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THE KANE FRACTURE ZONE IN THE CENTRAL ATLANTIC OCEAN

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The Kane fracture zone has been traced as a distinct topographic trough from the Mid-Atlantic Ridge near 24°N to the 80-m y B P isochron (magnetic anomaly 34) on either side of the ridge axis for a total of approximately 2800 km Major changes in trend of the fracture zone occur at approximately 72 m y B P (anomaly 31 time) and approximately 53–63 m y B P (anomaly 21–25 time) which are the result of major reorientations in spreading directions in the central Atlantic Ocean

The Kane fracture zone offsets the Mid-Atlantic Ridge axis left-laterally by 160 km at latitude 24°N [1–4] and has the largest offset of all the many fracture zones in the Central Atlantic Ocean between 16°N and the Azores Rabinowitz and Purdy [5] have delineated a distinctive trough which is interpreted to be the fossil trace of the Kane fracture zone, from the Mid-Atlantic Ridge approximately 1700 km westward to about the 80-m y B P isochron Major changes in the trends of the fracture zone were shown to exist near 52 5°W (magnetic anomaly 21–25, 53–63 m y B P [6]) and 55 5°W (magnetic anomaly 31, ~72 m y B P [6]) West of these changes in trend the offsets in the magnetic lineations have been shown to be comparable to that of the active portion of the fracture zone at the ridge crest [5] (~160 km)

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If fracture zones are fossil traces of relative plate motion [7,8] then one would infer that major changes in spreading direction occurred at ~53–63 m y B P and 72 m y B P However, with data only on the western limb of the fracture zone, it is equally possible that the change in direction of the trough could have been produced by an ~110-km northward migration of the fracture zone along the ridge axis and not by a change in spreading direction A fracture zone migration would produce a change in orientation of the trough in the same sense (i e "bending" to the south) on both sides of the Mid-Atlantic Ridge A spreading direction change would result in a change of orientation in the opposite sense (i e , "bending" to the north) east of the ridge In this paper we will show that the important changes in trends of the fracture that are observed west of the ridge axis are present at the conjugate location in the east and are observed in the opposite sense

In the spring of 1976, R/V "Knorr" carried out a detailed underway geophysical survey of the Kane fracture zone east of the Mid-Atlantic Ridge The survey was directed toward complementing and extending the previous investigations of Rabinowitz and Purdy [5] The data collected on the R/V "Knorr" cruise, together with previously collected measurements in the area (over 150 crossings with an average separation of ~10 n m , Fig 1) now allow us to identify this deep topographic trough for ~1700 km east of the Mid-Atlantic Ridge axis We show in Fig 2 line drawings of representative seismic reflection profiles at approximate conjugate locations at either side of the ridge crest No obvious patterns in variations of trough width or scarp height are observed In the region of the displaced ridge crest, the trough is continuous, narrow (2–10 km) and steep walled (15–25°) and about 4300 m in depth (e g , profiles 1A and 2A) The inactive portion is characterized by precipitous escarpments and a deep trough exceeding 6000 m in depth near their eastern and western extremities (e g , Fig 2, profiles 4E-6E and 4W-6W) Although the depths to seafloor are about equal in either extension of the fracture zone trough, the sediment thicknesses are generally greater west of the ridge axis

Reliable identification of magnetic lineations near the fracture zone east of the ridge axis has proven difficult West of the Mid-Atlantic Ridge we have been able to trace magnetic anomalies 31 to 34 immediately to the north and south of the fracture zone axis, the left-lateral offset of 160 km on these anomalies is similar to that observed at the ridge crest At this time only magnetic anomaly 34 has been identified south of the fracture zone trough east of the ridge crest (Fig 1)

We have plotted in Fig 3 depth to seafloor and depth to basement (from seismic reflection profiles) against the distance along the fracture zone The age scale assumes constant seafloor spreading from the present to ~80 m y B P (anomaly 34 time) The depth-age curves are overlain, aligned with respect to the northern and southern ridge axes We observe 1–1 5 km deep troughs at the ridge-fracture intersections Away from the active part of the transform on the western side we observe reasonable agreement between the observed and predicted depths between 0 and 50–60 m y B P when the depth-age curve is aligned at the northern ridge axis, reasonable agree-

