ИСПОЛЬЗОВАНИЕ МОДЕЛЕЙ СЕМЕЙСТВА КОМАГМАТ

и других программ, направленных на расчеты траекторий кристаллизации магм

Применение MELTS

(андезит-базальтовые серии Алеутских островов)

Journal of the Geological Society, London, Vol. **167**, 2010, pp. 1081–1088. doi: 10.1144/0016-76492010-070.

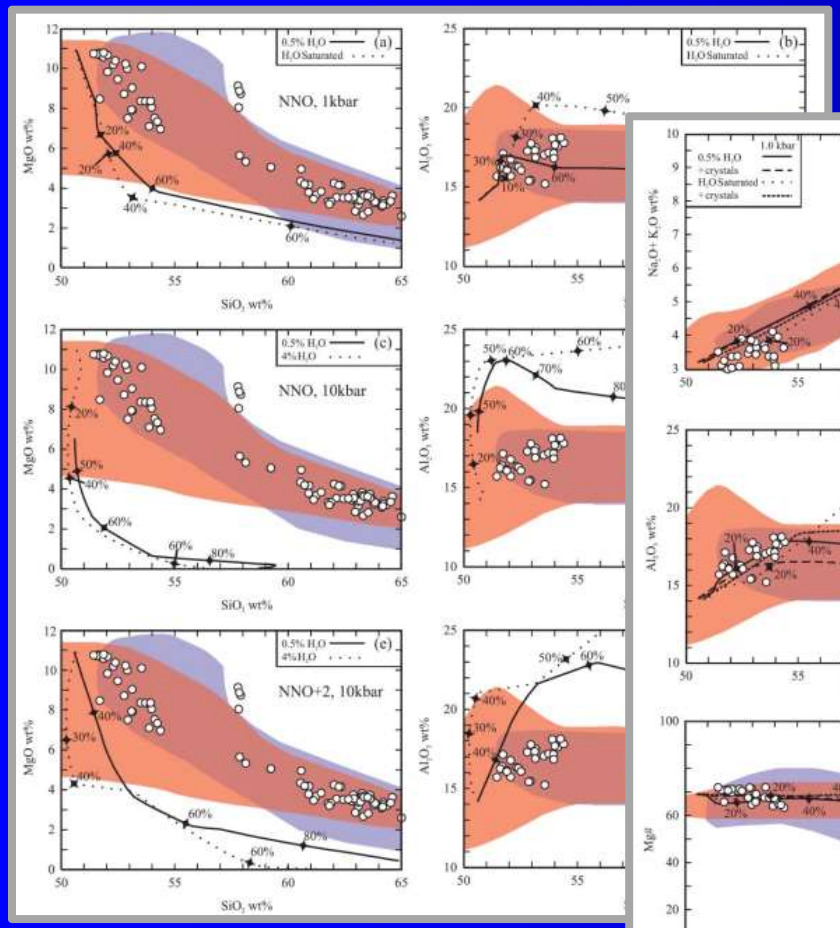
High-Mg andesite genesis by upper crustal differentiation

J. GREGORY SHELLNUTT[1,*] & GEORG F. ZELLMER[1,2]

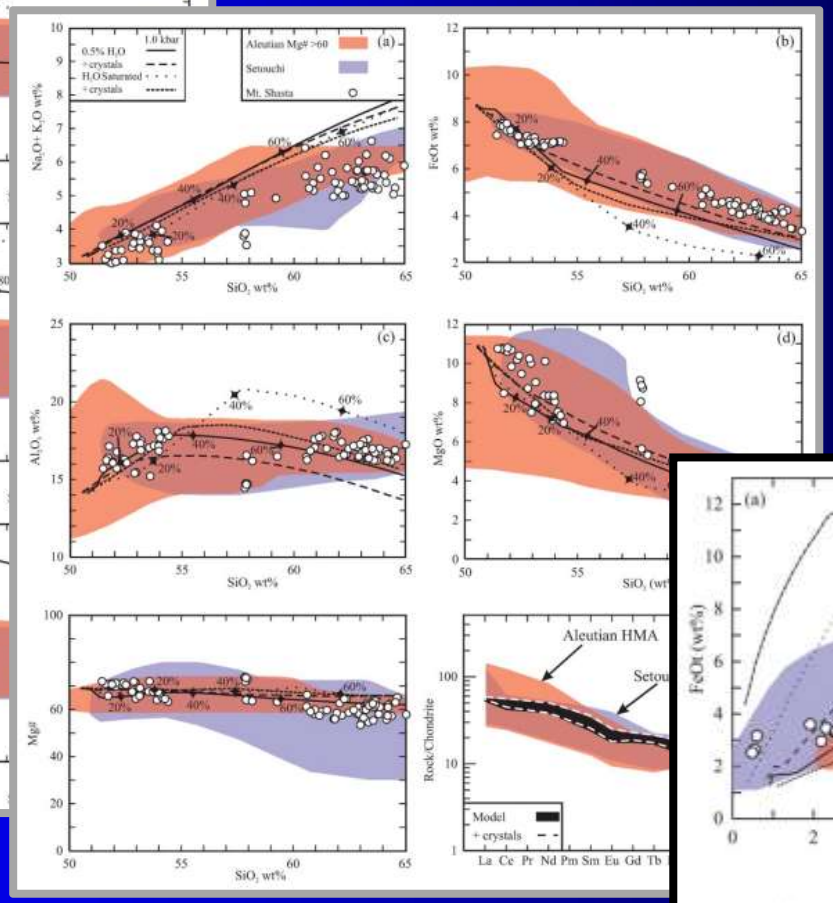
[1]*Institute of Earth Sciences, Academia Sinica, 128 Academia Road Sec. 2, Nankang, Taipei 11529, Taiwan*

[2]*Lamont–Doherty Earth Observatory, 61 Route 9W, Palisades, NY 10964, USA*

**Corresponding author (e-mail: jgshelln@earth.sinica.edu.tw)*



Меняем давление….



Добавляем воду….

Подбираем режим fO_2….

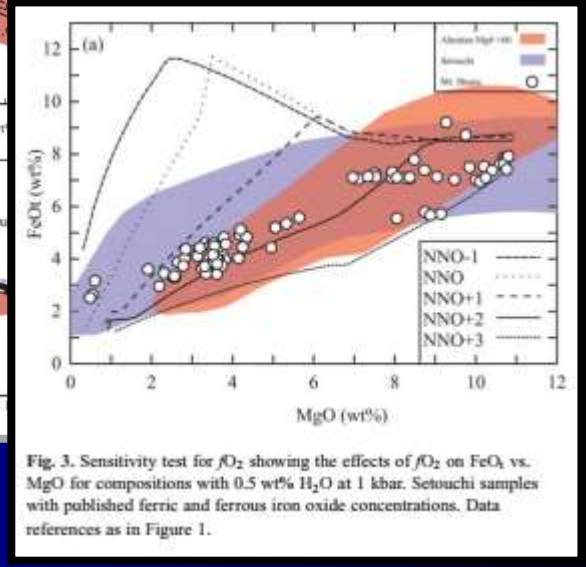
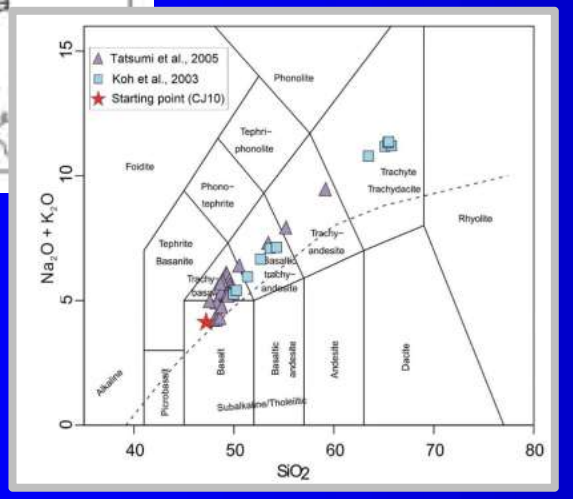


Fig. 3. Sensitivity test for fO_2 showing the effects of fO_2 on FeO_t vs. MgO for compositions with 0.5 wt% H_2O at 1 kbar. Setouchi samples with published ferric and ferrous iron oxide concentrations. Data references as in Figure 1.

Применение MELTS

(Высоко-Al шелочные магмы вулканических о-вов Кореи)



Le et al. Geoscience Letters (2024) 11:45
https://doi.org/10.1186/s40562-024-00360-8

Geoscience Letters

RESEARCH LETTER Open Access

Application of the MELTS program to the fractional crystallization of low-alumina alkaline magma on Jeju Volcanic Island, Korea

Hoang Yen Le[1,3], Cheolwoo Chang[2,3*] and Sung-Hyo Yun[2,3]

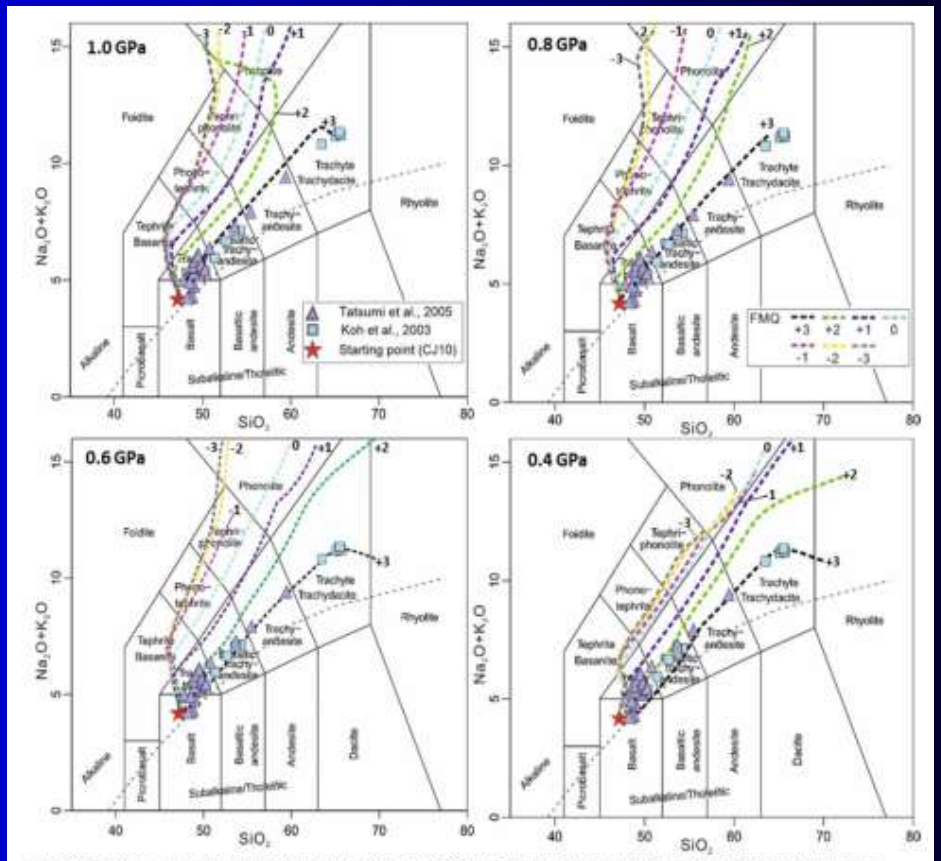


Fig. 6 Comparison of the evolution paths between the rhyolite-MELTS model and the natural samples from 1.0 to 0.4 GPa at various oxygen fugacities on the TAS diagram (after Le Bas et al. 1986)

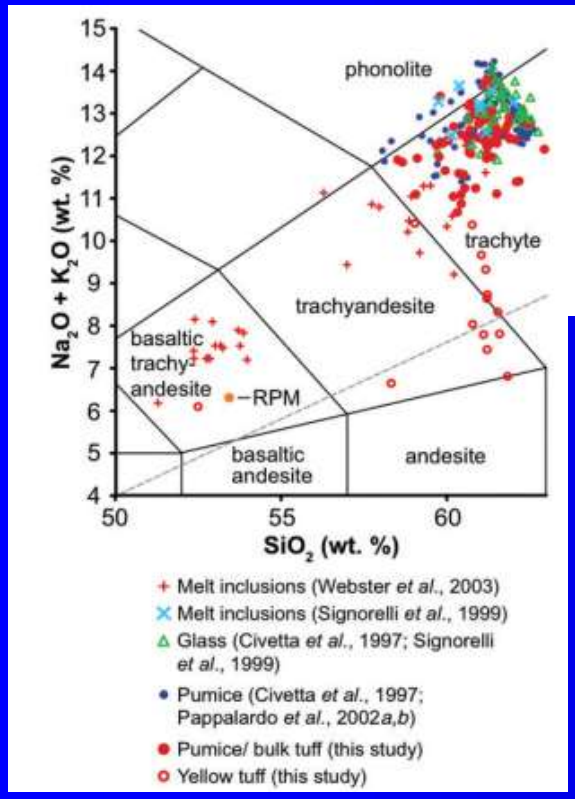
Оптимально QFM+3…

В итоге - безумно высокая окисленность магм!

