What we learned from the Izu-Bonin-Mariana fore-arc

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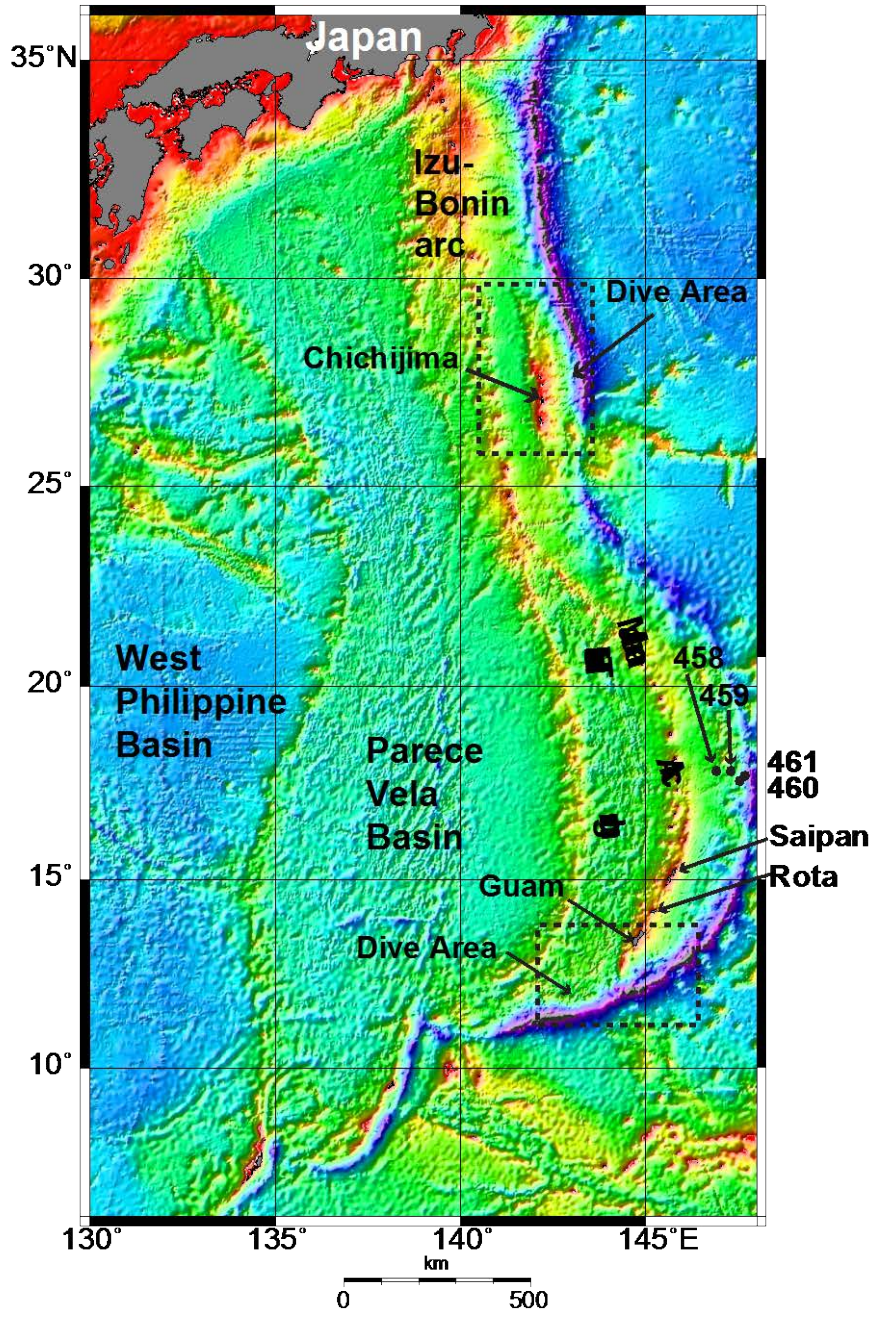
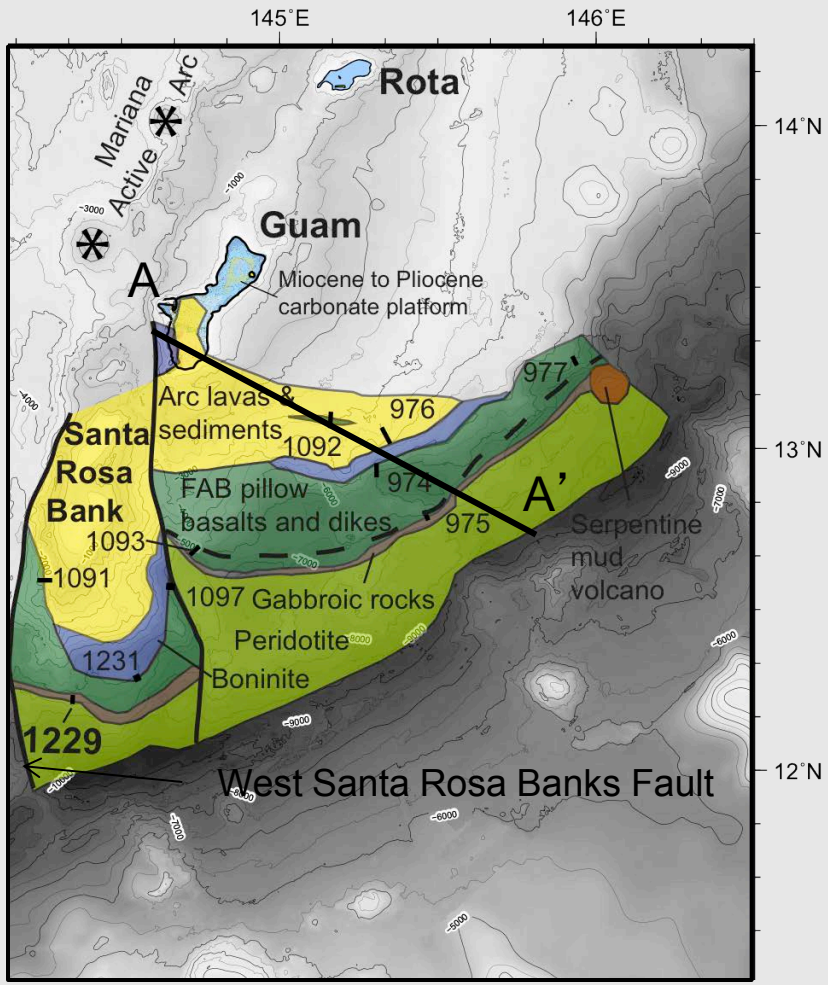
Izu-Bonin-Mariana (IBM) subduction system



