

# THE SOUTH RENNELL TROUGH : EVIDENCE FOR A FOSSIL SPREADING ZONE

B.M. LARUE, J. DANIEL, C. JOUANNIC and J. RECY<sup>(1)</sup>

22 SEP. 1977

J. R. S. T. O. M. ex 1

Collection de Référence

n° 8773 Geoph.

## ABSTRACT :

The South Rennell trough cuts, down to 5.000 m depth, along a 700 km long and 30 km wide slash, the eastern Coral Sea through the now inactive margin of the Indo-Australian plate. It lies between the North of the Chesterfield Group to the South Solomon trench with an arimuth N-30°-E. The cruises realized by ORSTOM : GEORSTOM I and II, AUSTRADec 3 and 4 and the previous works show symmetrical magnetic lineations. The basaltic nature of rock samples and the low density of the mantle allow to express the hypothesis of creation of the zone by oceanic spreading. Heat flow, depth and magnetic anomalies give an age of 30 M.y.

## RESUME :

Le fossé Sud Rennell entaille jusqu'à une profondeur de 5.000 m, l'est de la mer de Corail sur une longueur de 700 km et une largeur de 30 km. Il s'étend sur la marge inactive de la plaque Indo-Australienne entre le Nord du Groupe des Chesterfield et la fosse Sud Salomon selon un arimuth N-30°-E.

Les croisières réalisées par l'ORSTOM : GEORSTOM I et II, AUSTRADec 3 et 4 et les travaux précédents montrent des linéations magnétiques symétriques. La nature basaltique d'échantillons dragués et la faible densité du manteau supérieur permettent d'émettre l'hypothèse d'une création de la zone par expansion océanique.

Le flux de chaleur, la profondeur et les anomalies magnétiques concordent pour lui attribuer un âge de 30 M.a.

## I - INTRODUCTION

Between the Australian Continent and the Pacific plate (Fig. 1), a series of ridges, rises and basins is found that tells us the evolution of the plate boundaries between the Indo-Australian and the Pacific plates. It is important to have the nature and the age of the different structures encountered. The South Rennell trough is one of those. It cuts down to 5.000 m depth, along 700 km long and 30 km wide slash, the Eastern Coral Sea. It is seismically inactive (BARAZANGI and DORMAN, 1969, LOUAT and PASCAL, 1977).

The cruises GEORSTOM I and II carried out by ORSTOM, AUSTRADec 3 and 4 (ORSTOM, IFP, CFP, ELF, SNPA, CNEXO), CHAIN (WOODS-HOLE), GLOMAR CHALLENGER Leg. 30 (DSDP), MONSOON (HIG Hawai) and the "MAGNET PROGRAM" profiles, allow to present seismic, magnetic, gravity, heat flow data.

A bathymetric map (Fig. 2) has been drawn, using the Scripps Institution previous one and the new data.

## II - MORPHOLOGY AND SEISMIC

The region has previously been described (LARUE et al 1975). It shows some characteristics different from one side to the other of a shelf situated in the prolongation of

(1) Office de la Recherche Scientifique et Technique Outre-Mer, B.P. A5, Noumea Cedex, New Caledonia

THE SOUTH RENNELL TROUGH : EVIDENCE FOR A FOSSIL SPREADING ZONE

the Rennell Plateau. West to this shelf, it looks deeply hollowed (Fig. 3, profiles JK, LM) and its margins are reinforced by rises up to 2.000 m high. Eastly (Fig. 3, profiles AC', FG) the morphology is less marked and its general feature widen out, the trough remaining visible though less embanked.

The thin sedimentary filling is only found in the deepest part of the trough.

The general feature shows a symmetry and evocates an extensional rift.

III - MAGNETISM

The trough and its vicinity are characterized by magnetic anomalies of longer wavelength and larger amplitude than the surrounding area. It can be seen (Fig. 4) that it is possible to correlate the anomalies from a profile to another profile along a direction parallel to the Trough. The anomalies are also symmetrical as on Fig. 5, FG is correlated to its reverse GF. The center of symmetry is above the Southern flank of the trough, but after a linear matrix inverse program that calculates the apparent susceptibility, given the geometrical parameters of the magnetic layer, (HUTTON, 1970), it is possible to see (Fig. 6) that the trough is characterized by a positive susceptibility and flanked by two negative ones then turning to be positive again.

The zone with magnetic anomalies is wider on the eastern side of the shelf found on the morphology.

A longitudinal profile NP (Fig. 7) shows that the shelf exists off the trough as it is as well seen on the morphology as on the magnetism (point P). Another one exists more in the South east (point N). They can be tranverse faults.

IV - GRAVITY

A profile surveyed by the WOODS HOLE Oceanographic Institute on R.V. Chain and kindly communicated has been interpreted. Without any previous refraction work it has been interpreted from a standard crust, the same as this used by ROSE et al, 1968. The model has been computed with a 2 D program written by COLLOT and MISSEGUE, 1976.

Layer	thickness km	velocity km/s	density g/cm <sup>3</sup>
2	1,71 ± 0.75	5.07 ± 0.63	2.56 ± 0.11
3	4,86 ± 1.42	6.69 ± 0.26	2.95 ± 0.06
4	-	8,13 ± 0.24	3.33 ± 0.08

assuming those values, the fitting of the anomaly is not good. It is better if we consider a lower density for the mantle. We choose 3.2 (Fig. 8). The fitting is good on the trough. For our purpose it is not necessary to complicate the model any more. Though the structure is inactive, the upper mantle remains abnormal.

V - SAMPLES

Two superficial sampling brought back microcristalline paste with augitic phenocrystals basaltic splinters (MONZIER, 1975). Some new dredgings have been made but are not yet completely studied. A preliminary study shows from Southwest to Northeast, along the structure, augitic basalts, submarine olivine basalts, acid lava (MONZIER, 1976).

All those facts allow to express the hypothesis of a creation by oceanic spreading. Considering the fan shape of the structure we probably have a "sphenochasme" as described by CAREY, 1958 and found in the Woodbed basin by LUYENDYCK et al, 1973.

