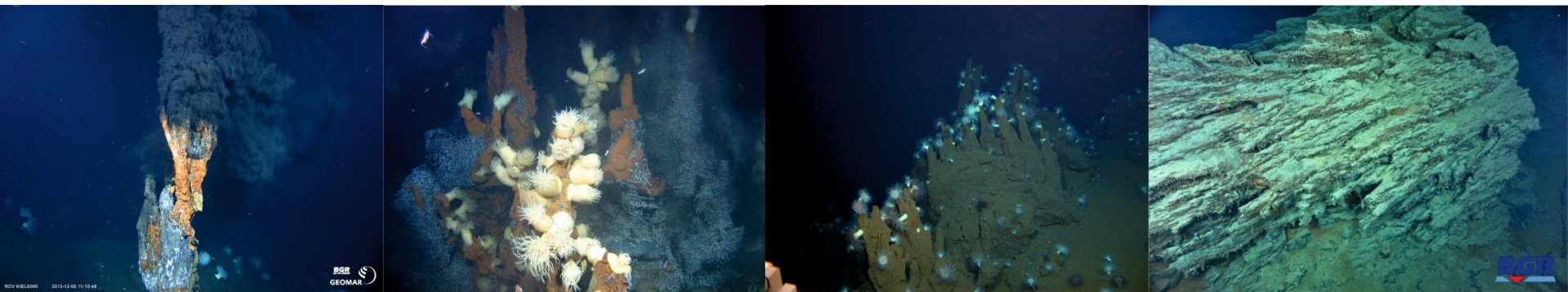
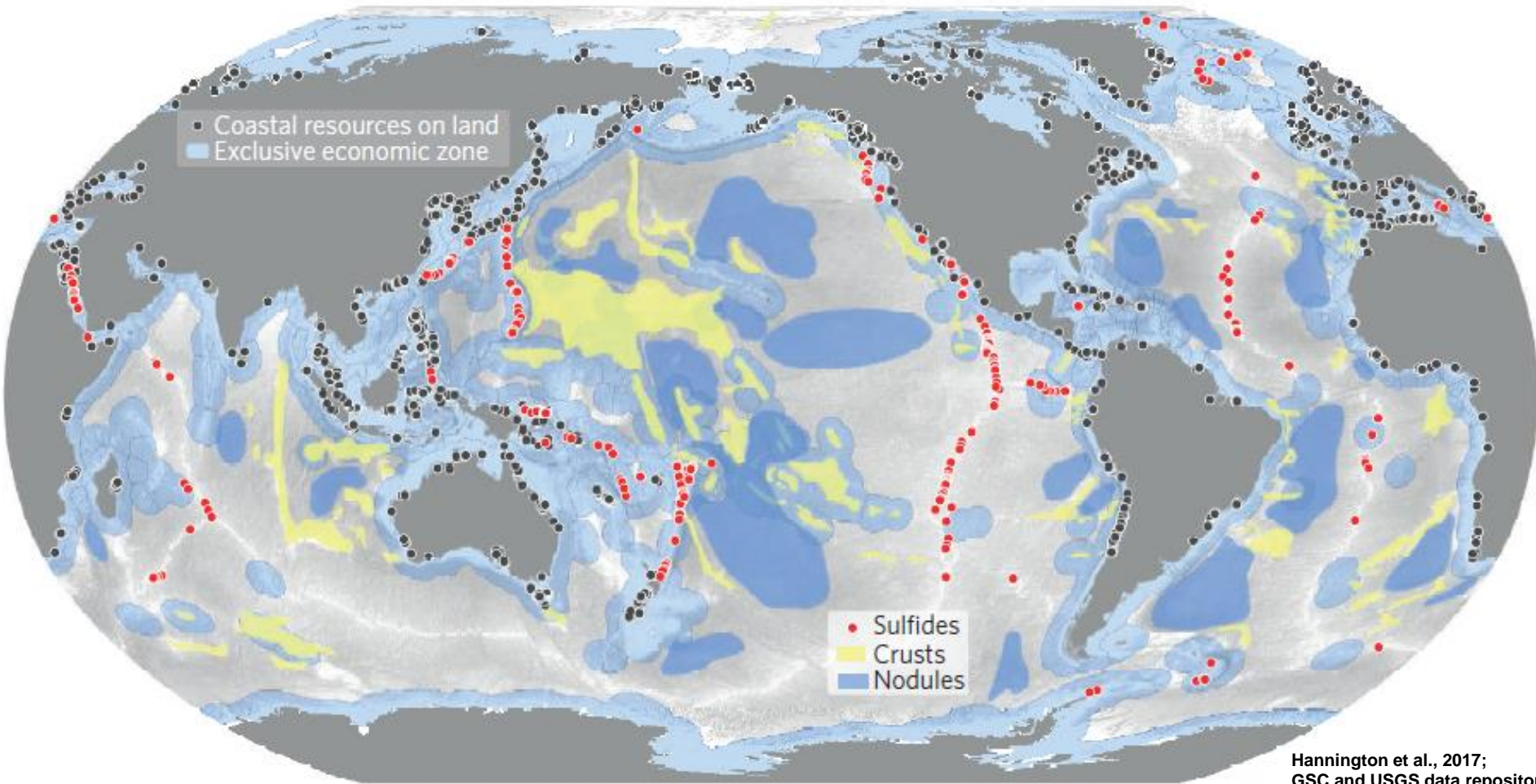




# Activities Under the German Exploration License for Massive Sulfides and Environmental Investigations in the Western Indian Ocean



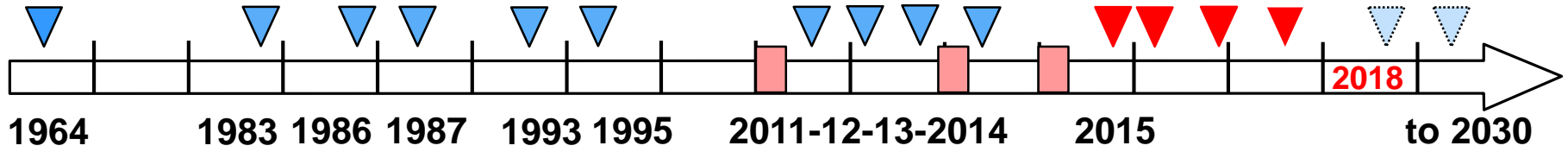
# Resource Continuum Land – Shore – Shelf – Sea



- Vast amounts of coastal and shelf resources
- Increasing resources on the seabed
- >1,700 ore deposits located <50km from the ocean coastline

# Exploration of Polymetallic Seafloor Massive Sulfides (SMS)

Exploration License in the Regulatory Framework of the International Seabed Authority



1st German research cruise to western Indian Ocean (IIOE)

GEMINO, HYDROTRUNC, HYDROCK research cruises to the CIR SO28, SO43, SO52, SO92, M33/2

Prospecting INDEX cruises CIR, SEIR

2015 Start of Exploration

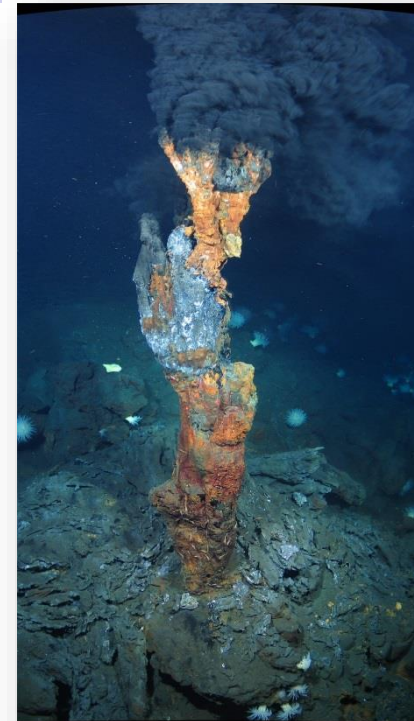
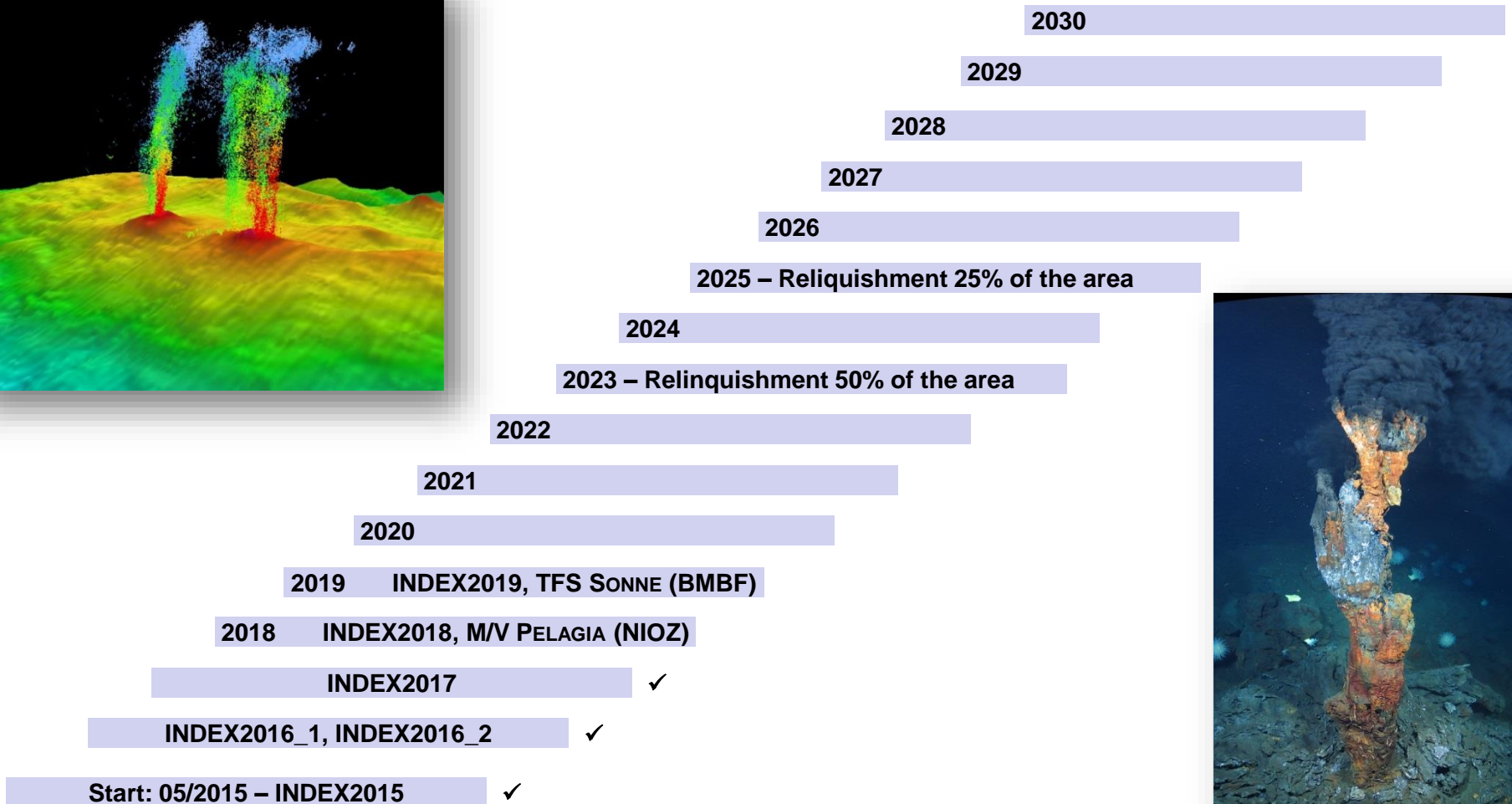
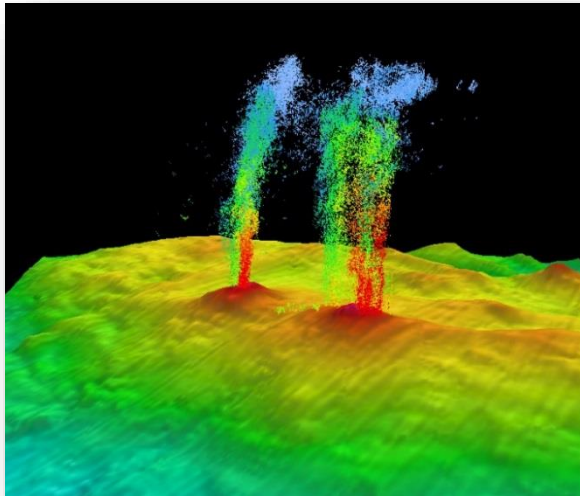


