

## Cruise leg SO242-2

Antje Boetius, Frank Wenzhöfer, Felix Janssen

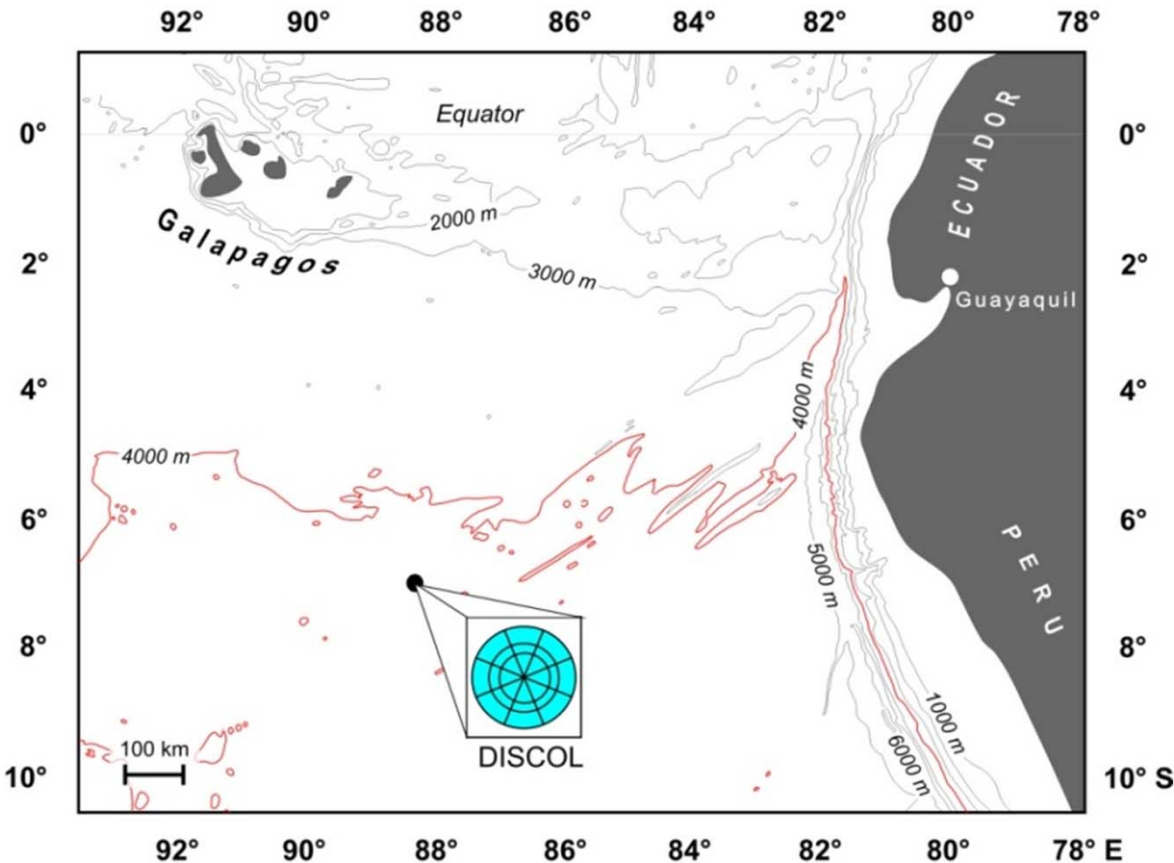
MPI Bremen | Joint Research Group on Deep-Sea Ecology & Technology



Image: Neptun Werft

## Cruise facts

- Cruise leader Antje Boetius, MPI Bremen
- Guayaquil – Guayaquil, 28. Aug. – 1. Oct.2015 (last JPIO PA leg)
- Directly following SO242-1 | (3 days in the harbor)
- Target area: DEA (DISCOL experimental area)
- 30 days at station plus 2 x 2 days transit (~ 600 nm)