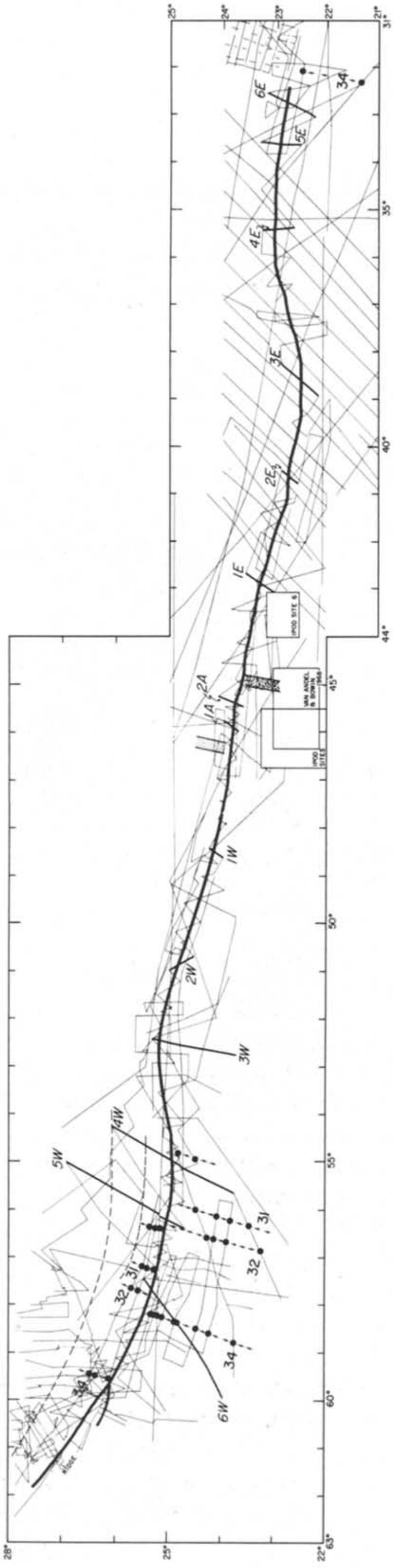

Fig 1 Location of Kane fracture zone Thick black line denotes location of fracture zone trough Dots are recognizable magnetic anomalies Note that the offset on either side of Kane fracture zone trough (~160 km) on western side is similar to offset of present-day ridge crests [5] Profiles 1W to 6W and 1A, 2A and 1E to 6E are given in Fig 2 Location of IPOD and other surveys also given [13–15] Ship tracks are primarily from Woods Hole Oceanographic Institution research vessels "Knorr", Atlantis II" and "CHAIN", Lamont-Doherty Geological Observatory research vessels "Vema" and "Robert D Conrad", and Dutch hydrographic vessel H M Neth S "Snellius"

