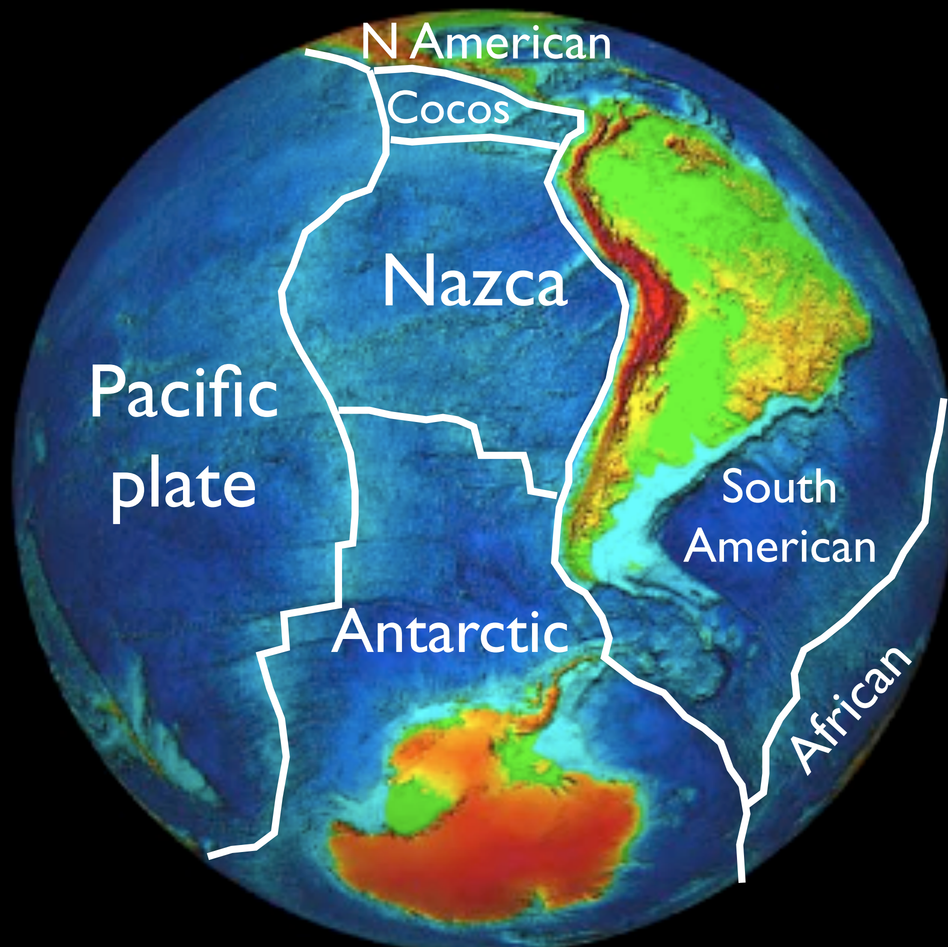
noaa ocean exploration

Patterns in Global Hydrothermal Activity

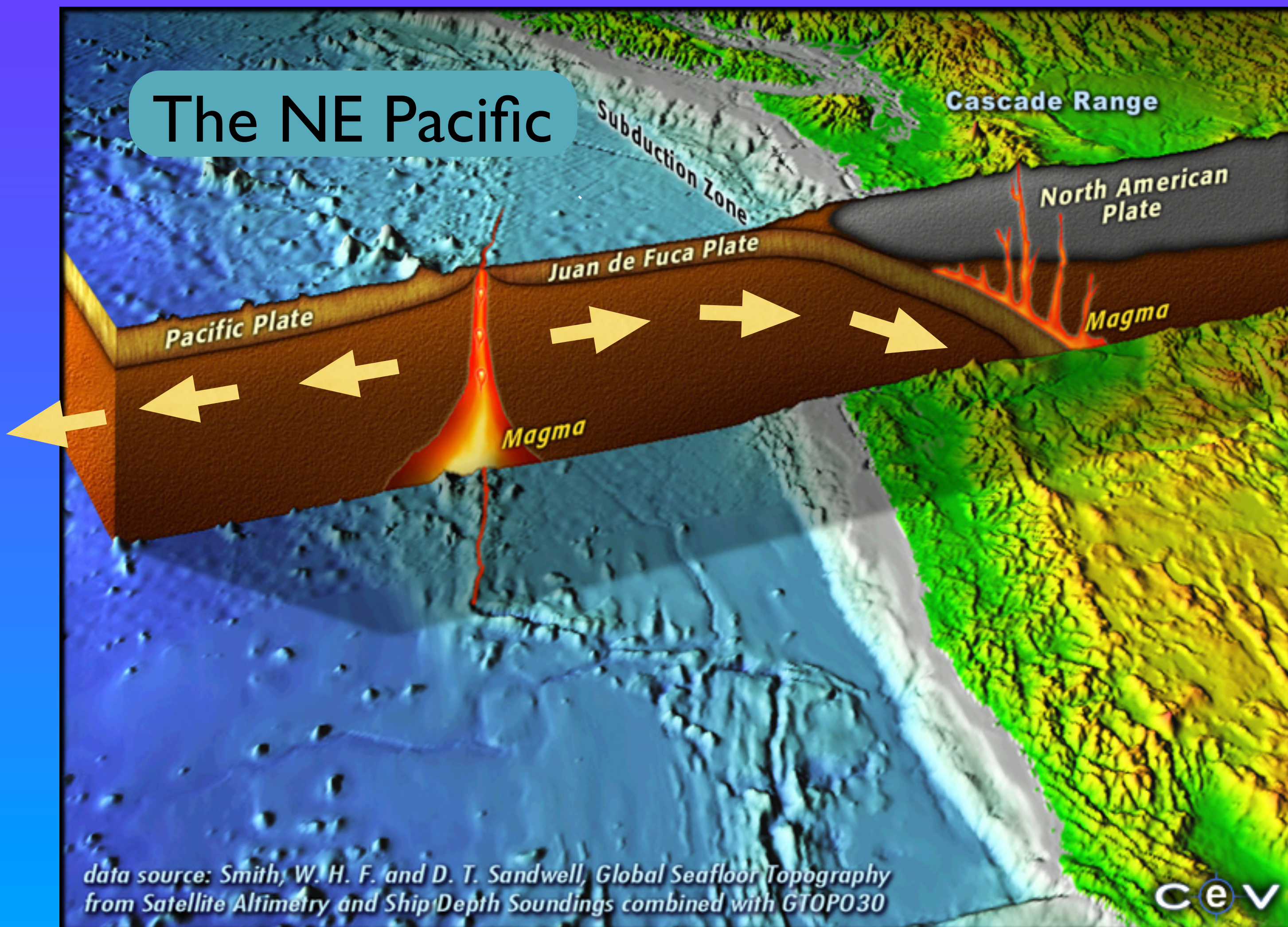
Presenter:
Edward T. Baker

Earth--the water planet

Earth--the dynamic planet



Volcanic environments created by plate creation and plate consumption



NOAA's Mission for global exploration

NOAA Research Plan Areas:

- Advance our understanding of ecosystems
