La mer 29: 155-158, 1991
Société franco-japonaise d'océanographie, Tokyo

JAMSTEC program on deep-sea carbon fluxes: present situation and future plans

Yoshito TSUJI*, Makio HONDA*, Takeo TANAKA* and Hiroshi HOTTA*

Abstract: The Japan Marine Science and Technology Center (JAMSTEC) was incorporated in 1971 as a general oceanographic institution with priority areas of research:deep-sea survey and research, ocean observation and coastal sea areas development and utilization. JAMSTEC has considered the balance beween science and technology, and engaged in the development of tools necessary for those researches such as deep-sea submersibles. Using these submersibles, hydrothermal phenomena with chimneys covered with deep-sea organisms were discovered in the Okinawa Trough, and cold seepage phenomena with colonies of clams in Sagami Bay; JAMSTEC is now engaged in basic studies of deep-sea organisms growing in those environments where such phenomena are observed. Also, CO_2 rich fluid and hydrate formation on the seafloor were found in the Okinawa Trough in 1989. A preliminary study of CO_2 status in the deep sea, focusing on the observation of the property change using the submersible SHINKAI 6500, was carried out in 1990. Marine snow observation using the submersible was started in 1990 and we found a midwater maximum of marine snow abundance in Suruga Bay. JAMSTEC has two future plans on deep-sea carbon fluxes: one is to clarify biological cycles of biogenic elements, joining an intergovernmental and international research project on bio-geochemical cycles in the ocean margins. The other is a study to evaluate the carbon flux from the hydrothermal vent field in the Okinawa Trough.

JAMSTEC was founded in 1971 with the cooperation of government, academic and private circles, for the propose of promoting the marine science and technology in Japan, its management coming under the general supervision of the Science and Technology Agency (STA).

JAMSTEC has carried out following various fields of R & D projects: development of diving technology for the effective utilization of the seafloor space on the continental shelf with depth up to 300 m, development of wave power energy technology and creation and utilization of calm sea space behind a large wave power generation system. JAMSTEC also attempts to understand dynamic processes of the ocean: studies on large-scale oceanic change phenomena, and the development of technologies required for carring out such studies, e.g., ocean acoustic tomography and ocean laser profiling.

JAMSTEC has engaged (and still does) in the development of tools necessary for deep-sea research in forms of manned and unmanned submersible systems. For manned submersibles, we are now equipped with the SHINKAI 2000 with depth capability up to 2,000 m, and the SHINKAI 6500 with depth capability up to 6,500 m. For unmanned probing, we have the Dolphin 3K, with depth capability up to 3,300 m. All of those submersibles are in active service now; one of the prominent discoveries is hydrothermal phenomena with active "black-smoker" in the Okinawa Trough.

* Japan Marine Science and Technology Center, Yokosuka, 237 Japan

JAMSTEC has engaged in basic studies of deep-sea organisms growing in those environment where hydrothermal phenomena and cold seepage phenomena were observed. A series of deep tow surveys in the North Fiji Basin conducted in the Japan-France cooperation research revealed a hydrothermal vent communities: deep-sea mussels, hairly gastropods, galatheid crabs, brachyuran crabs, barnacles and zoarcid fishes (HASHIMOTO *et al.*, 1989a). Deep-sea surveys at the Minami-Ensei Knoll in the Okinawa Trough showed dense deep-sea communities of sponges, deep-sea mussels, tube worms, shrimps, anomuran stone crabs, vesicomyid clams and tongue fishes in environments with hydrothermal fluid pouring from fissures in rock outcrops and coarse sandy bottom with grayish white alteration in colour (HASHIMOTO *et al.*, 1990). Cold seep communities dominated by the giant clam were found at the Okinoyama Bank site (HASHIMOTO *et al.*, 1988) and along the slope foot of the Hatsushima escarpment (HASHIMOTO *et al.*, 1989b) in Sagami Bay.

