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QUANTITATIVE ASSESSMENTS OF THE ENERGY AND MINERAL RESOURCES WITHIN EIGHTEEN WILDERNESS STUDY AREAS IN THE STATES OF COLORADO, NEVADA, OREGON, AND UTAH

Richard B. McCammon[1], W. David Menzie III[1], Richard F. Mast[2], and M. Devereux Carter[1], editors

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[1]U.S. Geological Survey, Reston, Virginia 22092
[2]U.S. Geological Survey, Denver, Colorado 80225

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INTRODUCTION

The U.S. Geological Survey (USGS) and the U.S. Bureau of Mines (USBM) at the direction of Congress in the Federal Land Policy and Management Act of 1976, conducted in cooperation with the Bureau of Land Management (BLM) joint energy- and mineral-resource studies within 12 States, including Colorado, Nevada, Oregon, and Utah. All reports on the energy and mineral resources of wilderness study areas identified by the BLM as suitable for wilderness designation within these states were completed on or before October 1, 1990.

After reviewing the energy- and mineral-resource reports, the BLM completed it's recommendations for wilderness areas. As a normal part of the Department of the Interior's review process, the BLM's recommendations were reviewed by the USGS and the USBM. This review identified 18 study areas in Colorado, Nevada, Oregon, and Utah that the BLM recommended for wilderness that have significant identified resources or as having a high or moderate potential for containing undiscovered energy- or mineral-resources. Following discussions with the BLM, the USGS agreed to provide quantitative resource assessments in these 18 study areas. The study areas in question are the Redcloud and Handies Peak Wilderness Study Areas in Colorado, the Clan Alpine Mountains, Fandango, Mount Stirling, Mormon Mountains, Roberts, Silver Peak, and Weepah Wilderness Study Areas in Nevada, the Blue Canyon and Owyhee Breaks Wilderness Study Areas in Oregon, and the Notch Peak, Fish Springs Range, Desolation Canyon, Coal Canyon, Spruce Canyon, Turtle Canyon, and Flume Canyon Wilderness Study Areas in Utah. This Open-File report presents the results of the quantitative assessments.[3] The reader is referred to the references given at the end of each section for a full discussion of the methodology and the background data used in the original wilderness study area reports to evaluate the energy and mineral resources.

[3] In this report, each studied area is referred to as "wilderness study area."

QUANTITATIVE MINERAL RESOURCE ASSESSMENTS

Methodology

The method of assessment used is similar to that described by Singer (1984) and applied by Drew and others (1986). The method consists of a three-step procedure. In step one, the mineral deposit types consistent with those described in Cox and Singer (1986) are identified for permissive host terranes based on a synthesis of all the available geologic, geochemical, geophysical, and mineral-resource data. The maximum depth of consideration for the occurrence of undiscovered deposits for the wilderness study areas is defined as 1,000 meters from the surface.

In step two, probabilistic estimates of the number of undiscovered deposits are made for each of the deposit types that may occur in the host terrane. Estimates are made independently by all the geologists on each assessment team at either the 90th, the 50th, and the 10th percent confidence levels or at the 90th, the 50th, the 10th, the 5th, and the 1st percent confidence levels. A consensus set of estimates is agreed to by the members of each team. The numbers for each deposit type are estimated independently. Each set of numbers is estimated as if all relevant data considered pertained solely to the existence of that type of deposit. In one situation, for the Mormon Mountains Wilderness Study Area, estimates for two permissive deposit types were based on similar geologic, geophysical and geochemical evidence. In this case, an interdependence could exist between the estimated numbers of deposits. Should the existence of one deposit type be proven, the estimated numbers for the other deposit type could be expected to decline sharply. Consequently, two possible scenarios were developed for the Mormon Mountains Wilderness Study Area.

In step three, the grade and tonnage models (Cox and Singer, 1986; Bliss, in press) are entered together with the estimates of the numbers of undiscovered deposits for each deposit type into a Monte Carlo computer simulation program to generate probabilitistic estimates of the metal endowments in undiscovered deposits. The probabilistic estimates are generated using the current version of the USGS Mark3 Simulator (Root and others, in press). The input for each deposit type for each study area consisted of the estimates of the numbers of undiscovered deposits and 10 piecewise-linear approximations of the grade and tonnage model data. Output from the simulator includes estimates of total metal endowments and ore tonnages in rank order based on 4,999 simulations. Metal endowments for the 90th, 50th, 10th (and, where appropriate, the 5th and 1st) percentiles of the simulated distributions were selected for presentation in the tables contained in this report.

The estimates of metal endowments represent in-place undiscovered resources. The gross in-place value of these resources was calculated assuming 5-year average metal prices (copper, $1.18/lb or $2600/metric ton; gold, $380.64/oz or $12,238,100/metric ton; silver, $4.02/oz or $129,230/metric ton; zinc, $.70/lb or $1,545/metric ton; lead, $.40/lb or $882/metric ton; molybdenum, $3.01/lb or $6,636/metric ton; tungsten [as WO_3], $50.4/metric ton unit [mtu] or $5,040/metric ton WO_3; U_3O_8, $15.01/lb or $33,100/metric ton U_3O_8). These estimates of gross in-place value do not imply that the undiscovered resources would necessarily be economic to produce. Such a determination would require an analysis of the costs of discovering the deposits, engineering feasibility studies of mining and concentrating the ores, and an economic evaluation of metal production.

Redcloud Peak and Handies Peak Wilderness Study Areas, Colorado

The assessment team of R. F. Sanford, W. C. Bagby, D. P. Cox, M. F. Diggles, L. J. Drew, E. H. McKee, W. D. Menzie, D. A. Singer, and G. T. Spanski identified the following deposit types as being likely to occur within these wilderness study areas included: Creede epithermal veins (model 25b[4]), Climax Mo (model 16), and Volcanogenic U (model 25f). Table 1 presents the number of undiscovered deposits of each type estimated to occur in the two areas. There is a good chance that the area contains one undiscovered Creede epithermal vein deposit and some chance the area contains two undiscovered Creede epithermal vein deposits. It is also likely the area contains one undiscovered Climax Mo deposit and some chance that the area contains two Climax Mo deposits. It is very likely that the area contains one undiscovered Volcanogenic U deposit, a good chance the area contains two such deposits and some chance that the area contains three such deposits. Table 2 presents the amount of copper (Cu), gold (Au), silver (Ag), zinc (Zn), and lead (Pb) estimated to occur in Creede epithermal vein deposits. Table 3 presents the amount of molybdenum (Mo) estimated to occur in Climax Mo deposits. Table 4 presents the amount of molybdenum and uranium (U_3O_8) estimated to occur in Volcanogenic U deposits. Table 5 presents the amount of each metal estimated to occur in the two wilderness study areas. Table 6 presents the gross in-place value of the estimated metal. The estimated mean gross in-place value of the minerals in undiscovered deposits is 4.9 billion dollars.