VI - DATING

The dating of magnetic anomalies is a problem with two unknowns : Age and Velocity. In the present case we can have estimations of both.

1) - Age :

Three coherent values of heat-flow give a mean value of 1,86 HFU (HALUNEN and VON HERZEN, 1973). Referring to the evolution curves of heat-flow (SCLATER and FRANCHETEAU, 1970) and depth (SCLATER et al, 1971) versus time for the great oceanic basins, this leads to give for both an oligocene age (Fig. 9).

2) - Velocity :

Le PICHON et al, 1973, point out that there is a rift when the velocity is inferior

to 3cm/y and no rift when the velocity is superior to 3cm/y.

We show that, the rift exists only on the western side of the shelf. If we have a fan shape opening, the velocity is continuously changing along the spreading center, increasing from West to East. We can then assume that the shelf is the 3cm/y frontier.

The computed using inversion time scale from HEIRTZLER et al 1968, and the observed anomalies are shown Fig. 10.

#### VII - CONCLUSIONS

We found that the surroundings of the South Rennell trough has been created by oceanic spreading, the so called trough being the remainings of the rift.

The fan shape or sphenochasme means that the pole of rotation was close to the ridge, probably near Chesterfield.

Compared with the mid oceanic ridges, the expansion is small in length, lateral extension and duration. Though the results are coherent with those of LUYENDYCK et al 1973, FEDEN et al 1977, WATTS et al 1977, WEISSEL 1977, we cannot but wonder if the whole lithosphere is involved.

As we still ignore the geometry of the boundary between the Indo-Australian and Pacific plates in the past, it is impossible to know if the opening was autonomous or related to the consumption process.

#### References

- BARAZANGI M. and DORMAN J. - 1969 - WORLD Seismicity maps compiled from ESSA - Coast and Geodetic Survey epicenter data.
- CAREY S.W. - 1958 - Continental Drift : a Symposium S.W. CAREY ed. - Hobard University pp. 177-355.
- COLLOT J.Y., MISSEGUE Fr. - 1975 - Modèle gravimétrique à 2 Dimensions sur la zone Nouvelle-Calédonie, Iles Loyautés, Fosse des Nouvelles-Hébrides - Rapport O.R.S.T.O.M.
- FURUMOTO A.S., MALAHOFF A. - 1977 - Evidence for a Spreading Zone in the Melanesian Complex : Bismark Sea. - International Symposium on Geodynamic in the SouthWest Pacific.

- HALUNEN A.J. and VON HERZEN R.P. - 1973 - Heat flow in the Western equatorial Ocean J. Geophys. Res. Vol. 78, pp. 5195-5208.
- HEIRTZLER, DICKSON G.O., HERRON E.M., PITMAN III W.C., LE PICHON X. - 1968 - Marine magnetic anomalies, geomagnetic field reversals, and motions of the ocean floor and continents. - J. Geophys. Res. Vol. 73, p. 2119-2136.
- HUTTON M.A. - 1970 - Interpretation of Oceanic magnetic anomalies using a linear inverse technique. Unpublished thesis University of DURHAM.
- LARUE B., DANIEL J., RECY J., DUBOIS J. - 1975 - De l'existence d'une zone d'expansion fossile dans l'est de la mer de Corail (Sud Ouest Pacifique) C.R.A.S. t 281 - D - p. 1455-58.
- LE PICHON, J. FRANCHETEAU, J. BONNIN - 1973 - Plate Tectonics p. 172 - Elsevier ed.
- LOUAT R. and PASCAL G. - 1977 - Energy released by shallow seismicity in the SouthWest Pacific. International Symposium on Geodynamic in the South West Pacific.
- LUYENDYCK P., MacDonald K.C., BRYAN W.B. - 1973 - Rifting History of the Woodlark Basin in the South West Pacific. Geol. Soc. Am. Bull. Vol. 84 pp. 1287-1300.
- MONZIER M. - 1975 - Campagne GEORSTOM II Nouméa - Rapport ORSTOM -
- MONZIER M. - 1976 - GEORSTOM III Nord - Rapport préliminaire sur les échantillons dragués 1ère partie - Rapport ORSTOM.
- ROSE J.C., WOOLLARD G.P. and MALAHOFF A. - 1968 - Marine gravity and magnetic studies of the Solomon Islands. in : the crust and upper mantle of the Pacific area pp. 379 - 410. Geophys. Monograph n° 12
- SCLATER J.C. and FRANCHETEAU J. - 1970 The implication of terrestrial heat flow observations on current tectonic and geochemical models of the crust and upper mantle of the Earth. Geophysical J. Vol. 20 pp. 509 - 542.
- SCLATER J.C., ANDERSON R.N., BELL M.L. - 1971 - Evolution of ridges and evolution of the Central Eastern Pacific J. Geophys. Res. Vol. 76, pp. 7888-7915.

THE SOUTH RENNELL TROUGH : EVIDENCE FOR A FOSSIL SPREADING ZONE

- WATTS A.B., WEISSEL J.K., DAVEY F.J. - 1977  
 Middle Cenozoic evolution of the South  
 Fiji marginal basin. International Sympo-  
 sium on Geodynamic in the S.W. Pacific.

- WEISSEL J.K. - 1977 - Evolution of the Lau  
 marginal basin - Int. Symp. on Geodynamic  
 in the S.W. Pacific.

