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GEOLOGY OF THE URANIUM DEPOSITS NEAR STANLEY, CUSTER COUNTY

By

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IDAHO BUREAU OF MINES AND GEOLOGY

MOSCOW, IDAHO

FOREWORD

Idaho's first commercial-grade uranium deposits, a few miles northeast of the town of Stanley, were the object of considerable exploration and development during the summer of 1958. Several shipments of ore were made. It was the good fortune of this Bureau to have available, during this early flush of activity, a geologist with several years of experience in the uranium areas of the Colorado Plateau, Mr. B. F. Kern. Mr. Kern's report, based upon the shallow workings available for inspection during 1958, is preliminary in nature, but should be of assistance to those people interested in further development and exploration in the Stanley area.

E. F. Cook
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ABSTRACT

The Stanley uranium area is in T 11 N, Rs 13 and 14 E, Boise Principal Meridian, approximately midway between the Idaho towns of Challis and Ketchum on U. S. Highway 93. The topography is rugged; the mean elevation is about 7,300 feet.

The Cretaceous Idaho batholith, dominantly quartz monzonite, forms the basement and is nonconformably overlain by the Oligocene-Miocene Challis Formation. The Challis Formation in the Stanley area consists of 2,000 feet of tuffs and flows of intermediate composition, with a 100-foot sequence of clastic terrestrial sedimentary rocks at the base. Silicic hypabyssal rocks, probably early Tertiary, intrude the batholith. Isolated patches of till are present on ridge tops. Fractures are the dominant structural feature, and the major fracture sets strike N 45° W, N 60°-70° E, and north.

Uranium occurs: (1) in steeply dipping fractures in batholithic rocks and silicic intrusive rocks, and (2) disseminated in beds of arkosic conglomerate at the base of the Challis Formation. Uraninite is the ore mineral in at least one of the bedded deposits. Both supergene ores and hypogene ores are present in the Stanley area. Few of the deposits have been explored to depths greater than 20 feet.

The known deposits are distributed in a northwesterly trending belt across the Stanley area. Fractures are the primary control in all deposits, and the N 45° W set of fractures is the most important. The following characteristics of the Stanley uranium deposits indicate their hydrothermal origin: (1) the control of the deposits by fractures, (2) the presence of such minerals as uraninite, marcasite, and stibnite in the ore, as well as the presence of a chalcedony gangue in some vein deposits, and (3) the hydrothermal alteration of the host rocks. The deposits are probably contemporaneous with the Challis volcanic rocks.

Sixteen groups of claims have been staked, totaling over 230 claims. Each group is described in the text. Approximately 2,300 tons of ore averaging near 0.25 percent U_3O_8 have been produced from the Stanley uranium deposits. Careful grade control will have to be maintained during mining. If sufficient reserves are developed, the feasibility of up-grading the ore should be determined. Fracture and host-rock control should be used as ore guides. Exploration has a reasonable expectancy of finding more ore, but there is no evidence which indicates that large ore bodies should be expected.

GEOLOGY OF THE URANIUM DEPOSITS NEAR STANLEY, CUSTER COUNTY, IDAHO

By

Billy F. Kern

INTRODUCTION

GENERAL STATEMENT

Interest in the recently discovered uranium deposits near the town of Stanley, Idaho, was intensified when ore was produced from two of the deposits in 1957 and 1958. Subsequent shipments of uranium ore from the Stanley deposits have brought the total production to more than 2,000 tons. Responsible mining companies have acquired holdings in the area, and further exploration and production are to be expected. The known deposits are in Custer County, Idaho, north of U. S. Highway 93 between Stanley and the Yankee Fork of the Salmon River (Pl. 3).

FIELD WORK

Most of the period from August 7, 1958 to September 9, 1958 was spent in the field. Air photographs were used to locate prospects, roads, and other culture. All data were transferred to a photographic enlargement of the 30-minute Custer quadrangle topographic sheet (scale: 1/125,000, contour interval 100 feet, edition of 1922). A tracing of this enlargement (scale: 1/31,250) was used as a base for the areal geologic map.

Geologic mapping was impeded by extensive soil cover. The soil is particularly well developed over granitic rocks, and this condition makes it necessary to map many contacts as inferred. On most prospects, the location and discovery pits are too shallow to provide much geologic information. This seems to be a common characteristic of uranium prospects, presumably because a radioactivity anomaly is considered by the locators to be sufficient grounds for the location of a lode claim. Unfortunately, an anomaly in the bottom of a shallow bulldozer cut may reveal little geologic information.

PREVIOUS INVESTIGATIONS

The area northeast of Stanley has been previously mapped only in reconnaissance. The area is included in a small-scale reconnaissance map by Umpleby and Livingston (1920); Umpleby, in 1915 briefly described the alluvial gold deposits in the vicinity of Stanley. The eastern half of the area was mapped by Ross and assistants (Ross, 1937, p. 4) in 1924-1930, and the remainder was mapped by Ross and Forrester for the Geologic Map of Idaho (1947)

ACKNOWLEDGMENTS

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Mr. Donald Laub of the Phillips Petroleum Company, Mr. Sherman Gardner of the Rare Metals Corporation of America, and Mr. Henry Childs of the Western Fluorite Mining Company contributed maps and other data concerning the properties under their supervision. They also gave liberally of their time and professional opinions. Mr. John Halverson generously provided an airplane trip over the Stanley area.

GEOGRAPHY

Location, accessibility, and culture

The uranium deposits are in the northeastern part of the Stanley mining district, in T 11 N, Rs 13 and 14 E, Boise Principal Meridian. The area is in the Challis National Forest, and is north of the Salmon River and east of Stanley (Pl. 3). The area will be referred to in this report as the Stanley uranium area or the Stanley area.

The Stanley uranium area is served by paved U. S. Highway 93, which follows the north bank of the Salmon River in south-central Idaho. The nearest towns are on the highway; Ketchum is 62 miles south of Stanley and Challis is 56 miles east of Stanley. Ketchum is the terminus of a branch line of the Union Pacific Railroad. Challis is the county seat of Custer County. Most of the claim groups have access roads suitable for summer use. A vehicle with four-wheel drive or four forward speeds is recommended at all times. No point in the Stanley uranium area is more than two hours' walk from a road.

The nearest uranium mill, the Vitro Minerals Corporation mill at Salt Lake City, Utah, is 380 miles to the south. The Dawn Mining Company mill at Ford, Washington, is 500 miles to the northwest.

Topography

The Stanley uranium area is in the Salmon River Mountains. The principal stream is Basin Creek (Pl. 2). Elevations range from 5,970 feet at the southeast corner of the area to 8,735 feet at the northeast corner; the area has considerable relief (Pl. 2). Hills west of Basin Creek are rounded, with broad summits and steep lower slopes. East of Basin Creek, sharp ridges and steep slopes are dominant.

Climate, Flora, and Fauna

Summer days are warm, with highs of 70 to 80 degrees; summer nights are cool. Snow comes in late October or November, and the area is under snow until May. Precipitation is about 16 inches annually, falling mostly as winter snow. Severity of winter increases toward the north, in the higher mountains. On summer mornings, fog may lie in the Salmon River valley, especially near Stanley.

North slopes support moderate growths of conifers, such as pines, fir, and spruce; lodgepole pines grow in thick stands. South-facing slopes have a cover of sage brush, with isolated trees at springs. Grasses, bushes, and flowering shrubs are common, particularly in narrow meadows along streams.

Mule deer and elk, as well as numerous squirrels, porcupines, and other rodents, were seen during the field investigation. The region is noted for its abundant salmon and trout.

GEOLOGY

GENERAL GEOLOGY

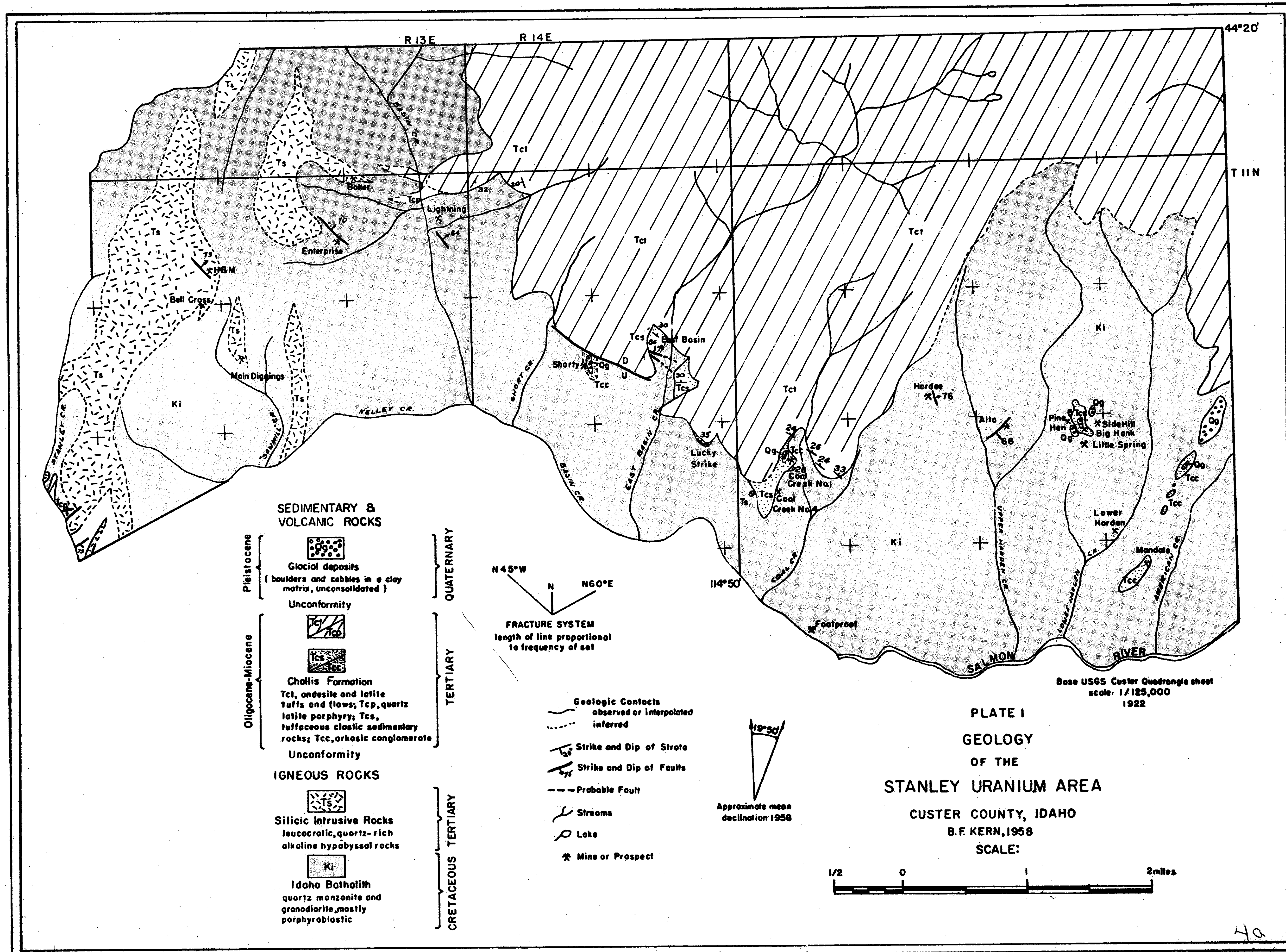
Regional geologic setting

The Stanley uranium area is in a region which has experienced severe orogenic disturbances. The dominant tectonic role of the region has been that of a positive element; it has apparently been emergent since the end of the Paleozoic Era (Ross and Forrester, 1958, p. 32-33). The rocks have been folded, intruded, and metamorphosed; volcanism has occurred on a grand scale. The Stanley uranium area is also part of a region which has been a substantial producer of metallic ores (Ross and Forrester, 1958, p. 47). It is perhaps not incongruous that an area with a history of tectonism and orogeny is also an area with a history of productive mining activity.

Geomorphology

The Stanley uranium area is in the Salmon River Mountains, which are part of the Northern Rocky Mountains geomorphic province (Fenneman, 1931, p. 150). The topography in the Stanley area is rugged. The streams flow in narrow valleys; such meanders as are present are narrow and irregular. The streams lack smooth profiles; many rapids and poorly-drained marshy areas are found. The courses of the principal streams, notably Basin Creek, Kelley Creek, and Little Basin Creek, are controlled by fractures. Numerous stream segments of northwest or northeast trend, connected by sharp bends, result in an angular stream pattern (Pl. 2). Fracture surfaces form the faces of some steep cliffs along the valleys. Most of the tributaries to the principal streams are sub-parallel to the north-trending fracture set, but further evidence that the tributaries are structurally controlled is lacking. Stream divides are well defined and upland tracts are drained. The drainage texture is intermediate. These observations indicate that the topography is in the late youth stage of the fluvial geomorphic cycle (Thornbury, 1956, p. 20). Basin, Little Basin, and Kelley Creeks are subsequent streams; their courses are controlled by fractures. Smaller streams are consequent.

