Geol. Mag. **154** (3), 2017, pp. 419–440. © Cambridge University Press 2016

10.101 / 0016 56 16000042

[illegible]

[illegible] 10003 [illegible] 210016 [illegible] 36 4 -5305 [illegible]

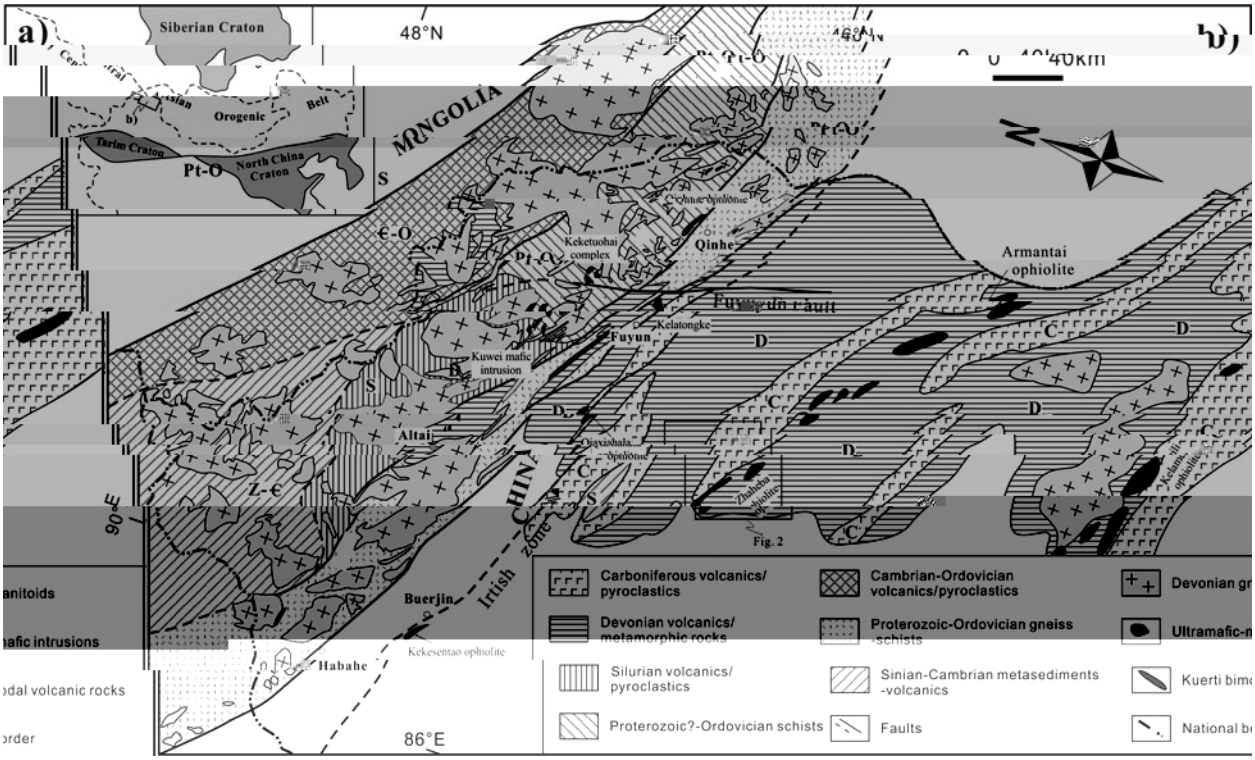
(*Received* 1 [illegible] 2015; *accepted* [illegible] 2016; *first published online* 1 [illegible] 2016)

Abstract [illegible] ~4 5 [illegible] ~400 [illegible] ε(*t*) (13 20) [illegible] δ [illegible] (+5.3 ‰) [illegible]

1. Intro uct on

[illegible] *et al.* 200[illegible] & [illegible], 200[illegible] *et al.* 2012 [illegible] *et al.* 2012, 2013 [illegible] *et al.* 2013) [illegible] *et al.* 200[illegible] *et al.* 200[illegible] *a*) [illegible] *et al.* 2000 [illegible] 2003 [illegible] *et al.* 200[illegible], 2014) [illegible] (2011) [illegible] (2014) [illegible]

[illegible] *et al.* 2002 [illegible] *et al.* 2004, 200[illegible] *a*) [illegible] *et al.* 200[illegible] *a,b* [illegible] 2012) [illegible] *et al.* 2003 [illegible] *et al.* 2003 [illegible] *et al.* 200[illegible] *a*) [illegible]



1. ( )
( ) ( ) (
et al. 200).

(1).
(2)

2. Reg onal geology, fiel observat ons an petrography

(1,
2).
(. 3).
15
(. 2,
)
5 1

> 0 %
(. 3 ,).
(.
et al. 2013)
(40 0 %) (30 50 %)
(5 10 %)
(. 3).

( )
( ) (et al. 2006).
(. 2).
(, 1 . 3).

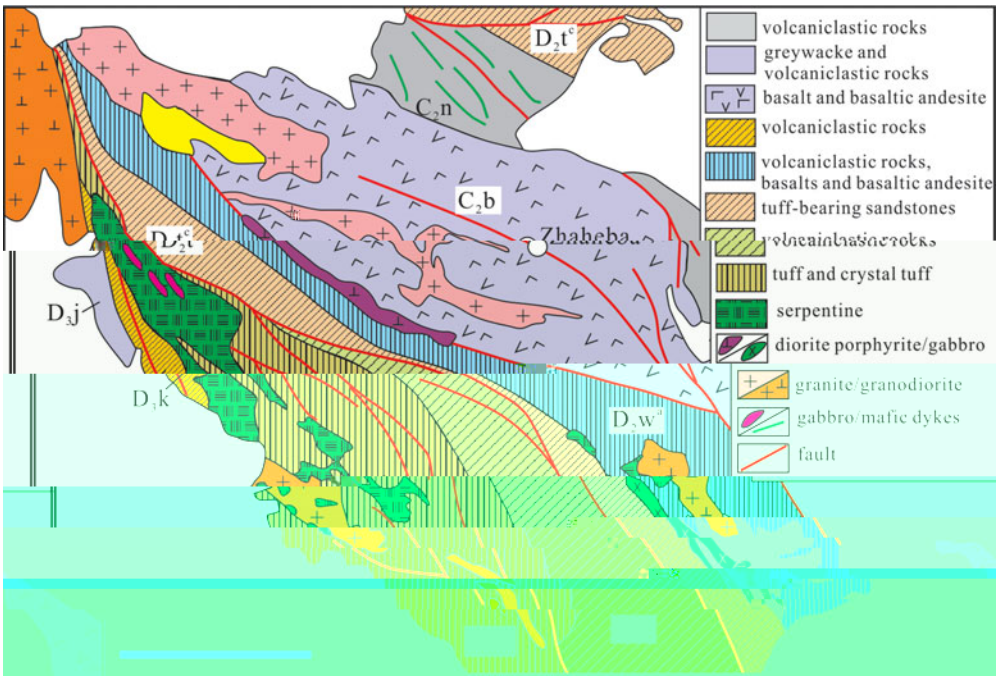


Fig. 2. ( ) (*et al.* 200 , 200 *a* , 1 , 3).

