December 2, 2015

Electrical measurement plan

Central Research Institute of Electric Power Industry

1. Aims

   The aims of this measurement are to monitor time variation of electrical potential and to estimate the underground electrical resistivity structure without CO2 around the previous CO2 released point.

2. Method

   Three cables with electrodes are set on the seafloor as shown figure 1 and figure 2. Each cable has ten electrodes at one side with five meters interval on the seafloor and ten conductors connected to a data logger at the other side on the ground.

   Time variation of electrical potential differences between measurement electrodes and a reference point (self-potential) are recorded continuously to a data logger.

   Electrical resistivity under the seafloor is evaluated by charging electricity between each measurement electrodes and an electrode at a far field and measuring electrical potential induced by the charged electricity at each measurement electrodes referred to a reference point.

3. Procedure

   1) The three cables will be set on the seafloor before May 23, 2016 by SAMS.

   2) A data acquisition system and a reference point will be set up in the morning of May 23, 2016.

   3) Self-potential data will be recorded continuously from the afternoon of May 23 to the morning of May 27, 2016.

   4) The electrical resistivity measurement will be conducted in the afternoon of May 27, 2016.

   5) The data acquisition and resistivity measurement equipment will be removed after the resistivity measurement.

   6) The cables will be removed and disposed after the resistivity measurement by SAMS.

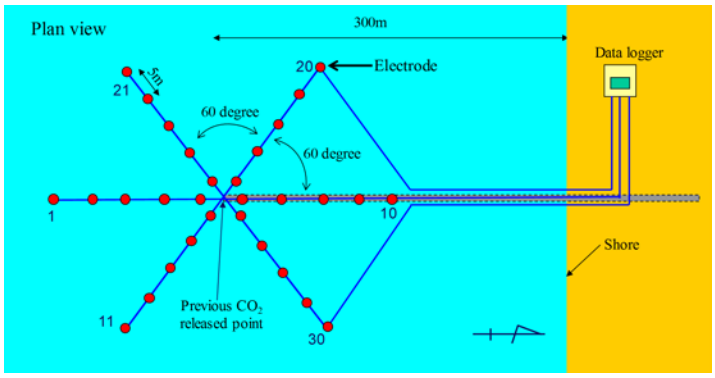


Figure 1 Electrical measurement points on the seafloor (Plan view)

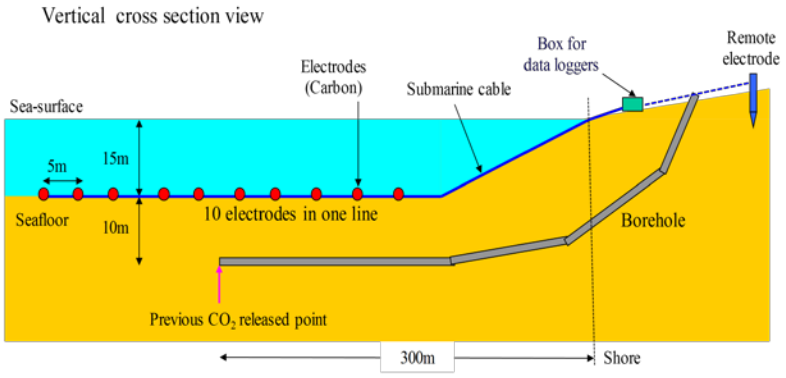


Figure 2 Electrical monitoring concept (Vertical cross section view)

Monitoring of leaked CO_2 after the QICS experiment

Kiminori Shitashima
International Institute for Carbon-Neutral Energy Research
Kyushu University

