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210016,

, 36 4 -5305,

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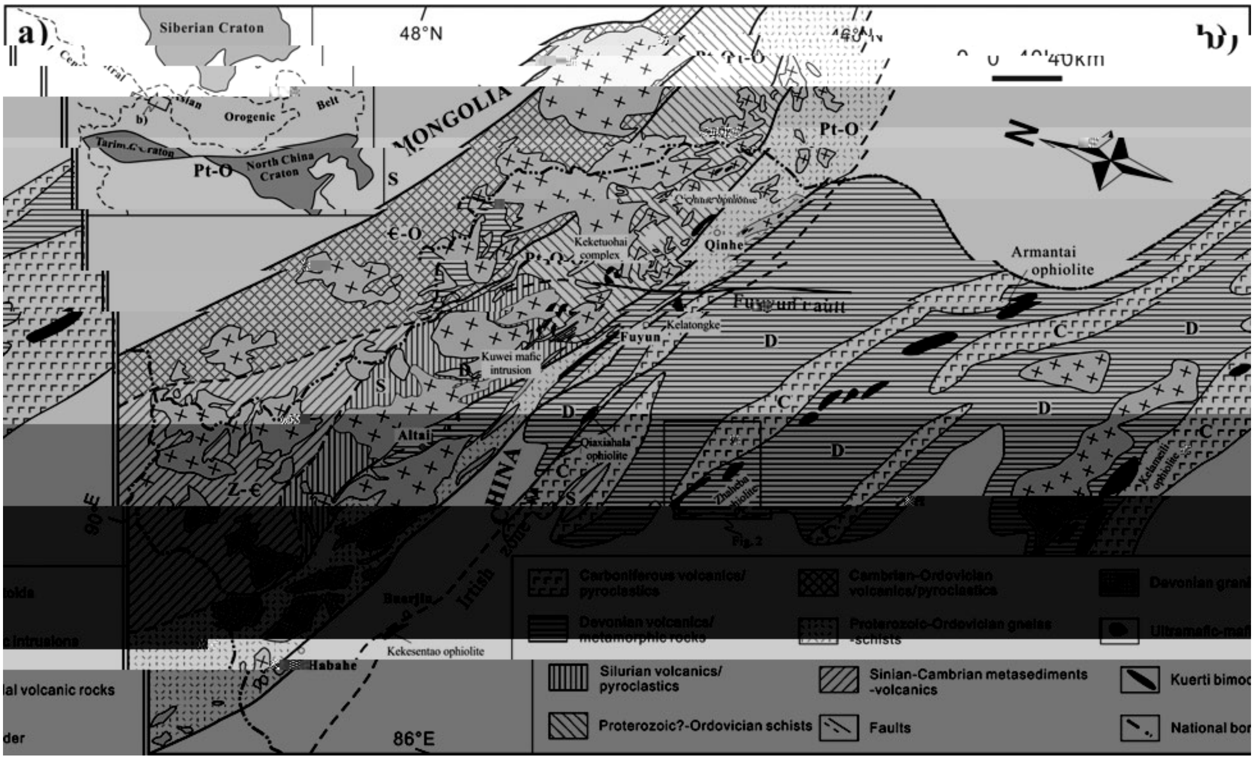
Abstract ~400 ~4 5 ε (t) (13 20) δ (+5.3 ‰)

1. Introduction

(et al. 200 & , 200 et al. 2012 et al. 2012, 2013 et al. 2013), (, 1 et al. 200 et al. 200 a). (, 1 , 1 3 et al. 2000 & , 2003 et al. 200 , 2014). & (2011) ( ), (2014)

( ), (& , 2000 & , 1 3 et al. 2002 et al. 2004, 200 a) (. 1). (et al. 200 d,b & , 2012). (, 1 3 et al. 2003 et al. 2003 et al. 200 a) (. 1).



1. (a) [illegible] et al. 2006).

[illegible]

2. Regional geology, field observations and petrography

[illegible]

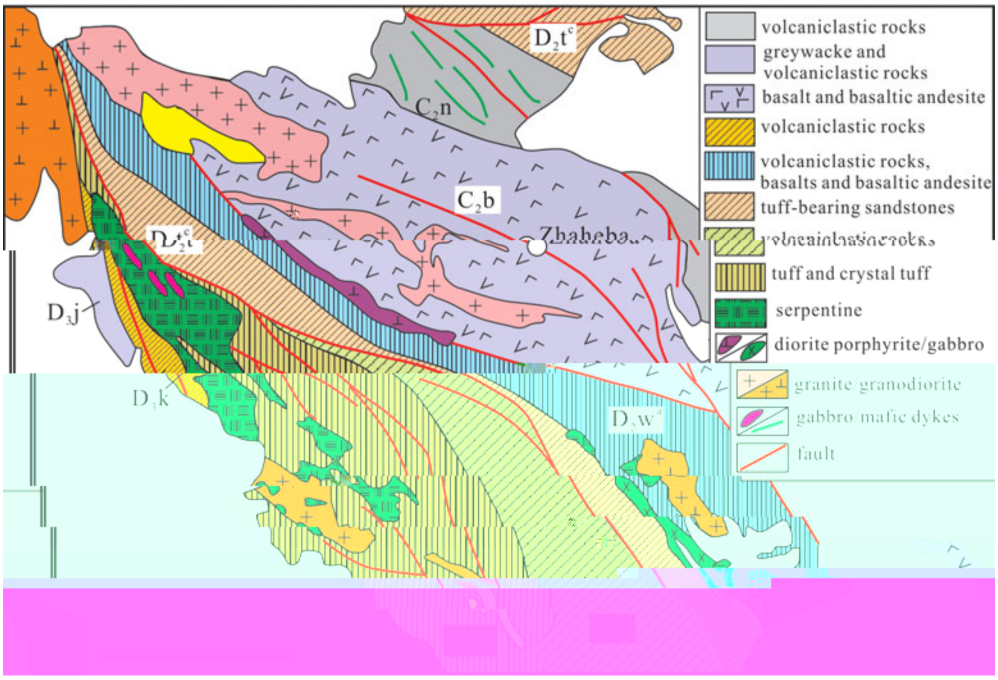


Fig. 2. [illegible] *et al.* 200[illegible], 200[illegible] [illegible] 1[illegible] 3).