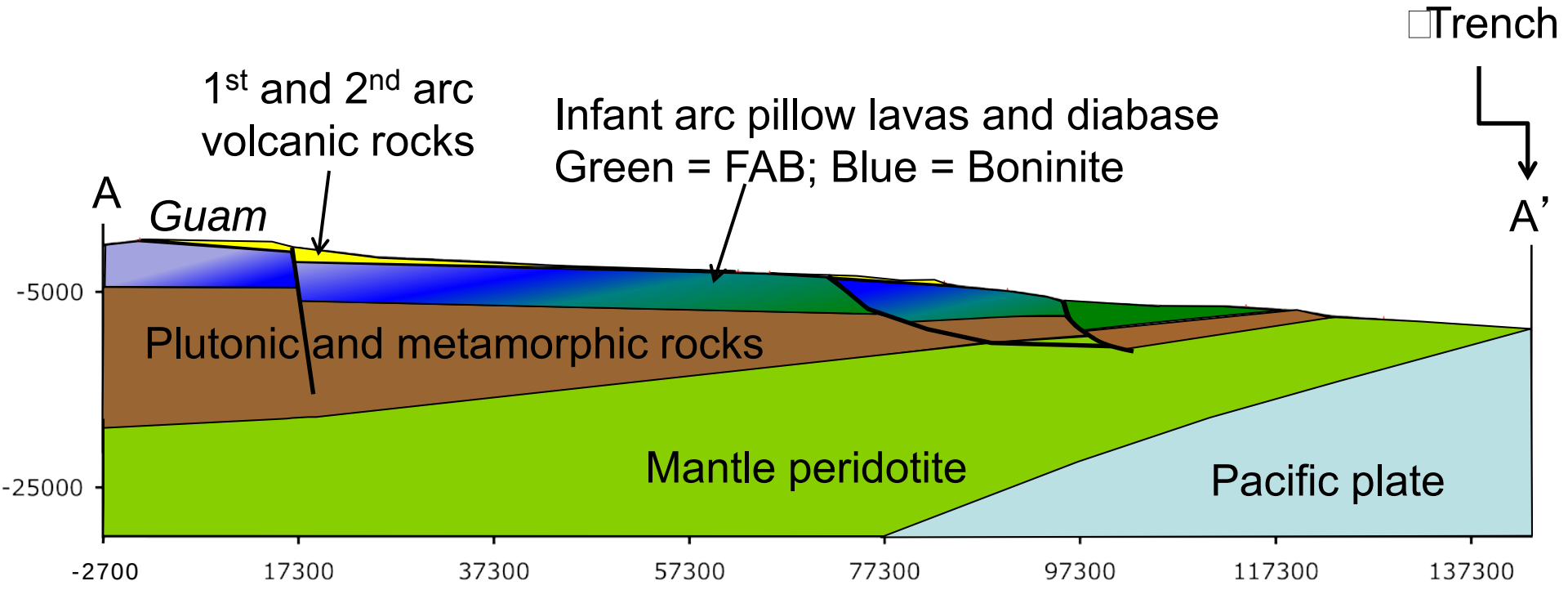
Diving

Mariana fore-arc



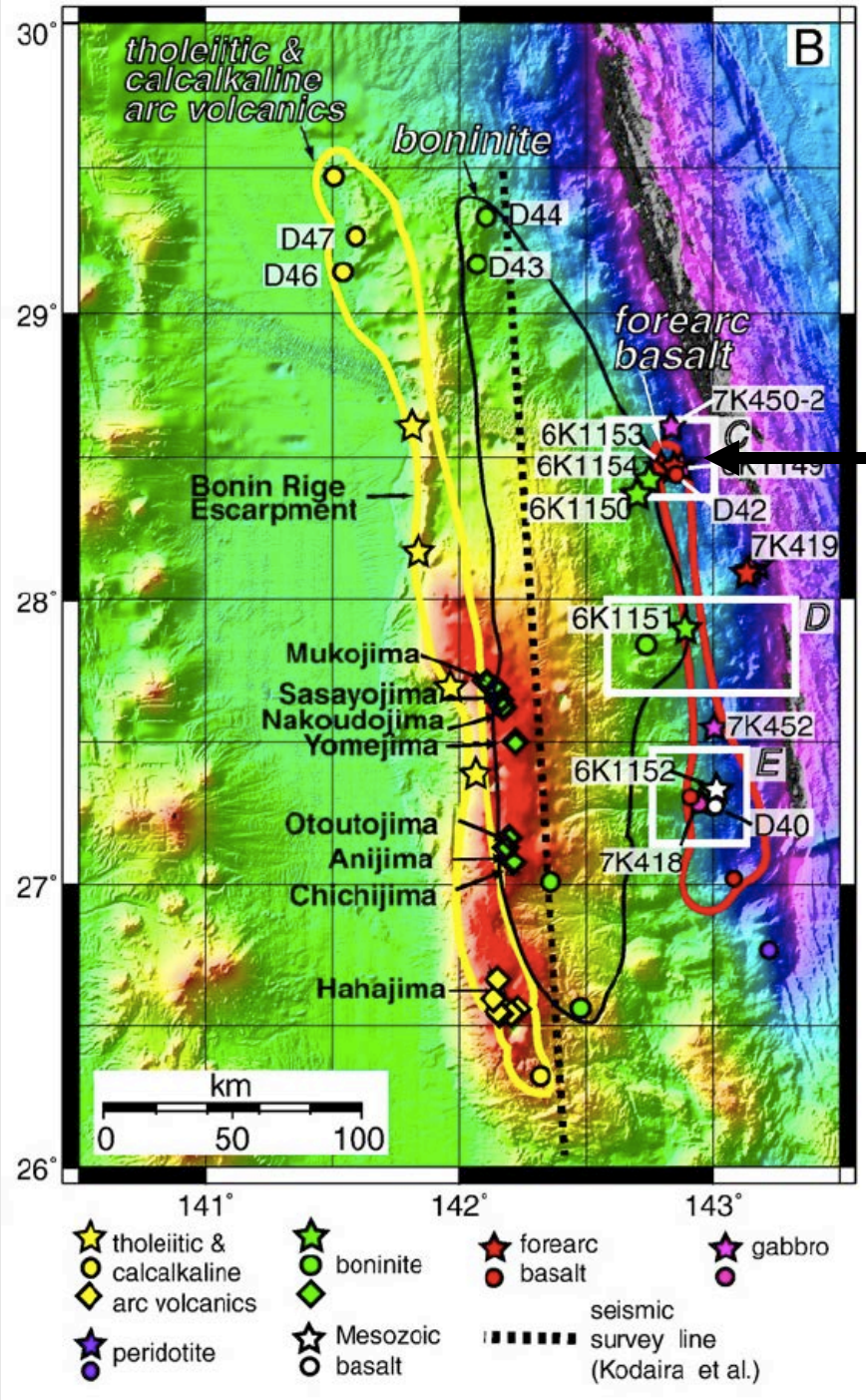
Reagan et al. (2013)