Observation

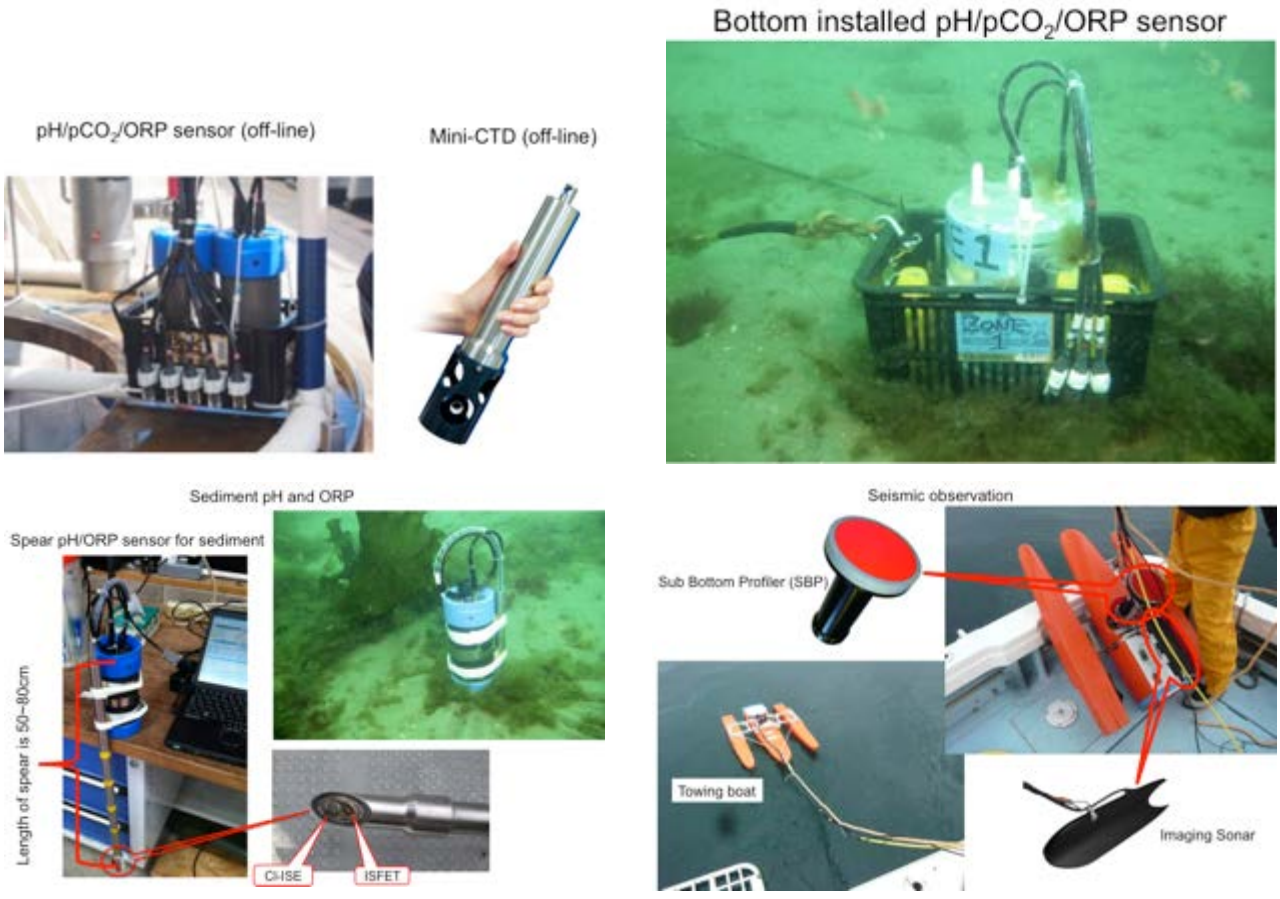
1. pH, pCO_2, ORP in seawater
   - Bottom installed sensor around the leakage point
   - Water column (vertical) observation with micro-CTD around the leakage point

2. pH in sediment
   - In-situ pH in sediment of 50~80cm deep from seafloor
     *We gave up drilling for deep layer (2~3m) monitoring by using a portable excavator

