

SIMILARITIES AND CONTRASTS IN TECTONIC AND VOLCANIC STYLE AND HISTORY ALONG THE COLORADO PLATEAUS-TO-BASIN AND RANGE TRANSITION ZONE IN WESTERN ARIZONA: GEOLOGIC FRAMEWORK FOR TERTIARY EXTENSIONAL TECTONICS.

R. A. Young, Department of Geological Sciences, SUNY, Geneseo, NY 14454, E. H. McKee, U.S. Geological Survey, Menlo Park, CA 94025, J. H. Hartman, Department of Geology and Geophysics, University of Minnesota, Minneapolis, MN 55455, A. M. Simmons, Department of Geological Sciences, SUNY, Buffalo, NY 14226

Recent studies of the Colorado Plateaus-to-Basin and Range transition zone in the area from the Hualapai Plateau southeastward to the Mohon and Juniper Mountains (figure 1) permit a revised perspective on the early and middle Tertiary geology of this region in western Arizona (1-7). The tectonic events in this region are related to volcanic activity and hence can be isotopically dated. The period of middle to late Tertiary volcanism (25 to 15 m.y. ago) along the margin of the Colorado Plateaus corresponds with the ages of volcanism and detachment faulting in the adjacent Basin and Range province (12). This contemporaneity suggests a relationship between regional magmatic and tectonic events from the Basin and Range province across the transition zone and onto the Colorado Plateaus.

Middle Tertiary volcanism in the Aquarius Mountains began about 25 m.y. ago and can be divided into two episodes throughout the transition zone (3,4,6,7,8). The older episode spanned the interval from 25 to 15 m.y. ago (late Oligocene to middle Miocene) and consists mainly of clinopyroxene-bearing, alkali-rich basalts and olivine tholeiites with lesser amounts of andesite, rhyodacite, and rhyolite (7,14). This was followed by an apparent gap in activity from about 15 to 10 m.y. ago. The younger period of volcanism spans the interval from 10 to 5 m.y. ago and is typified by the calc-alkaline basalt and low silica rhyolite suite exposed at the 8- to 9- m.y.-old Mt. Hope volcanic center (7,8).

The Oligocene and Miocene volcanic rocks rest unconformably on a regional, late Cretaceous and Paleocene (Laramide) erosion surface, recently confirmed by the identification of probable early Eocene fossils in the upper "rim gravel" section on the southern Coconino Plateau near Mt. Floyd (9,13). The disruption of the early Tertiary, north- to northeast-trending drainages across the present plateau margin by deformation along compressional Laramide structures permits a distinct separation of the major early and middle Tertiary structures (1,11). Further information concerning pre- and post-middle Miocene deformation is provided by the 17- to 18- m.y.-old Peach Springs Tuff, which in some places overlaps major structures and elsewhere is cut by major faults (5,6,10,15,16).

The late Cretaceous and early Tertiary monoclines and folds are inferred to have been active as late as early Eocene time in northwest Arizona, as deduced from their relations to the Paleocene and Eocene rim gravels (1). From the Hualapai Plateau to the Juniper Mountains region, Oligocene and middle Miocene (25 to 15 m.y.) volcanic centers and vents have close spatial relationships to the monoclines and folds. The younger Miocene (10- to 5- m.y.-old) volcanic rocks do not have any clear spatial association with the Laramide structures.

An outline of the Tertiary magmatic and tectonic history includes: 1) a late Eocene and Oligocene period of volcanic quiescence, possibly accompanied by sporadic normal faulting, 2) a late Oligocene to middle Miocene episode of extensional faulting and predominantly basaltic volcanism, possibly localized

