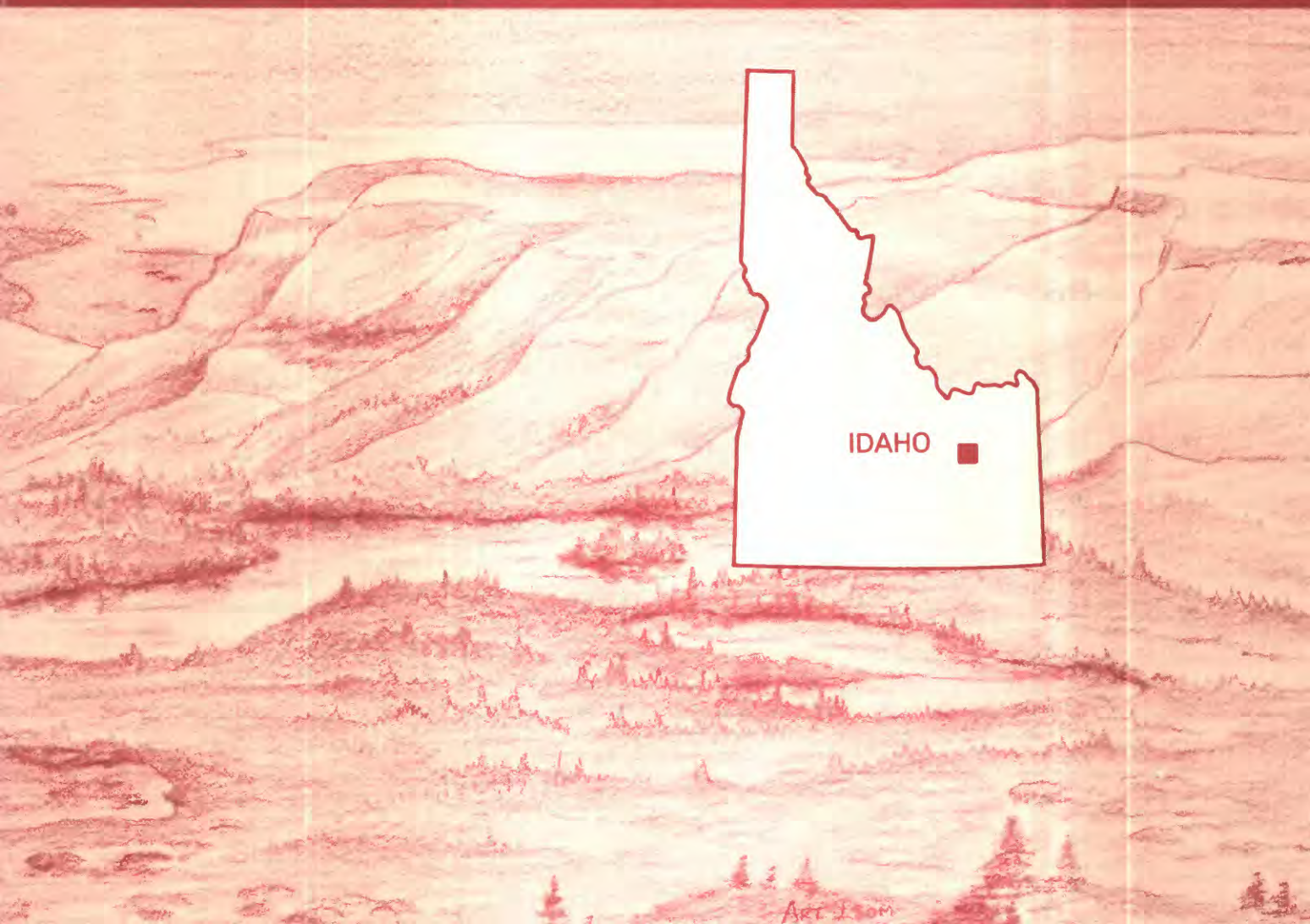
Mineral Resources of the Hell's Half Acre Wilderness Study Area, Bingham and Bonneville Counties, Idaho

U.S. GEOLOGICAL SURVEY BULLETIN 1718–A



DEFINITION OF LEVELS OF MINERAL RESOURCE POTENTIAL AND CERTAINTY OF ASSESSMENT

Definitions of Mineral Resource Potential

LOW mineral resource potential is assigned to areas where geologic, geochemical, and geophysical characteristics define a geologic environment in which the existence of resources is unlikely. This broad category embraces areas with dispersed but insignificantly mineralized rock as well as areas with few or no indications of having been mineralized.

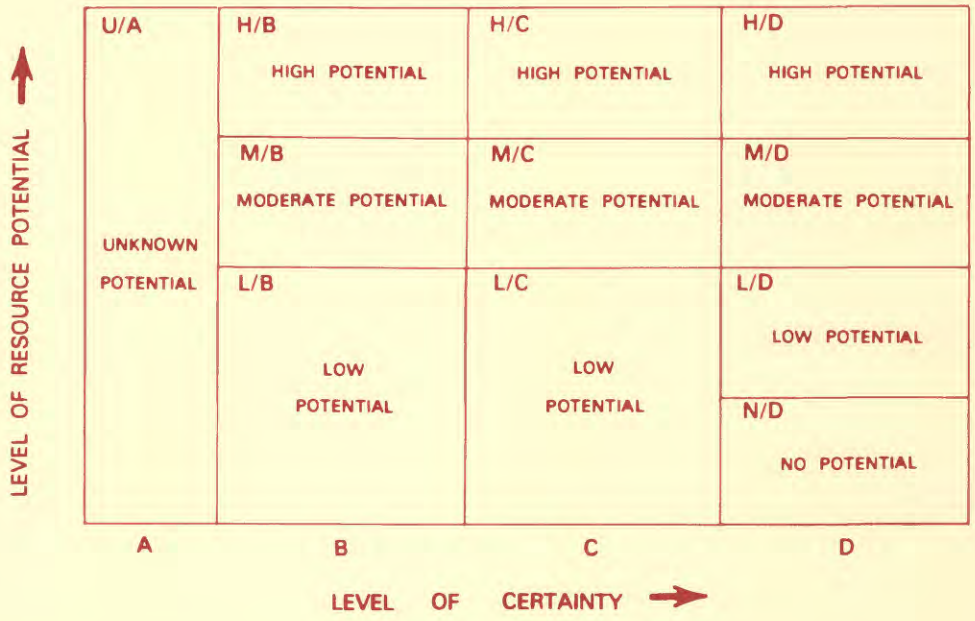
MODERATE mineral resource potential is assigned to areas where geologic, geochemical, and geophysical characteristics indicate a geologic environment favorable for resource occurrence, where interpretations of data indicate a reasonable likelihood of resource accumulation, and (or) where an application of mineral-deposit models indicates favorable ground for the specified type(s) of deposits.

