

Chemical mass transfer in shear zones a comparison of four mass l

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J. metamorphic Geol., 2012, **30**, 703–722

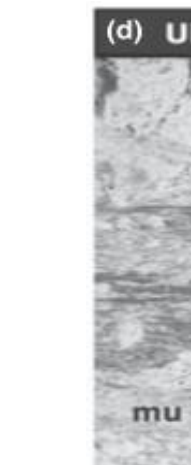
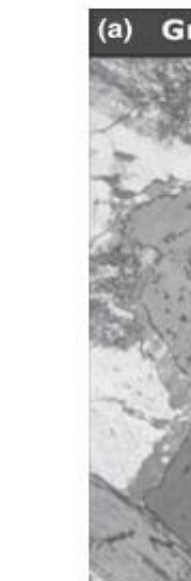
Role of chemical processes on shear : from the Grimsel metagranodiorite (

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and metacarbonate xenoliths: balance approaches

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zone formation: an example Aar massif, Central Alps)

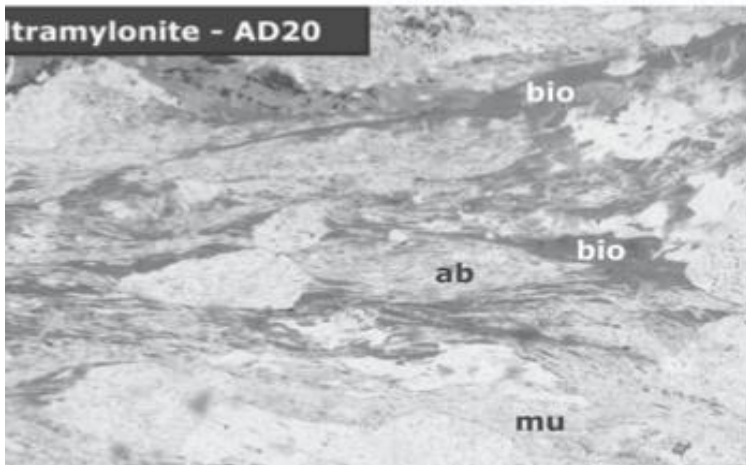
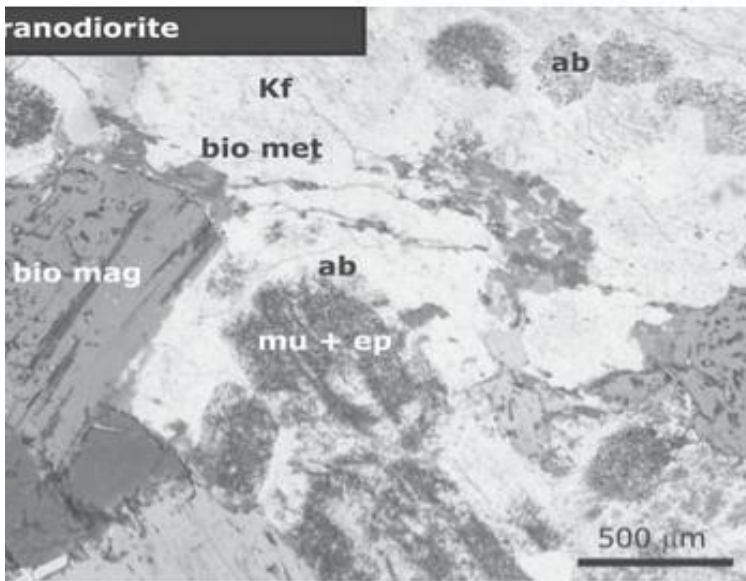
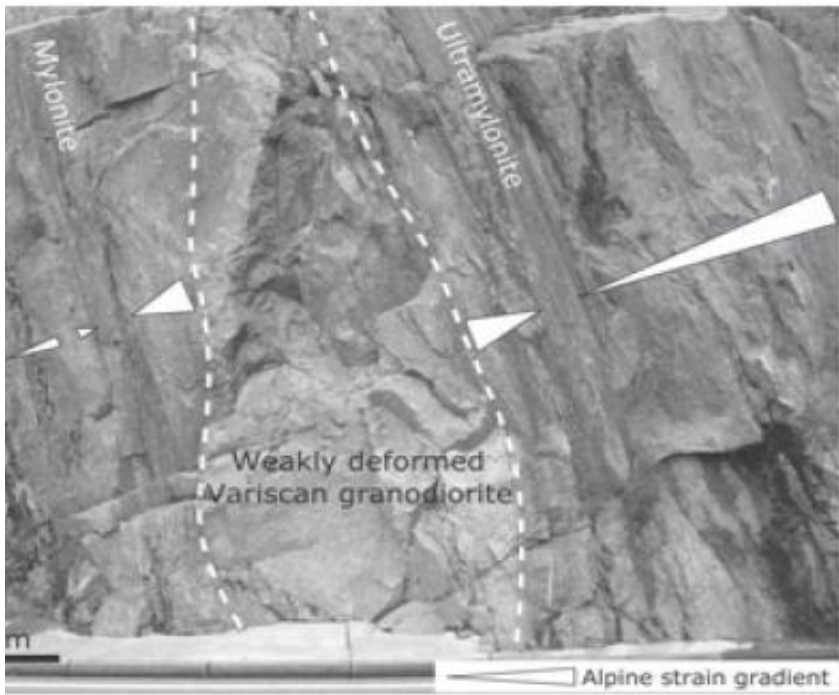
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Chemical mass transfer in shear zones and metacarbonate xenoliths: a c

Durand et al. (2015), EJM

Table 2 (Grimsel granodiorite → ultramylonite alteration)

Al₂O₃

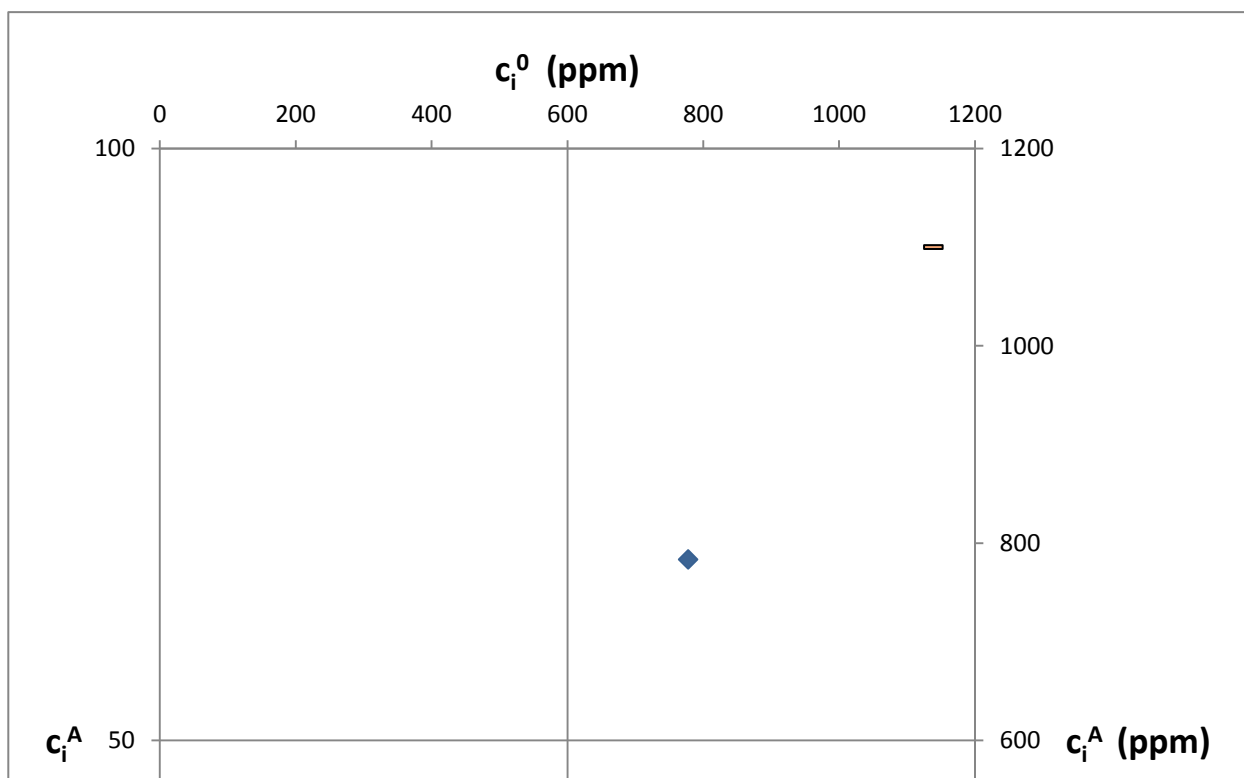
	c_i^0	σ_i^0	c_i^A	σ_i^A	b_i		Δm_i
SiO ₂	64.85	1.27	65.27	1.16	1.0065	1.0065	0.58
TiO ₂	0.65	0.05	0.64	0.07	0.9846	0.9846	-0.01
Al ₂ O ₃	16.49	0.62	16.45	0.47	0.9976	0.9976	0.00
Fe ₂ O ₃	4.17	0.28	3.96	0.36	0.9496	0.9496	-0.20
MnO	0.09	0.01	0.07	0.01	0.7778		-0.02
MgO	1.13	0.09	2.56	0.13	2.2655		1.44
CaO	2.98	0.27	0.84	0.35	0.2819		-2.14
Na ₂ O	5.12	0.43	4	0.6	0.7813		-1.11
K ₂ O	3.19	0.2	4.12	0.49	1.2915		0.94
P ₂ O ₅	0.15	0.03	0.16	0.02	1.0667	1.0667	0.01
H ₂ O	0.8	0.13	1.53	0.16	1.9125		0.73
Total	99.62		99.57				

