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42. *Results of Geomagnetic Survey during the Cruise of R/V Argo in Western Pacific 1966 and the Compilation of Magnetic Charts of the Same Area.**

By S. UYEDA, V. VACQUIER, M. YASUI, J. SCLATER, T. SATO, J. LAWSON, T. WATANABE, F. DIXON, E. SILVER, Y. FUKAO, K. SUDO, M. NISHIKAWA and T. TANAKA.

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Abstract

A total force geomagnetic survey was made in the northwestern Pacific during the US-Japan Scientific Cooperation Cruise of the R/V Argo of the Scripps Institution of Oceanography. In this survey, eleven seamounts were surveyed in detail both magnetically and bathymetrically. Combined with the existing data taken previously by both Japanese and US researchers, revised charts of the total geomagnetic field and its anomaly have been drawn for the area west of 172°E between 24°N and 46°N. The existence of magnetic lineations trending SWW-NEE which were noted previously have been confirmed, and their extension has been noted. They generally disappear as they get closer to the coast, but some seem to penetrate into the Japan Trench area. In the Shikoku Basin, the linear anomalies do not seem to exist. Some magnetic anomaly profiles have been investigated to see if there is any correlation with the anomalies in the Eastern and Central Pacific area. For a definite conclusion, however, good profiles in NNW-SSE direction in the northern Pacific area between 160°E and 180°E would be needed.

* Contribution from Earthquake Research Institute and Geophysical Institute, the Universiy of Tokyo and Scripps Institution of Oceanography, University of California, San Diego, California.

S. UYEDA: Earthquake Research Institute and Geophysical Institute, University of Tokyo.

V. VACQUIER, J. SCLATER, J. LAWSON, F. DIXON and E. SILVER: Scripps Institution of Oceanography, Marine Physical Laboratory, University of California, San Diego.

M. YASUI: Maizuru Marine Observatory, Japan Meteorological Agency.

T. SATO: Hydrographic Department, Maritime Safety Board.

T. WATANABE, Y. FUKAO, K. SUDO and M. NISHIKAWA: Graduate School, University of Tokyo.

T. TANAKA: Geophysical Institute, University of Tokyo.

1. Introduction

During the cruise of the R/V Argo of the Scripps Institution of Oceanography, University of California on ZETES Expedition legs III, IV and V, the total geomagnetic field intensity was measured by a ship-towed proton precession magnetometer. The Expedition was a part of the US-Japan Scientific Cooperation Program and both US and Japanese scientists worked together in obtaining and reducing the data.

The ship's tracks in the ZETES Expedition are shown in Fig. 1. In addition to the usual star fixes, Loran-C was used for locating the ship. In Fig. 1, rectangles roughly represent the areas where detailed surveys were made over seamounts. The area shown in Fig. 1 has been surveyed magnetically by a number of investigators. This paper presents a compilation of all existing available data. In addition to the ZETES cruise of the Argo, the following ships contributed to the present compilation: (1) R/V Ryofu Maru of the Japan Meteorological Agency and R/V Takuyo of the Hydrographic Department, Maritime Safety Board during the Japanese Expeditions of Deep Seas (JEDS), (Uyeda et al., 1964); (2) R/V Takuyo in the Japan Trench area in 1965 on her Upper Mantle Project Cruise, (Matsuzaki, 1966); (3) R/V S. F. Baird of the Scripps Institution of Oceanography on the JAPANYON Expedition in 1961, (R. E. Warren, private communication); (4) USNS Davis of the US Naval Oceanographic Office on AGOR-5 cruise in 1964, (Bracey, 1966 and private communication); (5) R/V Tansei Maru of the Ocean Research Institute, University of Tokyo and R/V Umitaka Maru of Tokyo University of Fisheries, (Tomoda et al., 1967) and (6) R/V Vema of the Lamont Geological Observatory, Columbia University, of Vema 20 and Vema 21 cruises (J. Heirtzler, private communication). Tracks of all the ships are shown in Fig. 2. As can be seen in the figure, the tracks are reasonably dense in some parts but there are many areas where the control is sparse. In Uyeda et al. (1964), charts of the total geomagnetic field and of the local anomaly were constructed tentatively. In the present paper it is intended to do the same with the addition of new data.

2. Seamounts

During the ZETES Cruise, eleven seamounts were surveyed in detail. The locations of the seamounts are indicated in Fig. 1 by symbols like Z-3-1, Z-3-2. Z-3-1, for example, means seamount No. 1 surveyed in leg III of ZETES Expedition. The position of the ship during bathymetric