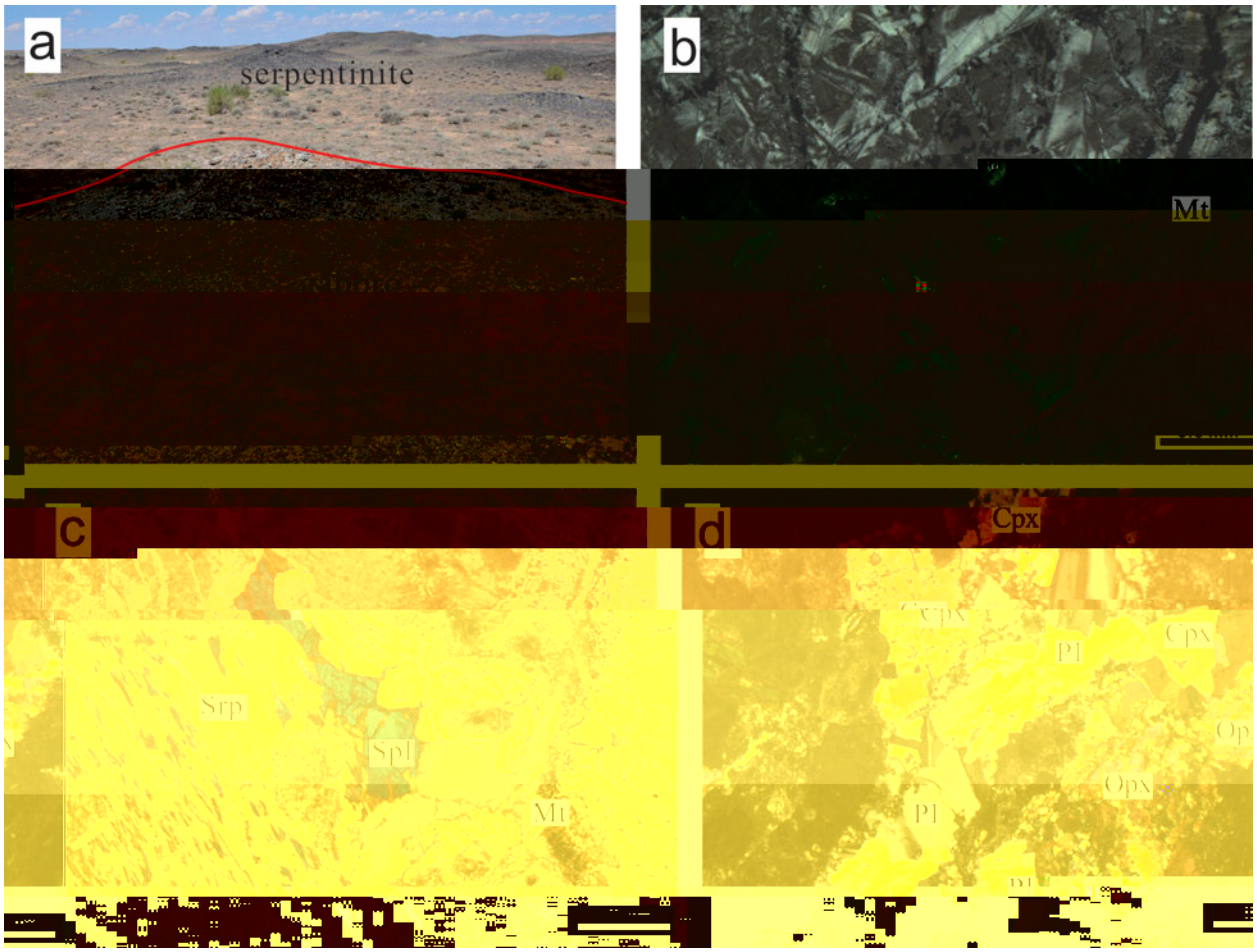


Fig. 3. ( ) . ( ) > 0%

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*). /

/ (/ , /16 = 0.0020052),

( )

δ 5.31 ‰ (*et al.* 2010*b*).

δ 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). / 6

143 /144 6 / =

0.11 4 146 /144 = 0. 21 ,

/ 6 0. 102

0. 0506 -1,

143 /144 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

Table 1. [illegible]

[illegible]	2013 [illegible] 01-1	2013 [illegible] 01-3	20132 [illegible] 01-4	2013 [illegible] 01-5	2013 [illegible] 01-6	2013 [illegible] 01-	2013 [illegible] 01-	2013 [illegible] 01 1	2013 [illegible] 01 2	2013 [illegible] 01 4
					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] 3	0.61	1. 6	1.04	0.6	0. 0	0. 4	0. 0	1 .2	1 .64	1 .33
[illegible] 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]	0.12	15.42	0.15	0.14	0.2	0.10	0.1421	[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
	0.005	0.064	0.00	0.005	0.00	0.003	0.003	0.051	0.044	0.222
	0.021	0.34	0.044	0.042	0.0 2	0.031	0.033	0.310	0.25	1.450
	0.004	0.04	0.00	0.00	0.011	0.005	0.005	0.04	0.043	0.21
	0.011	0.232	0.036	0.044	0.012	0.034	0.00	0.123	0.0 0	0. 3
	0.0 0	0.036	0.03	0.03	0.06	0.026	0.025	0.046	0.031	0.06
	0.26	1. 10	6.600	1. 0	0. 3	0.233	1.150	1.5 0	0.516	0.1 5
	0.406	0.0 2	0.12	0.112	0.0	0.1	0.054	0.16	0.1 1	0.6 5
	0.046	0.034	0.014	0.02	0.050	0.030	0.010	0.050	0.02	0.130
	0.1 1	0.144	0.203	0.364	0.042	0.0 4	0.0	0.066	0.042	0.0 3
	2013 01 5	2013 01 6	2013 01	2013 01	2013 01	2013 03 2	2013 03 3	2013 03 4	2013 03 5	2013 01 3
			(1)	(1)	(1)	(1)	(1)	(1)	(1)	(2)
					Major elements (%)					
2	4 .1	45.	4	53.1	51. 1	50.40	50.54	50.52	51.22	52.3
2	0.34	0.15	1.40	1.24	1.31	1. 0	1.63	1.31	1.1	0.33
3	1	1 .5	16.5	16.1	15. 3	15.	16. 6	15.55	15.4	1 .61
3	4.52	3.34	.	.1	.43	.0	.50	.42	. 2	3.44
	0.0	0.0	0.11	0.10	0.11	0.13	0.11	0.14	0.12	0.0
	6.	.42	4. 0	4.2	4.41	5.	3.2	6.06	.14	4.
	11.03	12.61	6.22	5. 5	6.3	6. 5	4.52	.4	.26	. 0
	4. 6	.3	. 2	.3	.00	4.52	.31	4. 0	4.0	.11
	0.13	0.11	0.3	0.31	0.42	2.04	0.33	1.2	2.03	0.1
5	0.04	0.02	0.62	0.62	0.65	0. 4	0.6	0.4	0.44	0.04
	3. 2	3.26	4.24	2.54	2. 3	2.2	5.14	2.65	1. 3	2.
	. 5	. 2	. 6	. 0	.4	.40	. 1	.6	.6	. 1
	4.	.4	.11	. 0	.42	6.56	.64	6.0	6.11	.2
#	5	1	55	54	54	56	41	56	64	4
					Trace elements (ppm)					
	.0	4. 5	1.16	1.12	1.4	.0	40.4	5.2	6. 2	5. 1
	0.22	0.135	1.2 4	1.6 3	1.316	1. 53	1.034	1.100	0.5 5	0.62
	25.0	23.	1 .6	1 .5	1 .5	.5	1 .2	25.2	1	1 .0
	11	3.	1 6	166	1 2	22	22	254	1	5.
	34.	163	60.5	62.6	64.1	116	1	0.	203	23.
	24.2	21.6	26.	23.6	24.6	2 .	2 .5	2 .0	2 .0	16.4
	4.	1 5	63.6	50.	51.4	6.	2 .	5 .3	132	1.1
	52. 4	55.5			3.(5 .3)-630 . 4. 0.	5. (16. 6)-500.066	-1.05 6	113.6.22	15.55 3. 4 2	.-64(10150.)-61 1.11.05 5 6 4.

