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CRUISE REPORT

Ship Name: R/V VEMA Cruise No: 33-10

Departure: August 27, 1976 (Date) from Keelung, Taiwan (Port)

Arrival: Sept. 20, 1976 (Date) at Yokohama, Japan (Port)

Days at Sea: 24 Days Foreign Port: 4 (No. of days in arrival port)

Area of Operation: West Philippine Basin

Program Description: Standard seismic reflection profiling, magnetics, gravity, piston coring, dredging, camera and nephelometer.

Participants: (All L-DGO unless otherwise specified)

Truchan, Marek	Chief Scientist
Herman, Bruce	Heat Flow and Gravity
Quick, Dennis	E. T.
Cranston, James	E. T.
Leiser, Nicholas	Computer Operator
Steeves, Herbert	Air Gun
Sundvik, Michael	Core Describer
Holland, Michael	Camera

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

CRUISE REPORT

R/V Vema 3310
August 27 to Sept. 20, 1976

Scientific Objectives and Areas

This 24-day leg was devoted to studies of three areas: 1) the Okinawa Trough, 2) the northern limb of the Central Basin Fault system and 3) the Oki Daito and Daito Ridge complex (Fig. 1). The main interest in the Okinawa Trough was to obtain heat flow measurements to better understand its evolution and of similar small basins with high heat flow values. A minimum of four stations were planned in the trough, two on the landward and seaward side of a basement high observed on a VEMA 28 traverse (profiles 2436-2437), which was suspected to be a linear feature inside and parallel to the trough. In addition to this work, the heat flow program was to include two micro surveys consisting of a suite of three cores forming a triangle of about 20 kms on the side. These sites were to be selected on the basis of uniform sediment cover and low basement relief. Two candidate locations considered were: one just north of Lapu-Lapu Ridge in the Philippine Basin and another in the Western Shikoku Basin at 29°N, 135.5°E.

The second (2) project consisted of running magnetic lines from the Central Basin Fault (CBF) to the Lapu-Lapu Ridge to see whether correlations could be established with

the magnetic lineations to the east identified by Watts et al. (in press).

The final major task (3) planned for the leg was to make an effort to dredge fresh rock samples from the Oki Daito and Daito Ridge complex. The origin and age of these enigmatic features are not known. Their shapes have suggested the possibility that they may be abandoned island arcs associated with the opening of the Philippine Basin (Watts et al., in press).

A minor assignment of the cruise was to sample three closely spaced cores, at 20-cm intervals, to contribute to the data library of the recently initiated acoustics-near-bottom processes program. The ultimate goal of this project is to establish correlations between sediment-lithology/ physical properties and 3.5 kHz echograms in various acoustic-type provinces. Until now, the data collected have come only from the North American Basin (see Conrad 1906, 1907 cruise reports). In this case, we chose to sample the cores planned in the heat flow site survey north of the Lapu-Lapu Ridge.

Accomplishments and Cruise Narrative

The R/V VEMA departed from Pier 1 in Keelung, Taiwan, at 0945 hrs on August 27 and headed for the southern edge of the Okinawa Trough (O.T.) somewhere in the vicinity of 125°E meridian. The idea was to obtain two transects of the O.T. on the way to the target area for the two pairs of heat

flow stations flanking the basement "ridge".

While heading for the site, a remarkable graben was observed (Fig. 3, profile 4), whose presence had not been previously reported. The discovery of such a significant feature altered our cruise plans and we felt compelled to survey it, spending as much time as possible in the O.T. and still trying to accomplish most of the remaining tasks.

The profiler data shown in Figure 2 have all been interpreted and drafted on board the VEMA and then reduced on the Xerox copier on our return to L-DGO. Figure 2 was similarly prepared.