- Explore our oceans

Global *vision*

Global *partners & customers*

Global *exploration program*

Global *resources & stewardship*

Key science questions for a global vision

What factors can be used to predict the distribution of hydrothermal vent sites at scales from global to local?

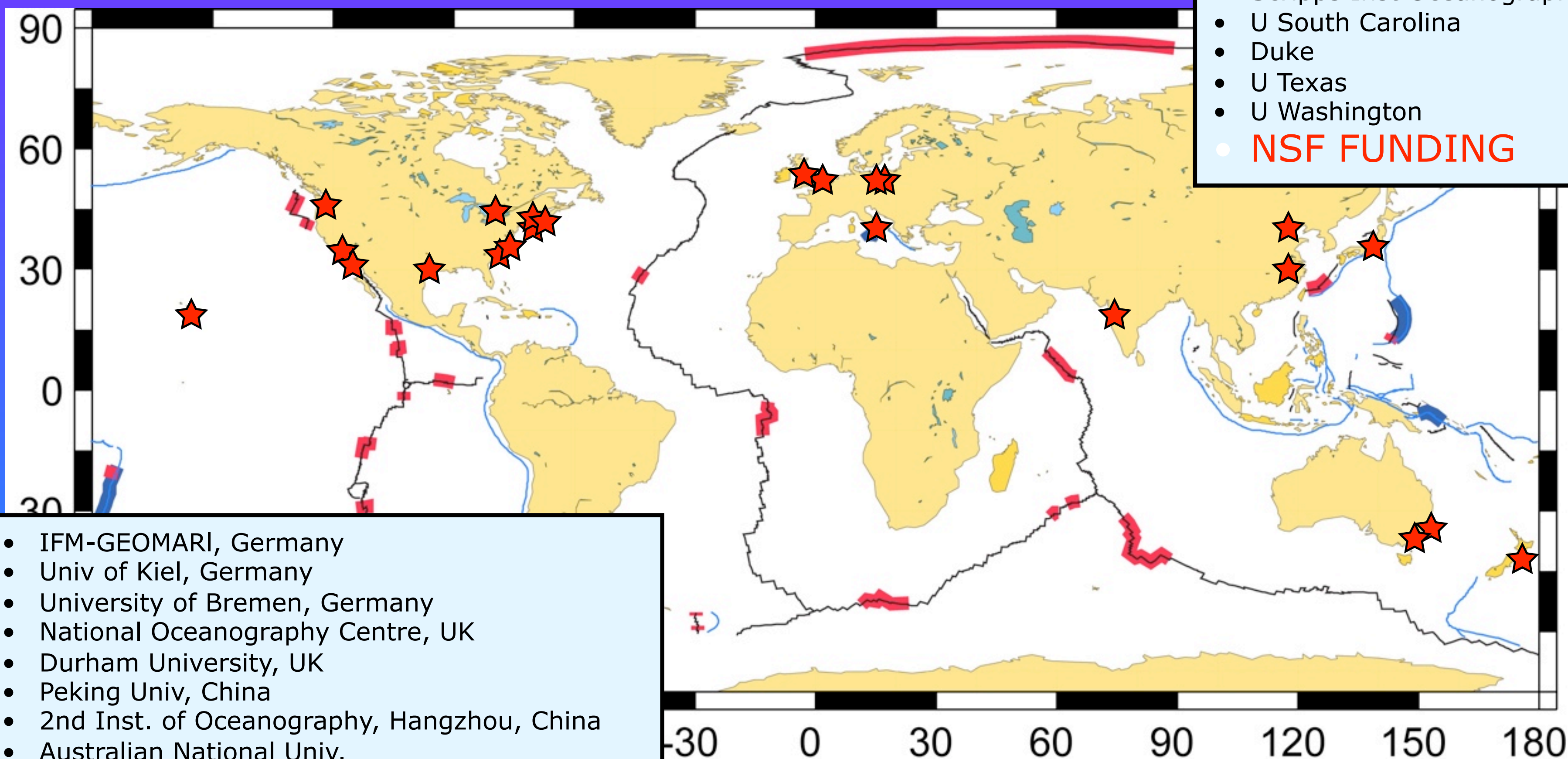
Heat supply? Permeability? Do arcs differ from ridges?