Examination of the topographic map (Pl. 2) indicates that the topography west of Basin Creek does not conform to the above description. The mountain tops are gently rounded but the lower valley slopes are steep. The fluvial cycle in the Stanley uranium area is one of rejuvenation. An older, more mature erosion surface is present at elevations near 7,500 feet. The surface is extensively exposed west of Basin Creek; elsewhere in the Stanley area, only rounded ridge tops remain as representatives of the older surface. An example of such a ridge is the one between Lower Harden and Upper Harden Creeks, where the transition from a steep valley side to a rounded ridge top takes place at 7,300 feet (Pl. 2). Such changes in slope do not coincide with any known change in bedrock. In some localities, glacial deposits rest upon the old erosion surface (Pl. 1). Small, isolated remnants of till have been found on rounded ridge tops at four places in the Stanley area, at elevations of 7,100, 7,300, 6,800, and 7,300 feet respectively. According to available



R 13 E
R 14 E
44°20'
T 11 N
114°50'
Tct
Ts
Ki
Tcp
Tcs
Tcc
Qg
Baker
Lightning
Enterprise
H&M
Bell Cross
Main Diggings
Shorty
East Basin
Lucky Strike
Coal Creek No.1
Coal Creek No.4
Hardee
Alto
Pine Hen
Side Hill
Big Hank
Little Spring
Lower Harden
Mandate
Foolproof
BASIN CR.
KELLEY CR.
SAWMILL CR.
STANLEY CR.
SHORT CR.
EAST BASIN CR.
COAL CR.
UPPER HARDEN CR.
LOWER HARDEN CR.
AMERICAN CR.
SALMON RIVER
SEDIMENTARY & VOLCANIC ROCKS
Pleistocene
Qg
Glacial deposits
(boulders and cobbles in a clay matrix, unconsolidated)
QUATERNARY
Unconformity
Oligocene-Miocene
Tct
Tcp
Tcs
Tcc
Challis Formation
Tct, andesite and latite tuffs and flows; Tcp, quartz latite porphyry; Tcs, tuffaceous clastic sedimentary rocks; Tcc, arkosic conglomerate
TERTIARY
Unconformity
IGNEOUS ROCKS
Ts
Silicic Intrusive Rocks
leucocratic, quartz-rich alkaline hypabyssal rocks
TERTIARY
Ki
Idaho Batholith
quartz monzonite and granodiorite, mostly porphyroblastic
CRETACEOUS
N45°W
N
N60°E
FRACTURE SYSTEM
length of line proportional to frequency of set
Geologic Contacts
observed or interpolated
inferred
Strike and Dip of Strata
Strike and Dip of Faults
Probable Fault
Streams
Lake
Mine or Prospect
19°50'
Approximate mean declination 1958
Base USGS Custer Quadrangle sheet
scale: 1/125,000
1922
PLATE I
GEOLOGY
OF THE
STANLEY URANIUM AREA
CUSTER COUNTY, IDAHO
B.F. KERN, 1958
SCALE:
1/2
0
1
2 miles

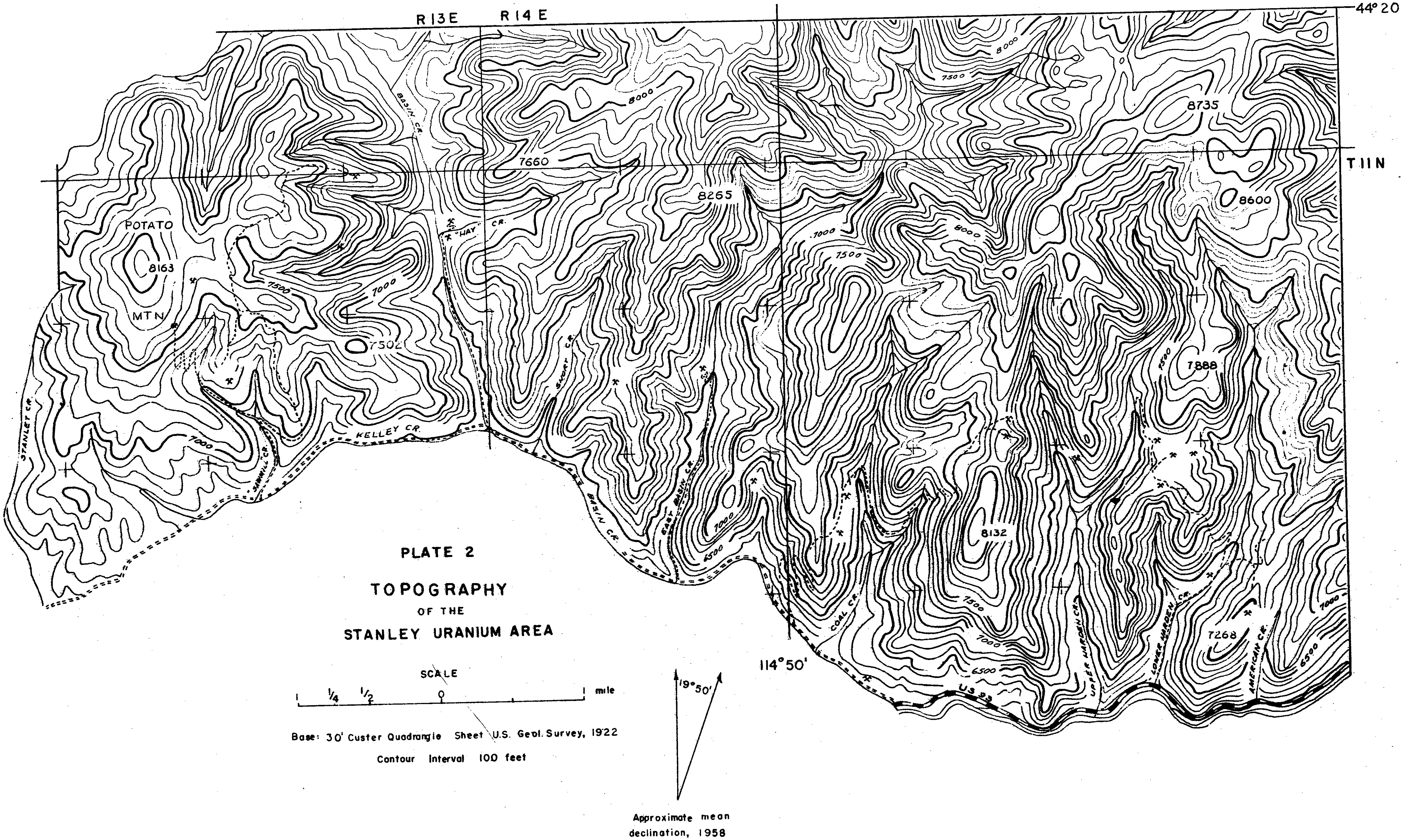


PLATE 2

TOPOGRAPHY

OF THE

STANLEY URANIUM AREA

Base: 30' Custer Quadrangle Sheet U.S. Geol. Survey, 1922

Contour Interval 100 feet

evidence, the old surface sloped to the south.

The evidence presented for rejuvenation of the erosion cycle in the Stanley uranium area is as follows:

(1) A surface of subdued topography is present near 7,500 feet.

(2) The accordant levels of the exposed portions of the surface do not correspond with a change in bedrock; the accordancy must have resulted from long-continued erosion of a stable area.

(3) Glacial deposits are present at accordant elevations on rounded ridge tops, indicating that there was a continuous surface at the time the deposits were laid down.

The glacial deposits are not correlative with the glacial debris of Wisconsin age which is present in terraces along the Salmon River at the southern boundary of the Stanley uranium area. Erosion subsequent to the latest Wisconsin glaciation in the region amounts to less than 100 feet (Ross, 1937, p. 97). In contrast, the till on ridge tops in the Stanley area is as much as 700 feet above the valley floors. Thus, there has been as much as 700 feet of down-cutting since the till was deposited. Similar old glacial deposits have been noted and described by workers in proximate regions (Anderson, 1956, p. 31-32; 1957, p. 19; Ross, 1937, p. 93-95). Indeed, an earlier glaciation has been generally recognized in eastern Idaho and adjacent regions (Alden, 1953; Ross 1929; Ross and Forrester, 1958, p. 42). Some writers have designated the glaciation as "Iowan(?)" and others "Nebraskan(?)." The glacial deposits in the Stanley area predate the latest Wisconsin glaciation; available evidence does not warrant a more precise dating.

STRATIGRAPHY AND PETROLOGY

Main features

Stratigraphic relationships in the Stanley uranium area are straightforward. The Idaho batholith forms the basement and is nonconformably overlain by the Challis Formation. A sequence of clastic sedimentary rocks which probably does not exceed 100 feet in thickness forms the basal part of the Challis Formation. Flows and tuffs comprise the major portion of the formation in the Stanley area. Glacial deposits are represented by isolated exposures of till less than 50 feet in thickness.

Idaho batholith

The Idaho batholith is exposed in one half of the Stanley area, principally in the southern and western parts. The batholithic rocks are characteristically deeply weathered, and abundant fractures give them a blocky appearance in outcrop. Weathered rock is light gray; large inset crystals of potassium feldspar are visible in some outcrops. Fresh rock is dark greenish gray and has a granitic texture.

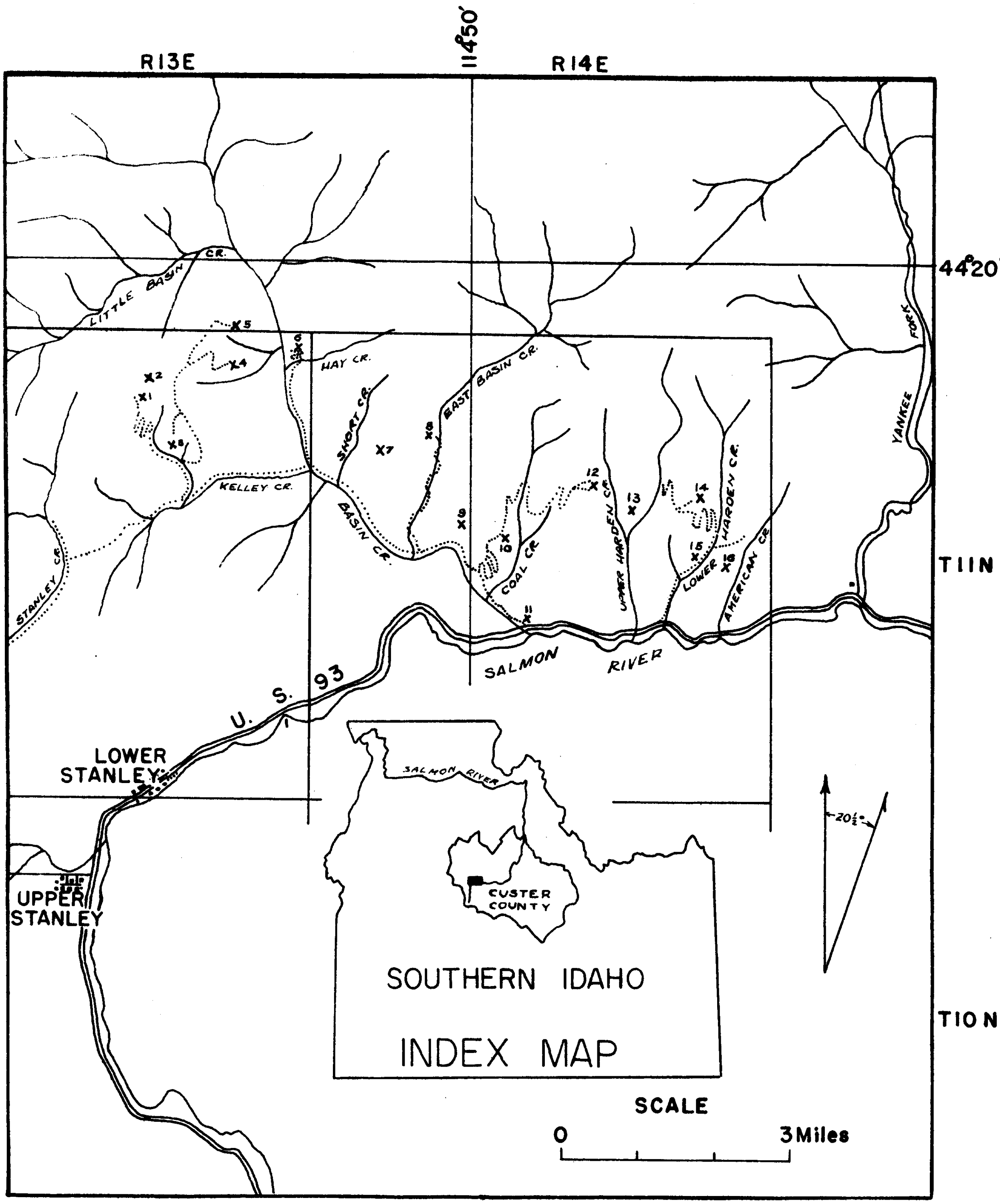


Plate 3. Uranium prospects in the Stanley mining district: (1) Bell Cross; (2) H and M; (3) Main Diggings; (4) Enterprise; (5) Baker and Potato Hill; (6) Lightning, etc; (7) Shorty; (8) East Basin; (9) Lucky Strike; (10) Coal Creek; (11) Foolproof; (12) Hardee; (13) Alta; (14) Big Hank, Pine Hen, Side Hill, Little Spring; (15) Lower Harden; (16) Mandate.

quartz is present in the rocks in excess of 10 percent, biotite is the dominant ferromagnesian mineral, and plagioclase feldspar is more abundant than potassium feldspar. The rocks of the Idaho batholith in the Stanley area are quartz monzonites and granodiorites. No systematic areal variation in composition is noted.

Ross (1937, p. 43-44) states that the greater part of the Idaho batholith in the general region is composed of quartz monzonite. The average composition of the quartz monzonite and granodiorite in the Stanley area are compared below:

Ross (1937, p. 44)		Stanley Uranium Area	
quartz	20-40%	quartz	27%
plagioclase (mostly oligoclase-andesine)	30-40%	plagioclase (oligoclase-andesine)	38%
microcline	10-40%	potassium feldspar	29%
biotite	5-15%	biotite	5%

The average age of the rocks of the Idaho batholith is given by Larsen and Schmidt (1958, p. 8-9) as 108 $\pm$12 million years (middle part of the Cretaceous). The age was determined by the lead-alpha dating of zircon, thorite, monazite, and xenotime occurring as accessory minerals in the batholith rocks. Sixteen specimens were used in the determination.

Quartz occurs as anhedral interstitial masses, subhedral crystals, and rarely as phenocrysts. Undulatory extinction is characteristic and extremely pronounced in some specimens. The average quartz content of the rocks is 27 percent.

Potassium feldspar is present to the extent of 29 percent. Most of the potassium feldspars occur as large porphyroblasts. Porphyroblasts as much as four inches long are seen in the batholithic rocks in the western part of the area. Perthite and microperthite are present but not common. Some of the potassium feldspar has undulatory extinction and much of it has patches of a grid-like appearance which resembles microcline twinning. Well-developed microcline twinning is exhibited by some crystals. Some porphyroblasts have concentric zones, causing them to resemble plagioclase feldspar.

Plagioclase feldspars are calcic oligoclase and sodic andesine. The anorthite content is uniform, ranging from An_{29} to An_{34}. Zoned plagioclase is rare. Prismatic euhedral crystals are dominant, averaging 0.8 millimeters wide. The rocks contain 38 percent plagioclase feldspar.

Biotite is pleochroic in shades of yellowish brown, and occurs in flakes with no preferred orientation. Biotite is the only common ferromagnesian mineral and amounts to 5 percent of the rock.

Accessory minerals are apatite, epidote, magnetite, and sphene. Biotite, "limonite," quartz, clay minerals, sericite, and muscovite are found as alteration products in ore-bearing rock.

All of the batholithic rocks are coarse-grained. The groundmass constituents average 0.7 millimeters in size and the porphyroblasts are generally about ten times as large as the groundmass crystals. The porphyroblasts contain small crystals of other minerals, resulting in a poikiloblastic texture. Most of the included grains are plagioclase laths, small spherical blebs of quartz, and biotite flakes. The included grains are oriented in some of the porphyroblasts. In one such porphyroblast, the inclusions occur in concentric rectangular zones around the core.

Replacement processes have been operative. The appearance of the porphyroblasts indicates that they are the product of potassium accession. Whether the porphyroblasts resulted from granitization or from late stage deuteric processes is beyond the scope of this paper. Myrmekitic intergrowths of vermicular quartz in plagioclase feldspar are especially common at the contacts between plagioclase and potassium feldspar. According to Williams, Turner, and Gilbert (1958, p. 20), this type of myrmekite results from the replacement of potassium feldspar by sodic plagioclase. The substitution of sodium and calcium for potassium indicates that the replacement history of the rocks has been complex, with reversals in the reactions at different stages. For a discussion of the changes in composition of the Idaho batholith rocks which resulted from the addition of certain elements, the reader is referred to Anderson (1942).

