AGENDA

Biogeoscapes CHINA planning workshop

Academic Exchange Center, Xiamen University, Xiang'an Campus
October 20-21, 2019

HOTEL: Academic Exchange Center
MEETING: Meeting Room 3, 3rd floor, Academic Exchange Center

20 October (Sunday)	
14:00-	**Check in the Lobby of the Academic Exchange Center**
18:30	**Diner at Sunset City in Xiang'an**
21 October (Monday)	
08:45	**Welcome by director of MEL (***Minhan Dai***)**
08:50	**Introduction and Overview of Meeting Goals** (*Dalin Shi*) Motivation for workshop and what we are hoping to achieve
09:00	**What have been learnt from other international programs** *10-15 minute talks* • GEOTRACES (*Yihua Cai*) • TARA Oceans (*Xin Lin*) • General Discussion
09:30	**Photo and Coffee Break**
10:00	**Examples of Biogeoscapes-like research** *15 minute talks, plus 5 minutes for questions* • Marine particulate trace metal cycling and phytoplankton trace metal composition (*Tung-Yuan Ho*) • Community-level responses to iron availability in open ocean planktonic ecosystems (*Xin Lin*) • Metaproteomics provides an overview on trace metal utilization in the Northern Indian Ocean (*Minghua Wang*) • Link between BIO to GEOTRACERS: case studies from lab culture to field observation (*Ruifeng Zhang*)
11:20	**How to integrate data with modelling tools** *15 minute talks, plus 5 minutes for questions* • Physical-biological-biogeochemical modelling in Pacific Ocean (*Peng Xiu*) • Integration of marine omics data into multi-scale biogeochemical models (*Yawei Luo*)
12:00	**Lunch**
14:00	**Introduction to the Biogeoscapes international planning workshop – what shared, discussed, proposed, and planned** (*Dalin Shi*)

14:30	**Discussion on** • Preliminary intellectual vision for Biogeoscapes • Potential parameters and what can we learn from them? • Challenges when linking omics and chemical data • Standardized methodologies & Inter-calibration • What might a typical cruise look like? (new sampling systems?) • How to integrate data with modelling tools? • Data management challenges
16:00	**Coffee break**
16:30	**Discussion on what and how China can contribute to Biogeoscapes?** • Where are the target regions for Biogeoscapes China? • What types of studies (e.g., sections, process studies, …)? • Shiptime and funding options and opportunities • How to promote Biogeoscapes in China? • Regional and international collaboration • Host the next international workshop in 2020?
18:30	**Dinner at Dacuozhai Seafood Restaurant in Aotou, Xiang'an**
<u>22 October (Tuesday)</u> Departure	

The minutes of the BioGeoSCAPES CHINA planning workshop

To introduce the preliminary objectives and mission of the proposed global program *BioGeoSCAPES*, solicit feedback and suggestions, and brainstorm and gather ideas on China's possible contribution and roles, 27 scientists from 11 research institutes in China met at Xiamen University, Xiamen, in October 2019. This document describes the presentations and discussions among the participants and the main outcomes of the meeting.

I. General introduction to BioGeoSCAPES (*Dalin Shi*)

See BioGeoSCAPES international workshop report for details.

II. Introduction to GEOTRACES and TARA Oceans

1. GEOTRACES (*Yihua Cai*)

Yihua gave an overall introduction to GEOTRACES in terms of its origin, development path, mission, research themes and current status. In particular, Yihua took time to introduce comprehensively the GEOTRACES-GP09 cruise organized and implemented by China this past April to June, detailing the objectives, transects, sampling parameters, domestic and international participants etc., and presenting data obtained so far.

2. TARA Oceans (*Xin Lin*)

Xin introduced TARA Oceans from three aspects, i.e., the origin, the research process, and the research findings, with particular focuses on the analysis process and application of metagenomic and metatranscriptomic data. She also put forward the prospect of a cooperation between TARA Oceans and GEOTRACES cruises on board XMU's R/V Tan Kah Kee in the future.

It was also added that given the already existing huge datasets of TARA Oceans, the sampling depths of both chemical and biological parameters in the future R/V TKK cruises can be designed specifically to be in accord with the sampling depths of TARA Oceans. On the one hand, we can take full advantage of the TARA Oceans data; on the other hand, it may be used for intercalibration.

III. "BioGeoSCAPES-like" research

1. Marine particulate trace metal cycling and phytoplankton trace metal composition (*Tung-Yuan Ho*)

Tung-Yuan introduced the GEOTRACES cruise in Taiwan led by him and focused on the adsorption of trace metals on particles, hoping to provide reference and help for the future sampling methods of BioGeoSCAPES. After the talk, three major questions were discussed among the participants, i.e., "Is the overestimation of particulate Fe and Zn due to the adsorption of metals from other sources to small particles?", "Whether trace metals adsorbed on small particles can be bioavailable?", and "Since diatoms can take up Al, can Al be used to estimate the terrestrial contribution of particles? ". Tung-Yuan suggested that the overestimation of the particulate Fe and Zn should be caused by adsorption, and the adsorption was mainly attributed to heavy elements. The depth distribution of Zn isotopes can be explained by adsorption, but it is not clear whether the adsorbed metals are bioavailable. In addition, the utilization

of Al by diatoms should be insignificant (if there is any), and Al is easily adsorbed on the cell surface, so it is not sure whether Al is actually utilized or only adsorbed.