Fig. 6 Comparison of the evolution paths between the rhyolite-MELTS model and the natural samples from 1.0 to 0.4 GPa at various oxygen fugacities on the TAS diagram (after Le Bas et al. 1986)

Примеры применения MELTS

(трахит-фонолитовые пироксластические серии к западу от Неаполя в Италии)



JOURNAL OF PETROLOGY | VOLUME 00 | NUMBER 0 | PAGES 1–35 | 2006 | doi:10.1093/petrology/egl068
Journal of Petrology Advance Access published December 23, 2006

Phase Equilibria Constraints on the Chemical and Physical Evolution of the Campanian Ignimbrite

SARAH J. FOWLER[1]*, FRANK J. SPERA[1], WENDY A. BOHRSON[2], HARVEY E. BELKIN[3] AND BENEDETTO DE VIVO[4]

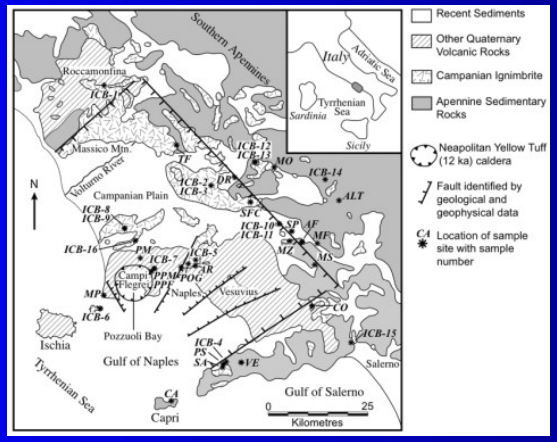
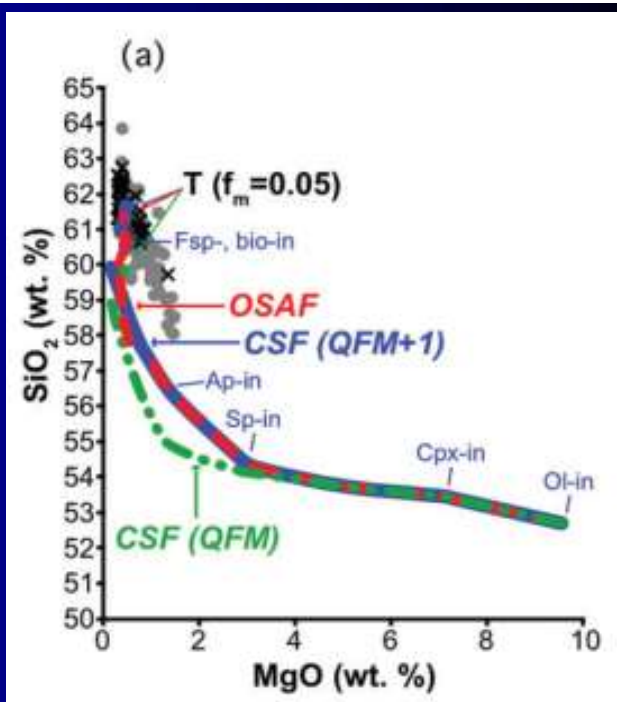
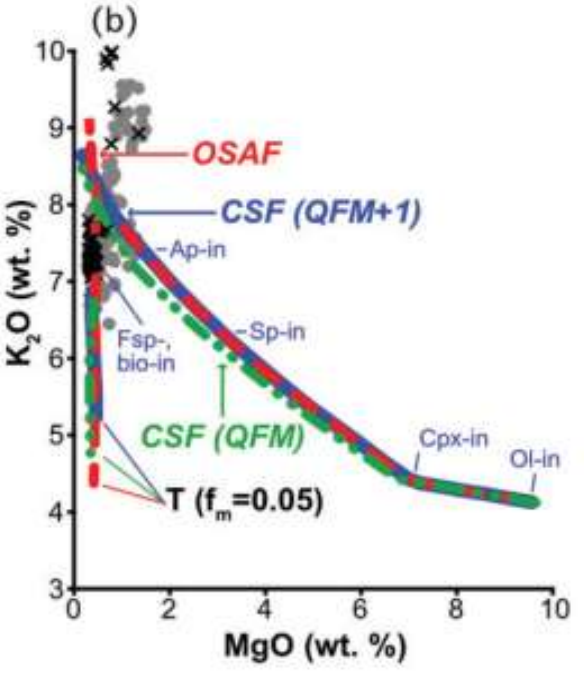


Fig. 4. Campanian Ignimbrite MgO vs oxide (wt%) variation diagrams showing CI data trend and MELTS simulation results. Filled grey circles, pumice and bulk tuff samples from this study and Civetta *et al.* (1997); ×, glass and melt inclusion data from Civetta *et al.* (1997) and Signorelli *et al.* (1999). As a result of probable reaction, the clinopyroxene-hosted melt inclusions presented in Fig. 3 (Webster *et al.*, 2003) provide no basis for comparison, and therefore are not included here. MELTS results represent evolution of reconstructed parental melt by closed-system fractionation (blue line, CSF with fO_2 along QFM + 1 buffer; green dot–dot–dash line, CSF with fO_2 fixed at QFM) and open-system assimilation–fractionation (red dashed line, OSAF with fO_2 along QFM + 1). Pressure is fixed





Применение MELTS

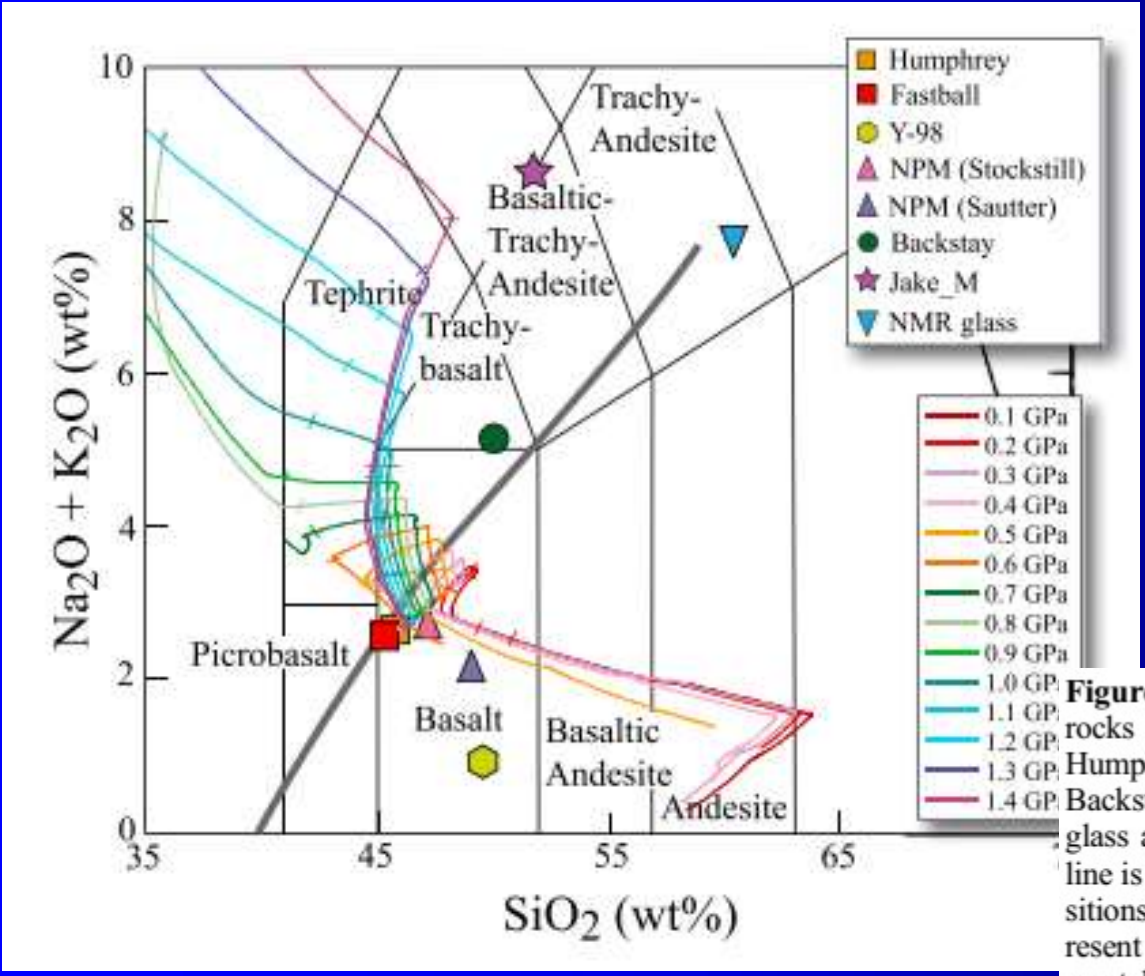
к "сериям" (!!!)
марсианских "магм"(!!!)

JOURNAL OF GEOPHYSICAL RESEARCH: PLANETS, VOL. 119, 1–18, doi:10.1002/2013JE004445, 2014

Exploring fractionation models for Martian magmas

Arya Udry,[1] J. Brian Balta,[1] and Harry Y. McSween Jr.[1]

Received 30 May 2013; revised 12 November 2013; accepted 13 November 2013; published 7 January 2014.



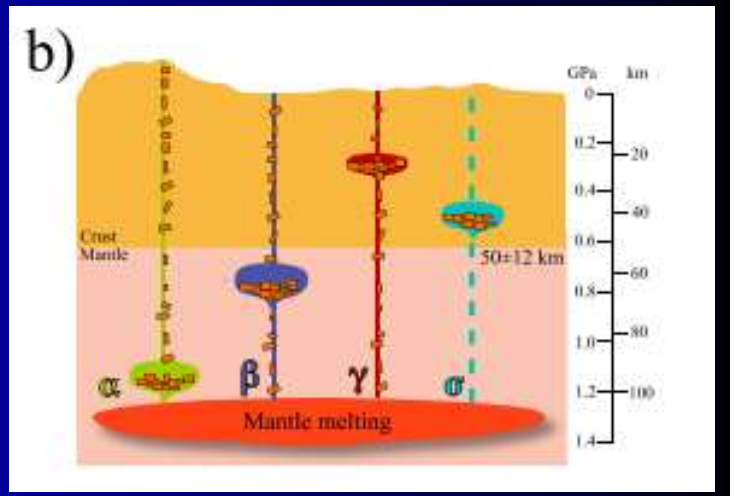


Figure 2. Total alkali-silica diagram for classifying volcanic rocks [*Le Bas et al.*, 1986], showing the compositions of Humphrey, Fastball, Y-98, nakhlite parental melts (NPM), Backstay, Jake_M, and nakhlite Miller Range intercumulus glass average compositions (references as in Table 1). Gray line is the boundary between alkaline and subalkaline compositions [*Irvine and Baragar*, 1971]. Different colored lines represent calculated liquid lines of descent for fractional crystallization of a Humphrey-like magma, under dry, isobaric conditions from 0.1 to 1.4 GPa at FMQ-1. Tick marks delineate 25% fractionation increments.

Применение программы PETROLOG

к толеитовым сериям Исландии

Earth and Planetary Science Letters 427 (2015) 272–285

Contents lists available at ScienceDirect

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Fe-XANES analyses of Reykjanes Ridge basalts: Implications for oceanic crust's role in the solid Earth oxygen cycle

Oliver Shorttle[a,*], Yves Moussallam[a], Margaret E. Hartley[a], John Maclennan[a], Marie Edmonds[a], Bramley J. Murton[b]

Более тонкая работа, ориентированная на оценки Fe_2O_3 в стеклах!!!

