

New K-Ar dates and the late Pliocene to Holocene geomorphic history of the central Rio Grande region, New Mexico: Discussion

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Bachman and Mehnert (1978) have reported a series of K-Ar ages from the central Rio Grande region, some of which are relevant to the age of the Ortiz surface. Recognizing that this "surface" of regional significance is a compound feature, they proposed that the name be restricted to a single surface: the upper surface of associated alluvial gravels. They then suggested that dated basalts provide a minimum age of 3 m.y. for the "Ortiz surface" thus restricted.

I believe the proposed restriction to be both unnecessary and undesirable. In any event, the dated basalt flows do not overlie the upper surfaces of alluvial gravels, but are interbedded with them. The minimum age of 3 m.y. applies to the unconformity at the base of associated gravels (lower Ortiz surface), not to their upper surface.

Bachman and Mehnert (1978, p. 215) would "restrict the term 'Ortiz surface' to the upper surfaces of the Puyé Formation in the Cerros del Rio region, 'river gravels,' Ancha Formation, and Tuerto Gravel." Tuerto Gravel (Yung and McCaffrey, 1903) is the alluvial cover of Ogilvie's (1905) "conoplain," type locality of the Ortiz surface (Bryan and McCann, 1938, p. 7–8; Bryan, 1938, p. 215). The general equivalence of the several alluvial formations was first formally proposed by Spiegel and Baldwin (1963, p. 57–60, Fig. 20) and is not questioned here. They are map units distinguishable by gravel types characteristic of their differing highland sources, but they are of the same age. Equivalence of the Puyé (2.9 m.y.) and Ancha (2.7 m.y.) Formations has been confirmed by fission-track dating of intercalated pumices (Manley, 1976).

Bachman and Mehnert reported four new K-Ar ages from basalt flows related to the Puyé and Ancha Formations. Two (loc. 2, 2.6 m.y.; loc. 3, 2.5 m.y.) were described in the legend for Figure 1 as "*in Puyé Formation*" (italics added). One [loc. 4, 2.6 m.y. (cinders) and 2.5 m.y. (flow)] is from the east margin of the Mesa Negra de La Bajada, where basalt tuff and flows *intertongue* with the Ancha Formation (Spiegel and Baldwin, 1963, p. 50 and Figs. 19 and 20). "If the tuff could be found and mapped in other than the vicinity of the basalt cliff it would be a valid basis for subdividing the Ancha Formation" (Spiegel and Baldwin, 1963, p. 55). The last (loc. 7, 2.8 m.y.) is from the south margin of the Mesa Negra de La Bajada and is said (Bachman and Mehnert, 1978, Table 1) to rest on a surface "cut on Ancha Formation." Basalt flows along the south and west margins of the Mesa Negra both overlie and are interbedded with gravels containing granitic debris from the Sangre de Cristo Mountains. The flows are coeval with parts of the alluvial aggradation farther east on the Santa Fe Plateau which is the Ancha

Formation. Samples from localities 4 and 7 date the Ancha Formation itself and are from units that do not rest upon its upper surface. The new K-Ar dates provide new confirmation of the equivalence of the Puyé and Ancha Formations. The minimum age of 3 m.y. (Bachman and Mehnert, 1978, p. 287) applies to the unconformity at their base. The upper surface of the Ancha Formation is younger than a member of the Banderier Tuff (Spiegel and Baldwin, 1963, p. 63–64).

Bachman and Mehnert (1978, p. 287) also "follow the precedent of Bryan and McCann (1938, Fig. 2) in correlating the surfaces that underlie the basalt flows at Santa Ana Mesa . . . with the Ortiz surface." Bryan believed that the *Alto de Mesa Santa Ana* was a remnant of the Ortiz surface (Bryan and McCann, 1938; Bryan, 1938, p. 218, Figs. 39 and 40), capped by one or more flow units younger than the main body of lavas in the mesa (Bryan, 1938, p. 208 and Figs. 39 and 40). Like Kelley (1977, p. 28), Bryan placed basalt interbedded with "river gravels" near San Felipe and near the mouth of Jemez Creek (Bachman and Mehnert, 1978, loc. 7, 2.5 m.y.) in a Santa Fe Formation older than the Ortiz surface.

The *Alto de Mesa Santa Ana* is the height of land along the west side of the Mesa Santa Ana. Kelley (1977, p. 28) reported that only Ortiz gravel overlies lava in the *Alto*. Farther north, between the *Alto* and the Keres volcanic pile, Ortiz "pediment gravel" unconformably overlies that part of the Cochiti Formation which interfingers with the Peralta tuff (about 8 m.y. old; Smith and others, 1970; Kelley, 1977, geologic map). Along the west margin of the *Alto*, Kelley's map shows more clearly that both basalt and gravel are unconformable on older beds in the Santa Fe. Yet, 24 km to the east near San Felipe, basalt appears to be conformable to enclosing "Santa Fe" beds. The lower Ortiz surface (unconformity beneath basalt and gravel) passes eastward across the west boundary of the Santo Domingo Basin into a conformable contact within a continuous sedimentary section. The lower Ortiz surface is thus an unconformity marginal to contemporary loci of subsidence and sedimentation. I return to this important inference below.

