WEST COLD SPRINGS - DIAMOND BREAKS AREA

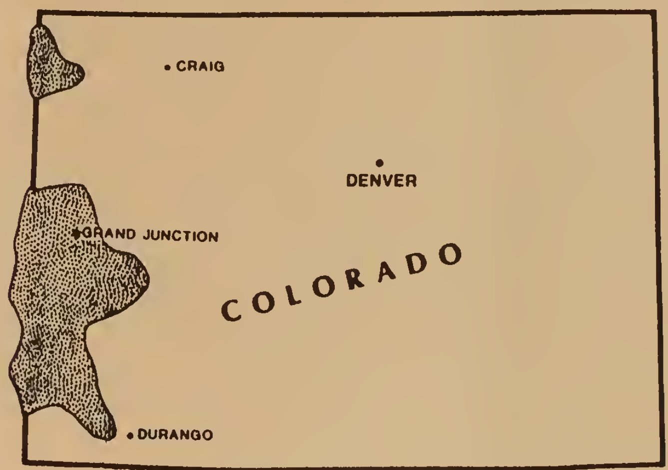
GEOLOGICAL RESOURCE AREA (GRA) 1

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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TABLE OF CONTENTS

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. Carpenter and Dr. Lepley should receive special acknowledgement. It was from the work of these consultants that this report on the West Cold Springs-Diamond Breaks 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 of 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 large 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 with 11 designated GEM Resource Areas (GRA's). This report addressed the West Cold Springs-Diamond Breaks area, GRA 1. Within the GRA is the West Cold Springs WSA (CO-010-208 & UT-080-103), and the Diamond Breaks WSA (CO-010-214 & Ut-080-113).

The geology of the GRA and WSA's consists mainly of sedimentary rocks such as sandstones, shales, and siltstones. Fuel minerals, especially gas, occur in sedimentary rocks. Because some types of sedimentary rocks are highly permeable, they may act as traps for gas. Anticlines found in the GRA help form gas traps along folds. The metamorphosed rocks in the Red Creek complex are hosts for copper and iron mineralization in fissure veins. Uranium mineralization similarly occurs in fractures in the same complex of rocks.

The resources in the GRA include known deposits of gas, copper, iron, uranium, vanadium, construction stone, and sand and gravel. The resources with the most value are the gas and sand and gravel.

West Cold Springs WSA and Diamond Breaks WSA do not contain any known deposits. Rock units known to contain mineralization in other parts of the GRA do not contain mineralization in the WSA's.

The classification for the leasable minerals, locatable and salable resources varies. There is a moderate favorability for occurrence of leasable minerals in the form of oil and gas in the West Cold Springs WSA, but low favorability in the other WSA. In both WSA's there is an unknown potential for locatable resources (base and precious metals) due to the lack of published literature and geologic field investigations. Both WSA's have a high favorability for salable resources occurrences in the form of dimension stone, and sand and gravel.

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 the 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 or mineralized commodities.

SECTION I

INTRODUCTION

The West Cold Springs-Diamond Breaks GRA (Figure I-1) is located in Moffat County Colorado, and Daggett and Uintah Counties, Utah. The GRA encompasses two Wilderness Study Areas (CO-010-214 and UT-080-113; CO-010-208 and UT-080-103). Their boundaries are shown on Overlay A.

The GRA area is located approximately 115 miles northwest of Grand Junction, Colorado, and 35 miles northeast of Vernal, Utah. Located within the GRA is the single, small settlement of Greystone, which is a local supply center for agricultural, ranching, mining, and oil and gas activities.

The GRA encompasses portions of Townships 7-12 North, Ranges 100-104 West in Colorado, and Townships 1-3 North and 1-3 South, Ranges 24-25 East in Utah. The entire area is bounded by Longitudes 108° 37' 16" and 109° 13' 19" and Latitudes 40° 35' 27" and 40° 57' 15". It contains approximately 750 square miles (2022 square kilometers or 480,700 acres) of Federal, state and private lands. The Bureau of Land Management portion of these holdings are under the jurisdiction of the Little Snake and White River Resource Area Offices of the Craig District Office.

The specific WSA's within the GRA have a total of 49,967 acres of Federal land. The acreages of the various contained WSA's are:

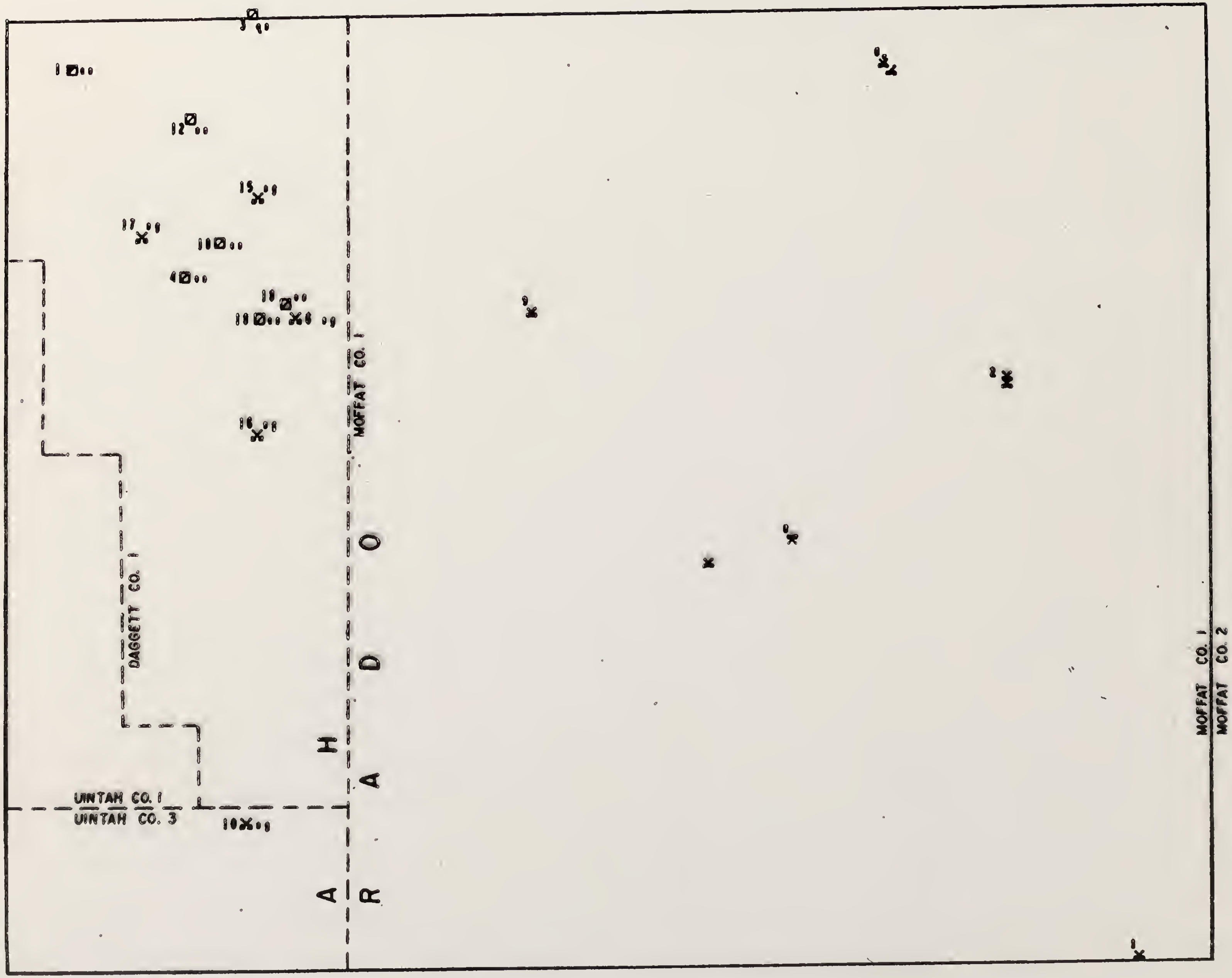
West Cold Springs (CO-010-208 and UT-080-103) - 14,587 acres
Diamond Breaks (CO-010-214 and UT-080-113) - 35,380 acres

The West Cold Springs WSA is located in the northern portion of the GRA, and is north of Browns Park National Wildlife Refuge. The Diamond Breaks WSA is in the west-central portion of the GRA, and is directly adjacent to the northwestern boundary of Dinosaur National Monument.

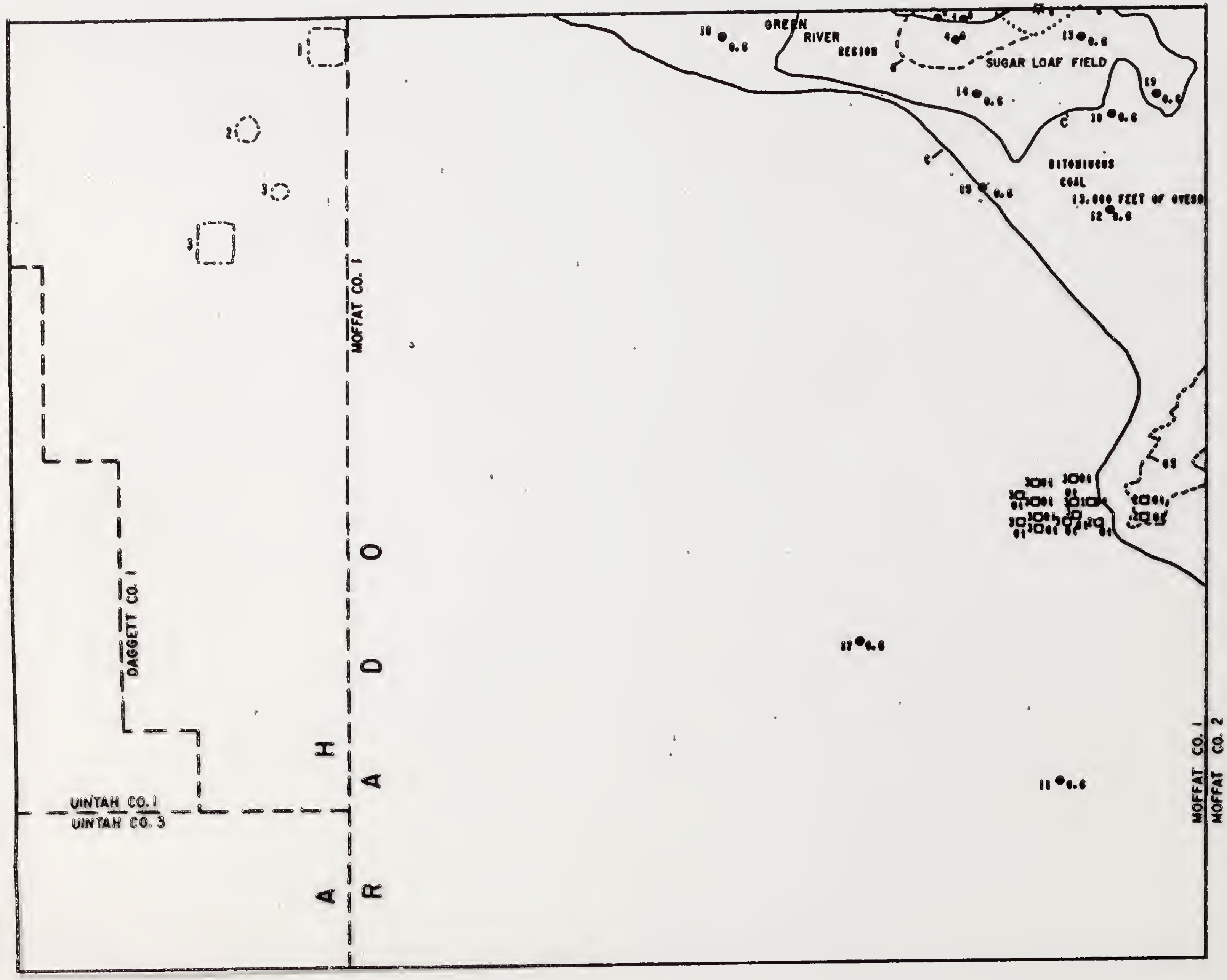
Due to the lack of available data on each WSA, emphasis was placed on gaining an understanding of the mineral potential of each WSA within the GRA. Information on the mineral resources of GRA was utilized to extrapolate and estimate the potentials of the WSA's from the existing data that in most cases, referred only indirectly to the WSA's. The purpose of this contract was 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, and certain 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 MSME/Wallaby's team of experts. Field investigations in the GRA were carried out by Dr. Paul Gilmour, and Dr. Robert Carpenter on September 2, 1982.

