



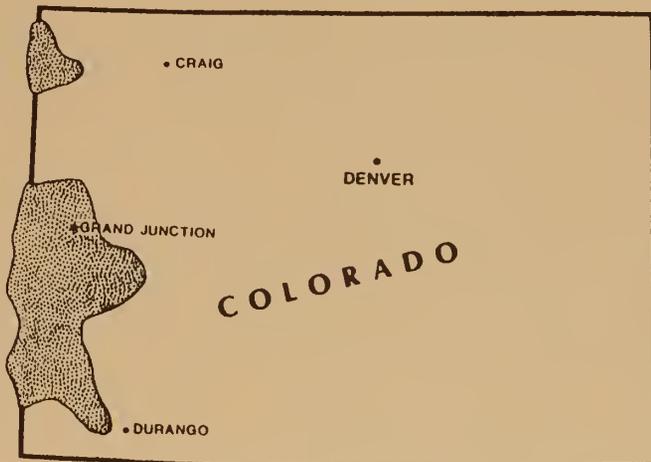
Demaree - Black Canyons Area  
GEOLOGICAL RESOURCE AREA (GRA) 3

FINAL REPORT

**PHASE 1: GEM**

(GEOLOGICAL, ENERGY and MINERALS)

**RESOURCE ASSESSMENT FOR  
REGION 4, COLORADO PLATEAU**



SUBMITTED TO:  
U.S. DEPARTMENT OF THE INTERIOR  
BUREAU OF LAND MANAGEMENT  
DENVER SERVICE CENTER  
DENVER, COLORADO 80225



**MSME/WALLABY ENTERPRISES**  
A JOINT VENTURE OF  
MOUNTAIN STATES MINERAL ENTERPRISES, INC.  
and WALLABY ENTERPRISES, INC.



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## FOREWORD

This report is one of a series of eleven reports addressing the Wilderness Study Areas (WSA's) located in what has been designated as the Colorado Plateau, Region 4, by the Bureau of Land Management (BLM), Denver Federal Center. The study was under the direction of Mr. Robert J. Coker, the Contracting Officer's Authorized Representative (COAR).

The WSA's have been segregated into eleven G-E-M (Geology, Energy, Minerals) Resources Areas (GRA's). Each designated GRA constitutes one report. The purpose of these reports is to assess the potential for geology, energy, and mineral (GEM) resources existing within a WSA and GRA. This information will then be used by BLM geologists in completing the assessment for GEM resources potential within the WSA's, and for the integration with other resource data for the decision on suitability for recommendation of the respective WSA.

The reports were developed and prepared by the Joint Venture team of MSME/Wallaby Enterprises, Tucson, Arizona, by Patricia J. Popp (Geologist), and Barbara J. Howie (Geologist) under the direction of Eric A. Nordhausen (Project Manager) and Richard Lundin (Principal Investigator), under BLM Contract No. YA-553-CT2-1041.

Consulting support was provided by a highly specialized geological team composed of: Ted Eyde, Dr. Paul Gilmour, Dr. Robert Carpenter, Dr. Donald Gentry, Dr. Edger Heylmun, Dr. Larry Lepley, Annon Cook, Walter Heinrichs, Jr., and Charles Campbell. Their contribution is both acknowledged and appreciated. The work of Dr. Gilmour, Dr. Gentry, and Dr. Lepley should receive special acknowledgement. It was from the work of these consultants that this report on the Demaree - Black Canyon Canyon GRA was able to be completed.

## EXECUTIVE SUMMARY

The BLM has adopted a two-phase procedure for the integration of geological, energy and minerals (GEM) resources data for suitable/nonsuitable decisions for wilderness study areas (WSA's). The two-phased approach permits termination of a GEM resources data gathering effort at the end of Phase One. The objective of this Phase One GEM resources assessment is the evaluation of existing data (both published and available unpublished data) and their interpretation for the GEM resources potential for the WSA's included in each region. Phase Two is designed to generate new data needed to support GEM resources recommendations.

Over 10 million acres of WSA's require GEM resources data input. These WSA's are unequally distributed in the eleven western states of the coterminous United States. The WSA's are grouped in six regional areas. The WSA's within the western part of Colorado, and a few crossing into Utah, were included as Region 4, also known as the Colorado Plateau Region. Except for one small area at the southwest extreme of the region and another at the north extreme, the region is within the northern half of the known Colorado Plateau physiographic province.

The 32 WSA's within Region 4 encompass 474,620 acres. These have been geographically segregated within 11 designated GEM Resource Areas (GRA's). This report addresses the Demaree-Black Canyons area, GRA 3. Within the GRA, is the Demaree Canyon WSA (CO-070-009), Black Ridge Canyon WSA (CO-070-113), Black Canyon West WSA (CO-070-113A) and the Wrigley Mesa/Jones Canyon WSA (UT-060-116/117).

The geology of the GRA consists mostly of sedimentary rocks such as shales, sandstones, mudstones, and limestone. Fuel minerals, specifically coal, oil, and gas occur in sedimentary rocks. Because some types of sedimentary rocks are highly permeable, they may act as traps for oil and gas. The structural features of note in the GRA include northwest striking faults and joint systems paralleling the axes of local anticlinal and monoclinical structures. These fault and joint systems may also act as traps for oil and gas.

The main mineral resources of the Demaree - Black Canyons Area GRA can be divided into two groups: 1) coal, oil, and gas; 2) sand, gravel, clay, and some uranium. Over half of the GRA contains known coal fields, and coal outcrops were noted in each WSA. The Mt. Garfield Formation, Dakota Formation, and Mancos Shale (for details on these formations, please see "Rock Units" in Section II) are known to contain coal in other parts of Colorado. The Mt. Garfield Formation is especially well known for high quality coal. All these formations are present in the GRA, and each of the WSA's. Gas and oil play an important part in the mineral resources of the GRA. The Garmesa Gas Field, part of Garmesa Anticline, is a major field contained in the GRA. The gas field has produced gas from units in the Mancos Shale, lower Dakota, and the Morrison Formations. These rock units are all present in the GRA, hosting a number of oil and gas wells in and around each WSA.

There are many sand and gravel, and clay operations in the center portion of the GRA. The majority of the deposits are along the Colorado River or its tributaries. The Wingate and Kayenta Formations have been quarried for dimension stone. The uranium occurrences in the GRA are in the Morrison Formation. In other parts of Colorado, the Morrison is known for uranium-vanadium, and copper mineralization.

Fuel minerals hold the strongest promise for Demaree Canyon WSA (CO-070-009). Gas may be contained in the WSA, indicated by the presence of a large number of producing gas wells in an around the WSA. Also, there are six oil drilling pads in the WSA, although there are no producing wells. The coal outcrops, and the presence of the Mt. Garfield Formation, a known producer of coal, indicate coal of some economic importance may also be present in the WSA. However, due to the brief nature of the field visit by the consultants, the extent and economic significance of the observed coal outcrops could not be determined.

The Black Ridge Canyon WSA (CO-070-113), Black Canyon West, Wrigley Mesa/Jones Canyon WSA's (CO-070-113A, UT-060-116/117) may contain uranium, in addition to the possible presence of coal as a result of the presence of the Dakota Formation. As previously mentioned, the brevity of the field visit did not allow the consultants to determine the extent or economic significance of the presence of the Dakota Formation.

The classification for the leasable minerals, locatable and salable resources varies. There is high favorability for leasable minerals in the form of oil, gas, and some coal. The favorability for locatable resources is unknown due to the lack of published literature and geologic field investigations. However, rock units known to contain locatable resources in other areas of Colorado and the western U.S. also exist in this GRA. Finally, there is high favorability for salable resources, primarily in the form of sand and gravel and clay deposits.

Overall, it is recommended that each WSA in the GRA receive additional work to determine the full economic potential of each area. This work should include further research in unpublished and proprietary literature, a detailed program of geologic mapping and sampling, and additional geochemical and stratigraphic studies to confirm the occurrence or lack of geology, energy, and mineralized commodities.

## SECTION I

### INTRODUCTION

The Demaree - Black Canyons Area GRA (Figure I-1) is located in Mesa and Garfield Counties, Colorado, and Grand County, Utah. The GRA encompasses five Wilderness Study Areas (WSA's) (CO-070-009, CO-070-113, CO-070-113A, and UT-060-116/117). Their boundaries are shown on Overlay A.

The GRA area is located approximately eight miles northwest of Grand Junction, Colorado. Located within the boundaries of the GRA are a number of small towns that are local supply centers for agriculture and ranching. These towns, Mack, Fruita, and Loma, are supplied by road networks from Grand Junction, the regional supply center. The towns are also local supply centers for the oil and gas operations in the area.

The area in Colorado includes portions of Townships 7-11 South, Ranges 102-104 West; and Townships 1-2 North, Ranges 2 & 3 West in Mesa and Garfield Counties. In addition, a portion of the GRA is located in Townships 15-20 South, Range 25 East, Grand County, Utah. The entire area is bounded by Longitudes 108° 40' and 109° 07' 30" and Latitudes 39° 00' to 39° 31'. It contains approximately 849 square miles (2,286 square kilometers, or 541,000 acres) of Federal, state and private lands. The Bureau of Land Management portion of these holdings are under the jurisdiction of the Grand Junction District and Resource Area Offices.

The specific WSA's within the GRA have a total of 93,840 acres of Federal land. The acreages of the various contained WSA's are:

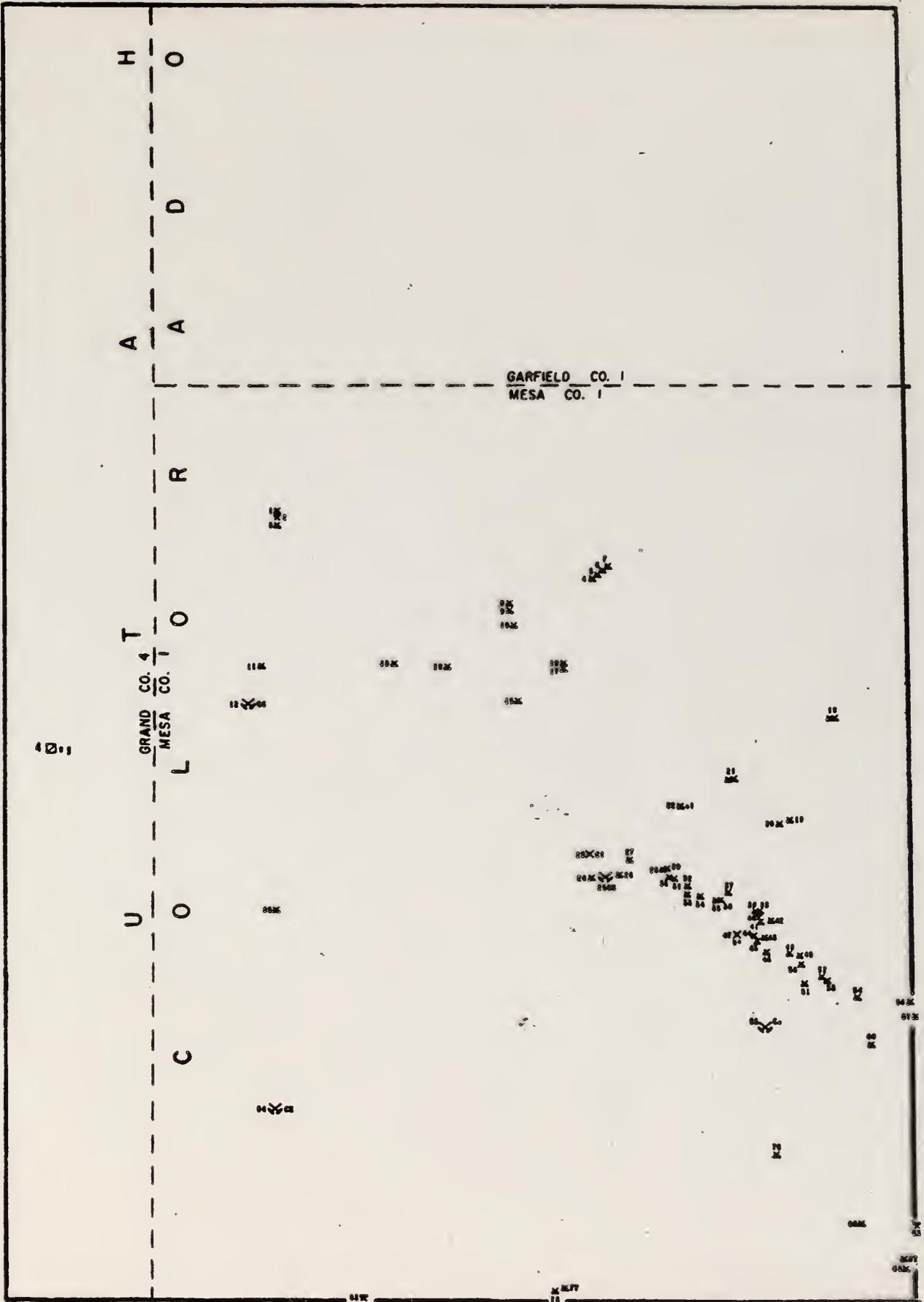
Demaree Canyon (CO-070-009) - 21,050 acres  
Black Ridge Canyon (CO-070-113) - 18,500 acres  
Black Canyon West-Wrigley Mesa-Jones Canyon (CO-070-113A & UT-060-116/117) -  
54,290 acres

The Demaree Canyon WSA is located in the northern portion of the GRA and is approximately 25 miles northwest of Grand Junction, Colorado. The other WSA's are located in the southern portion of the GRA and lie approximately eight miles west of Grand Junction.

