Reset K-Ar ages: evidence for three metamorphic core com plexes, western Nevada

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RESET K-Ar AGES: EVIDENCE FOR THREE METAMORPHIC CORE COMPLEXES, WESTERN NEVADA

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Three localities in western Nevada composed of gneiss, schist, and pegmatitic rocks are here considered to be metamorphic core complexes. These isolated exposures of Precambrian metamorphic rock in a terrane of undeformed late Miocene volcanic rocks yield late Miocene, reset K-Ar ages—a characteristic of all Cordilleran metamorphic core complexes. The proposed core complexes are at Mineral Ridge in the Silver Peak Range, in the Trappman Hills east of Goldfield, and in the Bullfrog Hills west of Beatty.

DISCUSSION

Three enigmatic exposures of metamorphic rock in a terrane of unmetamorphosed Late Proterozoic, Paleozoic marine strata, or late Tertiary volcanic rocks in southwestern Nevada are suspected to be parts of metamorphic core complexes. These three widely separated outcrops of metamorphic rock have long puzzled geologists, who have speculated variously that they are inliers of crystalline Precambrian basement or, possibly, local areas of younger Precambrian (Late Proterozoic) rock more intensely metamorphosed than elsewhere in the region. In any case, these gneissose, schistose, and locally pegmatitic rocks contrast very strongly with the surrounding rocks that are mostly undeformed late Miocene ash-flow tuff, lava flows, and some late Precambrian and Cambrian carbonate and quartzose strata.

With the recognition of metamorphic core complexes in a sinuous belt from southern Canada to northern Mexico and along the east side of the Basin and Range province at the latitude of southern Nevada (Crittenden and others, 1980), another explanation for these puzzling metamorphic rocks is considered—that they are parts of metamorphic core complexes. On this assumption samples were collected in 1975 for K-Ar dating because a feature characteristic of all the core complexes is an anomalously young, middle to late Cenozoic radiometric age (Damon and others, 1963; Armstrong and Hansen, 1966; Mauger and others, 1968; Best and others, 1974; Ross, 1974; Snoke, 1975; Compton and others, 1977; Davis and Coney, 1979; Banks, 1980; Keith and others, 1980; Reynolds and Rehrig, 1980; Armstrong, 1982). Coarse muscovite from samples of gneiss from these three localities was dated by the K-Ar method using standard isotope-dilution techniques.

The three enigmatic metamorphic rock exposures in southwestern Nevada are at Mineral Ridge in the Silver Peak Range, in the Trappman Hills 55 km east of Goldfield, and in the Bullfrog Hills 10 km west of Beatty (fig. 1). These isolated localities are about 65 km apart, have no visible connecting structures, and are unique in the region—no similar rocks are known anywhere else in this part of Nevada. The rocks in the Trappman Hills and Bullfrog Hills are shown as undivided gneiss and schist of older Precambrian age on the geologic map of southern Nye County, Nevada (Cornwall, 1972) and as gneiss, schist, and lesser amounts of gneissic granite, pyroxenite, hornblendite, migmatite, pegmatite, and marble of Precambrian X age on the Geologic Map of Nevada (Stewart and Carlson, 1978) and in Geology of Nevada (Stewart, 1980) (the Early [2500–1600 m.y.], Middle [1600–900 m.y.], and Late [900–570 m.y.] Proterozoic have been adopted by the U.S. Geological Survey, replacing Precambrian and Proterozoic X, Y, and Z respectively). Stewart (1980, p. 9) noted that the rocks of Bullfrog Hills and Trappman Hills are generally similar to the metamorphic rocks in the metamorphic core complex of the Ruby Mountains of eastern Nevada and that their assignment of a Precambrian X age is speculative. The Mineral Ridge rocks are shown on the Esmeralda County and Nevada geologic maps as Precambrian and Precambrian Z, respectively (Wyman Formation) (Albers and Stewart, 1972; Stewart and Carlson, 1978). The Mineral Ridge rocks include garnet-mica schist and calc-silicate hornfels intruded by muscovite pegmatites that form lit-par-lit migmatites (Bailly, 1951). On the basis of field observations, rocks from the three localities generally resemble each other, but more significantly, they do not resemble other rocks in the region. A similar and unique origin has seemed likely for the rocks from these three localities since they were first mapped 20 or more years ago, and the suspicion that they might be related to metamorphic core complexes has grown for the past eight years (E. B. Ekren, oral commun., 1975; Stewart, 1980; D. T. Marcott, oral commun., 1983).

