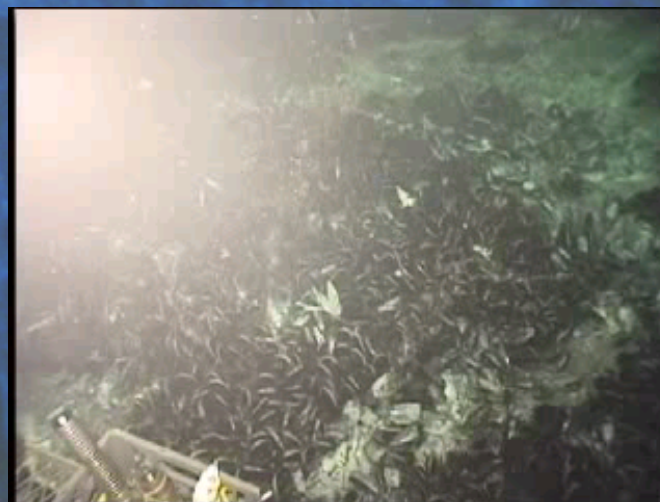
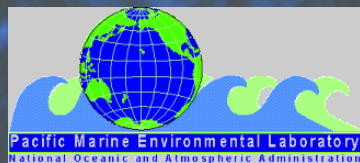
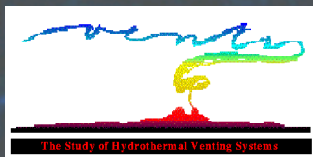