## Cruise participants

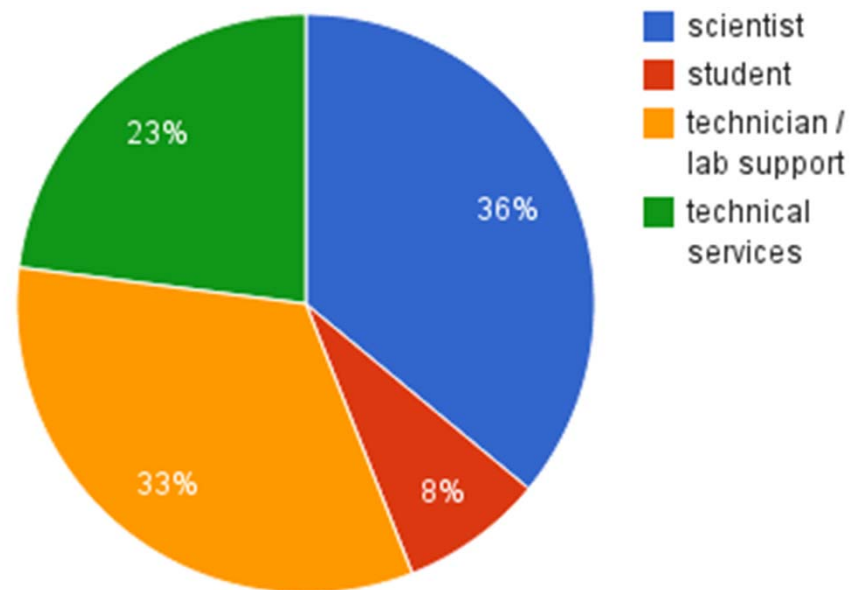
- Belgium | UGhent
- Germany | AWI, GEOMAR, JUB, MPI (& Fielax)
- Netherlands | NIOZ
- Norway | IRIS, NTNU
- Portugal | IMAR / UAzores
- UK | USouthampton



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- 40 Participants
  - > scientists, students
  - > (lab-) technicians
  - > technical services (ROV, data management)



## **In a nutshell: Scientific tasks and connection to leg 242-1**

- Habitat characteristics
  - > Detailed investigations of sampling / measurement / experimentation sites
  - > Large scale mapping performed during leg 1
- Benthic and hyperbenthic community characteristics
  - > Focus on small size classes (micro-, meiofauna) and megafauna
  - > Macrofauna addressed at leg 1
- (Bio-) geochemical processes and rates
  - > Focus on upper sediment layer and in situ measurements
  - > sampling of deeper sediment layers at leg 1
- Benthic foodwebs & energy transfer
  - > fate of fresh organic matter (remineralization, incorporation, transfer)
- Bioaccumulation and Ecotoxicology
  - > incorporation of contaminants, physiological / molecular responses

*Crucial: transfer of information on disturbance levels and agreement on common sampling sites for SO242-1 and 242-2!*

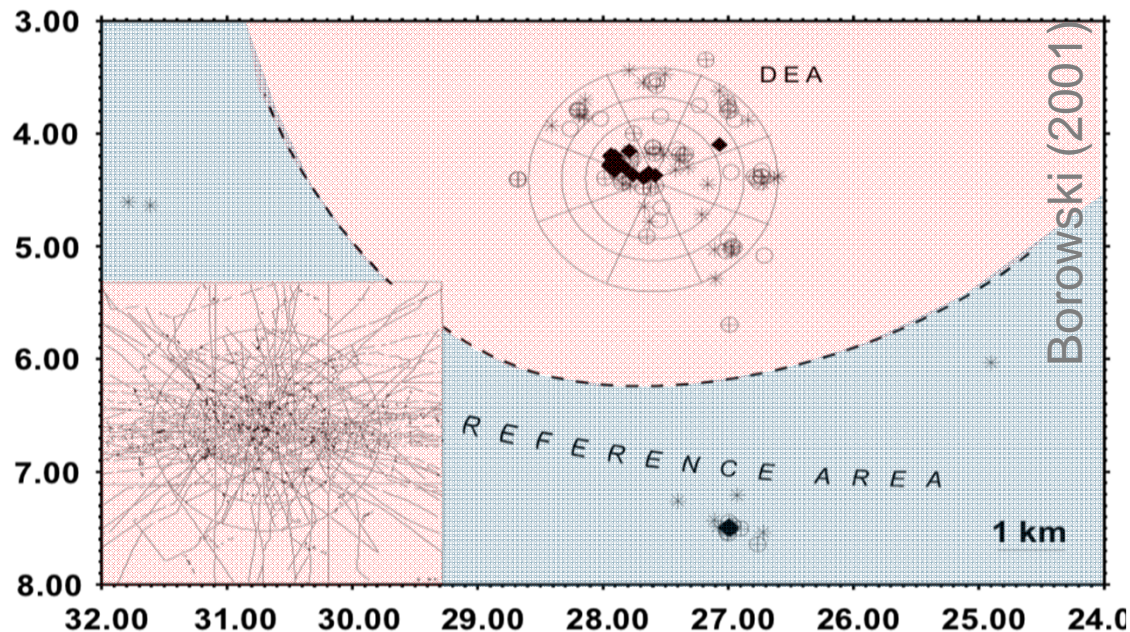
**Background:****Disturbance & recolonization experiment DISCOL and post impact studies**