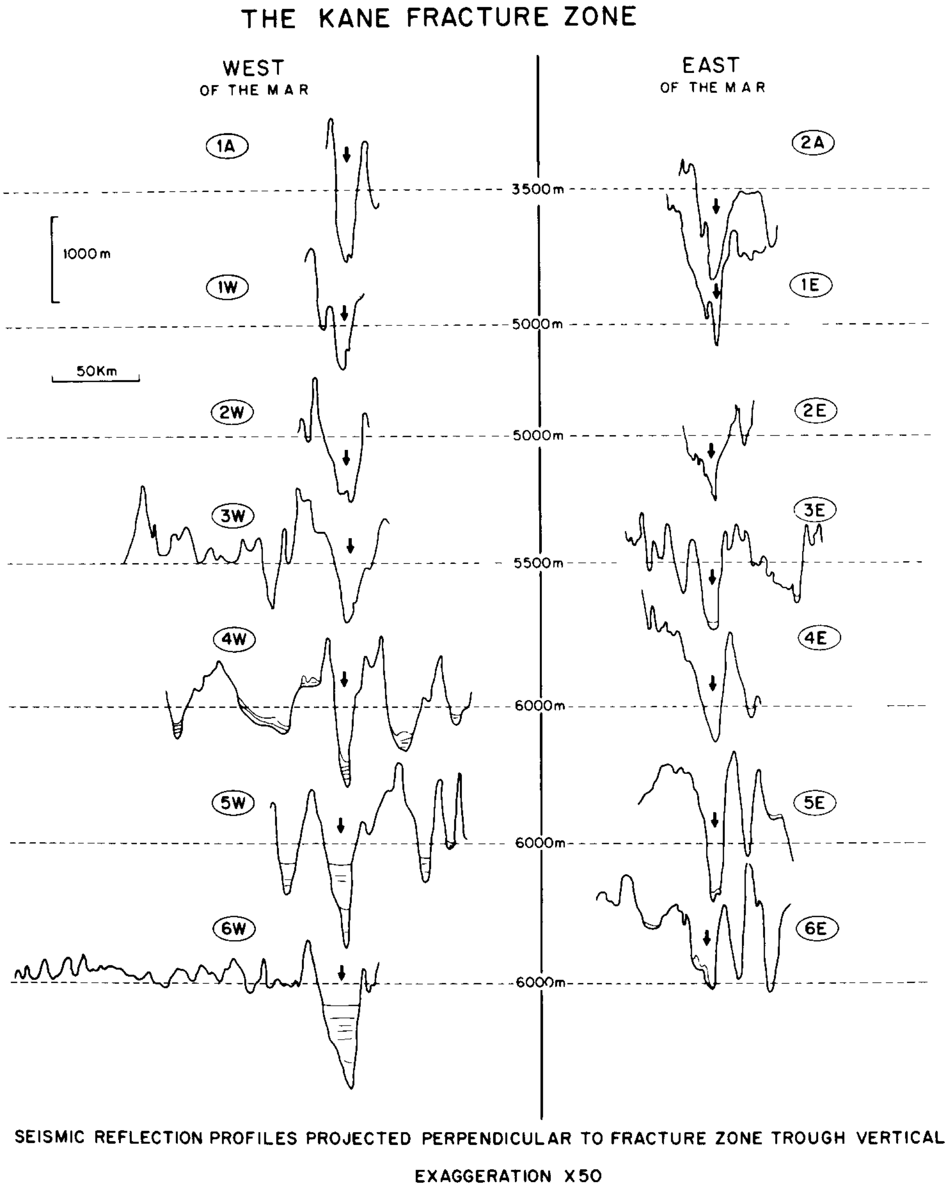

Fig 2 Line drawings of representative seismic profiles across Kane fracture zone at approximate conjugate locations on either side of ridge axis (1W to 6W and 1E to 6E) and at active transform (1A and 2A) Locations in Fig 1 Axis of fracture zone trough given by arrows

ment is also observed for this same time period on the eastern side when the depth-age curve is aligned at the southern ridge axis This suggests that no matter at which ridge crest the crust along the active transform is formed, it does not start cooling in a fashion predicted by the cooling curves until it has moved away from the thermal effects of both ridge axes, i e , even if material comprising the western trough was generated at the southern ridge axis, "normal" cooling would not commence until it has moved past the northern ridge axis The locations at which the agreement between the observed and predicted curves become

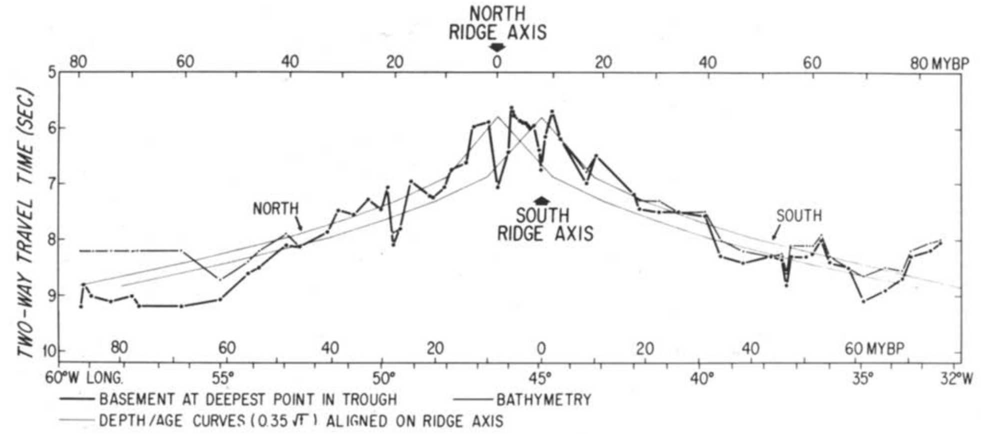

Fig 3 Depth to seafloor and depth to basement plotted against the distance along the Kane fracture zone Theoretical depth-age curves [9] calculated assuming constant spreading rate from 0 to 80 m y B P are shown aligned with both the northern and the southern ridge axes