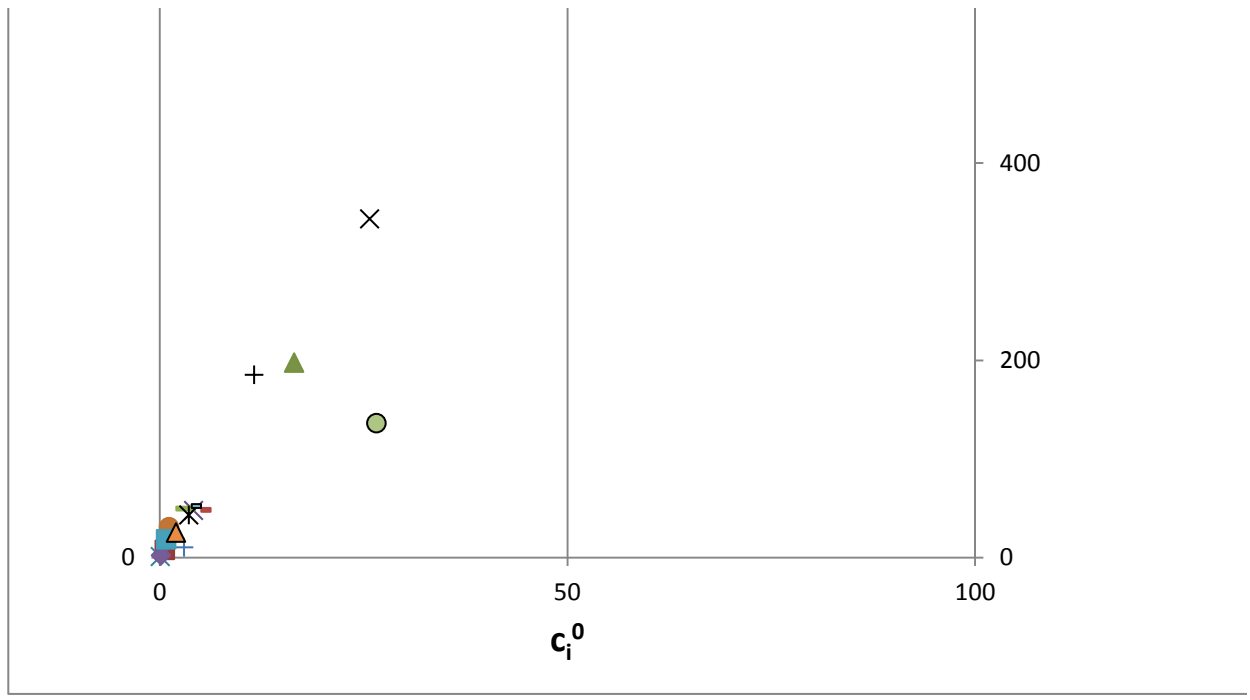
ppm

Nb	24	5	25	6	1.0417	1.0417	1
Zr	309	18	343	25	1.1100	1.1100	35
Y	43	8	43	4	1.0000	1.0000	0
Sr	319	47	136	63	0.4263		-183
Rb	139	29	185	53	1.3309		46
V	47	4	52	4	1.1064	1.1064	5
Ba	1139	114	1100	151	0.9658	0.9658	-36