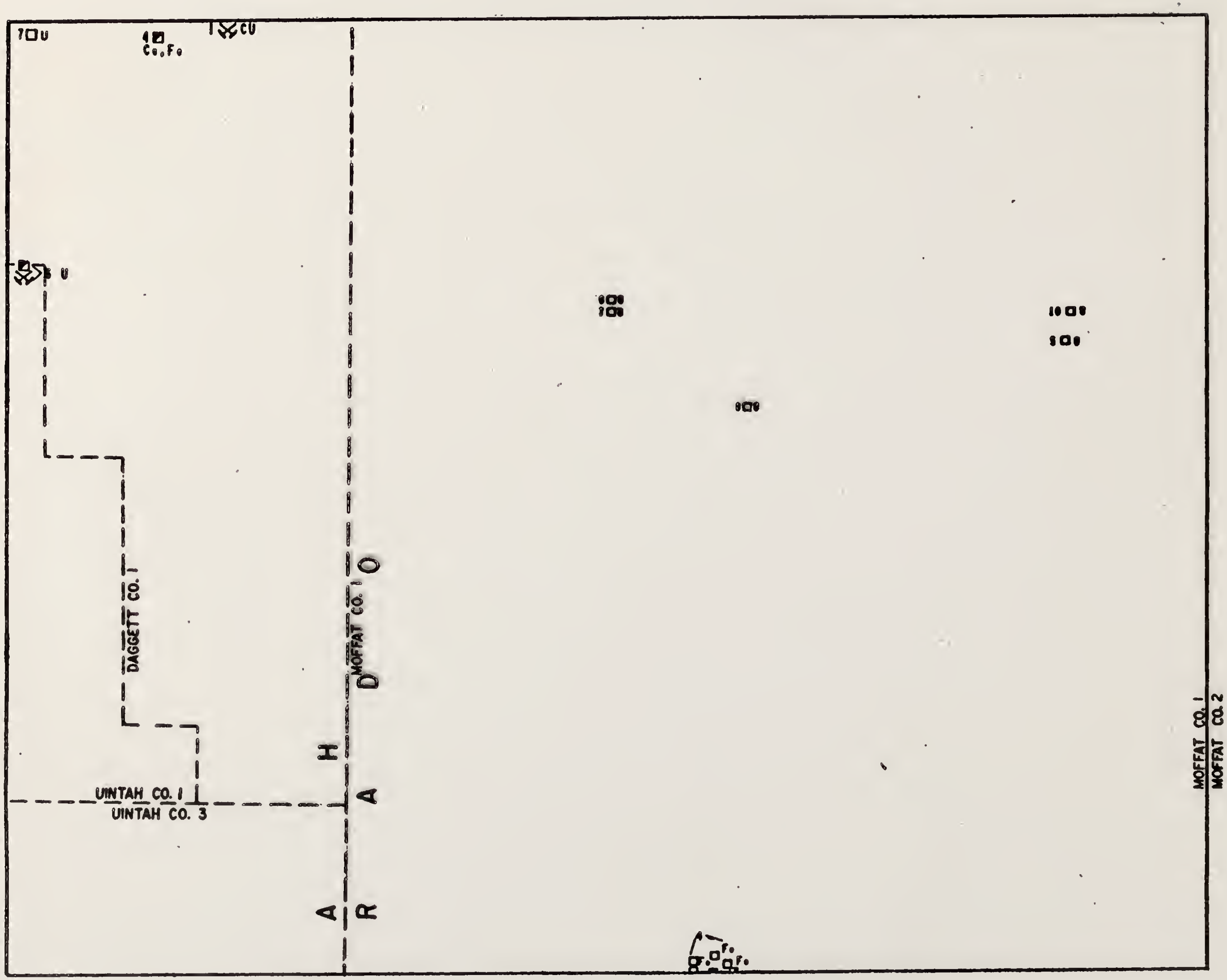
Both of these individuals are registered professional geologists and associates of MSME/Wallaby. Further analysis and study was provided through the photographic interpretation services of BLM 1:24,000 aerial photos by Dr. Larry Lepley, registered professional geologist and remote sensing specialist. The aerial photos used are included in Appendix A.



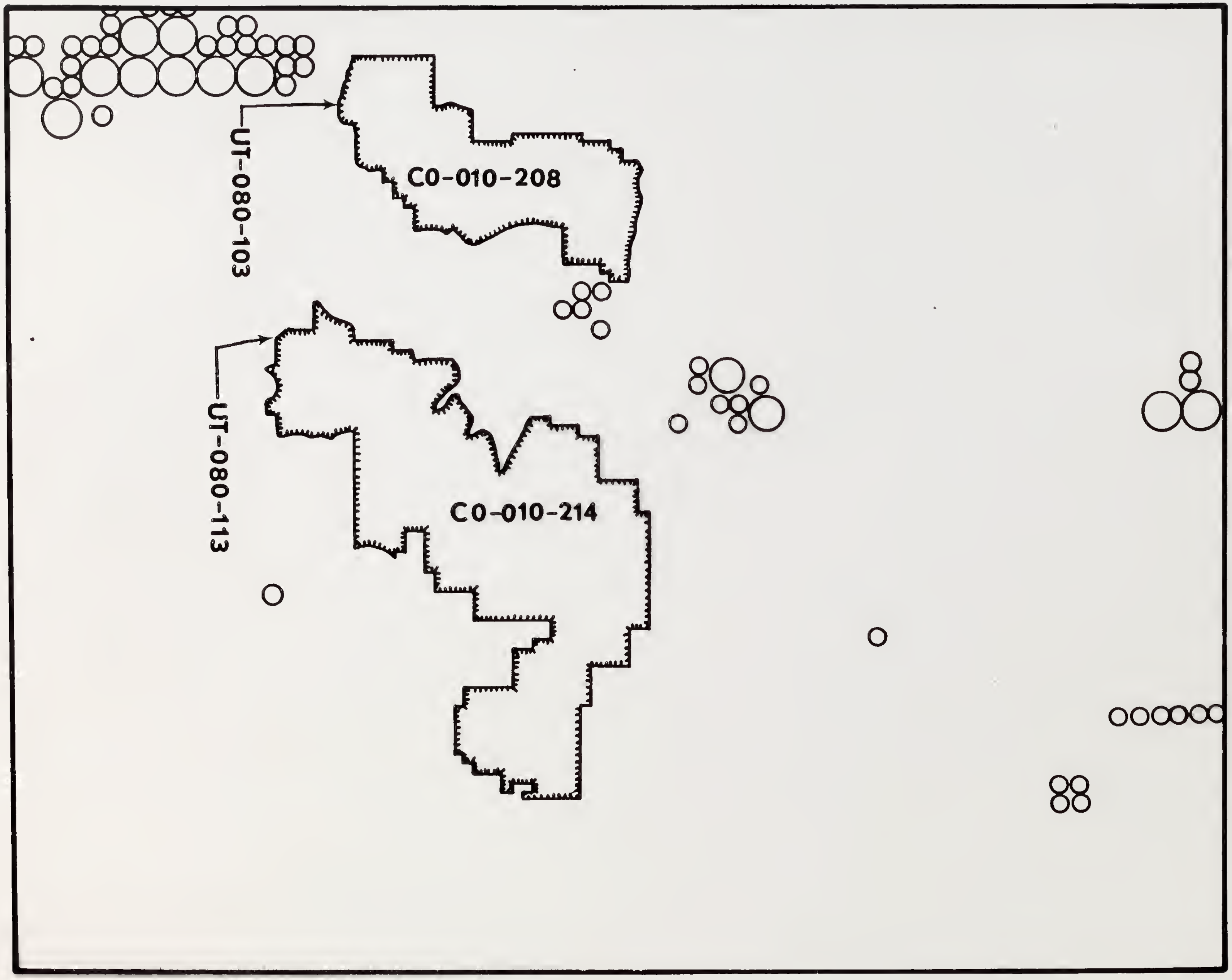
OVERLAY D
SAND, GRAVEL AND
INDUSTRIAL MINERALS



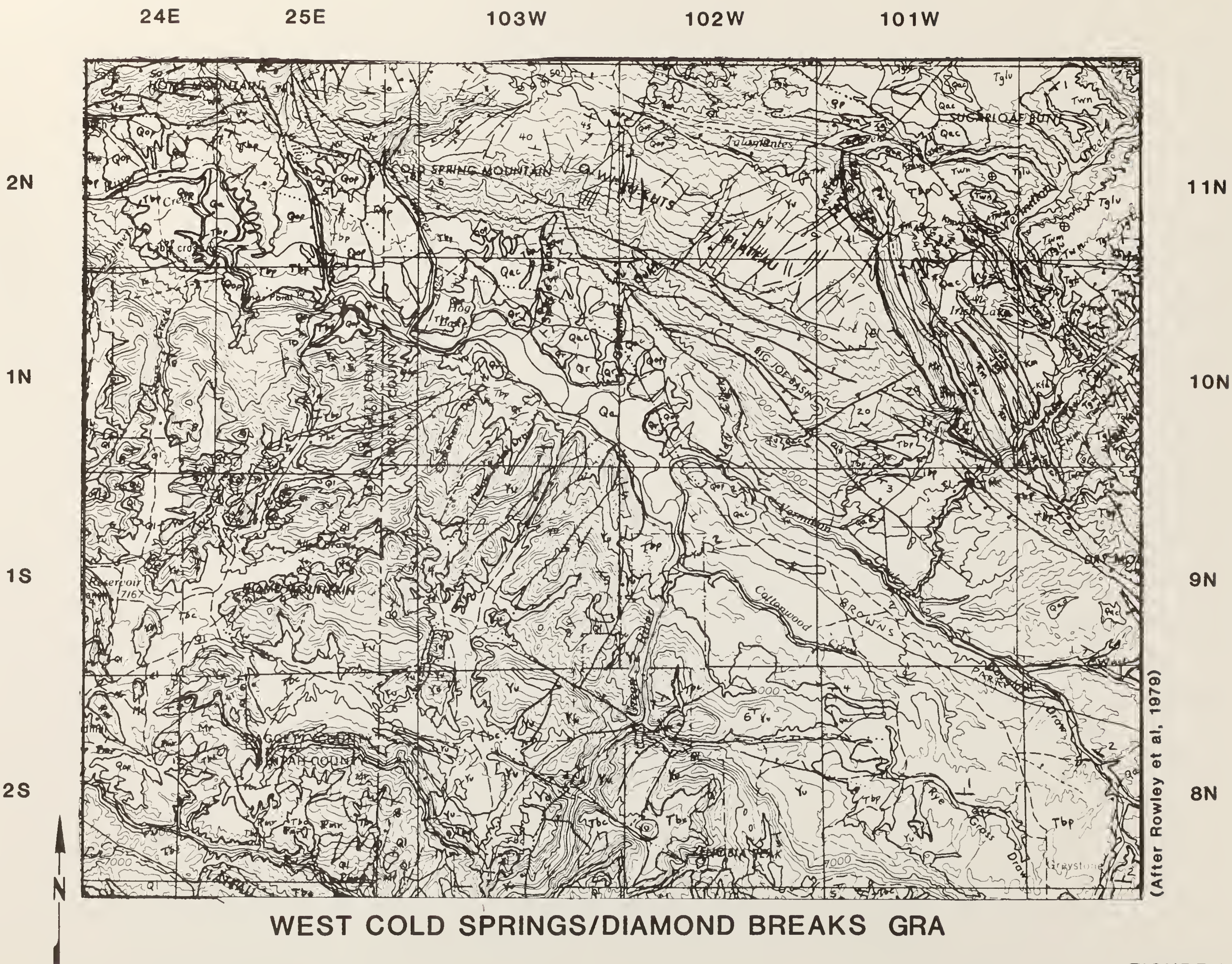
OVERLAY C
COAL, OIL AND GAS



OVERLAY B
MINES, PROSPECTS
AND MINERAL OCCURENCES



OVERLAY A:
PATENTED AND UNPATENTED
CLAIMS AND WSA BOUNDARIES



WEST COLD SPRINGS/DIAMOND BREAKS GRA

SCALE 1:250,000

FIGURE I-1
GEOLOGIC MAP

EXPLANATION

Quaternary (Approximately 2 million years before present (mybp) to present)	Qe	Eolian deposits
	Qa	Alluvium
	Qac	Alluvium and colluvium
	QP	Piedmont-slope deposits
	Qf	Fan deposits and colluvium
	Ql	Land slide deposits
	Qr	River-terrace deposits
	Qop	Old piedmont-slope deposits
	Qtg	Old gravel deposits
Tertiary (Approximately 62-2 mybp)	Tbb	Browns Park Formation and/or Bishop Conglomerate
	Tbp	Browns Park Formation
	Tbc	Bishop Conglomerate
	Tds	Duchesne River Formation, Starr Flat Member
	Tdl	Duchesne River Formation, LaPoint Member
	Tdd	Duchesne River Formation, Dry Gulch Creek Member
	Tdb	Duchesne River Formation, Brennan Basin Member
	Tu	Uinta Formation
	Tuu	Uinta Formation-upper part
	Tul	Uinta Formation-lower part
	Tb	Bridger Formation
	Tbu	Bridger Formation-upper part
	Tbl	Bridger Formation-lower part
	Tg	Green River Formation
	Tgp	Parachute Creek Member
	-m-	Mahogany ledge
	Tgl	Garden Gulch, Douglas Creek, and Anvil Points Members
	Tgla	Laney Member
	Tgw	Wilkins Peak Member
	Tgt	Tipton Tongue
	Tglu	Luman Tongue
	Tw	Wasatch Formation
	Twc	Cathedral Bluffs Tongue
	Twn	Niland Tongue
	Twm	Main body
	Tf	Fort Union Formation
Cretaceous (Approximately 135-62 mybp)	Kmvg	Mesaverde Group, undivided
	Kmvu	Mesaverde Group-upper unit
	Kmvc	Mesaverde Group-coal unit
	Kmvl	Mesaverde Group-lower unit
	Kmv	Mesaverde Group-upper, coal, and lower unit
	Ksc	Sego Sandstone, Buck Tongue of Mancos Shale, and Castlegate Sandstone
	Kbc	Buck Tongue of Mancos Shale and Castlegate Sandstone
	Kw	Williams Fork Formation
	Ki	Iles Formation
	Kla	Lance Formation and Fox Hills Sandstone

EXPLANATION (cont)

Cretaceous (cont)	Kle	Lewis Shale
	Km	Mancos Shale
	Kh	Hilliard Shale
	Kfd	Frontier Sandstone and Mowry Shale Members of Mancos Shale, and Dakota Sandstone
	KJcm	Cedar Mountain Formation (lower Cretaceous) and Morrison Formation (upper Jurassic)
	Kc	Cedar Mountain Formation
Cretaceous and Jurassic	KJmsc	Cedar Mountain Formation, Morrison Formation, Stump Formation, Entrada Sandstone, and Carmel Formation
Jurassic (Approximately 195-135 mybp)	JM	Morrison Formation
	Jmsc	Morrison Formation, Stump Formation and Entrada Sandstone
	Jmsc	Morrison Formation, Stump Formation, Entrada Sandstone, and Carmel Formation
	Jsc	Stump Formation, Entrada Sandstone, and Carmel Formation
	Jsc	Stump Formation and Entrada Sandstone
Lower Jurassic and Upper Jurassic	JTrgc	Glen Canyon Sandstone and Chinle Formation
	JTrg	Glen Canyon Sandstone
Triassic (Approximately 225-195 mybp)	Trc	Chinle Formation - Gartra Member
	TrPmp	Moenkopi Formation (lower Triassic) and Park City Formation (Permian)
	Trm	Moenkopi Formation
	Trmd	Moenkopi Formation and Dinwoody Formation
	Trd	Dinwoody Formation
Permian (approximately 280-225 mybp)	Pp	Park City Formation
Pennsylvanian (Approximately 320-280 mybp)	PPw	Weber Sandstone
	PPM	Morgan Formation
	PPmr	Morgan Formation and Round Valley Limestone
Mississippian (Approximately 342-320 mybp)	Mr	Mississippian rocks
Cambrian (Approximately 600-500 mybp)	C	Lodore Formation
Precambrian Approximately 3400-600 mybp)	Yu	Uinta Mountain Group
	Wr	Red Creek Quartzite