Ore-bearing granitic rocks are characterized by cataclastic textures and introduced minerals. In mildly deformed rocks, the quartz and potassium feldspars have undulatory extinction. More extreme deformation results in microbrecciation of all minerals. Reddish-brown biotite has crystallized in anomalous amounts in the ore-bearing granodiorite at the Hardee No. 3 prospect. Conversely, biotite has been extracted from ore-bearing granodiorite in the lower cut on the Lightning group, as compared with adjacent barren granodiorite.

Silicic intrusive rocks

Light-colored silica-rich rocks cut the batholith throughout the Stanley area. Large bodies of silicic intrusive rock are found in the western part of the area, but the zone of weathered rock is deep and the resulting soil cover obscures contacts. Such contacts are mapped from float, supplemented by isolated outcrops. In the southern and eastern parts of the Stanley area, the silicic intrusive rocks are represented by narrow aplite dikes. The silicic intrusive rocks cut the rocks of the Idaho batholith with sharp contacts. They are not found to intrude rocks of the Challis Formation; dikes are abundant in the batholith but they have not been found definitely cutting Challis rocks. On this evidence, the silicic intrusive rocks are younger than the Idaho batholith and probably older than the Challis Formation. Because no outcrops have been found in which Challis rocks truncate silicic intrusive rocks, the age relationships between these two units is tentative. The silicic intrusive rocks are regarded as early Tertiary in this report; possibly they were intruded during the Laramide orogeny. They bear no resemblance to the post-Challis intrusive rocks in adjacent areas as described by Ross (1937, p. 68-69).

Most of the silicic intrusive rocks are leucocratic; white and pink are the most common colors. The rocks typically have hypabyssal textures; aplites, porphyries, and pegmatites predominate. The rocks weather in rounded shapes and generally are more resistant than the enclosing rocks of the batholith.

All specimens of silicic rock examined in hand specimen or thin section are hydrothermally altered or weathered. Plagioclase feldspar has been considerably altered to clay minerals. In determining mineral percentages of the rocks, it is assumed that most of the clay represents altered plagioclase feldspar. The average composition of the silicic intrusive rocks is: quartz, 36 percent; orthoclase,16 percent; microcline,18 percent; plagioclase feldspar, 22 percent; and variable amounts of muscovite, sericite, and "limonite." Thus the typical rock is a silicic quartz monzonite.

The fundamental characteristics of the silicic intrusive rocks are as follows:

(1) They are rich in silica; the quartz content of the rocks varies from 15 to 55 percent.

(2) They are poor in ferromagnesian minerals.

(3) They are alkalic; potassic and sodic feldspars are much more abundant than calcic feldspars.

(4) They have textures typical of hypabyssal rocks.

(5) They occur in dikes and elongate, irregular bodies intruding the batholith.

Challis Formation

The Challis Formation crops out in the east-central part of the Stanley uranium area, which constitutes slightly less than half the total area. The Challis Formation nonconformably overlies the Idaho batholith. A thin layer of sedimentary rocks is present at the base of the unit, but the greater part of the 2,000 feet of Challis Formation exposed in the Stanley area is composed of flows and tuffs. Because of the relative importance of the sedimentary facies in the Stanley area, the term "Challis Formation" is used in preference to the term "Challis Volcanics" as defined by Ross (1930,p. 2; 1935, p. 46-53).

Based on field and fossil evidence, the Challis Formation is considered to be Oligocene-Miocene (Ross, 1937, p. 65-68). A single radioactive dating recently obtained suggests that the formation may be, at least in part, older (Ross and Forrester, 1958, p. 14-15).

The volcanic rocks of the Challis Formation in the Stanley area are tuffs and flows of intermediate composition. The rocks are drab green to black in the field and in hand specimen. Flows are generally darker than tuffs. Alteration (propylitization) is partially responsible for the color of the rocks; it has changed dark ferromagnesian minerals to lighter colored calcite and chlorite. The propylitization is probably deuteric. Bedding is seen in some outcrops, but the rock is commonly massive.

The flows are identified on the basis of their phenocrysts as porphyritic andesites. The rock texture is trachytic, with euhedral phenocrysts 0.1 to 1.0 millimeters long, sub-parallelly oriented in a felty matrix of clay. Phenocrysts constitute about half of the rock. Minerals present as phenocrysts are: calcitized amphibole(?), 20-30 percent; slender labradorite laths (An_{54}), 60-70 percent; subhedral quartz, 6-8 percent; and magnetite, 1-2 percent.

The tuff is composed of extremely angular, randomly oriented fragments of quartz and feldspar in a matrix of fine-grained, chloritized and calcitized rock particles. The size of the fragments varies, averaging 0.5 millimeters. The fragments constitute 35 percent of the rock, and the mineral distribution in the fragments is: labradorite (An_{56}), 40 percent; quartz, 30 percent; biotite, 25 percent; and orthoclase, in large Carlsbad twins, 5 percent. Because crystalline fragments constitute less than half of the rock, a conclusive identification is not made. Tentatively, the tuffs are quartz latites or dacites.

In addition to the extrusive rocks, some dark, porphyritic dike rocks which intrude the batholith are mapped with the Challis Formation. Phenocrysts of quartz, andesine, and sanidine constitute more than half of the rock; the rock is a quartz latite porphyry.

The non-resistant clastic sedimentary rocks at the base of the Challis Formation rarely crop out, being covered by soil and by talus from the overlying volcanic rocks. The sedimentary rocks are quartzose and feldspathic, and contain considerable amounts of clay and carbonaceous material. The total thickness is not known because a complete section is not exposed. The sedimentary rocks may be more than 100 feet thick on East Basin Creek, however (Pl. 1).

Exposed beds consist of arkosic conglomerate, and tuffaceous sandstone, mudstone, and siltstone. Tuffaceous sandstone and siltstone are dominant. The sandstone contains very angular quartz and feldspar fragments averaging 0.5 millimeters in diameter in a matrix of clay, calcite, and chlorite. The approximate proportions of the major constituents of the tuffaceous sandstone are: quartz, 40 percent; feldspar, 10 percent; and matrix 50 percent. The matrix is believed to be derived from fine-grained pyroclastic rock fragments. The tuffaceous sandstone resembles the tuff of the volcanic facies, except that the quartz fragments in the sandstone are more abundant and are slightly rounded.

The carbonaceous material in the sedimentary rocks occurs both in lignite lenses and in finely divided disseminated particles. Much of the material classed as lignite is black, lustrous, and fairly hard; it may be a coal of higher rank than lignite. No evidence of uranium concentration in the lignite lenses is noted. The lignite lenses are small, and "float" in clastic beds; they evidently represent woody material which accumulated in undrained ponds on the sub-aerial depositional surface.

Beds of arkosic conglomerate are present in the sedimentary sequence. The typical position for the arkosic conglomerate is at the base of the sedimentary sequence, in contact with the underlying granitic rocks, but lenses of conglomerate are seen higher in the sequence as well. The arkosic conglomerate is not more than five feet thick where it has been exposed, but thicknesses of 10 to 20 feet are present, based on cuttings from drill holes on the Coal Creek claims. The conglomerate is commonly very poorly indurated, and natural exposures are rare. Fresh rock is a mottled dark gray and white; weathered rock is light gray to light yellowish brown. Stratification is seldom seen, and some varieties of arkosic conglomerate resemble granitic rock which has weathered in place.

Rocks of different texture and composition, ranging from arkose to arkosic cobble conglomerate, are classified together under the unit term of arkosic conglomerate. The arkose (Williams, Turner, and Gilbert, 1955, Fig. 96) is composed of very angular quartz and feldspar fragments with little or no sorting. Quartz comprises 65 percent of the coarse fragments and feldspar, dominantly potassic, comprises 33 percent. A matrix of clay and sericite constitutes 25 percent of the rock. Both residual and slightly transported arkoses are found (Williams, Turner, and Gilbert, 1955, Fig. 104). The conglomerate facies is simply an arkose which has been transported farther; it is more indurated and more stratified than the residual or slightly transported arkoses, and it has more rounded quartz grains. The end-member of this arkose-conglomerate series is an arkosic cobble conglomerate exposed on the Coal Creek No. 4 claim (Pl. 1). The arkosic cobble conglomerate is composed of well-rounded cobbles and pebbles of igneous and metamorphic rocks which are not indigenous to the Stanley area, in a matrix of granitic gravel. The arkosic cobble conglomerate is more indurated than the arkose.

The arkosic conglomerate was deposited as a fluviatile sediment during the uplift which immediately preceded the Challis volcanism. The coarse and unsorted fabric, the presence of cut-and-fill structures, and the rapid thinning and thickening along strike seen in the available exposures suggest that the arkosic conglomerate occurs in lenticular bodies rather than as a continuous blanket-shaped basal conglomerate. The materials which compose the arkosic conglomerate are locally derived; the fragments are generally angular and did not travel far before deposition. The rounded cobbles and pebbles of exotic rock found in some outcrops must have attained their shape in a previous cycle of erosion.

Ross (1937, p. 49-50) divides the Challis Volcanics on the basis of lithology into a lower Latite-andesite Member, a middle Germer Tuffaceous Member, and an upper Yankee Fork Rhyolite Member. He includes the Challis rocks in the Stanley area in the Latite-andesite Member (Ross, 1937, Pl. 1). Ross describes a conglomerate at the base of the Germer Tuffaceous Member (Ross, 1937, p. 55-57), and I examined exposures of this conglomerate 30 miles east of the Stanley area. The Germer conglomerate in the exposures examined superficially resembles the cobble conglomerate exposed on Coal Creek in the Stanley area (Pl. 1), but the two conglomerates differ considerably in composition. Differences in source rocks of the conglomerates probably could account for the dissimilarities. If the arkosic conglomerate in the Stanley uranium area correlates with the Germer conglomerate, the Challis Formation of this report is correlative with the Germer Member of Ross' Challis Volcanics rather than the Latite-andesite Member. In either case, the members are rock units, and no time relationships are involved.

Glacial deposits

The only deposits of glacial origin in the Stanley uranium area are tills which lie on ridge tops at elevations near 7,000 feet. The thickness and shape of the till deposits are not determined because the till is unconsolidated and tends to creep and wash downslope. The thickness probably is less than 30 feet. The till is non-stratified and was deposited directly by ice. The deposits consist of boulders and cobbles in a matrix of white,clay-sized particles. The boulders and cobbles are composed of dark gray argillite from the Milligen Formation (Mississippian), dark gray quartzite from the Wood River Formation (Pennsylvanian), and light gray vein quartz. Milligen and Wood River beds are widely exposed east of the Stanley area (Ross, 1937, Pl. 1). The boulder and cobble erratics are smooth and many are faceted.

The till is considered to have been deposited by glaciers older than those of the latest Wisconsin ice age.

GEOLOGIC STRUCTURE

Regional folding and faulting which took place in Mesozoic time are well expressed in the Paleozoic sedimentary rocks east of the Stanley uranium area (Ross, 1937, p. 73-82). The only pre-Tertiary rocks in the Stanley area are granitic rocks of the Idaho batholith in which such deformation finds little expression. The structural processes of greatest effect in the Stanley area are the fracturing and volcanism which occurred in the Oligocene-Miocene. Tertiary deformation subsequent to the Challis volcanism is reflected in dips of 30 degrees or more in Challis rocks and by faults which may be seen in mining excavations.

The structural features of most importance to the uranium deposits of the Stanley area are fractures. There are three sets of fractures: N 45° W, N 60°-70° E, and north. The fractures dip steeply in either direction normal to the strike. No attempt is made to show individual fractures on the areal geologic map (Pl. 1). A diagrammatic representation is given, however: each set is represented by an arrow whose length is proportional to the frequency of the set; the representation is analogous to a vector diagram. Both faults and joints are included; the general term "fracture" is used in this report except in reference to faults where displacement or fault gouge are evident in the field. Fractures are much more common in granitic rocks than in volcanic rocks. The set of most frequent occurrence is the N 45° W set. Anderson (1948, p. 12) states that N 70° E fractures in the adjacent Yankee Fork district were first formed during the Laramide orogeny, and post-Challis fractures of N 70° E trend are the result of adjustments in the basement rocks. Ross and Forrester (1958, p. 35) state that northwest, northeast, and less prominently, north sets are widely distributed in Idaho. It is believed that in the Stanley uranium area, the three fracture sets are of Laramide age, and tectonism associated with the Challis volcanism locally reactivated the fractures, especially those of N 45° W trend. The N 45° W set of fractures is an important ore control.

GEOLOGIC HISTORY

After the formation of the Idaho batholith during the Cretaceous Period, Laramide orogenic forces caused fracturing of the rocks in the Stanley uranium area. The silicic intrusive rocks were emplaced in the early part of the Tertiary Period, possibly during a late phase of the Laramide orogeny. Relative crustal stability was established and an erosion cycle began. The area was uplifted in Oligocene-Miocene time. The erosive power and transporting capacity of the streams was increased and they were able to carry coarse debris, some of it from a considerable distance. Arkosic conglomerate was deposited as a fluviatile sediment. The coarser varieties of conglomerate were deposited in stream channels and small basins. Volcanism began, and pyroclastic material was added to the streams. More intense volcanism ensued, accompanied by fracturing. The fracturing took advantage of established lines of weakness, reactivating old fractures. Volcanic rock became dominant over sedimentary rock as more pyroclastic and molten rock was supplied. Uranium-bearing solutions were introduced; they rose along the fractures, depositing uranium minerals largely in response to changes in the wall rock. The area became stable again when volcanism ceased. An erosion cycle was initiated which led to a relatively flat surface over granitic rocks. In the Pleistocene Epoch, glaciers deposited cobble and clay till. Uplift occurred, and streams accomplished as much as 700 feet of downcutting before glaciation again took place in nearby mountains. Erosional processes have been in operation since the last glacial age.

URANIUM DEPOSITS

INTRODUCTORY NOTE

Uranium deposits have been found in a belt trending northwest across the Stanley area. The belt is nine miles long and two miles wide. Deposits are found in granitic rocks of the Idaho batholith, in silicic rocks which intrude the batholith, and sedimentary rocks of the Challis Formation. The uranium occurs in fractures with a chalcedony gangue and in fractures with no appreciable amount of gangue. The fractures vary in width from faults with several feet of gouge to paper-thin joints. Some deposits contain sulfides and some do not. Other variables could be cited, but a useful classification of the deposits into specific, mutually restrictive groups must await further exploration and development. The deposits have sufficient similarities in position and control, however, to be considered to have the same age and origin (p. 29).