Natural CO₂ from Submarine Hydrothermal Systems

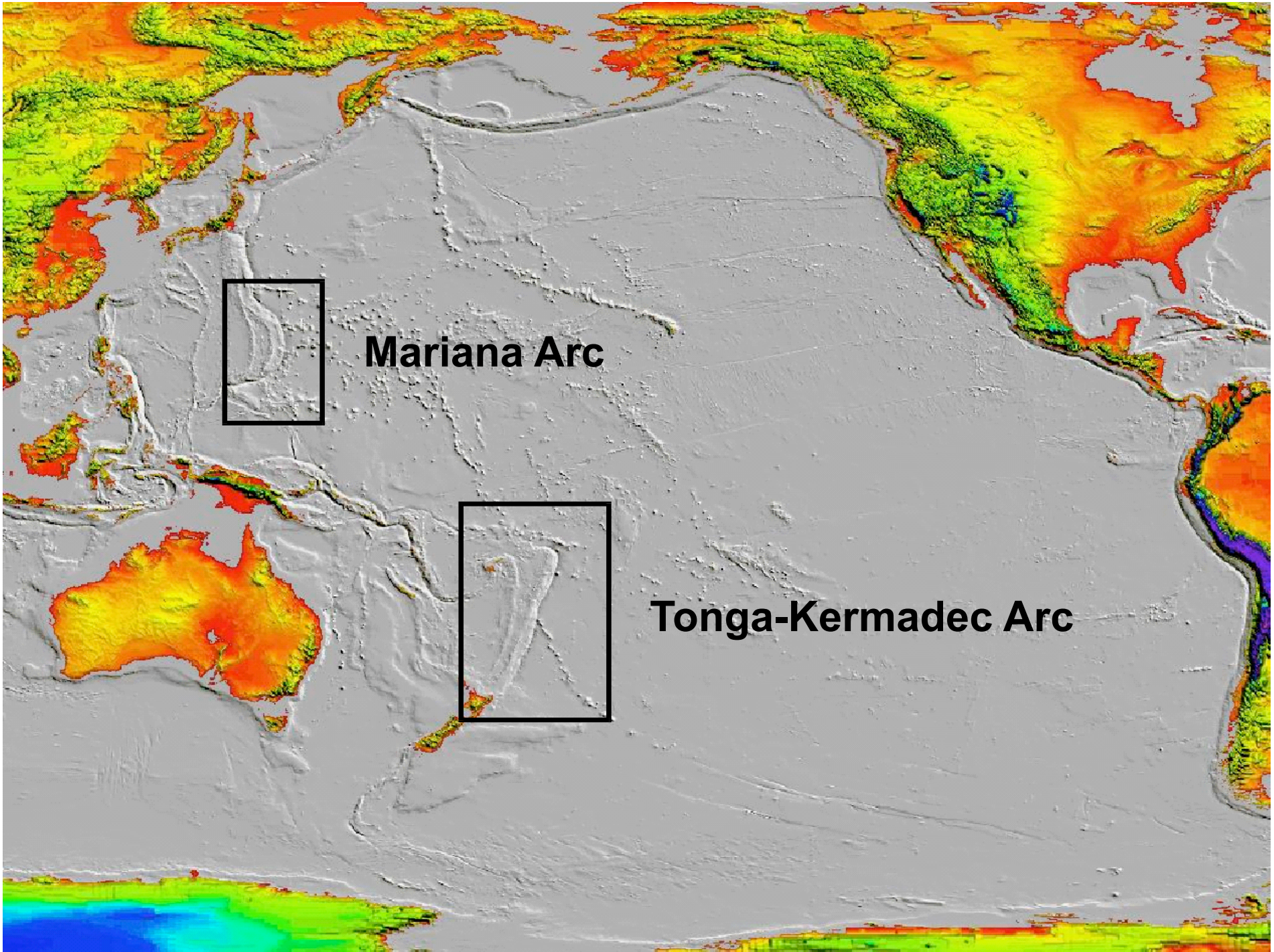
John Lupton, Presenter

Supported by NOAA's Ocean
Exploration Program



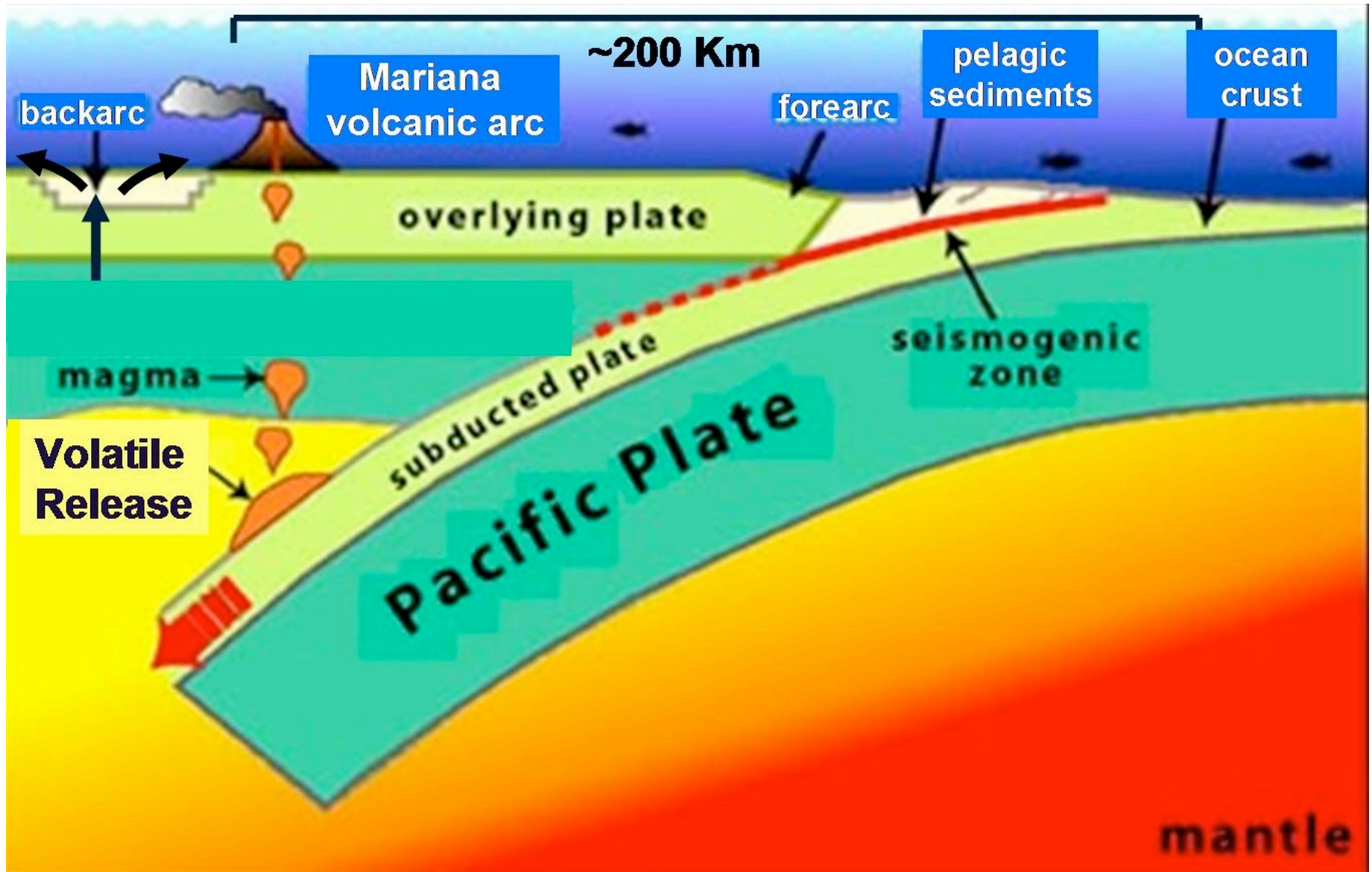
Outside Collaborators

- Marvin Lilley (Univ. of Washington)
- Ko-ichi Nakamura (AIST, Japan)