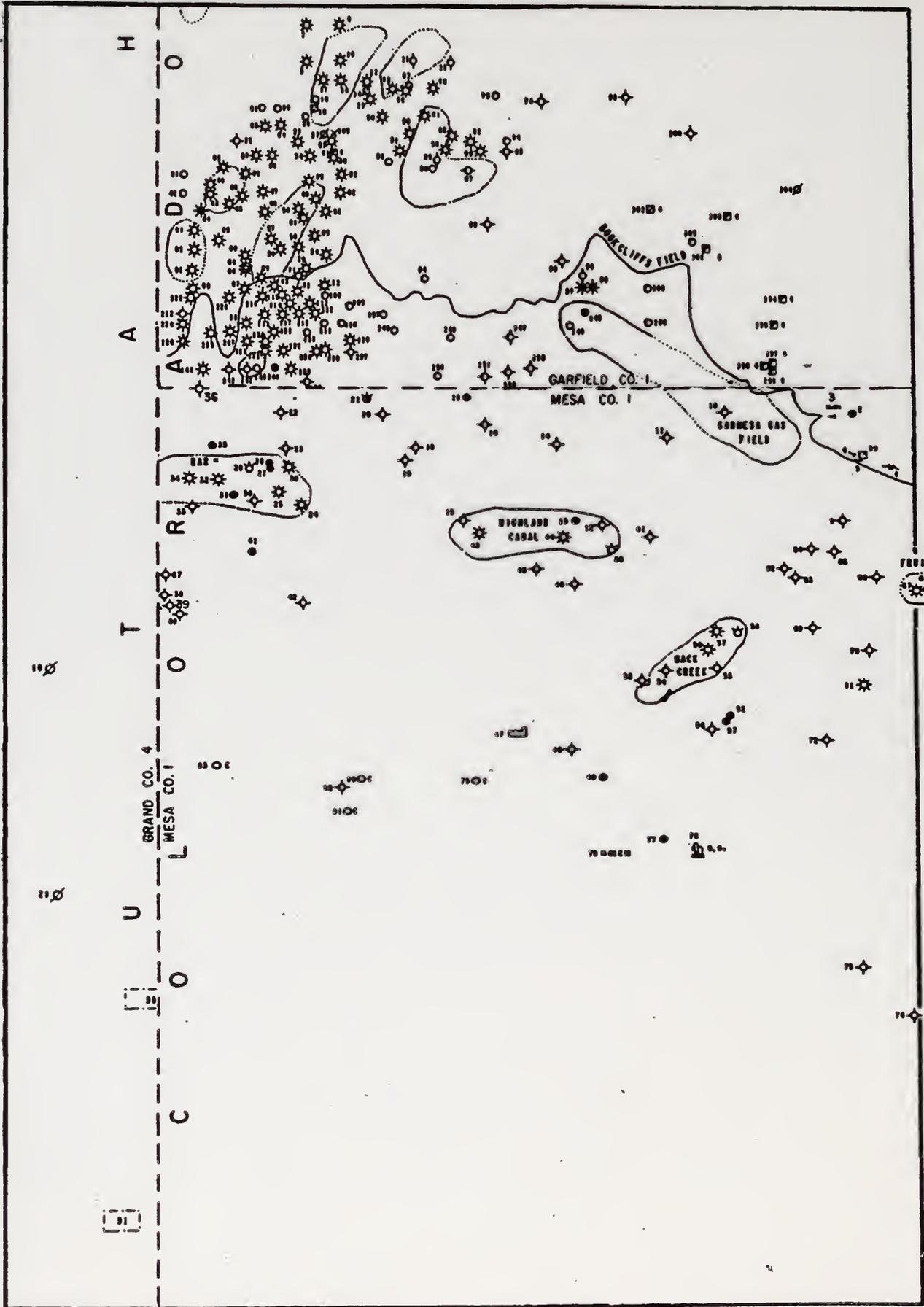
The Black Canyon West-Wrigley Mesa Jones Canyon WSA's have been combined for this report since they constitute nearly contiguous areas that have identical resource potentials and geologic characteristics.

Due to the lack of available data on each WSA, emphasis was placed on gaining an understanding of the mineral potential of each WSA within the GRA. Information on the mineral resources of the GRA was utilized to extrapolate and estimate the potentials of the WSA's from the existing data that in most cases, referred only indirectly to the WSA's. This is consistent with the purpose of this contract, which is to utilize the known geological information within each WSA and GRA to ascertain the GEM resource potential of the WSA's. The known areas of mineralization and claims have been plotted as overlays to Figure I-1.

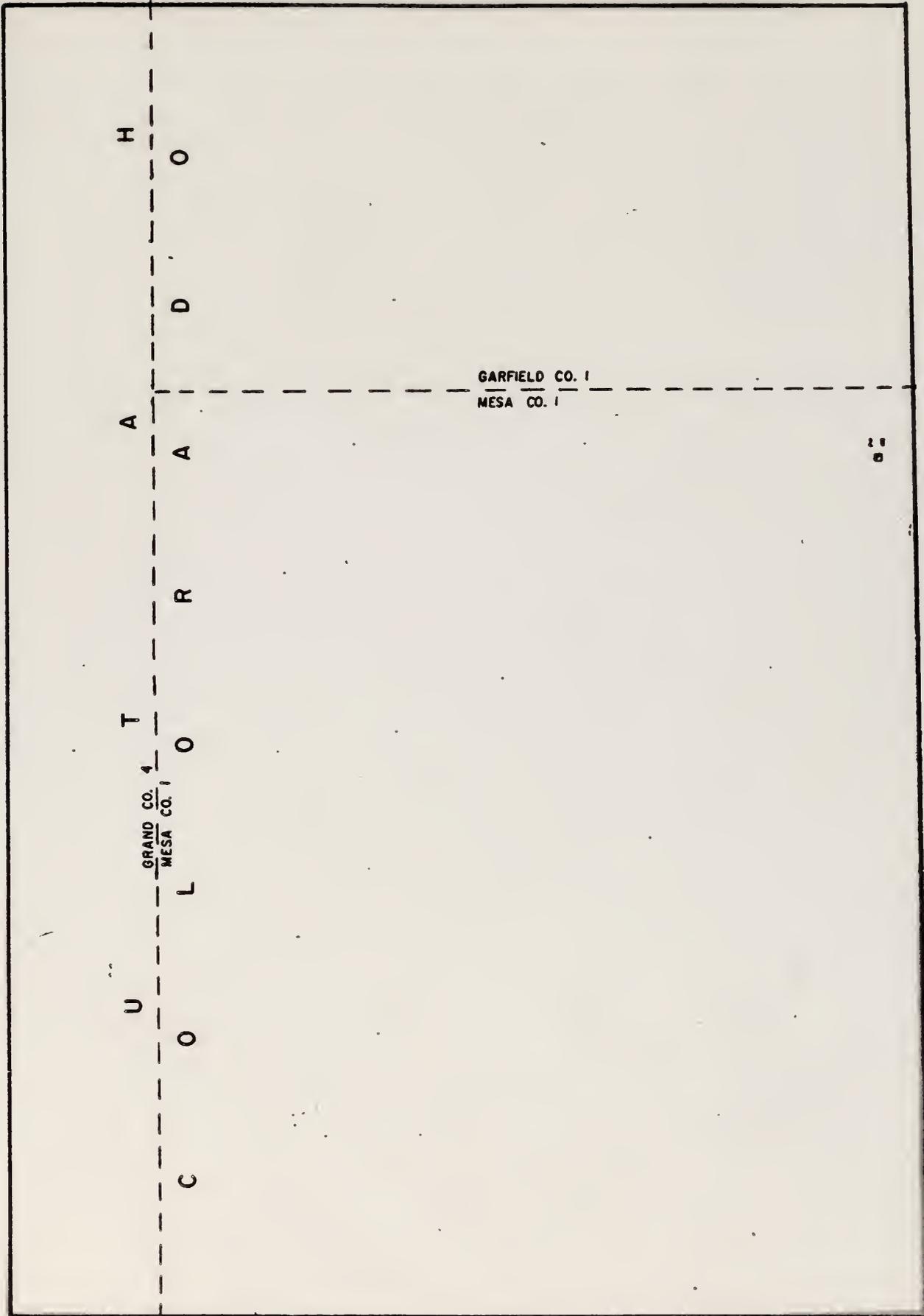
The information contained in this report was obtained from published literature, computerized data base sources, Bureau of Land Management File Data, company files and returned data sheets. The information was compiled into a series of files on each WSA and a series of maps that covered the entire western portion of Colorado. After a thorough review of the existing data, a program of field checking was carried out by a MSME/Wallaby team of experts. Field investigations in the GRA were carried out by Dr. Paul Gilmour, Dr. Donald Gentry and Mr. Ted Eyde during the period of August 31 - September 1, 1982. All of these individuals are registered professional geologists and associates of MSME/Wallaby. Further analysis and study was provided through the photographic interpretation services of LANDSAT aerial photos by Dr. Larry Lepley, a registered geologist and remote sensing specialist. The aerial photos used are included in Appendix A.



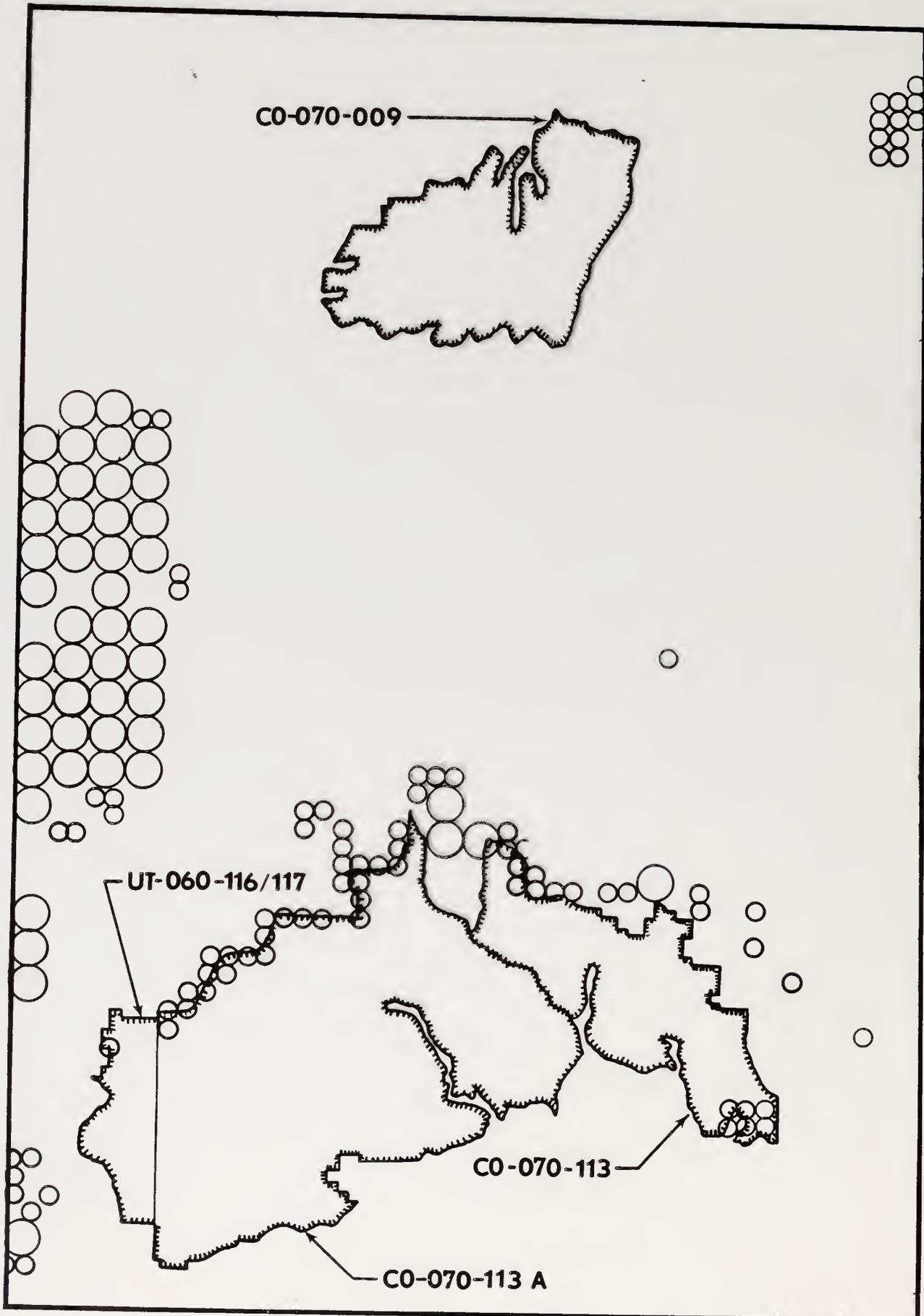
OVERLAY D  
SAND, GRAVEL AND  
INDUSTRIAL MINERALS



OVERLAY C.  
COAL, OIL AND GAS



**OVERLAY B  
MINES, PROSPECTS  
AND MINERAL OCCURENCES**



OVERLAY A  
PATENTED AND UNPATENTED  
CLAIMS AND WSA BOUNDARIES

104W

103W

102W

7S

8S

2N

1N

11S



(After Rowley et al, 1979)

### DEMAREE CANYON/BLACK RIDGE CANYONS GRA

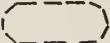
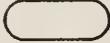
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FIGURE I-1  
GEOLOGIC MAP

## EXPLANATION

Quaternary (Approximately 2 million years before present (mybp) to present)	Qa, Qae	Alluvial and eolian deposits
	Qt	Terrace gravels
	Qp	Pediment deposits
Tertiary (Approximately 62-2 mybp)	Tgd	Green River Formation - Douglas Creek Member
	Tgdu	Douglas Creek Member, upper tongue
	Tgdl	Douglas Creek Member, lower tongue
	Twr	Wasatch Formation, Renegade Tongue
	Tw	Wasatch Formation, main body
	Two	Wasatch and Ohio Creek Formations
Cretaceous (Approximately 135-62 mybp)	Kt	Mesaverde Group, Tuscher Formation
	Kf	Mesaverde Group, Farrer Formation
	Kns	Mesaverde Group, Nelson Formation and Segó Sandstone
	Kh	Mesaverde Group, Hunter Canyon Formation
	Kmgs	Mesaverde Group, Mt. Garfield Formation and Segó Sandstone
	Kmb	Buck Tongue of Mancos Shale
	Kc	Mesaverde Group, Castlegate Sandstone
	Kb	Mesaverde Group, Blackhawk Formation
	Km	Mancos Shale, undifferentiated
	Kmu	Mancos Shale, upper shale member
	Kmf	Mancos Shale, Ferron Sandstone Member
	Kml	Mancos Shale, lower shale member
	Kd	Dakota Sandstone
	Kbc	Burro Canyon Formation
	Kdb	Dakota Sandstone and Burro Canyon Formation
	Jurassic (Approximately 195-135 mybp)	Jmb
Jms		Morrison Formation, Salt Wash Sandstone Member
Jse		Summerville Formation and Entrada Sandstone
Triassic (Approximately 225-195 mybp)	Trk	Kayenta Formation
	Tr w	Wingate Sandstone
	Tr kw	Kayenta Formation and Wingate Sandstone
	Tr c	Chinle Formation
Precambrian (Approximately 3400-600 mybp)	pCr	Complex of gneisses and schists

