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KANAB CREEK ROADLESS AREA, ARIZONA

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SUMMARY

On the basis of a mineral survey in 1982, the Kanab Creek Roadless Area in north-central Arizona has a probable mineral-resource potential for uranium and copper in four small areas around five collapse structures. Gypsum is abundant in layers along the canyon rim of Snake Gulch, but it is a fairly common mineral in the region outside the roadless area. There is little promise for the occurrence of fossil fuels in the area.

CHARACTER AND SETTING

The Kanab Creek Roadless Area encompasses about 14 sq mi within the Colorado Plateau Province and is about 18 mi north of the Grand Canyon, Arizona. It is contiguous with the Kanab Canyon Wilderness on the west and south sides and lies within the Grand Canyon Game Preserve of the Kaibab National Forest. The rugged canyon area is over 1500 ft deep at its deepest point, and crosses Kanab Canyon in its westernmost part. Altitudes in the roadless area range from 3720 ft to 6200 ft.

The nearest settlements in the region are Fredonia, 15 mi to the north, and Jacob Lake, 9 mi to the east; both towns are in Arizona and connected by State Highway 89A. The roadless area can only be reached by a few unmarked, unimproved jeep and hiking trails.

The rocks of the Kanab Creek Roadless Area consist of horizontal beds of sandstone, shale, and limestone, of Early Permian age. The rock units exposed include (in ascending order), the Esplanade Sandstone, Hermit Shale, Toroweap Formation (Seligman, Brady Canyon, and Woods Ranch Members), and the Kaibab Formation (Fossil Mountain and Harrisburg Members). The Triassic Moenkopi Formation is exposed 15 mi to the north.

The upper 160 ft of the Esplanade Sandstone is exposed at the mouth of Snake Gulch and consists mainly of a dark-reddish-brown mudstone and siltstone capped with a resistant reddish-brown to white massive ledge-forming sandstone. An erosional surface with relief of about 20 ft marks the unconformity between the Esplanade and Hermit Shale. The slope-forming Hermit Shale, (which is about 575 ft thick), consists of alternating bright-red-brown shaly mudstone and siltstone interbedded with pale-red-brown ledge-forming massive beds of sandstone. The contact with the overlying Coconino Sandstone, which is absent in the Kanab Creek Roadless Area, but exposed about 3 mi to the east-southeast, is a level surface with large tension cracks in the underlying Hermit Shale that are filled in with Coconino Sandstone. The Coconino Sandstone is a cross-laminated white sandstone only 14 ft thick in the upper 6 mi of Snake Gulch (outside of the roadless area) and nonexistent elsewhere. Reworked white Coconino Sandstone and red shale and sandstone of the Hermit form the interbedded layers of the basal Seligman Member of the Toroweap Formation. The Seligman Member, which is about 30 ft thick, forms a continuous cliff with the overlying Brady Canyon Member, which has a thickness of approximately 210 ft. The fossiliferous gray limestone beds of the Brady Canyon grade upward into slope-forming pale-red and gray shale and siltstone of the Woods Ranch Member of the Toroweap, which is about 160 ft thick. Thick layers of massive gypsum occur throughout the Woods Ranch Member. An erosional unconformity with as much relief as 10 ft marks the boundary between the Toroweap and the Kaibab. The basal unit of the Kaibab is a yellowish-gray fossiliferous cherty limestone representing the Fossil Mountain Member, which is about 280 ft thick. An arbitrary boundary is drawn at a gradational contact between the cliff-forming Fossil Mountain Member and the overlying slope-forming Harrisburg Member. The Harrisburg, which is about 200 ft thick, is a series of

[1]With contributions from Jack Antweiler, USGS.

alternating gray and pale-red shale and siltstone interbedded with gray limestone and gypsifereous siltstone. The Harrisburg forms the semiresistant plateau surface around the Kanab Creek Roadless Area and has variable thicknesses because of recent erosion. Unconsolidated Quaternary deposits are scattered on the slopes of the canyon as colluvium, and elsewhere as flood-plain deposits, alluvial-valley deposits, alluvial fans, and a few travertine deposits.

A few normal north-south trending faults occur at the east end and southeast of the Kanab Creek Roadless Area with a maximum throw of 1200 ft. One large fault, the Gunsight Point fault, occurs in Kanab Canyon just west of Snake Gulch. The sedimentary rocks of Snake Gulch dip very slightly from east to west, with a regional dip of 1°. Collapse structures are scattered at random on the Plateau surface on both sides of the canyon. The collapsed structures are recognized by gently dipping strata from 1° to 10° towards a central point in the center of a circular-shaped area. The collapsed areas vary in diameter from about 50 ft to 0.75 mi, and are commonly brecciated to the depth of Mississippian strata to form breccia pipes. Uranium often occurs in these structures.

MINERAL RESOURCES

The nearest known mineral deposits to the roadless area, until recently, were the copper deposits of the Jacob Lake-Warm Springs district, 4 mi east of Snake Gulch (Tainter, 1947). These are ribbon-like bodies of azurite and malachite at the intersection of vertical joints in beds of cherty sandy limestone of the Kaibab Limestone. Copper occurrences such as these could exist near the rims of Snake Gulch, but no copper minerals were observed within the Kanab Creek Roadless Area.

The presence of uranium resources and several uranium prospects related to collapse structures in a contiguous area of similar geology indicate a probable mineral-resource potential for uranium adjacent to parts of the Kanab Creek Roadless Area. Collapse structures (breccia pipes) are near the Snake Gulch canyon lands of the U.S. Bureau of Land Management and t Kaibab National Forest. A deposit of uranium in a c lapse structure (Pigeon Pipe) occurs on the north rim Snake Gulch and an area of probable uranium resour potential extends a small distance into the roadle area. Three small areas of probable potential arou four other collapse structures extend into the are Elsewhere, the Snake Gulch canyon has a little promi for the occurrence of mineral deposits except for laye of gypsum that occur in the Woods Ranch Member the Toroweap Formation along the rim of the canyo Mineral prospects are rare or nonexistent, and no sign icant anomalies were found in geochemical samples c lected within the roadless area.