Используются данные по Fe-XANES измерепниям Fe^{3+}/Fe_{tot} в стеклах

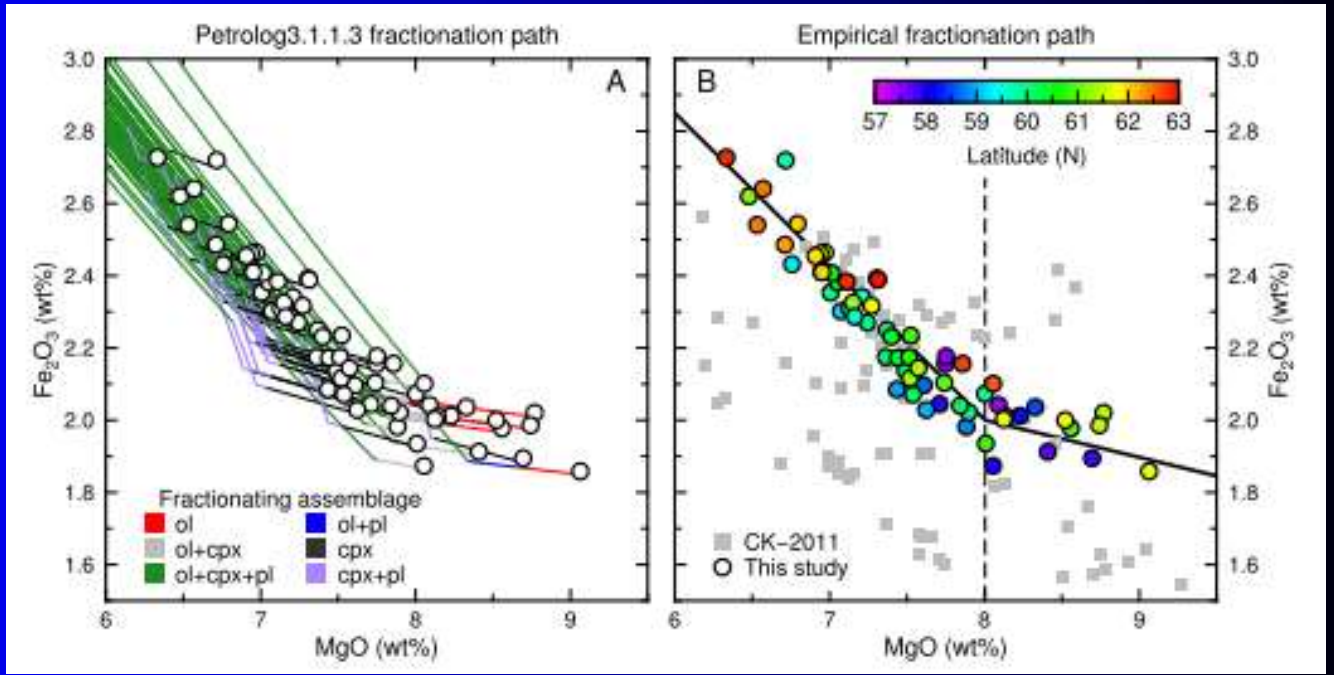
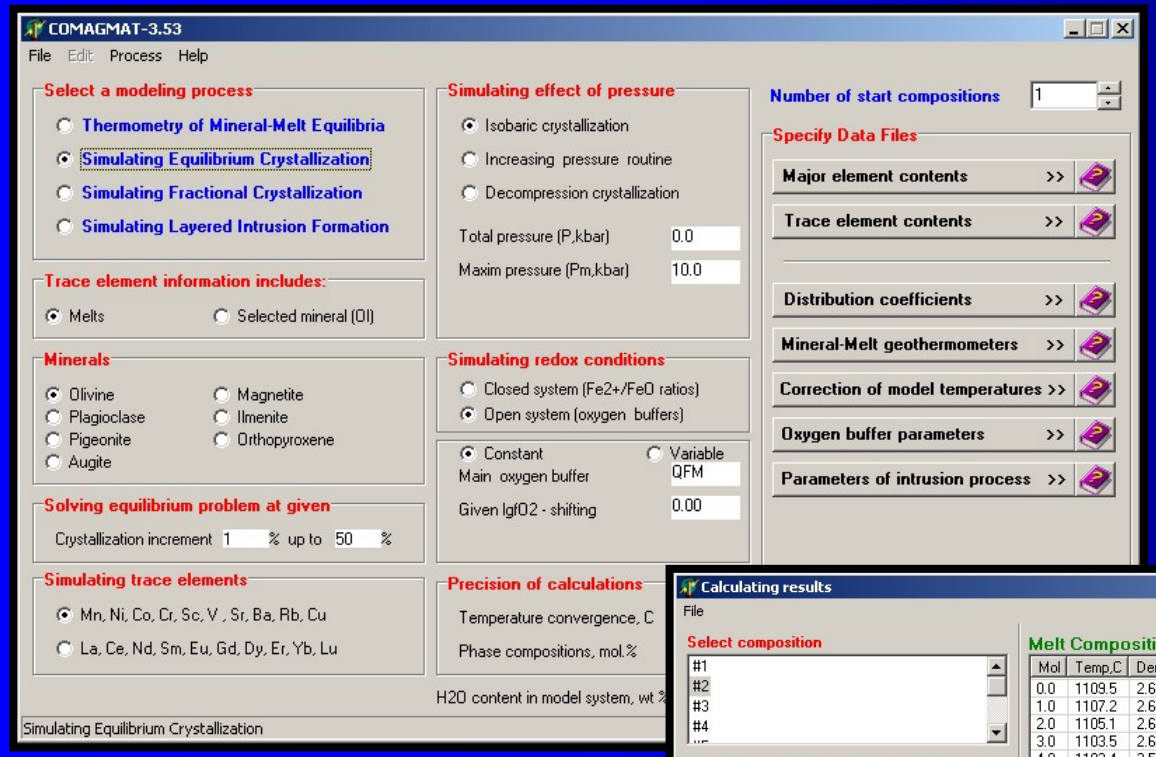


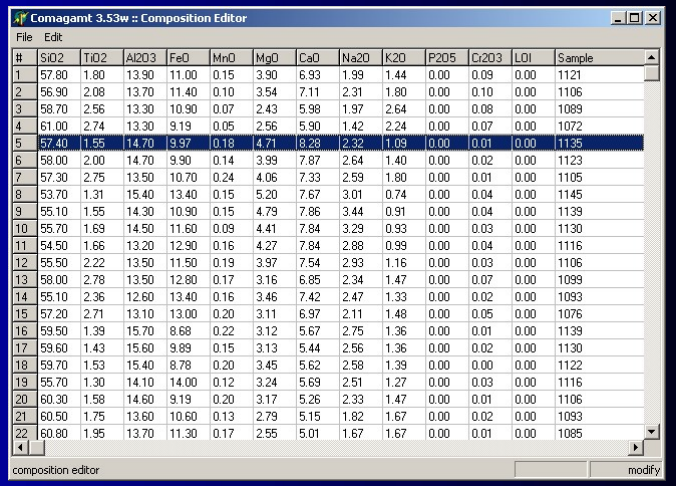
Fig. A.3. A comparison between models of fractionation in the Reykjanes Ridge dataset and empirical fits to the data. In (A) Petrolog (version 3.1.1.3, Danyushevsky and Plechov, 2011) is used to model fractional crystallisation starting from the major element composition of the sample glasses (open circles) and using the water data of Nichols et al. (2002). Pressure is set to 2 kbar, partition coefficients are $D_{ol}^{Fe_2O_3} = 0$, $D_{plag}^{Fe_2O_3} = 0$ and $D_{cpx}^{Fe_2O_3} = 0.45$ (Mallmann and O'Neill, 2009), and we used the mineral–melt models of Herzberg and O'Hara (2002). Fractionation paths are drawn as coloured lines showing the co-crystallising phases. (B) shows the mixed empirical (for samples with MgO < 8 wt%) and model (olivine addition to samples above 8 wt% MgO) method of data correction that has been used to construct figures in the main text. Coloured circles are the new data we present here; grey squares are data from Cottrell and Kelley (2011).

ПЕРЕХОДИМ К ПРОГРАММАМ КОМАГМАТ…

https://comagmat.web.ru/

WINDOWS ВЕРСИЯ МОДЕЛИ КОМАГМАТ-3

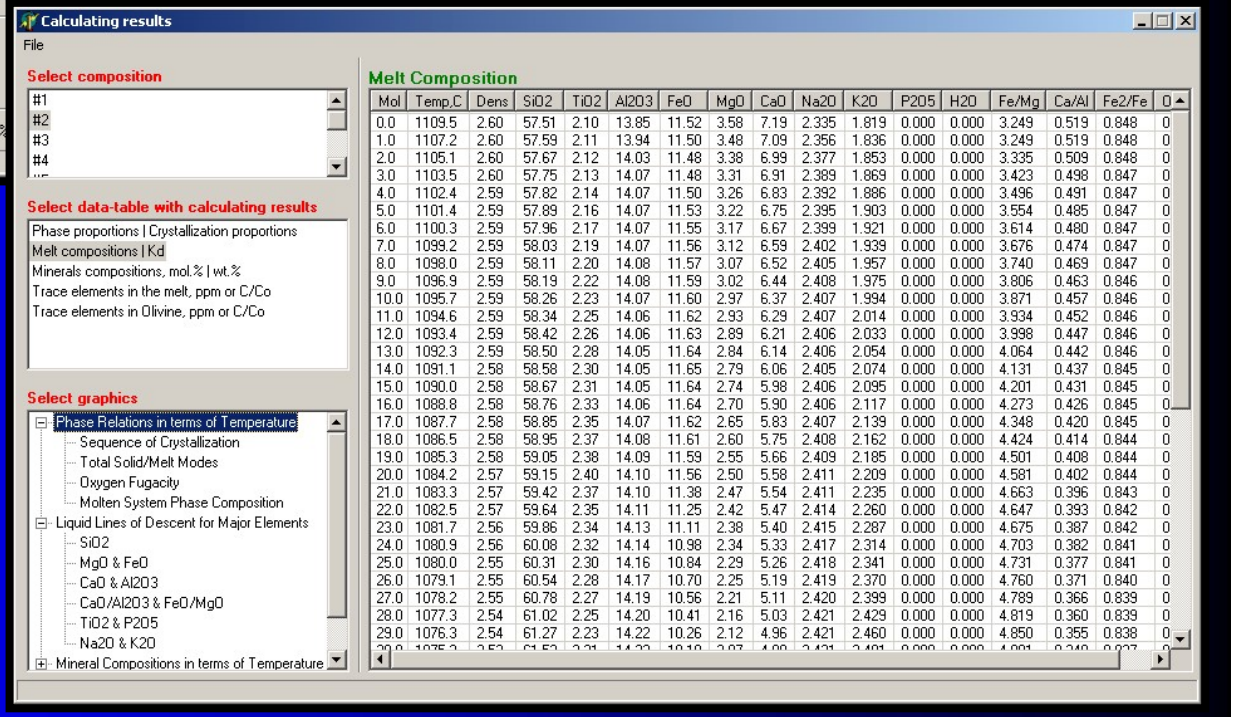




#	SiO2	TiO2	Al2O3	FeO	MnO	MgO	CaO	Na2O	K2O	P2O5	Cr2O3	LOI	Sample
1	57.80	1.80	13.90	11.00	0.15	3.90	6.93	1.99	1.44	0.00	0.09	0.00	1121
2	56.90	2.08	13.70	11.40	0.10	3.54	7.11	2.31	1.80	0.00	0.10	0.00	1106
3	58.70	2.56	13.30	10.90	0.07	2.43	5.98	1.97	2.64	0.00	0.08	0.00	1089
4	61.00	2.74	13.30	9.19	0.05	2.56	5.90	1.42	2.24	0.00	0.07	0.00	1072
5	57.40	1.55	14.70	9.97	0.18	4.71	8.28	2.32	1.09	0.00	0.01	0.00	1135
6	58.00	2.00	14.70	9.90	0.14	3.99	7.87	2.64	1.40	0.00	0.02	0.00	1123
7	57.30	2.75	13.50	10.70	0.24	4.06	7.33	2.59	1.80	0.00	0.01	0.00	1105
8	53.70	1.31	15.40	13.40	0.15	5.20	7.67	3.01	0.74	0.00	0.04	0.00	1145
9	55.10	1.55	14.30	10.90	0.15	4.79	7.86	3.44	0.91	0.00	0.04	0.00	1139
10	55.70	1.69	14.50	11.60	0.09	4.41	7.84	3.29	0.93	0.00	0.03	0.00	1130
11	54.50	1.66	13.20	12.90	0.16	4.27	7.84	2.88	0.99	0.00	0.04	0.00	1116
12	55.50	2.22	13.50	11.50	0.19	3.97	7.54	2.93	1.16	0.00	0.03	0.00	1106
13	58.00	2.78	13.50	12.80	0.17	3.16	6.85	2.34	1.47	0.00	0.07	0.00	1099
14	55.10	2.36	12.60	13.40	0.16	3.46	7.42	2.47	1.33	0.00	0.02	0.00	1093
15	57.20	2.71	13.10	13.00	0.20	3.11	6.97	2.11	1.48	0.00	0.05	0.00	1076
16	59.50	1.39	15.70	8.68	0.22	3.12	5.67	2.75	1.36	0.00	0.01	0.00	1139
17	59.60	1.43	15.60	9.89	0.15	3.13	5.44	2.56	1.36	0.00	0.02	0.00	1130
18	59.70	1.53	15.40	8.78	0.20	3.45	5.62	2.58	1.39	0.00	0.00	0.00	1122
19	55.70	1.30	14.10	14.00	0.12	3.24	5.69	2.51	1.27	0.00	0.03	0.00	1116
20	60.30	1.58	14.60	9.19	0.20	3.17	5.26	2.33	1.47	0.00	0.01	0.00	1106
21	60.50	1.75	13.60	10.60	0.13	2.79	5.15	1.82	1.67	0.00	0.02	0.00	1093
22	60.80	1.95	13.70	11.30	0.17	2.55	5.01	1.67	1.67	0.00	0.01	0.00	1085

