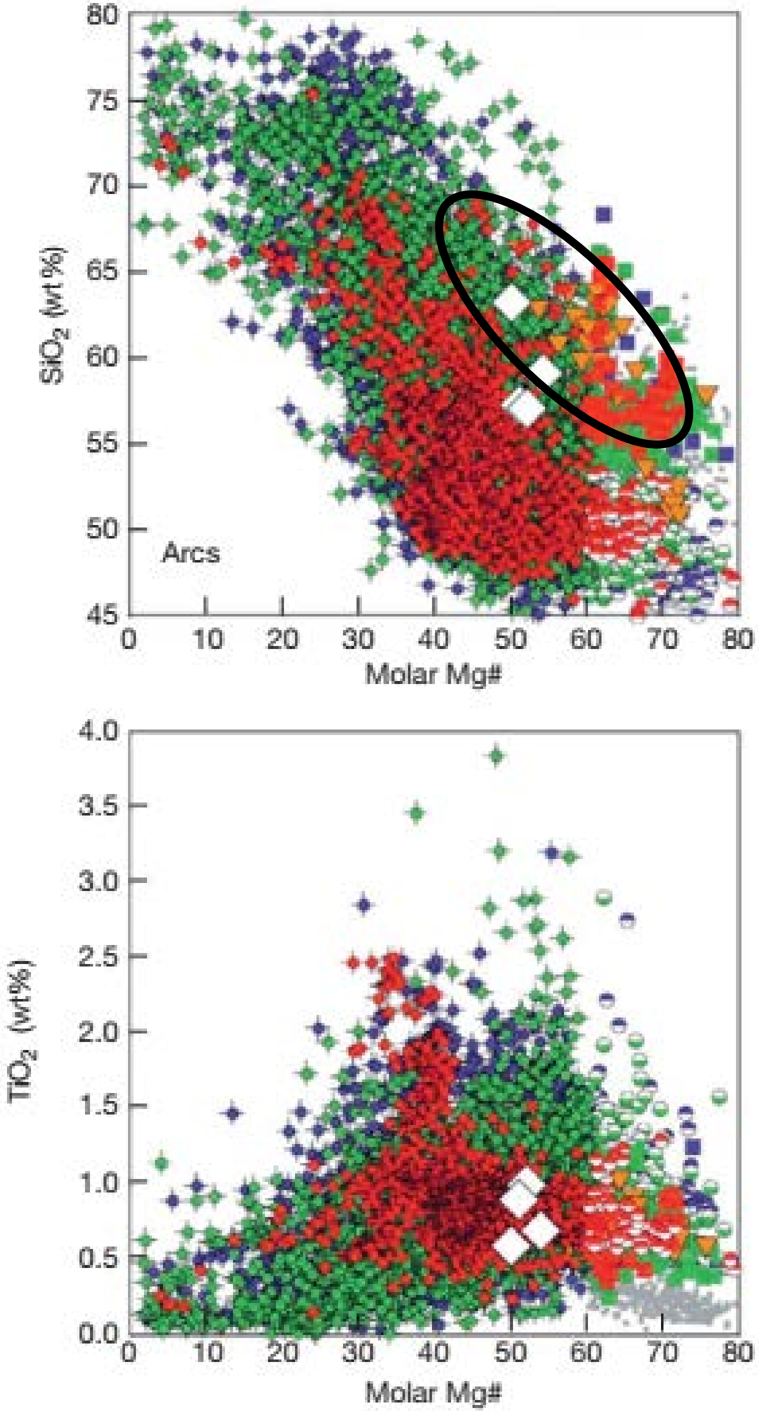
Обшая тема:

ОСТРОВОДУЖНЫЕ ФОРМАЦИИ МАГМАТИЧЕСКИХ ПОРОД

Лекция № 26

ПЕТРОХИМИЯ, ГЕОХИМИЯ И МЕХАНИЗМЫ ОБРАЗОВАНИЯ АДАКИТОВЫХ МАГМ



Разнообразие составов базальтов и среднекислых пород на активных окраинах

Синие – Океанические дуги

Зеленые – Континентальные дуги

Красные – Алеутская дуга

Серенькие – бониниты

Белые ромбы – оценки среднего состава континентальной коры
(Christensen&Mooney, 1995; McLennan&Taylor, 1985; Rudnic&Fountain, 1995; Weaver&Tarney, 1984)

After Kelemen et al. (Treatise of Geochemistry, 2014)

История появления термина адакиты

***Впервые описаны Кау (1978) на острове Адак (Алеуты) как* высоко-Mg андезиты**

***Defant, Drummond (1991) в Nature – обобщение подобных пород* дали название "адакиты"**

***Martin and Moyen (2003), Martin et al. (2005), Champion and Smithies (2003) – первые фундаментальные* обзоры**

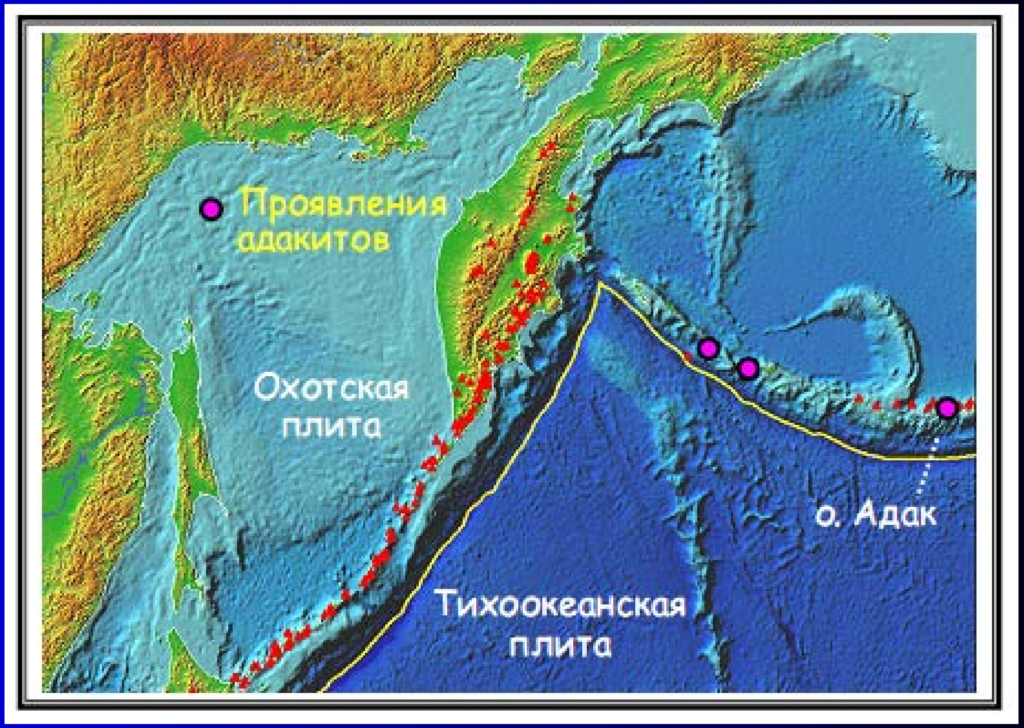


Схема сочленения Курило-Камчатской и Алеутской островных дуг

Находки адакитов и подобных пород

- **Japan** *(Morris, 1995; Furukawa and Tatsumi, 1999)*
- **Kamchatka** ***(Kepezhinskas et al., 1997)***
- **Aleutians** *(Yogodzinski and Kelemen, 1998)*
- **Northern Cascades** *(Defant and Drummond, 1993)*
- **Central America** *(Rogers et al., 1985; Defant et al., 1992)*
- **South America** *(Stern and Kilian, 1996; Monzier et al., 1997; Guivel et al., 1999)*
- **Greece** *(Pe-Piper and Piper, 1994)*
- **Papua New Guinea** *(Johnson et al., 1979)*
- **Philippines** *(Sajona et al., 1993; Castillo et al., 1999)*
- **Northern Hunter Ridge** *(Verbeeten, Crawford, 1995)*