# LEGEND

	-O OIL FIELD		MINERAL OREBODY
	-G GAS FIELD		MINERAL DEPOSIT
	-O <sub>s</sub> OIL SHALE		MINERAL OCCURRENCE
	-C COAL REGION		PROSPECT
	OIL WELL		ACCESSIBLE ADIT
	OIL & GAS WELL		INACCESSIBLE ADIT
	GAS WELL		VERTICAL SHAFT
	SHOW OF GAS		INCLINED SHAFT
	SHOW OF OIL		MINE TYPE UNKNOWN
	SHOW OF OIL & GAS		ACTIVE OPEN PIT, OR QUARRY
	-C COAL DEPOSIT		INACTIVE OPEN PIT, OR QUARRY
	-C COAL OCCURRENCE		ACTIVE GRAVEL OR CLAY (CI) PIT
	SHUT-IN WELL		INACTIVE GRAVEL OR CLAY (CI) PIT
	CO <sub>2</sub> OR He=HELIUM -RICH WELL		EXPLORATION HOLE WITH DATA AVAILABLE
	DRY WELL-ABANDONED		EXPLORATION HOLE WITHOUT DATA AVAILABLE
	MILL		UNPATENTED MINING CLAIM
	PLANT		PATENTED MINING CLAIM
	NATURAL GAS PROCESSING PLANT		MINERAL OR OIL & GAS LEASE
	REFINERY		

O	OIL	C <sub>b</sub>	LIGNITE	D <sub>s</sub>	DIMENSION STONE
G	GAS	C <sub>p</sub>	PEAT	F <sub>e</sub>	IRON
O <sub>s</sub>	OIL SHALE	A <sub>g</sub>	SILVER	M <sub>n</sub>	MANGANESE
O <sub>t</sub>	TAR SANDS	A <sub>u</sub>	GOLD	P <sub>b</sub>	LEAD
G <sub>i</sub>	GILSONITE	C <sub>u</sub>	COPPER	U	URANIUM
C	COAL	C <sub>i</sub>	CLAY	V	VANADIUM
				Z <sub>n</sub>	ZINC

## SECTION II

### GEOLOGY

#### PHYSIOGRAPHY

The GRA boundary includes valley, high cliff and plateau areas along the course of the Colorado River in western Colorado and eastern Utah. The northern part of the area is characterized by canyons cutting a prominent plateau. This area is known as the Roan and Book Cliffs area and has a vertical relief of approximately 2,000 feet. Another physiographic region within the GRA is the rolling topography of the Grand Valley area on the northern side of the Colorado River. This area is characterized by low-lying plain topography that has a gentle slope down to the Colorado River flood plain. The vertical relief in this area is approximately 300-500 feet. South of the Colorado River, the terrain consists of high ridges and canyons that rise abruptly from the Colorado River flood plain. Mesa tops in this southern portion of the GRA are characterized as having a rolling, hillock type of topography. The vertical relief in this area is approximately 3,000 feet.

The following descriptions address the physiographic composition of each of the WSA's within the Demaree Canyon - Black Canyon's Area GRA.

#### DEMAREE CANYON WSA (CO-070-009)

Canyons found within the boundary of the Demaree Canyon WSA have been formed by a combination of fluvial and tectonic processes. The Cretaceous and Tertiary units that form the Roan and Book Cliff areas are a part of a prominent plateau that extends throughout northwestern Colorado and eastern Utah. Within the WSA the vertical relief is approximately 2,000 feet.

#### BLACK RIDGE CANYON WSA (CO-070-113)

In the Black Ridge Canyon WSA there are high ridges and steep canyons with gently rolling hillock topography on the mesa tops. The canyon walls are composed of Triassic, Jurassic, and Cretaceous units that have been deeply cut by fluvial and tectonic processes. Vertical relief in the area is approximately 3,000 feet.

#### BLACK CANYON WEST-WRIGLEY MESA/JONES CANYON WSA'S (CO-070-113A & UT-060-116/117)

In these WSA's, a situation exists similar to the Black Ridge Canyon area in that the northeast edge of the Uncompahgre Plateau is deeply dissected by canyon systems that were formed by a combination of fluvial and tectonic processes. The canyons cut through a succession of Triassic, Jurassic and Cretaceous units that lie unconformably on the Precambrian basement units. Vertical relief in the area is approximately 3,000 feet.

#### ROCK UNITS

Within the GRA is found a variety of rock units that represent a large portion of Precambrian, Mesozoic and, Cenozoic time. The Precambrian section is represented

by a complex of gneisses and schists that indicates periods of volcanic, volcanoclastic and sedimentary deposition. These units have been moderately deformed and intruded by a series of felsic through mafic intrusive bodies. The Precambrian sequence is relatively unstudied in this area. These units are exposed at the bottoms of deep canyons in the southern part of the GRA (Cashion, 1973).

The Mesozoic section consists of Triassic mudstones, shales, sandstones and siltstones of the Chinle, Wingate, and Kayenta Formations. These units are thought to represent a period of deposition in a near-shore marine or lagoonal environment. The well cross-bedded Wingate Sandstone unit is thought to have been deposited in a subaerial, beach environment. The Jurassic section consists of, in ascending order, the Summerville, Entrada and Morrison Formations which crop out as mesa tops in the southern portion of the GRA. These formations are a series of sandstone, siltstone, shale, conglomerate, and limestone units that were also deposited in near-shore marine or lagoonal environments. The Entrada Formation is thought to be a beach deposit that exhibits good eolian crossbedding features. The Morrison Formation is known to contain uranium deposits in other areas of western Colorado. The Cretaceous section is represented within the GRA by the Burro Canyon Formation, the Dakota Sandstone, Mancos Shale, Mt. Garfield Formation and Sego Sandstone, and the Hunter Canyon Formation. These units can be described as a succession of shales, sandstones, mudstones and conglomerates with interbedded coal seams. The entire sequence also represents a period of shallow water, marine, and lagoonal deposition along a transgressive and regressive shoreline or was adjacent to a meandering fluvial system (Young, 1959). The Mt. Garfield Formation is a known source of high quality coal. The Dakota Formation is also known to contain thin coal beds in other parts of Colorado but has only thin, carbonaceous shale units in this GRA (Cashion, 1973). The conflicting nature of the literature (see Richardson, 1907; Cashion, 1973; Withington 1955), precludes more detailed descriptions of the Mesozoic Formations.

The Cenozoic stratigraphy is represented by sandstone, shale, and siltstones units of the Tertiary Wasatch Formation. This unit unconformably overlies the Cretaceous section and is thought to represent a period of shallow water marine deposit in a neritic lagoonal environment (Cashion, 1973; Richardson, 1907). In addition, Quaternary fluvial and eolian deposits are found throughout the GRA in areas of recent Colorado River or tributary deposition. Quaternary pediment gravels are found along the northern bank of the Colorado, and have been exploited in recent times as a source of sand and gravel, with minor placer gold values.

The following descriptions address the rock units of each of the WSA's within the Demaree Canyon-Black Canyons GRA.

#### DEMAREE CANYON WSA (CO-070-009)

Within the boundaries of the WSA are found the following rock units: Cretaceous Mancos shale, Mt. Garfield Formation, Sego Sandstone, Hunter Canyon Formation and the Tertiary Wasatch formation (Cashion, 1973). The Mt. Garfield Formation and the Sego Sandstone contain thick coal-bearing horizons that have been mined in the past. The section is quite well known and has been extensively studied for coal, oil and gas potential and production. Detailed studies by government and industry have been made of the stratigraphy and faunal succession relationship in the Mesozoic section.

## BLACK RIDGE CANYON WSA (CO-070-113)

Precambrian gneiss and schist units crop out in the bottom of the deeply cut canyons of this WSA. These units have not been extensively studied but are thought to be correlative with other, older Precambrian sequences in western Colorado. The units are moderately deformed, having been intruded by a series of felsic to mafic dikes and sills (Gilmour, Personal Communication, 1982). The entire Paleozoic section is absent from the sequence, so the Mesozoic sits unconformably on the basement Precambrian units. The Triassic Chinle, Wingate, and Kayenta Formations outcrop within the WSA and represent a sequence of sandstones, mudstones and shales. The Jurassic Summerville-Entrada and Morrison-Brushy Basin unconformably overlie the Triassic formations and are, in turn, unconformably overlain by the Cretaceous Dakota-Burro Canyon Formations (Cashion, 1973). The sandstone units of the Morrison Formation contain uranium mineralization in other areas of Colorado. The Dakota Sandstone is also known to contain coal in other areas of Colorado. Along the northern boundary of the WSA are areas of fluvial gravels which have been used as a source of sand and gravel (BLM/MRI maps).

## BLACK CANYON WEST-WRIGLEY MESA/JONES CANYON WSA'S (CO-070-113A & UT-060-116/117)

As in the Black Canyon area, we find Precambrian gneiss and schist units are found at the bottom of the deep canyons. These units are also moderately deformed, having been intruded by a series of felsic and mafic bodies. Again, a thick section of Mesozoic rocks occurs, represented by the Triassic Chinle, Wingate, and Kayenta Formations, and the Jurassic Summerville-Entrada and Morrison-Brushy Basin Formations. Small outcrops of quaternary pediment material are found in the western portion of the area (Cashion, 1973).

## STRUCTURAL GEOLOGY AND TECTONICS

Tectonic features within the GRA include high angle northwest striking faults and joint systems that parallel the axis of local anticlinal and monoclinical structures (Cashion, 1973). Of local importance are a set of northeast striking faults and joint systems. The prominent anticlinal structures (Garmesa, Highline, Hunters Canyon & Ashbury Creek Anticlinal) in the northern portion of the GRA are considered very important to the localization of oil and gas deposits and have been studied extensively by the major oil companies and the USGS (Heylman, Personal Communication, 1982; and Krey, 1962). The northeast striking structures that cut across these local fold features are considered very important in the localization of the specific oil and gas pools. Some of these structures are only known from subsurface drilling and seismic information, and are only generally described in the existing, available literature.

In the northern part of the GRA, a major unconformity lies at the base of the Tertiary section, with the Wasatch Formation lying unconformably above the Cretaceous Hunter Canyon Formation.

The southern part of the GRA has undergone uplift as a part of the Uncompahgre event. A series of northwest striking faults parallel the present course of the Colorado River between Grand Junction and Mack. These faults and attendant parallel shear systems, are themselves parallel to the major structures in the area

(Redlands Fault, Bitter Creek Anticline, Danish Flat Syncline, and the Seiber Nose). These structures have been studied in only a very limited way by the oil and gas industry and the USGS (Cashion, 1973).

In the southern portion of the GRA, various periods of erosion or non-deposition have occurred in the Mesozoic section. Unconformities have been identified at the base of the Dakota Formation and at the base of Jurassic Entrada Formation. The entire Paleozoic section is absent in this area with the Triassic Chinle Formation lying directly on the basement Precambrian complex. The Precambrian structures a little exposed and have not been extensively studied. Moderate deformation in the form of isoclinal folding and shearing is common to the older Precambrian units in Colorado.

The following descriptions address the structural and tectonic characteristics of each of the individual WSA's within the Demaree Canyon - Black Canyons GRA.

#### DEMAREE CANYON WSA (CO-070-009)

Structural features within the Demaree Canyon WSA include northwest striking high angle faults paralleling the axis of the Garmesa anticline and a high angle northeasterly striking fault south of Carbonera (Cashion, 1973). These faults have particular importance as they have localized oil and gas pools along the Garmesa structure. The northeasterly striking structures in the same area have exposed coal seams in the Mt. Garfield Formation along canyon walls and have made the mining of these deposits feasible. The unconformity at the base of the Tertiary section is well known and represents a period of non-deposition or erosion, prior to the deposition of clastic units at the base of the Eocene Wasatch Formation.

#### BLACK RIDGE CANYON WSA (CO-070-113)

Significant structural features in this area are high angle northwest striking faults that parallel the regional anticlinal and monoclinical folds that were formed as a part of the Uncompahgre episode of uplift (Krey, 1962). These faults and parallel joint systems form the zones of weakness along which erosion took place to form the northeast trending canyons that are a prominent feature of the WSA. Northeasterly striking joint systems and minor faults transect the dominant fault systems, and form other zones of weakness that have been transformed into side canyons. These episodes of faulting may have localized some of the uranium/vanadium deposits in the Morrison Formation in this area (Lepley, Personal Communication, 1982).

Unconformities at the base of the Dakota and Entrada Formations have been attributed to periods of erosion. Unlike other unconformity surfaces in the western U.S., these surfaces seem to be devoid of uranium mineralization. The entire Paleozoic section is missing in the WSA and may have never been deposited or may have been eroded to form the Permian Cutler Formation. The underlying Precambrian basement complex is folded and moderately sheared (Gilmour, Personal Communication, 1982).

## BLACK CANYON WEST-WRIGLEY MESA-JONES CANYON WSA (CO-070-113A & UT 060-116/117)

The Bitter Creek Anticline and the Delores River Fault are the major structural features in this area. The strike of these features is parallel to the other northwest striking features of the region. Faults and shear zones parallel to these structures have formed the prominent canyons of the WSA. Tributary canyons oriented parallel to the complimentary northeast joint sets complete the drainage pattern of the major fluvial systems. As in the adjacent Black Ridge Canyons WSA, there is a complete loss of the Paleozoic section. The Triassic and Jurassic units rest unconformably on the moderately deformed Precambrian section. An unconformity has been mapped at the base of the Jurassic Entrada Formation. No uranium mineralization has been noted along this surface within the study areas (Cashion, 1973).

### PALEONTOLOGY

Paleontological resources of the GRA are not well known. From the literature, it is known that the Mancos Shale and members of the Mesaverde Group contain marine fish and mollusk remains. Coal bearing horizons of the Cretaceous Dakota Formation are known to contain fossil plant remains, and the middle members of the Wasatch Formation contains mammal remains (NPS File Data, 1982; and Richardson, 1907).

The Triassic Chinle Formation is known from the literature to contain reptile, amphibian and plant remains in other areas of Colorado. The most significant potential host rock sequence for paleontological remains, however, must be the Jurassic Morrison Formation which is well known for saurian, reptile, bird and mammal fossils. The literature that directly pertains to the GRA does not describe any fossil localities of major significance (NPS File Data, 1982).

The following descriptions address the paleontological characteristics of each of the individual WSA's within the Demaree Canyon - Black Canyons GRA.

#### DEMAREE CANYON WSA (CO-070-009)

The faunal succession in the Cretaceous units outcrops within the WSA is well known and documented. However, the faunal units are not considered to be important paleontological resources. The Tertiary Wasatch units outcropping within the WSA are not well known as fossil localities, so the entire WSA has no reported fossil occurrences that are of major scientific importance.

#### BLACK RIDGE CANYON WSA (CO-070-113)

The well exposed Jurassic Morrison Formation is known to contain saurian remains in other areas of western Colorado. Of equal scientific interest is the presence of plant, bird and small mammal remains in some of the upper members of the Morrison. No evidence of such remains has been reported from this WSA. The Triassic Chinle Formation is also known to contain reptile, amphibian and petrified wood material from other localities in western Colorado. No material of this type has been reported from the study area. The only known fossil locality within the study area is found in Devil's Canyon where a thin coal seam has associated plant remains. Reported occurrences of other fossil material have been found in the literature (NPS File Data, 1982; and Richardson, 1907; BLM/MRI File Date).