At the intended site of the first heat flow station, instead of the expected outcropping basement "ridge", we found only its sediment-covered expression (Fig. 3, profile 3) and chose to return to the graben for our first station. We recalled that in the graben a "transaural" layer of adequate thickness existed, which should be sufficiently "soft" to penetrate. A two-pipe piston core with five heat flow probes was lowered and returned with the lowermost pipe bent. We retrieved one jar of material consisting of micaceous, olive gray sand with abundant angular quartz grains. The lowermost probe rode one meter up the pipe and no heat flow was measured. Thus, the fact remains that something hard was hit. It was either the "piercement" structure observed in Figure 2, profiles 2 and 3, or else the "transaural" layer consists of sand layers. That is not, however, what turbidites look like on a fathogram!

A camera station followed, intended to photograph the faults on the inner flank of the graben. Nothing dramatic was seen, although we apparently "hit" about 40 fms above the graben floor.

After station, the survey of the graben to the east continued. Three transects of this feature were made, all as dramatic as the first one (Fig. 2, profiles 2, 4 and 5). On the fourth crossing (Fig. 2, profile 6), the valley broadened and we decided to steam north. This time, we did find a 600-fm high basement ridge (Fig. 2, profile 6) with another graben north of it! A station was taken there, consisting of a cautious one piper. This time, 119 cm of good core was obtained consisting of olive gray sandy clay with layers of turbidites.

We now decided to trace the new graben to the east. Another one piper was taken on a faulted floor south of the deepest portion of the transect so as to be above possible turbidites coming from the China shelf. A 357-cm core was obtained consisting of a top layer (21 cm) of foram clay followed by sandy foram clay and interbedded clay and silt layers. Volcanic ash and glass shards were also present. Two more cores were taken in the eastern segment of the survey. On station 178 softer sediments were finally encountered. A 485 cm of good core was retrieved, consisting of top 19 cm dark yellowish brown foram clay followed by olive gray foram foram clay layers and micaceous sand layers.

At this point, we decided to return to the basement "ridge" (Fig. 2, profile 6) and dredge it. One more core was taken on the way, ending the heat flow program. Four stations were completed, but only two were good and these showed a high value in agreement with the results reported by the Japanese.

The dredge from the south flank of the "ridge" shown in profile 6 (Fig. 2) was a notable success. We obtained a full capacity load of granodiorites, diorites, greenschist basalts and tectonically sheared fragments of intrusive rocks.

The summary of our work in the Okinawa Trough is shown in Figures 2 and 3. We established the existence of a well-developed graben over 200 m deep and 8 km wide separated from a smaller graben by a narrow ridge. Faults in the southern graben exhibit "throws" of more than 20 m. The intensity of the faulting portrayed in Figure 3 is conservative; more closely spaced offsets will be uncovered with a more careful scrutiny of the data, something that could not have been done on board.

Magnetic Survey of the Central Basin Fault Sea-Floor Spreading System

Four magnetic lines extending from the crest of the CBF to the Lapu-Lapu Ridge (east-west oriented shaded area south of stations 181,182 and 183, Fig. 1). This survey was de-

signed to verify whether sea-floor spreading anomalies correlated on similarly oriented ship's tracks to the east could be extended. The uneven spacing between our tracks (Fig. 1) is due to the presence of magnetic lines that were isolated from the Watts et al. (in press) study to the east. (See their Fig. 6.)

The "disruption" in the middle of the easternmost lines in our survey (Fig. 1) is due to an evasive action order to wait for a typhoon to pass, coming across our path from the southeast. More than 40 hours were lost, but we did manage to complete the magnetic survey.

The Lapu-Lapu Ridge turned out to be very similar to the great faults of the eastern Pacific, such as the Clipperton, for example. A regional offset in depth exists across the fault and the feature has a south-facing escarpment.

Heat Flow Site Survey

After completion of the magnetic survey we took a suite of three heat flow stations forming a triangle about 20 km on the side, just north of Lapu-Lapu Ridge (Fig. 1). The geological setting was close to ideal. A uniform sediment cover was present overlying a smooth basement. The three cores (101, 102 and 103) were taken in 3100 fm depth and were respectively 1038 cm, 1022 cm and 894 cm long. The respective penetrations were 800 cm, 880 cm and 780 sm. The heat flow measurements were all successful.