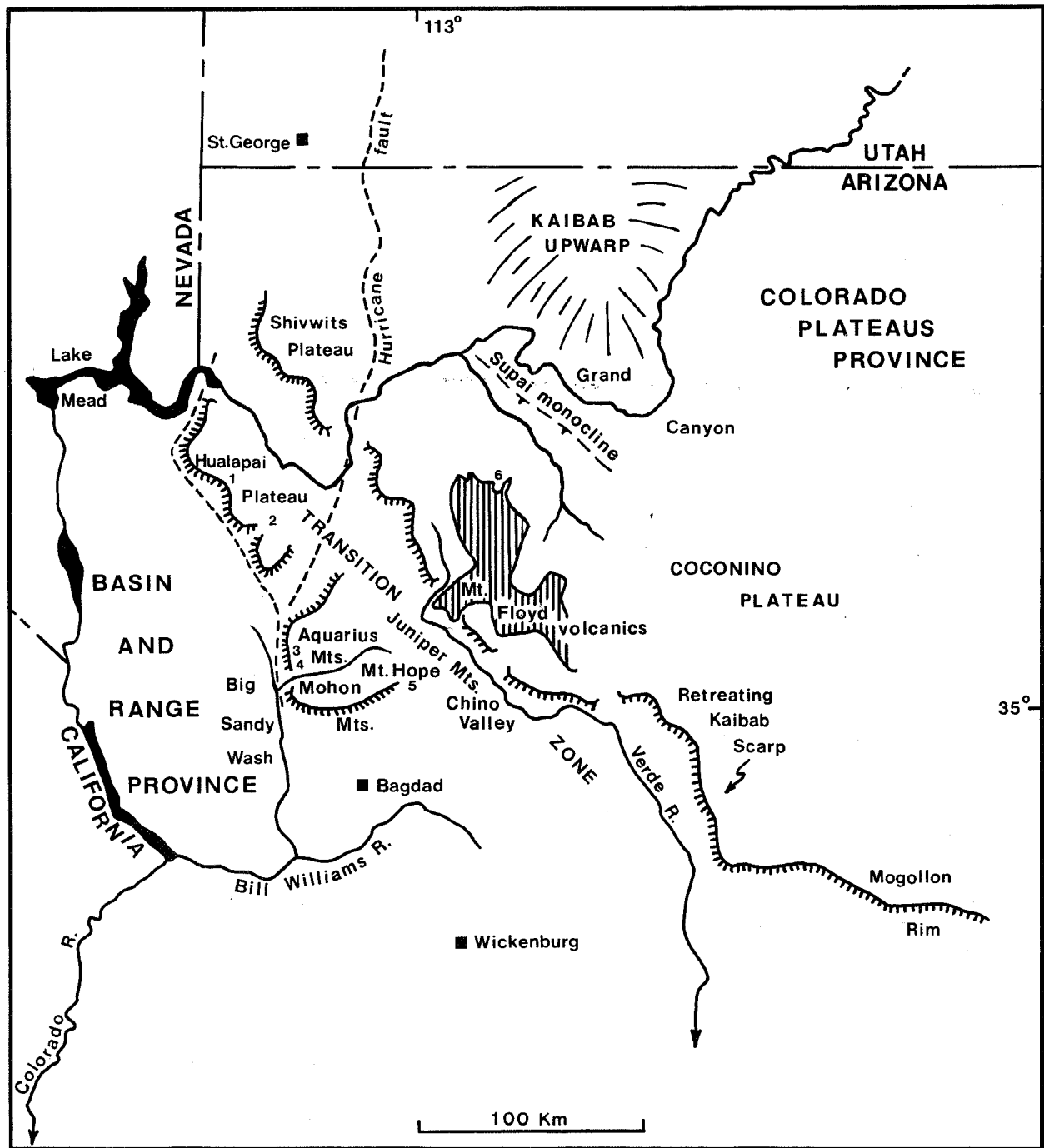


Figure 1. Features referred to in text and localities (numbers) where radiometric ages have been reported in publications by the authors. 1: 65.5 ± 3.5 m.y. granodiorite(?). 2: $*18.3 \pm 0.6$ m.y. Peach Springs Tuff. 3: 18.2 ± 1.5 m.y. basalt. 4: 24.5 ± 3.5 , 24.9 ± 0.9 m.y. basaltic andesites. 5: 8.0 ± 0.5 m.y. rhyolite, 8.5 ± 0.9 m.y. basalt (Mt. Hope). 6: $*14.0 \pm 0.6$ m.y. basalt.

* Uncorrected for new ^{40}K constants.

along preexisting Laramide structures, 3) a middle Miocene interval (15 to 10 m.y. ago) of volcanic quiescence, and 4) a late Miocene and Pliocene period of predominantly basaltic volcanism.