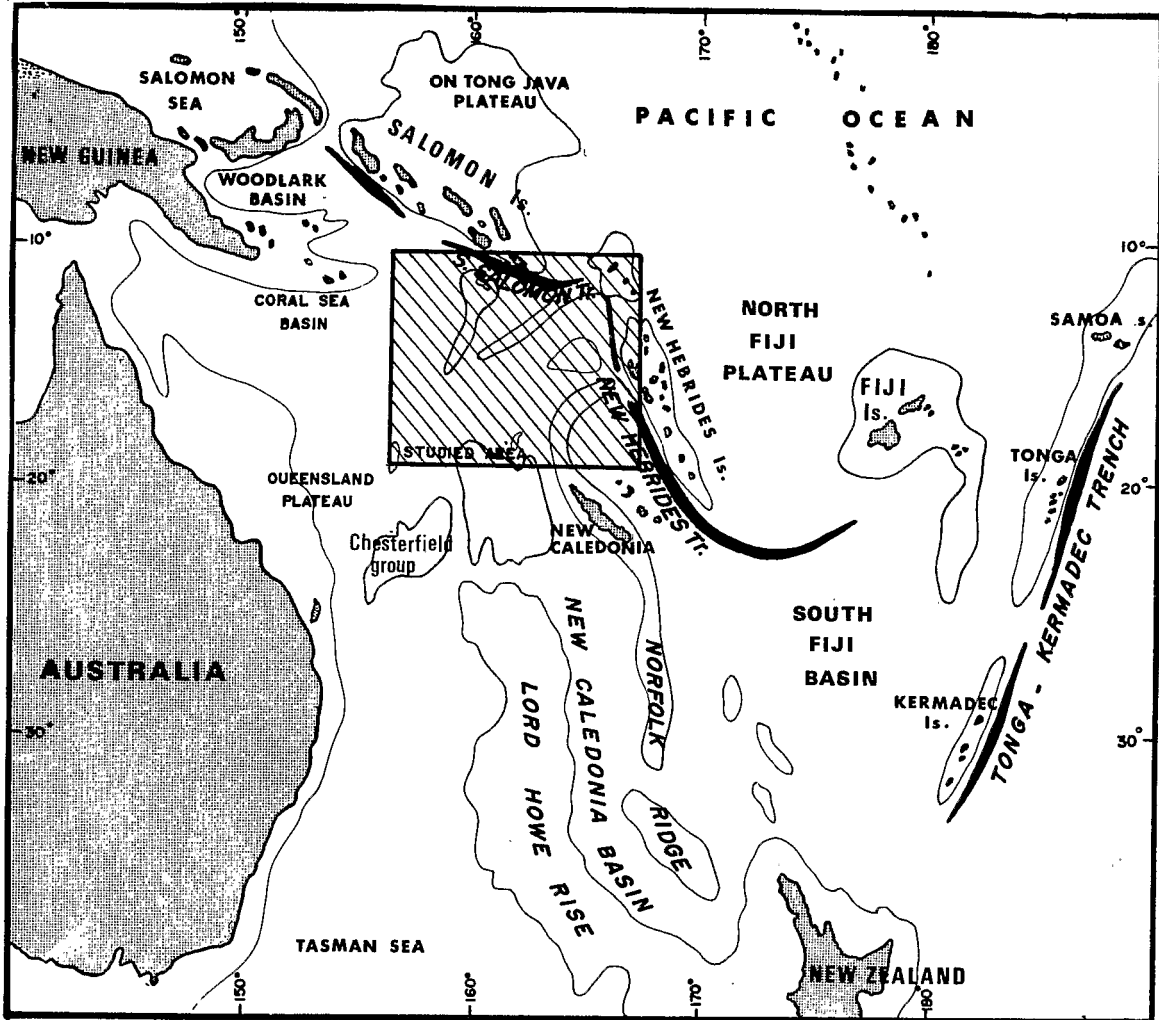


Fig. 1 - Bathymetry and major structural features of the Southwest Pacific.