- Cornel de Ronde (IGNS, New Zealand)
- Verena Tunnicliffe (Univ. of Victoria, B.C.)
- Gary Massoth (IGNS and Mass-Ex3 Consulting)
- Mark Schmitt (Univ. Kiel, Germany)



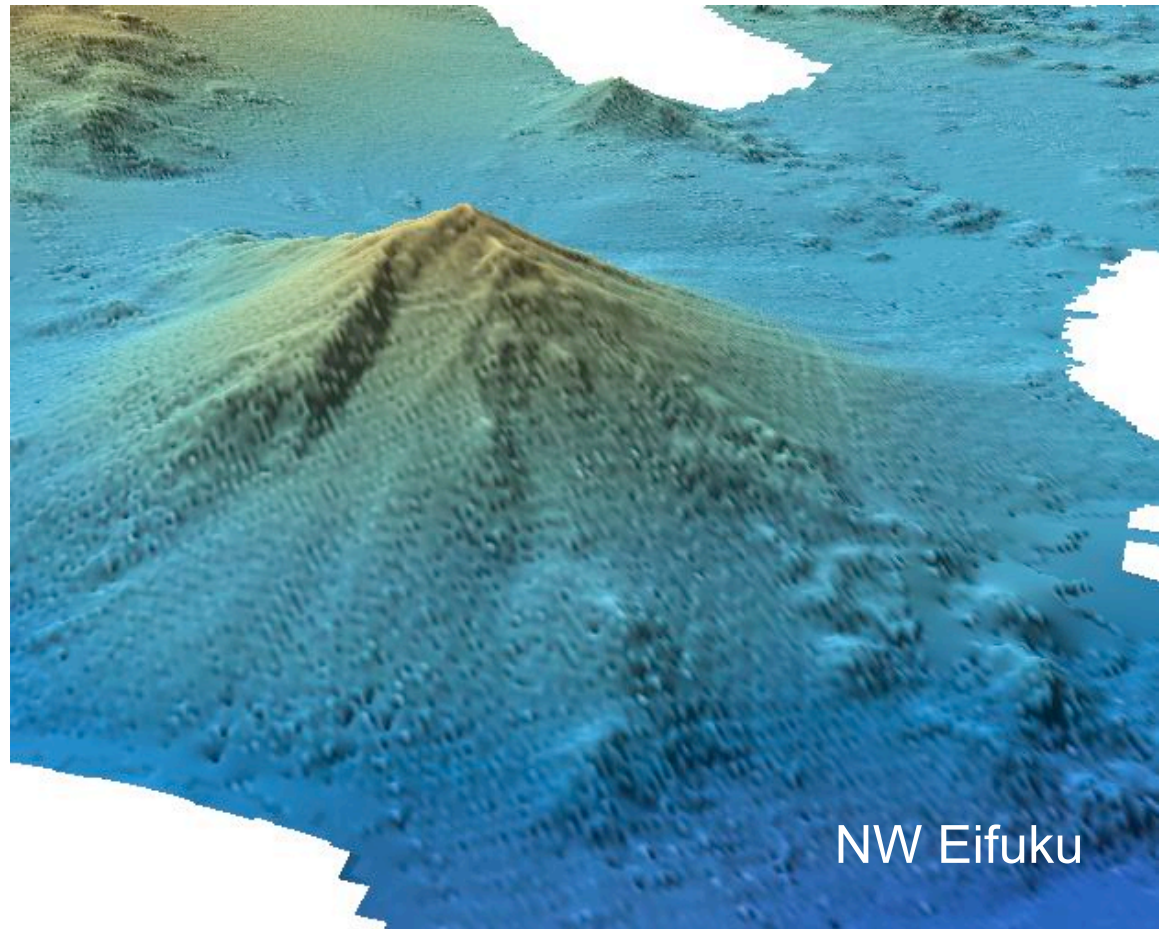
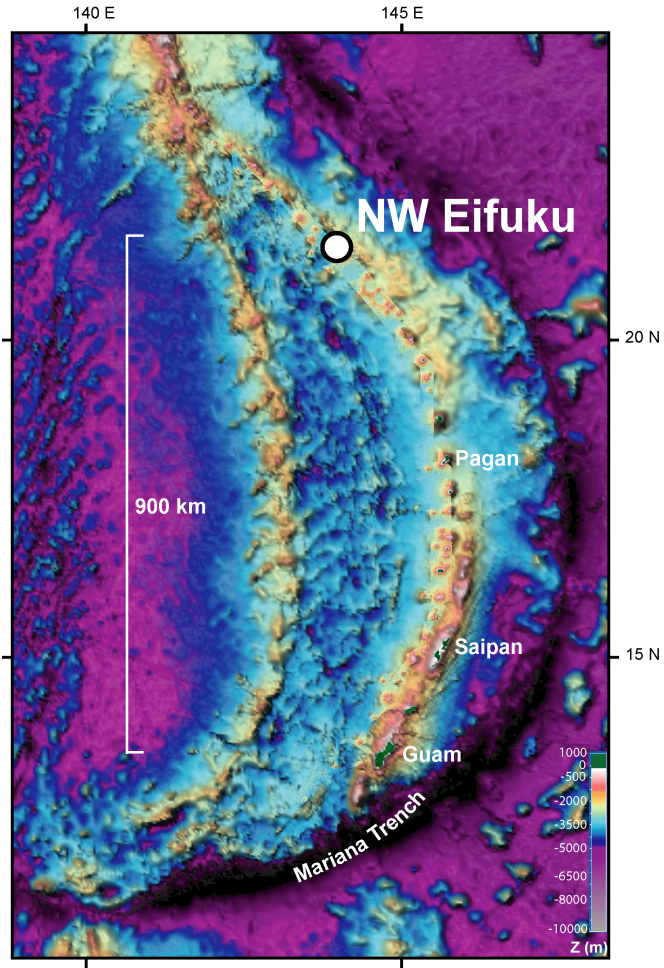
Mariana Arc

