with LCM virus. In this regard, others have reported an association of lymphomatosis and tumor in mice chronically infected with LCM virus (7). In addition to the activation of Gross viral genome, LCM virus infection also potentiates the growth and yield of rabies virus (8) and, under certain circumstances, vesicular stomatitis virus (9). In contrast, LCM virus infectivity is not apparently enhanced by leukemia viral infections. Other experiments in our laboratory have shown that Gross, Moloney, or Rauscher viruses or cells infected by them do not increase LCM virus infectivity or yield of LCM virus produced.

Our results have several important implications. First, the phenotypic expression of the Gross viral genome may be activated by a chronic nononcogenic virus which can be vertically transmitted. This effect results in the production of GSA and occurs both in mice with a high as well as a low incidence of leukemia. Second, in addition to its oncogenic properties, oncorna virus participates in immunologically induced disease by virtue of its interaction with sensitized cells or antibodies (or both) produced by the host. In situations where these viruses are activated or enhanced, as by the LCM virus in our studies, their contribution to immunologic diseases might be expected to increase.

MICHAEL B. A. OLDSTONE TADAO AOKI, FRANK J. DIXON Department of Experimental Pathology, Scripps Clinic and Research Foundation, La Jolla, California 92037, and Division of Immunology, Sloan-Kettering Institute for Cancer Research, New York

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# **Central North Atlantic Plate Motions**

Phillips and Luyendyk (1) have computed a pole of relative motion for the central North Atlantic for the past 40 million years on the basis of a detailed survey of the Atlantis fracture zone. The position of the pole was determined from the azimuth of the fracture zone at various points along the fracture zone by a technique similar to that of Morgan (2). The rate of opening was obtained by identification of anomalies in the vicinity of the fracture zone.

If the theory of plate motions is valid, it should be possible to use the pole obtained by Phillips and Luyendyk to describe other fracture zones at the North American-African plate boundary. Furthermore, if the pole and rate computed by Phillips and Luyendyk are used to rotate westward the positions of anomaly 13 on the east side of the ridge, the rotated anomalies should be

along the lineation corresponding to anomaly 13 on the west side of the ridge. We find that their pole satisfies neither of these criteria. We have compared a small circle generated by their pole with the Kane fracture zone (3) and find that there is a serious discrepancy (Fig. 1) which indicates that the position of the pole is in error. We have also rotated anomaly 13 from the east side of the ridge (4) to the west using their pole and rate of opening and assuming an age of 38 million years for anomaly 13 (5). The rotated lineation is seen to diverge considerably from the western lineation 13.

This divergence also indicates that the position of the pole is in error. The fact that the lineations do not meet at any point means that the half-spreading rate of 1.3 cm/year computed by Phillips and Luyendyk for a latitude



Fig. 1. The location of the Atlantis and Kane fracture zones (stippled areas) in the North Atlantic. The solid black lines are portions of small circles about the pole of rotation at 52.5°N, 34°W deduced by Phillips and Luyendyk. The open triangles give the present positions of anomaly 13. The solid triangles show the points from the east rotated to the west by use of the pole and rate of Phillips and Luyendyk (1).

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of 30°N is also in error. A rate somewhat less than 1.3 cm/year appears to be more nearly correct, although as Phillips and Luyendyk and Talwani et al. (4) point out, the rate has been relatively constant for the past 40 million years.

The error in determining the position of the pole arises principally from the fact that the method used by Phillips and Luyendyk is relatively insensitive in determining the latitude of the pole of rotation (distance of the pole from the fracture zone).

> W. C. PITMAN, III M. TALWANI

Lamont-Doherty Geological Observatory of Columbia University. Palisades, New York 10964

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Pitman and Talwani (1) note that the rotational pole for the African and North American plates deduced by Phillips and Luyendyk (2) from the Atlantis fracture does not provide a small circle that fits the trend of the Kane fracture. We believe this discrepancy may result from (i) uncertainties in the method of determining the pole position from the Atlantis fracture trend information as Pitman and Talwani (1) suggest, (ii) minor nonrigid plate behavior during geologic time, or (iii) the existence of more plates in the central Atlantic than are now recognized.

Although there may well be an error in our graphical determination of a pole position, we do not believe it can account for the observed misfit. For example, we recently developed a more rigorous least-squares computer search method to fit a small circle to a set of points representing the fracture zone trace. This technique provided an improved pole position of 57.9°N and 31.4°W. However, when its probable error cone  $(5^{\circ})$  is considered, it is not significantly different from our previous pole determination of 52.5°N,



Fig. 1. Chart showing the location of the Oceanographer (O), Atlantis (A), and Kane (K) fracture zones (stippled) in the central Atlantic. The curved lines are portions of sets of small circles drawn about the rotational poles: dashed lines, Morgan (3) and Le Pichon (4) at 58°N, 37°W; dotted lines, Bullard et al. (5) at 67.6°N, 14°W; and heavy solid lines, the pole determined in this paper at 57.9°N, 31.4°W. The identifying letters O, A, and K mark the intersection of the ridge crest and respective transform fracture trends.

34°W or the instantaneous poles of Morgan (3) and Le Pichon (4) at 58°N, 37°W. It is significantly different from the average motion pole of Bullard et al. (5) at 67.6°N, 14°W. A comparison of small circles drawn about these poles with known central Atlantic fracture zones is shown in Fig. 1. None of these poles forms a set of small circles that fit all the fracture trends. In fact, it appears that no single pole can be used to match all the trends.

The Atlantis fracture and Kane fracture west of 47°W are best fitted by small circles about our pole at 57.9°N, 31.4°W. The easternmost portion of the Kane and the entire Oceanographer fracture cannot be fitted to our pole or, for that matter, to any other common set of small circles (6). It is also important that a common pole cannot be found for the transform segments of these fractures.

These last observations point to minor nonrigid plate behavior over the 40 million years required to produce these central Atlantic fractures. Indeed, it is remarkable that the plates are so

little distorted, when the interaction of the African and North American plates with adjacent plates is taken into consideration. Plate interactions may generate horizontal stresses which reorient the fracture trends. These horizontal stresses should have caused their rotational pole to migrate through time or may cause additional small plates to be created.

# J. D. PHILLIPS B. P. LUYENDYK

## D. W. Forsyth

Woods Hole Oceanographic Institution, Woods Hole, Massachusetts 02543

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