As in the adjacent Black Canyon WSA, the Jurassic Morrison Formation is a possible host for paleontological resources, especially saurian, bird and mammal remains. Nevertheless, none have been reported from this area. The Triassic Chinle Formation is also known to contain reptile, amphibian and plant material in other areas of Colorado. No material, however, has been reported from this area (NPS File Data, 1982).

## HISTORICAL GEOLOGY

During Precambrian time, the southern portion of the GRA received sediments from both cratonic and island arc sources. It appears that this was a time of persistent volcanism and tectonic activity. Marine deposition of eugeosynclinal sediments was interrupted by the ebb and flow of cratonic and island arc volcanism and an extreme period of deformation caused by plate collisions and regional uplifting. These older Precambrian units were metamorphosed, deformed and intruded by a series of younger Precambrian mafic to felsic bodies. Some of these intrusives contained anomalous amounts of metals, and have mineral deposits associated with them in other parts of Colorado and western United States. Other base and precious metal deposit types are commonly found in Precambrian lithologies. These exhalative deposits are found in association with marine basins and rhyolitic volcanic systems, and are commonly associated with the older Precambrian lithologies. The younger Precambrian units are not thought to exist on the northern flank of the Uncompahgre Uplift and have not been encountered in drilling operations in the northern part of the GRA. In other parts of Northwestern Colorado, the younger Precambrian sedimentary section is partially preserved. The environment is of a predominantly clastic deposition in a marine environment. The Paleozoic section is entirely missing in the southern part of the GRA and has not been found in any of the drilling operations in the northern part of the area.

The oldest Mesozoic unit outcropping in the GRA is the Triassic Chinle Formation. The Chinle, Wingate, and Kayenta Formations of the Glen Canyon Group represent a time of Triassic sedimentation in a near-shore marine or lagoonal environment with episodes of eolian deposition of cross-bedded beach sand deposits. Certain fluvial and shallow water lacustrine deposits have also been identified in this sequence of sandstone, shale, siltstone, mudstone, limestone and conglomerate. It appears that the Triassic units were deposited along the margins of great, open seas that had existed since Paleozoic time. As the shorelines of these seas moved in response to orogenic episodes, the specific environments in the GRA changed from marine to terrestrial. During this time, shallow-water and near-shore swamps were formed. In other areas of Colorado, these Upper Triassic near-shore sediments are the host of Cu-Ag "redbed" deposits that were deposited in areas of rapidly changing Eh-pH conditions. The wide distribution of these types of deposits in western Colorado predicts that there is potential for Cu-Ag "redbed" types of deposits in the Chinle, Wingate, and Kayenta lithologies.

In other areas of Colorado are complete sections of the Lower Jurassic. Within the GRA these units are missing, and the Jurassic Entrada Formation lies unconformably on top of the Triassic Kayenta Formation. This unconformity represents the lower and middle Jurassic section and would indicate that the area was undergoing

erosion and non-deposition. This may have been a period when the GRA was a terrestrial topographic high that was rapidly being eroded and shedding sediments into shallow Jurassic basins. The Jurassic Summerville and Morrison Formations were deposited in near-shore lagoonal environments or shallow water marine and fluvial systems. Some lacustrine and fresh water fluvial deposits have also been identified from these rocks. As in the earlier Triassic section, mineral deposits are commonly found associated with limey sandstones, shales, and siltstones deposited in shallow, neritic basins that have fluvial channels meandering through them. Copper-silver-uranium-vanadium mineralization occurs in these units as "roll-front" and organically precipitated "stream channel" deposits. Such mineral deposits are very important economically and are known to occur in other portions of the Jurassic section in western Colorado, Utah, Arizona and New Mexico. These deposits are thought to represent an environment similar to that of the present Lower Mississippi Basin. Fossil plant material from this period is indicative of a tropical environment that was adjacent to an active fluvial or lacustrine system.

During Cretaceous time the area was the site of shallow water deposition in a lagoonal or swamp environment. The Lower Cretaceous Burro Canyon and Dakota Formations contain thin coal seams that may have economic significance. During most of the Lower Cretaceous, however, the GRA was a part of a beach or littoral environment adjacent to the Mancos Basin of central Colorado (Young, 1959).

Units of the Cretaceous Mancos Shale have been described as being sandstone and shale units deposited in a near-shore environment. Thin coal beds in the Mancos Shale may have some local economic significance. In the GRA proper, these units are represented by the carbonaceous units of the Mancos upper shale unit (Cashion, 1973). The Mesaverde Group Cretaceous units outcrop throughout the central and northern portions of the GRA and represent a period of cyclical deposition of shale, coal, limestone and sandstone units in a near-shore marine environment adjacent to the deep-water basins where the bulk of the Mancos Shale unit was deposited (Richardson, 1907). The Mt. Garfield Formation contains thick persistent coal beds in lower units (Rollins Sandstone Member). The upper members of this formation also contain thin, discontinuous coal seams of minor economic importance (Gentry, Personal Communication, 1982). These units were also laid down in a near-shore swamp or lagoonal environment. The Upper Cretaceous Hunter Canyon Formation represents a change in depositional environment. This sequence of sandstones and shales is thought to represent inland deposition in lacustrine or fluvial environments (Young, 1955).

The Hunter Canyon Formation is unconformably overlain by the Tertiary Wasatch Formation. This unconformity may represent a period of uplift and erosion prior to the formation of the Uinta sedimentary basin. Within the GRA are found thin lenses of the basal conglomeritic Ohio Creek Formation. The Wasatch Formation represents a period of shallow water terrestrial lacustrine deposition. The thin sandstone, shale and siltstone units sometimes contain local oil shale beds (Weeks, 1925).

The area was uplifted and subjected to erosion in Middle Tertiary times with the formation of the ancestral Colorado River Valley. Quaternary pediment, terrace gravel and eolian deposits formed on the exposed Cretaceous surfaces and alluvial deposits were formed along the various fluvial systems that were established.

#### DEMAREE CANYON WSA (CO-070-009)

According to the well information available, the Precambrian section is present under the WSA and was encountered in drill holes on the flanks of the Garmesa Anticline (Krey, 1962). No other information on the lithologies encountered is currently available. Within the boundaries of the WSA, only the Cretaceous and Tertiary units are exposed. The near-shore environments of the Mt. Garfield and Sege Formations characterize the Cretaceous section in this area. Isolated outcrops of the Tertiary Wasatch Formation cap the mesa tops and represent a period of fluvial or lacustrine deposition adjacent to major terrestrial lake systems.

Figures II-1 through II-6 illustrate the type formations presently existing in the WSA.

#### BLACK RIDGE CANYONS WSA (CO-070-113)

Precambrian gneisses, schists and intrusive rocks are unconformably overlain by the Mesozoic section. The Triassic Chinle, Wingate, and Kayenta Formations were deposited in the near-shore marine or lagoonal environment. Within the WSA there are no known occurrences of copper-silver "redbed" deposits. The Jurassic section is represented by the Entrada, Summerville and Morrison Formations. These rocks are thought to represent near-shore lagoonal and shallow water marine conditions with periods of transgressive and regressive marine and lacustrine shorelines. Fluvial terrestrial and delta-floodplain deposits have also been identified from these rocks. The characteristic sandstone hosted "roll-front" copper-silver-uranium-vanadium deposits which occur in these lithologies and in other parts of Colorado have not been identified within these units in the WSA. An occurrence of uranium-vanadium mineralization has been reported in the eastern portion of the WSA, but has not been positively correlated to these lithologies.

The Cretaceous Burro Canyon and Dakota Formations directly overlie the Jurassic section and represent periods of shallow water deposition in the lagoonal or swamp environment. Thin coal seams have been identified from the field reconnaissance efforts but have not been definitely correlated to these units. In other areas of Colorado and Utah, the Lower Cretaceous section has produced oil and gas (Brainard, 1962). The rest of the Cretaceous and Tertiary section has been eroded. Quaternary fluvial deposits are found along the northern boundary of the WSA and along the canyons that cut through the area.

Figures II-7 through II-10 illustrate the type formations presently existing in the WSA.

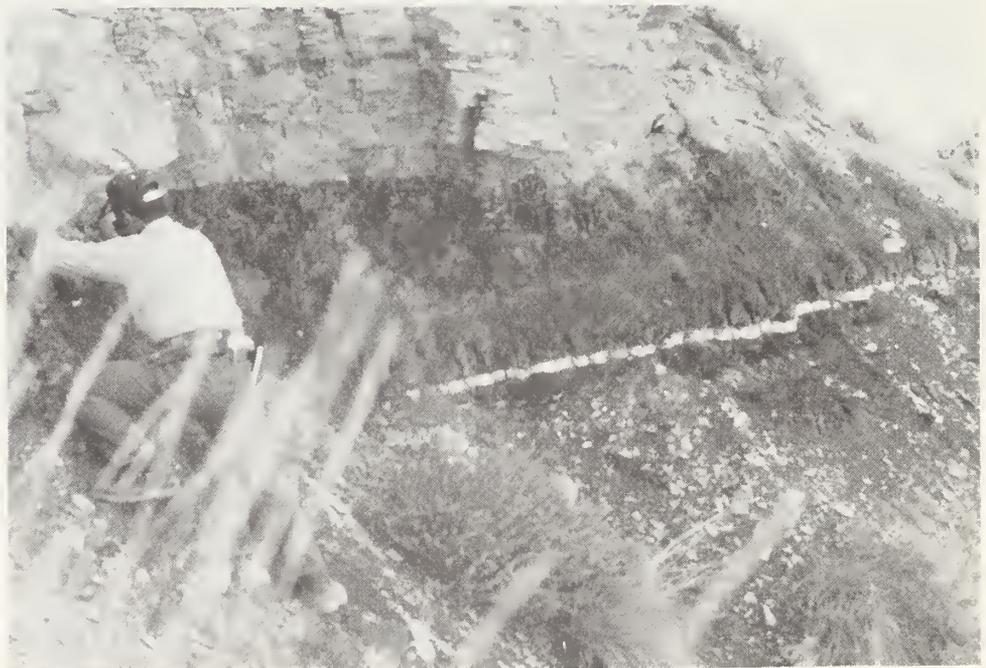
#### BLACK CANYON WEST-WRIGLEY MESA-JONES CANYON WSA (CO-070-113A & UT-060-116/117)

The Precambrian section in these areas is known only from USGS maps as consisting of gneisses, schists and intrusive rocks of older Precambrian age. As in the adjacent Black Ridge Canyon area, a thick section of Mesozoic units occurs. The environments of deposition are nearly identical with those in the Black Ridge Canyon area with the exception that the Cretaceous units have been eroded. There are no known metal or coal deposits within the area but potential for copper-silver mineralization exists in the Triassic Chinle, Wingate, and Kayenta Formations. The Jurassic Morrison and Brushy Basin Formations are not known to contain any uranium/vanadium deposits within the boundaries of the WSA.



**II-1**  
Munger Canyon  
coal mine, east of  
Demaree Canyon  
WSA.

**DEMAREE CANYON**



**II-2**  
Coal outcrop within  
WSA. T7S R103W  
Section 30.

**DEMAREE CANYON**



II-3  
East of Demaree  
Canyon WSA.

DEMAREE CANYON



II-4  
Coal outcrops -  
Sections 29-30.  
Demaree Canyon  
WSA from outcrop  
photographed in II-2.

DEMAREE CANYON



II-5

Drill hole on coal prospect.

T7S R103W NE NE Section 28.

## DEMAREE CANYON



II-6

Outcrop on coal  
prospect.

T7S R103W  
NE NE Section 28.

## DEMAREE CANYON



II-7  
Devils Canyon  
Precambrian  
outcrop.

**BLACK RIDGE CANYON**



II-8  
Devils Canyon,  
Precambrian.  
Segregation of  
pegmatites?

**BLACK RIDGE CANYON**



**II-9**

**Morrison formation,  
uranium prospect.**

**Carbonized wood in  
roof of adit. Edna**

**Claims - west side of  
Devils Canyon,  
Cherry Stem, north  
of radio tower.**

**BLACK RIDGE CANYON**



**II-10**

**Five foot wide pegmatite,  
quartz, feldspar, mica. Devils Canyon  
in the precambrian.**

**BLACK RIDGE CANYON**

## SECTION III

### ENERGY AND MINERAL RESOURCES

#### KNOWN MINERAL DEPOSITS

The known mineral deposits in the Demaree - Black Canyons GRA can be placed in two main groups: 1) coal, oil, and gas; and 2) sand, clay, and gravel pits. The number of oil, and gas wells, coal mines, and drilling activities are summarized below:

Gas Wells	Oil Wells	Oil & Gas Wells	Coal Mines	Show of Oil & Gas	Show of Gas	Adits	Plants	Refinery
105	14	3	9	1	3	5	1	1

The production of these operations is unknown.

Garfield County in the northern part of the GRA has the largest number of gas and oil wells. Among others, the Garmesa Gas Field is a prominent deposit. This gas field is part of the Garmesa Anticline, one of a number of structural features considered important to the localization of oil and gas. The gas and oil concentrations in the middle of the GRA in Mesa County are located mostly in known oil and gas fields. These gas fields may also be due to the trend of northern anticline structures located in the GRA (Cashion, 1973). Approximately half of the GRA contains coal fields, one of which is the Book Cliffs Coal Field, part of the extensive Uintah Region to the west (USGS and Colorado Geological Survey, 1977.) Some active coal mines are shown in the northeastern portion of the GRA in the Book Cliffs Field (See Overlay C).

The sand, gravel, and industrial mineral activities located in the GRA are summarized as follows:

Active Sand & Gravel Pits	Inactive Sand & Gravel Pits	Temporarily Shutdown Sand & Gravel Pits	Inactive Construction Zone	Inactive Clay Pit
3	56	1	4	2

The large majority of these occur in the southwestern portion of the GRA (See Overlay D). Most of these deposits follow some past or present drainage path of the Colorado River and its tributaries. Construction stone has been quarried from the Kayenta Formation in the southwestern part of the GRA.

The following descriptions address the known mineral deposits of each of the WSA's within the Demaree - Black Canyons GRA.

#### DEMAREE CANYON WSA (CO-070-009)

The known mineral deposits within the WSA are two gas wells located within the western border (See Overlay C, T7S R104W, Sec. 34, 35, #70, #73). Both wells are

producers (See Appendix B). Also included in the WSA are gas fields, including the Garmesa Gas Field (See Overlay C, and Enrich, 1930).

On the west, southwest, and northern borders are eight natural gas wells (See Overlay C, T7S R104W, Secs. 23, 26, 27, 34; T7S, R103W, Sec, 9, 16; T8S, R104W, Sec, 3, #53, #54, #55, #72, #83, #86, #112, #113). Like the previously mentioned gas wells, these are also producers. No production statistics were available for any of the wells.