THE SOUTH RENNELL TROUGH : EVIDENCE FOR A FOSSIL SPREADING ZONE

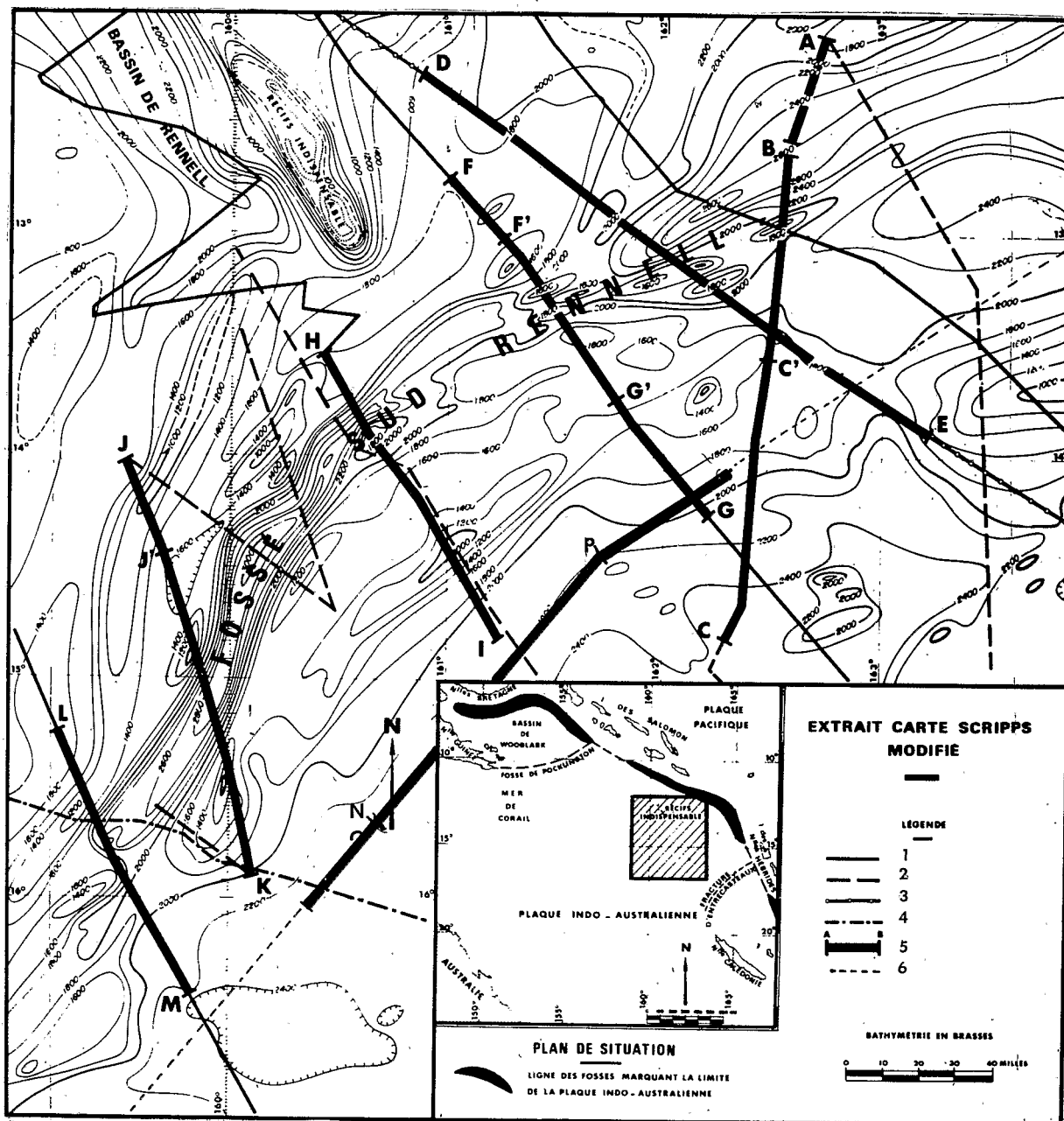


Fig. 2 - Bathymetric map and location of the profiles.

- 1 - GEORSTOM I
- 2 - GEORSTOM II
- 3 - CHAIN
- 4 - GLOMAR CHALLENGER
- 5 - Identification of cross-sections
- 6 - AUSTRADDEC 3

THE SOUTH RENNELL TROUGH : EVIDENCE FOR A FOSSIL SPREADING ZONE

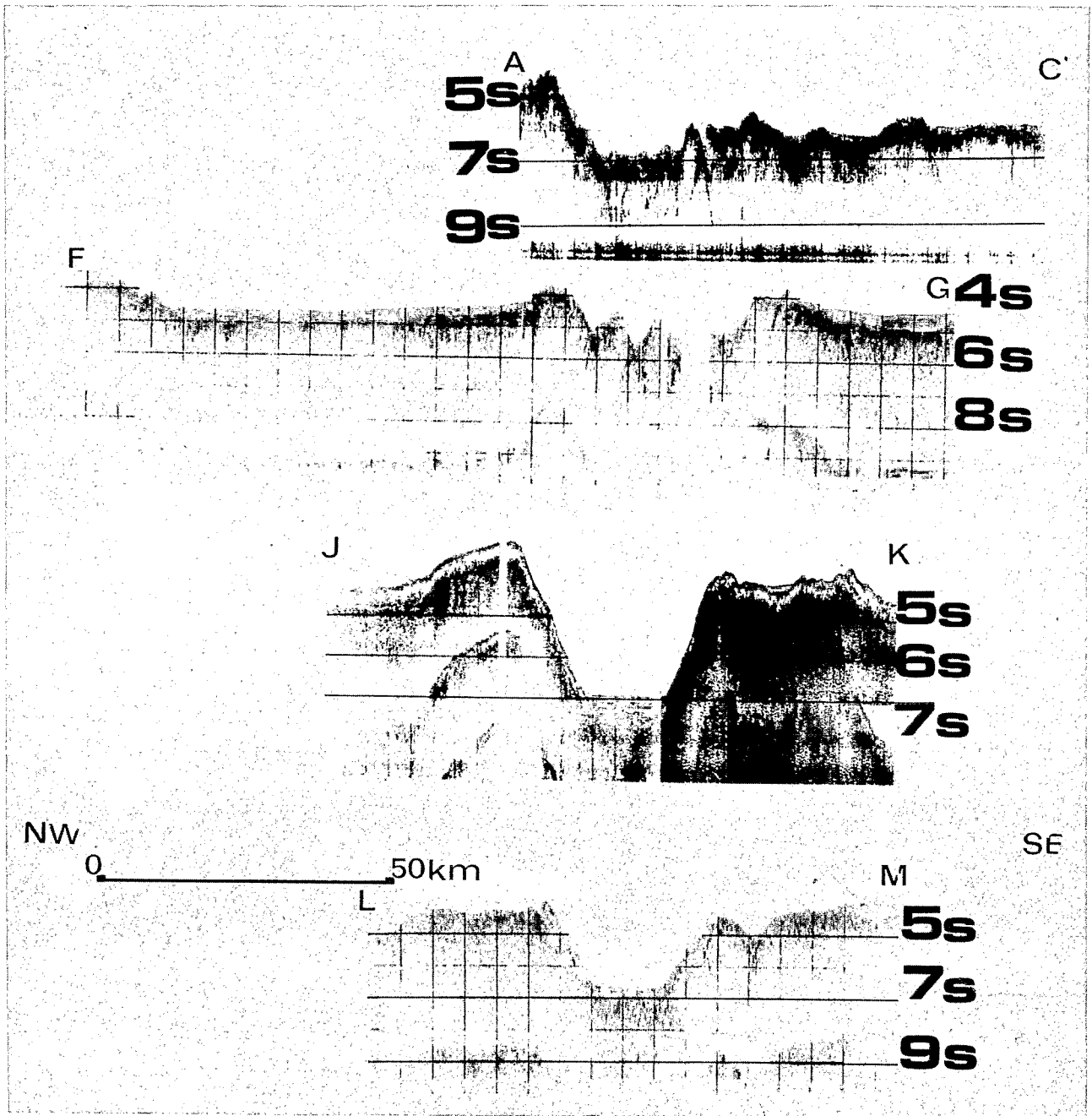


Fig. 3 - Seismic reflection profiles across the South Rennell trough.