Геохимические особенности адакитов

При общей высокой глиноземистости (Al_2O_3 >17 мас.%) эти среднекислые породы характеризуются:

(1) повышенными содержаниями Sr и Eu,

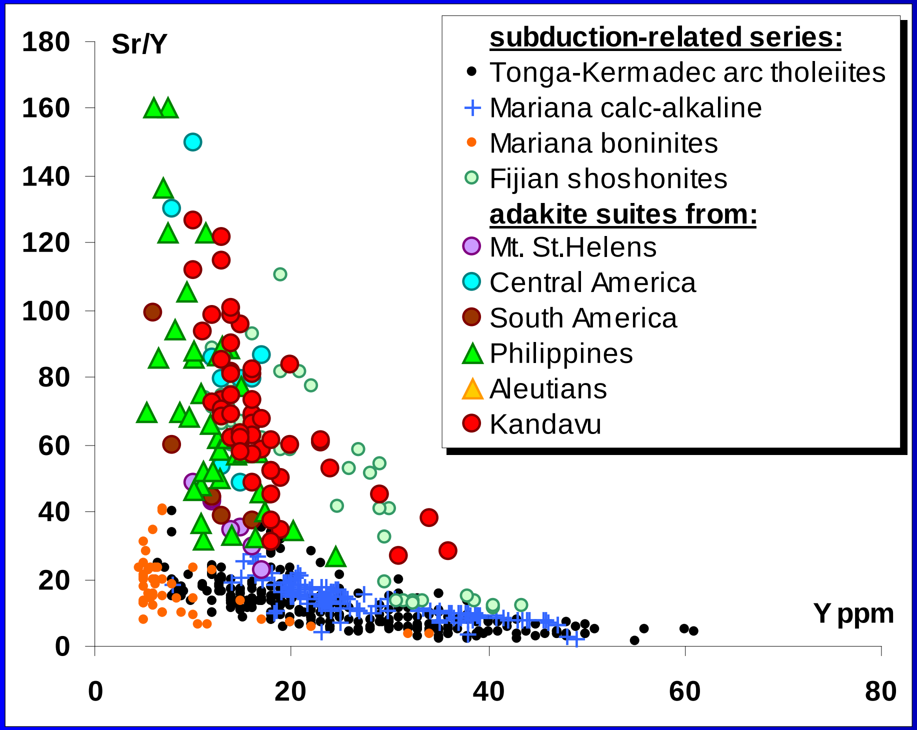
(2) повышенной (по сравнению с обычными дацитами) магнезиальностью,

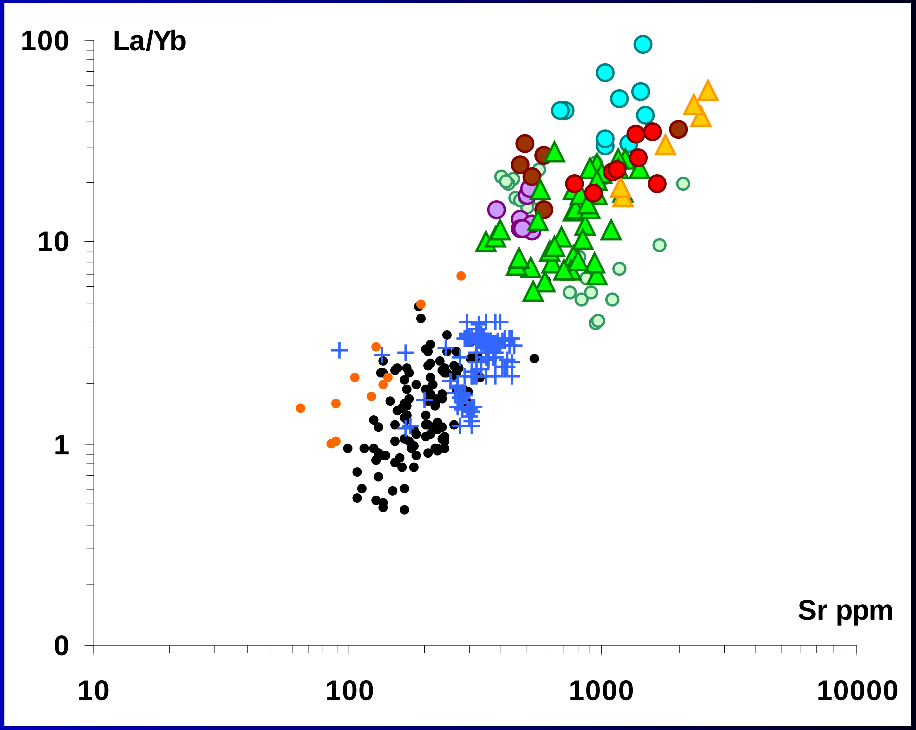
(3) относительно низким отношением $^{87}Sr/^{86}Sr$,

(4) крайне низкими содержаниями тяжелых РЗЭ и Y.

Такие “примитивные” соотношения обычно представляют на диаграммах зависимости отношения Sr/Y от магнезиальности

