The German Perspective

Achim Kopf Wolfgang Bach, Matt Ikari, Simone Kasemann, Tomas Feseker, Katrin Huhn

marum Univ. Bremen

Kaj Hoernle, Jens Greinert, Sven Petersen, Volker Liebetrau, Anton Eisenhauer, Tina Treude, Reinhard Werner, Matthias Haeckel, Stefan Krause, Andy Dale

GEOMAR

with numerous collaborators from NZ (and elsewhere)

The German Perspective

various cruises with RV Sonne and the MARUM seafloor drill MeBo, plus other opportunities

(i) MeBo capabilities

(ii) SONNE Research cruises

Cruise 1: Andrea Koschinsky, Wolfgang Bach hydrothermal Fe / Kermadec

Cruise 2: Kaj Hoernle et al. hydrothermal activity Colville-Kermadec ridge

B

Cruise 3: Karsten Gohl, Kaj Hoernle E' Chatham Rise tectonic evolution

Cruise 4: Katrin Huhn et al. Slope instability / GH processes, Hikurangi margin

Cruise 5: Achim Kopf, Jens Greinert link hydrogeology and seismicity / Hikurangi margin

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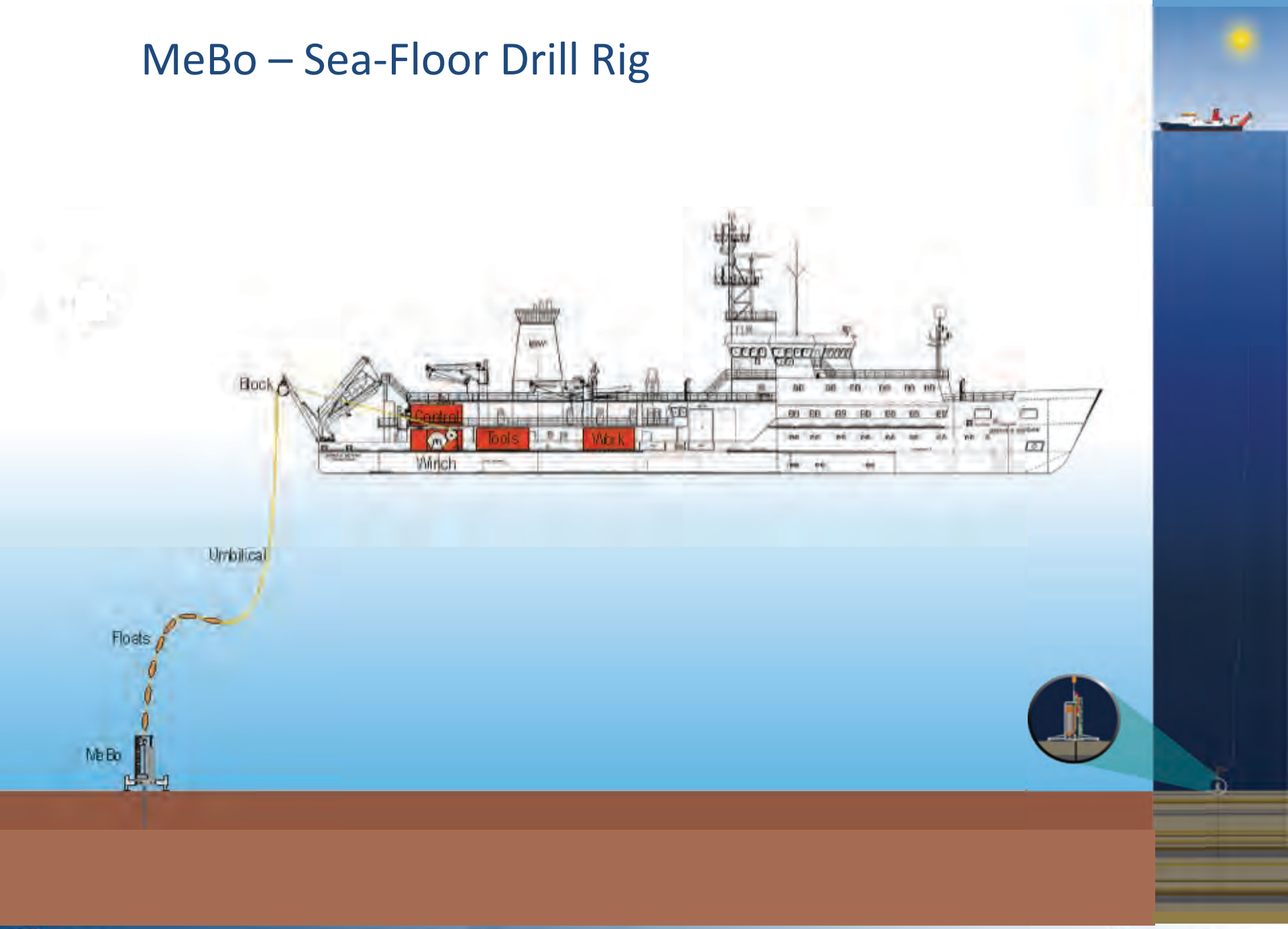
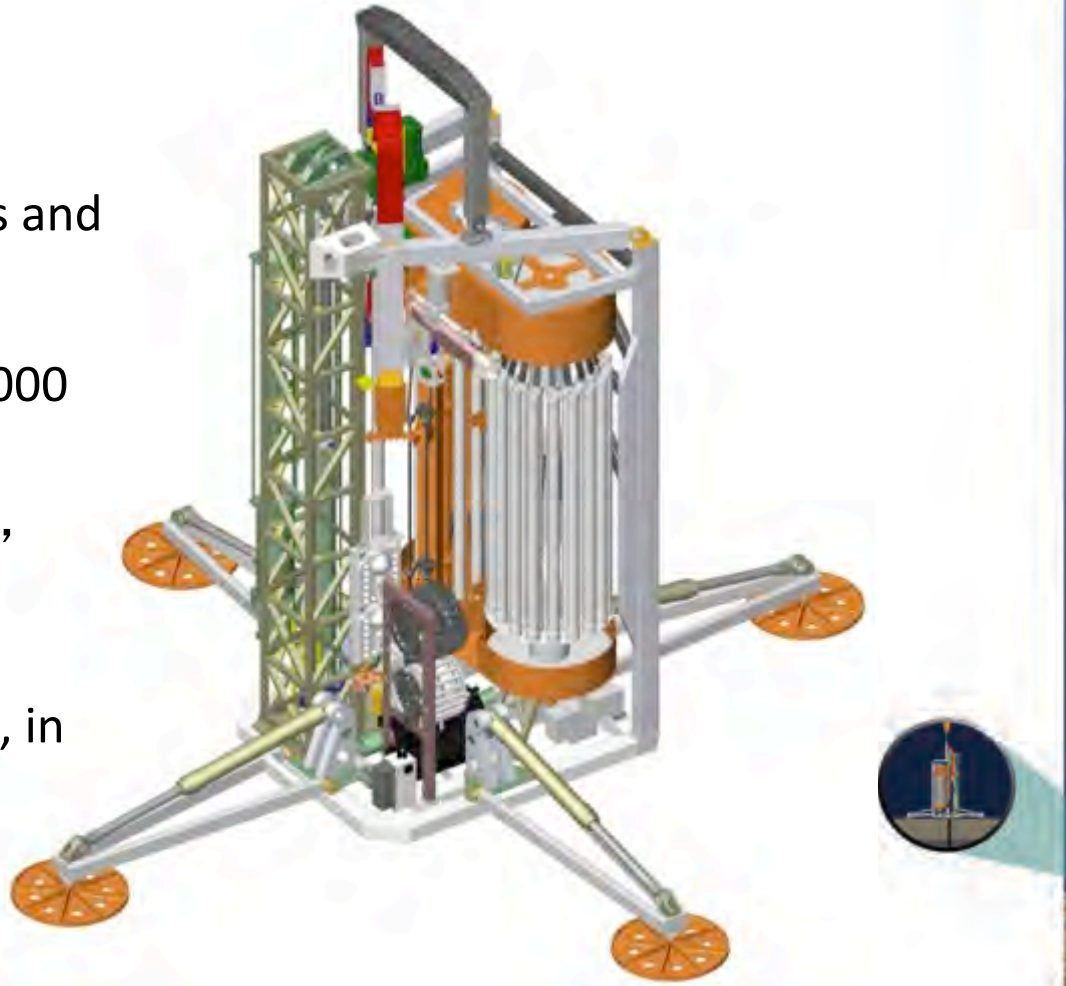
MeBo – Sea-Floor Drill Rig



