

Supplementary Materials: Channelized CO₂-Rich Fluid Activity along a Subduction Interface in the Paleoproterozoic Wutai Complex, North China Craton

Bin Wang, Wei Tian *, Bin Fu and Jia-Qi Fang

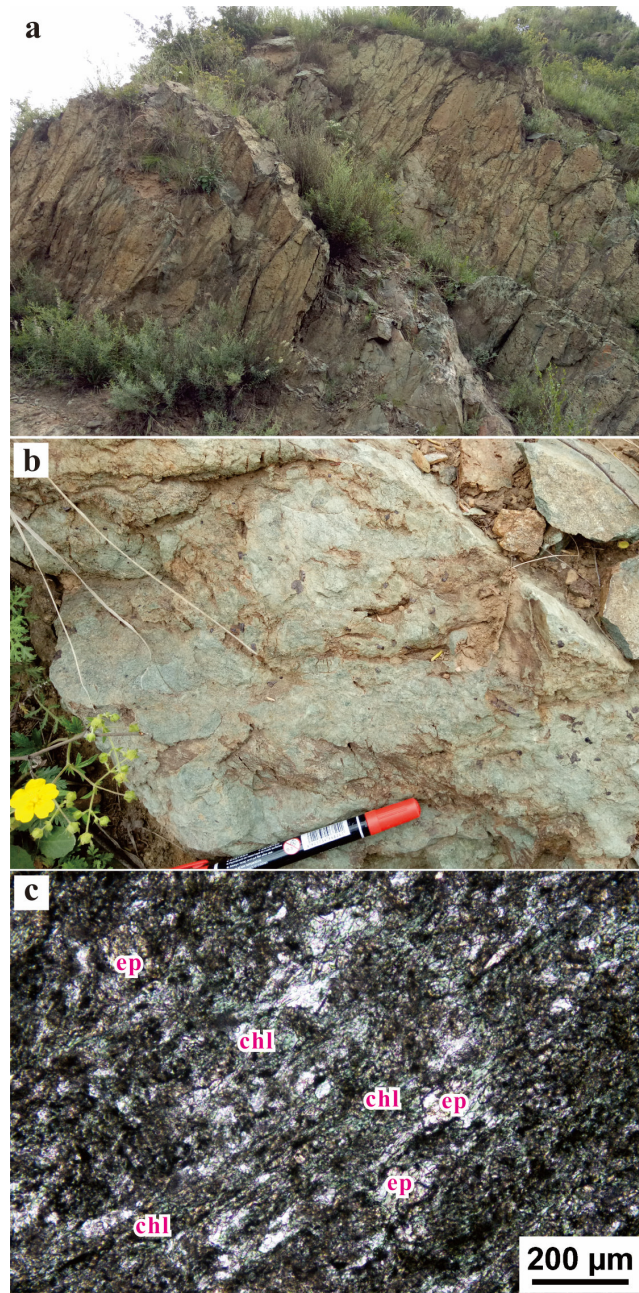


Figure S1. Pillow basalt petrography. (a) Field photograph of the pillow basalt. (b) Pillow basalt without any evident mineralization like the chlorite schist. (c) Photomicrograph of the pillow basalt. chl: chlorite; ep: epidote.

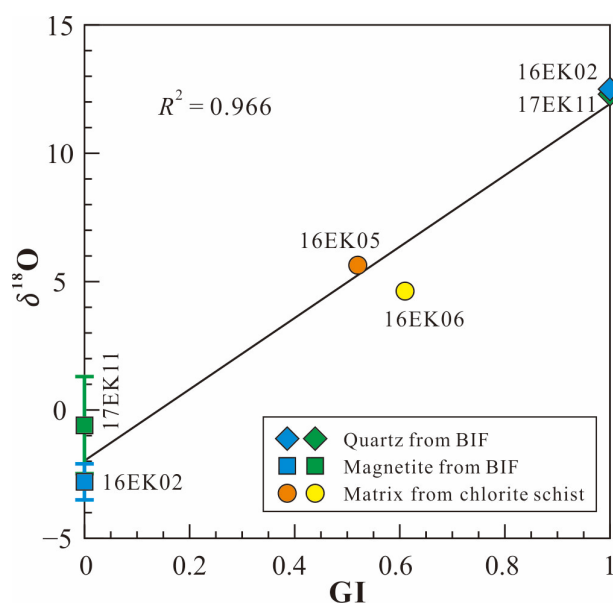


Figure S2. The $\delta^{18}\text{O}$ –GI diagram. It is used to assess the oxygen isotopic equilibrium between the BIF and chlorite schist. *GI*, Garlick Index [1].