## INDEX Indian Ocean Exploration



# Exploration of Polymetallic Seafloor Massive Sulfides (SMS)

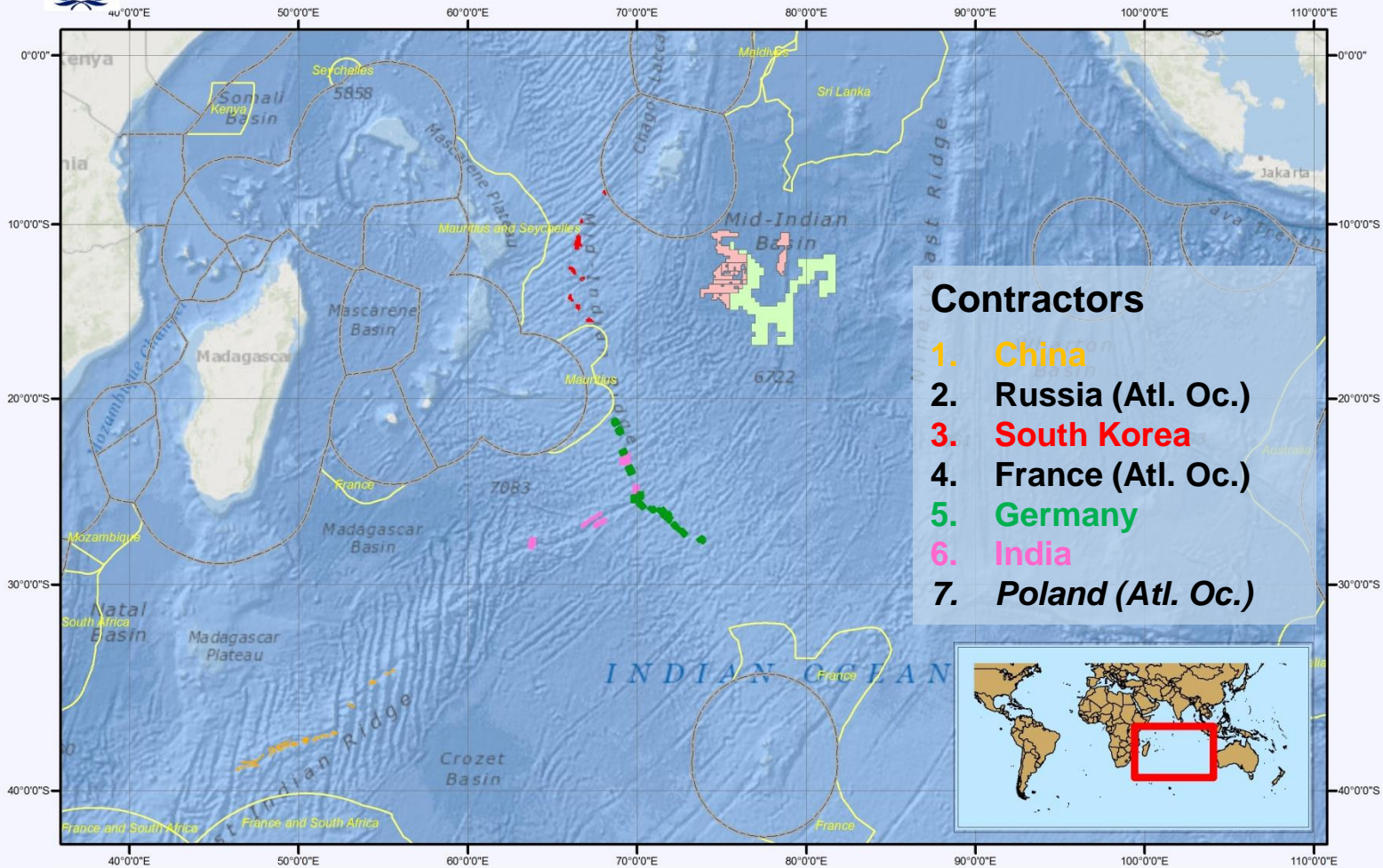
## Time Line and Activities





# Polymetallic Nodules and Polymetallic Sulphides Exploration Areas in the Indian Ocean

Approved plans of work and areas reserved for the International Seabed Authority



- ### Contractors
1. **China**
  2. **Russia (Atl. Oc.)**
  3. **South Korea**
  4. **France (Atl. Oc.)**
  5. **Germany**
  6. **India**
  7. **Poland (Atl. Oc.)**

<span style="color: magenta;">■</span> India - polymetallic sulphides exploration area	<span style="color: red;">■</span> India - polymetallic nodules exploration area	— Exclusive Economic Zones
<span style="color: green;">■</span> BGR (Germany) - polymetallic sulphides exploration area	<span style="color: lightgreen;">■</span> Area reserved for the Authority	<span style="border: 1px solid yellow;">□</span> ECS Submissions
<span style="color: orange;">■</span> COMRA (China) - polymetallic sulphides exploration area		
<span style="color: red;">■</span> Republic of Korea - polymetallic sulphides exploration area		

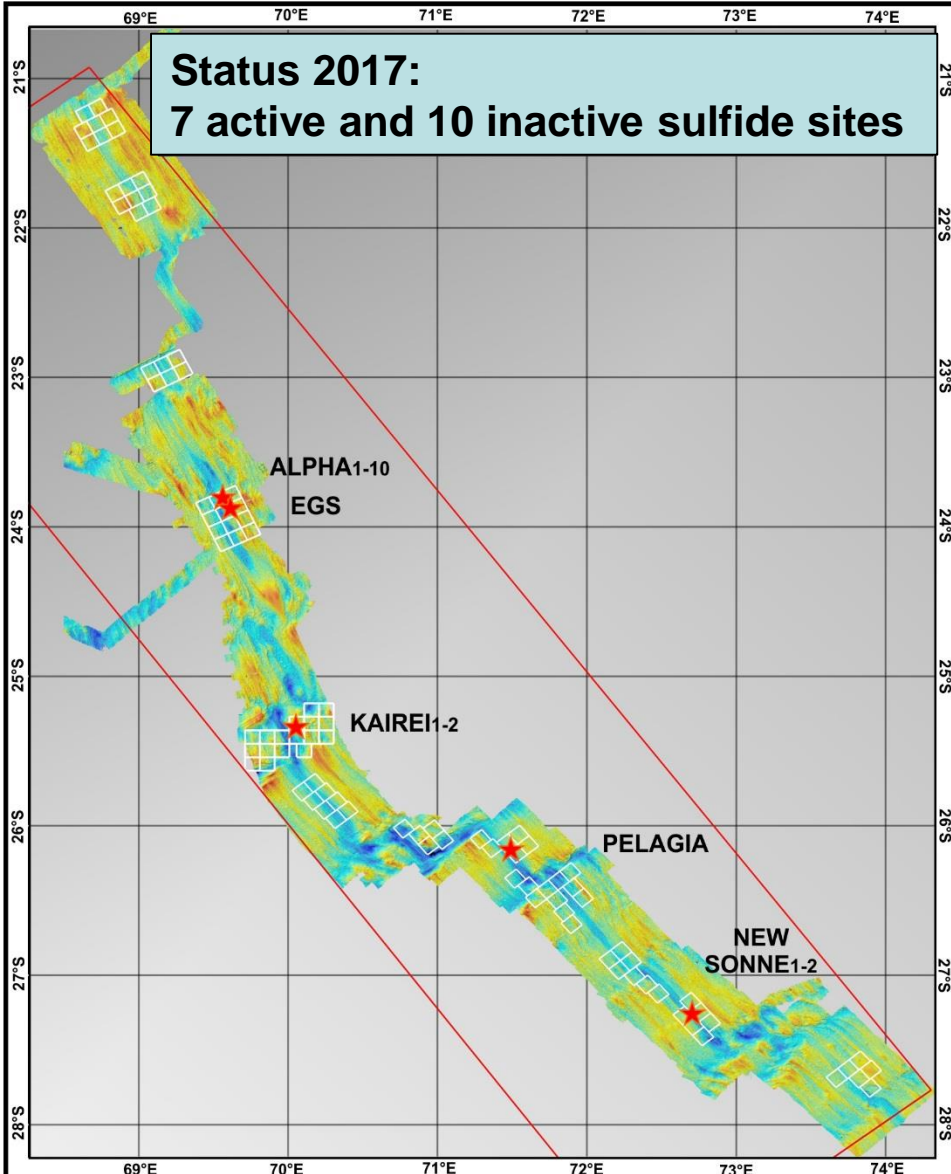
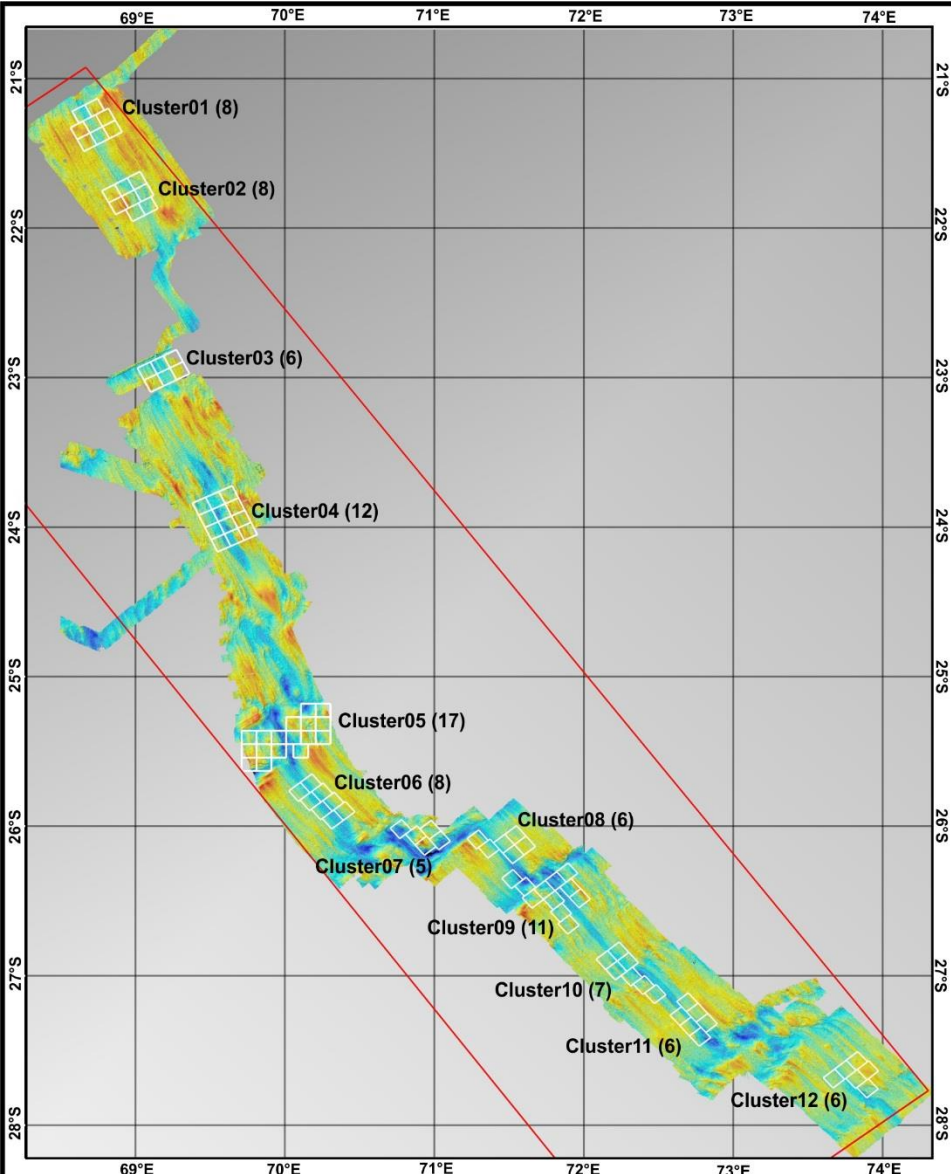
©International Seabed Authority, 25 July 2014. Background map: ESRI