How can hydrothermal processes be quantified?

How many sites? Chemical budgets? Temporal variability?

Global partners & customers

Surveys by/with VENTS

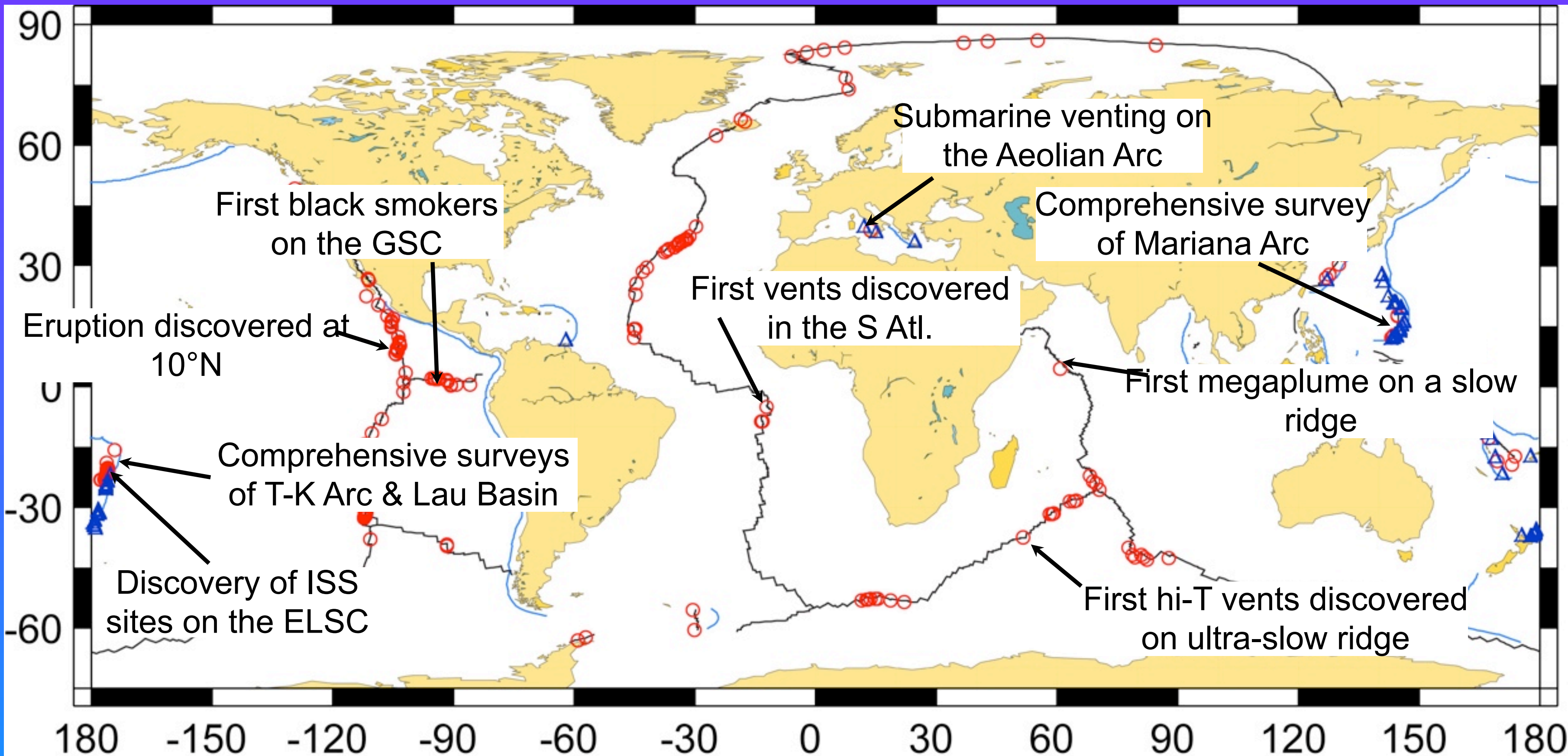


- U of Hawaii
- U of Rhode Island
- Lamont-Doherty Earth Obs.
- WHOI
- Brown Univ
- U California Santa Barbara
- Scripps Inst Oceanography
- U South Carolina
- Duke
- U Texas
- U Washington
- NSF FUNDING

- IFM-GEOMARl, Germany
- Univ of Kiel, Germany
- University of Bremen, Germany
- National Oceanography Centre, UK
- Durham University, UK
- Peking Univ, China
- 2nd Inst. of Oceanography, Hangzhou, China
- Australian National Univ.
- CSIRO, Australia
- National Institute of Oceanography, India
- GSN Science, NZ
- Inst. Nazionale di Geofisica e Vulcanologia, Italy
- Inst. per l'Ambiente Marino Costiero, Italy
- AIST Tsukuba, Japan
- Nautilus Minerals Inc, Canada