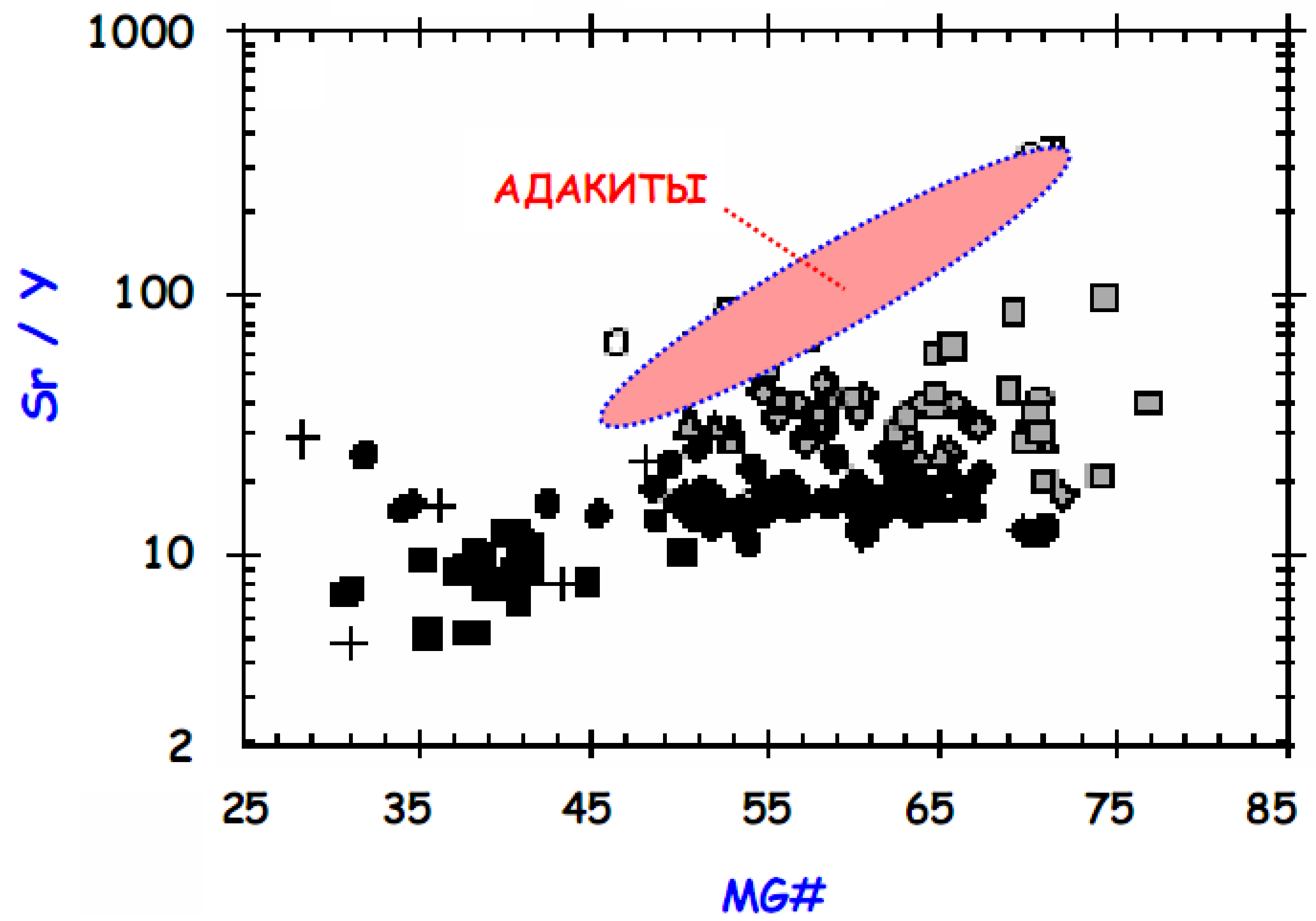
Геохимические характеристики адакитов



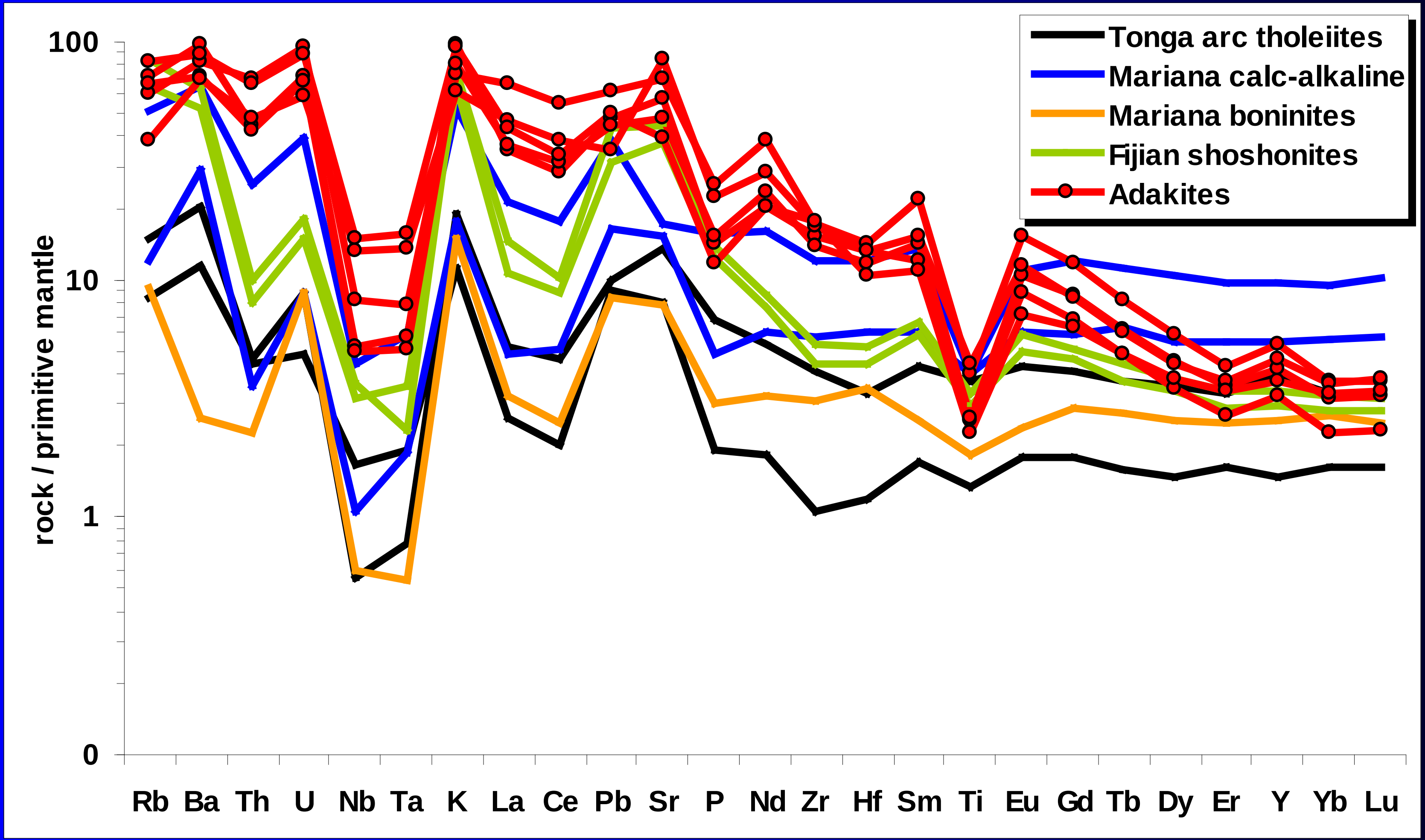


Предполагается, что важную роль в образовании адакитов играет плавление в поле стабильности граната

