ENVIRONMENTAL WORK CARRIED OUT BY IOM

Dr. Valcana Stoyanova  
Interoceanmetal Joint Organization  Szczecin,  Poland
Since its establishment IOM carried out a total of 20 research cruises.

The IOM exploration area (Sectors B1 and B2) extends meridionally over 510 km.
IOM contribution to development of Geological Model of CCZ

Area ~ 800,000 km²
Latitude: 8°38.77’ - 16° 52.76’N
Longitude: 118°52.5’–125°19.75’ W
Depth: 3,470 - 4,940 m

Amount of stations used: 985 sampled during 1990 – 2009
IOM exploration area (B1 and B2 Sectors) covers 75 000 km$^2$ in the eastern CCZ

- Seafloor morphology: fairly complex: around 30% has a slope exceeding 7°; Basement of volcanic massifs cover ~310km$^2$;

- Bottom sediment consists of clays and oozes with montmorillonite, chlorite, amorphous silica (Marquesas and Clipperton formation).

- Average nodule abundance is ~ 8.4 kg/m$^2$, with recorded maxim to 22.6 kg/m$^2$. 
Essentially, the IOM comprehensive environmental program began in 1994 and consists of two main phases:

*Phase I*: 1994 – 2000;

*Phase II*: 2001 – to present
Phase I: 1994 – 2000

Objective: to understand the natural environment conditions in the IOM claim area, to assess its spatial and temporal variability and to evaluate the potential impacts by nodule mining.

Study Subject (1):
- physical, chemical profiles in the water column;
- near-bottom currents regime;
- seafloor morphology;
- sediment mechanics;
- chemical composition of sediments;
- pore waters chemistry (nutrients, heavy metals);
- macro- and megabenthos.
Methodology:

- CTD casts, and water sampling by the Rosette sampler (14 stations observed in Oct, 1994 and Mar, 1995);
- current measurements (4 moorings for 8 months);
- box core (0.25 sq. m) sampling;
- observation with deep-towed acoustic and TV-photo profiling devices.

IOM Reference transect
For Phase I studies, a field experiment IOM BIE involving creation of stress to benthic communities and their habitat was conducted and subsequently monitored during 5 years.

**Study Subject (2):**
- disturbance thickness;
- suspension and re-settlement sediment;
- near-bottom currents regime;
- changes in the sediment properties;
- pore waters chemistry (nutrients, heavy metals);
- biological response to the disturbance in time series.
Methodology:

- Deep Sea Sediment Resuspension System (Disturber; SOSI) operations;
- sediment sampling by multiple and box corers;
- mooring system observation using current meters and sediment traps;
- TV-photo profiling.
Results of study done under Phase I were published in following papers:


Objective: to gather environmental baseline data necessary for establishment of baselines against which to assess the likely effects of its activities on marine environment and development of marine environment monitoring program.

Study Subject:
- meteorological observations;
- sediment and pore waters properties at specific layers;
- bioturbation;
- epibenthic megafaunal and macrofaunal communities’ characteristics.
Methodology:
- sediment sampling by box corers, equipped with a digital DSC-VI colour camera;
- TV-photo profiling;
- Side scan sonar and acoustic survey;
- Laboratory assays.


- Seafloor sediments were sampled and analyzed at a total of 311 stations;
- Epibenthic megafauna assemblages and its biogenic traces (*Lebensspuren*) was analyzed along 20 transects over a total of 607 km distance;
- Bioturbation ($^{210}$Pb) assay at 5 stations is in progress now;
- Macrofauna (composition and abundance) examination is in processing now.
In accordance with ISA guidelines on the assessment of potential environmental effects of exploration of polymetallic nodules in the Area (ISBA/7/LTC/Rev.1) and the recommendations developed by the ISA workshop on data standardisation (ISBA/10/LTC/4) all available data and information are currently processing on 6 groups of parameters: physical oceanography, chemical oceanography, sediment properties, biological communities, bioturbation, and sedimentation processes.
**Meteorological variables**