Tonga-Kermadec Arc



Typical subduction zone

Mariana Arc

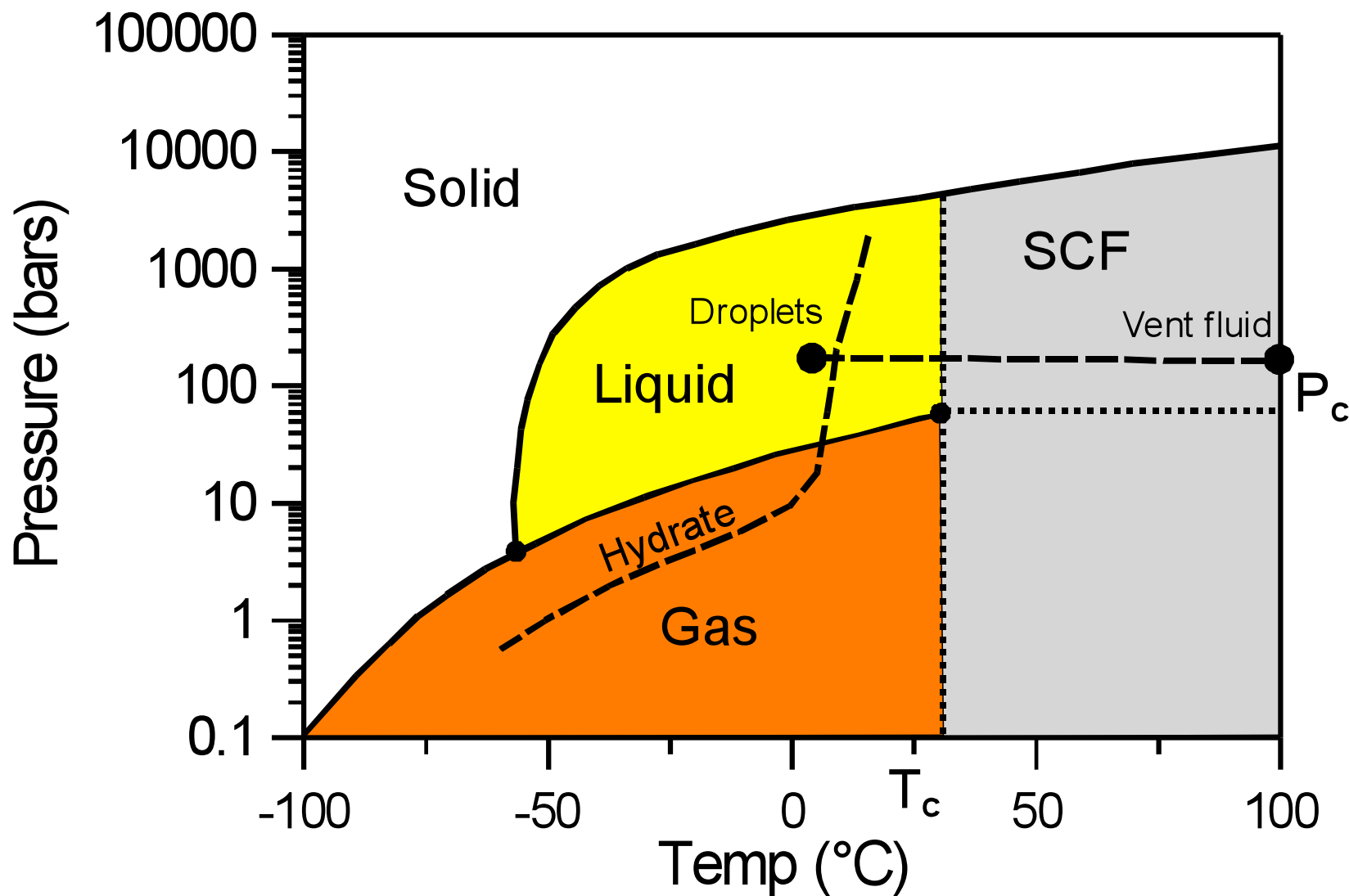




Champagne Vent, NW Eifuku, 2004

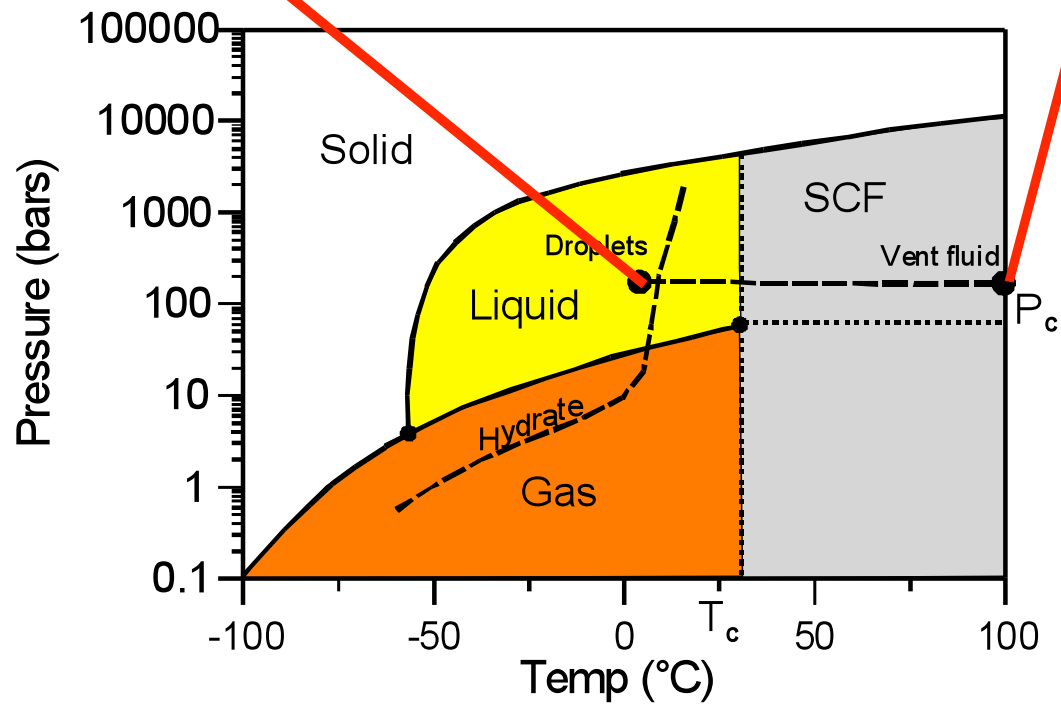


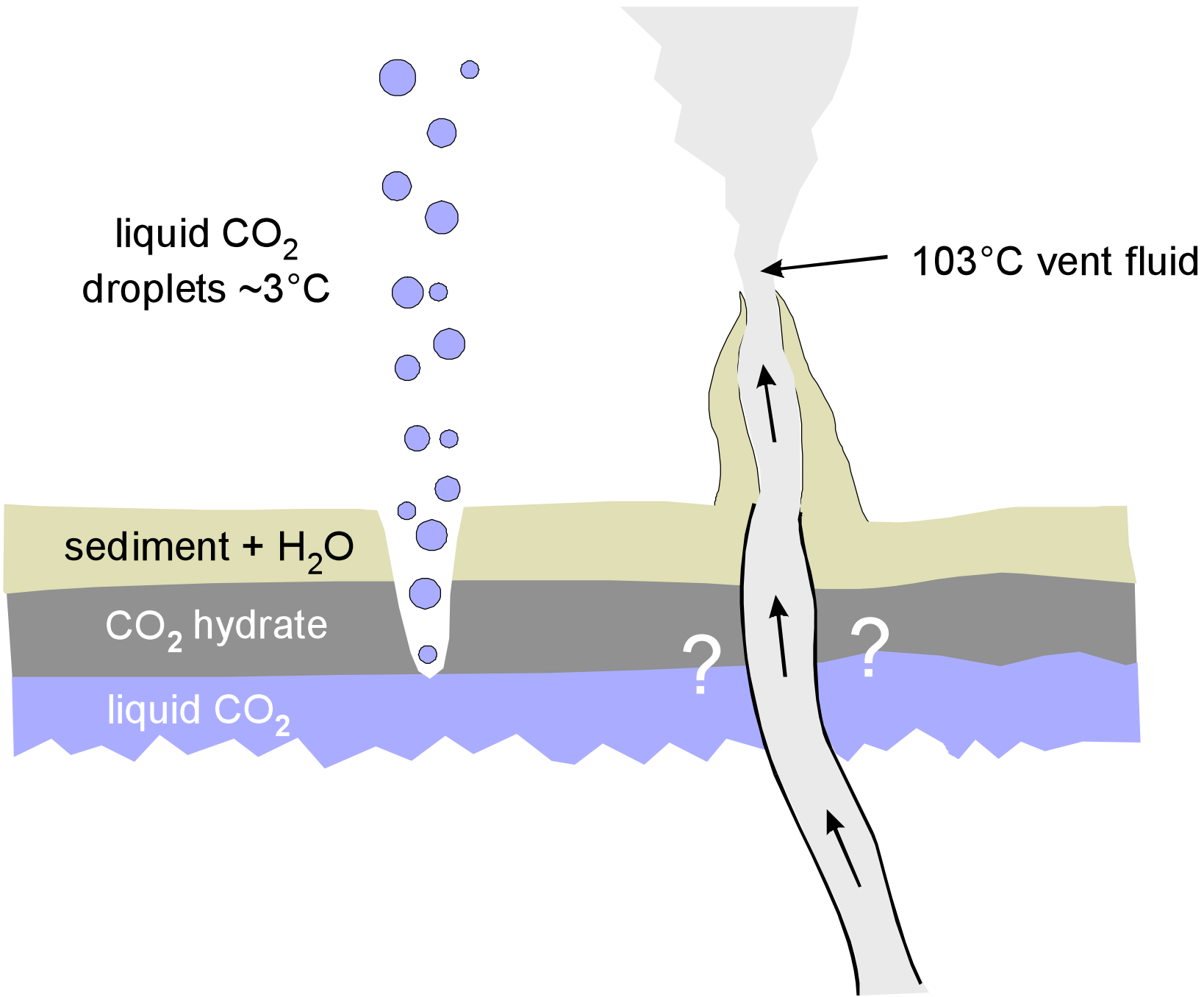
Champagne Vent, NW Eifuku, 2004

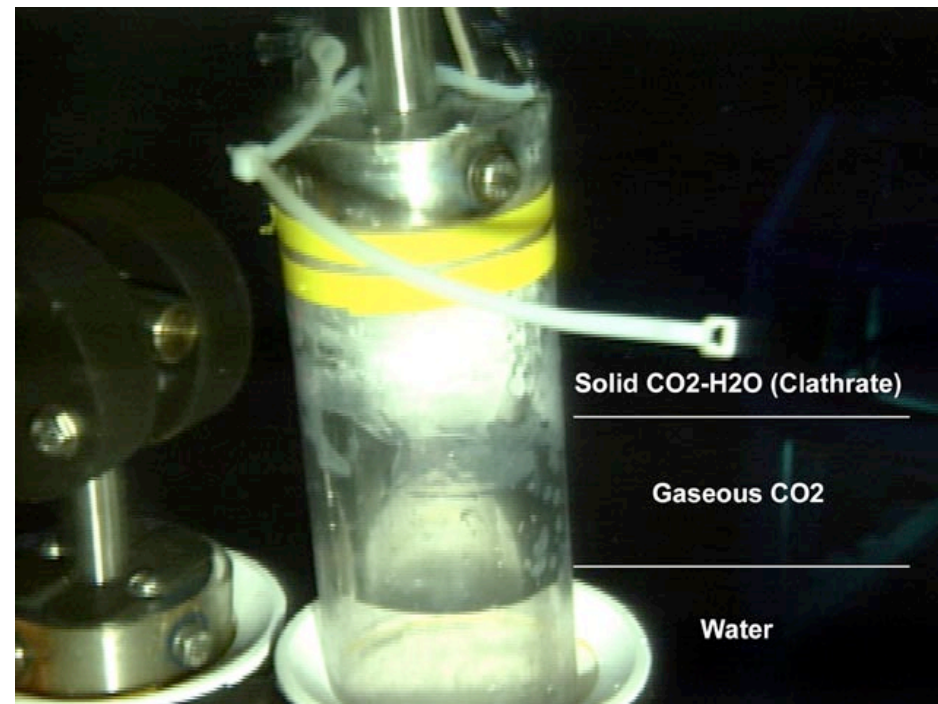


CO₂ Phase Diagram

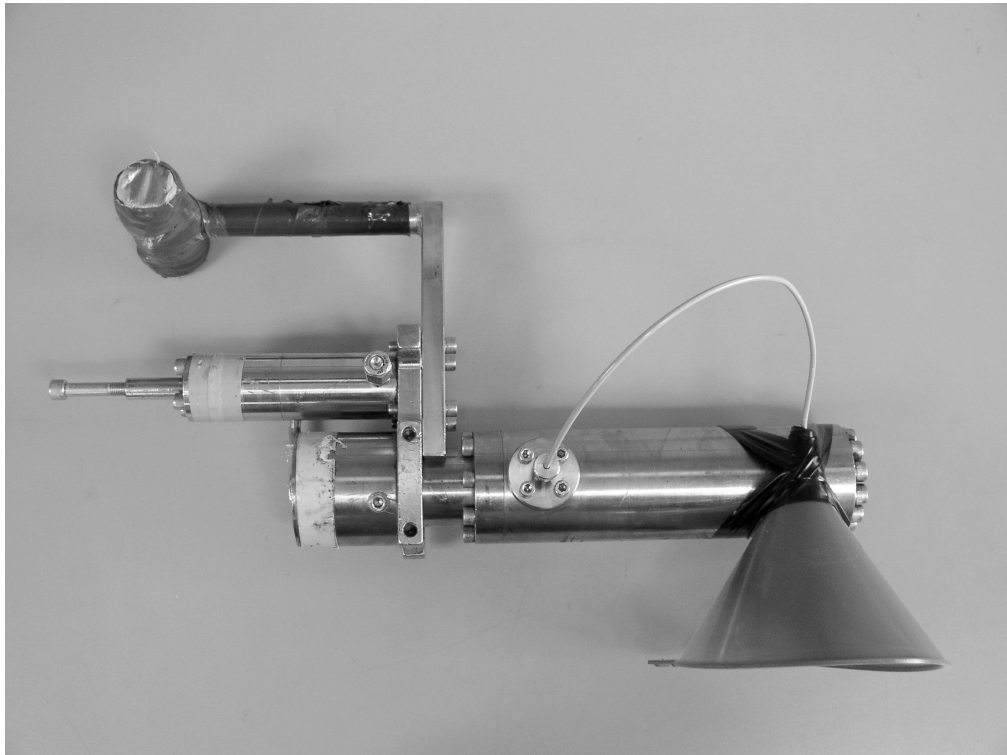