- Pre-impact study and disturbance carried out in 1989
- Post-impact studies immediately after disturbance and 0.5, 3, and 7 years later
- Focus on benthic metazoan communities
  - > microbial biodiversity never investigated
  - > assignment of samples to disturbance level vague
- (Bio-) geochemistry first addressed 7 years after disturbance
  - > no in situ flux studies
  - > assignment of samples to disturbance level vague
- Foodweb, ecotox, and contaminant bioaccumulation studies missing so far

*Direct comparison to previous studies difficult or impossible  
(exception: megafauna community characteristics )*

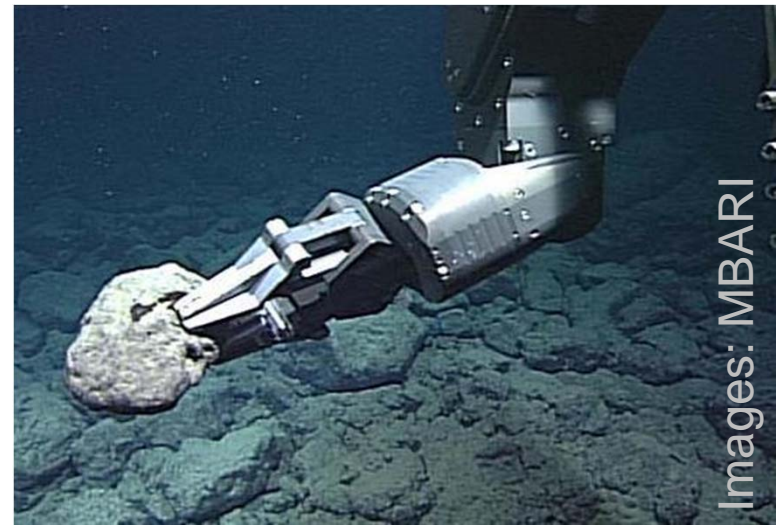
## General approach: disturbance effect assessment at SO242-1

- Long term disturbance effects
  - > Sampling and measurements along disturbance gradient
  - > **Disturbed area** (tracks, next to tracks) vs. **reference area** (with & w/o nodules)
  - > Persistent changes (and spatial variability) after 25 years



## General approach: disturbance effect assessment at SO242-1

- Long term disturbance effects
  - > Sampling and measurements along disturbance gradient
  - > **Disturbed area** (tracks, next to tracks) vs. **reference area** (with & w/o nodules)
  - > Persistent changes (and spatial variability) after 25 years
- Short term disturbance effects
  - > small scale in situ experiments
  - > nodule removal, surface sediment mixing, contaminant exposure
  - > effects on biogeochemistry, ecotoxicology, plume characteristics





## Scientific program, participating institutions and connection to WPs

Habitat characteristics (contribution to WP1)

*Persistent mining-related changes in benthic abyssal habitats*

- Seafloor characteristics at different levels of disturbance and nodule coverage
- ROV-based video surveys | GEOMAR, MPI
  - > Sediment surface characteristics, fauna & traces of faunal activity
- ROV-based photogrammetric and hyperspectral imaging surveys | NTNU
  - > microtopography, integrated biogeochemical, mineralogical, and morphologic characteristics of seabed features (nodules, organisms...)