The deep Paleozoic rocks could be favorable for c and gas in this area. However, the nearest drill ho about 12 mi northwest of the Kanab Creek Roadle Area, penetrated Cambrian strata, and was dry.

SUGGESTIONS FOR FURTHER STUDIES

It is unlikely that further study of the Kanab Cree Roadless Area would reveal evidence for mineral r sources at the surface, but studies of collapse structure in surrounding adjacent areas might reveal significan mineralization at depth, such as the recent discovery c the uranium ore body at depth in the Pigeon Pipe.

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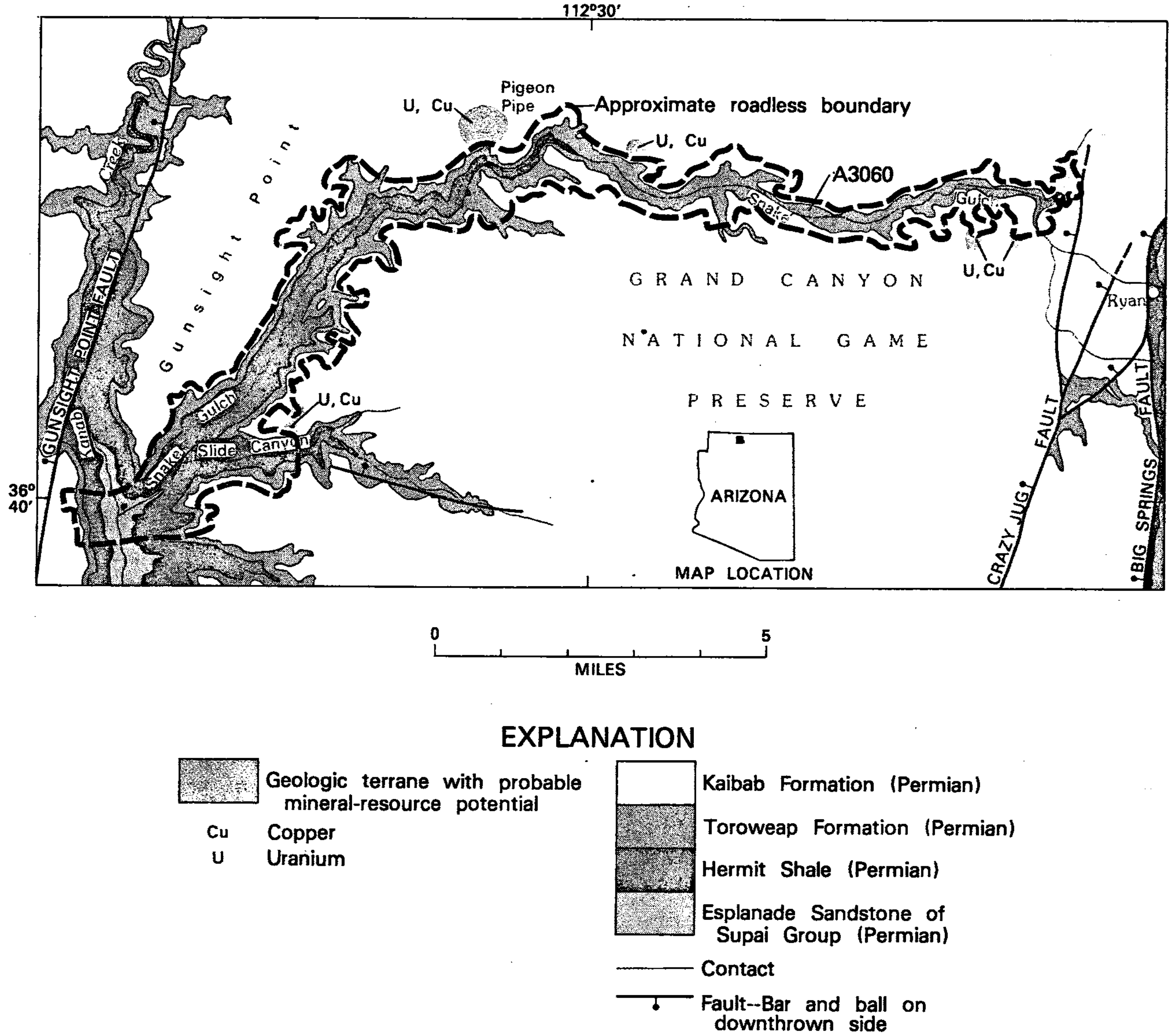

Figure 20.—Kanab Creek Roadless Area, Arizona.

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STRAWBERRY CRATER ROADLESS AREAS, ARIZONA

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SUMMARY

The results of a mineral survey conducted in 1980 in the Strawberry Crater Roadless Areas, Arizona, indicate little promise for the occurrence of metallic mineral or fossil fuel resources in the area. The area contains deposits of cinder, useful for the production of aggregate block, and for deposits of decorative stone; however, similar deposits occur in great abundance throughout the San Francisco volcanic field outside the roadless areas. There is a possibility that the Strawberry Crater Roadless Areas may overlie part of a crustal magma chamber or still warm pluton related to the San Francisco Mountain stratovolcano or to basaltic vents of late Pleistocene or Holocene age. Such a magma chamber or pluton beneath the Strawberry Crater Roadless Areas might be an energy source from which a hot-, dry-rock geothermal energy system could be developed, and a probable geothermal resource potential is therefore assigned to these areas.

CHARACTER AND SETTING

The Strawberry Crater Roadless Areas are located in Coconino County, Arizona, approximately 20 mi northeast of Flagstaff, Arizona. Together the two roadless areas encompass 15.5 sq mi in the northeastern portion of the Coconino National Forest. The Strawberry Crater Roadless Areas are accessible from U.S. Highway 89 by several interconnecting USFS roads.