THE SOUTH RENNELL TROUGH : EVIDENCE FOR A FOSSIL SPREADING ZONE

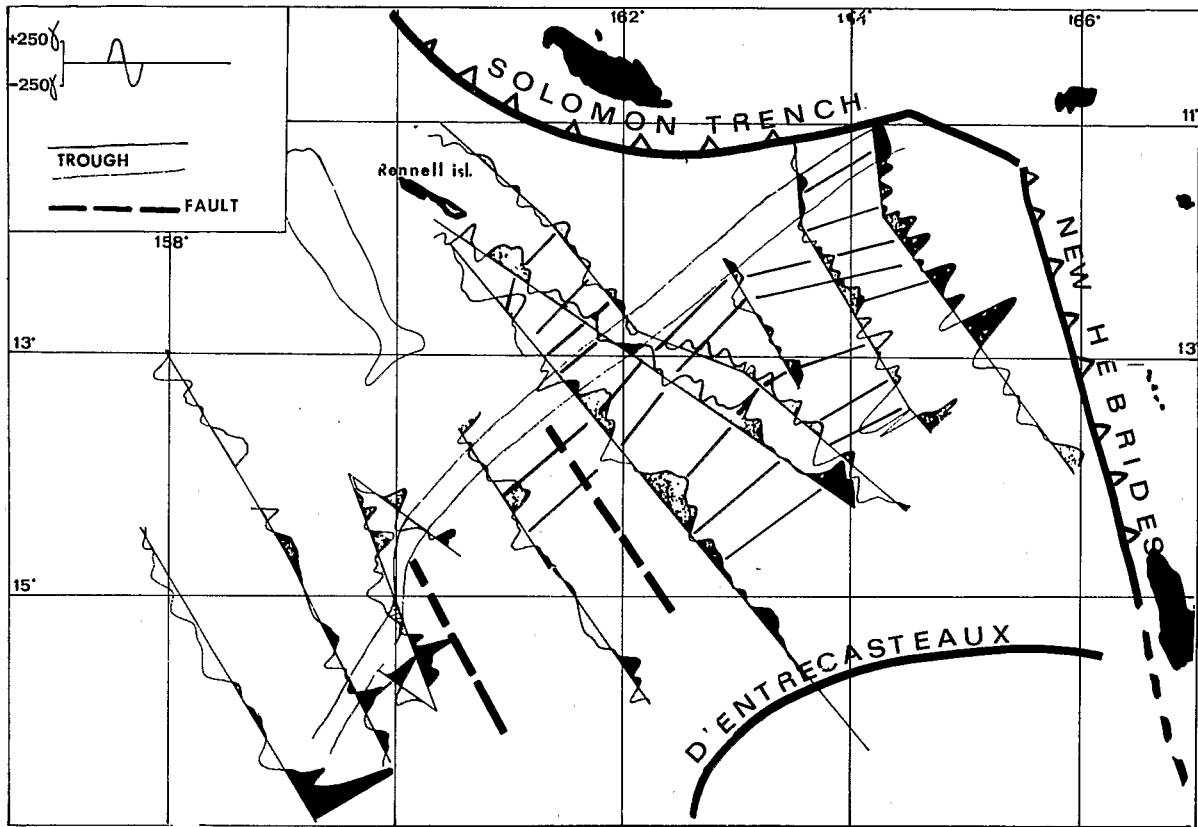


Fig. 4 - Magnetic anomalies tracks.

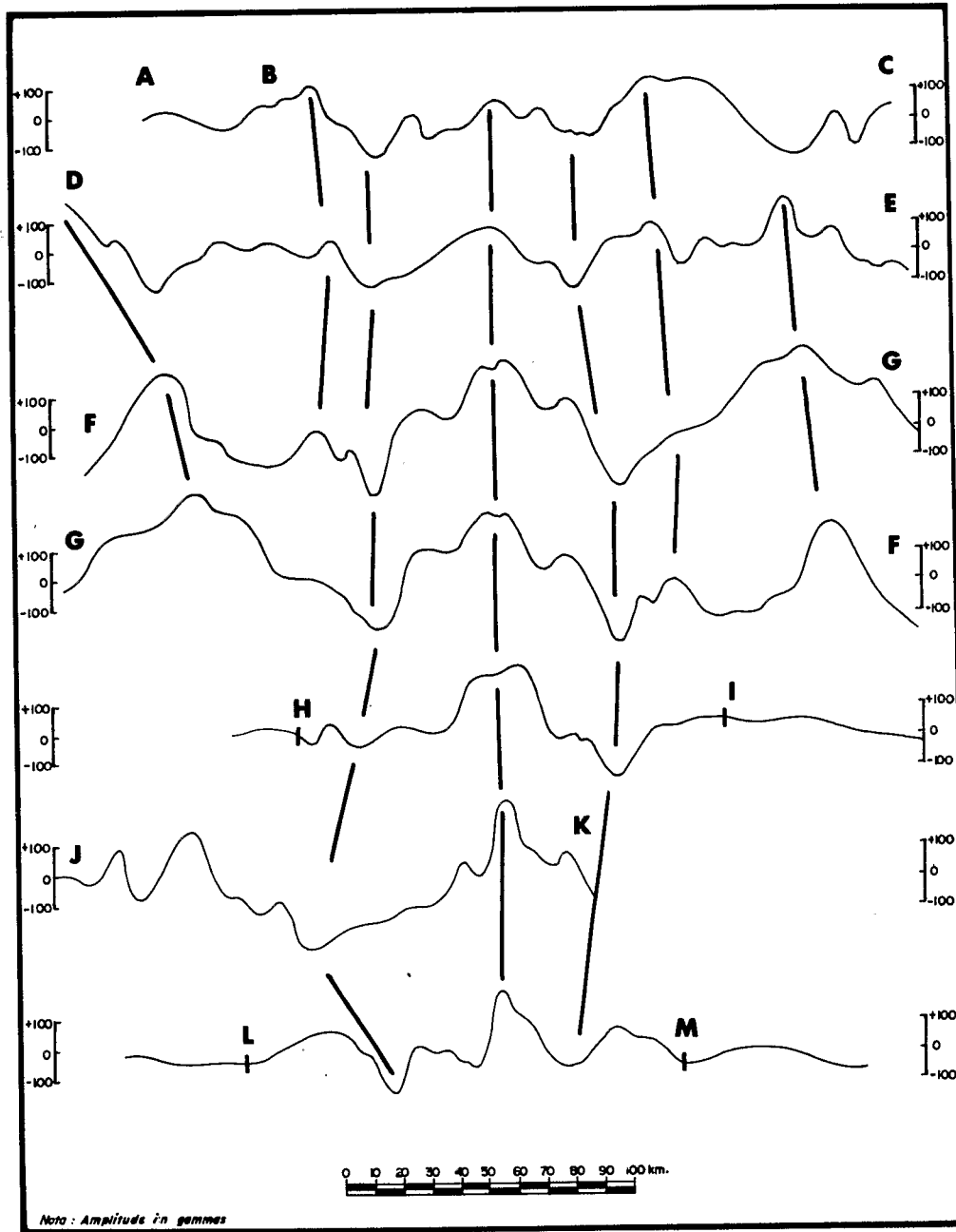


Fig. 5 - Correlations of magnetic anomalies.