[4] The deposit models referred to in this report are described either in Cox and Singer, 1986, or in Bliss, in press.

Table 1. **Estimated numbers of undiscovered deposits in Redcloud and Handies Peak wilderness study areas, Colorado.**

Deposit name	Model No.	Deposit Probability Levels				
		.9	.5	.1	.05	.01
Creede epithermal veins	25b	0	1	1	2	2
Climax Mo	16	1	1	1	2	2
Volcanogenic U	25f	1	2	3		

Table 2. **Estimated metal endowments in Creede epithermal vein deposits in the Redcloud and Handies Peak wilderness study areas, Colorado.**

(in thousand metric tons)

Metal	Endowment Values[5]					Mean Endowment[5]
	90%	50%	10%	5%	1%	
Cu	0	.44	21	40	140	8.7
Au	0	.001	.031	.068	.27	.016
Ag	0	.07	2.7	7.6	36	2
Zn	0	7	330	580	1,700	120
Pb	0	15	190	320	800	69

[5] In this and all succeeding tables of estimated metal endowments, the values are reported out to two significant digits.

Table 3. Estimated metal endowments in Climax Mo deposits in the Redcloud and Handies Peak wilderness study areas, Colorado. (in thousand metric tons)

	Endowment Values					Mean
Metal	90%	50%	10%	5%	1%	Endowment
Mo	31	400	1,500	1,900	2,900	610

Table 4. Estimated metal endowments in Volcanogenic U deposits in the Redcloud and Handies Peak wilderness study areas, Colorado. (in thousand metric tons)

	Endowment Values					Mean
Metal	90%	50%	10%	5%	1%	Endowment
Mo	0	0	.2	20	40	2.1
U_3O_8	.019	1	18	25	37	4.9

Table 5. **Estimated metal endowments for Creede epithermal veins (25b), Climax Mo (16), and Volcanogenic U (25f) in the Redcloud and Handies Peak wilderness study areas, Colorado.**
(in thousand metric tons)

Metal	Endowment Values					Mean Endowment
	90%	50%	10%	5%	1%	
Cu	0	.44	21	40	140	8.7
Au	0	.001	.031	.07	2.7	.016
Ag	0	.071	2.7	7.6	36	2
Zn	0	7	330	580	1,700	120
Pb	0	15	190	320	800	69
Mo	33	410	1,500	1,900	3,000	610
U_3O_8	.02	1	18	25	37	4.9

Table 6. **Estimated gross in-place value for Creede epithermal vein (25b), Climax Mo (16), and Volcanogenic U (25f) in the Redcloud and Handies Peak wilderness study areas, Colorado.**
(in millions of dollars)

Metal	Gross in-Place Value					Mean Value
	90%	50%	10%	5%	1%	
Cu	0	1	55	104	364	23
Au	0	12	379	857	3,304	196
Ag	0	9	349	982	4,652	258
Zn	0	11	510	896	2,627	185
Pb	0	13	168	282	706	61
Mo	219	2,721	9,954	12,608	19,908	4,048
U_3O_8	1	33	596	828	1,225	162

Clan Alpine Mountains Wilderness Study Area, Nevada

The deposit types identified as possibly occurring within the Clan Alpine Mountains Wilderness Study Area include Climax Mo (model 16), and Comstock epithermal vein (model 25c) deposits. Table 7 presents the number of undiscovered deposits of both types estimated to occur in the area. These estimates represent the consensus view of the assessment team whose members included: W. C. Bagby, D. P. Cox, M. F. Diggles, L. J. Drew, E. H. McKee, W. D. Menzie, D. A. Singer, and G. T. Spanski. There is a low probability that the area may contain one undiscovered Climax Mo and one undiscovered Comstock epithermal vein deposit. Table 8 and 9 present the estimated metal endowments in the two deposit types. Table 10 presents the estimated gross in-place values of the wilderness study area. Because the probability of occurrence of both deposit types is low, there is a significant chance that the gross in-place value of undiscovered deposits in this area is negligible, even though the mean gross in-place value is 350 million dollars.

Table 7. **Estimated numbers of undiscovered deposits in the Clan Alpine Mountains wilderness study area, Nevada.**

Deposit name	Model No.	Deposit Probability Levels				
		.9	.5	.1	.05	.01
Climax Mo	16	0	0	0	0	1
Comstock epithermal vein	25c	0	0	0	1	1

Table 8. **Estimated metal endowments in undiscovered Climax Mo deposits in the Clan Alpine Mountains wilderness study area, Nevada.**

(in thousand metric tons)

Metal	Endowment Values					Mean Endowment
	90%	50%	10%	5%	1%	
Mo	0	0	0	0	810	21

Table 9. **Estimated metal endowments in undiscovered Comstock epithermal vein deposits in the Clan Alpine Mountains wilderness study area, Nevada.**

(in thousand metric tons)

Metal	Endowment Values					Mean Endowment
	90%	50%	10%	5%	1%	
Au	0	0	0	.003	.036	.0016
Ag	0	0	0	.042	1.8	.11

Table 10. **Estimated gross in-place value for undiscovered Climax Mo (16) and Comstock epithermal vein (25c) deposits in the Clan Alpine Mountains wilderness study area, Nevada.**
(in millions of dollars)

	Gross in-Place Value					Mean
Metal	90%	50%	10%	5%	1%	Value
Mo	0	0	0	0	5,375	139
Au	0	0	0	37	441	196
Ag	0	0	0	5	233	14

Fandango Wilderness Study Area, Nevada

The deposit types identified as possibly occurring within the Fandango Wilderness Study Area include Polymetallic Replacement (model 19a) and Polymetallic Vein (model 22c) deposits. Table 11 presents the consensus number of undiscovered deposits estimates for both deposit types. Members of the assessment team included: W. C. Bagby, D. P. Cox, L. J. Drew, M. F. Diggles, E. H. McKee, W. D. Menzie, D. A. Singer, and G. T. Spanski. There is a low probability of the area containing a polymetallic replacement deposit, and more likely to contain undiscovered polymetallic vein deposits. Polymetallic replacement deposits are usually large, high grade deposits, while polymetallic vein deposits are usually small, high grade deposits. Table 12 presents the estimated metal endowments for the area. Table 13 presents the estimated gross in-place values for the area. The mean gross in-place value of the area is 110 million dollars. About 66 percent of the mean gross in-place value is in polymetallic vein deposits, with the balance in the replacement deposits.

Table 11. Estimated numbers of undiscovered deposits in the Fandango wilderness study area, Nevada.