Table S1. EMP analyses for dolomite, chlorite and muscovite in the chloritoschist sample 16EK05.

Dolomite								
No.	dol-1	dol-2	dol-3	dol-4	dol-5	dol-6	dol-7	dol-8
FeO	15.14	14.43	15.26	14.83	15.21	15.87	15.64	14.36
MnO	0.55	0.6	0.63	0.57	0.54	0.3	0.53	0.63
MgO	12.95	13.38	10.81	12.95	12.79	12.74	12.53	13.49
CaO	29.64	29.47	27.73	30	29.66	29.61	29.17	29.56
Total	58.28	57.88	54.43	58.35	58.2	58.52	57.87	58.04
O	6	6	6	6	6	6	6	6
Fe ²⁺	0.40	0.38	0.43	0.39	0.40	0.41	0.41	0.37
Mn	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.02
Mg	0.60	0.62	0.55	0.60	0.60	0.59	0.59	0.63
Ca	0.99	0.99	1.01	1.00	0.99	0.99	0.99	0.99
Cat.	2	2	2	2	2	2	2	2
X _{Fe}	0.40	0.38	0.44	0.39	0.40	0.41	0.41	0.37
Chlorite								
No.	chl-1	chl-2	chl-3	chl-4	chl-5	chl-6	chl-7	chl-8
SiO ₂	25.38	25.08	24.52	24.62	24.47	25.44	24.13	24.62
Al ₂ O ₃	20.33	20.89	20.14	20.78	20.45	19.68	21.09	20
Cr ₂ O ₃	0.27	0.23	0.32	0.33	0.41	0.23	0.22	0.34
FeO	27.11	26.99	27.25	27.89	27.42	28.17	27.91	27.69
MnO	0.04	0.08	0.04	0.02	0	0	0.02	0.01
MgO	13.43	12.97	13.34	13.19	13.26	12.9	13.64	12.79
Total	86.56	86.24	85.61	86.83	86.01	86.42	87.14	85.45
O	14	14	14	14	14	14	14	14
Si	2.74	2.72	2.69	2.66	2.67	2.77	2.60	2.71
Al ^{IV}	1.26	1.29	1.31	1.34	1.33	1.23	1.40	1.29
Al ^{VI}	1.32	1.38	1.29	1.32	1.30	1.29	1.28	1.30
Cr	0.02	0.02	0.03	0.03	0.04	0.02	0.02	0.03
Fe ³⁺	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.00
Fe ²⁺	2.45	2.44	2.50	2.52	2.50	2.56	2.41	2.55
Mn	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Mg	2.16	2.09	2.18	2.13	2.16	2.09	2.19	2.10
Cat.	10.0	9.9	10.0	10.0	10.0	10.0	10.0	10.0
X _{Fe}	0.53	0.54	0.53	0.54	0.54	0.55	0.52	0.55
T [°C] ^a	235	238	242	245	244	234	250	240
Muscovite								
No.	mu-1	mu-2	mu-3	mu-4	mu-5	mu-6	mu-7	mu-8
SiO ₂	46.66	47.03	47.28	47.22	47.06	47.27	46.48	47.56

