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A PRELIMINARY NOTE ON SOME UNUSUAL EXPLOSION-COLLAPSE CRATERS, QUEMADO BASALT FIELD, CATRON COUNTY, NEW MEXICO

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Abstract—A series of unusual volcanic craters which show the results of explosion followed by collapse have been identified at the northern end of the late Cenozoic Quemado basalt field. The basalt field is part of the Jemez lineament that strikes northeastelry across southern Arizona into northern New Mexico. Abundant in the field are cinder and spatter cones and lava flows of olivine basalt.

INTRODUCTION AND LOCATION

The Quemado or Red Hill volcanic field is located in west-central New Mexico, approximately 125 km south of Gallup or 45 km west of Quemado on U.S. Highway 60 in the northwestern portion of Catron County. The field consists of late Cenozoic basalt flows and craters that crop out over an area of approximately 515 km^2 between longitude 108°30′ to 109°03′ and latitude 33°30′ to 34°30′ (Fig. 1). The area is included within the reconnaissance geologic maps of the Canyon Largo and Reserve quadrangles (Weber and Willard, 1958; Willard and Weber, 1959).

Perry et al. (1987) and Laughlin et al. (1982) refer to the volcanic field as Red Hill, whereas Smith and Luedke (1984) use the term Quemado. Because at the present time Red Hill is represented by only a single road sign and Quemado is a permanent village, the term Quemado is recommended for usage.

GEOLOGIC SETTING

The Quemado basalts occur along the Jemez lineament, defined by Mayo (1958) as the northeast alignment of volcanic fields from southeastern Arizona (San Carlos) to northeastern New Mexico (Raton-Clayton); the lineament strikes approximately N52°E (Laughlin et al., 1982). The Jemez volcanic zone has been described as the most spectacular phenomenon of its kind in the United States and is referred to as the zone of greatest volcanic potential in the Southwest (Smith and Luedke, 1984). The volcanic activity along this trend initiated about 12 my ago (Springerville), and the youngest activity is dated at less than 10,000 years (Zuni-Bandera) (Smith and Luedke, 1984). The origin of the Jemez lineament may be the result of a Precambrian suture or a more modern stress field, or even a combination of both (Lipman and Mehnert, 1979; Ander, 1980; Chapin and Cather, 1981; Laughlin et al., 1981; Smith and Luedke, 1984; Aldrich and Laughlin, 1984). Perry et al. (1987) suggested that the Jemez lineament marks the boundary of the Colorado Plateau interior and a transition zone between the plateau and the Rio Grande rift to the east, and the Basin and Range to the south. Aldrich and Laughlin (1981, 1984) have postulated that the lineament represents the present tectonic boundary between the Colorado Plateau and the Basin and Range.

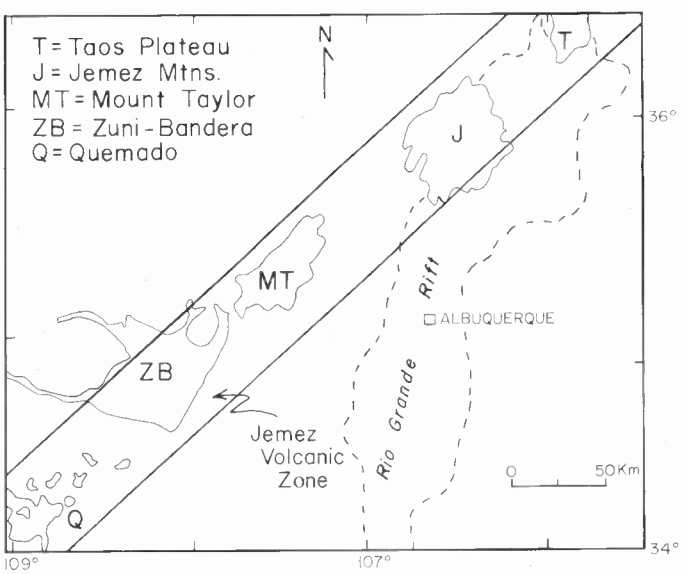

FIGURE 1. Index map showing the location of the Jemez lineament and the Quemado basalt field (after Baldridge et al., 1983).