HIGH mineral resource potential is assigned to areas where geologic, geochemical, and geophysical characteristics indicate a geologic environment favorable for resource occurrence, where interpretations of data indicate a high degree of likelihood for resource accumulation, where data support mineral-deposit models indicating presence of resources, and where evidence indicates that mineral concentration has taken place. Assignment of high resource potential to an area requires some positive knowledge that mineral-forming processes have been active in at least part of the area.

UNKNOWN mineral resource potential is assigned to areas where information is inadequate to assign low, moderate, or high levels of resource potential.

NO mineral resource potential is a category reserved for a specific type of resource in a well-defined area.

Levels of Certainty



A. Available information is not adequate for determination of the level of mineral resource potential.
B. Available information suggests the level of mineral resource potential.
C. Available information gives a good indication of the level of mineral resource potential.
D. Available information clearly defines the level of mineral resource potential.

Abstracted with minor modifications from:

Taylor, R. B., and Steven, T. A., 1983, Definition of mineral resource potential: Economic Geology, v. 78, no. 6, p. 1268–1270.

Taylor, R. B., Stoneman, R. J., and Marsh, S. P., 1984, An assessment of the mineral resource potential of the San Isabel National Forest, south-central Colorado: U.S. Geological Survey Bulletin 1638, p. 40–42.

Goudarzi, G. H., compiler, 1984, Guide to preparation of mineral survey reports on public lands: U.S. Geological Survey Open-File Report 84–0787, p. 7, 8.

Chapter A

Mineral Resources of the Hell's Half Acre Wilderness Study Area, Bingham and Bonneville Counties, Idaho

By MARGO I. TOTH and RONNY A. MARTIN
U.S. Geological Survey

PHILLIP R. MOYLE and RICHARD A. WINTERS
U.S. Bureau of Mines

U.S. GEOLOGICAL SURVEY BULLETIN 1718

MINERAL RESOURCES OF WILDERNESS STUDY AREAS—
SOUTHEASTERN IDAHO

DEPARTMENT OF THE INTERIOR
DONALD PAUL HODEL, Secretary

U.S. GEOLOGICAL SURVEY
Dallas L. Peck, Director

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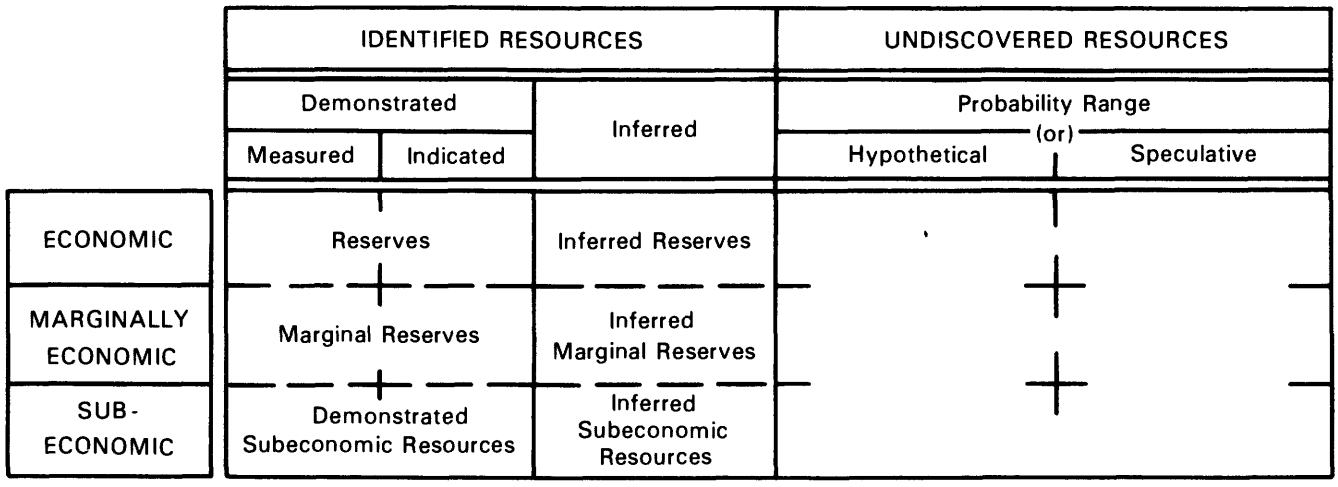
STUDIES RELATED TO WILDERNESS

Bureau of Land Management Wilderness Study Areas

The Federal Land Policy and Management Act (Public Law 94-579, October 21, 1976) requires the U.S. Geological Survey and the U.S. Bureau of Mines to conduct mineral surveys on certain areas to determine the mineral values, if any, that may be present. Results must be made available to the public and be submitted to the President and the Congress. This report presents the results of a mineral survey of the Hell's Half Acre (ID-33-15) Wilderness Study Area, Bingham and Bonneville Counties, Idaho.

RESOURCE / RESERVE CLASSIFICATION



Major elements of mineral resource classification, excluding reserve base and inferred reserve base. Modified from U. S. Bureau of Mines and U. S. Geological Survey, 1980, Principles of a resource/reserve classification for minerals: U. S. Geological Survey Circular 831, p. 5.