The eastern San Francisco volcanic field was previously studied by Moore and Wolfe (1976). The area, in the southern part of the Colorado Plateau, is underlain by largely basaltic Quaternary lavas and cinder cones that overlie nearly horizontal Permian Kaibab Limestone or Triassic siltstone or sandstone of the Moenkopi Formation. Holocene basaltic cinders from the eruption of Sunset Crater mantle much of the area. Locally, basaltic ash has been reworked to form small dunes. Tree-ring dating (Smiley, 1958) indicates that the lavas and cinders of the Sunset Crater eruptions are less than 1000 years old.

The Strawberry Crater flow consists of blocky basaltic andesite dated at less than 100,000 years old (Damon and others, 1974). The cone, built largely of agglutinated basaltic andesite spatter, was breached by the flow. Subsequently a small dacite vitrophyre plug was emplaced within the breached cone. In addition to resting on older Quaternary basalt, Strawberry Crater and its lava flow overlie the east edge of the rhyodacite of Deadman Mesa, which erupted from the O'Leary Peak silicic center and has been dated at about 0.17 m.y. (million years) old (P. E. Damon and M. Shafiqullah, unpub. data, 1980).

There has been no mining in the Strawberry Crater Roadless Areas, and exploration and mining activity in the general vicinity of Strawberry Crater have been limited to cinder and pozzolan deposits. Cinder deposits within 5 mi of the roadless areas were being mined in 1980. No other commodities are known to occur in the areas.

MINERAL RESOURCES

All rocks exposed in the Strawberry Crater Roadless Areas are relatively unaltered; there is no evidence of mineralization. Semiquantitative spectrographic analyses of samples of flow and pyroclastic units give values appropriate for unaltered basaltic rocks (Wolfe and Hahn, 1982) and show no indication of concealed metallic mineral resources.

The Strawberry Crater Roadless Areas contain deposits of cinder suitable for the production of aggregate block and deposits of decorative stone; similar deposits occur in great abundance throughout the San Francisco volcanic field outside the roadless areas.

The Strawberry Crater Roadless Areas are within a region of the San Francisco volcanic field that has probable resource potential for geothermal energy. The youngest volcanic vents of the San Francisco field are in the general vicinity of Strawberry Crater. These include Sunset Crater, which is less than 1000 years old, the rhyolite of Sugarloaf (K-Ar age is approximately 0.22 m.y.), and the dacitic to rhyolitic O'Leary Peak center (K-Ar ages of approximately 0.17 and 0.24 m.y.) (K-Ar ages from Damon and others, 1974, and P. E. Damon and M. Shatiqullah, unpub. data, 1980). Strawberry Crater itself erupted less than 0.1 m.y. ago (Damon and others, 1974). Strawberry Crater, O'Leary Peak, Sugarloaf, and the exposed conduit system for the San Francisco Mountain stratovolcano, which erupted largely between 1.0 and 0.4 m.y. ago, form an alinement that coincides closely with a distinct linear aeromagnetic low (Sauck and Sumner, 1970); a common volcano-tectonic control for these vents is suggested (Wolfe and Hoover, 1982). If an intrusive complex related to these alined vents and to the coincident aeromagnetic low contains residual magmatic heat or is partly molten, it may comprise a potential source of geothermal energy. Stauber (1982) suggested that one of several possible explanations for low compressional wave velocity approximately 6.5 to 22 mi below San Francisco Mountain would be the presence of partly molten rock. In addition, magnetotelluric soundings show local anomalously low resistivities at depth near Sunset and Strawberry Craters (Ware and O'Donnell, 1980). Possibly these anomalies reflect locally high lower crustal temperatures.

SUGGESTIONS FOR FURTHER STUDIES

Additional geophysical studies to elucidate the electrical and magnetic characteristics of the crust beneath the eastern part of the San Francisco volcanic fiel would contribute to evaluation of geothermal resource The most definitive information, however, will be ob tained only when and if holes suitable for heat-flov studies are drilled into the Precambrian basement.

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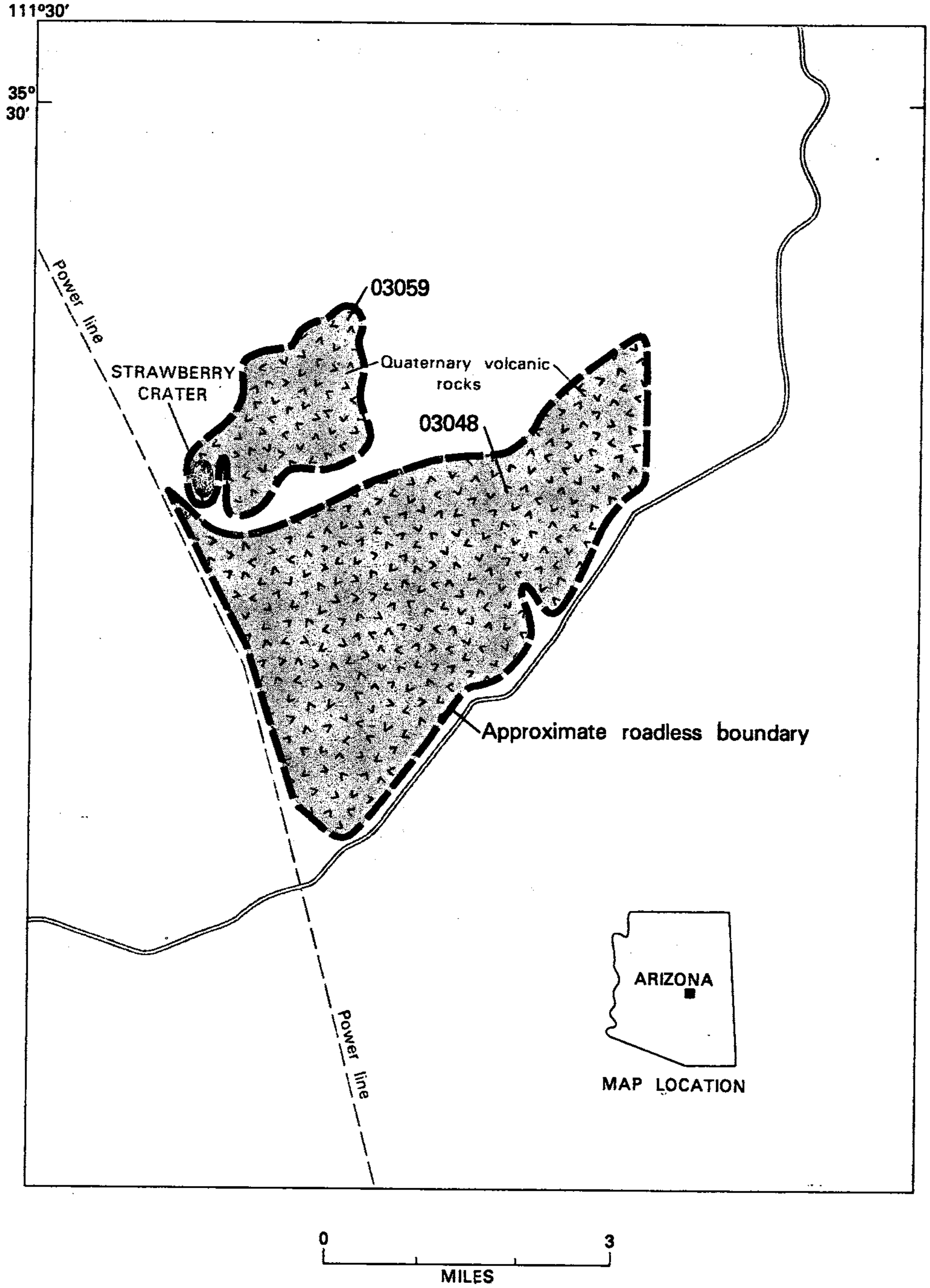

