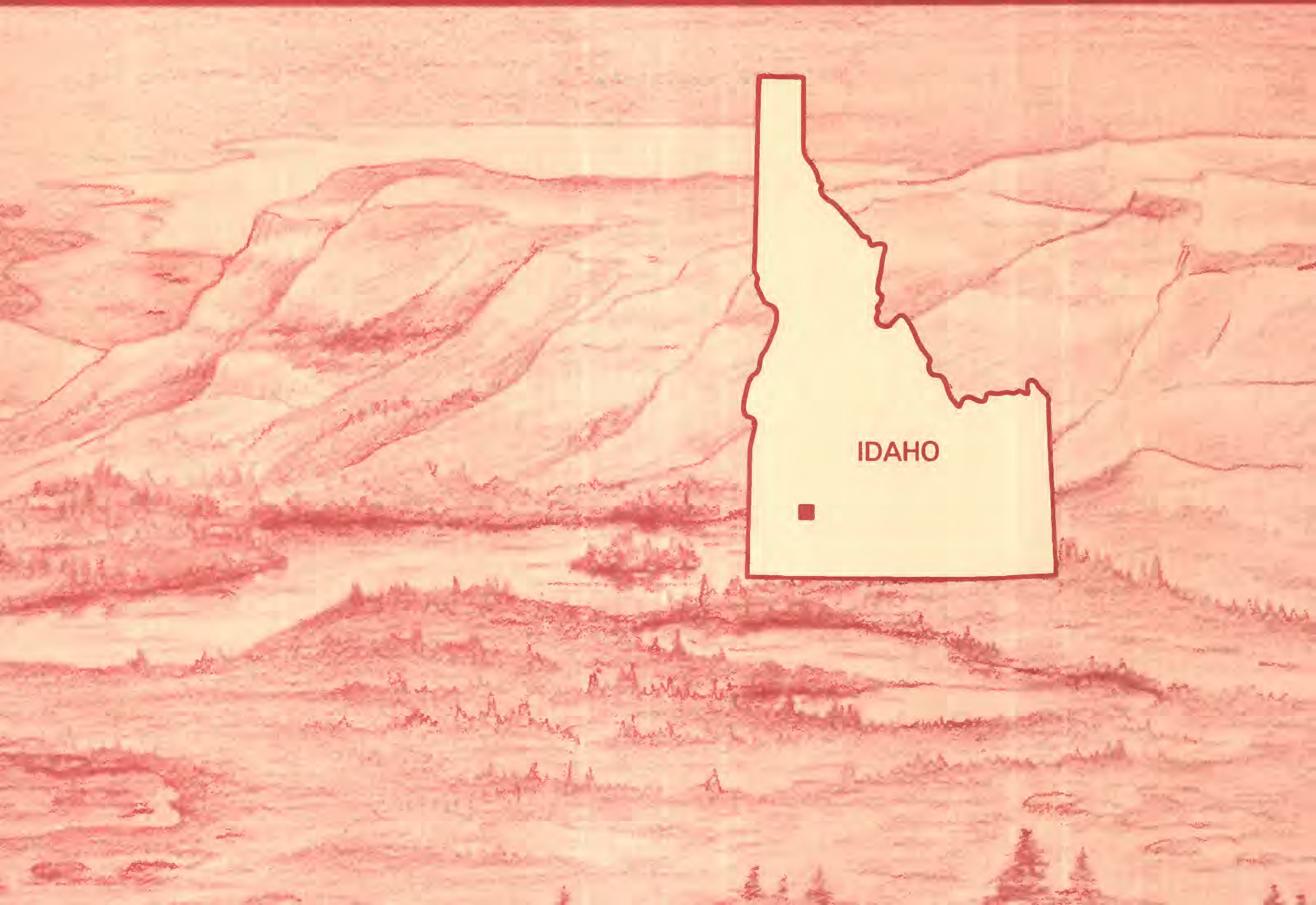
Mineral Resources of the Little Jacks Creek, Big Jacks Creek, and Duncan Creek Wilderness Study Areas, Owyhee County, Idaho

U.S. GEOLOGICAL SURVEY BULLETIN 1720–A



Chapter A

Mineral Resources of the Little Jacks Creek, Big Jacks Creek, and Duncan Creek Wilderness Study Areas, Owyhee County, Idaho

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U.S. GEOLOGICAL SURVEY BULLETIN 1720

MINERAL RESOURCES OF WILDERNESS STUDY AREAS—
BRUNEAU RIVER–JACKS CREEK REGION, 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 Little Jacks Creek (ID–111–006), Big Jacks Creek (ID–111–007C), and Duncan Creek (ID–111–007B) Wilderness Study Areas, Owyhee County, Idaho.

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Mineral Resources of the Little Jacks Creek, Big Jacks Creek, and Duncan Creek Wilderness Study Areas, Owyhee County, Idaho

By D. H. McIntyre, H. D. King, D. M. Kulik, *and* D. L. Sawatzky
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SUMMARY

In 1985 and 1986, the USBM (U.S. Bureau of Mines), the USGS (U.S. Geological Survey), and the Idaho Geological Survey conducted investigations to appraise the mineral resources and assess the mineral resource potential of the Little Jacks Creek (ID–111–006), Big Jacks Creek (ID–111–007C), and Duncan Creek (ID–111–007B) Wilderness Study Areas. These investigations revealed no identified mineral resources and a low mineral resource potential for tin and all other metals, oil and gas, and geothermal energy in the three study areas.

The Little Jacks Creek, Big Jacks Creek, and Duncan Creek Wilderness Study Areas are located in southwestern Idaho, south of the Snake River Plain. These three contiguous study areas are underlain chiefly by Miocene rhyolitic rocks that are locally covered by a thin veneer of basalt and locally separated by a thin deposit of poorly consolidated sedimentary rocks and silicic ash. The rock sequence is cut by numerous northwest-trending high-angle faults of small displacement. None of the rocks are hydrothermally altered.

No minerals have been produced and there are no known mineralized areas in the wilderness study areas. No mines, prospects, mineralized areas, patented mining claims, or mineral leases were identified in the study areas. Sand, gravel, and industrial rock resources are in the study areas, but sufficient quantities are available elsewhere to satisfy current local needs.

Nonmagnetic heavy-mineral concentrates collected during the stream-sediment geochemical survey locally contain high values for tin and lead. Very fine sand size to silt-size cassiterite (variety wood tin) occurs in the tin-rich samples. The cassiterite probably is derived from the sedimentary rocks locally present between the rhyolitic rocks and the basalt; its ultimate source is probably outside the wilderness study areas. The high lead values are probably man-caused contaminants. The wilderness study areas have a low mineral resource potential for undiscovered tin associated with the sedimentary rocks beneath the basalt and for all other metals. The potential for undiscovered oil and gas and geothermal resources also is low.

