	-84.6	10.1	-84.6	1.7	262	Shenshuit an	[9]
49	SZDG- ZK9302- CO6	phyllic rock	quartz	-98.0	11.0	-98.0	2.6	262	Shenshuit an	[9]
50	337000PD 01-B2-Q	quartz vein	quartz	-91.1	14.7	-91.1	6.2	262	Hongqigo u	[60]
51	3810PD30 1-B4-Q	quartz vein	quartz	-80.4	13.9	-80.4	5.5	262	Hongqigo u	[60]
52	3810PD30 1-B5-Q	quartz vein	quartz	-87.8	13.9	-87.8	5.5	262	Hongqigo u	[60]
53	3810PD30 1-B7-Q	quartz vein	quartz	-85.5	14.4	-85.5	6.0	262	Hongqigo u	[60]
54	3810PD30 1-B8-Q	quartz vein	quartz	-121.5	12.8	-121.5	4.4	262	Hongqigo u	[60]

55	GLLW-B1	phyllie rock	quartz	-61	15.8	-61.0	7.0	254.1	Guoluolon gwa	[19]
56	GLLW-B5	phyllie rock	quartz	-83	16	-83.0	7.1	251.3	Guoluolon gwa	[19]
57	GLLW-B6	phyllie rock	quartz	-79	15.1	-79.0	6.2	251.3	Guoluolon gwa	[19]
58	GLLW-B7	quartz vein	quartz	-87	15.6	-87.0	6.7	251.3	Guoluolon gwa	[19]
59	GLLW-B10	phyllie rock	quartz	-81	17.2	-81.0	8.3	251.3	Guoluolon gwa	[19]
60	GLLW-B12	quartz vein	quartz	-88	14.8	-88.0	5.9	251.3	Guoluolon gwa	[19]
61	GLLW-B13	phyllie rock	quartz	-64	15.2	-64.0	6.3	251.3	Guoluolon gwa	[19]
62	GLLW-B14	quartz vein	quartz	-72	16.2	-72.0	7.3	251.3	Guoluolon gwa	[19]
63	GLLW-B16	quartz vein	quartz	-80	15.8	-80.0	5.5	223.6	Guoluolon gwa	[19]
64	GLLW-B17	phyllie rock	quartz	-89	14.9	-89.0	6.0	251.3	Guoluolon gwa	[19]
65	GLLW-B18	phyllie rock	quartz	-83	16.2	-83.0	8.5	278.5	Guoluolon gwa	[19]
66	GLLW-B19	phyllie rock	quartz	-83	15.7	-83.0	6.8	251.3	Guoluolon gwa	[19]
67	GLLW-B20	phyllie rock	quartz	-89	16.6	-89.0	7.7	251.3	Guoluolon gwa	[19]
68	GLLW-B22	quartz vein	quartz	-96	16.5	-96.0	7.6	251.3	Guoluolon gwa	[19]
69	GLLW-B21	quartz vein	quartz	-84	16.2	-84.0	4.6	201.2	Guoluolon gwa	[19]
70	GLLW-B23	quartz vein	quartz	-91	16.7	-91.0	5.1	201.2	Guoluolon gwa	[19]
71	GLLW-B24	quartz vein	quartz	-101	16.9	-101.0	5.3	201.2	Guoluolon gwa	[19]
72	GLLW-B25	quartz vein	quartz	-96	15.7	-96.0	4.1	201.2	Guoluolon gwa	[19]
73	GLLW-B30	quartz vein	quartz	-91	16.6	-91.0	4.8	198.1	Guoluolon gwa	[19]
74	Kh-4	quartz vein	quartz	-71	17.1	-71.0	8.2	250	Kaihuang bei	[14]
75	Kh-5	quartz vein	quartz	-93	17.0	-93.0	4.6	190	Kaihuang bei	[14]
76	Shzg-4	quartz vein	quartz	-95	16.8	-95.0	4.4	190	Kaihuang bei	[14]
77	Khb44-2		quartz	-66	15.2	-66.0	8.3	300	Kaihuang bei	[14]
78	CKK3		quartz	-89	16.7	-89.0	5.0	200	Kaihuang bei	[14]