LEGEND

-O OIL FIELD

-G GAS FIELD

-Os OIL SHALE

-C COAL REGION

OIL WELL

OIL & GAS WELL

GAS WELL

SHOW OF GAS

SHOW OF OIL

SHOW OF OIL & GAS

-C COAL DEPOSIT

-C COAL OCCURRENCE

SHUT-IN WELL

CO_2 OR He=HELIUM -RICH WELL

DRY WELL-ABANDONED

MILL

PLANT

NATURAL GAS PROCESSING PLANT

REFINERY

MINERAL OREBODY

MINERAL DEPOSIT

MINERAL OCCURRENCE

PROSPECT

ACCESSIBLE ADIT

INACCESSIBLE ADIT

VERTICAL SHAFT

INCLINED SHAFT

MINE TYPE UNKNOWN

ACTIVE OPEN PIT, OR QUARRY

INACTIVE OPEN PIT, OR QUARRY

ACTIVE GRAVEL OR CLAY (Cl) PIT

INACTIVE GRAVEL OR CLAY (Cl) PIT

EXPLORATION HOLE WITH DATA AVAILABLE

EXPLORATION HOLE WITHOUT DATA AVAILABLE

UNPATENTED MINING CLAIM

PATENTED MINING CLAIM

MINERAL OR OIL & GAS LEASE

O	OIL	Cb	LIGNITE	Ds	DIMENSION STONE
G	GAS	Cp	PEAT	Fe	IRON
Os	OIL SHALE	Ag	SILVER	Mn	MANGANESE
Ot	TAR SANDS	Au	GOLD	Pb	LEAD
Gi	GILSONITE	Cu	COPPER	U	URANIUM
C	COAL	Cl	CLAY	V	VANADIUM
				Zn	ZINC

SECTION II

GEOLOGY

PHYSIOGRAPHY

Within the GRA boundary (see Figure I-1) are valley, plateau, high cliff and canyon areas along the course of the Green River in northwestern Colorado and northeastern Utah. The northern part of the area is characterized by canyons that have cut the prominant O-Wi-Yu-Kuts Plateau, forming a series of plateaus and ridges along the northern boundary of a wide valley known as Browns Park. This valley system exists along the course of the Green River and Vermillion Creek. The O-Wi-Yu-Kuts Plateau and other northwest and east-west trending ridges that flank the area rise 2,500 feet from the floor of the Browns Park Valley area. The northwest trending Browns Park Valley cuts across the entire GRA, and has a vertical relief of less than 500 feet. To the south and west of Browns Park is system of northeast trending ridges and canyons that are cut by tributaries of the Green River. In the center of this area is the deeply dissected Green River Canyon. In the southwest portion of the GRA, local valleys with low relief and mesa tops provide areas for agricultural and ranching activities. High ridges such as Home Mountain and Zenobia Peak rise 1,500-2,000 feet above the flat lying mesa and valley areas. Total vertical relief in this area can be as much as 3,000 feet.

The following descriptions address the physiographic setting of each of the individual WSA's within the West Cold Springs-Diamond Breaks GRA.

WEST COLD SPRINGS WSA (CO-010-208/UT-080-103)

Within the area, the predominant physiographic features are the steep, south facin slopes of Cold Spring Mountain. The top portion of this feature within the WSA is part of the O-Wi-Yu-Kuts Plateau, which gently slopes to the north. Cold Spring Mountain is cut by north and northeast trending drainages, Beaver Canyon and Spitzie Draw being the most major. Vertical relief with the WSA is approximately 2,000 feet.

DIAMOND BREAKS WSA (CO-010-214/UT-080-113)

The WSA is characterized by numerous steep-walled draws and canyons that cut a plateau and valley area. There are several high ridges west of the Green River Canyon that rise up to 8,000 feet in elevation. Nevertheless, vertical relief in the area is only 2,000 feet. Major northeast trending drainages cut through the WSA, and tend to isolate the mesa tops and ridge areas.

ROCK UNITS

Within the West Cold Springs-Diamond Breaks GRA is found a variety of rock units that represent a large portion of Precambrian, Paleozoic, Mesozoic and Cenezoic time.

The Precambrian is mainly represented by the marine sandstone and silty shale units of the Younger Precambrian Uinta Mountain Group. This series of units unconformably overlies the Red Creek Quartzite. The Red Creek Quartzite outcrops within the GRA but has only been mapped north and west of Browns Park (Rowley et al, 1979), and is considered to be the underlying basement complex. The Red Creek Quartzite is composed of deformed beds of metaquartzite, amphibolite, minor marble and intrusive felsic igenous rocks (Rowley et al, 1979; Gilmour, Personal Communication, 1982). Spotty copper, iron, and uranium mineralization has been reported from this unit in Utah (Unterman et al, 1954).

The Cambrian Lodore Formation crops out in the northeast and southwest portions of the GRA, and consists of a series of marine sandstone, shale, and conglomerate units that are occasionally fossiliferous. These have been known to contain base and precious metal replacement deposits at or near the Lodore-Madison contact in other areas of Colorado (Rowley et al, 1979; Carpenter, Personal Communication, 1982; Gilmour, Personal Communication, 1982).

The Mississippian Madison Formation is usually found in contact with the Ladore and is characterized as a fossiliferous and cherty marine limestone with local dolomitic units (Rowley et al, 1979). In areas outside of the GRA, small base and precious metal replacement deposits have been noted in this unit (Unterman et al, 1954; Carpenter, Personal Communication, 1982). Other Mississippian units that outcrop within the GRA include the shale, sandstone, and limestone units of the Humbug Formation, and the continental and marine shale-sandstone-limestone members of the Doughnut Shale Formation (Rowley et al, 1979).

The Pennsylvanian Round Valley Formation represents a sequence of marine limestone units with interbedded shale. The unit is moderately fossiliferous, and is directly overlain by the sandstone, shale and fossiliferous limestone members of the Morgan Formation. The Morgan is known to contain base and precious mineralization (mainly copper-silver-iron), in other areas of Colorado in basal conglomerate units (Unterman et al, 1954; Carpenter, Personal Communication, 1982; Rowley et al, 1979). It is considered a marine sequence that is in conformable contact with the overlying Pennsylvanian Weber Sandstone Formation. The Weber consists of a series of eolian and marine sandstone units that are thought to represent a near-shore dune environment (Rowley et al, 1979; Unterman et al, 1954).

Outcrops of the Permian Park City Formation are found in the extreme southwest corner of the GRA. This formation, deposited in areas to the west of the GRA, is composed of a series of limestone, sandstone, shale, siltstone, dolomite, and phosphatic shale units that represent a period of marine deposition in a restricted basin environment (Rowley et al, 1979; Unterman et al, 1954). Commercial thicknesses of the phosphate bearing units have been reported in areas to the west and south of the GRA (Unterman et al, 1954; Eyde, Personal Communication, 1982). In the northeast portion of the GRA, the Park City Formation is absent from the section, and the Pennsylvanian section is directly overlain by the Mesozoic section.

Pre-Cretaceous Mesozoic units known to exist within the GRA are the Triassic Moenkopi and Chinle Formations, the Triassic-Jurassic Glen Canyon Formation, and the Jurassic Stump, Entrada Sandstone, Carmel and Morrison Formations (Rowley et al, 1979).

The Triassic Moenkopi Formation consists of a series of shale and siltstone units that are thought to be of continental and marine origin. Minor gypsum beds are locally found within sandy portions of the stratigraphy (Rowley et al, 1979). Directly overlying the Moenkopi is the Chinle Formation. In northern Colorado and Utah, the Chinle is a fine-grained series of fluvial and lacustrine siltstones, sandstones, claystones, and shale. Within the GRA, the basal Gartra Member is usually found as a crossbedded fluvial sandstone and conglomerate unit. The Gartra Member may be equivalent to the Triassic Shinarump Formation of southern Utah and Arizona that contains significant uranium-vanadium deposits (Rowley et al, 1979; Unterman et al, 1954). The Triassic-Jurassic Glen Canyon Formation crops out in only the northeast part of the GRA, and is a strongly bedded eolian sandstone unit (Rowley et al, 1979).

The Jurassic sequence begins in ascending order with the Carmel Formation. This unit is composed of sandstone, shale, siltstone, mudstone, gypsum and fossiliferous limestone units. The gypsum beds in this Formation are of commercial value in other areas of Utah outside of the GRA (Rowley et al, 1979; Unterman et al, 1954; Eyde, Personal Communication, 1982). The Entrada Formation lies above the Carmel, and is composed of cross-bedded eolian sandstone units. Overlying the Entrada, the Stump Formation consists of two members of marine origin. The Redwater Member of the Stump lies directly above the Entrada and consists of a series of glauconitic shales and siltstones that are interbedded with glauconitic, oolitic limestone and fossiliferous sandstone. The Curtis Member consists of fossiliferous cross-bedded glauconitic sandstone beds (Rowley et al, 1979). The overlying Morrison Formation consists of a series of sandstone, shale, claystone, siltstone, and bentonite units that are locally fossiliferous. The Morrison is well known for uranium-vanadium deposits in other areas of Colorado and Utah (Rowley et al, 1979).

The Cretaceous units that outcrop within the GRA are thought to represent pre-Mesaverde Formation stratigraphy and include the Cedar Mountain, Dakota Sandstone, Mowry Shale, Frontier Sandstone, Hilliard Shale, and Mancos Shale Formations or Members. The Cedar Mountain Formation consists of a series of fluvial mudstone, shale, siltstone, conglomerate and limestone units. The overlying Dakota Formation is made up of sandstone, shale and conglomerate units with thin beds of coal and carbonaceous shale. The coal units of the Dakota are locally important but thin and discontinous (Gentry, Personal Communication, 1982; Rowley et al, 1979; Unterman et al, 1954). The Mowry Shale Member of the Mancos Shale is a siliceous marine shale with abundant fossil material. The Frontier Sandstone Member of the Mancos Shale is a crossbedded sandstone unit that contains minor carbonaceous shale and coal beds which are of minor economic importance (Rowley et al, 1979; Gentry, Personal Communication, 1982). The Hilliard Shale Formation consists of a single thick marine shale unit with minor sandstone. The overlying Mancos Shale Formation is also a single thick marine shale unit that contains minor siltstone and sandstone units (Rowley et al, 1979).

Tertiary units that crop out within the GRA include, in ascending order, the Wasatch, Green River, Bishop Conglomerate and Browns Park Formations (Rowley et al, 1979). The Wasatch Formation units that outcrop within the GRA include shale, siltstone, claystone, possible oil shale, coal, sandstone and carbonaceous shale, which are thought to be of fluvial or lacustrine origin. The Wasatch intertongues with the Green River sequence of marlstone, shale, oil shale, limestone, siltstone, sandstone and fluvial conglomerate units (Rowley et al, 1979). The Bishop Conglomerate Formation consists of sandstone, conglomerate siltstone, rhyolitic tuff, and limestone units, and is thought to represent a volcanic unit that was reworked in a fluvial and eolian environment. The Browns Park Formation directly overlies the Bishop Conglomerate and consists of sandstone, tuff, and limestone units, and is thought to be a part of a volcanic cycle that was active in Miocene time. The clastic units appear to be reworked volcanic material and locally contain minor amounts of uranium and vanadium mineralization in association with devitrified tuffaceous units (Rowley et al, 1979; Carpenter, Personal Communication, 1982).

Quaternary pediment, alluvial, landslide, and river terrace deposits are found overlying the exposed Precambrian Paleozoic, Mesozoic and Tertiary stratigraphy.

The following description addresses the rock units of each of the individual WSA's within the West Cold Springs-Diamond Breaks GRA.

WEST COLD SPRINGS WSA (CO-010-208/UT-080-103)

Within the boundaries of the WSA the Red Creek Quartzite outcrops in fault contact with the overlying younger Precambrian Uinta Mountain Group. The Uinta Mountain Group consists of marine sandstone and silty shale units. Within the WSA, neither the older Precambrian Red Creek Quartzite nor the Uinta Mountain Group units are mineralized (Rowley et al, 1979; Gilmour, Personal Communication, 1982). Outcrops of the Tertiary Browns Park Formation and the Quaternary pediment gravels that were included within the WSA boundary do not appear to be mineralized and have no reported mineral occurrences.

DIAMOND BREAKS WSA (CO-010-214/UT-080-113)

The Precambrian Uinta Mountain Formation outcrops as a series of sandstone and siltstone units (Rowley et al, 1979; Gilmour, Personal Communication, 1982) within the WSA. The Tertiary Browns Park Formation is found in the southern portion of WSA and is thought to directly overlie the Precambrian units. In this area, the Browns Park consists of a series of sandstone and tuffaceous units that were originally of volcanic origin. Quaternary alluvium deposits are found in the stream channels and canyon bottoms (Rowley et al, 1979). No occurrences of uranium-vanadium mineralization have been reported from within the Browns Park units that outcrop within the WSA.

STRUCTURAL GEOLOGY AND TECTONICS

Tectonic features found within the GRA include high angle west-northwest striking faults and shear zones that parallel the southwestern edge of the O-Wi-Yu-Kuts Plateau. Other faults and accompanying joint and shear zones strike northeast. These faults, joints, and shear zones are parallel to a mapped anticlinal structure that has been identified in the vicinity of Sugar Loaf Butte (Rowley et al, 1979). The trace of the axial plane of the Brown's Park Syncline has been mapped throughout the GRA (see Figure I-1; Rowley et al, 1979). This and another suspected syncline that has been mapped in the Talamantes Creek-Diamond Peak area, may have caused some of the west-northwest striking faults, shear zones and jointing. The anticlinal structure that has been mapped in the vicinity of Sugar Loaf Butte may have some importance in the localization of oil and gas deposits in the Sugar Loaf Gas Field (Heylmun, Personal Communication, 1982). This feature may persist across the Browns Park area and into the Diamond Breaks-Home Mountain area (Lepley, Personal Communication, 1982).