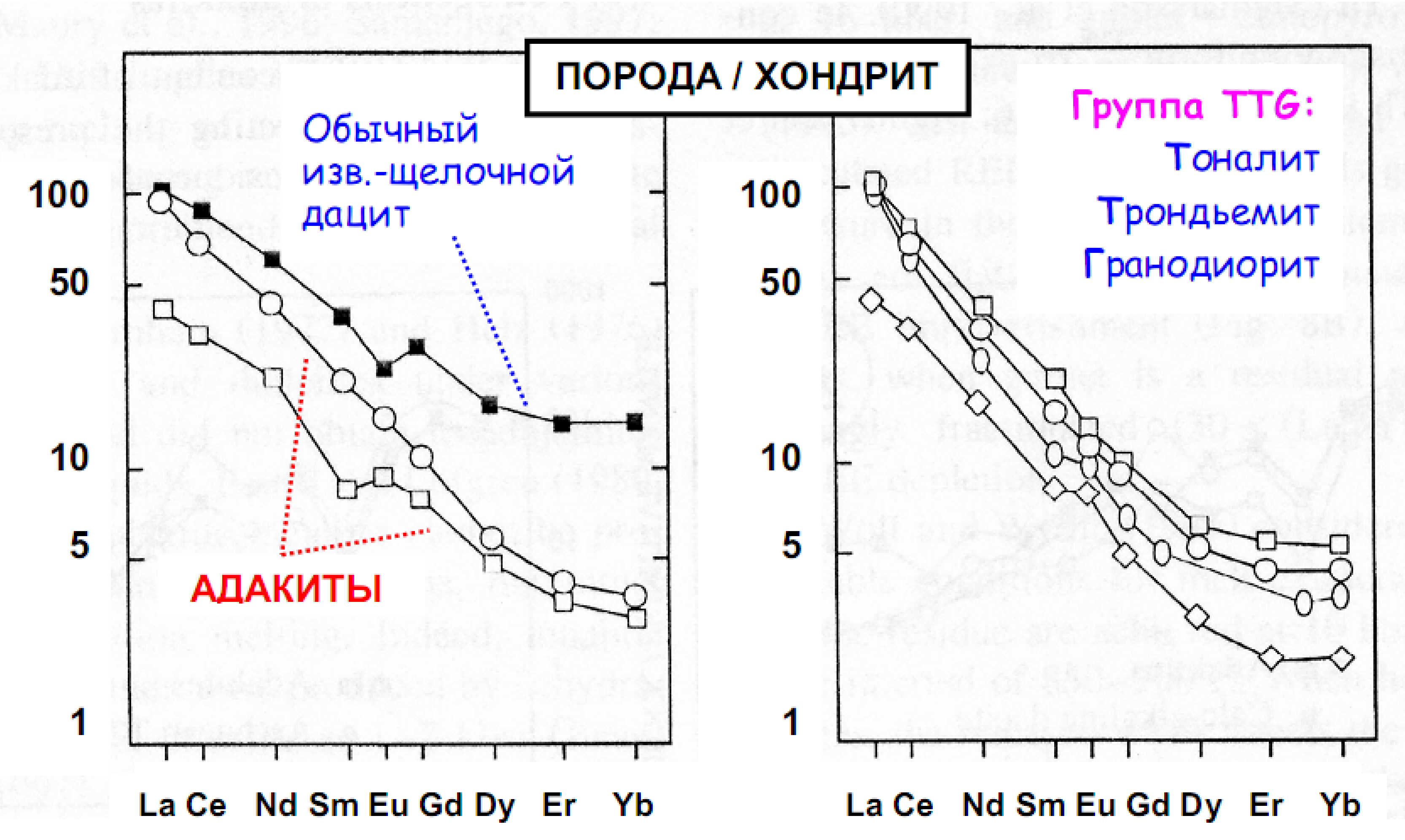
SR/Y В АЛЕУТСКИХ АДАКИТАХ И ВУЛКАНИТАХ ВОСТОЧНОЙ КАМЧАТКИ В ЗАВИСИМОСТИ ОТ МАГНЕЗИАЛЬНОСТИ