ANALYTICAL PROCEDURES

Samples of muscovite-bearing gneiss from the three localities were collected, and the muscovite was dated by the K-Ar method. The muscovite was separated from the rock by standard electromagnetic and density techniques and dated by isotope-dilution methods at the U.S. Geological Survey laboratory in Menlo Park, California. Sample preparation and analysis were similar to those described by Dalrymple and Lanphere (1969). The precision of the ages given here represents the estimated analytical uncertainty at one standard deviation, based on experience with replicate analyses. The constants used in the age calculations are: $\lambda_\epsilon + \lambda_\epsilon = 0.581 \times 10^{-10}yr^{-1}$; $\lambda_\beta = 4.962 \times 10^{-10}yr^{-1}$; and $^{40}K/K$ tot $= 1.167 \times 10^{-4}$.

POTASSIUM-ARGON AGES

The three ages determined, 16.7 ± 0.3, 14.0 ± 0.5, and 11.2 ± 1.1 m.y., are considered to be reset and to reflect reheating of much older gneiss. The Mineral Ridge rocks (K-Ar age, 16.7 ± 0.3 m.y.) are from the Wyman Formation, classified as Precambrian Z age by Stewart and Carlson (1978). The assignment to the Wyman Formation seems firmly established by detailing mapping, stratigraphy, and field observations (Albers and Stewart, 1972) and verifies a reported age of 700 m.y. based on Rb-Sr geochronology (Bailly, 1951). The complex structure of this area, which consists of large fault blocks that appear to have slid from an underlying dome of crystalline rocks, led Kirsch (1971) to the conclusion that the geology at Mineral Ridge is analogous to the chaos structure and turtleback domes of the Amargosa Chaos in the Death Valley area. The Death Valley turtlebacks are considered to be metamorphic core complexes by Coney (1979, 1980). Current study of the Mineral Ridge rocks by D. T. Marcott (oral commun., 1983) has revealed several features indicative of metamorphic core complexes.