Regional thrusting has caused the Precambrian units of Cold Spring Mountain and the O-Wi-Yu-Kuts Plateau to be thrust over the younger units of the Green River and Washakie Basins (Heylmun, Personal Communication, 1982). The presence of thrust faults is not apparent on the most recent geologic maps of the region (Rowley et al, 1979), but has been confirmed by recent seismic studies (Heylmun, Personal Communication). The extent of this thrusting is currently unknown.

Throughout most of the GRA, the Precambrian Uinta Mountain Formation is unconformably overlain by Tertiary and Quaternary units. This probably represents periods of deposition onto a pre-existing and exposed Precambrian topographic high. The Precambrian units are thought to have been thrust into their present position during the Tertiary, and have probably not been significantly eroded (Heylmun, Personal Communication, 1982; Carpenter, Personal Communication, 1982).

In the vicinity of Irish Lake in the northwest portion of the GRA, the Cambrian Lodore Formation directly overlies the Precambrian Uinta Mountain Formation. This relationship may represent an unconformable situation as the Uinta is known to be overlain by other Cambrian units in other parts of Utah and Wyoming (Carpenter, Personal Communication, 1982). Also in this area, the Paleozoic and Mesozoic sections are overlain by Tertiary units of the Bridger, Browns Park and Green River Formations. This relationship may reflect a structural feature but may also reflect Tertiary sedimentation in basins where Paleozoic and Mesozoic rocks were cropping out and, thus, a regional or local unconformity (Carpenter, Personal Communication, 1982).

The following descriptions address the structural and tectonic characteristics of each of the individual WSA's within the West Cold Springs-Diamond Breaks GRA.

WEST COLD SPRINGS WSA (CO-010-208/UT-080-103)

Structural features found within the WSA include high angle west-northwest striking faults, shear zones, and joint systems that parallel the axis of the Browns Park Syncline and the margin of the O-Wi-Yu-Kuts Plateau. In the north and northwestern portions of the WSA are found a series of northeast and north-northeast striking faults and joint systems that may have helped to determine the course of Beaver Creek. Other north-northwest striking faults and shear systems have been mapped in the O-Wi-Yu-Kuts Plateau area (Rowley et al, 1979). Northeast striking faults, shear zones, and joint systems have been mapped to the east of the WSA and may have been caused by the mapped anticlinal structure in the vicinity of Sugarloaf Butte (Lepley, Personal Communication, 1982 & Rowley, et al, 1979).

The area of the WSA adjacent to the northwest striking Browns Park Syncline is thought to be underlain by a regional thrust fault that has pushed the Precambrian Uinta Mountain Formation over the Tertiary units. This thrust fault may have importance in the localization of oil and gas deposits (Heylmun, Personal Communication, 1982).

Major unconformities have not been identified within the boundaries of the WSA.

DIAMOND BREAKS WSA (CO-010-214/UT-080-113)

Significant structural features that are found within this WSA include high angle north-northeast striking faults, shear zones, and joint systems (Rowley, et al, 1979). These features are on strike with similar structures found in the Sugarloaf Butte area and may be associated with an episode of folding and faulting (Rowley, et al, 1979).

The area of the WSA adjacent to the northwest striking Browns Park Syncline is possibly underlain by a regional thrust fault system (Heylmun, Personal Communication, 1982). The major canyon drainages within the WSA follow north-northeast striking structural features.

Major unconformities do not appear to exist within the boundaries of the WSA.

PALEONTOLOGY

Paleontological resources of the GRA have been studied by oil and mining companies in conjunction with oil, gas and mineral exploration activities (Robinson et al, 1975; Weber, 1971; Rowley et al, 1979). It is known that mammal remains have been recovered from the Tertiary Browns Park Formation (National Park Service, NPS File Data, 1982). Other units that are known to be fossil bearing within the GRA are listed below:

Cambrian Lodore Formation (gastropod, trilobite, brachiopod remains)
Mississippian Madison Formation (coral, gastropod, brachiopod remains)
Pennsylvanian Morgan Formation (brachiopod, coral remains)
Permian Park City Formation (marine mollusk remains)
Triassic Chinle Formation (fossil plant material)
Jurassic Morrison Formation (reptile and bird remains)
Tertiary Green River Formation (fresh water fish remains)

(NPS File Data, 1982)

None of the fossil localities from the above listed units are considered of current major scientific interest (NPS File Data, 1982).

The following descriptions address the paleontological resources of each of the individual WSA's within the West Cold Springs-Diamond Breaks GRA.

WEST COLD SPRINGS WSA (CO-010-208/UT-080-103)

There are no known fossil localities or occurrences of major scientific interest within the WSA (NPS File Data, 1982). In other areas, the Tertiary Browns Park Formation is known to contain fossil mammal remains (Unterman et al, 1954; NPS File Data, 1982). The few exposures of the Browns Park that are within the WSA boundary do not appear to be fossiliferous (Gilmour, Personal Communication, 1982).

DIAMOND BREAKS WSA (CO-010-214/UT-080-113)

There are no known fossil localities or occurrences of major scientific interest within the WSA (NPS File Data, 1982). Northeast of the WSA, the Browns Park Formation is known to contain fossil mammal remains (Unterman et al, 1954; NPS File Data, 1982). Only a few Tertiary outcrops are known to exist within the WSA and these have no fossil occurrences associated with them (NPS File Data, 1982; BLM/MRI File Data).

HISTORICAL GEOLOGY

During Precambrian time the entire GRA was receiving sediments from both cratonic and island arc sources (Gilmour, Personal Communication, 1982). 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 a period of extreme deformation was caused by plate collisions and regional uplifting. These older Precambrian units were metamorphosed, deformed, and intruded by a series of younger Precambrian mafic and felsic bodies. In this study area, the exposed older Precambrian rocks are mainly quartzites interbedded with gneiss and schist material.

The Precambrian sequence is relatively unstudied in the GRA and has only been partially correlated with other areas of Colorado (Unterman et al, 1954). In this area, the younger Precambrian is preserved, and consists of a thick section of clastic sediments. These lithologies represent a period of clastic deposition in a marine environment. From the information that is currently available, it appears that the younger Precambrian units of this area were deposited in a deep, marine basin that persisted through Paleozoic time.

The period of early and middle Paleozoic deposition was characterized by the formation of a series of shallow basins. It is thought that these basins were progressively filled by Cambrian, Devonian, and Mississippian sediments.

During most of the Paleozoic, there was an abundance of plant and animal life in the deep rift basins. Reef communities grew on shallow marine bedrock highs in association with algal bioherms. There was active earth movements within the basins creating northwest-striking faults and shear systems, which caused much in the way of up and down movement of the basement blocks that formed the floor of these basins.

In the Mesozoic, the area was the site of fluvial and lacustrine deposition in a terrestrial environment. The Triassic Moenkopi Formation overlies the Paleozoic units in much of the GRA, and is thought to represent an era when shallow, fresh water lakes in enclosed basins were subjected to periods of dessication and shallow water, clastic deposition. The Moenkopi Formation is known for its saurian tracks and vertebrate fossils in other areas of western Colorado. Thus, it is reasonable to assume that amphibian and reptile life may have existed within the GRA during this period (NPS File Data). The Chinle/Wingate/Kayenta Formations of the Glen Canyon Group represent a time of Triassic sedimentation in a near-shore environment with episodes of eolian deposition of well cross-bedded beach and dune 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 and restricted inland basins that had existed since Paleozoic time. As the shorelines of these seas moved in response to orogenic episodes and basin filling, 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 for copper-silver "redbed" deposits that were deposited in areas of rapidly changing Eh-pH conditions.

The Navajo Sandstone crops out in the western portion of the GRA and is thought to represent a period of inland sand dune accumulation in a terrestrial desert environment (Carter et al, 1965). This Triassic-Jurassic unit thins to the east and probably was not deposited on top of the Ancestral Uncompahgre Uplift highland (Baars et al, 1981).

The unconformity between the Navajo Sandstone and the overlying Jurassic Entrada Formation is probably a local feature that represents a period of non-deposition. The Navajo is known to exist only in selected, desert environments or basins, and may have never been deposited in some areas west of the Uncompahgre Highland. The Jurassic Entrada, however, is thought to have been deposited during a period of terrestrial fluvial and eolian deposition in small, restricted basins that eventually coalesced and buried the majority of the Uncompahgre Highland features. The Navajo-Entrada unconformity may then represent a period when the last remnants of the Uncompahgre topographic high were being eroded into shallow Jurassic basins. The Jurassic Summerville and Morrison Formations were being deposited in near-shore lagoonal environments, or shallow water marine and fluvial systems. Some fresh water 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. 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 Formation appears to have been deposited in a series of meandering river systems with adjacent terrestrial lakes. The terrestrial, clastic nature of this formation is thought to be characteristic of a beach or littoral environment (Young, 1955). The Upper Cretaceous Dakota Sandstone unconformabaly overlies the Burro Canyon Formation, and was probably deposited on an irregular surface of Burro Canyon outcrops rather than a true erosion surface (Carter et al, 1965). Clastic portions of the Dakota are found as channel fillings in the Burro Canyon paleosurface. From fossil evidence, it appears that the lower sections of the Dakota were deposited in shallow basins or stream channels. The carbonaceous shales of the Dakota are known to contain abundant plant remains, and were probably deposited in a near-shore swamp or lacustrine environment. Thin coal seams are known to exist within the Dakota and may have economic potential.

During upper Cretaceous time the thickest marine deposition occurred to the southeast and spread westward grading laterally into coarser sediments derived from the west and which are thought to signify the intial impulses of the "Early Laramide" deformation in the Uinta Range.

The deformation of the region brought about a gradual downwarping of the Uinta and Bridger Basins with a consequent development of small lakes and ponds which in time became extensive fresh-water bodies into which accumulated thousands of feet of fine sediment, now believed to be a source of some of the oil of the region. As deformation abated, the lake basins were gradually filled by the streams, eventually creating extensive flood plains on which additional thousands of feet of conglomerate, sandstone and shale accumulated (Bridger, Washakie and Uinta, Eocene; and Duchesne River, Oligocene) which have been the source of vast quantities of fossil material, including mammal, reptile, insect and plant remains.

Units of the Cretaceous Mancos Shale have been described as being sandstone and shale units deposited in a near-shore environment, and have local coal bearing horizons in the section.

The Cretaceous Mesaverde Group units crop out throughout the northeastern 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. Coal bearing units of the Mesaverde Group are found in the lower portion at the Williams Fork and Iles Formations and are considered a major energy resource (Vanderwilt, 1947).

The Mesaverde Group is overlain by the Tertiary Wasatch, Uinta, Green River and Browns Park Formations. This unconformity may represent a period of uplift and erosion prior to the formation of the Uinta sedimentary basin. The Wasatch, Uinta, and Green River Formations found in the GRA represent periods of shallow water terrestrial lacustrine deposition. The shallow water basins existed to the east of the GRA on the flank of the Uinta Arch.

The Tertiary Browns Park Formation was deposited in a series of structural basins that formed adjacent to the Uinta Arch and along its axis. These reworked, volcanic and sedimentary units locally contain uranium-vanadium deposits (Nelson et al, 1979). The Bishop Conglomerate also crops out within the GRA and is thought to represent eroded material from the exposed Precambrian and Paleozoic units.

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

Figures II-1 through II-4 illustrate the geology and geomorphology of the GRA.

WEST COLD SPRINGS WSA (C-010-208/UT-080-103)

Within this area only the Precambrian and Tertiary units are known to crop out. The full Paleozoic and Mesozoic section is thought to have existed but was eroded in Laramide times (60-40 mybp) and does not crop out within the WSA. The Precambrian units are thought to have been deposited in a marine environment adjacent to or a part of a major geosynclinal basin (Unterman et al, 1954) and were subsequently deformed and intruded by felsic units. The younger Precambrian Uinta Mountain Group rocks were deformed and uplifted in Laramide times and consist of a

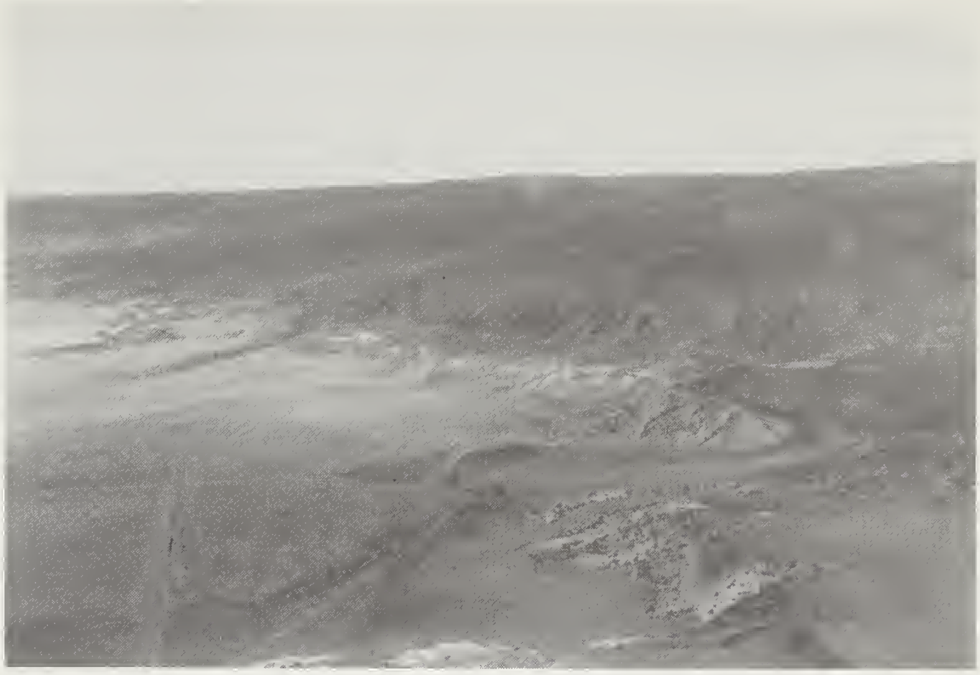


FIGURE II-1
SW flank of Cold Springs Mountains, looking NW. Precambrian Uintah sandstone and quartzite visible middle right. Sediments in foreground (Uraniferous).