modified from Jessup and Leitner, 1999





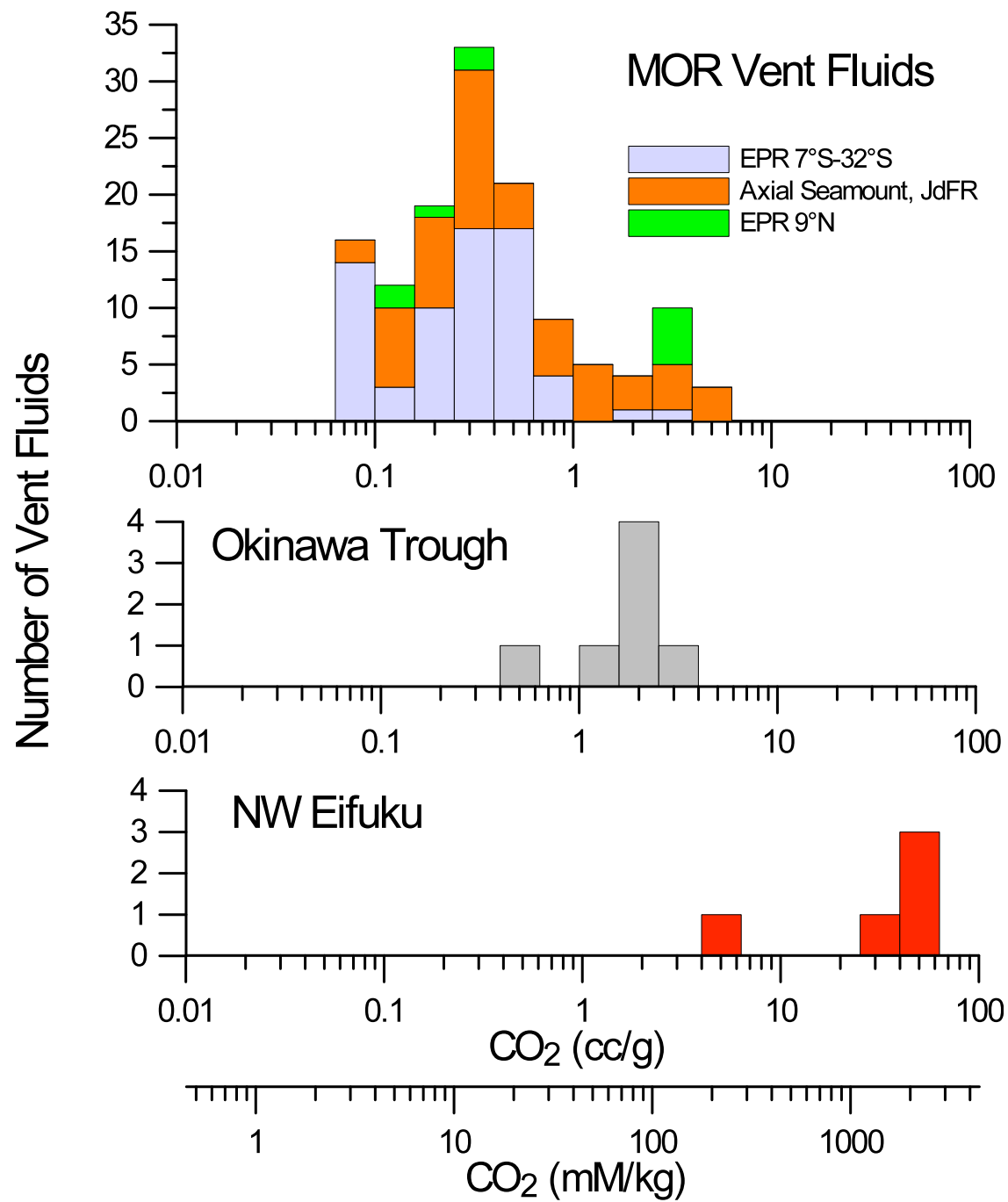


Sampling devices used for gas collections

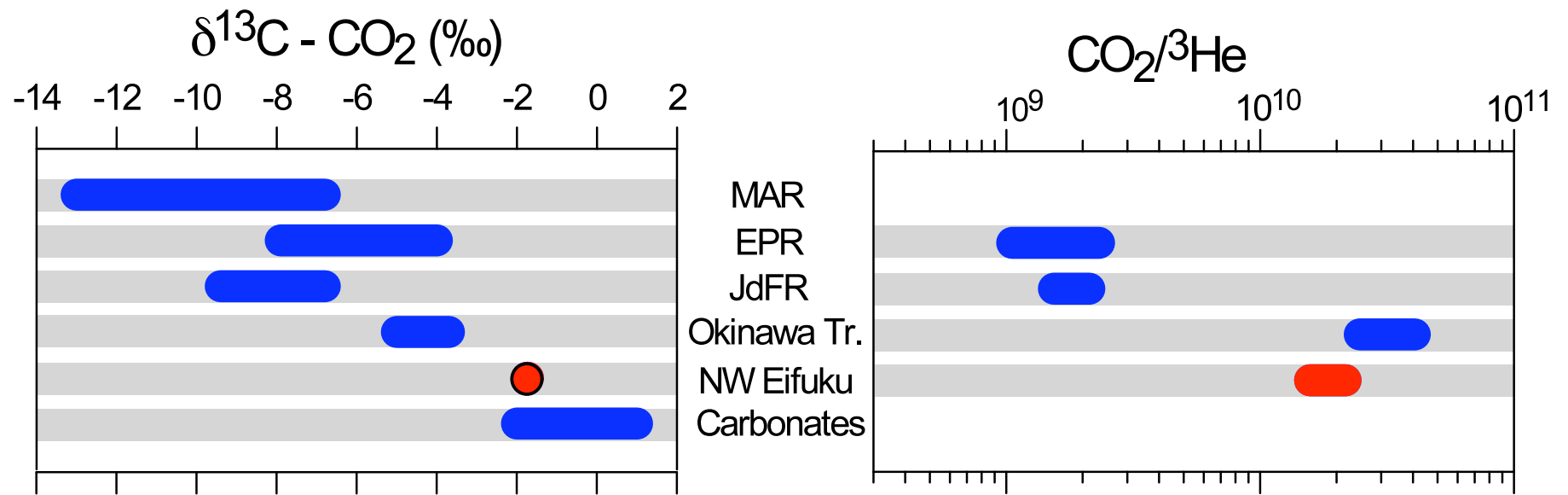


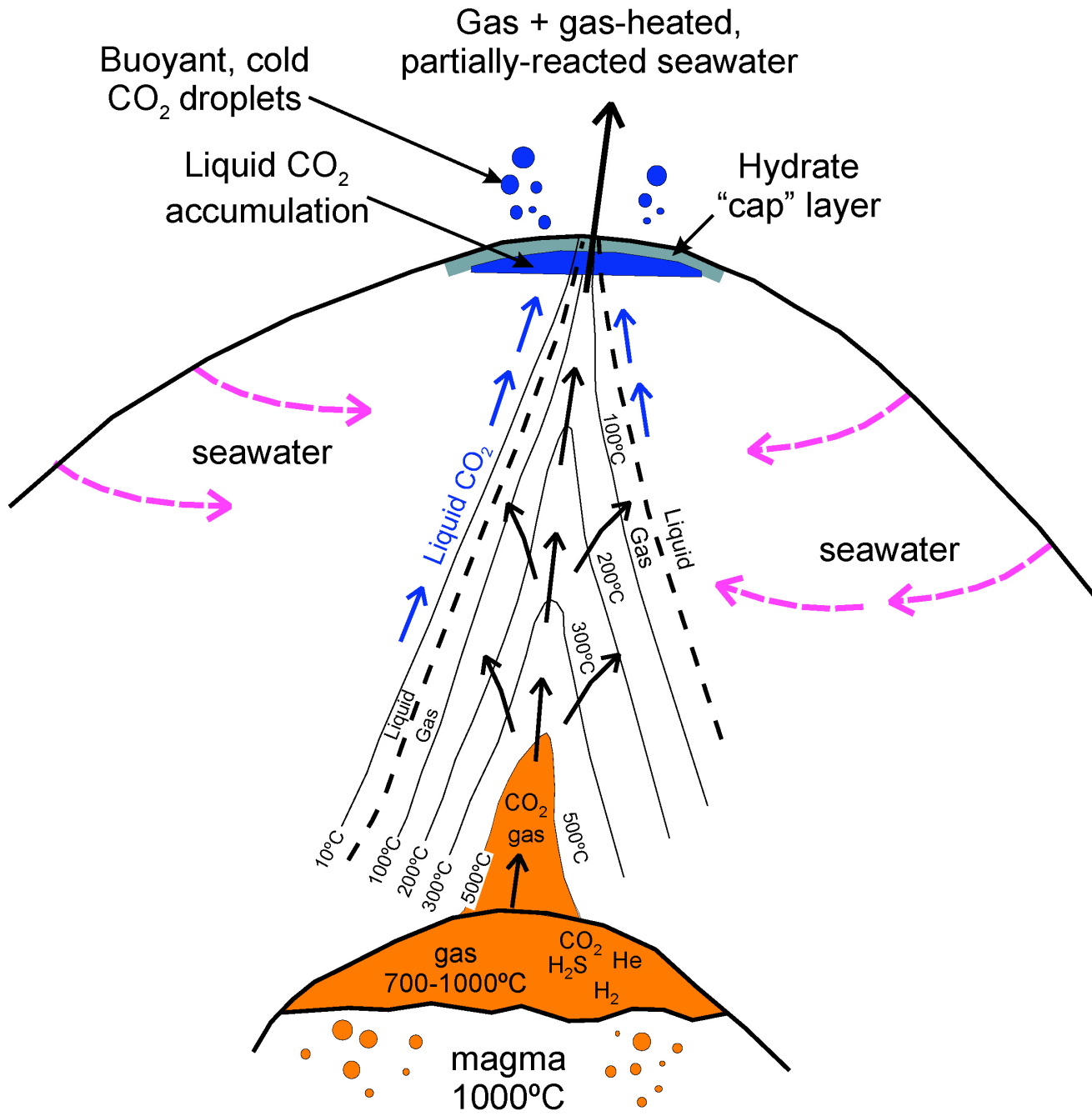


Champagne Vent, Droplet Catcher, 2005



Comparison with mid-ocean ridge systems





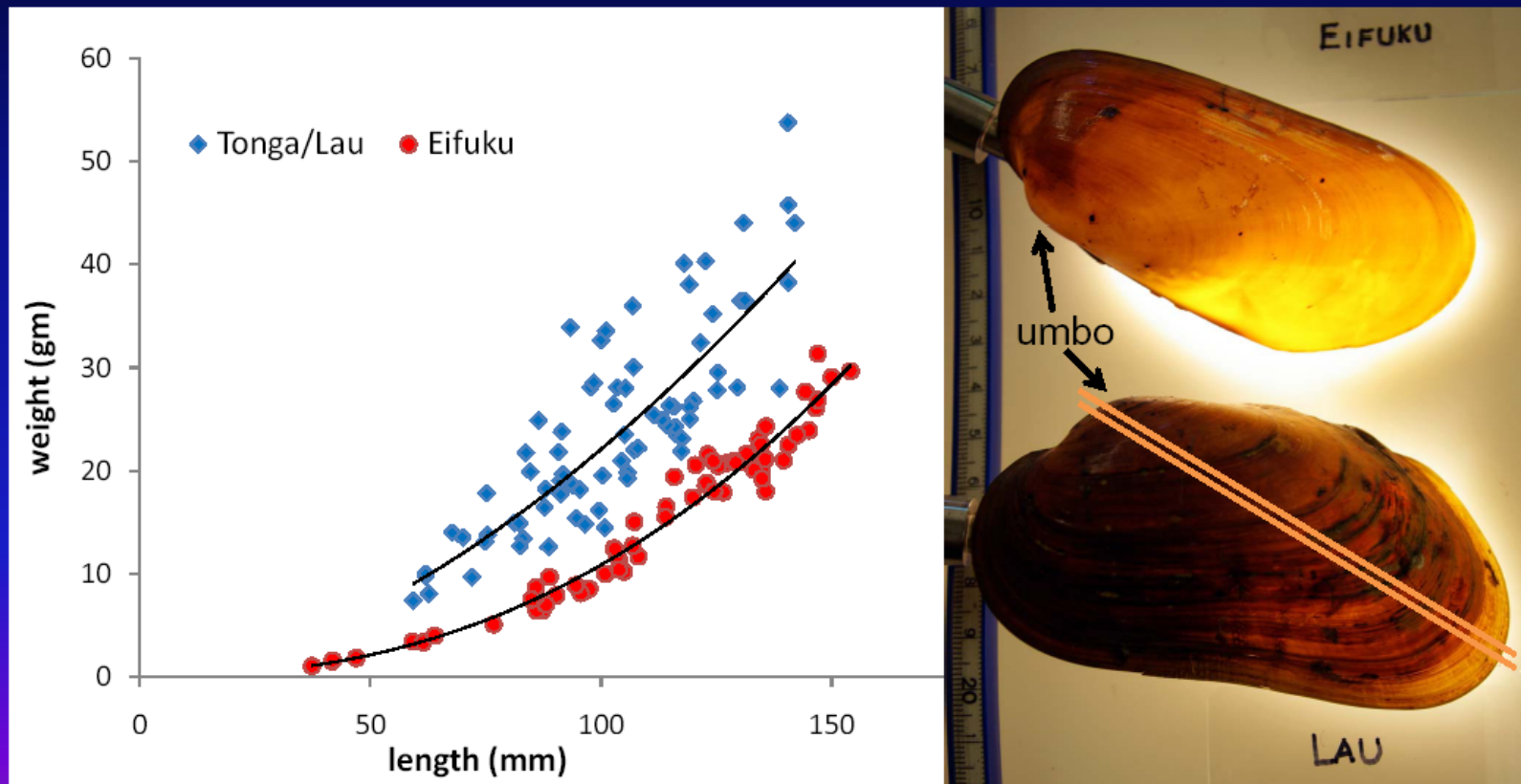