Deposit name	Model No.	Deposit Probability Levels				
		.9	.5	.1	.05	.01
Polymetallic Replacement	19a	0	0	0	0	1
Polymetallic vein	22c	1	2	4	--	--

Table 12. Estimated metal endowments in undiscovered Polymetallic Replacement (19a) and Polymetallic vein (22c) deposits in the Fandango wilderness study area, Nevada.
(in thousand metric tons)

Metal	Endowment Values					Mean Endowment
	90%	50%	10%	5%	1%	
Cu	0	.004	.4	1.3	11	.8
Au	0	.00002	.001	.003	.015	.0007
Ag	.0005	.028	.46	1	5.1	.27
Zn	0	1.2	44	100	260	22
Pb	.056	4	59	110	370	31

Table 13. **Estimated gross in-place value for undiscovered Polymetallic Replacement (19a) and Polymetallic vein (22c) deposits in the Fandango wilderness study area, Nevada.**
(in millions of dollars)

Metal	Gross in-Place Value					Mean Value
	90%	50%	10%	5%	1%	
Cu	0	0	1	3	29	2
Au	0	0	12	37	184	9
Ag	0	4	59	129	659	35
Zn	0	2	68	155	402	34
Pb	0	4	52	97	326	27

Mount Stirling Wilderness Study Area, Nevada

The deposit type identified by the assessment team of W. C. Bagby, D. P. Cox, M. F. Diggles, L. J. Drew, W. D. Menzie, D. A. Singer, and G. T. Spanski. as possibly occurring within the Mount Stirling Wilderness Study Area is Carbonate-hosted Au-Ag (model 26a). Examples of this deposit type include the Carlin deposit. Table 14 presents the estimated number of such deposits thought to occur in the wilderness study area. The geologists assigned the area low probability of containing an undiscovered Carbonate-hosted Au-Ag deposit. While certain features observed in the area are similar to features observed near the Prebble deposit, the relatively low probability of a deposit occurring in the area is reflective of significant differences in the geology of the Mount Stirling area from that of areas known to host Carbonate-hosted Au-Ag deposits. Table 15 presents the estimated metal endowments for the area. Table 16 presents the estimated gross in-place values for the area. The mean gross in-place value of the area is 32 million dollars. There is a significant chance that the value of undiscovered resources is negligible due to the fact that these types of deposits have large gross in-place values but occur with a low probability.

Table 14. Estimated numbers of undiscovered deposits in the Mount Stirling wilderness study area, Nevada.

Deposit name	Model No.	Deposit Probability Levels				
		.9	.5	.1	.05	.01
Carbonate-hosted Au-Ag	26a	0	0	0	0	1

Table 15. Estimated metal endowments in undiscovered Carbonate-hosted Au-Ag deposits in the Mount Stirling wilderness study area, Nevada.

(in thousand metric tons)

Metal	Endowment Values					Mean Endowment
	90%	50%	10%	5%	1%	
Au	0	0	0	0	.028	.0026
Ag	0	0	0	0	0.014	.00002

Table 16. Estimated gross in-place value in undiscovered Carbonate-hosted Au-Ag deposits in the Mount Stirling wilderness study area, Nevada.

(in millions of dollars)

Metal	Gross in-Place Value					Mean Value
	90%	50%	10%	5%	1%	
Au	0	0	0	0	343	32
Ag	0	0	0	0	2	0

Mormon Mountains Wilderness Study Area, Nevada

The assessment team, D. R. Shawe, D. P. Cox, S. D. Ludington, D. A. Singer, and G. T. Spanski, identified six deposit types for which numbers of

deposits could justifiably be estimated. The deposit types include Comstock epithermal veins (model 25c), polymetallic replacement deposits (model 19a), sediment-hosted Au-Ag (model 26a), porphyry Cu (model 17), porphyry Mo low-F (model 21b), and distal disseminated Ag-Au (model 19c). Although additional deposit types were considered, reliable grade and/or tonnage models either were lacking or else the field data were judged to be inadequate for purposes of making a quantitative assessment. Had such information been available, the assessment may have indicated the likelihood of additional undiscovered types of deposits. Table 17 contains the results of the estimation phase of the assessment.

Table 17. Estimated numbers of Undiscovered Deposits in Mormon Mountains wilderness study area, Nevada.

Deposit Name	Model No.	Deposit Probability Levels .9	.5	.1	.05	.01
Comstock epithermal veins	25c	0	0	0	1	2
Polymetallic replacement	19a	0	0	1	1	2
Sediment-hosted Au-Ag	26a	0	0	1	3	5
Porphyry Cu	17	0	0	0	0	1
Porphyry Mo, low-F	21b	0	0	0	0	2
Distal disseminated Ag-Au	19c	0	0	1	1	2

The low estimates reflected in these numbers is attributable in large part to the lack of strong supporting evidence for the existence of one or more deep seated plutons. Acquisition of more direct evidence confirming their existence would result in a shift of values in Table 17 to the left. For the Mormon Mountains area, the sediment-hosted Au-Ag and distal disseminated Ag-Au deposit types are permissive and their expectation for existence is based on similar evidences and should a sediment-hosted Au-Ag deposit be found, it would greatly reduce the probability for the existence of a deposit of the other and vice versa. It is, therefore, inappropriate to sum values for deposit types where this interdependence exists. Estimated endowments for the six deposit types possibly present in the Mormon Mountains Wilderness Study Area are given in Tables 18 to 23.

Table 18. **Endowments in Comstock epithermal vein deposits in Mormon Mountains wilderness study area, Nevada.**
(in thousand metric tons)

	Endowment Values					Mean
Metal	90%	50%	10%	5%	1%	Endowment
Au	0	0	0	.006	.06	.003
Ag	0	0	0	.085	3.6	.18

Table 19. **Endowments in polymetallic replacement deposits in Mormon Mountains wilderness study area, Nevada.**
(in thousand metric tons)

	Endowment Values					Mean
Metal	90%	50%	10%	5%	1%	Endowment
Cu	0	0	5.3	19	540	4.7
Au	0	0	.001	.005	.034	.002
Zn	0	0	210	580	2,200	110
Ag	0	0	.59	2	9.3	.41
Pb	0	0	210	540	2,200	110

Table 20. **Endowments in (carbonate) sediment-hosted Au-Ag deposits in Mormon Mountains wilderness study area, Nevada (in thousand metric tons)**

	Endowments					Mean
Metal	90%	50%	10%	5%	1%	Endowment
Au	0	0	.036	.084	.29	.016
Ag	0	0	0	.032	.9	.025

Table 21. **Endowments in distal disseminated Ag-Au deposits in Mormon Mountains wilderness study area, Nevada. (in thousand metric tons)**

	Endowment Values					Mean
Metal	90%	50%	10%	5%	1%	Endowment
Au	0	0	.01	.035	.13	.006
Ag	0	0	1.7	3.8	9.2	.58

Table 22. **Endowments in porphyry Cu deposits in Mormon Mountains wilderness study area, Nevada. (in thousand metric tons)**

	Endowment Values					Mean
Metal	90%	50%	10%	5%	1%	Endowment
Cu	0	0	0	0	1,400	89
Mo	0	0	0	0	2.2	2.6
Au	0	0	0	0	.008	.0008
Ag	0	0	0	0	.11	.021

Table 23. Endowments in porphyry Mo, low-F deposits in Mormon Mountains wilderness study area, Nevada. (in thousand metric tons)

	Endowment Values					Mean
Metal	90%	50%	10%	5%	1%	Endowment
Mo	0	0	0	0	360	12

The estimated metal endowments associated with the six mineral deposit types assessed in this study are generally small. Totals are given in Table 24 and 25. Two totals are presented to acknowledge the earlier cited interdependence that exists between the sediment-hosted Au-Ag deposit type and the distal disseminated Ag-Au deposit type. Although the presence of one would not absolutely rule out the possible occurrence of the other, the probability of its occurrence would decline significantly. Thus, totals are presented for two suites of five deposits each. It is to be assumed that the totals for Au and Ag are underestimated to a slight degree.

