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Tectonics of the Jemez Lineament in the Jemez Mountains and Rio Grande Rift

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The Jemez lineament is a NE trending crustal flaw that controlled volcanism and tectonism in the Jemez Mountains and the Rio Grande rift zone. The fault system associated with the lineament in the rift zone includes, from west to east, the Jemez fault zone southwest of the Valles-Toledo caldera complex, a series of NE trending faults on the resurgent dome in the Valles caldera, a structural discontinuity with a high fracture intensity in the NE Jemez Mountains, and the Embudo fault zone in the Española Basin. The active western boundary faulting of the Española Basin may have been restricted to the south side of the lineament since the mid-Miocene. The faulting apparently began on the Sierrita fault on the east side of the Nacimiento Mountains in the late Oligocene and stepped eastward in the early Miocene to the Cañada de Cochiti fault zone. At the end of the Miocene (about 5 Ma) the active boundary faulting again stepped eastward to the Pajarito fault zone on the east side of the Jemez Mountains. The north end of the Pajarito fault terminates against the Jemez lineament at a point where it changes from a structural discontinuity (zone of high fracture intensity) on the west to the Embudo fault zone on the east. Major transcurrent movement occurred on the Embudo fault zone during the Pliocene and has continued at a much slower rate since then. The relative sense of displacement changes from right slip on the western part of the fault zone to left slip on the east. The kinematics of this faulting probably reflect the combined effects of faster spreading in the Española Basin than the area north of the lineament (Abiquiu embayment and San Luis Basin), the right step in the rift that juxtaposes the San Luis Basin against the Picuris Mountains, and counterclockwise rotation of various crustal blocks within the rift zone. No strike-slip displacements have occurred on the lineament in the central and eastern Jemez Mountains since at least the mid-Miocene, although movements on the still active Jemez fault zone, in the western Jemez Mountains, may have a significant strike-slip component. Basaltic volcanism was occurring in the Jemez Mountains at four discrete vent areas on the lineament between about 15 Ma and 10 Ma and possibly as late as 7 Ma, indicating that it was being extended during that time.

Introduction

The mid-Miocene to Quaternary Jemez volcanic field is located on the western margin of the Rio Grande rift where it is intersected by the Jemez lineament. Although the tectonics of the rift are at least moderately well known, much less is known about the tectonics of the Jemez lineament, particularly within the Jemez Mountains. West of the Jemez Mountains on the Colorado Plateau the Jemez lineament trends N52°E, is 50 km wide, and is characterized by NNE trending faults [*Aldrich and Laughlin*, 1984]. This fault pattern extends eastward to the Nacimiento uplift on the west edge of the volcanic field (Figure 1). Within the Jemez Mountains the faults associated with the lineament trend northeast to east-northeast, but their structure is poorly understood. In the Rio Grande rift to the east of the Jemez Mountains the Embudo fault zone, a transform fault that "lies astride" the Jemez lineament transfers the major displacement from the Taos fault on the eastern side of the San Luis Basin to the Pajarito fault zone (Los Alamos fault [*Kelley*, 1978]) on the western side of the Española Basin [*Muehlberger*, 1979, p. 77].

In this paper the geometry and tectonic history of the Jemez lineament within the Rio Grande rift and Jemez Mountains are discussed. Results of an ongoing study of the NE trending Embudo fault zone (Jemez lineament) in the northeastern Jemez Mountains-northwestern Española Basin, which provide new data and constraints on the local development of the lineament, are presented. This fault zone was first recognized and mapped by *Kelley* [1978]. Recently, *Dethier and Manley* [1985] have more accurately delineated it. The fault zone, called the Santa Clara fault zone by *Harrington and Aldrich* [1984], is on strike with the Embudo fault zone which *Muehlberger* [1979, p. 80] indicated has a mappable trace between Pilar and Arroyo Hondo but is only a linear groove in landslides for a few kilometers southwest of Pilar (Figure 1). Because this fault zone is undoubtedly the westward continuation of the Embudo fault zone [cf. *Muehlberger*, 1979], I refer to it as such in this paper.

Stratigraphy

A generalized stratigraphic column presented in Figure 2 shows the approximate age and relationships of the key units in the northeastern Jemez Mountains-northwestern Española Basin. Sedimentary rocks of the Santa Fe Group in the northwestern Española Basin have been divided by *Manley* [1979] and *Dethier and Martin* [1984] into the Tesuque and Chamita formations. The Tesuque Formation is further subdivided into the Chama-El Rito and Ojo Caliente members. According to *Dethier and Martin* [1984] the Chama-El Rito Member is a middle Miocene (about 17–13 Ma old) fluvial sandstone; it grades upward into the younger Ojo Caliente Sandstone (about 13–10.5 Ma old). The Chamita Formation, which overlies the Ojo Caliente sandstone, consists primarily of sandstone and silty sand and is late Miocene–early Pliocene in age. Paleomagnetic data indicate the uppermost Chamita beds are about 4.5 Ma old [*MacFadden*, 1977].

Previously, volcanic activity in the Jemez Mountains was thought to have spanned the time period from about 10 Ma to 0.1 Ma [e.g., *Bailey et al.*, 1969; *Luedke and Smith*, 1978]; however, recent work shows volcanism began much earlier. *Gardner and Goff* [1984] report an average data of 13.2 ± 1.24 Ma on a basalt which overlies the Canovas Canyon Tuff in the southern Jemez Mountains and suggest mantle-derived basaltic volcanism began at > 13 Ma. An even older data has

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