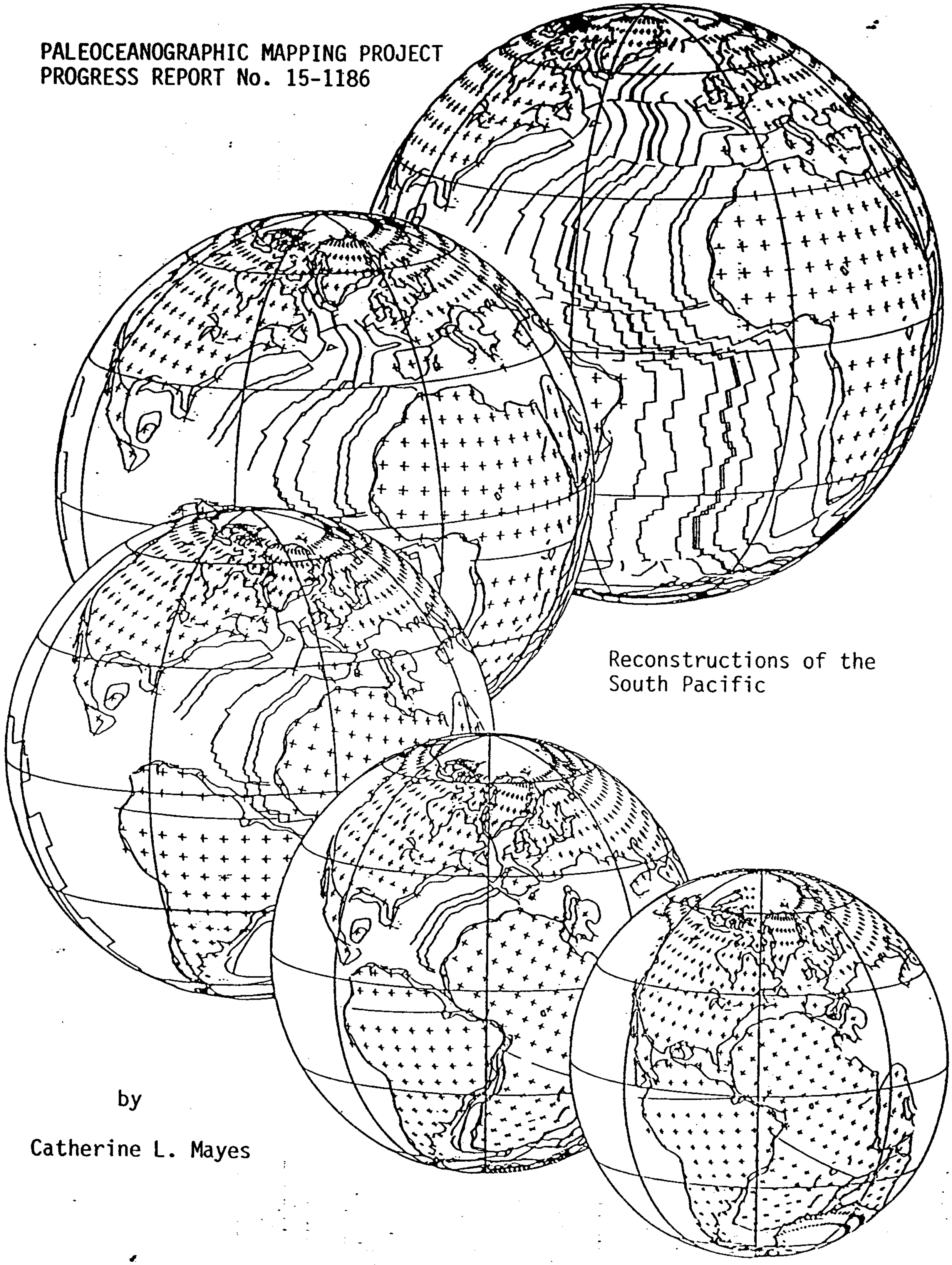
PALEOCEANOGRAPHIC MAPPING PROJECT
PROGRESS REPORT No. 15-1186



Reconstructions of the South Pacific

by

Catherine L. Mayes

Reconstructions of the South Pacific
by
Catherine L. Mayes

We present reconstructions of the Pacific region south of the equator for the following times: Anom. 5 (10.6 Ma), Anom. 7 (26.0 Ma), Anom. 21 (50.3 Ma), Anom. 25 (59.2 Ma), and 100 Ma (CQZ). The reconstructions with interpreted isochrons are based upon magnetic picks, magnetic anomaly trends, and fracture zone trends from the following sources: Christoffel and Falconer (1972), Herron (1972), Molnar, et al. (1975), Handschumacher (1976), Weissel, et al., (1977), Mammerickx, et al. (1980), Handschumacher, et al. (1981), Cande, et al. (1982), Klitgord and Mammerickx (1983), Cande and Leslie (1986), and Molnar (1986, pers. comm.). For all of our reconstructions, we hold the Pacific plate fixed in present-day coordinates. Using interactive graphics, we determined new poles of rotation for the Pacific-Antarctic, Pacific-Cocos, Pacific-Nazca and Nazca-Antarctic spreading systems.

