CRUISE REPORT

Ship Name: R/V VEMA   Cruise No: V 33-09

Departure:____7/25/76_____from__Singapore_____
               Date   Port

Arrival:_____8/24/76_____at___Keelung, Taiwan_____
               Date   Port

Days at Sea:_3D____   Days Foreign Port: 2 _____

                                    No. of days in arrival port

Area of Operation:

   Southeast Asian region

Program Description:

 A geochemical study of the isolated deep basins of the Southeast Asian region
with the objective of establishing the nature and rate of ventilation of the
basins and defining the chemical changes taking place withim them and the
imprint of the changes on the nature of the accumulating sediment.

Participants: (All L-DGO unless otherwise specified)

.L. Tanner, Coring O.S.   Alan Engvik, Gravity & Computer Tech.
D. Holland, E.T.   Michael Holland, Camera
.D. Quick, E.T.   ·   Nicholas Leiser, Computer Tech.
James Cranston, E.T. .   · M. Sundvik, Core Describer
Bruce Herman, Heat Flow   W. Broecker, Chief Scientist
J. Toggweiler, Gas analysis   Scott Broecker, Core Tech.
 Tech.   Peter Kaiteris, Gas analysis tech. (Queens College)
Herb Steeves, Air Gun

All inquiries regarding cruise should be made to the chief scientist.

PROJECT POTHOLES

LAMONT-DOHERTY GEOLOGICAL OBSERVATORY

PORTION OF

SLMEX

A JOINT SIO-LDGO STUDY OF GEOCHEMISTRY
AND PHYSICAL OCEANOGRAPHY OF THE DEEP
SOUTHEAST ASIAN ISOLATED BASINS

PRELIMINARY REPORT

During leg 9 of Vema expedition 33 a geochemical study of the isolated deep basins of the Southeast Asian region was conducted. The objective of this effort was to establish the nature and rate of ventilation of these basins and to define the chemical changes taking place within them and the imprint of these changes on the nature of the accumulating sediment.

Three approaches to the definition of the rate of ventilation were undertaken.

1) Geothermal heating of the isolated water: By relating the θ-S point for the isolated deep water to the θ-S trend for the "feed" waters in the adjacent Philippine Basin an estimate of the extent of heating can be made. From heat flow estimates (in the literature and those made by Bruce Herman during this leg) this temperature excess can be converted to an isolation time.

2) Radiocarbon dating: By contrasting the C^{14}/C ratio in the isolated basin water with that of the "feed" water from the adjacent Philippine Basin an estimate of the isolation time can be made. In order to do this a small correction must be made for carbon (and radiocarbon) input to the deep basin due to $CaCO_3$ dissolution and the oxidation of organic debris. The measurements of total dissolved inorganic carbon and partial pressure of CO_2 allow this to be done.

3) Ra^{228} profiles: The vertical distribution of Ra^{228} (half-life 5.6 years) should provide an estimate of the rate of vertical eddy diffusivity in these basins. Such estimates are necessary for modeling of the actual mixing dynamics. Such models must include the contribution of the downward mixing of the waters overlying the basin as well as of the input of water through overflow at the sill.

Several chemical processes occurring within the basin were studied.

1) Oxygen consumption by respiration.

2) Nitrate and phosphate production through respiration (work carried out by Patzert of SIO from the R.V. Thomas Washington as a cooperative complement to the work done on Vema).

3) Nitrate consumption (again based on data to be obtained by Patzert).

4) Calcite dissolution: From the ΣCO_2 and pCO_2 measurements the change in alkalinity of the isolated water can be estimated. This change is mainly the result of $CaCO_3$ dissolution (a small correction for nitrate production must be made, a la Brewer). This change can be converted to a rate using the isolation time derived from the mixing model. This rate can be compared with that derived from the sedimentation rate (as obtained from C^{14} dating of the cores of known $CaCO_3$ content) and the $CaCO_3$ versus water depth variation in cores from these basins. To do this the geometry of the

basin must, of course, be known.

