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43. *Palaeomagnetism of Nine Seamounts in the Western Pacific and of Three Volcanoes in Japan.*[*]

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Abstract

Assuming uniformity of magnetization, the direction and intensity of magnetization of nine seamounts in the Western Pacific off the coast of Japan have been computed from their topographic and magnetic surveys. The average position of the palaeomagnetic poles from the three seamounts in the Pacific Basin is at 56°N-66°W, which agrees in latitude with the average pole position of 51°N-14°W obtained previously from another group of four seamounts in the Pacific Basin off Hokkaido. A group of three seamounts west of the Izu-Bonin Arc (Shikoku Basin) gave an average pole position of 76°N-44°W. The difference in latitude between the pole positions of the groups within and outside the Pacific Basin can be interpreted as caused by a northerly drift of the Pacific Ocean floor. The radiometric age of the dredged rock samples indicates that the seamounts in the Pacific Basin originated in the Cretaceous. The same method of analysis has been applied to three active Japanese volcanoes over which aeromagnetic surveys had been made. Of the three volcanoes, two volcanic islands gave palaeomagnetic poles not far from the present geographic pole, but the inland volcano Aso gave a pole at low latitude. Low-latitude poles were also obtained from two undated seamounts on the NW Pacific (Shatsky) Rise.

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1. Introduction

It is possible to calculate the direction and magnitude of magnetization of a body from the combined results of a topographic and magnetic survey, provided that certain assumptions are satisfied. The assumptions are the uniformity of magnetization and flatness of the bottom shape of the body. Vacquier (1962) devised a machine method to do this, and the method has been applied to a number of seamounts and other magnetic bodies by Van Voorhis and Walczak (1963),, Henderson and Allingham (1964), Uyeda and Richards (1966), and Richards et al. (1967).

Assuming further that the material composing the mountain has a high Königsberger ratio, i.e., the remanent magnetization is much stronger than the induced one in the present geomagnetic field, a palaeomagnetic pole position can be computed following the usual procedures. From four Pacific seamounts near Japan, Uyeda and Richards (1966) obtained the palaeomagnetic poles in the north Atlantic Ocean, the average position of the poles being at 51°N-14°W. This meant that the palaeomagnetic latitude of the seamounts, now located at about 40°N, is almost zero. It was then tentatively proposed that these seamounts drifted northwestward from the equatorial eastern Pacific. Richards et al. (1967) made calculations on 17 seamounts, two land volcanoes and one laccolith. Most of the seamounts are located just southwest of the Hawaiian Islands, the rest being off California and in the Atlantic. Again all the palaeomagnetic poles from the Pacific seamounts were found to fall in the North Altantic and Europe. Richards et al. (1967) noticed that these poles seem to fit with no palaeomagnetic data based on usual terrestrial rocks, except those from Australia (Irving, 1964). A general northward drift of the Pacific Basin, including Australia, relative to the geographic pole was suggested.

In the present study, the same method of computation was applied to nine western Pacific seamounts and three active volcanoes in Japan. The magnetic and topographic surveys over these seamounts were conducted in 1966, as a part of the US-Japan Science Cooperation, during legs III and IV of the ZETES Expedition of R/V Argo, belonging to the Scripps Institution of Oceanography of the University of California. As for the volcanoes, aeromagnetic surveys were made by Kato et al. (1966) on Oshima Island, Matsuzaki and Utashiro (1965) on Sakurajima and R. Blank (1965) on Aso Volcano also as a part of the US-Japan Cooperative Science Program.

The computation was made by a HITAC 5020 electronic computer at the Computation Center of the University of Tokyo. The program, written in FORTRAN IV language, was the same as used in the previous study (Uyeda and Richards, 1966). The topography of the mountain is digitized and the total geomagnetic force at mesh points is read from the contour charts. They are the "digitized topography" and the observed "input field". The program computes the regional geomagnetic trend and removes it from the input values. The result is the observed anomaly ΔT_j. After computing the direction and intensity of magnetization, the anomaly field is recomputed using the topography to give the "computed anomaly". The difference of the observed and computed anomalies is the "residual, R_j". A ratio r is defined as

$$r=\sum_{j=1}^{n}|\Delta T_j|\Big/\sum_{j=1}^{n}|R_j|,$$

where n is the number of mesh points. r is called the goodness ratio.

2. Results of Computation

All the important results on seamounts and volcanoes are listed in Tables 1 and 2. The locations of the seamounts and volcanoes are illustrated in Fig. 1, S, A, B and R are the seamounts studied previously (Uyeda and Richards, 1966) and OSM, ASO and SJM are the volcanoes Mihara of Oshima Island, Aso and Sakurajima, respectively. Seamounts 3-1, 3-2, etc. are the seamount No. 1 and 2 in Leg III of the ZETES Cruise, and so forth. In the text they shall be designated Z-3-1, Z-3-2, etc. Seamounts Z-3-1 and Z-3-2 belong to the Northwest Pacific Rise (Shatsky Rise). Seamounts Z-4-1 to Z-4-4 are located in the Pacific Basin while Z-4-5 to Z-4-7 are in the Shikoku Basin which is west of the Izu-Bonin Trench-Arc System.

Contoured topographic and magnetic survey data, observed input field, observed anomaly, computed anomaly, and residual are shown for each seamount in Figs. 2-11. In the survey charts, ships' tracks are also indicated. The area used for the computation is the area enclosed in the outer boundary of the shaded area. Because of the requirement of the program, the area has to be rectangular for the topography, while the magnetic data can be chosen in any way. The magnetic data were taken from selected mesh points in the area indicated in Figure (b). The selected points can be identified in Figures (I) to (R).

Seamount Z-4-1 happened to be located on top of a regional magnetic anomaly due to a deep source. Under these circumstances, because the

Table 1. Result of Computation on Seamounts.

Seamount No. Zetes	Latitude	Longitude	(emu/cc)×10^{-2}				(Degree)			(γ) Mean of Abs. Residual	(γ) Mean of Abs. Anomaly	Goodness Ratio, R	Palaeomagnetic Latitude	Palaeomagnetic Pole Position	
			A	B	G	Intensity	Geomagnetic Declination	Geographic Declination	Inclination					Lat.	Long.
III-1	37°03′N	163°45′E	−0.014	−0.268	0.210	0.341	267	268	38	70	81	1.16	21°N	11°N	92°E
III-2	36°33′N	163°53′E	0.058	−0.513	0.502	0.720	276	278	44	98	242	2.48	26	21	91
IV-1	28°48′N	148°21′E	0.165	−0.074	0.029	0.183	336	334	9	18	40	2.25	4	55	19
IV-1′	28°48′N	148°21′E	0.132	−0.132	−0.129	0.226	315	313	−35	58	82	1.41	−20	24	17
IV-2	28°22′N	148°14′E	0.364	0.203	0.035	0.419	9	28	5	44	114	2.61	2	53	−82
IV-3	27°03′N	148°39′E	0.597	0.007	−0.145	0.643	17	16	−13	99	408	4.12	−7	53	−58
IV-4	27°57′N	147°34′E	0.202	0.064	−0.006	0.299	12	11	−1	57	100	1.75	−1	60	−54
IV-5	27°41′N	140°24′E	0.244	0.031	0.197	0.315	7	5	39	33	128	3.88	22	82	−78
IV-6	29°37′N	137°03′E	0.433	0.026	0.262	0.507	3	−1	31	43	80	1.88	17	77	−40
IV-7	30°09′N	136°40′E	0.120	0.007	0.014	0.121	3	−1	7	53	75	1.42	4	63	−41

Table 2. Palaeomagnetic Results from Three Volcanoes in Japan.

Name and Description	Lat.	Long.	(emu/cc)$\times 10^{-2}$				(Degree)			(γ) Mean of Abs. Residual	(γ) Mean of Abs. Anomaly	Goodness Ratio, R	Palaeomagnetic Pole Position	
			A	B	G	Intensity	Geomagnetic Declination	Geographic Declination	Inclination				Lat.	Long.
Sakurajima No. 1	31°35′N	130°40′E	0.045	0.010	0.143	0.151	13	8	72	26	63	2.41	64° N	140° E
No. 2	31°35′N	130°40′E	0.095	−0.029	0.142	0.173	343	338	55	28	69	2.49	71° N	58° E
Oshima 6000 ft	34°42′N	139°24′E	0.831	0.442	1.065	1.421	28	22	49	76	244	3.21	71° N	121° W
4000 ft	34°42′N	139°24′E	0.450	0.269	1.301	1.403	31	25	68	132	306	2.32	66° N	179° E
Aso Volcano: A Cone Base at 600 m	32°53′N	131°06′E	0.0076	−0.0181	0.523	0.0558	−61	−67	69	154	235	1.52	39° N	86° E
Cone Base at 800 m	32°53′N	131°06′E	−0.0408	−0.0119	0.0778	0.0788	257	251	81	161	222	1.38	26° N	112° E
Dipole at −6400 m $x=3.9$ $y=5.21$	32°53′N	131°06′E	0.0688	0.0273	0.0261	0.0785	28	22	19	102	307	3.01	60° N	95° W
Dipole with Mountain: Dipole	32°53′N	131°06′E	0.0359	0.0270	0.0150	0.0474	43	37	19	77	278	3.59	49° N	113° W
Dipole with Mountain: Aso Volcano	32°53′N	131°06′E	−0.0216	−0.0807	0.0236	0.0868	−99	−105	16					

