Earth and Planetary Science Letters, 96 (1990) 384–392
Elsevier Science Publishers B.V., Amsterdam – Printed in The Netherlands

[DT]

Kinematics of overlapping rift propagation with cyclic rift failure

Douglas S. Wilson

Department of Geological Sciences and Marine Science Institute, University of California, Santa Barbara, CA 93106 (U.S.A.)

Received July 5, 1989; revised version received October 10, 1989

Existing kinematic models for propagation of oceanic spreading ridges that incorporate overlap between ridge segments fail to describe detailed observations of the failed segments. I present a new model which discards the assumption of steady state behavior of the failing rift, permitting inward curvature of both rift tips in the overlap region. The shape of an inward-curving failing rift must continuously change, but is assumed to cyclically return to its original shape by discrete inward ridge jumps. Other assumptions of symmetric spreading and uniform simple shear deformation between the overlapping rift tips are retained from previous models. Inward curvature of failed rift structures provides much better agreement with observations, and is consistent with tensile fracture theory. If the offset between ridge segments is small enough, the inward jumps of the failing rift will cut across deformed structures originally formed at the propagating tip, possibly generating seafloor fabrics that crosscut each other at nearly right angles. Observations of such structures near the Gorda Ridge can be explained by a model incorporating variable cyclicity of the failing rift.

1. Introduction

In the original formulation of the rules of plate tectonics, transform faults were assumed to be fixed relative to each other and the ridge segments they offset. The propagating rift model [1], which discards this assumption, has been very successful in describing oblique offsets in magnetic anomalies as a result of the lengthening of a ridge segment through time at the expense of the adjacent segment. Detailed observations of active propagating rifts suggest that the assumption that ridges are necessarily offset by discrete transform faults should also be discarded, with the segments instead offset by zones of distributed shear with widths of 10 or more km [2,3].

McKenzie [4] has proposed a kinematic model for formation and deformation of isochrons in such a system (Fig. 1). His model assumes uniform simple shear deformation in the shear zone, with associated linear gradients in spreading rate on the bounding rift tips. The parabolic curvature of the rift tips is derived from the assumptions of symmetric spreading and steady state ridge geometry. Several features of this model depart from Hey's [1] original model, which was based on discrete transforms. Along the outer pseudofault, isochrons curve inward toward the ridge, faithfully recording the shape of the propagating tip in an undeformed part of the plate. Isochrons also curve toward the ridge along the inner pseudofault, but

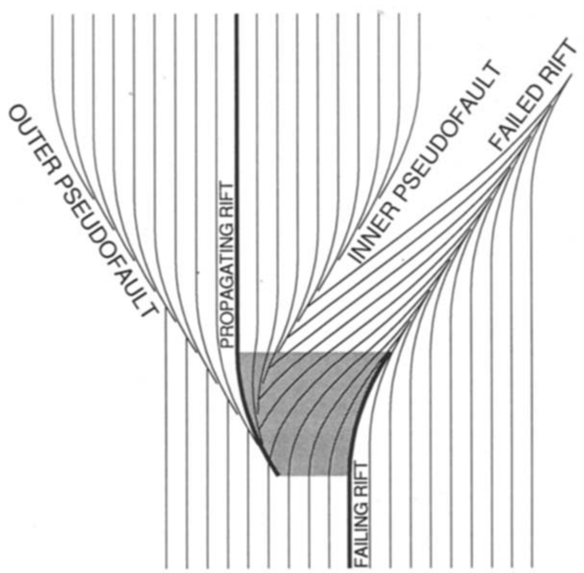

Fig. 1. Kinematic model after McKenzie [4] for steady state overlapping rift propagation. Bold lines denote active rift zones, and shading indicates the active shear zone between the two rift tips. Terminology follows Hey et al. [3].

0012-821X/90/$03.50