INTRODUCTION

In 1985, the USGS and the USBM, in cooperation with the Idaho Geological Survey, conducted mineral resource investigations in the Little Jacks Creek, Big Jacks Creek, and Duncan Creek Wilderness Study Areas. These three contiguous wilderness study areas (fig. 1) encompass 93,275 acres, divided as follows: Little Jacks Creek, 34,000 acres; Big Jacks Creek, 49,875 acres; Duncan Creek, 9,400 acres. The areas are located on a gently rolling plateau into which the gorges of Little Jacks Creek, Big Jacks Creek, and Duncan Creek are incised; these gorges commonly are a thousand or more feet deep. State Highway 51 passes east of the wilderness study areas. Light-duty roads and jeep trails provide access to

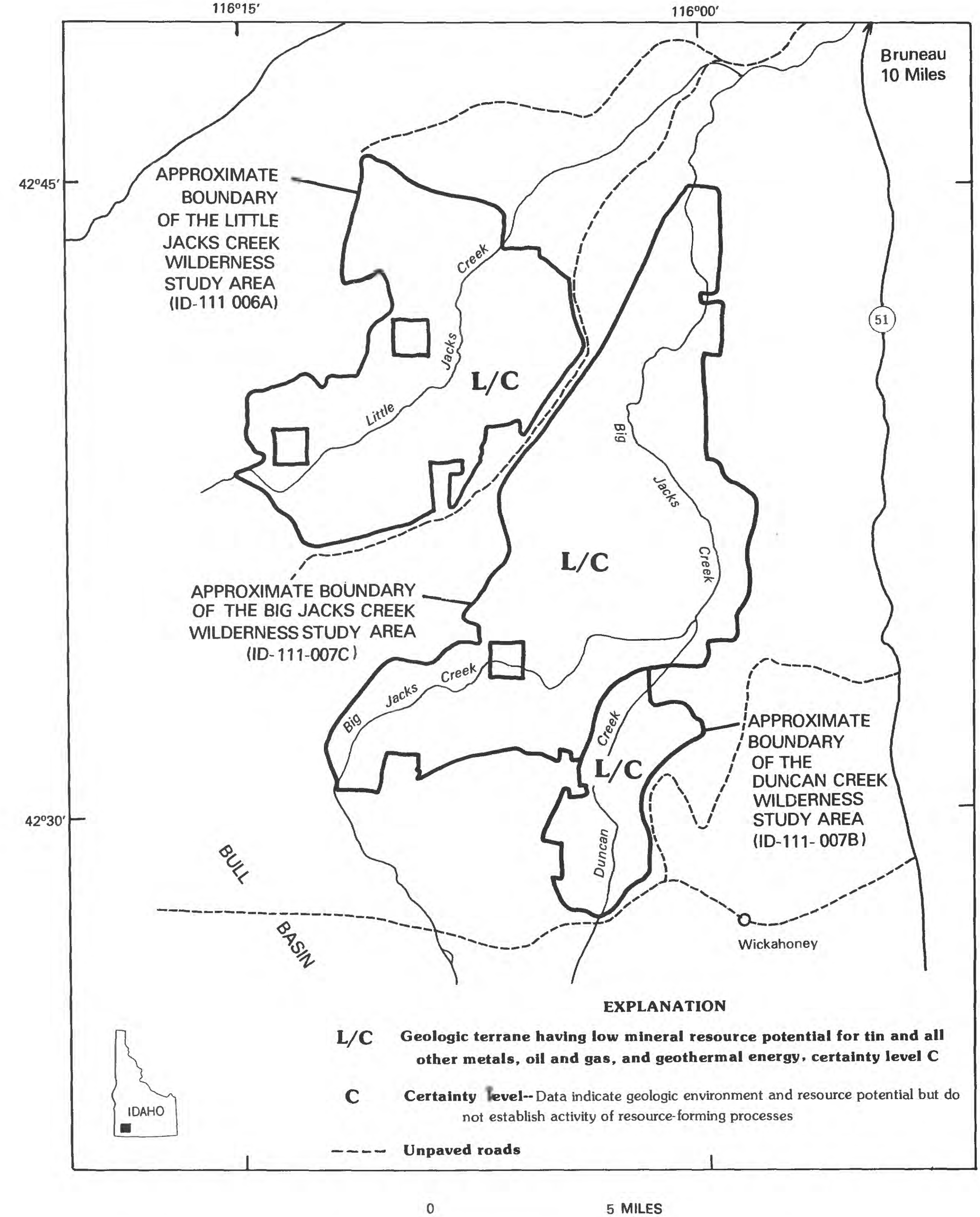

Figure 1. Map showing location and mineral resource potential of the Little Jacks Creek, Big Jacks Creek, and Duncan Creek Wilderness Study Areas, southwestern Idaho.

the areas from all sides. When water conditions permit, parts of Big Jacks Creek and Little Jacks Creek can be floated by raft.

This report presents an evaluation of the mineral endowment (identified resources and mineral resource potential) of the study area and is the product of several separate studies by the USBM and the USGS. Identified resources are classified according to the system of the USBM and USGS (1980), which is shown in the Appendix of this report. Identified resources are studied by the USBM. Mineral resource potential is the likelihood of occurrence of undiscovered metals and nonmetals, industrial rocks and minerals, and of undiscovered energy sources (coal, oil, gas, oil shale, and geothermal sources). It is classified according to the system of Goudarzi (1984), which is shown in the Appendix of this report. Undiscovered resources are studied by the USGS.

Investigations by the U.S. Bureau of Mines

The USBM appraisal of identified resources for the three wilderness study areas was by R. A. Winters and A. M. Leszcykowski (1986a, b, c). Their work included library research and examination of Owyhee County and U.S. Bureau of Land Management mining, lease, claim, and land status records. Field studies in the summer of 1985 involved searches for any mines, prospects, claims, or mineralized zones not on record. In addition, three rock samples and five samples of stream alluvium were taken from the three areas. The rock samples were pulverized and fire assayed for gold and silver at detection limits of 0.005 and 0.2 troy ounces per ton, respectively, and were analyzed for 40 elements by semiquantitative spectrography (Winters and Leszcykowski, 1986a, b, c). The alluvial samples, each consisting of two level panfuls, were first concentrated by hand panning. The concentrates were further reduced by a laboratory-size Wilfley table and inspected microscopically for gold and other valuable minerals.