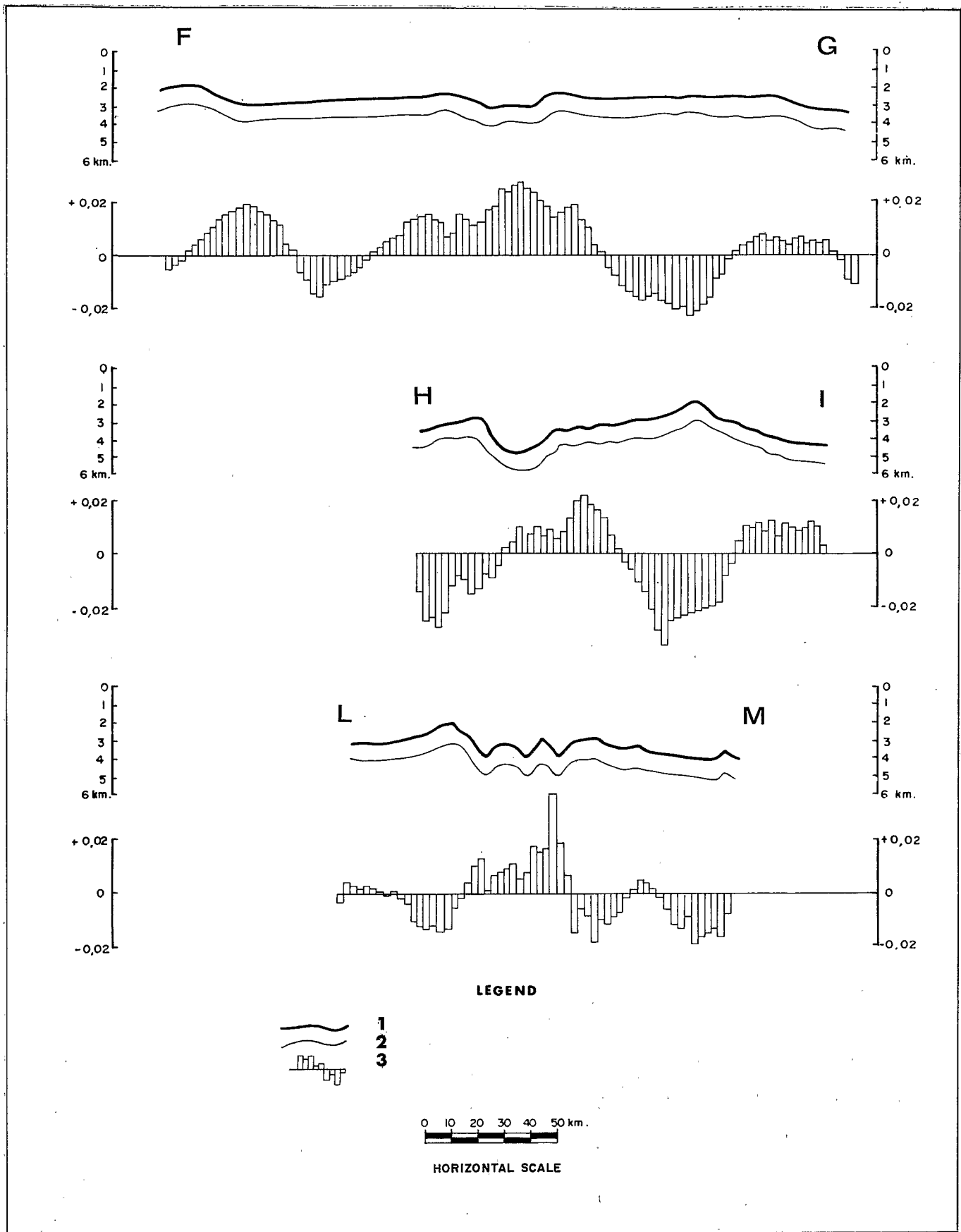


Fig. 6 - Distribution of computed apparent susceptibility.  
 1 - Sea Bottom  
 2 - Lower Limit of the magnetized Layer.  
 3 - apparent susceptibility computed (in e.m.u./cm<sup>3</sup>).