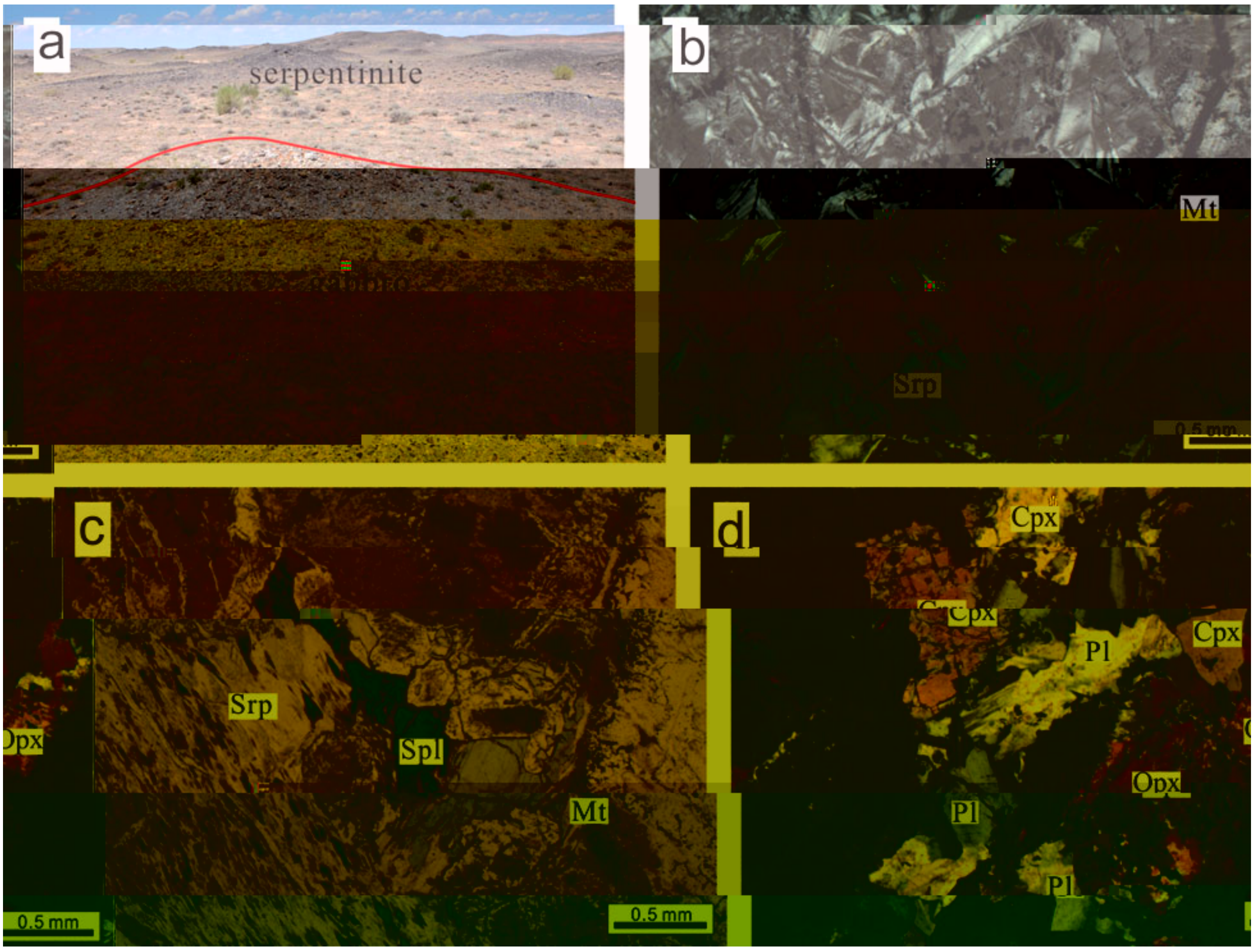


Fig. 3. [illegible]

3. Analytical procedures

3.a. Zircon U–Pb dating and Hf–O isotope analysis

(2013 01, 46° 32′ 51 ° 2′ 4) (2013 02, 46° 33′ 2 ° 2′ 36.)

et al. (2011). *et al.* 2010) (, 2003). 5 % 1 2 12 0 *et al.* (2010*a*). ±0.0020052), 5.31 ‰ (*et al.* 2010*b*). 5.44 ± 0.21 ‰ (2), 5.4 ± 0.2 ‰ (*et al.* 2013). 3

3.b. Mineral analysis

00 15 15 20 4 5

3.c. Whole-rock analysis

100 *et al.* (2004). 2 %. 6000 *et al.* (2004). 50 + 3 -1, -2 -2, -1 3, 3 5 %. 1. + 3 *et al.* (2004). 0.11 4 = 0. 21 0. 102 0. 0506 -1, 0.512104 0.5126 1 -1. 2.

4. Analytical results

4.a. Zircon U–Pb ages

100 150 μ 1 1 2 1. . 4). (22 123) (5) 0.4 0. . 30 4 5. ± 2.5

[illegible] 1. [illegible]

[illegible]	2013[illegible] 01-1 [illegible]	2013[illegible] 01-3 [illegible]	20132[illegible] 01-4 [illegible]	2013[illegible] 01-5 [illegible]	2013[illegible] 01-6 [illegible]	2013[illegible] 01-[illegible]	2013[illegible] 01-[illegible]	2013[illegible] 01 1 [illegible]	2013[illegible] 01 2 [illegible]	2013[illegible] 01 4 [illegible]
					Major elements (%)					
[illegible] 2	3 . 0	4 .20	3 .41	3 .62	3 .22	3 . 2	3 .05	4 .22	46.4	51.2
[illegible] 2	0.05	0.20	0.05	0.05	0.04	0.05	0.04	0.14	0.12	0.2
[illegible] 2 3	0.61	1. 6	1.04	0.6	0. 0	0. 4	0. 0	1 .2	1 .64	1 .33
[illegible] 2 3	.44	4.6	.	.36	.5	.16	. 4	3.6	3.24	3.
[illegible]	0.0	0.10	0.11	0.11	0.11	0.0	0.11	0.0	0.0	0.0
[illegible]	3 .21	24.5	3 . 2	3 .	3 .0	3 .31	3 .44	10.04	.03	5.
[illegible]										

1.

[illegible]	2013 01-1	2013 01-3	20132 01-4	2013 01-5	2013 01-6	2013 01-	2013 01-	2013 01 1	2013 01 2	2013 01 4
[illegible]	0.005	0.064	0.00	0.005	0.00	0.003	0.003	0.051	0.044	0.222
[illegible]	0.021	0.34	0.044	0.042	0.0 2	0.031	0.033	0.310	0.25	1.450
[illegible]	0.004	0.04	0.00	0.00	0.011	0.005	0.005	0.04	0.043	0.21
[illegible]	0.011	0.232	0.036	0.044	0.012	0.034	0.00	0.123	0.0 0	0. 3
[illegible]	0.0 0	0.036	0.03	0.03	0.06	0.026	0.025	0.046	0.031	0.06
[illegible]	0.26	1. 10	6.600	1. 0	0. 3	0.233	1.150	1.5 0	0.516	0.1 5
[illegible]	0.406	0.0 2	0.12	0.112	0.0	0.1	0.054	0.16	0.1 1	0.6 5
[illegible]	0.046	0.034	0.014	0.02	0.050	0.030	0.010	0.050	0.02	0.130
[illegible]	0.1 1	0.144	0.203	0.364	0.042	0.0 4	0.0	0.066	0.042	0.0 3
[illegible]	2013 01 5	2013 01 6	2013 01 (1)	2013 01 (1)	2013 01 (1)	2013 03 2 (1)	2013 03 3 (1)	2013 03 4 (1)	2013 03 5 (1)	2013 01 3 (2)
Major elements (%)										
[illegible]	4 .1	45.	4 .	53.1	51. 1	50.40	50.54	50.52	51.22	52.3
[illegible]	0.34	0.15	1.40	1.24	1.31	1. 0	1.63	1.31	1.1	0.33
[illegible]	1	1 .5	16.5	16.1	15. 3	15.	16. 6	15.55	15.4	1 .61
[illegible]	4.52	3.34	.	.11	.43	.0	.50	.42	. 2	3.44
[illegible]	0.0	0.0	0.11	0.10	0.11	0.13	0.11	0.14	0.12	0.0
[illegible]	6.	.42	4. 0	4.2	4.41	5.	3.2	6.06	.14	4.
[illegible]	11.03	12.61	6.22	5. 5	6.3	6. 5	4.52	.4	.26	. 0
[illegible]	4. 6	.3	. 2	.3	.00	4.52	.31	4. 0	4.0	.11
[illegible]	0.13	0.11	0.3	0.31	0.42	2.04	0.33	1.2	2.03	0.1
[illegible]	0.04	0.02	0.62	0.62	0.65	0. 4	0.6	0.4	0.44	0.04
[illegible]	3. 2	3.26	4.24	2.54	2. 3	2.2	5.14	2.65	1. 3	2.
[illegible]	. 5	. 2	. 6	. 0	.4	.40	. 1	.6	.6	. 1
[illegible]	4.	.4	.11	. 0	.42	6.56	.64	6.0	6.11	.2
[illegible] #	5	1	55	54	54	56	41	56	64	4
Trace elements (ppm)										
[illegible]	.0	4. 5	1.16	1.12	1.4	.0	40.4	5.2	6. 2	5. 1
[illegible]	0.22	0.135	1.2 4	1.6 3	1.316	1. 53	1.034	1.100	0.5 5	0.62
[illegible]	25.0	23.	1 .6	1 .5	1 .5	.5	1 .2	25.2	1	1 .0
[illegible]	11	3.	1 6	166	1 2	22	22	254	1	5.
[illegible]	34.	163	60.5	62.6	64.1	116	1	0.	203	23.
[illegible]	24.2	21.6	26.	23.6	24.6	2 .	2 .5	2 .0	2 .0	16.4
[illegible]	4.	1 5	63.6	50.	51.4	6.	2 .	5 .3	132	1.1

52. 4 55.5 .4 32. (132)-6300 -1.04.3(510.5)-1 5

4..05 6 1. 6 .6

1.

