New K-Ar age determinations from syntectonic deposits (Oligocene and Miocene), in southern Nevada and northwest Arizona

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NEW K-Ar AGE DETERMINATIONS FROM SYNTECTONIC DEPOSITS (OLIGOCENE AND MIOCENE), IN SOUTHERN NEVADA AND NORTHWEST ARIZONA

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Four new K-Ar age determinations were obtained on Cenozoic syntectonic deposits that are important to structural and stratigraphic investigations in the southern Nevada, southwest Utah, and northwest Arizona region. The radiometric ages were obtained from biotite contained in tuffaceous beds. The Horse Spring-Cottonwood Wash and Muddy Creek formations are composed of lacustrine limestone, clastic, evaporite, volcaniclastic, and volcanic beds. Thick asymmetric sequences of these syntectonic beds were deposited in basin-range extensional basins from Oligocene to Recent time. The basins lie in the downdropped hanging wall blocks of high-angle normal fault systems. Some Cenozoic beds were deposited on topographically low portions of range blocks, where the K-Ar samples were collected, and represent condensed and incomplete stratigraphic records relative to the thick basinal sequences.

INTRODUCTION

The study area lies at the juncture between Nevada, Utah, and Arizona (fig. 1) Several deformational episodes have affected the area, including Late Proterozoic rifting (Moore, 1972; J. Carpenter, 1989), Cretaceous decollement style folding and thrusting (Longwell, 1949; Armstrong, 1968; Carpenter and Carpenter, 1987) Cretaceous-Eocene? basement-involved folding and reverse faulting (Reber, 1951, 1952; Moore, 1972; Hintze, 1986; Carpenter and others, 1989), and Cenozoic basin-range extension (Longwell, 1928; Longwell and others, 1965; Olmore, 1971; Stewart, 1971; D. Carpenter, 1988, 1989; J. Carpenter, 1989; Carpenter and others, 1989).

CENOZOIC STRATIGRAPHY, STRUCTURE, AND TIMING OF NORMAL FAULTING

The Cenozoic rocks in the study area are subdivided into two primary sequences: 1) the Oligocene and Miocene Horse Spring-Cottonwood Wash sequence, and 2) the Miocene to Quaternary Muddy Creek sequence. A sequence is a relatively conformable succession of genetically related beds bounded by unconformities or their correlative conformities (Mitchum, 1977). Kowallis and Everett (1986) describe, in detail, the Muddy Creek Formation and interpret the depositional environment. We discuss the Horse Spring-Cottonwood Wash sequence for which we have obtained new age determinations.

Ostracod bearing cryptalgalaminate limestone beds contained near the base of the Horse Spring Formation in the Mormon Mountains (J. Carpenter, 1986) is similar to limestone beds near the base of the Cottonwood Wash Formation in the Virgin Mountains. An age determination (24.3 ± 1.0 m.y.) from basal beds of Cottonwood Wash Formation in the Virgin Mountains, Arizona is the first obtained on the formation in that area (Carpenter and others, 1989). Three age determinations (14.3 ± 0/6; 14.9 ± 0.7; and 16.6 ± 0.7 m.y.) were obtained from tuff beds in the Horse Spring Formation in the North Muddy Mountains. Sample lithologies are vitric tuffs with phenocrysts of plagioclase, rare K-feldspar, quartz and biotite shards, and rare lithic fragments in a partially devitrified groundmass. These beds lie up section from the basal limestone and polymictic conglomerate beds of the formation.

Greater than 7,600 m of low-density Cenozoic beds were deposited at the Virgin Valley basin depocenter based on seismic, gravity, and a synthetic seismic well tie, (D. Carpenter, 1988; 1989; J. Carpenter, 1989; Carpenter and others, 1989, fig. 1). Seismic reflection interpretations of the crustal structure demonstrate tilted horst blocks separated from half-graben blocks by high-angle normal faults (Carpenter and others, 1989, fig. 1, D. Carpenter, 1989; J. Carpenter, 1989). The seismic data image a fanning upward reflector geometry for Cenozoic beds that correspond to the beds that were run for K-Ar age determinations. The fanning upward geometry resulted from the syndepositional relation of the syntectonic beds with high-angle (60 degree dipping) normal faults. Consequently, this indicates that the high-angle normal faulting in the area initiated in the Oligocene (or earlier) and has continued to the Recent.

