Development of acoustic methods for detection of CO_2 leakage from sub-seabed storage site

*Takamichi Nakamura[1], Makoto Nishimura[1], Keisuke Uchimoto[1]

1.RITE, CO2 storage research group

Carbon dioxide capture and storage (CCS) is the primary technological option for reducing CO_2 emissions into the atmosphere and is expected to be an effective climate change mitigation technology. Because storage sites are selected deliberately to minimize the risk of leakage, CO_2 is assumed to be stable in the reservoirs. However, in a worst-case scenario, CO_2 could leak out from the ground surface into the atmosphere or from the seabed into the adjacent sea. Leakage could be caused by various factors, such as an increase in subsurface pressure due to CO_2 injection. CO_2 leakage may lead to significant damaging effects on the local environment. Therefore, concerns are emerging from the public about the risk of *in situ* leakage and ecological impacts. In Japan, operators of offshore CCS are required to plan monitoring programs, as stated in the Act for the Prevention of Marine Pollution and Maritime Disasters. In the monitoring plan, an operator has to be able to determine the location and extent of any CO_2 leakage. Consequently, it is necessary to develop detection methods of CO_2 leakage in the sea.
This study focuses specifically on active acoustic methods. Active acoustic methods, which are a type of bathymetry imaging, are examined for use in the detection of CO_2 leakage in shallow seawater columns. Side scan sonar (SSS) and multibeam sonar (MBS) were tested for use in detecting gas bubble streams in shallow coastal waters. In addition, image data was acquired with a sonar video camera. Gas bubbles were released from the seabed in a controlled manner using compressed air while scanning the seabed and water column using acoustic methods. All sonar technologies were able to detect gas bubbles and visualize gas streams in a water column (Fig.1). Both MBS and SSS data had a lower detection limit of bubbles at 100 mL/min of flow rate. MBS produced high precision localization, but detection sensitivities were affected by vessel speed. MBS is therefore most suitable for narrow area monitoring. SSS could scan wide views, and detection sensitivities were not affected by vessel speed, making SSS suitable for broad area monitoring. Additionally, there is some possibility of quantifying gas bubble concentrations from SSS scan data, which is the topic of ongoing research. Using the sonar video camera, gas streams could be visualized in the water column as dark areas in the video image. Sonar video cameras are only suitable for fixed-point observations. The data gathered indicate that acoustic methods are useful for the detection of CO_2 leakage, and may eventually be able to determine concentrations. In order to apply practical monitoring techniques, further experimental study in deep seas is required.

Keywords: sub-seabed CCS, leakage detection, acoustic methods

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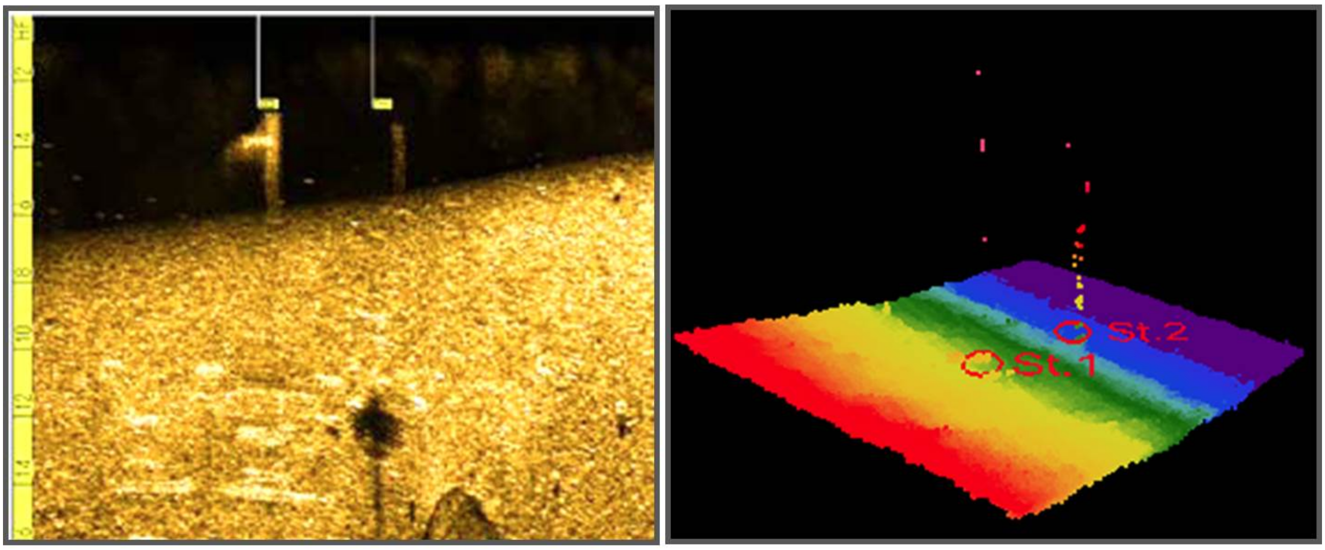

Fig. 1. Water column bubbles imaged on the data of SSS (left) and MBS (right)

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