THE SOUTH RENNELL TROUGH : EVIDENCE FOR A FOSSIL SPREADING ZONE

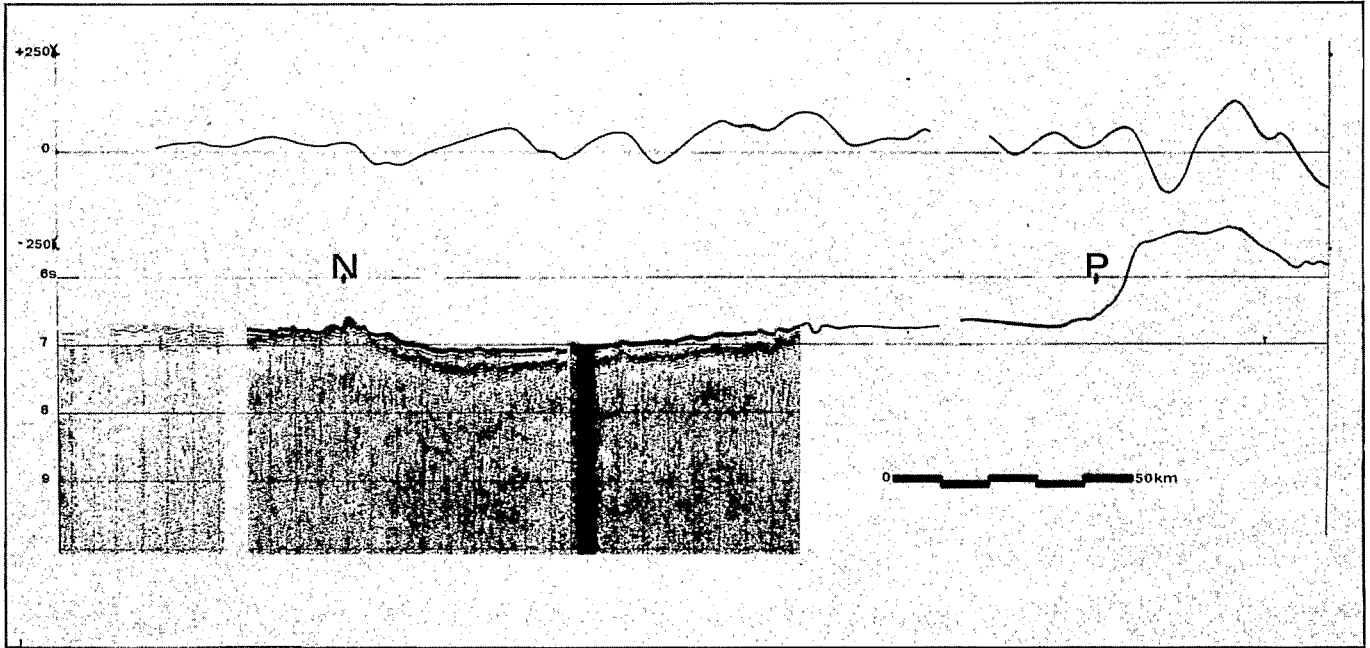


Fig. 7 - Seismic reflection - bathymetric and magnetic longitudinal profile.

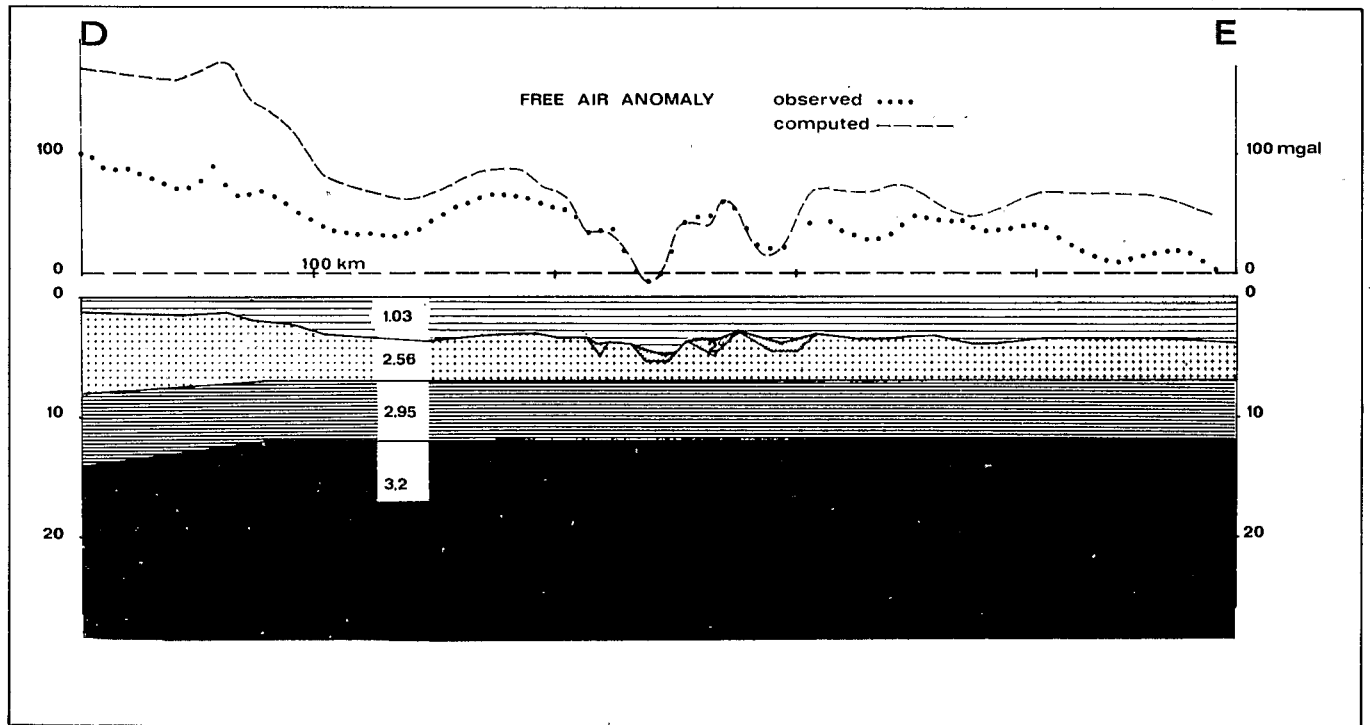


Fig. 8 - Gravity profile.