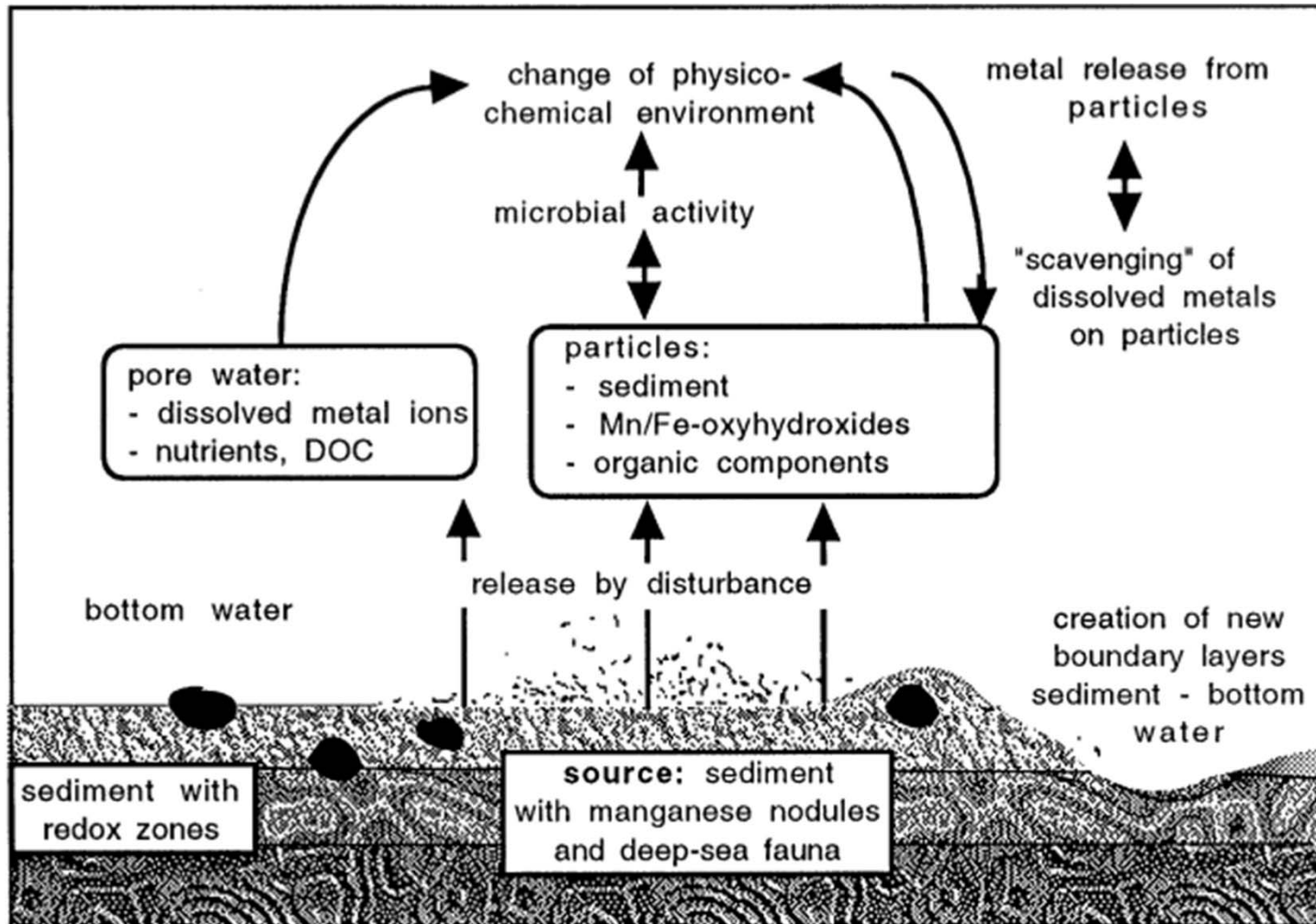
Benthic and hyperbenthic community characteristics (contrib. to WP2 & 3)

*Impact of mining-related disturbances on abyssal fauna across size classes*

- Megafauna density and biodiversity with towed photographic surveys | MPI
- Meiofauna density and biodiversity based on targeted sampling | UGhent  
> morphological and molecular identification
- Microbial biodiversity and functions | MPI  
> molecular analysis incl. identification of functional genes

## (Bio-) geochemical processes and rates (contribution to WP3 & 4)

*Disturbance impacts and reestablishment of a new equilibrium concerning surface sediment geochemistry, biogeochemical processes & trace metal budgets*