International and national collaborations since 2004

Global exploration



○ Midocean ridge vent sites = 280 [136 (48%) involved NOAA/VENTS]

Recent highlights, 2004-2008

△ Arc vent sites = 65 [39 (60%) involved NOAA/VENTS]

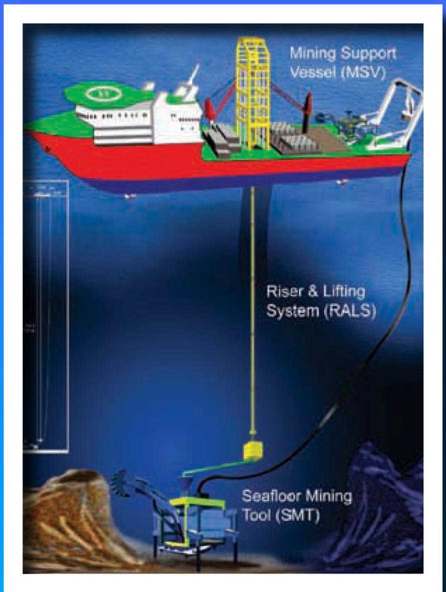
Global resources & stewardship

Discover and analyze the potential of marine natural products for biomedical and commercial applications.

from the Ecosystem Mission Res. Plan

- Biomedical and chemical engineering products from chemosynthetic ecosystems.

2010, offshore PNG



- High value metals (Au, Ag, Cu) mined from inactive hydrothermal deposits.

We provide <u>information</u> for <u>informed</u> decisions.

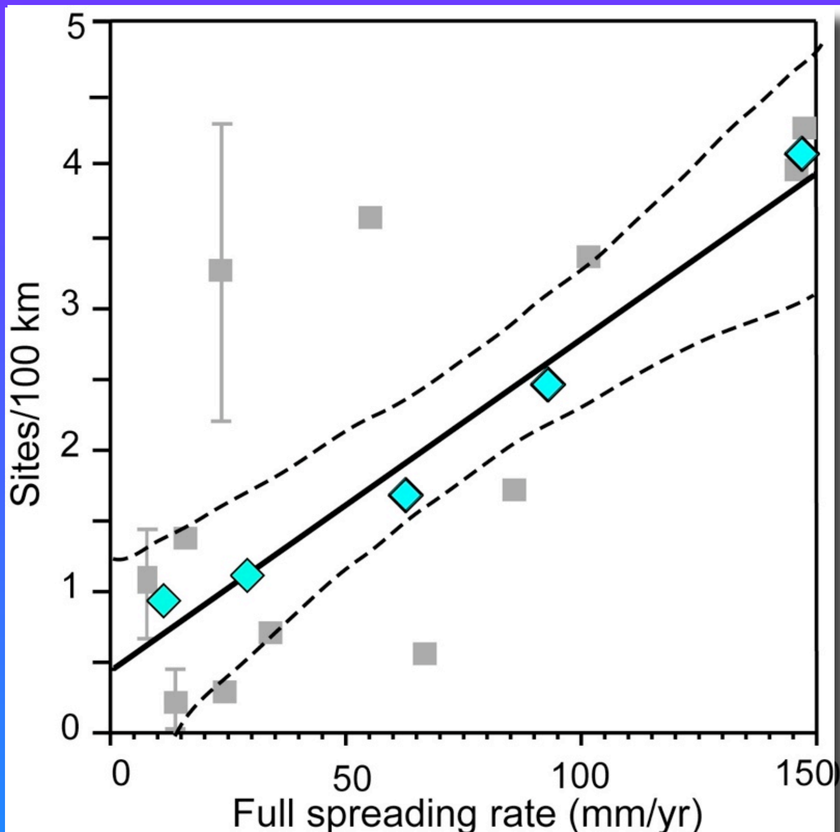
Using exploration data to quantify hydrothermal processes

- Global inventory and spatial distribution
  Biogeographic and mineral distributions

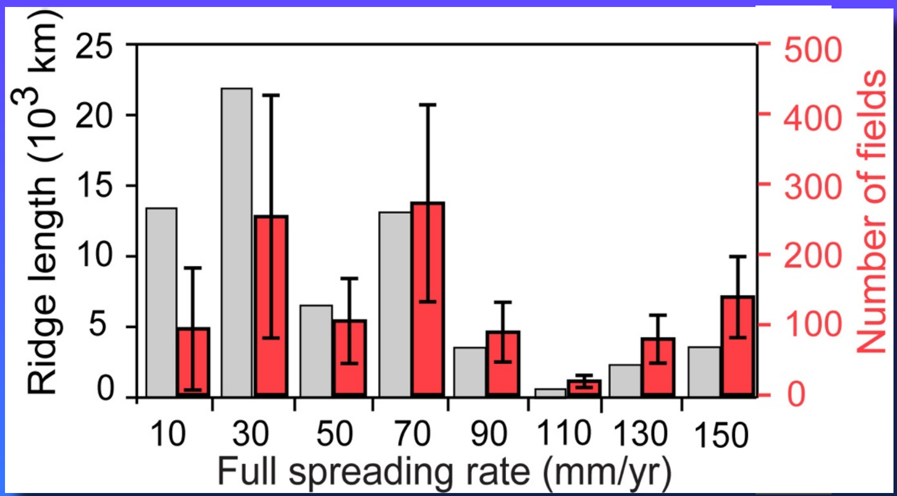
- Thermal and chemical fluxes
  Ecosystem production and mineral deposition