THE SOUTH RENNELL TROUGH : EVIDENCE FOR A FOSSIL SPREADING ZONE

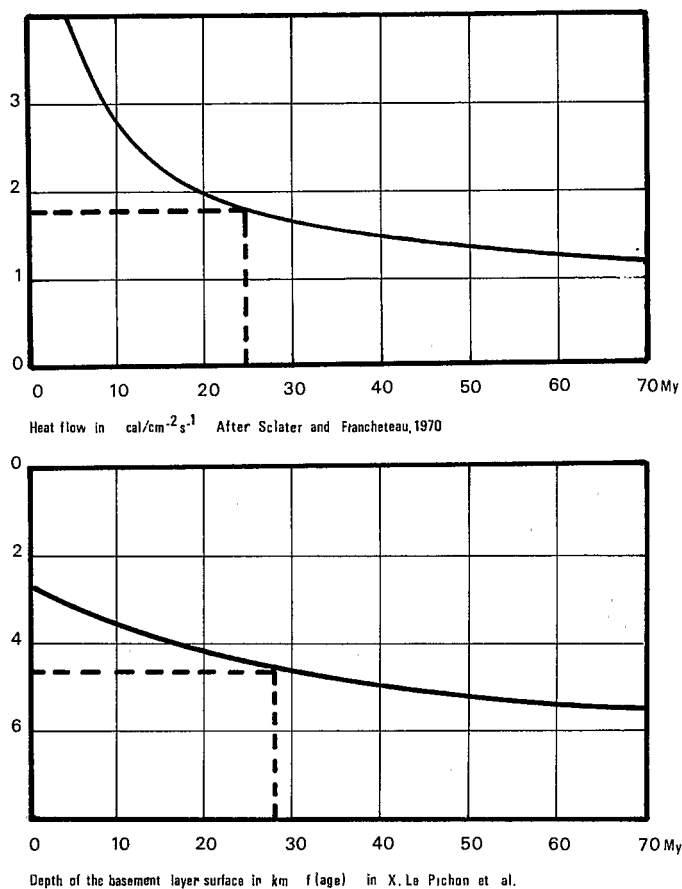


Fig. 9 - Heat flow and depth versus time.

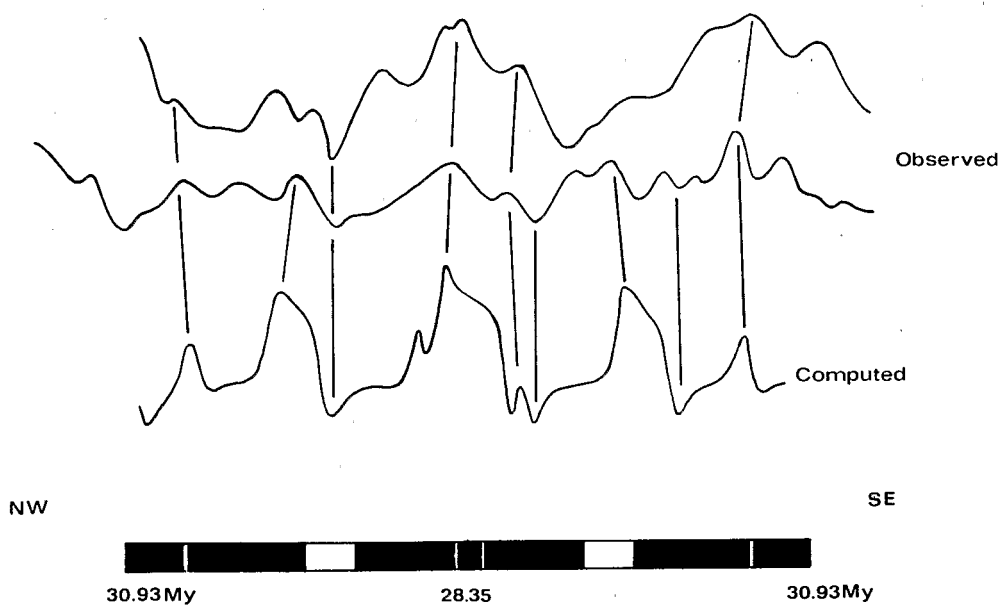
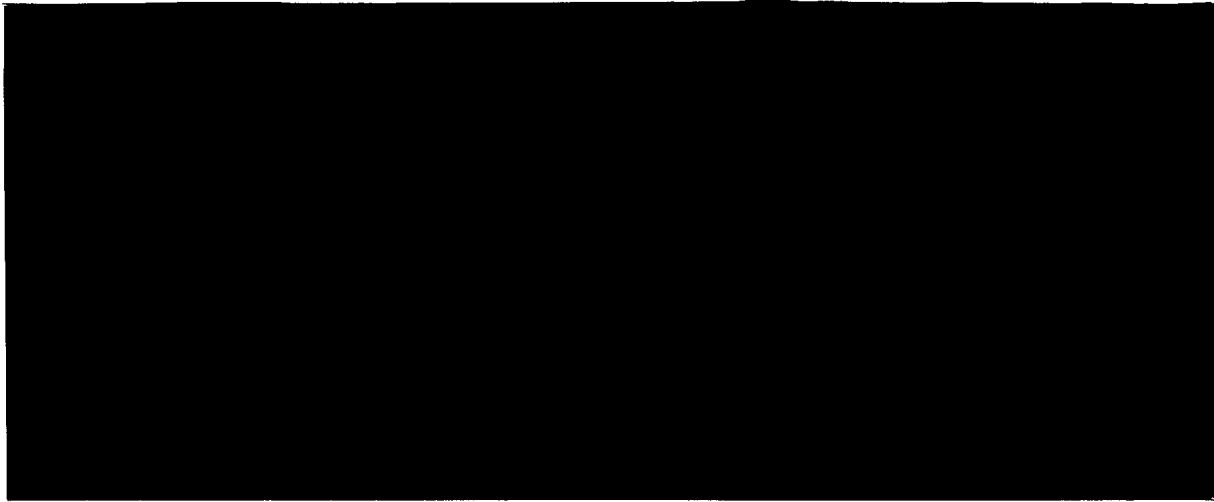


Fig. 10 - Synthesized and observed magnetic profiles.



TIRÉ A PART  
OFFPRINT

*Symposium International*

GEODYNAMICS IN  
SOUTH-WEST PACIFIC

GÉODYNAMIQUE DU  
SUD-OUEST PACIFIQUE

NOUMEA - NOUVELLE-CALÉDONIE  
27 AOÛT-2 SEPTEMBRE 1976

*Sous le patronage de*

Office de la Recherche Scientifique et Technique Outre-Mer  
Bureau de Recherches Géologiques et Minières  
Institut Français du Pétrole  
Inter-Union Commission on Geodynamics.