In contrast to the Pacific plate north of the equator where older anomalies have been identified, there are large areas south of the equator that must be assumed to be older than Anomaly 34. With the exception of a few dates obtained from DSDP results, we are unable to accurately determine the tectonic evolution of the older sections of the southern Pacific region. However, the Manihiki Plateau has been dated as Aptian-Berremian, which is approximately M0.

During the Early Cretaceous (Fig. 1), there was no motion between Marie Byrd Land and the Campbell Plateau . It appears that rifting initiated between Marie Byrd Land and the Campbell Plateau at the time of Anomaly 34 (84.0 Ma). Between Anomaly 34 and Anomaly 25 (Fig. 2), at least four plates were active in the South Pacific: the Pacific, the Antarctic, the Aluk and the Farallon plates. The evidence for these plates is preserved on the Pacific and Antarctic plates in several sets of anomalies which show different spreading rates.

Immediately prior to the time of Anomaly 21 (Fig. 3), the Pacific-Antarctic spreading center propagated northward, trapping a piece of crust that had been formed at the Pacific-Aluk spreading center on the Antarctic plate. At the same time, the Farallon plate began to move in a more northerly direction in relation to the Antarctic plate.

The next major change in the Pacific spreading system occurred between the times of Anomaly 7 (Fig. 4) and Anomaly 5 (Fig. 5). The Farallon plate broke-up into the Cocos and Nazca plates. This break-up produced a realignment of the entire ridge system. At the time of Anomaly 5, two parallel spreading centers were in operation along the Pacific-Cocos and Pacific-Nazca plate boundaries.

Our reconstructions and isochron map are the results of the first phase of a depth/age study of the South Pacific. Our revised reconstructions will help complete the circuit of poles of rotation around the South Pacific. Improved Pacific-Antarctic poles will help define the positions of critical areas such as New Zealand, and may be of use in determining the time of opening of the Ross Sea.

In the next few months, we will be revising the isochron set presented here to get a final version. We will be looking at the geoid data from the SEASAT data set to accurately locate fracture zones, tectonic fabrics, and other tectonic features such as seamount chains. We are using plots of peak and trough picks derived from the first derivative of the geoid. By following lines of peaks or troughs, we can identify fracture zones and tectonic fabrics (Fig. 6).

We will also reexamine the area south of the Campbell Plateau during the final pass at the isochrons. If we treat the ENE-trending anomalies south of the Campbell Plateau as a part of the Pacific-Antarctic spreading system as defined by picks to the north, we produce an unacceptable overlap of Isochrons 31, 28 and 25. We will treat these anomalies, which trend differently than those to the northeast, as the northern half of spreading at a plate boundary formed at the spreading center separating the Pacific plate and some previously unidentified plate. There is a change in sea floor, from smooth topography to the north of Anomaly 18 to rough topography to the south, which supports some change of tectonic regime (Molnar, et al., 1975). We will also examine how the addition of a plate in this area affects the plate circuit.

References:

Christoffel, D. A., and Falconer, R. H. H., Marine magnetic measurements in the southwest Pacific Ocean and the identification of new tectonic features, *in* Antarctic Oceanology II - The Australia-New Zealand Sector, ed. Hayes, D. E., pp. 197-209, Washington: AGU, 1972.

Cande, S. C., Herron, E. M., and Hall, B. R., The Early Cenozoic history of the southeast Pacific, Earth and Planetary Science Letters, 57, 63-74, 1982.

Cande, S. C., and Leslie, R. B., Late Cretaceous tectonics of the southern Chile trench, Journal of Geophysical Research, 91 (B1), 471-496, 1986.

Handschumacher, D. W., Pilger, R. H., Foreman, J. A., and Campbell, J. F., Structure and evolution of the Easter plate, *in* Geological Society of America Memoir 154, 63-76, 1981.