In the North Muddy Mountains, on the west, and the Virgin Mountains, on the east of the east-tilted Virgin Valley half-graben, Cenozoic formations were deposited directly on Cretaceous, Jurassic, and older rocks and document angular discordance (Longwell, 1928, 1949; Moore, 1972; Carpenter and others, 1989). In the North Muddy Mountains, beds of the Cenomanian Baseline Sandstone (Carpenter and Carpenter, 1987) are unconformably overlain by the Cenozoic Horse Spring Formation (fig. 1). Basal Cenozoic beds range between 21.3 ± 0.4 m.y. to 29.4 m.y. in age (Tschanz, 1960; Anderson, 1972; Ekren and others, 1977; Carpenter and others, 1989). The Horse Spring-Cottonwood Wash sequence is unconformably overlain by the Miocene-Quaternary Muddy Creek Formation in the Muddy and Virgin Mountain areas. The Muddy Creek Formation is the least deformed Cenozoic formation in the region.

DISCUSSION AND CONCLUSIONS

New K-Ar age determinations, for the Horse Spring Cottonwood Wash sequence, coupled with fanning upward reflector geometry of the thick Cenozoic basinal sequence suggest an Oligocene age for the onset of crustal extension, and high-angle (60 degree dips) normal fault geometries (D. Carpenter, 1988, 1989; J. Carpenter, 1989; Carpenter and others, 1989).

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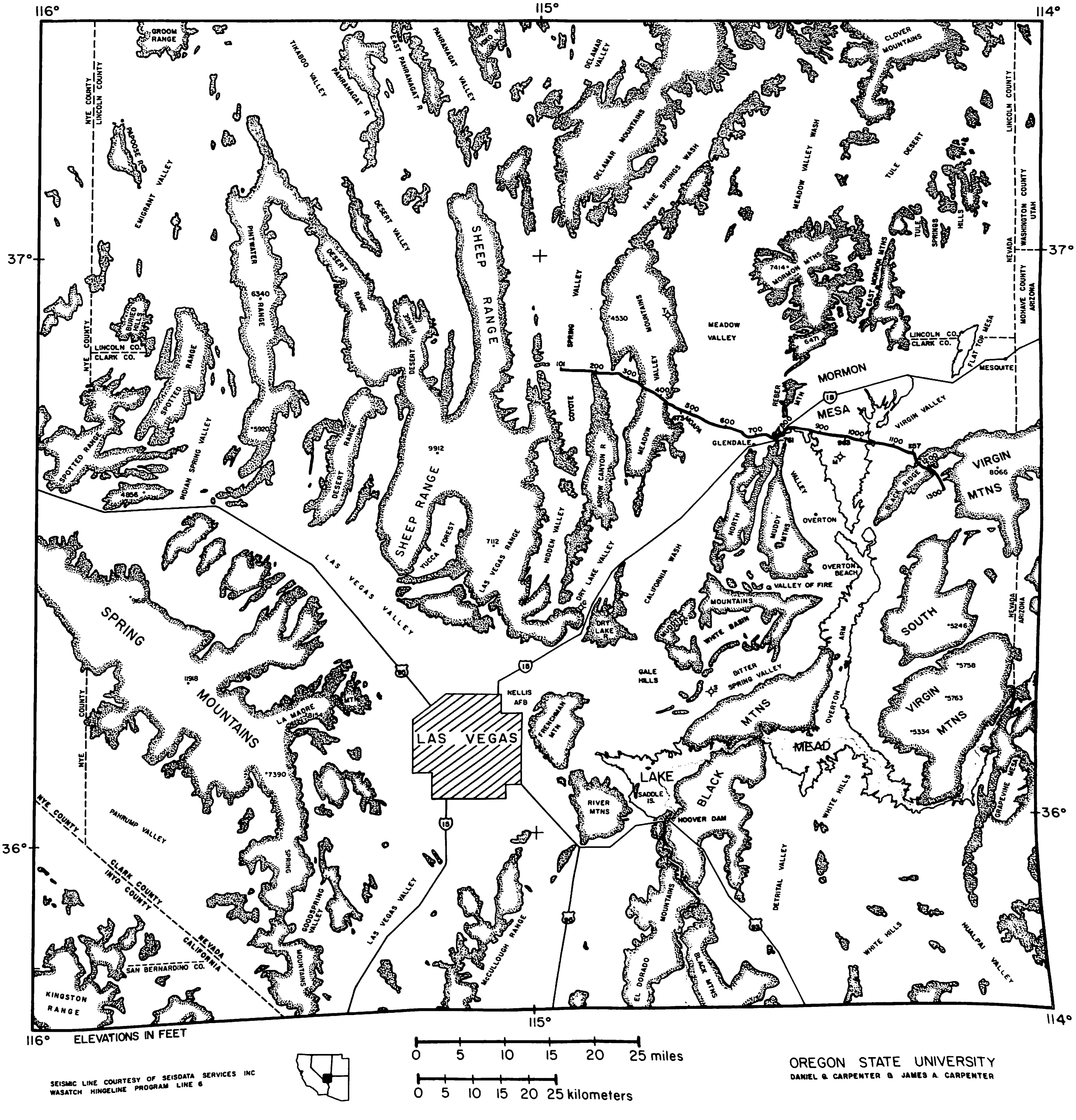