1.

	2013 ـ 01 ـ 5	2013 ـ 01 ـ 6	2013 ـ 01 ـ (1)	2013 ـ 01 ـ (1)	2013 ـ 01 ـ (1)	2013 ـ 03 ـ 2 (1)	2013 ـ 03 ـ 3 (1)	2013 ـ 03 ـ 4 (1)	2013 ـ 03 ـ 5 (1)	2013 ـ 01 ـ 3 (2)
	3	1.20	3 .60	46. 0	4 .30	23.40	43.00	25.20	32 0	6.56

Table 1.

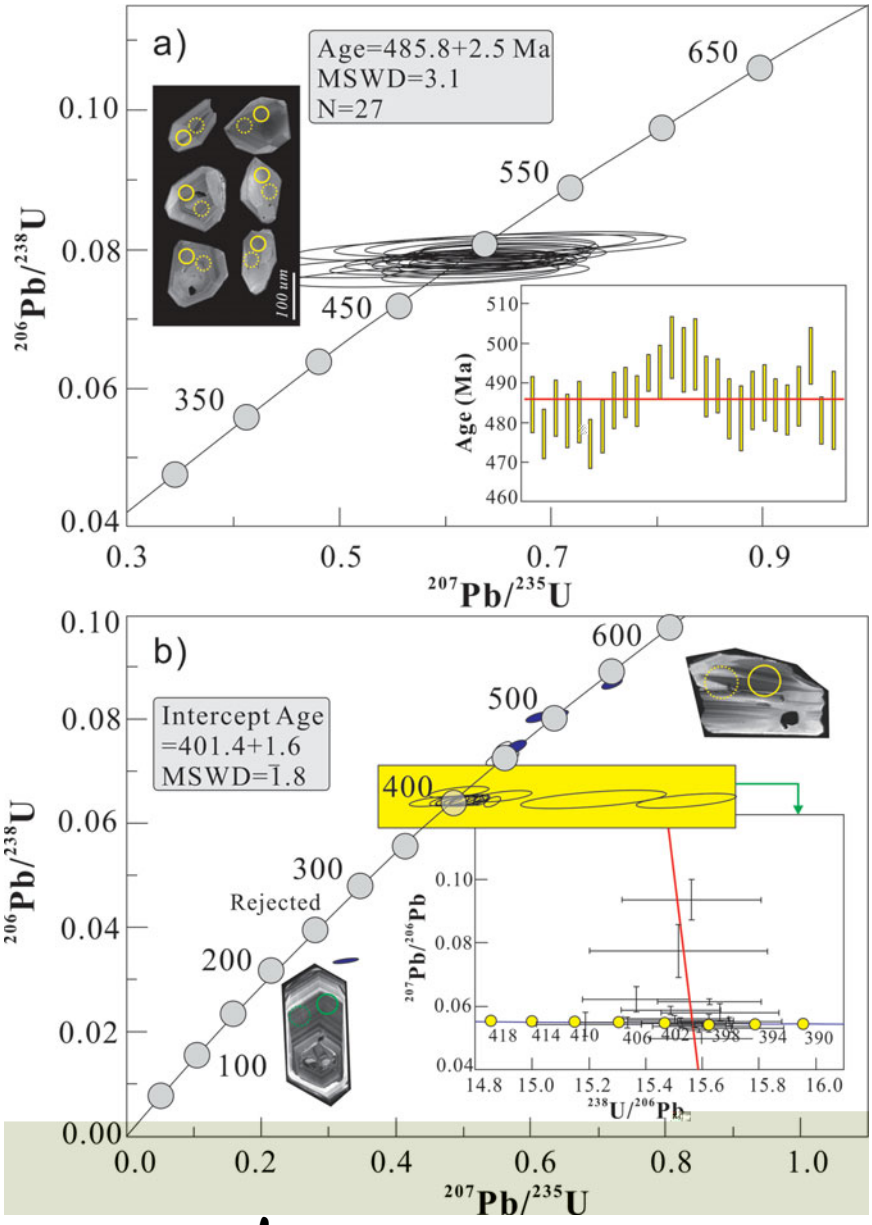
	2013 01 11 (2)	2013 02 1 (2)	2013 02 2 (2)	2013 03 1 (1)	2013 03 6 (1)	2013 01 10 (2)	04 06 (1)	04 24 (1)	04 2 (1)	03 1 (1)
					Trace elements (ppm)					
	1 .4	36.	42.4	26.0	32.4	1 .	/	/	/	/
	0.3 5	0.153	0.35	1.1	0. 4	0.46	/	/	/	/
	32.5	33.2	34.5	25.1	26.3	32.1	13.4	20.5	1 .	20.3
	1 4	203	21	33	341	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*).

2.

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

(*t*) = 10 000((143 /141) (*t*)/(143 /144) − (*t*)−1) (*t*)= (/ 6)
401



4. ( ) 1σ 2σ ( )

(. 4 = 2 , / = 3.1). - 4 ± 4 (*et al.* 2003).