<table>
<thead>
<tr>
<th>Parameters (X)</th>
<th>Air temperature (°C)</th>
<th>Water temperature (°C)</th>
<th>Wind speed (m/s)</th>
<th>Wind direction (°)</th>
<th>Sea state (B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of measurements, N</td>
<td>443</td>
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<td>$X_{min}$</td>
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<td>$X_{max}$</td>
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<td>30</td>
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<td>350</td>
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</tr>
<tr>
<td>$X_{mean}$</td>
<td><strong>28.3</strong></td>
<td><strong>28.5</strong></td>
<td><strong>6.83</strong></td>
<td><strong>63.5</strong></td>
<td><strong>2.4</strong></td>
</tr>
</tbody>
</table>
Sediment properties

- **Physical and mechanical characteristics**: bulk density, solid density, porosity, water contents, shear strength, vane shear, grain size;

- **Organic and inorganic carbon and calcium carbonate contents**;

- **pH, Eh, and amorphous silica (opal)**;

- **Heavy metals**: Fe, Mn, Co, Ni, Cu, Zn, Pb, Cd, As;

- **Pore water nutrients** (nitrites, nitrates, phosphates, and silicates);

- **Pore water heavy metals** (Fe, Mn, Co, Ni, Cu, Zn, Pb, Cd, As).
Types of deep sea sediments used for data systematization

- Silicious silty clay ($\text{SiO}_2 \text{ am} > 10 \%$);
- Slightly silicious silty clay ($\text{SiO}_2 \text{ am} 5\text{-}10 \%$);
- Red pelagic clays with zeolites ($\text{SiO}_2 \text{ am} < 5 \%$);
- Diatom ooze ($\text{SiO}_2 \text{ am} > 30 \%$);
- Radiolarian ooze (as above);
- Zeolitic crusts.

Intervals for measurements:
- 0 – 3 (5) cm geochemically active layer;
- 10 – 15 cm;
- 20 – 25 cm, and
- up to 40 cm in special case.

Sediments and nodules have been routinely studied at each station.
Nutrients and metal contents in pore waters and metals in sediment (Sta 2268)
<table>
<thead>
<tr>
<th>Sediment type</th>
<th>Bulk density, g/cm³</th>
<th>Solid density, g/cm³</th>
<th>Water content, %</th>
<th>Porosity, %</th>
<th>Shear strength, kPa</th>
<th>Vane shear strength, kPa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sediments of geochemically active layer</td>
<td>1.15 – 1.23 (n=219)</td>
<td>2.2 – 2.95 (n=219)</td>
<td>248 - 470 (n=232)</td>
<td>85 – 92 (n=199)</td>
<td>0.0 – 1.4 (n=29)</td>
<td>0.0 – 0.4 (n=67)</td>
</tr>
<tr>
<td>Slightly siliceous clayey silts</td>
<td>1.16 – 1.28 (n=532)</td>
<td>2.34 – 2.95 (n=532)</td>
<td>210 – 437 (n=552)</td>
<td>84 – 92 (n=479)</td>
<td>0.8 – 11.0 (n=427)</td>
<td>0.9 – 24.0 (n=480)</td>
</tr>
<tr>
<td>Siliceous clayey silts</td>
<td>1.18 – 1.25 (n=102)</td>
<td>2.29 – 2.94 (n=102)</td>
<td>219 – 342 (n=112)</td>
<td>83 – 90 (n=73)</td>
<td>0.8 – 5.8 (n=77)</td>
<td>1.3 – 16.0 (n=106)</td>
</tr>
<tr>
<td>Calcareous clayey silts</td>
<td>1.20 – 1.25 (n=11)</td>
<td>2.4 – 2.94 (n=11)</td>
<td>247 – 335 (n=12)</td>
<td>86 – 90 (n=11)</td>
<td>1.1 – 2.4 (n=9)</td>
<td>2.6 – 5.9 (n=6)</td>
</tr>
<tr>
<td>Red and zeolitic clays</td>
<td>1.18 – 1.54 (n=103)</td>
<td>2.42 – 2.96 (n=103)</td>
<td>96 – 360 (n=108)</td>
<td>74 – 90 (n=90)</td>
<td>1.3 – 12.0 (n=61)</td>
<td>2.7 – 19.0 (n=74)</td>
</tr>
<tr>
<td>Radiolarian oozes</td>
<td>1.12 – 1.25 (n=21)</td>
<td>2.05 – 3.0 (n=21)</td>
<td>255 – 591 (n=27)</td>
<td>86 – 95 (n=18)</td>
<td>2.1 – 40.0 (n=19)</td>
<td>3.9 – 114.0 (n=22)</td>
</tr>
<tr>
<td>Sediment type</td>
<td>Layer thickness , cm</td>
<td>$C_{\text{org}}$ ,%</td>
<td>$\text{CaCO}_3$ , %</td>
<td>$C_{\text{carb}}$ , %</td>
<td></td>
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<td>-------------------------------------------------</td>
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</tr>
<tr>
<td>Geochemically active sediment layer throughout the area</td>
<td>6.3±2.08 (n=110)</td>
<td>0.43±0.73 (n=108)</td>
<td>0.43±1.77 (n=107)</td>
<td>0.057±0.25 (n=65)</td>
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</tr>
<tr>
<td>Slightly siliceous clayey silts</td>
<td>6.3±2.16 (n=51)</td>
<td>0.43±0.07 (n=50)</td>
<td>0.16±0.15 (n=50)</td>
<td>0.013±0.01 (n=24)</td>
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</tr>
<tr>
<td>Siliceous clayey silts</td>
<td>6.7±1.6 (n=28)</td>
<td>0.41±0.04 (n=28)</td>
<td>0.13±0.13 (n=28)</td>
<td>0.011±0.003 (n=18)</td>
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<tr>
<td>Calcareous clayey silts</td>
<td>8.0±1.4 (n=2)</td>
<td>0.72±0.04 (n=2)</td>
<td>4.25±1.18 (n=2)</td>
<td>0.51±0.141 (n=2)</td>
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</tr>
<tr>
<td>Foraminiferan oozes</td>
<td>3.5±2.1 (n=2)</td>
<td>0.58±0.01 (n=3)</td>
<td>8.17±11.0 (n=3)</td>
<td>0.98±1.32 (n=3)</td>
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<tr>
<td>Red and zeolithic clays</td>
<td>5.4±2.0 (n=21)</td>
<td>0.44±0.06 (n=20)</td>
<td>0.48±1.64 (n=19)</td>
<td>0.012±0.008 (n=14)</td>
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<tr>
<td>Ethmodiscus oozes</td>
<td>8.7±3.1 (n=3)</td>
<td>0.39±0.03 (n=3)</td>
<td>0.08±0.01 (n=3)</td>
<td>0.01±0 (n=2)</td>
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</table>
### pH, Eh, and amorphous silica