Исходные составы

Инициализация параметров



Mol	Temp,C	Dens	SiO2	TiO2	Al2O3	FeO	MgO	CaO	Na2O	K2O	P2O5	H2O	Fe/Mg	Ca/Al	Fe2/Fe	O
0.0	1109.5	2.60	57.51	2.10	13.85	11.52	3.58	7.19	2.335	1.819	0.000	0.000	3.249	0.519	0.848	0
1.0	1107.2	2.60	57.59	2.11	13.94	11.50	3.48	7.09	2.356	1.836	0.000	0.000	3.249	0.519	0.848	0
2.0	1105.1	2.60	57.67	2.12	14.03	11.48	3.38	6.99	2.377	1.853	0.000	0.000	3.335	0.509	0.848	0
3.0	1103.5	2.60	57.75	2.13	14.07	11.48	3.31	6.91	2.389	1.869	0.000	0.000	3.423	0.498	0.847	0
4.0	1102.4	2.59	57.82	2.14	14.07	11.50	3.26	6.83	2.392	1.886	0.000	0.000	3.496	0.491	0.847	0
5.0	1101.4	2.59	57.89	2.16	14.07	11.53	3.22	6.75	2.395	1.903	0.000	0.000	3.554	0.485	0.847	0
6.0	1100.3	2.59	57.96	2.17	14.07	11.55	3.17	6.67	2.399	1.921	0.000	0.000	3.614	0.480	0.847	0
7.0	1099.2	2.59	58.03	2.19	14.07	11.56	3.12	6.59	2.402	1.939	0.000	0.000	3.676	0.474	0.847	0
8.0	1098.0	2.59	58.11	2.20	14.08	11.57	3.07	6.52	2.405	1.957	0.000	0.000	3.740	0.469	0.847	0
9.0	1096.9	2.59	58.19	2.22	14.08	11.59	3.02	6.44	2.408	1.975	0.000	0.000	3.806	0.463	0.846	0
10.0	1095.7	2.59	58.26	2.23	14.07	11.60	2.97	6.37	2.407	1.994	0.000	0.000	3.871	0.457	0.846	0
11.0	1094.6	2.59	58.34	2.25	14.06	11.62	2.93	6.29	2.407	2.014	0.000	0.000	3.934	0.452	0.846	0
12.0	1093.4	2.59	58.42	2.26	14.06	11.63	2.89	6.21	2.406	2.033	0.000	0.000	3.998	0.447	0.846	0
13.0	1092.3	2.59	58.50	2.28	14.05	11.64	2.84	6.14	2.406	2.054	0.000	0.000	4.064	0.442	0.846	0
14.0	1091.1	2.58	58.58	2.30	14.05	11.65	2.79	6.06	2.405	2.074	0.000	0.000	4.131	0.437	0.845	0
15.0	1090.0	2.58	58.67	2.31	14.05	11.64	2.74	5.98	2.406	2.095	0.000	0.000	4.201	0.431	0.845	0
16.0	1088.8	2.58	58.76	2.33	14.06	11.64	2.70	5.90	2.406	2.117	0.000	0.000	4.273	0.426	0.845	0
17.0	1087.7	2.58	58.85	2.35	14.07	11.62	2.65	5.83	2.407	2.139	0.000	0.000	4.348	0.420	0.845	0
18.0	1086.5	2.58	58.95	2.37	14.08	11.61	2.60	5.75	2.408	2.162	0.000	0.000	4.424	0.414	0.844	0
19.0	1085.3	2.58	59.05	2.38	14.09	11.59	2.55	5.66	2.409	2.185	0.000	0.000	4.501	0.408	0.844	0
20.0	1084.2	2.57	59.15	2.40	14.10	11.56	2.50	5.58	2.411	2.209	0.000	0.000	4.581	0.402	0.844	0
21.0	1083.3	2.57	59.42	2.37	14.10	11.38	2.47	5.54	2.411	2.235	0.000	0.000	4.663	0.396	0.843	0
22.0	1082.5	2.57	59.64	2.35	14.11	11.25	2.42	5.47	2.414	2.260	0.000	0.000	4.647	0.393	0.842	0
23.0	1081.7	2.56	59.86	2.34	14.13	11.11	2.38	5.40	2.415	2.287	0.000	0.000	4.675	0.387	0.842	0
24.0	1080.9	2.56	60.08	2.32	14.14	10.98	2.34	5.33	2.417	2.314	0.000	0.000	4.703	0.382	0.841	0
25.0	1080.0	2.55	60.31	2.30	14.16	10.84	2.29	5.26	2.418	2.341	0.000	0.000	4.731	0.377	0.841	0
26.0	1079.1	2.55	60.54	2.28	14.17	10.70	2.25	5.19	2.419	2.370	0.000	0.000	4.760	0.371	0.840	0
27.0	1078.2	2.55	60.78	2.27	14.19	10.56	2.21	5.11	2.420	2.399	0.000	0.000	4.789	0.366	0.839	0
28.0	1077.3	2.54	61.02	2.25	14.20	10.41	2.16	5.03	2.421	2.429	0.000	0.000	4.819	0.360	0.839	0
29.0	1076.3	2.54	61.27	2.23	14.22	10.26	2.12	4.96	2.421	2.460	0.000	0.000	4.850	0.355	0.838	0

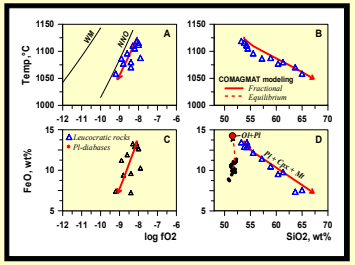
Результаты расчетов

Примеры применения программы КОМАГМАТ-3

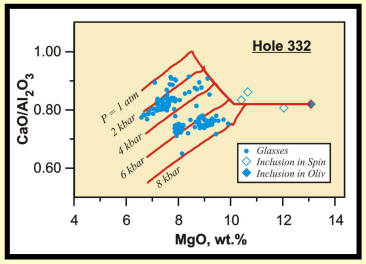
- ✓ **Geochemical thermometry of marginal rocks from the Skaergaard intrusion**

UT-04: *Ol* (1443°C) → *Aug* (1233°C) → *Pl* (1174°C),
UT-08: *Pl* (1332°C) → *Ol* (1231°C) → *Aug* (1164°C),
EC-10: *Ol* (1385°C) → *Aug* (1199°C) → *Pl* (1187°C),
MEO-18: *Pl* + *Ol* (1248 °C) → *Aug* (1161°C),
KT-47: *Ol* (1346°C) → *Pl* (1191°C) → *Aug* (1189°C),
*EG*4507: *Pl* (1242°C) → *Ol* (1225°C) → *Aug* (1163°C).

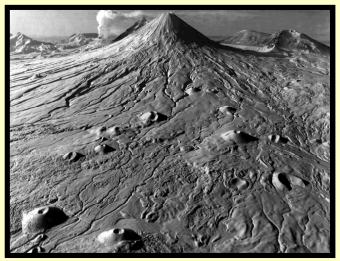
- ✓ **Modeling the formation of ferrodiorites from the Chazhma sill, Kamchatka**



- ✓ **Modeling polybaric fractionation of MORB glasses from Mid-Atlantic Ridge**



- ✓ **Modeling the generation of high-Al basalts from the Klyuchevskoy volcano, Kamchatka**



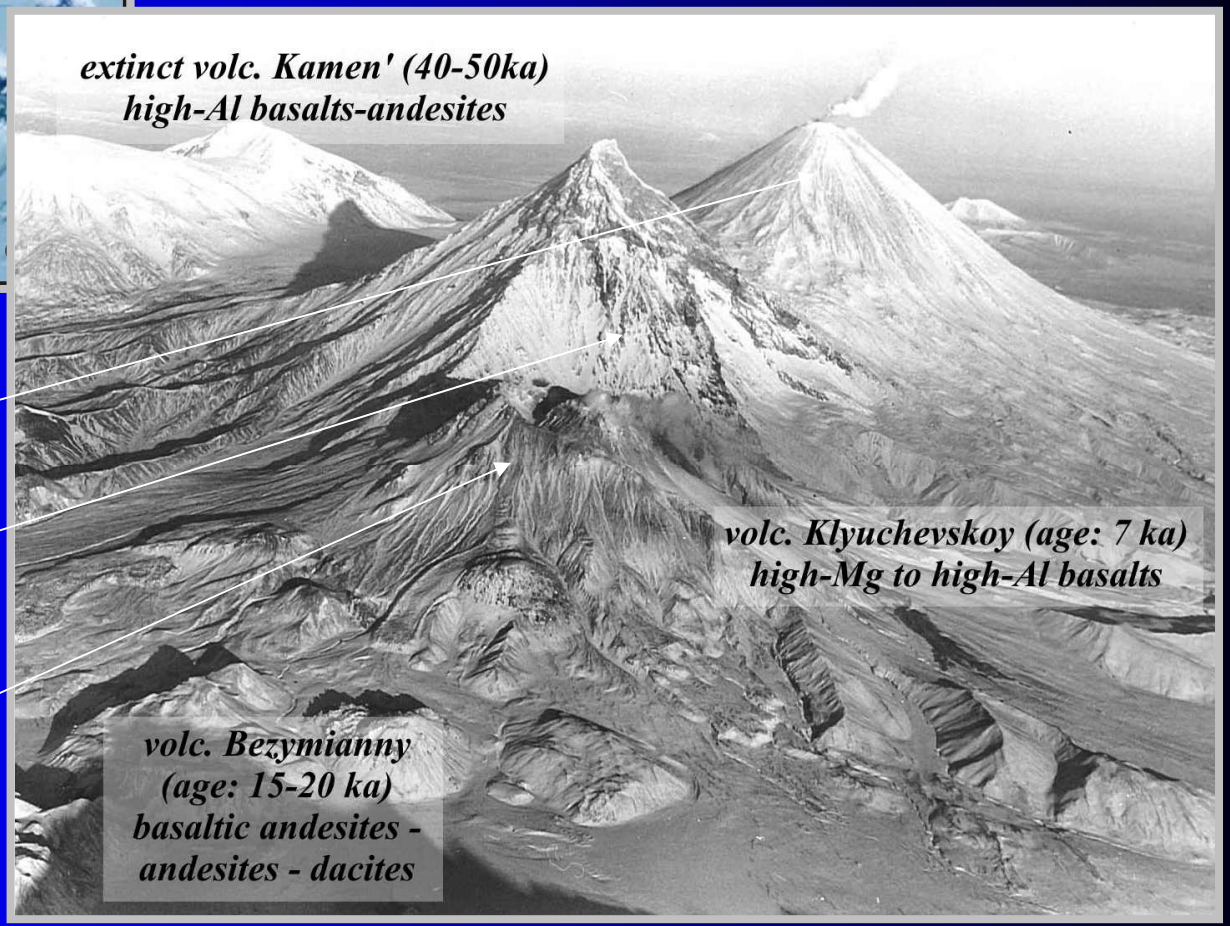
Моделирование серии от высоко-Mg до высоко-Al базальтов Ключевского вулкана на Камчатке

KLYUCHEVSKOY'S GROUP OF VOLCANOES (Kamchatka, Russia)