- Temporal variability
  Ecological diversity and mineral accumulation

Global inventory prediction



Baker and German, 2004



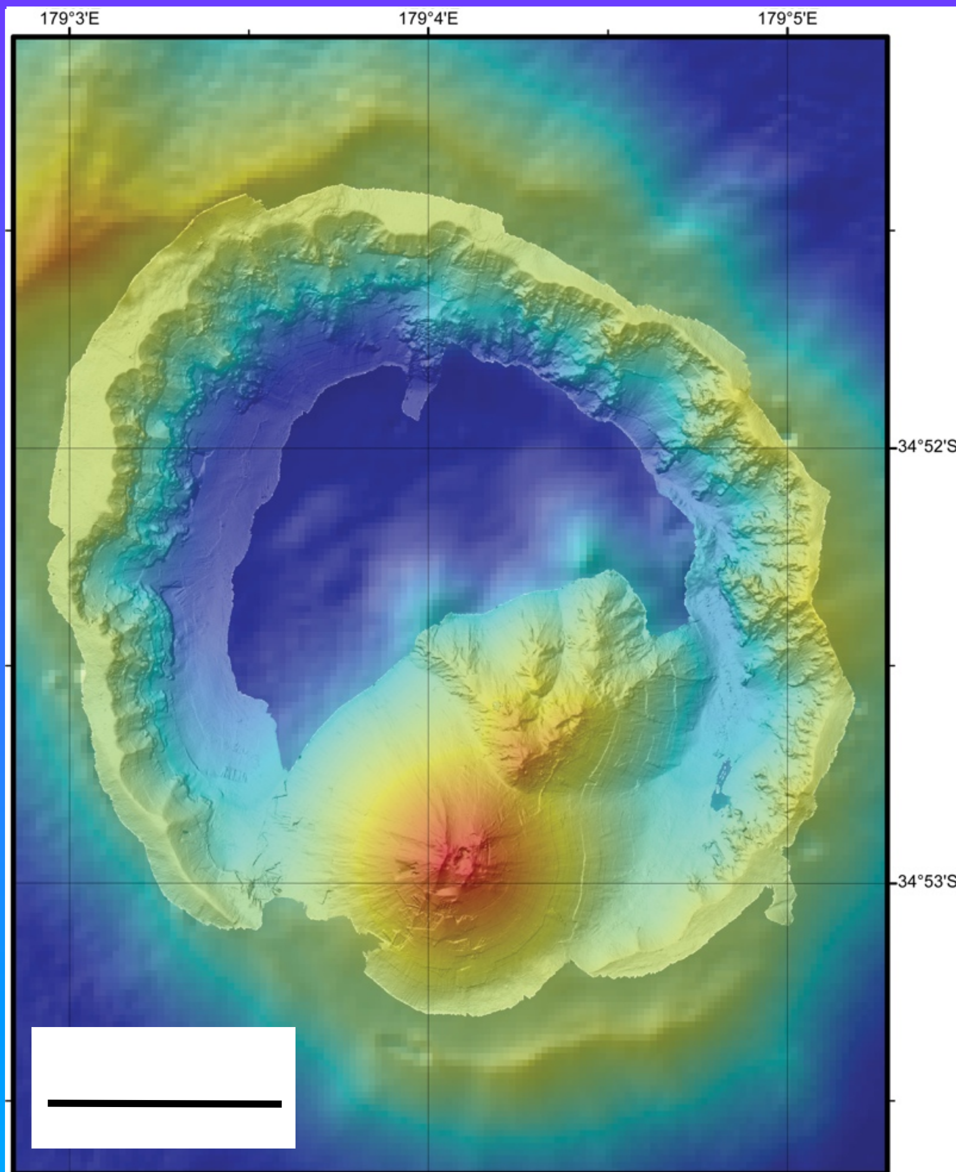
Baker and German, 2004

$\sum = 1049$ (95% CI=937-1167)

Total with arcs ~1300 active chemosynthetic sites

only ~160 so far observed or sampled

Thermal and chemical fluxes



Brothers Volcano, 2007

Kermadec arc

Autonomous Benthic Explorer (ABE)

