Sampling and Taxonomy of Macrobenthos for KODOS

Ok Hwan Yu[1], Craig R. Smith[2] et al.

[1] KIOST, Korea
[2] Univ. of Hawaii t Manoa, USA

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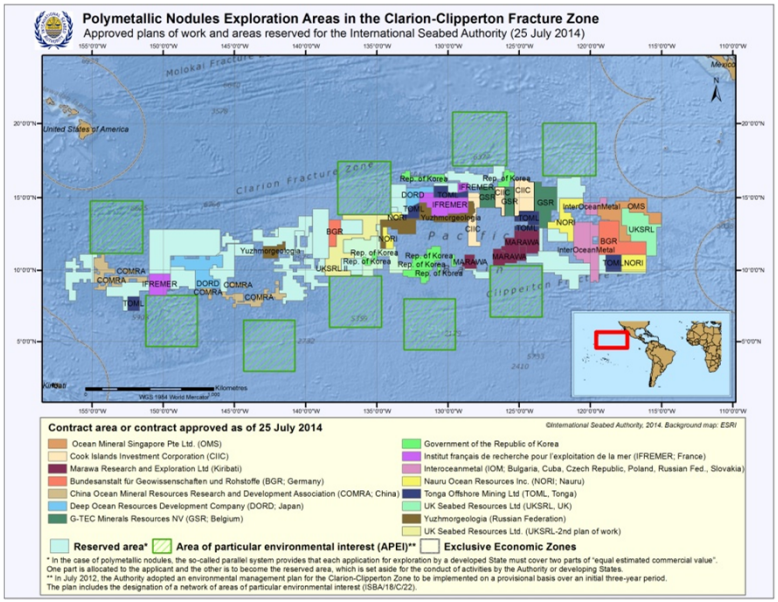
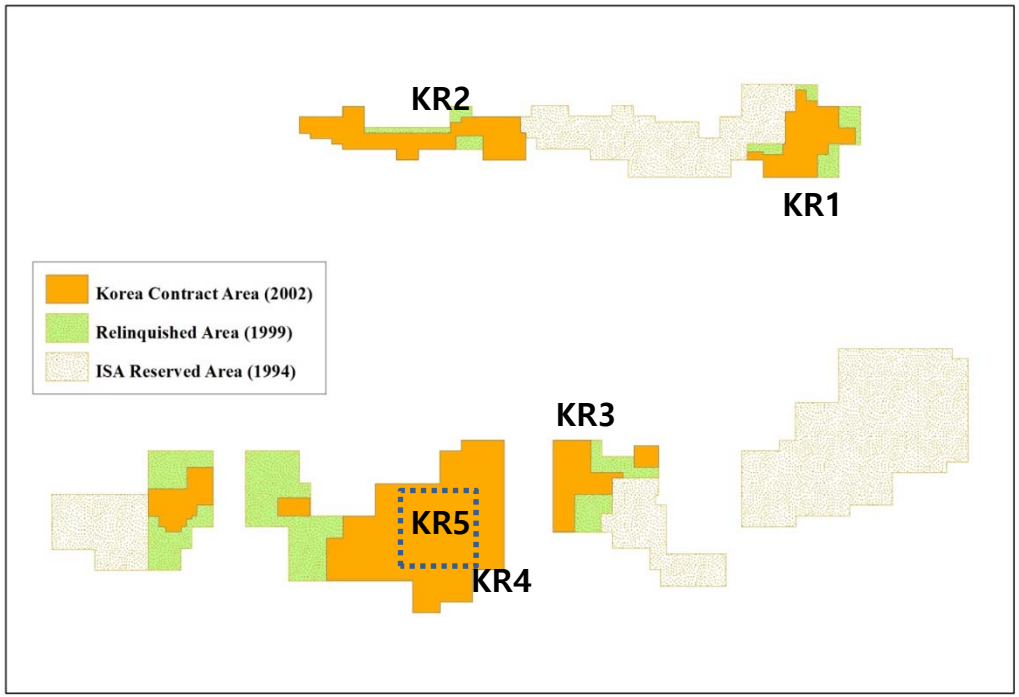
Korea Contract Area

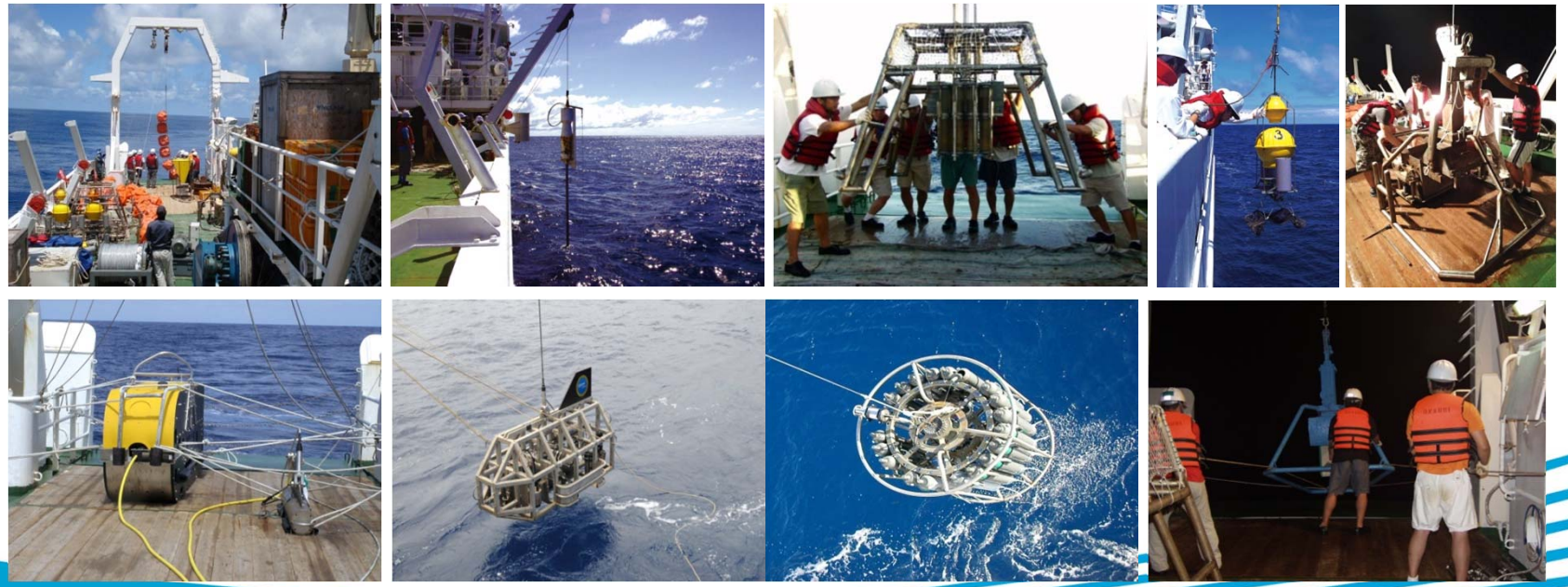
- 1994 : Registration as a pioneer investor (150,000 ㎢)
- 1997 : 1st relinquishment (30,000㎢)
- 1999 : 2nd relinquishment (15,000㎢)
- 2002 : Selection of final contract area (75,000㎢)