**BLACK RIDGE CANYON WSA (CO-070-113) AND  
BLACK CANYON WEST-WRIGLEY/MESA-JONES CANYON WSA'S (CO-070-113A, UT-060-116/117)**

A small prospect/working is found in the southeastern part of the Black Ridge Canyon WSA at the head of Devils Canyon, Section 26, T11S, R102W (Refer to Battleship Rock 7.5' Quad., Appendix A). This prospect is in the Edna claim group, specifically, Claim #2 and #11. These workings are in the Jurassic Morrison Formation, Salt Wash member. The workings were investigated by Dr. Paul Gilmour and Mr. Ted Eyde (field notes and photographs are in Appendix A). The workings have been delineated on BLM photograph 2-10-26 (Appendix A). Production from these workings is not known.

The only known mineral deposit in the Black Ridge Canyon West WSA is an abandoned architectural dimension stone quarry located in Section 26, T11S, R104W, southwest of Long Mesa (refer to Seiker Canyon 7.5' Quad.). The property is accessible from the south via dirt road. The quarry, which last operated in 1964 and 1965, was developed by a single low bench. Production data for the quarry is not available, however, only a three or four foot thickness of the Kayenta Sandstone is of an evenly bedded quality to be quarried.

Several sand and gravel operations border the Black Ridge Canyon and Black Canyon West WSA's along the Colorado River.

There are no known mineral deposits in the Wrigley Mesa/Jones Canyon WSA.

**KNOWN PROSPECTS, MINERAL OCCURRENCES, AND MINERALIZED AREAS**

As mentioned earlier, the prospects, mineral occurrences, and mineralized areas in this GRA consist mainly of coal, oil, and gas, along with a minor uranium prospect. The coal occurrence is in the Book Cliffs Coal Field, and other associated coal fields contained in the GRA. The gas and oil occur in or around the Garmesa Anticline. Summarized below are the mineral occurrences for coal, oil and gas. The uranium occurrence is the Edna uranium prospect, located in the southwestern section of the GRA.

Exploration Hole Without Data	Abandoned Location	Abandoned Gas Well	Dry Hole	Uranium Prospect
27	2	1	56	1

DEMAREE CANYON WSA (CO-070-009)

Within the WSA occur five abandoned locations and/or exploration holes without data (See Overlay C, T7S R103W, Sec. 28, 32; T8S R104W, Sec. 1, 2, #93, #94, #107, #108, #109) Coal outcrops occur on both sides of the canyon in the WSA in T7S, R103W, Secs. 28 - 30, 10 or 11 (Appendix A, Field Notes). In addition, there is a drill site with an operating drill rig along the south side of Demaree Canyon (Appendix A, Field Notes). From the aerial photographs in Appendix A, it is evident that six oil drilling pads occur within the northern section of the WSA (Photo 2-9-155). In the middle of the WSA are seven coal occurrences, noted by the consultants on their site visits (Appendix A, Topographic Map, Carbonera, CO).

BLACK RIDGE CANYON WSA (CO-070-113) AND  
BLACK CANYON WEST-WRIGLEY MESA/JONES CANYON WSA'S (CO-070-113A & UT-060-116/117)

The only known prospect consists of a series of trenches and roads located near or on the southeastern boundary of the Black Ridge Canyon WSA, at the east end of Black Ridge (refer to Field Notes, Appendix A).

A coal seam was observed in Devils Canyon in Section 14, T11S, R102W.

Aside from the above mentioned occurrence, no direct evidence of mineralization was observed by Dr. Gilmour and Mr. Eyde.

There are no known prospects or mineral occurrences in the Black Canyon West and Wrigley Mesa/Jones Canyon WSA. Mineralization was not observed in the Precambrian rocks in the Little Dolores River.

**MINING CLAIMS, LEASES AND MATERIAL SITES**

In the Demaree - Black Ridge Canyons GRA, there are no patented mining claims (refer to Overlay A). The number of unpatented mining claims are as follows:

<u>County, State</u>	<u>#Lode Claims</u>	<u>#Placer Claims</u>
Grand Co., UT	0	334
Garfield Co., CO	0	9
Mesa Co., CO	<u>141</u>	<u>78</u>
TOTALS	141	421

Of the 562 lode and placer claims, 84 claims border or are within the WSA's (Overlay A). A listing of claims and claimants, and of unpatented mining claims, is contained in Appendix C.

Research on oil and gas and coal leases was limited to within the WSA and an area extending one mile beyond the WSA boundary. Two oil and gas leases border the Wrigley Mesa/Jones Canyon WSA in Grand Co., Utah (refer to Overlay C and Appendix

B). Researching the data in Appendix A has delineated 54 oil and gas leases in Mesa and Garfield Counties. The Demaree Canyon WSA is within a known coal reserve leasing area recognized by the U.S. Geological Survey (See Appendix A, "Evaluations"). The coal reserve leasing area extends west from the Grand Mesa Coal Field along the Book Cliffs to the Colorado - Utah state line (Jones, 1978).

The following descriptions address the mining claims, leases, and material sites of each of the WSA's within the Demaree - Black Canyons GRA.

#### DEMAREE CANYON WSA (CO-070-009)

The WSA is included within a known coal reserve leasing area as defined by the USGS (Appendix A, Evaluations). As of June 14, 1982, there were no patented or unpatented mining claims or leases on material sites.

#### BLACK RIDGE CANYON WSA (CO-070-113)

#### BLACK CANYON WEST-WRIGLEY MESA/JONES CANYON WSA'S (CO-070-113A; UT-060-116/117)

As of June 14, 1982, there were no patented mining claims, leases or material sites in the Black Ridge Canyons WSA. There are, however, 32 unpatented mining claims, of which 17 are lode claims (Sections 14, 24, 25, and 26, T11S, R102W) and 15 are placer claims located along the northern boundary of the WSA (refer to Overlay A and Appendix C).

In the Black Canyon West and Wrigley Mesa/Jones Canyon WSA there were no patented mining claims, leases or material sites, as of June 14, 1982. There are no oil or gas leases within the WSA: however, two leases border the Wrigley Mesa/Jones Canyon WSA in section 32, T19S, R26E and Section 32, T20S, R26E (refer to Overlay C, Grand Co., UT, and Appendix B). There are 52 unpatented placer claims that lie along the northern boundary of this WSA on the Colorado River. There are no unpatented lode claims (refer to Overlay A, and Appendix B, Mesa Co., CO, and Grand Co., UT).

#### MINERAL DEPOSIT TYPES

The deposits in the Demaree Canyon-Black Ridge Canyons GRA can be most easily grouped by commodity types. They are oil, gas, coal, and sand, gravel, and clay pits.

The GRA contains six major gas fields, along with numerous other small gas fields (Refer to Overlay C). The six fields (Garmesa, Mack Creek, Fruita, Highline Canal, Coal Gulch, and Bar X), are located in the middle to northern section of the GRA. The production horizon, cumulative production, and type of trap for each field are summarized as follows:

Gas field	Productive horizon (all Cretaceous)	Cumulative production in million cubic feet 1-1-78	Type of trap
Bar X	Dakota, Buckhorn, Entrada, Morrison - Salt Wash	4,030,372	stratigraphic/structural
Coal Gulch	Mesaverde	110,614	Unknown
Garmesa	Dakota, Entrada, Buckhorn	unknown	Structural
Fruita	Buckhorn	607,228	Unknown
Highline Canal	Dakota, Morrison - Salt Wash	184,129	-do-
Mack Creek	Morrison	251,198	-do-

(Schwochow, 1978)

The fields are all a part of the Piceance Basin. The Cretaceous Mancos Shale and Mesaverde Group sediments were all deposited in a broad western flank of a Cretaceous seaway. The main source of the sediments was mostly from what is now western Utah. The gas resources in the formation are related structurally to northwest to southeast trending anticlines associated with the Uncompahgre Uplift and subsurface folding in the Piceance Basin (Schwochow, 1978; Gunter, 1962).

The Dakota Formation consists principally of a sequence of nonmarine sediments. The sediments include sandstones; (of which the Buckhorn is a member), silty, calcareous mudstones; carbonaceous shales, sandstones, and shales; and conglomeritic sandstones (Young, 1959). The Cozzette Sandstone occurs with the Corcoran Sandstone as a transition zone between the Mancos Shale and Mesaverde Group. A major producer of gas, the Cozzette Sandstone is fine to coarse grained and micaceous with fair to good porosity (Gunter, 1962). The Mesaverde Group consists of coal, carbonaceous shale and mudstone, massive alluvial sandstones and interbedded grey shales (Gunter, 1962).

The coal found in the GRA is in the Book Cliffs Coal Field, which is also a part of the Cretaceous Mesaverde Group (Speltz, 1976). The coal is mainly high-volatile C bituminous, with some high-volatile B present (Landis, 1959). In the 255 square miles of the Book Cliffs Coal Field, 2,293 million tons of bituminous coal is estimated to have been originally present (Landis, 1959).

The coal in the Mesaverde Group formed during the Cretaceous in a large geosyncline along the general line of the present Rocky Mountain range. As seas advanced and retreated, a trough through the geosyncline filled with erosion material from mountains to the west. Large marginal areas were subjected to non-marine deposition which changed as shorelines changed. It is thought coal was deposited in these

marginal areas. The formation of the Rocky Mountains, along with other orogenic episodes, caused the regions to break up into the principal coal fields of the state (Yingst, 1960).

Four of the most exploited coal seams occur in the Mt. Garfield Formation of the Mesaverde Group. These four seams in ascending order, are the Anchor, Palisade, Cameo, and Carbonera (Schwochow, 1978). The Anchor is a small seam which does not have as much economic importance of the other three. The Palisade coal consists of several seams, usually having only one minable seam in any one location (Schwochow, 1978). Most of the seams are characterized by local irregularities in thickness. The Cameo seam is most economically important, as it accounts for two-thirds of the field's production. Occupying a high position on the cliffs, coal seams in the Cameo are sometimes separated by shaly sandstones, and are intruded in some areas by sandstone dikes (Schwochow, 1978). The Carbonera coal seams occur as discontinuous lenses above the Cameo (Schwochow, 1978).

The sand, gravel, and clay deposits occur mostly as Quaternary sediments deposited along the course of the Colorado River and it's tributaries.

The following addresses the mineral deposit types in each WSA in the Demaree Canyon-Black Ridge Canyons GRA.

#### DEMAREE CANYON WSA (CO-070-009)

The only deposits in the WSA are two gas wells. Please see the preceding discussion on the gas fields located in the GRA for information about the WSA.

#### BLACK RIDGE CANYON WSA (CO-070-113)

BLACK CANYON WEST-WRIGLEY MESA/JONES CANYON WSA'S (CO-070-113A, UT-060-116/117)

These WSA's contain only two known deposits for uranium, and construction stone.

The uranium deposit in the Edna claim group is located in the Salt Wash Member of the Jurassic Morrison Formation. In the Morrison formation carnotite, a uranium and vanadium oxide, is the principal ore mineral. Carnotite is a secondary mineral deposited by waters that were in contact with primary uranium and vanadium minerals. Uranium mineralization occurs in the Salt Wash Member and the Brushy Basin Member of the Morrison Formation. The Salt Wash Member consists of interstratified sandstone and claystone units. The unit was formed as a large alluvial fan by an aggrading system of braided streams (Craig, et al, 1955). The Brushy Basin consists of variegated claystones with few lenticular conglomeratic sandstone strata. It was formed in fluvial and lacustrine environments with large amounts of clay (Craig, et al, 1955). It is thought the introduction of the ore was done by mineral-bearing solutions that seeped through the permeable layers after sediments accumulated. The source of the primary minerals is currently under dispute (Craig, et al, 1955).

The construction stone in the WSA occurs in the Triassic Kayenta Formation. The formation is composed of a light-colored thin-bedded sandstone. The stone quarried was a reddish-brown, thin-bedded sandstone. Production figures for the quarry are not known.

## MINERAL ECONOMICS

The inherent nature of discussing the economics of the minerals existing within the Demaree Canyon - Black Ridge Canyons GRA and its WSA's can only provide for a general approach inasmuch as there are many economic factors that enter into the development of an ore body. These include access, market value, grade, transportation, recovery and extraction methods, etc. Therefore, the discussion herein addresses the U.S. and Colorado demand the production status of each of the existing minerals in the WSA.

The mineral resources found in the GRA include coal, oil, gas, sand and gravel, and clay pits.

Specific information relating to the known oil and gas reserves and reserve potential in the Demaree Canyon WSA was not obtainable from the published literature or industry sources (Heylmun, Personal Communication, 1982). Known oil and gas resources are found in the Cretaceous section. These deposits will have continuing importance as long as the United States is a net importer of oil and gas. Current demand for petroleum products will maintain current levels or increase in the future (Petroleum Times Price Report, Oct. 1982). Exploration activity in western Colorado has slackened in the last six months with the number of active rigs drilling dropping approximately 15% (Heylmun, Personal Communication, 1982). Areas of current drilling activity include the Paradox Basin of Colorado and Utah, and areas north of the Colorado River in Mesa, Garfield and Moffat Counties, Colorado (Heylmun, Personal Communication, 1982).

Coal in the GRA occurs in the Bookcliffs Coal Field, part of the Cretaceous Mesa-verde Group (Schwochow 1978; Gentry, Personal Communication 1982). These units have been mined in the past but are thought to have produced little in the way of significant tonnage. The characteristics of coal from these units are largely unknown as is the production from any of the small, abandoned mines that have been reported in the literature or encountered in the field.

The future looks encouraging for coal as more and more utilities are switching back to coal for power generation (Schwochow 1978; Colo. Div. Mines Rept. 1980). Changes in technology and improvements in combustion/distillation techniques will increase the demand for Colorado coal, and coal byproducts (Gentry, Personal Communication, 1982).

The sand, gravel, and clay pits are considered "high place value" industrial minerals. These minerals are of economic value only when deposits are readily accessible, and in close proximity to a market.

The economic viability of the mineral resources in the WSA's in the Demaree Canyon-Black Ridge Canyons GRA are summarized as follows:

<u>WSA</u>	<u>Mineral Potential</u>	<u>Accessibility</u>	<u>Economic Potential[a]</u>
Demaree Canyon	Oil-Gas	Good	Good
WSA (CO-070-009)	Coal	Good	Good
Black Ridge	Uranium	Fair	Poor
Canyon WSA (CO-070-113)	Construction Stone	Good	Good
Black Canyon	Construction Stone	Poor	Poor
West-Wrigley	Sand and Gravel	Poor	Poor
Mesa/Jones Canyon			
WSA's (CO-070-112A, UT-060-116/117)			

[a] The economic potential rating is notwithstanding market demand fluctuations.