MeBo 1 – Sea-Floor Drill Rig

- 70 m drilling depth
- Coring of soft sediments and hard rocks
- Deployment depth to 2000 m water depth
- Mobile transport, six 20’ containers
- Capability of DH logging, in situ T, autoclave coring, long-term instruments

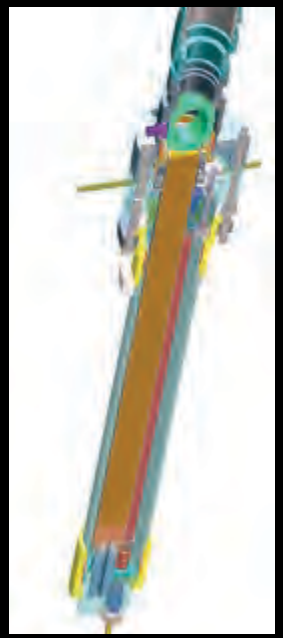



376.57
9.88
-1141.70
1847.24
-1097.73
52.5
54.8
Eve... Sun Jun 17 02:19:22 20
300 mm/min
7 Minuten pro Bohrung

MeBo payload

Self-contained GR logging tool exists

in situ T probes to be mounted to a MeBo core barrel (based on MTL)



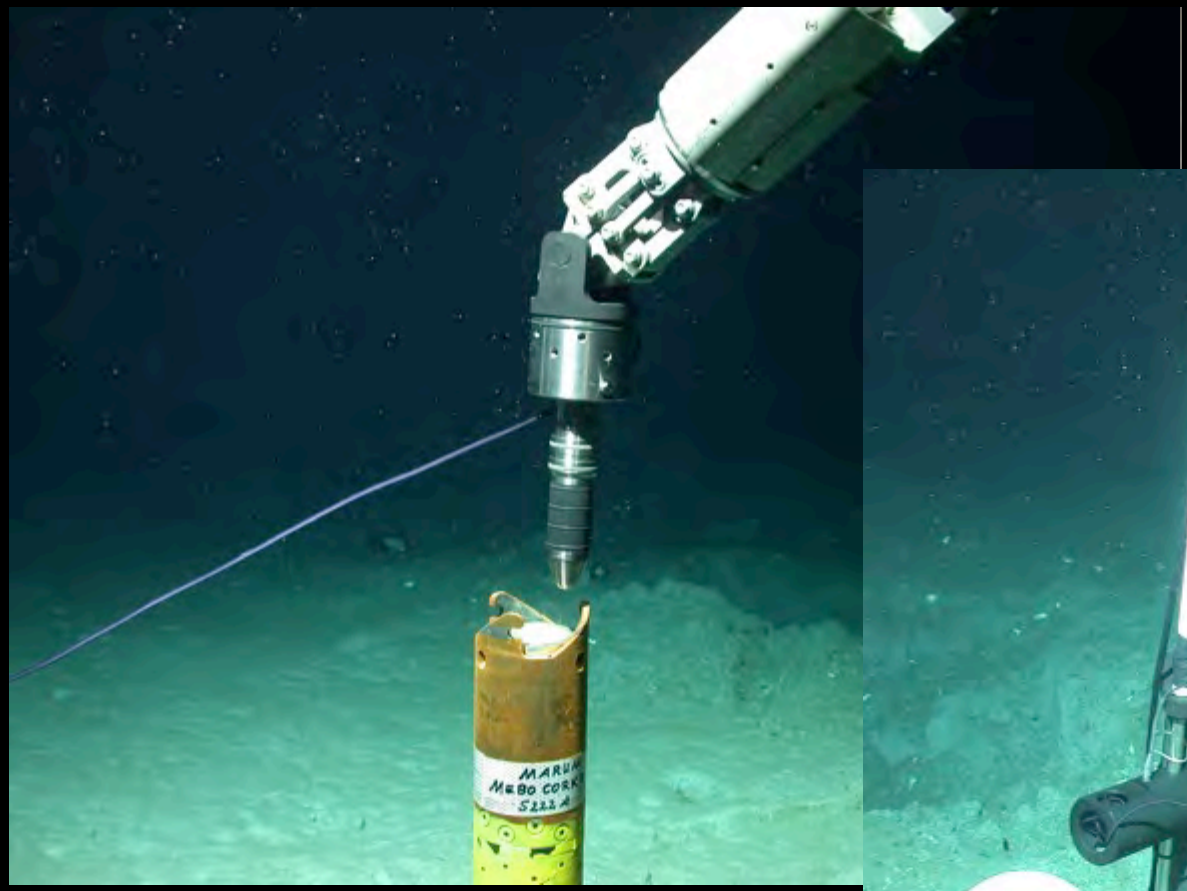
Autoclave coring chambers for GH research, etc. exist for MeBo