Simplified Schematic Cross-section



Izu-Bonin Forearc

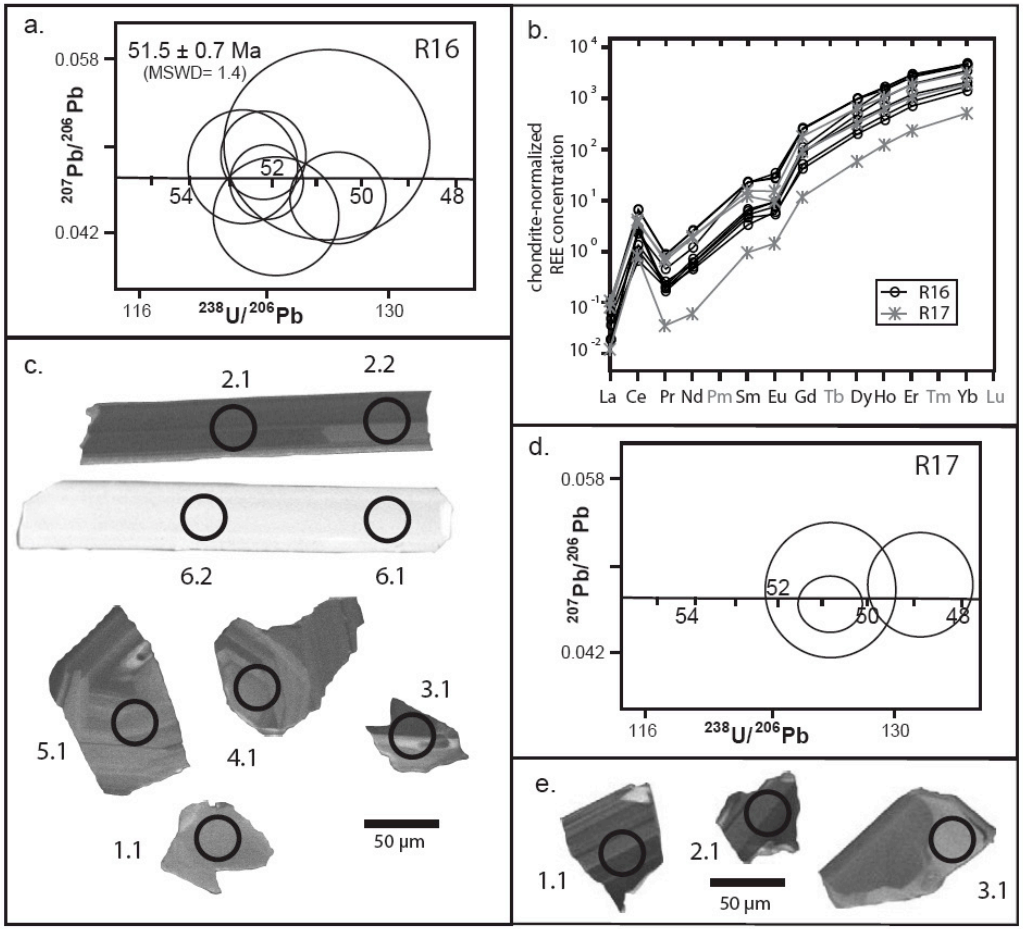
Ishizuka et al., (2011)

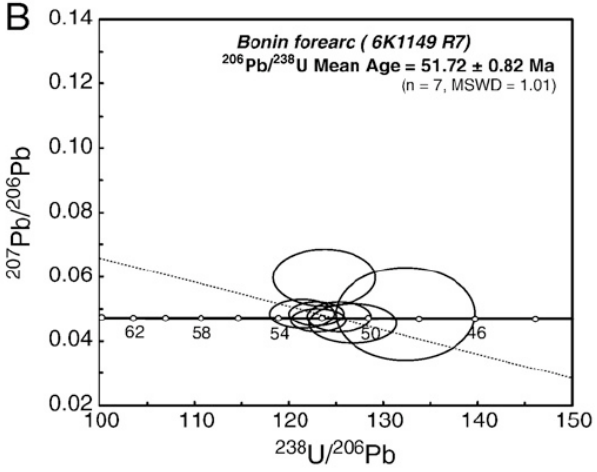


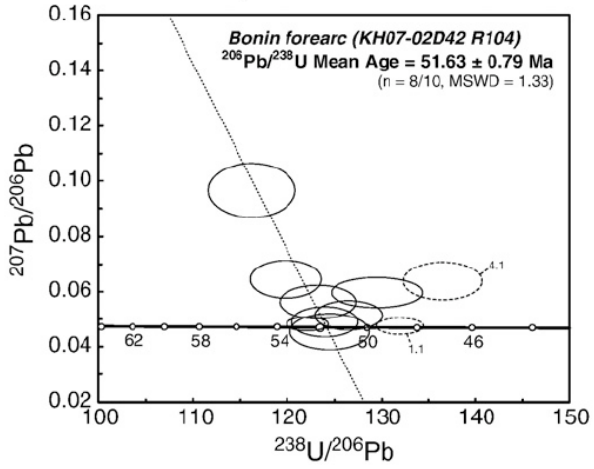
BON 1 & 2

Shinkai 6500 dives

Rock type	FAB
Sample	1092 R1
SiO_2	50.03
TiO_2	1.22
Al_2O_3	14.92
FeO*	11.73
MnO	0.14
MgO	7.33
CaO	11.98
Na_2O	2.42
K_2O	0.24
P_2O_5	0.10







Gabbro U-Pb zircon ages: 51.7-51.5 Ma

Ishizuka et al. (2011)