EXPLANATION

Geologic terrane with probable geothermal resource potential

Figure 30.—Strawberry Crater Roadless Areas, Arizona.

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SYCAMORE CANYON PRIMITIVE AREA, ARIZONA

By LYMAN C. HUFF, U.S. GEOLOGICAL SURVEY, and

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SUMMARY

On the basis of a mineral survey made by the USGS and USBM in 1965, the Sycamore Canyon Primitive Area has little promise for the occurrence of mineral commodities.

CHARACTER AND SETTING

The Sycamore Canyon Primitive Area, which occupies about 74 sq mi, lies about 24 mi southwest of Flagstaff, Arizona. The margin of this primitive area corresponds to the rim of deeply eroded Sycamore Canyon. To the southeast, beyond the canyon rim, lies an upland within the Coconino National Forest. To the northwest, also beyond the canyon rim, lies a similar upland within the Kaibab National Forest. These uplands near the head of the canyon have an elevation of about 6700 ft above sea level. In its lowest part, where Sycamore Creek leaves the primitive area at its southern end, the area has an elevation of 3600 ft. Through much of the area the canyon is more than 1700 ft deep.

The rocks in Sycamore Canyon consist almost entirely of flat-lying sedimentary rocks of Paleozoic age. Many of the formations that crop out in the Grand Canyon National Park also crop out in Sycamore Canyon and form similar beautiful cliffs.

The Paleozoic sedimentary rocks include thick formations of limestone, siltstone, and sandstone. Above these is a thin layer of mudstone and sandstone of early Mesozoic age, which is in turn overlain locally by gravel and basalt flows of Tertiary and Quaternary age. The alluvial sand and gravel deposits along the narrow flood plain of Sycamore Creek are also of Quaternary age. The basaltic igneous rocks present are located mostly near the head of the canyon. They are flows and dikes peripheral to the volcanic complex centering around San Francisco Mountain to the north.

Access to Sycamore Canyon is limited to hiking trails which wind down from the canyon rim to the narrow lowland along Sycamore Creek. Vistas are similar to that along the Kaibab Trail at Grand Canyon but on a smaller scale. Kelsey Spring and other springs in the northern part of the canyon provide fresh water near good camping sites. During late summer much of the flow of Sycamore Creek is underground and good sources of water in the lower part of the canyon are difficult to find.

MINERAL RESOURCES

No evidence of mineral deposits was discovered in this area. The sedimentary beds are cut by numerous small faults but none of these are mineralized. The rocks are well exposed so that if any mineral deposits were located in the area they would almost certainly be noticed.

The only mining claims located in the area are near the southern end where two partners excavated the clay fill in a cave close to Sycamore Creek in the belief that that is where the renegade Apache Indian Geronimo buried treasure. This cave, which is limestone, and its clay filling were examined carefully and concluded to be entirely natural.

To help evaluate the area for mineral resources, sediment samples were collected along Sycamore Creek and its tributaries. These were analyzed for traces of the ore metals without finding any local concentrations. In addition, a scintillometer was used to test rocks in the area without finding any abnormal radioactivity.

No oil wells have been drilled in the area and it is unlikely that any drilled would be successful. Geologic structures favorable for accumulating oil are lacking and geologic mapping indicates that Precambrian crystalline rocks unsuitable for oil underlie the area at relatively shallow depth.

SUGGESTIONS FOR FURTHER STUDIES

Further study of this primitive area offers little promise for the discovery of any hidden mineral deposits.