	2013 01 5	2013 01 6	2013 01	2013 01 (1)	2013 01 (1)	2013 03 2 (1)	2013 03 3 (1)	2013 03 4 (1)	2013 03 5 (1)	2013 01 3 (2)
			(1)							
[illegible]	3.	1.20	3 .60	46. 0	4 .30	23.40	43.00	25.20	32. 0	6.56
[illegible]	.	2.6	.50	.1(15101.2))	01.2)					

1.

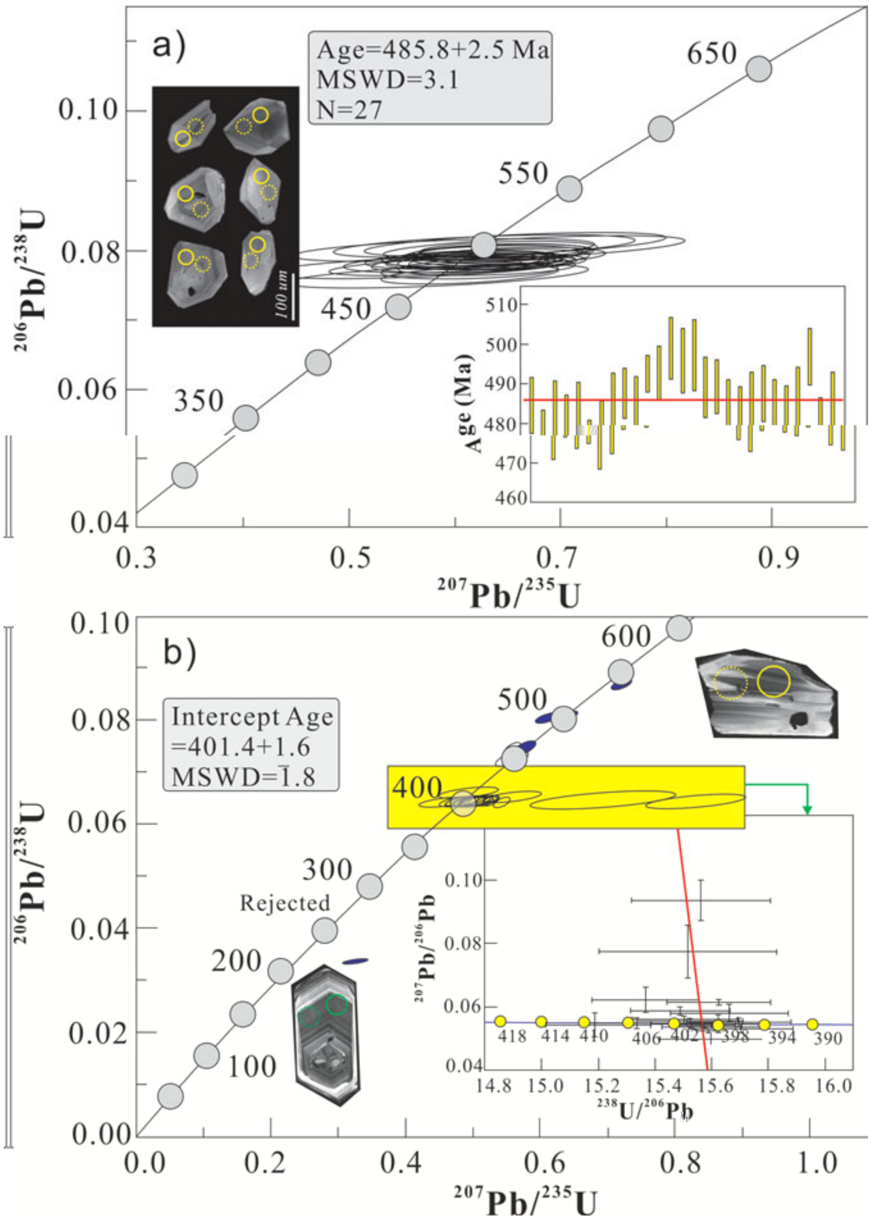
	2013 01 11 (2)	2013 02 1 (2)	2013 02 2 (2)	2013 03 1 (1)	2013 03 6 (1)	2013 01 10 (2)	04 06 (1)	04 24 (1)	04 2 (1)	03 1 (1)
				Trace elements (ppm)						
	1 .4	36.	42.4	26.0	32.4	1 .	/	/	/	/
	0.3 5	0.153	0.35	1.1	0. 4	0.46	/	/	/	/
	32.5	33.2	34.5	25.1	26.3	32.1	13.4	20.5	1 .	20.3
	1 4	203	21	33	341	1 5	144	1 4	214	265
	56.5	44.2	4 .	1 .	22.2	53.	15	162	214	265
	34.	3 .5	3 .3	23.1	24.	33.	20.6	30.	2 .	20.2
	66.4	4.6	6.4	25.4	2 .1	66.6	.1	114	5.5	.02
	6.4	236.4	256.	205.4	20 .	114.20	/	/	/	/
	4 .0	44.1	4 .0	4.	103	44.1	/	/	/	/
	12.0	11.1	11.2	14.	13.6	12.0	/	/	/	/
	0.5	1.420	1.0 0	3.130	3.2 0	0.5 3	4.	1 .1	22.0	1 .2
	1	1 50	5	2 0	24	6 6	1	31	111	6
	13.0	13.0	13.2	21.1	22.	12.5	13.2	13.2	14.	20.1
	54.	42.3	41.5	144	154	52.	243	133	164	151
	1.2	0. 4	0. 55	11.315	11. 5	1.25	20.2	12.	21.	12.2
	0.025	0.030	0.02	0.051	0.052	0.02	/	/	/	/
	0.3 1	0.2 6	0.32	1.560	1.450	0.360	/	/	/	/
	0.2	1. 20	1.030	0.365	0.406	0.336	/	/	/	/
	11	3 2	346	25	50	4.3	/	/	/	/
	10. 0	. 40	.610	26.40	26. 0	10.50	30.6	32.2	40.1	26.4
	23.00	1 . 0	1 .40	51.50	54. 0	22.30	5 .	62.	2.3	52.5
	2. 0	2.520	2.510	5. 50	6.1 0	2.6 0	6.	. 4	10.5	6.4
	11. 0	11. 0	11.60	22.30	24.30	11.60	2 .5	31.2	43.1	24.4
	2.540	2. 00	2.6 0	4.4 0	4. 00	2.3 0	4.5	5.2	6.	4. 5
	0. 6	0. 1	0. 0	1.163	1.25	0. 3	1.45	1.5	2.0	1.03
	2.4 0	2. 13	2. 54	4.14	4.46	2.522	3.56	4.01	5.35	4.23
	0.3 6	0.3	0.3	0.612	0.660	0.3 4	0.4	0.54	0.64	0.63
	2.1 0	2.150	2.220	3.420	3.6 0	2.130	2.5	2.	3.24	3. 5
	0.46	0.446	0.444	0. 2	0. 5	0.46	0.4	0.52	0.5	0.
	1.350	1.230	1.240	2.120	2.2 0	1.310	1.32	1.3	1.45	2.25
	0.1 0	0.16	0.1 5	0.304	0.32	0.1 4	0.1	0.2	0.2	0.34
	1.210	1.050	1.120	1. 60	2.110	1.210	1.25	1.23	1.24	2.13
	0.1 4	0.164	0.165	0.2 1	0.323	0.1 3	0.20	0.1	0.1	0.34
	1.3 0	0. 41	1.040	3.2 0	3.510	1.460	5.3	3.2	4.16	3. 2
	0.0 4	0.062	0.051	0.5	0.644	0.0 .	1.35	0.6	1.16	0.6
	0.151	2.0	1.50	2. 5	1.	0.33	/	/	/	/
	0.3 4	0.206	0.200	45.20	35.10	0.41	.13	.0	4.1	21.06
	1. 0	0. 61	0. 1	. 60	.2 0	1. 0	4.50	2.63	3.20	.41
	0.500	0.304	0.302	2. 30	3.4 0	0.501	1.	0.6	1.46	2.5

04 06, 04 26, 04 2 04 1 *et al.* (200 *a*).

