Microbial and viral communities of the deep seafloor sediment and manganese nodules from the CCZ, Pacific

**J. M. OTTE**1,2,3, M. MOLARI1,3, B. C. YAPAN1,3, J. B. VOLZ2, Y. BODURI1,3, F. JANSEN1,2,3, F. WENZHÖFER1,2,3

1HGF MPG Group on Deep Sea Ecology and Technology, 2 Alfred-Wegener-Institute Helmholtz Centre for Polar and Marine Research, Germany; 3 Max-Planck-Institute for Marine Microbiology, Germany

**Background & Summary**

- Manganese (Mn) nodules contain Ni, Co, Cu, Mn, Fe, and rare earth elements.
- The environmental impacts of large-scale deep-sea node mining are currently unknown.
- In Feb.-May 2019 (RV SONNE cruise SO268, Mining Impact II) the Belgian & German licence area in the Clarion-Clipperton Zone (CCZ; Eastern Pacific) were studied to obtain baseline characteristics of the >4000 m deep habitat.
- Research aspects: i) characterization of the distinct present & active microbial and viral communities of bottom water (>4000 m deep), (<5 m deep) seafloor sediment, and Mn nodules, ii) diversity and distribution of potential deep-sea cable bacteria and metal-cycling microorganisms, iii) enrichment of Mn-Fe-cycling bacteria, iv) investigation of deep-sea microbial metabolisms by metagenomic/transcriptomic, v) quantification of microbial extracellular enzyme activity & cell number, and vi) analysis of Bio-/geochemistry.
- In summary, the potential consequences associated with removal of Mn nodules and resuspension of sediments during mining could help to evaluate the environmental risks.

**Main Goals**

- To quantify microbial & viral community composition by Illumina 16S RNA sequencing (RNA & DNA based) from ≤100 Mn nodules and eight 5 m long gravity cores from the CCZ.
- To follow the distribution, quantify the abundance, detect the diversity and activity of relevant metal-cycling microorganisms, and as well of potential deep seafloor cable bacteria.
- To enrich potential Mn- and Fe-cycling microorganisms from “live” sediment & “live” Mn nodules under (an)oxic conditions.
- To evaluate microbial activity by extracellular enzyme activity.
- To investigate microbial metabolism of potential Mn- and Fe-cycling microbes by metagenomics/metatranscriptomics.
- To compare metal-cycler of different locations (a) Mn nodule areas (CCZ/DISCOL), (b) massive sulfide deposit (Indian Ocean).

**Field Sites – Clarion-Clipperton Fracture Zone (Eastern Pacific Ocean)**

Sampling locations of cruises SO239 & SO268

**Manganese (Mn) Nodules**

- ≤100 Mn nodules from BGR & GSR and different depth (≤0.5 cm)
- Differences in volume (17 - 640 cm³), weight (30 - 960 g), shape (round or elliptical), porosity, attached fauna
- Subsamples from on top of the nodule surface (a), bottom side (b), inside of the nodule core (c), 3 samples per nodule for DNA & RNA extraction; enzyme activity tests; cell counts

**Gravity Core Sediment**

- 5 m long gravity cores (GC) from eight different locations of the CCZ
- Differences in O₂ penetration depth (around 2-3.5 m;oxic and suboxic layers)
- 8 to 27 samples per GC core, taken at 0.5 m depth; stored at -20°C and -80°C
- Preliminary enzyme activity results of an oxic GC (GSR) from a carc region: Aminopeptidase activity until 40 ± 5 cm depth – detectable active C₄₀ degradation

**Preliminary Results – Microbial Activity of Manganese Nodules**

- e.g. β-Glucosidase and Chitobiase

**Working on board during SO268**

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