100 200 μ

/ 1 3 1 (1) 0%

(2)

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

4.b. M neral compos t ons

4.b.1. Spinel composition

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

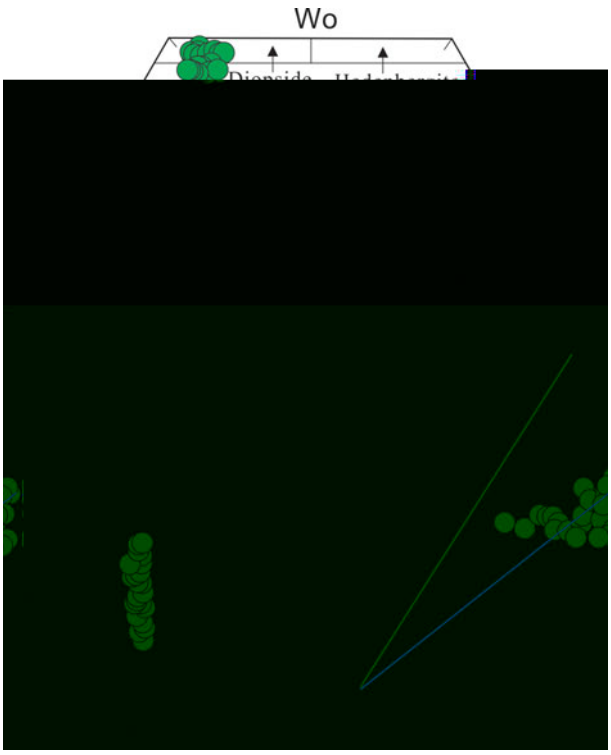
4.b.2. Pyroxene compositions

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

4.c. Whole-rock elemental geochem stry

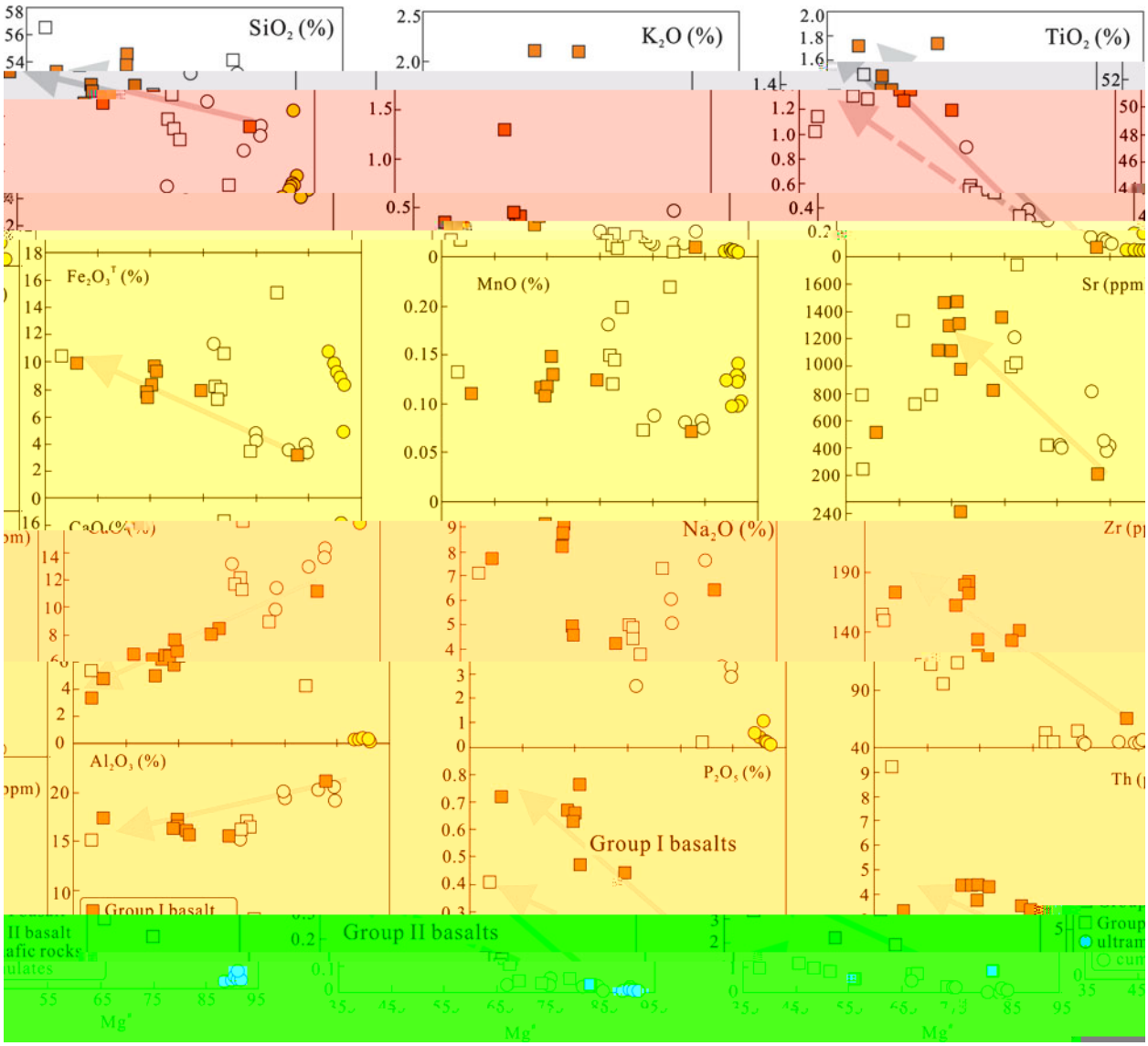
4.c.1. Serpentinites and cumulates

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



5. ( ) ( ) /
(.) 2 (%) 3 (%) ( ),
( ) 2 (%)

1 (. 1)
(. 6).
(3 103)
(5) (. 1). (> 12 %)
( ) (,
).
3, 3 2,
( ) (. 1).
( ), (, 2014 &
, 1).
2
45. % 51.2 %,
3 (3.24 4.6 %), 3 (1 .3 1 .6 %,
2013 01-3), (.54 15.42 %), 2
(0.12 0.34 %), (2. 1 .3 %,
2013 01-3) (0.11 0.46 %)
(. 1).