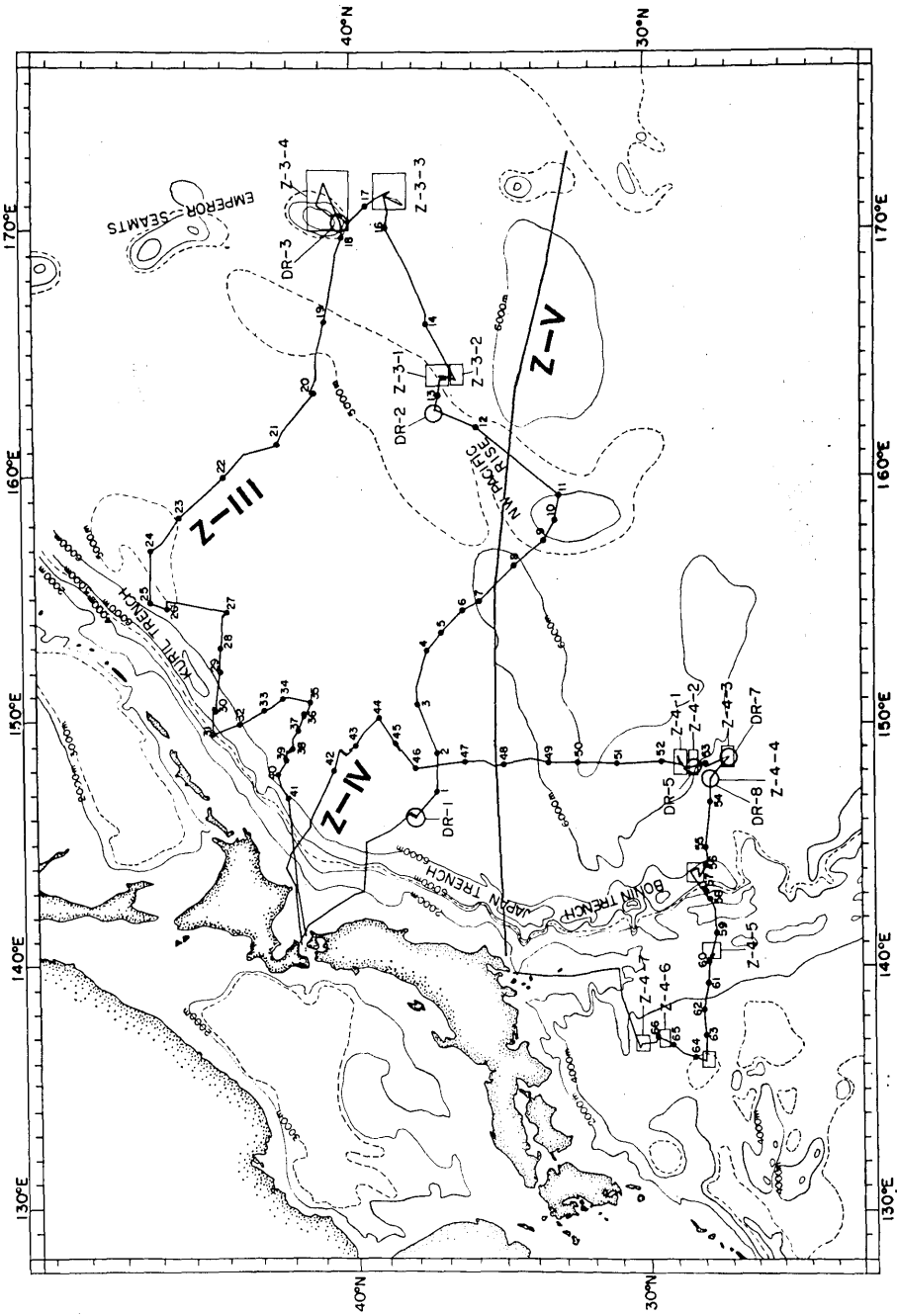


Fig. 1. Track of *R/V* Argo in the ZETES III, IV and V cruises. Numbered stations are heat flow stations, DR-; etc. are dredge stations, Z-3-1, etc. are seamounts surveyed.