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Mineral Resources of the Hell's Half Acre Wilderness Study Area, Bingham and Bonneville Counties, Idaho

By Margo I. Toth *and* Ronny A. Martin,
U.S. Geological Survey, *and*
Phillip R. Moyle *and*
Richard A. Winters,
U.S. Bureau of Mines

SUMMARY

The Hell's Half Acre Wilderness Study Area (ID–33–15) covers about 66,200 acres of very young basalt of the Snake River Group in Bingham and Bonneville Counties, southeastern Idaho, and lies 6 mi (miles) west of Idaho Falls. A joint mineral resource appraisal study of the wilderness study area was done in the summer months of 1984 by the U.S. Geological Survey and U.S. Bureau of Mines. The appraisal showed that the study area has identified resources of decorative stone (fig. 1). The mineral resource potential for metals, oil and gas, coal, and geothermal energy is low.

The wilderness study area is on the eastern edge of the Snake River Plain physiographic province, a broad, arcuate volcanic rock-filled depression containing basaltic lava flows as much as 6,000 ft (feet) thick. The study area encompasses more than half of the area of the Hell's Half Acre lava field, whose lavas were erupted about 4,100±200 years ago (Karlo, 1977a). The study area is characterized by a flat moonscape terrain with fissures, caves, ridges, depressions, and sparse vegetation. The basalts of the lava field are gray to black and unweathered, and contain phenocrysts of olivine and plagioclase. Chemically, they are typical of the Snake River Group, characterized by low SiO_2, high total iron, and low total alkali elements. A small calderalike crater in the northwestern part of the study area was the source of the basaltic eruptions. Basalts adjacent to the study area are from 780 to 1,130 ft thick.

The only mineralized rock in the study area contains sulfate minerals associated with the central vent of the Hell's Half Acre lava field. Thenardite, gypsum, and bloedite were identified as fumarolic crusts along fractures and as powdery deposits which fill cavities between flow units in the walls of the vent. None of the sulfates showed any enrichment in gold, arsenic, mercury, or antimony. Analysis of 10 typical samples of basalt showed no anomalous concentrations of any elements which might be associated with mineralization.

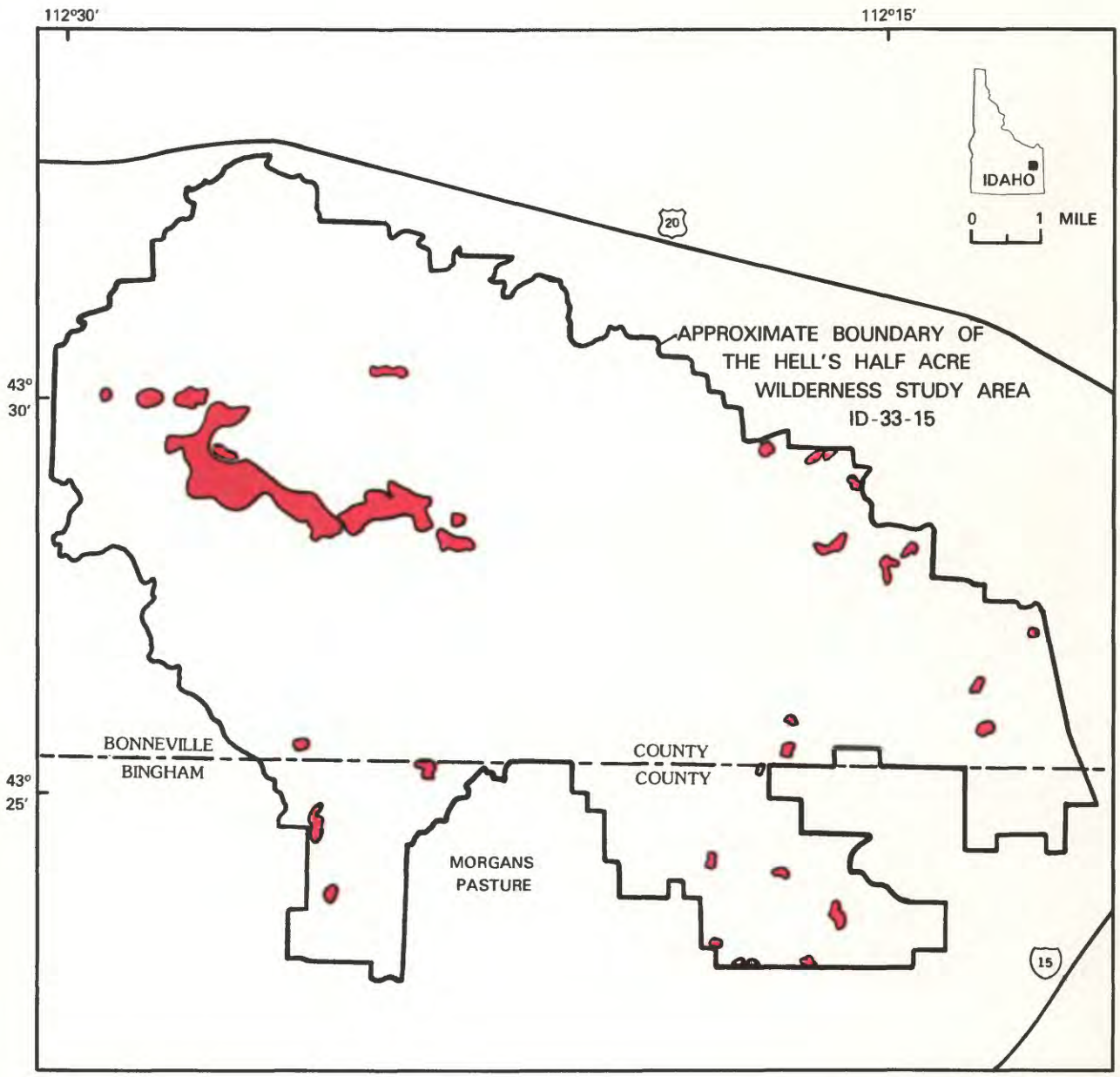
The wilderness study area contains 43,000 tons of indicated reserves and 106,000 tons of indicated and inferred, subeconomic resources of slab pahoehoe suitable for use as a decorative veneer. The lavas of the Hell's Half Acre Wilderness Study Area have a moderate likelihood of development for decorative stone. Most areas which contain suitable stone lie near the edge of the lava field, and minimal road construction would be required for access.