Exploration summary

- Stage I (1994-2010) : Resource assessment and environmental baseline study
  - ✓ 925 days (ave. 62 days/year)
- Stage II (2011-2015) : High resolution topographic and acoustic seafloor mapping in a prospective area and environment data collection for BIE (195 days)



Importance of macrofauna sampling in the nodule province

❖ Many thousands of macrofauna species have been found in the deep-sea benthic environment (e.g., 600 species of isopods from the deep Southern Ocean alone)

❖ Macrofauna are known to show relatively fast responses to changing conditions in their environment because of their sedentary life style, strong environmental associations and short life-spans

❖ All over the world macrofauna are therefore used to evaluate anthropogenic disturbance in various marine habitats (e.g., at dredge-spoil dumps and sewer outfalls)

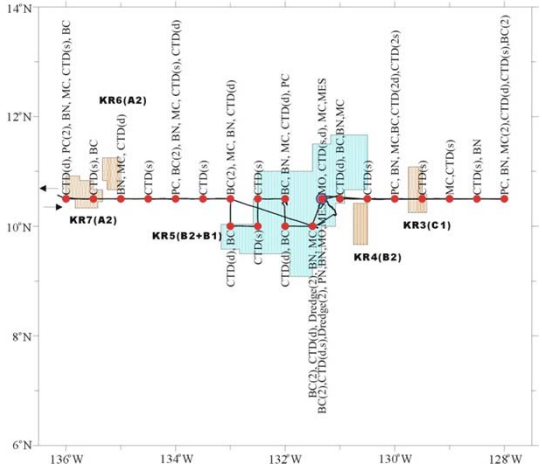
❖ Biodiversity remains poorly understood within the nodule province because of grossly under sampling and most species collected new to science

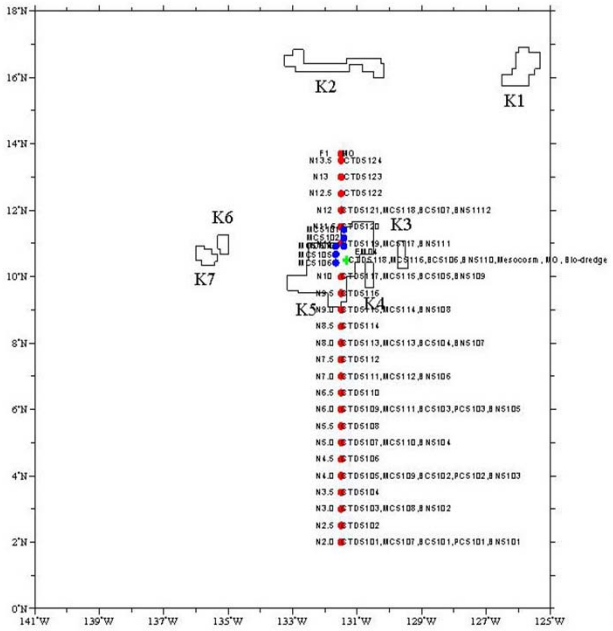
❖ Thus, evaluation of the diversity and species distribution of macrofauna is critical to predicting and managing the impacts of manganese nodule mining in the CCFZ

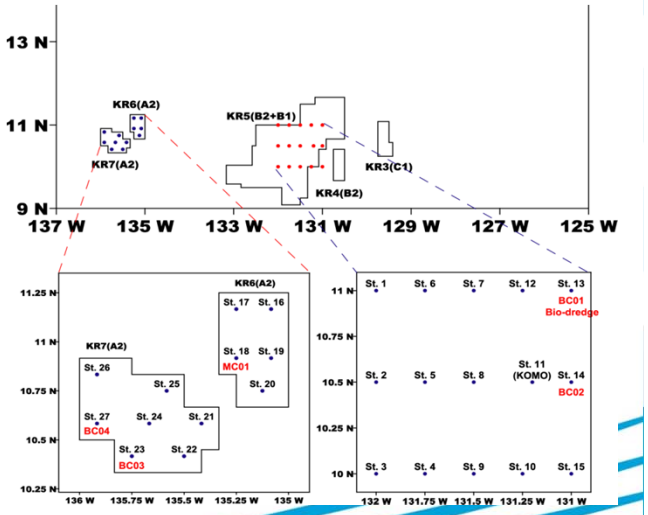
Stage I (1994-2010): traditional sampling

1998..... 2004 2006 2009 2010

- In the late 1990's, benthos was included to the monitoring program, but not sampled continuously until the middle of 2000's
- sampled longitudinally (2004), latitudinally (2005), locally (2006) around/in contracted area
  → using Box corer (0.06m²) with 500 um sieve
  → level of identification → Taxon