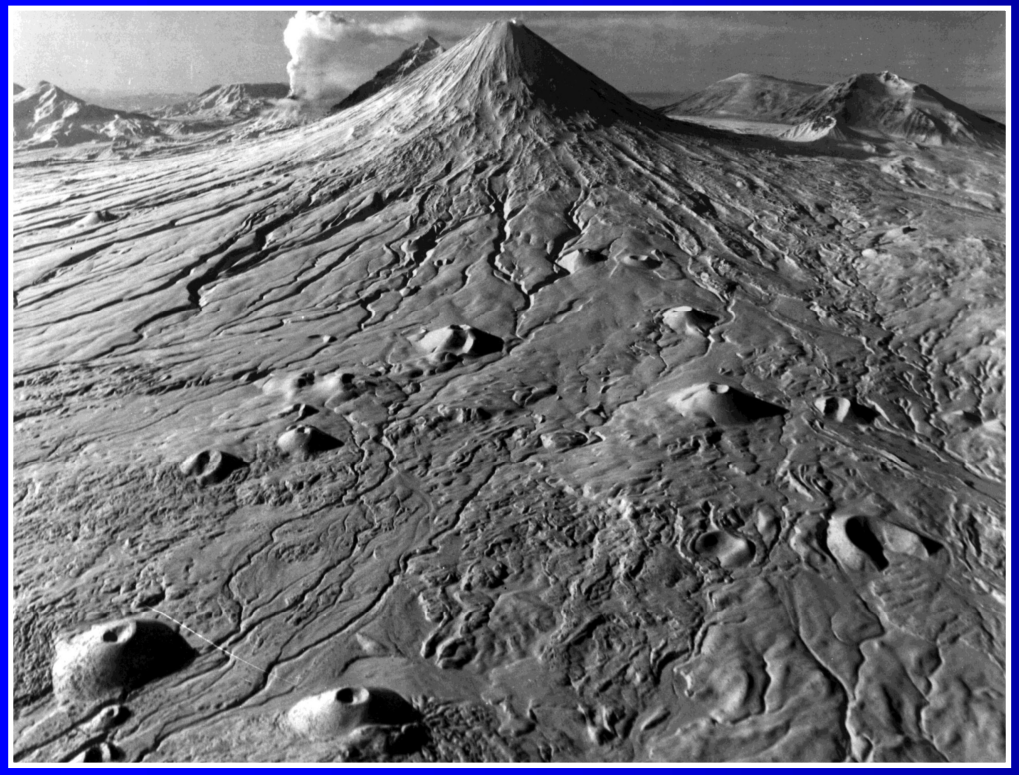
Klyuchevskoy: basalts

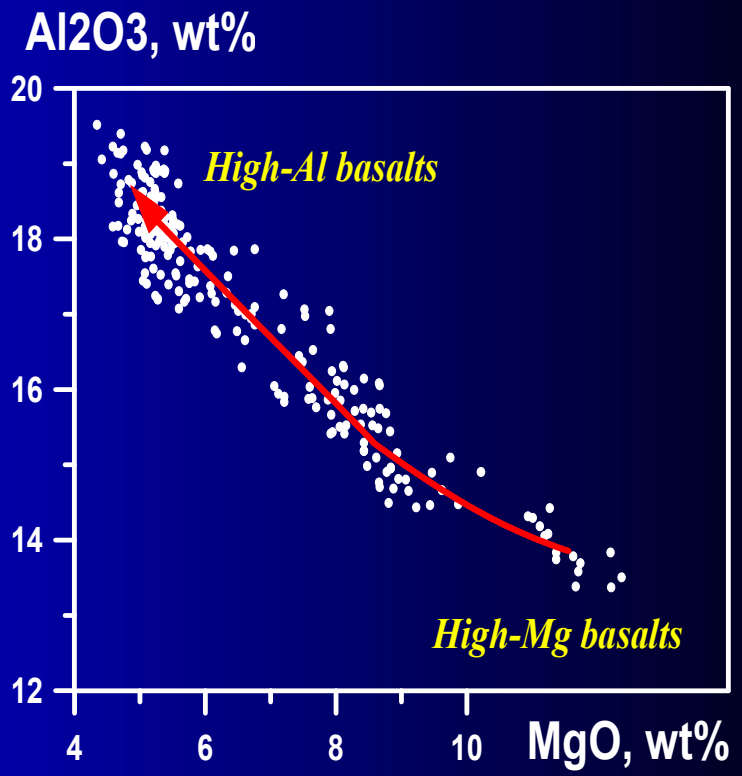
Kamen: basaltic andesites

Bezymianny: andesites



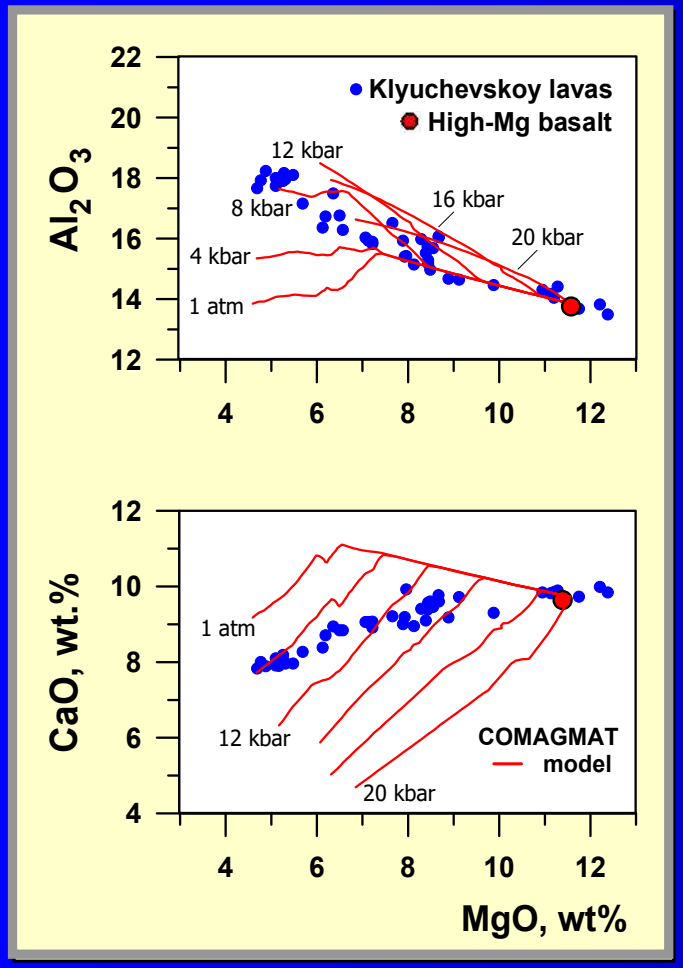
MODELING THE GENERATION OF HIGH-AL BASALTS from the Klyuchevskoy volcano, Kamchatka





The volcanic edifice consists of numerous basalt lava sheets and pyroclastic materials, **ranging continuously from high-Mg basalts to high-Al basalts containing at least 18% Al_2O_3**. The proposed genetic link between high-magnesia and high-alumina basalts includes the removal of mafic phases, **principally olivine and augite**.

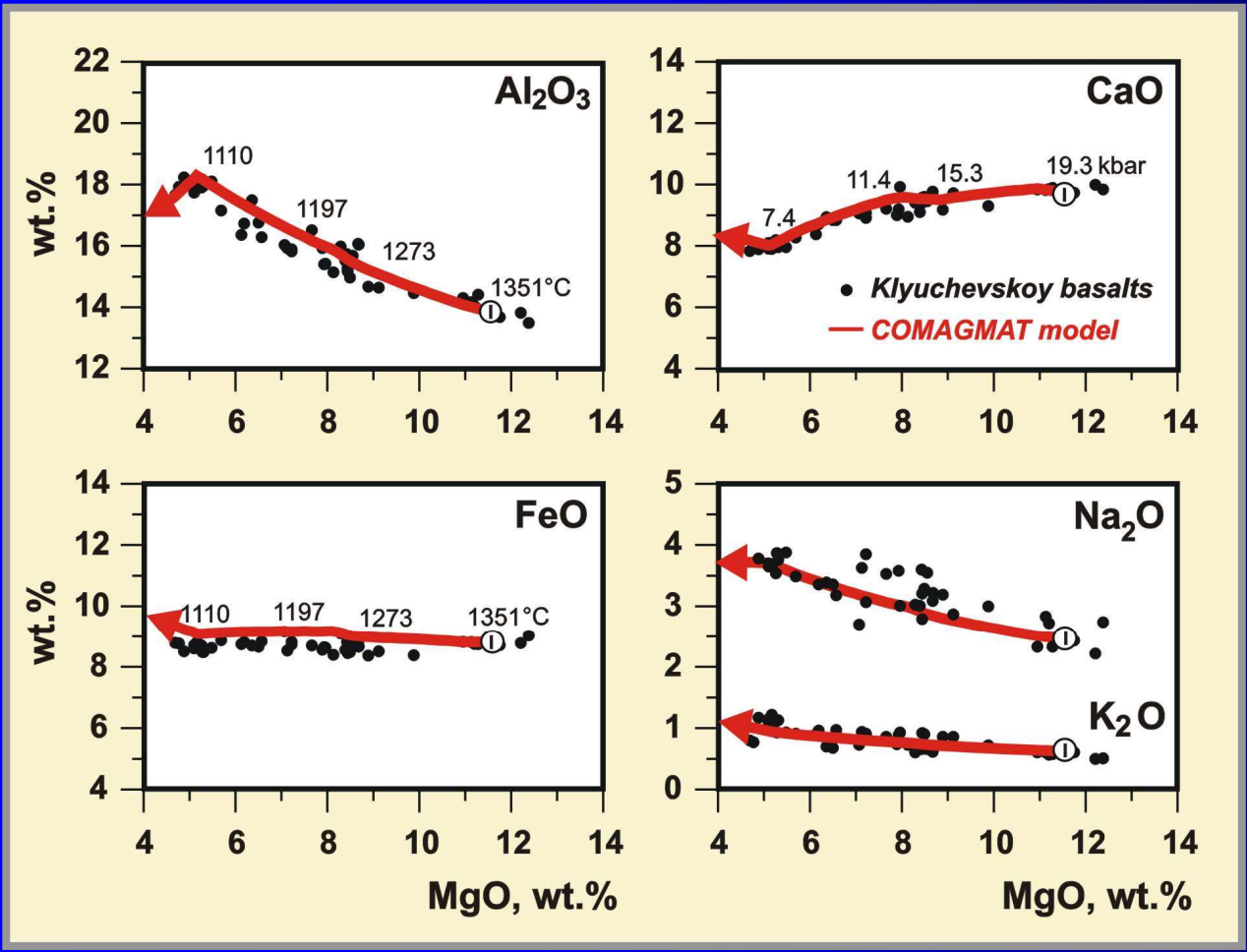
MODELING OF THE THE ISOBARIC FRACTIONATION PROCESS
at unhydrous conditions ranging from 1 atm to 20 kbars



At the pressures more than 8 kbars equilibrium crystallization of the high-magnesia parent results in the alumina enriched liquids. However, **the modeled trends do not provide an adequate match with the observed CaO-MgO trend**.

A possible explanation of these discrepancies is to link the formation of the observed suite with decompression fractionation of the parental high-magnesia magma containing small but significant water.

THE OPTIMAL MODEL OF THE DECOMPRESSION FRACTIONATION
for the high-Mg magma of the Klyuchevskoy volcano



These chemical trends can be produced by **~40% fractionation** of the ***Ol-Aug-Sp-Opx*** assemblage during ascent of the magma over **the pressure range 19-7 kbars**.

This is consistent with the decrease in the temperature from **1350 to 1100°C**, with ~2 wt.% of H2O in the initial melt.

Моделирование серии ферромонцонитов Чажминского силла на Камчатке

Taking tea among layered diabases of the Chazhma sill (Eastern Kamchatka, 1982)

MODELING THE FORMATION OF FERRODIORITES
from the Chazhma sill, Kamchatka

This intrusion is composed of differentiated rocks ranging from high-Al diabases to diorites and granophyres.

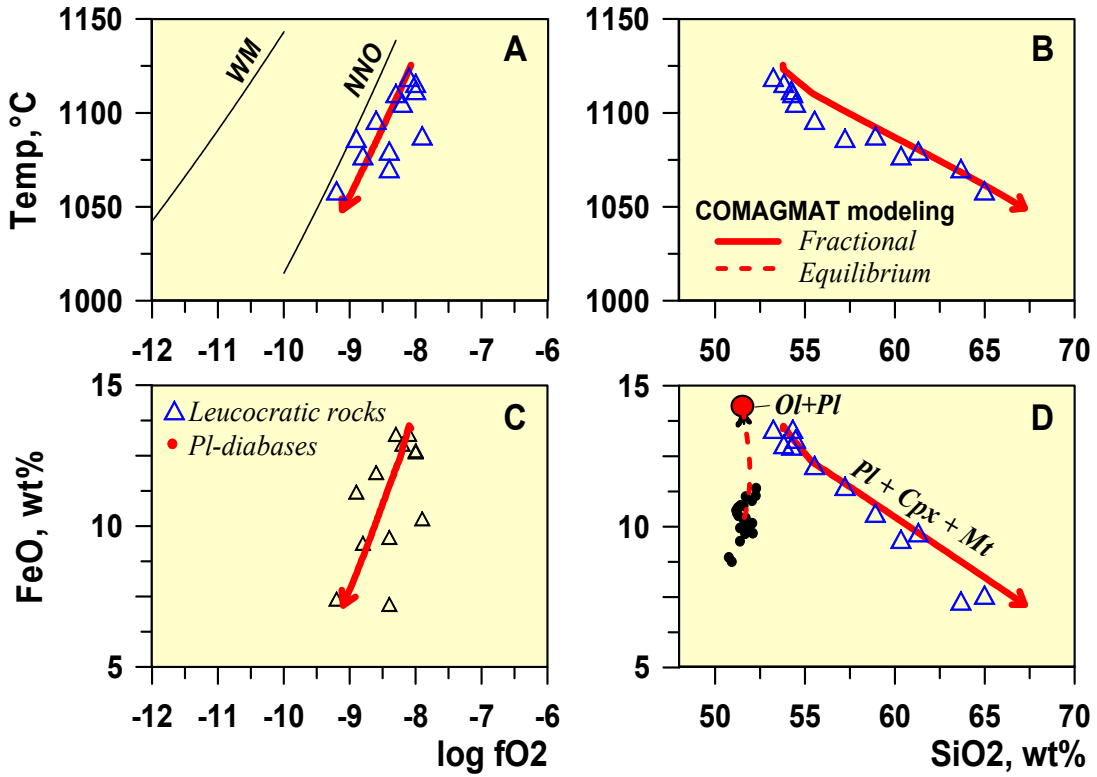
The diorites make up a large number of fine-grained leucocra-tic layers embedded between massive more dark diabases.