Handschumacher, D. W., Post-Eocene plate tectonics of the Eastern Pacific, *in* The Geophysics of the Pacific Ocean Basin and its Margin, Geophysical Monograph 19, ed. Sutton, G. H., Manghnani, M. H., Moberly, R., 177-202, Washington: AGU, 1986.

Herron, E. M., Sea-floor spreading and the Cenozoic history of the East-Central Pacific, Geological Society of America Bulletin, 83, 1671-1692, 1972.

Klitgord, K. D., and Mammerickx, J., Northern East Pacific Rise: Magnetic anomaly and bathymetric framework, Journal of Geophysical Research, 87 (B8), 6725-6750, 1982.

Mammerickx, J., Herron, E., and Dorman, L., Evidence for two fossil spreading ridges in the southeast Pacific, Geological Society of America Bulletin, 91, 263-271, 1980.

Molnar, P., Atwater, T., Mammerickx, J., and Smith, S. M., Magnetic anomalies, bathymetry and the tectonic evolution of the South Pacific since the late Cretaceous, Geophysical Journal of the Royal Society, 40, 383-420, 1975.

Schlanger S. O., and Jackson, E. D., et al. Initial Reports of the Deep Sea Drilling Project, Vol. 33, Washington: U.S. Government Printing Office, 973 pp., 1976.

Weissel, J. K., Hayes, D. E., Herron, E. M., Plate tectonics synthesis: the displacements between Australia, New Zealand, and Antarctica since the Late Cretaceous, Marine Geology, 25, 231-277, 1977.

Figure Captions

Figure 1. Reconstruction of the major plates around the Pacific Ocean at 100 Ma (Cretaceous Quiet Zone).

Figure 2. Reconstruction of the oceanic and continental plates of the South Pacific at the time of Anomaly 25. The Pacific was composed of four plates: the Pacific, the Farallon, the Antarctic,and the Aluk. There were two triple junctions, the Pacific-Antarctic-Aluk and the Pacific-Aluk-Farallon.

Figure 3. Reconstruction of the oceanic and continental plates of the South Pacific at the time of Anomaly 21. The Farallon plate begins to move in a more northerly direction in relation to the Antarctic plate, and the Pacific-Antarctic Ridge jumps to the west, trapping a piece of Pacific-Aluk spreading on the Antarctic plate.

Figure 4. Reconstruction of the oceanic and continental plates of the South Pacific at the time of Anomaly 7. Much of the Aluk plate has been subducted beneath the West Antarctic Penninsula.

Figure 5. Reconstruction of the oceanic and continental plates of the South Pacific at the time of Anomaly 5. The East Pacific Rise has changes orientation from northwesterly to northeasterly, and is also undergoing a ridge jump from the Galapagos Rise to the present-day EPR. The Farallon plate has broken up into the Cocos and Nazca plates, with rifting beginning on the Galapagos rift.

Figure 6. Interpretations of the SEASAT geiod data in the area of the Eltanin Fracture Zone. Circles represent peaks and triangles represent troughs. Dark lines connecting circles or triangles represent interpretations of tectic fabric or fracture zones.

