

Geophysical characteristics of mud volcanoes off the Tanegashima Island: results from the SCS reflection and the detailed AUV surveys

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Submarine mud volcanism and diapirism are well-known geological phenomena occurring in forearc basins at convergent margins, such as the Mediterranean Ridge, the Barbados and the Nankai Trough (e.g., Kopf et al., 1998, 2000; Summer and Westbrook, 2001; Morita et al., 2004). On the landward slope of the northern Ryukyu Trench, off the Tanegashima Island, southwestern Japan, Ujiie (2000) identified more than 30 diapirs from the side-scan sonar images and studied the sedimentological properties and ages using core samples from the two mud volcanoes. Additional geochemical analyses of sediment pore water extracted from the core samples further suggest the existence of methane hydrates within another mud volcano (Nakayama et al., 2010). However, the spatial distributions of such local point features and the development of mud volcanism off the Tanegashima Island are still unclear. In order to identify and characterize the mud volcanoes off the Tanegashima Island, we collected the multi-beam bathymetric and the single-channel seismic (SCS) reflection data during the YK12-17, YK13-07 and YK14-15 cruises by the R/V Yokosuka, operated by the Japan Agency for Marine-Earth Science and Technology (JAMSTEC). Multi-beam bathymetric data show at least 15 mud volcanoes (MV1 to MV15) in the study area. Most of the mud volcanoes are cone-shaped with central vents, except the MV8 which is more elongated. Seismic data show that these mud volcanoes are situated on top of the mud diapir structures identified by an acoustically transparent zone. The near-bottom acoustic surveys using the autonomous underwater vehicle (AUV) were carried out to obtain a detailed understanding of the surface structure. A total of twelve AUV “Urashima” dives (Dives #151-152, 156, 158-159 and 174-180) were completed on the ten mud volcanoes off the Tanegashima Island. During these dives, we successfully collected high-resolution bathymetric data (2 m grid spacing), side-scan sonar images and sub-bottom chirp profiles. The active mud volcanoes (MV1-MV4, MV7, MV8, and MV13) are characterized by high backscatter intensities on the mosaic images of the side-scan sonar data. These high backscatter intensities are interpreted as the area of fluid and mud emission and/or a rough surface. On the other hand, the MV14 located in the southern part of the study area is an old, presently almost inactive, mud volcano with a well-defined caldera with a diameter of ~450 m and a nearly flat area (less than 5°) inside the caldera rim. The caldera is filled with stratified sediment with thickness of about ~15 m as observed with the AUV sub bottom profiler. The mud flow deposits associated with the summit collapse on the flank of the MV14 were identified on the side-scan sonar data. These results suggest that the mud volcanoes off the Tanegashima Island appear to be more active in the central and the northern study area compared to the south. Our study helps to elucidate the development of mud volcanism off the Tanegashima Island, but further geophysical and geological data are needed to understand the detailed formation process of the mud volcanoes.

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