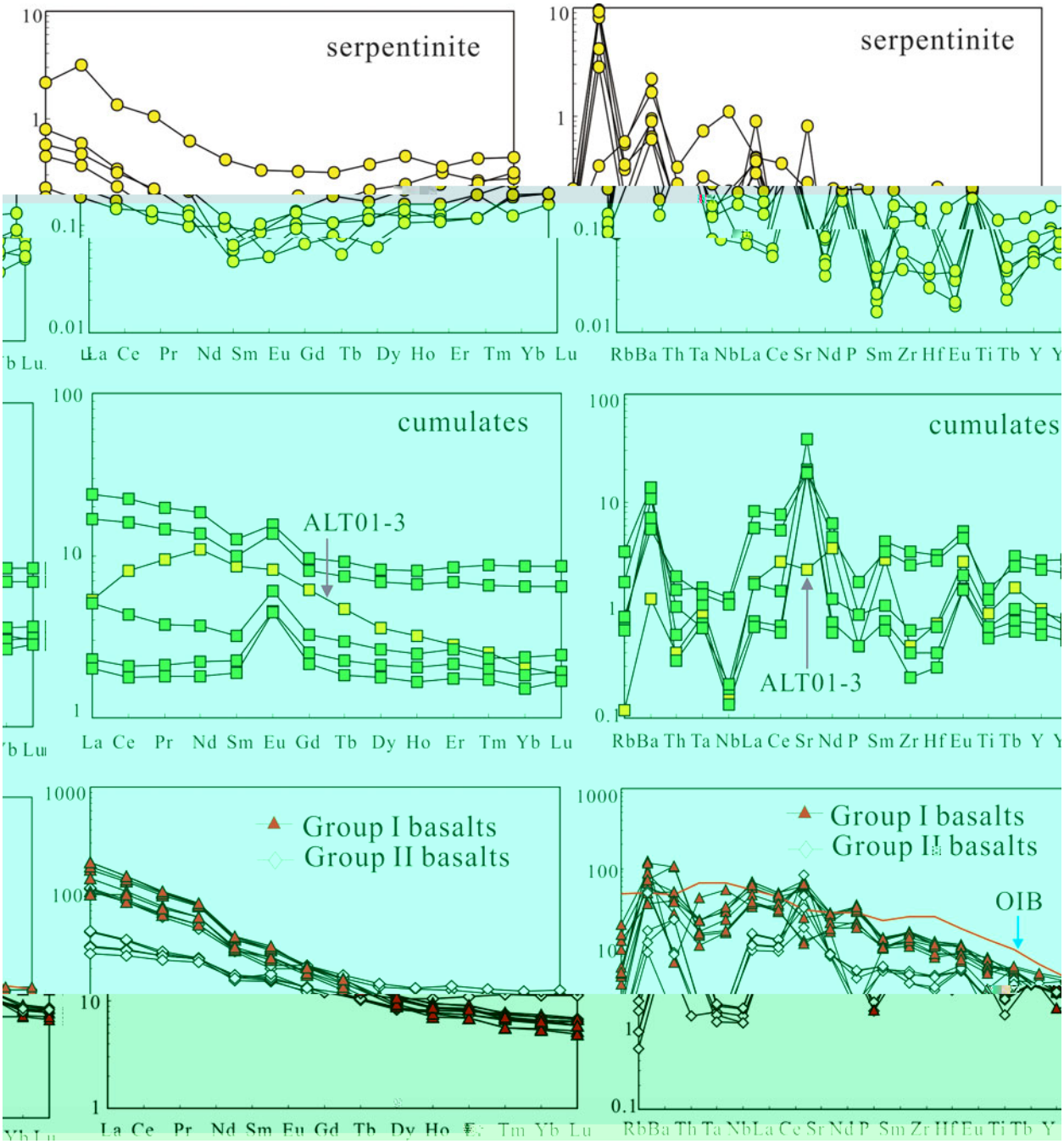
6. ( ) ( ) ( ) *et al.* 200 *a*).

(. 6). 5 41 ( ) (( ) = 1.3 2.) (/ = 1.1 2.2). 2013 01-3 ( ), (/ = 0.2 0.4)

1) 1 (1) 2 (2). 2 ( ). 1 2 ( ) 1 2 (. 6). 1 124 205 2 50 60 ( ) 1. 10 30 (20)

4.c.2. Basalts

43.15 % 5 .65 % (52 %,

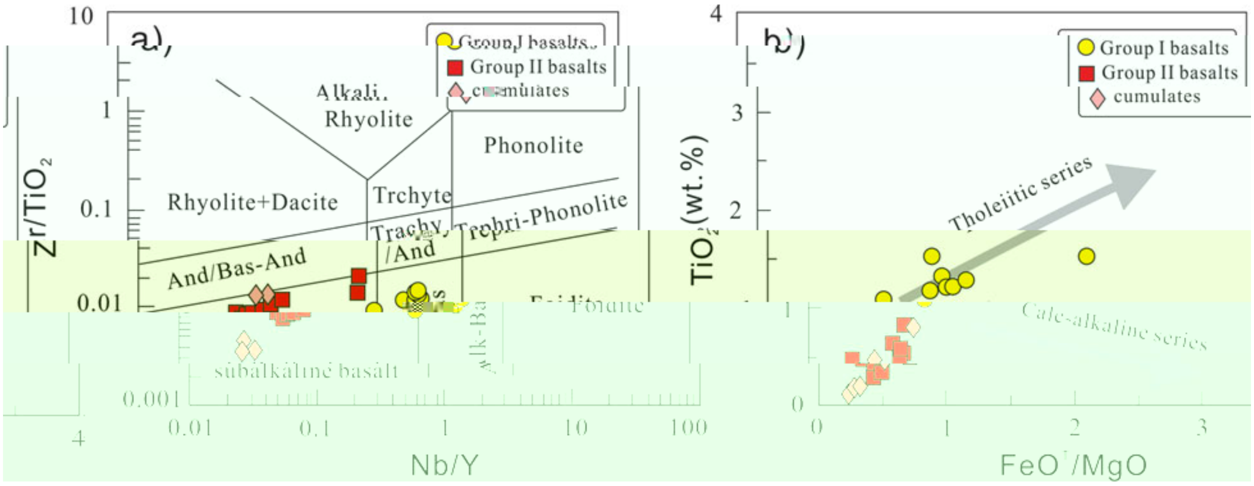


(1).

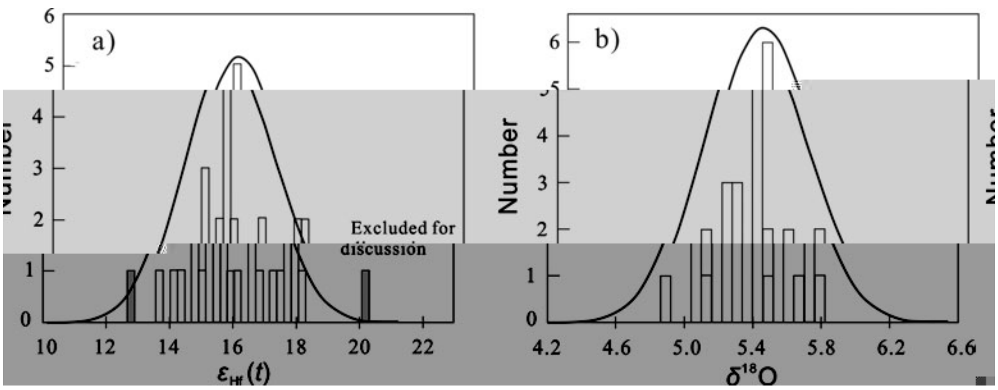
(/ = 0. 0 1.14) ( ). 2. (/) 4 6 (/ = 1.02 1.21) ( ). 1. / 0.44 0. 2. 1. / (~0.11). ( ).

4. . Whole-rock Sr–N an z rcon Hf–O sotopes

2. 1. 2. / 6 (0.0024 0.0452) / 6 (0. 04030 0. 0536), / 6 (0. 04015 0. 05111, 2013 03 1). 14 /144 0.0 0.13 4 143 /144 0.512 0 0.512 3 (*t*) +6.3 + .5 (2013 03 1 +1.).



[illegible] (1 4).