TiO ₂	0.24	0.24	0.13	0.19	0.25	0.23	0.25	0.2
Al ₂ O ₃	33.92	34.39	34.93	34.3	33.39	34.75	34.41	34.57
Cr ₂ O ₃	0.21	0.08	0.15	0.13	0.01	0.15	0.28	0.17
FeO	2.24	2.25	1.84	2.37	2.15	1.81	2.29	2.06
MnO	0	0	0.05	0.04	0	0	0	0.07
MgO	0.53	0.53	0.59	0.56	0.5	0.47	0.49	0.38
CaO	0.04	0.01	0	0.01	0.04	0.02	0	0.02
Na ₂ O	0.9	0.95	1.21	0.91	1.04	1.03	1.07	1.39
K ₂ O	8.87	8.96	8.07	9.15	8.93	8.88	9.11	8.53
Total	93.61	94.44	94.31	94.88	93.37	94.61	94.38	94.95
O	11	11	11	11	11	11	11	11
Si	3.15	3.14	3.14	3.15	3.18	3.14	3.12	3.15
Ti	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Al ^{IV}	0.85	0.86	0.86	0.85	0.82	0.86	0.88	0.85
Al ^{VI}	1.84	1.85	1.87	1.84	1.84	1.87	1.84	1.86
Cr	0.01	0.00	0.01	0.01	0.00	0.01	0.02	0.01
Fe ³⁺	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00
Fe ²⁺	0.13	0.13	0.07	0.13	0.12	0.10	0.13	0.11
Mn	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mg	0.05	0.05	0.06	0.06	0.05	0.05	0.05	0.04
Ca	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Na	0.12	0.12	0.16	0.12	0.14	0.13	0.14	0.18
K	0.76	0.76	0.68	0.78	0.77	0.75	0.78	0.72
Cat.	6.9	6.9	6.9	6.9	6.9	6.9	7.0	6.9
X _{Na}	0.13	0.14	0.19	0.13	0.15	0.15	0.15	0.20
Al _{M2}	0.91	0.91	0.93	0.91	0.91	0.93	0.91	0.92

$X_{Fe} = Fe^{2+}/(Fe^{2+} + Mg)$, $X_{Na} = Na/(Na + K)$, $Al_{M2} = Al^{VI}/(Al^{VI} + Mg + Fe^{2+})$; $a \ T [^{\circ}C] = 115.5 \ Al^{IV} + 20.1 \ Fe^{3+} + 40 \ [2-4]$.

Table S2. SHRIMP oxygen isotope (V-SMOW, ‰) analyses for quartz, magnetite and dolomite from the BIF and chlorite schist and for the relevant normalizing reference materials.

Quartz			Magnetite			Dolomite		
Spot#	$\delta^{18}O$	1 σ	Spot#	$\delta^{18}O$	1 σ	Spot#	$\delta^{18}O$	1 σ
EK2q-1	12.53	0.06	EK2mag-2	-1.59	0.05	EK5-1.1	11.89	0.04
EK2q-2	12.70	0.04	EK2mag-3	-6.03	0.04	EK5-1.2	11.84	0.04
EK2q-3	12.32	0.04	EK2mag-4	-1.81	0.04	EK5-1.3	11.83	0.04
EK2q-4	12.53	0.05	EK2mag-5	-2.00	0.05	EK5-1.4	11.97	0.04
EK2q-6	12.69	0.05	EK2mag-6	-3.21	0.04	EK5-1.5	11.67	0.04
EK2q-7	12.40	0.04	EK2mag-7	0.18	0.04	EK5-1.6	11.99	0.04
EK2q-8	12.54	0.04	EK2mag-8	-4.88	0.04	EK5-1.7	11.50	0.04
EK2q-9	12.56	0.04	EK2mag-9	-2.75	0.04	EK5-1.8	11.59	0.04
EK2q-10	12.48	0.05	EK2mag-10	-2.35	0.04	EK5-1.10	11.60	0.05
EK2q-11	12.25	0.04	EK2mag-11	-3.16	0.04	EK5-2.1	11.77	0.03
EK2q-12	12.32	0.04	EK2mag-12	-1.32	0.04	EK5-2.2	12.04	0.04
EK2q-13	12.95	0.04	EK2mag-13	-5.23	0.05	EK5-2.6	11.76	0.04
EK2q-14	12.50	0.05	EK2mag-14	-1.65	0.05	EK5-2.9	12.08	0.03
EK2q-15	12.55	0.04	EK2mag-15	-4.30	0.06	EK5-3.1	12.08	0.05
EK2q-16	12.23	0.05	EK2mag-16	-2.25	0.04	EK5-3.3	12.03	0.04
EK2q-17	12.71	0.03	EK2mag-17	-1.08	0.04	EK5-3.5	11.81	0.05
EK2q-18	12.85	0.04	EK2mag-18	-0.44	0.05	EK5-3.6	11.71	0.04
EK2q-19	12.13	0.05	EK2mag-19	-2.77	0.06	EK5-3.7	11.72	0.03
EK2q-20	12.50	0.04	EK2mag-20	-0.12	0.06	EK5-3.8	12.02	0.04
EK2q-21	12.18	0.04	EK2mag-21	-2.26	0.04	EK5-3.9	11.86	0.03
EK2q-22	12.04	0.06	EK2mag-22	-5.91	0.05	EK6-1.1	12.01	0.03
EK2q-24	12.34	0.05	EK2mag-23	-4.23	0.07	EK6-1.2	11.60	0.04
EK2q-25	12.28	0.04	EK2mag-24	-3.53	0.04	EK6-1.3	11.91	0.03
EK2q-26	12.52	0.06	EK2mag-26	-3.10	0.05	EK6-1.4	11.45	0.03
EK2q-27	12.56	0.04	EK2mag-27	-4.39	0.05	EK6-1.5	11.51	0.03
EK2q-28	12.01	0.05	EK2mag-29	-3.08	0.06	EK6-1.6	11.46	0.04
EK2q-30	12.89	0.06	EK2mag-30	-4.67	0.07	EK6-1.7	11.81	0.04
EK11q-1	11.94	0.05	EK11mag-1	-2.04	0.06	EK6-1.8	11.54	0.04
EK11q-2	12.50	0.04	EK11mag-2	-1.66	0.08	EK6-1.9	11.85	0.03
EK11q-3	12.25	0.05	EK11mag-3	0.26	0.07	EK6-1.10	11.98	0.04
EK11q-4	11.97	0.05	EK11mag-4	1.65	0.07	EK6-2.1	11.66	0.04
EK11q-5	12.17	0.05	EK11mag-5	-1.89	0.08	EK6-2.2	11.94	0.03