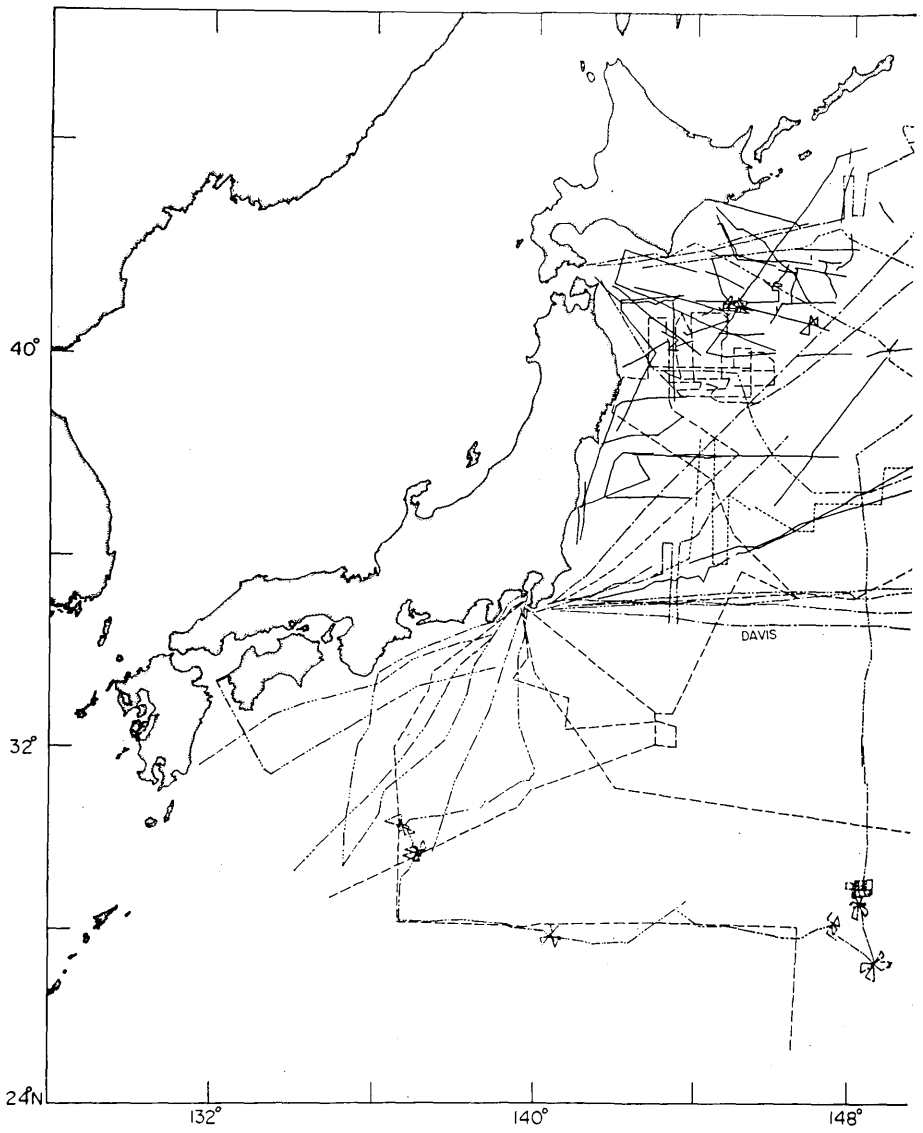
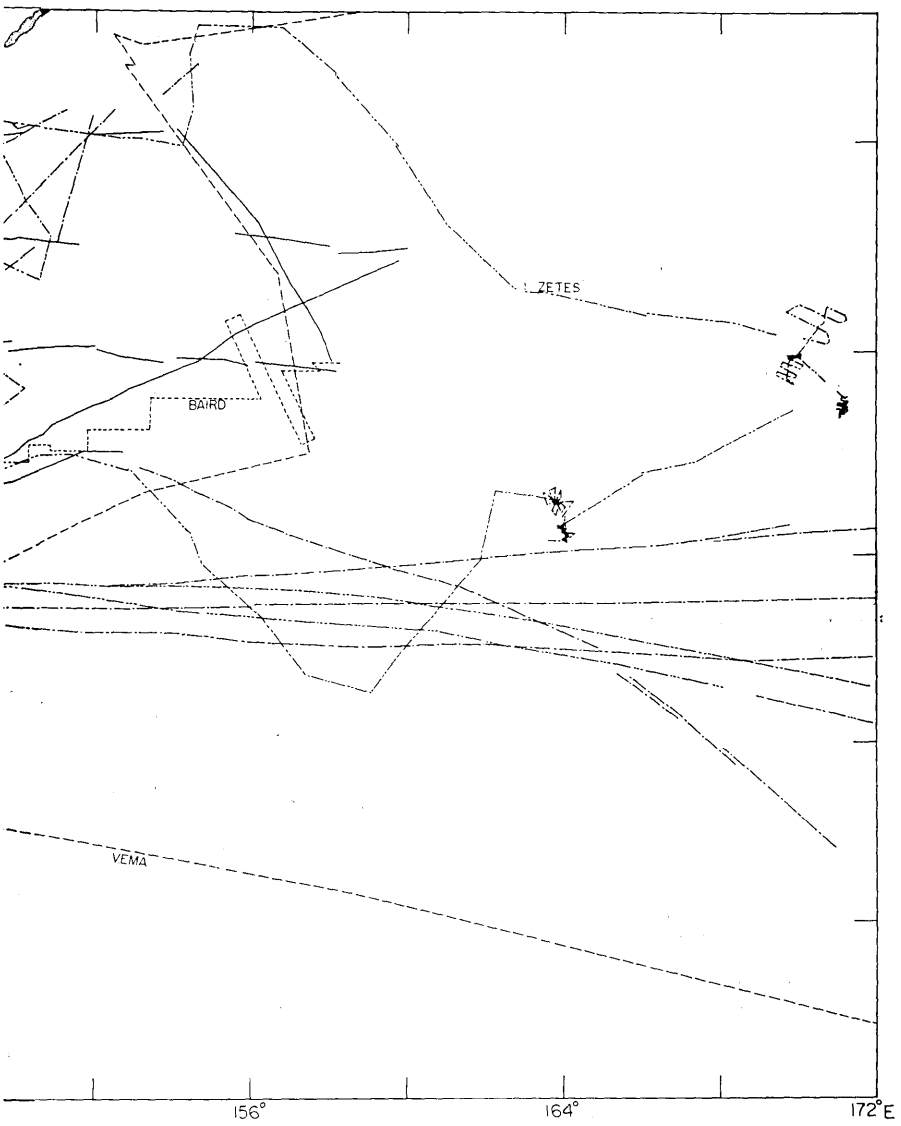


Fig. 2. Ship's tracks on which magnetic

and magnetic surveys of seamounts Z-3-3 and Z-3-4 was determined by dead reckoning and not from an anchored buoy as was done for the rest of them. They are shown on Figures 3 and 4. These surveys did not cover enough area to permit calculation of the magnetizations. Palaeomagnetic calculations were made on the other seamounts by



data are available in the present study.

Vacquier and Uyeda (1967), who also present the survey charts for these seamounts.

Several seamounts were dredged as shown in Fig. 1 by the notation DR. The fresher dredge samples were dated by the K-Ar method by M. Ozima, Geophysical Institute, University of Tokyo. As described fully