Koschinsky et al. 2001

(Bio-) geochemical processes and rates (contribution to WP3 & 4)

*Disturbance impacts and reestablishment of a new equilibrium concerning surface sediment geochemistry, biogeochemical processes & trace metal budgets*

- In situ quantification of benthic fluxes | MPI
  - > O<sub>2</sub>, DIC, nutrients (sensors and samples)
- Geochemical zonation & trace metal budget, sediment and BBL | GEOMAR, AWI, JUB
  - > solid phase and pore waters of retrieved cores
  - > major and minor elements, trace metals/ REE, anions/nutrients
  - > O<sub>2</sub>, DIC, TA
  - > DOC,  $\delta^{15}\text{N}$ -NO<sub>x</sub> and amino acids
  - > metal redox speciation (e.g. Fe(II)/(III) and Mn(II)/(III))
  - > Soluble metal complexes with biogenic organic molecules
- Biogeochemical processes and rates in sediments and nodules | MPI
  - > Shipboard incubations with labeled substrates
  - > exoenzyme activity, secondary production

### Benthic foodwebs & energy transfer (contribution to WP3)

*Alteration of abyssal food webs and ecosystem functions by mining-related disturbance*



Image: Natural History Museum

### Benthic foodwebs & energy transfer (contribution to WP3)

*Alteration of abyssal food webs and ecosystem functions by mining-related disturbance*

- Organic matter remineralization and C / energy transfer in benthic food webs | NIOZ, IRIS, UGhent
  - > In situ incubations with stable-isotope-labeled phytodetritus
  - > Remineralization (inorganic carbon, nutrients)
  - > Incorporation (biomass): micro-, meio-, macro-, megafauna
  - > Metabolic activity (benthic fluxes and megafauna incubations)
- Foodweb mapping based on natural stable isotopes in fauna tissue | IMAR

Bioaccumulation of contaminants and ecotoxicology (contribution to WP3)  
*Long term and short-term toxicological effect of metal exposure and physical disturbance on key abyssal benthic taxa*

- Persistent effects of DISCOL experiment | USOU, IMAR, UGhent,  
> sampling along disturbance gradient
- Short term effects of copper exposure | USOU, IMAR, UAveiro, UGhent  
> in situ experimental exposures of seafloor patches & megafauna
- Analyses
  - > megafauna & macrofauna:  
bioaccumulation, histology, enzyme activities & gene expression
  - > meiofauna: abundance and community composition

### In situ disturbance experiments (contrib. to WP2, 3 & 4)

- Immediate impacts: nodule removal, sediment disturbance, compaction, deposition | JUB, AWI, GEOMAR, MPI, UGhent
  - > benthic fluxes and geochemical conditions of nodule-stripped / disturbed sediments (e.g., O<sub>2</sub>, reduced metals; biogeochemical processes)
  - > meiofauna community patterns
- Composition, fate & local impact of mining plumes | JUB, AWI, GEOMAR, MPI
  - > suspended particle plumes and pore waters, geochemical concentrations, mobilized metals
- Dedicated or 'collateral' disturbance (e.g., during sampling activities)
  - > ROV manipulator / ROV thrusters
  - > sediment disturber
- Measurement of disturbance effects in enclosures...
  - > benthic chambers
- ...or open waters
  - > ROV-sampler, CTD-towyo
  - > moored ADCP and turbidity meter
  - > in situ pumps
  - > microprofiler (alterations of biogeochemical processes)