AVERAGE 1.0229

Δm 0.24

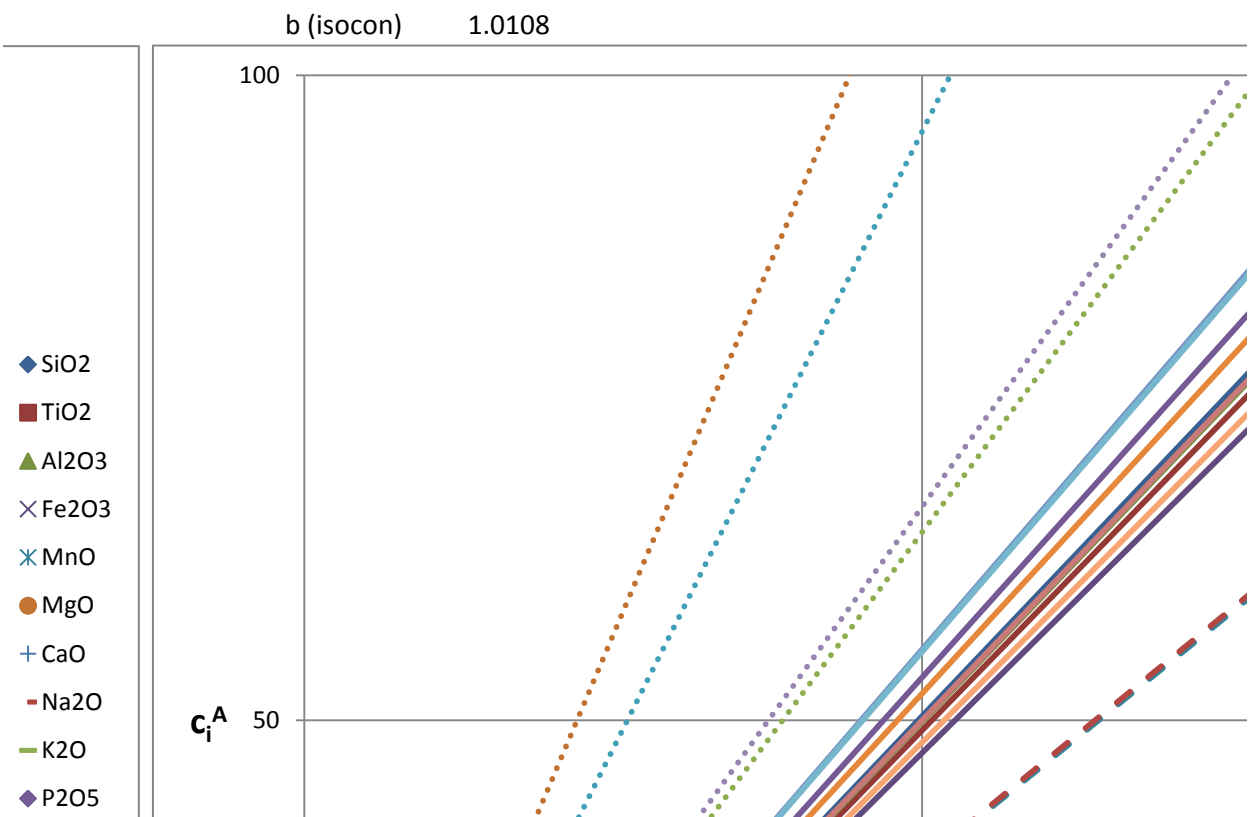




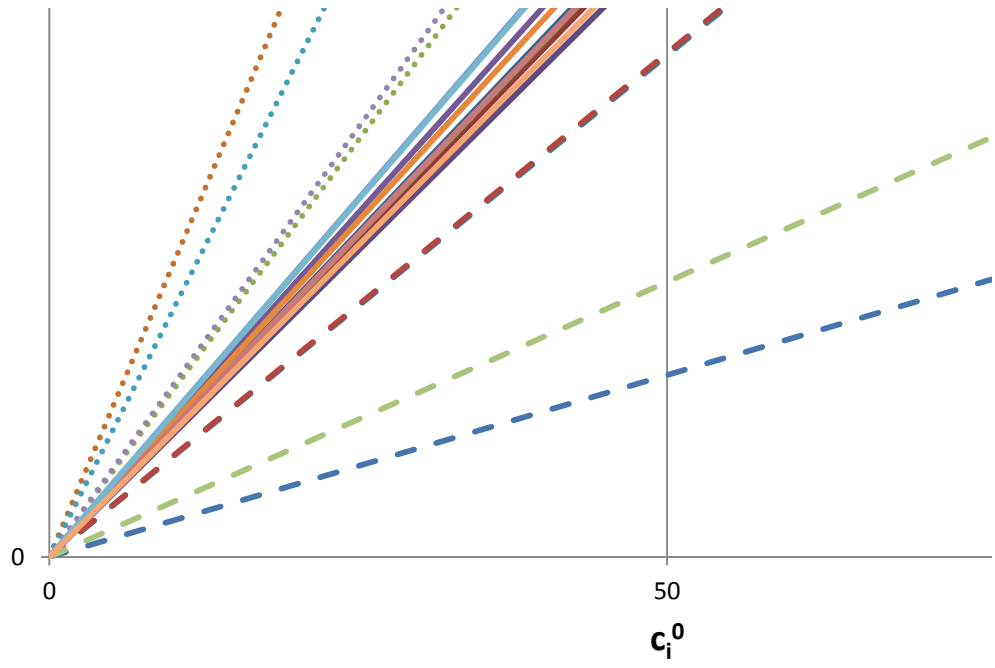
Comparison of four mass balance approaches

Fe2O3	Zr	10 comp	BO95	Al2O3	Fe2O3	Zr	10 comp
Δm_i	Δm_i	Δm_i					
3.88	-6.05	-1.04	-0.28	0.9%	6.0%	-9.3%	-1.6%
0.02	-0.07	-0.02	-0.02	-1.3%	3.7%	-11.3%	-3.7%
0.83	-1.67	-0.41	-0.22	0.0%	5.0%	-10.1%	-2.5%
0.00	-0.60	-0.30	-0.25	-4.8%	0.0%	-14.4%	-7.2%
-0.02	-0.03	-0.02	-0.02	-22.0%	-18.1%	-29.9%	-24.0%
1.57	1.18	1.37	1.40	127.1%	138.6%	104.1%	121.5%
-2.10	-2.22	-2.16	-2.15	-71.7%	-70.3%	-74.6%	-72.4%
-0.91	-1.52	-1.21	-1.16	-21.7%	-17.7%	-29.6%	-23.6%
1.15	0.52	0.84	0.89	29.5%	36.0%	16.4%	26.3%
0.02	-0.01	0.01	0.01	6.9%	12.3%	-3.9%	4.3%
0.81	0.58	0.70	0.71	91.7%	101.4%	72.3%	87.0%

ppm							
2	-1	0	1	4.4%	9.7%	-6.2%	1.8%
52	0	26	30	11.3%	16.9%	0.0%	8.5%
2	-4	-1	0	0.2%	5.3%	-9.9%	-2.2%
-176	-196	-186	-184	-57.3%	-55.1%	-61.6%	-58.3%
56	28	42	44	33.4%	40.2%	19.9%	30.1%
8	0	4	4	10.9%	16.5%	-0.3%	8.2%
19	-148	-64	-51	-3.2%	1.7%	-13.0%	-5.6%
5.30	-9.91	-2.24	-1.07				



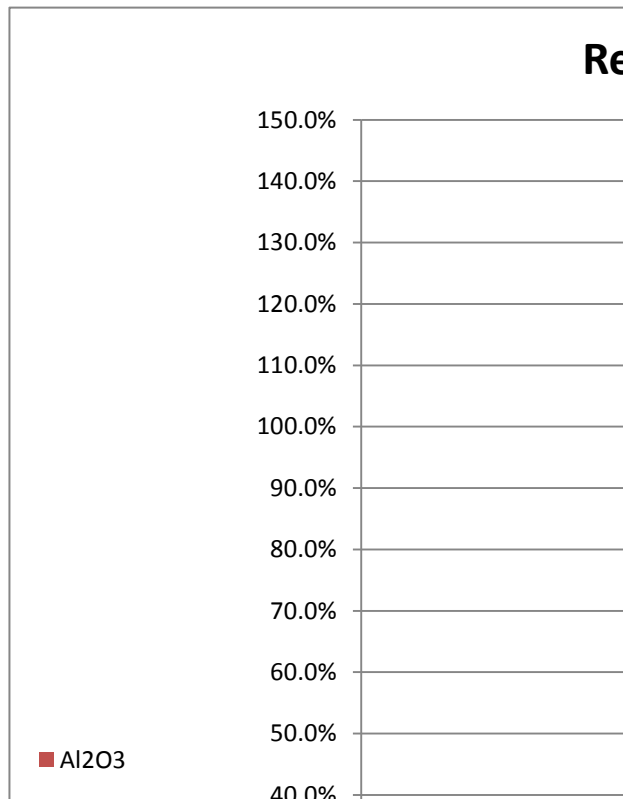
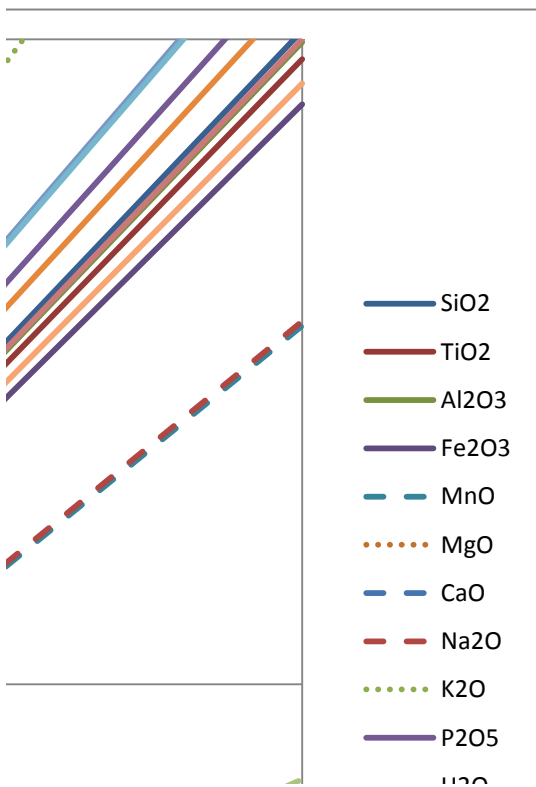
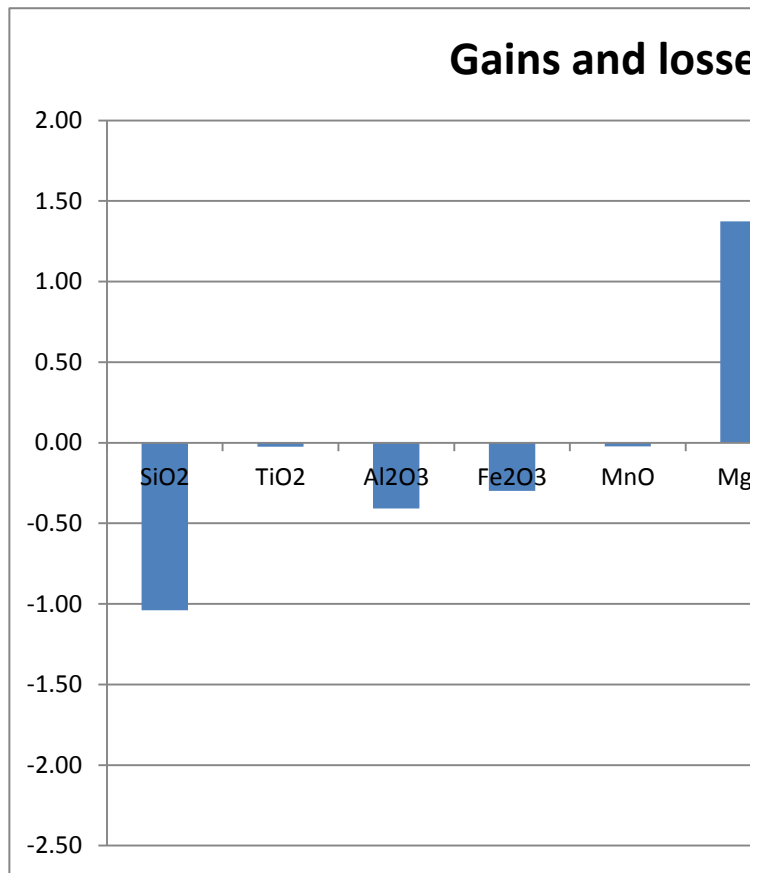
- H2O
- ▲ Nb
- × Zr
- ✖ Y
- Sr
- + Rb
- V
- Ba

