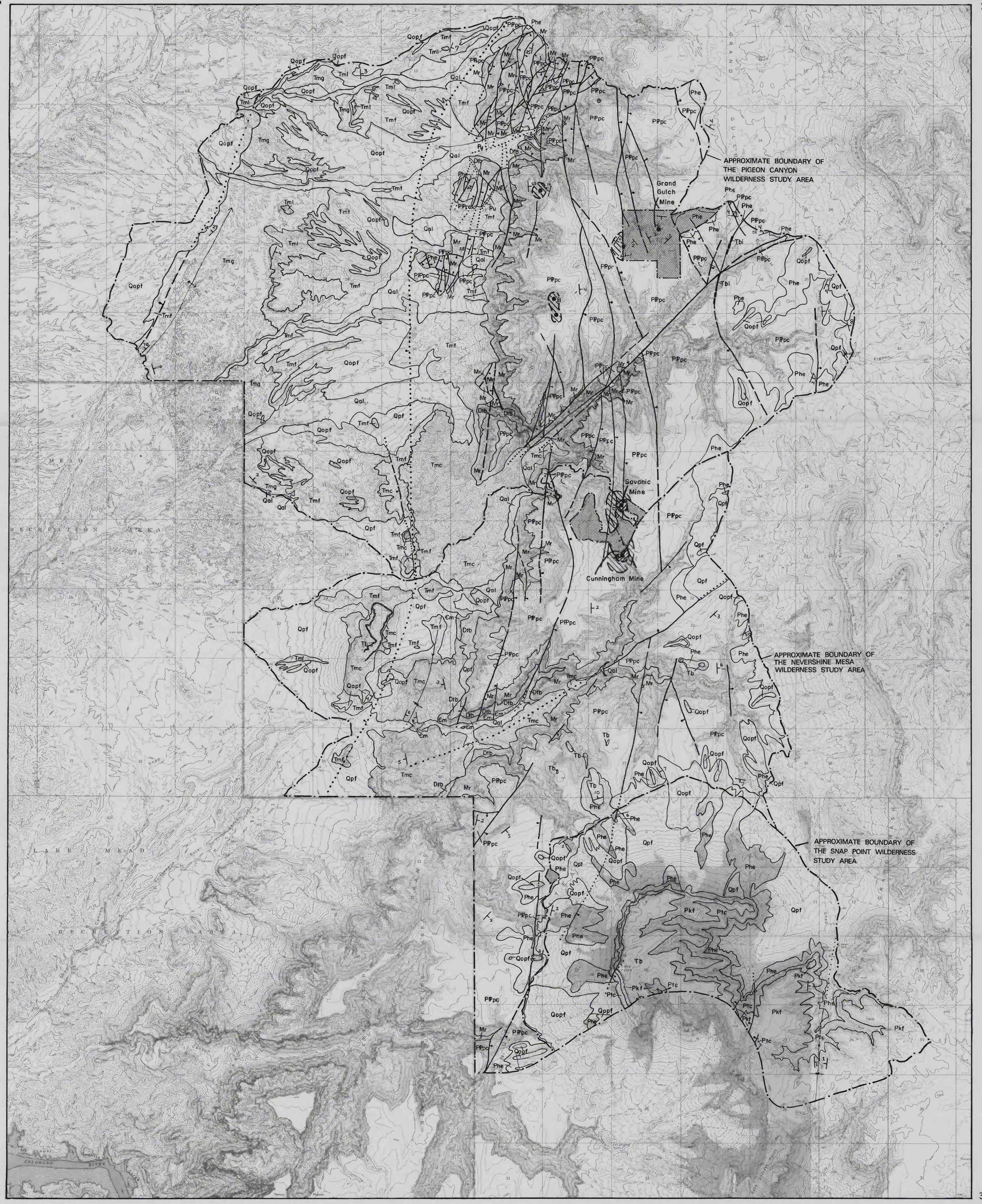
DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