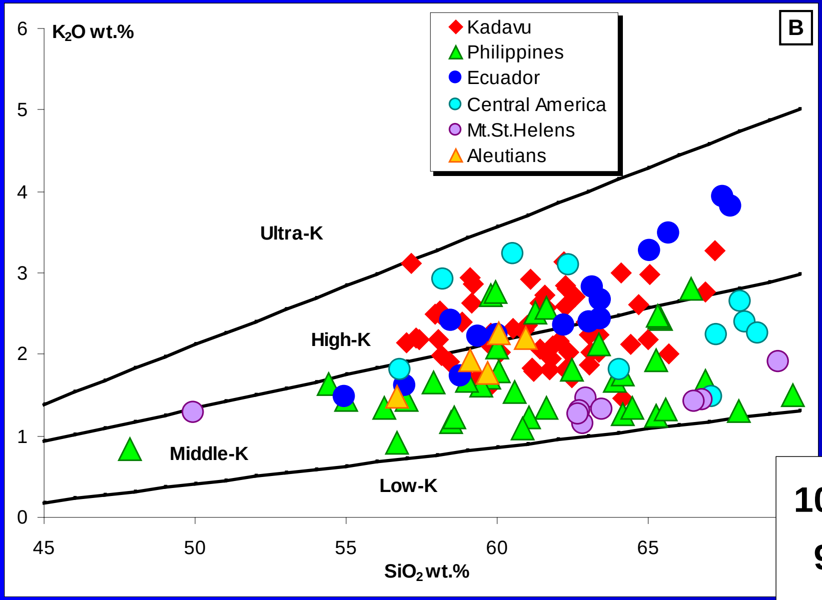
Геохимические характеристики адакитов



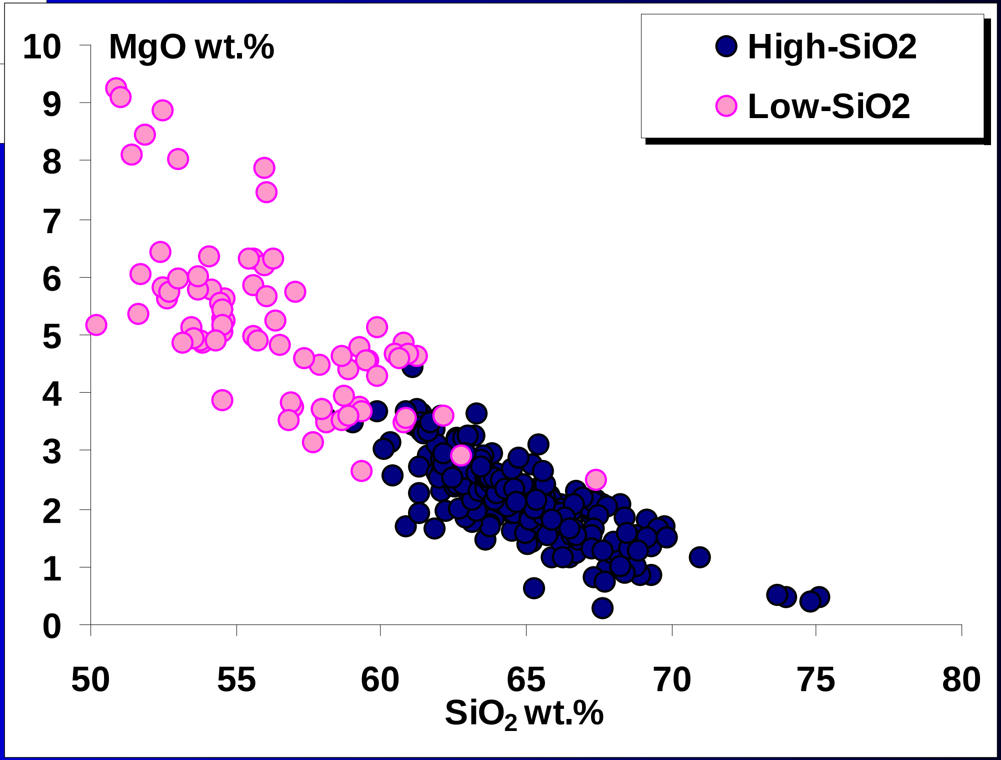
РАСПРЕДЕЛЕНИЕ РЕДКОЗЕМЕЛЬНЫХ ЭЛЕМЕНТОВ В АДАКИТАХ И АРХЕЙСКИХ TTG



Петрохимические характеристики адакитов



Martin et al. (2005) выделили две группы – высоко-SiO_2 и низко-SiO_2 адакиты

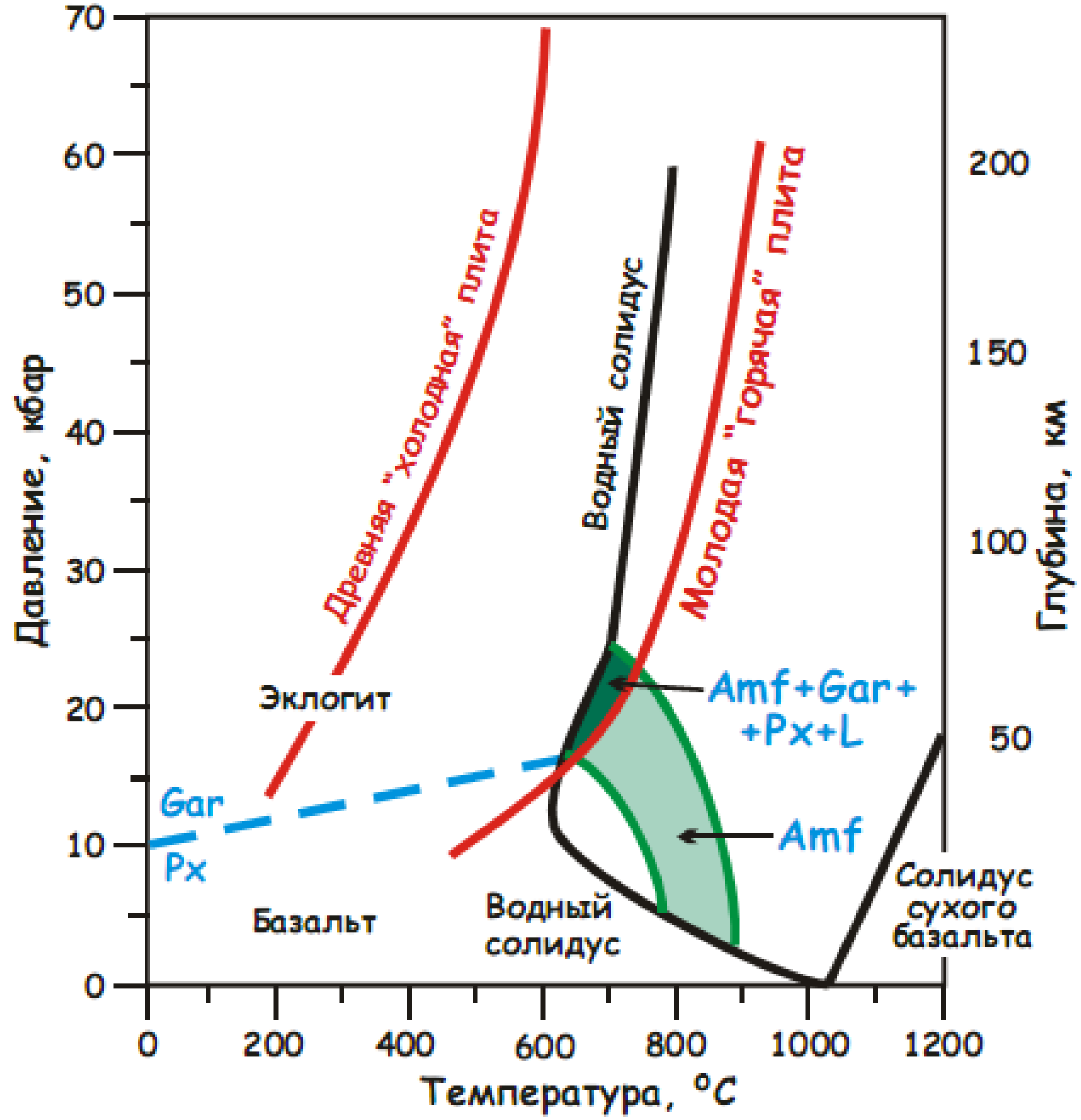


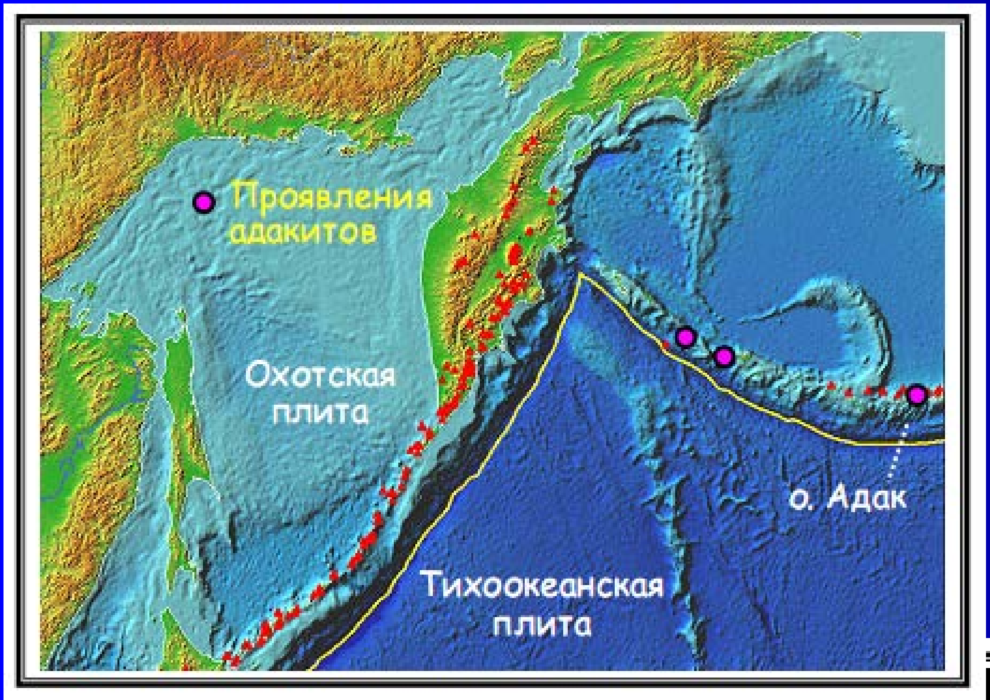
СРЕДНИЕ СОСТАВЫ АДАКИТОВ, АРХЕЙСКИХ TTG И ЭКСПЕРИМЕНТАЛЬНЫХ РАСПЛАВОВ

(полученных при плавлении базальтов)