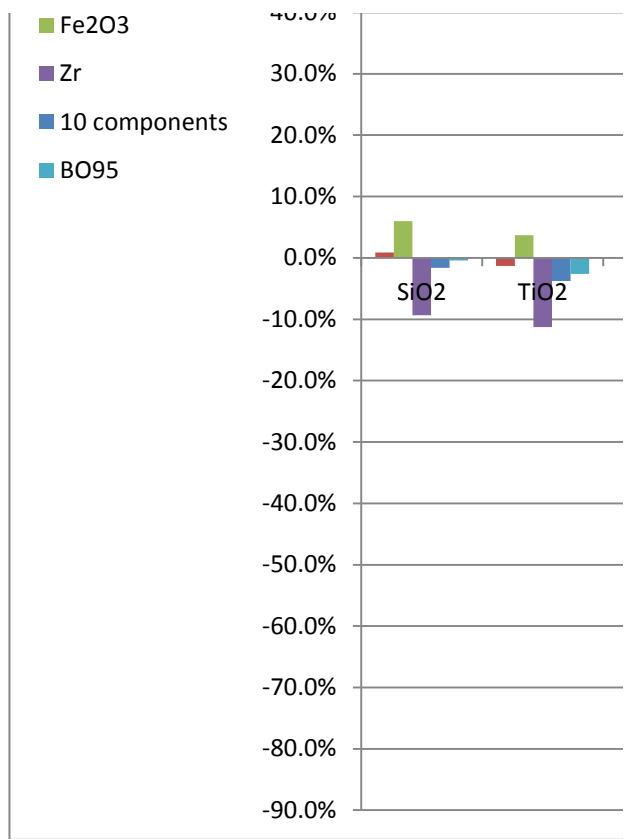
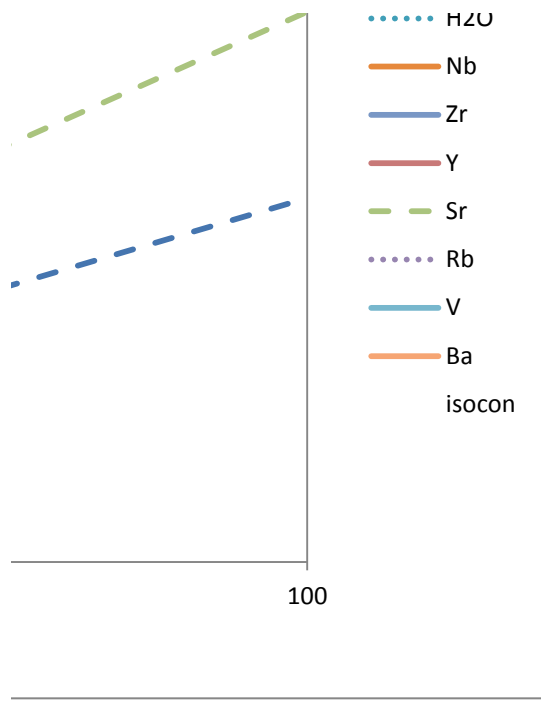


BO95

-0.4%
 -2.6%
 -1.3%
 -6.1%
 -23.1%
 124.1%
 -72.1%
 -22.7%
 27.8%
 5.5%
 89.2%

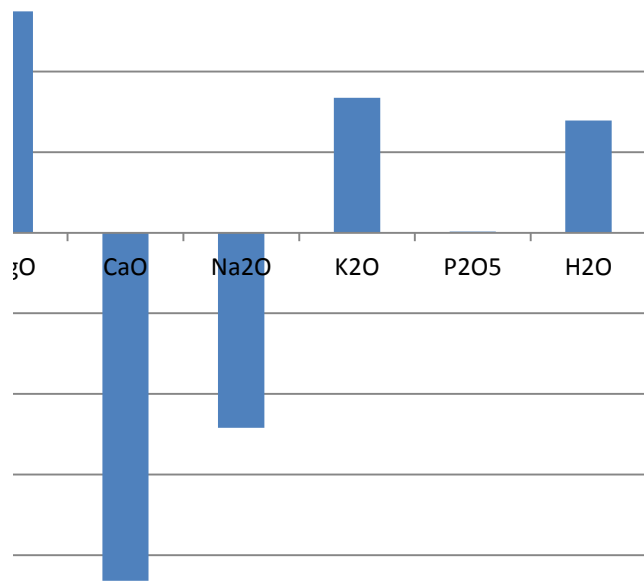
3.1%
 9.8%
 -1.1%
 -57.8%
 31.7%
 9.5%
 -4.5%



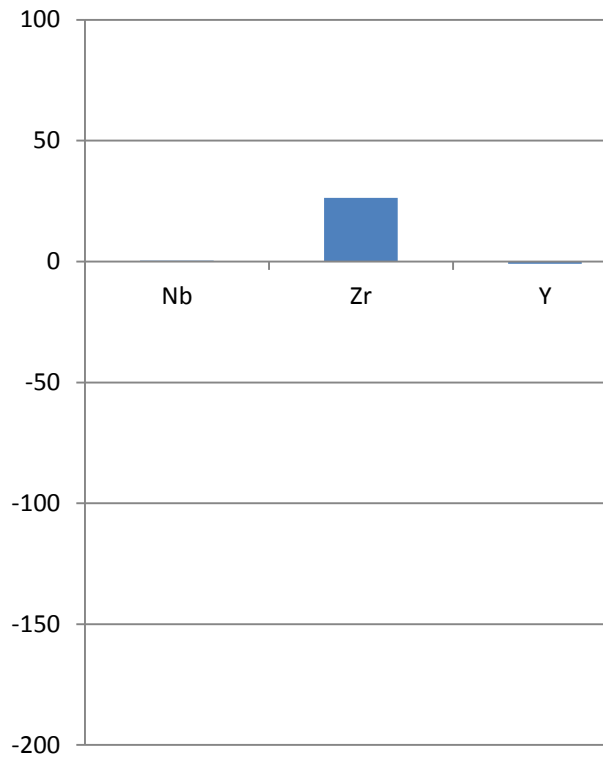


scaled c_i^0		scaled c_i^A	
0.00	100.00	0.00	100.65

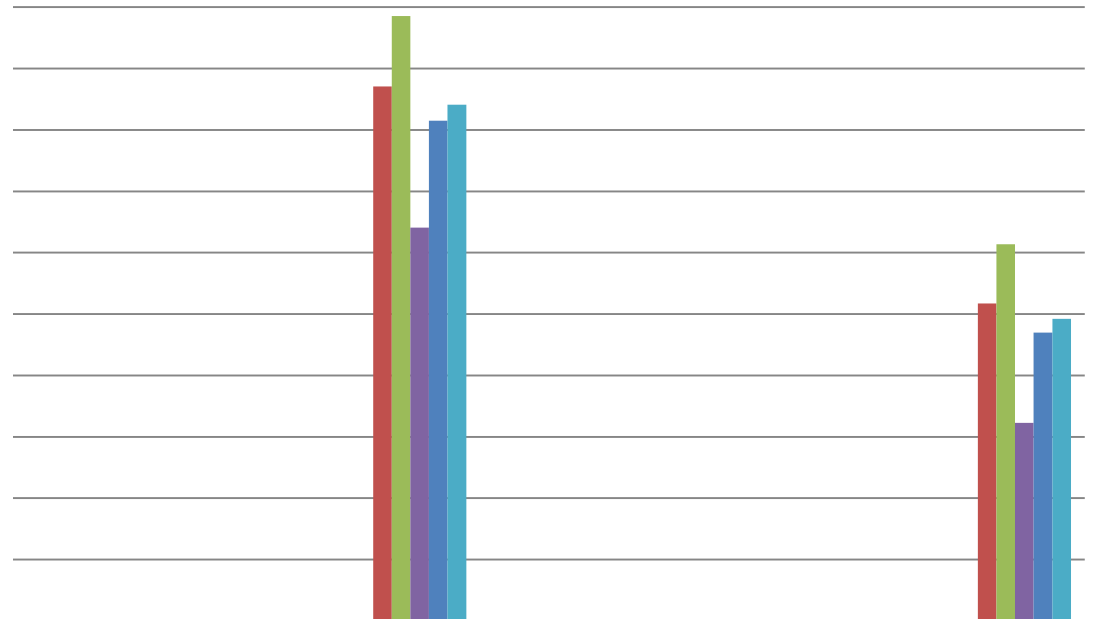
Losses (g/100 g)