MISCELLANEOUS FIELD STUDIES
MAP MF-1860-A
PAMPHLET ACCOMPANIES MAP

111°57'30"
36°22'30"
111°42'30"
36°22'30"



36°07'30"
111°57'30"
36°07'30"
111°42'30"

Base from U.S. Geological Survey, 1:24,000 Grand Gulch Bench, Gyp Hills, Mustang Point, Snap Canyon East, Snap Canyon West, and Snap Draw, 1971

SCALE 1:50 000
1 ½ 0 1 2 3 MILES
1 .5 0 1 2 3 KILOMETERS
CONTOUR INTERVAL 40 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

Geology by Ivo Lucchitta, L. S. Beard, and H. J. Rieck, 1981-83; local modifications in the Snap Point Wilderness Study Area from Huntoon and others (1982)

EXPLANATION

AREA OF HIGH POTENTIAL FOR URANIUM, COPPER, AND ASSOCIATED METALS SUCH AS LEAD, ZINC, SILVER, ARSENIC, NICKEL, MOLYBDENUM, COBALT, CHROMIUM, AND ANTIMONY

AREA OF MODERATE POTENTIAL FOR URANIUM, COPPER, AND ASSOCIATED METALS SUCH AS LEAD, ZINC, SILVER, ARSENIC, NICKEL, MOLYBDENUM, COBALT, CHROMIUM, AND ANTIMONY

CORRELATION OF MAP UNITS

Map units	Age	Period
Qal, Qpf	Holocene	QUATERNARY
Qopf	Pleistocene	QUATERNARY
UNCONFORMITY		
Tmc, Tmf, Tmg, Tml, Tb, Tbi	Miocene	TERTIARY
UNCONFORMITY		
Pkf	Leonardian	PERMIAN
UNCONFORMITY		
Ptc (Pu)	Leonardian	PERMIAN
UNCONFORMITY		
Phe (Pu)	Wolfcampian	PERMIAN AND PENNSYLVANIAN
PPpc	Virgilian to Morrowan	PERMIAN AND PENNSYLVANIAN
UNCONFORMITY		
Mr	Meramecian to Kinderhookian	MISSISSIPPIAN
UNCONFORMITY		
Dtb	Upper and Middle (?) Devonian	DEVONIAN
UNCONFORMITY		
Єm	Middle Cambrian	CAMBRIAN

DESCRIPTION OF MAP UNITS

Qal ALLUVIUM (QUATERNARY)--Tan to light-gray, unconsolidated, poorly sorted, angular boulders, cobbles, gravel, sand, silt, and clay deposited in active washes. Inset into other deposits, including other Quaternary units. Little or no vegetation cover. Thickness unknown, probably a few feet at most

Qpf PEDIMENT AND FAN GRAVELS (HOLOCENE AND PLEISTOCENE)--Unconsolidated to poorly consolidated, poorly sorted gravel deposits of pediments and alluvial fans. Composed of angular to subrounded clasts of local derivation, ranging in size from boulders to sand. Typically form smooth surfaces. Thickness unknown, probably a few tens of feet at most

Qopf OLDER PEDIMENT AND FAN GRAVELS (PLEISTOCENE)--Erosional remnants of poorly consolidated to well-consolidated, poorly sorted pediment and fan gravels. Lithologically similar to unit Qpf, but clearly older because Qopf is dissected and exposed as isolated remnants topographically higher than nearby Qpf. In places, strongly cemented into calcrete. Thickness typically less than 50 ft

MUDDY CREEK FORMATION (MIOCENE)--Poorly consolidated to well-consolidated, poorly bedded to well-bedded deposits of pinkish-tan to light-gray conglomerate, pinkish-tan to brick-red sandstone, siltstone, mudstone, and claystone, and off-white, light-pinkish-gray, and pinkish-gray fresh-water limestone and gypsum. Thin tuff beds present in places. Four facies have been mapped. In general, fine-grained facies occur in upper and central parts of the Muddy Creek basin. Facies generally grade into each other through intertonguing and lateral gradation with no constant order of superposition (Lucchitta, 1966). Map contacts between facies approximate, placed arbitrarily at change in dominant lithology. Thickness unknown, probably several thousand feet