These observations allowed us to conclude that there were no large scale mixing between these two magmas. This leucocratic material was probably injected into the main magma body simultaneously with, or just after emplacement, as the body began to crystallize.

MODELING THE FORMATION OF FERRODIORITES
from the Chazhma sill, Kamchatka

Geochemical studies have demonstrated that the compositions of Chazhma layers display a trend of decreasing iron with increasing silica content.

The presence of Magn crystals indicates these trends were originated due to the fractionation of magnetite-bearing assemblages from same basaltic andesite parent.



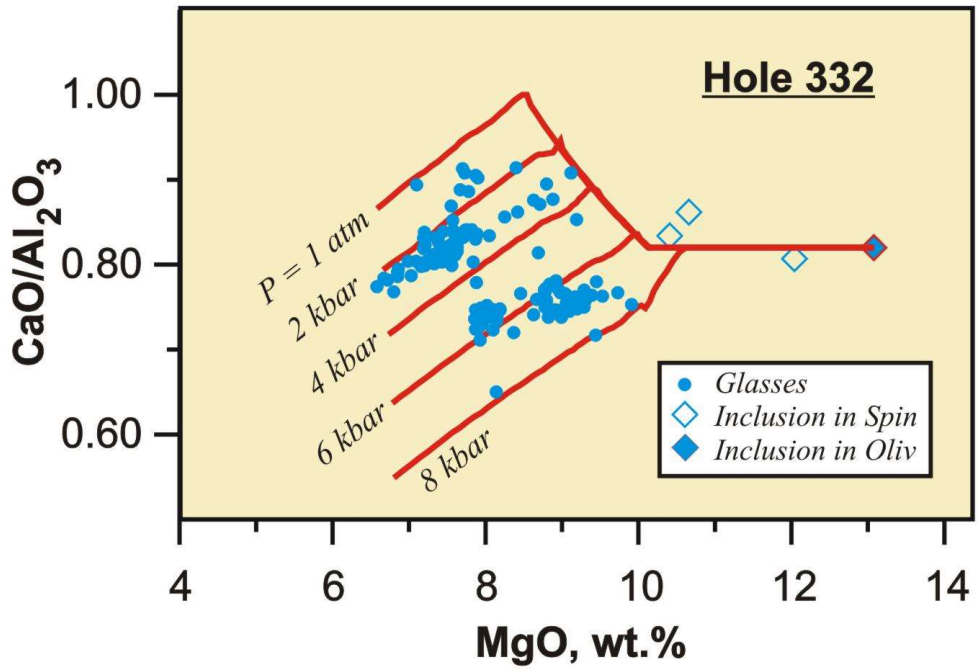
Finally, simulations near NNO buffer were carried out to accurately reproduce the iron-silica relations observed in the Chazhma suite.

Моделирование серий толеитовых стекол (MORB) Срединно-Атлантического хребта

MODELING POLYBARIC FRACTIONATION OF MORB GLASSES

The tholeiitic compositions form two evident clusters that could indicate of two different tholeiitic magmas fractionating Cpx at a depth.

In attempt to understand this diversity, we carried out a set of polybaric calculations simulating fractionation at low to elevated pressures for a proposed high-magnesia parental basalt.

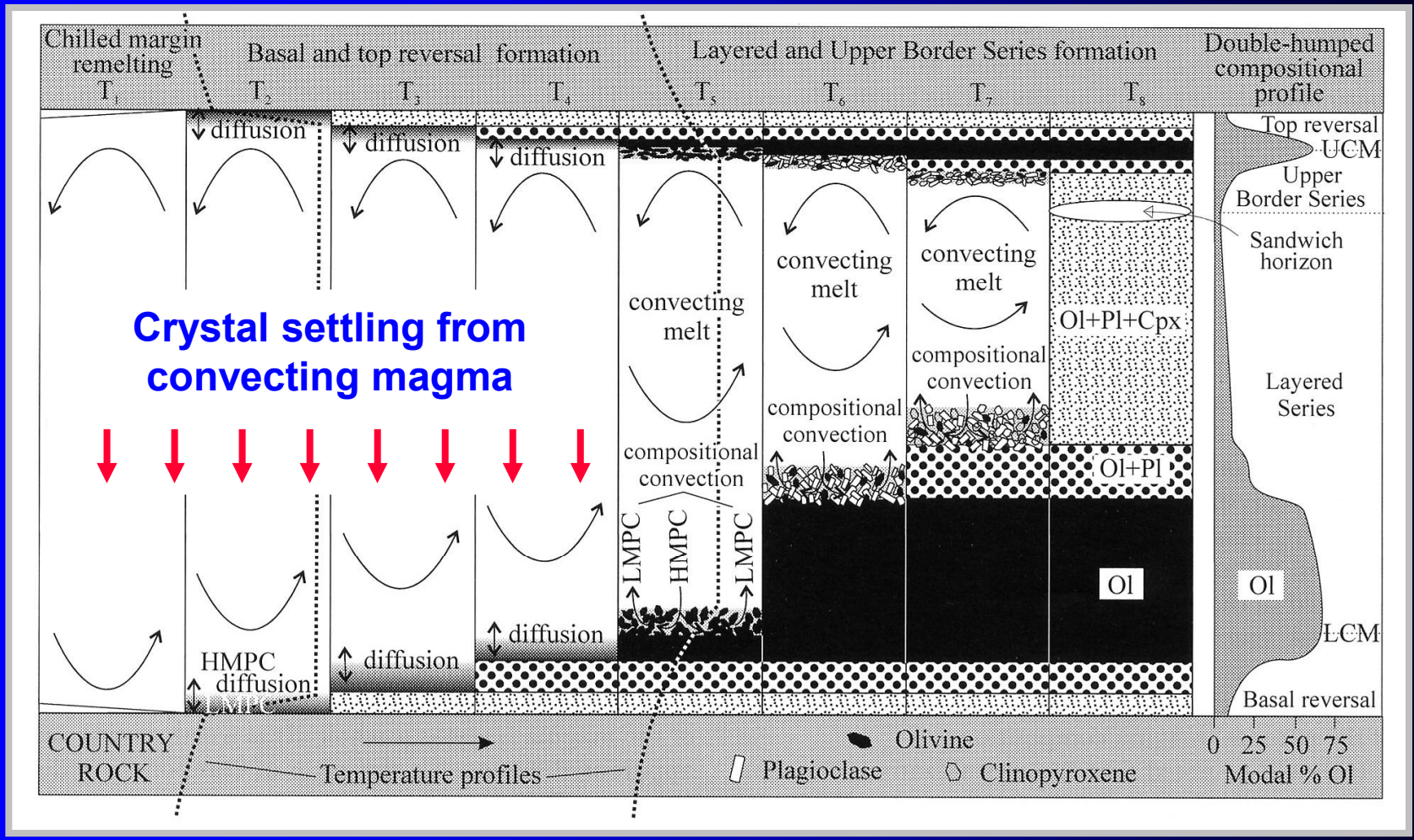


The results evidence for the diversity of tholeiitic glasses has been derived from same precursor, with these two compositional groups being different in the depth of the fractionation process.

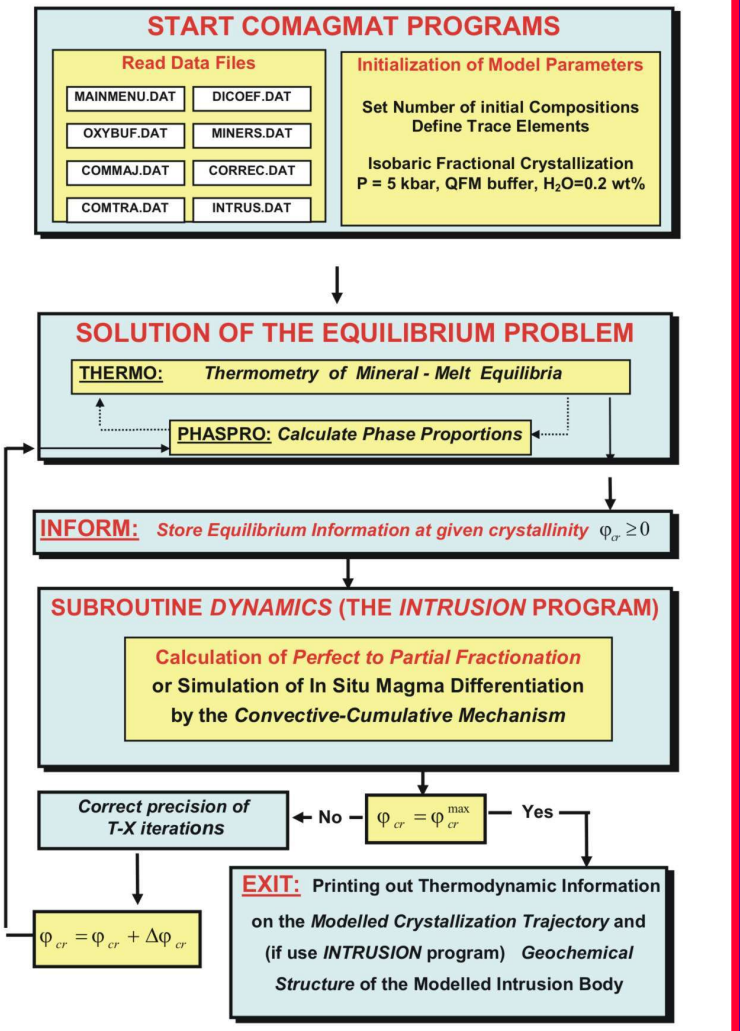
A part of these melts has been originated near 6 kbars, whereas the majority of the glasses indicate of low pressures crystallization at the depth of 2-3 kbars.