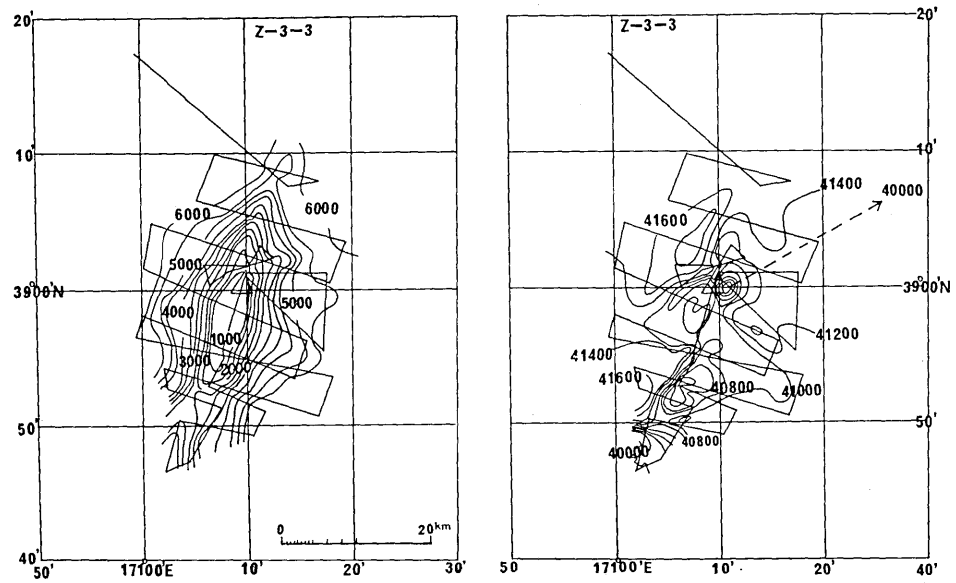


Fig. 3. Topographic and magnetic charts of seamount No. 3 of ZETES III. Depth in meters and the total geomagnetic force in gammas.

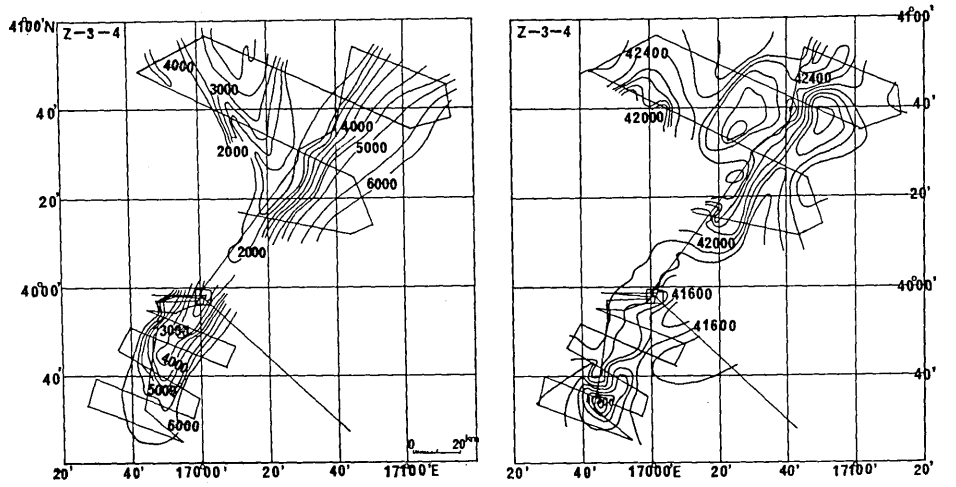


Fig. 4. Topographic and magnetic charts of seamount No. 4 of ZETES III. Depth in meters and the total geomagnetic force in gammas.

elsewhere, the ages of the basalts from DR-1, DR-6 and DR-7 were found to be Cretaceous. (Ozima et al., 1967).

3. Regional Magnetic Map

As mentioned in the Introduction, an attempt was made to compile all the available total geomagnetic force data to improve the existing regional magnetic maps (Uyeda et al., 1964) of the northwestern Pacific Ocean. Based on the magnetic data along the tracks shown in Fig. 2, maps of the total geomagnetic force, F, (Fig. 5) and of the total force anomaly, ΔF, (Fig. 6) have been constructed. The F Contours in the Shikoku Basin and on the land of Japanese Islands are due to Tomoda et al. (1967) and to Dr. N. Fujita of Geographical Survey Institute (private communication), respectively.

The anomaly values, ΔF, have been obtained by subtracting the regional value F_0 from F on a 1/2,500,000 map. For F_0, the Total Intensity of the Earth's Magnetic Force for the year 1955 (U.S. Hydrograghic Office, Chart No. 1703) was used. The formula used for obtaining the anomalous field was

$$\Delta F = F_{\text{obs}} - (F_{55} - 300\,\gamma) \ .$$

This balanced the anomaly about zero in the central portion of the chart but left a negative residual of about $200\,\gamma$ on the western end and a $200\,\gamma$ positive residual on the eastern end. This difference should have been accounted for by the difference in secular variation between longitudes 135°E and 165°E. However the secular variation gradient shown on the 1955 H. O. chart is of opposite sign and therefore could not be used. Our anomaly map may be regarded as preliminary until the new world magnetic charts become available.

The short time magnetic fluctuations were neglected. In the Pacific Ocean the anomaly values, ΔF, were computed from the raw values of F along ships' tracks, and not from the F contours. In other words, the contours in Fig. 5 and Fig. 6 have been drawn independently only from the values along the tracks. In the land of Japan and the Shikoku Basin, however, the contoured total field, F, was used for obtaining ΔF. South of Tokyo, the strip between 138°E-142°E has extremely complicated magnetic field distribution because of the presence of Izu-Bonin Islands and Ridge. But, so far, the data are much too few for drawing anomaly contours. Where the tracks were too widely separated for contouring the region between them, the direction of the short contours were drawn to agree with the general trend of the anomaly pattern of the area.