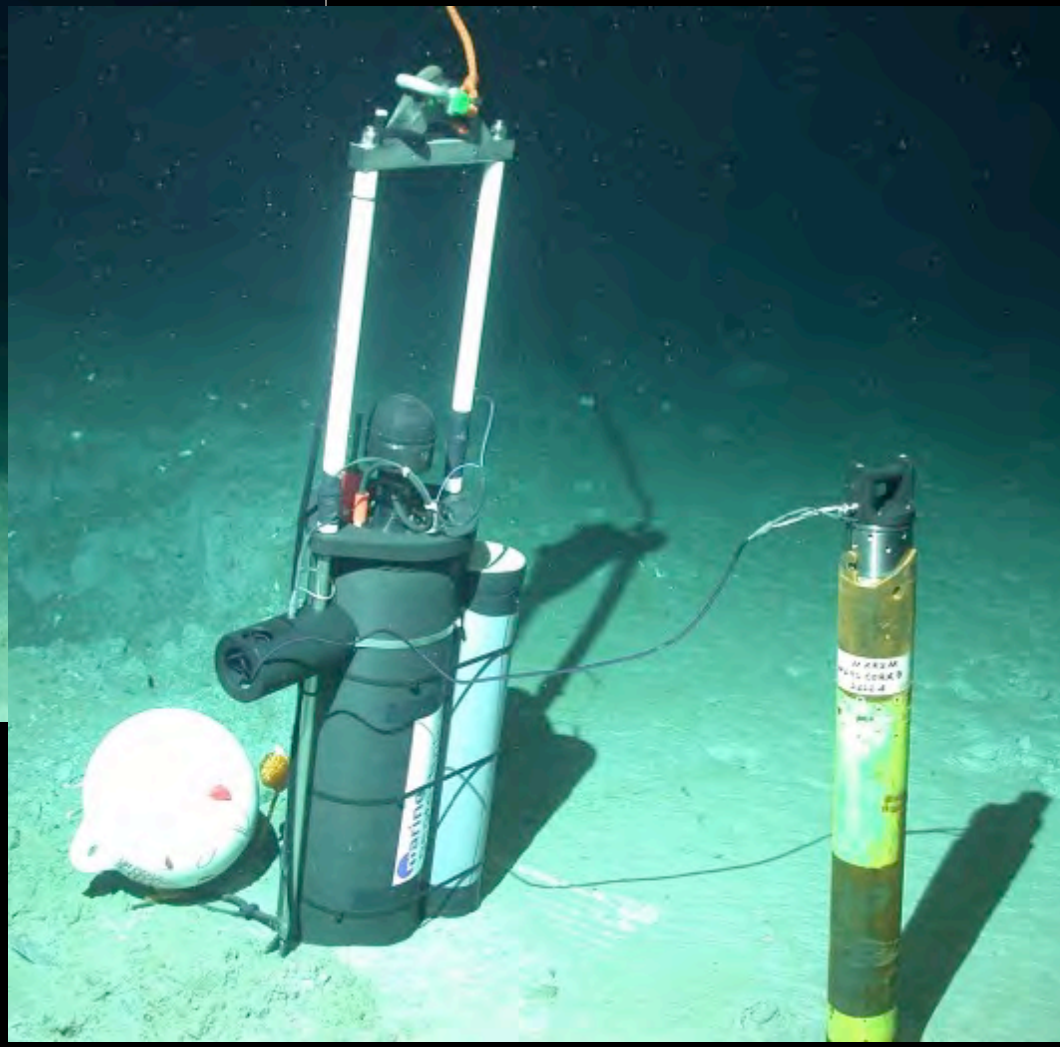
MeBo Plugs & CORKs

- monitor P and T w/ time
- send data via acoustic modem
- extract fluids via osmo-samplers, run biol. experiments

MeBo CORK A

acoustic modem
data logger
and transducers
batteries
needle w/ drop
weight containing
coiled tubing





MeBo-CORK B

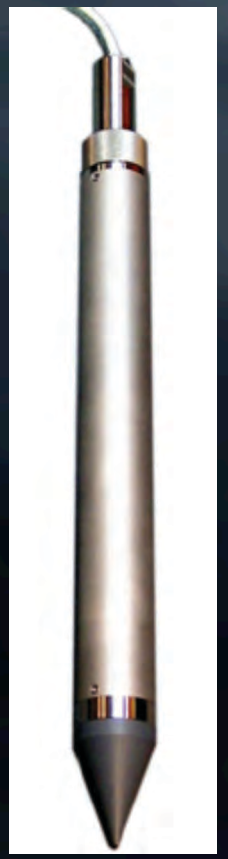
- monitor P and T w/ time
- send data via acoustic modem
- extract fluids via osmo-samplers, run biol. experiments

MeBo seafloor drill

MeBo1 is a powerful tool for non-IODP scientific drilling

- no drillship needed, just regular-size R/V
- payload of MeBo1 is to be increased, e.g.
Broadband seismometer for MeBo holes being tested

- **MeBo 2** with larger capabilities is being built now
(200 mbsf, 4000 m WD)



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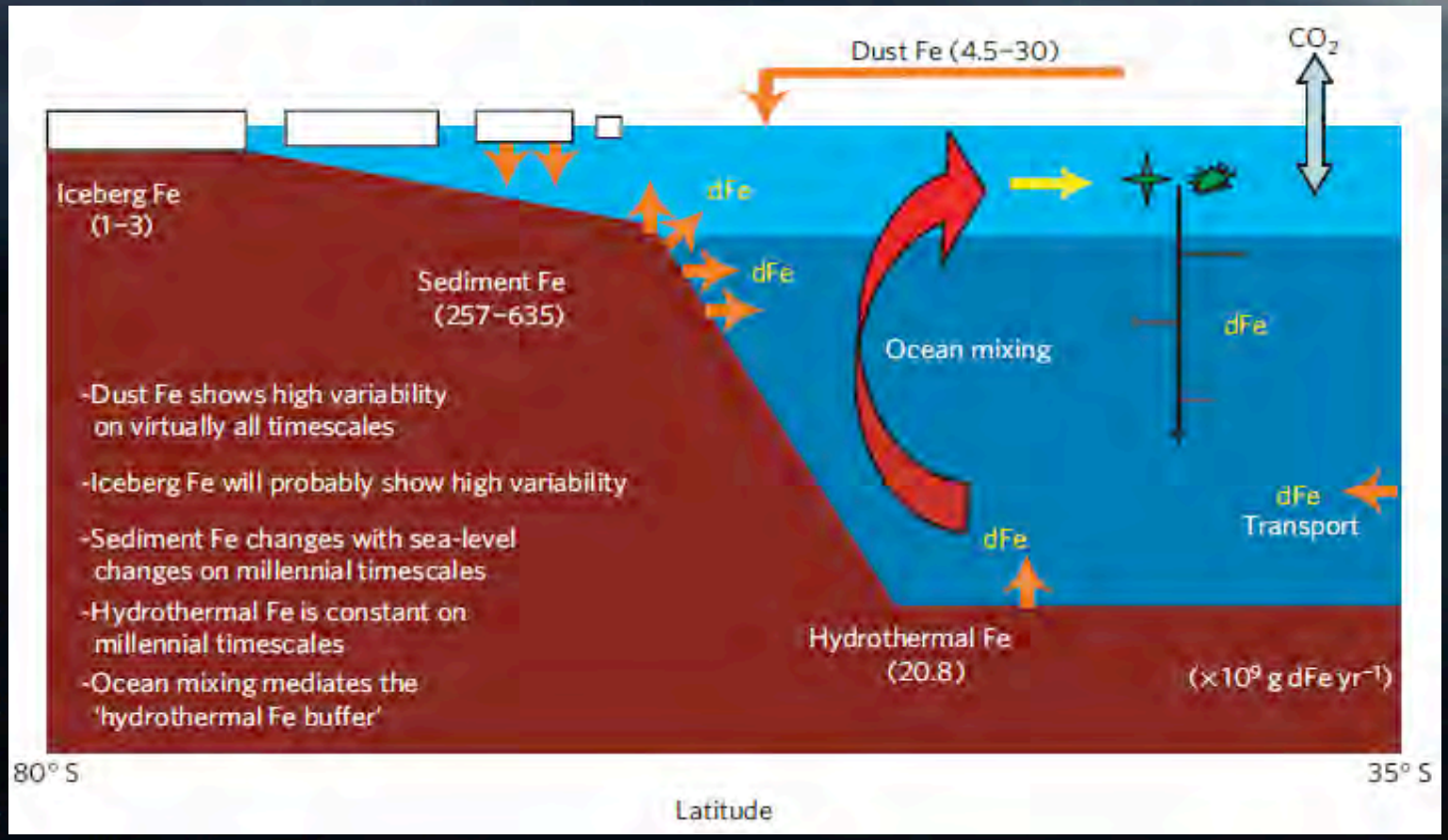
Hydrothermal vent research in the Kermadec Arc



Hydrothermal metal fluxes to the ocean:
How important are they for biogeochemical cycles?