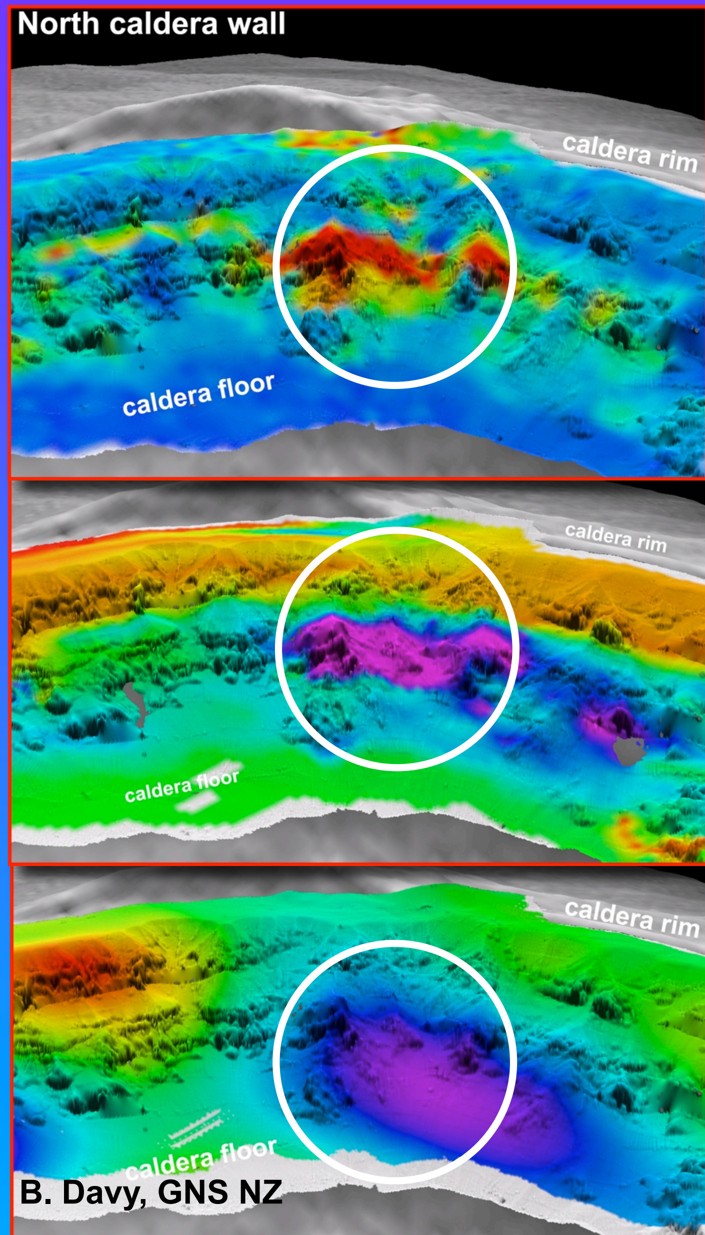
ABE tracks

Thermal and chemical fluxes

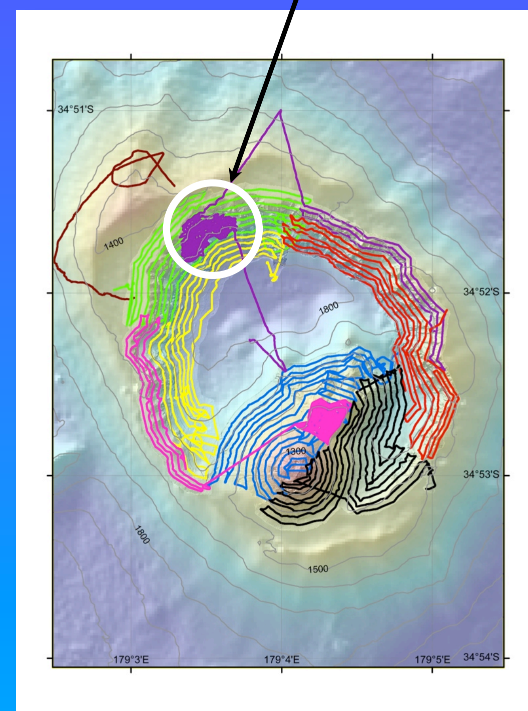
ΔT
High = hydrothermal discharge

ORP
Low = increased reduced chemicals (H_2S, Fe^{+2})