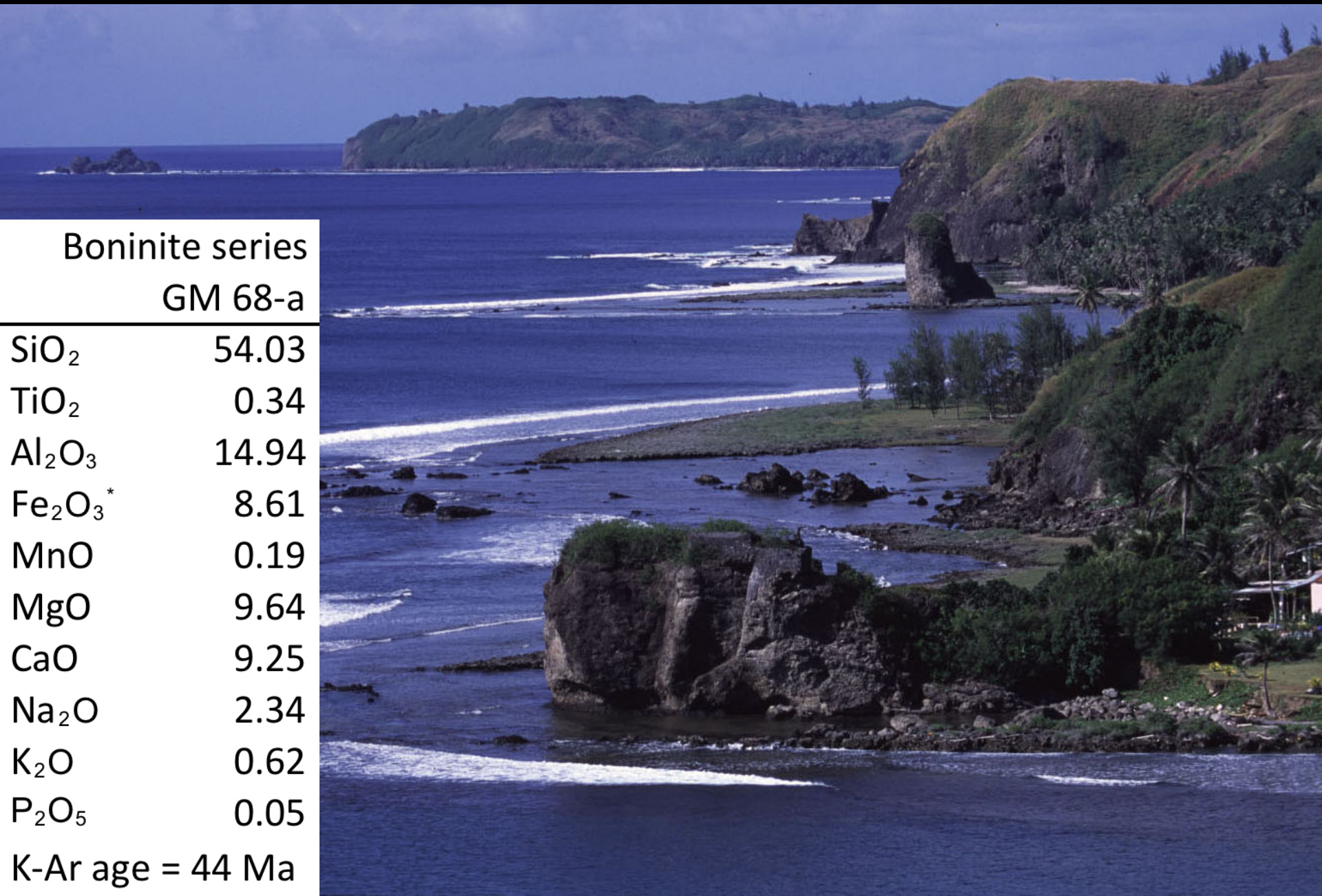
Reagan et al (2013)

Chichijima boninites

SiO_2	58.13
TiO_2	0.16
Al_2O_3	11.04
FeO*	8.61
MnO	0.17
MgO	11.25
CaO	7.79
Na_2O	1.68
K_2O	0.43
P_2O_5	0.02

$^{40}Ar/^{39}Ar$ ➔ 46-48 Ma; Ishizuka et al. (2006)