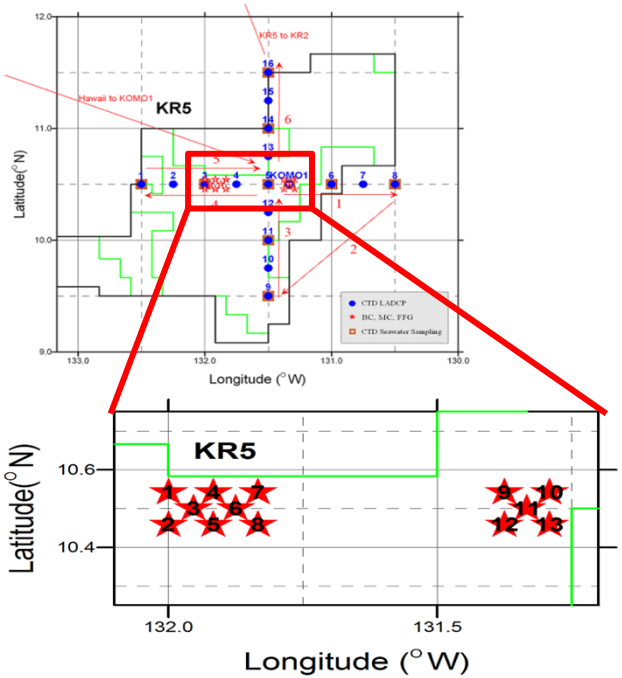




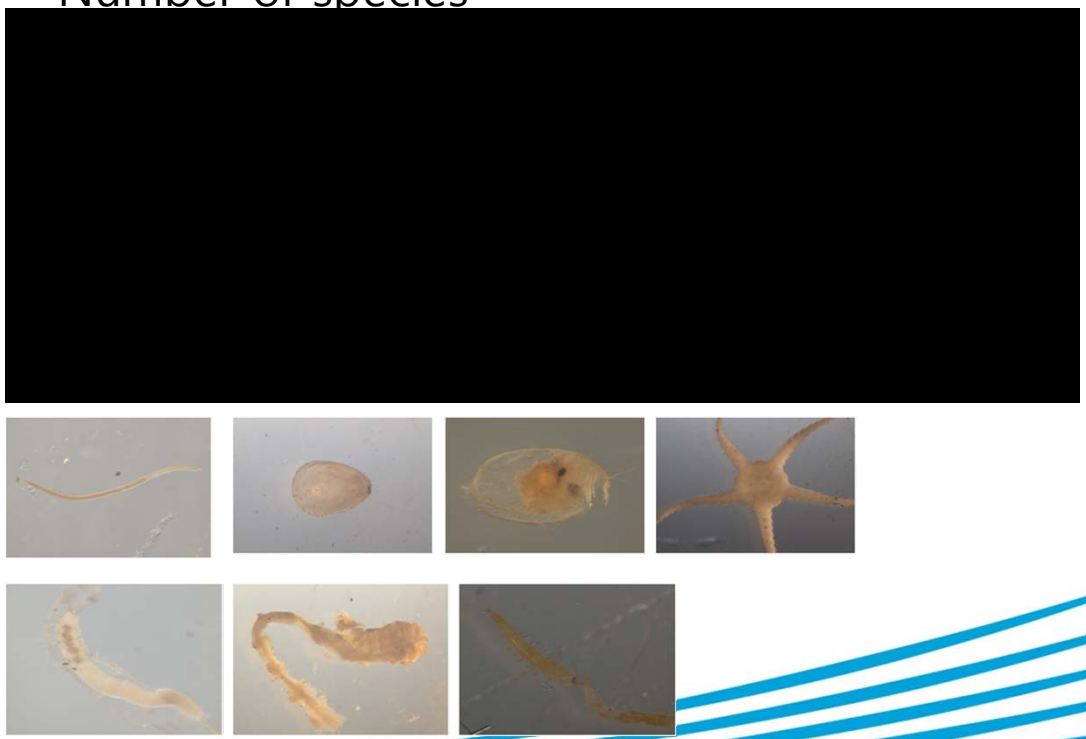
Stage I (1994-2010): traditional sampling

2004 2006 2009 2010

- **sampling inside KR5 area**
  → using Box corer (0.25m²) with 500 um sieve
  → level of identification → Taxon