## SECTION IV

### LAND CLASSIFICATION FOR GEM RESOURCES POTENTIAL

After thoroughly reviewing the existing literature and data base sources, MSME/Wallaby personnel plotted all known and documented mineral occurrences, mines, prospects, oil and gas fields, sand and gravel operations, processing facilities, mining claims, mineral leases, and the locations of anomalous geochemical samples from the National Uranium Resource Evaluation - Hydrological and Stream Sediment Reconnaissance - Airborne Radiometric and Magnetic Survey (NURE-HSSR-ARMS) programs. This plotted information and the data bases on each WSA was made available to a multi-faceted team of experts which made three successive evaluations of the GEM resource potential of each of the WSA's.

The team or panel of geological experts was comprised of:

Dr. Paul Gilmour: Base and precious metal deposits in western U.S. and Canada, expert on Precambrian mineral resources.

Mr. Ted Eyde: Base and precious metal deposits in western U.S., expert on industrial mineral resources.

Mr. Annan Cook: Base and precious metal deposits in western U.S., expert on porphyry deposits and mine evaluation.

Mr. Edward Heylmun: Oil, gas and oil shale deposits of western U.S.

Dr. Robert Carpenter: Mineral deposits of Colorado and western U.S., expert on geology of Colorado.

Dr. Donald Gentry: Expert in coal and oil shale deposits of Colorado and western U.S.

Dr. Larry Lepley: Expert in remote sensing and geothermal resources.

Mr. Walter E. Heinrichs: Geophysics and base and precious metal deposits of western U.S., expert on porphyry copper deposits.

As indicated earlier, Dr.'s Gilmour and Gentry, and Mr. Ted Eyde made certain field investigations as result of the base data analysis phase. The purpose of the field investigations was to either verify the existing data or assess relatively unknown areas. Dr. Lepley reviewed all aerial photographs for observable anomalies, which were then investigated by the field team, or verified against the existing base data.

The evaluations were then made on the basis of examination of the data bases, field investigations and the individual experiences of the members of the panel in such areas as base and precious metal, industrial and energy mineral deposits; oil and gas deposits; and geothermal resources. In the course of these evaluations, every

attempt was made to objectively rate the potential for a particular commodity within the respective study area. In this effort, the evaluation criteria proposed by the Bureau was rigorously used. The classification scheme used is shown in Table IV-1. In many cases the lack of information did not allow for a full determination of the GEM resource potential and the panel was forced to leave some areas unranked or classified for some commodities. The situation thus arises where there is an area that has been unclassified for a commodity, despite a reported occurrence, because it is next to an area where there is insufficient data to make a meaningful attempt at classification. Nonetheless, each resource has been additionally rated as to what level of confidence the panel of experts attached to the selected classification level. This is denoted by the letter associated with each rate classification. These are defined in Table IV-1.

A further restraint on this classification and delineation effort comes when there is a lack of subsurface information. Some areas are very well known from past exploration efforts and have an abundance of subsurface information. Other areas are practically unknown due to an absence of any past exploration or development efforts.

The WSA's, for the most part, are not well known geologically. For this reason, our expert team had to extrapolate geologic information from adjacent areas to make any sort of reasonable classification with some level of confidence. The following pages address those resources considered to be leasable, locatable and/or salable with associated maps locating the resource area (Figures IV-1 through 3):

**TABLE IV-1**  
**RESOURCE RATING CRITERIA**

**CLASSIFICATION SCHEME**

1. The geologic environment and the inferred geologic processes do not indicate favorability for accumulation of mineral resources.
2. The geologic environment and the inferred geologic processes indicate low favorability for accumulation of mineral resources.
3. The geologic environment, the inferred geologic processes, and the reported mineral occurrences indicate moderate favorability for accumulation of mineral resources.
4. The geologic environment, the inferred geologic processes, the reported mineral occurrences, and the known mines or deposits indicate high favorability for accumulation of mineral resources.

**LEVEL OF CONFIDENCE SCHEME**

- A. The available data are either insufficient and/or cannot be considered as direct evidence to support or refute the possible existence of mineral resources within the respective area.
- B. The available data provide indirect evidence to support or refute the possible existence of mineral resources.
- C. The available data provide direct evidence, but are quantitatively minimal to support or refute the possible existence of mineral resources.
- D. The available data provide abundant direct and indirect evidence to support or refute the possible existence of mineral resources.

● LEASABLE RESOURCES

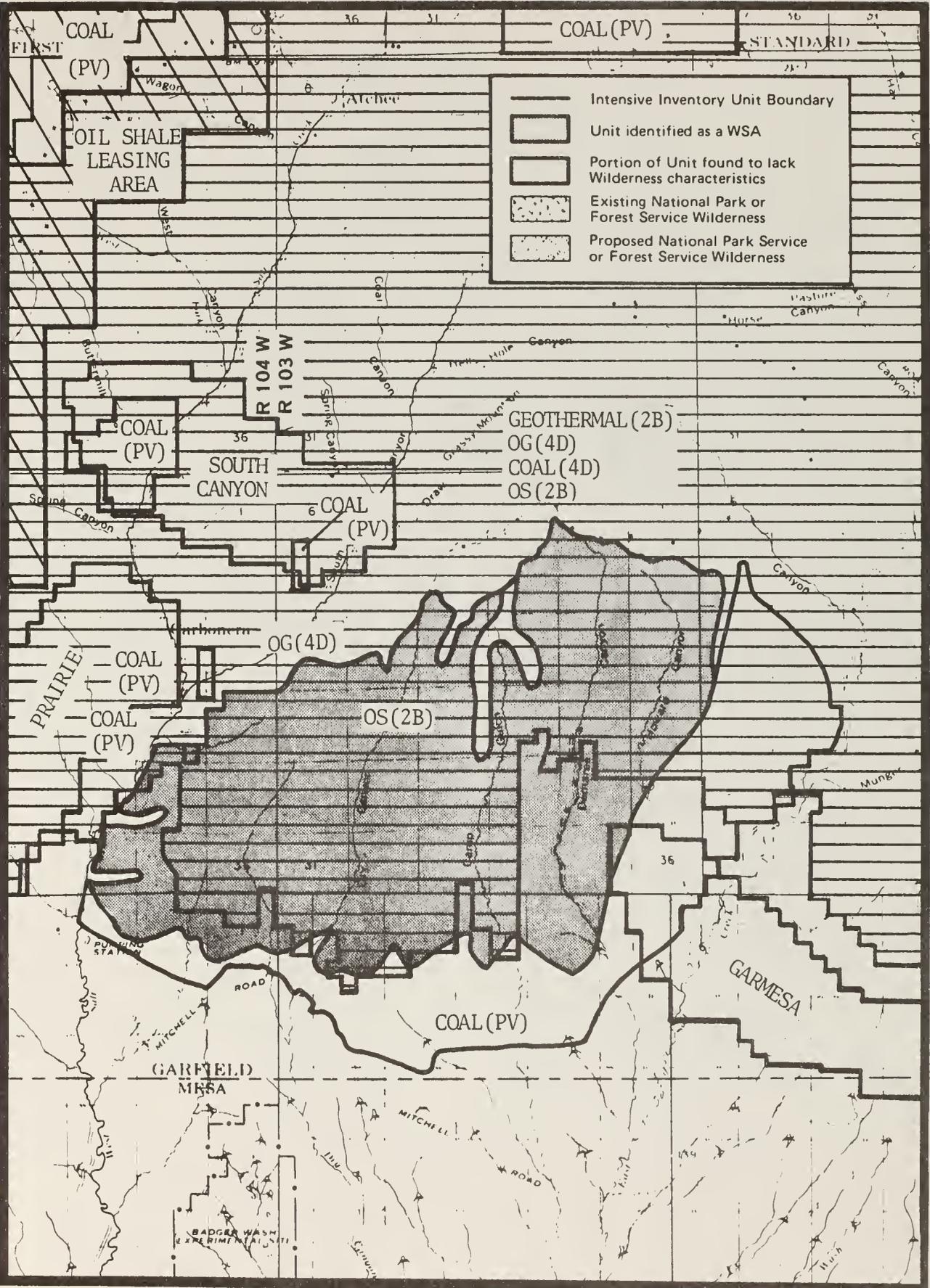
DEMAREE CANYON WSA (CO-070-009)

<u>Resource</u>	<u>Classification</u>	<u>Comments</u>
Oil & Gas	4D	The Garmesa anticline, a known gas producer, continues completely through the WSA. Gas production from the Jurassic Entrada Sandstone and the Cretaceous Buckhorn, Cedar Mountain and Dakota Sandstones.
Oil Shale	2B	
Coal	4D	Coal is in the Mt. Garfield Formation or equivalent formation.
Geothermal	2B	Unknown potential

BLACK RIDGE CANYON WSA (CO-070-113)

<u>Resource</u>	<u>Classification</u>	<u>Comments</u>
Oil & Gas	2B	Lack of stratigraphic section favorable for oil and gas occurrence, over Precambrian rocks.
Oil & Gas	2B	Classification for Precambrian
Coal	1A	The WSA lacks coal-bearing units
Geothermal	2B	Unknown potential

GRAND JUNCTION



T 6 S

T 7 S

T 8 S



MMS/LEASABLE RESOURCES  
Figure IV-1a

(After BLM, 1980)

GRAND JUNCTION

R 103 W

R3W

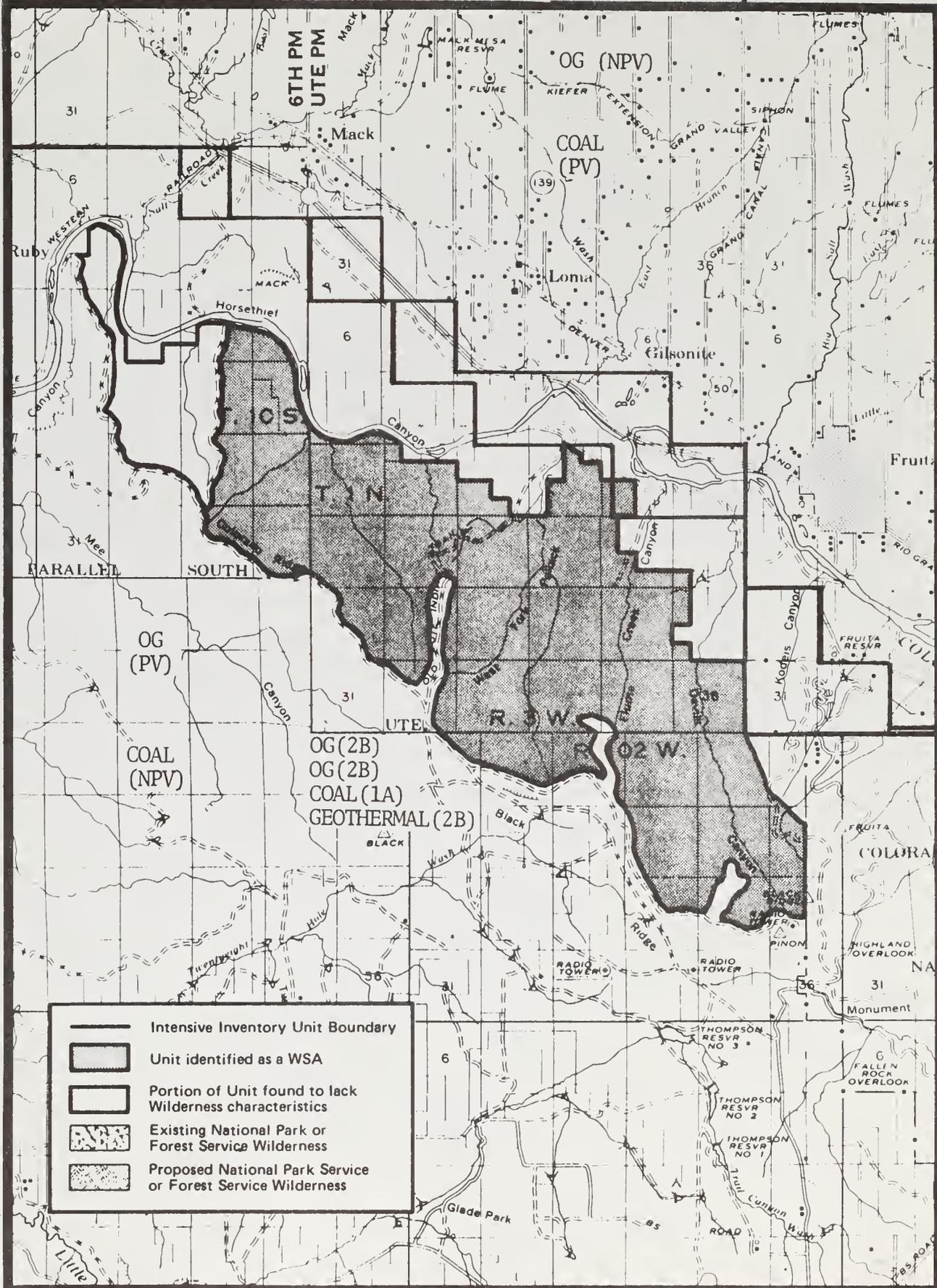
R2W

T 2 N

T 1 N

T 1 S

T 12 S



	Intensive Inventory Unit Boundary
	Unit identified as a WSA
	Portion of Unit found to lack Wilderness characteristics
	Existing National Park or Forest Service Wilderness
	Proposed National Park Service or Forest Service Wilderness



MMS/LEASABLE RESOURCES  
Figure IV-1b

(After BLM, 1980)

BLACK CANYON WEST (CO-070-113A)

<u>Resource</u>	<u>Classification</u>	<u>Comments</u>
Oil & Gas	2B	Lack of stratigraphic section favorable for oil and gas occurrence, over the Precambrian.
Oil & Gas	2B	Classification for Precambrian rocks
Coal	1A	The WSA lacks coal-bearing units
Geothermal	2B	Unknown potential

● LOCATABLE MINERALS

DEMAREE CANYON WSA (CO-070-009)

<u>Resource</u>	<u>Classification</u>	<u>Comments</u>
Precious Metals	1A	
Base Metals	1A	
Locatable Energy Minerals	3C	Uranium-Vanadium potential associated with Cretaceous Mancos Shale.
Other Locatable Minerals		Unknown

GRAND JUNCTION

R 104 W

R 103 W

R3W

OG (NPV)

OG (PV)

OG (NPV)

SECOND

STANDARD

PARALLEL

SOUTH

T. 10 S

T. 11 N

T 11 S

T 12 S

OG (2B)  
OG (2B)  
COAL (1A)  
GEOTHERMAL (2B)