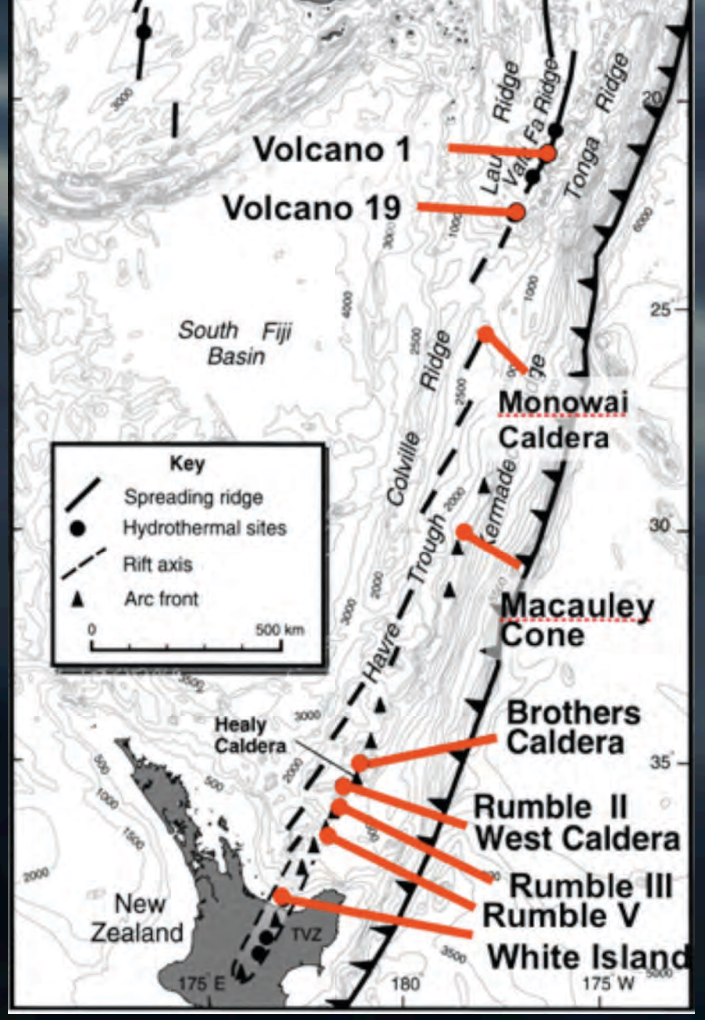
Cruise 1: Andrea Koschinsky, Wolfgang Bach

Overall goals

- The fate of hydrothermal Fe in the water column and implications for bioproductivity and carbon cycling in the oceans

- Relationship between volcanic, hydrothermal, and biological processes

- Regional symbiosis biogeography and global biogeography of vents *(e.g. genetic data suggest that symbiotic bathymodiolin mussels have their phylogenetic origin in NZ from where they have spread worldwide over vent, seep, wood fall and whale fall habitats)*



Cruise 2: Proposal to survey the Colville-Kermadec ridges and the Havre Trough

Proponents: K. Hoernle, R. Werner, S. Petersen (GEOMAR, Germany)
International Partners: C. Timm, C. de Ronde (GNS, NZ); E. Todd (USGS); J. Gill (UCSC)

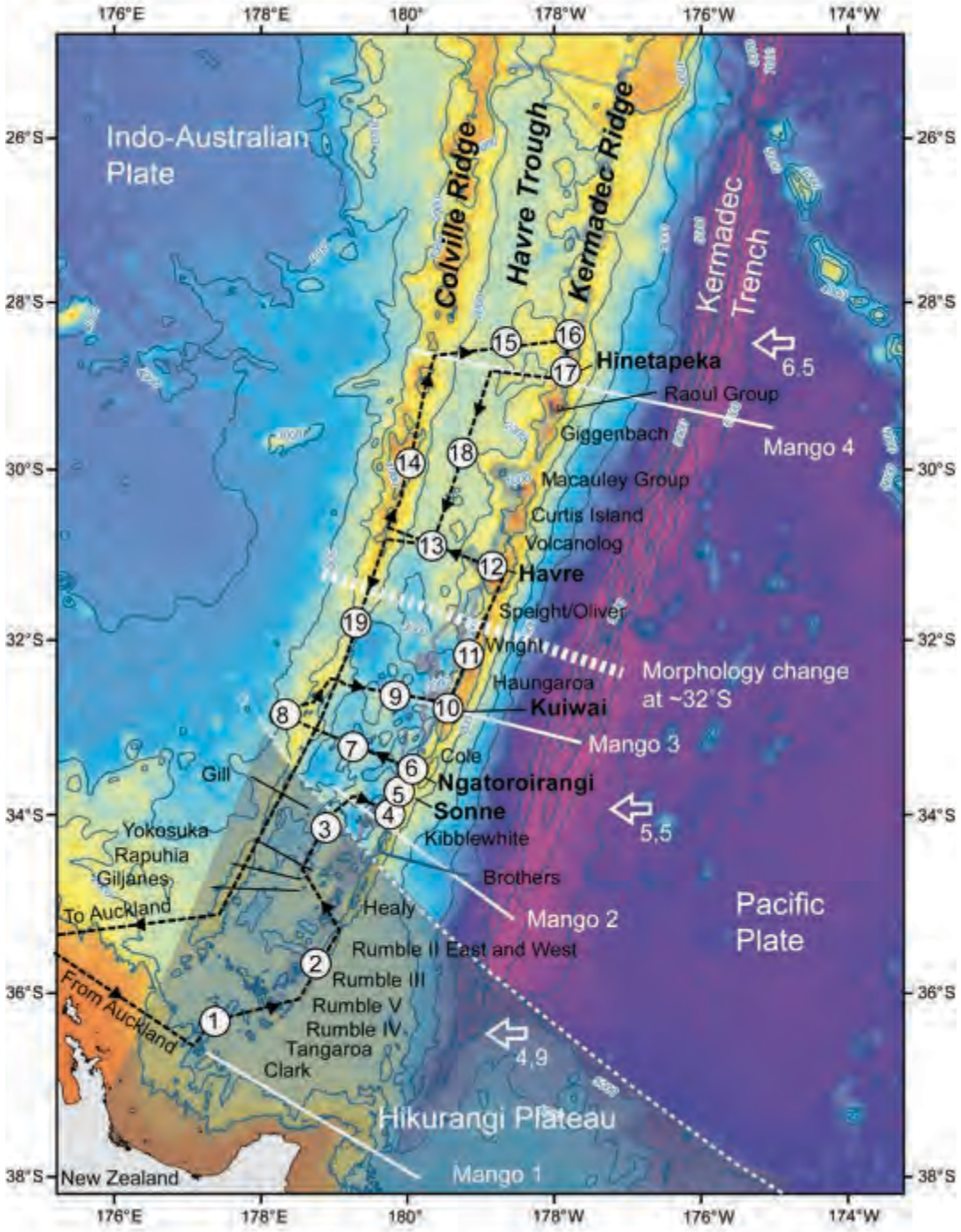
- Investigate the temporal and geochemical evolution of the Vitiaz-Kermadec arc using reconnaissance rock sampling, multi-beam mapping, magnetics and gravity,
- Look for ancient and recent hydrothermal activity along the Colville ridge, Havre Trough and selected arc volcanoes along the mid-Kermadec arc,
- Investigate the change in morphology at ~ 31˚-32˚S,
- Investigate the role of the subducting Hikurangi Plateau on melt genesis and hydrothermal activity.

GEOMAR Helmholtz-Zentrum für Ozeanforschung Kiel

GNS SCIENCE TE PŪ AO

USGS science for a changing world

UNIVERSITY OF CALIFORNIA SANTA CRUZ



Proposed cruise track

To accomplish the questions we plan to use:

- Rock dredges
- TV Grab
- AUV
- CTDO
- Multi-beam mapping
- Magnetometer
- Gravimeter

✧Combine new data with Mango OBS profiles

Planned analyses

- $^{40}Ar/^{39}Ar$, $^{210}Pb/^{226}Ra$ dating
- Major-trace (including volatiles) and isotope analysis (whole rock, glass, fluid inclusions)

Cruise 3: Karsten Gohl, Kaj Hoernle et al.