WEST COLD SPRINGS

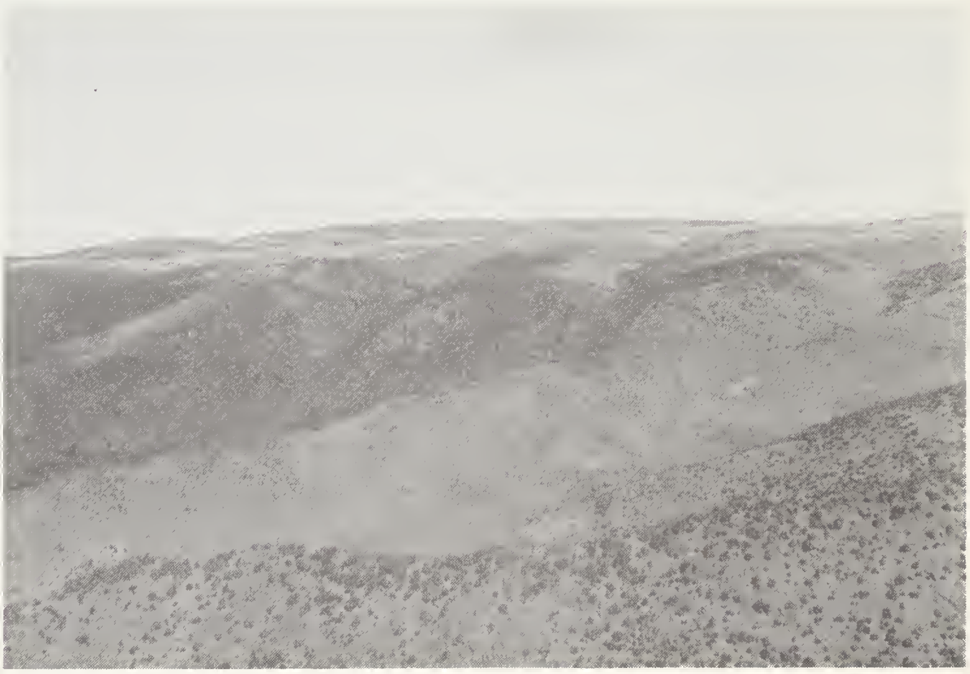


FIGURE II-2
Looking NW. Grazing land on top of Cold Springs Mountain.

WEST COLD SPRINGS

FIGURE II-3
Looking SW.
Meadows, hayfields, ranch road in valley near east end of WSA.

DIAMOND BREAKS

FIGURE II-4
View looking S from location just S of Green River and Haylake. Uintah formation in left and middle distance.

DIAMOND BREAKS

series of sandstones, quartzites, conglomerates and shales that may contain base and precious metal mineralization.

The Precambrian units were uplifted, deformed and eroded in the Tertiary and supplied material for the Bishop Conglomerate that unconformably overlies the exposed Precambrian stratigraphy in portions of the WSA. The Tertiary Browns Park Formation crops out along the edges of the WSA and is composed of volcanically derived sediments that contain uranium-vanadium mineralization in other areas of northwest Colorado (Nelson et al, 1979). Quaternary fluvial and eolian deposits lie unconformably upon the exposed Precambrian and Tertiary stratigraphy.

DIAMOND BREAKS WSA (CO-010-214/UT-080-113)

As in the nearby West Cold Springs area, the folded and uplifted Precambrian Uinta Mountain Group sediments are unconformably overlain by outcrops of the Bishop Conglomerate. The full Paleozoic and Mesozoic section is thought to have originally overlain the Precambrian Section but was stripped off by erosion during the Laramide period of uplift and deformation.

The Tertiary Browns Park and Bishop Conglomerate Formations occur as isolated outcrops within the WSA, unconformably overlying the exposed Precambrian stratigraphy. There are no reported occurrences of uranium-vanadium mineralization in the Browns Park units that occur in the WSA. Quaternary fluvial and eolian deposits lie unconformably upon the exposed Precambrian and Tertiary stratigraphy.

SECTION III

ENERGY AND MINERAL RESOURCES

KNOWN MINERAL DEPOSITS

The known mineral deposits in the West Cold Springs-Diamond Breaks GRA consist of gas, copper, iron, uranium and industrial minerals.

There are 13 producing gas wells in T11N, R101W at the southern extension of the Sugar Loaf Field (Mapco, 1982). From 1953 through 1974, the Sugar Loaf Field produced 45,551,294 million cubic feet of gas and 209,504 barrels of condensates. The Cretaceous Mesaverde Formation is the producing rock unit.

The northwestern corner of the GRA is the location of an underground copper-iron mine, an open pit copper mine and an open pit and underground uranium mine (Overlay B). The current operating status and production statistics are not known.

In addition, there are 13 sand and gravel pits, 6 construction stone quarries, and 1 silicon deposit in the GRA (Overlay D). The current operating status and production statistics are not known.

WEST COLD SPRINGS WSA (CO-010-208/UT-080-103)

There are no known mineral deposits in the West Cold Springs WSA.

DIAMOND BREAKS WSA (CO-010-214/UT-080-113)

There are no known mineral deposits in the Diamond Breaks WSA.

KNOWN PROSPECTS, MINERAL OCCURRENCES AND MINERALIZED AREAS

In the West Cold Springs-Diamond Breaks GRA, the known prospects, occurrences and mineralized areas consist of 14 tar sand occurrences, 12 dry oil and gas holes, 6 uranium occurrences, and 6 iron occurrences (Overlays B and C).

WEST COLD SPRINGS WSA (CO-010-208/UT-080-103)

The only known prospect in the West Cold Springs WSA is a dry oil or gas well located in Section 36 T11N, R103W.

DIAMOND BREAKS WSA (CO-010-214/UT-080-113)

There are no known prospects, mineral occurrences or mineralized areas in the Diamond Breaks WSA.

MINING CLAIMS, LEASES AND MATERIAL SITES

The unpatented mining claim data was obtained form the Bureau of Land Management's June, 14, 1982, Geographic Index (Appendix C). In the West Cold Springs-Diamond Breaks GRA, there are 508 unpatented lode claims and 78 unpatented placer claims

(Overlay A). The unpatented claims are primarily located west, south, and southeast of the West Cold Springs WSA in T2N, R24, 25E, Daggett County, Utah, and in Section 11, 12, 13, T10N, R103W and Sections 20, 21, 22, 27, 28 and 29, T10N, R102W in Moffat County, Colorado.

In Daggett County, Utah, the unpatented claims are principally controlled by Gulf Mineral Resources, Cameo Minerals, Incorporated, Minerals Exploration and Johns-Manville Corporation. In Moffat Company, Colorado, Minatome Corporation and Urangesellschaft USA are the largest mining/exploration companies holding unpatented claims.

There are no patented mining claims located within the GRA.

The data on leases was not obtained and compiled for the entire GRA. Please refer to the August 27, 1982, Oil and Gas Plats and Master Title Plats in Appendix A.

WEST COLD SPRINGS WSA (CO-010-208/UT-080-103)

As of June 14, 1982, there were no patented or unpatented claims located within the WSA.

As of August 27, 1982, there were several oil and gas leases contained within the WSA. Please refer to the Oil and Gas Plats and Master Title Plats in Appendix A.

DIAMOND BREAKS WSA (CO-010-214/UT-080-113)

As of June 14, 1982, there were no patented and unpatented claims in the WSA.

For data on leases, refer to the Oil and Gas Plats and Master Title Plats in Appendix A.

MINERAL DEPOSIT TYPES

The West Cold Springs-Diamond Breaks GRA contains known deposits of gas, copper, iron, uranium, vanadium, silicon, construction stone, and sand and gravel.

Gas production in the Sugar Loaf Field is derived from the conglomerate and sandstone beds in the Cretaceous Mesaverde Group and the Paleocene Fort Union Formation. The Mesaverde Group is composed of, in ascending order, the Rock Springs Formation, the Ericson Formation, and the Almond Formation. The Rock Spring Formation consists of fine to medium grained sandstone, siltstone and shale. The Ericson Formation is composed of a medium to coarse grained sandstone, shale, pebble conglomerates and coal beds. The Almond Formation consists of fine to medium grained sandstone, shale, and siltstone (Weber, 1971). Overlying the Mesaverde Group, in ascending order, is the Cretaceous Lewis Shale, the Fox Hill Formation, and the Lance Formation. The Tertiary Fort Union Formation is composed of relatively coarse-grained sandstones, noncalcareous silts and clays, and pebble conglomerates (Weber, 1971). The formation is principally of fluvial origin, however some silty beds may be of lacustrine origin (Weber, 1971). Gas traps are formed, along anticlinal folds, by the porous sandstone units which are underlain by impermeable units.

Deposits of copper and iron occur in the northwestern portion of the GRA. The deposits are found in the Archeozoic Red Creek complex. The Red Creek complex is composed of a complexly folded and fractured quartzite, a quartzose mica schist containing the accessory minerals of almandite and staurolite, amphibolite dikes and sills, epidiorite, complex carbonates and pegmatites (Ritzman, 1959). The primary ore minerals consist of chalcopyrite, chalcocite, pyrite, and hematite, with lesser amounts of bornite, malachite and azurite. The ore minerals occur in irregular quartz fissure veins along dioritic or pegmatitic dikes. Ore is usually disseminated into the quartzite and schist wall rock or the dikes (Ritzman, 1959).

In addition to copper and iron deposits, uranium deposits also occur in the Archeozoic Red Creek complex. However, only limited development has occurred since the deposits are relatively small and sparsely situated. Unlike the Morrison-type deposits where carnotite is the primary ore mineral, tyuyamunite is the primary ore mineral in the Red Creek complex deposits. Nevertheless, lesser amounts of carnotite and other uranium minerals are present (Ritzman, 1959). The disseminated and erratic mineralization occurs in fractures, similar to the copper and iron mineralization described above, in the complexly folded and faulted Red Creek complex (Ritzman, 1959).

Gemstone quality opal, malachite and azurite is associated with copper, iron and uranium mineralization (Ritzman, 1959).

Pediment gravels from various rivers and streams have been exploited as a source of sand and gravel.

Construction stone has been derived from various formations.

WEST COLD SPRINGS WSA (CO-010-208/UT-080-103)

There are no known deposits in the WSA, therefore any discussion on mineral deposits types would be theoretical.

DIAMOND BREAKS WSA (CO-010-214/UT-080-113)

There are no known deposits in the WSA, therefore any discussion on mineral deposit types would be theoretical.

MINERAL ECONOMICS

The inherent nature of discussing the economics of the minerals existing within the West Cold Springs-Diamond Breaks 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. Finally, because of the indicated complexity of the subject, the discussion herein is limited to address the U.S. and Colorado demand, as well as the production status of each of the existing minerals in the WSA.

The mineral resources found in this GRA include gas, copper-iron, uranium-vanadium, silicon, construction stone, and sand and gravel.

Gas production is from Cretaceous and Paleocene units in the Sugar Loaf Field. From 1953 through 1974, Sugar Loaf Field produced 45,551,294 million cubic feet of gas and 209,504 barrels of condensates. Current production statistics were not available. 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, October 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).

The copper and iron occur in irregular quartz fissure veins in the Archeozoic Red Creek Complex. The operating status and production statistics for the two mines in the GRA are not known. Production and demand for base metals, however, is down from past levels due to a general down-turn in the U.S. and work economy (Eng. and Mining Journal, Dec. 1982).

Commodities such as copper and iron are not being currently produced at much of a profit by any of the major mining operations in Colorado (Eng. and Mining Journal, Dec. 1982; Carpenter, Personal Communication, 1982).

The uranium and vanadium are also produced from quartz fissure veins in the Archeozoic complex. Production from the one uranium-vanadium mine in the GRA is not known. Current production is down from past production levels due to a general drop in the price of uranium (Eng. and Mining Journal, Dec. 1982). Uranium and vanadium are currently being produced at very little or no profit by many of the major mining operations in Colorado (Carpenter, Personal Communication, 1982). Future demand for uranium and vanadium is dependent on foreign production and the needs of the nuclear generating industry (Schwochow, 1978).

Construction stone and sand and gravel are considered to be "high place value" industrial minerals (Eyde, Personal Communication, 1982). "High place" minerals are of economic value only when the deposits are readily accessible, and in close proximity to a market (Eyde, Personal Communication, 1982).

The economic viability of the mineral resources in the WSA's in the West Cold Springs-Diamond Breaks GRA are summarized as follows:

WSA	MINERAL POTENTIAL	ACCESSIBILITY	ECONOMIC POTENTIAL [a]
West Cold Springs WSA (CO-010-208, UT-080-103)	Oil, Gas	Poor	Poor
Diamond Breaks WSA (CO-010-214, UT-080-113)	Oil, Gas	Poor	Poor

[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 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.