Sampling of each core for physical properties analysis for the acoustics-near-bottom processes program was carried out on each core. Good acoustic laminations on the 3.5 kHz fathograms were present for comparison with changes in lithology and physical properties.

Oki Daito Ridges - Dredging

Attempts to dredge fresh rocks from the Oki Daito Ridge complex were not successful, although very promising escarpments of high relief and prolonged bottom returns were located and substantial amount of time was spent on the bottom in each case. Furthermore, two of the three dredges taken were "hang up" registering near maximum tension on the accumulator.

For the first dredge (Sta. 184), we chose the middle portion of the Oki Daito Ridge where it appears to consist of three steep-sided ridges, two of which are capped with a thin sediment cover. We selected the southern side of the middle peak and lowered the dredge just below the sediment overburden to get at the youngest rocks and away from possible "rubble" below. The dredge came with about 700 lbs of weathered, friable basalt, manganese nodules and a large slab of manganese crust. There was sufficient amount of material to fill a 2x2x2 ft box. A camera station preceding the dredge (close to it, hopefully) revealed a field strewn with boulders and nodules.

An "ideal" dredge site was found for our second attempt (Sta. 185). This time, a "needle sharp" peak was selected,

marking the top of a very high-relief escarpment forming the southern boundary of the Oki Daito Ridge. We managed to hit near the very top of the peak and were rewarded with a couple of pieces of weathered basalt encrusted with manganese.

A camera station followed and gave us a measure of consolation. Spectacular pictures of enormous manganese-encrusted boulders dominated the scenery, indicating that it was unlikely to dredge anything fresh here.

The final dredge (Sta. 187) was taken about half-way down a cliff forming the southern boundary of the Daito Ridge near a topographic "saddle" joining it to the Oki Daito Ridge (Fig. 1). This time we retrieved nothing more than a few pieces of colonizing sponge coated with manganese and some manganese crust. A camera station in the vicinity (on the same cliff) revealed rock shapes beneath a continuous sedimentary mantle.

In conclusion, although dredging on the Daitos proved a failure, at least the L-DGO profiler coverage was increased over the two ridges. Also, attempts were made to record some sonobuoys. Four were launched along the axis of an intervening basin between the two ridges, but refractions were not recorded although there were hints of some.

The final accomplishment of the cruise was the completion of two heat flow stations planned in the Shikoku Basin (Sta. 188 and 189). The two cores taken measured 884 cm and 942 cm, and four probes worked on each.

Highlights

The discovery of a spectacular display of recent extensional tectonism in the Okinawa Trough constitutes an exciting new line of evidence that this marginal sea is actively spreading due, apparently, to the northward subduction of the Philippine plate at the Ryuku Trench.

The "picture-like" quality of the crisply "laminated" 3.5 kHz fathograms will allow an unprecedented close-up view of individual vertical offsets to better understand the behavior of unconsolidated sediments under stress. Above all, surficial mapping of these faults might produce a pattern revealing the direction of the forces responsible for the basin deformation. Although extension may have been the dominant style of deformation in the Okinawa Trough, the region undoubtedly contains a record of more complicated movements. Indeed, some of the faults in the eastern portion of the trough appear to be classical thrust sheets. Thus, a survey extending east of this study could verify whether a change from extensional to compressional tectonism has occurred.

Lastly, of great potential value is the dredge from the median "ridge" in the O.T. Dating of these rocks would indicate the time of rifting of this marginal sea.