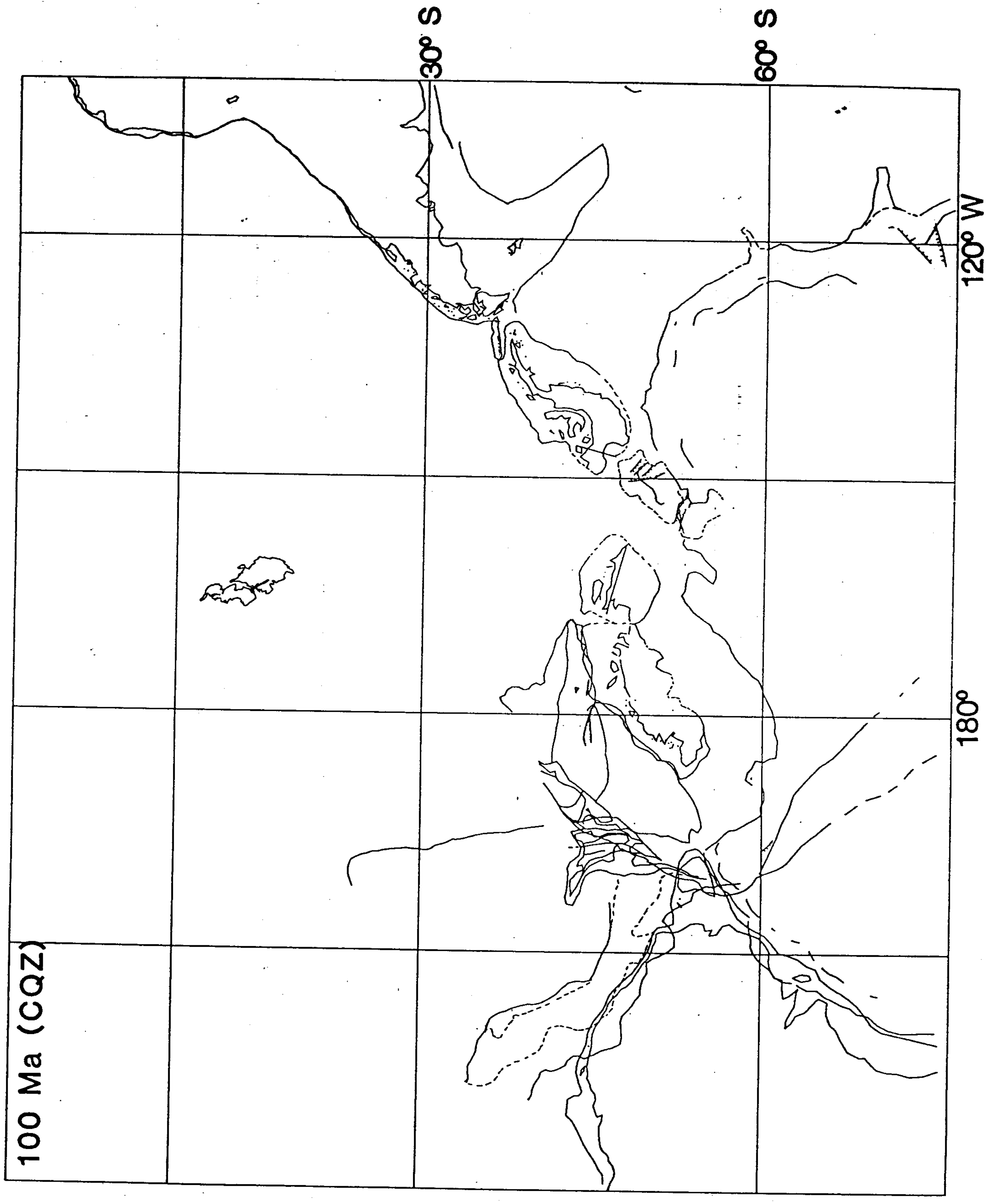


Figure 1

