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Mineral resource potential of the Emmett Wash Wilderness Study Area (AZ-010-009), Coconino County, Arizona

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The Federal Land Policy and Management Act (Public Law 94-579, October 21, 1976) requires the U.S. Geological Survey and the U.S. Bureau of Mines to conduct mineral surveys on certain areas to determine their mineral resource potential. Results must be made available to the public and be submitted to the President and the Congress. This report presents the results of a mineral survey of the Emmett Wash Wilderness Study Area (AZ-010-009), Coconino County, Arizona.

SUMMARY STATEMENT

The mineral resource potential of the Emmett Wash Wilderness Study Area is classed as follows: metalliferous deposits, extremely low; nonmetallic deposits (limestone), low; oil and gas resources, extremely low. The limestone (sandy dolomitic limestone) resources are fairly large, but the market for these materials is very small and entirely local.

INTRODUCTION

The Emmett Wash Wilderness Study Area (EWWSA) comprises 12,913 acres (5,225 hectares) in northeastern Coconino County, Arizona, about 20 miles (30 km) southwest of Page, Arizona. The EWWSA is bounded on the north and west by U.S. Highway 89A; on the east generally by the rim of the Marble Canyon of the Colorado River, which is the boundary of Grand Canyon National Park; and on the southwest and south by an unimproved access road and a section line. To the north and west, the area is contiguous with the Vermilion Cliffs-Paria Canyon Instant Study Area (Bush, 1982; Bush and Lane, 1980). The EWWSA could be more appropriately titled the "South Fork of Soap Creek WSA," for that at least flows through the area. Emmett Wash does not flow through nor do any of its tributaries; only a few ephemeral tributaries to the Rider Canyon part of House Rock Wash drain the southern part of the EWWSA.

The study area is a small part of the Marble Platform, a rock-held stripped plain that extends southward on both sides of the Colorado River from Lees Ferry and that rises in altitude from about 3,100 feet (950 m) to about 6,000 ft (1,800 m) some 40 mi (65 km) to the south (Haynes and Hackman, 1978). Local relief on the interfluves in the study area and elsewhere on the Platform seldom exceeds a few tens of feet, but along Soap Creek and a minor unnamed drainage southeast of Soap Creek, and in Rider Canyon the downcutting reaches hundreds of feet. All the streams in the EWWSA are intermittent or ephemeral, although permanent springs in the headwaters of Soap Creek probably ensure that there is year-round subsurface flow along most of its length.

Eolian sand and a mixture of eolian and fluvial sands and silts cover a large part of the EWWSA, mostly in its southwestern sector. Bedrock is near or at the the surface nearly everywhere, and soil is thin and sandy. Vegetation is sparse and consists almost entirely of desert shrubs and grasses, consistent with the arid to semiarid climate.

Cattle raising is the only activity inside the study area, but tourism, recreational fishing, and Colorado River expeditions are serviced at Cliff Dwellers Lodge, just across Highway 89A at the EWWSA's northern boundary.

No mining has been conducted within the EWWSA, but some prospecting for uranium has been done nearby, and minor production has resulted at two deposits (Bush and Lane, 1980). The mineral resource potential of the Emmett Wash Wilderness Study Area is negligible.

GEOLOGY, GEOCHEMISTRY, AND GEOPHYSICS

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Geologic setting

The bedded rocks of the Emmett Wash Wilderness Study Area extend from the Pennsylvanian and Permian Supai Formation to the Lower and Middle(?) Triassic middle red member of the Moenkopi Formation (Petersen, 1959; Phoenix, 1963) (see fig. 1 on pl. 1). The Supai Formation and the overlying Permian Hermit Shale, Coconino Sandstone, and Toroweap Formation crop out only in the steep-walled canyons of Soap Creek, in an unnamed drainage southeast of Soap Creek, and in Rider Canyon (the lower end of House Rock Wash). The Permian Kaibab Limestone conformably overlies the Toroweap and forms the floor of the Marble Platform. Along the northwestern side of the EWWSA erosional remnants of the middle red member of the Moenkopi Formation rest on the Kaibab, and in turn are overlain by unconsolidated eolian, fluvial, and alluvial-fan deposits. In the foothills of the Vermilion Cliffs immediately to the west, the Shnabkaib and upper red members of the Moenkopi, and the Shinarump, Petrified Forest, and Owl Rock Members of the Triassic Chinle Formation crop out and are involved in extensive toreva blocks, landslides, and mudflows. Above these units the Vermilion Cliffs consist of the Upper Triassic and Lower Jurassic Glen Canyon Group, made up of the Dinosaur Canyon and Springdale Members of the Moenave Formation, the Kayenta Formation, and the massive caprock of the Navajo Sandstone, which forms the surface of the Paria Plateau. The lithologic and outcrop characteristics of these rocks are described in the columnar section shown in table 1.