Table 24. Estimated metal endowments for deposit models 25c, 19a, 21b, 17 and 26a in Mormon Mountains wilderness study area, Nevada. (in thousand metric tons of metal)

	Endowment Values					Mean
Metal	90%	50%	10%	5%	1%	Endowment
Cu	0	0	10	55	1,800	112
Ag	0	0	1.1	2.8	14	.65
Au	0	0	.054	.10	.35	.021
Pb	0	0	205	540	2,240	110
Zn	0	0	214	580	2,260	112
Mo	0	0	0	18	380	11

Table 25. **Estimated metal endowments for deposit models 25c, 19a, 21b, 17 and 19c in Mormon Mountains wilderness study area, Nevada. (in thousand metric tons of metal)**

Metal	Endowment Values					Mean Endowment
	90%	50%	10%	5%	1%	
Cu	0	0	10	55	1,800	112
Ag	0	.006	3.5	9.4	17	1.2
Au	0	0	.03	.07	2	.012
Pb	0	0	205	540	2,240	110
Zn	0	0	214	580	2,260	112
Mo	0	0	0	18	380	11

Tables 26 and 27 present the gross in-place values of the two groups of deposit types that may occur within the Mormon Mountains Wilderness. The mean gross in-place values of the two scenarios are 940 million and 970 million dollars, respectively. For both scenarios there is a significant chance that the gross in-place values are negligible because although the deposits postulated are large they are only given low probabilities of occurring.

Table 26. **Estimated gross in-place value for deposit models 25c, 19a, 21b, 17 and 26a in Mormon Mountains wilderness study area, Nevada. (in millions of dollars)**

Metal	Gross in-Place Value					Mean Value
	90%	50%	10%	5%	1%	
Cu	0	0	26	143	4,680	291
Ag	0	0	142	362	1,809	84
Au	0	0	661	1224	4283	257
Pb	0	0	181	476	1,976	97
Zn	0	0	331	896	3,492	173
Mo	0	0	0	119	2,522	73

Table 27. **Estimated gross in-place value for deposit models 25c, 19a, 21b, 17 and 19c in Mormon Mountains wilderness study area, Nevada. (in millions of dollars)**

Metal	Gross in-Place Value					Mean Value
	90%	50%	10%	5%	1%	
Cu	0	0	26	143	4,680	291
Ag	0	1	452	1,215	2,197	155
Au	0	0	367	857	2,448	147
Pb	0	0	181	476	1,976	97
Zn	0	0	331	896	3,492	173
Mo	0	0	0	119	2,522	73

Roberts Wilderness Study Area, Nevada

The Roberts Wilderness Study Area is thought to contain undiscovered Carbonate-hosted Au-Ag (26a) deposits similar to the Carlin deposit. Table 28 presents the estimated number of such deposits thought by the assessment team of E. H. McKee, W. C. Bagby, D. P. Cox, M. F. Diggles, L. J. Drew, W. D. Menzie, D. A. Singer, and G. T. Spanski to occur within the area. Industry has conducted extensive exploration adjacent to the wilderness study area and the assessment team believes the area has a very high probability of containing one undiscovered Carbonate-hosted Au-Ag deposit. The team believes there is some probability that the area contains two such deposits. Table 29 presents the estimated metal endowments for the area, and table 30 presents the estimated gross in-place values for the area. The mean gross in-place value is 860 million dollars.

Table 28. Estimated numbers of undiscovered deposits in the Roberts wilderness study area, Nevada.

		Deposit Probability Levels				
Deposit name	Model No.	.9	.5	.1	.05	.01
Carbonate-hosted Au-Ag	26a	1	1	1	2	2

Table 29. Estimated metal endowments in undiscovered Carbonate-hosted Au-Ag deposits in the Roberts wilderness study area, Nevada. (in thousand metric tons)

	Endowment Values					Mean
Metal	90%	50%	10%	5%	1%	Endowment
Au	.001	.013	.12	.29	1	.007
Ag	0	0	0	.004	.015	.0006

Table 30. Estimated gross in-place value for undiscovered Carbonate-hosted Au-Ag deposits in the Roberts wilderness study area, Nevada. (in millions of dollars)

Metal	Gross in-Place Value					Mean Value
	90%	50%	10%	5%	1%	
Au	12	159	1469	3549	12,238	857
Ag	0	0	0	1	2	.08

Silver Peak Range Wilderness Study Area, Nevada

The Silver Peak Range Wilderness Study Area is thought to contain undiscovered Comstock epithermal vein (25c) deposits. Table 31 presents the number of such deposits the assessment team of W. C. Bagby, D. P. Cox, M. F. Diggles, L. J. Drew, E. H. McKee, W. D. Menzie, D. A. Singer, and G. T. Spanski estimated to occur in the area. Based upon discussions with W. J. Keith, the assessment team concluded there is a good chance that the area contains one undiscovered Comstock epithermal vein deposit, and some chance that it contains two such deposits. Comstock epithermal vein deposits are characterized by their relatively high gold grades (average Au grade of 7.5 grams per tonne). Table 32 presents the estimated metal endowments, and table 33 presents the estimated gross in-place values for the area. The mean gross in-place value estimated is 410 million dollars.

Table 31. Estimated numbers of undiscovered deposits in the Silver Peak Range wilderness study area, Nevada.