Number of species



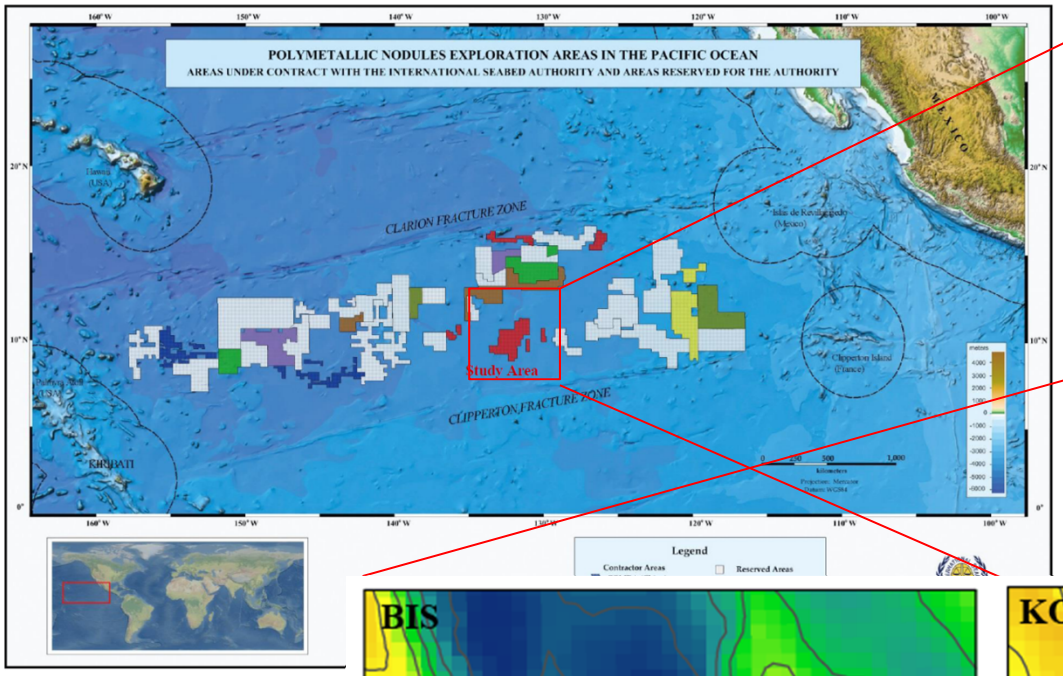
Stage II (2011-2015): Enhanced sampling

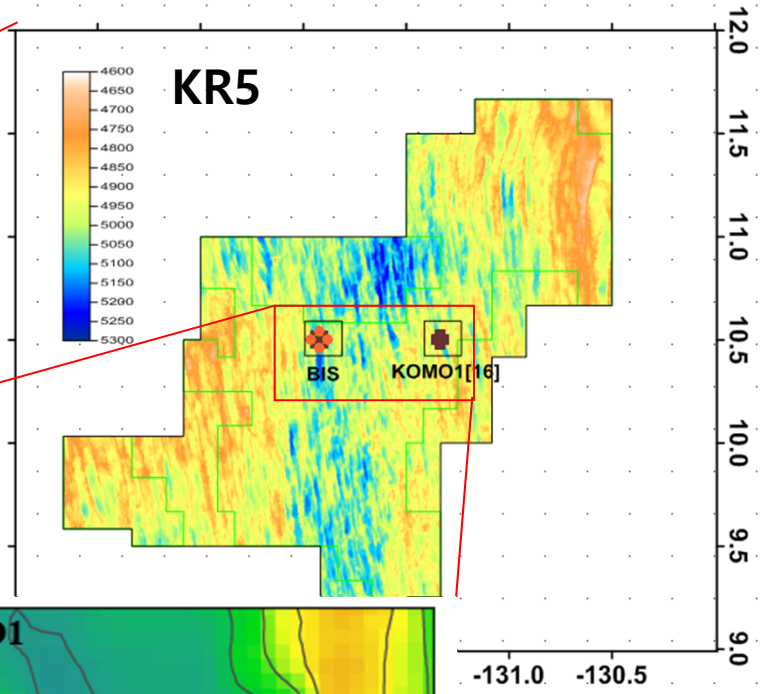
- **The macrofauna study focused on the natural variability of species and density within potential benthic impact experiment (BIE) in the KR5 block of the Korea Deep Ocean Study (KODOS) area**
  - ✓ to establish a baseline data for predicting and managing the impacts of manganese nodule mining on macrofauna community in the CCFZ

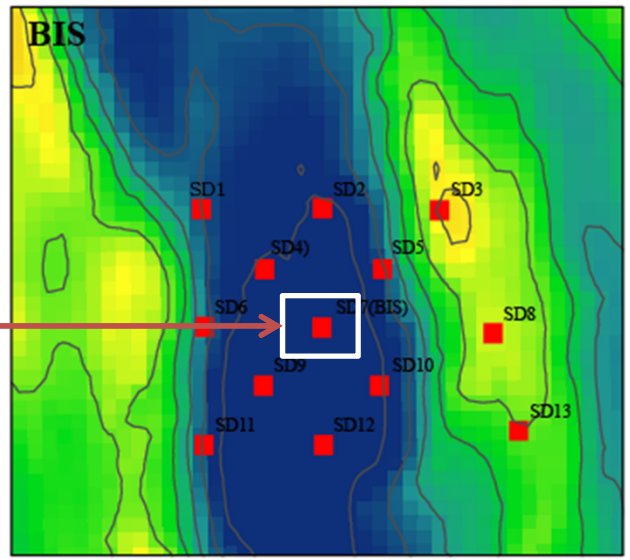
- **International collaborate study with Dr. Craig R. Smith (Univ. of Hawaii, USA)**
  - ✓ to enhanced the sampling techniques : changed the sieving size (250 um) and the sampling proceeding with a elutriation device
  - ✓ to analyze the biodiveristy of macrofaunal polychaetes and compare the diversity of polychaetes between the Korean claim areas in the central CCFZ, and other portions of the CCFZ

Sampling area (Stage II)

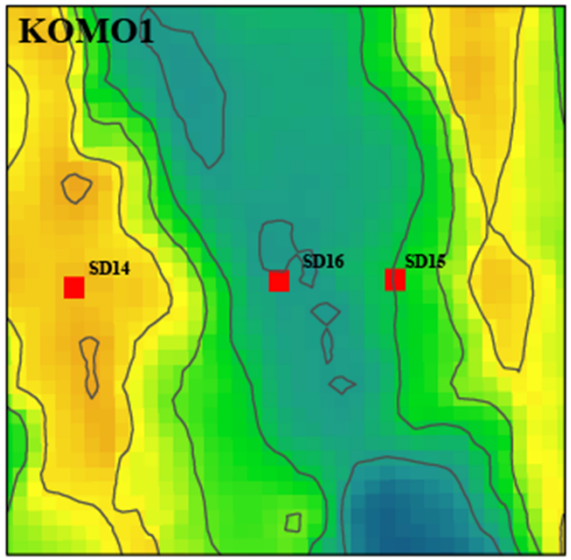
- focused on specific two areas such as potential benthic impact experiment (BIE) and reference sites (KOMO1) in the KR5 block