Magnetics
Low = active or inactive discharge sites

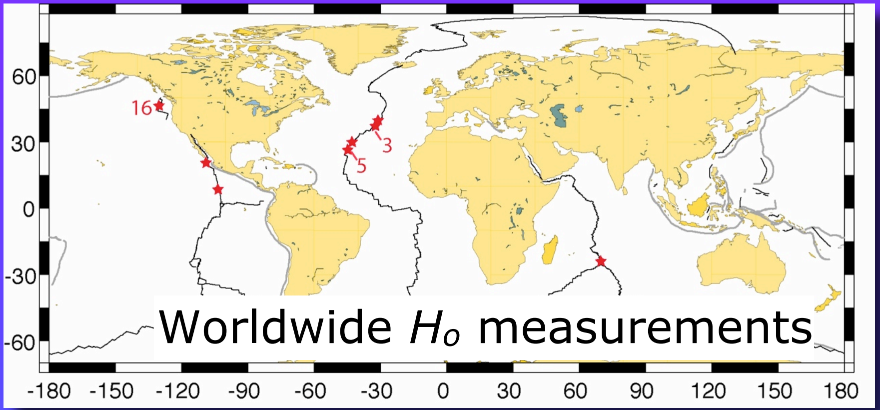


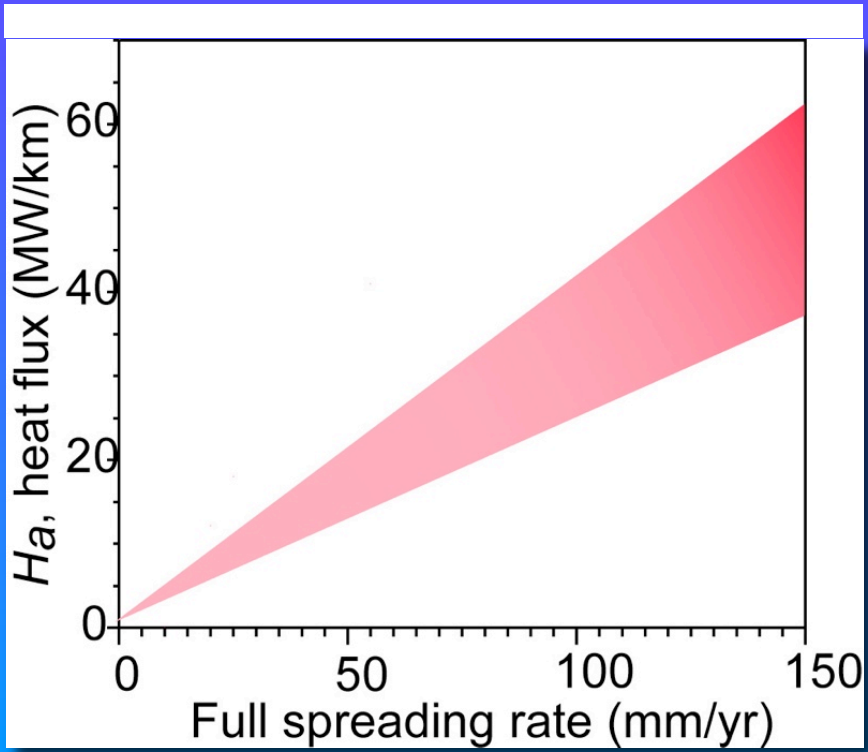
High-T vents



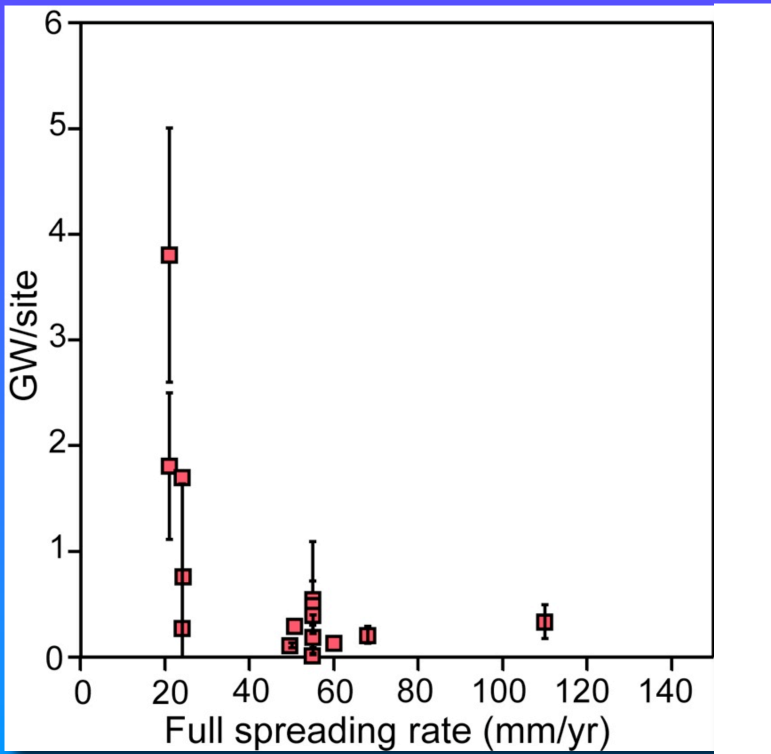
Temporal variability

How continuous
is vent field discharge?