<table>
<thead>
<tr>
<th>Sediment type</th>
<th>Layer thickness, cm</th>
<th>pH</th>
<th>Eh</th>
<th>SiO$_{2am}$, %</th>
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</thead>
<tbody>
<tr>
<td>Geochemically active sediment layer throughout the area</td>
<td>6.3±2.08 (n=110)</td>
<td>7.39±0.12  (n=110)</td>
<td>553±110  (n=110)</td>
<td>9.59±3.92  (n=107)</td>
</tr>
<tr>
<td>Slightly siliceous clayey silts</td>
<td>6.3±2.16 (n=51)</td>
<td>7.38±0.11  (n=52)</td>
<td>561±2  (n=52)</td>
<td>8.50±1.62  (n=50)</td>
</tr>
<tr>
<td>Siliceous clayey silts</td>
<td>6.68±1.6 (n=28)</td>
<td>7.41±0.11  (n=28)</td>
<td>544±2  (n=28)</td>
<td>12.61±4.01  (n=28)</td>
</tr>
<tr>
<td>Slightly calcareous clayey silts</td>
<td>5.7±1.2 (n=3)</td>
<td>7.39±0.21  (n=3)</td>
<td>552±67  (n=3)</td>
<td>10.2±0.15  (n=3)</td>
</tr>
<tr>
<td>Foraminiferan oozees</td>
<td>3.5±2.1 (n=2)</td>
<td>7.49±0.02  (n=2)</td>
<td>497±14  (n=2)</td>
<td>6.64±8.68  (n=2)</td>
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<tr>
<td>Red and zeolithic clays</td>
<td>5.4±2.1 (n=21)</td>
<td>7.37±0.11  (n=20)</td>
<td>562±40  (n=20)</td>
<td>8.17±5.8  (n=19)</td>
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<tr>
<td>Ethmodiscus oozees</td>
<td>8.7±3.1 (n=3)</td>
<td>7.33±0.04  (n=3)</td>
<td>541±86  (n=3)</td>
<td>10.27±1.82  (n=3)</td>
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### Heavy metals