*More planning needed...*



## Main instruments

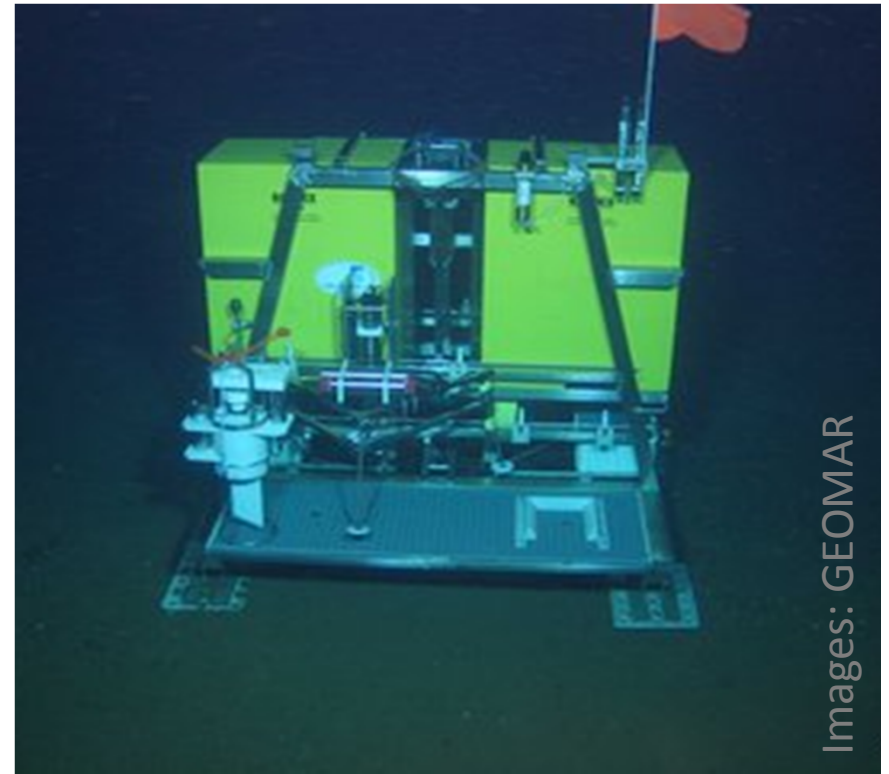
### Samplers

- TV-guided Multi-Corer (TV-MUC) | GEOMAR, JUB, AWI, UGhent, MPI...
  - > Targeted sediment sampling for upper surface layer investigations (geochemistry, meio- and microfauna biodiversity)
- CTD, In situ pumps
  - > Suspension and chemical plume sampling connected to experiments and 'collateral disturbances'
  - > CTD turbidity casts and moored in situ pumps



## SO242: Main instruments

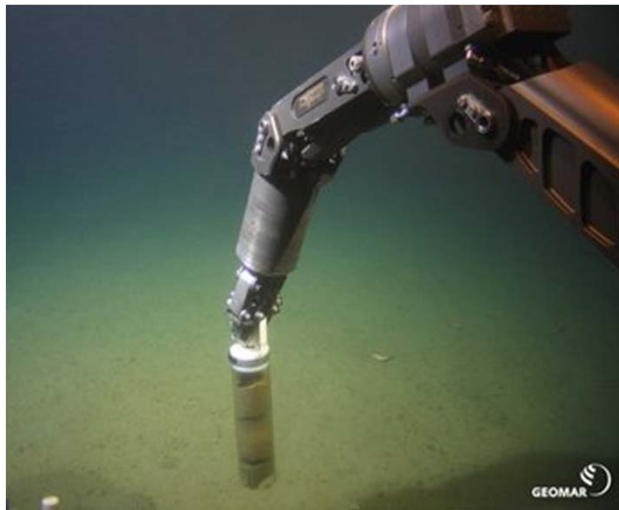
ROV Kiel 6000 & Elevator | GEOMAR, used by all groups



Images: GEOMAR

### ROV Kiel 6000 sampling and imaging tools | GEOMAR, UKiel, NTNU

- Push-Cores: Sediment sampling for upper surface layer investigations  
> geochemistry, shipboard biogeo-incubations, meio- and microfauna
- Diverse samplers (scoop, Hand-net, slurp gun...): Megafauna and Nodule sampling, sediment disturbance  
> in situ experiments, food web mapping, contaminant body burden