Investigations by the U.S. Geological Survey

A new geologic map of the study areas was prepared for the USGS by Daniel F. Kauffman and Bill Bonnichsen, Idaho Geological Survey (Kauffman and Bonnichsen, in press). Harley D. King conducted a stream-sediment geochemical survey within the study areas (M. S. Erickson and others, unpub. data, 1986). A gravity survey was conducted by Dolores M. Kulik and a remote-sensing study was conducted by Don L. Sawatzky.

APPRAISAL OF IDENTIFIED RESOURCES

By R. A. Winters and A. M. Leszcykowski
U.S. Bureau of Mines

No mines, prospects, or mineralized structures were identified within the wilderness study areas except for one placer claim, located in 1924 and currently inactive, which extends into the northernmost part of the Big Jacks Creek Wilderness Study Area. No economic concentrations of minerals were detected in any of the rock or placer samples. Parts of the three wilderness study areas formerly were covered by oil and gas lease applications; all applications were cancelled prior to 1985. No known exploration has occurred in the areas covered by the lease applications.

Sand and gravel occurrences along Little Jacks Creek, Duncan Creek, Big Jacks Creek, and their tributaries are small in volume and consist of gravel and sand derived from the local volcanic rocks. The small volume and angular nature of the gravel preclude it from being considered a resource.

ASSESSMENT OF POTENTIAL FOR UNDISCOVERED RESOURCES

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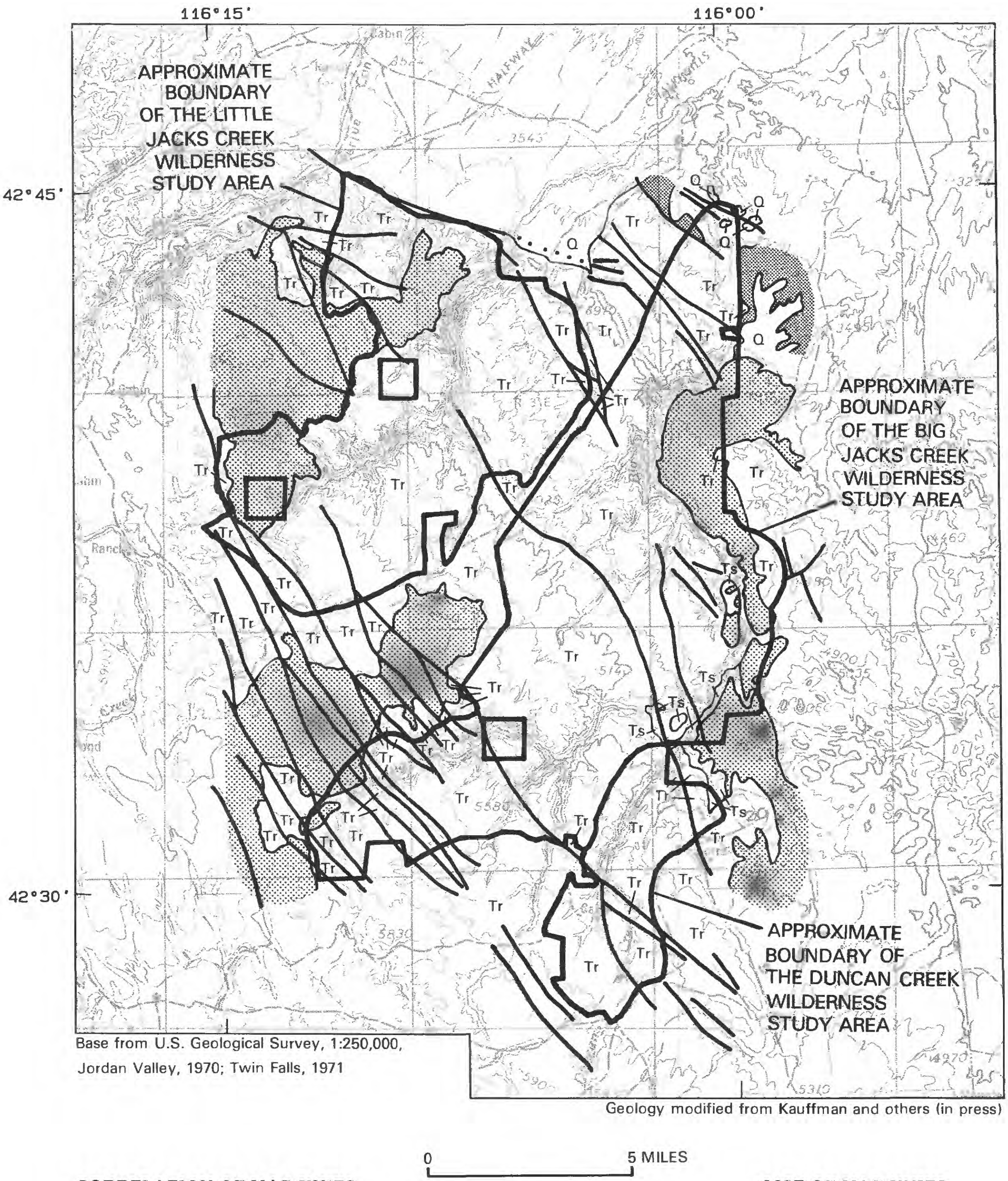
Geology

The Little Jacks Creek, Big Jacks Creek, and Duncan Creek Wilderness Study Areas are underlain by a sequence of rhyolitic rocks that are best exposed in the canyons along the creeks, but also crop out widely on the plateau surface (fig. 2). The rhyolitic rocks are overlain, locally, by a thin veneer of basalt erupted mainly from vents within and near the study areas. A thin layer of poorly consolidated sedimentary rocks and silicic ash separates the rhyolitic rocks from the overlying basalt in parts of the study areas.