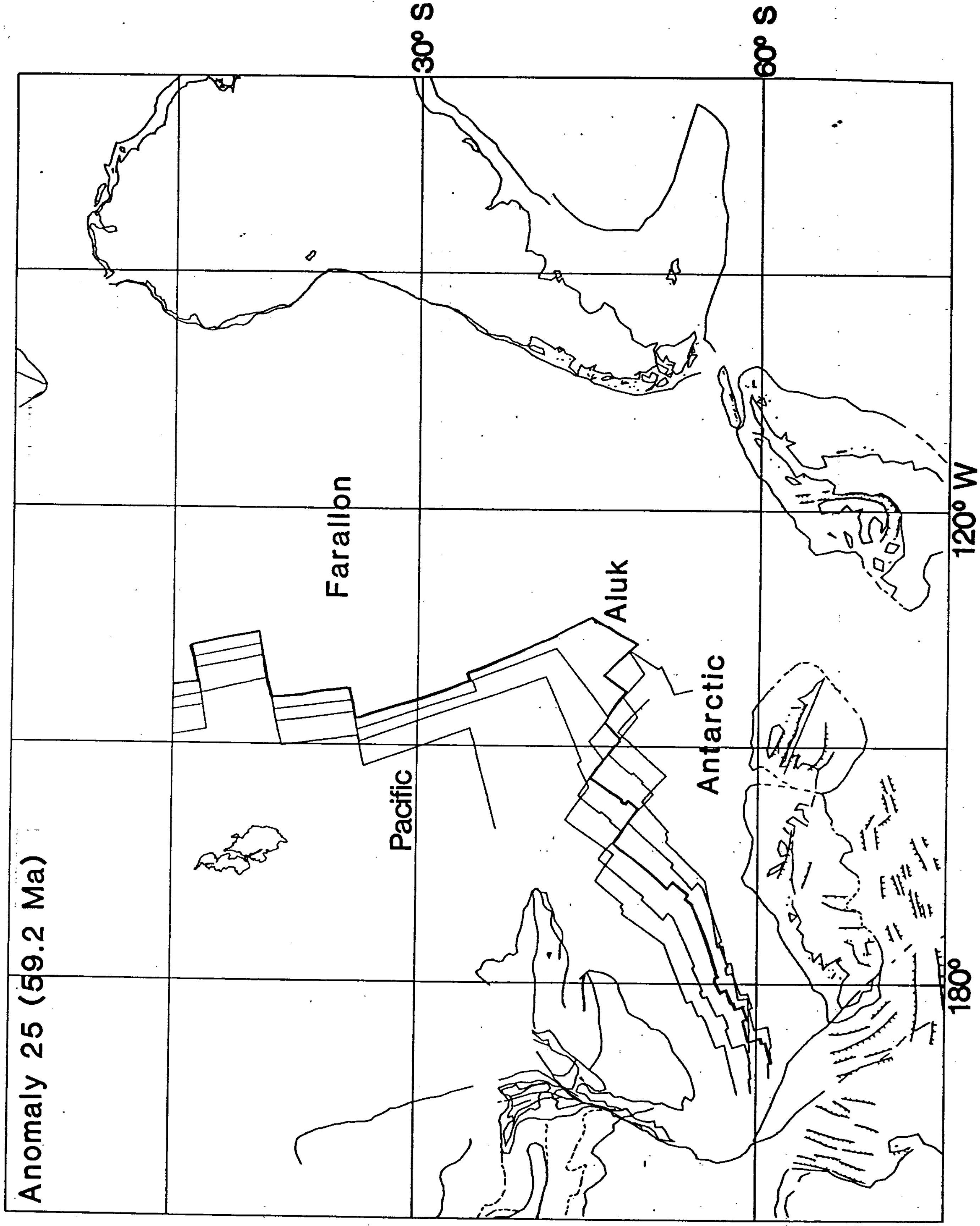
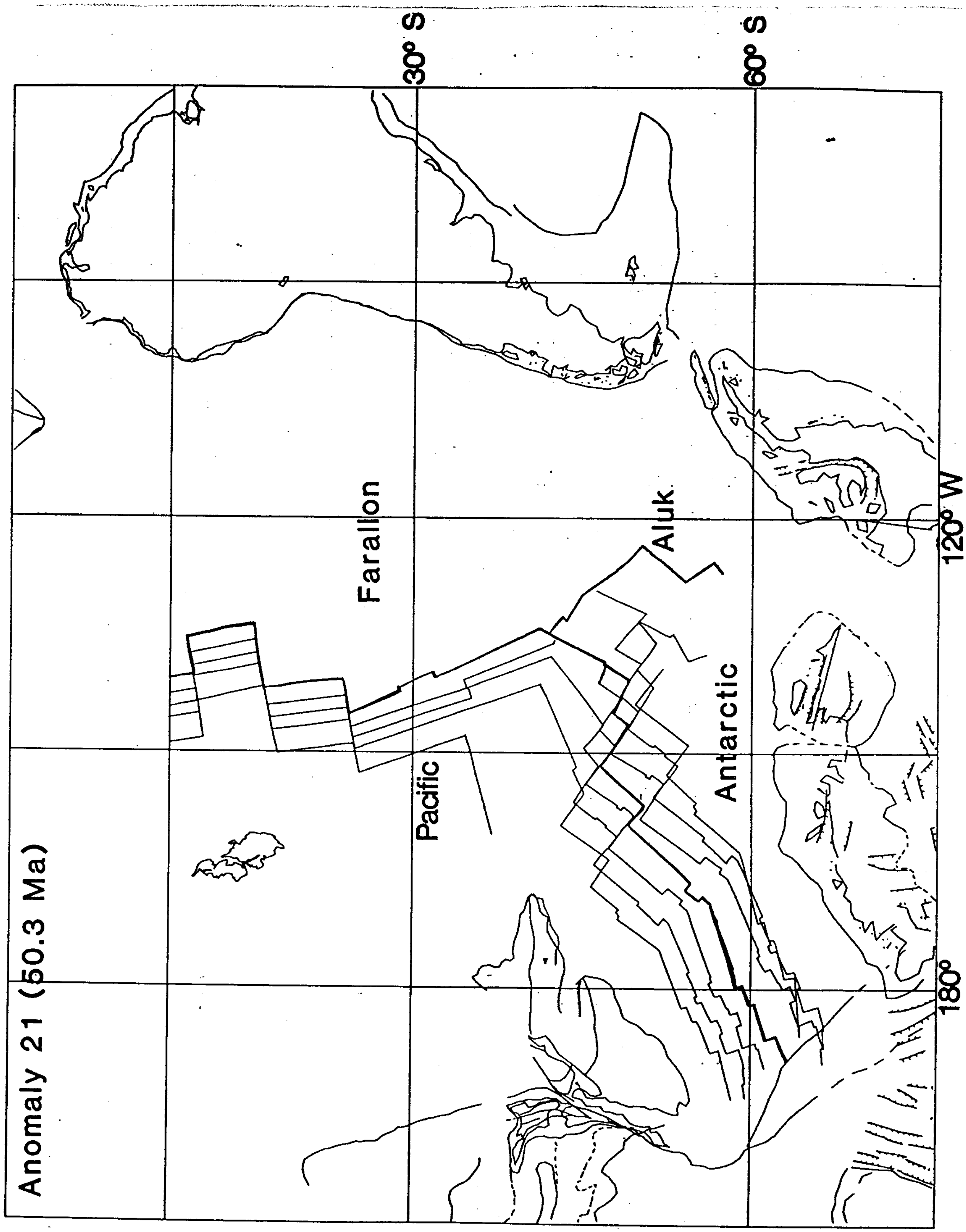