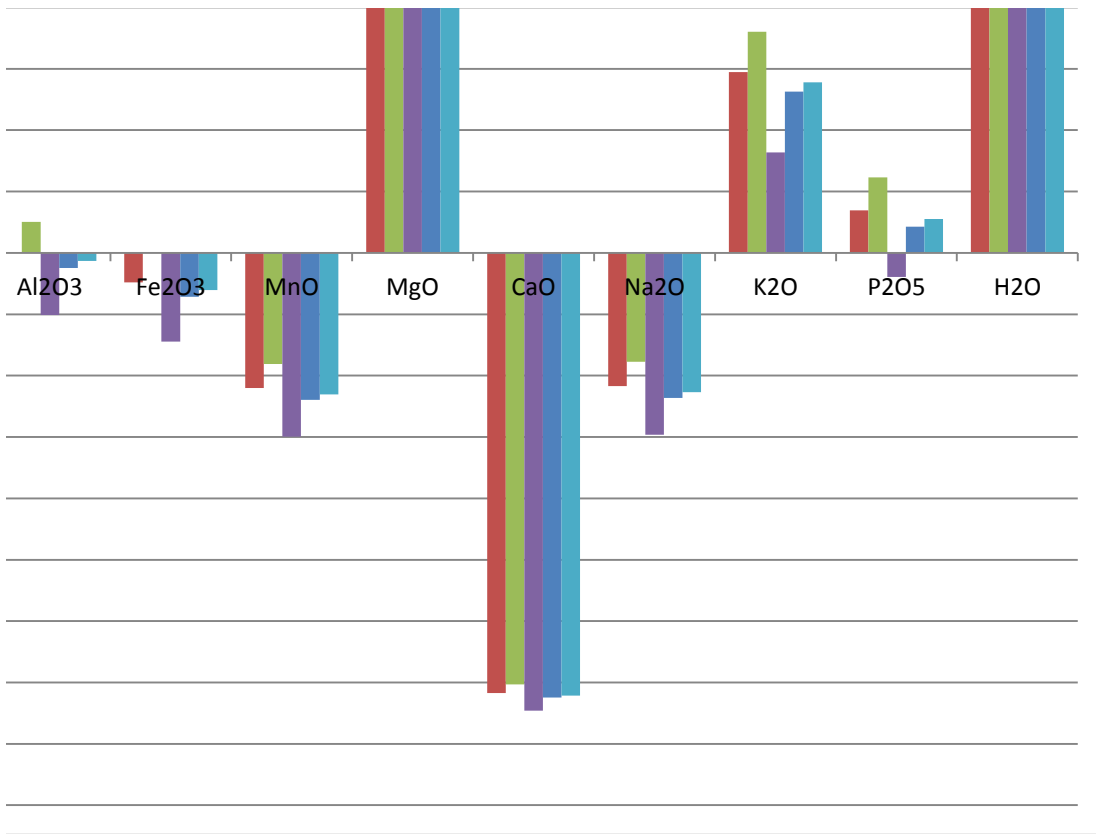


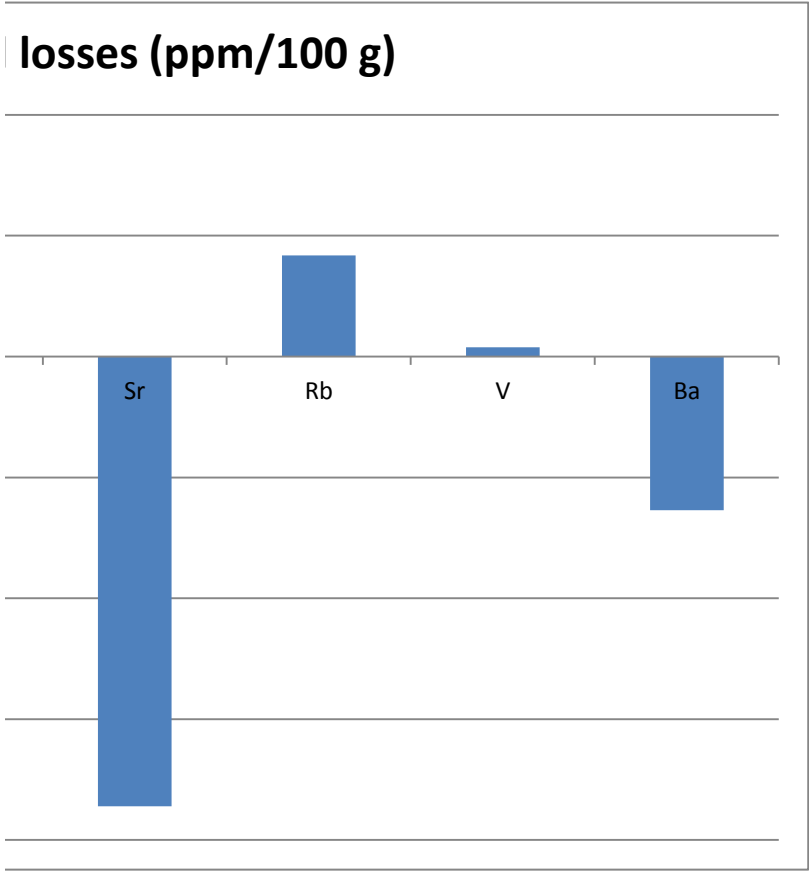
Gains and



Relative gains and losses (%)







	c_i^0	σ_i^0	c_i^A	σ_i^A	b_i	K	L	M	rovnice	b	1.01	K	L	M	rovnice
SiO2	64.85	1.27	65.27	1.16	1.006476	0.000002	0.000000	8.877179	0.000000			109.393704	-0.258839	8.961614	12.1780367
TiO2	0.65	0.05	0.64	0.07	0.984615	0.000000	0.000000	0.000054	0.000000			0.000165	-0.000001	0.000056	2.94418014
Al2O3	16.49	0.62	16.45	0.47	0.997574	0.000000	0.000000	0.364137	0.000001			4.420922	-0.037081	0.376584	11.641076
Fe2O3	4.17	0.28	3.96	0.36	0.949640	0.000000	0.000000	0.040121	0.000000			0.446198	-0.010316	0.043977	9.91168624
MnO	0.09	0.01	0.07	0.01	0.777778	0.000000	0.000000	0.000000	0.000000			0.000001	0.000000	0.000000	
MgO	1.13	0.09	2.56	0.13	2.265487	0.000000	0.000000	0.003419	0.000000			-0.080669	-0.032916	0.000634	
CaO	2.98	0.27	0.84	0.35	0.281879	0.000000	0.000000	0.016459	-0.000001			2.550300	-0.695425	0.038804	
Na2O	5.12	0.43	4	0.6	0.781250	0.000000	0.000000	0.223591	0.000000			6.606915	-0.516435	0.301317	
K2O	3.19	0.2	4.12	0.49	1.291536	0.000000	0.000000	0.094140	0.000000			-1.605231	-0.064845	0.078944	
P2O5	0.15	0.03	0.16	0.02	1.066667	0.000000	0.000000	0.000002	0.000001			-0.000003	0.000000	0.000002	-1.97774986
LOI	0.8	0.13	1.53	0.16	1.912500	0.000000	0.000000	0.007641	0.000000			-0.049476	-0.017778	0.001838	
Total	99.62		99.57												
ppm															
Nb	24	5	25	6	1.041667	0.002140	0.000000	3984.985006	0.000001			-2186.911052	-27.698285	3787.661638	-0.58469038
Zr	309	18	343	25	1.110032	0.480134	0.000000	1049034.146212	0.000000			-18112926.657702	-615585.515822	914031.598755	-20.4900052
Y	43	8	43	4	1.000000	-0.005844	0.000000	6399.999595	-0.000001			3257.034389	-28.013172	6624.754066	0.48741752
Sr	319	47	136	63	0.426332	-10.396674	0.000000	19101323.528700	-0.000001			740629969.312529	-155250761.916788	38763900.206613	
Rb	139	29	185	53	1.330935	4.911870	0.000000	18479147.672205	0.000000			-45376321.845382	-3366198.232596	13456421.456126	-3.62224981
V	47	4	52	4	1.106383	0.000490	0.000000	1266.315913	0.000000			-13657.144660	-652.513552	1046.402682	-13.675097
Ba	1139	114	1100	151	0.965759	-292.298532	-0.000006	#####	0.000000			4218405877.741190	-69211049.633529	1301750759.711000	3.18739574