Rhyolitic Rocks

The rhyolitic rocks commonly are dark brown, reddish brown, or reddish purple, crystal poor, and contain sparse, small crystals of plagioclase, pyroxene, and



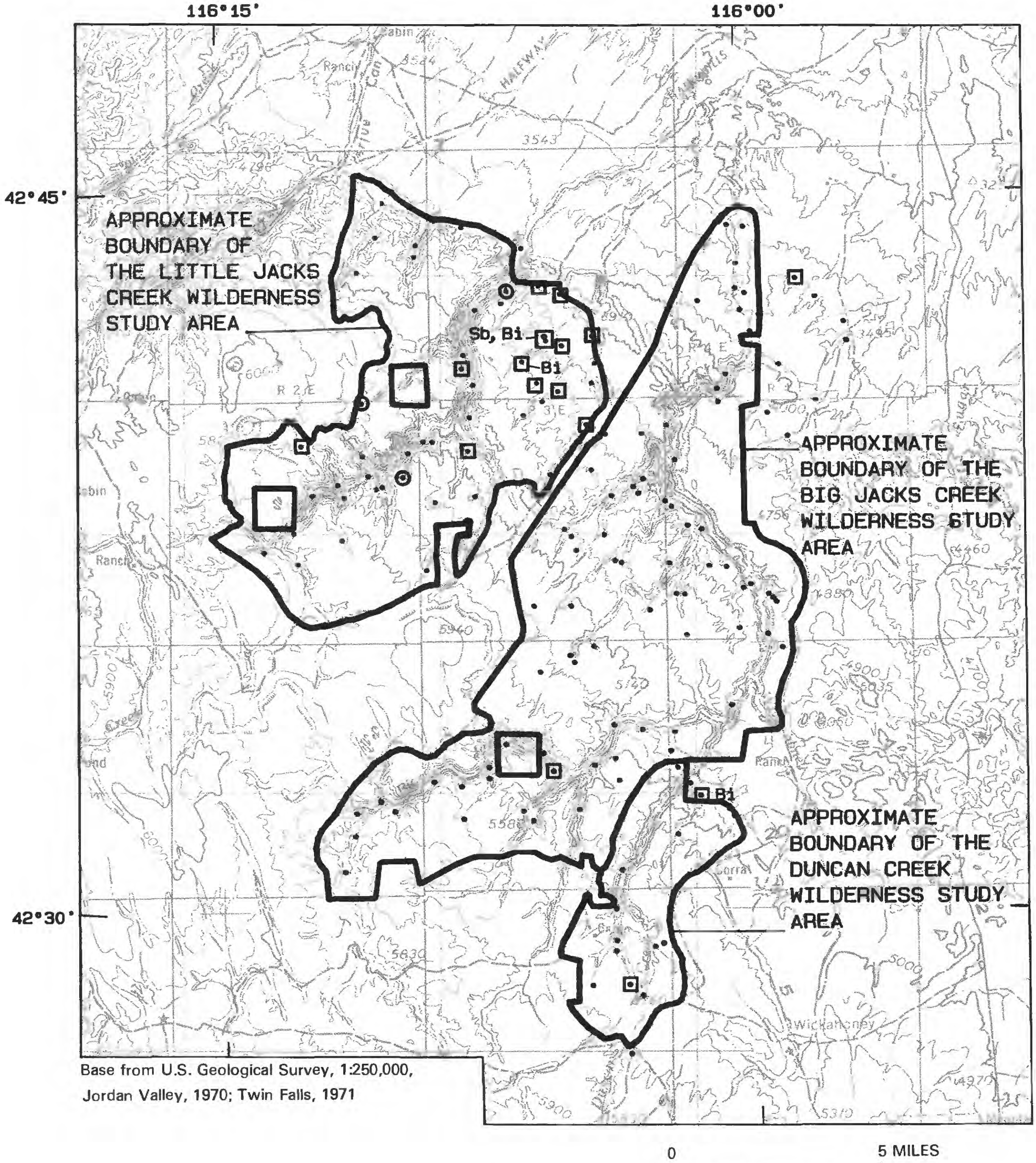
CORRELATION OF MAP UNITS

Q	Holocene and Pleistocene
Tch	Pliocene and Miocene
Tb	Pliocene and Miocene
Ts	Miocene
Tr	Miocene

LIST OF MAP UNITS

Q	**Surficial deposits**
Tch	**Chalk Hills Formation**
Tb	**Basalt**
Ts	**Sedimentary rocks**
Tr	**Rhyolitic rocks**
———	**Contact**
━━━	**Fault**--Dotted where concealed

Figure 2. Map showing generalized geology of the Little Jacks Creek, Big Jacks Creek, and Duncan Creek Wilderness Study Areas.



EXPLANATION

- **Stream-sediment sample locality**
- **Greater than 2,000 ppm Sn (tin) in heavy-mineral concentrates**--High values of Bi (bismuth) and Sb (antimony) also found in some heavy-mineral concentrates
- **High values of Pb (lead) in heavy-mineral concentrates**

Figure 3. Map showing sample locations and anomalous concentrations of tin, lead, antimony, and bismuth in samples from the Little Jacks Creek, Big Jacks Creek, and Duncan Creek Wilderness Study Areas.

opaque oxides; quartz and sanidine are uncommon constituents of some units. In the canyons, individual cooling units form ledges that extend for several miles. Black, glassy zones occur at the bottom and top of some units; some have brecciated zones at the bottom or top. Thin layers of poorly consolidated silicic volcanic ash separate some cooling units; these ash layers seldom are well exposed. None of the rhyolitic rocks are known to be hydrothermally altered.

Current studies (Kauffman and Bonnichsen, in press) suggest that most of the rhyolitic cooling units are lava flows. Past studies (Ekren and others, 1984) concluded that the rhyolitic rocks were emplaced as a sequence of extremely hot ash-flow tuffs that developed lava-like characteristics due to flowage prior to final chilling; these rocks were called Little Jacks Tuff by Ekren and others (1984).

Potassium-argon age determinations for these rocks within the wilderness study areas are from 11.2 to 9.6 Ma (Mega-annum) (Armstrong and others, 1980; Hart and Aronson, 1983).

Basalt and Associated Sedimentary Rocks and Silicic Ash

Basalt lava, erupted from vents within and near the wilderness study areas, flowed over a relatively flat surface on top of the rhyolitic rock sequence. The basalt is commonly dark gray to black and contains small, sparse phenocrysts of plagioclase and olivine. The flows are fine to medium grained and none are hydrothermally altered.

The basalt lava is commonly seen as one or more thin, black flows cropping out at some canyon rims and, away from the canyon rims, as a widespread, rough, and rocky veneer on the plateau surface. The vents for the flows are expressed as low hills that rise above the general level of the plateau. No potassium-argon ages are available for these rocks; however, they are considered to be Pliocene or Miocene (Kauffman and Bonnichsen, in press) (see geologic time chart in Appendix).

Locally, poorly consolidated sedimentary rocks, sediments, and silicic ash crop out beneath the basalt or between units of the rhyolite. In many places within the wilderness study areas, such deposits are very thin or absent or might be concealed by debris shed from overlying outcrops of the basalt or rhyolite. Good exposures of these rocks are seldom found, and therefore our understanding of these deposits is incomplete. They have been characterized as white, tan, and brown lacustrine and fluvial deposits of silt, clay, and sand (Kauffman and Bonnichsen, in press). Locally prominent are deposits of silicic volcanic ash.