Deposit name	Model No.	Deposit Probability Levels				
		.9	.5	.1	.05	.01
Comstock epithermal vein	25c	0	1	1	2	2

Table 32. **Estimated metal endowments in undiscovered Comstock epithermal vein deposits in the Silver Peak Range wilderness study area, Nevada.**
(in thousand metric tons)

Metal	Endowment Values					Mean Endowment
	90%	50%	10%	5%	1%	
Au	0	.0027	.042	.092	.3	.02
Ag	0	.025	2.1	5.7	26	1.3

Table 33. **Estimated gross in-place value in undiscovered Comstock epithermal vein deposits in the Silver Peak Range wilderness study area, Nevada.**
(in millions of dollars)

Metal	Gross in-Place Value					Mean Value
	90%	50%	10%	5%	1%	
Au	0	33	514	1,126	3,671	245
Ag	0	3	271	737	3,360	168

Weepah Springs Wilderness Study Area, Nevada

The Weepah Springs Wilderness Study Area may contain undiscovered Carbonate-hosted Au-Ag (26a) deposits. The assessment team of E. A. du Bray, W. C. Bagby, D. P. Cox, M. F. Diggles, L. J. Drew, W. D. Menzie, D. A. Singer, and G. T. Spanski estimated the number of such deposits thought to occur in the area as shown in Table 34. The team concluded there is some chance that the area contains one Carbonate-hosted Au-Ag deposit and a slight chance the area contains two such deposits. Table 35 presents the metal endowments estimated to occur in these deposits Table 36 presents the gross in-place value of these deposits. The mean gross in-place value is estimated to be 94 million dollars, but because the deposits are estimated to occur with a low probability, there is a significant chance that the gross in-place value is negligible.

Table 34. Estimated numbers of undiscovered Carbonate-hosted Au-Ag deposits in the Weepah Springs wilderness study area, Nevada.

		Deposit Probability Levels				
Deposit name	Model No.	.9	.5	.1	.05	.01
Carbonate-hosted Au-Ag	26a	0	0	0	1	2

Table 35. Estimated metal endowments in undiscovered Carbonate-hosted Au-Ag deposits in the Weepah Springs wilderness study area, Nevada.

(in thousand metric tons)

	Endowment Values					Mean
Metal	90%	50%	10%	5%	1%	Endowment
Au	0	0	0	.015	.12	.0077
Ag	0	0	0	0	.0003	.00007

Table 36. **Estimated gross in-place value in undiscovered Carbonate-hosted Au-Ag deposits in the Weepah Springs wilderness study area, Nevada.**

(in millions of dollars)

Metal	Gross in-Place Value					Mean Value
	90%	50%	10%	5%	1%	
Au	0	0	0	184	1,469	94
Ag	0	0	0	0	0	.01

Blue Canyon and Owyhee Breaks Wilderness Study Areas, Oregon

The assessment team of D. A. Singer, W. C. Bagby, and J. J. Rytuba identified Hot-spring Au-Ag (model 25a) type deposits as being likely to occur within the two wilderness study areas. Table 37 presents the number of undiscovered deposits of this type. There is a good chance for at least one undiscovered Hot-spring Au-Ag type deposit and some chance of as many as two undiscovered deposits. Table 38 presents the amount of gold and silver estimated to be contained in undiscovered deposits. Table 39 presents the gross in-place value of the estimated metal. The estimated mean gross in-place value of the metals in undiscovered deposits is 762 million dollars.

Table 37. **Estimated numbers of undiscovered deposits in Blue Canyon and Owyhee Breaks wilderness study areas, Oregon**

Deposit name	Model No.	Deposit Probability Levels		
		0.9	0.5	0.1
Hot-spring Au-Ag	25a	1	1	2

Table 38. **Estimated metal endowments in Hot-spring Au-Ag deposits in Blue Canyon and Owyhee Breaks wilderness study areas, Oregon (in thousand metric tons)**

Endowment Values	Probability Levels			Mean
Metal	0.9	0.5	0.1	Endowment
Au	.0016	.028	.15	.06
Ag	0	.072	.64	.25

Table 39. **Estimated gross in-place value for Hot-spring Au-Ag (25a) in Blue Canyon and Owyhee Breaks wilderness study areas, Oregon (in millions of dollars)**

	Gross in-Place Value			Mean
Metal	0.9	0.5	0.1	Value
Au	20	343	1,836	734
Ag	0	9	83	32

Notch Peak Wilderness Study Area, Utah

The assessment team of J.M. Hammarstrom, R.B. McCammon, and D.B. Stoeser identified Tungsten skarn (model 14a) type deposits as being likely to occur within this wilderness study area. Table 40 presents the number of undiscovered deposits of this type. There is a good chance for at least one undiscovered Tungsten skarn type deposit and some chance of as many as two undiscovered deposits. Table 41 presents the amount of tungsten (WO_3) estimated to be contained in undiscovered deposits. Table 42 presents the gross in-place value of the estimated tungsten. The estimated mean gross in-place value of tungsten in undiscovered deposits is 220 million dollars.

Table 40. Estimated numbers of undiscovered deposits in Notch Peak wilderness study area, Utah

Deposit name	Model No.	Deposit Probability Levels 0.9	0.5	0.1
Tungsten skarn	14a	1	1	2

Table 41. Estimated metal endowments in Notch Peak wilderness study area, Utah
(in thousands metric tons)

Metal	Probability Levels 0.9	0.5	0.1	Mean Endowment
WO_3	.07	8.8	130	44

Table 42. Estimated gross in-place value for Tungsten skarn (14a) in Notch Peak wilderness study area, Utah
(in millions of dollars)

Metal	Gross in-Place Value 0.9	0.5	0.1	Mean Value
WO_3	0	44	655	220

Fish Springs Range Wilderness Study Area, Utah

The assessment team of D. A. Lindsey and W. D. Menzie identified Polymetallic replacement (model 19a) and Sediment-hosted Au (model 26a.1) deposit types as being likely to occur within this wilderness study area. Table 43 presents the number of undiscovered deposits of each type. There is a slight chance of one Polymetallic replacement type deposit and a moderate chance of at least one Sediment-hosted Au type deposit and a slight chance of as many as two Sediment-hosted Au type deposits. Table 44 presents the amount of gold, silver, copper, lead, and zinc estimated to occur in undiscovered Polymetallic replacement type deposits. Table 45 presents the

amount of gold and silver estimated to occur in undiscovered Sediment-hosted Au type deposits. Table 46 presents the amount of gold, silver, copper, lead, and zinc estimated to occur in undiscovered Polymetallic replacement and Sediment-hosted Au type deposits. Table 47 presents the gross in-place value of the estimated metal. The estimated mean gross in-place value of the metals in undiscovered deposits is 730 million dollars.