INTRODUCTION

The Hell's Half Acre Wilderness Study Area (ID–33–15) in Bingham and Bonneville Counties, Idaho (fig. 2), comprises 66,200 acres covered by very young basalt. The eastern border of the study area lies about 6 mi west of Idaho Falls, and the southern border lies about 10 mi north of Blackfoot. U.S. Highway 20 roughly parallels the study area on the north, and U.S. Highway 26–Interstate 15 approaches the study area on the east. Access to the southern part of the study area is by dirt roads which lead to Morgans Pasture. Most of the study area is inaccessible by vehicle due to the rough surface of the young basalt flows. However, secondary and unimproved roads provide access to most of the wilderness area boundary.

The Hell's Half Acre Wilderness Study Area is characterized by a flat, moonscape terrain marked by crevices, fissures, caves, ridges, depressions, and very sparse vegetation. Topographic relief ranges from a low of 4,690 ft along the southern margin, to 5,351 ft at the central vent in the northwestern part of the study area. Lichens and mosses grow on the younger lava flows, and diverse plants including juniper trees, sagebrush, and grasses grow on older lava flows, called kipukas. No streams are within the study area, and all precipitation infiltrates directly into the Snake River Plain aquifer 200 to 800 ft below the surface (Mundorff and others, 1964).

The USGS (U.S. Geological Survey) made a mineral resource assessment of the Hell's Half Acre Wilderness Study Area in the summer of 1984. The work consisted of field checking previous mapping by



EXPLANATION

Area of indicated reserves of decorative stone

Figure 1. Map showing mineral resource potential and identified resources in the Hell's Half Acre Wilderness Study Area, Idaho. The study area has low mineral resource potential for metals, oil and gas, coal, and geothermal energy, with certainty level C. Unpatterned areas contain indicated and inferred subeconomic resources of decorative stone.

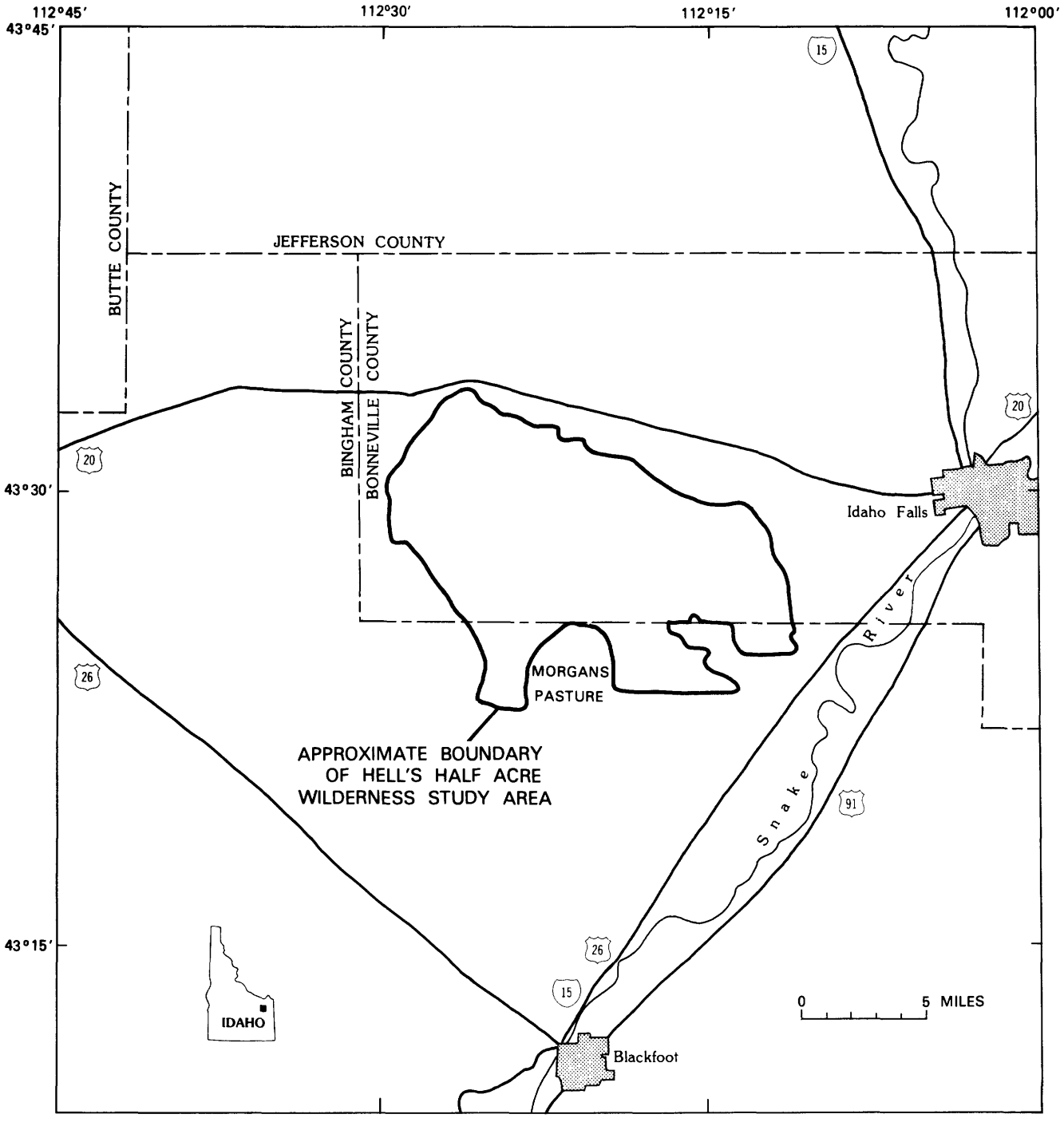


Figure 2. Index map showing the location of the Hell's Half Acre Wilderness Study Area, Bingham and Bonneville Counties, Idaho.