Marek Truchan

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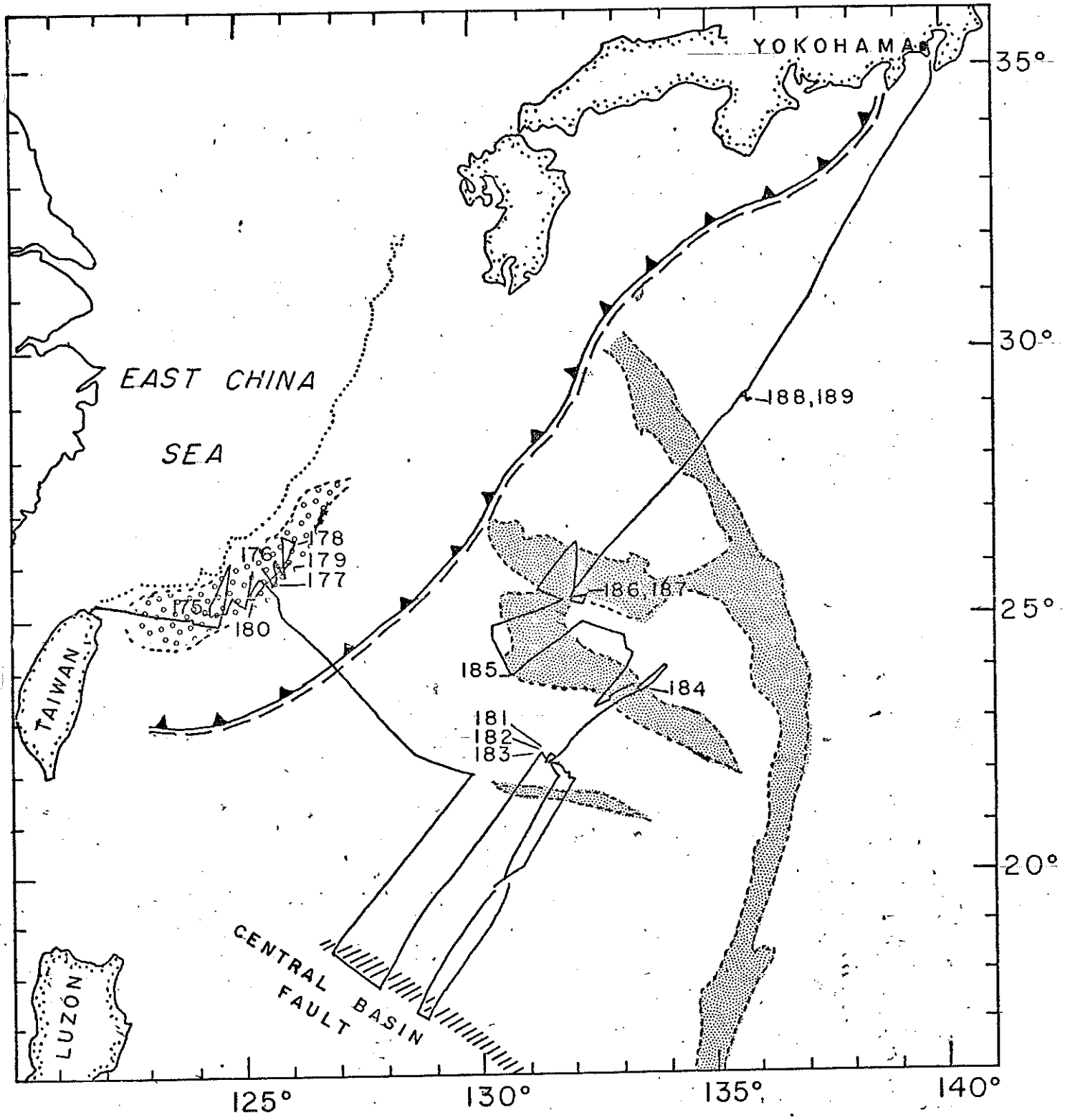