## SO242: Main instruments

### ROV Kiel 6000 sampling and imaging tools | GEOMAR, UKiel, NTNU

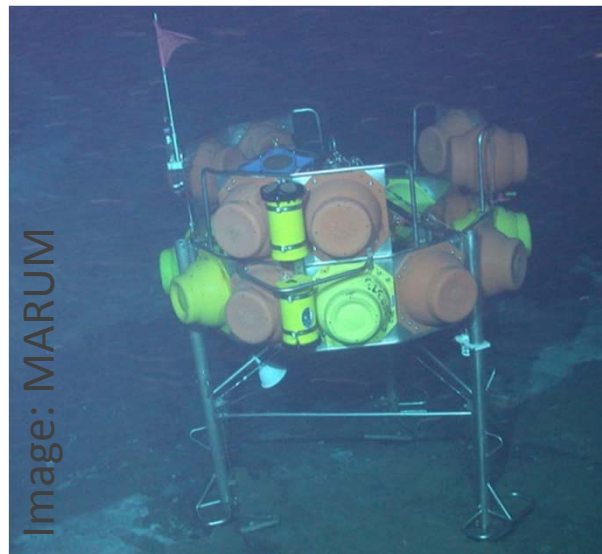
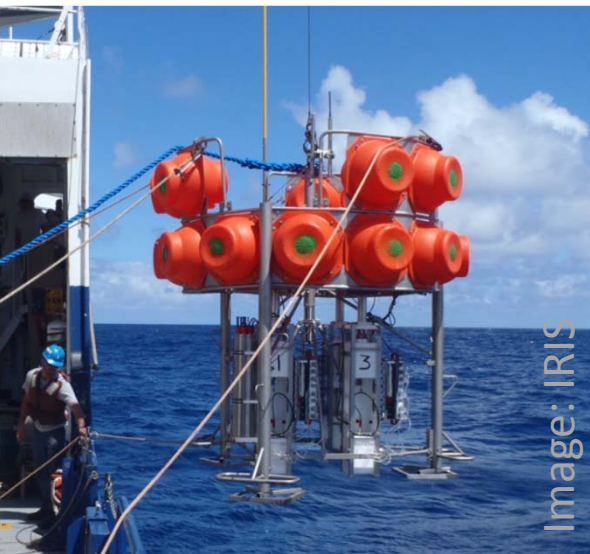
- Cameras (HD video, auxiliary cameras)
  - > video habitat surveys, hyperspectral and photogrammetric habitat mapping
- Fluid sampler 'Kiel Pumping System' (KIPS)
  - > plume sampling



# SO242: Main instruments

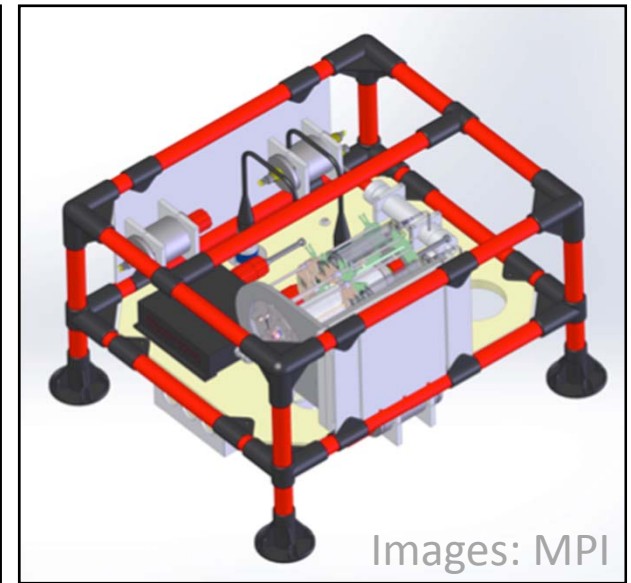
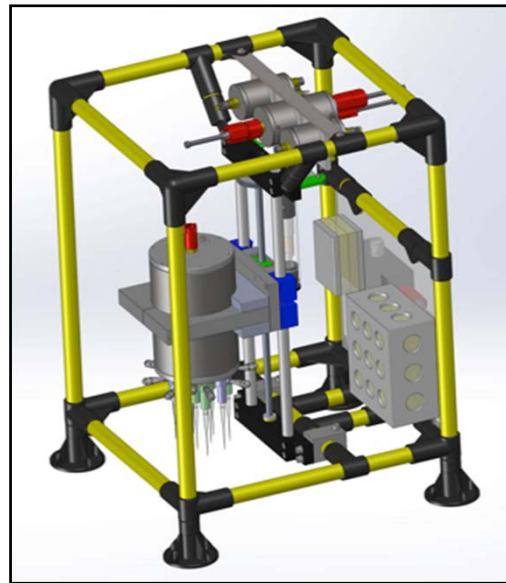
## Lander-based systems | IRIS, NIOZ, MPI, GEOMAR