Bryan further proposed (Bryan and McCann, 1938) that the *Llano de Albuquerque*, in the Albuquerque-Belen Basin, was a remnant of the Ortiz surface. He specifically abandoned an earlier view that it was the essentially depositional surface of "basin fill." Rather, he postulated, it was a surface of erosion cut across mildly deformed basin fill and capped by a separate gravel veneer that was not itself deformed. Wright (1946, p. 404–406) suggested that a principal unconformity in the Sand Hill fault zone, which Bryan and McCann (1937, p. 815) had interpreted to separate "basin fill" from alluvial cover, developed during accumulation of the youngest member of that fill ("Upper Buff" of Bryan and McCann, 1937;

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Ceja member of Kelley, 1977). No separate alluvial cover associated with the postulated surface of erosion can be consistently distinguished (Kelley, 1977, p. 20). The broad surface of the Llano de Albuquerque, after all, may be viewed as the depositional surface of the "Upper Buff" (Ceja member), locally deformed and repeatedly regraded during its accumulation.

Spiegel and Baldwin (1963, p. 60 and Fig. 20) therefore suggested that "Upper Buff" and Ancha Formation were essentially equivalent. Mafic flows at Los Lunas (loc. 13, Bachman and Mehnert, 1978) interbedded with "Upper Buff" (Wright, 1946, p. 406) and an air-fall tuff at the same locality as well are 1.1 m.y. old. Bachman and Mehnert (1978, p. 288) therefore rejected previous correlations of the Llano de Albuquerque with the Ortiz surface (as restricted), because it is too young. However, as seen above, Bandelier Tuff is interbedded with the Ancha Formation, too. The Los Lunas dates can more easily be taken to provide confirmation of the general equivalence of the upper surfaces of the Llano de Albuquerque, Alto de Mesa Santa Ana, and Ancha Formation. The lower Ortiz surface, to which Bachman and Mehnert's dates assign a minimum age of 3.0 m.y., is the base of the "Upper Buff" (Ceja member) in the Albuquerque-Belen Basin.

I agree with Bachman and Mehnert that careful distinction of lower (unconformity) and upper (aggradational) Ortiz surfaces will be necessary to the discussion and eventual understanding of the geologic history and geomorphic development of the Rio Grande depression. I believe, nevertheless, that restriction of the name to a single surface would be unfortunate. The upper surface is the visible surface of the modern landscape, on parts of which one can walk freely. It is the surface contoured by Wright (1946) and Kelley (1977). As recognized by Ogilvie (1905), however, outside the central axis of the Rio Grande depression, it is the broad form of the lower surface cut in older rocks that controls the regional aspect of the upper surface. It is the lower surface that bespeaks an important interval of deformation and erosion ("post-Santa Fe uplift of the mountains"; Bryan, 1938, p. 215). Significant parts of older basins of deposition (Tesuque Formation and equivalents) were removed from the sedimentary domain. It is clearer now than it was in 1938 that both Ortiz surfaces have been deformed. Even outside the principal loci of subsidence and continuous sedimentation, the lower Ortiz surface is modestly aggraded. As Bryan foretold, how-

ever, the late Miocene and early Pliocene ("Hemphillian") Rio Grande "rift," at least from the Española Valley to Albuquerque, was narrower than its predecessor basins. Along its margins, recognition of the lower Ortiz surface will allow us to take its measure.

REFERENCES CITED

- Bachman, G. O., and Mehnert, H. H., 1978, New K-Ar dates and the late Pliocene to Holocene geomorphic history of the central Rio Grande region, New Mexico: *Geological Society of America Bulletin*, v. 89, p. 283-292.
- Bryan, Kirk, 1938, Geology and ground-water conditions of the Rio Grande depression in Colorado and New Mexico, in U.S. National Resources Planning Board, the Rio Grande Joint Investigation in the upper Rio Grande basin: Washington, D.C., U.S. Government Printing Office, v. 1, pt. 2, p. 197-225.
- Bryan, Kirk, and McCann, F. T., 1937, The Ceja del Rio Puerco — A border feature of the Basin and Range province in New Mexico, Pt. 1, Stratigraphy and structure: *Journal of Geology*, v. 45, p. 801-828.
- 1938, The Ceja del Rio Puerco — A border feature of the Basin and Range province in New Mexico, Pt. II, Geomorphology: *Journal of Geology*, v. 46, p. 1-16.
- Kelley, V. C., 1977, Geology of Albuquerque Basin, New Mexico: New Mexico Bureau of Mines and Mineral Resources Memoir 33, 60 p.
- Manley, Kim, 1976, Tephrochronology of the Tesuque, Ancha, and Puyé Formations of the Santa Fe Group, Española Basin, New Mexico: *Geological Society of America Abstracts with Programs*, v. 8, p. 606-607.
- Ogilvie, I. H., 1905, The high altitude conoplain: A topographic form illustrated in the Ortiz Mountains, New Mexico: *American Geologist*, v. 36, p. 27-34.
- Smith, R. L., Bailey, R. A., and Ross, C. S., 1970, Geologic map of the Jemez Mountains, New Mexico: U.S. Geological Survey Miscellaneous Geological Investigations Map I-571.
- Spiegel, Zane, and Baldwin, Brewster, 1963, Geology and water resources of the Santa Fe area, New Mexico: U.S. Geological Survey Water-Supply Paper 1525, 258 p.
- Wright, H. E., Jr., 1946, Tertiary and Quaternary geology of the lower Rio Puerco area, New Mexico: *Geological Society of America Bulletin*, v. 57, p. 383-456.
- Yung, M. B., and McCaffrey, R. S., 1903, Ore deposits of the San Pedro district, New Mexico: *American Institute of Mining Engineers Transactions*, v. 33, p. 350-362.

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