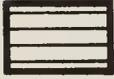
	Intensive Inventory Unit Boundary
	Unit identified as a WSA
	Portion of Unit found to lack Wilderness characteristics
	Existing National Park or Forest Service Wilderness
	Proposed National Park Service or Forest Service Wilderness



MMS/LEASABLE RESOURCES  
Figure IV-1c

(After BLM, 1980)

LEGEND FOR MINERALS MANAGEMENT SERVICE CLASSIFICATIONS



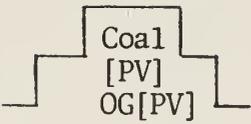
Defined KGS and/or Coal Leasing Areas



Areas Prospectively Valuable for Sodium or Potassium



Defined Oil Shale Leasing Area

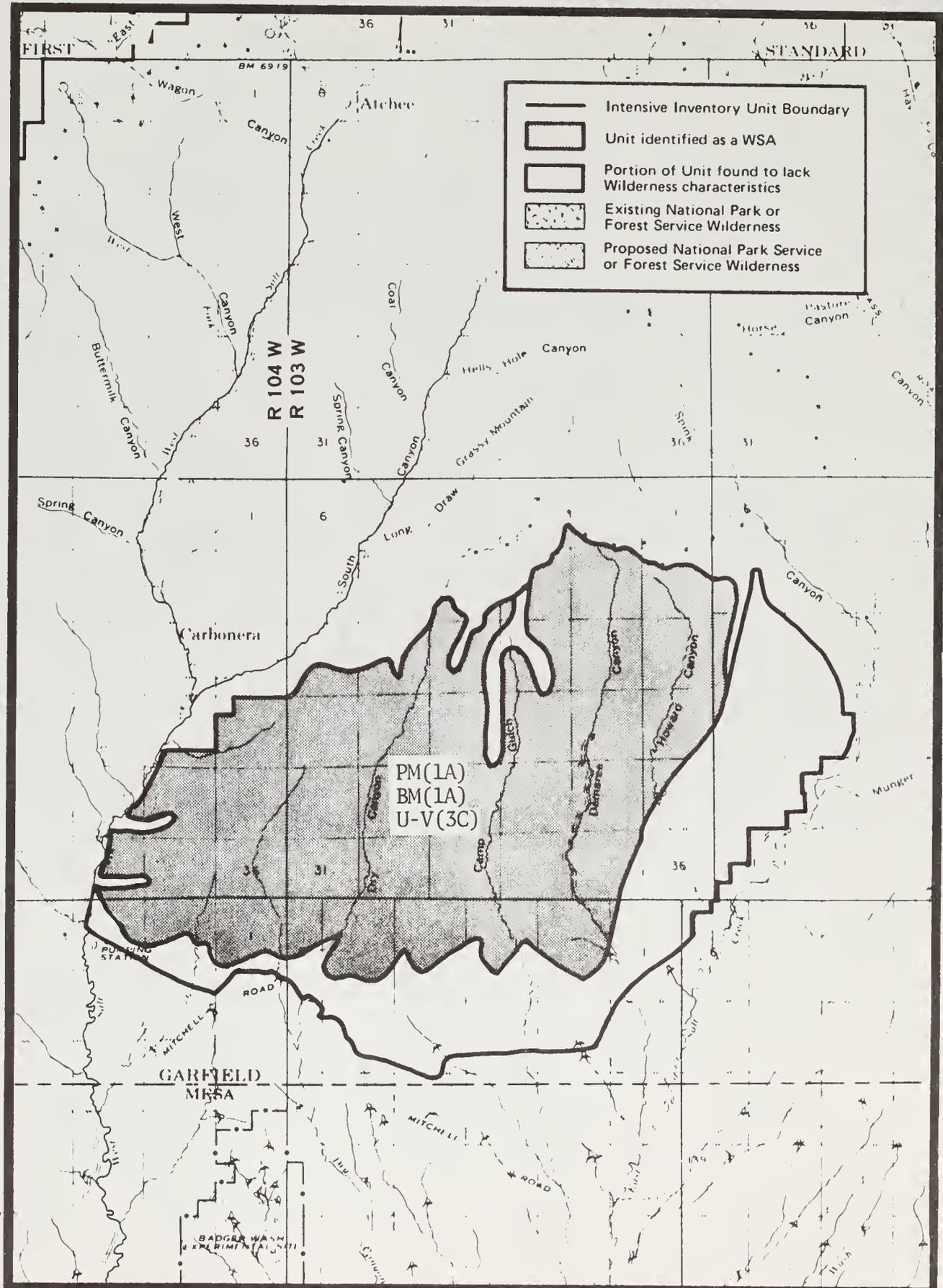


Areas Identified as Prospectively Valuable for  
Coal or Oil, Gas

Coal [NPV]  
OG [NPV]

Areas Identified as Not Being Prospectively Valuable  
for Coal, or Oil, Gas

GRAND JUNCTION



- Intensive Inventory Unit Boundary
- Unit identified as a WSA
- Portion of Unit found to lack Wilderness characteristics
- Existing National Park or Forest Service Wilderness
- Proposed National Park Service or Forest Service Wilderness

PM(1A)  
BM(1A)  
U-V(3C)

(After BLM, 1980)

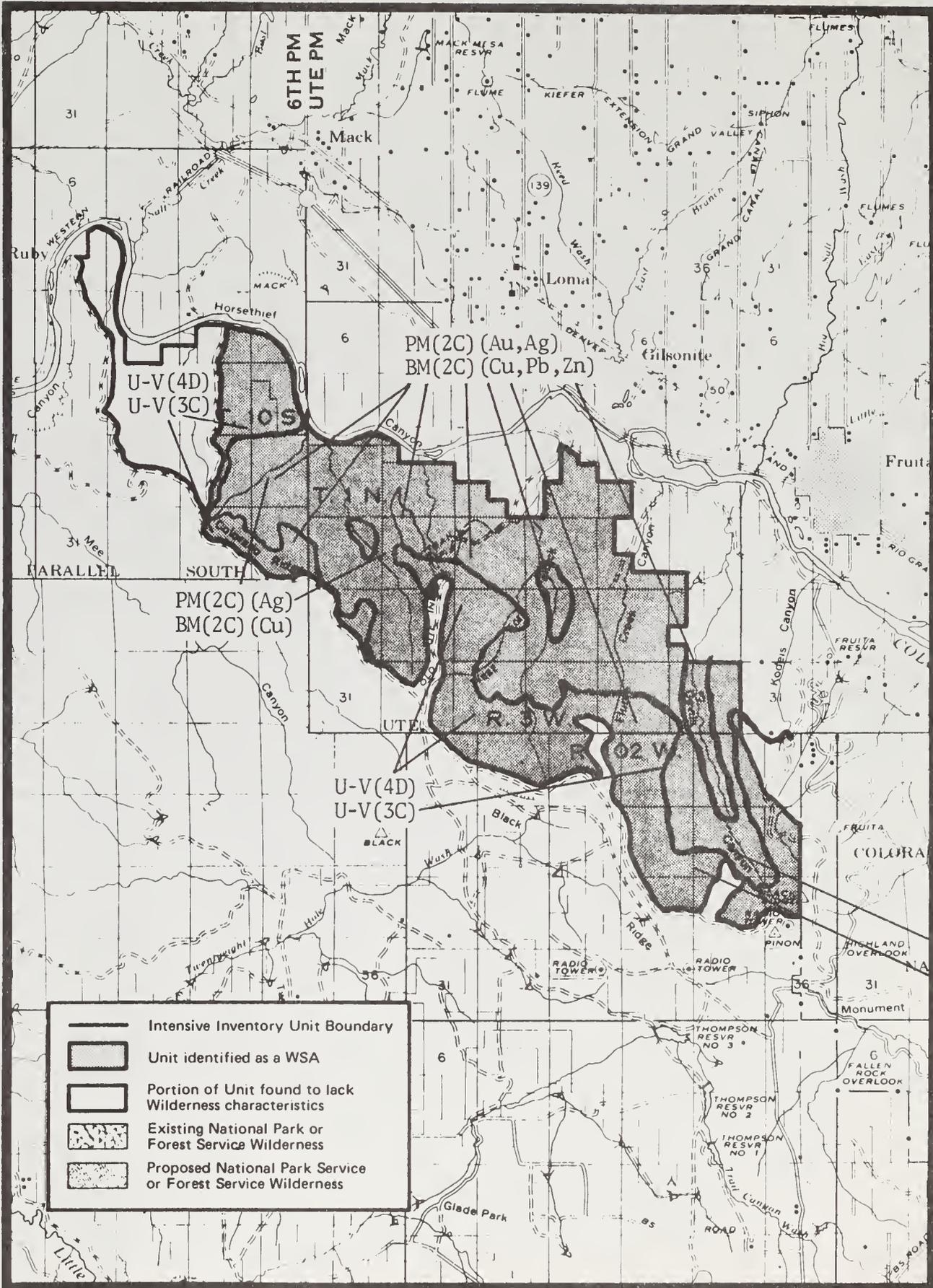
LOCATABLE RESOURCES  
Figure IV-2a

BLACK RIDGE CANYON (CO-070-113)

<u>Resource</u>	<u>Classification</u>	<u>Comments</u>
Precious Metals	2C	Au, Ag mineralization potential associated with Precambrian felsic volcanics and sediments.
	2C	Ag mineralization potential associated with Triassic "red bed" deposits.
Base Metals	2C	Cu, Pb, Zn mineralization potential associated with Precambrian felsic volcanics and sediments.
	2C	Cu mineralization potential associated with Triassic "redbed" deposits.
Locatable Energy Minerals	4D	Uranium-Vanadium mineralization in the Jurassic Salt Wash Member of the Morrison Formation.
	3C	Uranium-Vanadium mineralization in the rest of the Jurassic section.
	2A	Uranium-Vanadium mineralization potential in the Triassic Chinle Formation.
Other Locatable Minerals		Unknown

R 103 W

GRAND JUNCTION



T 12 N

T 11 N

T 11 S

U-V(4D)  
U-V(3C)

- Intensive Inventory Unit Boundary
- Unit identified as a WSA
- Portion of Unit found to lack Wilderness characteristics
- Existing National Park or Forest Service Wilderness
- Proposed National Park Service or Forest Service Wilderness

(After BLM, 1980)

LOCATABLE RESOURCES  
Figure IV-2b

BLACK CANYON WEST-WRIGLEY MESA/JONES CANYON (CO-070-113A, UT-060-116/117)

<u>Resource</u>	<u>Classification</u>	<u>Comments</u>
Precious Metals	2C	Au, Ag mineralization potential associated with Precambrian felsic volcanics and sediments.
	2C	Ag mineralization potential associated with Triassic "red bed" deposits.
Base Metals	2C	Cu, Pb, Zn mineralization potential associated with Precambrian felsic volcanics and sediments.
	2C	Cu mineralization potential associated with Triassic "redbed" deposits.
Locatable Energy Minerals	4D	Uranium-Vanadium mineralization in the Jurassic Salt Wash Member of the Morrison Formation.
	3C	Uranium-Vanadium mineralization in the rest of the Jurassic section.
	2A	Uranium-Vanadium mineralization potential in the Triassic Chinle Formation.
Other Locatable Minerals		Unknown

● SALABLE RESOURCES

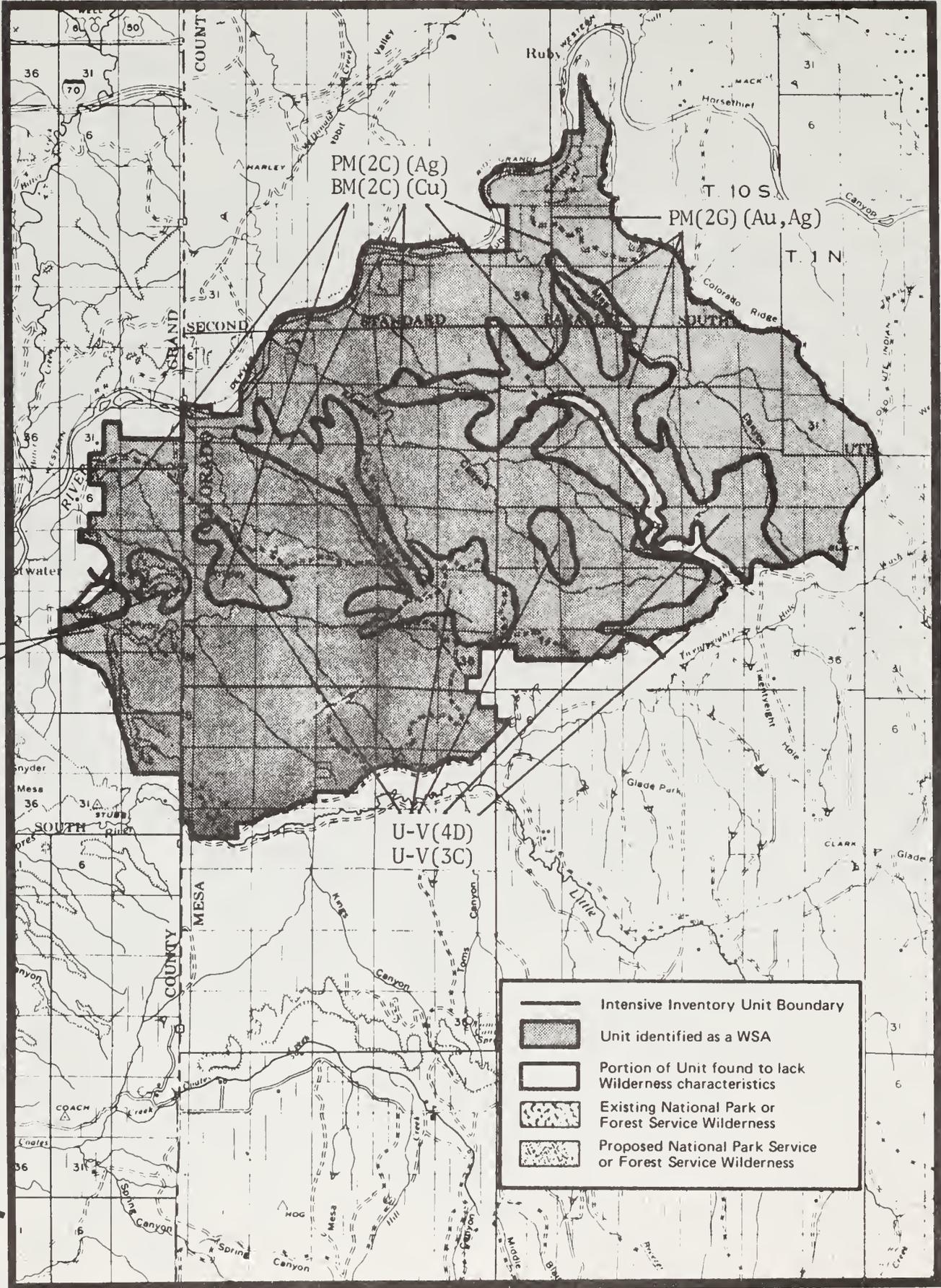
DEMAREE CANYON WSA (CO-070-009)

<u>Resource</u>	<u>Classification</u>	<u>Comments</u>
Bentonite	4D	The Mancos Shale may contain favorable units. The economic potential is rated as low to moderate.
Dimension Stone	4D	The Segoe, Wingate and Hunter Canyon formations are favorable for dimension stone. The economic potential is rated as low to moderate.