[illegible] 2. [illegible]

[illegible]	[illegible]	[illegible] ( )	[illegible] ( )	[illegible]/ 6[illegible]	[illegible]/ 6[illegible] (1σ)	([illegible]/ 6[illegible])i	[illegible] ( )	[illegible] ( )	14[illegible]/ 144[illegible]	143[illegible]/ 144[illegible] (1σ)	(143[illegible]/ 144[illegible])i	ε[illegible] (t)
2013[illegible]01 3	[illegible] (2)	0.36	3[illegible]2	0.002	0.[illegible]04030(2[illegible])	0.[illegible]04015	2.4	10.	0.13[illegible]4	0.512[illegible]3[illegible](40)	0.5124[illegible]4	6.
2013[illegible]01 10	[illegible] (2)	0.5	6[illegible]6	0.0024	0.[illegible]04[illegible]5[illegible](23)	0.[illegible]04[illegible]45	2.3	11.6	0.1235	0.512[illegible]0[illegible](43)	0.5124[illegible]6	.1
2013[illegible]03 1	[illegible] (1)	3.13	2[illegible]0	0.0335	0.[illegible]06324(20)	0.[illegible]06133	4.4	22.3	0.121	0.512533(4[illegible])	0.512214	1.
2013[illegible]03 2	[illegible] (1)	2.	1320	0.0063	0.[illegible]042[illegible](20)	0.[illegible]04255	4.[illegible]5	2[illegible].6	0.1046	0.512[illegible]1[illegible](51)	0.512445	6.3
2013[illegible]03 3	[illegible] (1)	.06	516	0.0452	0.[illegible]0536[illegible](43)	0.[illegible]05111	5.	36.	0.0	0.512[illegible]0[illegible](30)	0.512450	6.4
2013[illegible]03 4	[illegible] (1)	[illegible].65	14[illegible]0	0.01	0.[illegible]0422[illegible](51)	0.[illegible]04120	4.55	24.5	0.1123	0.512[illegible]03(53)	0.51250	.5

ε(t) = 10 000((143[illegible]/144[illegible])(t)/(143[illegible]/144[illegible])[illegible](t) − 1) ε(t) [illegible] ([illegible]/ 6[illegible])i [illegible] 401 [illegible]



[illegible] 4. ([illegible]) [illegible] 1σ [illegible] 2σ ([illegible]) [illegible].

([illegible] 4 [illegible] = 2 , [illegible] = 3.1). [illegible] 4 [illegible] ± 4 [illegible] ([illegible] *et al.* 2003). [illegible] 100 [illegible] 200 μ [illegible]

[illegible] 1 3 [illegible] 1 (1) [illegible] 0 % [illegible] (2) [illegible]

(2, ...4). ... 2 ... 450 ... 500 ... 21 ... 206 ... 23 ... 401 ± 2 ... = 3.3). ... 206 ... 23 ... 20 ... 235 ... 401.4 ± 1.6 ... = 1. ... 206 ... 23 ... .4), ... 1, 3).

4.b. Mineral compositions

4.b.1. Spinel composition

... .3). ... 100 ... 300 μ ... 4 ... 2 ... 3 ... 2 ... 3 ... 2 ... (100 ... /(... + ...)) ... 44 ... 60 ... (100 ... /(... + ...)) ... 25 ... 61. ... (*et al.* 2010). ... *et al.* 2013).

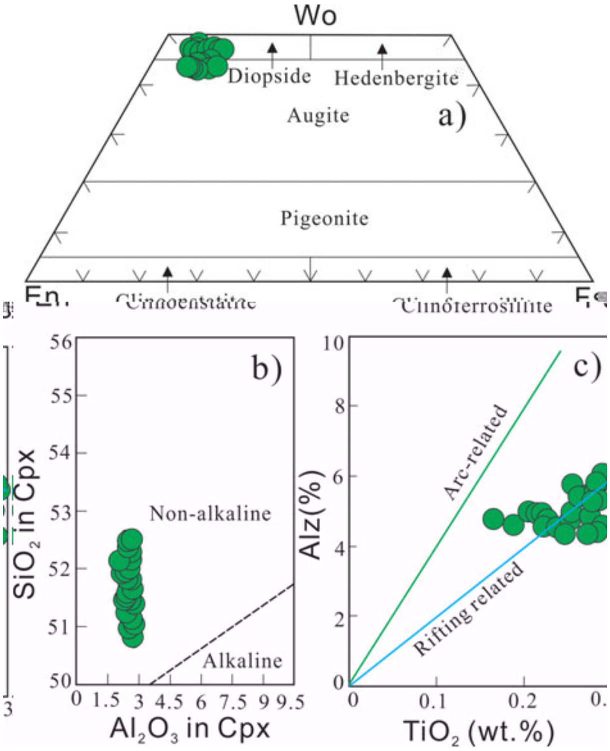
4.b.2. Pyroxene compositions

... (= 4 6). ... 2 ... 0.5 %) ... 5 ...). ... 41 4 ... 46 55 ... 1 ... .5). ... 2 ... 3 ... 2 ... 2 ... .5 ,).

4.c. Whole-rock elemental geochemistry

4.c.1. Serpentinites and cumulates

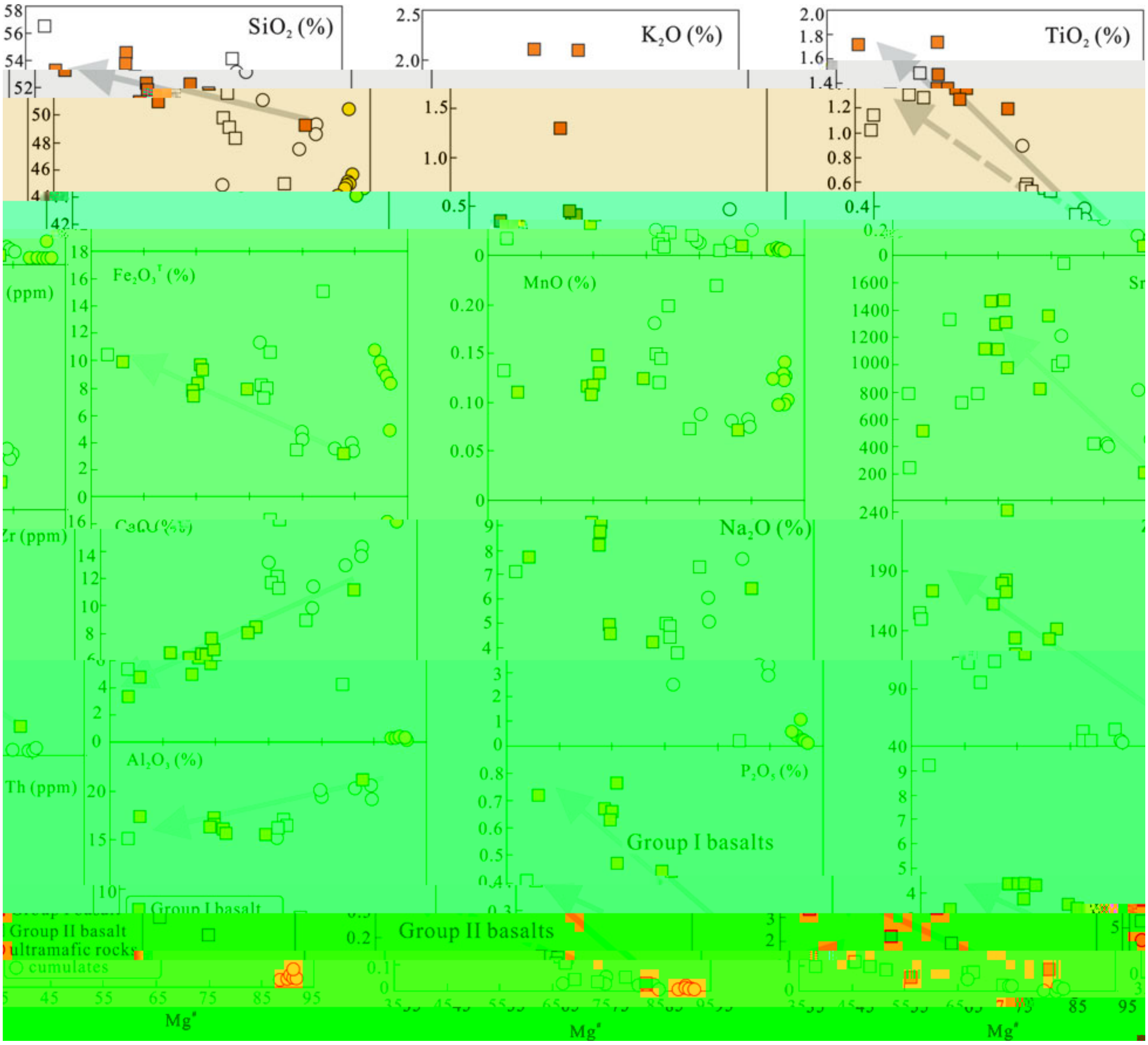
... (> 12 %, ... 2 (... 40 %), ... 2 3 (... 1.0 %), ... 2 (0.03 0.06 %), ... 2 (0.04 0. 2 %) ... 2 (0.04 0.05 %). ... 2 3 ...