Basalt mantling the plateau surface was more extensive in the past than it is now. Erosion has stripped the basalt, and underlying sedimentary rocks where present, from much of the area. Where the basalt and underlying sedimentary rocks have been removed by erosion, the rhyolitic rocks are exposed beneath the rather flat erosion surface.

Structure

The rocks in the wilderness study areas form a uniformly dipping sequence that dips at a low angle northeastward toward the Snake River Plain and is cut by numerous high-angle faults. Displacement on most of the faults is small; on many, vertical offset of the rocks is too small to be shown on the geologic maps. Exposed fault zones consist of masses of rather loose-appearing rubble, attesting to low confining pressures at times of faulting. Alteration in the fault zones is absent to very weak.

Geochemistry

Methods

The reconnaissance geochemical study of the Little Jacks Creek, Big Jacks Creek, and Duncan Creek Wilderness Study Areas included the collection, analysis, and evaluation of samples from each area. Table 1 shows the distribution of samples collected.

Table 1. Number of samples collected from the Little Jacks Creek, Big Jacks Creek, and Duncan Creek Wilderness Study Areas

	Nonmagnetic heavy-mineral-concentrate samples	Stream-sediment samples (fines)	Rock samples
Little Jacks Creek	56	59	9
Big Jacks Creek	16	81	14
Duncan Creek	7	17	2

Analyses of the stream-sediment samples represent the chemistry of the rock material eroded from the drainage basin upstream from each sample site. Such information is useful in identifying those basins that contain concentrations of elements that may be related to mineral deposits. Nonmagnetic heavy-mineral-concentrate samples provide information about the chemistry of a limited number of minerals in rock material eroded from the drainage basin upstream from each sample site. The selective concentration of minerals, many of which may be ore related, permits determination of some elements that are not easily detected in stream-sediment samples.

Analytical data and a description of the sampling and analytical techniques used are given by M. S. Erickson and others (unpub. data, 1986).

All samples were analyzed semiquantitatively using direct-current arc emission spectrographic methods. The rock and stream-sediment samples were analyzed using techniques described by Myers and others (1961) and the nonmagnetic heavy-mineral concentrates using techniques described by Grimes and Marranzino (1968). Certain elements of special interest or that have high lower limits of determination by emission spectrography were also analyzed in rock and stream-sediment samples using the following methods: antimony, arsenic, bismuth, cadmium, and zinc by ICAP–AES (inductively coupled argon plasma–atomic emission spectroscopy, after Crock and others, 1983) using a modification of the digestion method of O'Leary and Viets (1986); gold by atomic absorption using a modification of the method described by Thompson and others (1968); and mercury by a modified Koirtyohann and Khalil (1976) cold-vapor atomic-absorption method.

Sample localities are shown on figure 3, along with-samples containing anomalous concentrations of tin, lead, antimony, and bismuth.

Summary of Analytical Results

Nonmagnetic heavy-mineral concentrates from 13 sample sites in the Little Jacks Creek Wilderness Study Area contained anomalous concentrations of tin, 2,000 ppm (parts per million) and greater. Two of the samples anomalous in tin also contained anomalous bismuth, 20 and 70 ppm. One of these also contained 700 ppm antimony. Bismuth and antimony commonly are present in material containing abundant tin. Three samples yielded anomalous values for lead, ranging from 500 to 5,000 ppm; these samples were from sites different from those that yielded high values for tin. No other elements were present in anomalous concentrations in these samples. No other samples collected during the geochemical survey in the Little Jacks Creek Wilderness Study Area contained anomalous concentrations of any element.

Nonmagnetic heavy-mineral concentrates from one sample site in the Big Jacks Creek Wilderness Study Area and one site a few miles northeast of the study area contained greater than 2,000 ppm tin. No other elements were present in anomalous concentrations in these samples. No other samples collected during the geochemical survey in the Big Jacks Creek Wilderness Study Area contained anomalous concentrations of any element.

Nonmagnetic heavy-mineral concentrates from one sample in the Duncan Creek Wilderness Study Area and one sample adjacent to the study area contained greater than 2,000 ppm tin; one of these also contained 20 ppm bismuth.

All the sample sites from which samples containing anomalous tin were collected are located in parts of the study areas underlain by rhyolitic rocks. The highest values are associated with streams only a mile or so long that drain the erosion surface on the rhyolite from which the basalt and associated sediments and silicic ash have been stripped. Samples from many nearby streams draining the area of rhyolite exposures contain little or no tin. Tin was not detected in any samples of the rhyolitic rocks.

The samples with high values for lead are not systematically associated with any geologic feature. Each sample contains high values only for lead; other, commonly associated elements are not present in high concentrations. These samples, moreover, all were from places near roads or places where people could reasonably have been expected to have gone in the past. Therefore, we interpret these data to indicate that the lead is caused by a contaminant (probably bullet fragments or birdshot); these wilderness study areas have long been popular with hunters. Unfortunately, this surmise has not been directly verified by detailed examination of the samples because, in each case, all that remains of the sample is the part ground to fine powder for the chemical analysis.

Characteristics of Tin-Bearing Concentrates

Visual examination of parts of the nonmagnetic heavy-mineral concentrates containing 2,000 ppm tin and greater that were set aside for reference showed that the tin occurs as very fine sand size to silt-size grains of cassiterite (variety wood tin). A simple chemical test for tin, immersion of the cassiterite in hydrochloric acid in the presence of metallic zinc, verified the visual identification. The bulk of most reference samples consisted of zircon, accompanied by minor pyroxene and biotite. Several samples contained a few grains of pyrite.

Zircon, the most abundant mineral in most of the nonmagnetic heavy-mineral concentrates from the three areas occurs chiefly as well-formed, prismatic crystals; a few tiny, rounded zircon grains also were present in one sample. Zircon does not occur in the basalt and is uncommon in the rhyolite. Those grains seen in the rhyolite are tiny, rounded blebs, similar only to those that are subordinate in the nonmagnetic heavy-mineral concentrates. The well-formed zircon crystals must have another source.

Pyroxene in the nonmagnetic heavy-mineral concentrates occurs as well-formed, prismatic crystals. The species of pyroxene present have not been determined. Some of this pyroxene could have been derived locally from either the basalt or the rhyolite.

Biotite in the nonmagnetic heavy-mineral concentrates occurs as rounded, altered thick flakes that never are larger than very fine sand. Biotite is unknown both in the basalt and rhyolite; it must have another source.

Pyrite, present in several of the samples examined, occurs as untarnished, subangular grains. Angularity and freshness of the pyrite suggests a local source; the source has not been found.