Edmond Vent Field

# Project Objectives

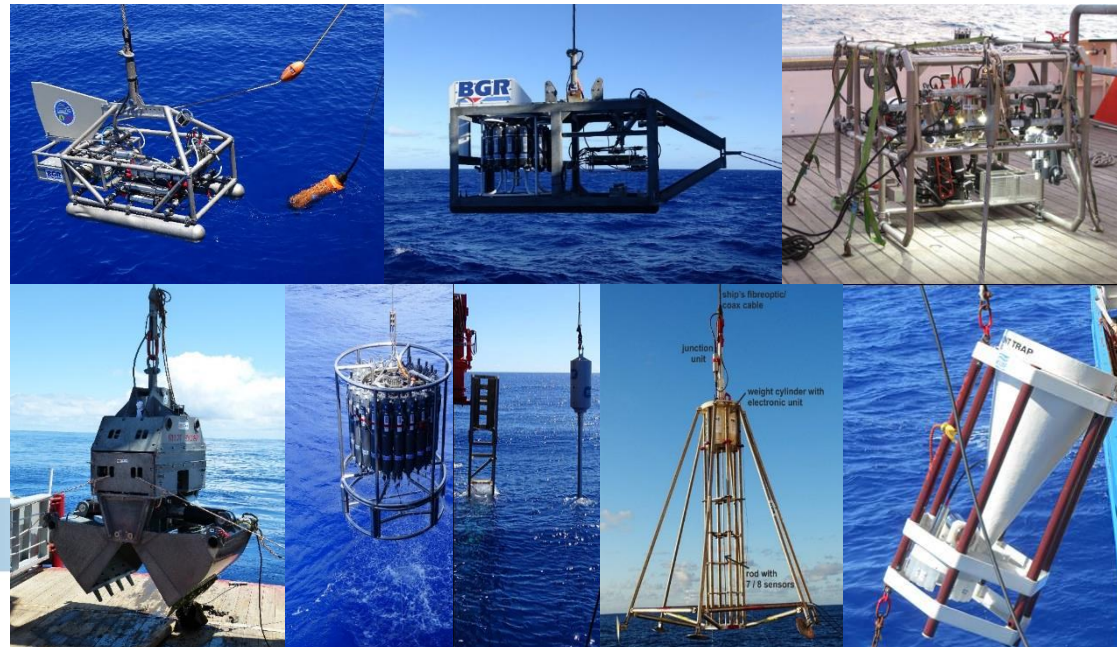
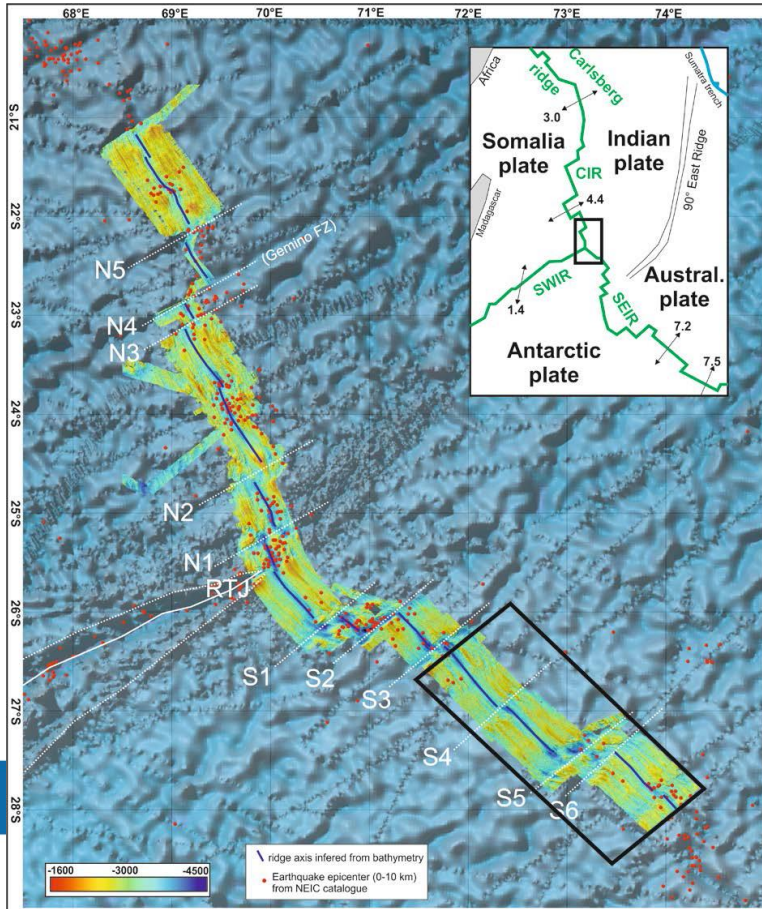
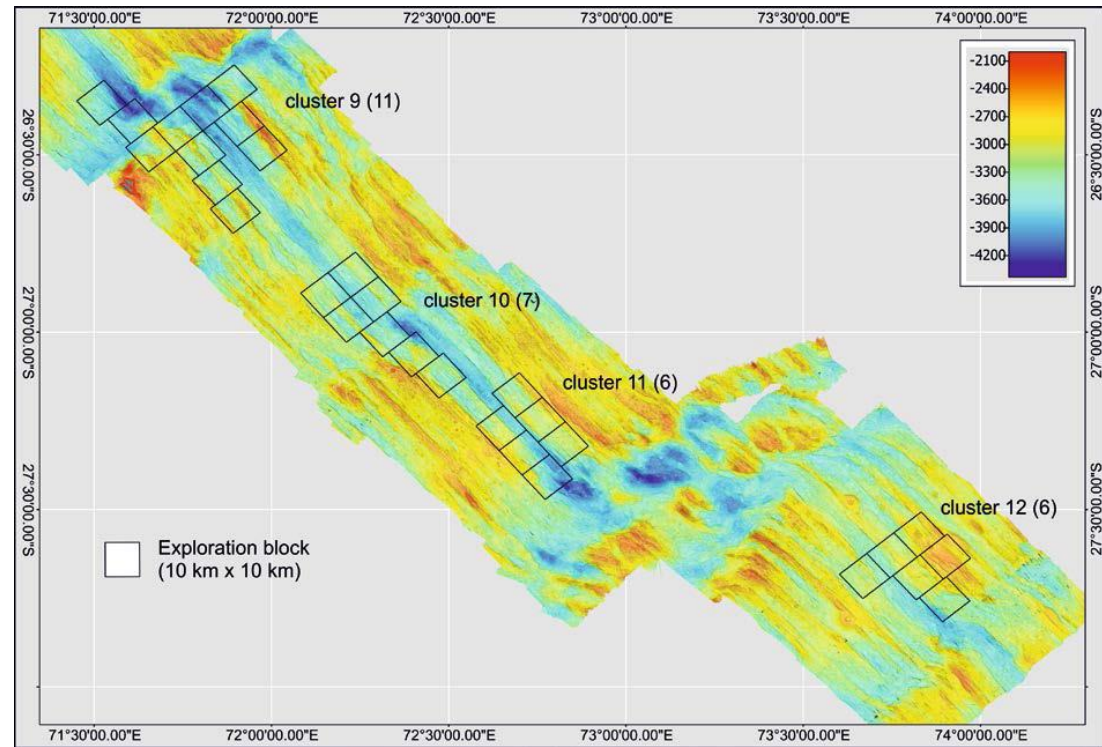
- **Exploration: Inactive SMS**
- **Dimensions, Metal Concentrations**
- **Identification of Economically Feasible Deposits ( $\geq 2,5$  Mio. t)**
- **Environment: Biodiversity, Habitat Analysis, Mass Transfer, Bottom Currents**
- **Conceptual Development of Mining Techniques**
- **Optimized Metallurgical Process**



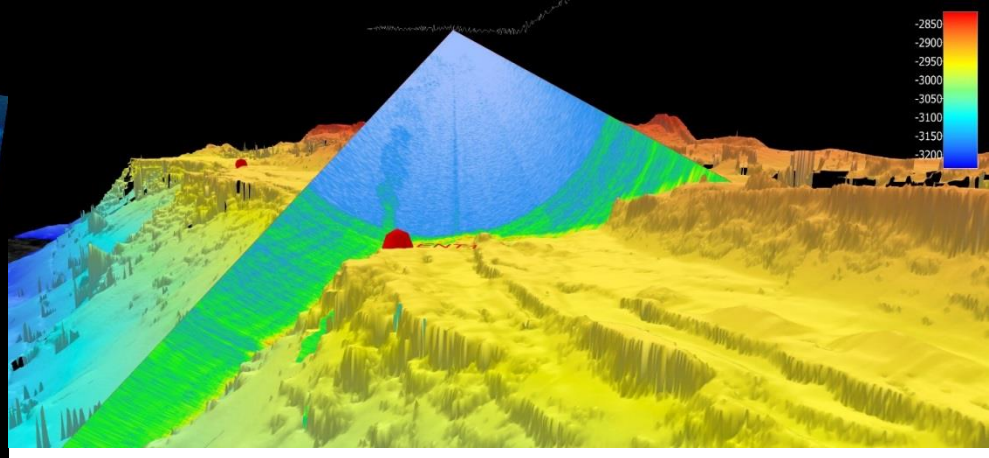
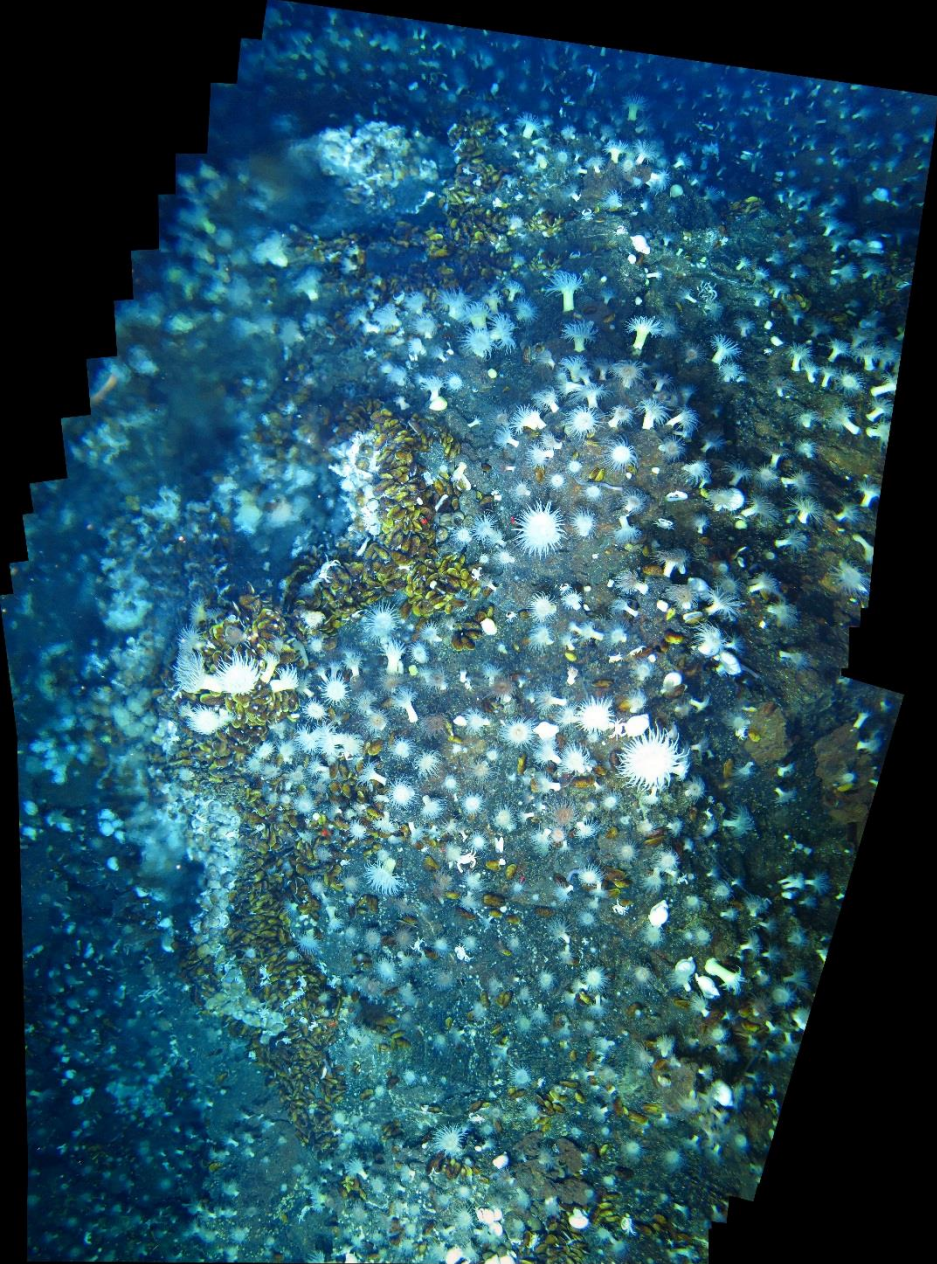
**SMS Status in the German License Area**