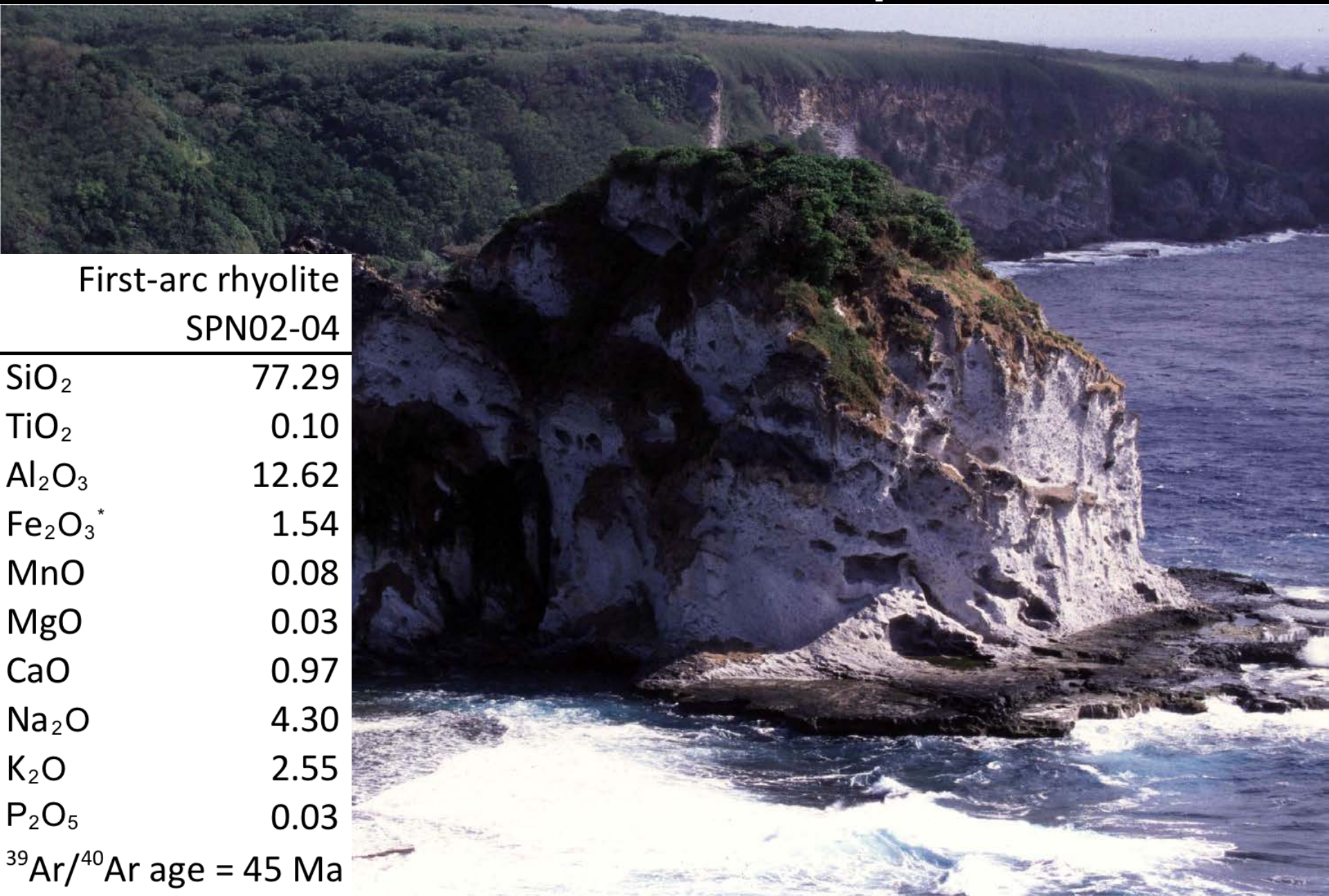
SW Guam



Boninite series	GM 68-a
SiO_2	54.03
TiO_2	0.34
Al_2O_3	14.94
$Fe_2O_3^*$	8.61
MnO	0.19
MgO	9.64
CaO	9.25
Na_2O	2.34
K_2O	0.62
P_2O_5	0.05

K-Ar age = 44 Ma

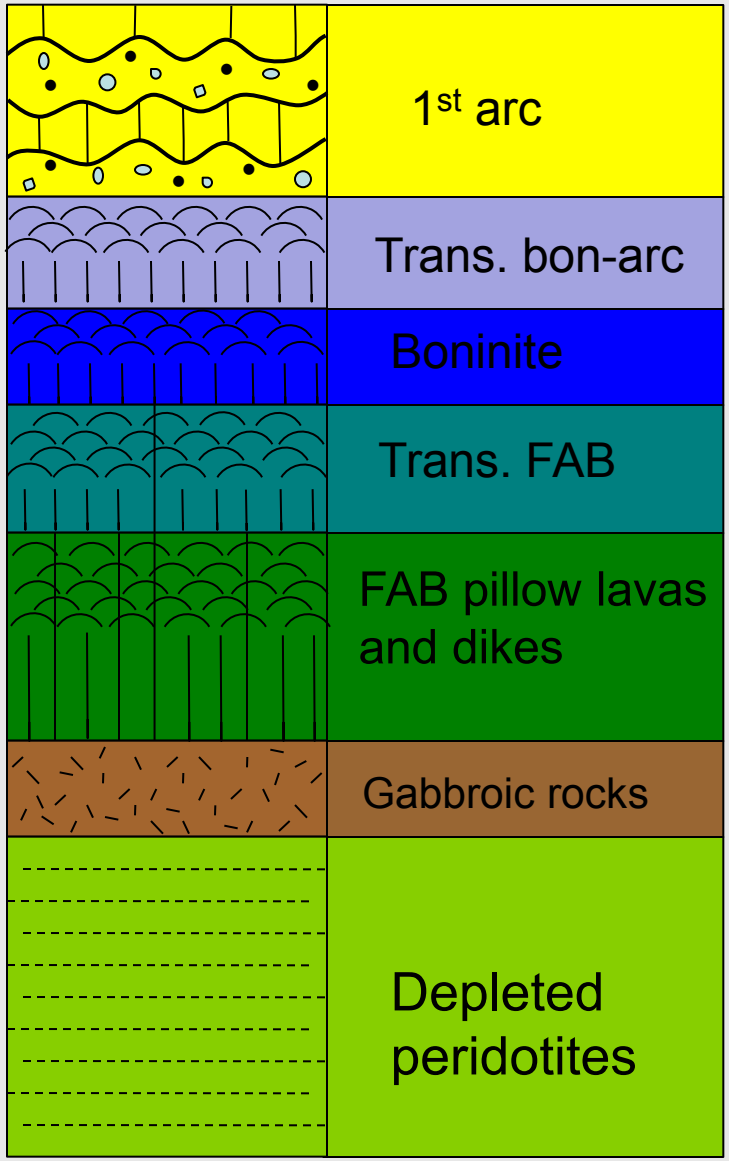
Bird Island, Saipan



First-arc rhyolite SPN02-04	
SiO_2	77.29
TiO_2	0.10
Al_2O_3	12.62
$Fe_2O_3^*$	1.54
MnO	0.08
MgO	0.03
CaO	0.97
Na_2O	4.30
K_2O	2.55
P_2O_5	0.03