Sources for Minerals in Concentrates Containing Tin

Most minerals (including tin minerals) identified in the nonmagnetic heavy-mineral concentrates that contain abundant tin do not occur in the basalt and rhyolitic rocks within the wilderness study areas. The highest tin values are in samples from streams draining the erosion surface on the rhyolite from which the basalt and associated sediments and sedimentary rocks have been nearly or completely eroded. Lack of tin either in the basalt or the rhyolite suggests that the sediments and rocks locally present between the basalt and the rhyolite are probably the carriers of the tin. The high specific gravity and small grain size of the cassiterite may have favored its lodgement and concentration in irregularities on the erosion surface. Later, small streams draining this erosion surface on the rhyolite would have carried away and further concentrated the cassiterite. The final concentration of the cassiterite would have taken place during our sampling of these streams and the making of the nonmagnetic heavy-mineral concentrates. Lack of exposures of the sediments and rocks in critical areas prevents direct testing of this hypothesis on the origin of the tin anomalies.

Source regions for the stream deposits, which according to Kauffman and Bonnichsen (in press) account for much of the sediment locally exposed beneath the basalt, may have been sources for the tin and some of the other exotic minerals. Cassiterite (variety wood tin) is known from placer deposits in the Silver City area, located about 40 mi northwest of the wilderness study areas (Piper and Laney, 1926). Cassiterite (variety wood tin) also has been found in Miocene stream deposits north of Silver City; the headwaters of these streams were the Silver City area (McIntyre, 1972). The mineralized rhyolitic rocks exposed in the Silver City area are the most likely source for the cassiterite found in the placers. Tin occurs in small amounts in hydrothermally altered rhyolitic rocks west of Silver City (Barrett, 1985). These rhyolites have been dated at about 16 Ma (Armstrong, 1975), distinctly older than the rhyolitic rocks exposed in the wilderness study areas. We propose that the Silver City region may have been the ultimate source for the cassiterite that is found in the wilderness study areas.

Zircon and biotite occur in a rhyolitic ash-fall deposit that rests on the rhyolitic rocks and is overlain or interbedded with the basalt, near the east border of the Duncan Creek Wilderness Study Area. This deposit, at least 40 ft thick, consists chiefly of glass shards and minor pumice. It also contains quartz, sanidine, plagioclase, pyroxene, amphibole, biotite, magnetite, and zircon. A heavy-mineral concentrate prepared from a 6-pound bulk sample of the ash contained no cassiterite. The zircon in the ash includes many well-formed prismatic grains that appear similar to some of those found in the nonmagnetic heavy-mineral concentrates. Some of the biotite in the nonmagnetic heavy-mineral concentrates may also have been supplied by the ash.

Geophysics

Geophysical data provide information on the subsurface distribution of rock masses and the structural framework. Gravity, magnetic, and remote-sensing studies were undertaken as part of the mineral resource evaluation of the Little Jacks Creek, Big Jacks Creek, and Duncan Creek Wilderness Study Areas.

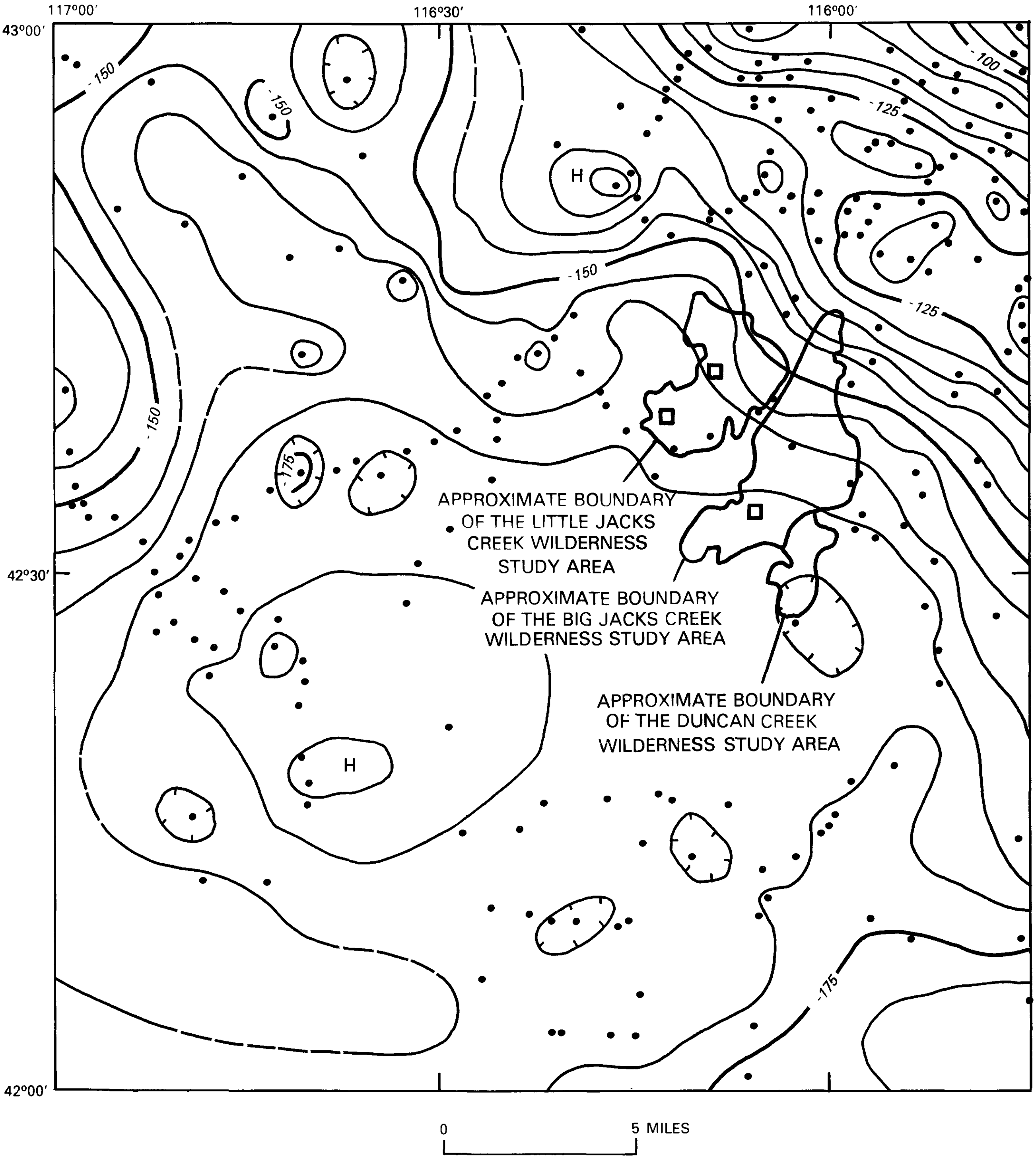
Gravity Data

Gravity data were obtained from files maintained by the Department of Defense, supplemented with data obtained by D. M. Kulik in 1985. Bouguer gravity anomaly values were computed using the 1967 gravity formula (International Association of Geodesy, 1967) and a reduction density of 2.67 g/cm^3. Terrain corrections were made by computer for a distance of 167 km from the station using the method of Plouff (1977). A complete Bouguer gravity anomaly map is given on figure 4.