In New Mexico the late Cenozoic volcanic fields along the Jemez lineament consist of the Taos plateau, Jemez Mountains, Mount Taylor, Zuni-Bandera and Quemado (Fig. 1). Presently only the Quemado volcanic field lacks information to characterize the morphology, petrology and age of the basaltic rocks.

VOLCANIC FEATURES

At present, only the northern portion of the volcanic field has been investigated; this includes observations in secs. 8, 9, 15 and 16 of T1S, R19W (Fig. 2). Within this area occur basaltic lava flows, cinder cones, cinder-spatter cones and several explosion-collapse craters.

Volcanic craters

The largest and most spectacular crater in the volcanic field is Quemado crater which occurs just south of U.S. 60 in secs. 15 and 16 (Fig. 2). The crater has a diameter of approximately 1170 m and a depth of nearly 33 m below the surrounding terrain. It has a raised rim, composed of volcanic cinder, which almost completely encircles the crater. The height of the rim ranges from approximately 7 m on the western side to over 47 m on the northeastern side of the crater. A cinder cone and five small cinder-spatter cones occur on the floor of the crater. The cinder cone is approximately 330 m in diameter and 53 m in height and merges into the rim deposits on the eastern side of the crater. The much smaller cinder-spatter cones, with diameters of 50 to 100 m and 8 to 17 m height, display a basalt vent breccia of agglutinated spatter, cinder and bomb fragments. Occasionally, small highly vesicular tongues of lava occur on their flanks. Large volcanic bombs are locally abundant on the cinder-spatter cones, with several measuring 3 m in length and 2 m wide. On the western rim of Quemado crater, a basalt flow crops out and dips to the north where it is buried under the volcanic cinder. At the southwestern corner of the crater this flow is faulted and dips to the east under the cinder rim. Because the basalt flow is covered by the volcanic cinder, the cinder accumulated after the emplacement of the lava flow and is therefore younger than the basalt.

The proposed sequence of events in the formation of Quemado crater, from oldest to youngest, are as follows: (1) emplacement of basaltic lava flows, (2) a period of faulting in which several of the flows were displaced, (3) explosive volcanism producing large quantities of volcanic ejecta and building of the large cinder cone completely covering the present crater site, (4) collapse under the cinder cone producing the present depression and (5) renewed volcanic activity forming cinder and cinder-spatter cones on the floor of the crater (Fig. 3).

To the north of Quemado crater in secs. 8 and 9 occur a cluster of four small cinder-spatter cones and a large cinder cone (Fig. 2). The cones occur in a shallow depression which is bounded on the west by

a fault scarp and on the east by a rim of volcanic cinder representing a portion of an older cinder cone. The rim deposits reach a maximum height of approximately 37 m above the floor of the central depression. Although the relationships between the volcanic cones are not as clear as at Quemado crater, it is thought that these features were produced by a similar sequence of initial volcanic explosion, collapse and then final cone–building volcanism (Fig. 3).