<table>
<thead>
<tr>
<th>Sediment type</th>
<th>Fe [%]</th>
<th>Mn [%]</th>
<th>Cu [ppm]</th>
<th>Ni [ppm]</th>
<th>Zn [ppm]</th>
<th>Co [ppm]</th>
<th>Pb [ppm]</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Geochemically active layer</strong></td>
<td>3.99±0.39</td>
<td>0.49±0.18</td>
<td>341±146</td>
<td>190.9±137.3</td>
<td>117.2±52.3</td>
<td>71.8±46.9</td>
<td>33.±10.3</td>
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<td>(n=109)</td>
<td>(n=109)</td>
<td>(n=109)</td>
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<td>(n=109)</td>
<td>(n=109)</td>
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<td>(n=109)</td>
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<tr>
<td><strong>Slightly siliceous clayey silts</strong></td>
<td>4.03±0.38</td>
<td>0.46±0.11</td>
<td>309.4±82.0</td>
<td>169.6±36.1</td>
<td>122.8±46.9</td>
<td>64.2±11.4</td>
<td>33.8±6.06</td>
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<tr>
<td>(n=50)</td>
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<td>(n=50)</td>
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<tr>
<td><strong>Siliceous clayey silts</strong></td>
<td>3.88±0.32</td>
<td>0.46±0.19</td>
<td>337.4±17.0</td>
<td>193.5±182.0</td>
<td>101.1±44.5</td>
<td>70.2±44.5</td>
<td>32.1±11.1</td>
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<tr>
<td><strong>Foraminiferan oozees</strong></td>
<td>3.9±0.28</td>
<td>0.67±0.07</td>
<td>355±35.4</td>
<td>170±70.7</td>
<td>85±21.2</td>
<td>58.6±16.2</td>
<td>29±2.83</td>
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<tr>
<td><strong>Red and zeolithic clays</strong></td>
<td>4.14±0.42</td>
<td>0.57±0.27</td>
<td>430±219</td>
<td>242.7±22.5</td>
<td>131.4±66.2</td>
<td>96.0±89.7</td>
<td>37.3±16.9</td>
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<tr>
<td><strong>Ethmodiscus oozees</strong></td>
<td>3.52±0.71</td>
<td>0.43±0.16</td>
<td>320±101</td>
<td>160±52.9</td>
<td>153±105</td>
<td>61.2±8.6</td>
<td>30±6.6</td>
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</table>
# Pore waters Nutrients

<table>
<thead>
<tr>
<th>Sediment type</th>
<th>NO$_2^-$</th>
<th>NO$_3^-$</th>
<th>PO$_4^{3-}$</th>
<th>SiO$_3^{2-}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geochemically active sediment layer throughout the area</td>
<td>0.22±0.11 (n=107)</td>
<td>39.74±20.7 (n=107)</td>
<td>2.42±0.44 (n=107)</td>
<td>332.2±35.6 (n=107)</td>
</tr>
<tr>
<td>Slightly siliceous clayey silts</td>
<td>0.22±0.10 (n=50)</td>
<td>37.42±5.3 (n=50)</td>
<td>2.46±0.44 (n=50)</td>
<td>330.6±37.4 (n=50)</td>
</tr>
<tr>
<td>Siliceous clayey silts</td>
<td>0.22±0.12 (n=28)</td>
<td>37.35±5.9 (n=28)</td>
<td>2.23±0.35 (n=28)</td>
<td>327.9±36.9 (n=28)</td>
</tr>
<tr>
<td>Slightly calcareous clayey silts</td>
<td>0.11±0.01 (n=3)</td>
<td>36.89±2.34 (n=3)</td>
<td>2.32±0.11 (n=3)</td>
<td>331.1±40.3 (n=3)</td>
</tr>
<tr>
<td>Calcareous clayey silts</td>
<td>0.16±0.01 (n=2)</td>
<td>43.5±0.43 (n=2)</td>
<td>2.5±0.29 (n=2)</td>
<td>324.2±0.01 (n=2)</td>
</tr>
<tr>
<td>Foraminiferan oozes</td>
<td>0.11±0.09 (n=2)</td>
<td>41.64±4.32 (n=2)</td>
<td>2.0±0.13 (n=2)</td>
<td>331±44.9 (n=2)</td>
</tr>
<tr>
<td>Red and zeolithic clays</td>
<td>0.22±0.09 (n=19)</td>
<td>38.51±4.91 (n=19)</td>
<td>2.58±0.50 (n=19)</td>
<td>345.9±31.2 (n=19)</td>
</tr>
<tr>
<td>Ethmodiscus oozes</td>
<td>0.20±0.04 (n=3)</td>
<td>107.94±118.7 (n=3)</td>
<td>2.64±0.66 (n=3)</td>
<td>317.9±22.9 (n=3)</td>
</tr>
</tbody>
</table>
**Heavy metals in pore waters (ppb)**