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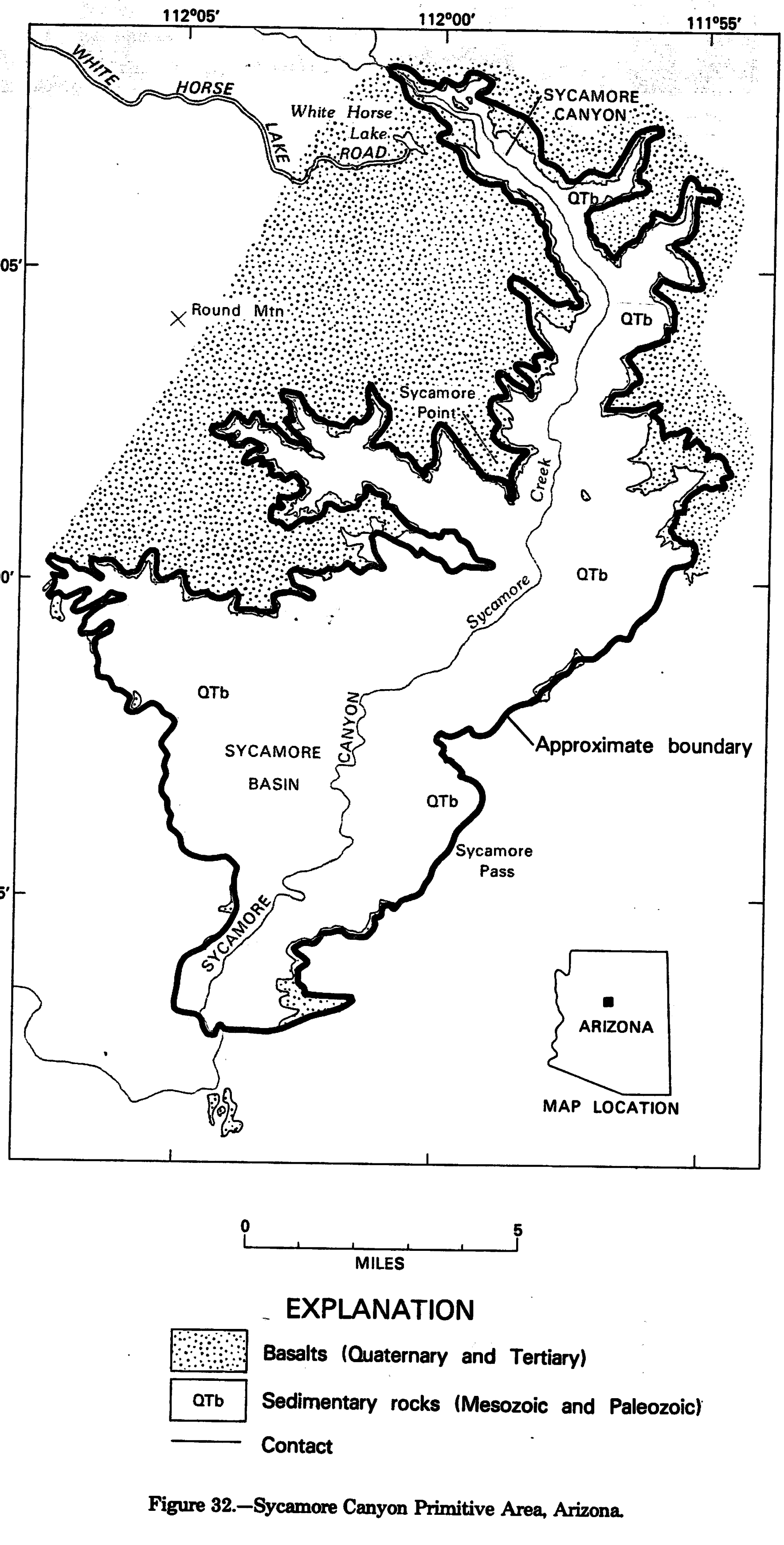

Figure 32.—Sycamore Canyon Primitive Area, Arizona.

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RATTLESNAKE ROADLESS AREA, AR

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SUMMARY

There is little promise for the occurrence of mineral or energy resources in the Rattlesnake Roadless Area, Arizona, as judged from field studies by the USGS and USBM in 1982. Significant concentrations of minerals within the roadless area are not indicated by geologic mapping, geochemical sampling, or aeromagnetic studies. Basalt, volcanic cinders, sand and gravel, and sandstone that may be suitable for construction materials occur in the area, but are more readily accessible outside the roadless area boundary.

CHARACTER AND SETTING

The Rattlesnake Roadless Area is an area of about 110 sq mi located in Yavapai and Coconino Counties, central Arizona. Sedona and Oak Creek, the nearest population centers, are located, respectively, at the northwest corner and along the western margin of the roadless area.

The roadless area boundary mainly follows the rims of steep-walled canyons cut into the Mogollon Rim of the Colorado Plateaus by Dry Beaver Creek and its main tributaries in Jacks, Pine Tank, and Rattlesnake Canyons. The area is skirted by Interstate Highway 17 to the east and southeast, by State Highway 179 to the southwest and west, and by Schnebly Hill Road (USFS road 153) to the north. The canyon mouths mark the edge of the Mogollon Rim where its gently westward dipping surface falls off abruptly to the Verde Valley, a structural basin in the Arizona transition zone floored with a thick sequence of deeply dissected lake deposits. The maximum altitude in the roadless area is 6834 ft on the eroded plateau surface; the lowest altitude, 3480 ft, is on Dry Beaver Creek where it flows into Verde Valley.

The canyon walls in the area expose multicolored sedimentary rocks of Pennsylvanian to Early Permian age as much as 2500 ft thick, unconformably overlain by basaltic rocks and associated gravels and fluviolacustrine deposits of Tertiary age as much as 500 ft thick. The exposed Paleozoic rocks include (from bottom to top): distinctive reddish siltstone and sandstone of the lower, middle, and upper units of the Supai Formation (525 ft), including in the upper unit the gray to greenish-gray limestone of the Fort Apache Limestone(?) Member of the Supai Formation (about 25 ft); a transition zone of alternating red and gray siltstone and sandstone (550 ft); the grayish thick-bedded, primarily eolian crossbedded sandstone of the Coconino Formation (600 ft); the grayish thin- to medium-bedded sandstone of the Toroweap Formation (350 ft); and erosional remnants of the lower part of the grayish to buff limestone and dolomite of the Kaibab Formation (less than 300 ft). Subsurface data indicate that the exposed sedimentary rocks are underlain by Cambrian to Pennsylvanian sandstone, siltstone, and limestone more than 1000 ft thick that lie unconformably above metamorphosed and intruded basement rocks of Precambrian age (Earl Huggins, oral. commun., 1983).

