

Clay modeling of rift asymmetry and associated structures

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Abstract

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A clay model is used to simulate the development of half-graben of alternating asymmetry in a rift zone. The sense of asymmetry is determined by the spatial arrangement and movement pattern of plates below the clay. The plates can be thought of as analogous to low-angle detachment horizons below rifts. The change in half-graben asymmetry occurs across a "transfer zone" marked by a highly faulted anticlinal saddle whose axis is oblique to the rift trend.

Introduction

Several recent papers have indicated that many rifts may be composed of a series of half-graben of alternating asymmetry along strike linked by structurally complex "accommodation zones" or "transfer zones" (Bally, 1982; Bosworth, 1985, 1986, 1987; Ebinger et al., 1985; Le Fournier et al., 1985; Lister et al., 1986; Rosendahl, 1986; Sander, 1986). It is not clear what produces the asymmetry, but it is thought that low-angle normal faults (detachment faults) play an important role in the process. Courtillot et al., (1974) and Elmohandes (1981) used clay models to investigate the development of structures linking rift segments. These studies dealt with initially offset rift segments, and did not treat the topic of alternating asymmetry along rifts.

Model design

We have used simple clay models to investigate the development of linked half-graben of alternating asymmetry and associated accommodation zones. We are aware of the limitations of using

clay to model geologic structures (Naylor et al., 1986). Ours are not carefully scaled models in terms of material properties and displacement rates. Nevertheless, we feel that even simple clay models are adequate and suitable given our use of them, namely, as heuristic or idea-generating devices to gain insight into the formation of rift-related faults and fracture patterns.

The modeling apparatus consists of four thin (1 mm) plexiglas plates resting on a stationary base with two guide strips along its length (Fig. 1). The four plates can be independently fixed to the base, or moved relative to each other along the length of the frame. Plate surfaces are roughed with 60 grit sandpaper to ensure good adhesion of the overlying clay. A clay cake approximately 4 cm thick is placed on the plates. The clay powder (Amaco No. X-23, American Art Clay Co., Inc., Indianapolis, Indiana, U.S.A.) is mixed with water to make a soft paste with a shear strength of about 10^{-3} MPa (measured with a Torvane CL-600A instrument, Soiltest Co., Evanston, Illinois, U.S.A.).

Asymmetric rifting is produced using the overlapping plate technique of Cloos (1968). When two overlapping plates are slowly pulled apart, a

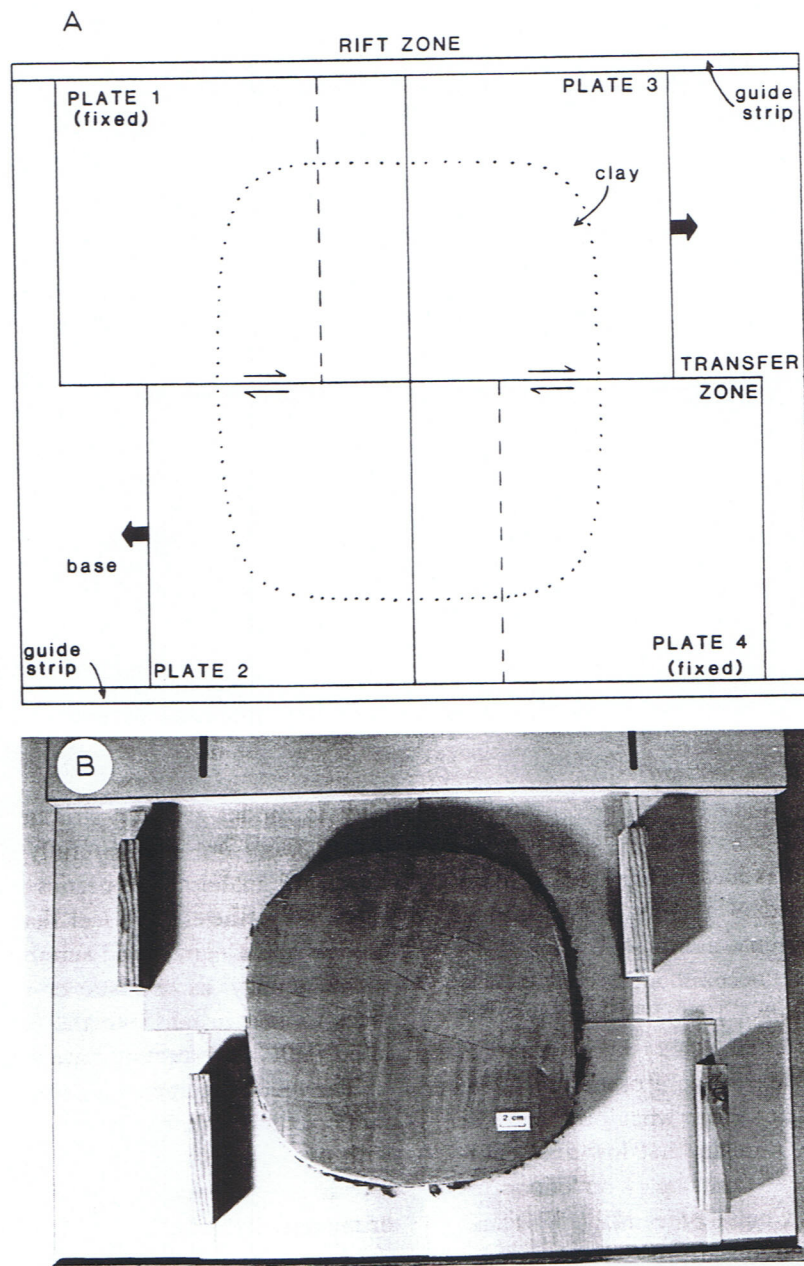


Fig. 1. A. Sketch of the modeling apparatus. B. Starting configuration of the plates, and the overlying, undeformed clay cake.

half-graben is formed in the overlying clay. Cloos (1968) found that asymmetry is not a function of the absolute motion of the plates but, rather, depends on their overlap relationship. The half-graben is always formed and carried on the lower of the two plates, and the deeper part of the graben is always on the side near the top plate. Stated another way, a half-graben is formed when

new substrate plate surface is created beneath the clay cake, as in a conveyor belt, when the lower plate slides out from under the upper plate. Half-graben dip is toward the line of new plate contact. This result is achieved irrespective of whether both plates are moved, or whether the lower plate is fixed and the top plate moved, or vice versa. Several models were run to confirm these results.