<table>
<thead>
<tr>
<th>Sediment type</th>
<th>Fe</th>
<th>Mn</th>
<th>Co</th>
<th>Ni</th>
<th>Cu</th>
<th>Zn</th>
<th>Pb</th>
<th>Cd</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Geochemically active sediment layer throughout the area</strong></td>
<td>1.74±1.6 (n=64)</td>
<td>4.43±9.8 (n=64)</td>
<td>0.037±0.03 (n=64)</td>
<td>2.40±2.3 (n=64)</td>
<td>5.67±3.3 (n=64)</td>
<td>9.51±6.6 (n=64)</td>
<td>3.08±2.2 (n=64)</td>
<td>0.55±0.5 (n=64)</td>
</tr>
<tr>
<td><strong>Slightly siliceous clayey silts</strong></td>
<td>1.6±1.3 (n=24)</td>
<td>4.16±7.2 (n=24)</td>
<td>0.036±0.02 (n=24)</td>
<td>3.08±3.3 (n=24)</td>
<td>6.27±2.9 (n=24)</td>
<td>8.76±3.1 (n=24)</td>
<td>3.75±2.9 (n=24)</td>
<td>0.73±0.7 (n=24)</td>
</tr>
<tr>
<td><strong>Siliceous clayey silts</strong></td>
<td>2.02±2.4 (n=19)</td>
<td>3.07±2.1 (n=19)</td>
<td>0.024±0.01 (n=19)</td>
<td>1.91±1.4 (n=19)</td>
<td>4.96±2.6 (n=19)</td>
<td>8.94±6.7 (n=19)</td>
<td>2.78±1.4 (n=19)</td>
<td>0.44±0.5 (n=19)</td>
</tr>
<tr>
<td><strong>Slightly calcareous clayey silts</strong></td>
<td>1.20±0.36 (n=3)</td>
<td>2.61±1.24 (n=3)</td>
<td>0.031±0.03 (n=3)</td>
<td>0.82±0.1 (n=3)</td>
<td>4.13±0.87 (n=3)</td>
<td>5.79±1.86 (n=3)</td>
<td>1.61±0.04 (n=3)</td>
<td>0.22±0.07 (n=3)</td>
</tr>
<tr>
<td><strong>Calcareous clayey silts</strong></td>
<td>1.91±0.43 (n=2)</td>
<td>37.5±0.43 (n=2)</td>
<td>0.083±0.02 (n=2)</td>
<td>1.6±1.35 (n=2)</td>
<td>3.24±0.34 (n=2)</td>
<td>7.06±1.32 (n=2)</td>
<td>2.02±0.45 (n=2)</td>
<td>0.33±0.01 (n=2)</td>
</tr>
<tr>
<td><strong>Foraminiferan oozes</strong></td>
<td>0.43 (n=1)</td>
<td>0.53 (n=1)</td>
<td>0.024 (n=1)</td>
<td>1.5 (n=1)</td>
<td>3.06 (n=1)</td>
<td>20.4 (n=1)</td>
<td>4.34 (n=1)</td>
<td>0.47 (n=1)</td>
</tr>
<tr>
<td><strong>Red and zeolithic clays</strong></td>
<td>1.72±1.1 (n=13)</td>
<td>2.57±1.2 (n=13)</td>
<td>0.05±0.05 (n=13)</td>
<td>2.50±1.7 (n=13)</td>
<td>6.87±5.1 (n=13)</td>
<td>12.7±10.7 (n=13)</td>
<td>2.92±2.1 (n=13)</td>
<td>0.49±0.3 (n=13)</td>
</tr>
<tr>
<td><strong>Ethmodiscus oozes</strong></td>
<td>1.17 (n=1)</td>
<td>5.55 (n=1)</td>
<td>0.078 (n=1)</td>
<td>3.32 (n=1)</td>
<td>5.65 (n=1)</td>
<td>5.2 (n=1)</td>
<td>2.16 (n=1)</td>
<td>1.09 (n=1)</td>
</tr>
</tbody>
</table>
Nodule blanketing by sediment as evidence of the complexity and length of geological processes.