Hotchkiss (1976), Karlo (1977a, b), and Kuntz and others (1979), and reviewing the geology and published geochemistry of the Snake River Plain basalts and the Hell's Half Acre volcanic field, including work in an unpublished report by Fredericksen and Fernette (WGM, Inc., unpub. report, 1983). Mineral resource potential was classified according to the system outlined by Goudarzi (1984) (see inside front cover). A stream-sediment sampling program could not be undertaken because of the absence of any flowing streams and (or) sediment.

The USBM (U.S. Bureau of Mines) conducted a study of the area in 1984 and researched the mining and mineral-exploration history, appraised decorative-stone resources, and searched for mining-related activities within or adjacent to the wilderness study area. Their results are presented here and in a report by Moyle and Winters (1985). Identified resources are classified according to the guidelines presented in U.S. Geological Survey and U.S. Bureau of Mines (1980) (see resource/reserve classification chart on p. IV of this report).

APPRAISAL OF IDENTIFIED RESOURCES

By Phillip R. Moyle and Richard A. Winters, U.S. Bureau of Mines

Mining and Mineral-Exploration History

Basaltic lava rock from the eastern Snake River Plain has been used as dimension stone in this area since the 1880's (Mansfield, 1927) and more lately as decorative stone. The blocky building-stone variety is no longer in vogue. Slabs of pahoehoe lava, found as float in the Hell's Half Acre lava field, have been mined and marketed as decorative stone for more than 15 years, as a result of a strong demand for earth-tone veneers. Mining of float consists of selecting suitable flat material, generally 1 to 3 in. (inches) thick and 8 in. or more in diameter, and loading it onto a truck.

BLM (U.S. Bureau of Land Management) records (Idaho Falls District Office) show sales to the American Stone Co., from 1969 to 1971, of about 1,000 tons from each of two areas just south of the study area in secs. 2, 11, and 32, T. 1 S., R. 35 E. (pl. 1). Royalty (fair market value) to the BLM at that time was $0.15/ton. A three-year competitive sale was made to another party in 1979 for a $28,000 bid. Cumulative sales were 1,176 tons at about $52–$55/ton F.O.B. (free on board) mine or as much as $75/ton F.O.B. stone yard. The sale area included 400 acres in sec. 9, T. 1 S., R. 36 E. (pl. 1). The contract went into default in 1982 with about 20 to 30 tons of 1-6 in.-thick clinker, probably nonmarketable stone left on the pallets in the sale area.

Several unauthorized removals of pahoehoe have been made from the lava field. At least one removal occurred from the study area; most of the marketable stone in a 55-acre area in secs. 19 and 20, T. 2 N., R. 36 E. was mined illegally in the early 1980's. Illegal removal of decorative stone from the lava field amounts to at least several hundred tons (Tim Carroll, BLM staff geologist, oral commun., 1984). Currently, most of the public lands just south of the study area are classified as a common-use area by the BLM to meet persistent local demand for the material.

Mines and Prospects, Mining Claims, and Leases

No mines and prospects, mining claims, or leases occur within the wilderness study area.

Minability of Deposits

Marketing

Slab pahoehoe, similar in all respects to that which occurs in abundance in the study area, is mined in the Idaho Falls-Blackfoot area. It is marketed as a decorative veneer in the Pacific Northwest and competes with other varieties of decorative rock as well as brick and culture (synthetic) stone.

A market survey of stone dealers in Spokane, Wash., and Boise and Idaho Falls, Idaho, in 1984 showed retail prices for decorative stone ranging from a low of $50–$70/ton for locally mined field rubble (field basalt) to about $250/ton for travertine mined in Montana and a variety of slab pahoehoe mined from Black Butte near Shoshone, Idaho. Slab pahoehoe from the Hell's Half Acre lava field retails for $125/ton and competes well with the other stone varieties. Pahoehoe, observed on pallets in stoneyards, is slablike, ranges in thickness from 1 to 3 in., is generally 8 to 12 in. or more in diameter, and commonly has lichen or moss on the weathered surface. The tops of the slabs have a frothy or ropy appearance, whereas the undersides have some drip features and casts of older flows. The unweathered underside of slab pahoehoe is used by some masons for a different decorative appearance. Masons prefer the blunted or squared edges of slab pahoehoe over other feather-edge varieties of stone because of the ease of application. Also, the light weight (low apparent density due to numerous vesicles or gas cavities) eases handling and gives large coverage per ton of stone. According to dealers, 1 ton of slab pahoehoe will generally cover 70 to 120 ft^2 (square feet), depending on thickness, whereas 1 ton of nonvesicular varieties of decorative stone covers only 35 to 50 ft^2. Two dealers stated that slab pahoehoe, sold under the name "Idaho Moss," is the most popular wall and fireplace veneer in the Spokane area. Annual sales in Spokane are about 500 to 1,000 tons per year.

Production Costs

Detailed studies of the Hell's Half Acre lava field, and economic data from historic and current mining operations, were used to determine the minability and production costs of slab pahoehoe from the study area. Mining typically includes only: (1) removal of rock naturally detached from outcrops (float) or which can easily be pried loose with a steel bar, and (2) transportation to a central point. Public lands just south of the study area are currently (1985) open to common-use mining of decorative stone, generally by home owners and other low-volume users. The BLM assesses a royalty of $4/ton. An inventory conducted by Tim Carroll (written commun., 1984) in 1980 determined that marketable slab pahoehoe on the lava field which includes the study area typically ranges from 0 to more than 5 tons/acre, and averages 1 ton/acre. Data from a 1979 competitive stone sale indicated a mining cost of $10–$20/ton, a shipping cost to Spokane of about $20/ton, and a profit of about $20/ton (Tim Carroll, written commun., 1984). By comparison, the 1979–80 mining cost for slab pahoehoe mined from mining claims on Black Butte near Shoshone, Idaho (Maley and Holland, 1981) ranged from $32 to $35/ton with a shipping cost of $4/ton to Boise and $20/ton to Bend, Ore. Occurrence of the marketable Black Butte variety of slab pahoehoe ranges from 0 to 90 tons/acre. Parcels considered depleted by commercial operators still contained from 6 to 16 tons/acre in accessible areas; this amount suggests the lower economic limit for commercial operations.