$^{39}Ar/^{40}Ar$ age = 45 Ma

Apparent fore-arc stratigraphy



32-45 Ma

46-43 Ma

46-48 Ma

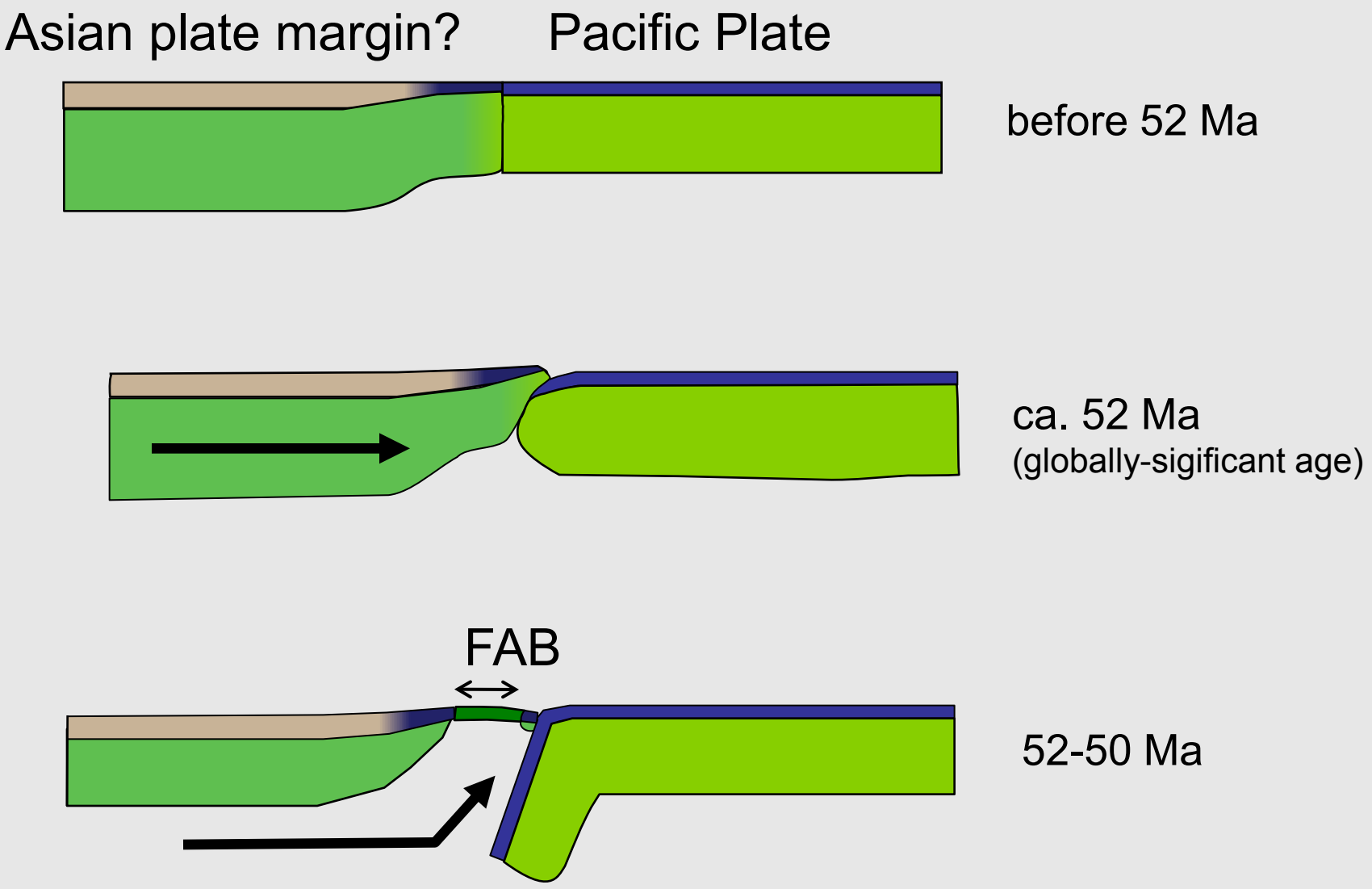
~49 Ma

50-52 Ma

49-52 Ma

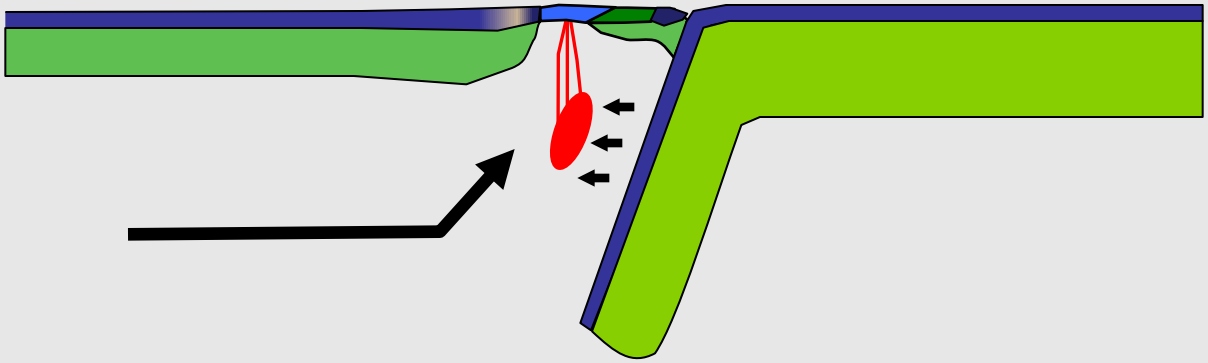
Ages

Reagan et al. (2013);
Ishizuka et al. (2011);
Reagan et al. (2008);
Ishizuka et al. (2006);
Cosca et al. (1998);
Meijer et al. (1983)



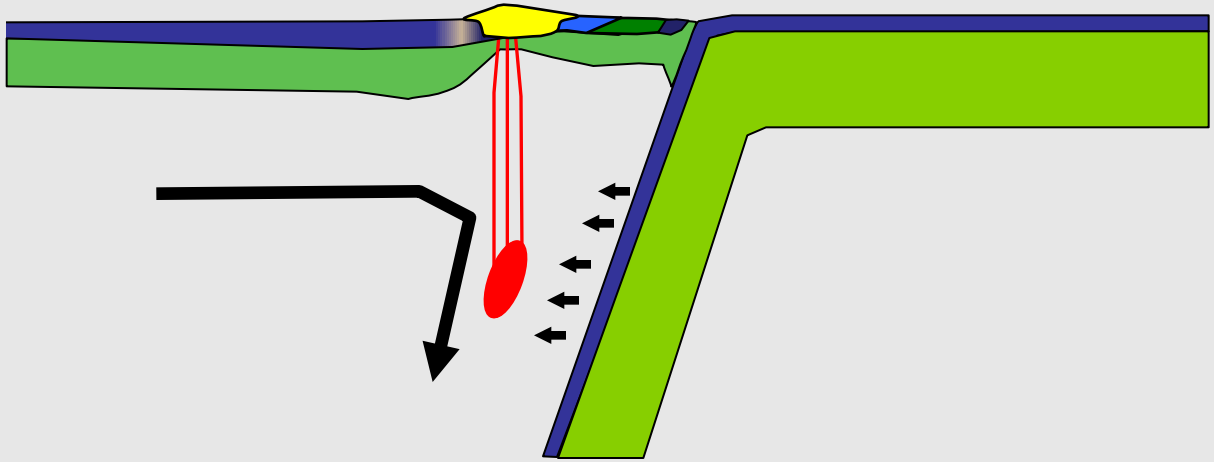
after Stern and Bloomer (1992) and Hall et al. (2003)

