INTERNATIONAL EXPLORATIONISTS

HGS INTERNATIONAL GROUP DINNER MEETING—NOVEMBER 18, 1991

L. A. STANDLEE—Biographical Sketch

Larry A. Standlee is currently a Senior Research Geologist with Conoco Exploration Research and Services, Ponca City, Oklahoma. He received his B.S. in geology in 1973 from the University of Texas at Arlington; his M.A. in geology from Rice University in 1976 and his Ph.D. in geology, also from Rice, in 1978. Prior to joining Conoco in 1985, he was an exploration geologist for Chevron U.S.A. in Denver and an Assistant Professor of Geology at the University of Tulsa.

He has experience in field-based structural and stratigraphic studies in the Sierra Nevada Mountains (northern California), the eastern Basin and Range (Nevada/Utah), and the Colorado Plateau/Basin and Range transition zone in central Utah. His recent work involves regional structural/tectonic studies of northern Alaska, Barents Sea, North Sea, West Texas, and equatorial West Africa. His current research interests are the dynamics, kinematics, and thermal evolution of continental rifting, 3-D geometry of extensional fault systems, and salt tectonics.

CONTROLLING FACTORS IN THE INITIATION OF THE SOUTH ATLANTIC RIFT SYSTEM

Several models for the initiation and early history of the South Atlantic rift have been proposed recently. These models are variants of the asymmetric, low-angle detachment model originally derived from the Basin and Range (western USA) and applied to many continental rifts and passive margins. Although this concept can account for some of the general features of the South Atlantic margins, here we propose a new model, based on principles of fracture mechanics and lithospheric dynamics, that gives a more elegant explanation for the geologic complexity and compound form of the entire rift system from Angola to Nigeria

We recognize three dominant controlling factors in the development of the South Atlantic rift. These are (1) basement anisotropy, with the overall rift closely following the east side of the Pan African/Brasilianos orogen; (2) formation of two triple junctions above hot spots, initiating the breakup of Gondwana; and (3) linkage of the triple junctions by propagating megafractures, with the level of structural complexity directly reflecting the degree of megafracture interaction. Late Jurassic/Early Cretaceous extensional fault systems are strongly influenced by the trend and geometry of the Proterozoic basement. They generally follow southwest-dipping planes of weakness seen on many seismic lines along the West African margin. Moreover, the depth at which extensional faults sole out, and the length of individual fault segments are directly related to major culminations and depressions in the basement. The former regions became inter-basinal highs, whereas the latter evolved into the Kwanza, Congo, and Gabon Basins. Variations in fault geometry along strike are therefore not the result of reversals in dip direction, as recently described from the East African rift, but simply reflections of older basement anisotropy and asymmetry.

Although the overall South Atlantic rift opened from south to north, the initial breaks occurred over two hot spots, the Benue triple junction and the Walvis hot spot. Late Jurassic/Early Cretaceous doming, erosion and volcanism were associated with both regions, although more prominent to the south. These were points of "active" rifting over mantle plumes. Subsequent collapse of these regions of thinned crust resulted in thick sediment accumulations. Megafractures radiated away from both hot spots, eventually linking in the vicinity of northwest Gabon/northeast Brazil.

Many of the structural complexities of this region are accounted for by the propagating megafracture model. The essence of this model is that, as two fractures approach each other head-on, their local stress fields will interact and affect the geometry of the evolving fault patterns. Consequences of this interaction are the following: (1) the earliest crustal extension is distributed over a wide region, as the propagating megafractures diverge from each other. This stage is represented by the Reconcavo/Tucano/Jatoba system in Brazil and the Interior Basin/N'Komi system in Gabon; (2) exterior rift basins are quickly abandoned as active extension steps inward to focus along the line of eventual continental separation. Only minor extension and thermal subsidence are associated with the exterior basins. They are not laterally connected (via low-angle detachments) to adjacent basins, but instead predate them; (3) rifting is "passive" in regions of propagating megafracture interactions, hence overall subsidence prevails during initial rifting activity. Pre-rift sediments were thereby preserved only in these areas, and, if originally present along strike of the rift, were completely eroded away. Once a throughgoing rift was established, South America and Africa began to move apart. As extension increased, the style of faulting changed markedly. Early, curvilinear half-grabens were crosscut by an orthogonal set of normal faults and transfer faults, a geometry similar to that found in oceanic crust.