Ratio of blanket nodules can reach to 90%.

Blanketing nodules

Nodule blanketing by the sediment is a more characteristic feature of the northern part.

Buried nodules
Recent environmental work carried by IOM were focused on examination of composition, abundance, and spatial distribution pattern of megabenthos.

Biogenic traces on bottom sediment (*Lebensspuren*) were also analyzed.

Some results will be now presented.
## Taxonomy of recognized benthic animals
*(in accordance with ITIS)*

<table>
<thead>
<tr>
<th>Phylum</th>
<th>Protozoa</th>
<th>Subphylum Sarcodina</th>
<th>Superclass Rhizopoda Class Xenophyophorida</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phylum</td>
<td>Porifera</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phylum</td>
<td>Cnidaria</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phylum</td>
<td>Annelida</td>
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<td></td>
</tr>
<tr>
<td>Phylum</td>
<td>Arthropoda</td>
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<tr>
<td>Phylum</td>
<td>Mollusca</td>
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<td></td>
</tr>
<tr>
<td>Phylum</td>
<td>Echinodermata</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phylum</td>
<td>Chordata</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Phylum Protozoa
- **Subphylum Sarcodina**
- **Superclass Rhizopoda Class Xenophyophorida**

### Phylum Porifera
- **Superclass**

### Phylum Cnidaria
- **Subphylum Medusozoa**
- **Class Scyphozoa**
- **Class Hydrozoa**
- **Class Anthozoa**
  - **Subclass Hexacorallia**
    - **Order Actiniaria**
    - **Subclass Zoantharia**
    - **Order Antipatharia**
    - **Order Ceriantharia**

### Phylum Annelida
- **Class Polychaeta**

### Phylum Arthropoda
- **Subphylum Crustacea**
- **Class Gastropoda**
- **Class Cephalopoda**
  - **Subclass Coleoidea**
  - **Superorder Octobrachia**
  - **Order Octopoda**
  - **Superorder Decabrachia**

### Phylum Mollusca
- **Class Gastropoda**
- **Class Cephalopoda**
- **Subclass Coleoidea**
- **Superorder Octobrachia**
- **Order Octopoda**
- **Superorder Decabrachia**

### Phylum Echinodermata
- **Subphylum Pelmatoza**
  - **Class Crinoidea**
  - **Class Asteroidea**
  - **Superclass Cryptosyringida**
    - **Class Holothuroidea**
    - **Class Ophiuroidea**
    - **Class Echinoidea**
    - **Order Diadematoida**
    - **Order Echinothurioida**

### Phylum Chordata
- **Subphylum Tunicata**
- **Class Asciidiaceae**
- **Subphylum Vertebrata**
- **Superclass Osteichthyes**
Xenophyophorids: The most abundant Protozoan

Average abundance reach up to 1187 inds/ha

These protozoans play the relevant role in assemblage of deep-water environment, giving for other animal groups an additional source of nutrition and a substratum for settlement and attachment.

*The ophiuroids are found in assemblage with xenophyophorids in many cases, standing on a sediment at their base.*
The most numerous metazoan fauna (2009) were:

- Sponges (~37%);
- Sea urchins (~13%);
- Ophiuroids (~12%);
- Actinians (~12%);
- Holothurians (~11%).