Моделирование геохимической структуры пластовых интрузивов

CONVECTIVE-CUMULATIVE MODEL SIMULATING THE FORMATION OF DIFFERENTIATED SILLS FROM THE SIBERIAN PLATFORM

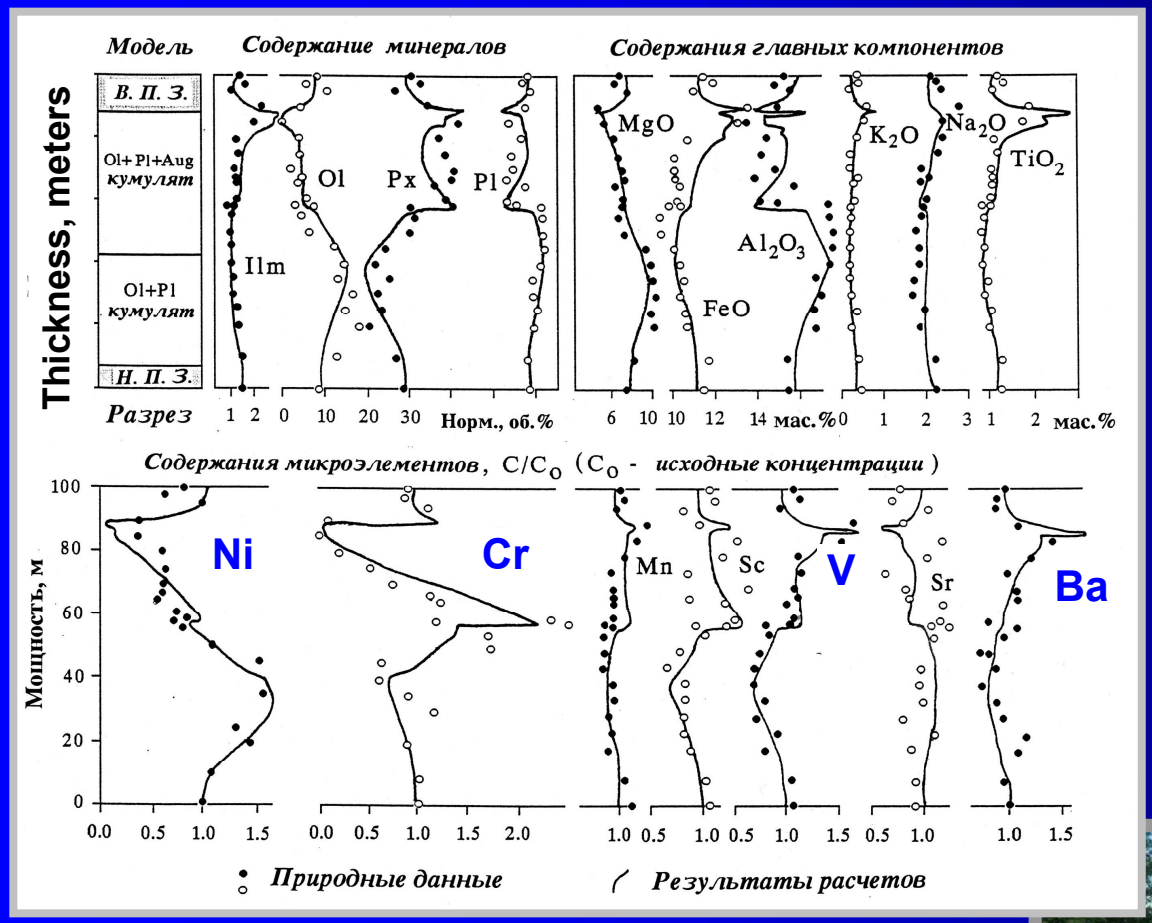


DEVELOPMENT OF "INTRUSION" PROGRAM AND FIELD STUDIES



Integration of physical constraints into the COMAGMAT model

COMPARISON OF CALCULATIONS WITH OBSERVATIONS



- Natural data for the Vavacan sill
- / Calculations

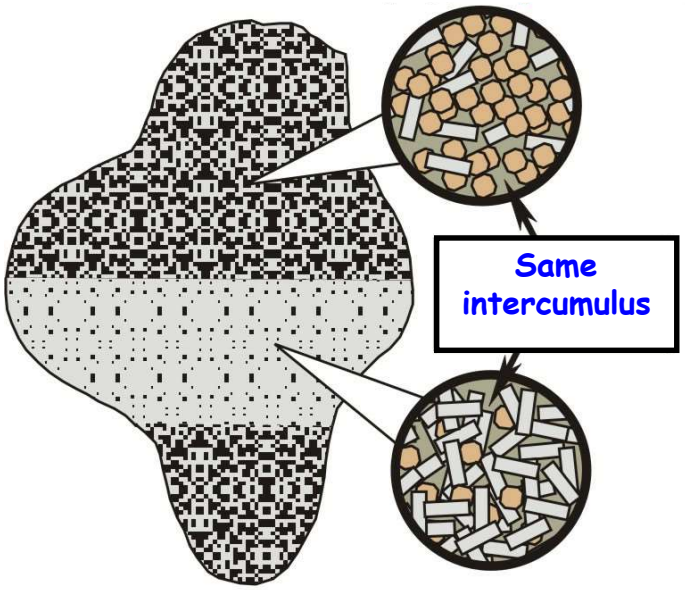
ГЕОХИМИЧЕСКАЯ ТЕРМОМЕТРИЯ

как метод решения обратных задач в магматической петрологии

METHOD OF GEOCHEMICAL THERMOMETRY

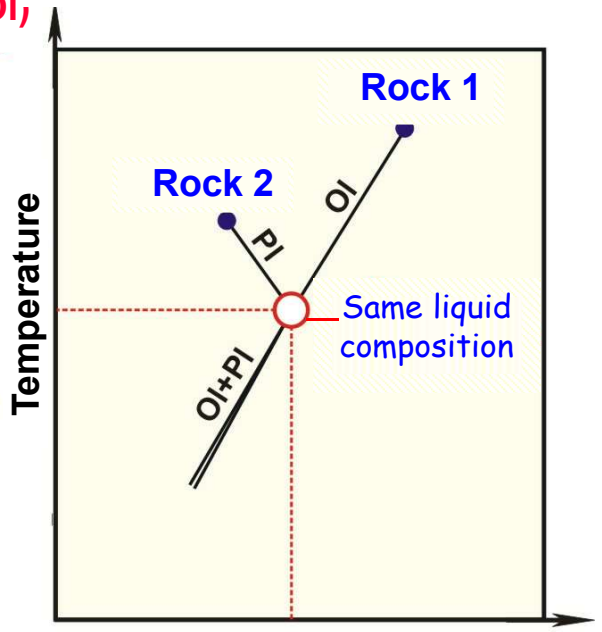
Samples of Ol-Pl cumulates

Rock 1 (enriched with Ol)



Rock 2 (enriched with Pl)

INTERSECTION OF MODELED LIQUID LINES OF DESCENT



The method was designed to extract genetic information as "recorded" in the whole chemistry of cumulus rocks, such as the temperature, intercumulus melt and mineral compositions, and the initial modal (i.e. phase) proportions.

Method of geochemical thermometry is accomplished by means of computer modeling of the course of equilibrium crystallization for a set of rocks that assumed to have contained the same intercumulus liquid composition.

GEOCHEMICAL THERMOMETRY OF MARGINAL ROCKS from the Skaergaard intrusion

COMPOSITIONS OF THE MARGINAL ROCKS

Compo-nents	Primitive cumulates [Hoover, 1989]					Chilled gabbro
	UT-04, *d*=2.5	UT-08, *d*=8.5	EC-10, *d*=1.0	MEO-10, *d*=3.0	KT-47, *d*=6.0	EG4507, n.d.
SiO_2	44.65	48.38	46.92	47.45	48.19	48.08
TiO_2	0.69	0.60	0.63	0.40	0.81	1.17
Al_2O_3	**4.88**	**20.91**	**9.36**	**18.32**	**11.37**	**17.22**
FeO	14.16	7.19	12.84	9.49	11.04	9.63
MnO	0.24	0.10	0.10	0.15	0.19	0.16
MgO	**23.61**	**7.06**	**17.22**	**9.83**	**14.53**	**8.62**
CaO	9.15	11.79	11.14	10.40	11.60	11.38
Na_2O	0.81	2.61	1.22	2.36	1.78	2.37
K_2O	0.03	0.17	0.04	0.06	0.13	0.25
P_2O_5	0.00	0.03	0.02	0.00	0.08	0.10

***UT*-04:** *Ol* (1443°C) → *Aug* (1233°C) → *Pl* (1174°C),
***UT*-08:** *Pl* (1332°C) → *Ol* (1231°C) → *Aug* (1164°C),
***EC*-10:** *Ol* (1385°C) → *Aug* (1199°C) → *Pl* (1187°C),
***MEO*-18:** *Pl* + *Ol* (1248 °C) → *Aug* (1161°C),
***KT*-47:** *Ol* (1346°C) → *Pl* (1191°C) → *Aug* (1189°C),
***EG*4507:** *Pl* (1242°C) → *Ol* (1225°C) → *Aug* (1163°C).

These rocks belong to the Marginal Border Series of the Skaergaard intrusion.

All of them were selected within 10 m from the intrusive contact and have no any record of parental magma fractionation.

The results indicate a wide high-temperature field of ***Ol*** for high-magnesia samples and an early crystallization of ***Pl*** for aluminum enriched compositions.

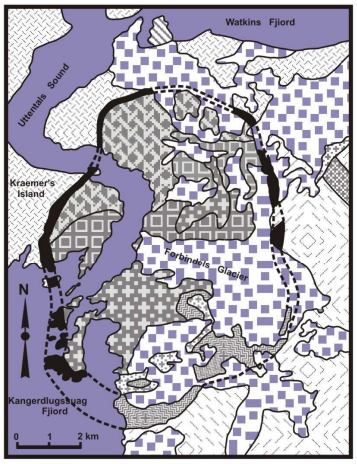
The Skaergaard intrusion

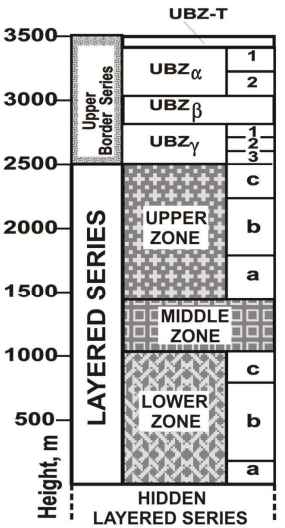
In these T-X coordinates the modeled liquid lines of descent demonstrate a closing together and intersection near 1165°C.

This intersection is consistent with the premise that the selected rocks were mechanical mixtures of cumulus crystals plus a trapped melt.

Average liquid composition representing this cluster of six evolutionary lines at 1165°C is considered to present a probable initial melt composition intrinsic to the original crystal mush from which the contact rocks have been crystallized.

Map & generalized section

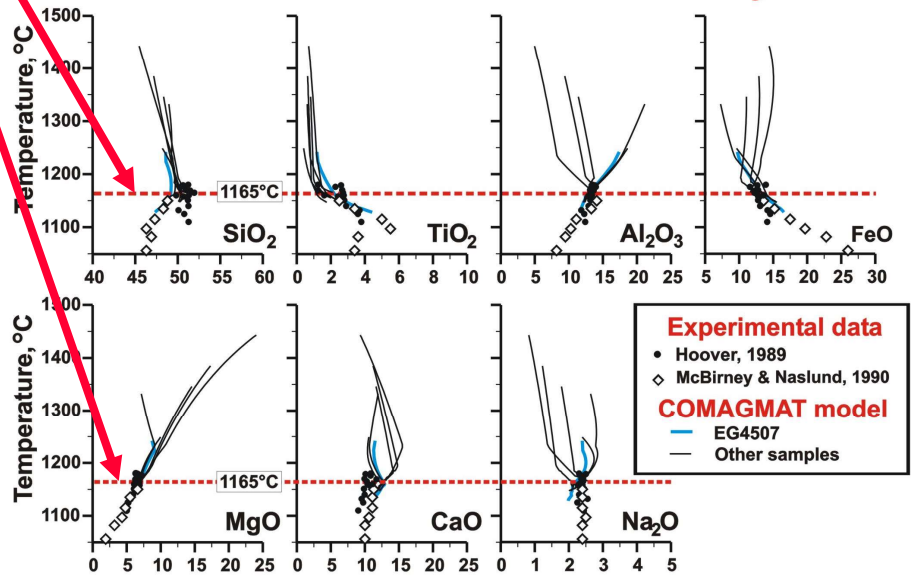




Initial Melt at 1165°C

Oxide	wt.%
SiO_2	50.01
TiO_2	1.68
Al_2O_3	12.95
FeO	13.24
MnO	0.19
MgO	6.90
CaO	12.40
Na_2O	2.37
K_2O	0.26
P_2O_5	0.15

Results of Geochemical Thermometry



ПРО МОДЕЛИРОВАНИЕ КРИСТАЛЛИЗАЦИИ ВНЕЗЕМНЫХ БАЗАЛЬТОИДОВ

ПРОГРАММА "МЕТЕОМОД"

Meteoritics & Planetary Science 32, 123–133 (1997)

METEOMOD: A numerical model for the calculation of melting-crystallization relationships in meteoritic igneous systems

A. A. ARISKIN[1]*, M. I. PETAEV[2], A. A. BORISOV[1] AND G. S. BARMINA[1]

[1]Vernadsky Institute of Geochemistry and Analytical Chemistry, Russian Academy of Sciences, Moscow 117975, Russia
[2]Harvard-Smithsonian Center for Astrophysics, Cambridge, Massachusetts 02138, USA
*Correspondence author's e-mail address: ariskin@glas.apc.org