The volcanic rocks mantling the Plateau surface are mainly alkali olivine basalt flows that locally overlie Tertiary gravels and that were fed by dikes or plugs which cut underlying rocks as young as late Tertiary in age. Radiometric dating of basaltic flows in the region (Damon and others, 1974; Peirce and others, 1979) indicates that volcanic activity was concentrated mainly in Miocene and Pliocene time. The volcanic rocks directly overlie either eroded Paleozoic strata or Tertiary conglomerates. At lower altitudes, interbedded conglomerates and lacustrine deposits are intercalated with basalt flows that record late volcanic eruptions contemporaneous with marginal lacustrine deposition in Lake Verde during Pliocene time (Nations and others, 1981). Within the roadless area, Lake Verde at its maximum extent rose to about the present 5000 ft level.

[1]With contributions from George H. Billingsley, USGS.

During dissection after the lake retreated, a series of Quaternary fluvial gravels were deposited in the roadless area. Locally, as many as five aggradational epicycles are recorded by terrace gravels and alluvial fans that graded to successively higher levels above present stream grade.

The nearly flat lying Paleozoic and Cenozoic rocks in the roadless area are cut by a system of near-vertical curving normal faults that trend northwest, north-south, and east-west. Traced southward through the area, the northwest-trending and north-south-trending faults tend to decrease in displacement and to split into a series of curving faults that define both horsts and grabens. This progressive decrease in displacement and bifurcation into secondary faults suggest that the roadless area lies near the margin of a structural subprovince. Downward displacements on bounding faults have occurred around the Munds Mountain-Lee Mountain upland. A magnetic high coincides with the differentially elevated crustal block, which indicates that the block is probably intruded at depth by an igneous body of high magnetic susceptibility (Martin, 1983). Faulted basalt flows on Horse Mesa, which have a potassium-argon age of 6.4 million years (Peirce and others, 1979), suggest latest fault movement along the north-south-trending Oak Creek Canyon fault zone in late Miocene or later time.

MINERAL RESOURCES

Based on geologic mapping, geochemical sampling and analysis (Gerstel and others, 1983), aeromagnetic data (Martin, 1983), and a review of County and Federal land records, the roadless area is evaluated as having little promise for the occurrence of mineral-resource potential. Significant mineral concentrations were not observed nor previously reported from the roadless area. Field observations and geochemical sampling along steep-dipping faults and intrusive contacts, and the available subsurface information do not suggest extensive mineralization at depth. Concentrations of heavy minerals that would suggest potential placer deposits or buried upstream source bodies were not tected in outcrop nor indicated by geochemical s pling of the fluvial and fluviolacustrine deposits in roadless area. The basaltic flows, cinders, and sand gravel can be used for road metal, concrete aggreg riprap, or cinder block, and some of the sandstone posed in canyon walls might provide usable buildi stone and flagstone. Similar construction materi however, are more readily accessible and closer markets outside the roadless area boundaries.

SUGGESTIONS FOR FURTHER STUDIE

Further mapping and sampling in the roadless a offer little promise for establishing any significa mineral-resource potential.

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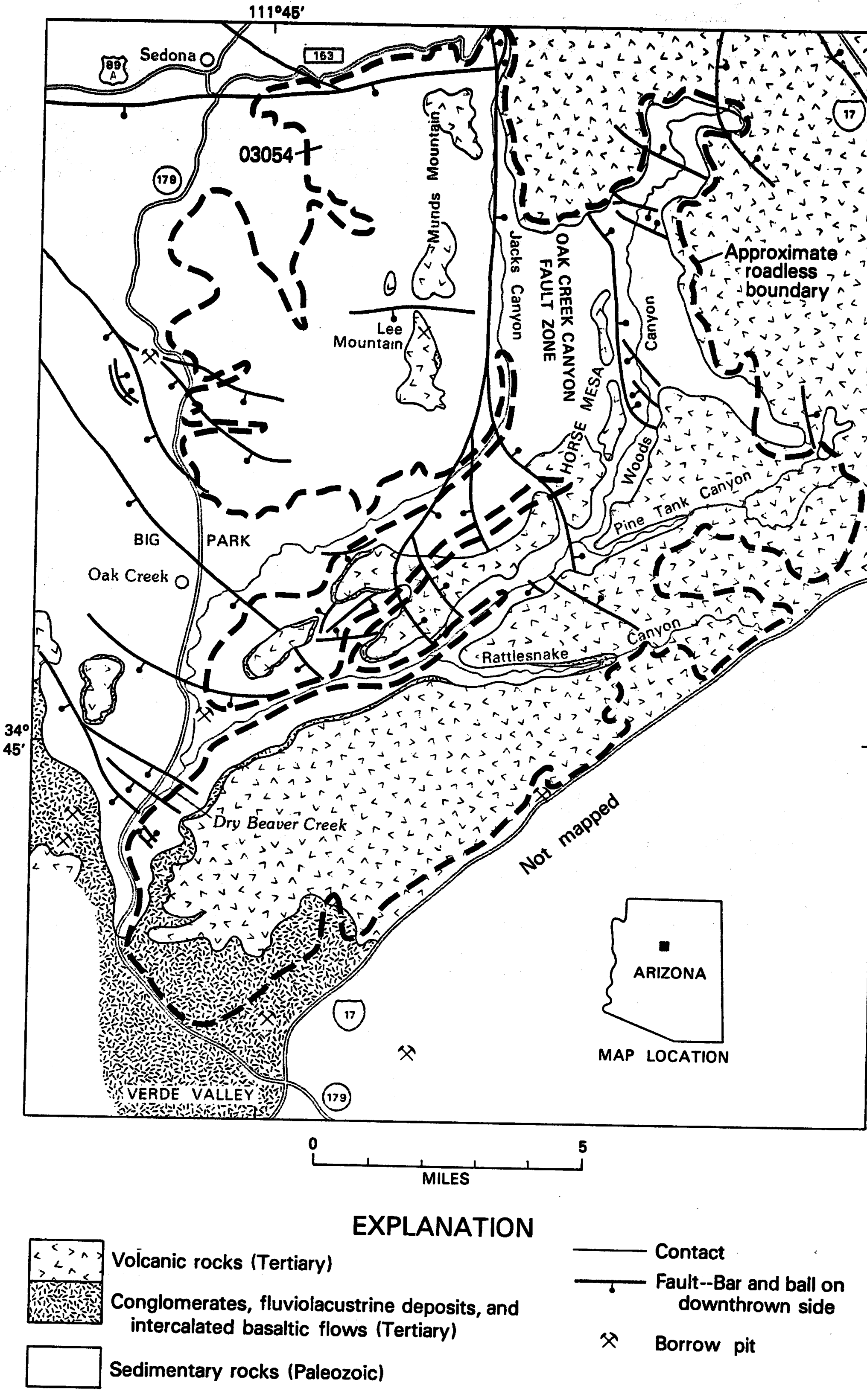