Some of the uranium deposits in the Stanley area have characteristics not unlike those of uranium deposits in other regions of the Northwest. The general geology of the Stanley area is similar to that of western Montana northeast of Butte (Becraft, 1956). The Boulder batholith, dominantly quartz monzonite, is intruded by silicic rocks (alaskite, aplite, alaskite porphyry, and pegmatite) similar in lithology and age (Late Cretaceous or Paleocene) to those of the Stanley area. Uranium occurs in chalcedony veins; the uranium is intimately associated with dark gray chalcedony. The Alta deposit in the Stanley area is very similar.

In some of the mines of the Coeur d'Alene silver-lead-zinc district of northern Idaho, uranium is found in rock which is stained with red iron oxides; the greatest uranium concentration is in white alteration zones within the red-stained rock (Thurlow and Wright, 1950; Robinson, 1950). An analogous situation is found at the Side Hill No. 1 deposit. (It is well known that a similar spatial relationship of uranium ore to rock color exists in many of the uranium districts in the Colorado Plateau.) Unpublished information (oral communication, Mr. A. E. Weissenborn, U. S. Geological Survey, Spokane, Wash.) concerning the uranium deposits near Spokane, Washington, suggests that they may have important features in common with the Stanley deposits. The only other known uranium deposits in this part of Idaho are in adjacent Lemhi County (Anderson, 1958). The Lemhi County deposits have no important similarities to the Stanley deposits, in spite of the geographic proximity.

In the Cochetopa mining district, Colorado, commercial uranium vein deposits are being developed (Malan and Ransport, 1959). Ore bodies are found where favorable sandstone of the Morrison Formation (Jurassic) is intersected by mineralized faults. The ore contains pitchblende and marcasite; the dominant gangue is chalcedony and the associated alteration is argillic. The ore is probably Tertiary in age. In these characteristics, the Cochetopa deposits are similar to the Stanley deposits.

HISTORY AND PRODUCTION

Gold placers have supplied by far the greater part of the mineral production of the Stanley mining district. Most of the placers were located on the creeks east of Stanley which rise in the mountains to the southeast and flow northwest into the Salmon River. The creeks bear such names as Big Casino and Four Aces. Valley Creek, Kelley Creek, and Stanley Creek (Pl. 2) also have produced placer gold. In contrast to the Stanley district, the surrounding region has been a prolific producer of different ores. Ross and Forrester (1958, p. 47) comment that:

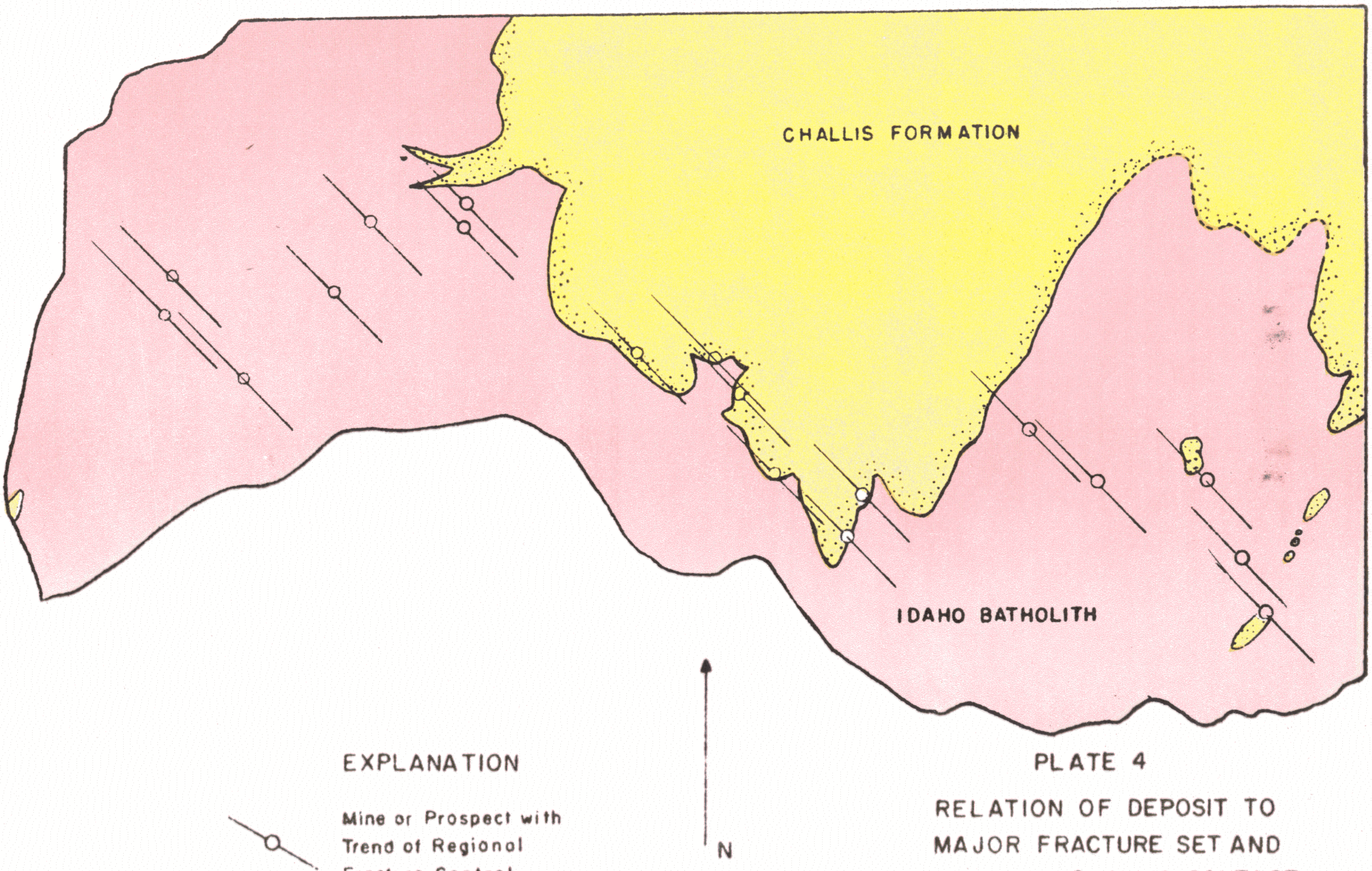
> "The mining districts in Custer and Blaine Counties and adjacent parts of Butte, Camas, and Elmore Counties together constitute the most productive region in Idaho outside of the Coeur d'Alene region. The mines of Custer County alone produced more than $42 million prior to World War II."

Although it has been known for many years that brannerite ($(U,Ca,Fe,Th,Y)_3 Ti_5 O_{16}$(?)) (Volborth, 1958) is present in the gold-bearing gravels on Kelley Creek (Bell, 1915), the first claims to be filed for uranium are the four Foolproof and Abbie Lou claims filed September 3, 1955. The next discovery, the Bell Cross, precipitated a considerable local interest in uranium. There are presently about 250 claims in the Stanley area. The companies which hold the majority of the claims are: Phillips Petroleum Company, of Salt Lake City, Utah; Western Fluorite Mining Company, of Hailey, Idaho; Rare Metals Corporation of America, of Salt Lake City, Utah; and Sidney Mining Company, of Kellogg, Idaho.

The first shipment of uranium ore was made by Western Fluorite in August 1957; one carload (approximately 60 tons) was shipped to the Vitro Minerals Corporation mill at Salt Lake City, Utah. The ore was mined from a pit northwest of the juncture of "Hay" Creek and Basin Creek. In June 1958, two carloads were shipped to the same mill by Phillips Petroleum from the Coal Creek No. 4 claim. The first carload of ore contained, according to mill assays, 0.36 percent U_3O_8 and the second contained 0.21 percent U_3O_8. By November 20, when mining was terminated for the winter, approximately 2,300 short tons of uranium ore had been produced from the Stanley area deposits, all from properties belonging to Western Fluorite or Phillips Petroleum. The average grade of the ore probably was near 0.25 percent U_3O_8. The ore was trucked to Ketchum and Hailey, Idaho, and trans-shipped by rail to Salt Lake City. The ore which has been shipped is amenable to economic extraction of the contained uranium.

ORE CONTROL

The uranium deposits in the Stanley area exhibit fracture control. The known deposits lie in a northwest-trending belt nine miles by two miles which cuts across different rock types. The belt appears to be composed of several en echelon segments which strike northwest. In Plate 4, each deposit is represented by a circle, and a line one inch long is drawn through the circle. The line strikes N 45° W, the same as the major fracture set in the Stanley area. No implication is intended that every deposit is controlled by fractures of this set; the map merely illustrates that the deposits are unmistakably aligned in a northwest direction.



EXPLANATION

Mine or Prospect with Trend of Regional Fracture Control

Batholith-Challis Fm. Contact

PLATE 4

RELATION OF DEPOSIT TO MAJOR FRACTURE SET AND BATHOLITH-CHALLIS CONTACT

SCALE:

0 1 2miles

(B. F. Kern, 1958)

Plate 4 also indicates the distribution of the deposits relative to the contact between the Idaho batholith and the Challis Formation. Detailed study of some deposits reveals that the uranium is controlled by N 45° W fractures. In other deposits, northeast fractures are a local control; the structural control in still other deposits is undetermined. In summary, the distribution of the deposits in the area and the distribution of the ore in many deposits are controlled by northwest-trending fractures. The presence of fractures is considered essential to ore formation.

Another control which was operative is host-rock control. The term host-rock control as used in this report includes stratigraphic control and lithologic control, because preferential hosts for uranium deposits include both sedimentary and igneous rocks. The most common host rock is arkosic conglomerate, which occurs at or near the base of the Challis Formation. Several of the more promising deposits are in arkosic conglomerate, and it seems to offer favorable conditions for uranium concentration. Other rocks which act as hosts are the silicic intrusive rocks. None of the known deposits in silicic intrusive rocks have an apparent ore potential, but the preferential location of uranium in these rocks is important to future exploration. An exposure which illustrates how uranium tends to concentrate in silicic intrusive rock is on the Lower Harden claims. A narrow aplite dike which intrudes the batholith is exposed just above the Lower Harden Creek road. Northeast-trending fractures cut the aplite and the enclosing quartz monzonite. The fractures are essentially barren where quartz monzonite is the wall rock, but small pods of highly mineralized material occur at the intersections of the fractures and the aplite dike.

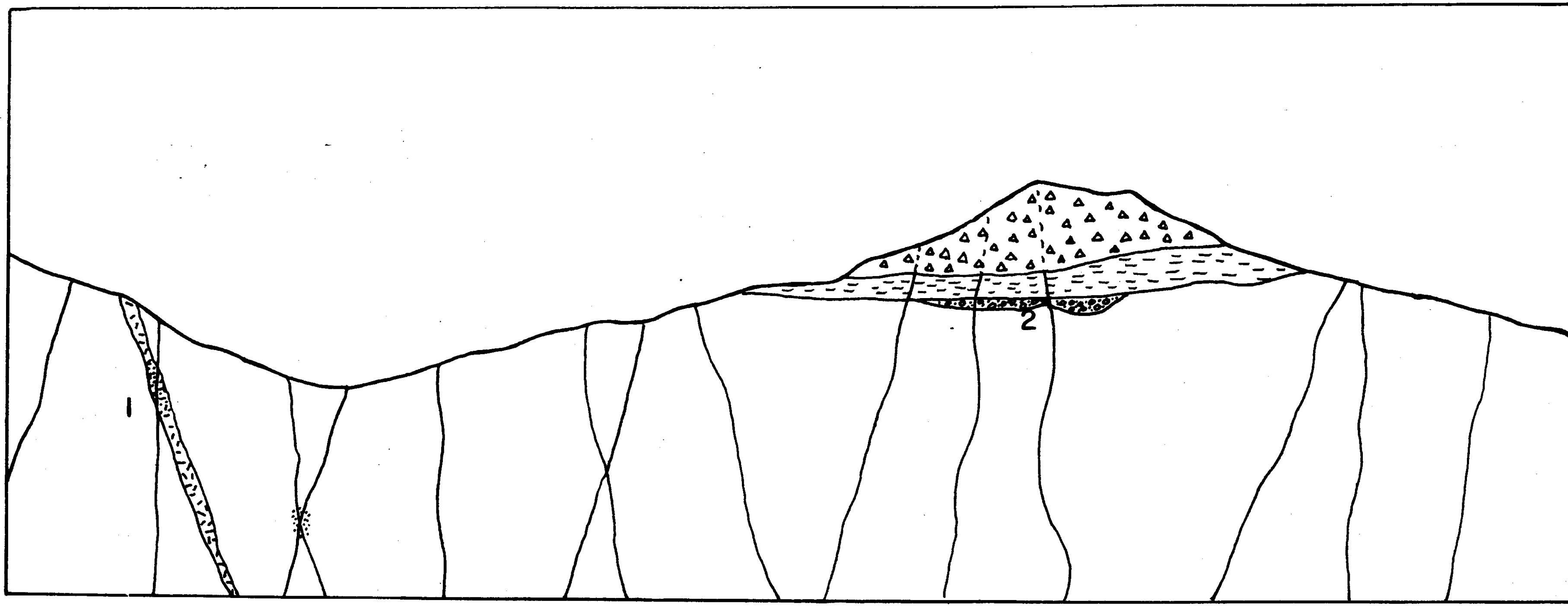
The recognition of the ore controls in the Stanley uranium area is of academic and economic importance. Fractures, especially those belonging to the northwest set, were channels for the rising ore-bearing solutions. Fractures are the principal control and are essential to ore formation. If a favorable host rock such as the arkosic conglomerate is intersected by these fractures, an especially favorable environment for an ore body is created. The presence of a favorable host rock, however, is not essential to ore formation. Several attractive prospects are fracture-controlled deposits in granitic rocks; the nature of the wall rock does not appear to have been important.

MINERALOGY

Supergene uranium minerals are found above the water table in the Stanley area. The supergene (secondary, oxidized) minerals occur as small, soft, bright-green and yellow grains; some are fluorescent. In some of the deposits, supergene minerals are disseminated through the rock; in other deposits, they form coatings on pebble surfaces and fracture surfaces. The following supergene minerals were identified by microscopic and X-ray analysis:

phosphuranylite-renardite $Ca(UO_2)_4(PO_4)_2(OH)_4 \cdot 7H_2O$ -
$Pb(UO_2)_4(PO_4)_2(OH)_4 \cdot 7H_2O$

autunite $Ca(UO_2)_2(PO_4)_2 \cdot nH_2O$



EXPLANATION

- Volcanic Rock
- Fine-Grained Sedimentary Rock
- Arkosic Conglomerate

(Volcanic Rock, Fine-Grained Sedimentary Rock and Arkosic Conglomerate: Challis Formation)

- Silicic Dike
- Quartz Monzonite
- Fracture
- Mineralized Rock

LOOKING NORTH

Approximate Scale

0' 500'

PLATE 5

HYPOTHETICAL CROSS SECTION

Localization of Uranium in

1. Silicic Intrusive Rock

2. Arkosic Conglomerate

(B.F. Kern, 1958)

Considering the multitude of secondary uranium minerals which are known, it is significant that the minerals recognized in the Stanley ores are so similar chemically. Other secondary minerals not identified in the oxidized ore studied are probably present in the Stanley area, however.