EK11q-6	12.26	0.04	EK11mag-7	−3.22	0.09	EK6-2.4	11.51	0.04
EK11q-7	12.44	0.04	EK11mag-8	−2.84	0.08	EK6-2.5	11.62	0.04
EK11q-8	12.85	0.07	EK11mag-9	2.51	0.06	EK6-2.6	11.83	0.03
EK11q-10	12.61	0.06	mgt2-1.1	−1.10	0.04	EK6-2.7	11.77	0.04
EK11q-11	12.73	0.05	mgt2-1.2	−1.53	0.05	EK6-2.8	11.72	0.04
EK11q-12	12.39	0.04	mgt2-1.3	−1.41	0.04	EK6-2.9	11.35	0.04
EK11q-13	12.06	0.04	mgt2-1.4	−1.77	0.04	EK6-3.1	11.83	0.04
EK11q-14	12.56	0.04	mgt2-1.5	−1.28	0.05	EK6-3.2	11.59	0.04
EK11q-15	12.97	0.04	mgt2-1.6	−1.47	0.05	EK6-3.3	11.54	0.04
EK11q-16	12.77	0.05	mgt2-1.7	−1.47	0.04	EK6-3.4	11.29	0.05
EK11q-17	11.70	0.05	mgt2-1.8	−1.49	0.04	EK6-3.5	11.50	0.04
EK11q-18	12.43	0.04	mgt2-1.9	−1.51	0.06	EK6-3.7	11.44	0.03
EK11q-19	11.91	0.04	mgt2-1.10	−1.08	0.05	EK6-3.8	11.52	0.04
EK11q-20	11.88	0.04	mgt2-2.1	−1.95	0.07	EK6-3.9	11.68	0.04
UWQ1-1.1	12.35	0.05	mgt2-2.2	−0.65	0.08	EK6-3.10	11.91	0.04
UWQ1-1.2	12.34	0.05	mgt2-2.3	−0.93	0.06	NBS19-1.1	28.77	0.05
UWQ1-1.3	12.30	0.04	mgt2-2.4	−1.24	0.09	NBS19-1.2	28.50	0.04
UWQ1-1.4	11.93	0.06	mgt2-2.5	−0.82	0.06	NBS19-1.3	28.59	0.04
UWQ1-1.5	12.09	0.06	mgt2-2.6	−1.21	0.09	NBS19-1.4	28.47	0.03
UWQ1-2.1	12.01	0.05	mgt2-2.7	−1.41	0.07	NBS19-2.1	28.51	0.04
UWQ1-2.2	12.27	0.05	mgt-1.1	−3.53	0.06	NBS19-2.2	28.54	0.05
UWQ1-2.3	12.54	0.06	mgt-1.2	−3.48	0.08	NBS19-2.3	28.60	0.04
UWQ1-2.4	12.51	0.04	mgt-1.3	−2.81	0.10	NBS19-2.4	28.65	0.03
UWQ1-2.5	12.52	0.06	mgt-1.4	−2.57	0.08	NBS19-3.1	28.83	0.03
UWQ1-2.6	12.34	0.04	mgt-1.5	−2.62	0.08	NBS19-3.2	28.44	0.04
UWQ1-2.7	12.70	0.05	mgt-2.1	−0.84	0.06	NBS19-4.1	28.80	0.05
UWQ1-2.8	12.01	0.04	mgt-2.2	−0.50	0.07	NBS19-4.2	28.64	0.05
-	-	-	mgt-2.3	−0.82	0.09	NBS19-5.1	29.05	0.05
-	-	-	mgt-2.4	−0.95	0.10	NBS19-5.2	28.55	0.05
-	-	-	mgt-2.5	−0.36	0.08	NBS19-6.1	28.90	0.04
-	-	-	mgt-3.1	−0.47	0.08	NBS19-6.2	28.61	0.04
-	-	-	mgt-3.2	−0.95	0.11	NBS19-7.1	28.68	0.04
-	-	-	mgt-3.3	−0.71	0.09	-	-	-