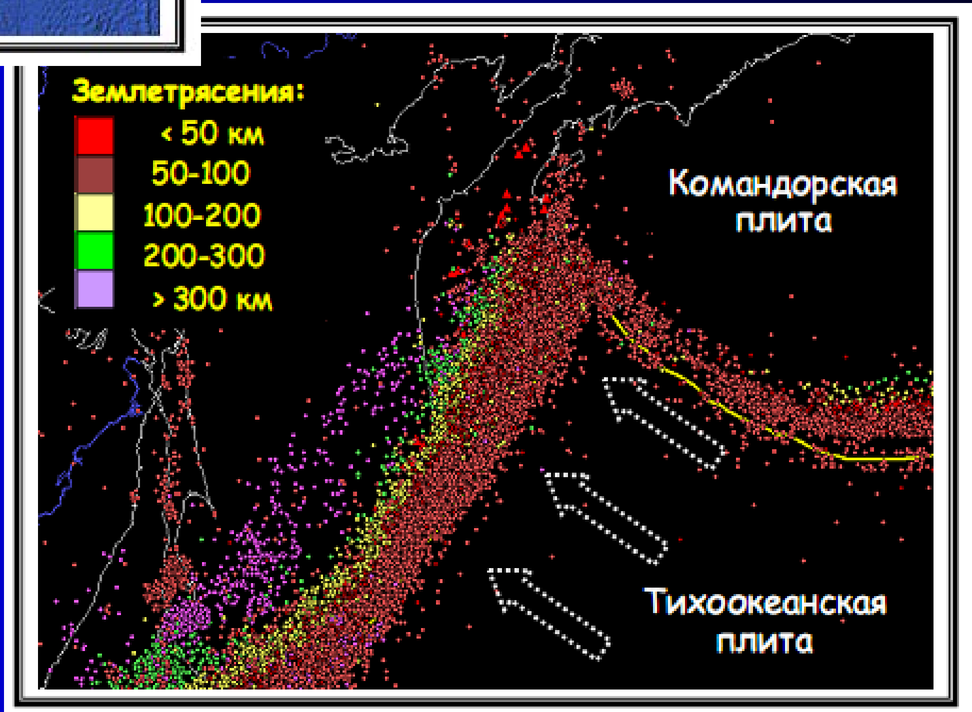
Оксиды	АДАКИТЫ		TTG (n=355)	Экспериментальные расплавы	
	Вулканиты (n=81)	*Плутоны (n=9)*		*Rapp et al., 1991*	*Winther & Newton, 1991*
SiO_2	64.66	67.30	69.79	69.75	69.76
TiO_2	0.51	0.54	0.34	0.54	0.85
Al_2O_3	16.77	15.78	15.56	16.89	15.59
FeO	3.78	1.08	2.81	2.66	3.42
MnO	0.08	0.05	0.05	0.09	0.03
MgO	2.20	1.96	1.18	1.26	0.71
CaO	5.00	3.67	3.19	3.93	3.16
Na_2O	4.09	4.19	4.88	4.20	4.50
K_2O	1.72	2.15	1.76	1.31	1.81
P_2O_5	0.17	1.12	0.13	-	-

ВОЗМОЖНЫЕ Р-Т ПАРАМЕТРЫ ВЫПЛАВЛЕНИЯ АДАКИТОВЫХ МАГМ





Проявления
адакитов
Охотская
плита
о. Адак
Тихоокеанская
плита



Землетрясения:
< 50 км
50-100
100-200
200-300
> 300 км
Командорская
плита
Тихоокеанская
плита

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High Sr/Y and La/Yb ratios: The meaning of the "adakitic signature"

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The name of "adakite" is used to describe a far too large group of rocks, whose sole common feature is high Sr/Y and La/Yb ratios. However, such a signature can be achieved via different processes: melting of a high Sr/Y (and La/Yb) source; deep melting, with abundant residual garnet; fractional crystallization or AFC; or interactions of felsic melts with the mantle, causing selective enrichment in LREE and Sr over HREE. A database of the compositions of "adakitic" rocks—including "high silica" and "low silica" adakites [Martin, H., Smithies, R.H., Rapp, R.P., Moyen, J.-F., Champion, D.C., 2005. An overview of adakite, tonalite–trondhjemite–granodiorite (TTG) and sanukitoid: relationships and some implications for crustal evolution. Lithos, 79(1–2), 1–24.], "continental" adakites and Archaean adakites–was assembled. Geochemical modeling of the potential processes is used to interpret it, and reveals that (1) the classical model of "slab melting" provides the best explanation for the genesis of high-silica adakites; (2) low-silica adakites are explained by garnet-present melting of an adakite-metasomatized mantle, i.e., at depths greater than 2.5 GPa; (3) "Continental" adakites is a term encompassing a huge range of rocks, with a corresponding diversity of petrogenetic processes, and most of them are different from both low- and high-silica adakites; (4) Archaean adakites show a bimodal composition range, with some very high Sr/Y examples (similar to part of the TTG suite) reflecting deep melting (>2.0 GPa) of a basaltic source with a relatively high Sr/Y, while lower Sr/Y rocks formed by shallower (1.0 GPa) melting of similar sources. Comparison with the Archaean TTG suite highlights the heterogeneity of the TTGs, whose composition spreads the whole combined range of HSA and Archaean adakites, pointing to a diversity of sources and processes contributing to the "TTG suite".