Anomaly 25 (59.2 Ma)
30° S
60° S
120° W
180°
Farallon
Pacific
Aluk
Antarctic

Figure 2



Anomaly 21 (50.3 Ma)
30° S
60° S
120° W
180°
Farallon
Aluk
Pacific
Antarctic

Figure 3

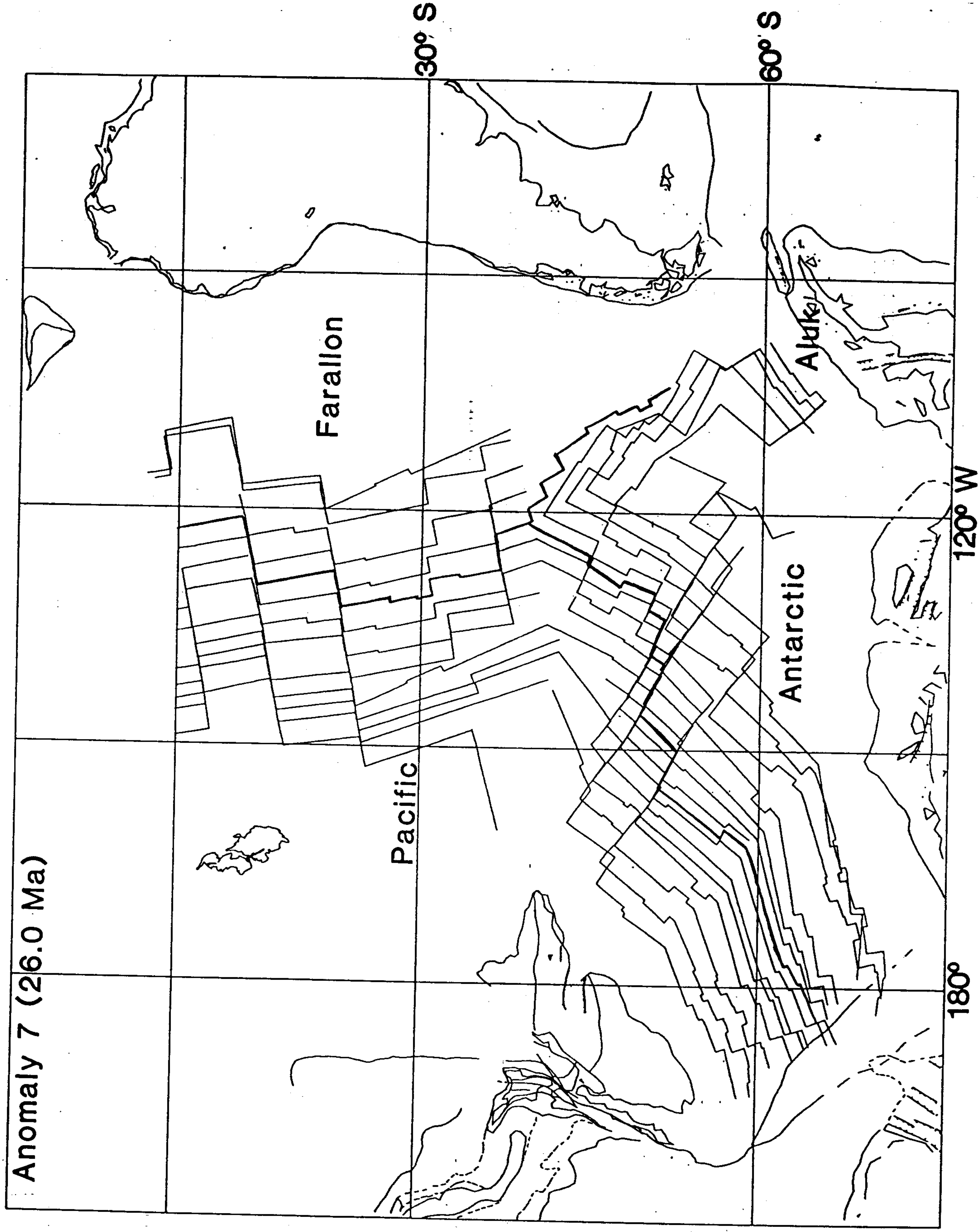

Anomaly 7 (26.0 Ma)
30° S
60° S
120° W
180°
Farallon
Pacific
Antarctic
Aluk

Figure 4

