Geologic structure of the Kuroshima Knoll, off Yaeyama Islands: relationships with cold seep phenomena

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The Kuroshima Knoll, which is isolated from the island shelf by submarine canyons, is about 26 km south of Ishigaki Island in the southwestern Ryukyu Arc. The flat top of the knoll ranges from 630 to 800 m in depth, and consists of the Pliocene to lower Pleistocene Shimajiri Group (lithified to semi-lithified mudstone/sandstone) and the recent sediments (gravels and muddy sand). Chemosynthetic communities and cold seep carbonates were found on the top of the knoll during the survey of 1771 Yaeyama Earthquake Tsunami, using deep-tow camera system. Dead and living chemosynthetic communities, such as Calyptogena and Bathymodiolus, widely occur on the eastern top of the knoll. Many carbonates, such as chimneys and nodules, were also found in or near dead Calyptogena colonies. The distribution of chemosynthetic communities and carbonates is limited in the east and west direction. Moreover, we found more than 10 gas venting sites accompanied with living Bathymodiolus colony. The result of carbon and oxygen isotopic analysis of the cold seep carbonates suggests that cold seep probably originated from the dissociation of gas hydrate. Thus, the Kuroshima Knoll is one of the best fields for the study of gas hydrates dissociation, because this area is sensitive for gas hydrate stability. We present the outline of single channel seismic reflection survey carried out at the Kuroshima knoll in January, 2002.

Though seismic data processing and analysis are now under progress, the following characteristics became apparent:

1) Topographical high from the Kuroshima Knoll to the Hateruma Island consists of an anticline with E-W axis. On the other hand, the submarine canyon of northern side of the knoll corresponds to a syncline with E-W axis.

2) The Kuroshima Knoll consists of two seismic stratigraphic units. Unit A, 200 to 600 msec (TWT) thick, is sheet-like sediment body in accordance with sea bottom, and conformably or obliquely overlies the Unit B. This unit is interpreted as the upper part of Shimajiri Group. Unit B is more than 500 msec (TWT) thick, and is possibly interpreted as the lower part of Shimajiri Group.

3) Many faults and slip planes are developed on the top to slope of the knoll.

4) A free gas layer may be present not only beneath the gas venting site, but also the bank of western side of the Kuroshima Knoll.

The above evidences strongly suggest that the cold seep is constrained by tectonic (fault) activity. On the other hand, the relationship between a free gas layer and the dissociation of gas hydrate is still unclear. We need to resolve the hydrogeologic process through the long-term monitoring of the cold seep using CAT meter and others.