Tmc Conglomerate facies
Tmf Sandstone-siltstone-mudstone-claystone facies
Tmg Gypsum facies
Tml Limestone facies

Tb OLIVINE BASALT (MIOCENE)--Sparsely porphyritic, nearly unweathered basalt, vesicular to scoriaceous in places. Typically contains 5-10 percent olivine that is altered to iddingsite and is as much as 5 mm in size, but typically about 1 mm; brown plagioclase common. Equigranular matrix, felty texture locally. K/Ar age of 9.07 ± 0.8 m.y. (J. F. Naman, written commun., 1983). Thickness 0-250 ft

Tbi Olivine basalt dike

Pkf FOSSIL MOUNTAIN MEMBER OF SORAUF (1963) OF KAIBAB LIMESTONE (LEONARDIAN, LOWER PERMIAN)--Cliff-forming, thick-bedded, granular to finely crystalline, gray to light-tan-gray fossiliferous limestone; contains networks of gray granular chert veinlets in its lower part and dark-gray to brown concretionary chert in upper part. Forms highest of two massive cliffs near top of Paleozoic rock sequence. Thickness 300-350 ft

Ptc TOROWEAP FORMATION AND COCONINO SANDSTONE, UNDIVIDED (LEONARDIAN, LOWER PERMIAN)--Toroweap Formation consists of three units: two thin, red to yellow-brown, highly gypsiferous, friable, slope-forming sandstone units separated by the third unit--a conspicuous, massively bedded, coarsely crystalline limestone that forms the largest single cliff in Upper Grand Wash Cliffs in Snap Point Wilderness Study Area. Coconino Sandstone, a buff to reddish-white, fine-grained quartz sandstone displaying large-scale high-angle cross beds, is mapped with the Toroweap because it is less than 60 ft thick and locally absent in the three Wilderness Study Areas. Thickness 350-450 ft

Phe HERMIT SHALE AND ESPLANADE SANDSTONE, UNDIVIDED (WOLFCAMPIAN, LOWER PERMIAN)--Hermit Shale consists of brick-red, thin-bedded siltstone and deep-red shaly siltstone. Esplanade Sandstone of the Supai Group is light-red to white, medium- to thick-bedded, fine-grained, cross-laminated, locally silty sandstone. Interbedded gray to tan, thin- to medium-bedded dolomitic limestone layers and minor, local, limestone-pebble intraformational conglomerate occur locally in the lower part of the Esplanade. Hermit overlies Esplanade, and the contact between the two units appears to be interfingering and transitional; however, throughout the western Grand Canyon area the contact is marked by an obscure unconformity, which is difficult to recognize and of low relief (McKee, 1975b, p. 305-308; McKee, 1975a; Billingsley, 1978, p. 12-13). Unit Phe weathers to a slope whose base is broken by several small cliffs. Along the Grand Wash Cliffs, the lower part of the Esplanade Sandstone includes and is correlated with the Pakoon Limestone of McNair (1951). Thickness about 1,200 ft

Pu LOWER PERMIAN ROCKS, UNDIVIDED (LEONARDIAN THROUGH WOLFCAMPIAN)--Includes Fossil Mountain Member of Sorauf (1963) of Kaibab Limestone, Toroweap Formation, Coconino Sandstone, Hermit Shale, and Esplanade Sandstone. Occurs in highly faulted blocks in which it is impractical to map individual formations

PPpc PAKOON LIMESTONE OF McNAIR (1951) (WOLFCAMPIAN, LOWER PERMIAN) AND CALLVILLE LIMESTONE (VIRGILIAN-MORROWAN, PENNSYLVANIAN), UNDIVIDED--Pakoon is a pink-gray to gray, fine-grained, medium-bedded, fossiliferous, locally cherty dolomitic limestone forming ledges and slopes. Callville is a gray to pink-gray, fine- to coarse-grained, locally oolitic, cherty, or cross-bedded, cliff-forming limestone and sandy limestone interbedded with slope-forming reddish-brown-weathering shaly limestone and calcareous shale; Callville is also a cliff-forming, commonly cross-stratified sandy limestone to calcareous sandstone. Thickness of Pakoon about 300 ft, Callville about 700 ft