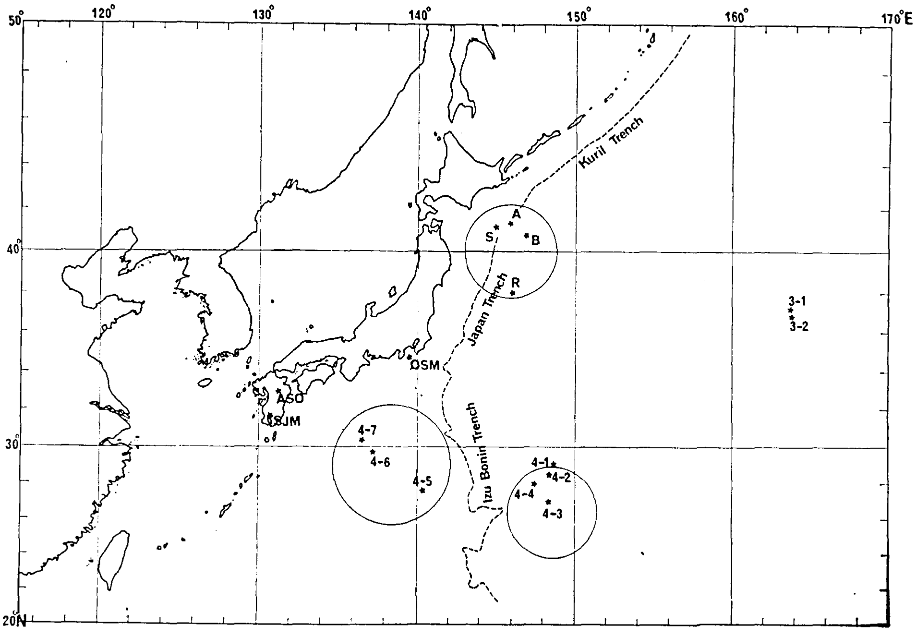
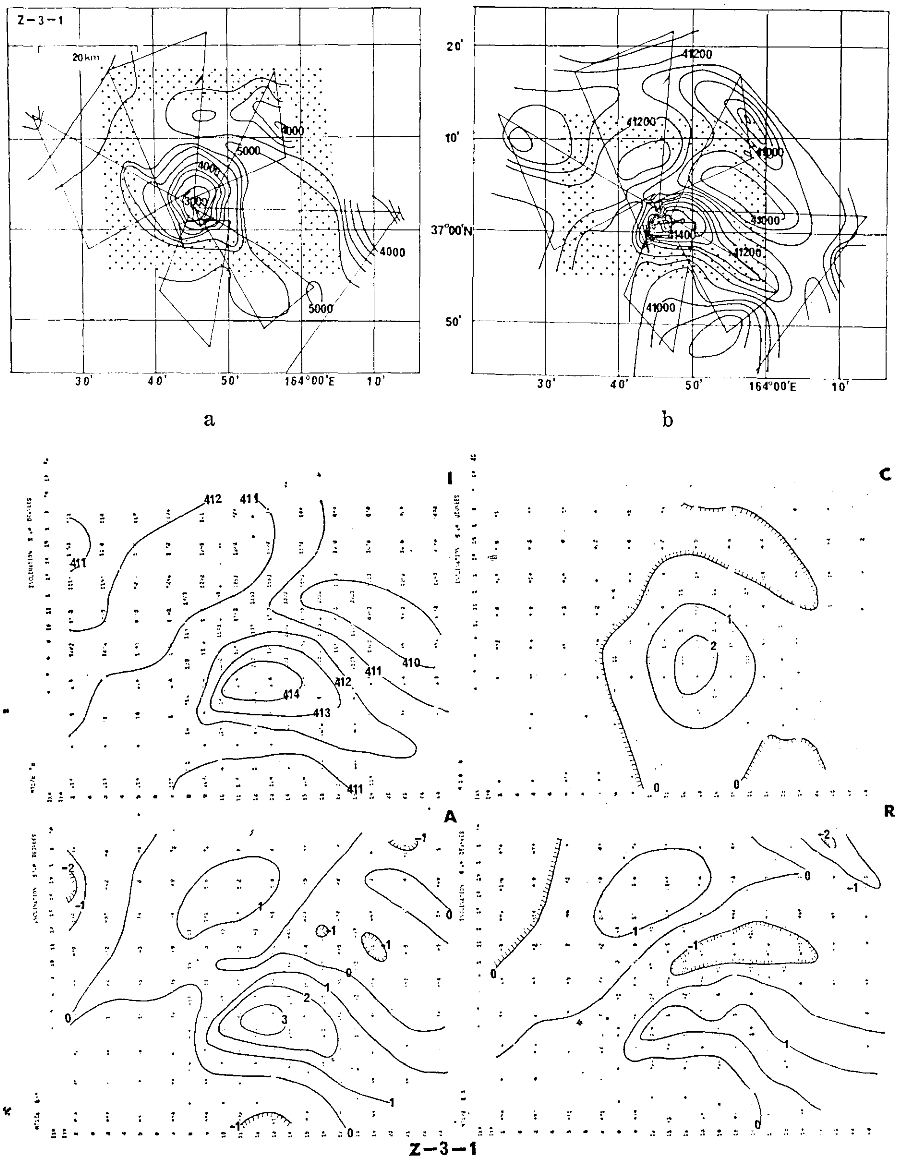


Fig. 1 Localities of seamounts and volcanoes studied. A, B, R and S are the seamounts studied previously (Uyeda and Richards, 1965), and symbols 3-1, 4-2 etc. stand for the seamounts No. 1 of ZETES III, No. 2 of ZETES IV, *etc.* Large circles define group of seamounts of which palaeomagnetic pole positions are averaged in Fig. 18.

OSM...... Oshima Island (Mihara Volcano)
ASO ...... Aso Volcano
SJM ...... Sakurajima Island

program can remove only a constant magnetic slope, it cannot effectively separate the magnetic effect of the uplift from the observed field. This accounts for the low value of 1.41 for the goodness ratio that was obtained for this seamount by the standard procedure. We attempted to improve the calculation by removing arbitrarily the trend pictured on Figure 5b which was guessed from inspection of the observed field (Figure 4b). The difference shown on Figure 5a was fed to the computer. The results of the computation are shown in Figure 5, (I) to (R). Now the goodness ratio has become 2.25 (Table 1) and the fit much improved. However, after this recalculation, the direction of magnetization of Z-4-1 is still substantially different from that of other nearby seamounts (Table 1).

The palaeomagnetic latitude of the seamounts at the time of their formation listed in Table 1 was computed from the inclination of their



a

b

Fig. 2. Seamount Z-3-1.
(a) Topography (depth) in meters
(b) Observed field in gammas
(I) Input field in milligauss
(A) Anomaly field 〃
(C) Computed anomaly 〃
(R) Residual field 〃

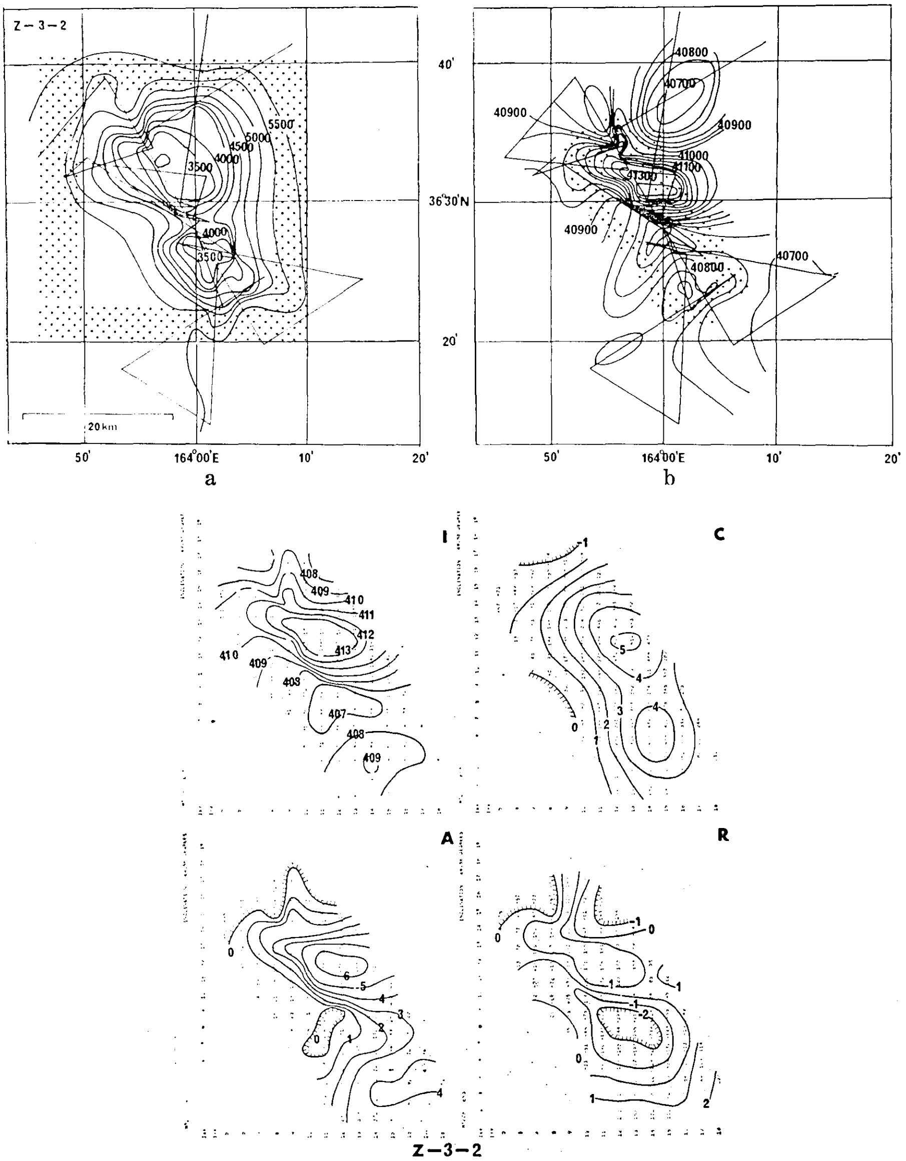


Fig. 3. Seamount Z-3-2.
(a) Topography (depth) in meters
(b) Observed field in gammas
(I) Input field in milligauss
(A) Anomaly field 〃
(C) Computed anomaly 〃
(R) Residual field 〃

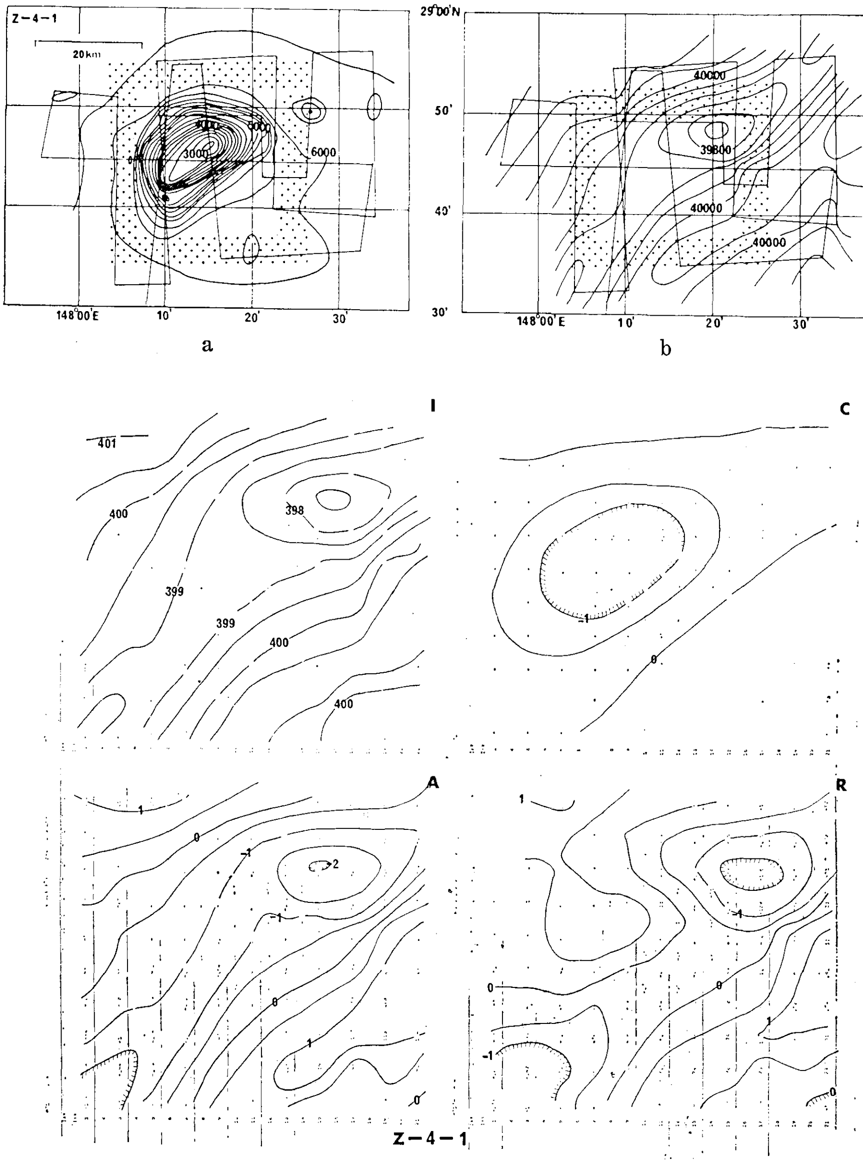


Fig. 4. Seamount Z-4-1.
(a) Topography (depth) in meters
(b) Ovserved field in gammas
(I) Input field in milligauss
(A) Anomaly field 〃
(C) Computed anomaly 〃
(R) Residual field 〃