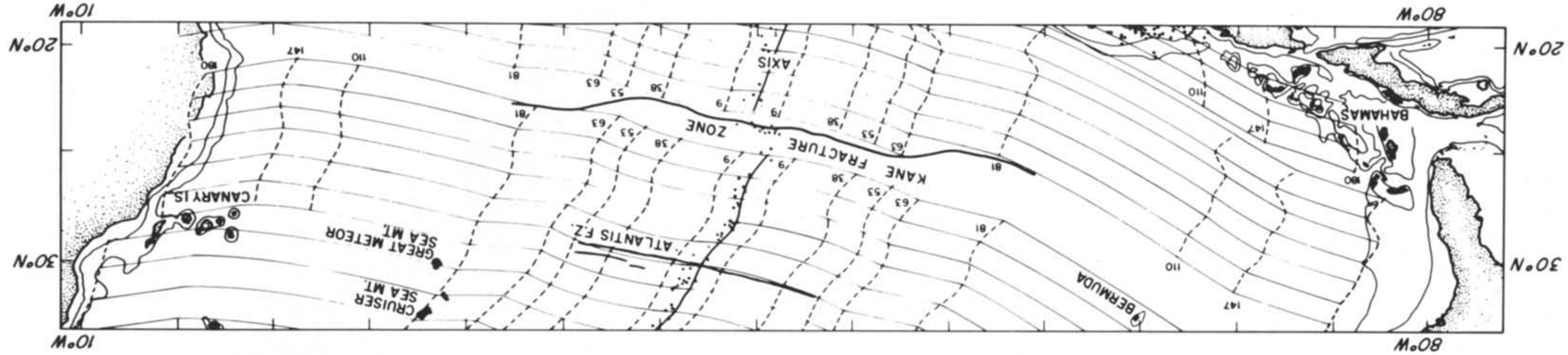

Fig 4 Location of Kane fracture zone superimposed on synthetic flow lines of plate motion [6] Note that the Kane fracture zone parallels synthetic flow lines with exception of region between ~50 and 70 m y B P

poor (55 and 38°W) correspond to the locations of the major changes in trend of the trough

Discussion

We suggest that these changes in trend of the fracture zone that occur at magnetic anomaly 31 time (~72 m y B P) and anomaly 21–25 time (~53–63 m y B P) result from major changes in the spreading geometry of the Central Atlantic Ocean at these times Recent investigations of the Atlantis (J D Phillips, personal communication), Oceanographer [10] and other smaller fracture zones [11,12] in the Central Atlantic Ocean, have also revealed important changes in trends and morphology along their length

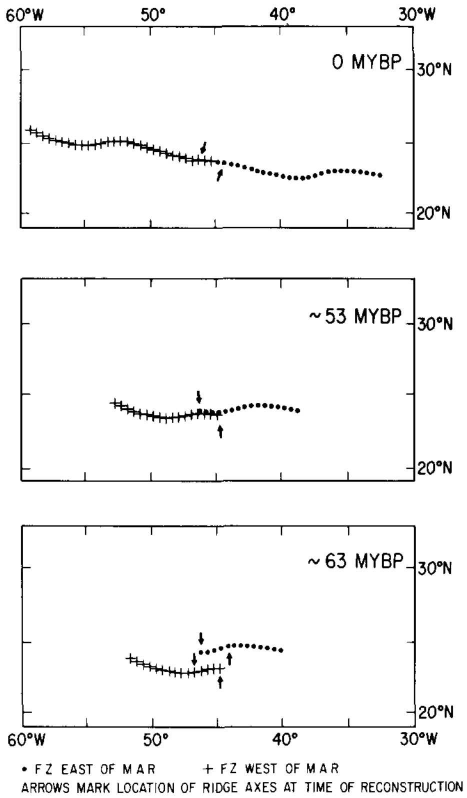

Fig 5 Reconstructions of Kane fracture zone trough to 53 and 63 m y B P The eastern limb (dots) and western limb (crosses) were rotated clockwise and counterclockwise respectively, using the finite poles and rotations of Pitman and Talwani [6] The rotation angle used for each limb was half the total finite rotation

We have plotted the location of the Kane fracture zone trough as described above, on the synthetic flow lines of plate motion given by Pitman and Talwani [6] (Fig 4) With the exception of the sections of the fracture zone between ~52 5 and 55 5°W on the western side and 36 and 39°W on the eastern side, the fracture zone trough closely parallels their flow lines

In Fig 5 we show reconstructions using the finite poles and rotations given by Pitman and Talwani [6] Their anomaly 21 (~53 m y B P) pole gives an excellent correspondence of the two fracture zone segments when they are reconstructed back to that time However, their anomaly 25 (~63 m y B P) pole gives a significant discrepancy when reconstructed

In summary, a distinct topographic trough has been traced for about 2800 km from 80 m y B P west of the ridge axis to its corresponding location east of the ridge crest Major reorientations in the trends of the trough are observed at corresponding locations east and west of the ridge crest at about 50–70 m y B P and most probably result from major reorientations in the spreading directions in the Central Atlantic Ocean

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