# Exploration Cruise SO259 INDEX 2017, TFS SONNE

August 24 – October 13  
Colombo/Sri Lanka –  
Cape Town/South Africa

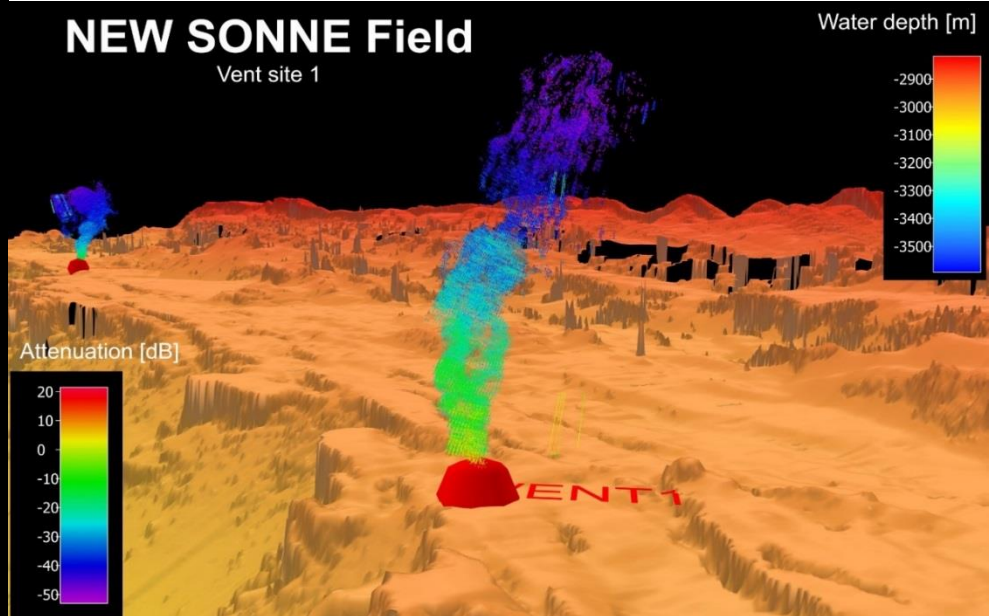






## NEW SONNE Field

Vent site 1



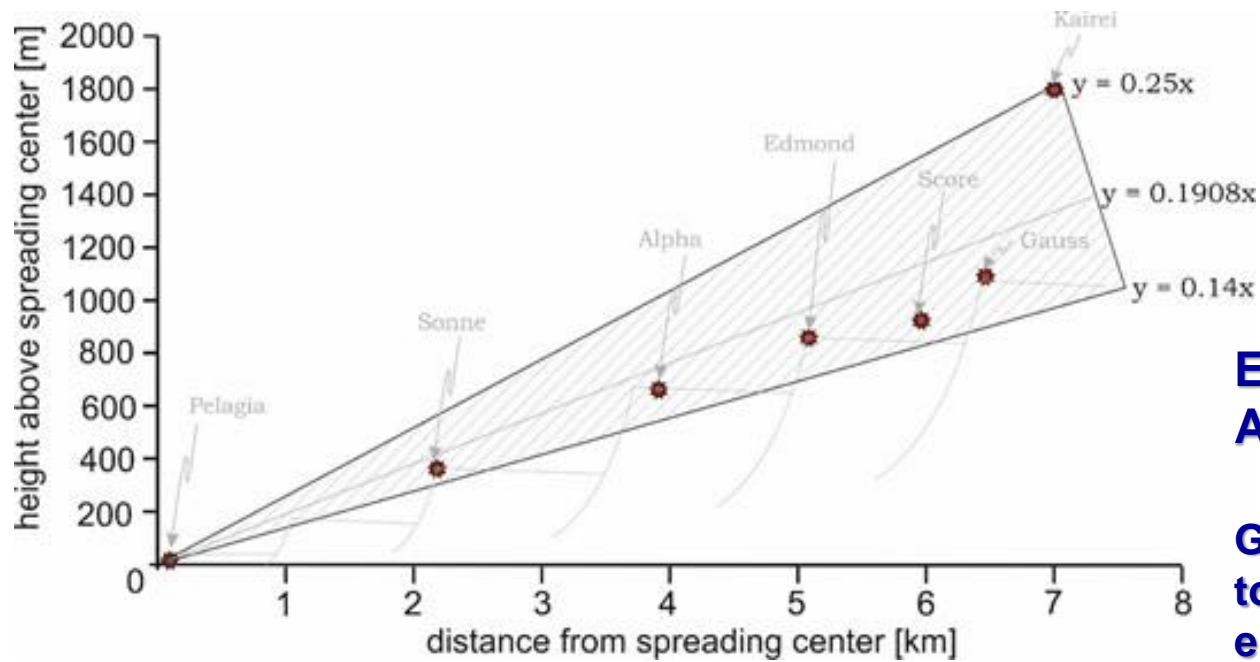
## Identification of the NEW SONNE Field

Cruise SO259 (INDEX2017)



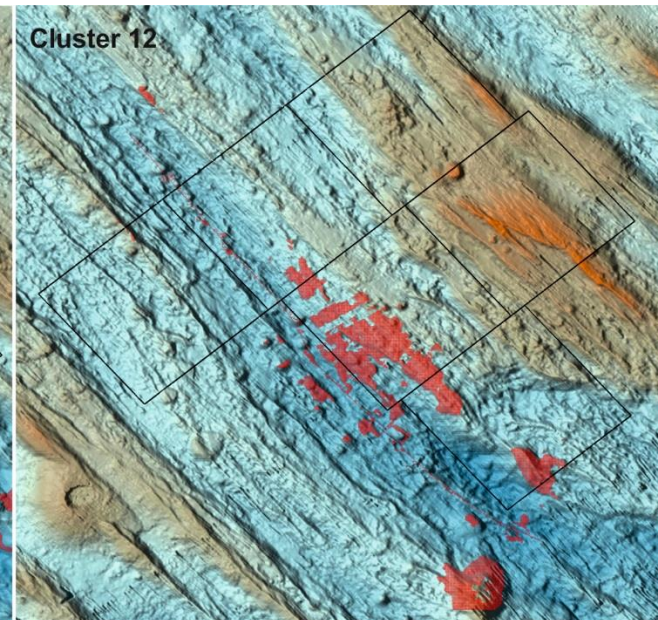
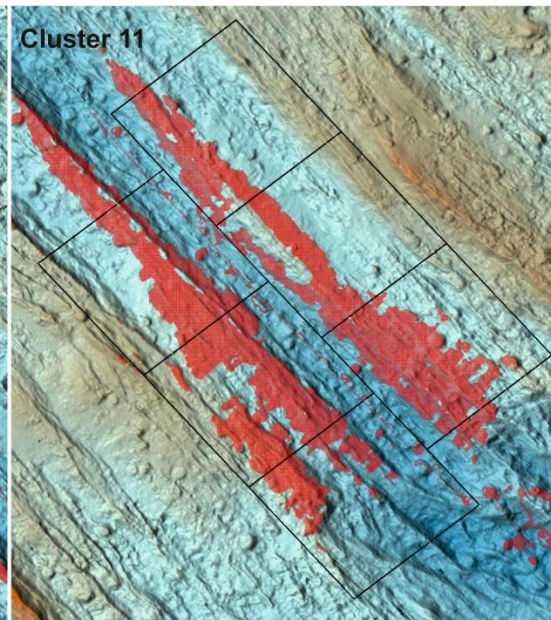
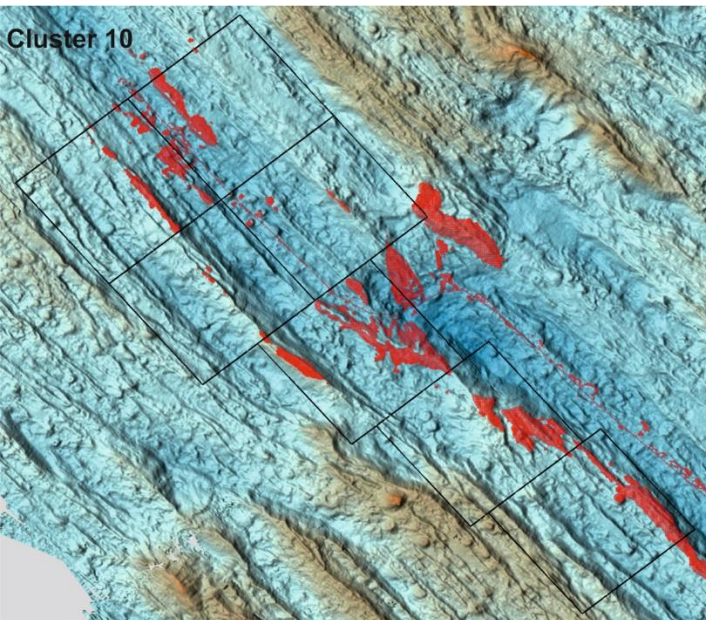
Bundesanstalt für  
Geowissenschaften  
und Rohstoffe