Heat available: H_a



Heat output: H_o

Temporal variability

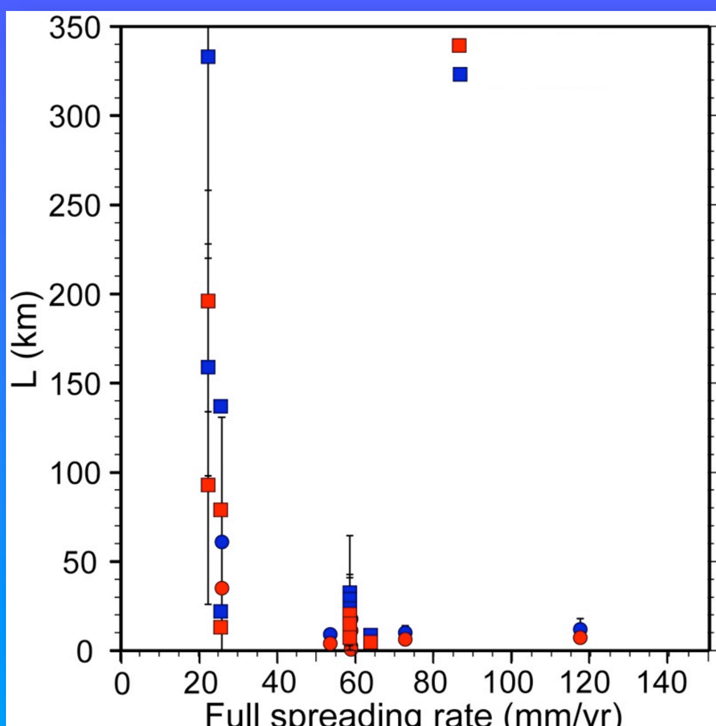
For steady discharge,

$$\frac{\text{Heat output } (H_o)}{\text{Heat available } (H_a \bullet L)} = 1$$

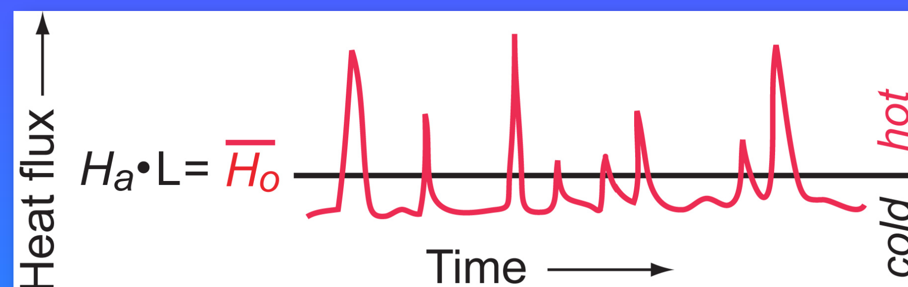
$\frac{H_o}{H_a}$ = L = axial cooling length for *steady* discharge

$\frac{2000 \text{ MW}}{(10 \text{ MW/km})(200 \text{ km})}$

100 MW



Baker, 2007



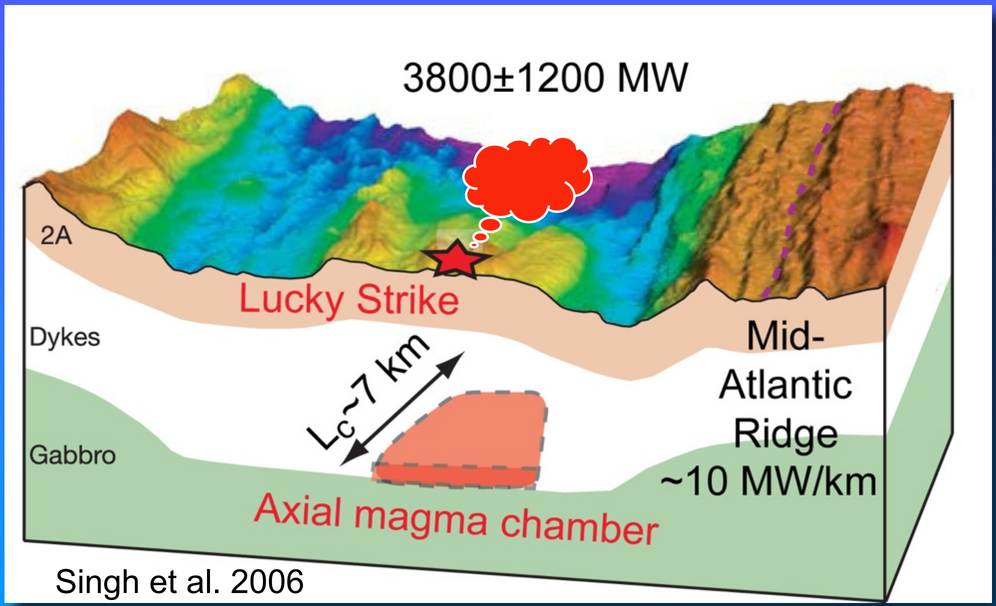
if L_c (true cooling length) is known

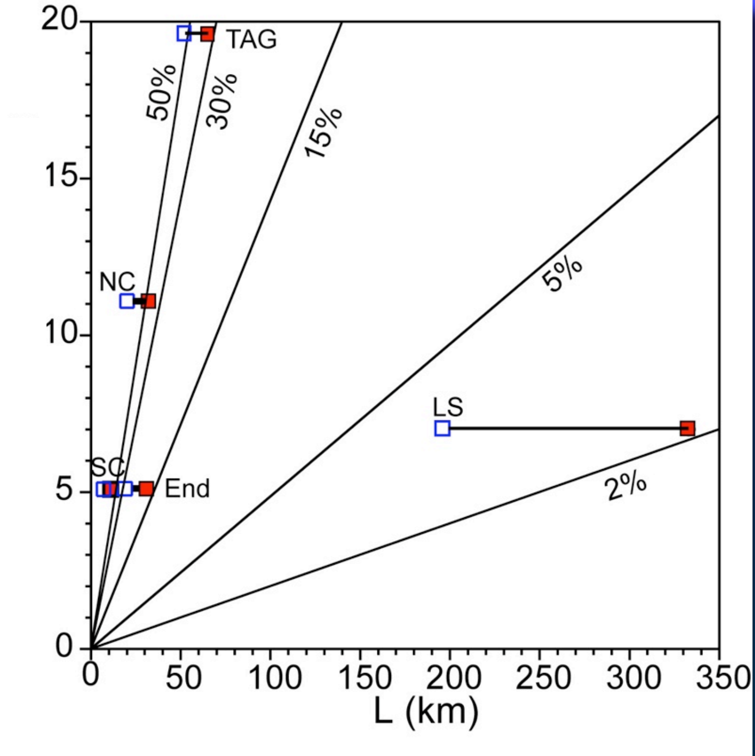
then, duty cycle = $[\frac{L_c}{L}]$x 100

Temporal variability: punctuated cooling

$$\left[\frac{L_c}{L}\right] \times 100 = \text{duty cycle}$$

$$\left[\frac{7\ \text{km}}{333\text{-}196\ \text{km}}\right] \times 100 = 2\text{-}4\%$$





Future Directions

Quantify processes:

- *Employ or develop new technologies (AUVs, solid-state chemical sensors).*

Temporal variability:

- *Establish seafloor observatories.*
- *Expand acoustic monitoring networks.*