The overall temporal and spatial relations between middle Tertiary volcanism and tectonism from the Basin and Range province onto the edge of the Colorado Plateaus province suggest that a single magmatic-tectonic episode affected the entire region more or less simultaneously during this period. The episode followed a post-Laramide (late Eocene through Oligocene) period of 25 million years of relative stability. Middle Tertiary volcanism did not migrate gradually eastward in a simple fashion onto the Colorado Plateaus. In fact, late Oligocene volcanism appears to be more voluminous near the Aquarius Mountains than throughout the adjacent Basin and Range province westward to the Colorado River. Any model proposed to explain the cause of extension and detachment faulting in the eastern part of the Basin and Range province must consider that the onset of volcanism appears to have been approximately synchronous from the Colorado River region of the Basin and Range across the transition zone and onto the edge of the Colorado Plateaus.

REFERENCES

- (1) Young, R.A. (1985, in press) Geomorphic Evolution of the Colorado Plateau margin in west-central Arizona: A tectonic model to distinguish between the causes of rapid symmetrical scarp retreat and scarp dissection. 15th Annual Binghamton Geomorphology Symposium, Tectonic Geomorphology, Allen and Unwin.
- (2) Young, R.A. (1982) Paleogeomorphologic evidence for the structural history of the Colorado Plateau margin in western Arizona. In: Frost, E.G. and Martin, D. (eds.) Mesozoic-Cenozoic Tectonic Evolution of the Colorado River Region, California, Arizona, and Nevada. Cordilleran Publishers, San Diego, p. 29-39.
- (3) Young, R.A. (1979) Laramide deformation, erosion, and plutonism along the southwestern margin of the Colorado Plateau. Tectonophysics, 61, p. 25-47.
- (4) Young, R.A. and McKee, E.H. (1978) early and Middle Cenozoic drainage and erosion in west-central Arizona. Geol. Soc. of Amer. Bull. 89, p. 1745-1750.
- (5) Young, R.A. (1966) Cenozoic geology along the edge of the Colorado Plateau in NW Arizona (PhD Dissert.) St. Louis, Washington University, 167p, maps.
- (6) Young, R.A. and Brennan, W.J. (1974) The Peach Springs Tuff--Its bearing on structural evolution of the Colorado Plateau and development of Cenozoic drainage in Mohave County, Arizona. Geol. Soc. Amer. Bull. 85, p. 83-90.
- (7) Goff, F., Arney, B.H., and Eddy, A. (1982) Scapolite phenocrysts in a latite dome, northwest Arizona, U.S.A. Earth and Planetary Letters, 60, p. 86-90 (also map IA-9202, Los Alamos National Lab Informal Map).
- (8) Simmons, A.M. (in progress) The geology of Mt. Hope, a silicic volcanic center in west-central Arizona (M.A. thesis) SUNY Buffalo, NY.
- (9) Young, R.A. and Hartman, J.H. (1984) Early Eocene fluviolacustrine sediments near Grand Canyon, Arizona: Evidence for Laramide drainage across northern Arizona into southern Utah. Geol. Soc. Amer. Abstracts with Programs 16, No. 6, p. 703.

- (10) Nielson-Pike, J.E. (1984) Peach Springs Tuff: Key to Tertiary Correlation, Colorado River, Arizona and California. Geol. Soc. Amer. Abstracts with Programs, 16, No. 6, p. 610.
- (11) Drewes, H. (1978) The Cordilleran orogenic belt between Nevada and Chihuahua. Geol. Soc. Amer. Bull. 89, p. 641-657.
- (12) Frost, E.G. and Martin, D. (eds.) (1982) Mesozoic-Cenozoic Tectonic Evolution of the Colorado River Region, California, Arizona, Nevada. Cordilleran Publishers, San Diego, 615 p.
- (13) McKee, E.D. and McKee, E.H. (1972) Pliocene uplift of the Grand Canyon--time of drainage adjustment. Geol. Soc. Amer. Bull. 83, p. 1923-1932.
- (14) Fuis, G.S. (1974) The geology and mechanics of formation of the Fort Rock Dome, Yavapai Co., Arizona (PhD Dissert.) Pasadena, Calif. Inst. of Tech., 279 p.
- (15) West, N.W. and Glazner, A.F. (1985) Possible correlation of the Redfire and Peach Springs Tuffs: A 500 km³ tuff in the Mohave Desert and western Arizona? Geol. Soc. Amer. Abstracts with Programs, 17, No. 6, p. 418.
- (16) Brooks, W.E. and Marvin, R.F. (1985) Discordant isotopic ages and potassium metasomatism in volcanic rocks from Yavapai County, Arizona. Geol. Soc. Amer. Abstracts with programs, 17, No. 6, p. 344.