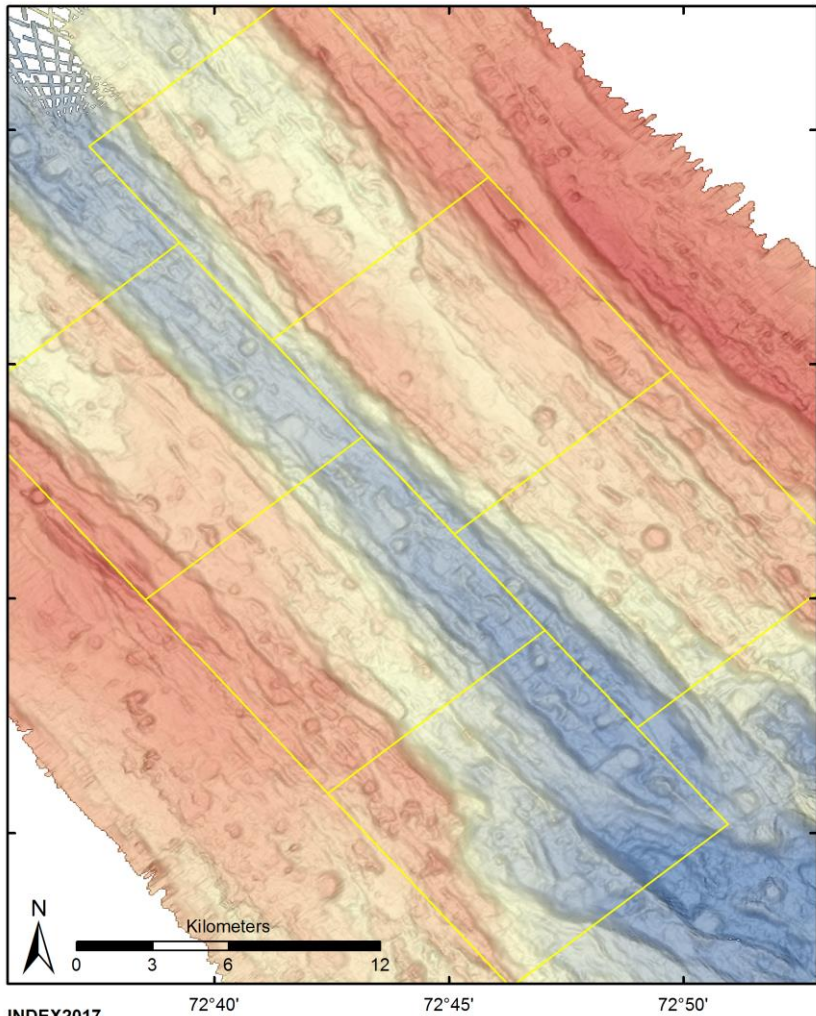
GEOZENTRUM HANNOVER



## Exploration Concept and Area Assessment

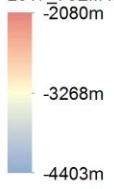
Geomorphology vs. Distance to Spreading Axis  
e.g., Cluster 10-11-12



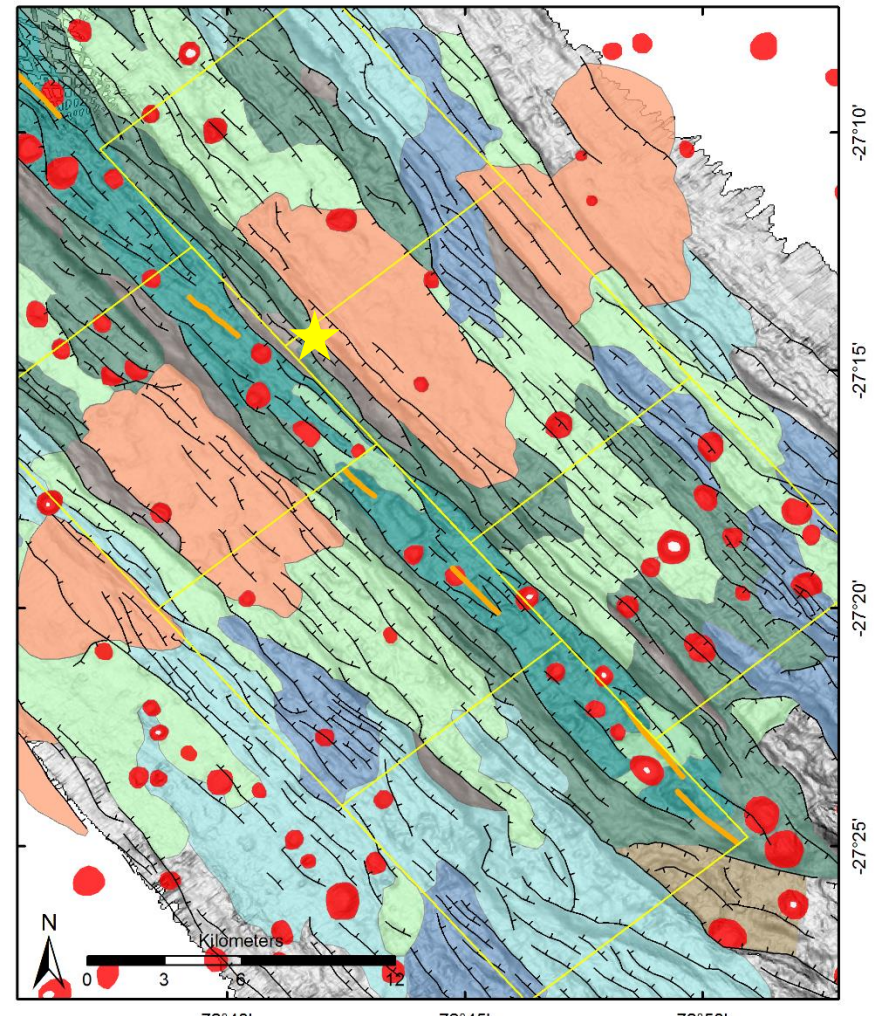


INDEX2017

2017\_78EM122 Bathymetry [40m]



## Bathymetry



INDEX2017

- Fault
- Caldera wall fault
- AVR crest
- Crater
- Volcano
- Shield volcano
- Large volcanic mound
- Rifted axial volcano
- Volcanic plain
- Hummocky terrain
- Sedimented hummocky terrain
- Offaxis volcanic plain
- Smooth off-axis high
- Hummocky off-axis high
- Talus
- Sedimented basin

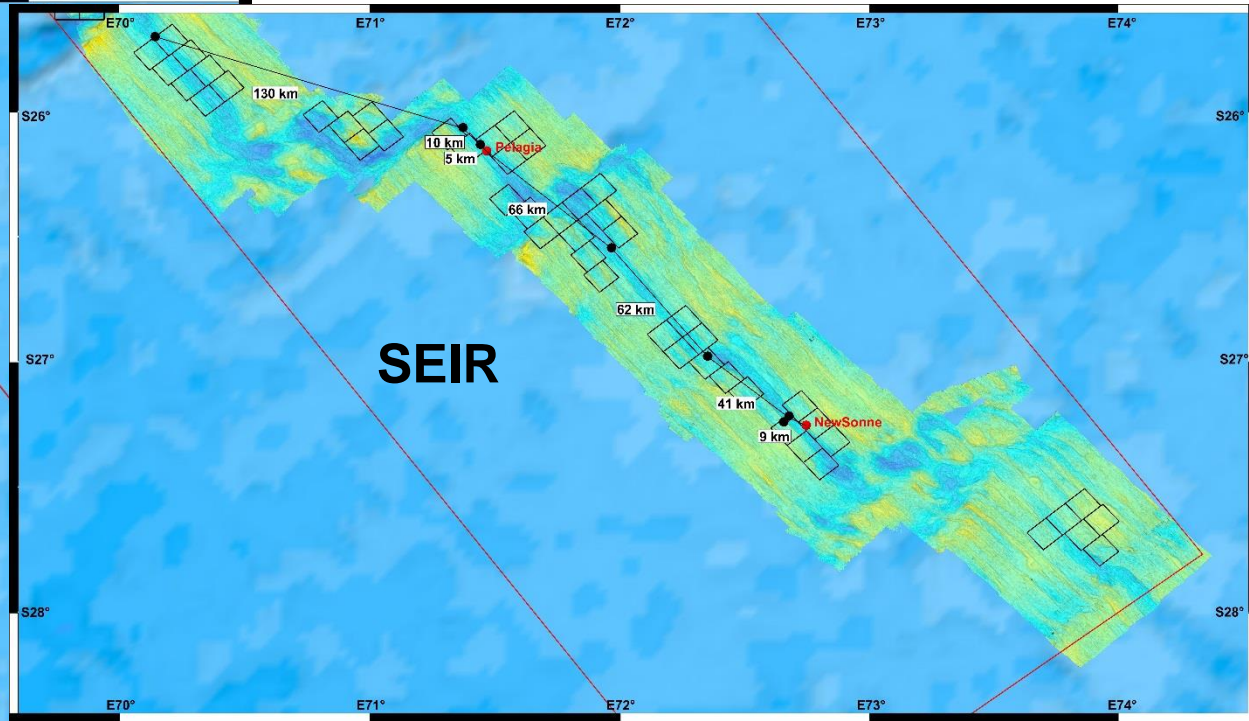
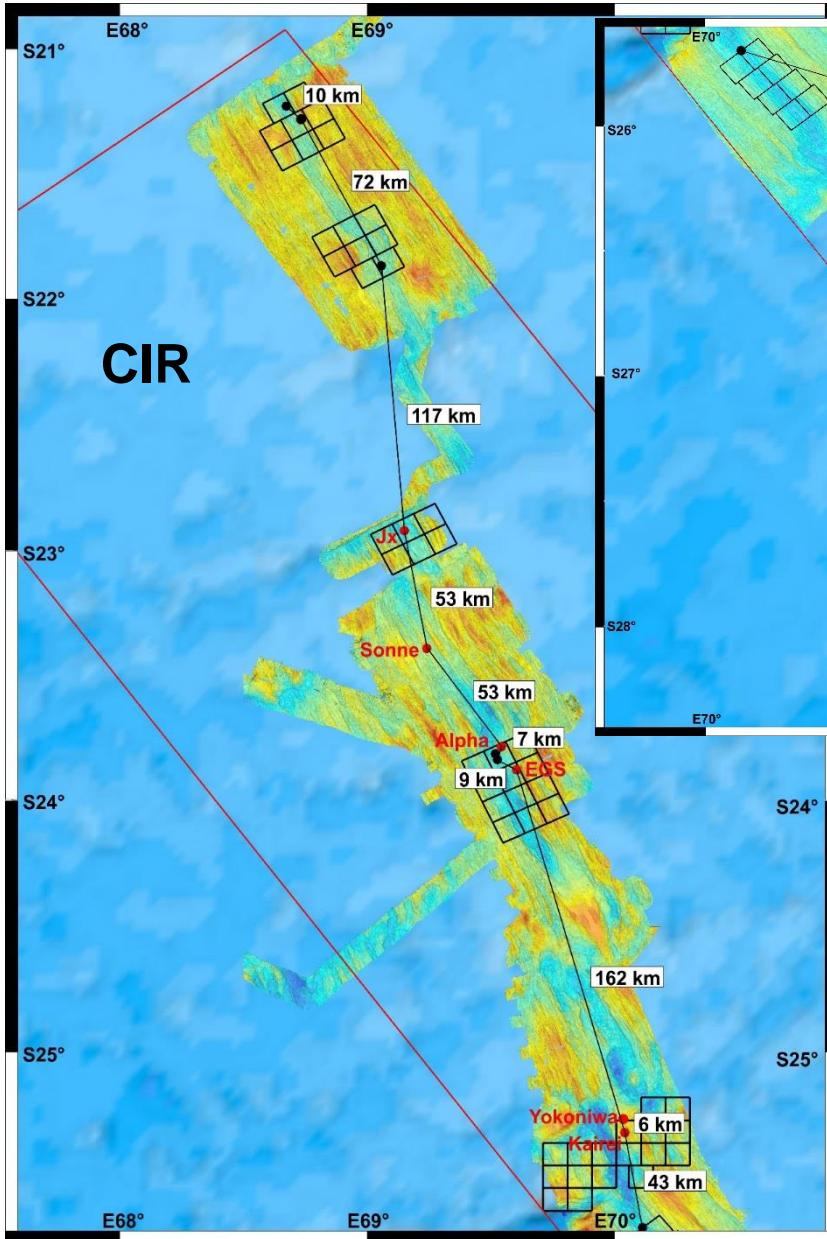
## Geol. Interpretation