We have developed a new means of measuring $\underline{in~situ}$ dissolution rates of calcite. By deploying C^{14}-tagged calcite crystals and determining the extent of C^{14} loss we can detect losses of as little as 10 molecular layers. This method was tested for the first time on this leg. Exposures were made at nine stations.

5) A cross check on the above is available from the ΣCO_2 data. The increase in the total dissolved inorganic carbon content of the isolated basin water should be that calculated by summing the O_2 loss (corrected for the nitrate and phosphate gain) and half the alkalinity gain (corrected for the nitrate increase).

6) The rate of supply of barium from dissolving (or oxidizing) particles: By measuring the difference in the basium content between the basin waters and their Philippine Sea counterparts the rate of barium addition can be estimated.

7) The rate of Ra^{226} supply from basin sediments: By measuring the Ra^{226} concentration difference between the basin waters and their Philippine Sea counterparts the net Ra^{226} increase during isolation can be estimated. This excess must be corrected for loss of Ra^{226} due to radioactive decay during residence in the basin and for the input of Ra^{226} resulting from the dissolution of barium bearing particles (using the measured excess of barium and the Ra^{226}/Ba ratio in surface water).

The basins in which these studies were carried out are shown on the map in Figure 1 and listed in Table 1 along with their vital statistics (potential temperature, sill depth and basin depth).

The analyses were (or are to be) made by the following procedures.

1) Salinity - on board using a Plessy-Fergusson salinometer.

2) Oxygen - on board using the standard Carpenter modification of the Winkler method.

3) Total dissolved inorganic carbon - ashore on mercuric chloride poisoned samples using the I.R. technique of Li et al. The measurements are to be made in the laboratory of Taro Takahashi at Queens College in New York City.

4) Partial pressure of CO_2: Eight liter water samples were equilibrated with recirculated marine air on the ship within an hour or so after collection. The equilibrated air samples will be analyzed for CO_2 content in the laboratory of Taro Takahashi.

5) Barium: Half liter water samples were stored in acid cleaned polyethylene bottles. The analyses will be made in the laboratory of John Edmond at MIT.

6) Radium-226: Twenty liter water samples were stored in "Cubitainers" for return to the LDGO geochemistry laboratory for analyses by the standard radon stripping method.

7) Radiocarbon: Two hundred liter samples were collected using an LDGO manufactured Gerard barrel. These samples were acidified at sea and stripped of CO_2 using procedures and reagents identical to those used by the GEOSECS program. The NaOH in which the CO_2 was collected has been sent to the laboratory of Minze Stuiver at the University of Washington for C^{14}/C measurement.

8) Radium-228: Mn coated fibers prepared by the procedures developed by Moore were sent down in Niskin bottles equipped with salt link release funnels to prevent water flow through the bottles during descent. These bags have been returned to the LDGO geochemistry laboratory for Ra^{228}/Ra^{226} activity ratio measurements. Using the absolute Ra^{226} measurements concentrations of Ra^{228} can be calculated from these ratios.

9) C^{14}-tagged crystals: Calcite crystals tagged with C^{14} to detphs of from 50 to 300 molecular layers (by heating in the presence of C^{14}-tagged CO_2 gas) were lowered on the outside of Niskin bottles and allowed to soak for periods of eight hours at various water depths. The crystals were coated with candy so that during their descent through the calcite supersaturated shallow waters they would not be coated with precipitated carbonate. The crystals

will be returned to the laboratory of Taro Takahashi where the loss of C^{14} due to <u>in situ</u> dissolution will be determined.

10) Temperature: Standard reversing thermometers mounted on the Niskin bottles were deployed in each cast.

11) Depth: The water depth of each sample can be estimated from (a) the reversing thermometer results, (b) wire out. For samples taken near the bottom the PDR bottom depth, the pinger to bottom distance and the pinger to sample bottle wire spacing allow accurate depths to be obtained.

12) Tritium: A tritium profile down to 1000 meters was obtained in the South China Sea to determine whether significant amounts of tritium had reached the Sulu Sea sill depth (420 meters). Negotiations will be carried out with Ostlund of the Miami laboratory to see whether he will make the measurements on these samples.