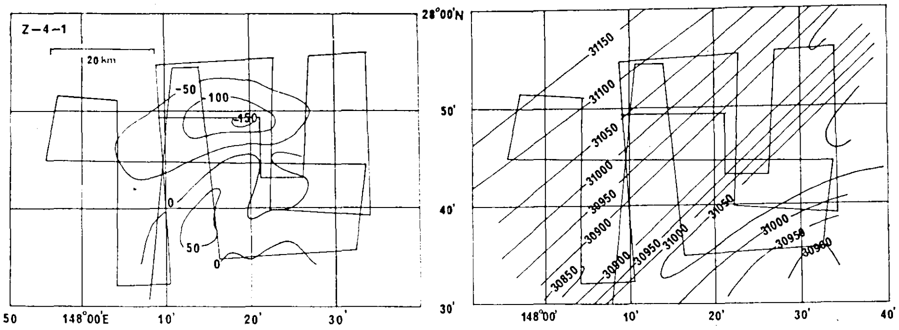
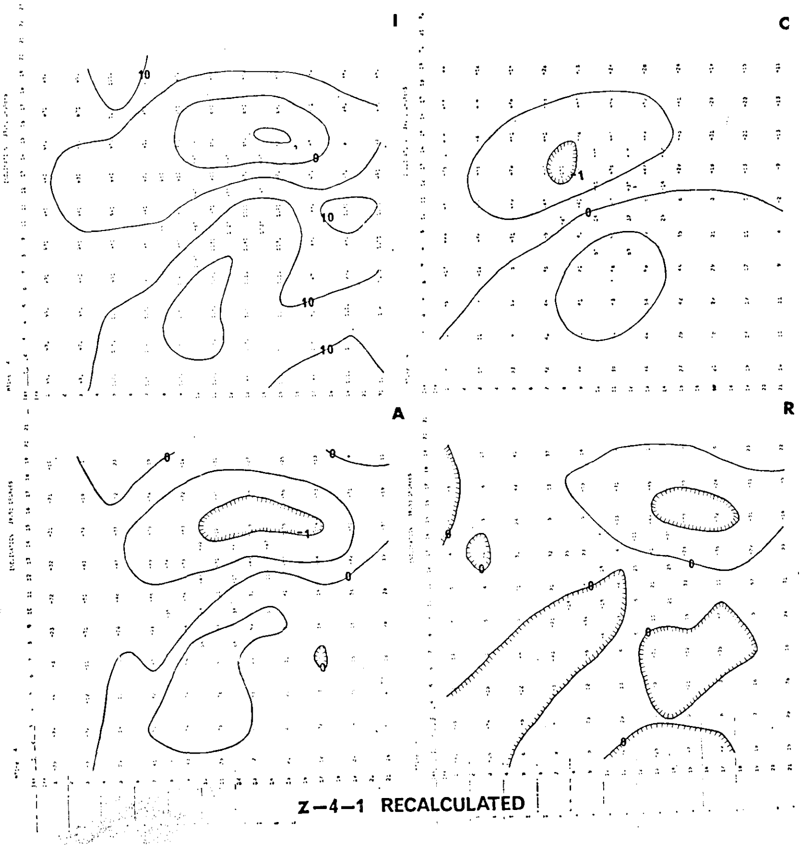


Fig. 5. Seamount Z-4-1 recalculated.

(a) Anomaly field for recalculation in gammas

(b) Local trend field for recalculation in gammas



(I) Input field in milligauss
(A) Anomaly field 〃
(C) Computed anomaly 〃
(R) Residual field 〃

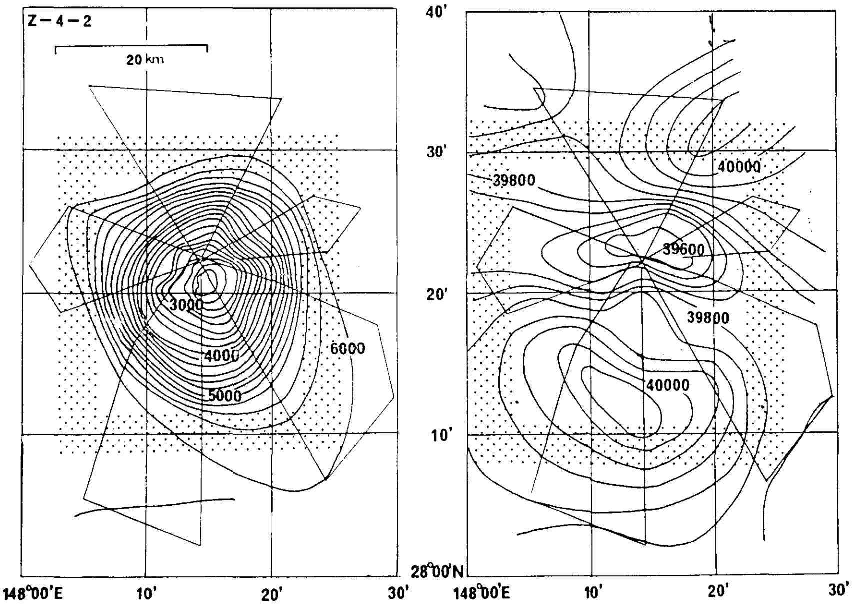
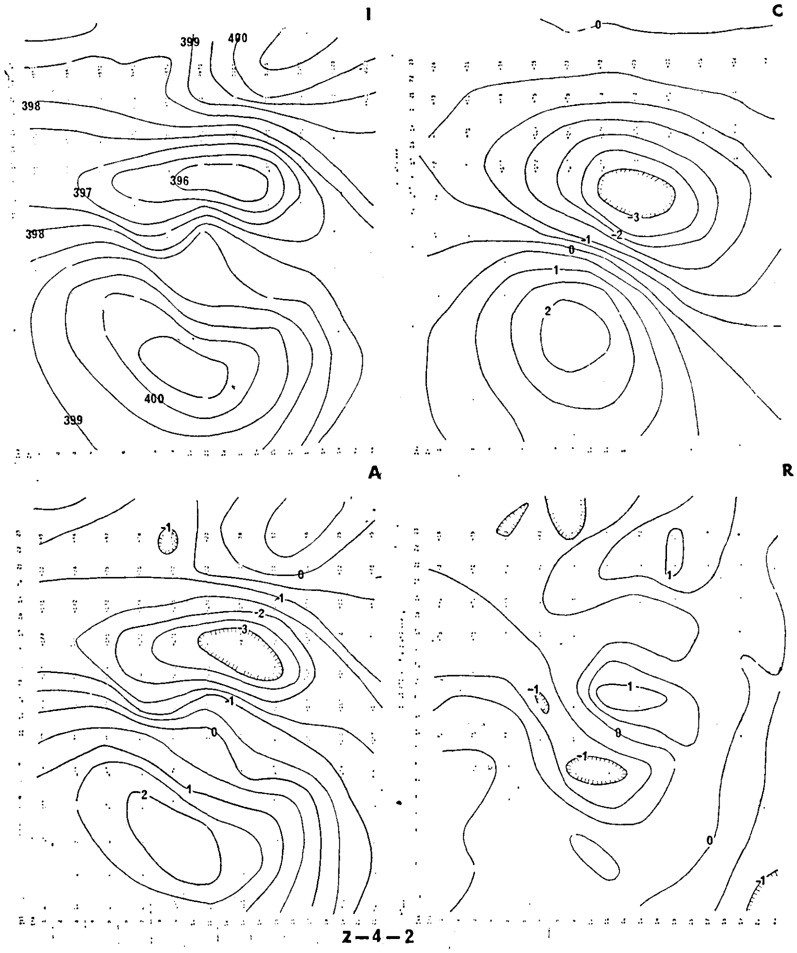


Fig. 6. Seamount Z-4-2.
(a) Topography (depth) in meters (b) Observed field in gammas



(I) Input field (C) Computed anomaly
(A) Anomaly field (R) Residual field
(in milliguass)

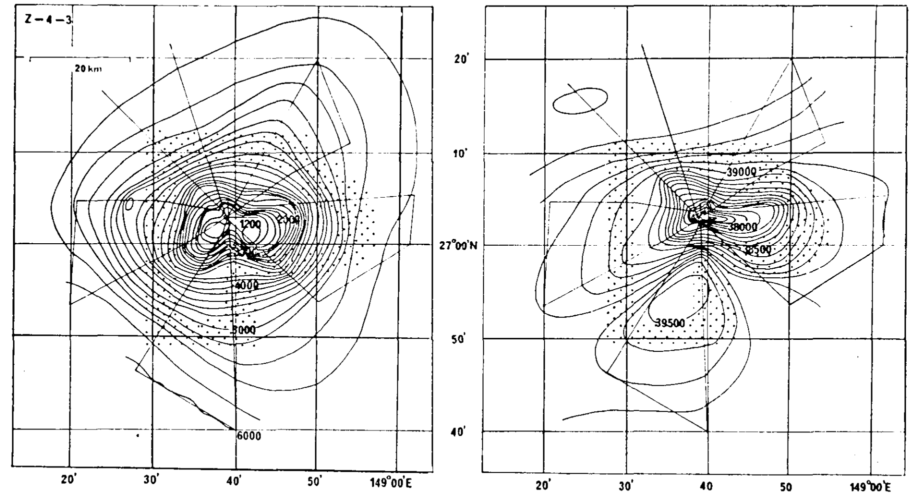
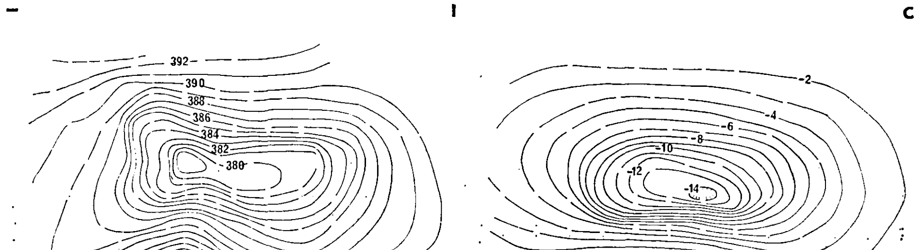


Fig. 7. Seamount Z-4-2.
(a) Topography (depth) in meters (b) Observed field in gammas



Z-4-3

(I) Input field (C) Computed anomaly
(A) Anomaly field (R) Residual field
(in milligauss)

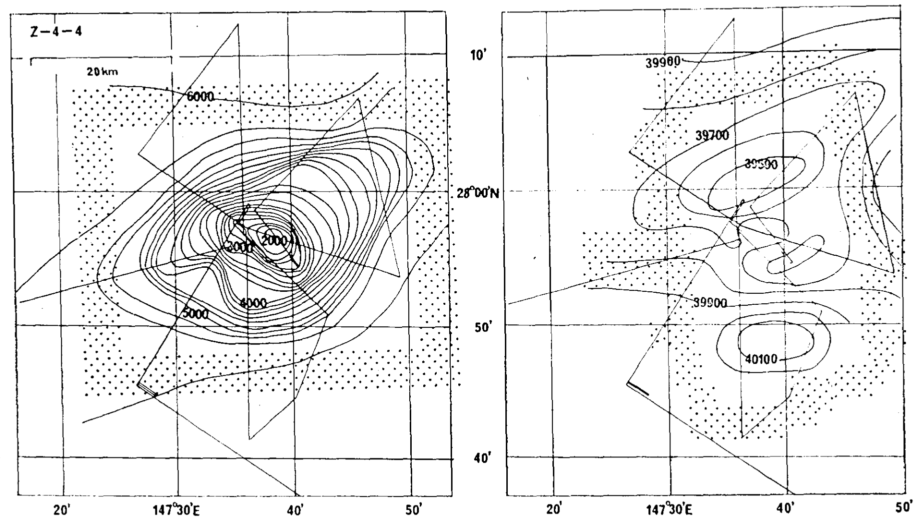
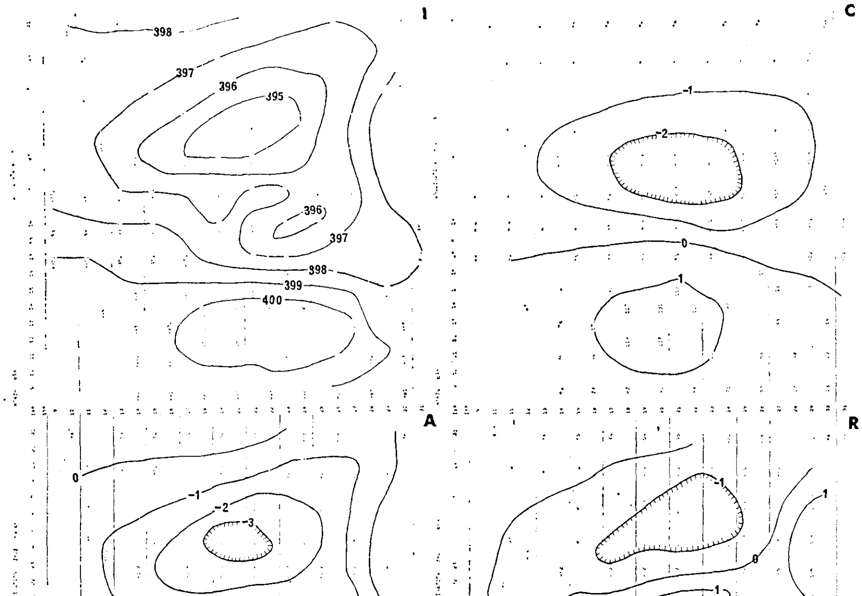