CHATHAM RISE: Compressional, extensional and breakup mechanisms of a submarine continental plateau

Proponents: K. Gohl (AWI, Germany), K. Hoernle, R. Werner (GEOMAR, Germany)
International Partners: B. Davy, N. Mortimer, A. Tulloch, C. Timm (GNS, NZ)

- Investigate processes of collision of Hikurangi Plateau with Chatham Rise
- Study of the crustal and lithospheric structures and magmatic processes of Eastern Chatham Rise to improve understanding of rifting and breakup from West Antarctica
- Analyze the nature and role of Wishbone Ridge as possible transform fault
- Study the origin of syn-rift volcanic rocks found along the estern margin

AWI
Alfred-Wegener-Institut
für Polar- und Meeresforschung
in der Helmholtz-Gemeinschaft

GEOMAR
Helmholtz-Zentrum für Ozeanforschung Kiel

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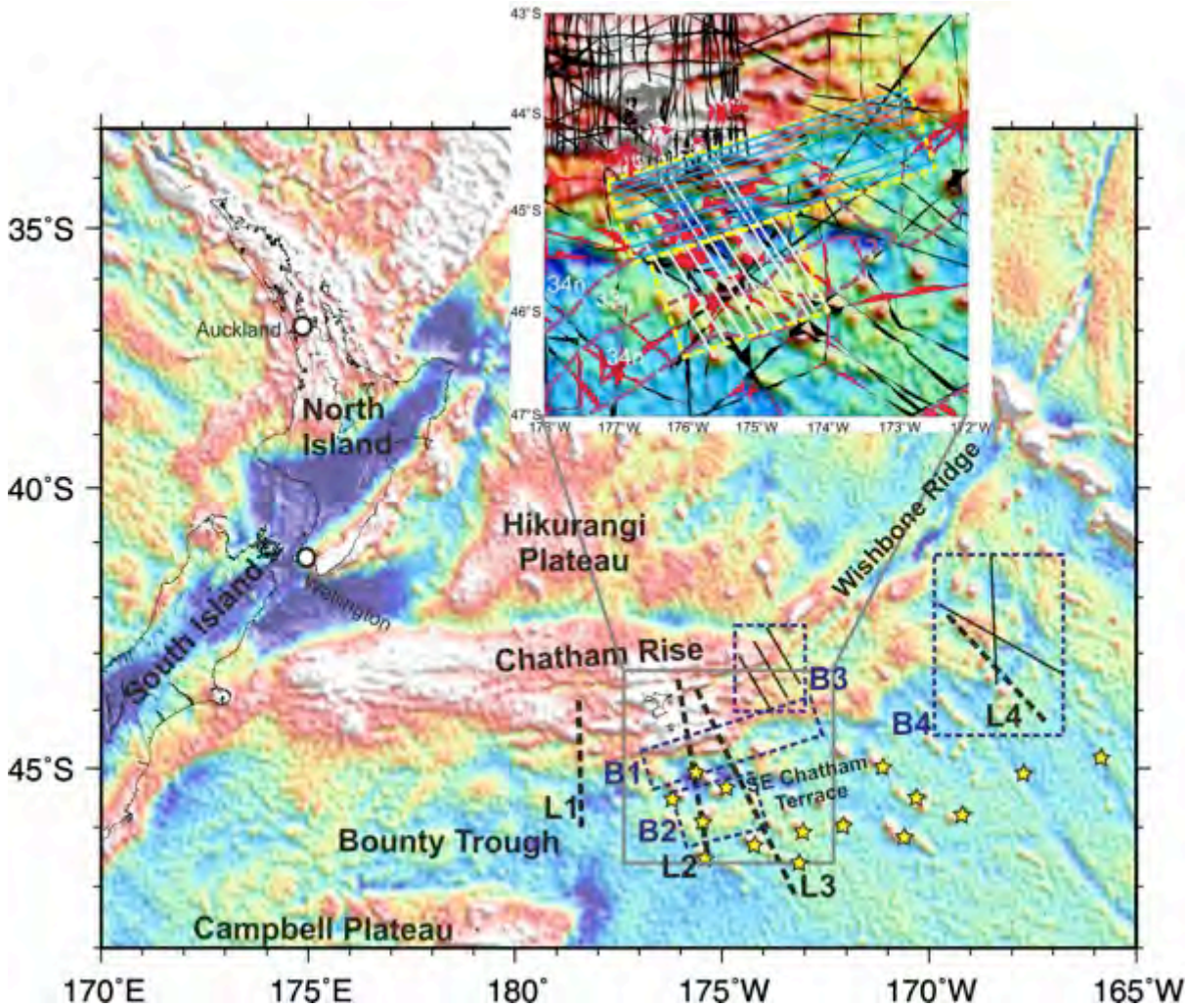
Areas of investigation



To address the objectives we plan to use:

- Seismic refraction (OBS)
- Seismic reflection
- Multibeam surveying
- Dredging
- Magnetometer
- Gravitymeter

Planned analyses

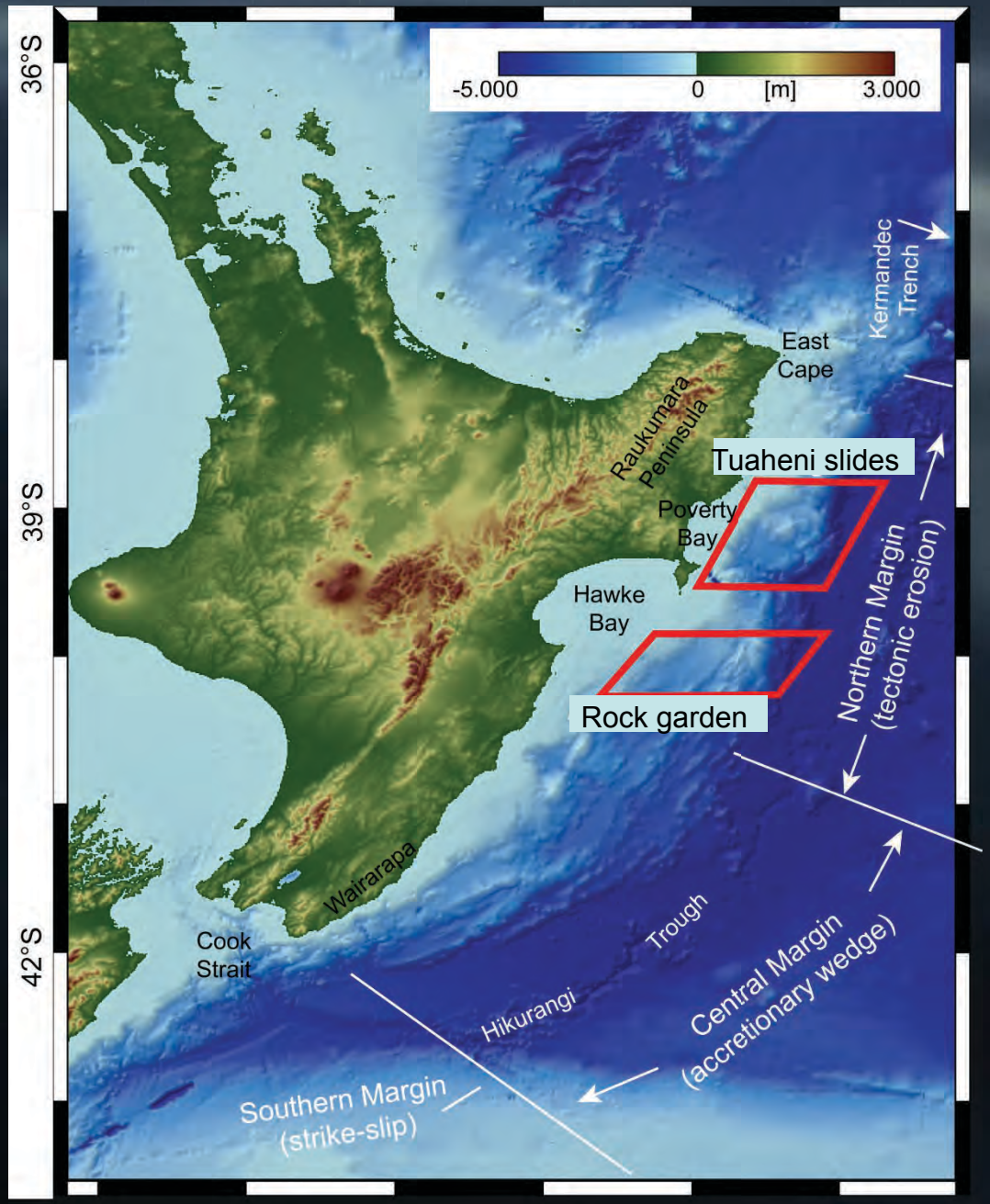
- Processing and inversion of seismic and potential field data for crustal structures, composition and evolution
  - $^{40}Ar/^{39}Ar$ dating
  - Major-trace (including volatiles) and isotope analysis (whole rock, glass, fluid inclusions)

Cruise 4: Katrin Huhn et al.

