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HEAT AND EXTENSION AT MID- AND LOWER CRUSTAL LEVELS OF THE RIO GRANDE RIFT; Kenneth H. Olsen and W. Scott Baldridge, Los Alamos National Laboratory; Jonathan F. Callender, New Mexico Museum of Natural History.

The process by which large amounts (50-200 percent) of crustal extension are produced was concisely described by W. Hamilton (1,2) in 1982 and 1983. More recently, England (3), Sawyer (4), P. Morgan and coworkers (5,6), and others have moved toward quantifying models of lithospheric thinning by incorporating laboratory and theoretical data on rock rheology as a function of composition, temperature, and strain rate. Hamilton's description identifies three main crustal layers, each with a distinctive mechanical behavior: brittle fracturing and rotation in the upper crust, discontinuous ductile flow in the middle crust and laminar ductile flow in the lower crust. The temperature and composition dependent brittle-ductile transition essentially defines the diffuse "boundary" between upper and middle crust.

Perhaps the most distinctive feature of this extensional model is the lenticular, transposed nature of the middle crust—with lenses of more competent rocks ("megaboudins") interspersed with less competent material along ductile shear zones. These are closely akin to the metamorphic core complexes exposed by erosion in western North America. We have recently reviewed geophysical and petrologic data (7,8) on the Rio Grande rift and have attempted to formulate a broad interdisciplinary "picture" of the nature of the crust, tectonic development, and volcanism in the rift. One of our principal conclusions is that, within the rift, the structure of the middle crust is very probably lensoidal and horizontally stratified and the contact between the middle and upper crust is probably characterized by a low-angle detachment surface—all in accordance with Hamilton's generalized model. This type of crustal environment would very likely yield magma "pillows" and stratiform, sill-like intrusions in the middle crust, such as the Socorro magma body.

Perhaps somewhat surprisingly, our analysis also leads us to conclude that the heat responsible for the highly ductile nature of the lower crust and the lensoidal and magma body structures at mid-crustal depths in the rift was infused into the crust by relatively modest (< 10 percent by mass) magmatic upwelling (feeder dikes?) from Moho levels. Seismic velocity-versus-depth data, supported by gravity modeling and the fact that volumes of rift related volcanics are relatively modest (< 6000 km^3) for the Rio Grande system, all imply velocities and densities too small to be consistent with a massive, composite, mafic intrusion in the lower crust.

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