Transitional & Boninite



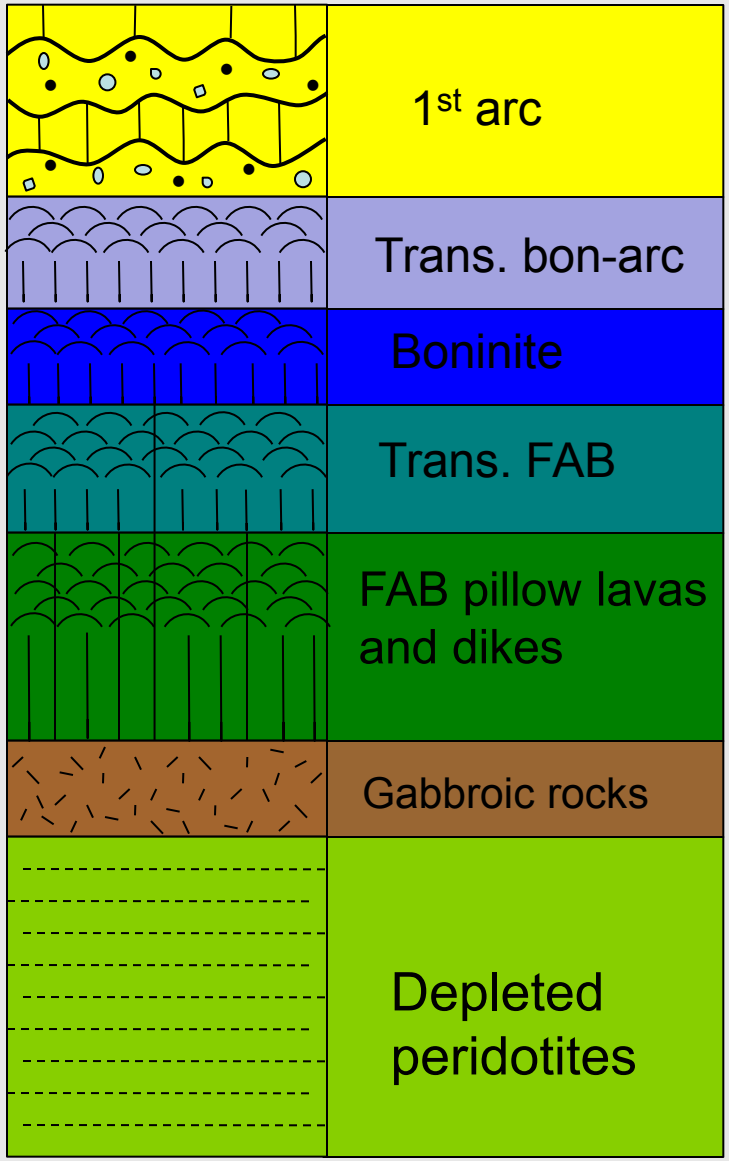
49-43 Ma

Normal arc



45Ma and younger

IBM fore-arc stratigraphy



Ophiolites with similar strata:

Troodos (Tethyan)
[e.g. Pearce & Robinson, 2010]

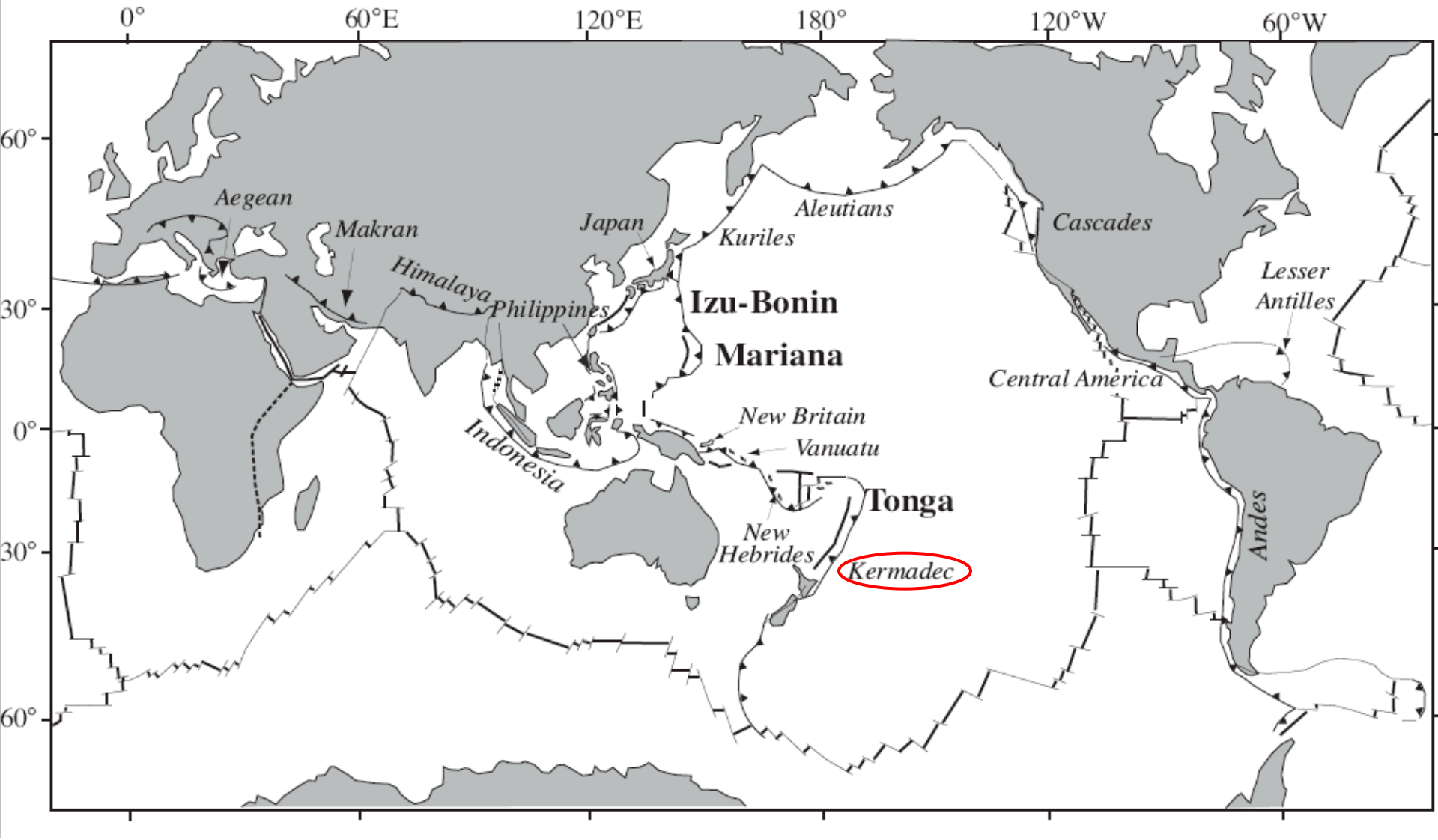
Oman (Tethyan)
[e.g. Ishikawa et al., 2002]