The Owyhee plateau area of southwestern Idaho is characterized by intermediate Bouguer anomaly values between -150 and -175 milligals over a predominantly rhyolitic terrane. The Duncan Creek Wilderness Study Area and the southern parts of the Big Jacks Creek and Little Jacks Creek Wilderness Study Areas are at the margin of a roughly circular gravity low, 20 to 25 mi in diameter, that suggests an underlying volcano-tectonic depression that could be the source of some of the extrusive rocks exposed there. This low coincides with a broad, shallow structural sag centered on the source area for the Miocene Swisher Mountain Tuff (Ekren and others, 1984). Toward the northeast, a relatively steep gravity gradient separates the circular gravity low from a gravity high (shown in the northeast corner of fig. 4) over the basalts of the Snake River Plain. The northern parts of the Big Jacks Creek and Little Jacks Creek Wilderness Study Areas lie within the gradient near the margin of the Snake River Plain.

Aeromagnetic Data

The aeromagnetic data are from the aeromagnetic map of Idaho (U.S. Geological Survey, 1978). Flight lines are east-west at 5-mi intervals and 12,500-ft barometric elevation.



EXPLANATION

-150 **Gravity contours**--Dashed where approximate. Hachures indicate gravity low. Contour interval 5 milligals

● **Gravity station**-- From this study

H **Gravity high**

Figure 4. Complete Bouguer gravity anomaly map map of the Little Jacks Creek, Big Jacks Creek, and Duncan Creek Wilderness Study Areas.

The aeromagnetic values show only moderate (approximately 300 gammas) variation over the rhyolite terrane southwest of the wilderness study areas (fig. 5). The northeastern parts of the Big Jacks Creek and Little Jacks Creek Wilderness Study Areas lie along a steep magnetic gradient that reflects an abrupt thickening of buried basalts of the Snake River Plain (Mabey and others, 1983). A high-amplitude, short-wavelength, southwest-trending magnetic high in the western part of the Little Jacks Creek Wilderness Study Area (fig. 5) coincides with outcrops of Eocene volcanic rocks at the margin of the Snake River Plain (Mabey, 1982; Ekren and others, 1981). The steep gravity and magnetic gradients between the rhyolites of the plateau and the basalts of the Snake River Plain parallel the northwest-trending fault system mapped in the study areas (fig. 2), suggesting that the margin of the plain is fault controlled.

Remote-Sensing Data

Linear features on Landsat MSS (multispectral scanner) images were mapped by photogeologic interpretation in the region of southern Idaho. Linear features are the surface expression of rock fracture patterns and other structural and lithologic lineaments. Analysis of linear features in conjunction with geologic and geophysical maps may reveal new relationships, such as fracture control of mineralization.

In southwestern Idaho, expression of linear features is very poor in volcanic deposits, as in the Snake River Plains and also in the Owyhee plateau. North and west of the study areas linear features are well expressed in an area bounded by long 116°–117° W. and lat 42°30′–43° N. Concentrations of linear features have dominant N. 20° W. and N. 60° E. trends. The north-northwest trend is consistent with a N. 40° W.-trending gradient on the aeromagnetic map (fig. 4) and northwest-trending high-angle faults in the study area (fig. 2). The east-northeast trend is typical of pervasive regional fracture sets.

Mineral and Energy Resource Potential

No hydrothermal alteration was noted during geologic mapping in any of the three wilderness study areas (Kauffman and Bonnichsen, in press) nor has alteration of the rocks been noted during past studies (that is, Ekren and others, 1984, and references cited therein). No veins or other mineralized structures are known in the wilderness study areas. No minerals have been produced and no surface evidence exists for metallic-mineral or energy resources in the wilderness study areas. There are no features present that would suggest the presence of metallic-mineral or energy resources at depth beneath the wilderness study areas.

Much of the surface in all three study areas is blanketed by basalt that has not been known to contain mineral deposits. The rhyolitic rocks present beneath the basalt in the study areas are unaltered, and are a type not known to be associated with mineral deposits. The rhyolitic rocks are characterized by low water and fluorine contents (Ekren and others, 1984, table 10) and an anhydrous mineral assemblage. No anomalous concentrations of any elements were detected by our analyses of these rocks.

Little is known about the sediments and sedimentary rocks that locally are present between the basalt and the rhyolite because the sediments and rocks are poorly exposed. They are the probable source for the cassiterite (variety wood tin) that occurs in some of the streams draining the erosion surface from which the basalt and the sediments and sedimentary rocks have been stripped. It is unlikely that high concentrations of cassiterite exist within the sediments and sedimentary rocks because the amount that has been detected by the stream-sediment geochemical survey is low. High values occur only in a few samples of stream sediment that underwent deliberate concentration during the collection process. The three study areas have low mineral resource potential for tin and all other metals, with certainty level C.

Accumulations of oil and gas are unlikely because of high temperatures produced during volcanism in the past and because of the numerous high-angle faults. A geothermal resource at depth is unlikely as there are no hot springs within the study areas; none are found even along highly permeable, rubble-filled fault zones. None of the high-angle faults show signs of significant alteration that might be attributed to past hot-spring activity. The resource potential for oil and gas and geothermal energy is low in the three wilderness study areas, with certainty level C.

Recommendations for Future Work

A study devoted to better characterization of the sediments and sedimentary rocks locally present beneath the basalt would add to our understanding of them and to the sources and mode of occurrence of the cassiterite (variety wood tin). The study would be difficult because exposures of these rocks are so scarce.