2. Link between BIO to GEOTRACERS: case studies from lab culture to field observation (*Ruifeng Zhang*)

Ruifeng presented the relationship between organisms and trace metals in three study cases. *First*, "whether Fe is the key factor to stimulate Vibrio bloom in the ocean". In this study, by conducting field experiments, laboratory experiments and model simulations, it was found that Vibrio bloom was not simply triggered by inorganic Fe, indicating that comprehensive consideration should be given to the understanding of factors inducing microbial bloom. *Second*, "what limits primary production in the tropical northwestern Pacific". Based on the GEOTRACES-GP09 cruise, the study found that primary production in the northwestern Pacific was generally N limited, while Fe was the secondary limiting nutrient at the 11° N section. Dust addition incubation experiments showed that the maximum growth rate of the community was affected by P in seawater. *Third*, "trace metals and phytoplankton communities in the Southern Ocean". Based on the 35th Chinese Southern Ocean scientific investigation on board R/V Xue Long, it is found that the transport of Fe from deep waters may be the key factor supporting the growth of phytoplankton in the Southern Ocean, and the growth of phytoplankton consumed trace metals such as Zn, Co, Cd in seawaters.

3. Community-level responses to iron availability in open ocean planktonic ecosystems (*Xin Lin*)

Xin shared the Caputi et al. 2019 paper. The study analyzed the response of marine plankton to Fe based on the results of laboratory mechanistic research and the TARA Oceans global metagenomeic and metatranscriptomic data. The results from gene to community structure showed that the structure and interaction of small plankton populations are important for their response to Fe. This study suggested that omics data can be helpful for predicting seawater Fe concentration, especially the bioavailable Fe concentration, understanding the mechanism of complex plankton community's response to Fe, and improving the existing biogeochemical models involving Fe concentration.

Tung-Yuan: there are uncertainty and bias in model prediction of trace metals in marginal seas, and the response of organisms to environment factors should be taken into account.

Dalin: there may be mismatch between biological data and chemical data, and omics data are instantaneous, which may not reflect organisms' response to nutrients. Therefore, laboratory mechanistic study is necessary, which is helpful for explaining and relating the omics data to chemical parameters.

Ruifeng: there are still challenges on the time scale in terms of connecting biological processes with biogeochemical cycles.

4. Metaproteomics provides an overview on trace metal utilization in the Northern Indian Ocean (*Minghua Wang*)

Based on the metaproteomic data, Minghua reported the utilization of trace metals in picoplankton in the North Indian Ocean. Two key scientific questions of the study are: 1) the distribution of metalloproteins in the North Indian Ocean, and 2) key biological processes these metalloproteins involved in. The data showed that the proportion of different metalloproteins is quite different, among which Fe is dominant (47%). In

addition, 16S rDNA sequence analysis showed that cyanobacteria and proteobacteria were dominant in the community. Interestingly, it was found that Ni containing proteins were very abundant in picophytoplankton, which suggests the importance of conducting size fractionation for sampling and analysis in BioGeoSCAPES.

IV. How to integrate data with modelling tools

1. Physical-biological-biogeochemical modelling in Pacific Ocean (*Peng Xiu*)

Peng introduced his work on coupling Fe cycle with the ROMS-CoSiNE model and the application of CoSiNE-Fe model in the northwestern Pacific Ocean.

Tung-Yuan: the definition of bioavailable Fe is very complex, as there is organic ligand chelated Fe in addition to inorganic Fe, and different species have different capacity of using organically bound Fe. Laboratory experiments on Fe bioavailability may be helpful for improving the model simulation.

2. Integration of marine omics data into multi-scale biogeochemical models (*Ya-Wei Luo*)

Ya-Wei pointed out that since the NPZD model in 1990 there are still issues with the framework of marine ecosystem models over the past 30 years. Biogeochemical models may thus need to be considered from a different, new perspective. In 2017, a study published in Science combined omics and modelling, by simulating genome and transcriptome in the model, and speculating about the possible community structure under different marine environment conditions.