Mussel beds on NW Eifuku:
Does low pH environment
change calcification?
Tunncliffe et al. 2007

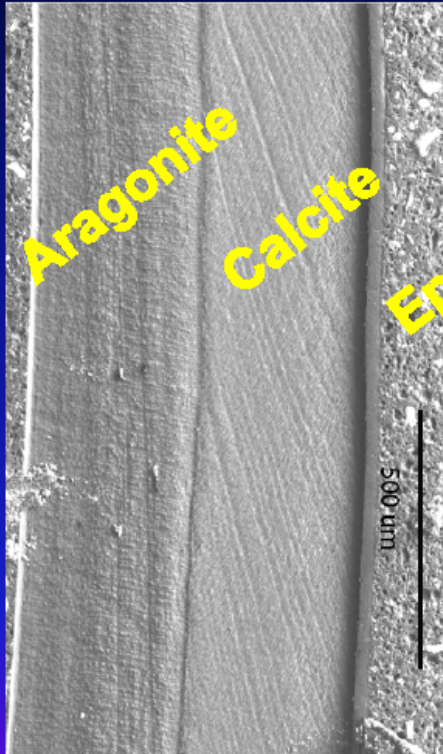
Shell Samples (from live mussels)

Sample	Site	Depth m	# shells	pH	alk	Max T °C
E1	Eifuku	1576	41	5.88		2.3
E2	Eifuku	1596	11	5.94	2.49	2.5
E3	Eifuku	1610	5	6.51	2.46	2.4
E4	Eifuku	1638	12	5.36	2.62	2.7