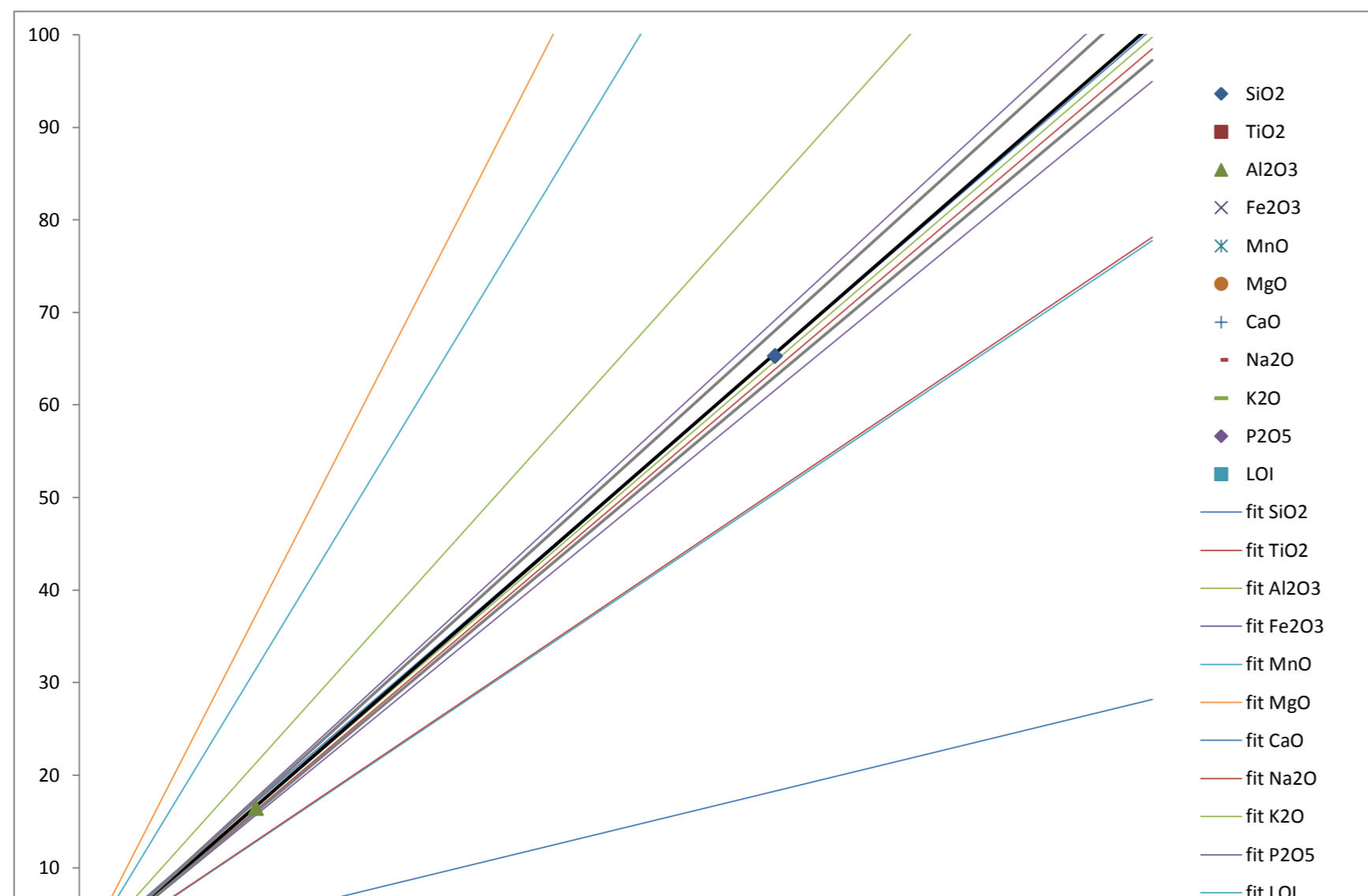
smodch 0.5206643
smodch Si, Al, Ti, P, 0.038105

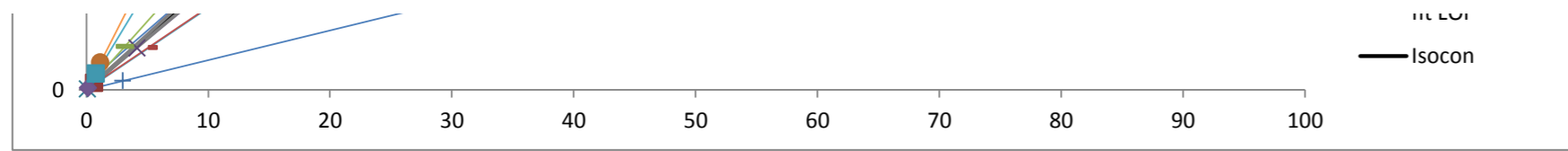
0.000000

Fitting of the isocon:

(Baumgartner and Olsen, 1995)

$$\frac{\partial \chi^2}{\partial b} = \frac{\partial}{\partial b} \left[\sum_{i=1}^n \frac{(c_i^A - b c_i^0)^2}{(\sigma_i^A)^2 + b^2 (\sigma_i^0)^2} \right] = 0.$$





0.01	0.65	100	100.65
0.01	0.01	100	98.46
0.01	0.16	100	99.76
0.01	0.04	100	94.96
0.01	0.00	100	77.78
0.01	0.03	100	226.55
0.01	0.01	100	28.19
0.01	0.04	100	78.13
0.01	0.04	100	129.15
0.01	0.00	100	106.67
0.01	0.02	100	191.25
0.01	1.00	100	
0.01	0.00	100	
0.01	0.25	100	104.17
0.01	3.43	100	111.00
0.01	0.43	100	100.00
0.01	1.36	100	42.63
0.01	1.85	100	133.09
0.01	0.52	100	110.64
0.01	11.00	100	96.58
0.01	0.00		
0.01	#####	100	101.08
0.01	#####	100	104.8927
0.01	0.00	100	97.27157