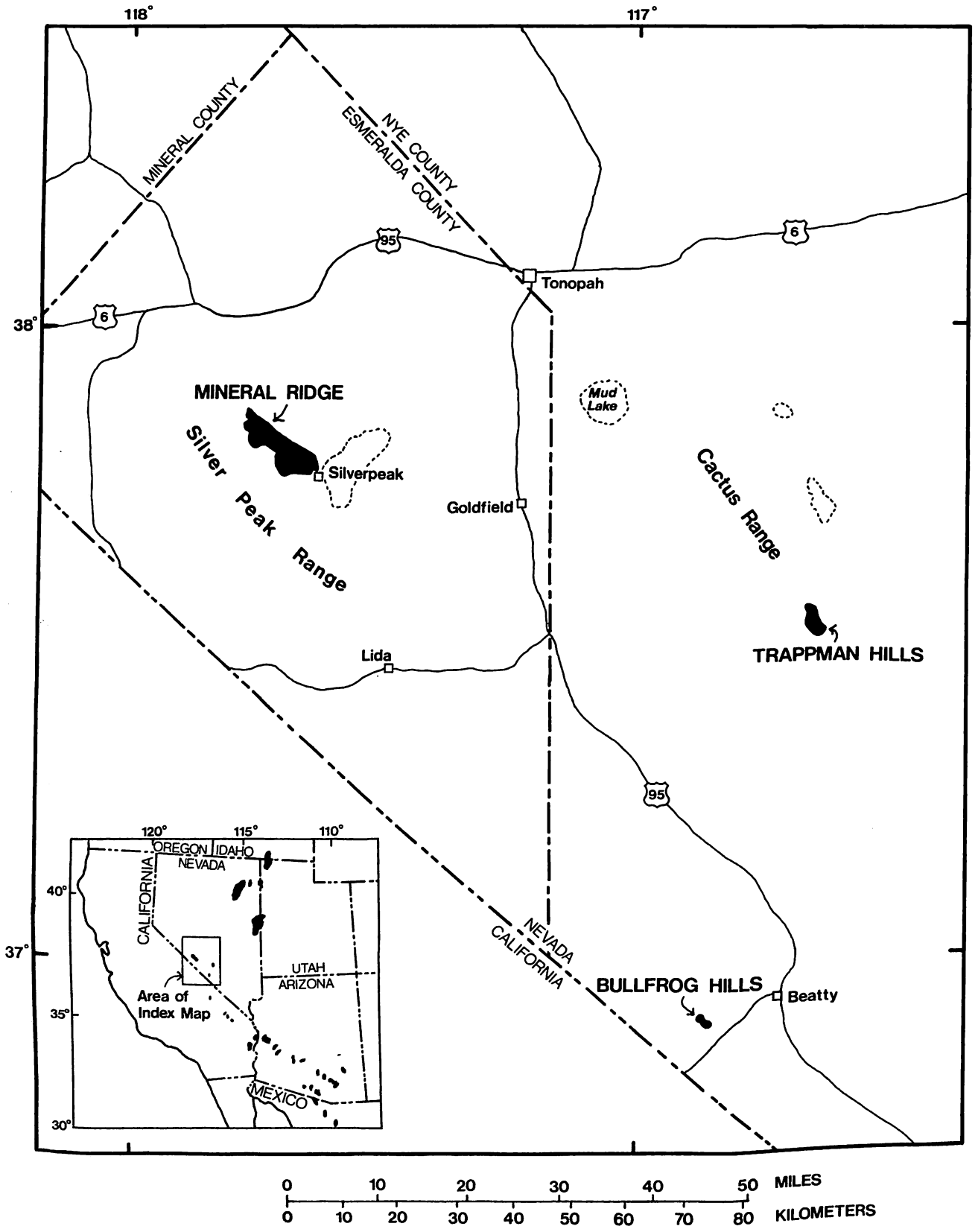

FIGURE 1. Southwestern Nevada, showing locations of three suspected metamorphic core complexes: (1) Mineral Ridge, (2) Trappman Hills, and (3) Bullfrog Hills. Insert shows additional known metamorphic core complexes (black) in the Southwestern United States.

The metamorphic rock from the Trappman Hills (K-Ar age, 14.0 ± 0.5 m.y.) is considered to be "... probable early Precambrian Age..." by Cornwall (1972, p. 4). This designation implies that the rock is older than Late Proterozoic, probably Middle Proterozoic. The resemblance of the Trappman Hills rocks to those at Mineral Ridge suggests that they belong to the Wyman Formation or its correlatives and are Late Proterozoic. Whatever Proterozoic designation, the metamorphic rocks in the Trappman Hills are much older than the K-Ar age of 14.0 ± 0.5 m.y. There is no published geologic information on the rocks from the Trappman Hills.

The gneissic rocks in the Bullfrog Hills (K-Ar age, 11.2 ± 1.1 m.y.) are considered to be of "older Precambrian" age by Cornwall and Kleinhampl (1964) and Cornwall (1972). This assignment, which suggests a Middle Proterozoic age of between 900 and 1600 m.y., is based on a general similarity between this gneiss and that of crystalline basement rocks in the Death Valley region, which is Middle Proterozoic or older. The Geologic Map of Nevada (Stewart and Carlson, 1978) and Stewart's (1980) discussion designate the Bullfrog Hills gneiss as Precambrian X. In his discussion on the age of these rocks, Stewart (1980) suggested that they could be younger than Precambrian X or Y. There is little doubt, however, that the rocks are Precambrian or possibly Paleozoic and that the middle Miocene K-Ar age reflects a much later thermal event.

ACKNOWLEDGMENTS

Discussions with E. Bartlett Ekren of the U.S. Geological Survey about the curious metamorphic rocks in the Trappman Hills and the Bullfrog Hills led us both to the conclusion that these rocks are related to metamorphic core complexes. Ekren collected samples of gneiss from the Trappman Hills and the Bullfrog Hills that were used for K-Ar age determination. Augustus K. Armstrong and John H. Stewart offered constructive reviews of this manuscript, and Gregory A. Davis of the University of Southern California and Dayton T. Marcott of the Massachusetts Institute of Technology discussed freely their present research at Mineral Ridge, Nevada.

SAMPLE DESCRIPTIONS

1. K-Ar
(Mineral Ridge, Silver Peak Range; Esmeralda Co., NV). Garnet-mica schist considered to be metamorphosed Late Proterozoic Wyman Formation. *Analytical data:* K_2O = 10.45%; $^{40}Ar^*$ = 2.5378 x 10^{-10} mole/g; $^{40}Ar^*/^{40}Ar$ = 63.5%. *Comment:* The age determined is interpreted as a reset age. Reason for resetting unknown.
muscovite 16.7 ± 0.3 m.y.

2. K-Ar
(Trappman Hills; 55 km E of Goldfield; Nye Co., NV). Quartz-mica schist considered to be of "older Precambrian" age by Cornwall (1972) and Precambrian X (speculative age) by Stewart and Carlson (1978) and Stewart (1980). *Analytical data:* K_2O = 10.34%; $^{40}Ar^*$ = 2.0966 x 10^{-10} mole/g; $^{40}Ar^*/^{40}Ar$ = 31.8%. *Comment:* The age determined is interpreted as a reset age. Reason for resetting unknown.
muscovite 14.0 ± 0.5 m.y.

3. K-Ar
(Bullfrog Hills; 10 km W of Beatty; Nye Co., NV). Coarse quartz-mica gneiss considered to be of "older Precambrian" age by Cornwall (1972) and Precambrian X (speculative age) by Stewart and Carlson (1978) and Stewart (1980). *Analytical data:* K_2O = 10.59%; $^{40}Ar^*$ = 1.7084 x 10^{-10} mole/g; $^{40}Ar^*/^{40}Ar$ = 17.3%. *Comment:* The age determined is interpreted as a reset age. Reason for resetting unknown.
muscovite 11.2 ± 1.1 m.y.

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