The depth to which supergene uranium minerals will persist varies in different deposits. The major controlling factors are the permeability of the host rock and gangue material, and the position of the water table. The water table at one deposit forms a well defined plane of demarcation between rock which contains supergene uranium minerals and rock which contains hypogene uranium minerals. In most of the Stanley prospects, only supergene minerals have been exposed, and supergene minerals constitute the ore in some deposits.

The ore minerals in some deposits are hypogene ("primary," "unoxidized"). Ore from the East Basin deposit was selected for laboratory study. The ore in this deposit is in a soft, dark gray and white, noncalcareous, arkosic conglomerate. Fine-grained silvery sulfide minerals are disseminated through the ore; white, highly argillized zones in the ore are the most radioactive. The East Basin ore was crushed in a hand mortar. The heavy minerals were selected by panning and examined under the binocular microscope. Black euhedral crystals with an octahedral habit and a greasy luster were identified as uraninite. The dominant non-radioactive heavy mineral occurs in finely crystalline, silvery white aggregates; it was identified as marcasite. Bornite is sparingly present. Marcasite and uraninite constitute almost the entire heavy mineral fraction; the two minerals are commonly mixed together in an aggregate of tiny crystals. The ore minerals appear to have been precipitated contemporaneously.

In order to determine the distribution of the ore minerals, a second sample of ore was ground and screened. The weight percentage and radiometric assay of each screen fraction are reported below:

Radioactivity of Size Fractions of Crushed East Basin Ore

Size	Weight (grams)	Percent of Total Weight	Radiometric Assay (percent equivalent U_3O_8)
+35	620	57.3	0.156
-35+48	119	11.0	0.169
-48+65	105	9.7	0.180
-65+100	50	4.6	0.200
-100+150	38	3.5	0.228
-150	150	13.9	0.274
Total	1,082	100.0	
			weighted average 0.172

The data from the table, supplemented by microscopic examination, indicate that the uranium minerals are not concentrated in any size fraction. However, the radioactivity is greater in the smaller sizes, with an inverse relation between size and radioactivity which is not far from constant.

Microscopic examination reveals that marcasite is more abundant in the larger sizes.

The ore was assayed for uranium oxide, copper, nickel, and cobalt. The U_3O_8 content is 0.442 percent by chemical assay and 0.30 percent by radiometric assay. Although the heavy minerals gave a positive reaction for nickel when tested with dimethylglyoxime, and bornite was recognized microscopically, the assay indicates that neither copper, nickel, nor cobalt are present in the ore.

The material tested is the first hypogene ore exposed for mining in the Stanley uranium area. The material may not be representative of the entire deposit, but these few tests do suggest certain characteristics of this particular ore and possibly of similar ores yet to be developed in the Stanley uranium area:

(1) Most of the ore minerals occur as discrete grains rather than being intimately dispersed in gangue.

(2) The ore minerals are distributed through a wide range of sizes; care must be taken at all stages of mining and milling to save the fines.

(3) The uranium in the fines may be difficult to extract.

AGE AND ORIGIN

Observations made during this investigation support the conclusion that the uranium deposits were contemporaneously formed from a common source of ore-bearing fluids. (Later-formed supergene minerals are present and further exploration may reveal that a certain amount of enrichment by secondary processes has taken place in some deposits.) The evidence which supports a hydrothermal origin of the ores is as follows:

(1) Some of the deposits are veins. Uranium in one vein has been found in underground workings 250 feet below the outcrop of the vein.

(2) Some veins have chalcedony gangue, and the host rock is chalcedonized.

(3) Crystalline uraninite, stibnite, and marcasite are present in some ores. These minerals are considered in this case to be primary (Dana and Ford, 1949, p. 411, p. 438-439).

(4) The host rocks have been hydrothermally altered.

(5) In at least one deposit in which the host rocks are sedimentary, sulfide minerals, uranium minerals, and alteration minerals are found in fractures in the granitic rock below the ore.

(6) The deposits are fracture-controlled.

The deposits have certain characteristics in common. Of these common characteristics, the following are offered as evidence of synchroneity of the deposits:

(1) The deposits are grouped together in a relatively small area.

(2) The deposits have the same ore controls.

(3) The deposits occur at approximately accordant elevations.

Because the ore is hydrothermal, it must be younger than the rocks in which it occurs; therefore the ore is younger than the sedimentary rocks at the base of the Challis Formation. No evidence is found to indicate that the ore is younger than the volcanic rocks of the Challis Formation which overlie the sedimentary rocks. Thus the uranium deposits are considered to be approximately the same age as the volcanic rocks of the Challis Formation. This in turn suggests that the ore was formed during the mid-Tertiary metallogenic epoch generally recognized to have taken place in south-central Idaho, in which the metallizing activity is thought to be associated with the Challis volcanism (Anderson, 1948, 1951; Ross and Forrester, 1958, p. 51). A point worthy of consideration is that the known deposits are near the periphery of the Challis volcanic mass. It seems that if the magma which produced the volcanic rock is the same magma which produced the uranium solutions, the uranium deposits would be nearer the central part of the volcanic mass, nearer the source of the volcanic rock.

The fact that uraninite is recognized in some of the ores indicates that the age of the uranium deposits might be determined by radioactive dating. Not only would the age of the primary uranium mineralization be revealed, but a standard would be provided with which to compare the relative ages of associated rocks and perhaps the ages of other ores of the same metallogenic epoch. A significant contribution to the knowledge of the geology of south-central Idaho would thus be made.

The great disparity between chemical and radiometric assays of some samples cannot be explained. Assiduous sampling and assaying to determine equilibrium relations may result in a better understanding of the age and geochemistry of the Stanley uranium deposits. Clay minerals and a small amount of sericite are the only alteration minerals observed. Thus the alteration must have operated at low to medium temperatures. The uraninite and marcasite crystals and grains are commonly a fraction of a millimeter in diameter, and are euhedral to subhedral. Most of the ore grains break free from the host rock and they must have been precipitated under low pressure conditions. The chalcedony gangue in many deposits and the stibnite in the Alta vein are indicative of low temperatures and pressures (Dana and Ford, 1949, p. 411). Finally, the geologic history of the Stanley area as interpreted in this report provides that the uranium-bearing solutions were introduced after subaerial erosion of the Idaho batholith, when no great thickness of Challis rocks was present. According to the observations described above, the uranium deposits are of epithermal, or perhaps leptothermal, origin.

Gruner (1956), Miller (1958), and others have shown that several soluble uranyl complex ions are stable over a wide range of temperatures, pressures, and hydrogen ion concentrations. Their experiments further show that uranium dioxide (uraninite) is precipitated in the presence of reducing agents. It seems quite likely that the uranium in the Stanley deposits was transported as uranyl complex ions in aqueous solutions which were not very hot and were neither extremely acidic nor extremely alkaline. The presence of contemporaneous marcasite is compatible with this hypothesis, for Dana and Ford state that "At ordinary temperatures, (marcasite) may be deposited from nearly neutral solutions." Gruner (1956, p. 503), in reference to the uranium deposits of western United States, says that "Pyrite or marcasite is always present in the unoxidized uraniferous beds." Media which could precipitate the uranium from solution are abundant, especially in the arkosic conglomerate. The arkosic conglomerate is more permeable than the underlying granitic rocks and the overlying fine-grained clastic and pyroclastic rocks. Thus the uranium-bearing solutions would tend to spread laterally and disperse, and the temperature and pressure would be decreased. The loose, granular nature of the arkosic conglomerate, as well as the presence of soft, spongy, altered feldspars, would greatly increase the area of rock surface in contact with the solutions. Finally, carbonaceous material and perhaps organically generated H_2S in the arkosic conglomerate would also act as effective precipitants for the uranium (Gruner, 1956, p. 514; Miller, 1958). It is quite possible that circulating ground water may have accomplished some redistribution of the uranium in the arkosic conglomerate; all the uranium in any one part of the bed, probably was not supplied by the immediately adjacent fractures.

The solutions which deposited uranium in veins in granitic rock were probably hotter and more alkaline than the solutions which spread laterally through arkosic conglomerate. Stibnite, present in the Alta vein, is deposited by low temperature alkaline waters (Dana and Ford, 1949, p. 411).

ECONOMIC POTENTIAL

In any discussion of economics of uranium deposits, the nature of the market must be taken into consideration. The uranium ore market is one based not so much upon supply and demand as upon government decree. In the following discussion, it is assumed that the reader will make whatever adjustments are necessary according to the market conditions in effect. Whatever the conditions, however, a deposit, in order to be economic, must meet two fundamental requirements:

(1) The quality of the ore must be such that it meets the standards established by the buyer and returns a profit to the mine operator.

(2) The quantity of the ore must be sufficient to justify the necessary expenditures preparatory to producing the ore, as well as the direct and indirect costs of the mining operation.

The quality of the ore produced from the Stanley uranium area through 1958 meets the requirement. The grade and extraction characteristics of the ore were sufficient so that the ore was acceptable at the mill. Ore of good grade can be blended at the mill with low-grade ore, thus increasing the mill's production of concentrates, from which its profits are derived. Therefore, medium- and high-grade ores are generally in demand, providing they are amenable to economic extraction of the contained uranium. Any increase in the grade of the Stanley ores would be very beneficial; not only would the demand for the ore be greater, but the federal ore-buying schedule favors ore of a higher grade. For example, the value of a ton of ore containing 0.20 percent U_3O_8 is $16.00 and ore containing 0.40 percent U_3O_8 is worth $35.00; the value increases at a rate greater than that of the grade.[1] Thus a tenor substantially higher than 0.20 percent U_3O_8 will have to be maintained if more than small operations dependent upon the U. S. Atomic Energy Commission bonus are to be expected.

The second requirement, a sufficient quantity of ore, has not yet been met in the Stanley uranium area. Proved reserves are very small. However, exploration has hardly begun, and it is my opinion that well-planned exploration will find more ore in the Stanley area.

Evidence available at the present early stage of exploration does not suggest that any individual ore deposit will be large. Where one or more dimensions of an ore body or potential ore body have been exposed, the dimensions are such that the deposit is not likely to contain more than a few tens of thousands of tons. It is conceivable that if several such ore bodies are found not far apart, they could best be mined by the same operator as if they were separate stopes or pits in a large mine. If up-grading becomes feasible, lower grades of ore will become commercial and the reserves may be greatly increased.

One further economic aspect that should be considered is the possibility of up-grading the ores to a high-grade concentrate before shipment to the mill. By this means, large reserves of sub-marginal ore can become smaller reserves of valuable shipping product. Only in the case of uranium ore, with its skewed price schedule, is it possible to mine ore at a loss and still realize a profit from its sale. For example, ore containing 0.10 percent U_3O_8 is worth $4.00 per ton, probably less than the cost of getting it out of the ground. One hundred tons has a value of $400. If the ore is mined and up-graded to 1.00 percent U_3O_8, the value becomes $94.50 per ton, or $945 for the ten tons of concentrate. Thus, the gross value of the shipping product has increased to nearly 250 percent of its original value. Of course this example ignores the costs of the up-grading process and assumes 100 percent recovery; nevertheless, the implications are manifest. Naturally, some ores are not amenable to economic up-grading. When and if an ore reserve is developed which is

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[1] All values quoted include the development allowance but do not include a production bonus nor a haulage allowance. Ultimate ore values should be ascertained according to the operator's contract with the mill and according to the prevailing U. S. Atomic Energy Commission schedule.

sufficient to justify the necessary capital expenditure, metallurgical investigations can be made to determine whether or not up-grading is feasible. If the potential profit is great enough, a practical method can probably be developed. Thus it resolves that if up-grading is applicable to the Stanley ores, the mining economics of the area will be considerably modified. The fundamental requirement -- an adequate reserve of reasonably uniform grade -- remains.

There are no supply centers or rail facilities in the immediate Stanley area. Living accommodations are scarce in the summer season and living costs are high. The severe winters will present problems. These factors will add to the operating costs, and a relatively good grade of ore will be needed in order to return a reasonable profit to the operator.

MINES AND PROSPECTS

Bell Cross

The Bell Cross group of claims is in the SE 1/4 sec. 3, T 11 N, R 13 E, on the east slope of the long hill near the western boundary of the Stanley uranium area. The eastern contact of a large silicic intrusive body passes through the claims. The group is joined on the north by the H and M group. There are sixteen Bell Cross claims. The claims have mutual sidelines and the center lines trend easterly. The claims are owned by the Bell Cross Corporation; among those who hold interests are Virgil Cross, Robert Belini, and John Halverson. The Bell Cross was the second uranium prospect located in the Stanley area, and its discovery caused considerable local excitement.

The Bell Cross claims are accessible from the road which leads up "Sawmill" Creek from Kelley Creek. About one mile from Kelley Creek, the road leaves the stream and climbs the ridge to the west.

Several discovery and development pits are on the property. The largest pit is at the end of the access road. The pit is more than 200 feet long and 100 feet wide at the center; the deepest point is 15 feet deep. The collars of two drill holes can be seen in the northwest wall of the pit. There is perhaps a ton of broken rock piled in the pit which could be shipped as ore.

The locality is one in which deeply weathered quartz monzonite is cut by aplite and granite porphyry dikes, as well as reddish to yellowish brown chalcedony veinlets. The rocks have been highly silicified. Four sets of fractures are exposed in the large pit: (1) N 46° W, dipping 87° N; (2) N 60° E, dipping 64° N; (3) north, dipping 61° E; and (4) N 15° E, dipping 83° E. The fractures and uranium minerals are younger than all exposed rocks.

Four mineralized fractures which belong to the N 45° W set are exposed in the large pit; the wall rock of each fracture is aplite and the gangue is brown chalcedony. The widest vein exposed is less than one foot wide. A chip sample across the vein contains 0.60 percent

$_{ch}U_3O_8$ and 0.73 percent $_eU_3O_8$.[1] The vein is exposed on two levels in the main pits for a vertical distance of 13 feet. The vein is narrower on the upper level. The two diamond drill holes are collared in the outcrop of the vein; the operators apparently attempted to drill straight down the vein. Mineralized chalcedony and chalcedonized porphyry and aplite are exposed in shallow pits for 2,000 feet to the northwest. A grab sample of chalcedonized aplite from one of these pits contains 0.08 percent $_eU_3O_8$. Mineralized rock is probably not continuous through the entire 2,000 feet, and none of the shallow pits expose a commercial ore shoot.

In summary, uranium mineralization was localized by northwest fractures. Aplite and granite porphyry were the most susceptible host rocks. Only short, narrow shoots of ore grade material are present along the widest vein, suggesting that if ore is present at depth it will be narrow and spotty. The rock in the locality is silicified. Very selective mining in the large pit might be able to produce a few tons of shipping grade ore. Ore in significant amounts is not exposed and there is no apparent reason to expect it to be present at depth.