Fig. 8. Seamount Z-4-4.
(a) Topography (depth) in meters (b) Observed field in gammas



(I) Input field (C) Computed anomaly
(A) Anomaly field (R) Residual field
(in milligauss)

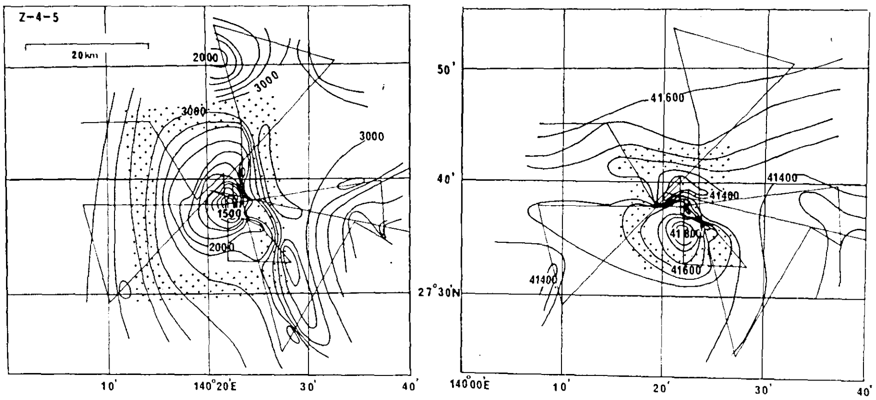
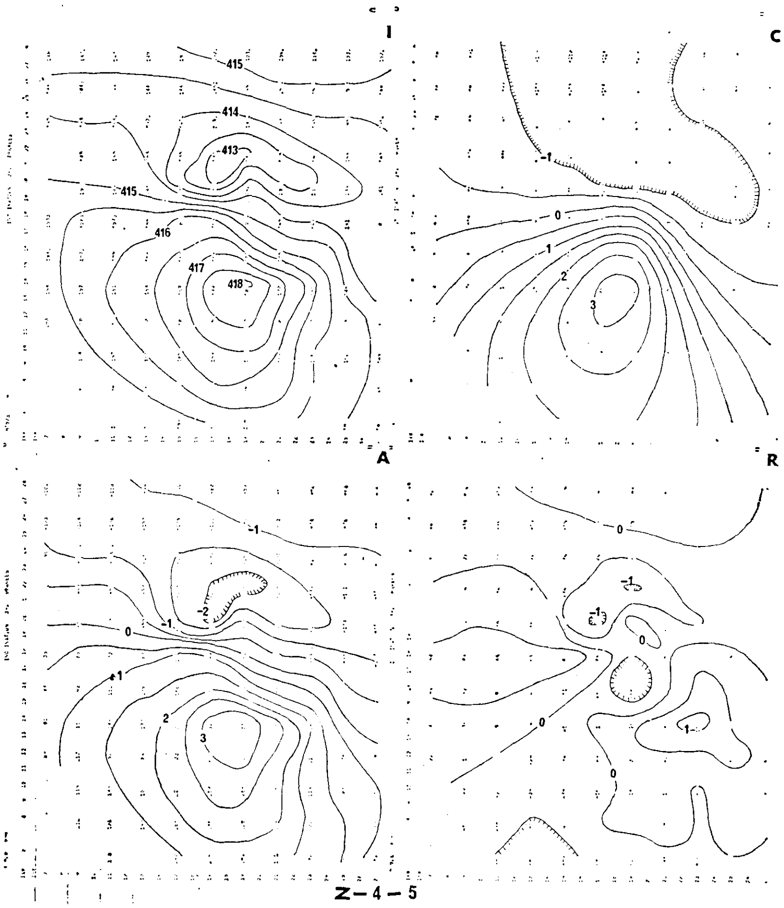


Fig. 9. Seamount Z-4-5.
(a) Topography (depth) in meters (b) Obeserved field in gammas



(I) Input field (R) Residual field
(A) Anomaly field (in milligauss)
(C) Computed anomaly

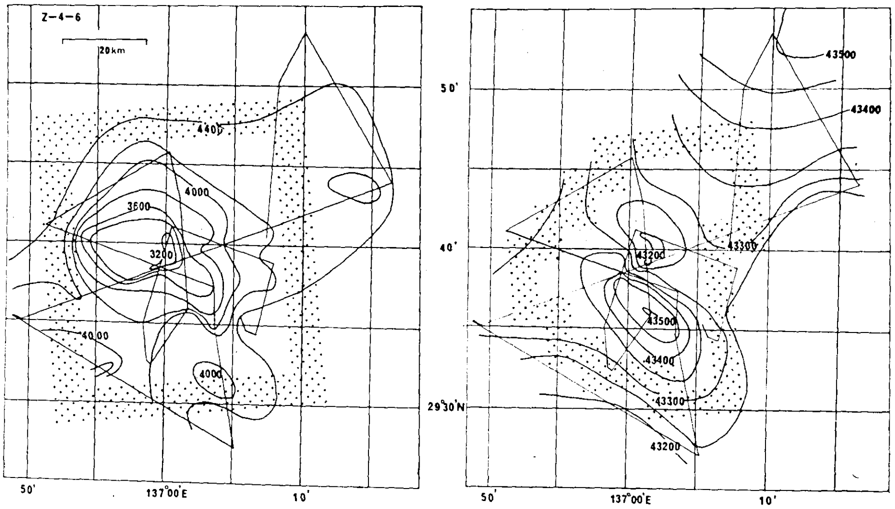
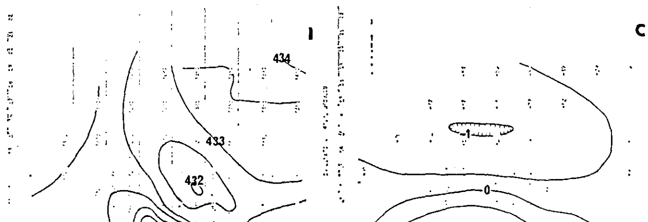


Fig. 10. Seamount Z-4-6.
(a) Topography (depth) in meters (b) Observed field in gammas



(I) Input field (C) Computed anomaly
(A) Anomaly field (R) Residual field
(inmilligauss)

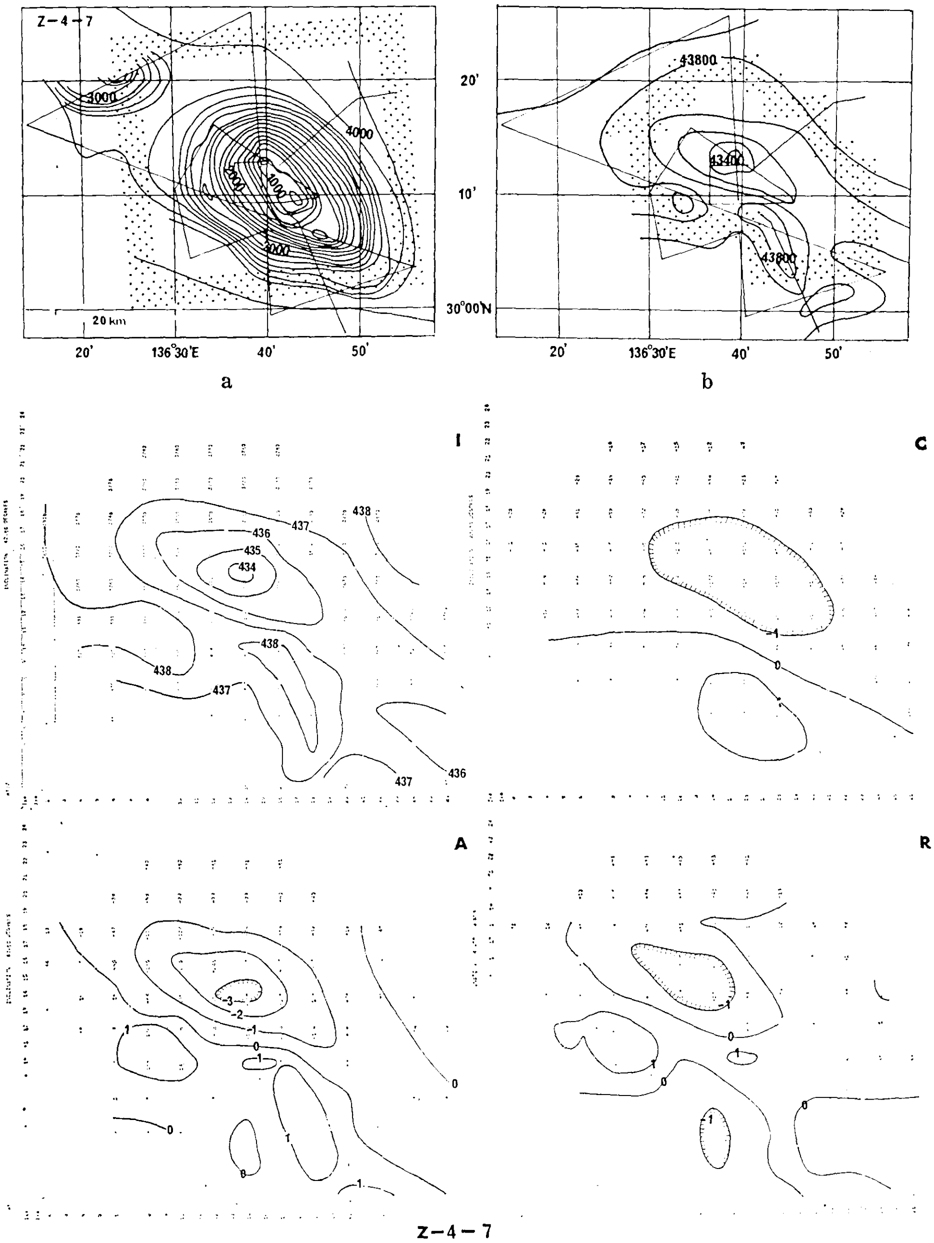


Fig. 11. Seamount Z-4-7.