Mr REDWALL LIMESTONE (MERAMECIAN TO KINDERHOOKIAN, MISSISSIPPIAN)--Light-gray, aphanitic to sugary, thin- to thick-bedded, fossiliferous, partly cherty limestone forming a massive cliff. Thickness 650-700 ft

Dtb TEMPLE BUTTE LIMESTONE (UPPER AND MIDDLE(?) DEVONIAN)--Gray to olive-gray, medium-grained, medium- to thick-bedded, typically fetid limestone. More resistant and less resistant beds alternate, producing steep ledges and slopes. Thickness about 450 ft

Єm MUAV LIMESTONE (MIDDLE CAMBRIAN)--Gray, very fine grained, thin-bedded dolomitic limestone, and whitish-gray, sugary, laminated dolomite ("undifferentiated dolomite" of Billingsley, 1978, p. 5). Forms massive cliffs separated by steep slopes. Exposed thickness about 650 ft

CONTACT

FAULT--Dashed where approximately located; dotted where concealed. Bar and ball on downthrown side

ANTICLINE, SHOWING DIRECTION OF PLUNGE--Dashed where approximately located; dotted where concealed

SYNCLINE, SHOWING DIRECTION OF PLUNGE--Dashed where approximately located; dotted where concealed

STRIKE AND DIP OF BEDS
Inclined beds
Horizontal beds

COLLAPSE STRUCTURE--B indicates exposed breccia

AREA EXCLUDED FROM WILDERNESS CONSIDERATION

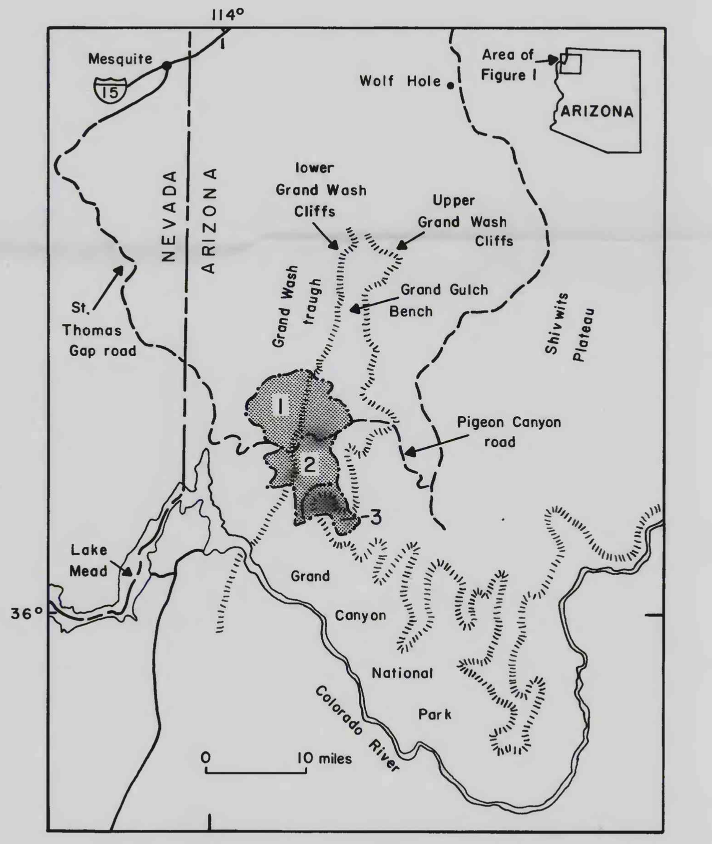


FIGURE 1.--Index map showing the location of the Pigeon Canyon (1), Nevershine Mesa (2), and Snap Point (3) Wilderness Study Areas, Mohave County, Arizona.