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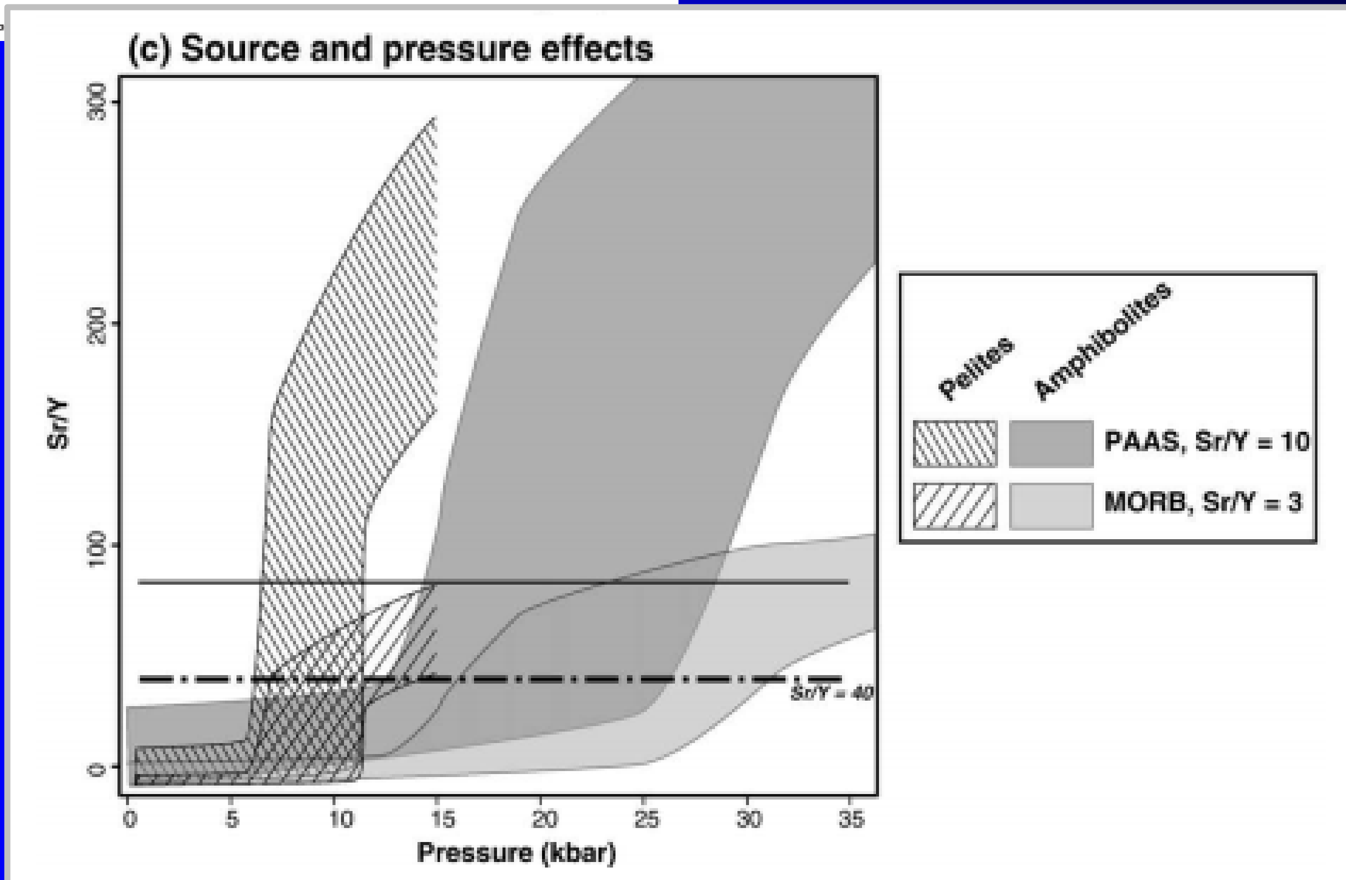

Fig. 4. Sr/Y enrichment as a function of the depth of melting and the composition of the source. (a) and (b) (Sr/Y) enrichment as a function of depth of melting for amphibolitic (a) and "crustal" (pelites and greywackes, b) sources. The size of circles are proportional to the melt amount (*F*). (c) Absolute Sr/Y values for the melting of amphibolitic (grey) and crustal (hatched) sources; the fields correspond to the range of data, as in panels (a) and (b). Two source composition are used, a MORB-like source (Sr/Y = 3) and a PAAS (Post-Archaean Average Shale, Taylor and McLennan, 1985) source (Sr/Y = 10). The horizontal lines correspond to Sr/Y = 40 (the cut-off value in Defant and Drummond, 1990) and ca. 90 (example in text).

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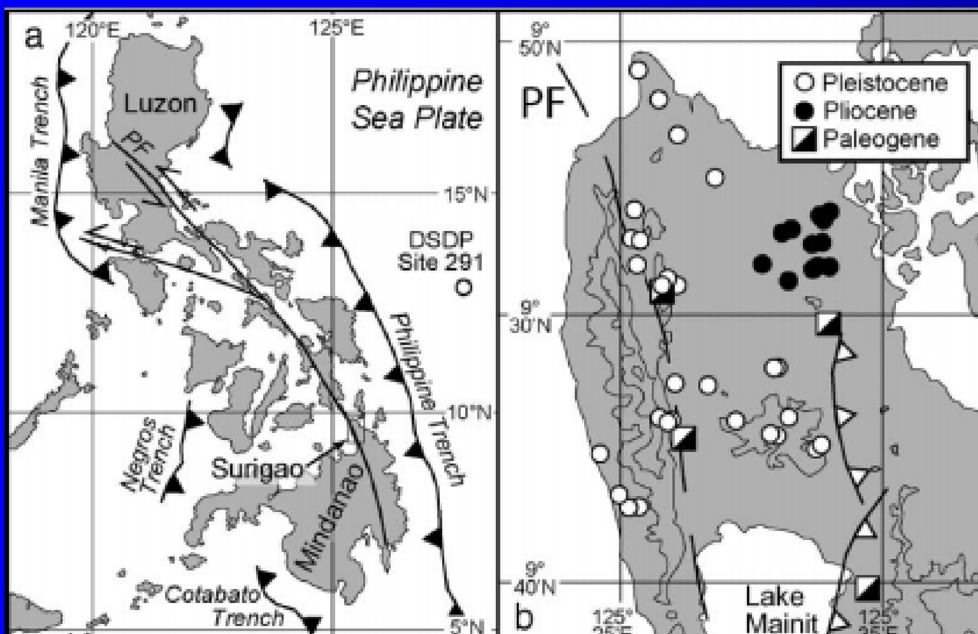
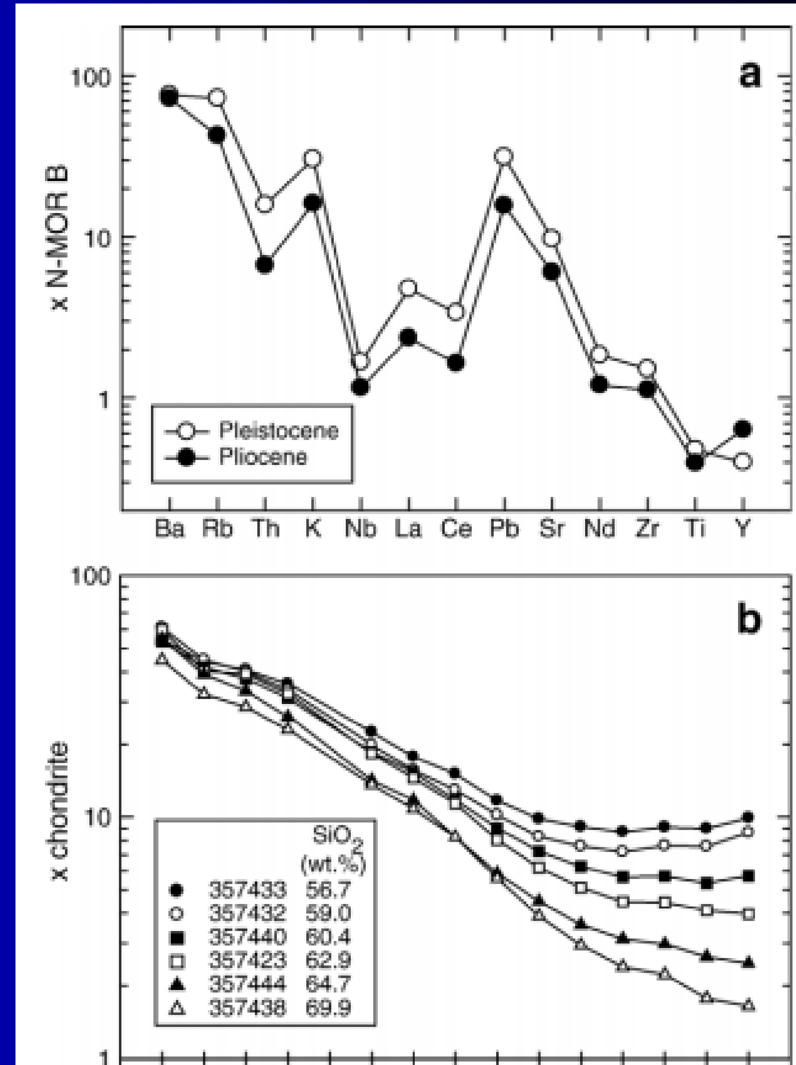
Adakites without slab melting: High pressure differentiation of island arc magma, Mindanao, the Philippines