H and M

The H and M group of 16 contiguous claims in sec. 3, T 11 N, R 13 E adjoins the Bell Cross group on the north, and may be reached by jeep or truck via the Bell Cross road. The claims were filed on the 16th of August, 1957, by John Halverson and Kenneth Morgan of Jerome, Idaho. A series of five bulldozer cuts aligned in a northwest direction constitutes the development. The largest cut, at the southeast end of the series, is 100 feet by 25 feet by 10 feet. There has been no production from the H and M group.

The rock exposed in all pits is aplite so highly silicified as to resemble a quartzite. Some "limonite" staining is present, and a few chalcedony veinlets may be seen. Fractures are abundant; fractures of six different local sets are noted. Rocks on the H and M claims are more intensely fractured and silicified than the rocks on the adjacent Bell Cross claims. A prominent fault zone strikes N 45° W and dips 79° S. Most of the fractures in the zone strike N 11° W or N 45° W and dip from 40° to 80° east or west. Cross-faults are also present; a prominent one is exposed in the large pit.

No ore is exposed, and the rock in the bottom of the large pit is only slightly anomalously radioactive. The general geologic relations are similar to those on the Bell Cross claims, and the rock is more intensely silicified than the rock on the Bell Cross claims. Thus, if it is assumed that the silicification is related to uranium mineralization, further prospecting of the H and M claims would be justified. Valuable information might be gained from one or two holes drilled to intersect the fault zone below the bottom of the large pit.

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[1] percent $_{ch}U_3O_8$ = percent U_3O_8 by chemical assay
percent $_eU_3O_8$ = percent equivalent U_3O_8 by radiometric assay.

Main Diggings

The Main Diggings claims, in sec. 11, T 11 N, R 13 E, lie on an oval-shaped ridge which separates the two forks of "Sawmill" Creek. Several signs along the access road indicate that the claims were filed by E. K. Evans, Box 24, Ketchum, Idaho. The principal development is on the Main Diggings No. 3 claim, which is reached via a branch road leading south from a point about two miles up the Potato Hill road from "Sawmill" Creek. There are several bulldozer cuts, as much as 150 feet long, distributed along the east and southeast side of the ridge. No production is recorded from the claims.

The pits expose iron-stained silicic intrusive rocks, cut by chalcedony veinlets. A weak radioactivity anomaly is present in most of the pits. Northwest fractures are the most prominent. It appears that geologic relationships on the Main Diggings claims are similar to those on the Bell Cross claims: uranium-bearing chalcedony veinlets in silicic intrusive rocks are the source of the radioactivity. There is no evidence of an ore potential on the Main Diggings claims.

Enterprise

The Enterprise group of 16 claims is on the east flank of Potato Mountain in sec. 2, T 11 N, R 13 E. The claims were filed by A. W. Schrank and were controlled in 1958 by the Phillips Petroleum Company. There has been no production from the Enterprise claims. The development consists of three bulldozer pits and a drift. The pits expose a prominent mineralized fault zone which strikes northwest and dips northeast. The drift was driven along the fault zone from a point 450 feet southeast of the highest pit. The face of the drift is approximately 250 feet down the dip of the fault zone below the highest pit. The drift is 7 feet by 8 feet in cross section and 450 feet long; it has 30 feet of cross-cuts at the face. The drift was driven by Brown Brothers, of Hailey, Idaho, on a contract from Phillips Petroleum.

The fault zone, where exposed in the highest pit, strikes N 50° W and dips 68° N. The country rock is quartz monzonite and aplite crops out 40 feet southwest of the pit. The fault zone has a strip of gouge 3.2 feet wide, which is three times more radioactive than background.[1] The greatest radioactivity, 5 X background, comes from the two feet of gouge next to the footwall. Exposures in the other two pits are similar. At the portal of the drift, the fault zone strikes N 40° W, and the strike changes by a few degrees at various places in the drift. The hanging wall of the fault zone is quartz monzonite, and the footwall is gouge and breccia. A few pegmatite stringers are present. No anomalous radiation had been detected at the time of my last visit, and the drift was straight down-dip from the radioactive surface exposure. However, the drift had generally followed the hanging wall, and the strongest radioactivity at the surface is next to the footwall. Later, a cross-cut was driven into the footwall block, and a narrow, highly mineralized veinlet was intersected. The veinlet was short, and did not

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Hereafter in this report, radioactivity will be indicated as "n X background."

constitute ore. It should be remembered that the fault zone, where exposed at the surface, did not contain ore; it was only mineralized. Furthermore, the shoot may have a pitch to the northwest and would not be present directly down-dip from its surface exposure. It would not be judicious, simply on the basis of this experience, to conclude that uranium mineralization does not have persistence at depth in the Stanley area.

Baker and Potato Hill

The Baker and Potato Hill claims are near the NW cor. sec. 1, T 11 N, R 13 E. The claims are on a ridge which intersects Basin Creek about one-fourth of a mile north of "Hay" Creek. The five Baker claims and two Potato Hill claims were filed by Jerry Korfist, Box 75, Baker, California. No ore has been produced.

Several bulldozer cuts, four to eight feet deep, are present. The cuts expose more pegmatite than was seen anywhere else in the Stanley area. No anomalously radioactive rock was found, however. The shallow excavations yield little geologic information, and the bedrock outside the pits is covered. Because I was unaccompanied by anyone familiar with the property, it is possible that important features were not seen.

Lightning, Aspen, and Copperite

The 61 Lightning, Aspen, and Copperite claims are in secs. 1 and 12, T 11 N, R 13 E; they form a strip 3,000 feet wide along Basin Creek, and a strip 1,500 feet wide along "Hay" Creek. A road leads up Basin Creek as far as "Hay" Creek. The claims were staked by Bill Brooks and Melvin Peterson of Hailey, Idaho, and were held in 1958 by the Western Fluorite Mining Company. A carload of ore was shipped August 7, 1957.

Development has been concentrated in the vicinity of the juncture of "Hay" Creek and Basin Creek. Two large cuts have been made, one high on the ridge north of "Hay" Creek and one just above creek level on the south side of "Hay" Creek. Both of the cuts expose uranium-bearing batholithic rock. In addition, several cuts to the north, along Basin Creek, expose rock which is anomalously radioactive, especially where aplite dikes are present.

The fracture pattern of batholithic rock in the vicinity of the two large Lightning cuts near the juncture of the creeks is unusual. South of "Hay" Creek, the dominant set of fractures strikes northwest, as in other parts of the Stanley uranium area. North of "Hay" Creek, the most prominent fractures strike west and dip north. The origin of the important local fracture set is probably related to the dark intrusive Challis rocks which support the ridge north of "Hay" Creek. The rocks form necks and plugs, quite possibly connected by dikes. Lava covers the lower slopes of the ridge. Where the ridge meets Basin Creek, the flows and necks give way to two porphyry dikes which trend across Basin Creek and beyond. The local dominance of westerly striking fractures was probably caused by the intrusion of the necks and plugs.

In the upper pit, north of "Hay" Creek, the dominant fractures strike N 70° W and dip 70° N. A narrow aplite dike which strikes west is exposed in the pit, at the north edge of the now-removed 50-ton ore body. The aplite may have had some influence in localizing the ore body. Secondary uranium minerals coat fractures in the batholithic rock. The tenor of the ore is thought to have been near 0.25 percent U_3O_8. The rocks in the pit are stained to some extent by "limonite." A sample of selected ore remaining in the pit contains 0.37 percent $_{ch}U_3O_8$ and 0.45 percent $_eU_3O_8$.

On the south side of "Hay" Creek, the lower Lightning cut exposes significantly mineralized granodiorite. The face of the cut is 12 feet high. The dark greenish gray granodiorite is relatively unaltered. The uranium ore is fracture-controlled. The common northwest and east-northeast fracture sets are present, as well as the local west set. The west set is not as prominent as the northwest set, presumably because the cut is more than a thousand feet from the Challis intrusive rocks. Movement has taken place along northwest and west fractures. A wide fault zone which strikes N 37° W and dips 65° W is strongly radioactive. The zone is composed of a series of slickensided parallel faults with little or no gouge. The amount of displacement is not known. The mineralized portion of the zone begins at a prominent fault near the footwall. Across a width of three feet toward the hanging wall, the radioactivity is greater than 20 X background. (No allowance is made for mass effect, and this three feet of the zone is cut back into the face a short distance.) For sixteen feet across the zone, the radiation exceeds 10 X background. It appears that most of the uranium minerals coat fracture surfaces. Therefore, only a very large sample would be representative. However, a three-pound sample of typical ore contains 1.06 percent $_{ch}U_3O_8$ and 1.00 percent $_eU_3O_8$. The high uranium content of the sample, strengthened by the very anomalous radioactivity through a considerable width in the zone, indicates that further development is certainly warranted. The hard rock without visible gouge or water should not be difficult to drill; inclined holes drilled from the hanging wall to intersect the zone at depth might give, with comparative simplicity and economy, sufficient information to evaluate the potential of the prospect. The zone should be tested at depth and along strike with drilling or underground exploration or both.

In conclusion, granitic rock of the Idaho batholith is significantly mineralized at the lower Lightning cut on "Hay" Creek, and further exploration of the mineralized zone is economically justified. One major reason that uranium minerals have precipitated in commercial quantities at this locality may be because of the unusual fracture pattern. If northwest fractures were the channels which guided the ore-bearing solutions, the rather sudden appearance of west-striking fractures in dominance may have triggered precipitation of uranium minerals. The change in the physical environment of the solutions may account for the uncommon occurrence of ore-grade material where there is no important change in rock type.

Shorty

The Shorty group of 12 claims is in secs. 7 and 8, T 11 N, R 14 E. The claims were reached in the summer of 1958 by climbing the ridge between Short Creek and East Basin Creek, and walking about one-half mile to the northeast. A road was begun from Short Creek on September 10, 1958. The claims lie just south of the long fault which forms the contact between the Idaho batholith and the Challis Formation. The group is approximately 3,600 feet by 3,000 feet, and is joined on the east by the East Basin group. The first claims were staked by Harold R. Schafer on September 9, 1957; later, more claims were added by Bill Brooks and Melvin Peterson. The property was controlled in 1958 by the Sidney Mining Company. Development on the Shorty claims was limited at the time of my visit to a few shallow cuts, none of which penetrated bedrock.

Highly radioactive till containing secondary uranium minerals was exposed in two shallow cuts at the top of the ridge near the batholith-Challis fault contact. It seemed probable that the uranium minerals in the till were deposited by ground water, and that mineralized arkosic conglomerate underlies the till; arkosic conglomerate was not seen, however. A subsequent oral communication from Mr. Malcolm Brown, president of Sidney, indicates that uranium mineralization has been found in arkosic conglomerate, and that further exploration is planned.

Information available when I examined the prospect was meager. It appears, however, that a bed of arkosic conglomerate is present beneath a veneer of glacial debris at an elevation of 7,400 feet on the Shorty claims. The arkosic conglomerate has been mineralized, and the deposit is probably similar in origin to the East Basin and Coal Creek deposits.

East Basin

The East Basin claims lie on both sides of East Basin Creek in secs. 8 and 17, T 11 N, R 14 E. The claim centers trend normally to the creek and form a group whose boundaries are 1,500 feet east and west of the creek, near the ridge tops. The group is nearly two miles long. The south portion is joined on the west by the Shorty claims and on the east by the Lucky Strike group. A fair road leads up East Basin Creek as far as the East Basin No. 1 mine. The claims were staked by Jerry Korfist of Baker, California, and are now controlled by the Western Fluorite Mining Company.

Development work has been concentrated on the East Basin No. 1 claim. Three bulldozer cuts were made in the west slope above the creek. A small bench was later cut by hand, and evidence of appreciable uranium mineralization was revealed. Another bench, 35 feet wide and over 100 feet long, was cut above the first bench, and ore was ready to be stripped from the floor of the large bench when the field investigations were completed (Pl. 6). By the time mining operations were halted for the winter, approximately 1,300 tons of ore containing 0.21 percent $_{ch}U_3O_8$ had been shipped to Salt Lake City for milling (oral communication, Mr. Henry Childs).

The southern part of the group overlies batholithic rocks. Farther north, Challis volcanic rocks crop out on the slopes, and descend to the floor of the valley a short distance north of the East Basin No. 1 mine. Uranium minerals in arkosic conglomerate at the base of the Challis Formation are exposed in the cuts on East Basin No. 1, and arkosic conglomerate is the ore bed in the mine (Pl. 6). The rock below the ore is a highly-altered porphyroblastic quartz monzonite. A gray-green equigranular granodiorite is in fault contact with the quartz monzonite 100 feet south of the ore bench.

The section of sedimentary rock above the ore-bearing arkosic conglomerate is illustrated in Plate 6, which is a scale drawing of the wall of the ore bench. The drawing indicates the lenticular, cut-and-fill structure of the rocks. The greater part of the sequence is composed of beds of poorly indurated tuffaceous sandstone, sandstone, and siltstone. Lignite is abundant. Coarse channel fillings are common. Minor faulting is present. Attitudes are erratic, but the composite dip seems to be northeast. The sequence is at least 100 feet thick.

The four-foot bed of arkosic conglomerate at the base of the sequence is uniformly mineralized through its exposed length. The conglomerate is highly kaolinized and very soft. Above the water table, secondary uranium minerals are common enough to effect a distinct yellow-green coloration of the rock in some places. Below the water table, only hypogene uranium minerals are present, and the rock is a mottled dark gray and white. Uraninite and marcasite are the dominant metallic minerals. A sample of oxidized ore contains 0.04 percent $_{e}U_3O_8$; a large sample of unoxidized ore contains 0.442 percent $_{ch}U_3O_8$ and 0.29 percent $_{e}U_3O_8$. Because of the higher grade of the unoxidized ore, leaching of uranium may have taken place above the water table. However, many more samples would have to be cut, as more ore is exposed, to establish that leaching, and perhaps enrichment, processes have been operative.

The lateral extent of the ore is not known. The ore is cut off at the surface by a fault on the west and the inferred underground relations are shown in Plate 8. The depth to ore increases toward the east, because the beds dip northeast. The arkosic conglomerate is not thought to be a continuous bed, and the lateral extent of individual bodies of arkosic conglomerate is not expected to be large; however, what is a small body of a sedimentary unit will be a large body of ore if it is uniformly mineralized. Presently available information does not permit reliable tonnage estimates; the thickness of the arkosic conglomerate bed suggests that the ore body probably does not contain more than several thousand tons of ore.

Many vertical fractures, less than one inch wide, are exposed in the quartz monzonite below the ore. The fractures are radioactive and contain sulfides. The uranium-bearing solutions rose along the fractures; when they entered the arkosic conglomerate, they spread laterally and precipitated hypogene ore minerals. Ground water may have redistributed the ore in the conglomerate. Subsequent oxidation produced the supergene minerals above the water table. No wide ore-bearing fracture has been found.