Figure 27.—Rattlesnake Roadless Area, Arizona.

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FOSSIL SPRINGS ROADLESS AREA, ARIZONA

By L. S. BEARD,[1] U.S. GEOLOGICAL SURVEY, and

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SUMMARY

Based on field studies conducted by the USGS and the USBM during 1980–81, the Fossil Springs Roadless Area in central Arizona is concluded to have little promise for the occurrence of mineral or energy resources. Rocks in the Supai Formation (Pennsylvanian-Permian) near the central part of the roadless area contain widespread but spotty copper mineralization and trace amounts of uranium. Analyses obtained during the study define geochemical anomalies in two portions of the area that remain unexplained. The suites of anomalous metals suggest the possibility of hydrothermal veins and the presence of ultramafic rocks; neither were found in the field. Construction materials present within the roadless area—chiefly basalt, sandstone, limestone, and dolomite—are readily available in abundance and more accessible in adjacent areas. The presence of oil and gas is unlikely; the only producing wells in Arizona are in formations not present in the Fossil Springs Roadless Area.

CHARACTER AND SETTING

The Fossil Springs Roadless Area includes about 22 sq mi of plateau and canyons in the Coconino National Forest in Yavapai, Gila, and Coconino Counties, Arizona. The roadless area lies near the Mogollon Rim, southern boundary of the Colorado Plateau, which in this vicinity is characterized by steep-walled canyons cut into a high tableland of relatively flat lying Paleozoic sedimentary rocks veneered locally with Tertiary volcanic rocks.

Paleozoic and Cenozoic rocks present in the Fossil Springs Roadless Area have a cumulative thickness of about 3000 ft. The bulk of the outcrops in the canyon walls in the northeastern part of the area consist of sandstone, siltstone, shale, and minor limestone of the Supai Formation (Pennsylvanian and Permian) and crossbedded sandstone of the Coconino Sandstone (Permian). To the northwest, the plateau is covered by Tertiary volcanic rocks, a few tens to a few hundred feet thick. South of Fossil Springs the volcanic rocks, chiefly dark gray basalts and yellowish-gray basaltic and dacitic tuffs, thicken abruptly to more than 2000 ft against an ancestral Mogollon Rim (Twenter, 1962) cut into the Paleozoic section by prevolcanism erosion. Preserved locally beneath the volcanics are Tertiary gravel deposits containing clasts of lower Paleozoic and Precambrian lithologies. A K-Ar age of 10.16±0.22 million years for a basalt flow about 1250 ft above the floor of the canyon gives a minimum age of formation of the ancestral Mogollon Rim and subsequent deposition of the gravels (Pierce and others, 1979). A unique feature of the area is a deposit of travertine (Pleistocene and Holocene) that forms a conspicuous bench above Fossil Springs. Thin sheets of colluvium and masses of landslide blocks obscure much of the outcrop throughout the roadless area.

The prevailing dip of the Paleozoic strata is low toward the north or northeast. This homoclinal structure is broken into several fault blocks in which the strata dip westerly or southerly. All the faults in the roadless area are high-angle normal faults that have displacements commonly ranging from about 50 to 400 ft. The Tertiary volcanic rocks, which rest unconformably on the Paleozoic strata, are flat lying in the northern part of area, but south of Fossil Springs they dip gently southwestward. Most of the faults that cut Paleozoic strata seem to displace the volcanic rocks also, but with less displacement. The buried ancestral Mogollon rim appears to be in part structurally controlled, but this is difficult to prove because of poor exposures. Few of the

[1]With contributions from G. W. Weir, USGS.

faults can be traced in the volcanics away from the canyon rims because of the lack of lithologic contrasts on the plateau top.

MINERAL RESOURCES

An aeromagnetic map of the Fossil Springs Roadless Area (Davis and Weir, 1983) shows variations in total magnetic intensity of the area related to magnetic property contrasts in the volcanic rocks and to magnetic contrasts between the basalts and the sedimentary rocks. There are no magnetic lows that might represent zones of alteration in which metallic mineral deposits may occur, nor of magnetic highs that would indicate any large masses of high magnetic susceptibility, other than basalt.

Geochemical analyses obtained on samples of stream sediments, pan concentrates of stream sediments, bedrock, and mineralized rock from the copper-uranium occurrences define complex geochemical anomalies that as yet cannot be geologically accounted for. Panned concentrate samples containing anomalous levels of chromium, cobalt, and nickel normally associated with ultramafic rocks were found in the central part of the area, about 1 mi upstream from Fossil Springs. In the upper reaches of Calf Pen Canyon, large barium and beryllium anomalies in the pan concentrates suggest possible hydrothermal vein deposits. Neither ultramafic rocks nor vein systems were observed in the field. The source of these anomalies is not known. The chromium, cobalt, and nickel anomalies are perhaps related to either a thin mafic dike or flow or to mineralization along a fault zone; neither was observed in the field. The barium and beryllium anomalies might be related to barite veins; although none are known in the roadless area, occurrences have been reported to the south along Tertiary fault zones (C. M. Conway, oral commun. 1982). The anomalies do not seem to indicate the occurrence of mineral resources.