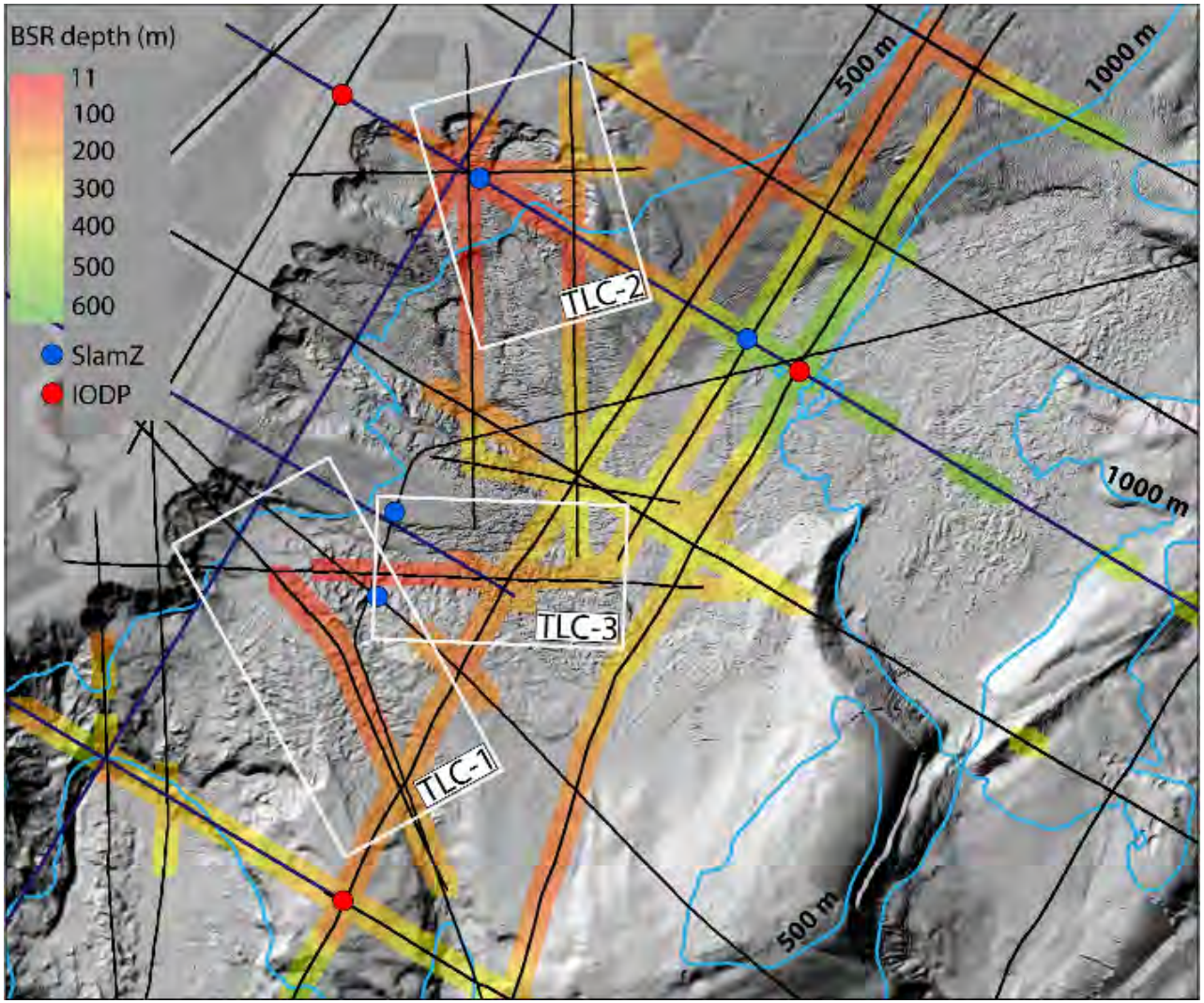
Drill two different gas hydrate bearing slide complexes in different tectonic settings with the MeBo drill rig along transects from the undisturbed slope apron, the headwall along the landslide body to its distal part of deposition

Focus on Tuaheni slides closer to the IODP transect, where creep and incipient deformation has been observed

Start monitoring activities?



•Tuaheni Slide transects

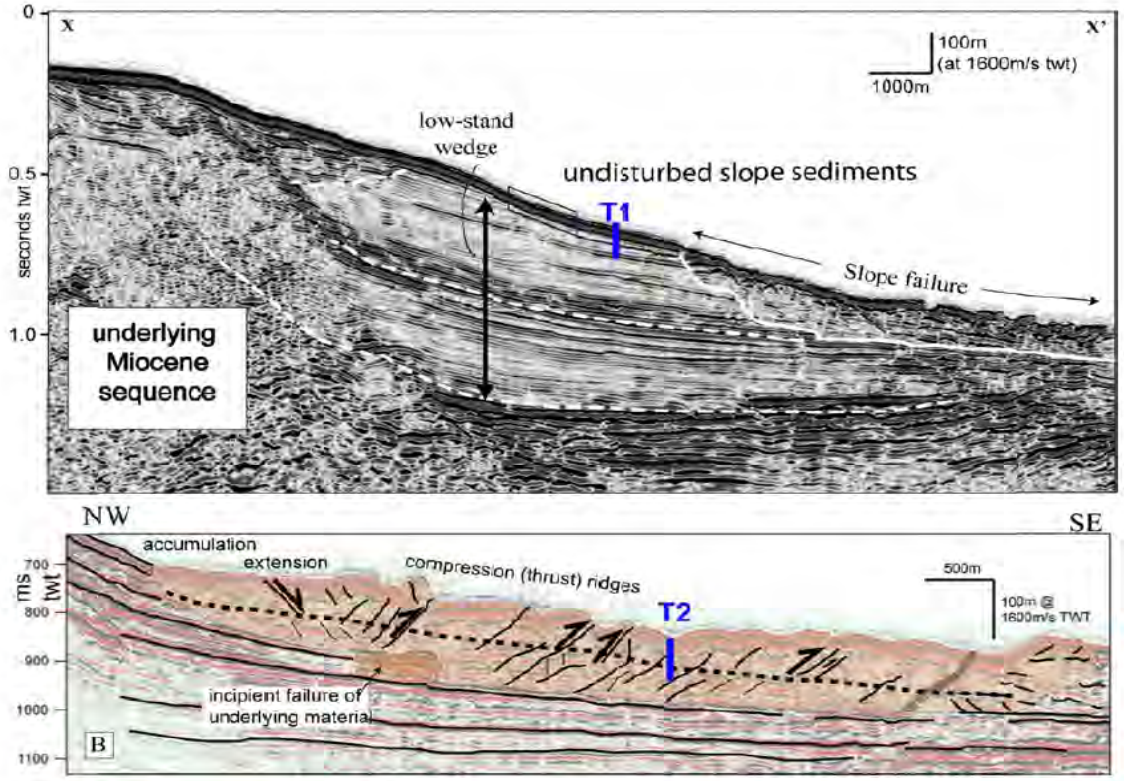


• postulated that this slide event occurred during sea level high stand

• potential trigger mechanisms:
-> earthquakes and/or
-> gas hydrate dissociation causing decrease in sediment strength