Table 43. Estimated numbers of undiscovered deposits in Fish Springs Range wilderness study area, Utah

Deposit name	Model No.	Deposit Probability Levels				
		0.9	0.5	0.1	.05	.01
Polymetallic replacement	19a	0	0	0	1	2
Sediment-hosted Au	26a.1	0	1	1	2	2

Table 44. Estimated metal endowments in Polymetallic replacement deposits in Fish Springs Range wilderness study area, Utah (in thousand metric tons)

Metal	Probability Levels					Mean Endowment
	0.9	0.5	0.1	.05	.01	
Au	0	0	0	.0002	.009	0.0004
Ag	0	0	0	.27	3.6	.150
Cu	0	0	0	.94	40	1.8
Pb	0	0	0	98	900	36
Zn	0	0	0	73	1,100	40

Table 45. Estimated metal endowments in Sediment-hosted Au deposits in Fish Springs Range wilderness study area, Utah (in thousand metric tons)

Metal	Probability Levels					Mean Endowment
	0.9	0.5	0.1	.05	.01	
Au	0	.0064	.087	.2	.950	.049
Ag	0	0	0	.002	.012	.0004

Table 46. **Estimated metal endowments in Polymetallic replacement and Sediment-hosted Au deposits in Fish Springs Range wilderness study area, Utah**
(in thousand metric tons)

Metal	Probability Levels 0.9	0.5	0.1	.05	.01	Mean Endowment
Au	0	.007	.088	.2	.95	.05
Ag	0	0	0.004	.27	3.6	.150
Cu	0	0	0	.94	40	1.8
Pb	0	0	0	98	900	36
Zn	0	0	0	73	1,100	40

Table 47. **Estimated gross in-place value for Polymetallic replacement (19a) and Sediment-hosted Au (26a.1) deposits in Fish Springs Range wilderness study area, Utah**
(in millions of dollars)

Metal	Gross in-Place Value 0.9	0.5	0.1	.05	.01	Mean Value
Au	0	86	1,077	2,448	11,626	612
Ag	0	0	1	35	465	19
Cu	0	0	0	2.4	10.4	4.7
Pb	0	0	0	86	794	32
Zn	0	0	0	113	1,700	62

Summary of Mineral Resource Assessments

Table 48 presents the mean gross in-place value of each of the nine wilderness study areas. The Redcloud and Handies Peak area has the highest mean gross in-place value at 4.9 billion dollars. The Mormon Mountains has the second highest value at either 940 or 970 million dollars. The Roberts area has the third highest mean gross in-place value at 860 million dollars, followed by Blue Canyon and Owyhee Breaks (730 million dollars), Fish Springs Range (718 million dollars), Silver Peak (410 million dollars), Clan Alpine (350 million dollars), Notch Peak (220 million dollars), Fandango (110 million dollars), Weepah (94 million dollars), and Mount Stirling (32 million

dollars). In addition to the mean gross in-place values, it is important also to note the variability of the estimated values. The Clan Alpine, Mormon Mountains, Mount Stirling, and Weepah study areas all have significant chances of containing negligible undiscovered resources.

In interpreting the results, consideration should also be given to the type of deposit that is likely to occur within the study areas. Of the deposit types considered in this assessment, Carbonate-hosted Au-Ag, Climax Mo, Comstock epithermal vein, Creede epithermal vein, Distal disseminated Ag-Au, Polymetallic replacement, and Porphyry Cu type deposits are the most likely exploration targets because of their grade and tonnage characteristics.

Table 48. Summary table of gross in-place values for the Redcloud and Handies Peak, CO; Clan Alpine, NV; Fandango, NV; Mormon Mountains, NV; Mount Stirling, NV; Roberts, NV; Silver Peak, NV, and Weepah, NV wilderness study areas.

Wilderness Study Area	State	Estimated Value (millions of dollars)
Redcloud & Handies Peak	Colorado	4,900
Clan Alpine	Nevada	350*
Fandango	Nevada	110
Mormon Mountains	Nevada	940/970*
Mount Stirling	Nevada	32*
Roberts	Nevada	860
Silver Peak	Nevada	410
Weepah	Nevada	94*
Blue Canyon & Owyhee Breaks	Oregon	760
Notch Peak	Utah	220
Fish Springs Range	Utah	730

*Areas with a significant chance of a negligible gross in-place value.

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QUANTITATIVE OIL AND GAS ASSESSMENTS

Methodology

An evaluation of the potential for undiscovered resources of conventionally recoverable oil and gas in the Desolation Canyon, Coal Canyon, Spruce Canyon, and Flume Canyon Wilderness Study Areas, Utah was performed by Tom Fouch, geologist and Bob Crovelli, mathematician-statistician. Bob Crovelli is responsible for the methodology used in generating numerical estimates for the National Oil and Gas Assessment (Mast and others, 1989) and Tom Fouch has had extensive experience both within the USGS and previously with Shell Exploration in the Uinta Basin.

Because seismic and geochemical data necessary for a full prospect analysis are lacking, the assessment of the four wilderness study areas is based upon an allocation of resources from appropriate plays analyzed during the National Assessment. In many cases, the study areas contained less than one percent of the resources of the play, thus being at the very limits of the data available and the methodology employed (Mast and others, 1990).

Below is a table that includes the estimates for the individual Wilderness Study Areas (WSA) as well as the estimates for larger regions with which these estimates may be compared. The results are expressed as a range of possible resources, so as to emphasize the uncertainties inherent in such estimates. There is a low confidence in the results and we believe the less precise numbers listed in the table under "recommended results" better represent our view of the resources, given the limited data available for these small tracts of land. The potential for undiscovered conventional oil and gas resources are largest in the Desolation Canyon WSA. Resources in Flume Canyon WSA and Coal Canyon WSA are small and in Spruce Canyon WSA are negligible. When compared to undiscovered resources in the province or the region in which these WSA's lie (Figures B1 and B2A), the resources in the four wilderness study areas are very small. Desolation Canyon WSA, the most prospective of the four areas, contains only 3.4 percent of the gas resources and 2.3 percent of the oil resources estimated for federal lands in the Uinta-Piceance and Paradox basins.

Desolation Canyon, Coal Canyon, Spruce Canyon, and Flume Canyon Wilderness Study Areas, Utah

Table 49. Undiscovered recoverable conventional oil and gas resources

	Oil (Millions of Barrels)			Total Gas (Billions of Cubic Feet)		
	F95	F5	Mean	F95	F5	Mean
BLM Wilderness Study Areas in Utah (Uinta-Piceance and Paradox Basin Provinces)						
Calculated Resources						
Desolation Canyon	0.670	23.738	6.684	11.495	165.411	52.072
Coal Canyon	0.049	0.083	0.061	0.940	5.812	2.185
Spruce Canyon	0.012	0.020	0.014	0.503	0.905	0.651
Flume Canyon	0.013	0.022	0.016	0.528	7.495	2.305
Recommended Results						
Desolation Canyon	Negl.	30	5	Negl.	200	50
Coal Canyon	Negl.	Negl.	Negl.	Negl.	10	2
Spruce Canyon	Negl.	Negl.	Negl.	Negl.	Negl.	Negl.
Flume Canyon	Negl.	Negl.	Negl.	Negl.	10	2
Provinces						
All Lands						
Uinta-Piceance	37	551	199	1112	3761	2190
Paradox Basin	8	718	194	35	1264	382
Federal Lands						
Uinta-Piceance	10	280	90	680	2480	1400
Paradox	<10	490	130	20	250	90
Region 3						
All lands	482	3384	1523	9596	39278	21280
Federal Lands	230	2230	910	5460	26160	13380
Wilderness Lands	18	4141	22	314	2001	929