The Fossil Springs Roadless Area does not lie within an organized mining district. Four bulldozer cuts originally made during coal prospecting and later utilized for copper and uranium exploration in Permian rocks are included in a block of claims located in 1962 and 1969 in the central part of the roadless area. The prospects were inactive in 1980 and early 1981. Quarries in Paleozoic sandstone and Tertiary basalt near the borders of the roadless area were also inactive in 1980 and early 1981.

Copper-uranium occurrences are found within a discontinous zone, a few tens of feet thick, in the lower third of the Supai Formation about 400 ft above the base of the formation. This zone is characterized by lenses of limestone-pebble conglomerate, sandstone, and carbonaceous shale, interstratified with lesse amounts of siltstone, shale, and sandstone. Radioacti ity due to the uranium occurrences is generally confine to coaly layers within carbonaceous shale and most c the copper minerals also occur in the carbonaceous sha or in gray sandstone and conglomerate interlayere with carbonaceous shale. Mineralization is sporadic an not concentrated; the sparsely mineralized rock occu pies only a small part of the zone and is commonly onl a few inches to a few feet thick and extends a few feet t several tens of feet along the outcrop. This minor mine alization is not assessed as being a resource and n resource potential for the area was identified.

Flagstone has been quarried from two small working in the Coconino Sandstone near the southeast edge c the area. Basalt quarried from three small workings o the southeast and south edges of the area was probabl used locally as road material. Both of these commod ities are in abundance outside the area. No energy re source potential was identified in this study.

SUGGESTIONS FOR FURTHER STUDY

Although there is little promise for the occurrence o mineral resources in the Fossil Springs Roadless Are studies to identify the source of the geochemical anoma lies could have valuable implications for regional stud ies and mineral exploration in the surrounding area Anomalies of this type are unexpected in terms of wha is presently known of the geology of the area; of partic ular interest is that ultramafic bodies are not known t occur in this region.

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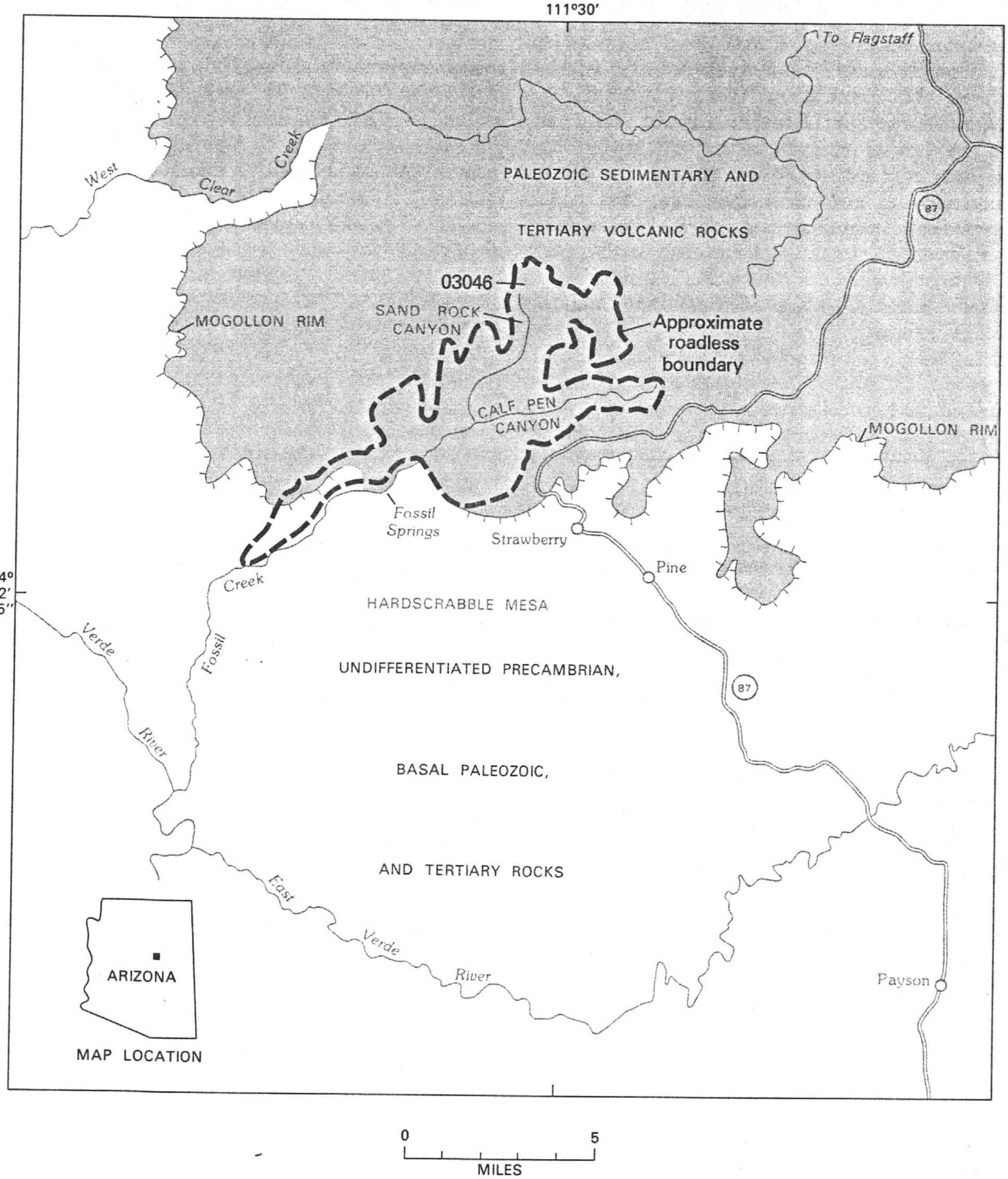

Figure 16.—Fossil Springs Roadless Area, Arizona.

and stratigraphically controlled.

The mineralized area also