Mirdita (Tethyan)
[e.g. Dilek et al., 2008]

Pindos (Tethyan)
[e.g. Dilek and Furnes, 2009]

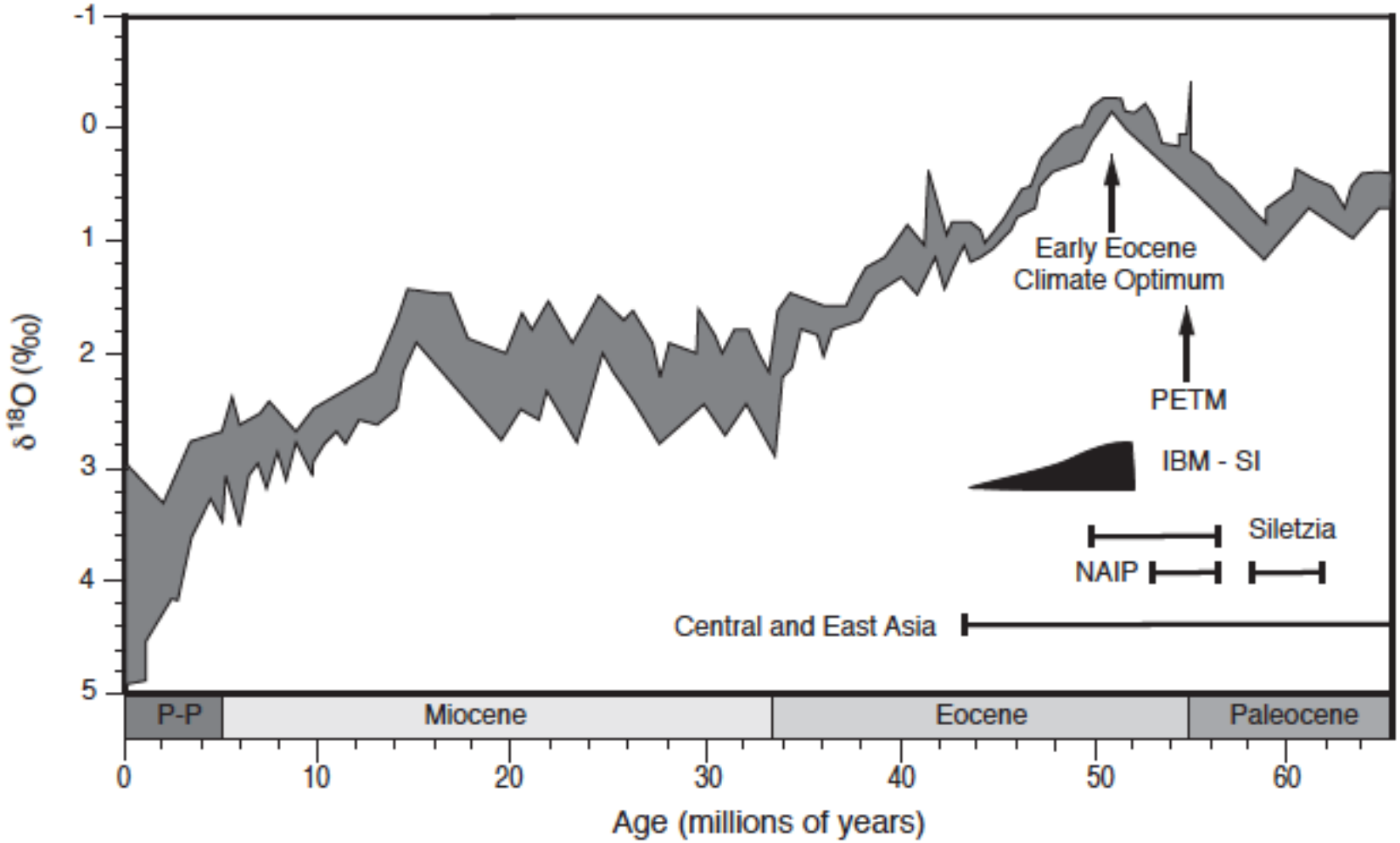
Othris (Tethyan)
[e.g. Barth and Gluhak, 2009]

Kudi (Cambrian)
[e.g. Yuan et al., 2005]



from: Stern et al. (2012)

Effect on climate?



After Zachos et al. (2008)

JOIDES Resolution schedule

Expedition name	Exp #	Ports	Dates	Total days (port/sea)	Days at sea (trans/ops)	Co-chief scientists	USIO contacts
Asian Monsoon	346	Valdez, Alaska to Busan, Korea	29 Jul-28 Sep '13	60 (5/55)[5]	14/41	R. Tada R. Murray	C. Alvarez Zarikian J. Lofi
End of Integrated Ocean Drilling Program / Start of International Ocean Discovery Program Dry Dock/Non-IODP: 28 September 2013 to 26 January 2014							
South China Sea Tectonics	349	Hong Kong to Keelung	26 Jan-30 Mar '14	63 (3/60)	6/54	C.-F. Li J. Lin	D. Kulhanek T. Williams
Izu Bonin Mariana Rear Arc	350	Keelung to Yokohama, Japan	30 Mar-30 May '14	61 (5/56)	4/52	Y. Tamura C. Busby	P. Blum G. Guèrin
Izu Bonin Mariana Arc Origins	351	Yokohama to Yokohama, Japan	30 May-30 Jul '14	61 (5/56)	5/51	R. Arculus O. Ishizuka	K. Bogus
Izu Bonin Mariana Forearc	352	Yokohama, Japan to Keelung	30 Jul-29 Sep '14	61 (5/56)	7/49	J. Pearce M. Reagan	K. Petronotis S. Morgan

Conclusions

- MORB-like lavas (FAB) are the most abundant igneous rocks in the IBM fore-arc and are part of an in-situ ophiolite.
- These lavas were generated during subduction initiation at 51-52 Ma, and might extend as far south as the Tonga and Kermadec fore-arcs.
- Approximately synchronous with many changes in plate motion (e.g. Hawaii-Emperor bend) and peak in global atmospheric temperatures
- ~3 million year transition from FAB to boninitic volcanism; transition to arc volcanism took 7-8 million years
- Western Pacific forearcs have ophiolitic stratigraphy; other ophiolitic provinces (e.g. Tethyan) might have resulted from other global subduction initiation events.