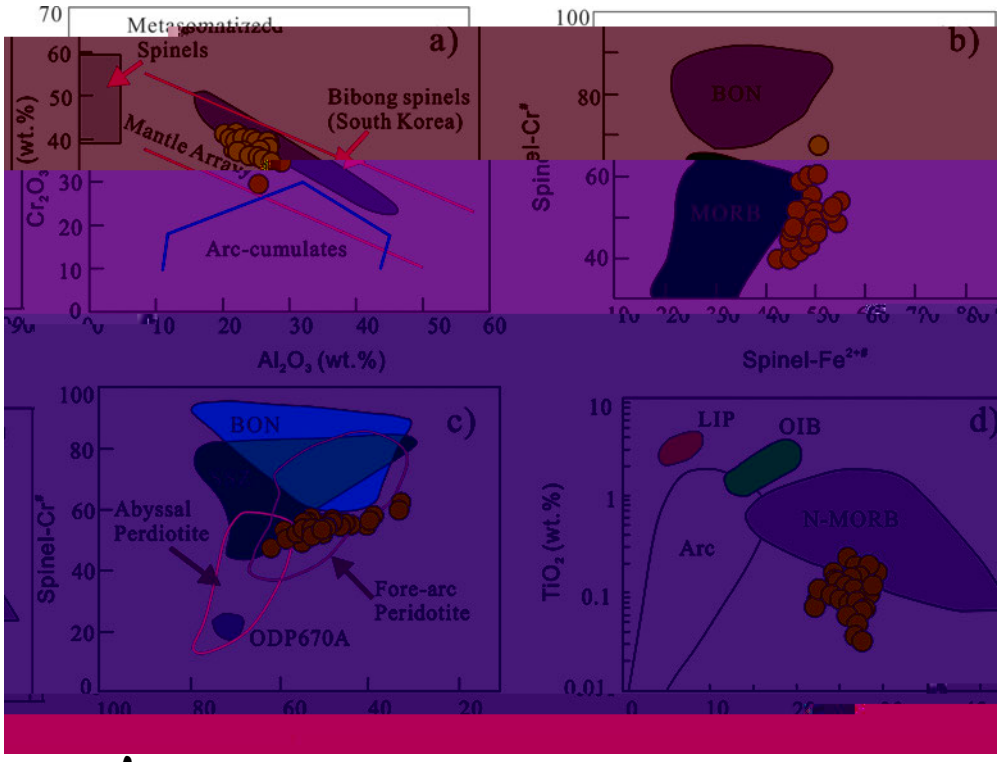
[illegible] εHf(t) [illegible]

[illegible] (2013 [illegible] 01) [illegible] 2 [illegible] εHf(t = 4 5 [illegible] 13 [illegible] 20. [illegible] 2 5 [illegible] 5 [illegible] εHf(t) (> 16) [illegible] εHf(t), [illegible] 15. [illegible] δ18O [illegible] 4. 1 ‰ [illegible] 5. 3 ‰, [illegible] δ18O [illegible] 5.3 ± 0.23 ‰ [illegible]. [illegible] ~400 [illegible] εHf(t) [illegible] 1.4 [illegible] .2 [illegible] 6 0 [illegible] 20 [illegible] (*et al.* 200).

5. Discussion

5.a. The individual members of the Zhaheba ophiolite

[illegible] *c.* 4 6 [illegible] 401 [illegible] (503 ± [illegible]) [illegible] (416 ± 3 [illegible]) [illegible] *et al.* 2012 [illegible] *et al.* 200 *b*, [illegible] 1). [illegible] (401 [illegible]) [illegible] (4 6 [illegible]) [illegible] 1, 3). [illegible] 1), [illegible]

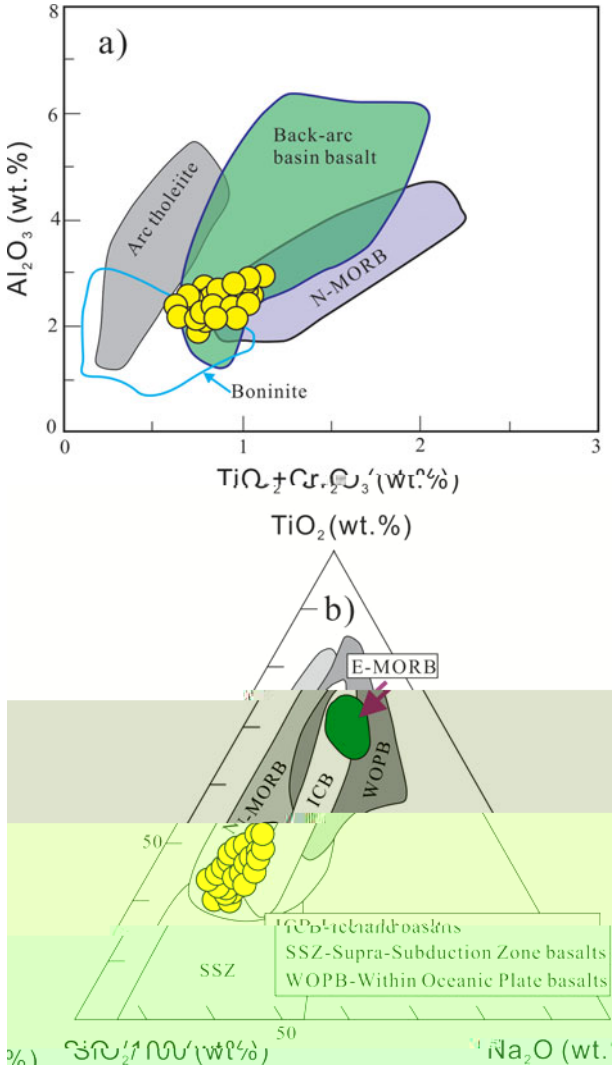


10. ( ) & / , 2000). ( ) . (100 /(+)) 2+ . (100 2+/(2+ +)) (1 4 & , 2001). ( ) . (100 /(+)) . (100 /(+)) (et al. 1 5). ( ) 2 3 (& , 2001).

(500 4 0) (et al. 2003 et al. 2015), (436 400) (et al. 200 b, 2014) (3 0 350) (et al. 2003 / et al. 2006).

5.b. Or g n of the serpent n te an cumulates

(& , 2002 et al. 2010



11. ( ) ( ) 3 2+ 3 ( ) 2 2/100

( ).

5 3 2+ 3 (. 11) 2/100 2 (. 11) (.).

(. 12),

(. 12).

et al. (2002)

( ).

5.c. Petrogenes s of the Devon an basalts

1 2. 1 (11 24 15), 5 (0.4 0.6 %) / (11 15, 60) (/)) (& , 2001) (. 13).

(1) (& , 2002) (2) (& , 1 . 2 & , 1 . 3 *et al.* 1 . 6).