- Flux lander with chambers, microprofilers
  - > sediment biogeochemical processes and interfacial fluxes
- Chamber lander for food pulse experiments with labeled algae
  - > organic matter remineralization, energy transfer
- Deep-Sea Observatory Lander (DOS) | GEOMAR
  - > BBL characteristics, seafloor observations
- Integrated Sediment Disturber (ISD) | AWI
  - > defined disturbance of circular patches



### ROV- (& crawler-) manipulated biogeochemical measurement systems | MPI

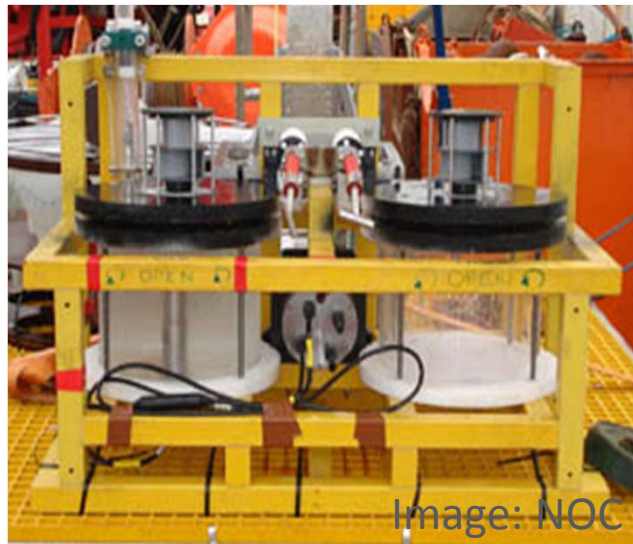
- Benthic flux measurements: chamber, microprofiler, & eddy correlation modules  
> sediment biogeochemical processes and rates
- Nodule respiration measurements with incubation chambers  
> Nodule contribution to sediment biogeochemical processes



## SO242: Main instruments

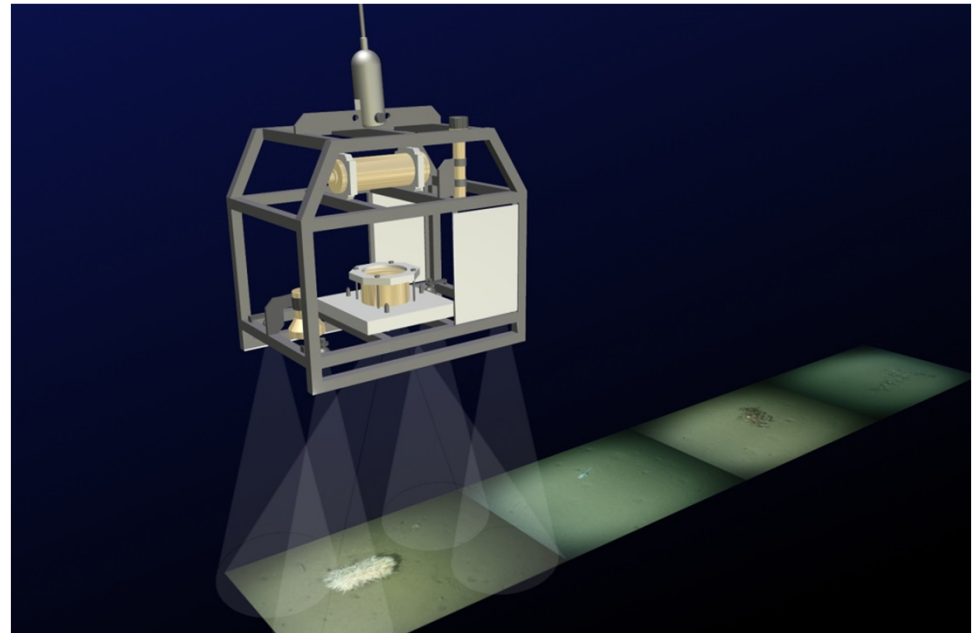
ROV- manipulated in situ experimental systems |  
ISIS, NIOZ, USOU, IMAR, UGhent

- ROV-foodpulse chambers, megafauna incubation chambers, Corrals  
> food web and ecotox studies



## Ocean Floor Observation System (OFOS) | MPI

- photographic surveys
  - > Habitat mapping and Megafauna community characterization



Images: AWI



## SO242: Main instruments

### Station time

- Total 30 d (720 h)