# Bathymetry and Geolog. Interpretation



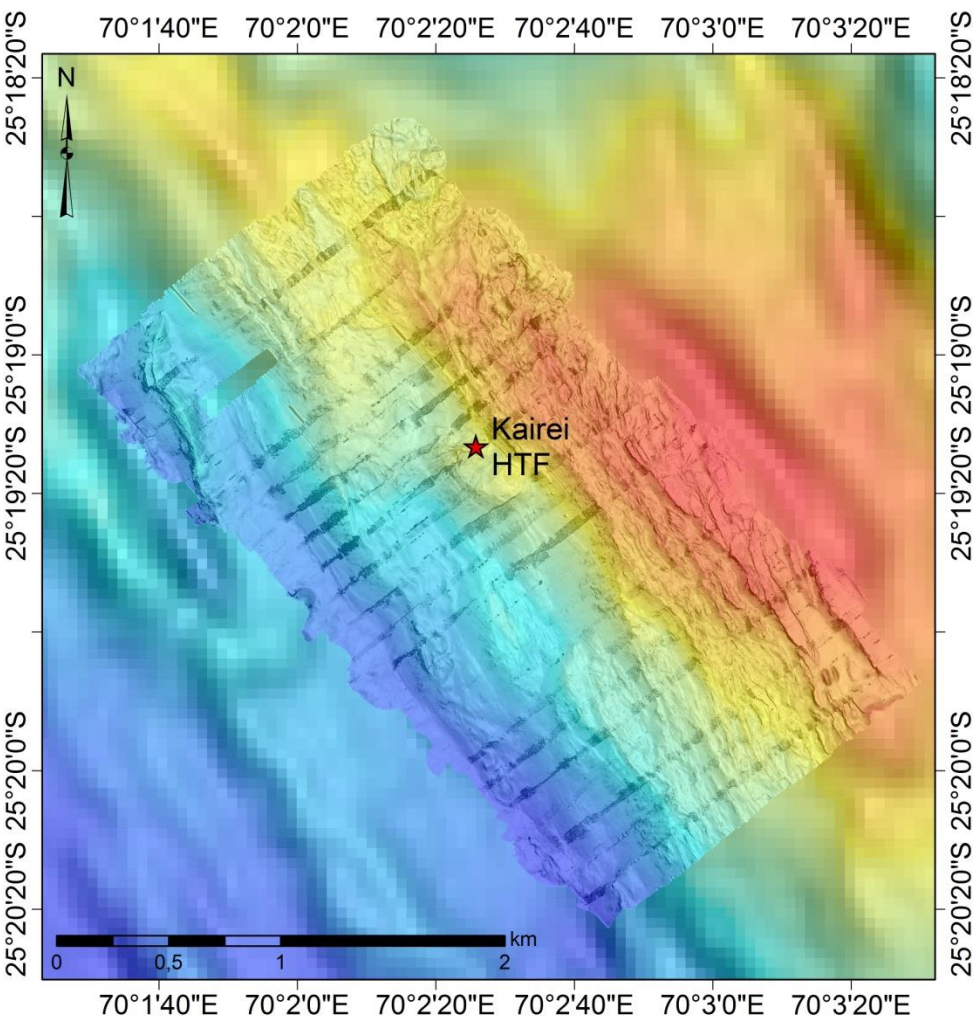
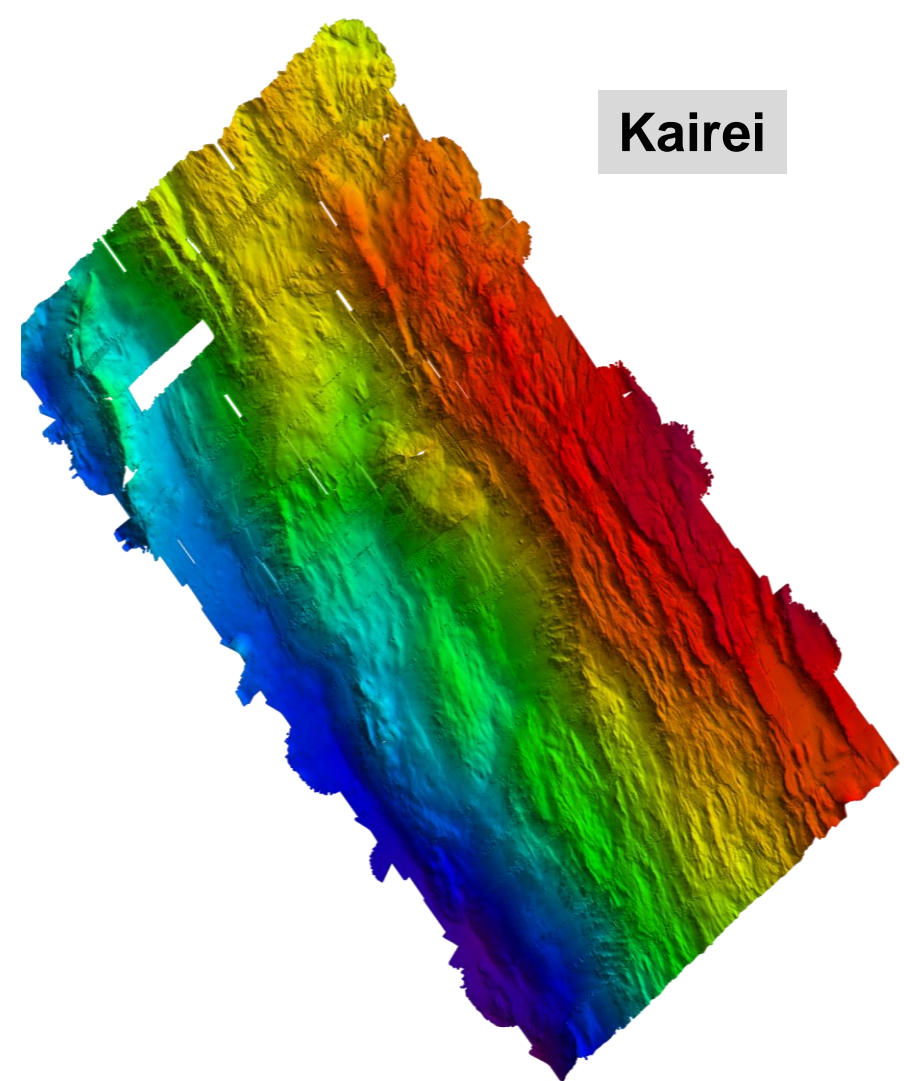
Bundesanstalt für  
Geowissenschaften  
und Rohstoffe

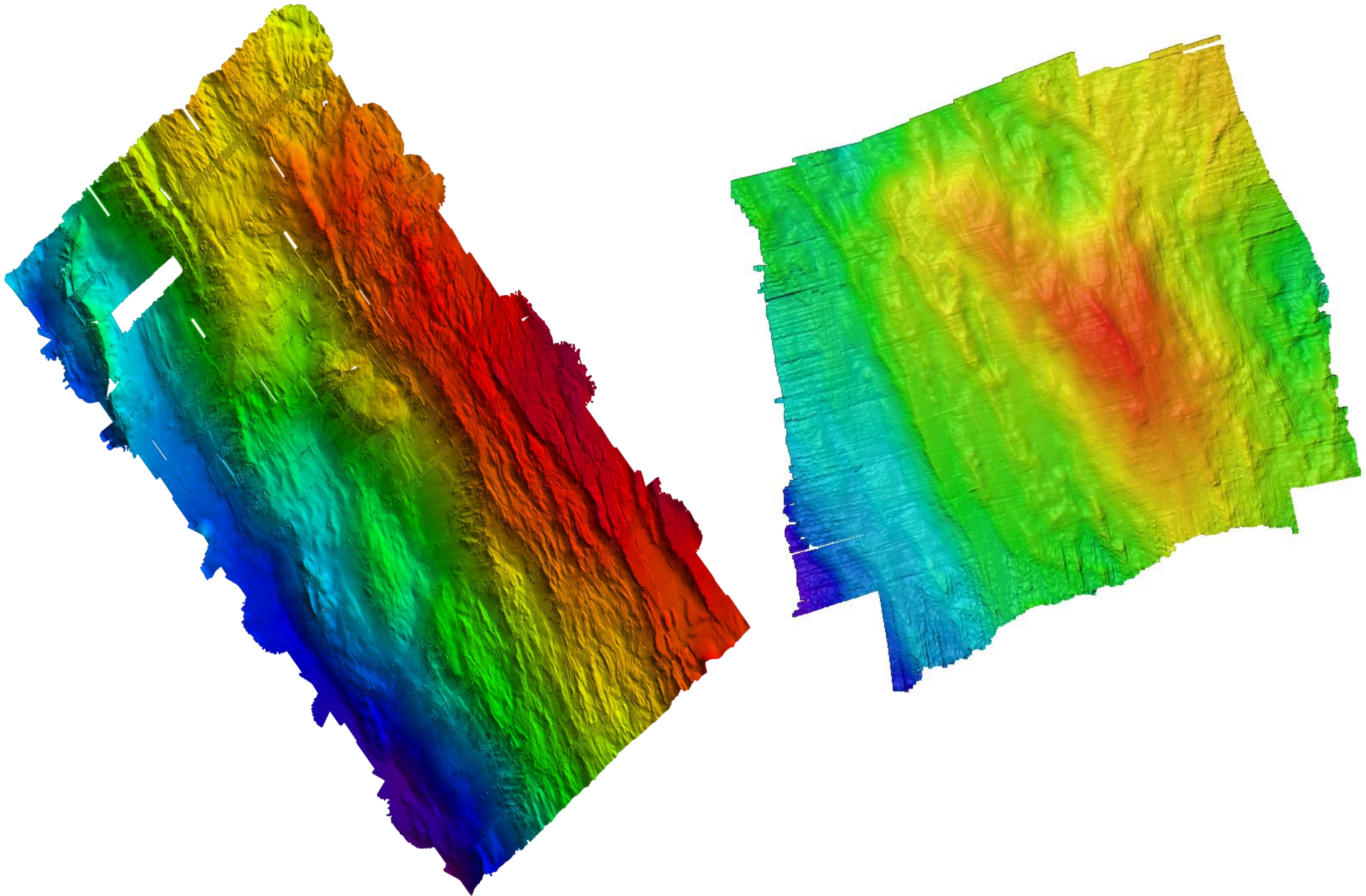
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- **CIR: Six sulphide sites, active vents and inactive fields, five plumes**
  - overall average spacing (sites and plumes): 54 km
  - sulphide site spacing: 57 km
  
- **SEIR: Two active vent fields**
  - overall average spacing (sites and plumes): 46 km
  - distance sulphide sites: 176 km
  
- **CIR & SEIR: Spacing of all sulphide sites: 90 km**
  - Including the identified plumes: 50 km