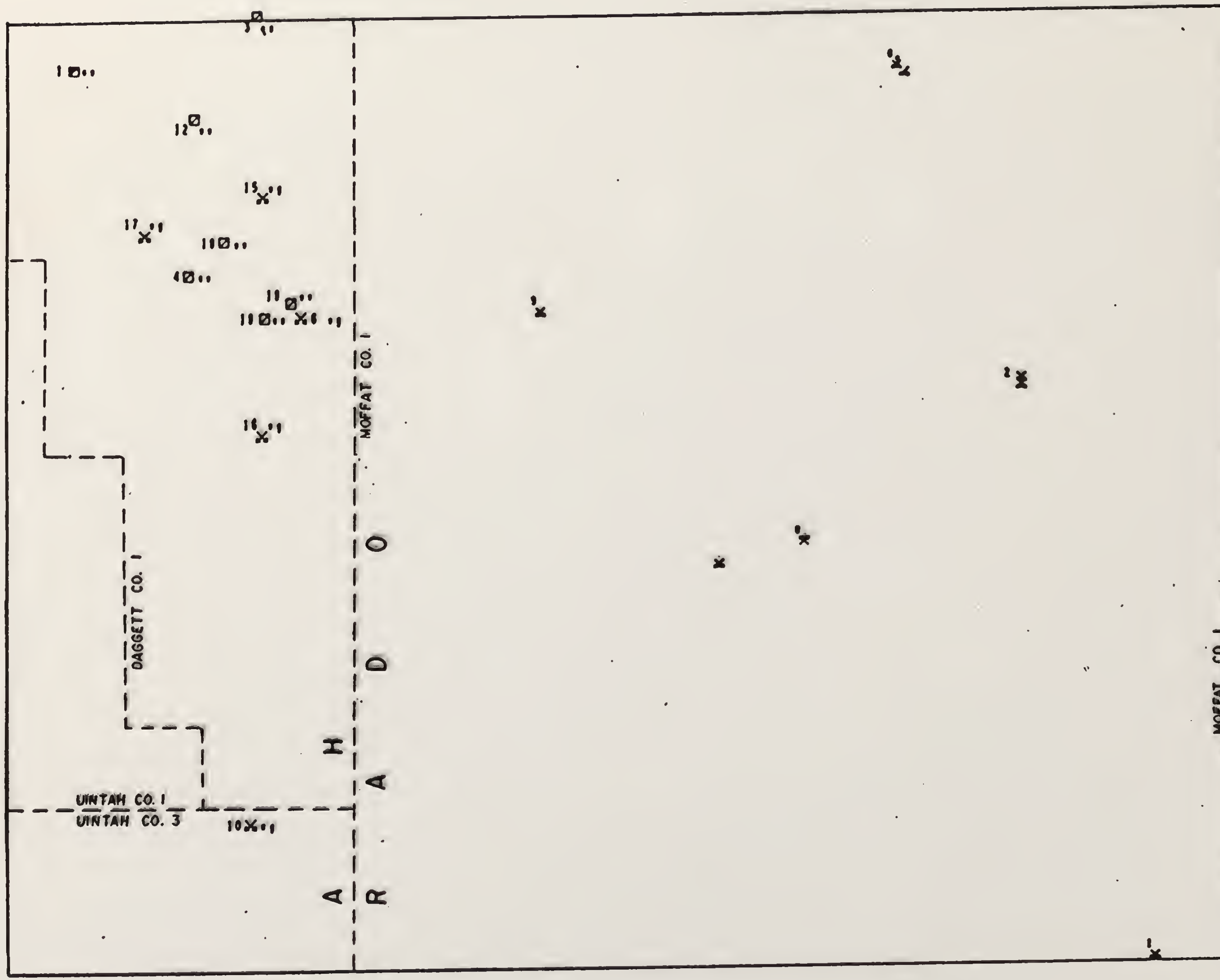
Mr. Walter E. Heinrichs: Geophysics and base and precious metal deposits of western U.S., expert on porphyry copper deposits.

As indicated earlier, Dr.'s Gilmour and Carpenter 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.

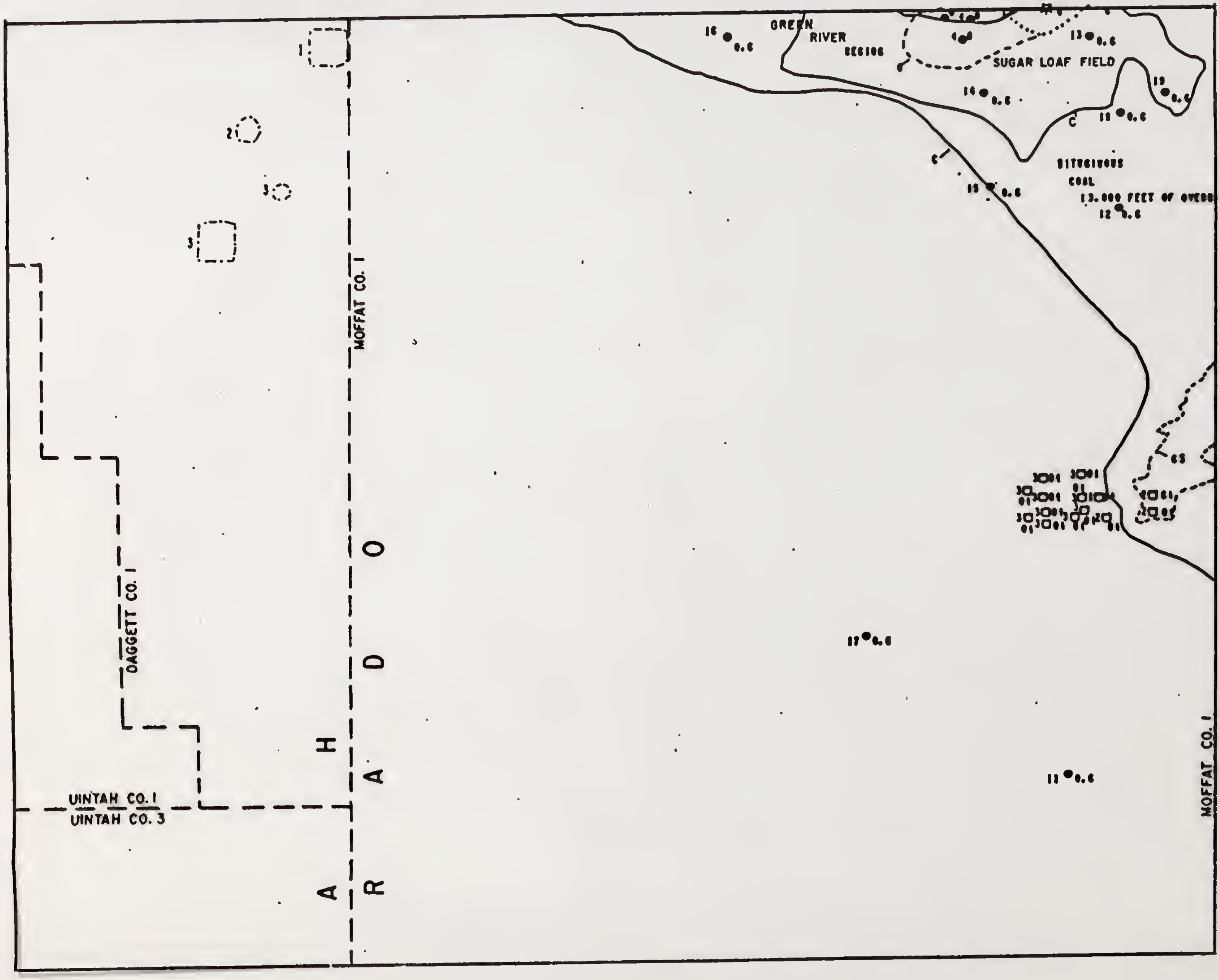
The evaluations were then made on the basis of examination of the data bases, field investigations and the individual experiences of the members of the panel in such areas as base and precious metal, industrial and energy mineral deposits; oil and gas deposits; and geothermal resources. In the course 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 it's 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 their selection of classification level. This is denoted by the letter association with each rate classification. These are defined in Table IV-1.

A further restraint on this classification and delineation effort comes in the area of the 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.

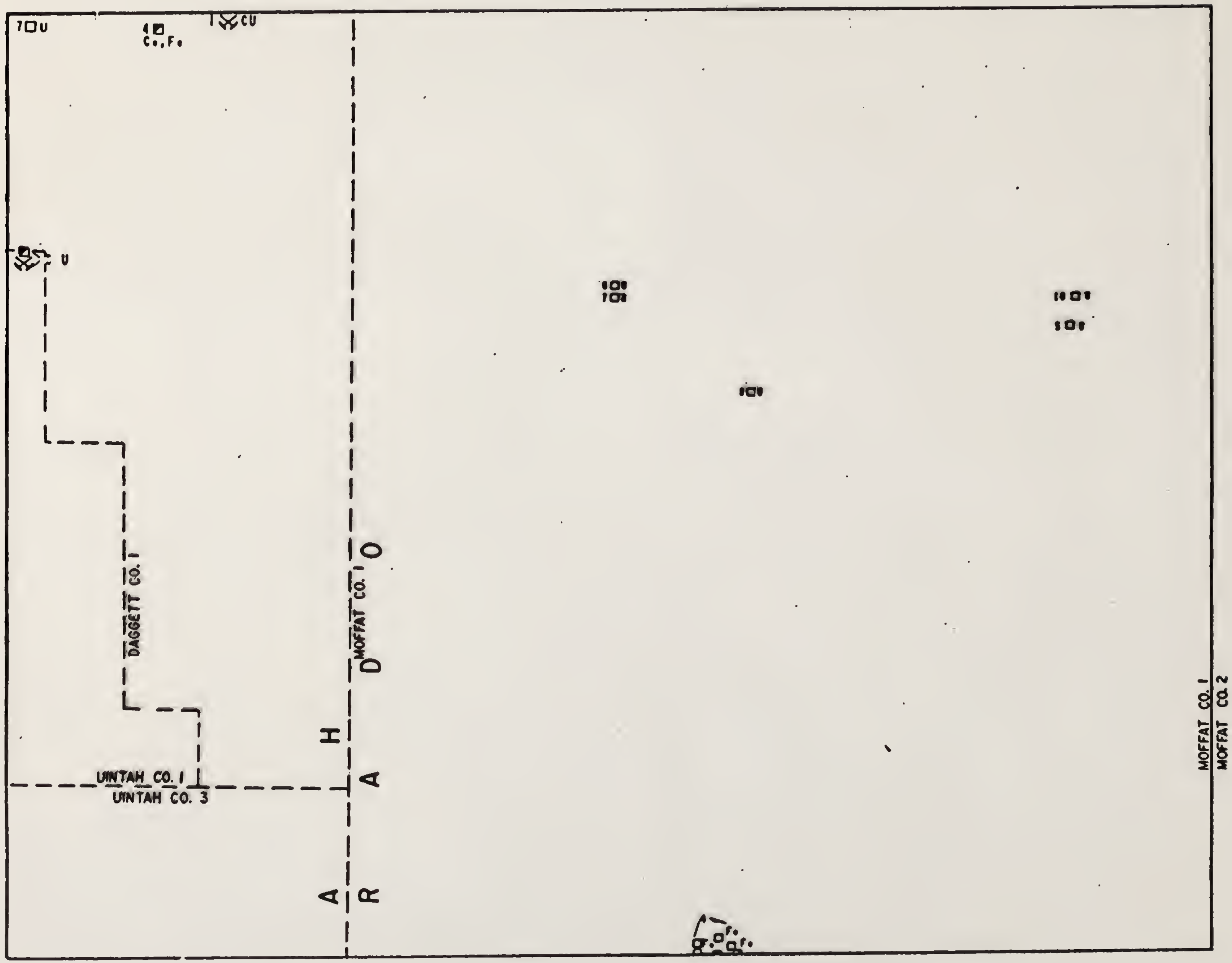
The WSA's, for the most part, are not well known geologically. For this reason, our expert team had to extrapolate geologic information from adjacent areas or other areas of the state to make any sort of reasonable classification with some level of confidence. The following pages address those resources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



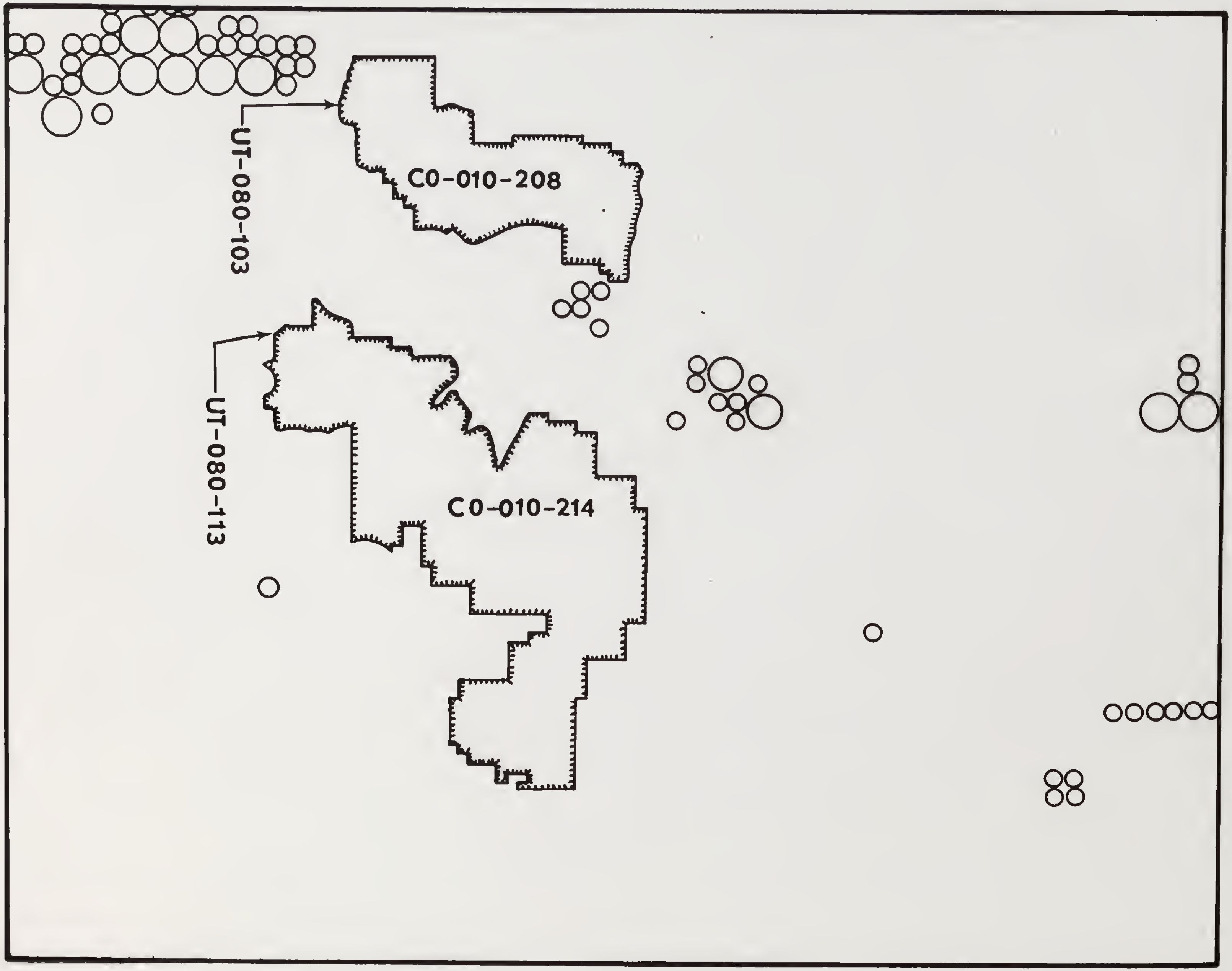
OVERLAY D
SAND, GRAVEL AND
INDUSTRIAL MINERALS



OVERLAY C
COAL, OIL AND GAS



OVERLAY B
MINES, PROSPECTS
AND MINERAL OCCURENCES



OVERLAY A:
PATENTED AND UNPATENTED
CLAIMS AND WSA BOUNDARIES

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 resource.

