Gas seep distribution and subsurface structure off the northeast coast of Sado Island, eastern margin of the Japan Sea

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This study examined the subsurface structure controlling the gas seepages based on the integrated analysis of the gas seep distribution over eight years and the very shallow subsurface structure off the northeast coast of Sado Island, Japan.

In the vicinity of the continental slope, about 40 km off the northeast coast of Sado Island and about 50 km from the Iwafune-oki Oil-Gas Field, gas seeps have been observed (Niigata Prefecture, 2013 & 2016). In July and November 2021, acoustic, sub-bottom profiler (SBP), and CTD surveys were conducted by Japan's Independent Institute Co., Ltd. to investigate the detailed gas seep distribution and the subsurface structure.

In this study, we conducted an integrated analysis using the acoustic, geophysical, and geochemical survey data from 2013-2021 (partly reported by Asakura *et al.*, 2021) to clarify the subsurface structure controlling the gas seepages. The gas seeps were concentrated right below the top of the gas hydrate stability zone (TGHSZ) and on the continental shelf. To evaluate and compare seep sites originating from different subsurface sources in future works, we performed cluster analysis and cluster size classification of the gas plumes. The large clusters existed along with an NNE-SSW trend consistent with the fault system in the eastern margin of the Japan Sea. The SBP data revealed some fault systems and a fault/erosional cliff below the TGHSZ depth. They were associated with gas chimneys, acoustic blanking, enhanced reflection, and acoustic turbidity, suggesting the existence of gas-fluid systems. Many gas plumes were observed above/around these features. The subsurface structure shallower than the TGHSZ was not clearly observed.

Considering the geological setting of the surrounding area, these results suggest that the gas seepages are related to the distribution, such as the NNE-SSW fault system in the study area. We consider that the gas source may be hydrocarbon gas coming from the Hirase Group, a representative oil and natural gas reservoir in the Niigata region. The gas seep distribution in this study area implies that more gas seeps may exist on the continental shelf among this study area and the coastal area off Niigata.

Keywords: Gas seeps, Gas plumes, Sado Island, Japan Sea