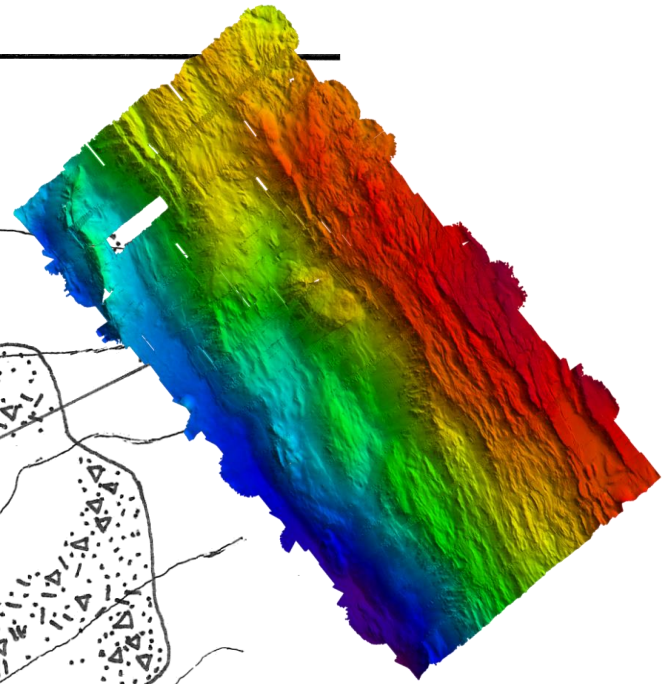
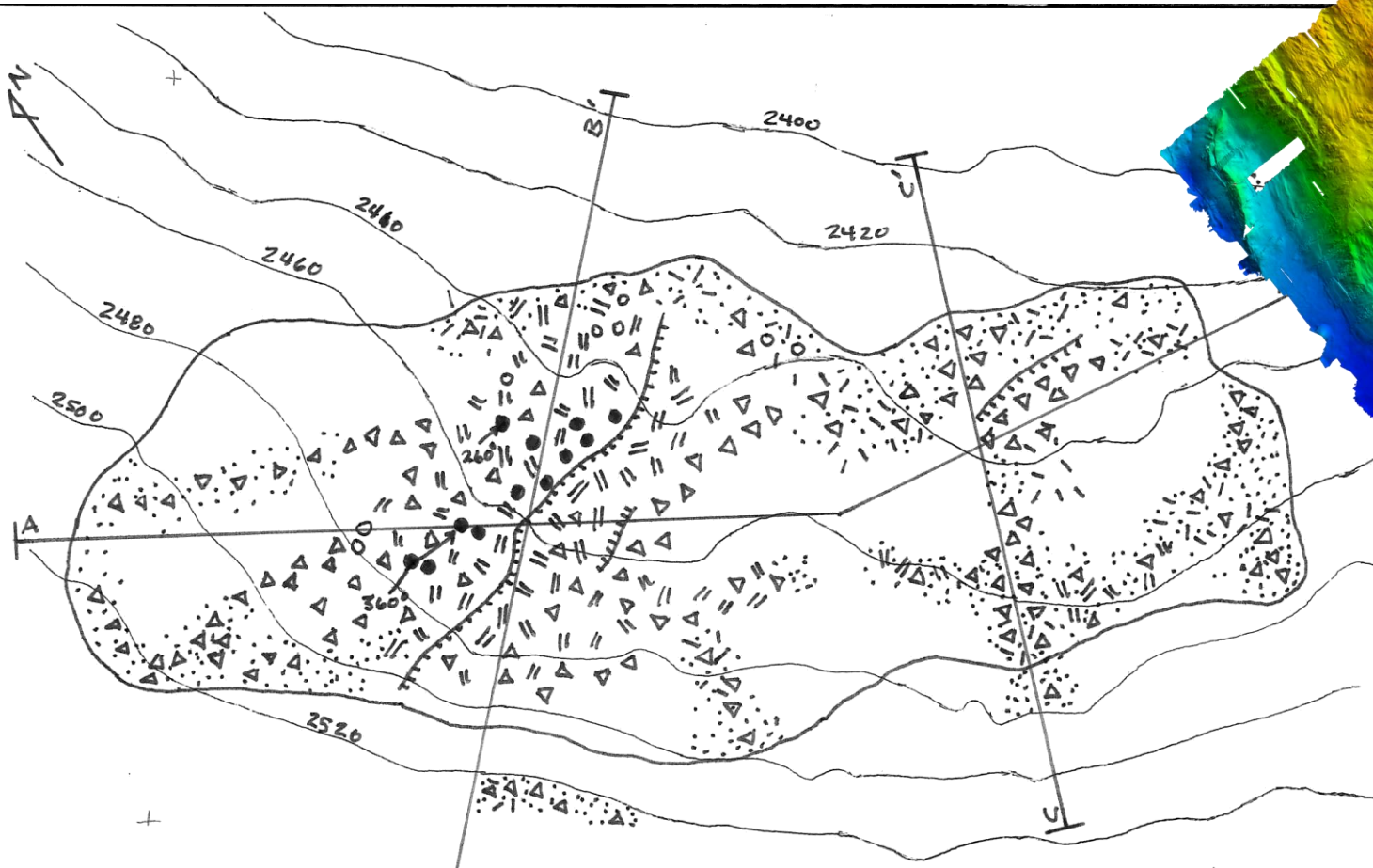
# Kairei





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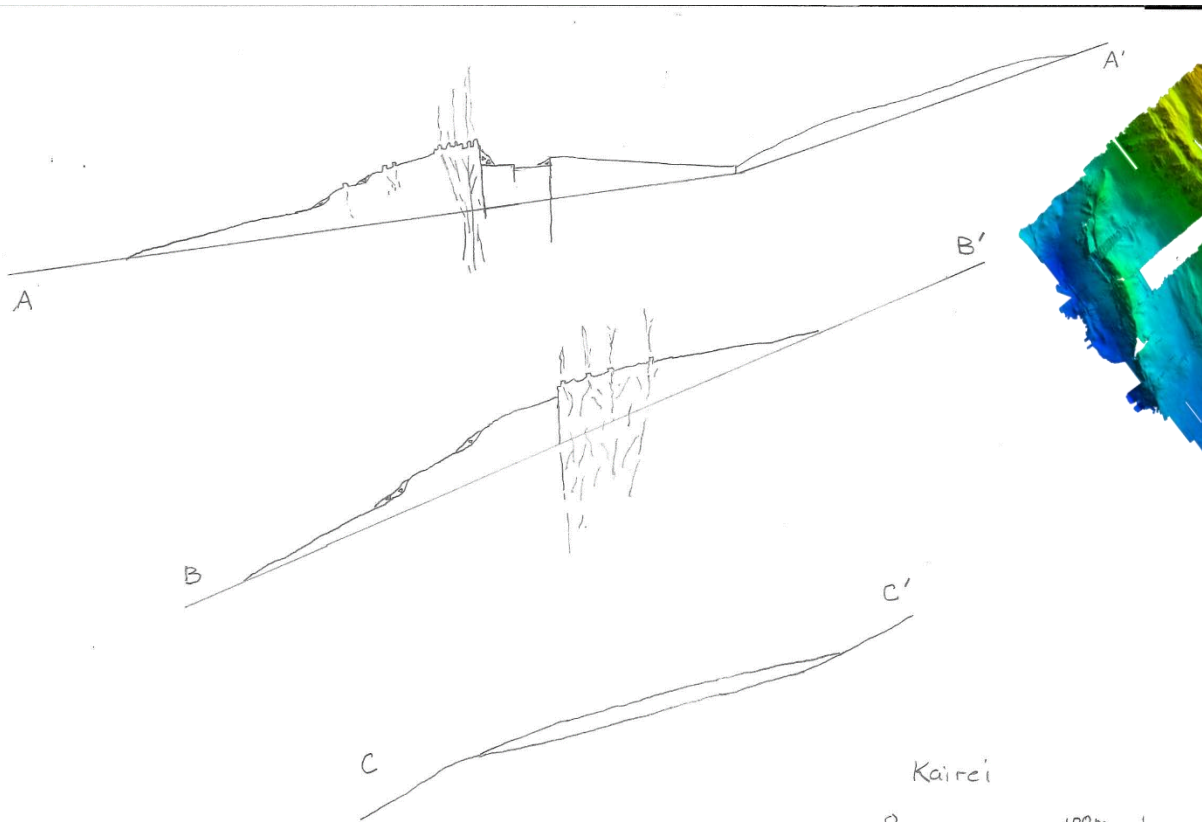
GEOZENTRUM HANNOVER



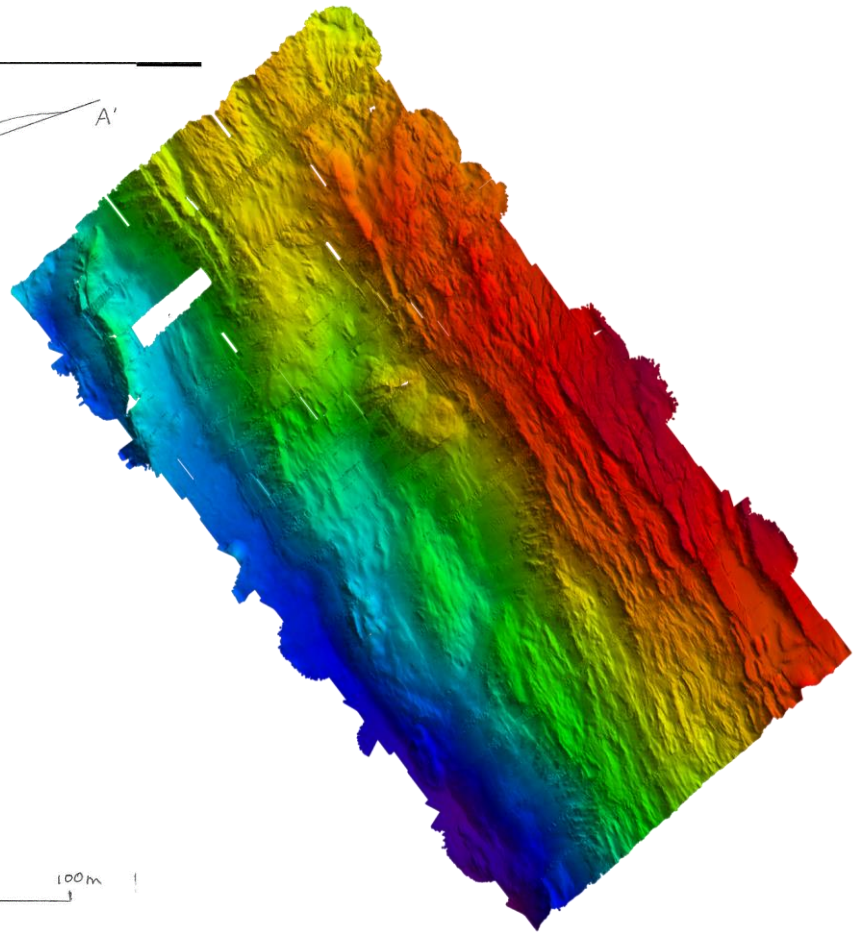
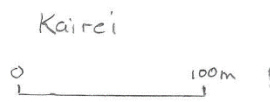
Katzei