As was known previously, the magnetic lineations exist in the NEE-

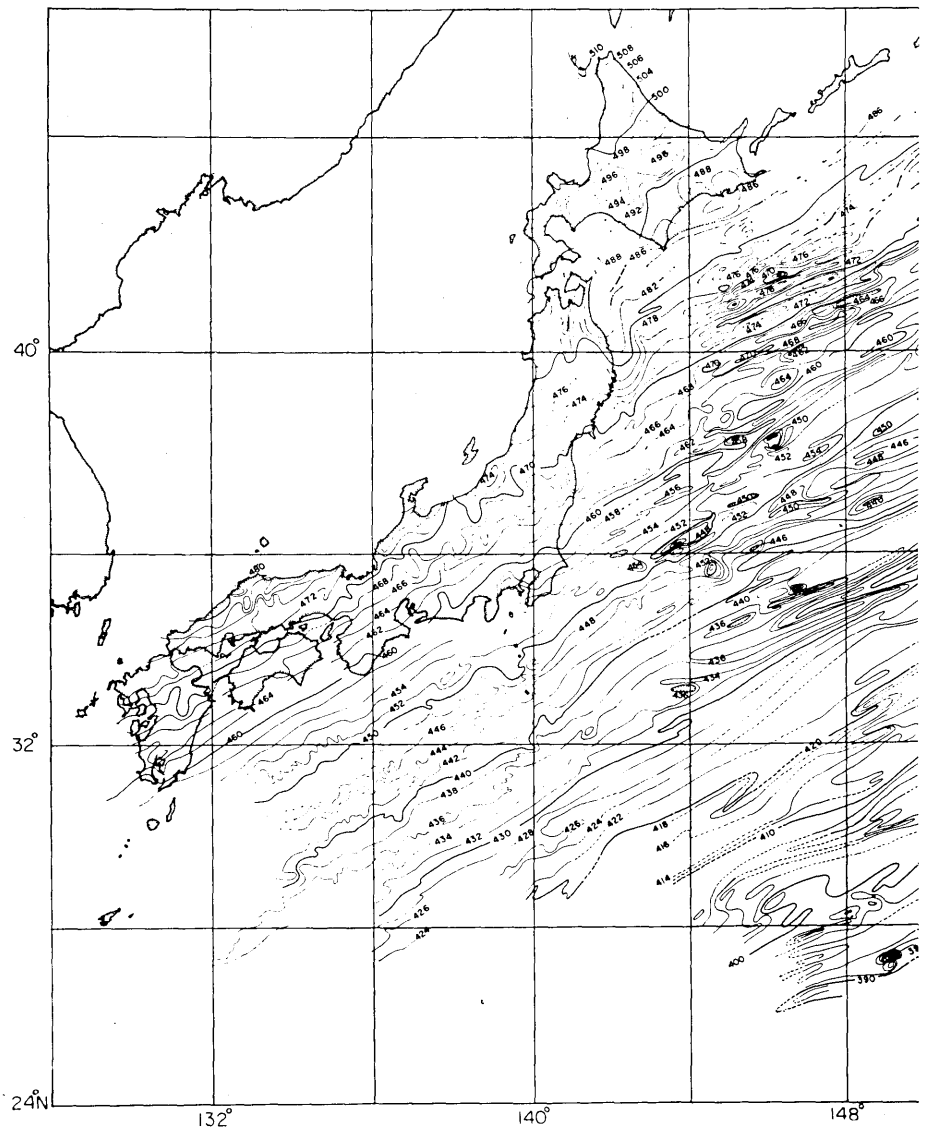
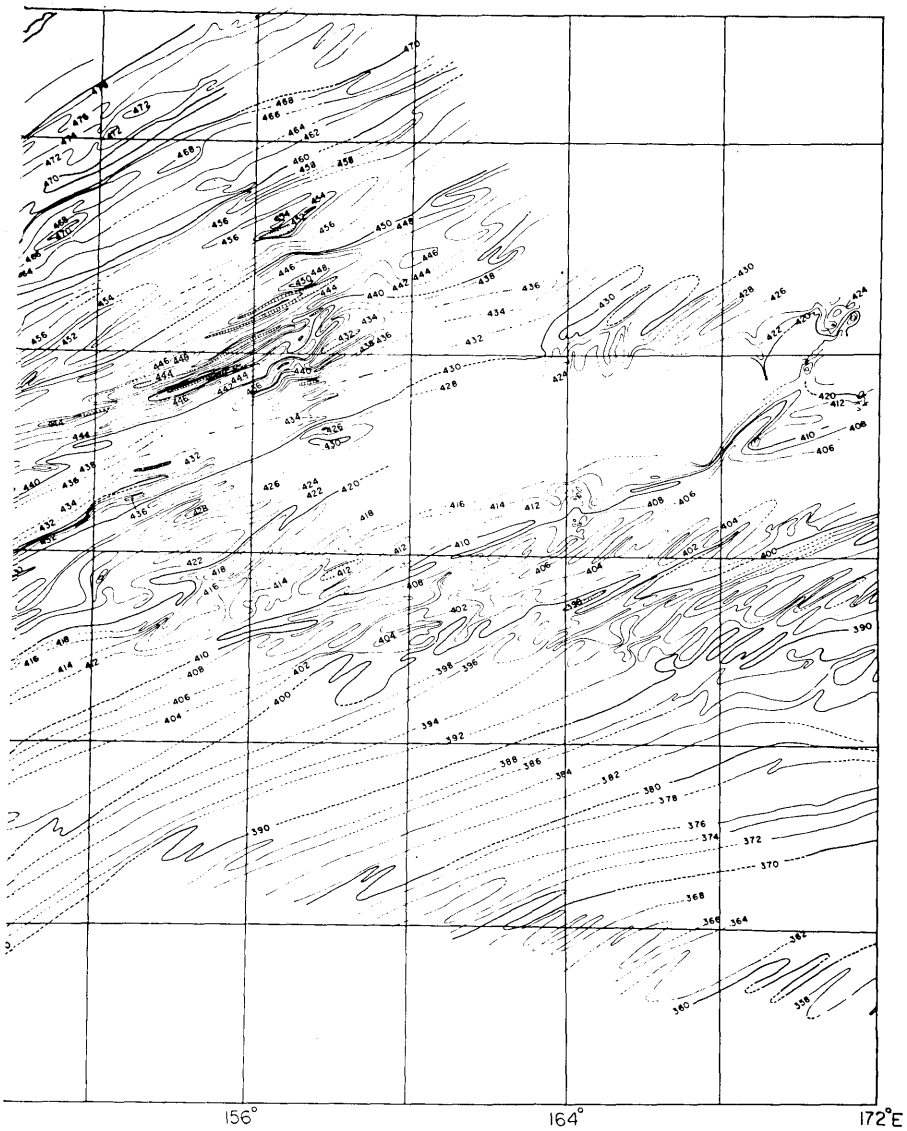


Fig. 5. Total magnetic force distribution in the

SWW direction in the northwestern Pacific. This direction is almost parallel with the regional planetary field. This parallelism is a mere coincidence because the regional field originates in the Earth's core whereas the lineations must be caused by the magnetic structure in the uppermost layers. The trend of the lineations is parallel with the Kuril



northwestern Pacific Ocean; contour interval=200γ.