Colin G. Macpherson [a,*], Scott T. Dreher [a], Matthew F. Thirlwall [b]





mechanisms for generating the adakitic signature. (1) Adakitic melt was produced from basaltic arc magma by fractional crystallisation of a garnet-bearing assemblage. (2) Solidified basaltic rock containing garnet melted to yield adakitic magma. In

Схема образования Филиппинских адакитов

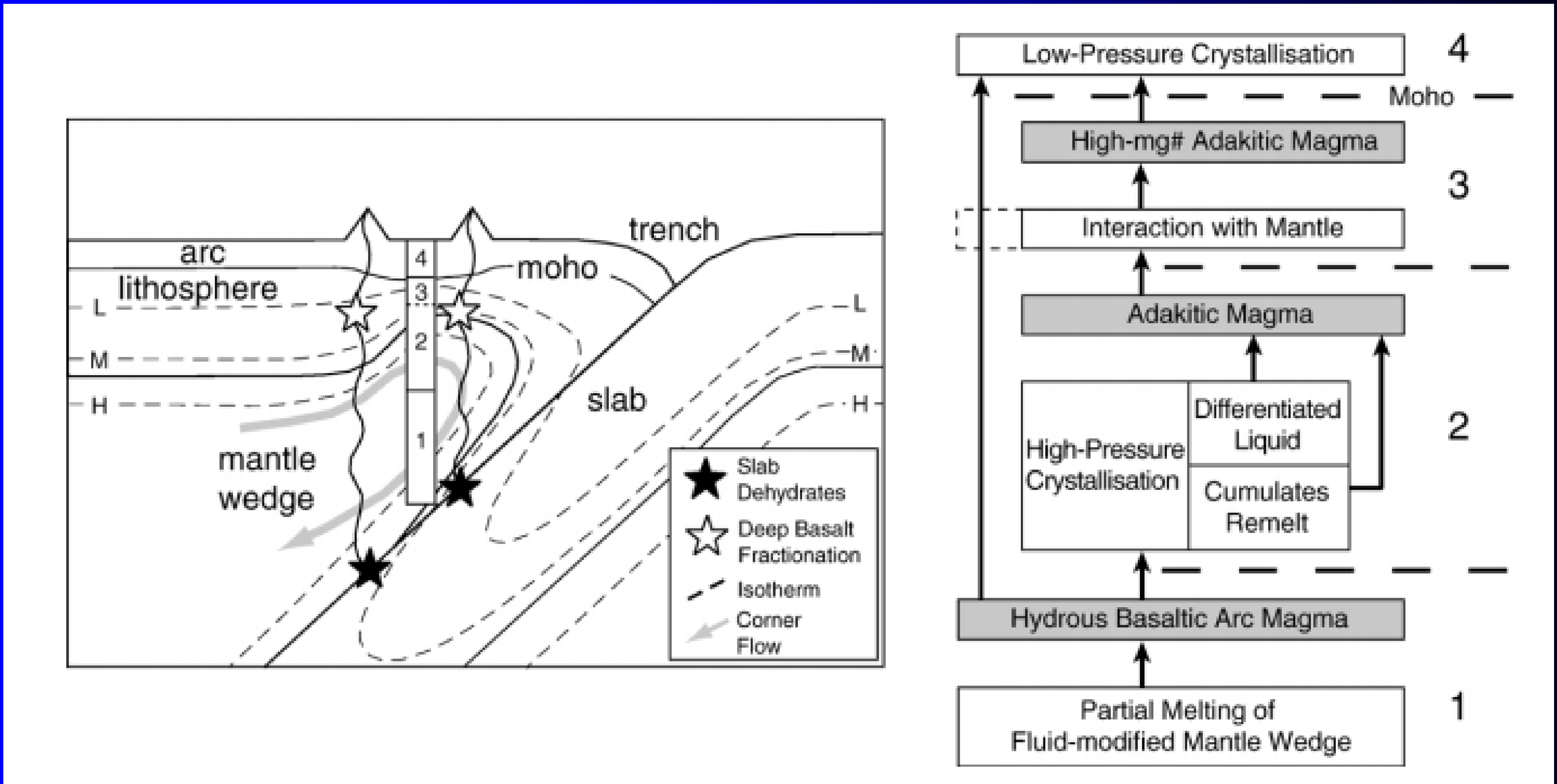


Fig. 6. Schematic illustration of adakite production by deep differentiation in an arc with thin crust. The slab is subducted beneath overriding arc lithosphere and induces corner flow (convection) in the mantle wedge. Dashed lines are schematic isotherms (for relatively low (L), medium (M) and high (H) temperature) illustrating that at any depth the shallow mantle is hottest where the arc lithosphere is thinnest (after [2,70–72]). Numbers in the vertical column refer to the flow diagram on the right, which summarises the possible mechanisms identified for generating adakitic melt without slab melting. Stage 1; genesis of primitive arc basalt. Stage 2; high pressure processing of basalt yields adakitic magma either directly, by fractional crystallisation, or indirectly, by remelting crystallised basaltic rock. Stage 3; interaction between adakitic magma and mantle peridotite. Stage 4; low-pressure crystallisation. Where the crust is thick Stage 2 can occur above the Moho and Stage 3 would be bypassed [24–26]. In mature arcs with a high magma flux to the crust Stage 4 will obscure or obliterate adakitic chemistry.