Mineral Economics

Slab pahoehoe from the study area would have a 1985 retail price of about $125/ton. Production costs would be about $35/ton, and the mine operator would make a profit of $30–$45/ton. The remaining $45–$60/ton value would be divided between shipping costs, estimated to range from $10 to $25/ton depending on the distance to market, and the retailer, who would probably require about $35/ton for handling and profit. The mining cost and profit margin are primarily dependent on the amount of marketable stone present in a given area. The surface area of those parcels considered to be profitable generally contains greater than 20 percent marketable stone or greater than 100 tons/acre. Aa lava fields will probably not attract commercial interest in the foreseeable future, due to difficult access. Most of the remainder of the lava field has a relatively low tonnage of suitable slab pahoehoe per acre and is considered subeconomic for large-volume commercial operations. However, the remainder of the lava field does have value for consumers who gather their own decorative stone to avoid the wholesale and retail markup.

Based upon networks of hand-constructed jeep trails over parts of the Hell's Half Acre lava field, most parts of the study area are assumed to be accessible. With the exception of the vent area in the northwestern part of the study area, most parcels containing suitable stone lie near the edge of the lava field and would require minimal jeep-trail construction.

Reserves and Identified Resources

The mineral survey identified slab pahoehoe suitable for decorative veneer in 46 parcels in 10 clusters (table 1). The slab pahoehoe occurs in high concentrations in solidified lava lakes and squeeze-up areas. Small tonnages also occur in some aa lava fields. Boundaries of the favorable areas were plotted on aerial photographs, traverses were conducted over representative plots to determine the percentage of float suitable as decorative veneer, and samples were taken to determine apparent density. The acreage of each parcel was determined by the computer method of digitizing the area and a tonnage was calculated. Resource calculations consider only the surface layer (1–3 in. thick).

Stone resources in the study area and other pertinent data are shown in table 1. Resource/reserve definitions are contained in U.S. Bureau of Mines and U.S. Geological Survey (1980). The study area contains a total of about 150,000 tons of 1–3 in.-thick slab pahoehoe resources suitable for veneer. Thirty-two parcels of the lava field in the study area contain a total of 43,000 tons of indicated reserves; the marketable stone in these areas ranges from 78 to 370 tons/acre and averages 170 tons/acre. About 46,000 tons of indicated, subeconomic resources of slab pahoehoe occur in the remaining 14 parcels; the marketable stone in these areas ranges from 25 to 87 tons/acre and averages 35 tons/acre.

Based upon BLM data, those parts of the wilderness study area containing slab pahoehoe but not included in the parcels shown on plate 1 or in kipukas are estimated to total about 60,000 acres with an average of 1 ton/acre of slab pahoehoe. A total of 60,000 tons of subeconomic resources are inferred.

ASSESSMENT OF POTENTIAL FOR UNDISCOVERED RESOURCES

By Margo I. Toth and Ronny A. Martin, U.S. Geological Survey

Geology

Geologic Setting

The Hell's Half Acre Wilderness Study Area is on the eastern edge of the Snake River Plain physiographic province, a broad, arcuate, volcanic rock-filled depression covering about 18,000 mi^2 (square miles). The

Table 1. Decorative stone resources in the Hell's Half Acre Wilderness Study Area, Idaho
[From Moyle and Winters, 1985; <, less than; ≥, greater than or equal to; est., estimated]

Site No. (pl. 1)	Area (acres)	Usability factor[1] (percent)	Average thickness (in.)	Apparent density (lb/ft^3)	Resource size[2] (tons)	Frequency factor[3] (tons/acre)	Coverage factor[4] (ft^2/ton)
			INDICATED RESERVES				
2a	7.8	40			1,300	160	
2b	3.9	40	2	109	630	160	110
2c	2.6	90			970	370	
2d	1.5	90	1		260	170	230
Total					3,160		
4a	14				2,000		
4b	2.2				310		
4c	4.7				670		
4d	4.8	30	1-3	129	700	140	91
4e	5.6				810		
4f	1.9				270		
4g	2.4				340		
Total					5,100		
5	3.6	35		127	580	160	93
6a	4.2				480		
6b	4.4	20-25	1-3	139	510	120	85
6c	4.2				480		
Total					1,470		
7a	9.1	10-15			910	100	
7b	9	30			2,100	240	
7c	20	30			4,800	240	
7d	7.5		3	147	900		54
7e	7.9	15			950	120	
7f	7.8				940		
7g	8.5				1,000		
Total					11,600		
9a	8.2	30			1,100	140	
9b	11	10-30	1-3	123	1,000	91	96
9c	3.6	20-25			360	100	
Total					2,460		
10a	20	15			1,600	78	
10b	7.4	30			1,200	160	
10c	3	30			470	160	
10d	11	40	1-3	141	2,300	210	83
10e	20	40			4,300	210	
10f	20	45			4,700	230	
10g	18	45			4,200	230	
Total					18,770		
Total indicated reserves					43,140		

western Snake River Plain is a complex graben, bounded on the north and south by normal faults (Malde and Powers, 1962; Hill and others, 1961), with as much as 9,000 ft of displacement since the early Pliocene (Malde, 1965). The structure of the eastern Snake River Plain, where the study area lies, may reflect downwarping (Kirkham, 1931) or the presence of bounding faults (King, 1977).

The eastern Snake River Plain trends northeastward and is bounded on the north and south by a deformed sequence of sediments showing basin-and-range structures, capped by nonfolded Tertiary volcanic rocks (Karlo, 1977a). Eaton and others (1975) suggested that the eastern Snake River Plain is an extension of the Yellowstone volcanic field. They also suggested that a magma chamber may be present beneath the Yellowstone rhyolite plateau and may have been a source for the volcanism which has migrated northeastward, relative to the axis of the eastern Snake River Plain, over the last 15 m.y. (million years).