Figure B1. **Petroleum Regions Assessed**

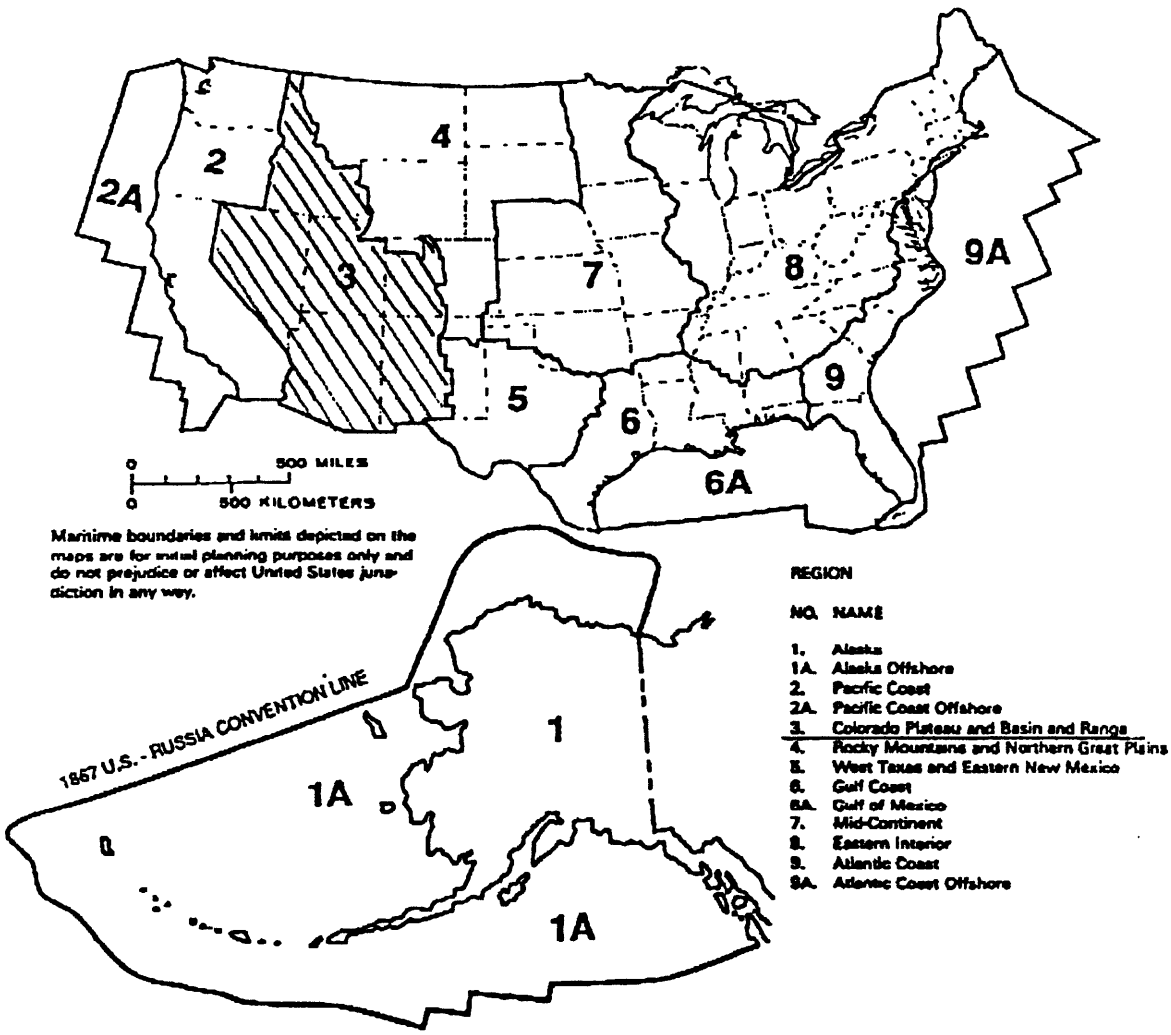
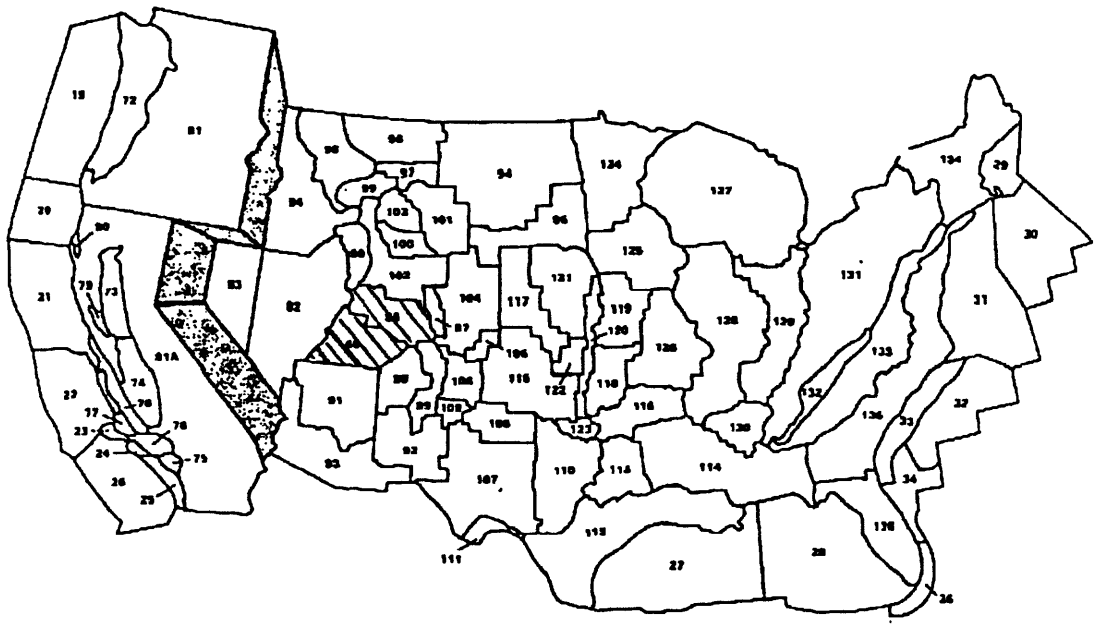


Figure B2A. Index Map of Lower 48 States Showing Provinces Assessed



Province No. 85 - Paradox Basin
Province No. 86 - Uinta-Piceance Basin

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QUANTITATIVE COAL RESOURCE ASSESSMENTS

Methodology

Coal resource tonnage estimates were determined using procedures outlined by Wood and others (1983). Areas within 0.25 mi (measured), 0.25 to 0.75 mi (indicated), and 0.75 to 3 mi (inferred) of a measured section or cored drill hole were delineated and size of the area determined using a planimeter. Areas farther than 3 mi from a measured section or cored drill hole are classified as areas of hypothetical resource; the size of the area determined by grid overlay. Estimates of hypothetical coal resource are based on assumption of continuity of rank, thickness, and extent beyond the inferred. Identified resource includes measured, indicated, and inferred. Potential resource comprises all of the hypothetical coal.