V. Discussion

1. About BioGeoSCAPES

1) Suggestions and feedbacks on missions and themes of BioGeoSCAPES:

- The omics framework needs the support of geoscience; biology emphasizes the process, chemistry emphasizes the flux, and we need to think about what scientific questions can be answered in terms of geoscience for BioGeoSCAPES; scale is one of the key issue; we should find geoscience phenomena first, and then connect with biology; field study should be the major part of BioGeoSCAPES, but needs to be complemented with laboratory experiments.
- Eventually biology and omics should serve to answer geoscience questions; scientific questions should be put forward in order to answer large scale oceanography/geoscience questions; we should think about what new questions can be asked and answered, on top of GEOTRACES.
- In the preliminary concept of BioGeoSCAPES, the term *metabolism* seems a bit too narrow to reflect the large scale of global ocean. For example, it can be combined with three major themes: A) global change, B) ecosystem diversity, and C) sustainable development.
- We should identify large scale scientific questions: A) ecosystem structure related issues; B) function related issues: carbon fixation and nitrogen fixation; C) genome related issues; D) metabolic pathway related issues; E) model related issues, requiring quantitative data and parameterization; F) long-term observation.
- One possible scientific question: what trace metals limit biological growth or determine community structure in different regions of the global ocean?
- As trace metals can be used as cofactors of enzymes, we can explore the roles of

metals in ancient ocean, present ocean and future ocean from an evolutionary perspective.
- Identify the common interests of chemists and biologists, and choose time scales that would meet the requirements of both biology and chemistry.

2) It is highly suggested to draft a conceptual framework of BioGeoSCAPES, similar to that of GEOTRACES, to show the overall research scope, specific scientific questions, research themes, etc. of BioGeoSCAPES.

3) How to determine the time and space scale? For example, genome, transcriptome and proteome are on different time scales. In addition, most of the field observations are space-specific, and it can be difficult to match the laboratory results with the field observations.

4) Questions and suggestions for the methods of omics, parameter standardization, and data intercalibration, etc:

- Identify a scientific question before determining the parameter standard.
- For omics, primers for 16S rRNA analysis are not unified. How to sample, store, extract, and process samples? How to standardize these operations? How to compare data obtained from different sequencing instruments?
- Primers and instruments can be standardized; methods can be developed gradually - the key is to find out the core, mature and concerned things to form standardized protocols (for example, we can learn from sampling and bioinformatics analysis protocols used by TARA Oceans); or we can establish a number of large platforms specifically for omics analysis in different nations worldwide.
- Whether omics data could be semi quantitative? We can establish an internationally recognized standardized method.
- Each laboratory should use the same methods so that the data are able to be compared.
- We should first focus on the quality of data before worry about the comparison between them.
- There are challenges in calibration. Omics provide information, if a unified standard is used for omics analysis, potential new information may be ignored in different studies.

5) Questions and suggestions for numerical model and the combination of model and omics data:
- How to incoporate parameters of different time scales into the model?
- The prediction ability of model should reflect the "feedback", which requires a new model.
- Field observation needs the laboratory experiments to provide physiological and biochemical information such that quantitative data can be used in the model.

6) It is suggested to include organic geochemistry in BioGeoSCAPES, using isotopes to reflect the metabolic process with organic geochemical technology.

2. What and how China can contribute to BioGeoSCAPES?

1) TARA Oceans do not have the data of China seas, so we can start from there. For example, the South China Sea has a large seasonal variation and a large spatial scale, so we can study the South China Sea first and then go to the northwestern Pacific.

2) R/V TKK can operate at the same time with TARA in a same area to obtain the data of omics and trace metals, which can substantially promote BioGeoSCAPES.

3) Our target regions can be high latitude oceans (connected with global change), e.g., Arctic and subarctic north Pacific, and those around China.

4) Develop trace metal clean autonomous sampling systems and in situ incubation systems.

5) Host international workshop/meeting, trace elements and omics training workshop, and summer school, etc.

6) Provide berths for international community on China BioGeoSCAPES cruises and other cruises as well.

7) …

List of BioGeoSCAPES CHINA planning workshop participants:

Tung-Yuan Ho
Academia Sinica, Taipe, China

Shuying Leng
Division of Ocean and Polar Sciences
Department of Earth Sciences
National Natural Science Foundation of China

Hongbin Liu
Qinglu Zeng
Hong Kong University of Science and Technology

Yong Wang
Institute of Deep-sea Science and Engineering
Chinese Academy of Sciences

Jingling Ren
Max Meixun Zhao
Ocean University of China

Yuntao Wang
Second Institute of Oceanography
Ministry of Nature Resource, China

Ruifeng Zhang
Zhu Zhu
Shanghai Jiao Tong University

Meng Li
Shenzhen University

Peng Xiu
South China Sea Institute of Oceanology
Chinese Academy of Sciences

Pinghe Cai
Yihua Cai
Zhimian Cao
Minhan Dai
Shuh-Ji Kao
Haizheng Hong
Bangqin Huang
Xin Lin
Xin Liu
Ya-Wei Luo
Dalin Shi
Tiantian Tang
Minghua Wang
Yao Zhang
Kuanbo Zhou
Xiamen University