Table 1. Continued

INDICATED SUBECONOMIC RESOURCES							
1a	10	<5	2 (est.)	135 (est.)	250	25	87
1b	10				250		
1c	13				320		
Total					820		
3a	15	<5	≥2 (est.)	135 (est.)	380	25	87
3b	59				1,500		
3c	64				1,600		
3d	600				15,000		
3e	170	15-20			14,000	87	
3f	300	5-10			11,000	38	
3g	35	<5			870	25	
3h	14	<5			350	25	
Total					44,700		
8a	6.4	5-10	2-3	138	300	47	69
8b	4.7	5-10			220	47	
8c	5.4	5			170	32	
Total					690		
Total indicated subeconomic resources					46,210		
INFERRED SUBECONOMIC RESOURCES IN WILDERNESS STUDY AREA							
60,000 acres at estimated 1 ton/acre average					60,000		
Total resources in wilderness study area					149,000		

[1]Percentage of loose surface slab pahoehoe suitable as a decorative veneer.
[2]Data may not add to totals shown because of independent rounding.
[3]Tons/acre of slab pahoehoe suitable as a decorative veneer.
[4]Number of square feet of wall that a mason can cover with 1 ton of decorative veneer.

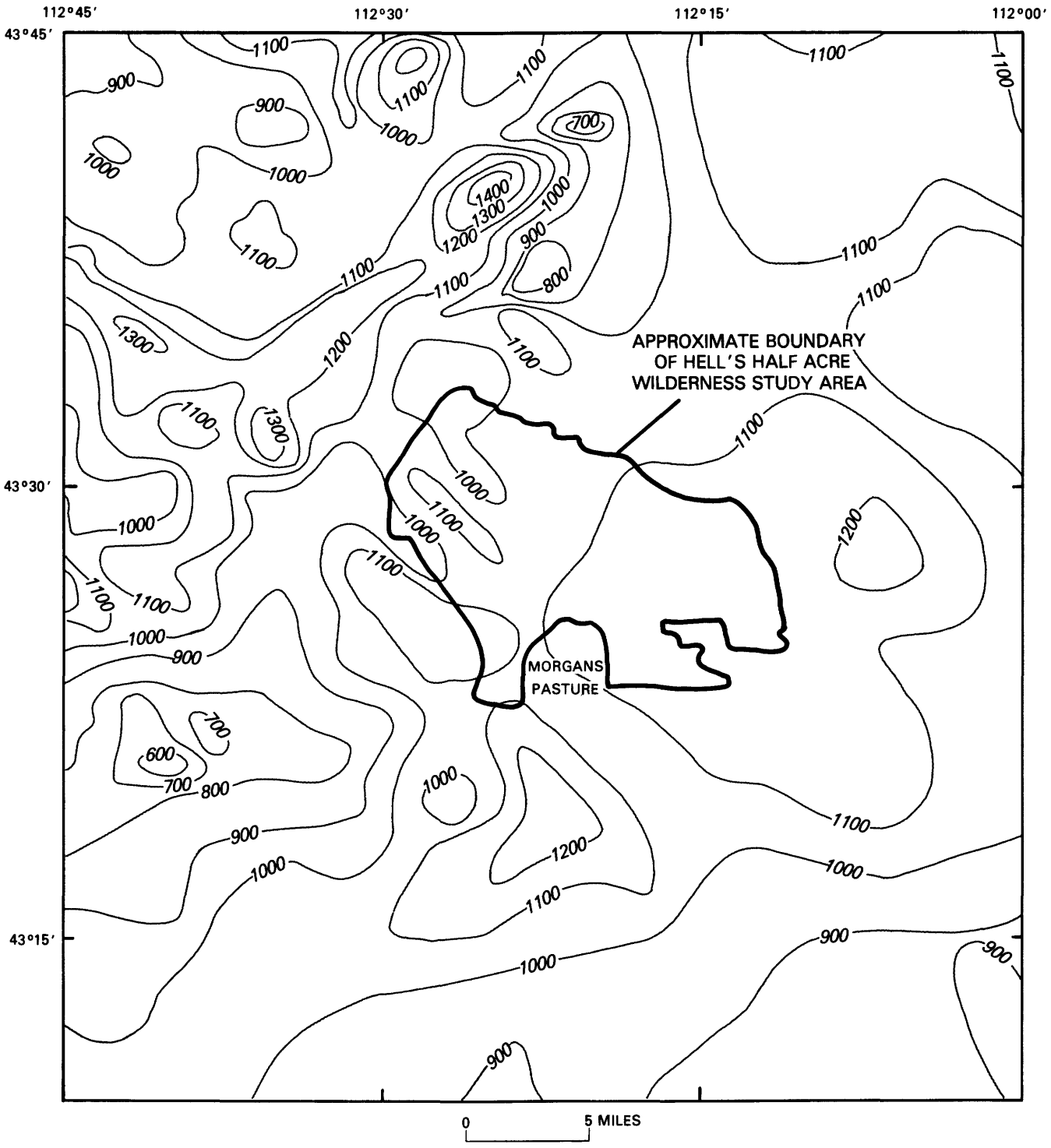
The Snake River Plain consists of late Pliocene to Holocene basalts as much as 6,000 ft thick (Zohdy and Stanley, 1972), with a few isolated outcrops of more silicic rocks (King, 1977). The Snake River Group ranges from Pleistocene to Holocene. The basalts of the plain were erupted in a style unique from other large basalt fields in the world, termed "plains" volcanism by Greeley (1977). In contrast to other large basalt fields, the basalts from the Snake River Plain originated from small, low, central-vent volcanoes, from fissures, from lava tubes, and from intracanyon eruptions.

Description of Rock Units

The Hell's Half Acre Wilderness Study Area includes more than half of the Hell's Half Acre lava field (144 mi^2), which was erupted about 4,100 ± 200 years ago (Karlo, 1977a). The basalts of the field are part of the Snake River Group, and they are gray to black, are unweathered, and contain 5 to 10 percent phenocrysts of olivine and plagioclase in a groundmass of olivine, plagioclase, augite, spinel, and glass. Glass averages about 20 percent in the rocks. Vesicles in the basalt are commonly filled with opal, chalcedony, and calcite. Some parts of the field contain xenoliths of olivine gabbro (Karlo, 1977a).