Arc and with the southwestern Honshu, too. This parallelism may be of some tectonic or genetic significance.

At least three groups of lineations may be recognized in Fig. 6. They pass through 41°N-146E, 40°N-156°E and 36°N-151°E. Among these, the southernmost group is a newly found feature, though its

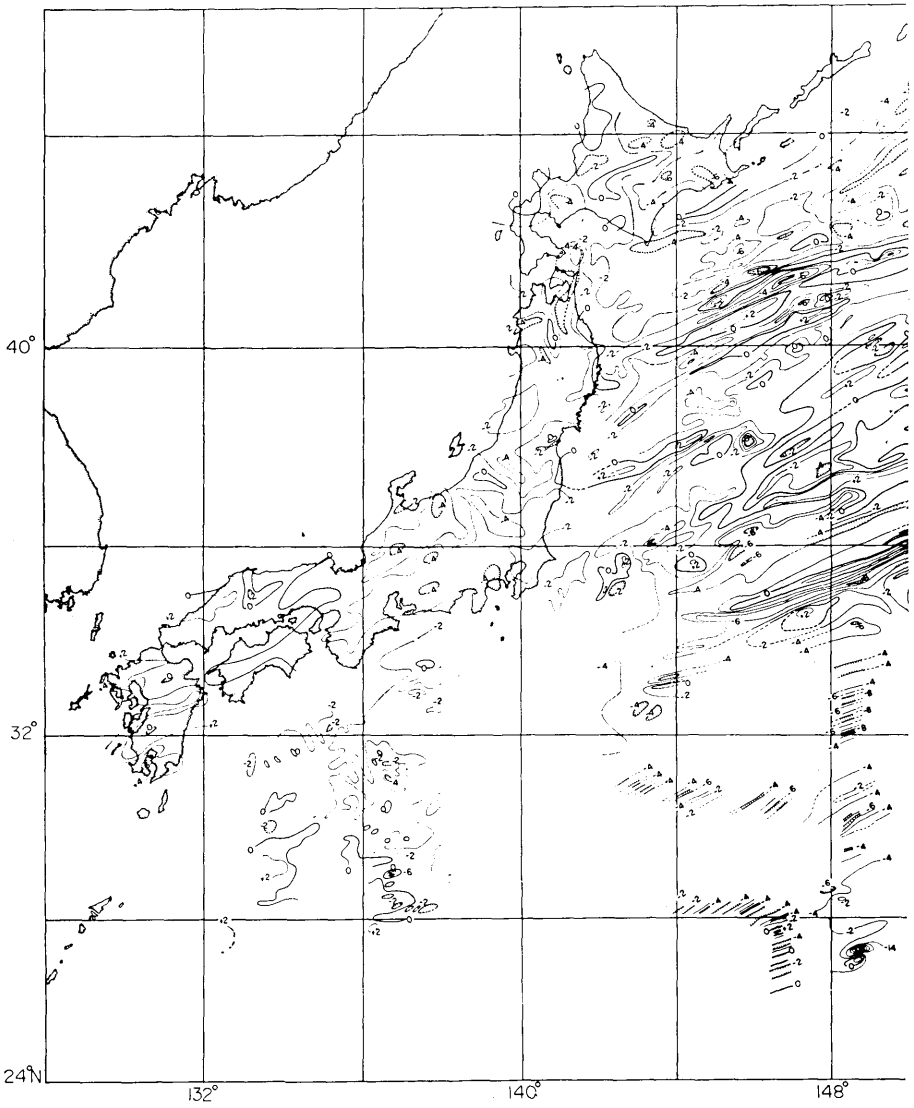
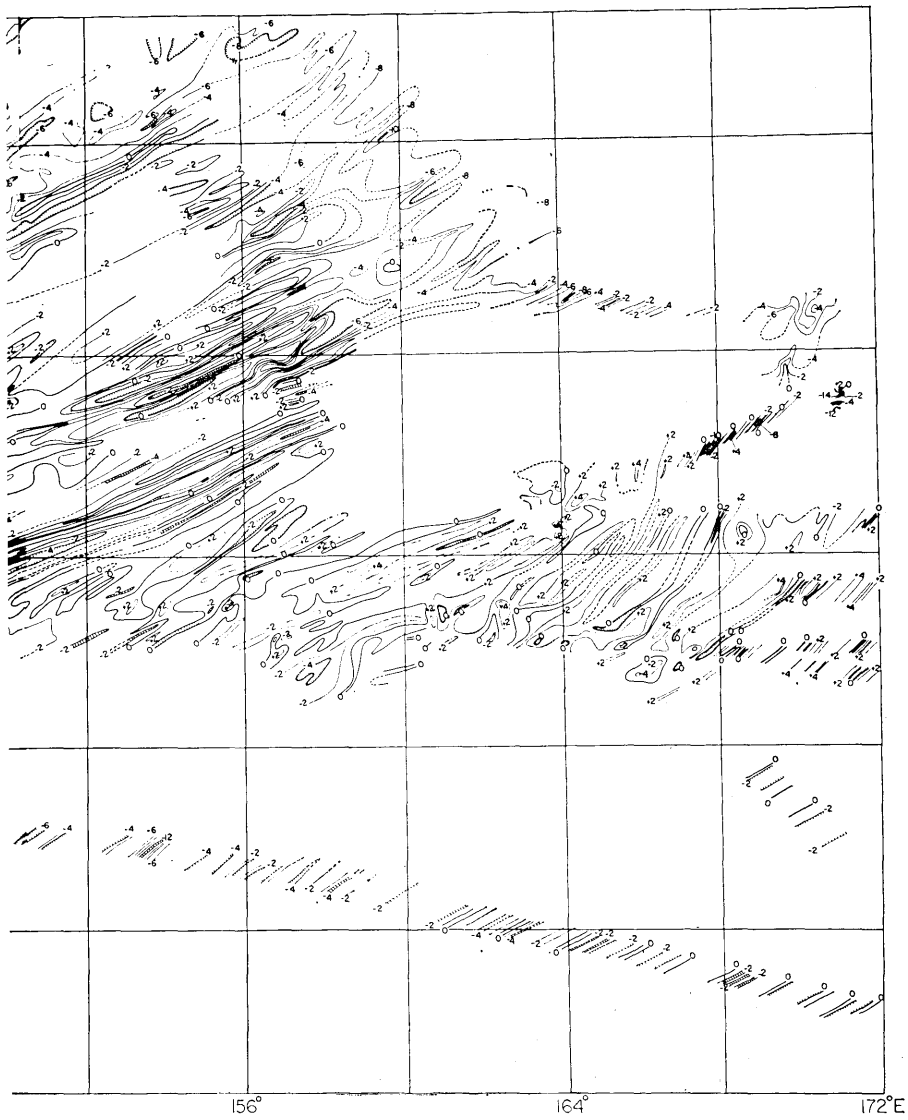