BIE site



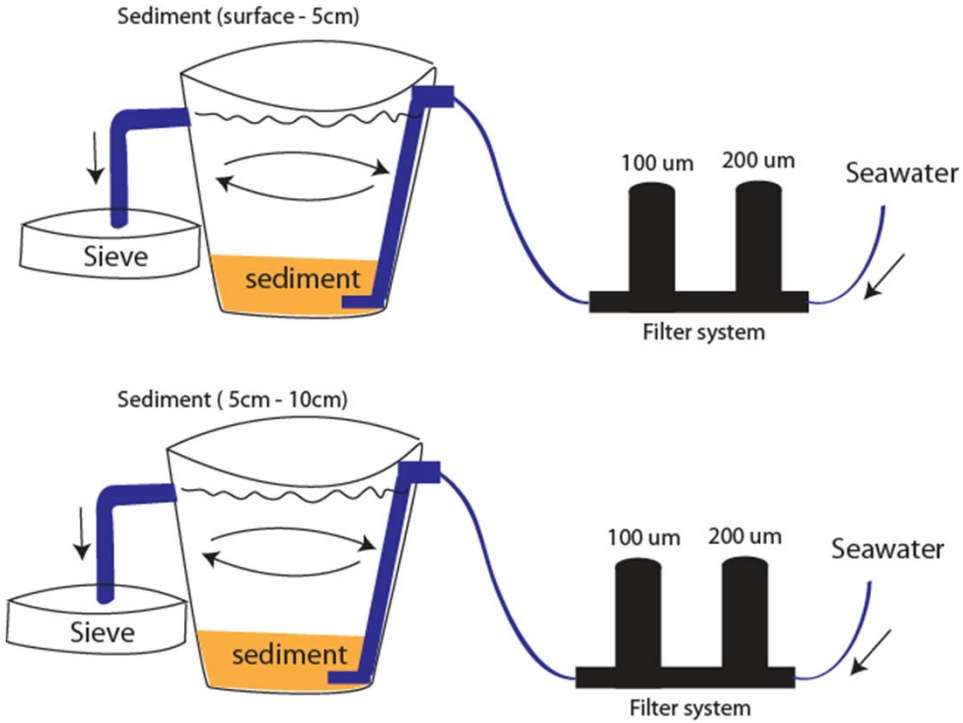
Sampling methods (Stage II)

- using a box corer (0.25m^2)
- sampling depth : upper sediment depths (from the surface to a depth of 10cm)

Sediment washing using a elutriation device

Sampling methods (Stage II)

- using a box corer (0.25m^2)
- sampling depth : upper sediment depths (from the surface to a depth of 10cm)
- seived with a 250 um mesh using a sample washing elutrator for 2 hours



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Results : diversity and abundance of macrofauna

- Species: 11 taxa 45 species (2012) → 21 taxa 96 species (2013)
- Mean density: 84 ind./m^2 (2012) → 514 ind./m^2 (2013)
- High density in upper sediments (surface -5cm depth)
- Polychaetes and crustaceans comprising the dominant taxa
- polychaetes : 43 species identifying
- Crustacea: 16 species of isopods, 9 tanaidacean species, 3 cumacean species, 3 ostracod species, 5 amphipod species

Polychaete species

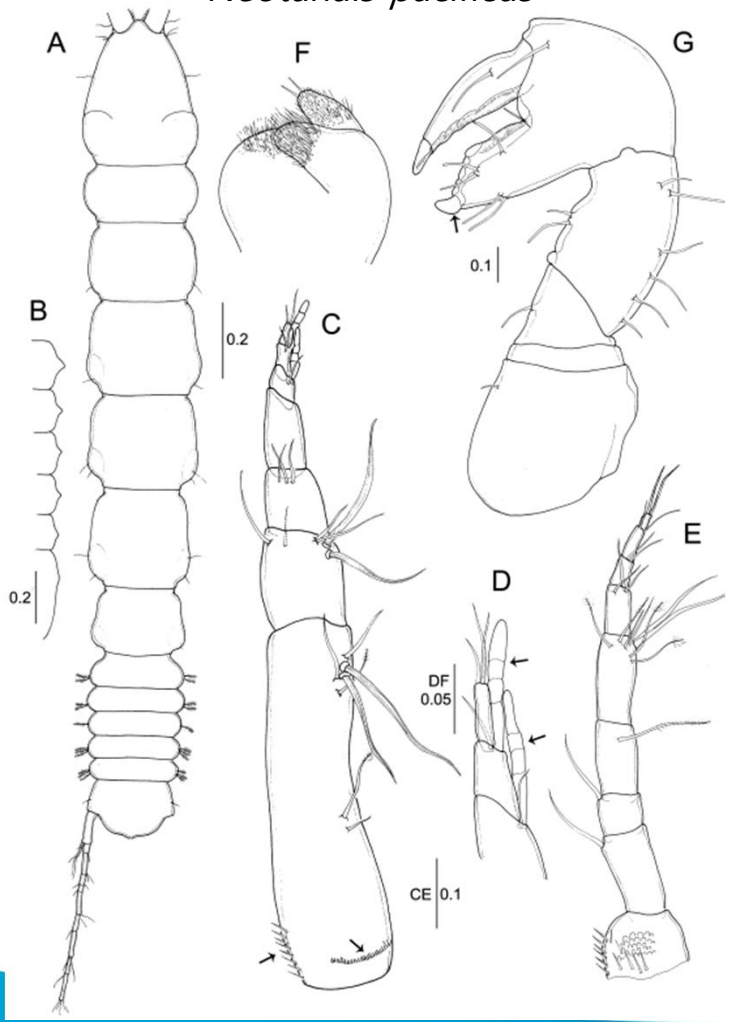
Cirratulidae sp.1	Paraonidae sp. 4 - Aricidea sp. B
Ctenodrilidae sp. 1	Pseudomystides sp. A - Pseudomystides cf. rarica
Opheliidae sp. 2 - Kesun cf. abyssorum	Capitellidae sp. 1
Paraonidae sp.1	Goniadidae sp.1
Paraonidae sp. 2 - cf. Paraonella abranchiata	Lumbrineridae sp.1
Serpulidae sp.1	Chaetozone sp. A
Aurospio dibranchiata	Acrocirridae sp. 3
Ceratocephale sp. A - Ceratocephale abyssorum	Cirratulidae. sp. 1 - Tharyx sp. A
Alciopina cf. parasitica	Aphelochaeta sp. A
Glycera sp. A	Eumida sp. A
Phyllodocidae sp.1	Syllidae sp. 1
Spionidae sp.1	Ampharetidae sp. 1
Spiophanes sp. indeterminate	Onuphidae sp. 2
Exogone (Parexogone) sp. A	Paraonidae sp. 3 - Aricidea sp. A
Paralacydoniidae sp. 1 - Paralacydonia cf. paradoxa	Braniella palpata
Acrocirridae sp.1	Euphrosinopsis cf. crassiseta
Acrocirridae sp. 2 - Flabelligena sp. A	Sphaerodoropsis sp. A
Notomastus sp. A	Paralacydoniidae sp.1
Goniadidae sp. 2 - Progoniada cf. regularis	Glycera sp. B
Opheliidae sp.1	Trichobranchidae sp. 1 - cf. Terebellides abyssalis
Paraonidae sp. 1 - Levinsenia uncinata	Monticellina sp. A
	Dorvilleidae sp. 1