The flow units erupted from a single vent in the northwestern part of the area (pl. 1), represented by a small calderalike crater. The eruptions involved several different phases of basalt as outlined by Karlo (1977a): undifferentiated massive flow units about 30 to 65 ft thick, which make up most of the Hell's Half Acre field; fissure eruptive units, which are related to the crater area and consist of thin fissure flows, spatter ramparts, and spatter cones; flow units fed by rootless vents; and thin, near-vent flow units, which resulted from lake overflow. Karlo (1977a) also indicated that there was no significant time interval between eruption of the various phases. Most of the flows erupted as pahoehoe lava, but aa, scoria, cinders, and ash are also present in minor amounts.

According to Karlo (1977a), the basalts of the Hell's Half Acre lava field are typical of the Snake River Group, characterized by low SiO_2 (46–47 percent), high total iron



EXPLANATION

—600— **Magnetic contours**—Showing total-intensity magnetic field of the Earth in gammas relative to arbitrary datum. Contour interval 100 gammas. Data from U.S. Geological Survey (1978); flight level 9,000 ft, flight-line spacing 1 mi

Figure 3. Aeromagnetic map of the Hell's Half Acre Wilderness Study Area and vicinity, Bingham and Bonneville Counties, Idaho.

(14.5–16 percent), and low total alkali elements (3.3–3.4 percent). Within the central vent of the Hell's Half Acre field, a late minor fumarolic phase deposited gypsum, bloedite, and thenardite as crusts along fractures and as powdery deposits which fill cavities between flow units.

The thickness of the basalts at the Hell's Half Acre lava field is unknown. However, work by Crosthwaite (1973) and Barraclough and others (1966) indicated that the thickness of the basalts exceeds 1,130 ft a few miles northwest of the study area and exceeds 780 ft a few miles northeast of it.

Geophysics

Regional aeromagnetic data (U.S. Geological Survey, 1978) for the Hell's Half Acre Wilderness Study Area are from an aeromagnetic survey flown at 9,000-ft barometric elevation (about 4,000 ft above the ground) and at 1-mi flight-line spacing (fig. 3). Basalt flows across the Hell's Half Acre lava field were not detected by the high-altitude aeromagnetic survey; the broad, long-wavelength anomalies are caused by highly magnetic rocks beneath the surface flows. A narrow, elongate northwest-trending magnetic high is over the lava vent for the Hell's Half Acre field and aligns with a mapped fracture zone (pl. 1) and with a vent just outside the study area in Morgans Pasture. The magnetic-high ridge across the study area is probably caused by intrusive mafic rocks at depth along the northwest-trending fracture zone; the fracture zone probably controlled vent emplacement. The elongate shape of aeromagnetic anomalies both northwest and southeast of the study area suggests that the mapped fracture zone may extend outside the wilderness study area.

Mineral and Energy Resources

Recent basaltic lava flows comprise the Hell's Half Acre Wilderness Study Area, and the lavas have low mineral resource potential for metals. The only mineralized area in the study area contains limited amounts of sulfate minerals associated with the central vent of the Hell's Half Acre lava field. The sulfate minerals in two places were analyzed by Fredericksen and Fernett (WGM, Inc., unpub. report, 1983), and none of them showed any enrichment in gold, arsenic, mercury, or antimony. The USBM (Moyle and Winters, 1985) also analyzed ten samples of basalt, eight from the various flow units and two from the vent area. These samples were analyzed for 40 elements by semiquantitative emission spectroscopy, and for gold and silver by fire-assay methods. None of the samples showed anomalous concentrations of any elements which might be associated with mineralization. The study area has low mineral resource potential for metals, with certainty level C.

The wilderness study area also lacks host rocks and structures favorable for the occurrence of oil and gas or coal. The resource potential for these commodities is therefore low, with certainty level C.

Doherty and others (1979) found rhyolitic ash flows and lava flows beneath basaltic cover in a deep drill hole in the eastern Snake River Plain. Whether mineral and energy resources are present in these silicic lavas is unknown. Whether oil-bearing rocks are present beneath the lava is also unknown. Locating mineral and energy resources beneath the basaltic cover of the study area would require extensive geophysical exploration and drilling.

The depths to the water table beneath the Snake River Plain basalts are from 200 to 800 ft (Mundorff and others, 1964), deep enough to inhibit the near-surface expression of any geothermal features. Numerous hot and warm springs and wells occur along the northern and southern margins of the Snake River Plain (Breckenridge and others, 1980) where geothermal systems are less diluted by the effects of the Snake River Plain aquifer. No thermal water is known within the study area, and several wells adjacent to the study area have water which indicates low heat gradients. The resource potential for geothermal sources in the wilderness study area is therefore considered to be low, with certainty level C. A major program of geophysical exploration and drilling would be required to completely evaluate the geothermal resources of the wilderness study area.

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GEOLOGIC TIME CHART

Terms and boundary ages used by the U.S. Geological Survey, 1986

EON	ERA	PERIOD		EPOCH	BOUNDARY AGE IN MILLION YEARS
Phanerozoic	Cenozoic	Quaternary		Holocene	0.010
				Pleistocene	1.7
		Tertiary	Neogene Subperiod	Pliocene	5
				Miocene	24
			Paleogene Subperiod	Oligocene	38
				Eocene	55
				Paleocene	66
	Mesozoic	Cretaceous		Late Early	96 138
		Jurassic		Late Middle Early	205
		Triassic		Late Middle Early	~ 240
	Paleozoic	Permian		Late Early	290
		Carboniferous Periods	Pennsylvanian	Late Middle Early	~ 330
			Mississippian	Late Early	360
		Devonian		Late Middle Early	410
		Silurian		Late Middle Early	435
		Ordovician		Late Middle Early	500
		Cambrian		Late Middle Early	~ 570[1]
Proterozoic	Late Proterozoic				900
	Middle Proterozoic				1600
	Early Proterozoic				2500
Archean	Late Archean				3000
	Middle Archean				3400
	Early Archean				
pre-Archean[2]		3800?			4550

[1] Rocks older than 570 m.y. also called Precambrian, a time term without specific rank.

[2] Informal time term without specific rank.

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