Fig. 6. Distribution of the total force anomaly in the

existence was suspected by A. Raff of the Scripps Institution and J. Heirtzler of the Lamont Observatory. (Both personal communication). This group of lineations goes over the northwest Pacific Rise (Shatsky Rise). The Shikoku Basin seems to lack the linear anomalies according to the anomaly contours (Fig. 6) drawn on the basis of the total force



northwestern Pacific Ocean; contour interval=200 γ.

contours (Fig. 5) given by Tomoda et al. (1967). One might recall here that thermally, too, this Basin is different from the Pacific Basin east of the Izu-Bonin Arc (Vacquier et al., 1967).

Continuation of the linear anomaly bands in both the continentward and oceanward directions is a matter of great interest. The lineations

are not apparent in the Japanese Islands, but Yasui et al. (1967) report that the Japan Sea has linear bands in the same direction as in the northwestern Pacific. The linear bands in the Japan Sea, however, are much less distinct. On approaching the continent, the lineations fade away as has been noticed in the eastern Pacific (Raff and Mason, 1961). But in the case of our northernmost group of lineations, linear bands seem to penetrate into the Japan Trench at about 40°N. As for the possible continuations in the northeasterly direction, it may be pointed out that none of them extend over the track of ZETES III from about 40°N-170°E to 46°N-155°E. This might be caused by the presence of horizontal faulting SW of the northernmost ZETES track. Also suggested by the total force anomaly aeromagnetic chart in the Kuril-Kamchatka island arc area by Solov'yew and Gainanov (1963), a possible extension

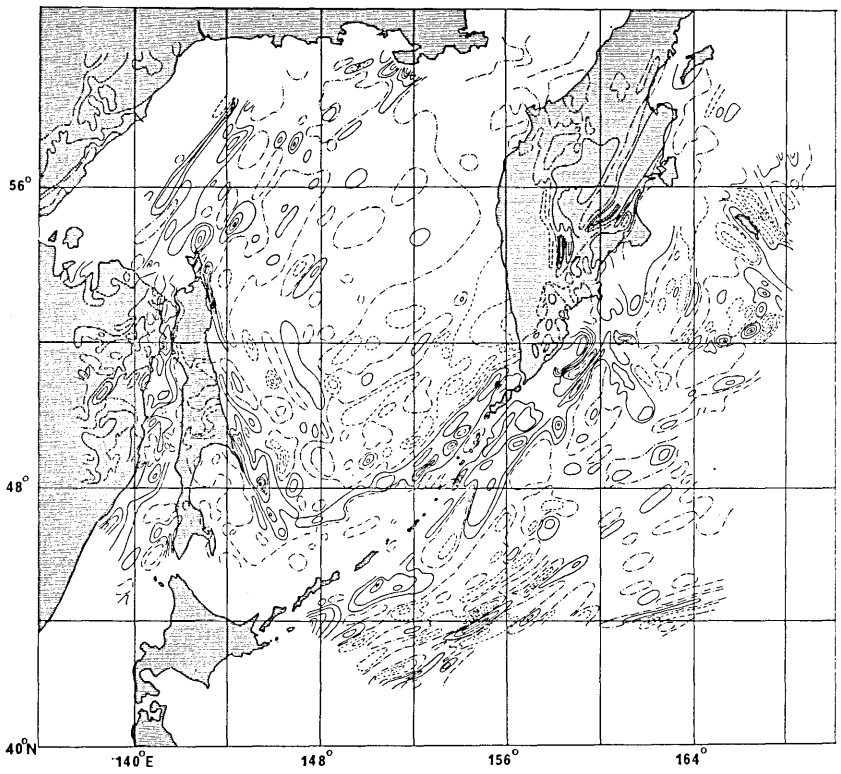


Fig. 7. Aeromagnetic chart of the total force anomaly in the Kuril-Kamchatka area (after Solov'yew and Gainanov, 1963).
----- negative anomaly. ——— positive anomaly. -·-·-· zero anomaly.
contour interval=100 γ.