0 100 m  
H. Gibson  
M. Rowald

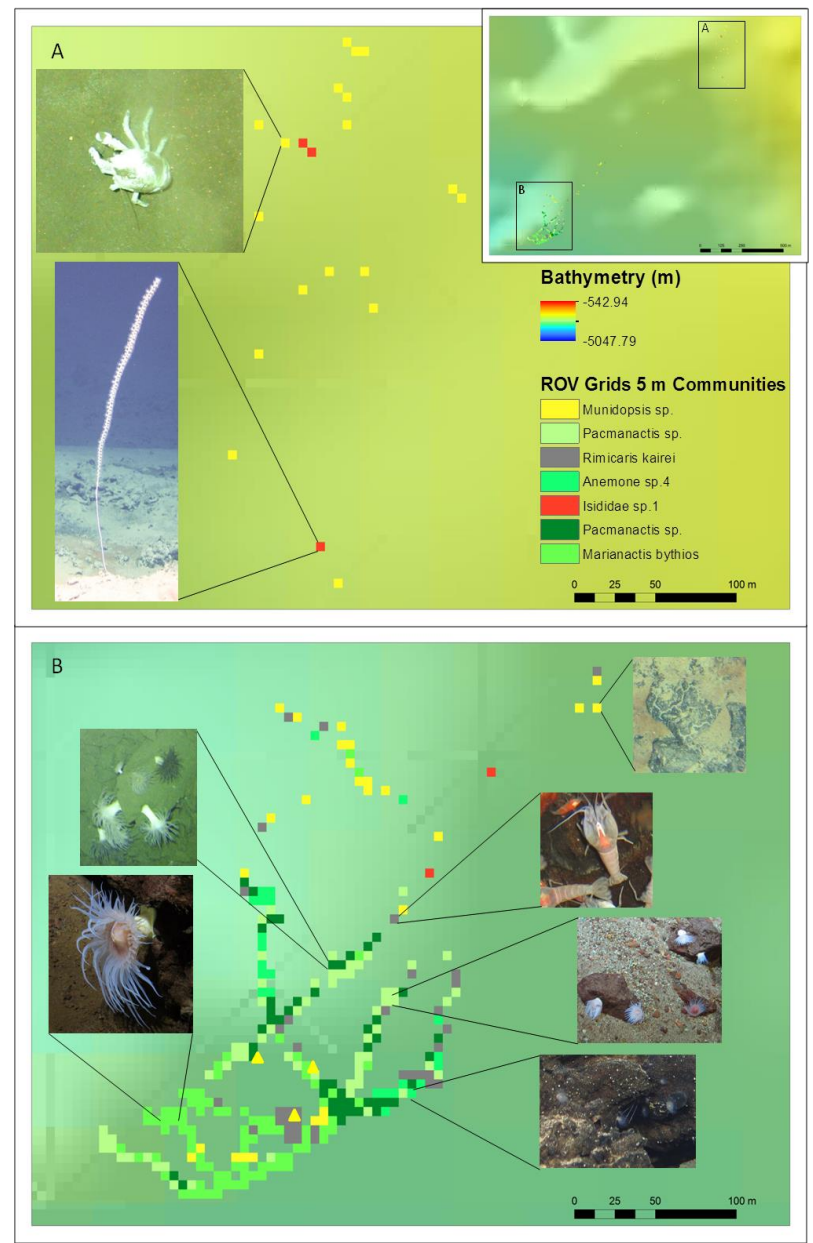
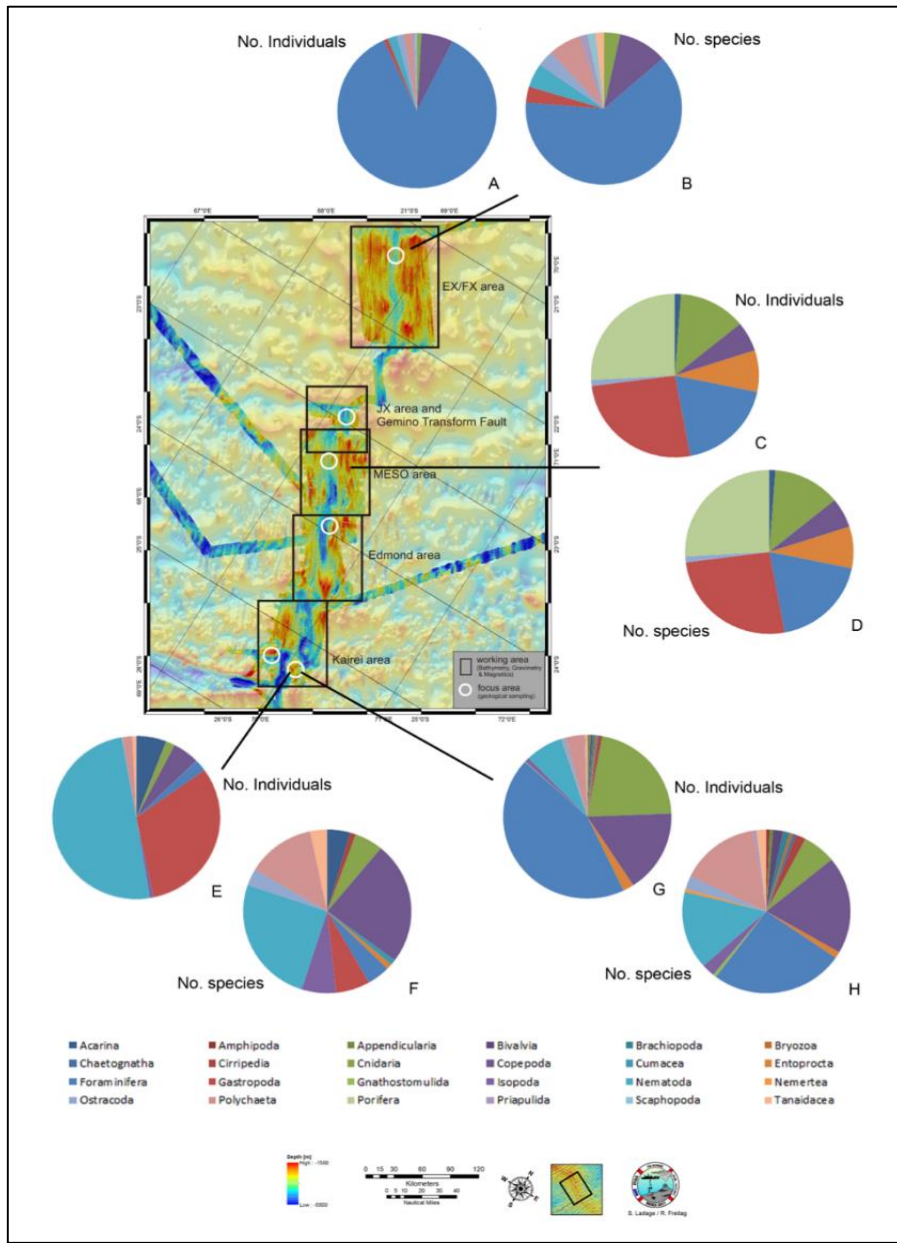
- ○ chimney active, Inactive
- ≡ chimney debris
- △ sulfide blocks
- ⋯ Fe-stained sediment
- ~ Fe-oxide crust

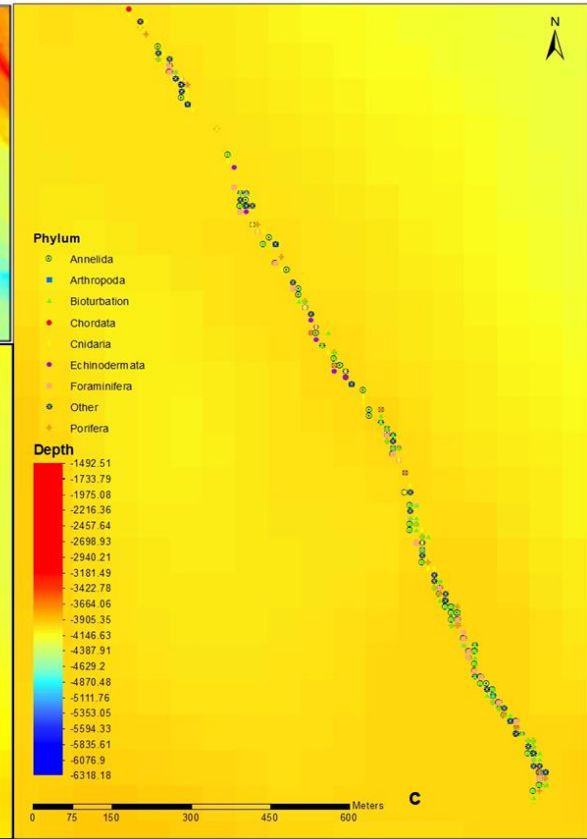
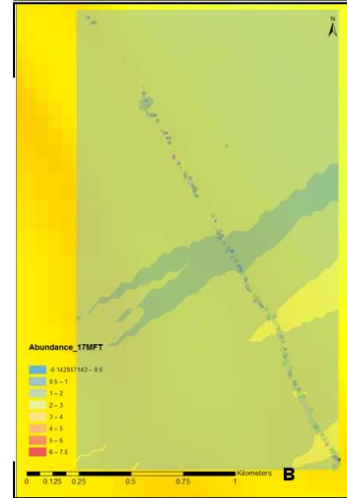
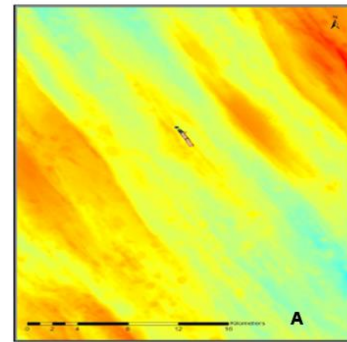
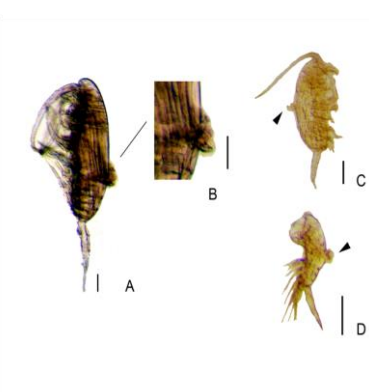
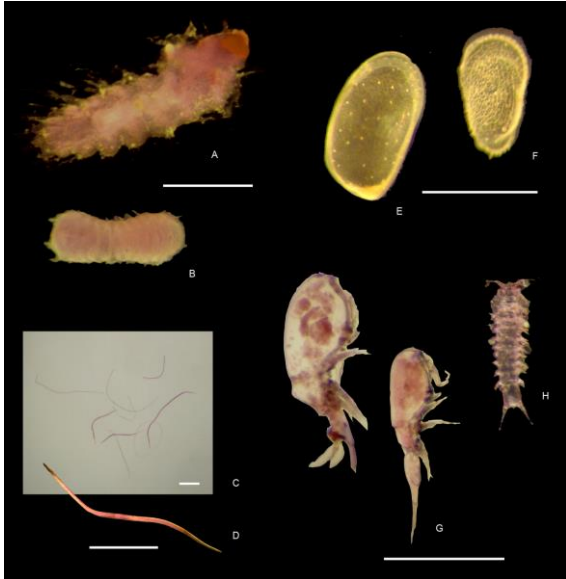
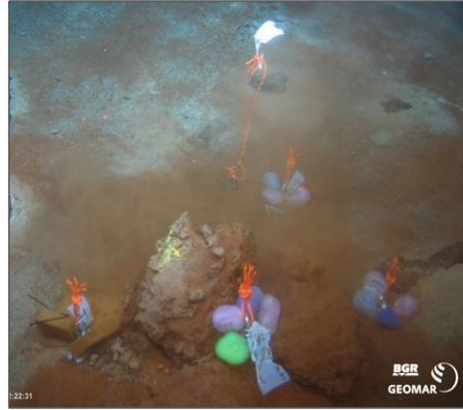
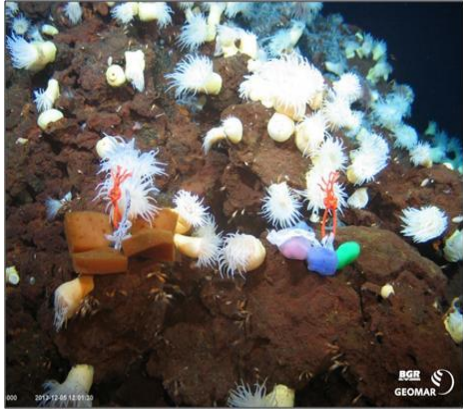


H. Gibran  
M. DeWolfe









# Environmental Assessment, Biodiversity



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Geowissenschaften  
und Rohstoffe

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# Reporting, Academia, Research, Media and ISA Affairs

- Annual Reports to ISA
- Talks and Lectures for the Public and Universities
- Research Contracts to Universities
- PhD students 1 + 3
- Master / Bachelor Theses 3 / 10
- ISA Training Program – 10 Trainees in Five Years

Expedition, Six Weeks of Lab Work and Marine Research Experience

Ghana (2), Egypt (2), Nigeria, Argentina (2), Singapore, Cook Islands, Thailand