The ore body may present certain mining problems. The ground, being both soft and wet, will probably require considerable support if underground methods are used. The low degree of induration of both the ore and the overburden suggests that mining by open benches may be the best method; little if any blasting would be needed, and the ground seems to hold a fairly steep face without sloughing. Directly behind the bench, the slope of the hill is rather gentle for some distance; a sizeable tonnage of ore could be removed with a stripping ratio on the order of 12 to 1. The ratio will vary according to the trend of the ore. Before the mining method is planned, the trend and structural relations of the ore should be determined by drilling. This is especially important in a new prospect in a new area -- so little is known about the ore body. Also, the grade of the ore so far mined is marginal. The mining method must keep costs down and grade up, and it is necessary to know more about the ore body in order to engineer a mining method of optimum economy.

On the Uranus No. 1 claim, across East Basin Creek and at about the same elevation as the East Basin No. 1 mine, shallow pits expose uranium in tuffaceous sandstone. One exposure of barren arkosic conglomerate is present. The beds strike N 85° W and dip 30° N. The Uranus claims are part of the East Basin group.

Further investigation of the East Basin and Uranus claims is certainly justified. Such investigation should not be restricted to the known ore body; the entire locality should be prospected for beds of arkosic conglomerate similar to the ore-bearing bed in the East Basin No. 1 pit.

Lucky Strike

The six Lucky Strike claims are in the NE 1/4 sec. 17, T 11 N, R 14 E. The group is at the head of the short canyon between Coal Creek and East Basin Creek, at the contact between the Idaho batholith and the Challis Formation. The claims may be reached from the Coal Creek claims on the west by a steep trail. The group is 1,800 feet by 3,000 feet, and the center lines of the claims trend easterly. The claims were located by Bill Brooks and Melvin Peterson, and were held in 1958 by the Rare Metals Corporation.

Several low benches trending northwest have been cut above the trail, near the southwest corner of the group on Lucky Strike No. 1. The benches expose mineralized tuffaceous sandstone and arkose at the base of the Challis Formation. The Challis sedimentary sequence appears to be less than 50 feet thick. The mineralized bed is exposed in the benches for 70 feet. Twenty-eight holes, most of them less than six feet deep, were drilled. Radioactivity probing of the holes reveals that the bed is mineralized for at least 15 feet into the hill; holes farther down-dip are barren, but some of them are not deep enough to intersect the bed. The tenor of the ore is somewhat higher than 0.20 percent U_3O_8; a definite average has not been determined. Examination of cuttings from the drill holes indicates that two faults are present.

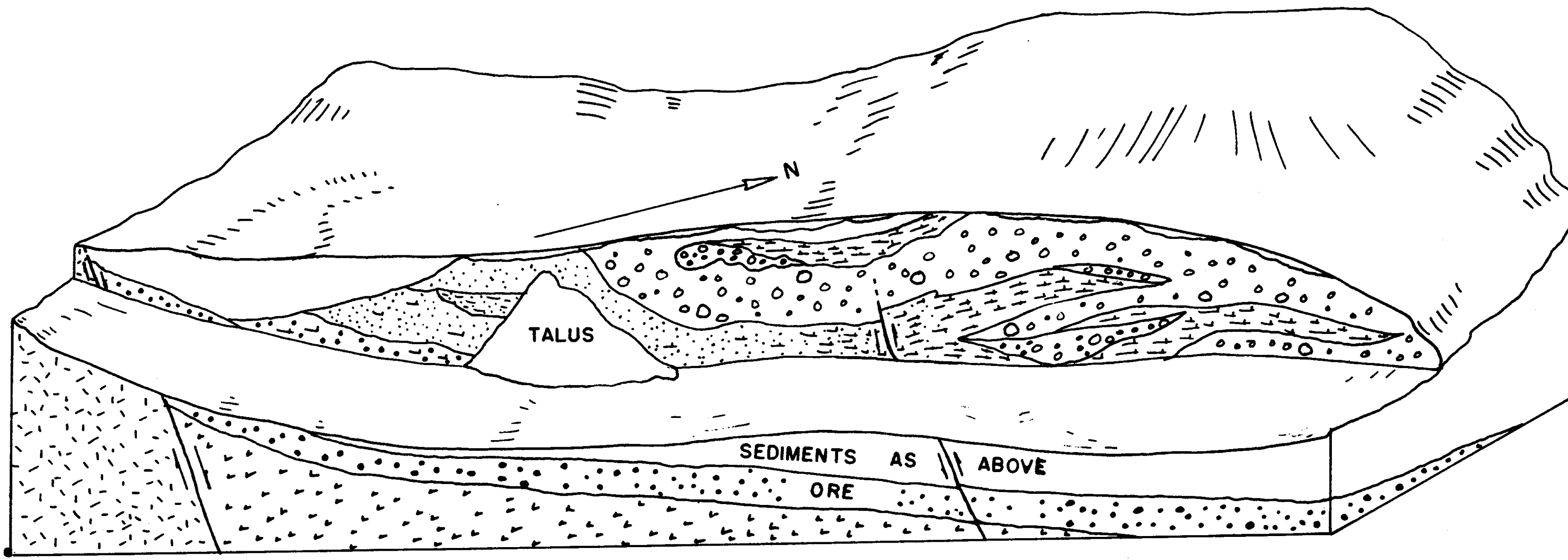
In summary, ore-grade mineralization is found at the base of the Challis Formation. An insufficient tonnage has been developed to warrant any immediate mining plans, and the prospect has several disadvantages which must be considered:

(1) The sedimentary rocks are limited in thickness and lateral extent; probably only a small volume of favorable host rock is present.

(2) The prospect is confined by steep slopes on three sides, posing difficulties for open pit mining.

(3) A high stripping ratio should be anticipated because the mineralized bed dips into a very steep slope.

Because of the disadvantages, the grade and tonnage of ore required to bring the Lucky Strike prospect into production are higher than for most



EXPLANATION

- Soil
- Sand & Sandstone
- Lignite
- Arkosic Conglomerate
- Mudstone
- Boulders & Cobbles
- Granodiorite
- Quartz monzonite

PLATE 6

BLOCK DIAGRAM

EAST BASIN ORE BENCH

(Subsurface inferred)

SCALE:

0' 20' 40'

(B.F. Kern, 1958)

prospects in the Stanley uranium area. Even if a small tonnage which could be mined economically should be developed, the ore could not be won until a haulage road is constructed.

Coal Creek

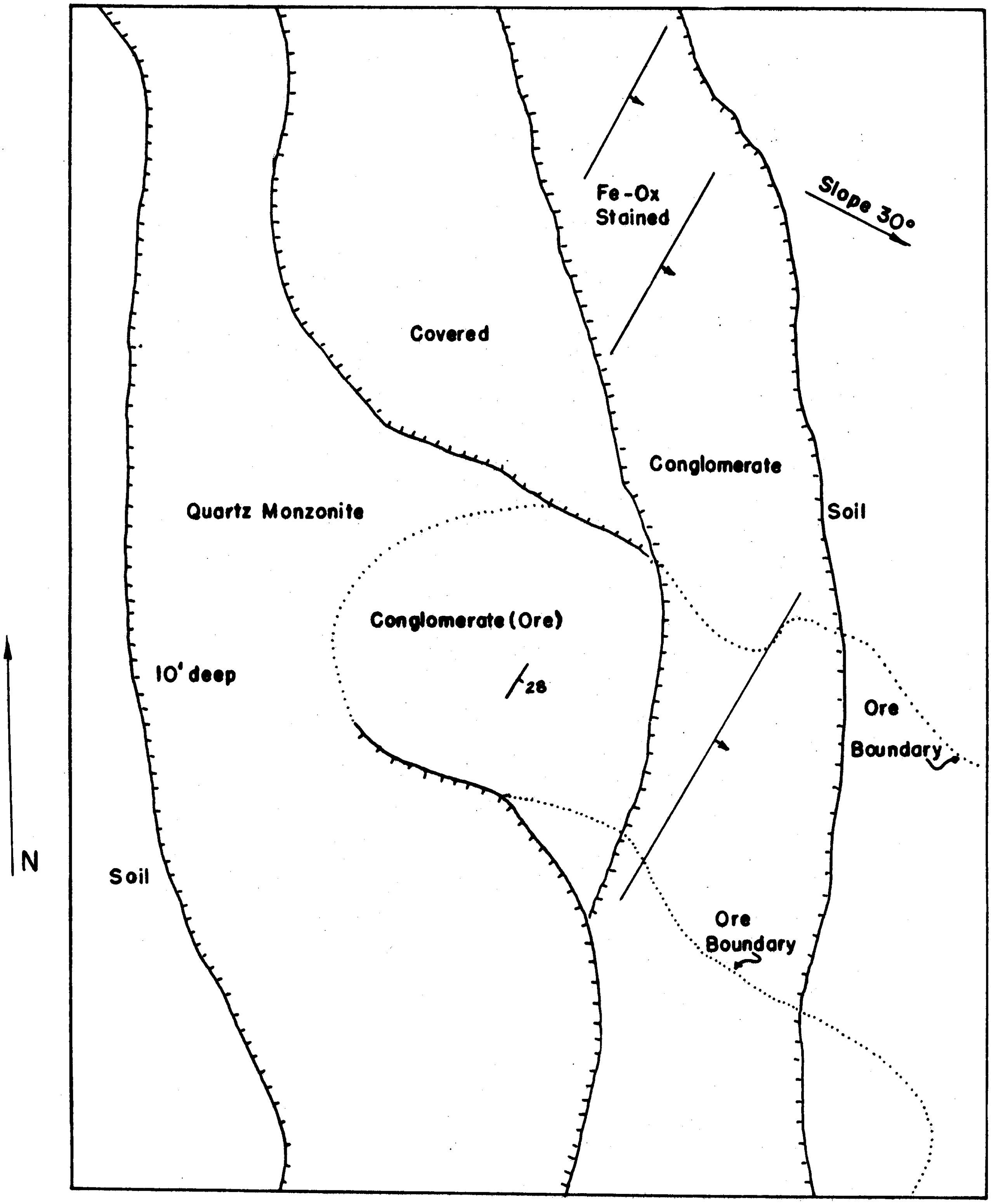
The Coal Creek claims lie on the top and east slope of the ridge west of Coal Creek, in sec. 16, T 11 N, R 14 E. A very steep road which branches off the Basin Creek road about 1.5 miles from U. S. Highway 93 provides access. The group is composed of the Coal Creek, Badger, and Deer Strike claims, a total of 14 claims. They were staked by Bill Brooks and Melvin Peterson and were held in 1958 by the Phillips Petroleum Company.

Development consists of two large pits on the Coal Creek No. 1 and Coal Creek No. 4 claims. Approximately 120 tons of ore had been shipped from the Coal Creek No. 4 pit at the time of the field investigations. The first carload assayed 0.36 percent U_3O_8 at the mill and the second carload assayed 0.21 percent U_3O_8. By the end of the 1958 summer operations, sixteen carloads of ore had been shipped, half from Coal Creek No. 1 and half from Coal Creek No. 4.

The host rock in the Coal Creek No. 1 pit is arkosic conglomerate. The bed rests on quartz monzonite, and tuffs and tuffaceous sedimentary rocks crop out in the road cut above the pit. The arkosic conglomerate displays little stratification and is poorly consolidated. Part of its lack of induration probably can be attributed to the alteration to which it has been subjected in the vicinity of the ore deposit. The rock is tinted with red and yellow iron oxides, and contains carbonaceous matter and gray clay. Iron-stained fractures strike west to northwest and dip steeply north. The ore-bearing portion of the arkosic conglomerate bed is outlined by an elongate pit from which the first ore was removed. The pit measures 80 feet by 12 feet, and the depth ranges from 2 feet to 5 feet. An eleven-foot channel sample cut in the bottom of the pit near its center contains 0.718 percent ${}_{ch}U_3O_8$ and 0.62 percent ${}_{e}U_3O_8$. A sample of stockpiled ore from the pit contains 0.10 percent ${}_{e}U_3O_8$. The sifting of fine, soft secondary uranium minerals downward during mining and transport of the ore may partially account for the disparity between the assays.

The arkosic conglomerate is moderately and uniformly kaolinized. The red iron-oxide staining is localized by fractures, and green autunite is visible along the fractures. Although the deposit is not large, it is easily and inexpensively mined by a stripping method; there is less than five feet of overburden and the ore requires little or no blasting.

The discovery pit of the Coal Creek No. 1 claim is 1,500 feet to the north. The ore-bearing rock is arkosic cobble conglomerate at the base of the Challis Formation. The very coarse texture, the heterogenous composition, and the lack of stratification in the conglomerate are indicative of channel fill deposits. The conglomerate strikes N 35° E and dips 28° SE. The strike is anomalous relative to other Challis rocks in the locality, and can probably be attributed to faulting. Attempts to



EXPLANATION

Dip and Strike of Strata

Dip and Strike of Faults

PLATE 7

COAL CREEK NO. I PIT

SCALE:

0' 30' 60'

(after D.G. Laub, 1958)

find a fault were unsuccessful. The slope of the ground conforms to the dip of the conglomerate in some places; the conglomerate is more resistant than the rocks above and below it. Jackhammer drilling has delineated the ore zone as shown in Plate 7. Drilling done since the map was made shows that the ore continues downhill, becoming wider and thicker. The terminus had not been reached at the time of the field investigations. A grab sample of the ore contains 0.31 percent $_eU_3O_8$. The Coal Creek No. 1 deposit probably is larger than the Coal Creek No. 4 deposit, and should yield at least several hundred tons of 0.20-0.30 percent U_3O_8 ore at a low mining cost.

Foolproof

The two Foolproof and three Abbie Lou claims are in the SE 1/4 sec. 21, T 11 N, R 14 E, 2,000 feet up the Basin Creek road from U. S. Highway 93. The claims were the first in the Stanley area to be staked for uranium. Several shallow cuts just above the Basin Creek road comprise the development. The claims were located by M. H. Patterson, John Benzer, and M. R. Knight, on September 3, 1955.

The country rock is quartz monzonite. A fault zone striking N 80° E and dipping 72° S is radioactive more than 3 X background. The zone consists of two parallel gougy faults separated by three feet of slightly altered quartz monzonite. The anomalous radioactivity disappears six feet along the strike of the faults to the east, and no other anomalous radioactivity was found. The portion of the claims west of Basin Creek was not examined. No production has come from the claims and they have no known reserves.

Hardee

The Hardee group of eight claims is in the S 1/2 sec. 10, T 11 N, R 14 E, on a ridge west of the west fork of Upper Harden Creek. The Coal Creek road extends as far as the Hardee No. 1 claim. The claim center lines trend easterly and the group is approximately 4,500 feet east-west by 1,800 feet north-south. The group is joined by the Alta claims on the east. The claims were located by Bill Brooks and Melvin Peterson and were later acquired by Phillips Petroleum. Bulldozer cuts and shallow drill holes comprise the development. Sixty tons of ore were shipped from the Hardee No. 3 claims after the field investigations were completed.