5. ... ( ) ( ) ... 2 (%) ... 2 3 (%) ... 2 (%) ...

... 1 (1). ... .6). ... (3 103) ... (5) (1). ... (> 12 %) ... 2 ... 2 ... 2 3 ... 2 3 ... 2, ... 1). ...), ... , 2014 ... & ... 1).

... 45. % ... 51.2 %, ... 2 3 (3.24 4.6 %), ... 2 3 (1 .3 1 .6 %, ... 2013 ... 01-3), ... (.54 15.42 %), ... 2 (0.12 0.34 %), ... 2 (2. 1 .3 %, 2013 ... 01-3) ... 2 (0.11 0.46 %) ... 1).

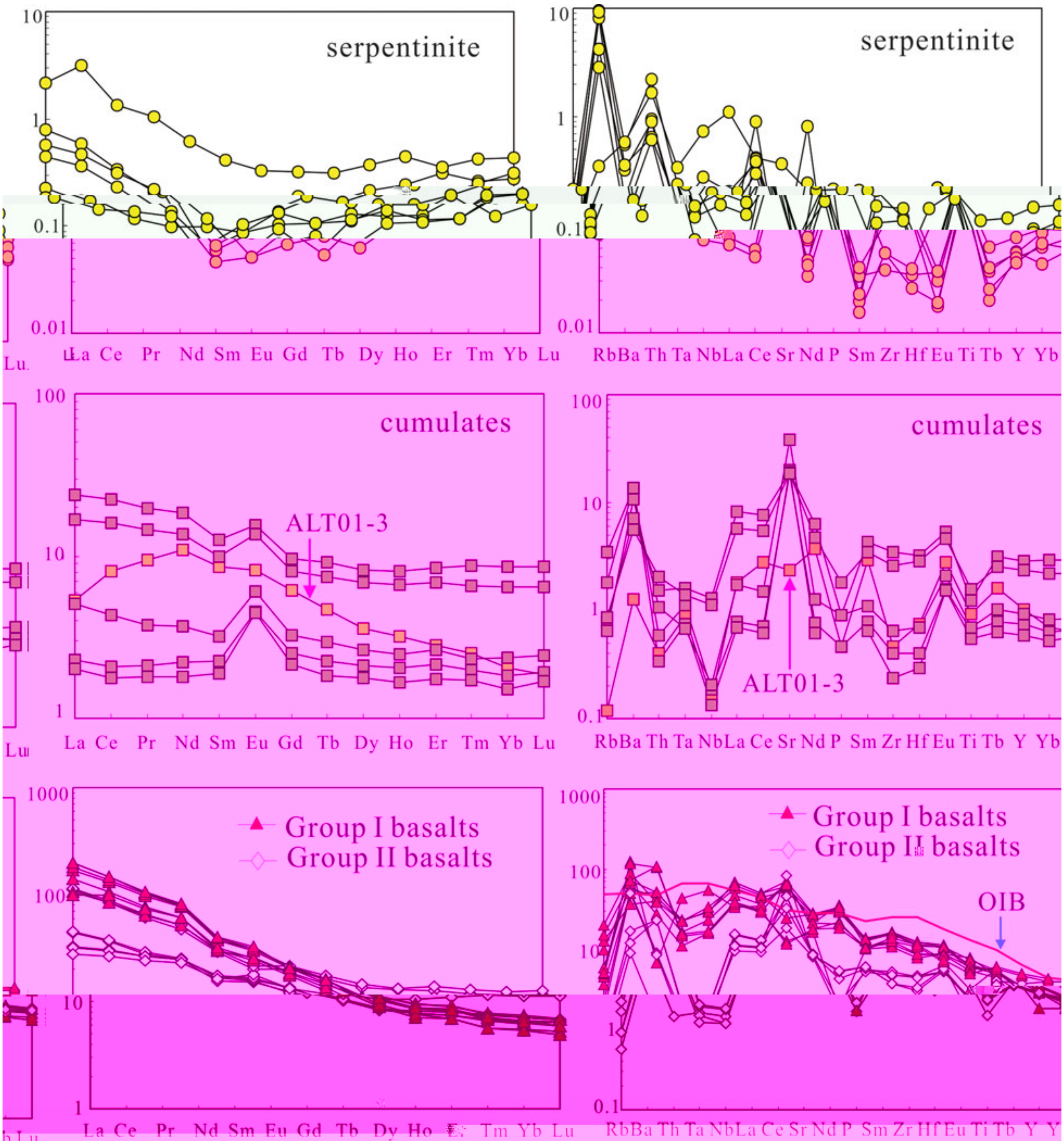


6. [illegible] *et al.* 200[illegible] [illegible]).

[illegible] 6). [illegible] 41 [illegible] = 1.3 [illegible] 2.[illegible] [illegible] = 1.1 [illegible] 2.2). [illegible] 2013 [illegible] 01-3 [illegible] = 0.2 [illegible] 0.4) [illegible]

4.c.2. Basalts

[illegible] 43.15 % [illegible] 5 .65 % [illegible] 52 %, [illegible] 1). [illegible] 1 [illegible] 1) [illegible] 2 [illegible] 2). [illegible] 2 [illegible] 6). [illegible] 124 [illegible] 205 [illegible] 2 [illegible] 50 [illegible] 60 [illegible] 1 [illegible] 10 [illegible] 30 [illegible] 20) [illegible]

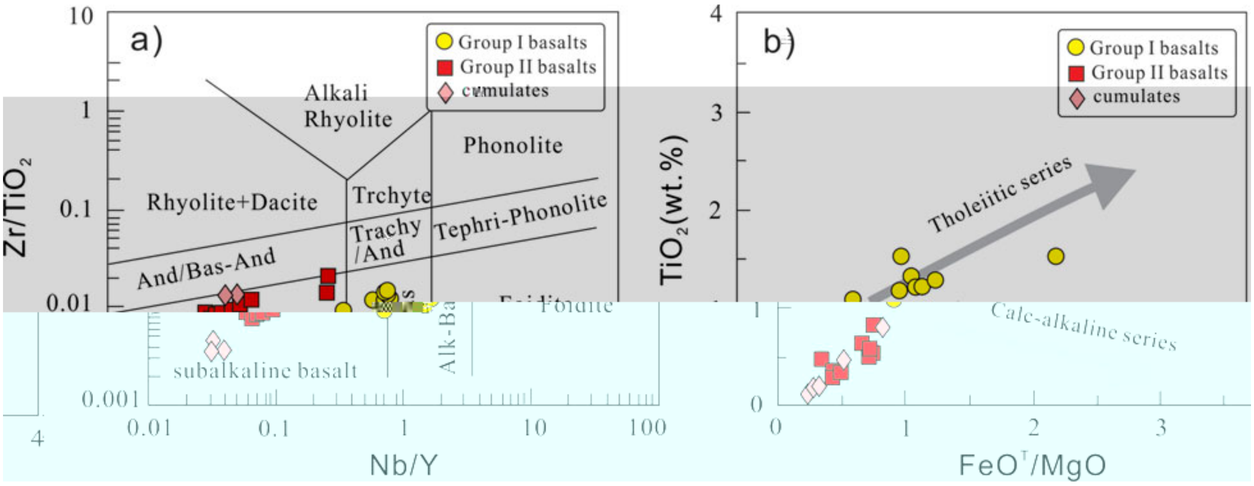


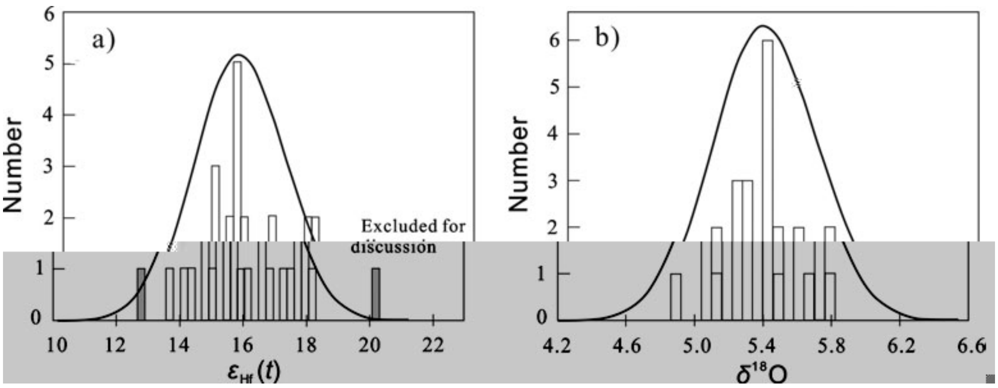
( ) & (1).