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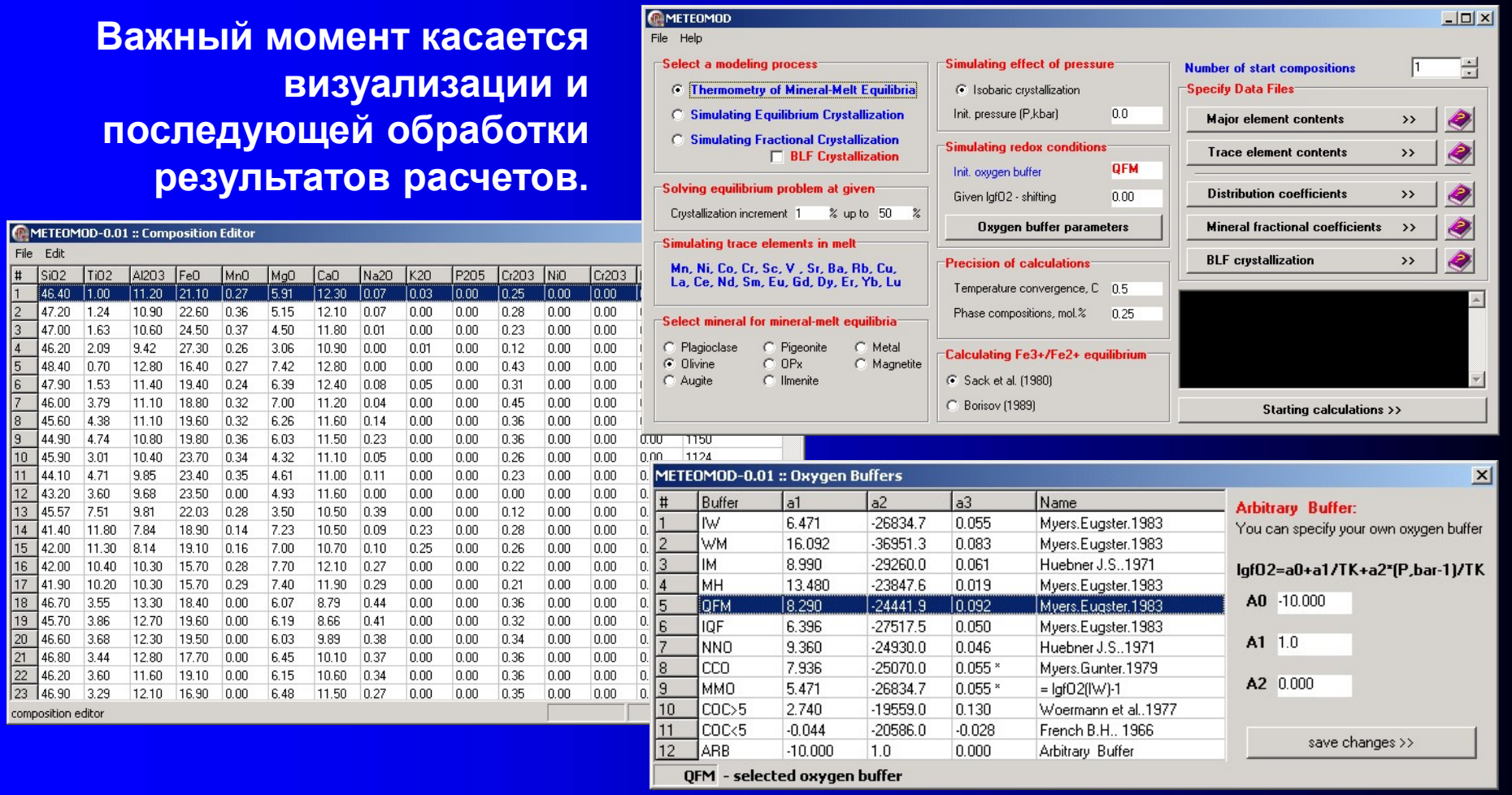
Abstract–The METEOMOD model is a computer program designed to calculate melting-crystallization relationships in igneous systems compositionally similar to ordinary chondrites and basaltic achondrites. The core of METEOMOD is a set of empirically calibrated equations, called geothermometers, which describe equilibria between silicate melt and minerals such as olivine, orthopyroxene, pigeonite, augite, plagioclase, and metallic Fe in terms of pressure, temperature, and liquid compositions. The silicate mineral geothermometers are calibrated from a database containing the compositions of melts and minerals produced in melting experiments on 113 meteoritic and 141 synthetic systems. The metallic iron-silicate melt geothermometer is calibrated from a database of 396 melting experiments.

The Meteorite Melting Model or METEOMOD calculates crystallization temperatures and contents of major end members in mineral solid solutions with accuracies of ±10–15 °C and ±1–2 mol%, respectively. Input parameters for the program are (1) increment in crystallization degree; (2) one of 12 f_{O_2} buffers routinely used in petrology; (3) shift from the buffer in log units, if any; (4) a choice of equilibrium or fractional crystallization trajectory; (5) terminal crystallization degree; (6) contents of ten major elements in wt%; (7) a set of minor and trace elements in parts per million; (8) the number of initial compositions to be modeled in a single computation run. The output consists of a series of tables that list equilibrium temperatures, O fugacities, and proportions of melt and minerals and their compositions, as a function of the degree of crystallization.

The results of application of METEOMOD to modeling of melting-crystallization of the St. Severin LL chondrite are compared with the experimental data of Jurewicz *et al.* (1995).

Совершенствование ЭВМ-модели МЕТЕОМОД:
примеры интерфейсов новой версии модели

Важный момент касается визуализации и последующей обработки результатов расчетов.



#	Buffer	a1	a2	a3	Name
1	IW	6.471	-26834.7	0.055	Myers.Eugster.1983
2	WM	16.092	-36951.3	0.083	Myers.Eugster.1983
3	IM	8.990	-29260.0	0.061	Huebner J.S..1971
4	MH	13.480	-23847.6	0.019	Myers.Eugster.1983
5	QFM	8.290	-24441.9	0.092	Myers.Eugster.1983
6	IQF	6.396	-27517.5	0.050	Myers.Eugster.1983
7	NNO	9.360	-24930.0	0.046	Huebner J.S..1971
8	CCO	7.936	-25070.0	0.055 *	Myers.Gunter.1979
9	MMO	5.471	-26834.7	0.055 *	= lgfO2(IW)-1
10	COC>5	2.740	-19559.0	0.130	Woermann et al..1977
11	COC<5	-0.044	-20586.0	-0.028	French B.H.. 1966
12	ARB	-10.000	1.0	0.000	Arbitrary Buffer

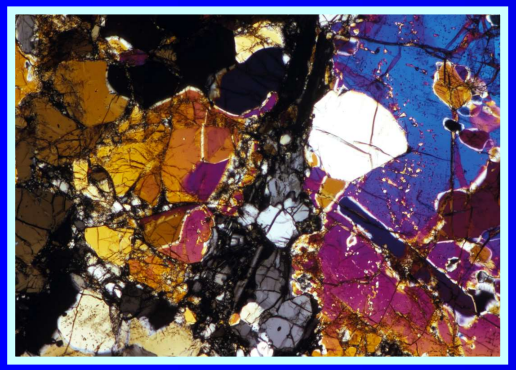
Модель МЕТЕОМОД включает возможность экспорта результатов вычислений в современные редакторы электронных таблиц и программы построения графиков (включая EXCEL).

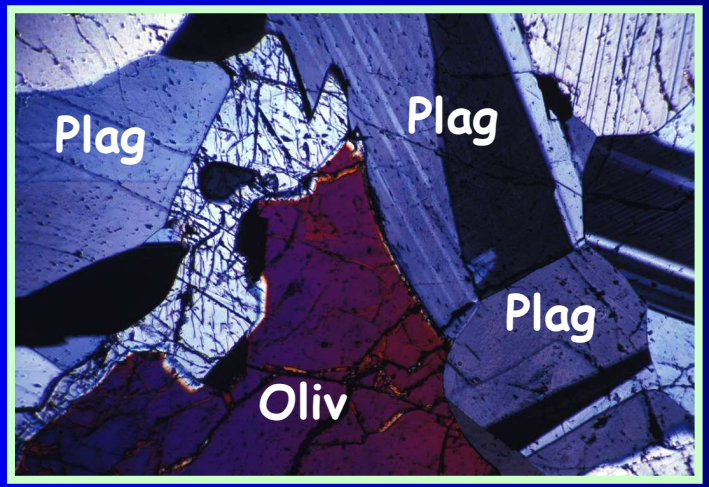
Проблемы образования материковых лунных пород: моделирование "серии" АНТ

Дунит 72415-418
58.7 г.
4.55 млрд. лет

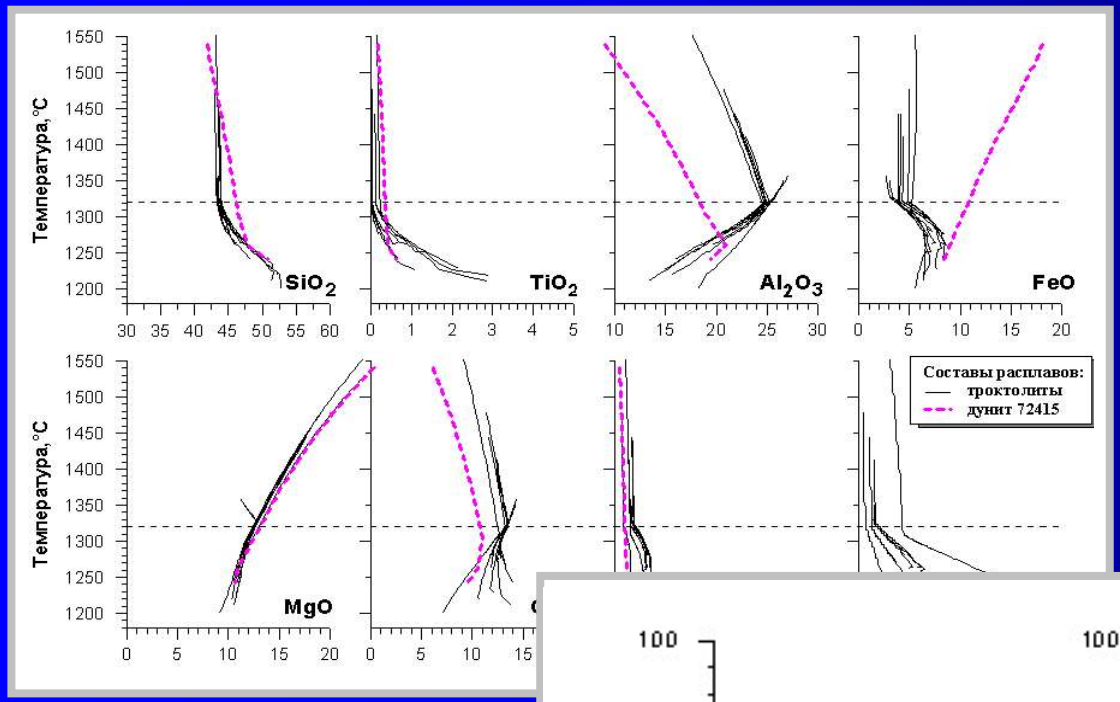
Троктолит 76535
155.5 г.
4.3-4.6 млрд. лет

Анортозит 62255
1239 г.
> 4.4 млрд. лет





Результаты моделирования кристаллизации троктолитов и дунита 724215

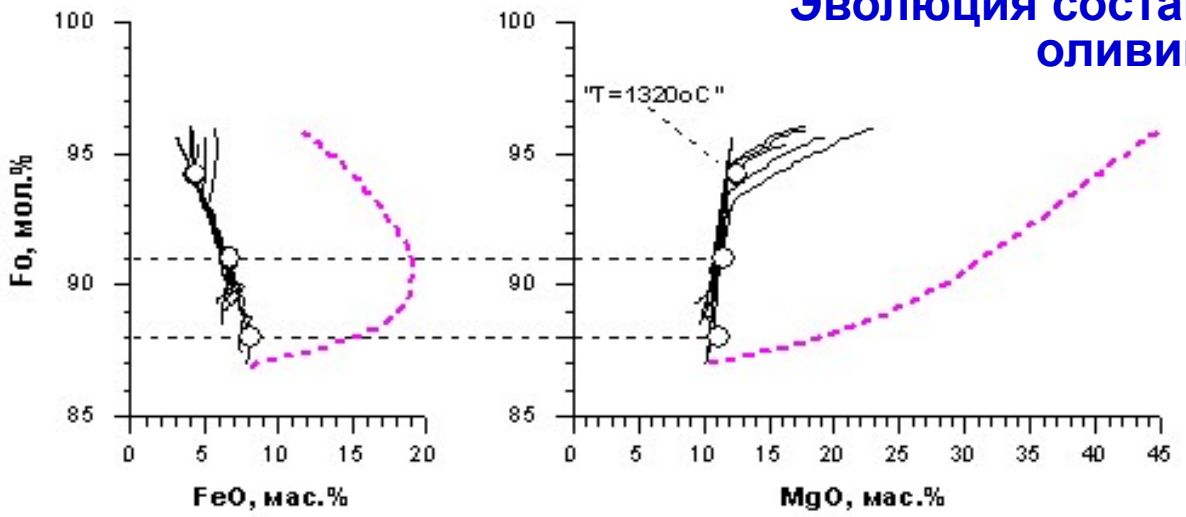


Модельные линии эволюции показывают, что при T~ 1300°C троктолитовые расплавы формируют компактные кластеры, состав которых можно оценить, опираясь на состав оливина.

Зависимости состава остаточной жидкости от температуры

Сиреневый пунктир – расплавы дунита

Эволюция состава оливина



ГЛАВНОЕ ИЗ ЛЕКЦИИ…

БЕЗ ПОЛЕВЫХ РАБОТ НЕТ РЕАЛЬНОЙ ПЕТРОЛОГИИ !

PROPOSED EVOLUTION OF THE MAGMA PLUMBING SYSTEM for the Klyuchevskoy volcano