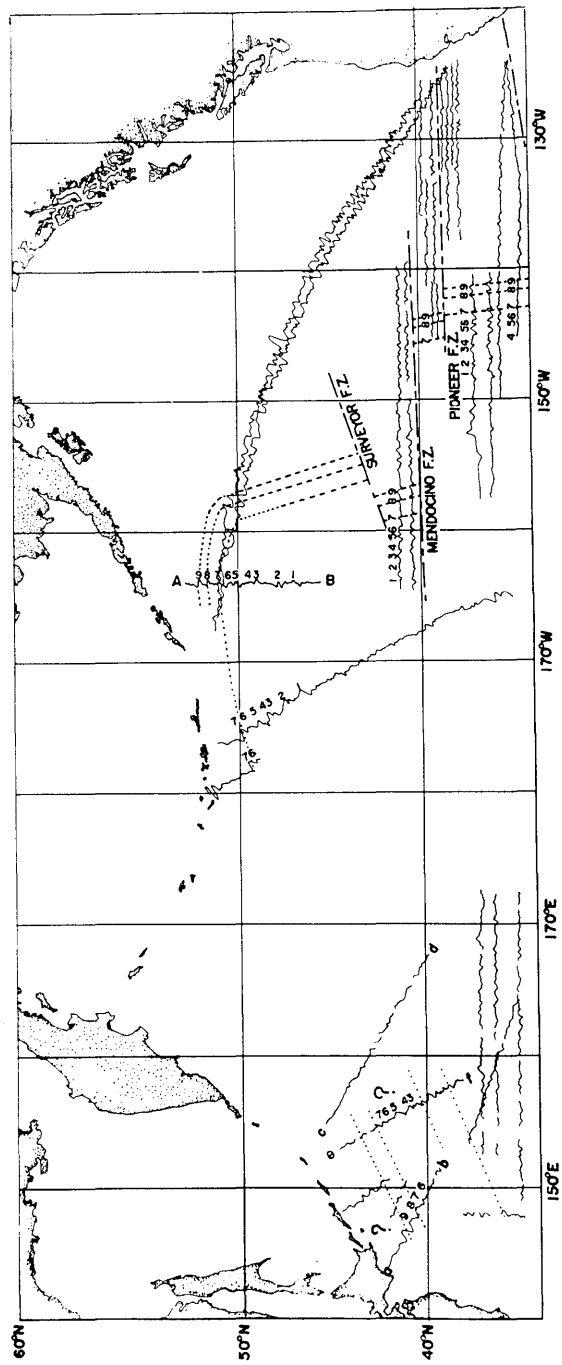


Fig. 8. Some magnetic profiles in the northern Pacific.
Profile a-b ZETES IV,
Profile c-d ZETES III,
Profile e-f Vema-20,
Profile A-B after G. Peter.
Profiles from different sources are plotted to different vertical scales.

of our northernmost group seems to bend gently along the Kuril Arc toward the northeast to get lost on reaching the intersecting region of the Kamchatka and the Aleutian Arcs. Their chart redrawn in Fig. 7 indicates the existence of a group of lineations at about 44°N-162°E, which may well be a displaced continuation of some of our lineations.

With the present density of data, however, it is not possible to postulate any offset of lineations in the area as has been done so dramatically in the eastern Pacific (Vacquier, 1965). A more detailed areal survey as well as extension of the survey area northeastward is, thus, highly desirable. Peter (1966 and private communication), on the other hand, reports that the N-S lineations that have been traced in the northeastern Pacific over the distance of 20° in latitude sharply bend to the SWW direction on approaching the Aleutian Trench as evidenced by the profiles reproduced in Fig. 8. In Fig. 8, profiles in the eastern Pacific have been taken from Vacquier (1965), Peter (1966) and Bracey (1963), We have looked for their possible continuation among our lineations in the northwestern Pacific. Some of the profiles have been plotted in Fig. 8 to see if Peter's "guide" anomalies numbered 1 to 9 could be identified in the western Pacific. Although in Fig. 8, the profiles a-b (ZETES IV) and e-f (Vema-20) seem to have the characteristics of some of the "guide" anomalies, this similarity is insufficient for tracing the Peter anomalies into the western Pacific. On the whole, the lineations are less persistent in the northwestern Pacific than in the northeastern. As can be observed in Fig. 8, long profiles in the area between 160°E-180°E would be beneficial to the theories about the development of not only the Pacific Ocean floor but also of the Circum-Pacific island arcs (Uyeda and Vacquier, 1967).

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42. 1966年Argo号による西太平洋地磁気測量結果及び同地域の磁気分布図

地震研究所 上田誠也
スクリプス海洋研究所 V. VACQUIER
舞鶴海洋気象台 安井正
スクリプス海洋研究所 J. SCLATER
水路部 佐藤任弘
スクリプス海洋研究所 J. LAWSON
東京大学大学院 渡部暉彦
スクリプス海洋研究所 F. DIXON, E. SILVER
東京大学大学院 深尾良夫, 須藤研, 西川正名
東京大学理学部 田中照子

日米協同観測計画による上記の地磁気全磁力測量結果及び，現存する日米両国での北西太平洋海域の地磁気データにもとづいて，北緯 24°～46° の間，東経 172°E 以西での地磁気全磁力及びその異常の分布図が得られた．この結果，従来しられた SWW-NEE 方向にのびる縞状磁気異常が確認された．このような縞状構造のパターンを，東部太平洋での N-S 方向のそれ関係づけることは，太平洋の生成を知る上に重要であることが示される．