GRAND JUNCTION

V(4D)  
V(3C)

T 11 S

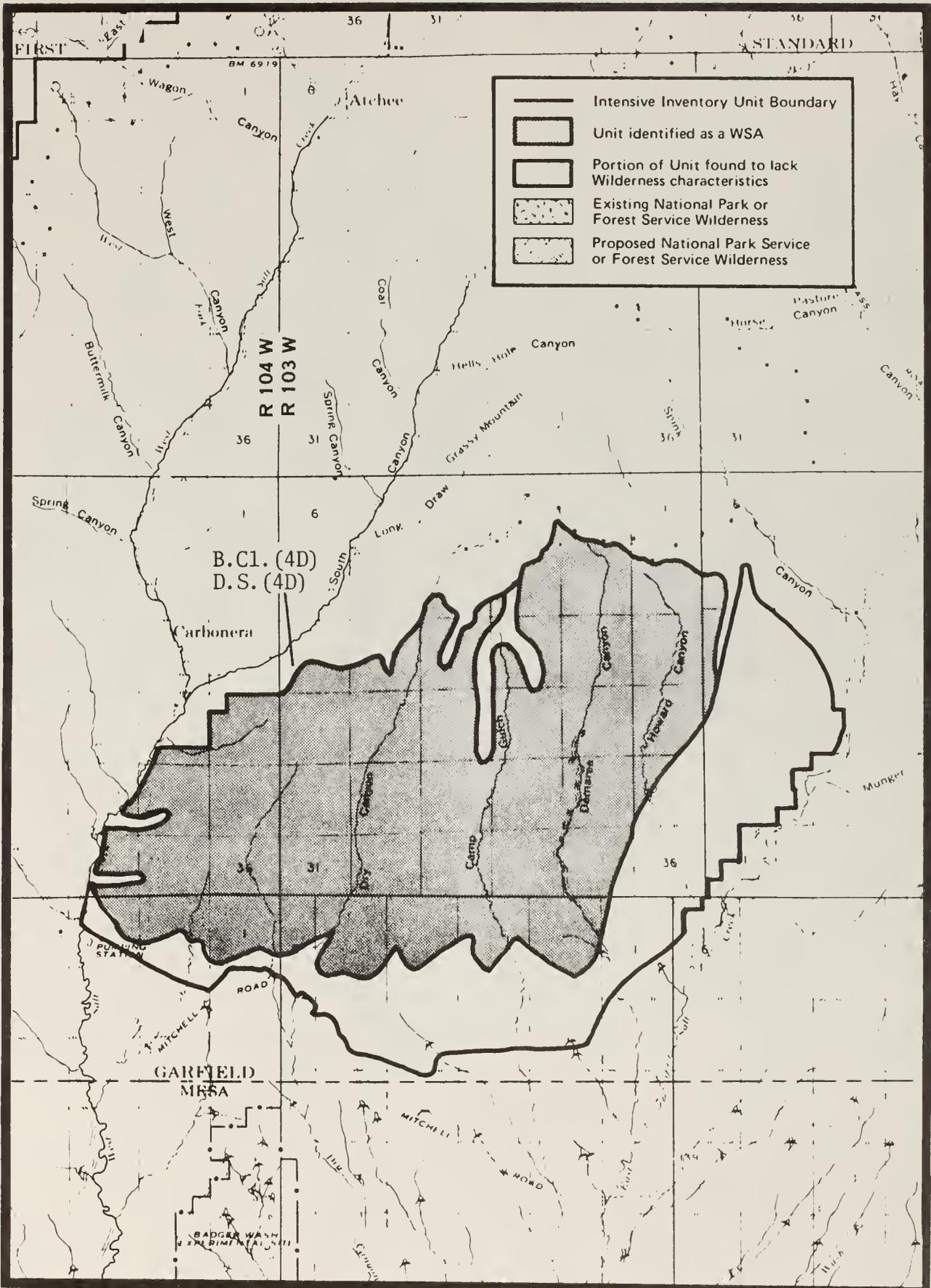


0 1 2 3 4 5 Miles

LOCATABLE RESOURCES  
Figure IV-2c

(After BLM, 1980)

GRAND JUNCTION



SALABLE RESOURCES  
Figure IV-3a

(After BLM, 1980)

BLACK RIDGE CANYON WSA (CO-070-113)

<u>Resource</u>	<u>Classification</u>	<u>Comments</u>
Dimension Stone	4D	The Entrada Sandstone, Wingate and Chinle Formations are favorable units for dimension stone. The economic potential is rated as low to moderate.
Clays	4D	The Morrison contains favorable units for clay deposits. The economic potential is rated low to moderate.
Quartz, Mica, Feldspar	3D	Derived from Precambrian pegmatites and migmatites. The economic potential is rated low to moderate.

BLACK CANYON WEST - WRIGLEY MESA/JONES CANYON WSA'S (CO-070-113A/UT-060-116/117)

<u>Resource</u>	<u>Classification</u>	<u>Comments</u>
Dimension Stone	4D	The Entrada Sandstone, Wingate and Chinle Formations may contain favorable units for dimension stone. The economic potential is rated as low to moderate.
Clays	4D	The Morrison may contain favorable units for clay deposits.
Quartz, Mica, Feldspar	3C	Derived from Precambrian pegmatites and migmatites.

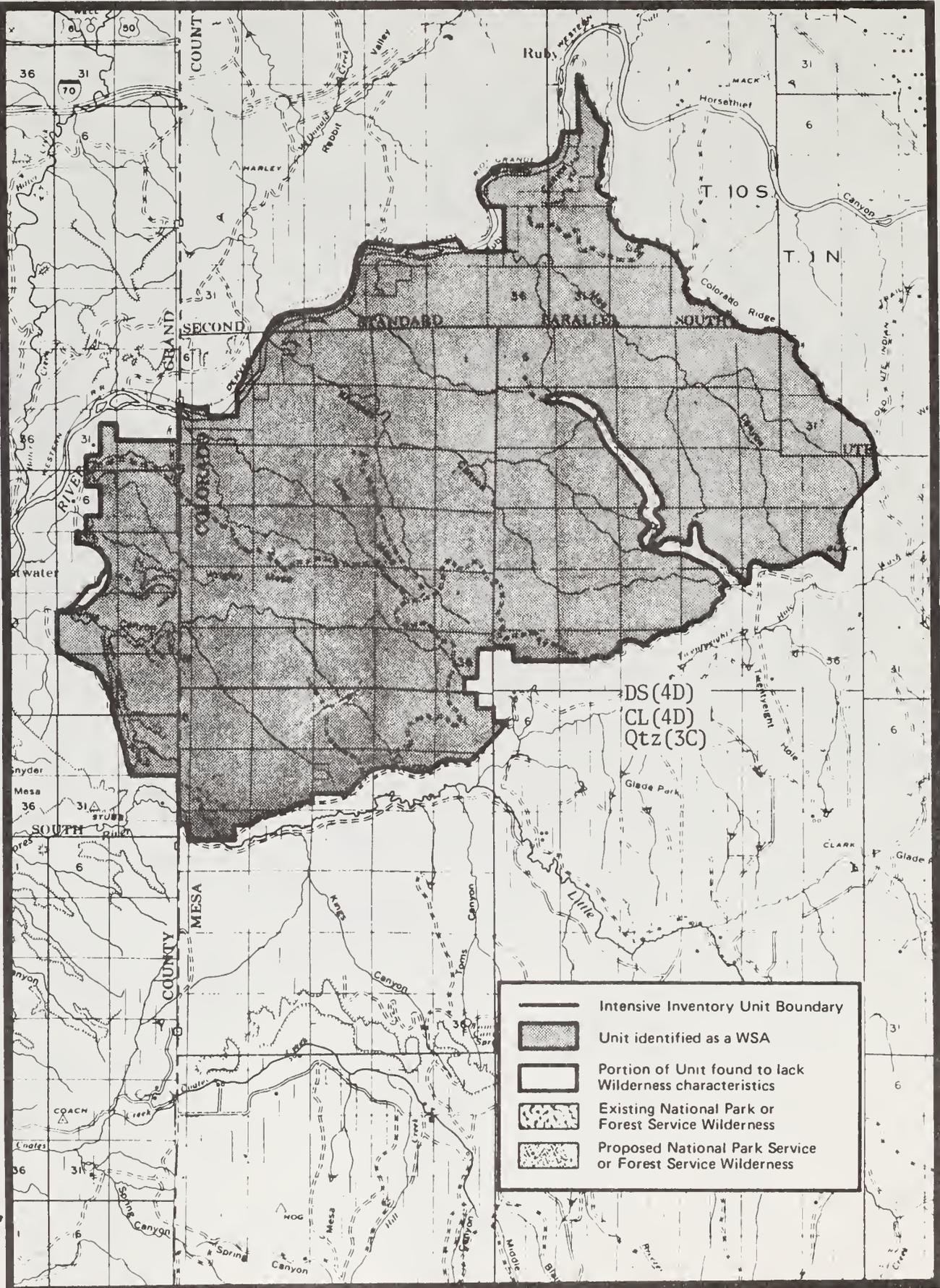


R 104 W

R 103 W

GRAND JUNCTION

T 11 S



DS(4D)  
 CL(4D)  
 Qtz(3C)

	Intensive Inventory Unit Boundary
	Unit identified as a WSA
	Portion of Unit found to lack Wilderness characteristics
	Existing National Park or Forest Service Wilderness
	Proposed National Park Service or Forest Service Wilderness



SALABLE RESOURCES  
 Figure IV-3c

(After BLM, 1980)

## SECTION V

### RECOMMENDATIONS FOR FURTHER STUDY

In the course of analyzing, assessing and evaluating each of the WSA's in the Demaree-Black Canyon GRA - both in the field and in available data - certain unknowns were uncovered that should be investigated in order that each WSA's GEM resources be more fully documented. This section recommends the type of studies and data gathering that should be made to inventory more completely each WSA.

#### DEMAREE CANYON WSA (CO-070-009)

Since this area is known to have great potential for oil, gas and coal resources, it is recommended that every effort be made to ascertain the full extent of this potential. Cooperative agreements should be made with various oil and gas producers to obtain proprietary information not available to this study. Such information as the projected reserves of the area, the importance of structural traps in localizing oil and gas pools, and the exact identification of pay zones within the generally favorable lithologies is of vital importance in the exact areal delineation of sub-surface potential.

In addition, a detailed program of geologic mapping and sampling should be carried out to fully delineate the extent of the coal bearing horizons in the Cretaceous section. Any sampling carried out under such a program must include analysis of the coal material for the ash and sulphur content as well as BTU content. Much work has already been done on lithofacies reconstruction in the Cretaceous in adjacent areas. Studies of this nature would be useful in determining the probable northern extent of the coal measures and thus, the viability of the coal as a mineable resource.

The outcrops of the Tertiary Wasatch Formation should be sampled for their kerogen content and correlated to other units in northwestern Colorado and eastern Utah. Examination of the Wasatch units should be made by paleontologists for environments favorable for the preservation of mammal remains.

Examination of any outcrops of the Mancos Shale for specialty or structural clays should be made in the course of any geologic mapping program.

From the work to date and the material compiled in the course of this project, it appears that this area has significant potential for GEM resources. (For a further detailed discussion of the potentials involved see Section IV).

#### BLACK RIDGE CANYON WSA (CO-070-113)

In this area the potential for GEM resources is largely unknown. Detailed geologic and geochemical studies are warranted to ascertain the mineral potential of the Precambrian and Mesozoic lithologies. Special attention should be paid to possible sedimentary and eesscc lithologic assemblages associated with Precambrian base and precious metal exhalite systems. Of equal importance is the potential for base metal mineralization in the Triassic Chinle and Wingate Formations. Stratigraphic

and lithofacies mapping should be carried out to determine if any environments with favorable depositional characteristics exist. A relatively low-cost way to accomplish these goals is to conduct a stream sediment and outcrop sampling program in conjunction with a geologic mapping effort.

All existing mines, prospects and known mineral occurrences should be mapped and thoroughly sampled to delineate the full extent of the existing mineralization and the potential of the host lithologies. This is of particular importance in the determination of the uranium-vanadium potential of the Jurassic Morrison Formation and the coal potential of the Cretaceous Dakota Formation. With regards to these specific units, a detailed study should be made of facies changes within these units, and the correlations with other units in western Colorado and eastern Utah. In other areas these units have significant potential GEM resources and thus, should be studied in this area where there is little available information. Though the airborne and ground NURE-HSSR-ARMS information does not delineate any areas with anomalous values, ground radiometrics in conjunction with the geological-geochemical would be helpful in identifying any areas of mineral potential.

The known coal seams in Devil's Canyon should be mapped in detail and sampled. Analysis for Btu, ash and sulphur content of each deposit should be made and the extent of the seam or seams delineated.

Stream sediment samples should be analyzed for their copper, molybdenum, lead, arsenic, uranium, vanadium and gold content.

Since some of the Precambrian units have been used in the past as a source of local road building material, it would be wise to do further work on the demand for this material.

In conclusion, from the work to date and the material compiled in the course of this project, it appears that the potential for GEM resources in this area is largely unknown. It is recommended that this area receive further extensive study prior to any decision as to its inclusion in the Wilderness System. (For further detailed discussion of the potential thought to exist within the WSA, refer back to Section IV).

BLACK CANYON WEST-WRIGLEY MESA/JONES CANYON WSA's (CO-070-113A; UT-060-116/117)

The GEMS potential of this area is essentially the same as the adjacent Black Ridge Canyon area. This being the case, it is recommended that the same sort of geological mapping and geochemical sampling program also be done in this area. Such a program should concentrate on the favorable sections of the Precambrian and Mesozoic lithologies and seek evidence of favorable environments for mineral deposition.

Of particular importance should be a detailed examination of the outcropping units of the Jurassic Morrison Formation and detailed mapping of the facies units within this generally favorable formation.

There are no known prospects or mineral occurrences within the WSA, and the area is known only generally from reconnaissance mapping of the area. This being the case, it appears that the potential for GEM resources in the area is largely unknown. It is recommended that it receive extensive further study. (For further detailed discussion of the various potential involved, see Section IV).

## SECTION VI

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