A particularly changes in the composition of the bottom megafauna was observed between two sets data:

In 2009 there was a strong decrease in the relative abundance of ophiuroids and holothurians.
The composition of the megafauna showed marked between-habitat differences.

The nodule bottom megafauna was dominated by sponges (to 30%), ophiuroids (to 35%), holothurians (to 20%), and fish (to 5%).

The nodule-free bottom megafauna were dominated by ophiuroids (up to 42%), holothurians (to 27%), sponges (to 13%), and fish (to 10%).

N, nodule-bearing bottom; NF, nodule-free bottom
Influences of nodules abundance on benthic community’s structure

May – June 2004

Structure of megafaunal communities (most frequent taxa) present in nodule-free and nodule-rich bearing (nodule abundance >10 kg/m²)

- Higher number of faunal morphotypes in the nodule-bearing seafloor than in the nodule-free areas
Sponges were represented mostly by class Hexactinnellida (glass sponges) and demo sponges (regular sponges), the firsts occurring mainly as stalked forms. Their abundance reach to 293 inds/ha.
Sea urchins abundance reach to 106 inds/ha. They were represented by two groups: *Plesiodiadema globulorum* from Diadematoidea order; and less numerous, group of sea urchins of Echinothurioida.
Ophiuroids occurred with the high frequency in the all habitat types. (abundance ~103 inds/ha)
Actinians were represented by six-radial corals (Hexacorallia) which in turn enters into a class of coral polyps (Anthrozoa).
(abundance ~ 102 inds/ha)
Holothurians were the most diverse abyssal megafauna group.
(abundance ~ 95 inds/ha).
Totally 160 specimens were recognized belonging to 22 species (according to Foell et al, 1986; and Tilot, 2006 classification).

Holothurian *Psychropotes longicauda*

Holothurian from *Peniagone* genus

Holothurian from *Synallactes* genus

Scotoplanes (?)
Holothurians
Many species were very rare in nodule site and were recognized only by one specimens

Porifera *Chondrocladia*

Large sea spider *Colossendeis*

Anthrozoa

Ascidia
TROPHIC STRUCTURE OF THE MEGABENTHOS

Mean abundance (ind/ha) of megafauna animals of different feeding types

The numbers of deposit feeders and suspension feeders are approximately equal, thus the carnivorous compound only 4% from the all numbers of animals.

**Detritus feeders** – Ophiuroids, Echinoids, Holothurians, Asteroids;

**Suspension feeders** – Sponges, Actinians, Anthrozoans, Antipatarians.
Carnivores
Lebensspuren

Photo: IOM

Photo: IOM

Photo: IOM

Photo: IOM
Abundance of sponges and ophiuroids (inds/ha) in the IOM site studied in 2009
The highest diversity in the structure of megafaunal communities was recorded in the gently undulating plains and on the horst slopes, thus the distribution of each faunal taxa was significant variable in respect to the bottom relief.
The study and assessment of megabenthic communities from bottom photographs represent one mobile and cost-effective possibility to obtain substantial data on environmental baselines;

The presence of nodules influences on composition and structure of benthic megafaunal communities;

Most megafauna animals are deposit and suspension feeders, consuming upper layer sediment and near bottom suspended particles;

Most suspension feeders use also nodules for attachment, so removing nodules during mining can seriously destroy their habitat;

The spatial distribution of each megafaunal group appears to vary with the associated seafloor morphology, nodule coverage and other particular features of the local environment.

Due to wide megafaunal distribution in nodule sites, the megabenthic organisms could be used as indicator group for monitoring of marine environment during mining.
CONCLUSIONS

- The major outcome of the environmental research carried out by IOM was the considerable body of data and information collected during studies in the CCZ.

- In accordance with the general objectives and priorities of IOM, most of the focus has been on sediments and nodule properties.

- Future efforts of IOM will refer to obtain substantial progress in the establishment of environmental baselines and its monitoring within prime areas.

- Development and issue of atlas of megafaunal community living within IOM exploration area is planned to be finish within next two years.

- In turn, because of the great variability of marine components and conditions within entire CCZ, a new comprehensive program for environmental research is required. Such program must rely on interaction and collaboration between contractors, scientific community, and other officials under the priority of the ISA.
ACKNOWLEDGEMENTS
The studies were supported by the IOM sponsoring states.

THANK YOU