

## Recognition of mud volcanoes penetrating Kumano Trough (Forearc basin) - 1999 and 2000 Shinkai 6500 dive results

# Ko-ichi Nakamura[1], Shin'ichi Kuramoto[2]

[1] AIST, IMRE, [2] AIST

Suggestive small cone-like features in the middle of the Kumano Trough was first drawn on 1/20,000 bathymetric chart no. 6360, Kumano Nada, published by the Hydrographic Department in 1976. This chart also shows that the northern part of the Kumano Trough basin floor is relatively higher than that of southern part. (Note: The revised bathymetric chart, Kumano Nada, no. 6635, published in 1996 has no indication of small cone-like features, although it showed 20 to 40 m high step features.) During the GH82-2 cruise of the Geological Survey of Japan in 1982, several acoustic survey lines detected small cone-like features. Nakamura tried to dredge samples from one of those in 1983 and got several small pieces of sandstone and carbonate precipitate (GH83-1 cruise, D533 dredge). He wrote that a part of the deformed central rise partly exposed on the seafloor in the middle of the Kumano Trough in 1985.

Kuramoto recognized seven shaded circular features in the towed side-scan sonar (IZANAGI) images (Kuramoto et al., 1998) in Kumano Trough in 1996. He tentatively named these features from east to west through No. 1 to No. 7 Kumano mud volcanoes (MVs) in the FY 1999 proposal of the Deep Sea Research project of JAMSTEC in 1998.

Among seven features, five were revealed their cone shapes by R/V Yokosuka's swath bathymetric survey prior to the Shinkai 6500 dive program of JAMSTEC in November, 1999. The detailed bathymetric map also revealed that No. 5 MV has two peaks ranging NW to SE.

Except for No. 3 MV, various types of rocks were collected in mud on summits of cone features by the dive program. Rocks could not be transported from the continental shelf to the hundred-meter high summits from the surrounding basin floor. Some of the rock samples were highly fractured, which indicate the deep origin.

We summarize the MVs activity or age in the following order based on seven dives conducted in 1999 and 2000 (Nakamura: Dive 524, No. 4 MV, Dive 526, 527 and 528, No. 5 MV, Nakamura: Dive 585, No. 6 MV, Jens Greinert (GEOMAR) : Dive 586, No. 5 MV, Dirk Rickert (GEOMAR): Dive 587, No. 5 MV and Erwin Suess (GEOMAR): Dive 588, No. 3 MV).

No. 3 MV - incipient stage: Its relief from the basin floor is only 10 to 15 meters with 500 diameter. However, the shaded relief on the side scan image and the back scatter attenuation by the swath bathymetry is almost the same with those of the other mud volcanoes. Active Calyptogena colonies developed on the broad summit. Several rock fragments were also observed near the colonies.

Southern summit of No. 5 MV - high active stage: Summit diameter: 300 m. 150 m high. Basal diameter: 1,200 m. Dense Calyptogena colonies with more than hundred Calyptogena population were sporadically distributed mostly in the small trough or depression on the summit. Rock fragments of fine to coarse sandstone, fractured mudstone with carbonate veins and carbonate precipitate (less than 30 cm size) are abundant throughout the summit.

Northern summit of No. 5 MV - low active stage: Summit depression diameter: 1,000 m. Basal diameter: 1,600 m. 100 m high. Only one colony with ca. 30 Calyptogena was observed. Sparse distribution of dead Calyptogena were scattered throughout the summit as well as the rock fragments.

No. 4 MV - suspension or intermission stage: Summit diameter: 400 m. Basal diameter: 1,000 m. Flank slope diameter: 2,000 m. 120 m high. Although the dead Calyptogenas were distributed throughout the summit, there was no active colony. Rock fragments were also observed throughout the summit as well as the flank slope.

No. 6 MV - sediment drape stage: Summit diameter: 600 m. Basal diameter: 2,000 m in N-S and 1,300 m in E-W. 80 m high. Only one dead Calyptogena was observed along the entire 2,000 m dive track. Only one small cluster of rock fragments was found at the southeast corner of the summit.

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