Within the study area the rocks are virtually unfaulted. The homoclinal (and regional) dip is 1° to 2°, from generally northwestward in the southern part of the area to northward in the northern part. In detail, there are small warps in the Kaibab Limestone, but their persistence in depth is uncertain--they may not be present in the underlying and virtually totally concealed Toroweap Formation.

Factors affecting mineral resource assessment

Lithology of the few exposed formations is the most important factor affecting a mineral resource assessment. Structural features are negligible--there are no faults, few joints, and only minor warps along the north-dipping homocline. No significant alteration of the sedimentary rocks is evident. The bedded rocks range from sandy dolomitic limestone through shales and siltstones to fluvial and eolian crossbedded sandstones.

The Kaibab Limestone is at or near the surface over virtually the entire EWWSA, but only the uppermost 100 ft (30 m) or so are easily accessible. The remainder of the 400-ft-thick (120 m) unit, and the underlying Toroweap, Coconino, and Hermit rocks are exposed only at the forks of Soap Creek and in the nearly vertical walls of Soap Creek and Rider Canyons. Only the basal few feet of the middle red member of the Moenkopi Formation remain overlying the Kaibab in isolated, low buttes; thin surficial deposits of eolian and fluviatile sands cover large areas, and deposits of pediment gravels are considerably less extensive.

Bush and Lane (1980 and 1982) have reported that stratigraphic facies changes eastward from the western part of the Arizona Strip might result in

Table 1.--Columnar section of the sedimentary rocks that contribute to the surficial deposits of, or that underlie the Emmett Wash Wilderness Study Area, Coconino County, Arizona

[Based on Phoenix (1963) and Green and others (1977)]

Age	Name			Thickness	Description	Weathering form
Holocene and Pleistocene (?)	No formal names			30± ft 10± m	Alluvial fan sand and gravel, windblown and reworked fluvial sand and silt, mudflow and rockslide debris	Lobate tongues, hummocks, and alluvial sheets
Early Jurassic and Late Triassic(?)	Glen Canyon Group	Navajo Sandstone		1675-1855 ft 510-565 m	Sandstone, shades of gray to red-brown and orange, massive, sweepingly crossbedded in places, few lenses of dark-brown chert	Nipples, buttes, high sheer cliffs
Late Triassic(?)		Kayenta Formation		120-310 ft 35-95 m	Sandstone, pale-red-brown, massive, crossbedded and evenbedded, and alternating sandstone and siltstone, ripple marked	Benches and ledges, cliffs
		Moenave Formation	Springdale Member	180-220 ft 55-65 m	Sandstone, red, massive, darkly stained, broadly lenticular beds	Cliffs
			Dinosaur Canyon Member	90-220 ft 25-65 m	Sandstone, red-orange, flat-bedded, siltstone, varicolored, and mudstone, varicolored	Ledges, steep slopes
Late Triassic	Chinle Formation		Owl Rock Member	150-200 ft 45-60 m	Limestones, cherty, conglomeratic, nodular; sandstone, siltstone, clayey mudstones, dark-red, nonbentonitic	Cliffs and slopes
			Petrified Forest Member	625-810 ft 190-245 m	Mudstone and claystone, variegated yellow, pink, green, and blue, bentonitic; some siltstone, sandstone, and limestone pebble conglomerate	Smooth, rounded "popcorn" slopes
			Unnamed unit	0-175 ft 0-50 m	Sandstone, arkosic, crossbedded, light-colored and silty mudstone, dark-red, gray, gray-green. Dies out westward. Fossil logs.	Ledges, steep slopes
			Shinarump Member	0-150 ft 0-45 m	Conglomeratic sandstone and conglomerate, lenticular, crossbedded, light-gray to pale-brown, fills channels, organic trashy fossil logs, uraniferous, cupriferous	Prominent bench and ledges
Middle(?) and Early Triassic	Moenkopi Formation		Upper red member	15-120 ft 5-35 m	Limy siltstone, mudstone, silty claystone, micaceous, thin limestone in east; sandstone, massive, pale-brown, makes "marker" bed near base	Cliffs and steep slopes
			Shnabkaib Member	0-15 ft 0-5 m	Clayey siltstone, micaceous, gypsiferous, thin-bedded, uniform light-gray to light-gray-green, noncalcareous	Steep slopes
			Middle red member	310-650 ft 95-200 m	Siltstone and mudstone, micaceous, gypsiferous, uniform pale-red-brown, noncalcareous, thin-bedded, ripple marked	Concave slopes
Early Permian	Kaibab Limestone			325± ft 100+ m	Upper third: limestone, cherty, dolomitic; dolomite, siltstone; calcareous sandstone; tan and light-gray, fossiliferous. Lower two-thirds: dolomite, cherty; limestone, dolomitic; sandstone; alternating sequence, white to grayish-yellow, fossiliferous	Cliffs and benches
	Toroweap Formation			120 ft 35 m	Upper part interbedded, white and light-grayish-yellow, fine-grained, crossbedded sandstone, dark-red silty mudstone and siltstone, light-gray, cherty limestone; somewhat wavy bedding; horizontally bedded basal sandstones are usually reddish-brown	Cliffs and steep slopes
	Coconino Sandstone			60 ft 20 m	Light-yellow-gray, medium- to fine-grained, tangentially (and sweepingly) crossbedded, eolian sandstone; crossbeds may transgress nearly entire unit; rain prints, vertebrate tracks	Sheer cliffs
	Hermit Shale			500 ft 150 m	Deep brownish-red, thin-bedded siltstone and shale; lighter colored fine-grained sandstone interbeds; ripple marked, rain prints. Locally apparently unconformable on the Supai Formation	Smooth, steep slopes
Permian and Pennsylvanian	Supai Formation			500 ft 150 m	Light colored, fine- to medium-grained, medium- to thick-bedded sandstone in upper third, interbedded with red-brown siltstone and shale. Lower two-thirds inaccessible, cliff-forming interbedded sandstone and limestone; probably deltaic	Steep slopes and ledges above sheer cliffs