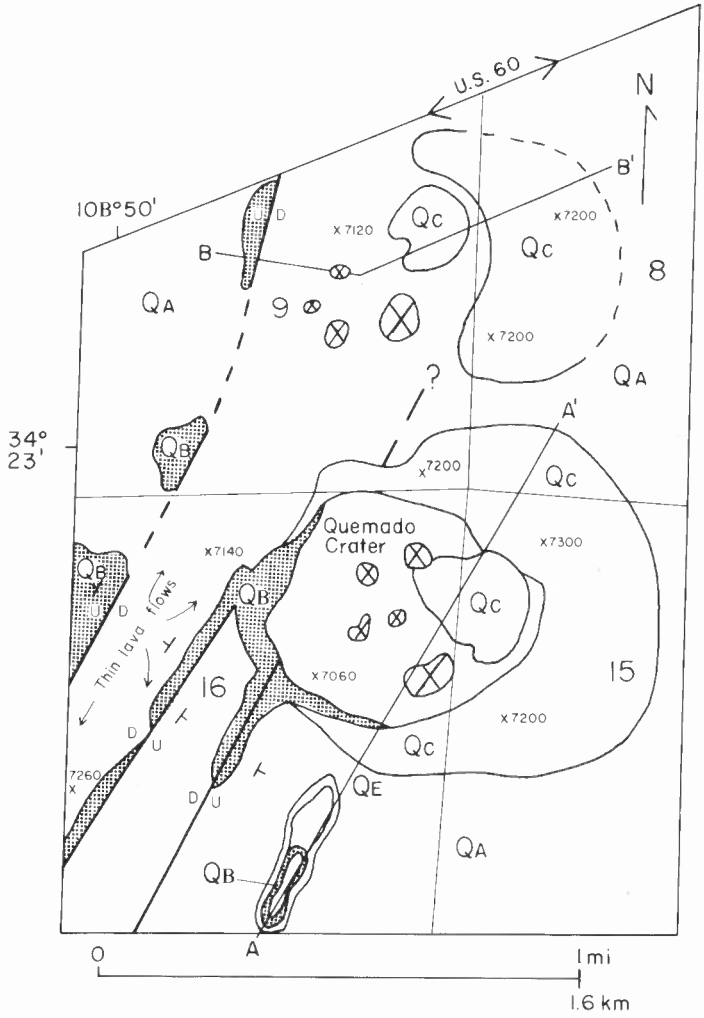

FIGURE 2. Geologic map of the northern part of the Quemado basalt field (QA = Quaternary alluvium; QC = Quaternary cinder; QB = Quaternary basalt; QE = Quaternary basalt ejecta blocks; TQg = Tertiary-Quaternary, Gila Conglomerate; X = spatter cone; ×7260 = elevation, in feet; 9 = section number; A–A′ and B–B′ = cross sections).

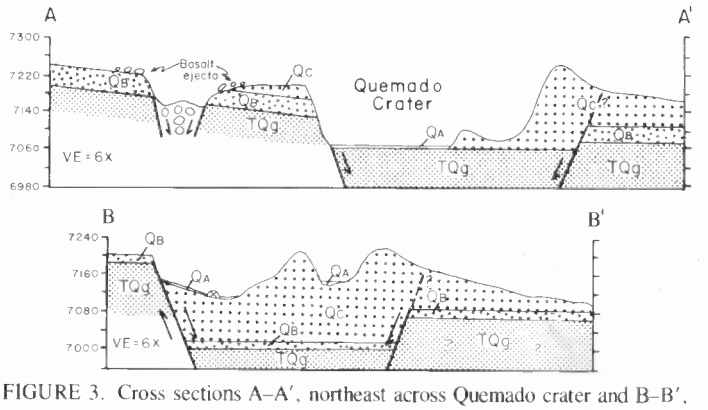

FIGURE 3. Cross sections A–A′, northeast across Quemado crater and B–B′, east across secs. 8 and 9 (for explanation of symbols see Figure 2).

Just south of Quemado crater, in sec. 16, occurs a small elongate depression approximately 200 m in length with a width of about 67 m and a depth of around 22 m. The elongation of the crater is parallel to the strike of the adjacent faults. In the walls of the depression, basaltic flow(s) are exposed. Blocks of dense basaltic flow rock completely encircle the crater with the size of the fragments decreasing outward from the rim of the crater. The origin of this feature is probably a shallow gas explosion which fragmented the overlying basalt and produced the present rim of coarse ejecta. This event was followed by collapse in which the majority of fragmented material subsided into the crater. A crater of similar origin has been described from the Potrillo basalt field in south–central New Mexico (Hoffer, 1987).

Lava flows

A preliminary reconnaissance of the area indicates that the basaltic lava flows were emplaced by both fissure and central eruptions. The flows are of olivine basalt and range in thickness from 2 to 8 m. The basalts of the Quemado field overlie the Gila Conglomerate, a Tertiary-Quaternary formation, composed of well-rounded cobble–, pebble– and sand–sized fragments of both sedimentary and volcanic rocks. Approximately 12 km south of Quemado crater, the olivine basalt flows are underlain by an older basalt unit in which much of the olivine has been converted to iddingsite. This lower unit is thought to be Tertiary in age (Willard and Weber, 1958). No radiometric age dates have been published on the olivine basalts, but Perry et al. (1987) indicate an age of less than 5 my. Petrographically, the basalts are microporphyritic with small phenocrysts of olivine and plagioclase set in a fine-grained groundmass of equidimensional pyroxene, subparallel plagioclase laths and glass.

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