T1	Tonga	1103	10	7.85	2.46	-
L1	Lau	1830	10	8.42	2.34	2.0
L2	Lau	1820	10			
L3	Lau	1900	12	Water collection using a low pumping sampling or with evacuated bottles with controlled intake flows.		
L4	Lau	2622	14			
L5	Lau	2714	12			

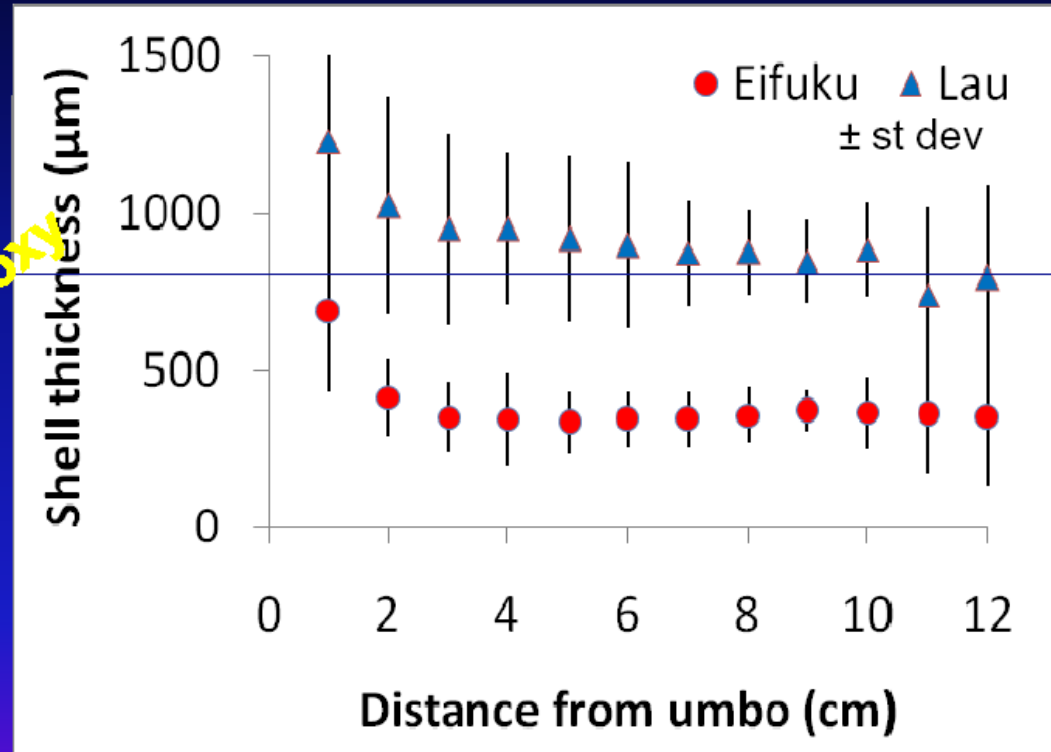
Dry weight of shells: much lighter shells in high CO₂ setting