(/ = 0. 0 1.14) ( ). 2 (/) 4 6 (/ = 1.02 1.21) ( ). 1 0.44 0. 2 1 (~0.11) ( ).

4.d. Whole-rock Sr–Nd and zircon Hf–O isotopes

2. 1 2 / (0.0024 0.0452) / (0. 04030 0. 0536), / (0. 04015 0. 05111, 2013 03 1). 14 /144 0.0 0.13 4 143 /144 0.512 0 0.512 3 ε (t) +6.3 + .5 (2013 03 1 +1.).





5. Discussion

5.a. The individual members of the Zhaheba ophiolite

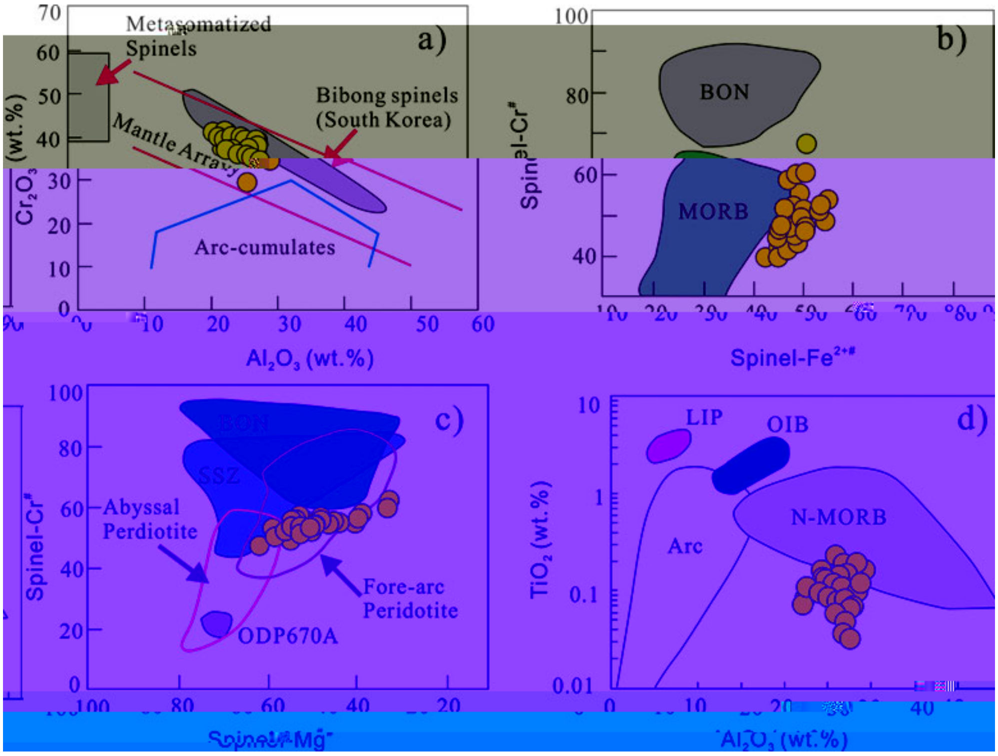
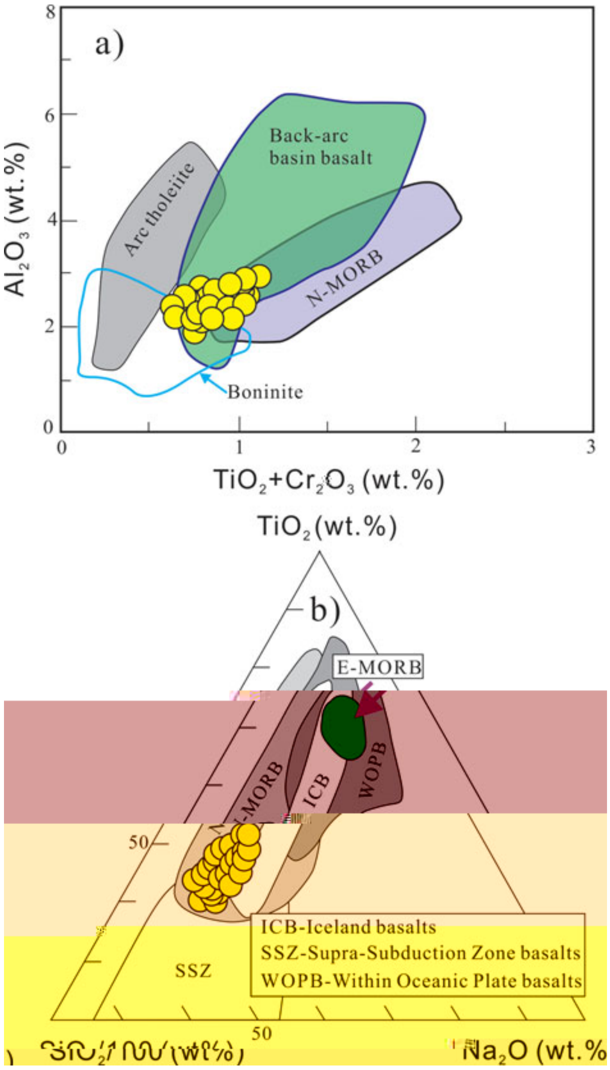


Figure 10. [illegible] ... 2000) ... (100 ... 2+ ... (100 ... 2+/(2+ +)) ... 2001) ... (100 ... et al. ... 5) ... 2001).

[illegible] (500 4 0) (et al. 2003 ... et al. 2015), ... (430 400) (et al. 200 b, 2014 ...) ... (3 0 350) (et al. 2003 ... et al. 2006).

5.b. Origin of the serpentinite and cumulates

[illegible] (& , 2002 ... et al. 2010 ...



5.c. Petrogenesis of the Devonian basalts

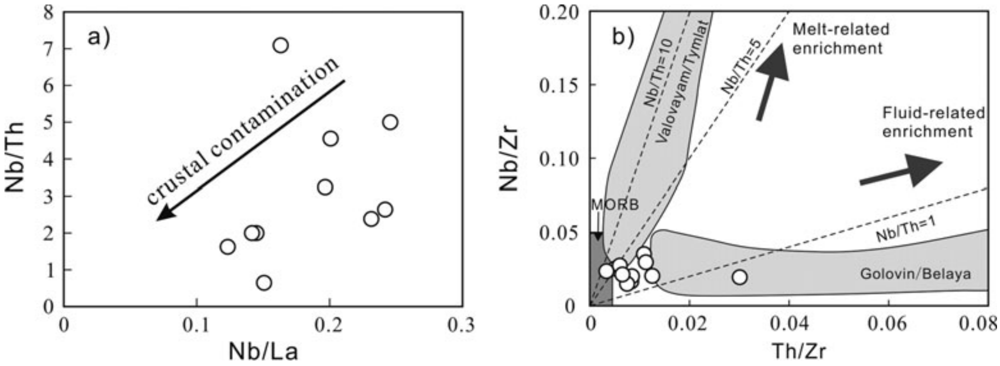


Figure 12. [illegible]