Taxa	Species	Taxa	Species
CIS	Desmosoma sp1	CTA	Carpoapseudes sp1
CIS	Eurycope sp1	CTA	Colletea sp1
CIS	Haplomesus sp1	CTA	Colletea sp2
CIS	Haploniscus sp 2	CTA	Leviapseudes sp1
CIS	Haploniscus sp3	CTA	Stenotanais arenasi
CIS	Haploniscus sp4	CTA	Tanadicaea bc130212 sp1
CIS	Ianirella sp1	CTA	tanaidacea
CIS	Ilyarachna sp1.	CTA	Typhlotanais pereosetulosa
CIS	Jaeropsis sp1	CTA	Typhlotanais sp1
CIS	Macrostylis hadalis	CAM	amphipod sp1
CIS	Macrostylis sp1	CAM	Atylus sp1
CIS	Macrostylis sp2	CAM	Harpiniopsis sp1
CIS	Macrostylis sp3	CAM	Microjassa sp1
CIS	Macrostylis sp4	CAM	Monoculodes sp1
CIS	Myodocopida		
CIS	Cypridina sp1		

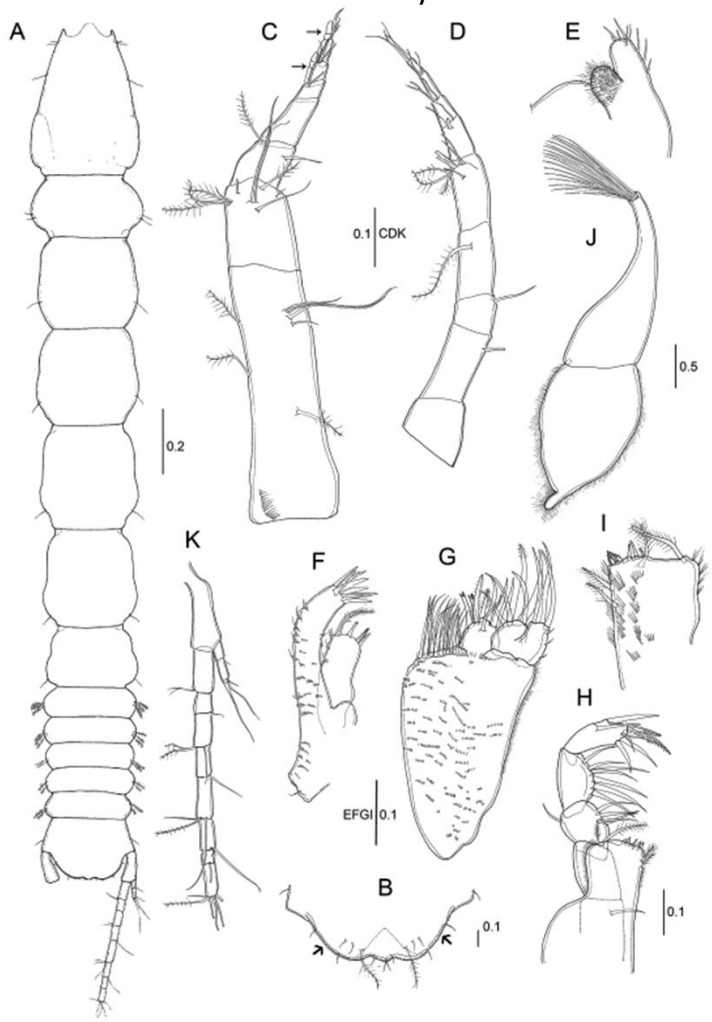
Results : diversity of macrofauna

- Two new Neotanais (Tanaidacea) species :*Neotanais pacificus, N. capillus* (Wi et al. JCB 2014) and identifying more new species of Neotanais