3. Seismic observation (towing) using SBP and SSS

Space for preparation/setting of observation

- Desk (1.5mW x 1mD) for sensor
- Floor space (2m x 2m) for towing boat



December 2, 2015

Sampling and chemical analyses of pore water and sediments

AIST

1. Introduction

Sampling and chemical analyses pore water and sediment at Ardmuckinish Bay addresses two unsettled issues from QICS: (1) the fate of the released CO2 potentially remaining in the subsurface sediments, and (2) the mechanism behind the rapid recovery of pore water parameters to pre-release levels. To trace the injected CO2, carbonate content of the sediment will be compared between the area close to the CO2 release point and the unaffected reference site. Time series in situ monitoring of pore water chemistry in the subsurface sediments will be conducted in order to investigate pore water dynamics. To characterize pore water behaviour more precisely, we will conduct a tracer test. For collection of pore water from various depths, a custom-made pore water extractor as well as ready-made samplers.

2. Method

Approach (1): quantification of the injected CO2 remaining in the subsurface sediments.

Pore water sampling and analysis (Exp. 1): Pore water samples will be collected from two locations of the QICS experiment (QZ1: above the CO2-release diffuser, and QZ4: the reference site, 450 m away from QZ1) in Ardmucknish Bay (locations shown in Fig.1). A commercially available ready-made pore water samplers with 5 mm in diameter (Fig. 2) will be used for sampling of shallow layer at the depths up to 50 cm or 100 cm of sediments, depending on the results of a preliminary test. For deeper sediments at the depths up to 1.5 m, we will use custom-made pore water extractor with 2.5 cm in diameter (Fig. 2). The extractor is equipped with a sharp tip, a filter protected with a perforated stainless steel cover and a connecter for a syringe. Installation of the samplers and collecting samples by suction will be preliminary tested by divers from the National Facility for Scientific Diving at SAMS. At each location and depth, sampling will be carried out with three replicates. The arrangement plan of the samplers installed to sediments is shown in Fig. 3. The collected pore waters and overlying seawater will be analysed for nutrients and carbonate species including pH, DIC and δ13C-DIC.

Sediment sampling and analysis (Exp. 2): Sediments will be collected using the SAMS mega-corer. The pore waters will be extracted through pre-drilled holes in the core barrel wall by inserting Rhizon pore water samplers. The sediments will then be sliced into 2.5 cm sections, freeze-dried and analysed for inorganic carbon contents and δ13C. Some samples will be sent to Japan and analysed for δ13C-DIC and δ13C-carbonates.

Approach (2): investigation of physically forced behaviour of pore water.

Serial monitoring of pore water chemistry (Exp. 3): The commercially available ready-made pore water extractors will be installed at the depths from 5 cm to 1 m of sediments as above at QZ1 and CZ (Fig. 1). The arrangement plan of the samplers is same as above (Fig. 3). CZ will be set close to the coastline where seawater constituents are strongly affected by freshwater, as they are above the halocline and thus have different salinity. CZ will be located at the distance by walking from the beach.

The pore waters will be collected from the extractor at high, ebb, low and flood tides. The samples will be analysed for salinity, density, nutrients, anions, pH, DIC and δ13C-DIC.

Tracer test (Exp. 4): Six sets of the commercially available ready-made pore water extractors are installed at

depth of 10 cm, 20 cm, 30 cm and 50 cm at QZ1 as the arrangement plan shown in Fig. 4. The conservative tracers (bromide and/or fluorescein dye) will be spiked into 20 cm depth of sediment through one of the extractors. At intervals of 2 hours, pore water samples will be collected from the extractors and analysed for the tracer.