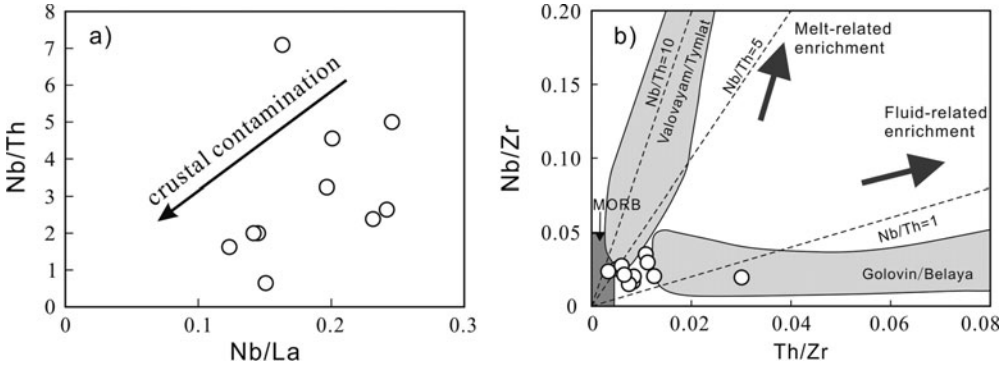
1 (& , 200 *et al.* 2011) / 6 (0. 04120 0. 06133) (*t*) (+1. + .5).

/ (3.44 20.4) (1.51 2.54) (& , 1 6).

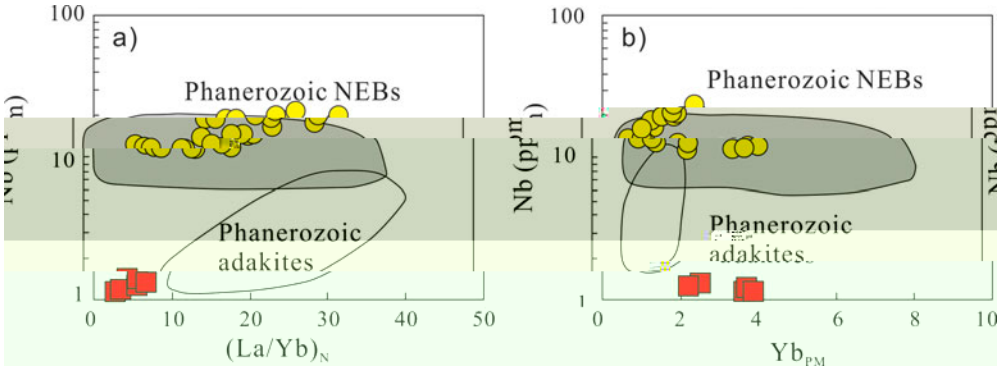
1 (*et al.* 1 . 6 , 1 . 6).

(& 2000).

(& , 1 . 2 *et al.* 1 . 6). *et al.* (200)



12. ( ) ( )



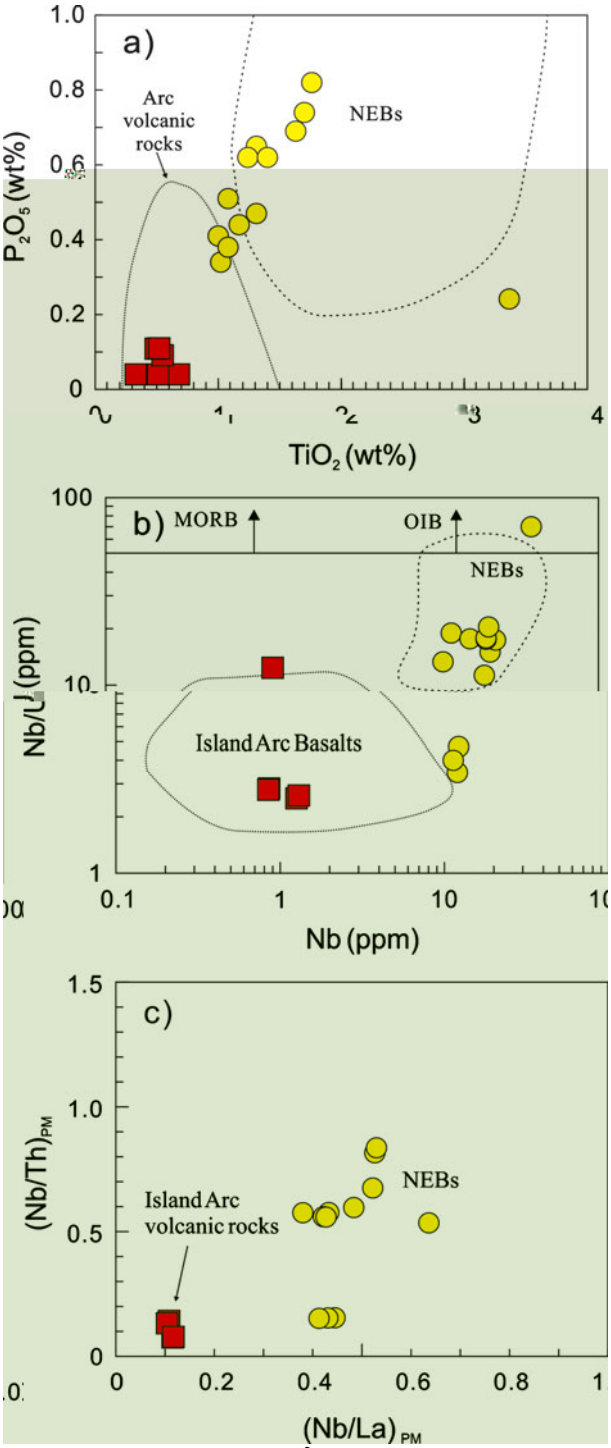
13. ( ) ( ) ( ) ( ) 1.

(*t*) (1. .5) (^{6}) (0. 04120 0. 06133) (. 2). (*t*) (^{6}) 1. 2. 2 (< 0.3) / / ( ), / (& , 1. 1 , 2002). 2. (/) (0. 1.0), (/) (0.1 0.2) (0.6 1.0) 2. (& , 1. 6). 2. 5 / (1 . 14). (. 14). 2. 1 2.

5. . Impl cat ons for the Palaeozo c accret on process n eastern Junggar

(416 *et al.* 2014 *et al.* 2015), (503 4 5 *et al.* 2003 *et al.* 2015) (400) (. 1.). (*et al.* 2014),

et al. 200 , 200 *a*,*b* *et al.* 200 *a*). (*et al.* 200 *b*).



14. ( ) ( ) ( ) ( ) & (1 2) *et al.* (1 5);

et al. (2015) 400 3 0

460 3 5 *c.* 400 (*et al.* 2006, 200 *et al.* 200 *et al.* 200 *et al.* 200 , 200 *et al.* 2012 *et al.* 2015).

(& 2002 / *et al.* 200).