STUDIES RELATED TO WILDERNESS
Bureau of Land Management Wilderness Study Areas

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 the mineral values, if any, that may be present. Results must be made available to the public and be submitted to the President and the Congress. This report summarizes the results of a mineral survey of the Pigeon Canyon (AZ-010-109), Nevershine Mesa (AZ-010-105A), and Snap Point (AZ-010-105B) Wilderness Study Areas, Mohave County, Arizona.

MINERAL RESOURCE POTENTIAL SUMMARY STATEMENT

Field and laboratory investigations of the Pigeon Canyon, Nevershine Mesa, and Snap Point WSA's (Wilderness Study Areas) in Mohave County, Ariz., were conducted to determine the mineral resource potential of these lands. The investigations indicate that both the Savanic Mine collapse structure (which occupies parts of the Pigeon Canyon WSA and an area excluded from wilderness consideration) and the Cunningham Mine collapse structure (which occupies parts of the Nevershine Mesa WSA and an area excluded from wilderness consideration) have high potential for resources of uranium, copper, and other metals[1]. In addition, a small area within the Nevershine Mesa WSA that lies between the Savanic Mine and the Cunningham Mine collapse structures has moderate potential for resources of uranium, copper, and other metals because of its proximity to the two mineralized collapse structures and because joints between the two collapse structures can be hosts for uranium, copper, and other metal deposits.

Most collapse structures of the Grand Canyon region are not mineralized, but several have yielded substantial quantities of uranium, copper, and other metals. For this reason four previously unknown mineralized collapse structures in the Pigeon Canyon WSA have moderate potential for resources of uranium, copper, and other metals.

The remainder of the Pigeon Canyon and the Nevershine Mesa WSA's has low potential for resources of uranium, copper, and other metals. The Snap Point WSA has no known mineralized zones or collapse structures that can be hosts for uranium, copper, and other metal deposits and therefore has low potential for resources of these commodities.

The potential for resources of oil and gas is low in exposed Paleozoic rocks east of the Grand Wash fault in all three WSA's. In those parts of the Pigeon Canyon and Nevershine Mesa WSA's west of the Grand Wash fault, the potential for the resources of oil and gas is moderate in buried Paleozoic rocks. Gypsum occurrences west of the Grand Wash Cliffs in the Pigeon Canyon and Nevershine Mesa WSA's have moderate resource potential for gypsum; however, this commodity is readily available and more accessible elsewhere in southern Utah and northern Arizona. Slightly anomalous amounts of syngenetic uranium and molybdenum occur in the gypsum deposits but represent a low resource potential at best for these elements. There are no gypsum deposits in the Snap Point WSA. No coal-bearing rocks were observed to crop out in the three WSA's and none are expected to be found in the subsurface of the three WSA's.

Industrial mineral resources (building stone, sand and gravel, and limestone) are present in all three WSA's. However, these commodities are more accessible and readily available elsewhere in northern Arizona and southern Utah.

[1]In this report, the term "other metals" refers to associated metals such as lead, zinc, silver, arsenic, nickel, molybdenum, cobalt, chromium, and antimony.

INTRODUCTION

The Pigeon Canyon, Nevershine Mesa, and Snap Point WSA's measure 33,348, 19,457, and 9,380 acres, respectively, for a total of 62,185 acres. The area is accessible by road from the north (fig. 1).

The three WSA's are located at the boundary between the Colorado Plateaus province to the east and the Basin and Range province to the west. The boundary is defined here by the Grand Wash fault, whose north-trending fault-line scarp is composed of the west-facing lower Grand Wash Cliffs and Upper Grand Wash Cliffs. The terrain above the Upper Grand Wash Cliffs is on the Shivwits Plateau, which is mostly east of the three WSA's. The Shivwits Plateau is at an altitude of 6,000-6,500 ft. Below and west of the lower Grand Wash Cliffs is the Grand Wash trough, within the Basin and Range province; altitudes here range from 2,000 to 3,000 ft. The Grand Gulch Bench, at an altitude of 4,400-4,600 ft, separates the lower Grand Wash Cliffs from the Upper Grand Wash Cliffs.