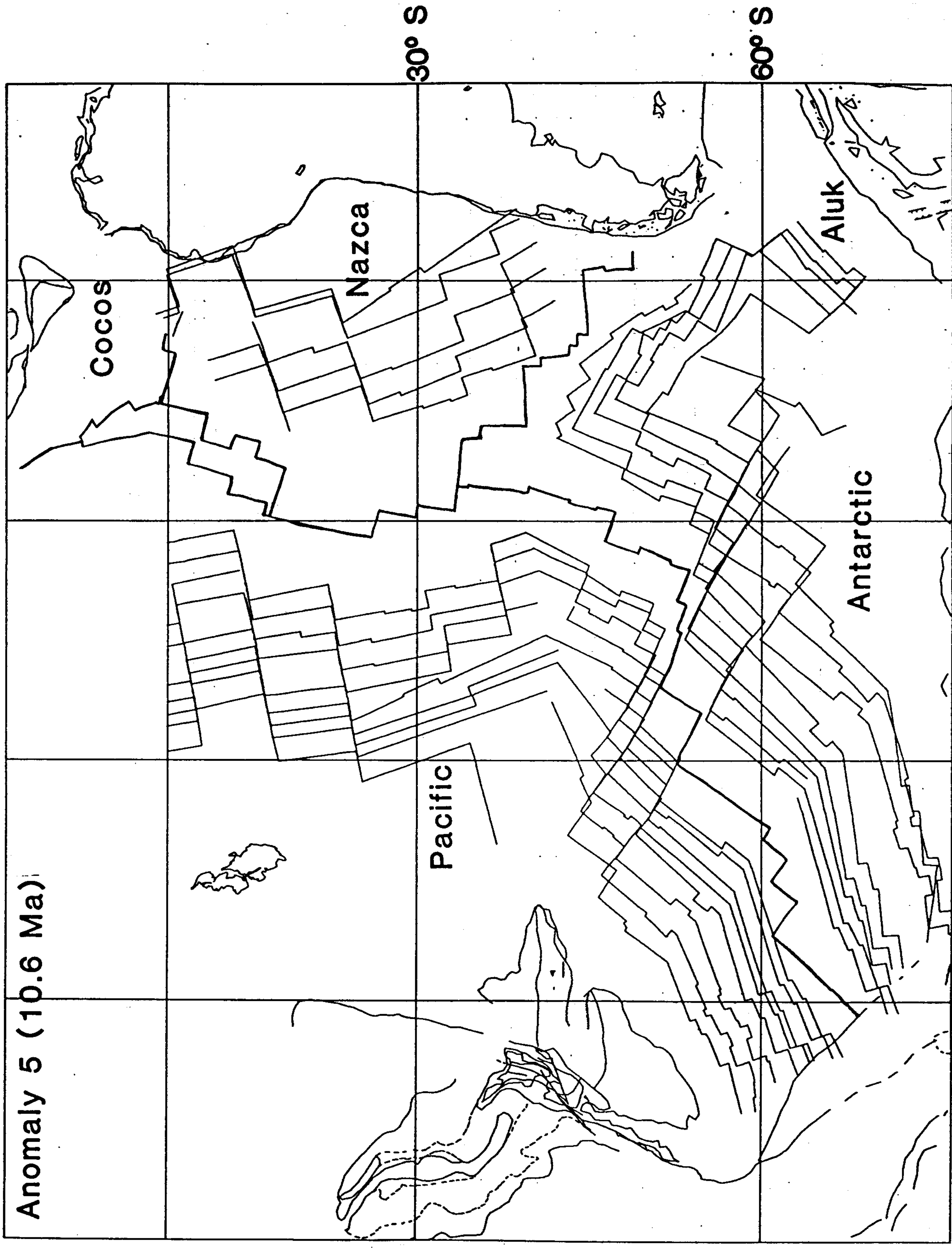

Anomaly 5 (10.6 Ma)
30° S
60° S
Cocos
Nazca
Aluk
Pacific
Antarctic
120° W
180°

Figure 5

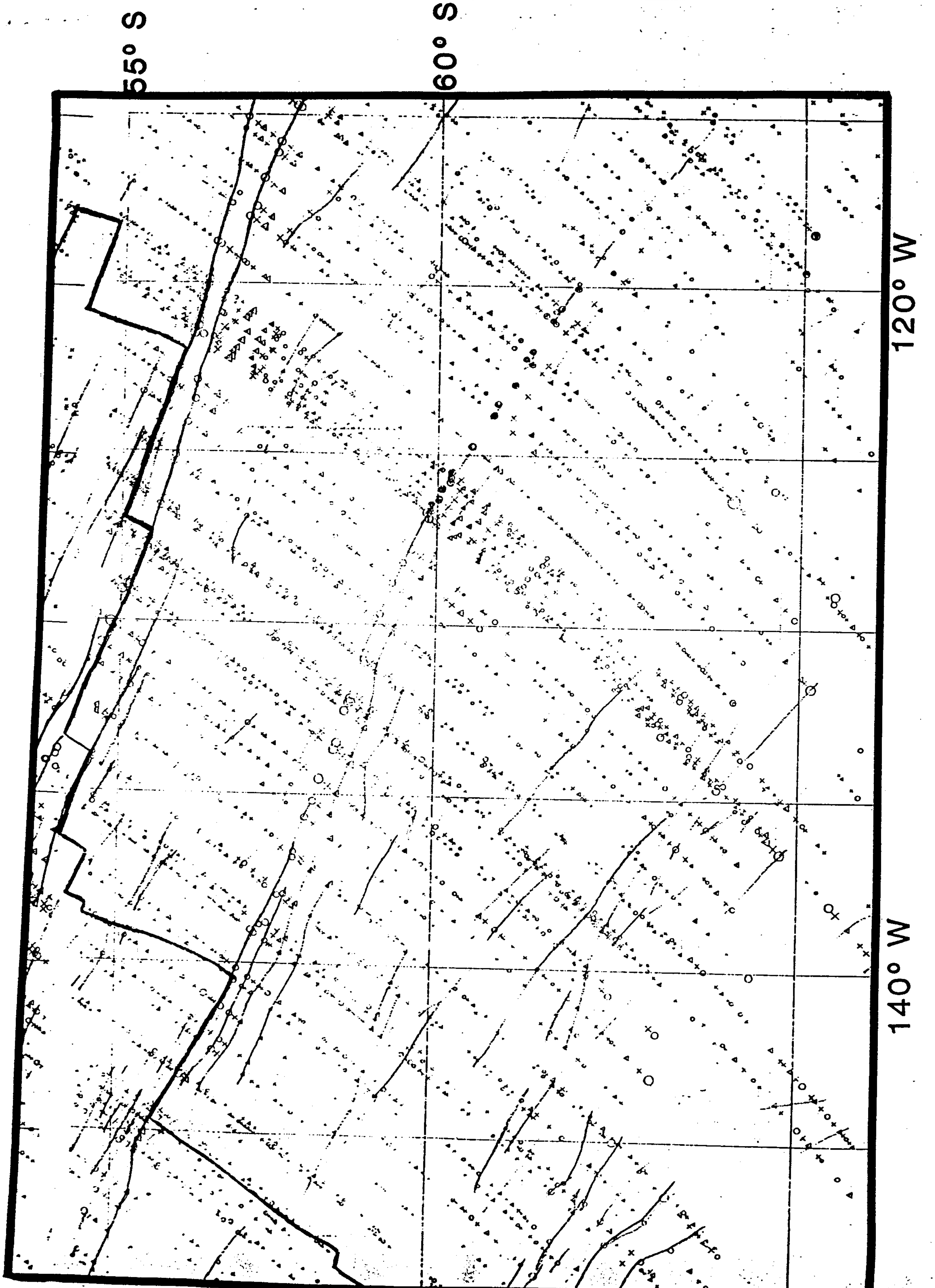


Figure 6