VEMA 33-10

KEELUNG TO YOKOHAMA

AUG. 27 TO SEPT. 20

1976

Fig. 1

Vema 33-10

OKINAWA TROUGH SURVEY

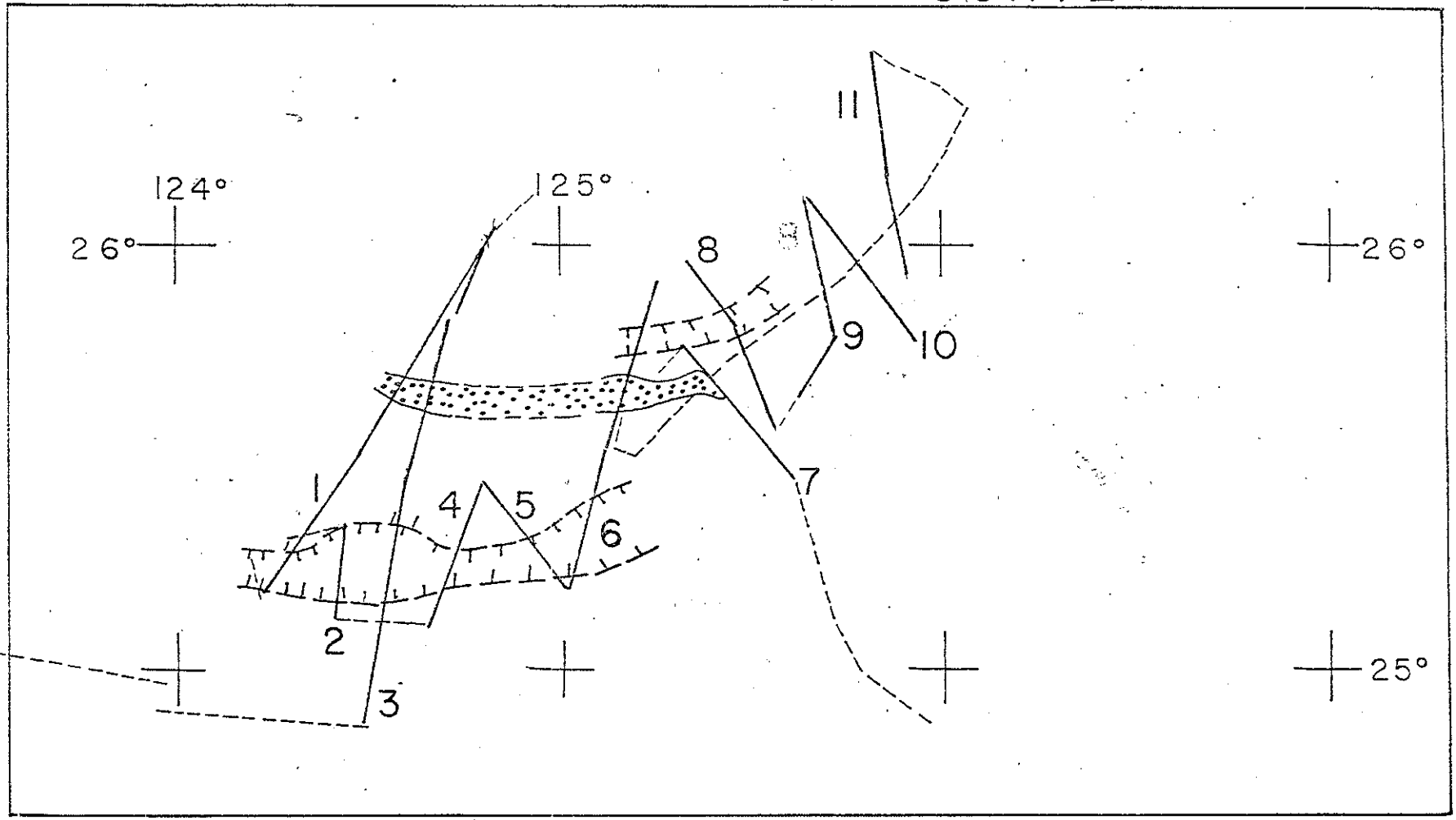

Fig. 2

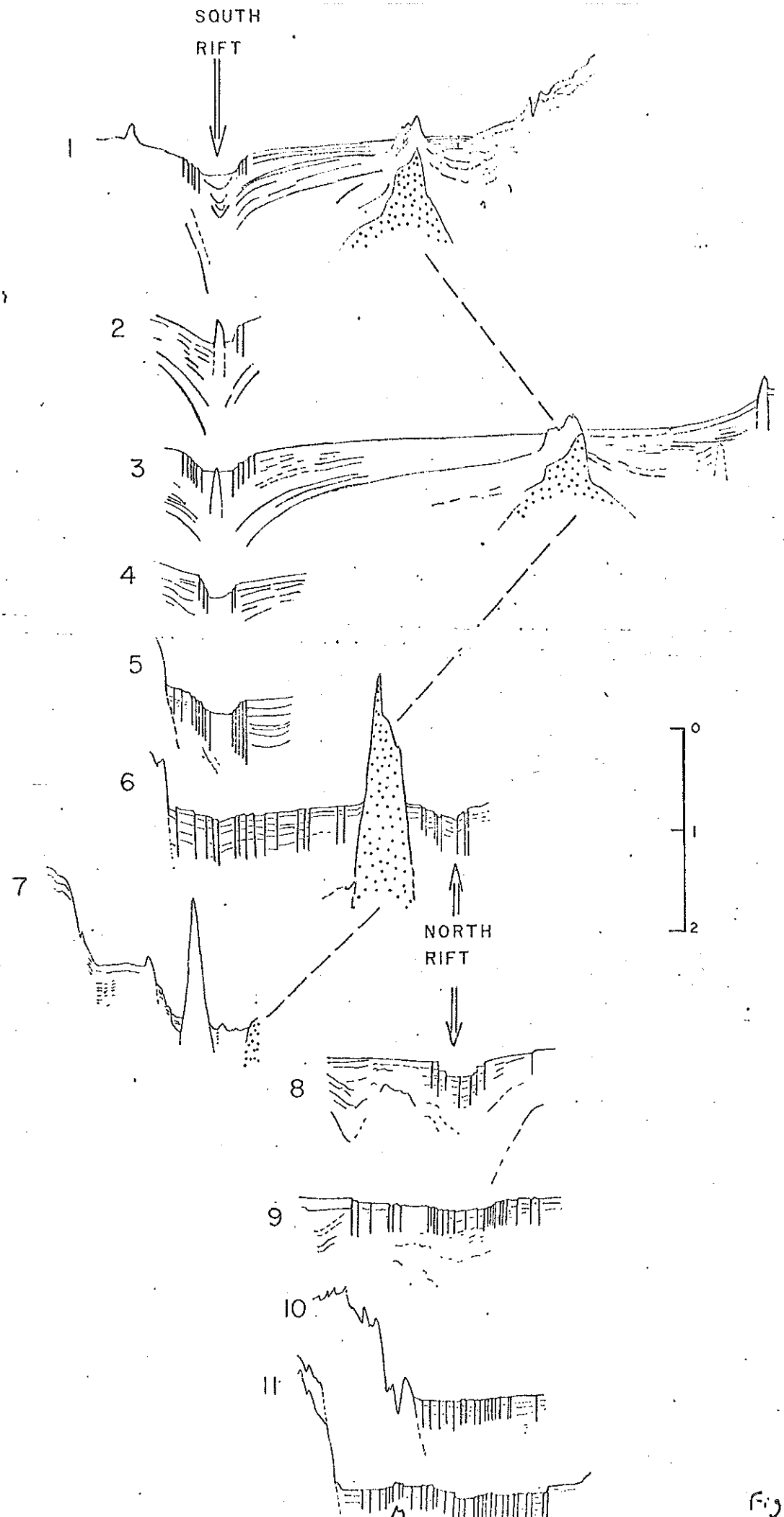

Fig. 3