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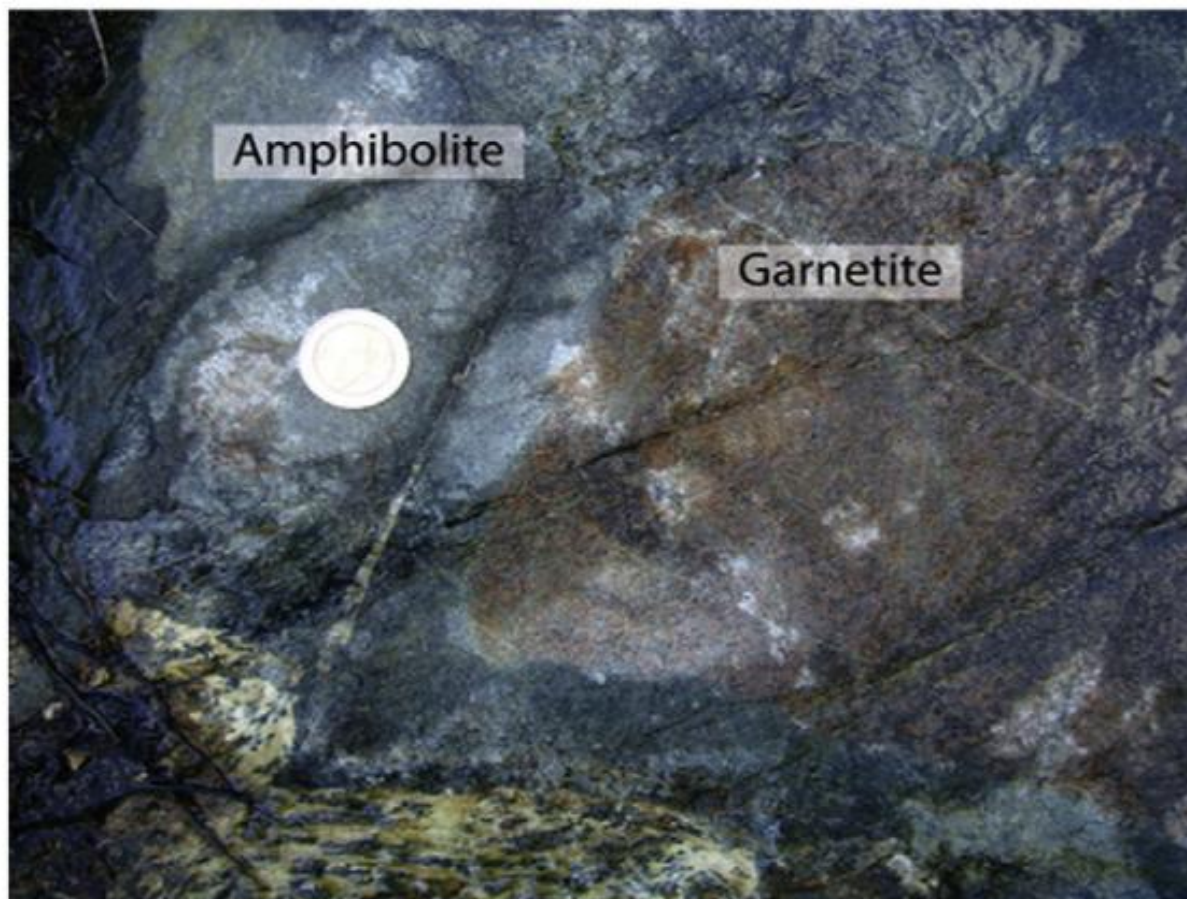
Coupled mass transfer through a fluid phase during the hydration of granulite: An example from the Caledonides, Norway

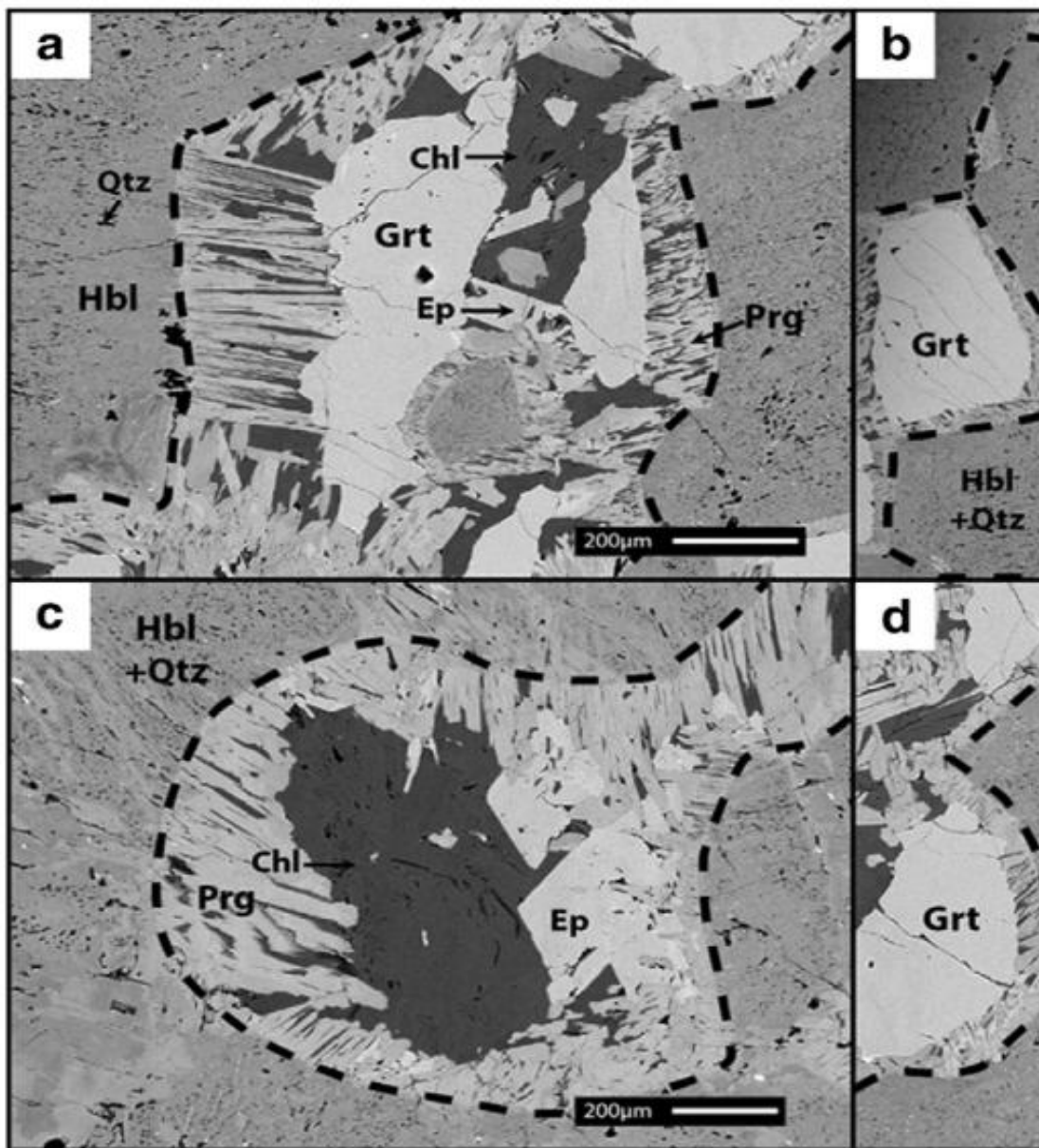
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^b PGP, Department of Geosciences, University of Oslo, N-0316, Norway

^c The Institute for Geoscience Research (TIGeR), Curtin University, Perth 6102, Australia