Thickness of shells on cut slices

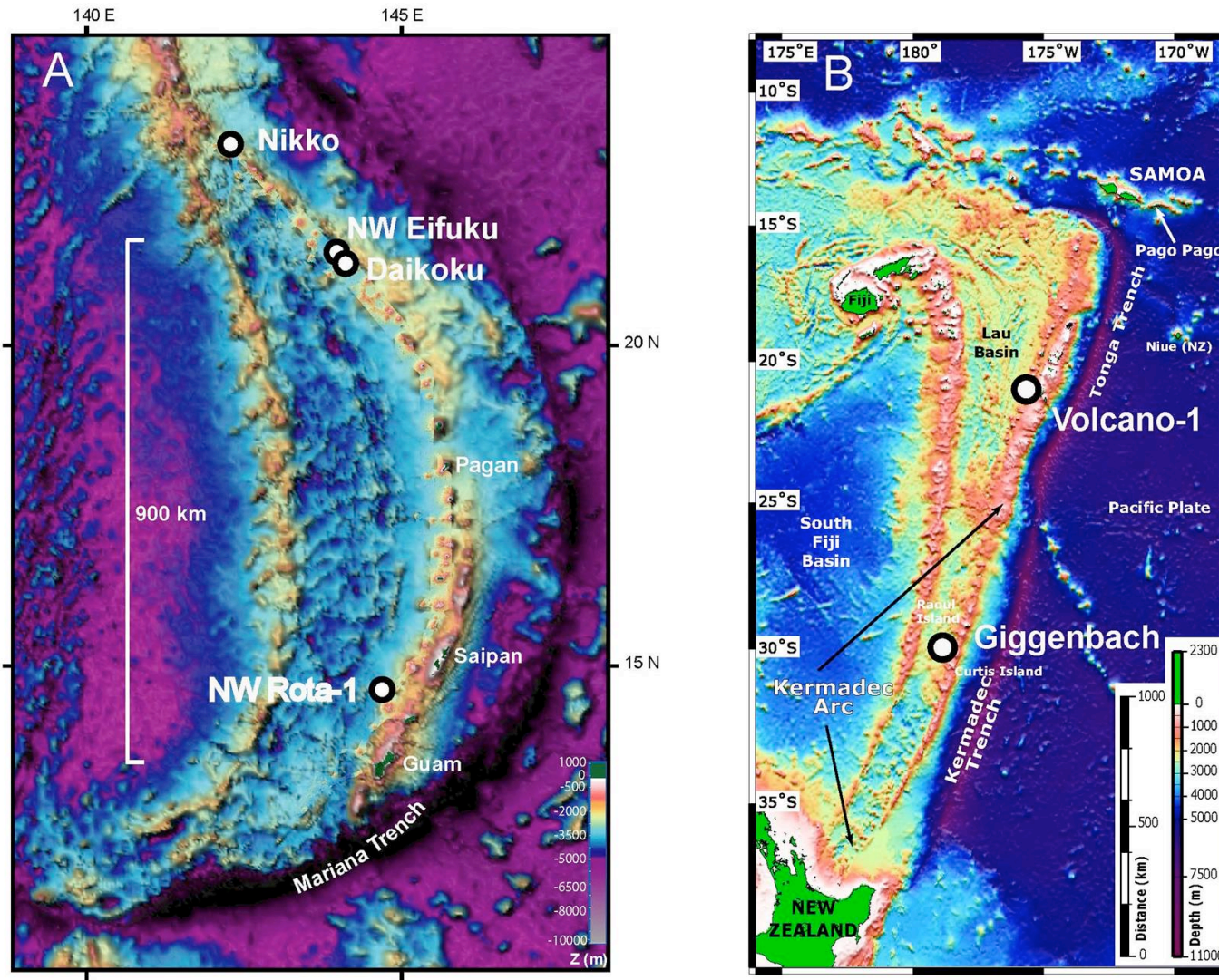


thickness



Shells from low CO₂ habitat are 2.5 times the thickness of those on Eifuku Volcano

8



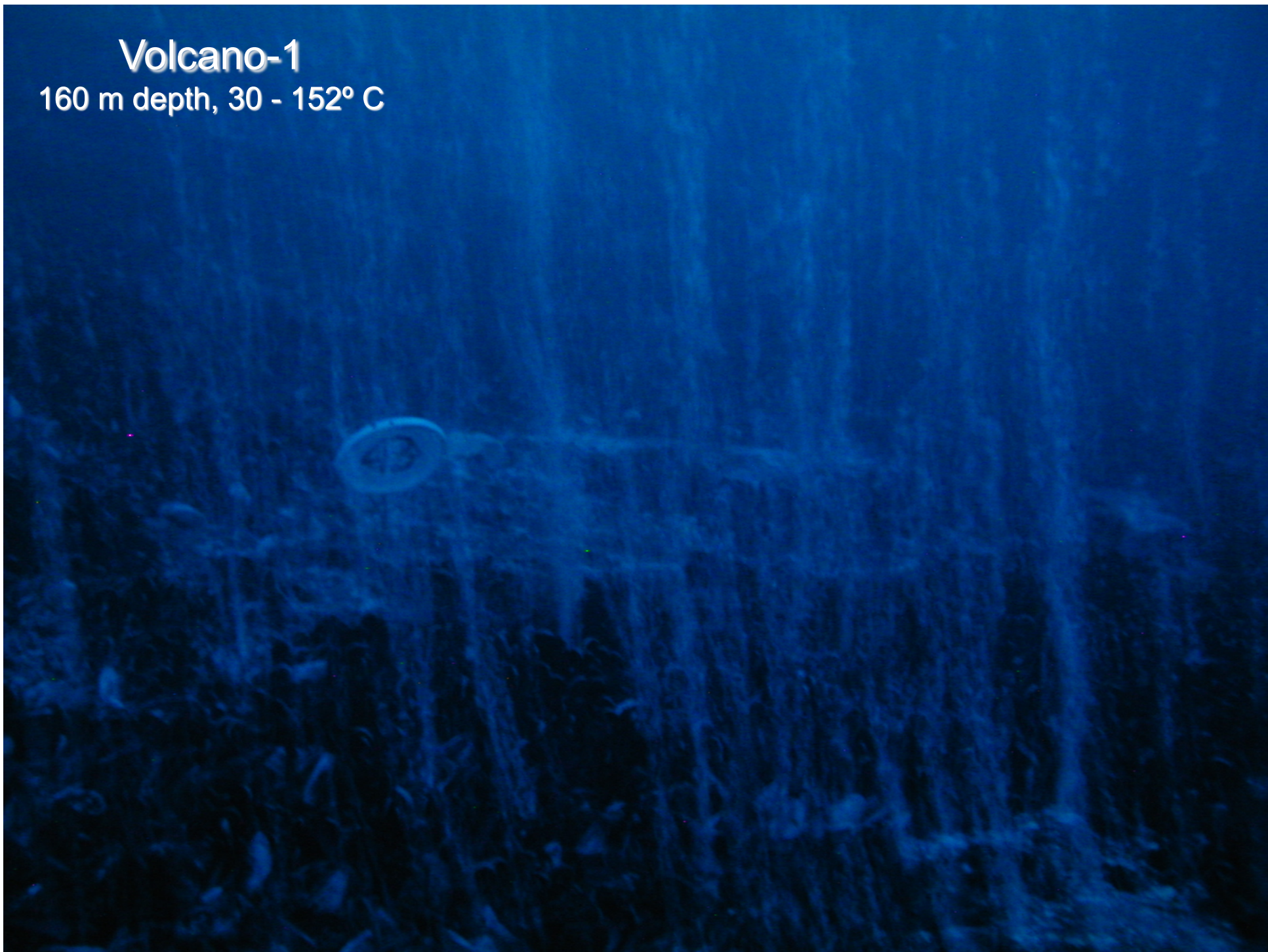
Of 22 volcanoes studied on the Mariana and Tonga-Kermadec Arcs,
6 are venting a separate CO₂-rich gas phase



Nikko (2005) 455 m depth

Volcano-1

160 m depth, 30 - 152° C





Volcano-1, Tonga-Kermadec Arc

Summary

- Of 22 active submarine volcanoes investigated, 6 had a free CO₂-rich gas phase
- Excess CO₂ is derived mainly from subducted marine carbonates incorporated into the volcanic melt.
- Tunncliffe et al. study indicates that the mussel shells on NW Eifuku compromised by low pH environment.
- CO₂ flux at NW Eifuku equals 0.1% of the global mid-ocean ridge carbon flux

Future Directions

- Estimate the carbon flux at CO₂-rich hydrothermal sites
- Assess effect of submarine CO₂ venting on the global oceanic carbon budget
- Evaluate the effects of high CO₂ concentrations on marine ecosystems via biological studies at natural sites such as NW Eifuku – relevance to Ocean Acidification