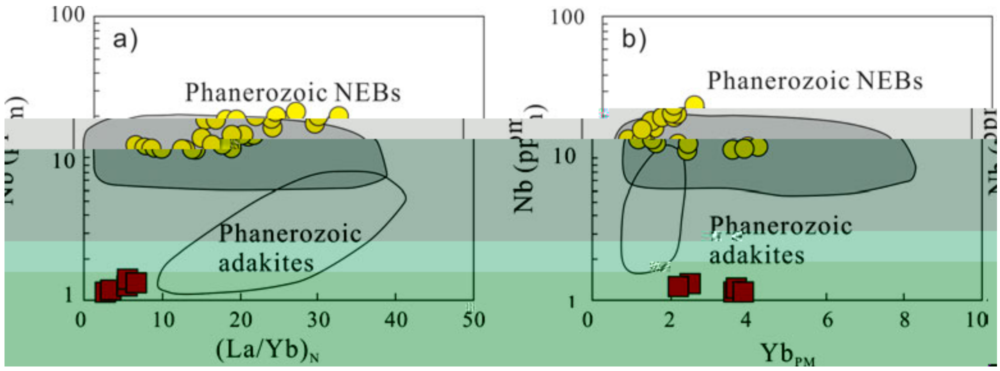
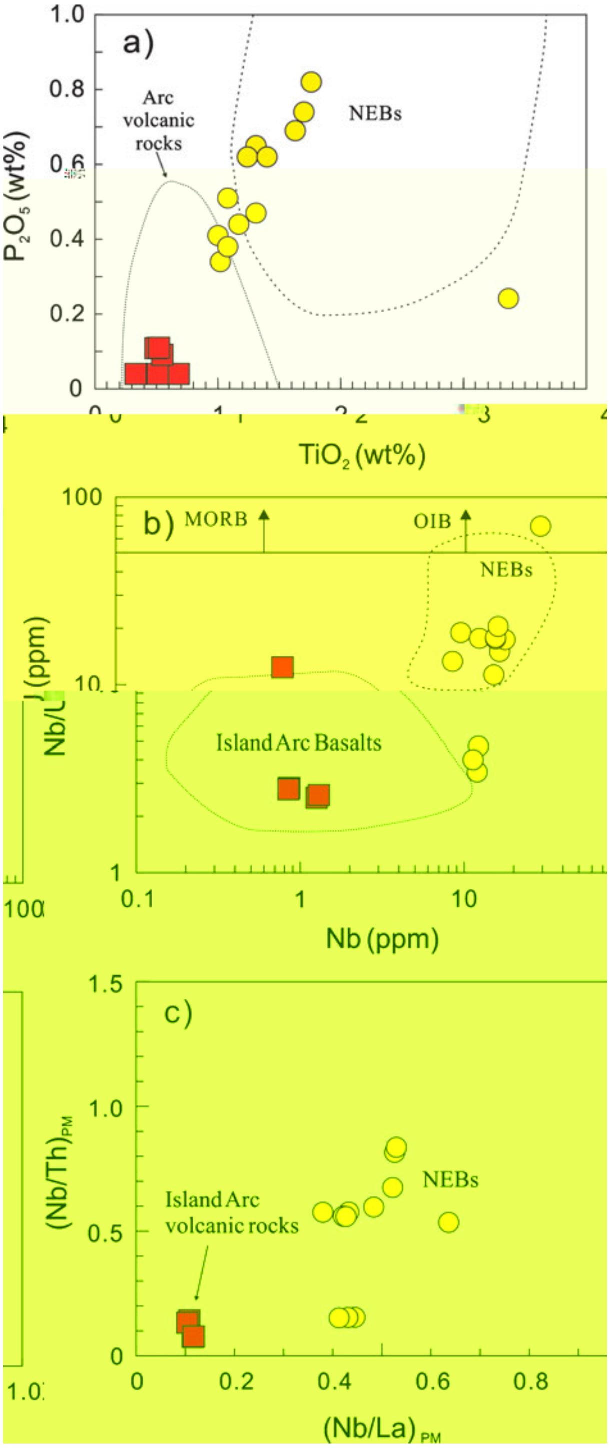


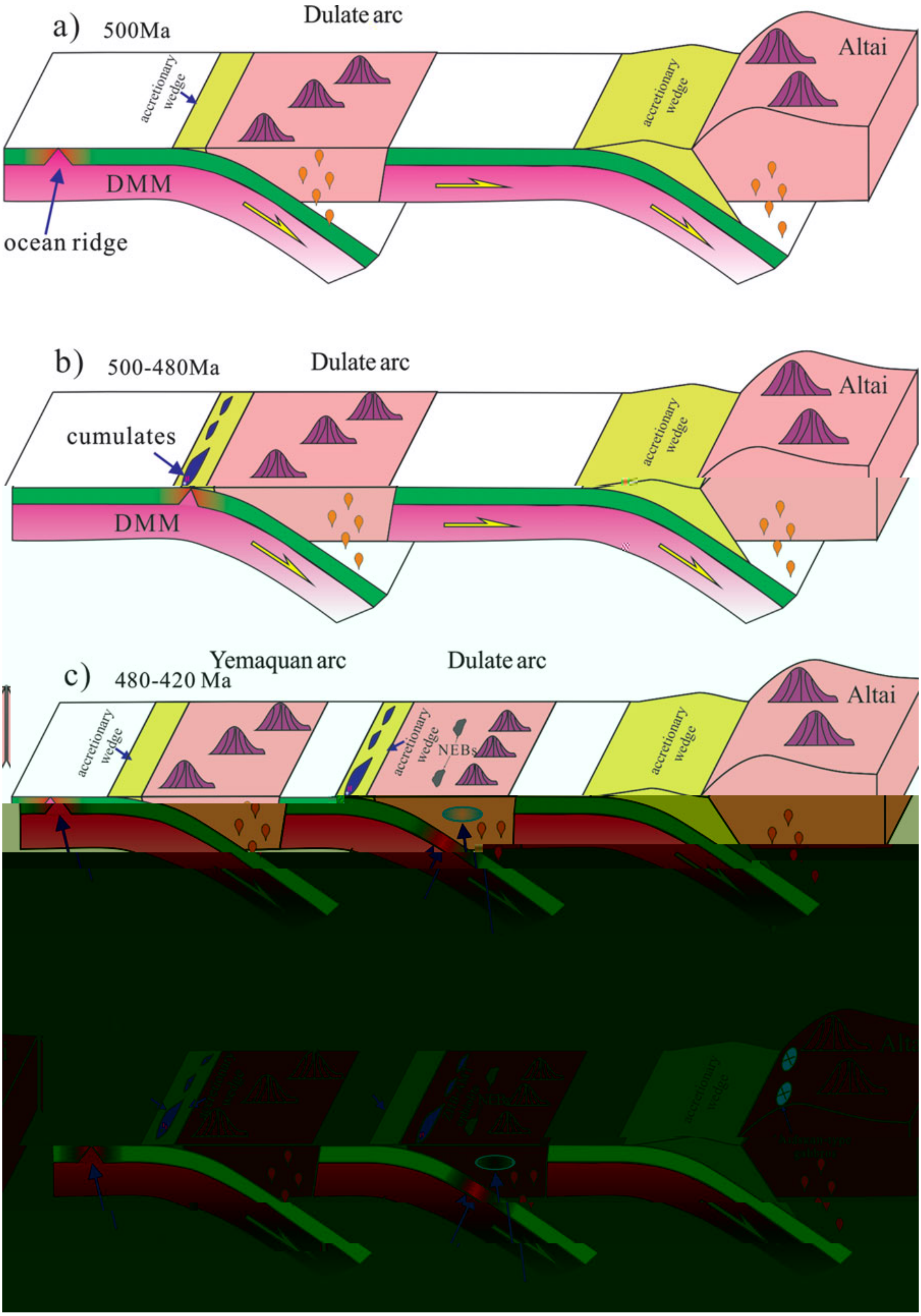
Figure 13. [illegible]

[illegible]

5.d. Implications for the Palaeozoic accretion process in eastern Junggar

[illegible]


a)
Arc volcanic rocks
NEBs
P_2O_5 (wt%)
TiO_2 (wt%)
b) MORB
OIB
NEBs
Island Arc Basalts
Nb/La (ppm)
Nb (ppm)
c)
NEBs
Island Arc volcanic rocks
$(Nb/Th)_{PM}$
$(Nb/La)_{PM}$


a)
500Ma
Dulate arc
accretionary wedge
accretionary wedge
Altai
DMM
ocean ridge
b)
500-480Ma
Dulate arc
cumulates
accretionary wedge
Altai
DMM
c)
480-420 Ma
Yemaquan arc
Dulate arc
accretionary wedge
accretionary wedge
NEBs
accretionary wedge
Altai

15. ( ), [illegible]

(4) [illegible] (420 3 0 [illegible]) ([illegible] *et al.* 2014 [illegible] *et al.* 2015). [illegible] 1 [illegible] 2 [illegible] 15 [illegible] (400 3 0 [illegible]). [illegible]

6. Conclusions

(1) [illegible] ~4 5 [illegible] *c.* 400 [illegible]

(2) [illegible]

(3) [illegible]

Acknowledgements. [illegible] 305 [illegible] (2011 [illegible] 06 03-01).