(a) Topography (depth) in meters (b) Observed field in gammas

(I) Input field (A) Anomaly field

(C) Computed anomaly (R) Residual field

(I), (A), (C), (R) in milligauss

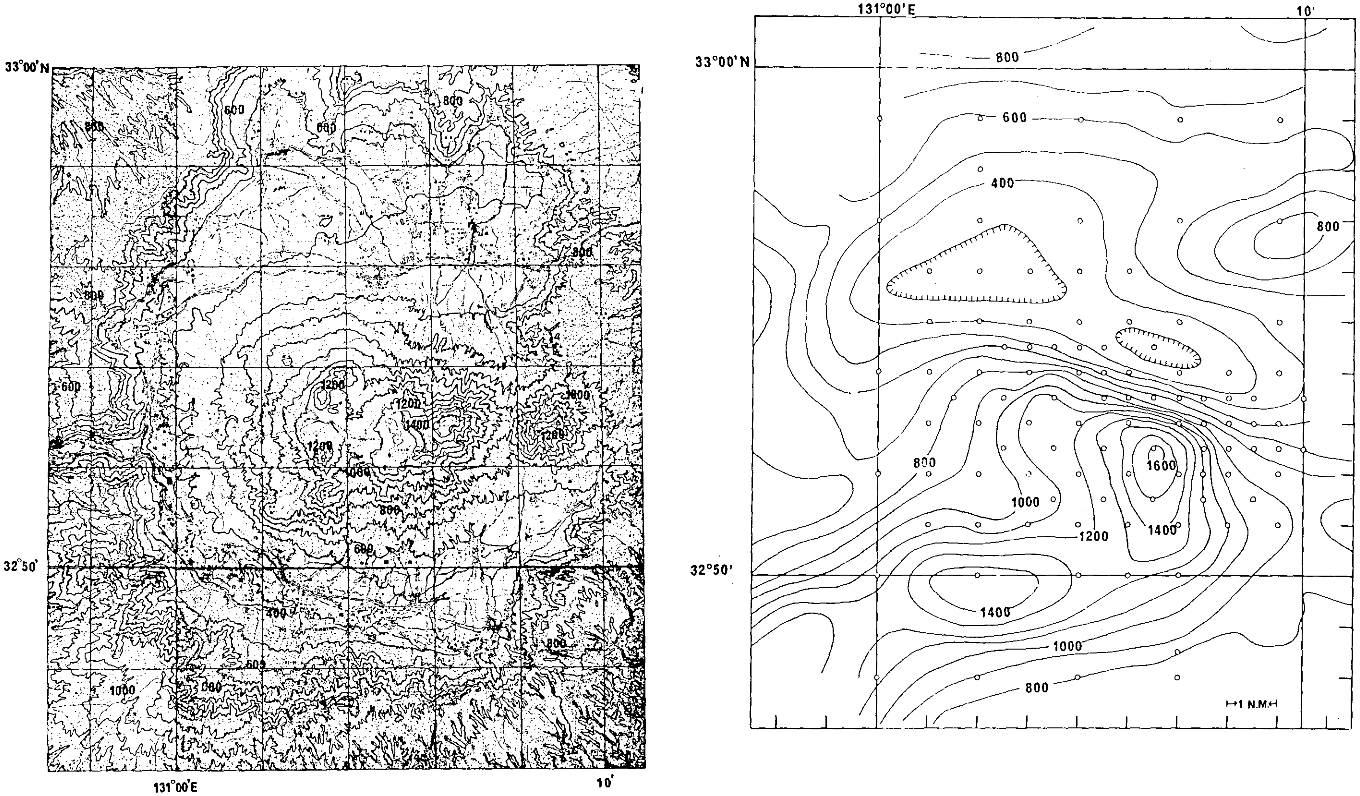
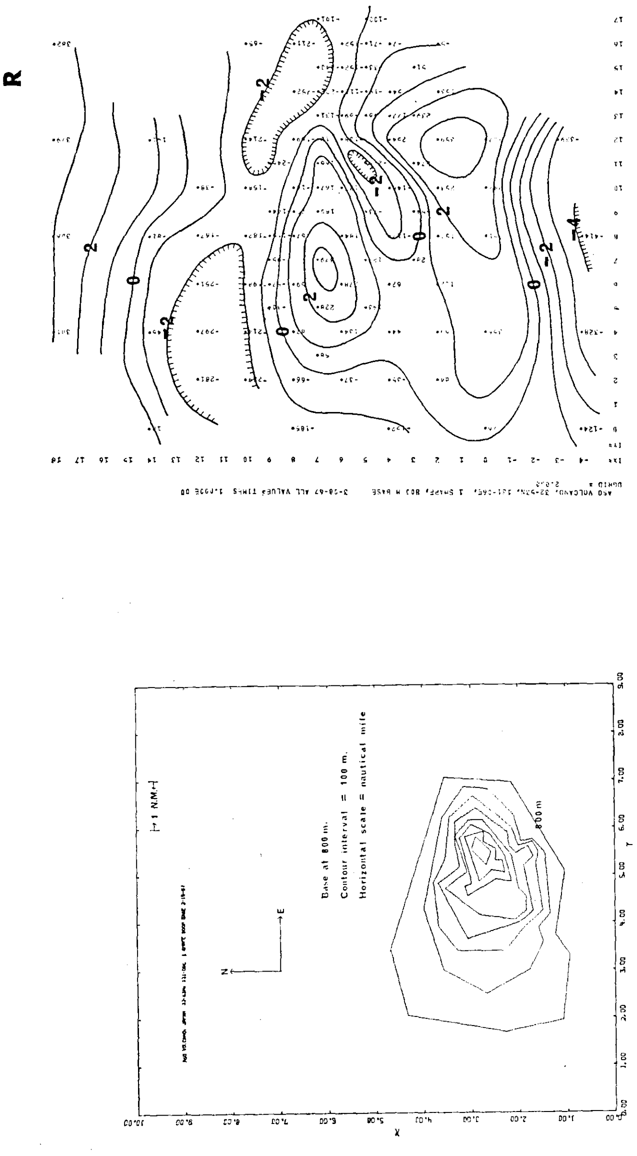


Fig. 12. Volcano Aso.

(a) Topography in meters

(b) Total magnetic intensity in gammas. (after R. Blank) Flight height 2100 m. The small circles indicate locations where magnetic data were read for the computation.



(c) Idealized topographic diagram used in the calculation.

(d) Residuals for assumption of a single body such as shown in Figure 12 (c). (milligauss)

Fig. 12. Volcano Aso.

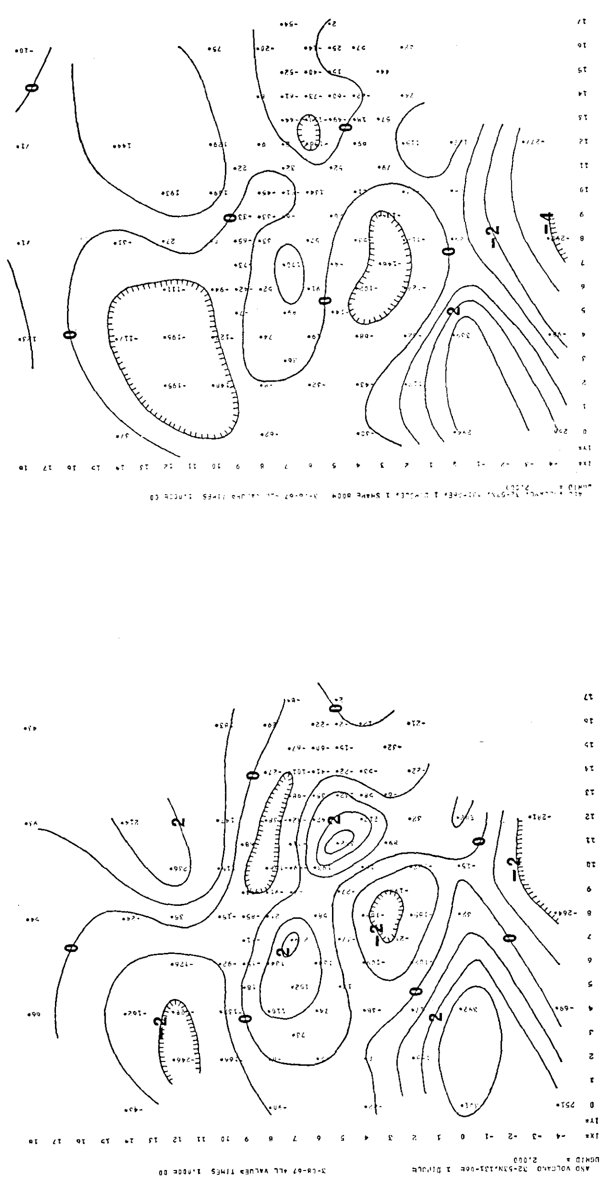


Fig. 12. Volcano Aso.

(e) Residuals for a dipole 6400 m. below sea level and located at $x=3.90$ and $y=5.21$ nautical miles. (milligauss)

(f) Residuals for a model combining the model of Figure 12 (c) with the dipole described in 12 (e). (milligauss)

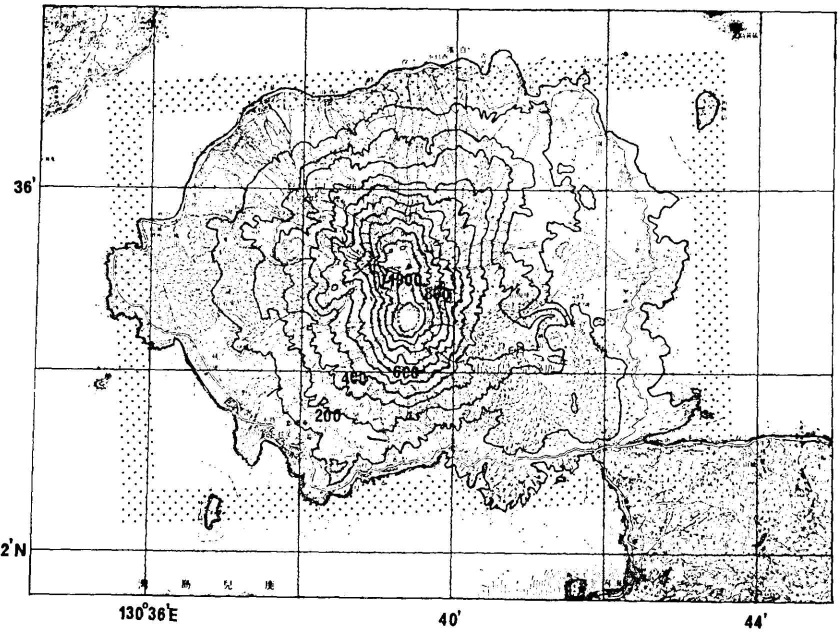
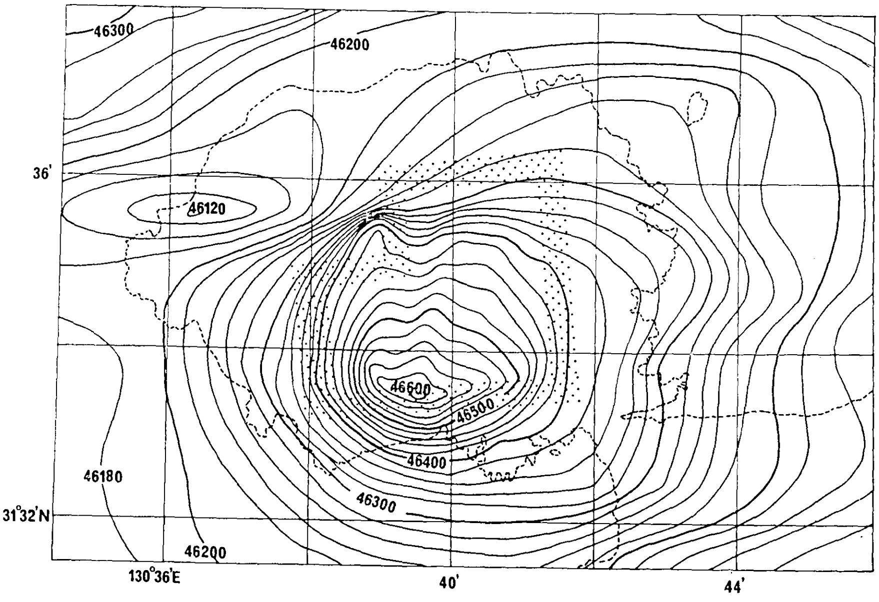
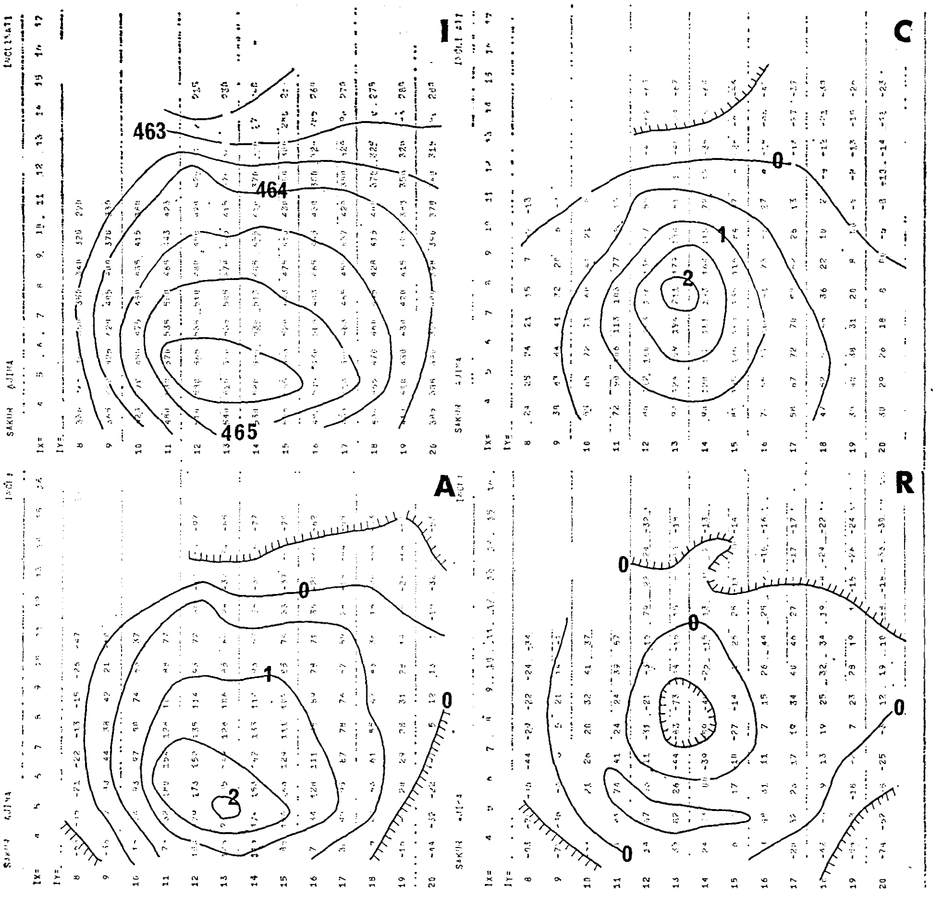