Table 1.--Columnar section of the sedimentary rocks that contribute to the surficial deposits of, or that underlie the Emmett Wash Wilderness Study Area, Coconino County, Arizona.

stratigraphic traps for oil and gas in the Permian rocks (Kaibab, Toroweap, Coconino). These rocks underlie the EWWSA, and are exposed in the walls of Marble Canyon and its tributaries. No structural traps appear to be present. There are no known oil seeps or occurrences of dead oil in these exposures, and the nearness of the study area to the exposures suggests that no organic fuels remain if, indeed, they ever were present. There is no data on which to base speculation on oil and gas possibilities of the unexposed rocks that lie between the Coconino Sandstone and the Precambrian basement.

Stream sediments in the EWWSA were sampled at 12 sites along stream courses (a density of one sample per thousand acres) and an additional 21 samples were taken outside the EWWSA, within about 1 mi (1.7 km) of the boundary (fig. 2 on pl. 1). No anomalous concentrations of metals were found (table 2 on pl. 1). The sediment samples are only partly representative of the rocks that crop out in the study area as they are derived to a considerable extent from Triassic and younger rocks that lie northwest of the area.

Geophysical data are virtually lacking. No detailed surveys (scale 1:125,000 or larger) have been made. The area has been studied at much smaller scale (1:250,000 or less), but at these scales the data are not sufficiently detailed to be appropriate for this mineral resource assessment (see Zietz and Kirby, 1967, 1968; LKB Resources, 1979).

MINING DISTRICTS AND MINERALIZATION

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The Emmett Wash Wilderness Study Area contains no known mineralized areas, has had no mining activity, and is not part of a formal mining district. Bush and Lane (1980, 1982; Lane, 1982) have described a few uranium-copper-vanadium-silver deposits that lie from a few hundred yards to a couple of miles from the western and northwestern borders of the EWWSA. The host rocks, the Shinarump and Petrified Forest Members of the Chinle Formation, have been eroded totally from the study area.

ASSESSMENT OF MINERAL RESOURCE POTENTIAL

Metalliferous deposits

The potential for metalliferous deposits in the study area is extremely low. None of the lithologies in the pre-Triassic rocks (sandy dolomitic limestone, shales, siltstones, fluvial and eolian crossbedded sandstones) are known to be metalliferous in the EWWSA or in nearby areas. None of the samples suggest any anomalous concentrations of metals. Younger uraniferous and auriferous rocks of Triassic age have been completely eroded from the area.

Nonmetallic deposits

The potential for industrial rocks and minerals in the EWWSA is low and is confined to the use of the Kaibab Limestone and small patches of gravel (not shown on the geologic map) in the surficial deposits.

The rocks of the upper part of the Kaibab have been tested for suitability for cement, but are too siliceous and too high in $MgCO_3$ (McKee,

1938, p. 62-66; Kiersch, 1955, p. 15). They are suitable for use as agricultural limestone ("agstone," Kiersch, 1955, p. xii) and road metal, but because of their substantial chert content they may be too reactive to use as concrete aggregate. They may not be sufficiently resistant to abrasion to use as top dressing in asphalt road mat. Large quantities are readily available, as the rock is easily accessible throughout the area (fig. 3 on pl. 1), but the market is entirely local (a few miles) for the Kaibab is available at the surface over an area of several thousand square miles. On figure 3 (on pl. 1) the area where the Kaibab is at the surface, within about 1 mile (1.7 km) of U.S. Highway 89A, is rated as low potential.

The patches of gravel are too small to be considered as anything but a local resource.

Oil and gas resources

The potential for oil and gas resources in the study area is considered to be extremely low. If ever there was live oil or gas, it has dissipated to the atmosphere.

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