HF4,5: to test large number of outcropping faults with respect to their thermal efficient fluid transport potential
HF6 interrelations between slid masses small-scaled thermal heterogeneities

Tuaheni and Rock garden drill sites

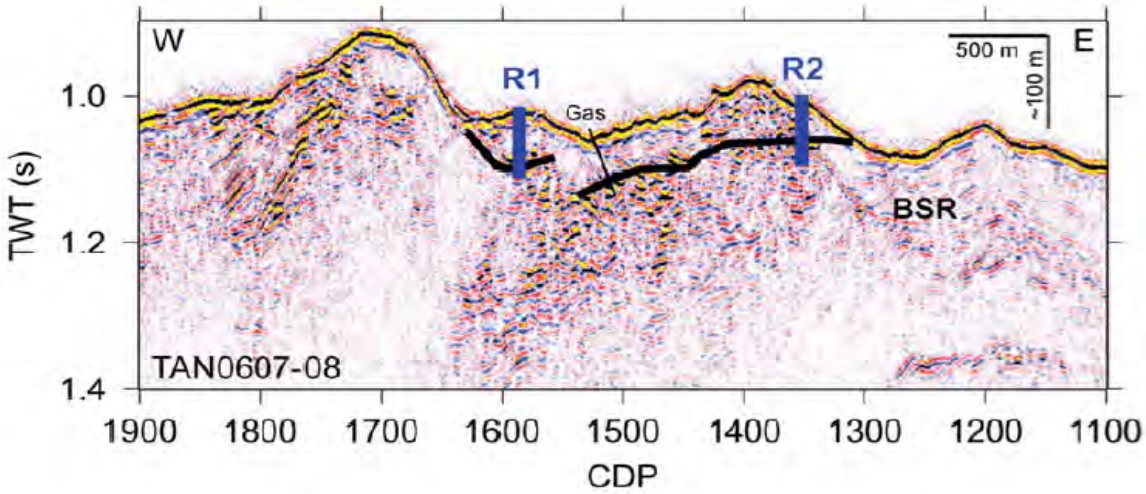


T1: reference site; undisturbed sediment representing accreted strate during sea level low stand

T2: slid masses; coring of a prominent reflector marking gas and/or gas hydrates

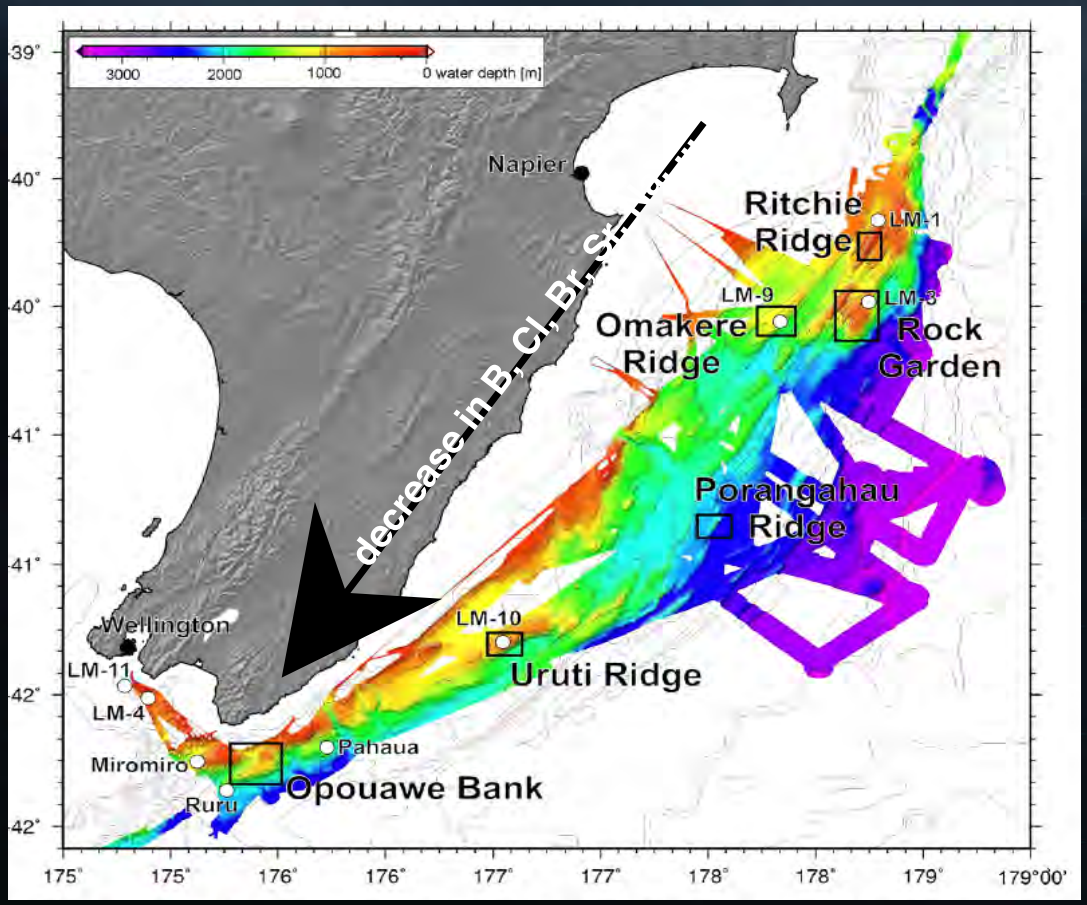
R1: base of gas hydrate stability zone at ~ 40mbsf;

R2: drill through slid mass and the glide plane of a small slide into the underlying undisturbed sediment



Cruise 5: Achim Kopf, Jens Greinert et al.

Sites of seepage and mud volcanism to link hydrogeology and seismicity (present and past)



Working areas with very good regional knowledge due to several earlier cruises

Focus sites:

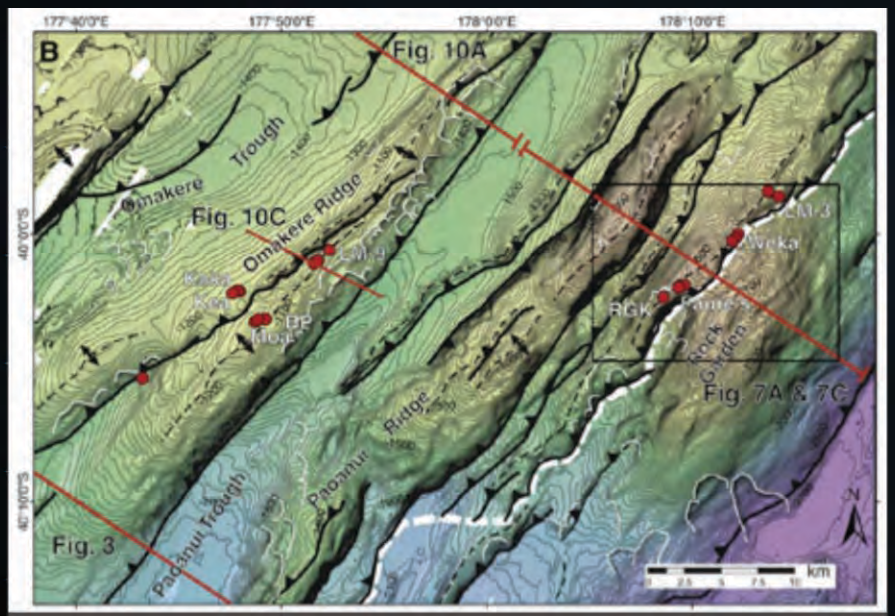
1) Omakere Ridge
2) Parangahau Ridge
3) Uruti Ridge
4) Opouawe Bank