FIGURE 1. Physiographic map showing fault-bounded horsts (ranges) and grabens (basins) and major cultural features.

SAMPLE DESCRIPTIONS

The decay constants used for the age determinations are: $\lambda_\beta = 4.962 \times 10^{-10}$/yr; $\lambda_\epsilon = 10^{-10}$/yr; $K^{40}/K = 1.193 \times 10^{-4}$ g/g.

1. *34981-1* K-Ar
Light tan biotite-bearing vitric tuff from the Cottonwood Wash Formation (36°36'20"N, 113°57'29"W; SW¼ SW¼ NW¼ S18,T37N,R15W; Cane Springs quad., Mohave Co., AZ). *Analytical data:* K = 6.630, and 6.578%; $^*Ar^{40}$ = 0.01114, and 0.01126 ppm; $^*Ar^{40}/\Sigma Ar^{40}$ = 0.618 and 0.611.
(biotite concentrate) 24.3 ± 1.0 m.y.

2. *35014-1* K-Ar
White biotite-bearing vitric tuff from previously unmapped Horse Spring Formation (36°30'60"N, 114°28'38"W; NW¼ SE¼ NE¼ S27,T16S,R67E; Overton quad., Clark Co., NV). *Analytical data:* K = 5.414, and 5.361%; $^*Ar^{40}$ = 0.006298, and 0.006171 ppm; $^*Ar^{40}/\Sigma Ar^{40}$ = 0.644, and 0.445.
(biotite concentrate) 16.6 ± 0.7 m.y.

3. *35053-2* K-Ar
White biotite-bearing vitric tuff from previously unmapped Horse Spring Formation (36°37'30"N, 114°33'50"W; NE¼ NE¼ NE¼ S23,T15S,R66E; Weiser Ridge quad., Clark Co., NV). *Analytical data:* K = 4.997, and 4.869%; $^*Ar^{40}$ = 0.005113, 0.005374, and 0.004837 ppm; $^*Ar^{40}/\Sigma Ar^{40}$ = 0.268, 0.168, and 0.271.
(biotite concentrate) 14.9 ± 0.7 m.y.

4. *35099-1* K-Ar
White biotite-bearing vitric tuff from previously unmapped Horse Spring Formation (36°32'37"N, 114°35'37"W; SE¼ SW¼ S10,T16S,R66E; Weiser Ridge quad., Clark Co., NV). *Analytical data:* K = 6.497, and 6.491%; $^*Ar^{40}$ = 0.006516 and 0.006451 ppm; $^*Ar^{40}/\Sigma Ar^{40}$ = 0.274, and 0.300.
(biotite concentrate) 14.3 ± 0.6 m.y.

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