Date	Station	Plan	Procedures
23rd	QZ1	Exp.4	Tracer test system setting
	QZ1	Exp.1&3	Pore water sampler setting
	QZ1	Exp.4	Tracer injection
	QZ4	Exp.1	Pore water sampler setting
	QZ1	Exp.4	Tracer sampling (Day-0)
24th	QZ1	Exp.4	Tracer sampling (Day-1)
	QZ1	Exp.2	Mega-corer sampling
	QZ4	Exp.2	Mega-corer sampling
	QZ4	Exp.1	Pore water sampling and sampler removal
	CZ	Exp.3	Pore water sampler setting (moved from QZ4)
25th	QZ1	Exp.4	Tracer sampling (Day-2)
	QZ1	Exp.1&3	Serial sampling (3~4 times) and sampler removal
	CZ	Exp.3	Serial sampling (3~4 times) and sampler removal
26th	QZ1	Exp.4	Tracer sampling (Day-3)
27th	QZ1	Exp.4	Tracer sampling (Day-4) and sampler removal

3. Requirements for space and equipment

Laboratory space: 1.8 m (W) x 0.7 m (D)

Procedures	Equipment required
Pore water sample processing	
Nutrient analysis	Autoanalyzer
pH measurement	
Density measurement	
Sample fixation with HgCl2	HgCl2 solution
Sediment sample freeze-dry	Freeze-dryer
Tracer preparation	Tracer reagent
Tracer measurement	Spectro-fluorometer

Floor space (warehouse): 2 m x 2 m

Procedures	Equipment required
Pore water extractor setting	
Mega corer sample preparation Pore water sampling Sediment cutting	Mega corer and apparatus for subsampling

Fig. 1 Map of the sampling location in Ardmucknish Bay.
QZ 1: QICS Zone 1 (above CO2-release diffuser),
QZ 4: QICS Zone 4 (reference site), CZ: adjacent to coastline

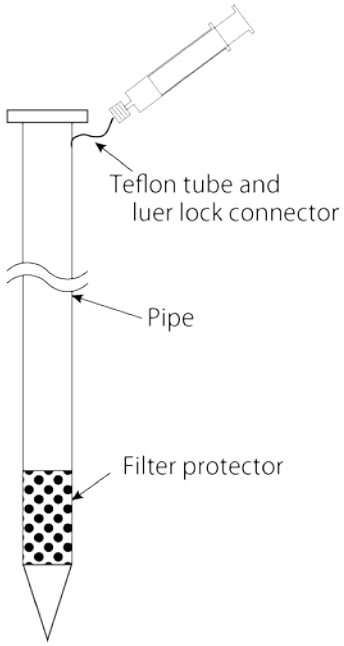


Fig. 2 Schematic illustration of pore water extractor.