Fig. 13. Sakurajima Volcano.
(a) Topography in meters



(b) Aeromagnetic map in gammas, flight height at 6000 ft. (after Matsuzaki and Utashiro)



SAKURAJIMA

(I) Input field in milligauss
(A) Anomaly field 〃
(C) Computed anomaly 〃
(R) Residual field 〃

magnetization I by the formula $2 \cot p = \tan I$, where p is the palaeomagnetic co-latitude. This assumes that the contribution of induced magnetization can be neglected.

For all the seamounts, the palaeomagnetic inclination is consistenly shallower than the inclination of the present field. This can be seen in Table 1 by comparing the present latitude and the palaeomagnetic latitude. Thus, provided that the basic assumptions of palaeomagnetism are valid, these seamounts must have been situated in lower magnetic latitudes when magnetized. This is also true for the seamounts studied previously (Uyeda and Richards, 1966).

Some of the active volcanoes in Japan have been aeromagnetically surveyed. These volcanoes are essentially Quaternary features and expected to be magnetized in the direction not far from the direction of the geocentric axial dipole field. Mihara volcano, Oshima Island, was surveyed at two flight levels 6000 ft. and 4000 ft. by Y. Kato et al. (1965). Sakurajima volcano at 6000 ft. level by Matsuzaki and Utashiro (1966) and Aso volcano by R. Blank (1966) at the flight height of 2100 m. Topographic maps of these volcanoes and bathymetric charts around the islands are available in 1/50,000 in the publications of the Geographical Survey Institute, Japan and the Hydrographic Department, Japan. The magnetic and topographic maps of these volcanoes and the results of computation are shown in Figs. 12–16.

Table 2 shows computations for two altitudes of flight over Oshima Island, one for an altitude of 6,000 ft., the other for an altitude of 4,000 ft. The higher altitude gave a better result as could be expected because it gives a more accurate representation of the field.

Sakurajima and Oshima Island volcanoes gave goodness ratios of 2.53 and 3.21 respectively, indicating fairly reliable results. Their palaeomagnetic latitudes agree with their present latitudes, which was expected because of their young age.

The topography and the magnetic intensity of Mt. Aso are complex (Figs. 12a and 12b). Inspection of the observed magnetic intensity (Fig. 12b) reveals effects coming from sources at different depth. From the several calculations kindly carried out by Mr. M. L. Richards by the Talwani (1965) method(1), we have selected one set which shows that good fits can be obtained when the uplift is divided into bodies having different magnetizations and that therefore, the results obtained on

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(1) The Talwani (1965) method is equivalent to that of Vacquier (1962), but it can handle a larger structure and uses less computer time.

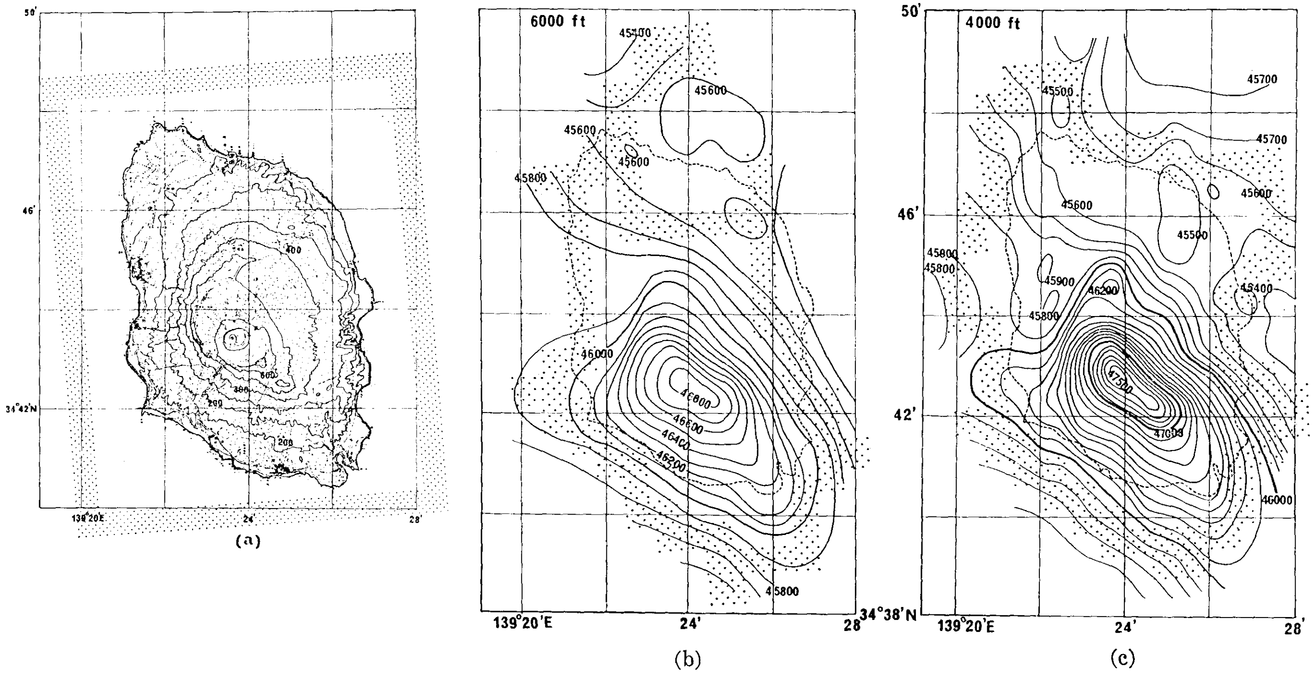

Fig. 14. Oshima Island (Mihara Volcano).

(a) Topography in meters
(b) Aeromagnetic map in gammas, flight height at 6000 ft
(c) Aeromagnetic map in gammas, flight height at 4000 ft

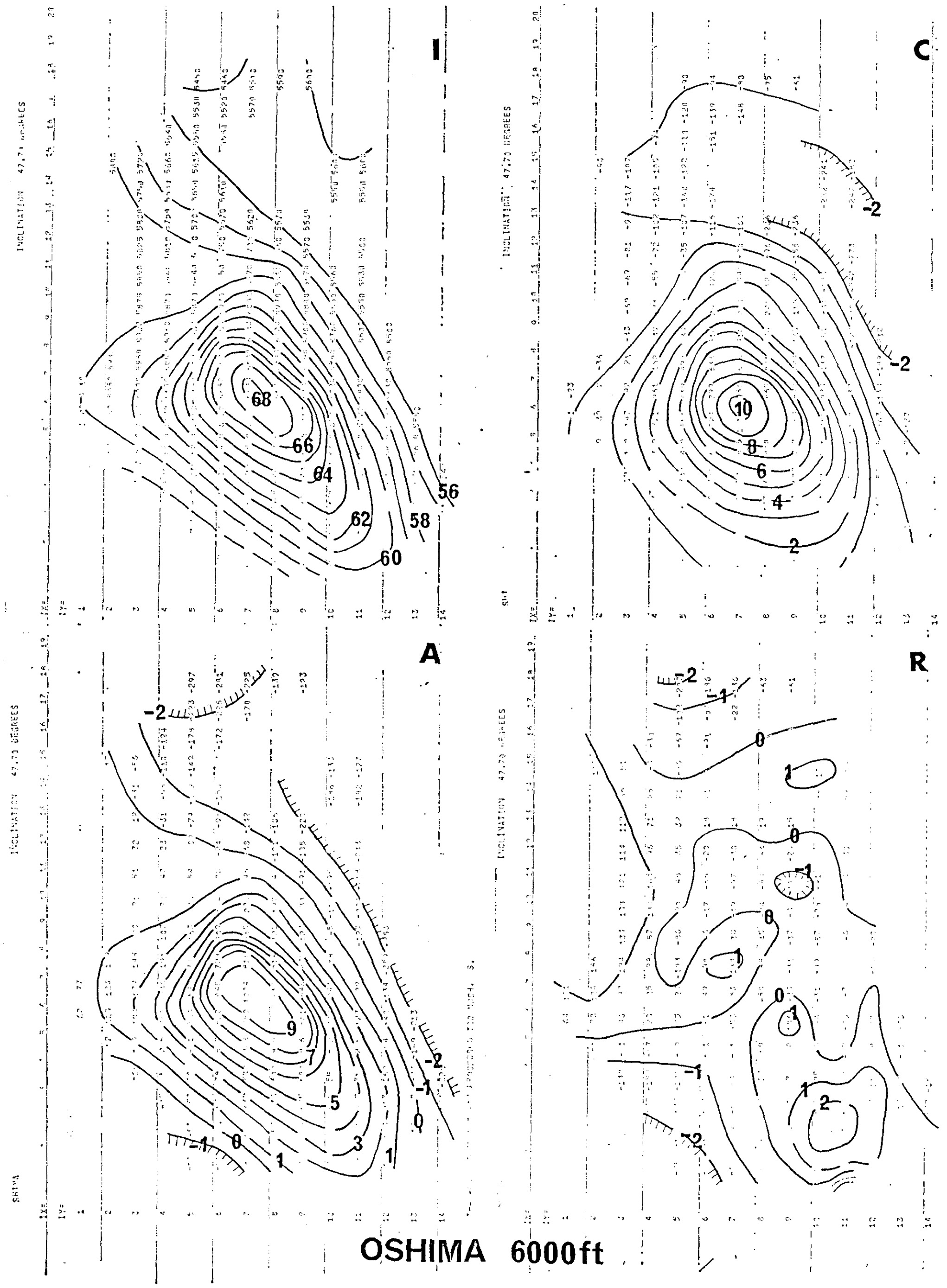

Fig. 15. Oshima.
(I) Input Field minus 400 milligauss at 6000 ft in milligauss
(A) Anomaly field in milligauss
(C) Computed anomaly 〃
(R) Residual field 〃