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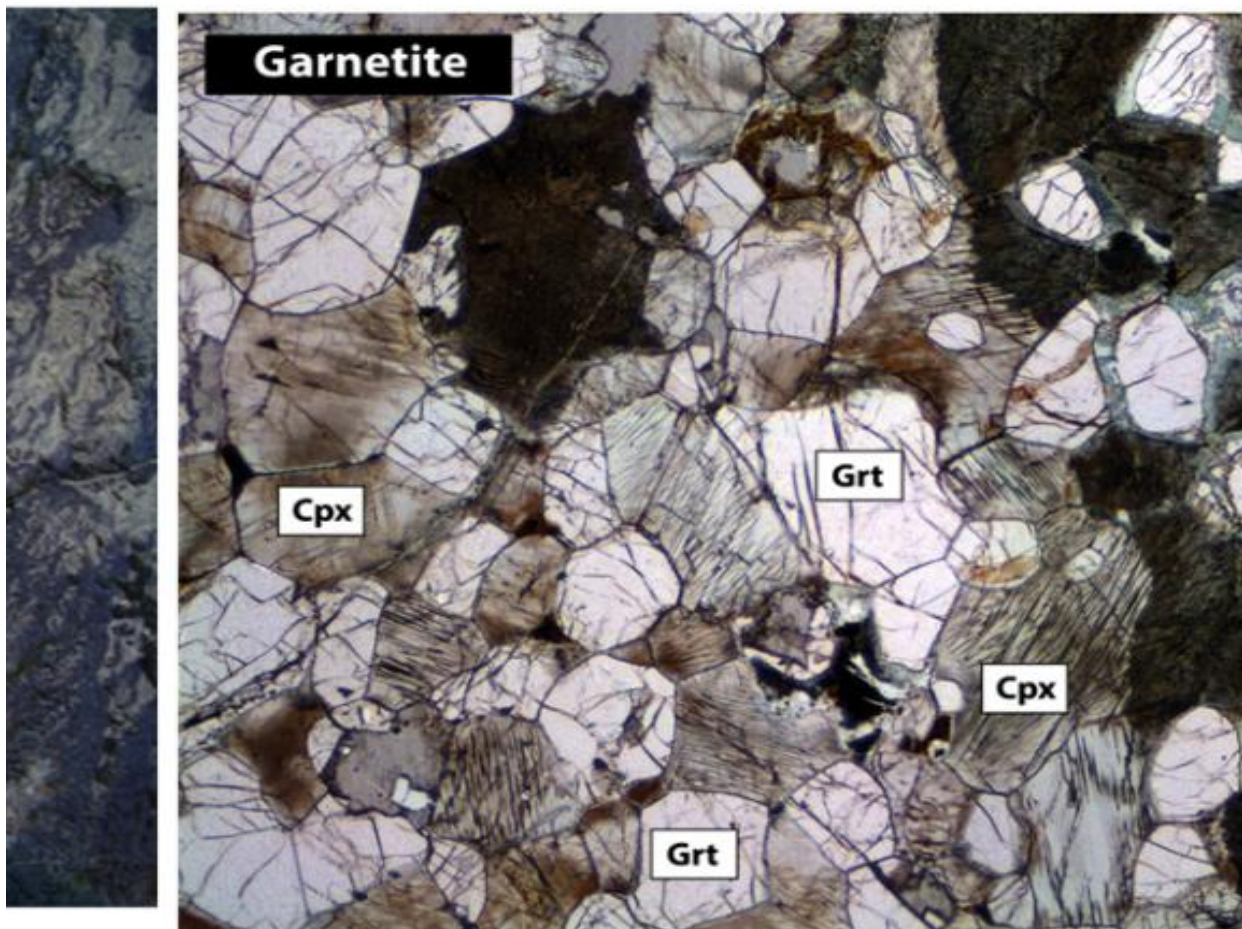
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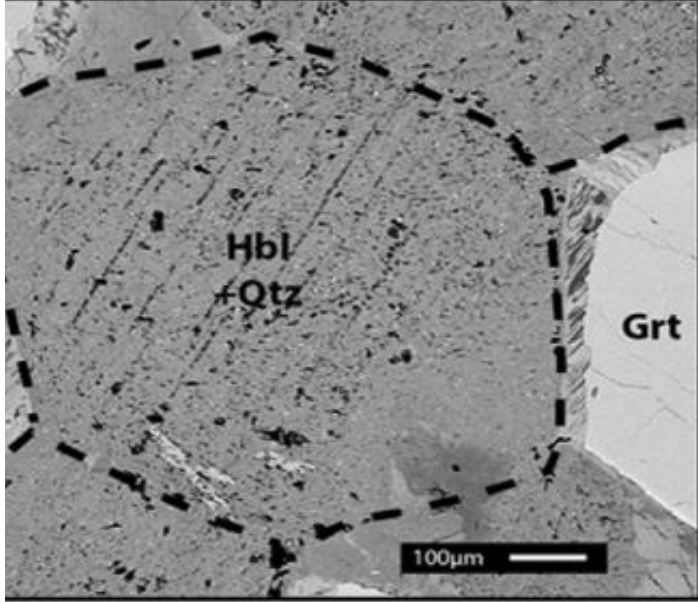
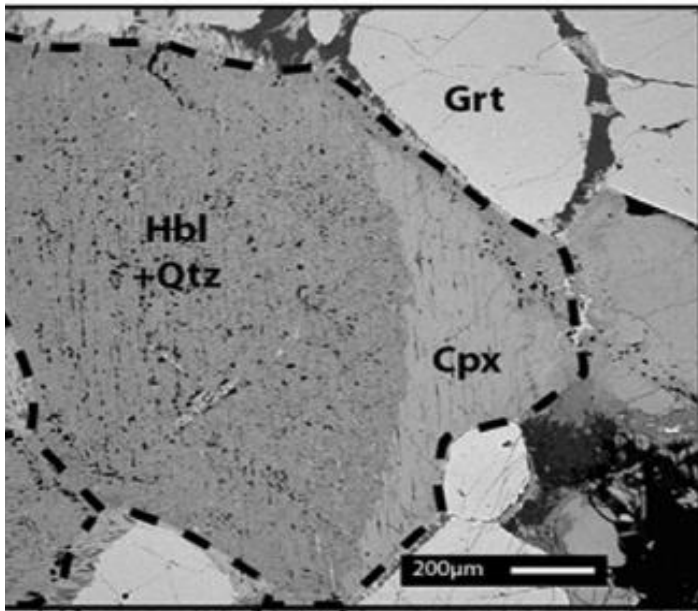


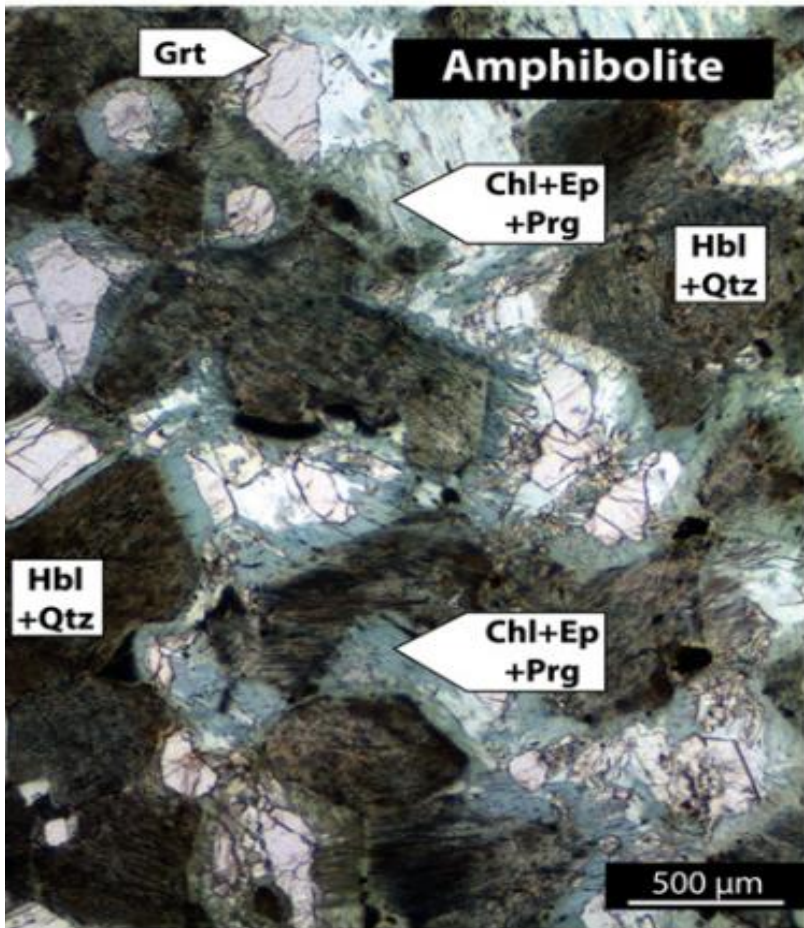
and volume preservation e from the Bergen



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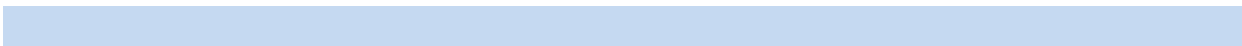
Coupled mass transfer through a fluid phase and volume preservation

Centrella et al. 2015, Lithos

	Cpx	Hbl+Qz	Grt	Prg+Chl+Ep	garnetite	amphibolite
ρ	3.2	3.2	3.8	3	3.5	3.1
SiO ₂	48.92	53.64	40.61	37.64	44.57	45.1
TiO ₂	0.81	0.64	0.07	0.5	0.59	0.58
Al ₂ O ₃	7.23	7.98	22.59	19.44	13.94	13.57
FeO	7.13	9.48	17.69	11.5	12.45	12.45
MnO	0.01	0.18	0.4	0.04	0.18	0.18
MgO	13.01	13.37	13.96	13.24	13.13	13.6
CaO	19.44	12.72	5.44	9.59	12.72	11.6
Na ₂ O	1.49	0.38	0	1	0.97	1.23
K ₂ O	0	0.06	0	0.3	0	0.19
H ₂ O	0	1.55	0	7.25	0.16	2.43

during the hydration of granulite: An example from Bergen Arcs, Norv

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