Self ejecting liquid CO_2 was found in 1989 in the hydrothermal active area of Izena Hole in the Okinawa Trough (KIMURA *et al.*, 1990). SAKAI *et al.* (1990) observed formation of CO_2 hydrate from CO_2-rich liquid which emerge from a white alteration zone into the bottom seawater, and sampled liquid CO_2 bubbles into an acryl cylinder to observe their phase change during the ascent of the SHINKAI 2000. The discoveries of liquid CO_2 and CO_2 hydrate make an in situ experiment for JAMSTEC to examine the physico-chemical property of CO_2-H_2O system in the deepsea (HONDA *et al.*, 1991). Dry ice (solid CO_2) put into a transparent acryl cylinder without bottom was carried to the deepsea using SHINKAI 6500; formations of liquid CO_2 and CO_2 hydrate and inversion of density between liquid CO_2 and the ambient seawater wereobserved, confirming the same manner of the CO_2 status change as predicted from the phase diagram for CO_2. Also, this experiment showed formations of "makaroni-like" solid which seemed to be CO_2 hydrate containing liquid CO_2 in it, and require more precise experiments in future to know the property of the solid in detail.

JAMSTEC also carried out measurement of quantitative distribution of marine snow in Suruga Bay on 29th April 1990, using a camera and a strobe and a clear-sight (a cylinder with the clear water inside and the light-shielded body except transparent parallel planes) on the submersible SHINKAI 2000 (TSUJI *et al.*, 1991). Marine snow particles were analyzed using an image analyzer and the profiles of marine snow abundance were obtained. One of the profiles showed a maximum of marine snow density in the midwater (TSUJI and SUKIZAKI, 1992). The analysis of marine snow abundance profiles showed the significant differences between the size classes; the larger the size, the deeper the depth of maximum density is located. A comparison of the profiles between marine snow abundance and salinity suggested two processes for the occurrence of the size different profiles: marine snow advection with high salinity waters to the water column where it was observed and size sorting by sedimentation in the water column (TSUJI and SUKIZAKI, in preparation).

JAMSTEC will start two projects on the studies of deep-sea carbon fluxes. One is the study on bio-geochemical cycle in the ocean margins; multi-disciplinary research on biogeochemical cycles and fluxes of biogenic elements in ocean margins. This project is one of the new proposals for the "Special Coordination Funds for Promoting Science and Technology (SCF)" of STA, and will be started in fiscal year 1992 for a period of five years. This project aims to clarify quantitatively bio-geochemical cycles of biogenic elements by hourly, daily, seasonally and yearly time-series surveys in the marginal seas of the Pacific, and moreover to evaluate the role and the function of marginal seas in global changes. The Changjiang and Yellow rivers, which empty into the East China Sea, transport large amount of nutrient and suspended matter

from land to the ocean. The knowledge of the influence of these large rivers on the oceans will give us a suitable model for the estimate of the exchange at continental margins in the global ocean flux stydy. The East China Sea is the primary target area, followed by the Japan Sea, the South China Sea and the Okhotsk Sea. The other project is to estimate the influence of the carbon flux produced by hydrothermal activity on the ocean interior and the seafloor in the Okinawa Trought; it will be started in fiscal year 1992 for a period of more than five years. The study includes the survey of the distribution of hydrothermal vents, time-series carbon fluxes at the typical vent site, horizontal and vertical transport of carbon produced from the vent system and from the thermal vent communities, and the comparison of carbon fluxes among the hydrothermal, the biogenic and the terrigenic origins. The survey of the distribution of the CO_2 hydrate under the seafloor is essential to estimate the volume of self ejecting CO_2 liquid in the field. The facilities such as submersibles, sediment traps, marine snow camera, high-resolution sub-bottom profiler and long time-range monitoring stations on the seafloor will be utilized.

References

HASHIMOTO, J., S. MATSUZAWA and H. HOTTA (1988): Searching for Biological Communities at the Okinoyama Bank Site in the Sagami Bay. JAMSTECTR DEEPSEA RESEARCH **4**: 177-188.