LEASABLE RESOURCES

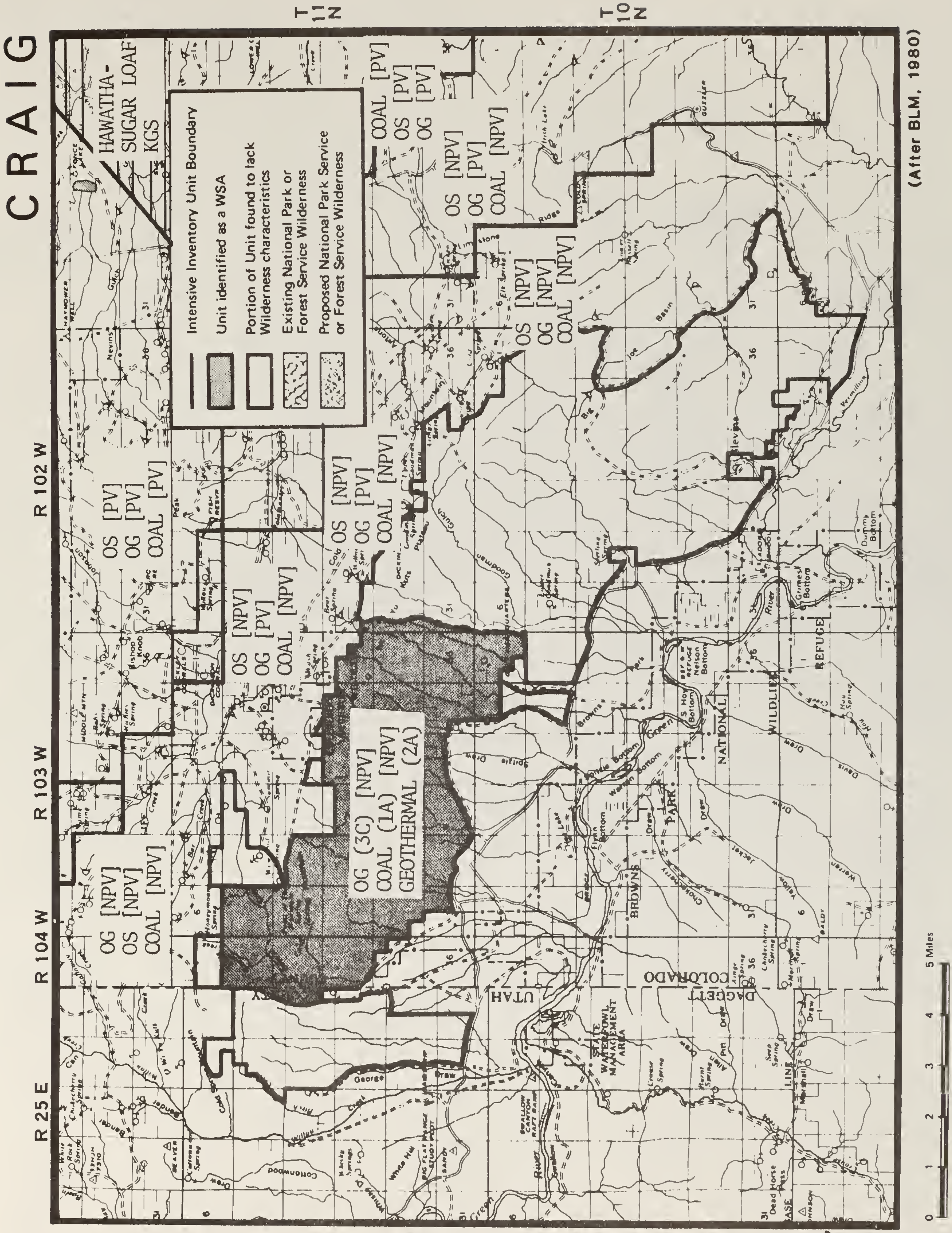
WEST COLD SPRINGS WSA (CO-010-208/UT-010-103)

Resource	Classification	Comments
Oil & Gas	3B	Oil and gas well in Precambrian overthrust plate adjacent to the NE corner of WSA. Structure can be assumed to extend under the WSA.
Coal	1C	The WSA lacks the coal-bearing formations.
Geothermal	2A	Thermal springs adjacent to the WSA in Utah. This area contains east-west structures.

DIAMOND BREAKS WSA (CO-010-214/UT-080-113)

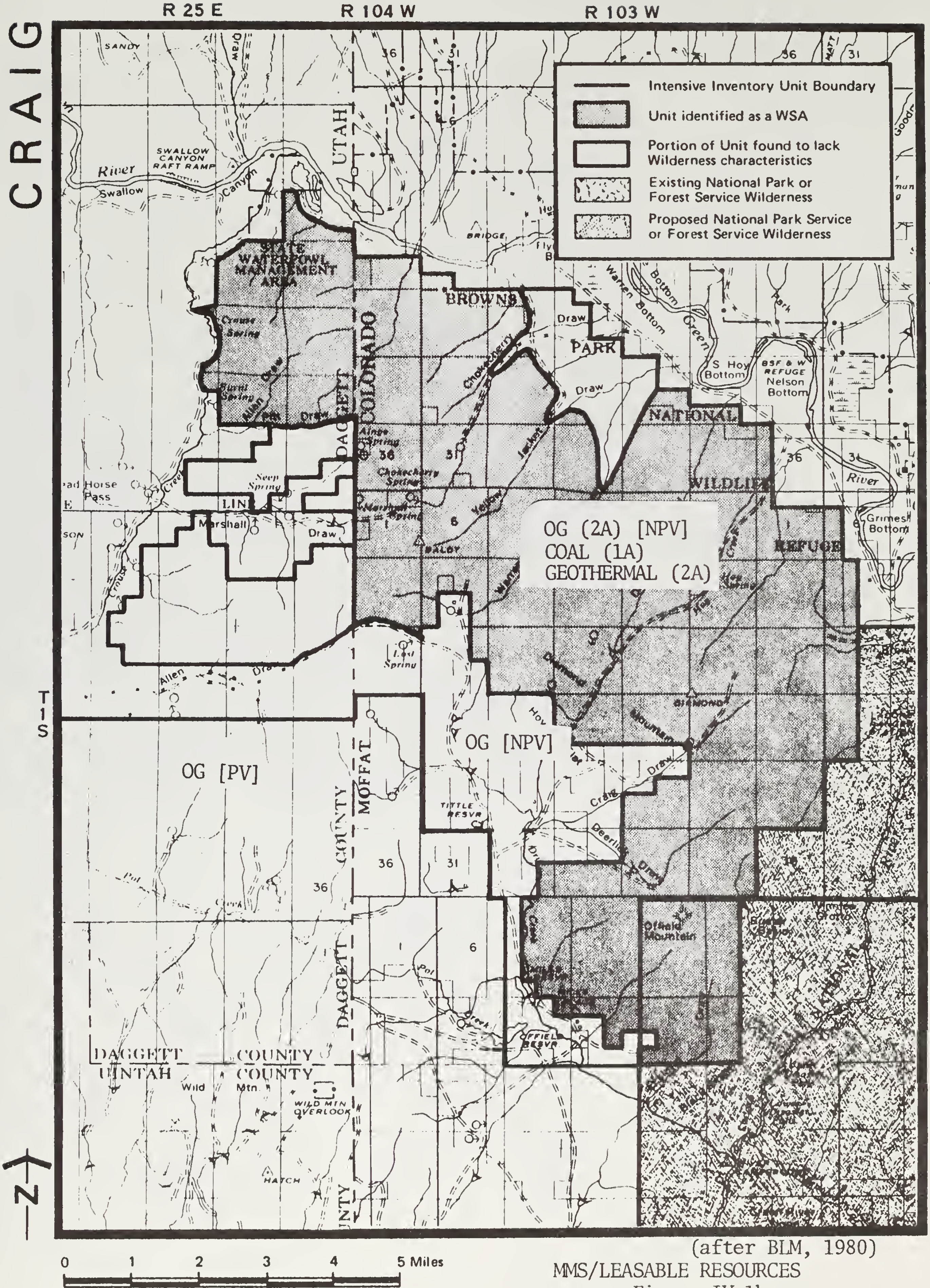
Resource	Classification	Comments
Oil and Gas	2A	Oil and gas production in the Precambrian overthrust plate NE of the WSA. There is the possibility that this structure exists at depth in the WSA.
Coal	1C	The WSA lacks the coal-bearing formations.
Geothermal	2A	Thermal springs are located in Utah near the WSA, possible along east-west structures.

CO-010-208 Cold Springs West



MMS/LEASABLE RESOURCES
Figure Iv-1a

CO-010-214 Diamond Breaks

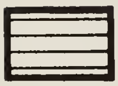


(after BLM, 1980)

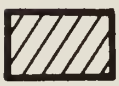
MMS/LEASABLE RESOURCES

Figure IV-1b

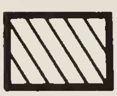
LEGEND FOR MINERALS MANAGEMENT SERVICE CLASSIFICATIONS



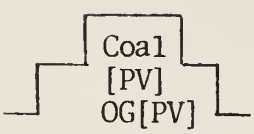
Defined KGS and/or Coal Leasing Areas



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

LOCATABLE MINERALS

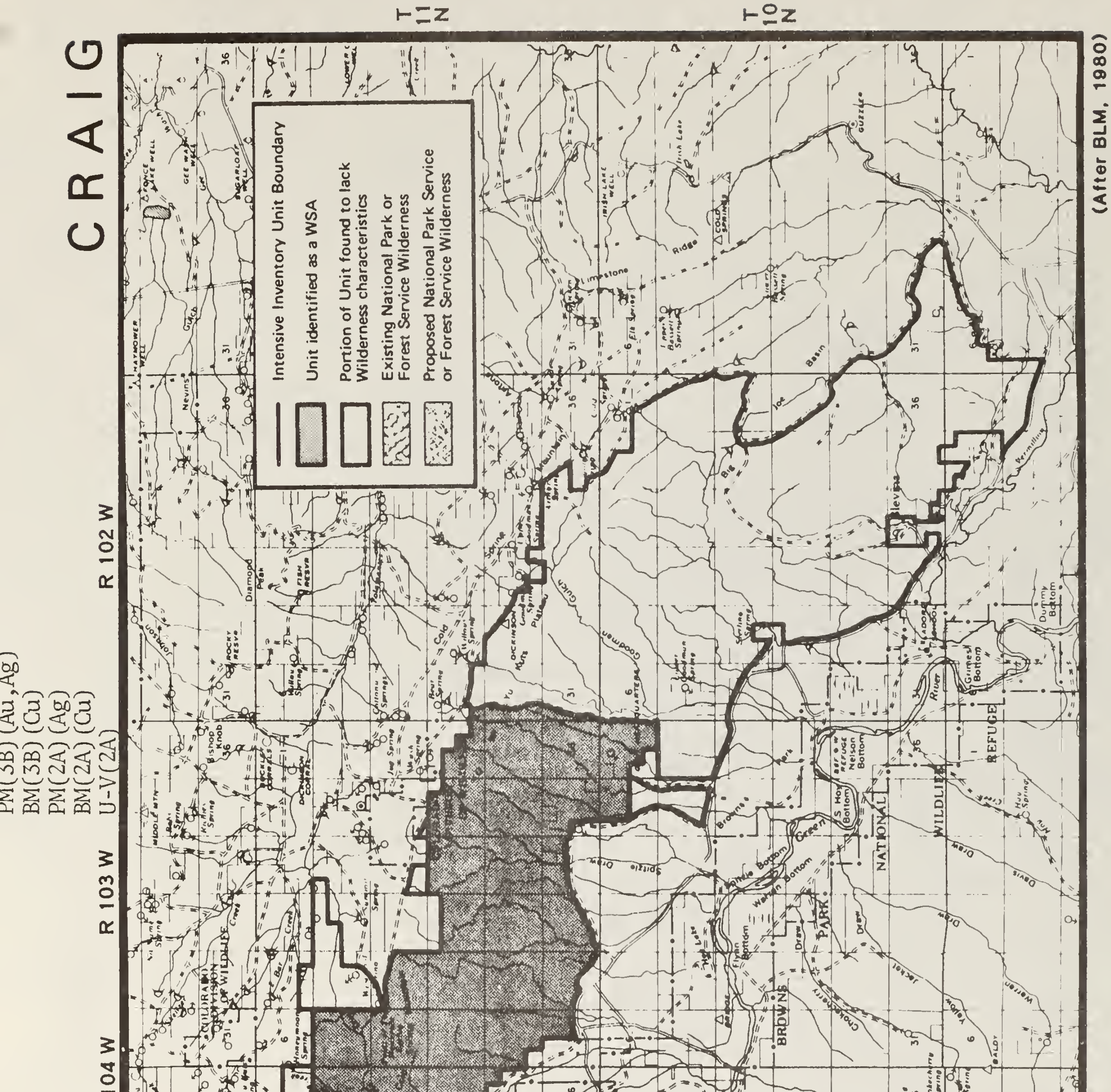
WEST COLD SPRINGS WSA (CO-010-207/UT-080-103)

Resource	Classification	Comments
Precious Metals	3B	Au, Ag minerals potential associated with Precambrian Red Creek units.
	2A	Ag mineralization potential associated with Precambrian Uinta Group units.
Base Metals	3B	Cu mineralization associated with Precambrian Red Creek units.
	2A	Cu mineralization potential associated with Precambrian Uinta Group units.
Locatable Energy Minerals	2A	Uranium-Vanadium potential associated with Precambrian Uinta Group units.
Other Locatable Minerals:	Unknown	

DIAMOND BREAKS WSA (CO-010-214/UT-080-113)