Neotanais pacificus



Neotanais capillus



A Case study : diversity and species ranges of polychaetes

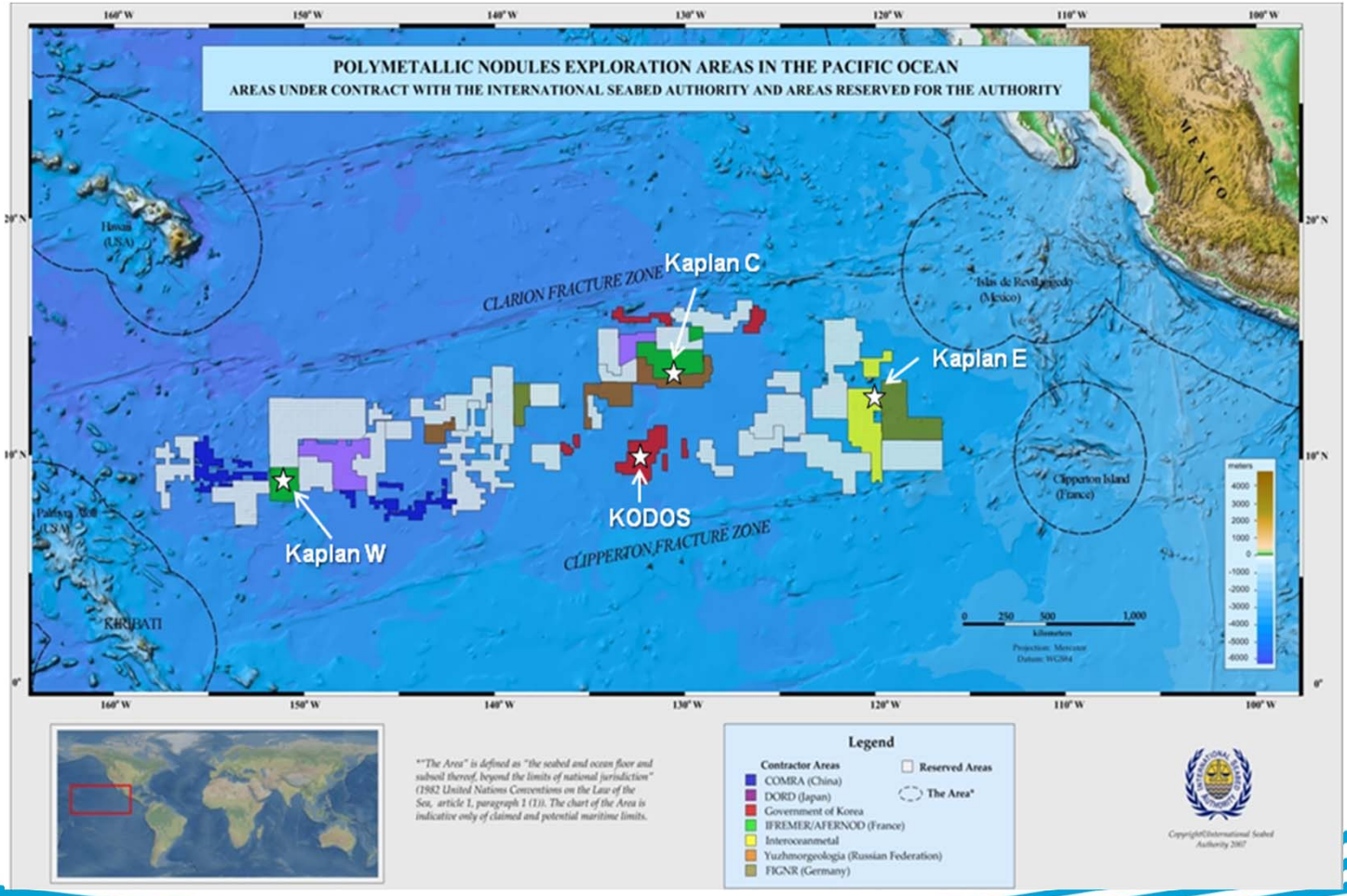
- The objective
  - ✓ to conduct morphological taxonomic analyses on macrofaunal polychaetes and then species from six target families were compared to polychaetes collected by other expeditions in the Pacific nodule province
  - ✓ to establish levels of overlap in polychaete familial and species composition and diversity between the Korean claim areas in the central CCFZ, and other portions of the CCFZ

- The identification of polychaetes
  - ✓ Individual specimens identified to species or assigned a species number
  - ✓ Species was assigned from previous PIP (Natural History Museum, London) collections in the CCFZ or a new PIP number entered for newly collected species

- The analysis
  - ✓ statistically compared to the abundance, and biodiversity at the polychaete family level using the Chao I family richness and Rarefaction

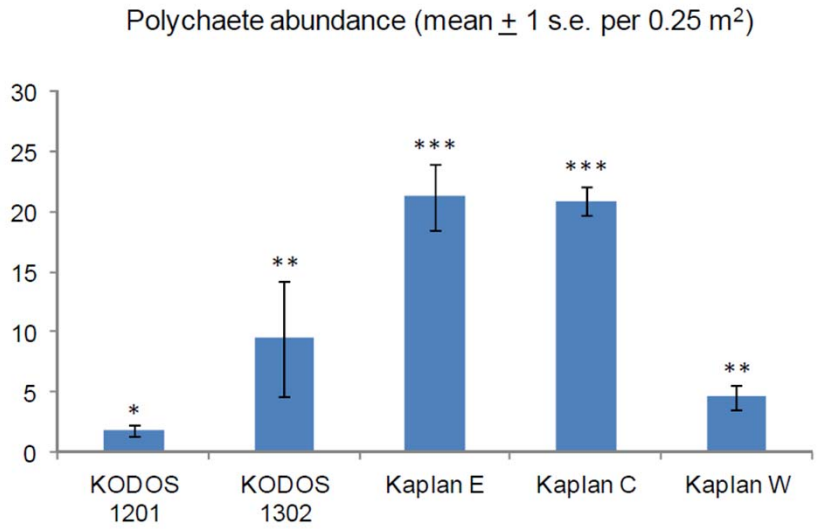
A Case study : diversity and species ranges of polychaetes

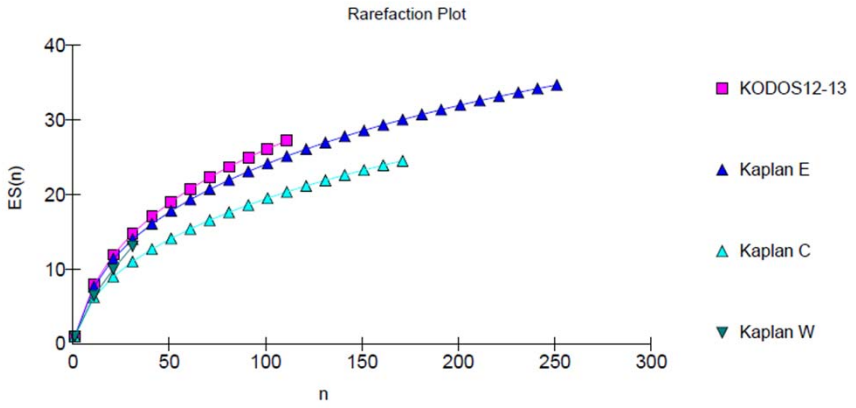
- Species were compared with specimens from the Kaplan sites, collected across the CCFZ in 2003 and 2004 (Smith et al., 2008b)