Table S3. Bulk-rock composition of the chlorite schist samples.

Samples	SiO ₂	TiO ₂	Al ₂ O ₃	Fe ₂ O ₃	MnO	MgO	CaO	Na ₂ O	K ₂ O	P ₂ O ₅	CO ₂	S	LOI	GI ^b
16EK05 ^a	39.69	0.73	11.78	11.86	0.19	6.84	8.63	0.3	2.35	0.05	14.57	0.027	17.31	0.52
16EK06 ^a	45.58	1.88	12.34	17.55	0.14	6.96	4.27	1.59	0.12	0.19	6.34	0.011	9.69	0.61
Sample	Figures	H ₂ O ^d	CO ₂ ^d	SiO ₂	Al ₂ O ₃	CaO	MgO	FeO	K ₂ O	Na ₂ O	X(CO ₂)	-	-	-
16EK05 ^c	Figure 6a	50	0	25.84	4.52	6.02	6.64	5.81	0.98	0.19	0	-	-	-
		20	30	25.84	4.52	6.02	6.64	5.81	0.98	0.19	0.6	-	-	-
	Figure 6b	37.5	12.5	25.84	4.52	6.02	6.64	5.81	0.98	0.19	0.25	-	-	-

^awt %, analyzed by X-ray fluorescence (XRF) spectrometer at the National Research Center of Geoanalysis, Chinese Academy of Geological Sciences; ^bGI (Garlick Index) = (O_{Si} + 0.58 O_{Al})/O_{total} [1]; ^cmol %, normalized in NCKFMASHC' system, used for phase equilibria modelling; ^dadjusted proportions. X(CO₂) = CO₂/(H₂O + CO₂).

References

- Garlick, G.D. Oxygen isotope fractionation in igneous rocks. *Earth Planet. Sci. Lett.* **1966**, *1*, 361–368, doi:10.1016/0012-821x(66)90026-4.
- Rausell-Colom, J.A.; Wiewiora, A.; Matesanz, E. Relation between composition and d001 for chlorite. *Am. Mineral.* **1991**, *76*, 1373–1379.
- Nieto, E. Chemical composition of metapelitic chlorites: X-ray diffraction and optical property approach. *Eur. J. Mineral.* **1997**, *9*, 829–841.
- Battaglia, S. Applying X-Ray Geothermometer Diffraction to a Chlorite. *Clays Clay Miner.* **1999**, *47*, 54–63, doi:10.1346/ccmn.1999.0470106.