HASHIMOTO, J., D. JOLLIVET and 88 SHIPBOARD PARTY (1989a): The hydrothermal vent communities in the North Fiji Basin: Results of Japan-France Cooperative Research on board KAIYO 88, La mer, **27**: 62-71.

HASHIMOTO, J., S. OHTA, T. TANAKA, H. HOTTA, S. MATSUZAWA and H. SAKAI (1989b): Deep-sea communities dominated by the giant clam, *Calyptogena soyoae* along the slope foot of Hatsushima Island, Sagami Bay, central Japan. Paleogeography, Paleoclimatology, Paleoecology, **71**: 179-192.

HASHIOMOTO, J., K. FUJIKURA and H. HOTTA (1990): Observations of Deep Sea Biological Communities at the Minami-Ensei Knoll. JAMSTECTR DEEPSEA RESEARCH, **6**: 167-179.

HONDA, M., J. HASHIMOTO, J. NAKA and H. HOTTA (1991): CO_2 Hydrate Formation and Inversion of Density between Liq. CO_2 and H_2O in Deep Sea: Experimental Study using submersible "Shinkai 6500" . In the proceedings of The First International Workshop on Interaction between CO_2 and Ocean, 3-4 December 1991, Abiko.

KIMURA, M., T. OOMORI, E. IZAWA, Y. KATO, T. ONO, T. TANAKA, T. KOIKE and S. NISHIOKA (1990): Newly found vent system and ore deposits in the Izena Hole in the Okinawa Trough, Japan. JAMSTECTR DEEPSEA RESEARCH, **6**: 87-97.

SAKAI, H., M. YAMAMOTO, T. TANAKA, T. GAMO, E. KIM, J. ISHIBASHI, K. SHITASHIMA, T. MATSUMOTO, T. OOMORI, J. YANAGISAWA and M. TSUTSUMI (1990): Geochemical studies of the hydrothermal system at the Izena Cauldron using "SHINKAI 2000" ——reports on dive numbers 413 and 415, and on the liquid CO_2 bubbles and hydrate collected during dives number 424. JAMSTECTR DEEPSEA RESEARCH, **6**: 69-86.

TSUJI, Y., S. SUKIZAKI, E. IKEMOTO and K. OTSUKA (1991): A Simple Method for in situ Measurement of Marine Snow Abundance: Clear-site Method. JAMSTECTR DEEPSEA RESEARCH **7**: 63-71.

TSUJI, Y. and S. SUKIZAKI (1992): Measurement of marine snow abundance using the submersible. In press.

深海の炭素循環に関する海洋科学技術センターの研究活動：現状及び将来

辻　義人・本多牧生・田中武男・堀田　宏

海洋科学技術センター（センター）は総合的な海洋開発・研究機関として1971年に設立され，主たる研究活動として深海調査研究，海洋観測及び沿岸域の開発利用を行っている。センターは科学と技術の調和を重視しており，研究に不可欠な施設・技術（たとえば有人・無人の深海潜水調査船）の開発を行ってきた。これらの潜水調査船によって特有の深海生態系を有する沖縄トラフの熱水噴出域及びシロウリガイ群集を有する相模湾の冷水湧出域が発見され，現在センターではこれらの生物に関する基礎研究を行っているところである。また，海底における液体二酸化炭素の噴出及び二酸化炭素－水ハイドレイトの形成が1989年に沖縄トラフではじめて観測された。これを実験的に再現するために，センターでは沈降中の「しんかい6500」によって深海における二酸化炭素の相変化の観測を1990年に実施した。さらにセンターは，1990年から潜水調査船を使用したマリンスノーの調査を開始し，駿河湾の中深度層においてマリンスノー密度の最大を観測した。センターは，深海の炭素循環に関して二ケの将来計画を有する。一つは，科学技術庁の振興調整費「縁辺海における物質循環に関する国際共同研究」に参加し，複数の国内（国外）研究機関とともに東シナ海を主とした縁辺海において生物地球化学的な調査・研究を行うものである。他は，海洋の物質循環に与える熱水噴出域の影響を定量的に評価するために，沖縄トラフにおいて調査・研究を行うものである。