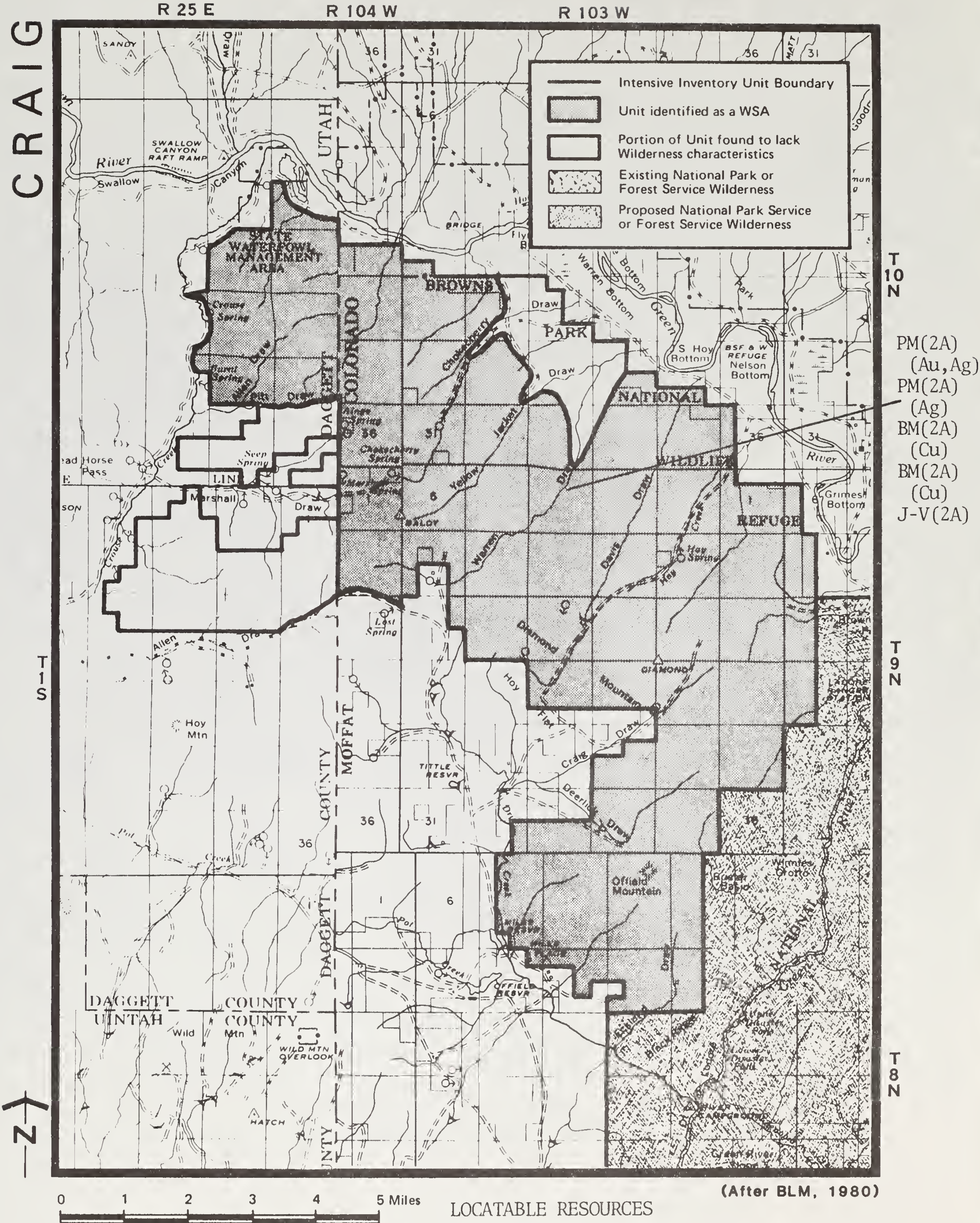
Resource	Classification	Comments
Precious Metals	2A	Au, Ag mineralization potential associated with Precambrian Red Creek units.
	2A	Ag mineralization potential associated with Precambrian Uinta Group units.
Base Metals	2A	Cu mineralization associated with Precambrian Red Creek units.
	2A	Cu mineralization potential associated with Precambrian Uinta Group units.
Locatable Energy Minerals:	2A	Uranium-vanadium potential associated with Precambrian Uinta Group units.
Other Locatable Minerals:	Unknown	

CO-010-208 Cold Springs West



LOCATABLE RESOURCES
Figure IV-2a

CO-010-214 Diamond Breaks



LOCATABLE RESOURCES
Figure IV-2b

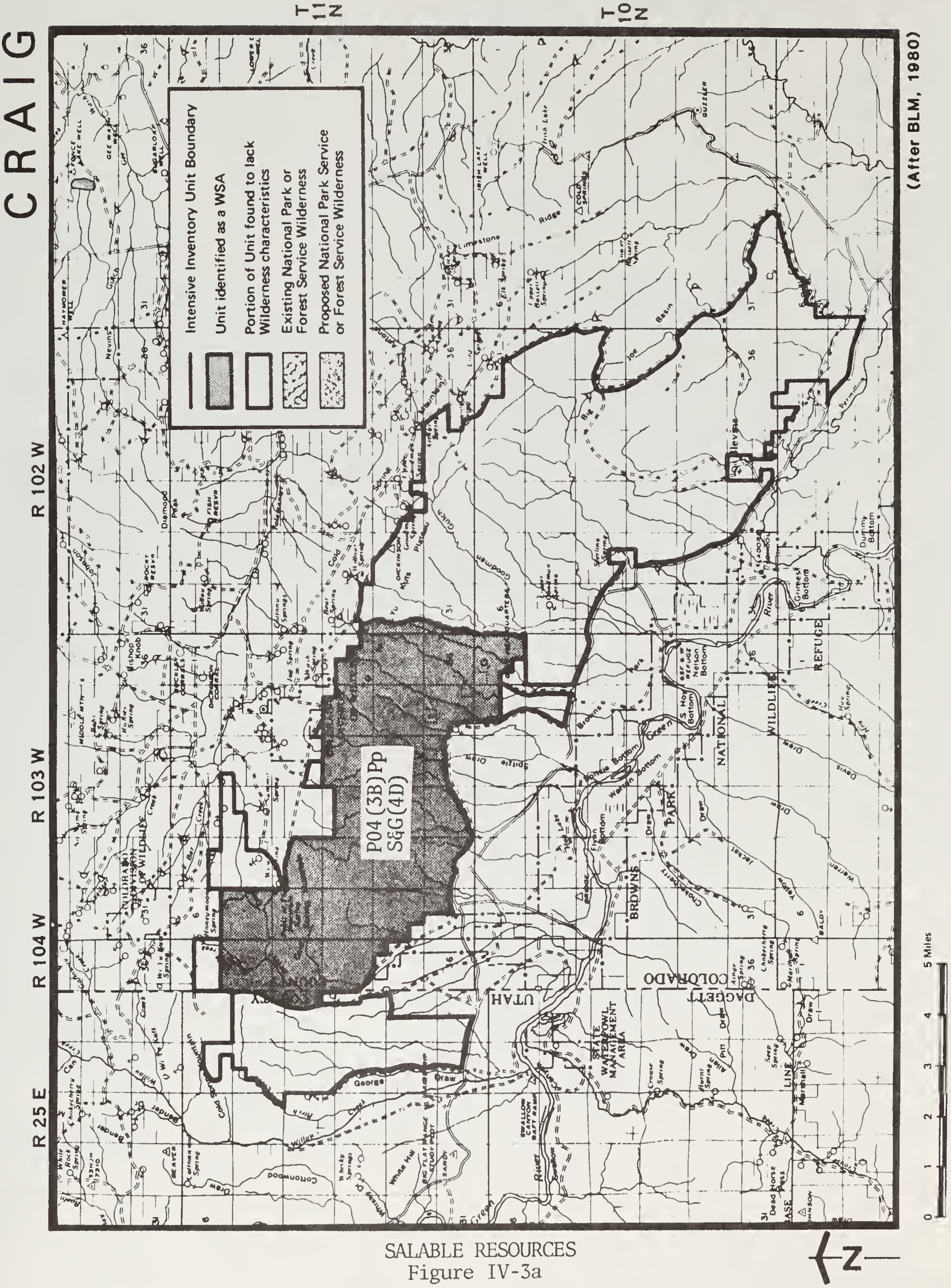
SALABLE RESOURCES

WEST COLD SPRINGS WSA (CO-010-208/UT-080-103)

Resource	Classification	Comments
Phosphate	3B	Phosphate deposits are known to occur in the Permian Phosphoria Formation. The economic potential is limited.
Sand and Gravel	4D	Exploited from Quaternary bench gravels and stream channels. The economic potential is limited.

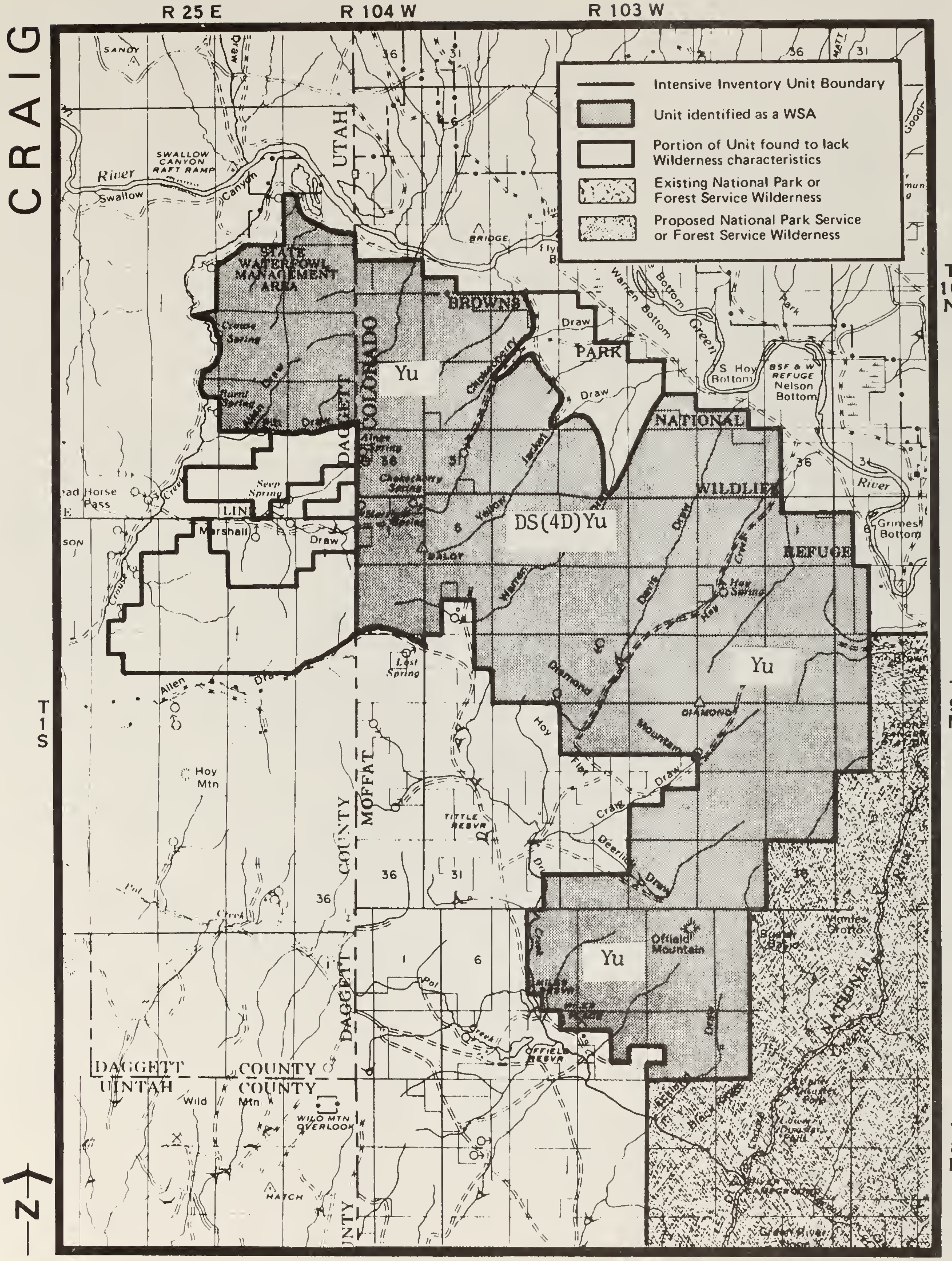
DIAMOND BREAKS WSA (CO-010-214/UT-080-113)

Resource	Classification	Comments
Dimension Stone	4D	The Uinta Quartzite may occur within the WSA, which has been quarried in the past. The economic potential is rated very low. There are no existing developments in the WSA.



SALABLE RESOURCES
Figure IV-3a

CO-010-214 Diamond Breaks



0 1 2 3 4 5 Miles

SALABLE RESOURCES
Figure IV-3b

SECTION V

RECOMMENDATIONS FOR FURTHER STUDY

In the course of analyzing, assessing and evaluating each of the WSA's in the West Cold Springs-Diamond Break - 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.

WEST COLD SPRINGS WSA (CO-010-208/UT-080-103)

Since this area is known to have some potential for oil and gas 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 zones 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 Precambrian units. Any sampling carried out under such a program must include analysis of the copper, silver and uranium content of these units. The outcrops of the Tertiary Browns Park Formation should be sampled for the uranium content and correlated to other units in northwestern Colorado and eastern Utah.

Examination of the Browns Park units should be made by paleontologists for environments favorable for the preservation of mammal remains.

DIAMOND BREAKS WSA (CO-010-224/UT-080-113)

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 lithologies. Special attention should be paid to possible sedimentary assemblages associated with Precambrian base and precious metal systems. 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.

Any prospects and mineral occurrences should be mapped and thoroughly sampled to delineate the full extent of existing mineralization and the potential of the host lithologies. This is of particular importance in the determination of the uranium-vanadium potential of the Precambrian Uinta Group units. 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 northwestern Colorado and eastern Utah. In other areas these units have significant potential GEM resources 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 work would be helpful in identifying any areas of mineral potential.

Stream sediment samples should be analyzed for their copper, molybdenum, lead, arsenic, uranium, vanadium and gold content. This data will supplement the existing NURE-HSSR-ARMS information.

Since some of the Precambrian units have been used in the past as a source of local road building material and dimension stone, 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.

SECTION VI

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