GEOLOGY

That part of the three WSA's east of and including the lower Grand Wash Cliffs is underlain by near-horizontal and little-deformed Paleozoic rocks (from the Middle Cambrian Muav Limestone to the Lower Permian Fossil Mountain Member of Sorauf (1963) of the Kaibab Formation), and locally by small remnants of Tertiary basalt and Quaternary pediment and fan gravels. High-angle normal faults cutting Paleozoic rocks increase in number near the Grand Wash fault, which is a major high-angle dip-slip normal fault that trends approximately north and that has down-to-the-west displacement.

That part of the three WSA's west of the lower Grand Wash Cliffs is underlain by Tertiary interior-basin deposits (Muddy Creek Formation) that filled the basin formed by movement along the Grand Wash fault. This fault is buried by the Muddy Creek Formation and is therefore not exposed in the three WSA's. Basalt is locally present in the Muddy Creek Formation, and Quaternary pediment and fan gravels are widespread. The presence of Paleozoic rocks beneath the Tertiary deposits is inferred west of the Grand Wash fault because these Paleozoic rocks occur nearby in isolated ridges and dip steeply to the east. Late Tertiary deformation in the three WSA's was minimal.

Small-scale structural features consist of collapse structures (Billingsley and others, 1983; Hoffman, 1977) that occur in the Pennsylvanian Callville Limestone and the Lower Permian Pakoon Limestone of McNair (1951) as a result of solution in the underlying Mississippian Redwall Limestone. The collapse structures are dominantly circular in plan, are cone shaped in section, and are characterized by inward-dipping strata. Collapse structures in which brecciated rock is visible at the surface are termed breccia pipes. Many of the collapse structures throughout northern Arizona are known to contain uranium and copper minerals.

GEOCHEMISTRY

No geochemical anomalies related to mineral deposits were found in the three WSA's, other than those associated with three mines (Cunningham, Grand Gulch, and Savanic) that occur near the Pigeon Canyon and Nevershine Mesa WSA's. Because uranium has been discovered in collapse structures at a number of places in the Grand Canyon region and because samples from the three mines in and near the WSA's contain as much as 0.07 weight percent uranium in some of the highly mineralized rock samples, other collapse features in the WSA's were sampled for uranium. However, none of the other collapse structures were found to contain appreciable amounts of uranium or any other element (Hopkins and others, 1984).

Samples of gypsum from the Miocene Muddy Creek Formation near the western boundary of the Pigeon Canyon WSA contain as much as 5,000 parts per million (ppm) Sr, 10 ppm Mo, and 50 ppm Sn. Although these concentrations are geochemically anomalous, the anomalies are directly related to the syngenetic components of sedimentary gypsum deposits, and are not of themselves indicative of metallic deposits in this area.

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Mineral resource potential for oil and gas, gypsum, and coal in the Pigeon Canyon, Nevershine Mesa, and Snap Point Wilderness Study Areas

	Pigeon Canyon Wilderness Study Area	Nevershine Mesa Wilderness Study Area	Snap Point Wilderness Study Area
Oil and gas	Moderate potential west of Grand Wash fault Low potential east of Grand Wash fault	Moderate potential west of Grand Wash fault Low potential east of Grand Wash fault	Low
Gypsum	Moderate potential west of Grand Wash Cliffs No deposits known east of Grand Wash Cliffs	Moderate potential west of Grand Wash Cliffs No deposits known east of Grand Wash Cliffs	No deposits known
Coal	None	None	None

MINERAL RESOURCE POTENTIAL MAP OF THE PIGEON CANYON, NEVERSHINE MESA, AND SNAP POINT WILDERNESS STUDY AREAS, MOHAVE COUNTY, ARIZONA

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