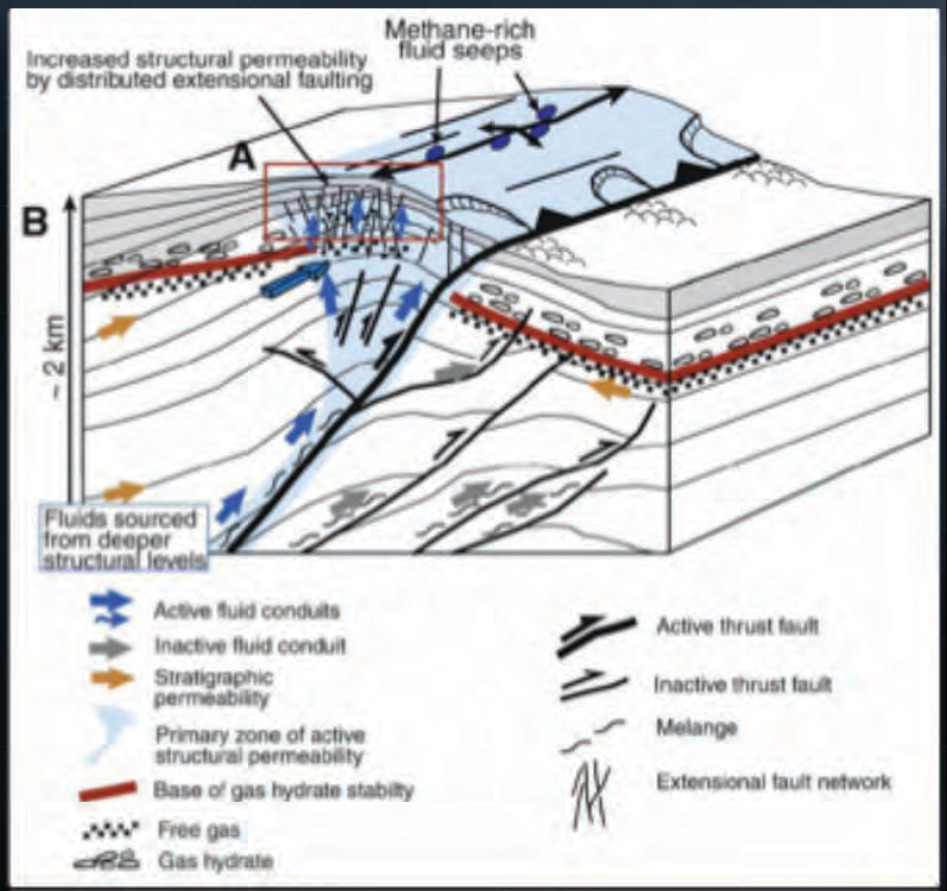
Fluid source reconstruction:

Where are they coming from?

Recover deep-seated fluids from seep locations without the chemical influence of surface-near biogeochemical processes

- Standard pore water geochemistry
- Hydrocarbon geochemistry & isotopic composition
- Various stable isotope systems (Sr, O, H, Li, Cl)
- Nobel gases





Paleo-seep activity reconstruction:

When have they been active?

Use MeBo to recover long cores from chemoherms at Uruti Ridge (LM-10), Opouawe Bank (Tui), Omakere Ridge (Moa, Bear's Paw)

- Mineralogic and petrographic characterisation of carbonat phases
- Stable isotope studies
- Dating to identify periods of increased precipitation
- Biomarker studies
- Primary dolomite?

Seafloor paved with massive carbonate slabs at Uruti Ridge (left) and coral overgrowth of an old chemoherm complex at Omakere Ridge (right); from Liebetrau et al., 2010

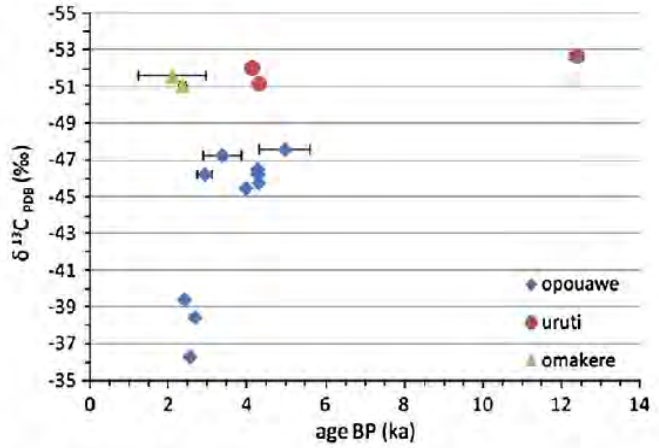
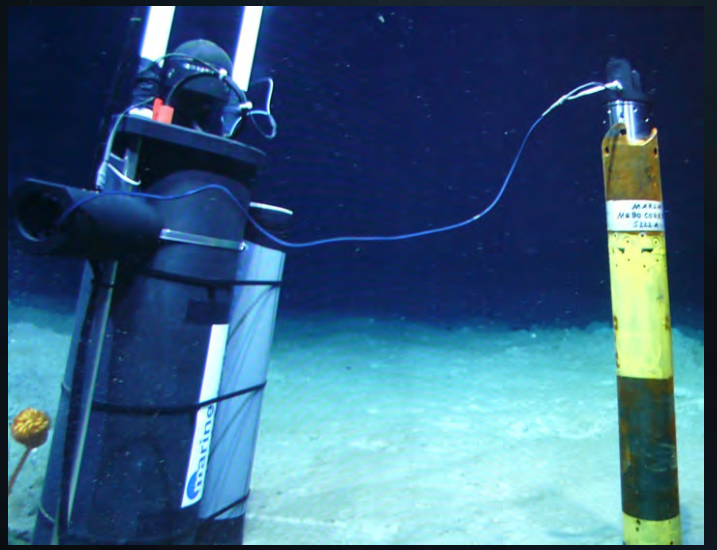


Fig. 3. $\delta^{13}C_{PDB}$ (‰) and U–Th ages in thousand years before present (ka BP) from three different cold seep areas of the Hikurangi Margin (Opouawe Bank = diamonds, Uruti Ridge = dots, Omakere Ridge = triangles).

Monitor fluid flow activity:
Is there a connection between transient changes in fluid flow and long-term pressure and temperature records and local seismicity?

- Install several MeBo CORKs along strike, ideally with acoustic data link (e.g. in cooperation with NIWA for data retrieval during the duration of monitoring)
- Is fluid flow linked to seismic activity, i.e. are fluid flow activity/pore pressure transients useful as earthquake precursors?
- develop Opouawe Bank as cabled deep sea observatory by installing a fibre optical cable from Cape Pallisar?



SUMMARY

- Several cruises coming with German RV Sonne, some already granted (landslides, Fe mineralisation, Chatham Rise), some in the proposal stage (Hikurangi seeps, Kermadec)
- MeBo drilling (and CORKING) feasible in some campaigns
- CORKs either as stand-alone systems (to be recovered in a second cruise appx 3 years later),or with acoustic modem (then cooperation with NIWA for data retrieval needed)
- Cabled observatories as a potential long-term goal, with fluid flow linked to seismic activity and slope failure, ideally to complement the IODP approach at Hikurangi and, more generally, to study earthquake precursors and SSEs

akopf@marum.de