For simplicity, all coal, bony [high mineral matter content] coal, and bone [impure coal] were treated as coal in determining the thickness of coal beds because not all measured sections differentiated between these types. Therefore, some of the coal resources estimated may be too high in ash content to be economically exploited. All coal beds 14 in (inches) thick or greater (less partings) were added together to determine the thickness of coal resources in each zone. A square mile 1 ft thick was assumed to contain 1,152,000 short tons of coal (standard value for bituminous coal).

Desolation Canyon, Coal Canyon, Spruce Canyon, Turtle Canyon and Flume Canyon Wilderness Study Areas, Utah

Table 50. Estimated tonnage and value of coal in five wilderness study areas in Utah

Study Area	Overburden, in feet: 0-3,000 — Demonstrated Reserve base 1) 0-1,000 ft	0-3,000 — Identified Resource 2)	0-3,000 — Potential Resource 3)	0-3,000 — Total	3,000-10,000 — Identified Resource	3,000-10,000 — Potential Resource	3,000-10,000 — Total	Grand Total
	Tonnage (in millions of short tons)							
Desolation Canyon	5	120	223	343	0	224	224	567
Turtle Canyon	0	81	8	89	109	34	143	232
Coal Canyon	22	183	105	288	0	55	55	343
Spruce Canyon	0	0	50	50	0	110	110	160
Flume Canyon	0	0	35	35	0	145	145	180
Total	27	384	421	805	109	568	677	1,482
	Value (at assumed selling price of $20/short ton; in millions of $)							
Desolation Canyon	100	2,400	4,460	6,860	0	4,480	4,480	11,340
Turtle Canyon	0	1,620	160	1,780	2,180	680	2,860	4,640
Coal Canyon	440	3,660	2,100	5,760	0	1,100	1,100	6,860
Spruce Canyon	0	0	1,000	1,000	0	2,200	2,200	3,200
Flume Canyon	0	0	700	700	0	2,900	2,900	3,600
Total	540	7,680	8,420	16,100	2,180	11,360	13,540	29,640

1) Measured and Indicated; coal thickness greater than 42" in Desolation Canyon and greater than 28" in Coal Canyon.

2) Measured, Indicated, and Inferred; all coal thickness greater than 14 in; includes Demonstrated Reserve Base.

3) Estimates are for coal in place. Recoverable coal will be lower.

Table 51. Estimated potential coal resources in five wilderness areas, Utah (coal greater than 14 inches, in millions of short tons)

[lt, less than; gt, greater than]

Study Area	Overburden, in feet					
	0-3,000					
	0-1,000	1,000-2,000	2,000-3,000	Total	Greater than 3,000	Total 0-10,000
Desolation Canyon						
Central part 1)	0	9	16	25	220 3)	245
Southwestern part 1)	65	17	0	82	0	82
Southeastern part 2)	3	80	33	116	4 4)	120
Subtotal	68	106	49	223	224	447
Turtle Canyon 1)	0	0	8	8	34 5)	42
Coal Canyon 2)	0	15	90	105	55 4)	160
Spruce Canyon 2)	0	0	50	50	110 5)	160
Flume Canyon 2)	0	0	35	35	145 5)	180
Total	68	121	232	421	568	989

1) Book Cliffs Coal Field -- one coal zone (Sunnyside); high-volatile bituminous A and B coal; low S; med-high ash; coal thickest NW of Turtle Canyon; splits and becomes thinner to south and east; quality lower to south; active mining 7-10 mi west of Turtle Canyon area; all mines lt 3,000 ft of overburden.

Desolation Canyon, central part: subeconomic; assume coal thins from 4 ft average in west to 0 at Green River in east; coal gt 14 in in 89 sq mi.

Desolation Canyon, southwestern part: estimate made in USGS Bulletin 1753-B.

Turtle Canyon: estimate made in USGS Bulletin 1753-B.

2) Sego Coal Field -- four coal zones; high-volatile bituminous C coal; low S, med-high ash; numerous thin beds with many partings, lenticular; thickest and best quality coal in western part of Coal Canyon area; eastward from Coal Canyon the coal zones contain many thinner splits with much bony coal and bone (high ash); no mining since 1954; all previous mining under lt 2,000 ft of overburden.

Desolation Canyon, southeastern part: subeconomic; assume coal maintains 9-ft average thickness (total of all coal gt 14 in) as Bulletin 1753-B shows for Floy Canyon resource (all within 2 miles), in 12 sq mi.

Coal Canyon: subeconomic; assume coal maintains 8-ft average thickness (total of all coal gt 14 in) as Identified Resources within 2 mi; in 17.5 sq mi.

Spruce Canyon; subeconomic; assume mainly thin, bony, impure coal with 6-ft average (total of all coal gt 14 in), in 23 sq mi.

Flume Canyon: subeconomic; assume mainly thin, bony, impure coal with 6-ft average thickness (total of all coal gt 14 in), in 26 sq mi.

3) to 10,000 ft 4) to 4,000 ft 5) to 5,000 ft

Table 52. Estimated value of potential coal resources in five wilderness areas in Utah (at assumed selling price of $20/short ton 1))

Study Area	Total Coal 2) (million sh tons)	Within Potentially Minable Depth 3) (million sh tons)	Possible Value 4) (million $)
Desolation Canyon			
Central part	245	25	500
Southwestern part	82	82	1,640
Southeastern part	120	116	2,320
Turtle Canyon	42	8	160
Coal Canyon	160	105	2,100
Spruce Canyon	160 5)	50 5)	1,000
Flume Canyon	180 5)	35 5)	700

1) Current contract price of coal immediately west of the Turtle Canyon area is approximately $20/ton. The coal in Turtle Canyon probably maintains the quality of this nearby commercial coal. All other coal in the study areas is of lesser quality (lower heat content, higher ash, more impurities, etc.) and therefore would command a lesser price.

   At the estimated current maximum potential selling price of $20/ton, the cost of producing all but possibly the Turtle Canyon coal would undoubtedly exceed the potential sales price.

2) All coal to 10,000 ft of overburden.

3) Overburden less than (lt) 3,000 ft.

   Deepest mining that has occurred in the vicinity of the Five Wilderness Areas:

   Overburden lt 3,000 ft: Desolation Canyon, central and southwestern parts; Turtle Canyon (Book Cliffs Coal Field)

   Overburden lt 2,000 ft: Desolation Canyon, southeastern part; Coal Canyon; Spruce Canyon; Flume Canyon (Sego Coal Field).

4) Estimated for the coal within potentially minable depth (lt 3,000 ft of overburden). Approximately 50% of the coal in-place could be recovered. Consequently, only one-half of values in this column could potentially be attained.

5) Probably thin, impure coal, bony coal, and bone; lenticular beds with no one bench exceeding 2 ft in thickness.

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