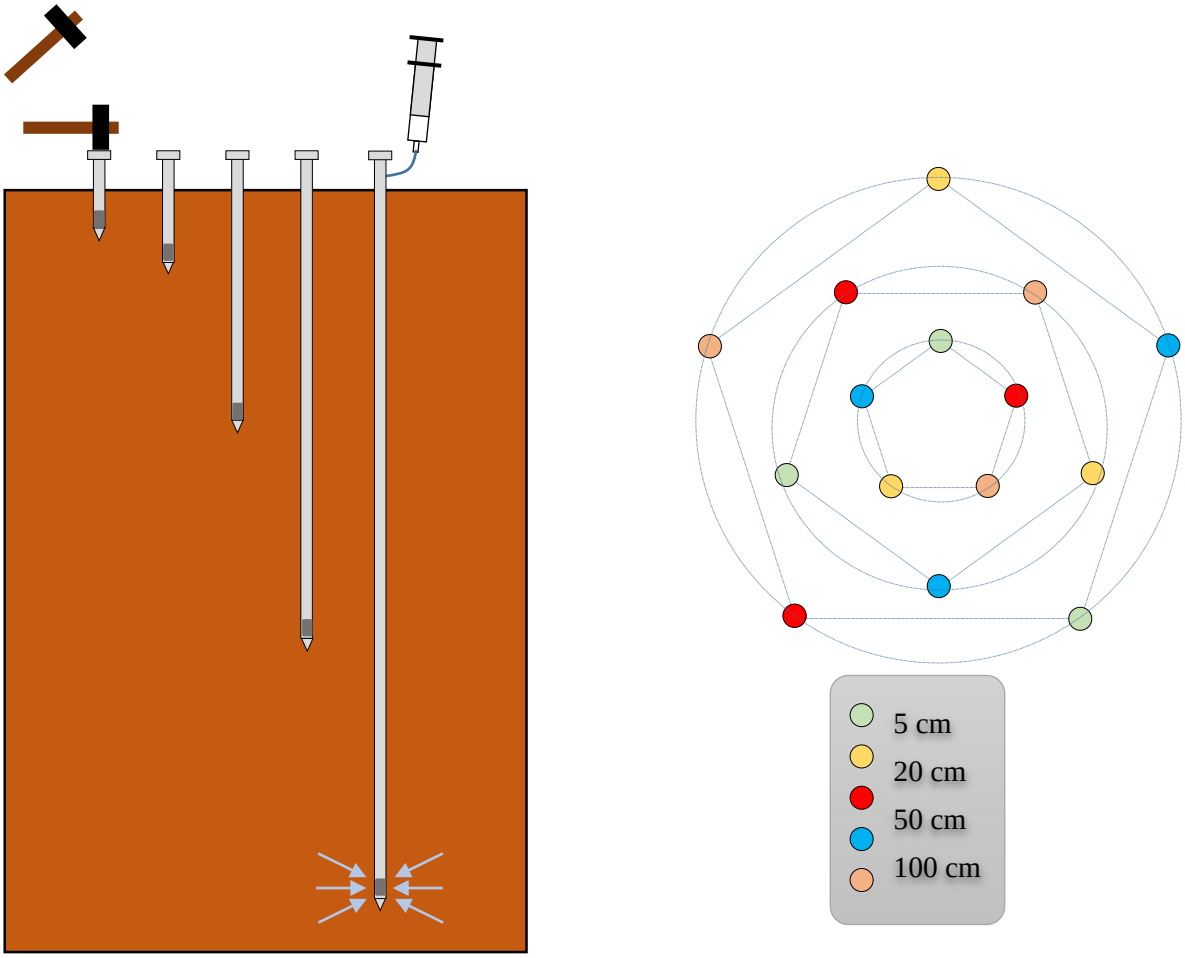


Fig. 3. Schematic view of pore water extraction strategy (left) and arrangement plan on sediments (right).

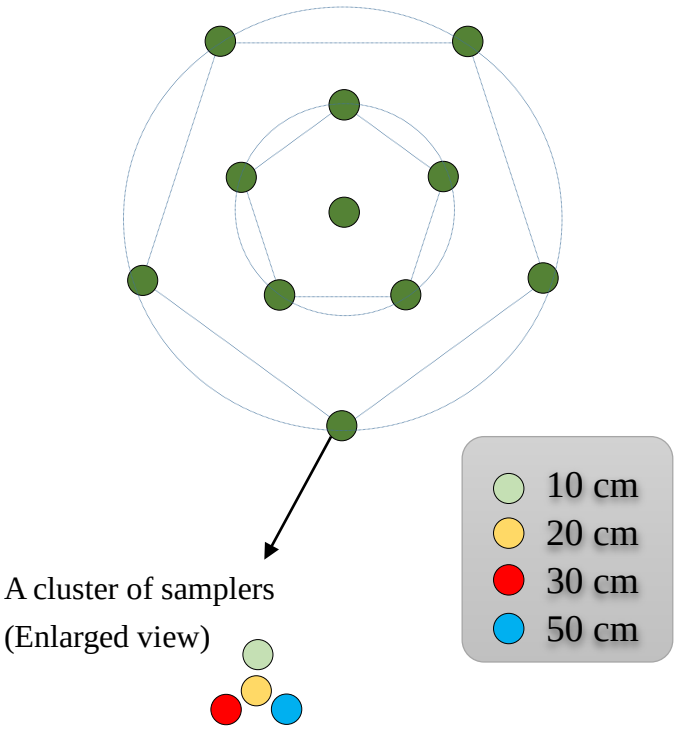


Fig. 4. Arrangement plan of samplers on sediments for the tracer test.