Supplementary material

[illegible] /10.101 [illegible] 0016 56 16000042.

References

[illegible] 4. [illegible] *Chemical Geology* **113**, 1 1 204.

[illegible] & [illegible] 2001. [illegible] *Journal of Petrology* **42**, 22 302.

[illegible] & [illegible] 200 [illegible] *Lithos* **97**, 2 1 [illegible]

[illegible] & [illegible] 2002. [illegible] *Geology* **30**, 0 10.

[illegible] & [illegible] 200 [illegible] *Earth Accretionary Systems in Space and Time* ([illegible] & [illegible]), 1 36. [illegible] 31 [illegible]

[illegible] & [illegible] 2002. [illegible] *Geological Magazine* **139**, 1 13.

[illegible] 3. [illegible] *Geological Society of America Bulletin* **105**, 15 3 [illegible]

[illegible] 1 [illegible] *Ophiolites.* [illegible] 220 [illegible]

[illegible] & [illegible] 3. [illegible] *Geology* **21**, 54 50.

[illegible] & [illegible] 2. [illegible] *Journal of Geological Society, London* **149**, 56 [illegible]

[illegible] & [illegible] 4. [illegible] *Contributions to Mineralogy and Petrology* **86**, 54 6.

[illegible] & [illegible] 2003. [illegible] (2) [illegible] *Ophiolites in Earth History* ([illegible] & [illegible]), 43 6 [illegible] 21 [illegible]

[illegible] & [illegible] 2011. [illegible] *Geological Society of America Bulletin* **123**, 3 411.

[illegible] & [illegible] 2015. [illegible] *Chinese Journal of Geology* **50**, 140 54 [illegible]).

[illegible] & [illegible] 2000. [illegible] *Contributions to Mineralogy and Petrology* **140**, 2 3 5.

[illegible] & [illegible] 1. [illegible] *Lithos* **27**, 25 [illegible]

. J. . J. & . 2011. *Geological Bulletin of China* **30**, 150 15).

. J. & . 2011. *Geochimica et Cosmochimica Acta* **75**, 504 2.

. J. . J. & . 2001. *Nature* **410**, 6 1.

. J. & . 2002. *Chemical Geology* **182**, 22 35.

. & J. . J. 1. 6. . *Journal of Geophysical Research: Solid Earth (1978–2012)* **101**, 11 31 .

. & J. . 2000. 2. . *Contributions to Mineralogy and Petrology* **139**, 20 26.

. J. & . 2012. . *Geological Bulletin of China* **31**, 126).

. J. & . 2014.). *Chinese Science Bulletin (Chinese Version)* **59**, 2213 22.

. & . 2000. . *Transactions of the Royal Society of Edinburgh: Earth Sciences* **91**, 1 1 3.

. & . 1. 0. . *Journal of Petrology* **31**, 6 1.

. & . 2003. . *Earth Science Frontier* **10**, 43 56).

J. . J. & . 2001. . *Journal of Petrology* **42**, 655 1.

J. 1. 6. . *Nature* **380**, 23 40.

. & . 2000. . *Tectonophysics* **326**, 255 6 .

. & . 2010*a*. 50 . *Lithos* **114**, 1 15.

. & . 2004. . *Geological Magazine* **141**, 225 31.

. J. & . 2010*b*. . *Geostandards and Geoanalytical Research* **34**, 1 34.

J. J. & . 2013. . *Chinese Science Bulletin* **58**, 464 54.

. & . 200 . *Lithos* **113**, 2 4 1.

J. . J. & . 2010. . *Chinese Science Bulletin* **55**, 1535 46.

J. 2003. *User's Manual for Isoplot 3.00: A Geochronological Toolkit for Microsoft Excel*. 4, 3.

J. . J. J. J. . & . 2015. ( ) . *Gondwana Research*, 6 2015. 10.1016/ . .2015.04.004.

. 1 4. . *American Journal of Science* **274**, 32 355.

. J. 1 5. ( ). *Geology* **23**, 51 4.

. 1 . *Structure of Ophiolites and Dynamics of Oceanic Lithosphere*. J 36

. 1. . *Journal of Petrology* **38**, 104 4.

. & . 200 *a*. . *Acta Petrologica Sinica* **25**, 16 24).

. & . 200 *b*. *Acta Petrologica Sinica* **25**, 14 4 1).

. & . 200 . . *Acta Petrologica Sinica* **23**, 162 34).

. & . 2002. 1 6 . *Proceedings of the Ocean Drilling Program, Scientific Results, vol. 176* (J. . J. . J. &), 1 60.

200 . *Chinese Science Bulletin* **14**, 21 6 1.

2010. *Lithos* **117**, 1 20 .

200 . *Journal of Asian Earth Sciences* **30**, 666 5.

200 . *Lithos* **100**, 14 4 .

2014. *Elements* **10**, 101

2001. 2. *Contribution to Mineralogy and Petrology* **141**, 36 52.

2013. *Gondwana Research* **24**, 3 2 411.

6. *Journal of Petrology* **37**, 6 3 26.

2013. *Precambrian Research* **231**, 301 24.

2012. *Precambrian Research* **192–195**, 1 0 20 .

Philosophical Transactions of the Royal Society of London **335**, 3 2.

5. *Nature* **377**, 5 5 600.

3. *Nature* **364**, 2 30 .

2014. (~440) *Lithos* **206–207**, 234 51.

2002. *Reviews of Geophysics* **40**, 3-1 3-3 .

200 . *Science in China Series D – Earth Sciences* **52**, 1345 5 .

Magmatism in the Ocean Basin ( ), 52 4 42.

200 . *Chemical Geology* **247**, 352 3.

200 . *Acta Petrologica Sinica* **23**, 1 33 44 ( ).

Contributions to Mineralogy and Petrology **133**, 1 11.

2006. *Journal of Geology* **114**, 35 51.

200 . *Lithos* **110**, 35 2.

2012. *Earth-Science Reviews* **113**, 303 41.

Chemical Geology **20**, 325 43.

2002. *Journal of Geology* **110**, 1 3 .

2006. *Geology in China* **33**, 4 6 6 ( ).

2014. ( ) *Geoscience Frontiers* **5**, 525 36.

200 . *Journal of Asian Earth Sciences* **32**, 102 1 .

2013. *Gondwana Research* **23**, 1316 41.

2004. *Journal of Geological Society, London* **161**, 33 42.

[illegible] 200[illegible] *a*. [illegible] *International Journal of Earth Sciences* **98**, 11[illegible] 21[illegible].

[illegible] & [illegible] 200[illegible] *b*. [illegible] *American Journal of Sciences* **309**, 221[illegible]0.

[illegible] 3. *Regional Geology of the Xinjiang Uygur Autonomous Region*. [illegible] 2[illegible] 145 ([illegible]).

[illegible] & [illegible] 2015. [illegible] *Journal of Asian Earth Sciences* **113**, 5[illegible].

[illegible] & [illegible] 2012. [illegible] *Gondwana Research* **21**, 246[illegible]65.

[illegible] & [illegible] 200[illegible] *Chemical Geology* **242**, 22[illegible]3[illegible].

[illegible] & [illegible] 2006. [illegible] *Acta Geologica Sinica* **80**, 254[illegible]63 ([illegible]).

[illegible] & [illegible] 2003. [illegible] *Chinese Science Bulletin* **48**, 2231[illegible]5.

[illegible] & [illegible] 2013. [illegible] *Lithos* **179**, 263[illegible]4.

[illegible] & [illegible] 2012. [illegible] *Journal of Asian Earth Sciences* **52**, 11[illegible]33.

[illegible] & [illegible] 200[illegible]. [illegible] *Acta Petrologica Sinica* **24**, 1054[illegible]5[illegible] ([illegible]).

[illegible] & [illegible] 1[illegible]6. [illegible] *Annual Review of Earth and Planetary Sciences* **14**, 4[illegible]3[illegible]5[illegible]1.