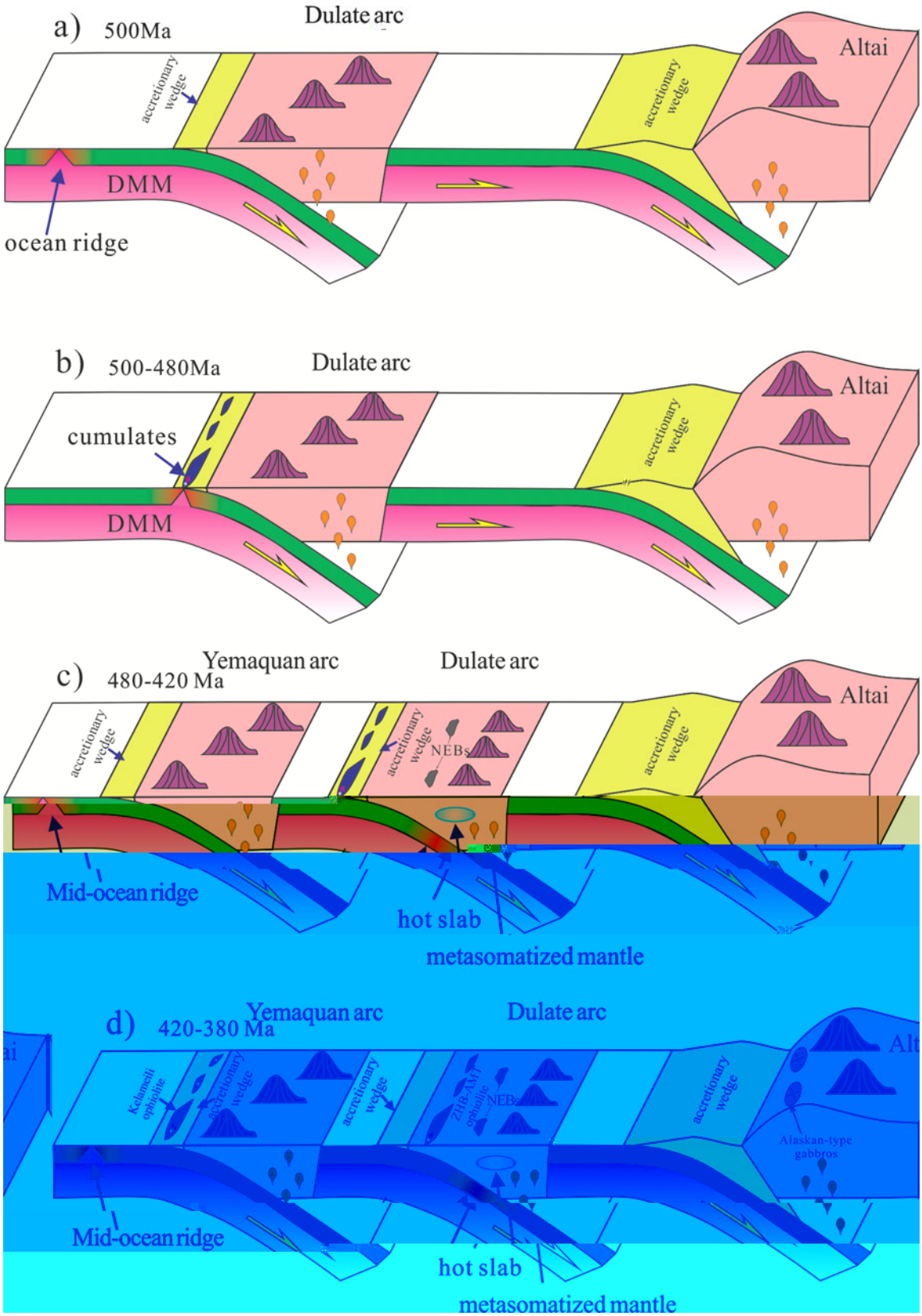
(*et al.* 2015).

(5.), 1 2 (1 15). *et al.* (200 , 200 *b*) *et al.* 200). (& , 1 1 & , 200 *et al.* 2013).

(1), (*c.* 500), (15).

(2) (500 4 0), (15).

(3) (4 0 420), (45 *et al.* 2015) (440 *et al.* 2014) (15).


a) 500Ma
Dulate arc
accretionary wedge
Altai
DMM
ocean ridge
b) 500-480Ma
Dulate arc
cumulates
Altai
DMM
c) 480-420 Ma
Yemaquan arc
Dulate arc
accretionary wedge
NEBs
Altai
Mid-ocean ridge
hot slab
metasomatized mantle
d) 420-380 Ma
Yemaquan arc
Dulate arc
Kelameili ophiolite
ZIIE-AMT ophiolite
NEBs
Alaskan-type gabbros
Mid-ocean ridge
hot slab
metasomatized mantle

15. (

(4)

(420 3 0)
(*et al.* 2014 *et al.* 2015).
1.)
2.
(. 15).

(400 3 0).

6. Conclus ons

(1)
~4 5
c. 400

(2)

(3)

Acknowle gements.
305
(2011 06 03-01).

Supplementary mater al

/10.101 / 0016 56 16000042.

References

1 4.
Chemical Geology **113**, 1 1 204.
& . 2001.
Journal of Petrology **42**, 22 302.
& . 200
Lithos **97**, 2 1
& 2002
Geology **30**, 10.
& 200
Earth Accretionary Systems in Space and Time (&), 1 36.
31
& 2002.
Geological Magazine **139**, 1 13.
1 3.
Geological Society of America Bulletin **105**, 15 3
1 *Ophiolites*
, 220
& 1 3.
Geology **21**, 54 50.
& 1 2.
Journal of Geological Society, London **149**, 56
& 1 4.
Contributions to Mineralogy and Petrology **86**, 54 6.
& 2003
(2)
Ophiolites in Earth History (&), 43 6
21
& 2011
Geological Society of America Bulletin **123**, 3 411.
& 2015.
Chinese Journal of Geology **50**, 140 54 ( ).
& / 2000.
( )
Contributions to Mineralogy and Petrology **140**, 2 3 5
& 1 1.
Lithos **27**, 25 .

. 2011. *Geological Bulletin of China* **30**, 150–13).

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

. & . 2001. . *Nature* **410**, 6 –1.

& . 2002. ( ) . *Chemical Geology* **182**, 22–35.

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

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

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

. & . 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).

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

. 1 6. . *Nature* **380**, 23– 40.

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

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

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

. & . 2010*b*. . *Geostandards and Geoanalytical Research* **34**, 11– 34.

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

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

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

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

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

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

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

. 1 . *Structure of Ophiolites and Dynamics of Oceanic Lithosphere*. , 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 . 40 /3 . *Acta Petrologica Sinica* **23**, 162– 34).

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

. & . 1 6 ( ). *Journal of Petrology* **37**, 6 3 26.

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

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

. & . 1 1. . *Philosophical Transactions of the Royal Society of London* **335**, 3 2.

. & . 1 5 . *Nature* **377**, 5 5 600.

. & . 1 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 .

. & . 1 . *Magmatism in the Ocean Basin* (. & .), . 52 4 . . 42.

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

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

. & . 1 . . *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.

. & . 1 . . *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.

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

200 *b*. *American Journal of Sciences* **309**, 221 0.

1 3. *Regional Geology of the Xinjiang Uygur Autonomous Region*. 2 145 ( ).

2015. . *Journal of Asian Earth Sciences* **113**, 5 .

2012. *Gondwana Research* **21**, 246 65.

200 . *Chemical Geology* **242**, 22 3 .

2006. *Acta Geologica Sinica* **80**, 254 63 ( ).

2003. *Chinese Science Bulletin* **48**, 2231 5.

2013. . *Lithos* **179**, 263 4.

2012. . *Journal of Asian Earth Sciences* **52**, 11 33.

200 . *Acta Petrologica Sinica* **24**, 1054 5 ( ).

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