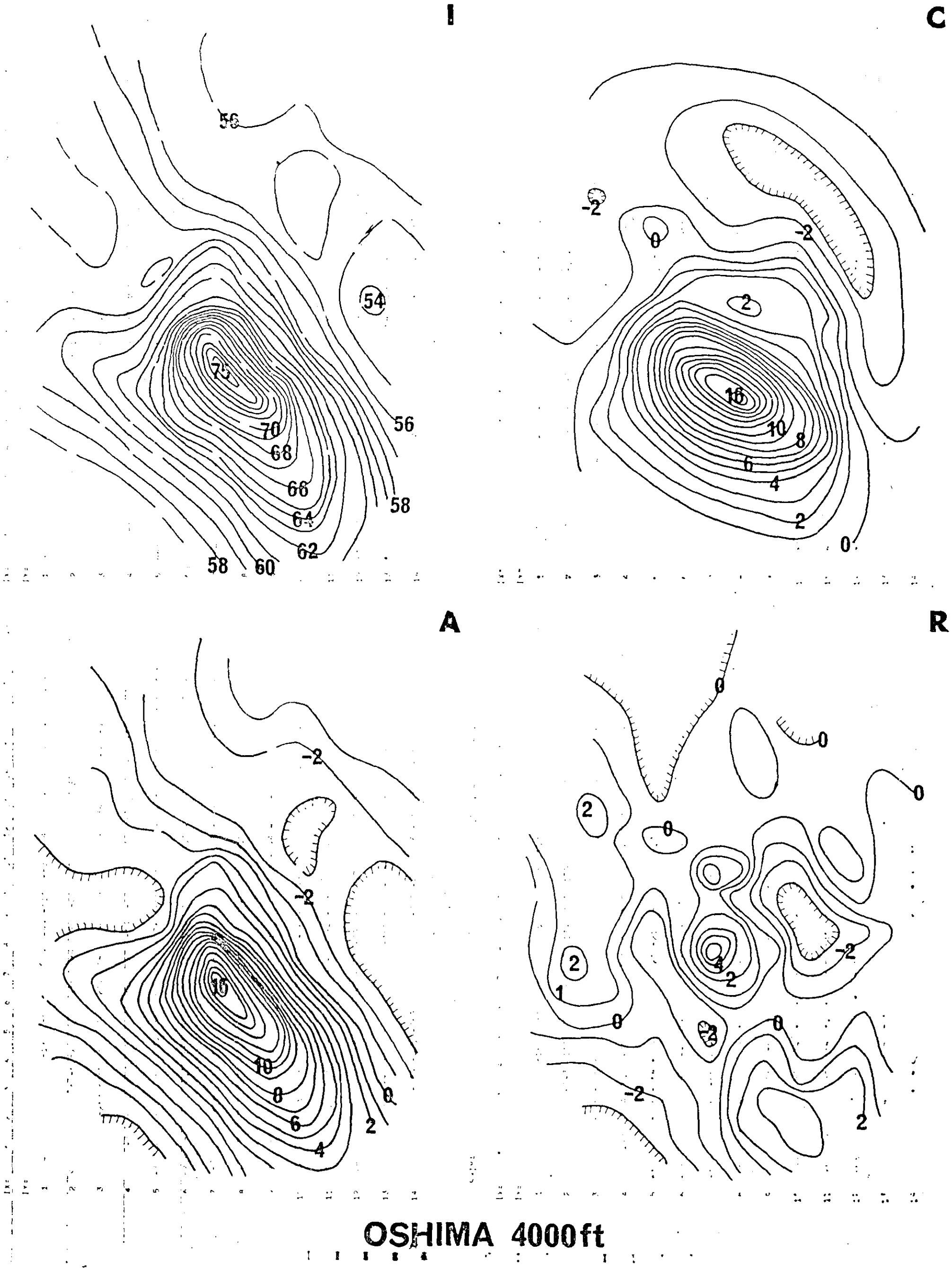

Fig. 16. Oshima.

(I) Input field minus 400 milligauss at 4000 ft in milligauss

(A) Anomaly field in milligauss

(C) Computed anomaly 〃

(R) Residual field 〃

complex models cannot be trusted. The first arbitrary decision we had to make was where to locate the base of the uplift on the topographic map. We chose the 800 m contour and idealized the topography as shown on diagram of Fig. 12 c. The first calculation on the basis of a single body gave a goodness ratio of only 1.38. The residuals of Fig. 12 d (R) suggest that in addition to the visible uplift, part of the magnetic field was coming from a deeper source. Another calculation was carried out using a dipole 6400 m below sea level located by trial and error at $x=3.90$ mi. $y=5.21$ mi. as a model of the source, and ignoring the presence of the mountain. The dipole may be regarded as replacing actual sources at some depth which cause the broad magnetic anomalies, so that in effect, its use is a method of removing a non-planar regional magnetic field. This gave a surprisingly good ratio of 3.01. However, the residuals for this calculation shown on Fig. 12 e indicate that the mountain does have a magnetic signature that should be left out. Thereupon, we combined the effects of the two models in the last calculation by assuming that the magnetic field was coming from a deep dipole and the uplift with the base contour of 800 m. Despite the arbitrary nature of the model for this calculation, the goodness ratio came out 3.59. The residuals are shown on Fig. 12 f. The computations on Mt. Aso are also summarized in Table 2. In all calculations the latitude of the palaeomagnetic pole position computed from Mt. Aso does not correspond to any known recent palaeomagnetic epoch. The high value of the goodness of fit ratio of 3.01 obtained for the dipole alone, indicates that the larger part of the anomaly is not coming from the mountain.

3. Palaeomagnetic Poles and Discussion

Palaeomagnetic pole positions have been calculated following the usual palaeomagnetic conventions for each seamount and volcano. The results are listed in Tables 1 and 2, and in Fig. 17. In this figure, the results from the seamounts studied previously (Uyeda and Richards, 1966) are also included.

Firstly, it may be seen in the figure that volcanoes Oshima and Sakurajima give pole position not far from the present geographic pole, and that volcano Aso does not.

It may also be observed in this diagram that the palaeomagnetic pole of the seamounts fall in the north Atlantic Ocean, except in the case of seamounts Z-3-1 and Z-3-2. Both of the latter seamounts belong to the Northwest Pacific Rise and one of them gave a small value of the

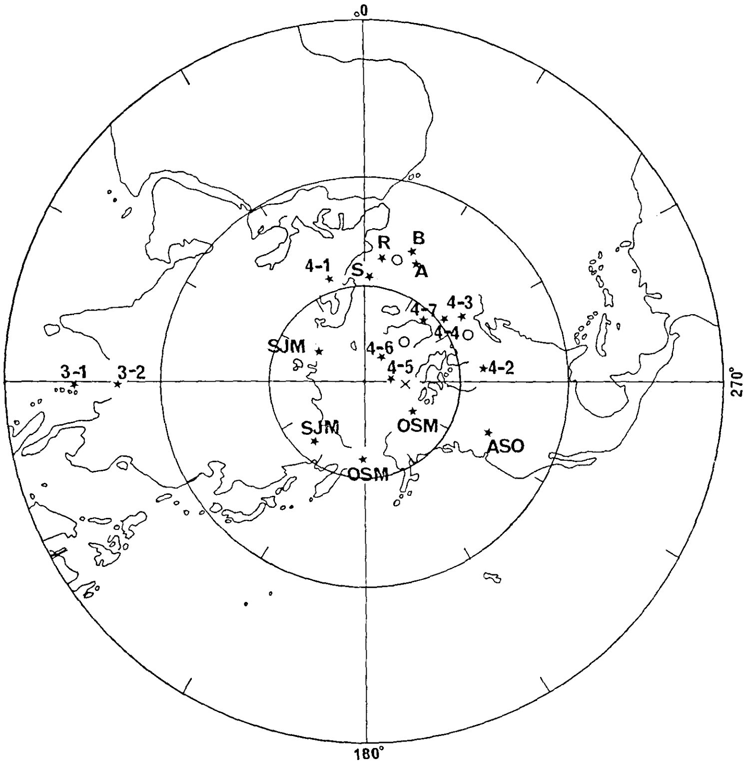

Fig. 17. Palaeomagnetic pole positions of the Western Pacific seamounts and Japanese Volcanoes. Hollow circles are the average pole positions for each group of seamounts encircled in Fig. 1.

× ...... present geomagnetic pole

goodness ratio (1.16). Their geomagnetic pole positions are remarkably close to each other, and this odd location might indicate an unusual vagary of the geomagnetic field at the time of their formation.

The average palaeomagnetic pole of the three seamounts (Z-4-2, Z-4-3, Z-4-4) in the Pacific Basin is at 56°N-66°W with the confidence angle of 15° at 95% level (k=72). This pole agrees in latitude with the average pole position obtained previously from another group of four seamounts (R, S, A, B, in Figure 1). The latter pole position is 51°N-14°W with the confidence angle of 9° at 95% level (k=106). Seamount Z-4-1 has been omitted from the present consideration, since, as explained above, this seamount is situated on the top of a regional anomaly trend. Another group of three seamounts (Z-4-5, Z-4-6, Z-4-7) in the Shikoku

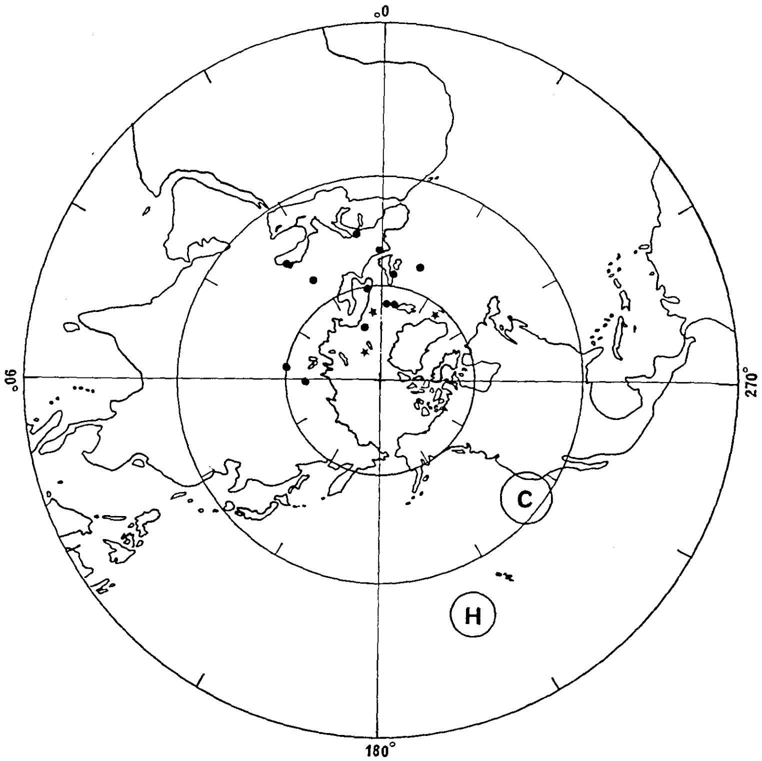

Fig. 18. Palaeomagnetic pole positions of the seamounts near Hawaiian Islands and off California. (after Richards et al., 1966)

Full circles......poles from Hawaiian seamounts

Stars ....poles from Californian seamounts

H and C surrounded by larger circles indicate the locality area of the seamounts.

Basin, west of the Izu-Bonin Arc, gave the average pole position at 76°N-44°W with the confidence angle of 18° at 95% level (K=50). This position is significantly different from the poles given by the seamounts in the Pacific Basin.

As to the age of these seamounts, seamount Sysoev designated by S on Figures 1 and 17 yielded some Cretaceous index fossils in dredge hauls (Uyeda and Richards, 1966).