A Case study : diversity and species ranges of polychaetes

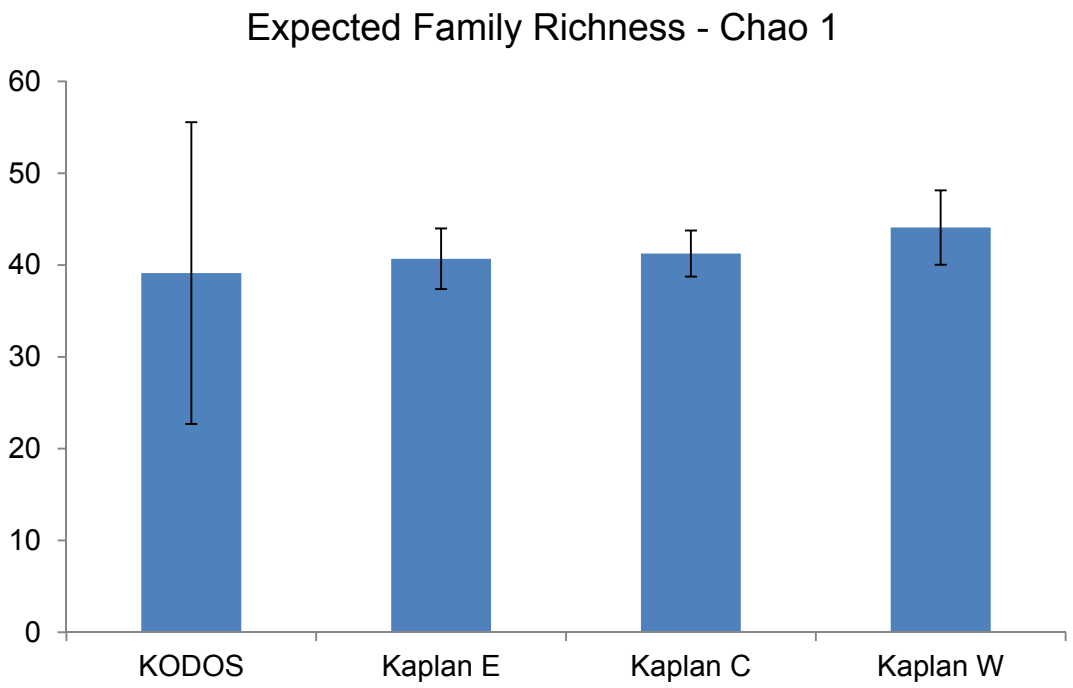
- Polychaetes sampled during KODOS 2013 was five folds higher than collected during KODOS 2012
- The abundance in KODOS samples was significantly lower that at most of Kaplan sites, but no difference between the abundance in KODOS 1203 and in Kaplan W
- 28 polychaete families with six dominant families (Cirratulidae, Paraonidae, Syllidae, Spionidae, Goniadidae, Phyllodocide)
- The diversity of benthic polychaete families at the KODOS site appears to be similar to, or higher than, family diversity at the Kaplan sites





A Case study : diversity and species ranges of polychaetes

- The total number of benthic families estimated from KR5 at KODOS is not significantly different from the Kaplan sites
- Many of the dominant families at the Kaplan C site nearest the KODOS site are also relatively abundant in the KODOS material, suggesting that the family composition at the KODOS site may be similar to that at Kaplan C



A Case study : diversity and species ranges of polychaetes

- 20 working species from 6 dominant families to the Polychaete Intercalibration Project (PIP) master list at the Natural History Museum, London
- Fourteen of the intercalibrated KODOS material represented new working species
- Six polychaete species from the KODOS region are shared with other locations in the CCFZ, but most of polychaetes have only been found at KODOS region

Six dominant families of polychaetes

Family	Species
Cirratulidae	Aphelochaeta sp. A
	Chaetozone sp. A
	Cirratulidae sp. 1
	Monticellina sp. A
	Cirratulidae sp. indeterminate (damaged or partial specimen)
Paraonidae	cf. Paraonella abranchiata
	Aricidea sp.A
	Aricidea sp.B
	Levinsenia uncinata
Syllidae	Braniella palpate
	Exogone(Parexogone) sp.A
	Syllidae sp. 1
	Paraonidae sp. indeterminate (damaged or partial specimen)
Spionidae	Aurospio dibranchiate
	Spiophanes sp. indeterminate
	Spionidae sp. indeterminate (damaged or partial specimen)
Goniadidae	Progoniada cf. regularis
Phyllodocidae	Eumida sp. A
	Pseudomystides rarica
	Phyllodocidae sp. indeterminate (damaged or partial specimen)

Six dominant species

Family	Species
Paralacydoniidae	Paralacydonia cf. paradoxa
Paraonidae	Levinsenia uncinata
Syllidae	Braniella palpate
Spionidae	Aurospio dibranchiate
Goniadidae	Progoniada cf. regularis
Phyllodocidae	Pseudomystides rarica

Summary

- In Stage II(2011-2012), Our project have been made the international collaborate study with Dr. Craig R. Smith (Univ. of Hawaii, USA) to enhance the sampling techniques and the biodiversity of macrofauna

- By changing the sieving size (250 um) and the sampling proceeding with a elutriation device, the number of species and density of macrofauna in Stage II increased compared to the previous study, suggesting the sampling effort may be important

- To higher recovery efficiencies of abyssal macrofauna for biodiversity and species range studies in the KODOS region, more attention needed for control the box-core bow-wave effects and the gentle washing during the sieving process (e.g., very low wash-water flow rates, no sieve agitation) to prevent damage to the extremely fragile

Future work plan for macrofuana study

- Acquisition of continuous macrofauna species and abundance data in and around the contract area, focused on the selected benthic impact experiment and reference sites, independently and/or through international cooperative studies
  - ✓ continued for identification of macrofauna species
  - ✓ to understand the natural variability in the macrobenthic community
  - ✓ to establish a baseline data for predicting and managing the impacts of manganese nodule mining on macrofauna community in the CCFZ
  - ✓ comparison of diversity and abudance with other expeditions in the Pacific nodule province

Acknowledgement

- **Co-authors : Dongsung Kim, Dong Jin Ham, Gun Chang Lee, Kyong Hong Kim, Se-jong Ju, Chan Min Yoo (KIOST), Jin Hee Wi[1)](RICEFP), Iris Altamira[2)](Univ. of Hawaii)**

- **R/V Onnuri captain and crews**

Thank you and any questions?