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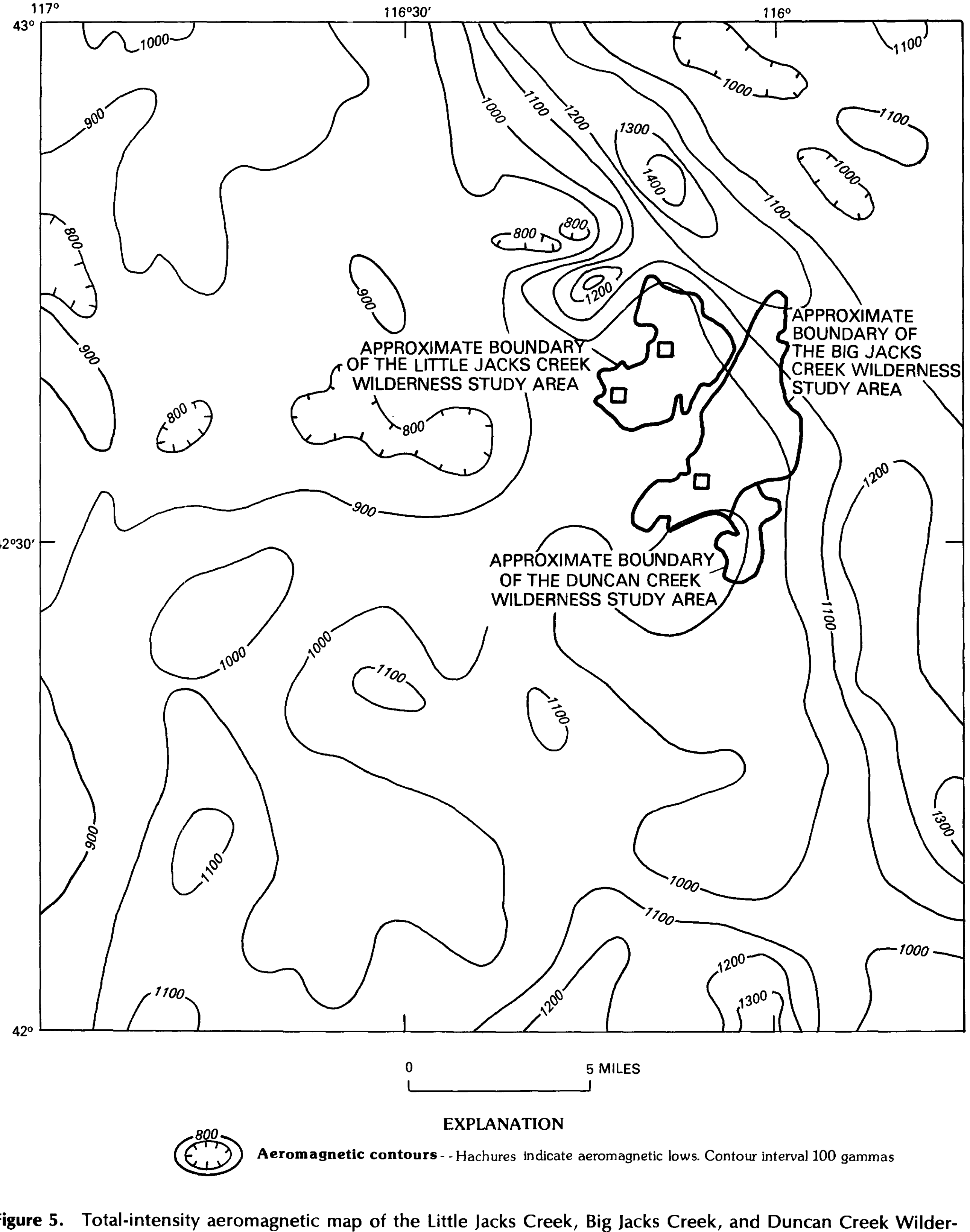

Figure 5. Total-intensity aeromagnetic map of the Little Jacks Creek, Big Jacks Creek, and Duncan Creek Wilderness Study Areas. Data and contours from U.S. Geological Survey (1978).

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APPENDIX

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.

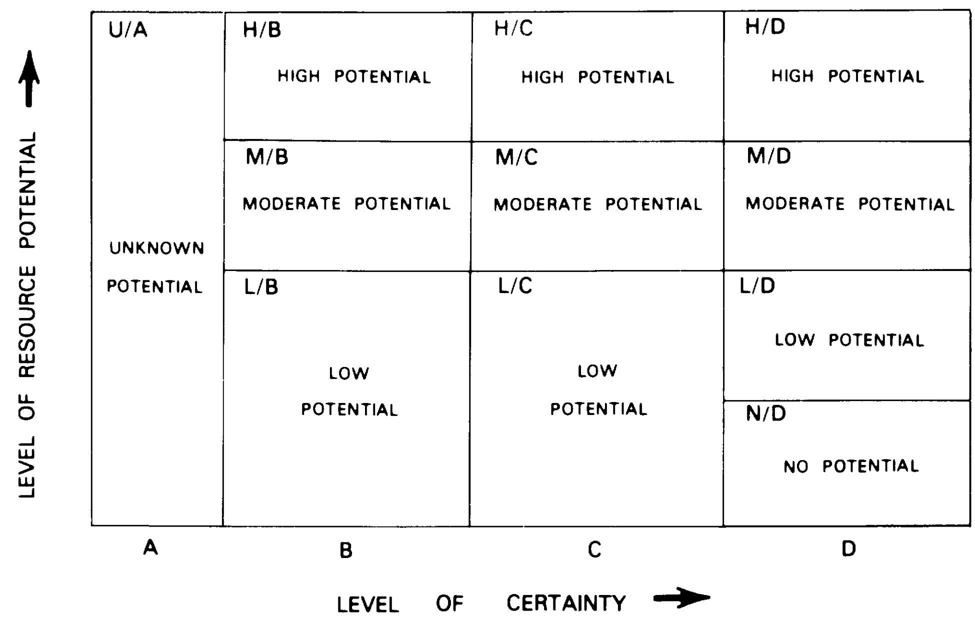
MODERATE mineral resource potential is assigned to areas where geologic, geochemical, and geophysical characteristics indicate a geologic environment favorable for resource occurrence, where interpretations of data indicate a reasonable likelihood of resource accumulation, and (or) where an application 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:

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RESOURCE / RESERVE CLASSIFICATION

	IDENTIFIED RESOURCES			UNDISCOVERED RESOURCES	
	Demonstrated		Inferred	Probability Range (or)	
	Measured	Indicated		Hypothetical	Speculative
ECONOMIC	Reserves		Inferred Reserves		
MARGINALLY ECONOMIC	Marginal Reserves		Inferred Marginal Reserves		
SUB-ECONOMIC	Demonstrated Subeconomic Resources		Inferred Subeconomic Resources		

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.

GEOLOGIC TIME CHART
Terms and boundary ages used in this report

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	96
				Early	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				3800?
pre-Archean[2]					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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