Seamount Ryofu (R in Figures 1 and 17) was dredged, as well as seamounts Z-3-1, Z-3-4, Z-4-2, Z-4-3, Z-4-4 and the less altered rocks were dated by the K-Ar method by Ozima et al. (1967) to give the following ages: The tholeiitic basalt from seamount R gave a whole rock K-Ar age of 72 m.y. The alkali olivine basalt from seamount Z-4-1 gave two ages of 63.5 and 74 m.y. while a mineral age of 79.2 m.y. was obtained from separated plagioclase. The tholeiitic basalts from seamount Z-4-3 gave whole rock ages of 87.3 and 95.5 m.y., while other tholeiitic basalts from seamounts Z-3-1 and Z-4-4 gave the age of 18.2 m.y. and 25.3 m.y. The last two ages are considerably younger than the rest. The rocks are by no means free from alteration, therefore these ages should be taken as giving the minimum values. No rocks were obtained from the seamounts in the Shikoku Basin.

From these measurements it is likely that except for seamounts Z-3-1, Z-3-2 and possibly Z-4-4, the seamounts surveyed in the Northwest Pacific Basin were formed in Cretaceous time. The palaeomagnetic latitudes of seamounts Z-4-2, Z-4-3 and Z-4-4 may be interpreted as due to a northerly drift of the Pacific Ocean floor amounting to 35° of latitude.

Richards et al. (1967) give palaeomagnetic poles for seamounts near the Hawaiian Islands and off California. The seamounts near Hawaii are of Cretaceous age but the age of the others is unknown. The palaeomagnetic poles from these seamounts are also in the same area as those of the present results (Figure 18), which can also be interpreted as having been caused by the northward drift of the North Central Pacific. Such a drift is supported by studies of the direction of fault movement in the circum Pacific margins such as Philippines-Taiwan region (Allen, 1962) and is contrary to the view that the Pacific Basin is rotating counterclockwise as has been proposed by Benioff (1957) and Pavoni (1964).

Irving (1964 (Figure 6.28)) pictures the general northward drift of the palaeomagnetic poles from several continents since Permian time. Looking at his figure in more detail one sees that by Cretaceous time Europe, North Asia, and North America give tightly grouped palaeomagnetic poles centering about 70°N-180°. Cretaceous poles from East Africa listed in Irving (1964) also fall close to this position as well as the Cretaceous pole computed from Caryn Seamount located at 36°40′N, 67°58′W and gave a palaomagnetic pole at 74°N-178°E (Vine, 1965). A possible interpretation is that the relative latitudes of North America, Africa and Northern Eurasia have remained fixed since the Cretaceous, but that since that time the pole wandered to its present position. However, Australia (Irving, 1964) and the Pacific Ocean seamounts as shown in Figures 17 and 18 have traveled northward about 35° since the Cretaceous. India has also traveled northward during that time (Irving, 1964).

The recent palaeomagnetic work of Sasajima and Shimada (1965) and of Kato and Muroi (1965) on formations of Cretaceous and Palaeogene ages has yielded palaeomagnetic poles which can be interpreted by a northerly displacement of Japan.

If the northerly drift of the floor of the the Pacific Ocean which we are postulating as an explanation for the shallow dip angle of the magnetization of the older seamounts be related to the contemporary hypothesis of ocean floor spreading originally proposed by Hess (1965), and followed later by Menard (1964), Wilson (1965), Vine and Matthews (1963), and Vine (1966), we find our seamounts are very far indeed from present-day sources of such spreading, which are the East Pacific Rise and the South Pacific Rise. The Northwest Pacific (Shatsky) Rise and the Emperor Seamount Ridge have been found inactive in the recent geologic past because of normal heat flow (Vacquier et al., 1966). The drift of the central Pacific seamounts might also have been influenced by the fossil Darwin Rise (Menard, 1964). Some light on this question might be shed by the palaeomagnetism of seamounts in the Southern Pacific.

Appendix. Computations on Rikitake-Hagiwara Cones

The generally low values of the dip angle of magnetization which characterize our seamount calculations made it desirable to test again the method of computation on an analytical model. At the suggestion of Professor T. Rikitake, calculations were carried out on analytically computed anomalies over magnetized truncated circular cones obtained by the method of Rikitake and Hagiwara (1965). Calculations were carried out on a cone whose sides had a slope of 10° and whose ratio of top to bottom diameters was 0.1. Figure 19 shows the analytically computed total magnetic intensity at four different elevations above this cone, assuming only induced magnetization dipping 48° and where the magnetic declination is zero. Table 3 shows the inclination and declination angles given by the computer program. In the case of this model the differences between the actual and the computed inclination and declination angles are acceptably small. An example of the results of computations is given in Fig. 20.

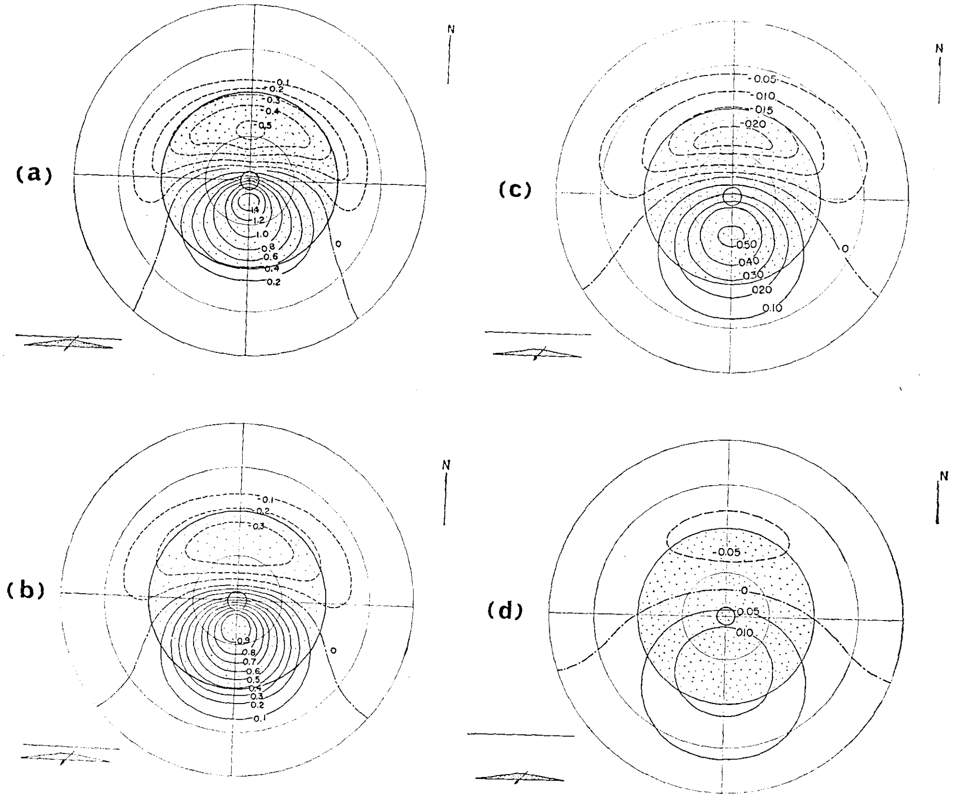

Fig. 19. Analytically computed anomaly total force field ΔF of a uniformly magnetized circular cone, which has the slope angle of 10° and the ratio of top and bottom radii of 0.1. Inclination of magnetization is assumed 48°. Declination of magnetization is assumed 0°. (after Rikitake and Hagiwara, 1965)

(a) ΔF at a height of 0.2 in the units of the bottom radius
(b) ΔF at a height of 0.3 in the units of the bottom radius
(c) ΔF at a height of 0.5 in the units of the bottom radius
(d) ΔF at a height of 1.0 in the units of the bottom radius

Table 3. Results of Computation on Rikitake-Hagiwara's Cones.

Flight height in units of bottom radius	Inclination	Computed declination	Computed inclination	Goodness ratio R.
1.0	48°	1.6°	47.7°	14.3
0.5	〃	0.8°	48.6°	25.3
0.3	〃	1.0°	47.6°	15.7
0.2	〃	3.0°	52.1°	8.7

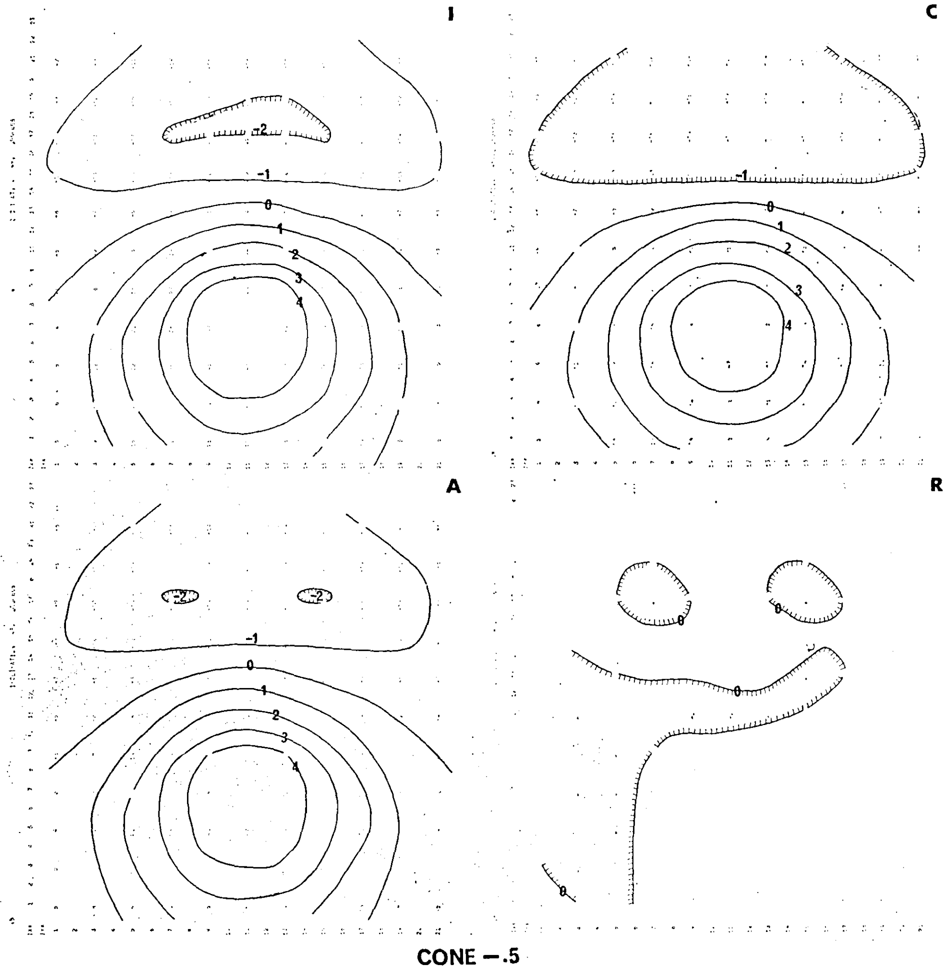

Fig. 20. Results of computation on the cone: flight height=0.5.

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43. 西太平洋における9個の海山及び日本の3個の火山の古地磁気学

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地震研究所 上田誠也

1966年に行なわれた日米協同観測結果にもとづいて，西太洋海域における9個の海山について，その磁化を計算した．計算結果から求められる古地磁気学的磁極は，主として北部大西洋に集中し，かつて，北海道沖の4個の海山から求められたものと一致する傾向を示す．底質岩石の年代は白亜紀末であろうことがK-Ar法によつて得られているので，今回の研究は，太平洋底が，中生代末以来，現在の磁極に対して北上したという事実を示唆する．このことは大陸移動説におけるゴンドワナ大陸の分裂とも，最近の海洋底拡大説とも矛盾しない．阿蘇，桜島，伊豆大島等については，航空磁気測量結果にもとづいて，同様の計算が行なわれた．阿蘇火山の場合には，地形のみでなく，地下に双極子を仮定する方がよいように思われる．