Excepting the ubiquitous aplite and pegmatite dikes, only granitic rocks of the Idaho batholith were found on the Hardee claims. On Hardee No's. 1 and 2, several narrow iron-stained fractures are mineralized. They strike northwest, and through exposed strike lengths of less than 15 feet, the radioactivity exceeds 10 X background.

On the Hardee No. 3 claim, an iron-stained fault which strikes N 15° W and dips 76° E is exposed in a bulldozer cut. It is a reverse fault with the west side downthrown. The radioactivity is greater than 10 X background for two feet across the fault. Approximately 100 feet to the north, the overburden had been stripped from a large area of anomalously radioactive, biotite-rich granodiorite. (A relatively flat-lying body of ore was subsequently drilled out which is 15 to 20 feet wide, at least 20 feet thick, and of unknown length.) A zone ten feet wide at the surface is 50 X background. A ten-foot sample cut by Mr. D. C. Laub assayed 0.25 percent U_3O_8, and a two-foot sample of the best ore assayed 1.5 percent U_3O_8. A check sample of representative ore which I cut contains 0.25 percent ${}_eU_3O_8$. This prospect appeared very promising at the time of the field investigation, and it subsequently yielded a carload of ore. Under the petrographic microscope, the granodiorite is seen to be brecciated. No ore minerals are visible, and the paragenetic relations between ore and allochemical biotite are not revealed.

More than 100 feet downhill from the ore body described above, there is a small body of radioactive reddish quartz monzonite aplite. Fractures in the aplite strike N 20° W and are radioactive up to 15 X background. A sample of the radioactive aplite contains 0.39 percent ${}_eU_3O_8$. Still farther downhill to the north, a small exposure of batholithic rock with no apparent alteration and no prominent fractures is as much as 30 times more radioactive than background.

In summary, different types of rock in different places on the Hardee claims are anomalously radioactive. North-northwest and east-northeast fractures are important ore controls. The presence of commercial ore, the widespread anomalous radioactivity, and the existence of strong fractures on the Hardee claims makes them worthy of further exploration.

Alta

The Alta group, on the hill between the lower forks of Upper Harden Creek, is in the NW 1/4 sec. 14, T 11 N, R 14 E. The group is joined on the east by the Little Spring claims and on the west by the Hardee group. The Lower Harden Creek road has been extended as far as the east fork of Upper Harden Creek; from that point it is a half-mile walk to the outcrop of the Alta vein. The six Alta claims form a group approximately 3,000 feet north-south by 1,800 feet east-west. In 1958 the claims were controlled by Jake and Alex Kerbs of Rupert, Idaho. There has been no production.

Development on the Alta claims consists of five shallow prospect pits along a conspicuous fault vein in the batholith. The fault strikes N 54° E and dips southeast; the dip ranges from 45° at the east end of the vein to 68° at the west end. Near the east end the fault cuts a pegmatite dike, and apparent displacement as indicated by the dike is right-lateral, with four feet of offset and five feet of overlap on the dike. The vein as exposed in the pits is from two to three feet wide and over 400 feet long. The vein is composed of dark and light gray chalcedony, with a silicified footwall gouge and a strongly-altered hanging-wall quartzite. There appears to be a sharp ore contact at the footwall, and an assay contact at the hanging wall. Blades of stibnite are interspersed in the chalcedony. Grab samples of stibnite-bearing chalcedony contain 2.492 percent ${}_{ch}U_3O_8$ (1.98 percent ${}_eU_3O_8$). The high assay of this material, though probably not representative of the entire vein, plus the strong radioactivity of the vein as a whole, indicates that stoping widths of commercial-grade material are present, at least in shoots. The vein is exposed along the flank of a hill; the dip of the vein is subparallel to the slope of the hill. Thus the vein could be tested at depth with inclined drill holes or an adit, located downhill below the outcrop. A bulldozer could peel away the hanging wall near the outcrop and expose a small tonnage for extraction from the surface. In short, the vein is so situated relative to the topography that it could be tested at depth with comparative simplicity, and if warranted, a small tonnage of ore could be mined inexpensively. It is suspected that the ore minerals are intimately mixed with chalcedony, and the ore may be refractory. Amenability testing should precede much monetary expenditure on the prospect.

Big Hank, Pine Hen, Side Hill, and Little Spring

These claim groups are contiguous and logically constitute a single group in the vicinity of the common corner of secs. 11, 12, 13, and 14, T 11 N, R 14 E, on the bifurcated ridge between Upper Harden Creek and Lower Harden Creek. A road leads up Lower Harden Creek from U. S. Highway 93. There are three Big Hank claims, six Pine Hen claims, five Side Hill claims, and four Little Spring claims. The Pine Hen and Big Hank claims lie along the top of the ridge, with the Side Hill claims on the northeast and the Little Spring claims on the southwest. All the claims together form a rough rectangle whose long sides trend northwest. The Big Hank and Pine Hen claims were, in 1958, under lease to the Rare Metals Corporation, and the Sidney Mining Company controlled the Side Hill and Little Spring groups. Bill Brooks and Melvin Peterson staked all the claims. About three miles of road was constructed, numerous bulldozer trenches were cut, and a few shallow jackhammer holes were drilled. There has been no production.

Three major rock units are exposed on the claims. Overlying the deeply weathered batholithic rock are isolated beds of arkosic conglomerate, somewhat more stratified and indurated than in localities to the west. Patches of till rest on the arkosic conglomerate and the batholithic rock. The non-indurated till washes downslope and obscures stratigraphic relations (Pl. 8).

Two different cold springs in the locality are anomalously radioactive. Subsequent exploration found no ore in the immediate vicinity of the springs, nor did the exploration disclose the source of the radioactivity. It is my opinion that the springs are located on a fault which is a watercourse; either the fault is mineralized, or it cuts rock that is.

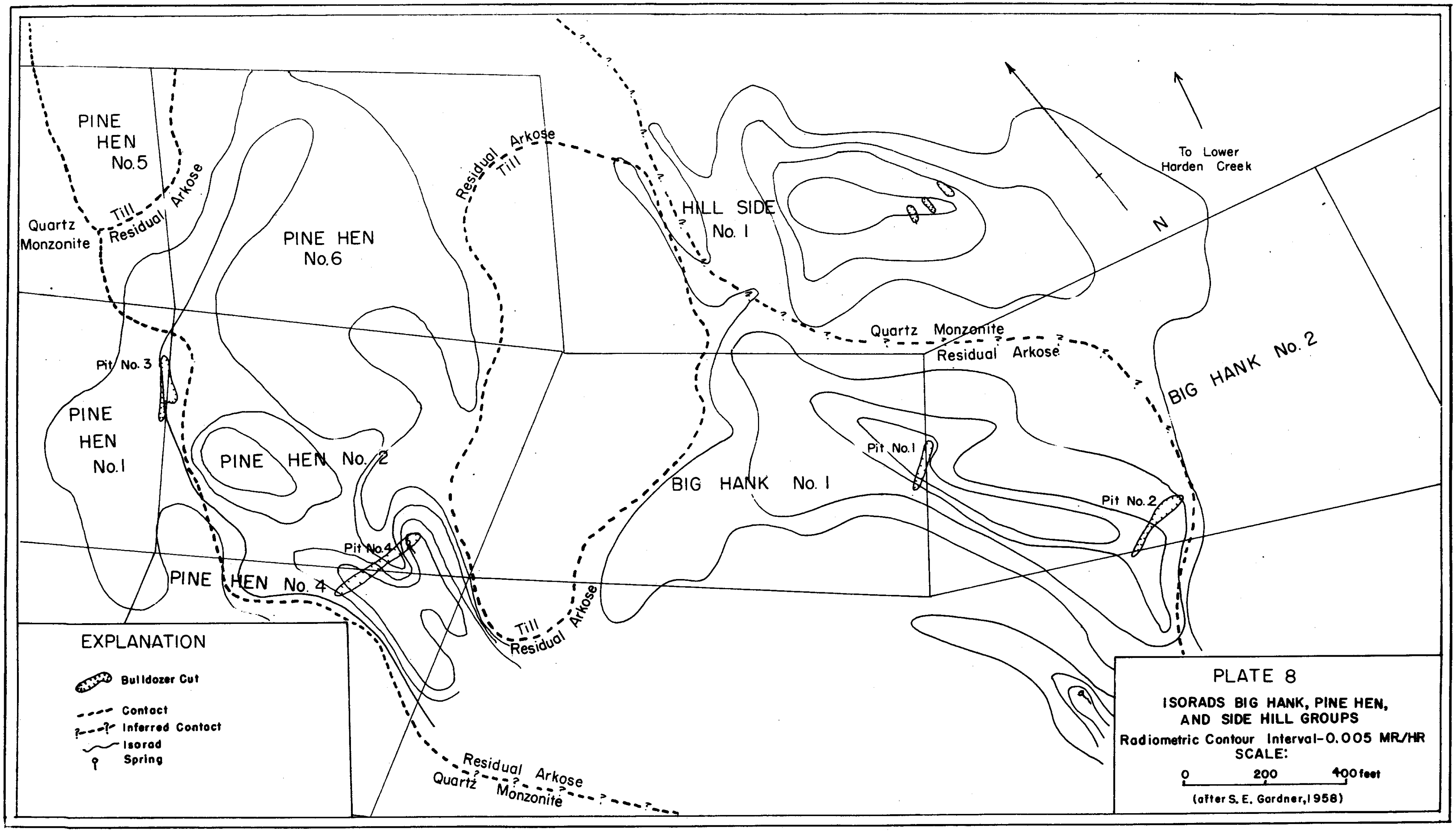
The principal point of interest on the Side Hill group is a series of five cuts which expose a mineralized zone in granitic rock so highly altered and weathered that it resembles residual arkose. The zone is exposed in the cuts for a strike length of 475 feet. The mineralized rock in the zone is not grossly different in appearance from the barren rock on either side. The zone is marked by high radioactivity, red iron-oxide staining, and commonly by the presence of autunite. In individual pits, the zone has an average trend of N 60° W; projecting from pit to pit, however, the trend curves from N 40° W to due west. It may be that the veins are short, and do not connect. It seems more likely that there has been post-ore faulting, and the zone originally had a northwest trend. Four conspicuous cross-faults are exposed in the discovery pit of Side Hill No. 1. The zone ranges in width from 10 feet to 40 feet.

The walls are commonly assay walls, but a fault or small shear may locally represent the wall. The widest exposed portion of the zone is in the discovery pit of the Side Hill No. 1 claim. Autunite is conspicuous along the west wall of the discovery pit. A 35-foot channel sample was taken in the west wall of the pit, where the radioactivity is greater than 5 X background. Because the sampled length is not normal to the zone, the true width of the zone is 32 feet. The sample contains 0.05 percent eU_3O_8. Iron-oxide stain, more red than yellow, is a guide to ore. The highest radioactivity comes from patches of soft, white, "bleached" rock within envelopes of red-stained rock. The "bleached" effect is attributed to kaolinization of the feldspars, and leaching and reduction of introduced iron. Autunite is especially concentrated along small veinlets of manganese and pegmatite stringers, and along relict faults almost completely obscured by alteration. The zone is narrower in pits northwest of the discovery pit; there has been no exploration southeast of the discovery pit.

Plate 8 is an isorad map of a portion of the Pine Hen and Big Hank claims. The radioactivity data was obtained from a ground survey, using a scintillation detector of the type normally used for aerial surveys. The radioactivity of equally spaced points on the ground was plotted on a Brunton-and-pace map, and lines connecting points of equal radioactivity (isorads) were drawn. The work was done by Rare Metals personnel. Not only were areas of anomalous radioactivity found and delineated, but differences in radioactivity of the various rocks permitted the mapping of contacts. The interpreted contacts have not been verified by excavations, but the general pattern is reasonable. (This mapping method might be worthy of consideration any place where a relatively inexpensive procedure is needed to establish approximate geologic relationships in small covered areas. The method is analogous to the use of radiometric logs in stratigraphic correlations as practiced by petroleum geologists; the presence of uranium deposits is probably not necessary, and possibly is deleterious.) The isorad patterns around the small deposits in pits 1, 2, and 3 are elongate northwest, in the direction in which the pits are aligned. The same is true of the radioactive springs. The map seems to bear out the conclusion that the small deposits are connected by northwest fractures.

The results of shallow jackhammer drilling in points of anomalous radioactivity on the Big Hank and Pine Hen groups are essentially negative. Although there is uranium-bearing rock of commercial grade at the anomaly centers, the deposits have no continuity. I have concluded that they are small disconnected pods along a zone of fracture.

In conclusion, northwest-trending fractures, probably mostly faults, have been conduits of uranium-bearing solutions. Although the usually favorable arkosic conglomerate is present, the best known possibilities for a commercial ore body are in the mineralized zone in granitic rock on the Side Hill claims. It seems possible that further exploration might find a narrower, but richer, shoot within the wide, low-grade zone on the Side Hill claims. Two other comments regarding the ore potential of the group are:


PINE HEN No.5
Quartz Monzonite
Till
Residual Arkose
PINE HEN No.6
Residual Arkose Till
HILL SIDE No. 1
To Lower Harden Creek
N
Quartz Monzonite
Residual Arkose
BIG HANK No. 2
Pit No. 3
PINE HEN No.1
PINE HEN No. 2
BIG HANK No. 1
Pit No.1
Pit No. 2
Pit No.4
PINE HEN No. 4
Till Residual Arkose
Residual Arkose
Quartz Monzonite
EXPLANATION
Bulldozer Cut
Contact
Inferred Contact
Isorad
Spring
PLATE 8
ISORADS BIG HANK, PINE HEN, AND SIDE HILL GROUPS
Radiometric Contour Interval-0.005 MR/HR
SCALE:
0 200 400 feet
(after S. E. Gardner, 1958)

33a

(1) The arkosic conglomerate which is exposed along the northeast side line of the Big Hank No. 1 claim should be examined in detail (Pl. 8). The bed is only slightly off the trend of the Side Hill mineralized zone, and if uranium-bearing fractures intersect the conglomerate somewhere, a good possibility for an ore body would be present at the intersection. There is at least one radioactivity anomaly in this bed.

(2) The proposal that the Big Hank pits and the radioactive springs are connected by fractures striking northwest is not intended to enhance the ore potential of the prospects. There is no apparent reason to expect that anything but small pods of mineralized rock, similar to those already found, are present at depth.

Lower Harden

The Lower Harden claims are in the SW 1/4 sec. 24, T 11 N, R 14 E, on Lower Harden Creek about 1,000 feet south of the first branch road crossing the creek (Pls. 1 and 2). The claims were filed May 20, 1958, by E. K. Evans. Two claims, Lower Harden No. 1 and Lower Harden No. 2, are described in the location notices, but the description places one superimposed on the other. Several shallow prospect pits are found 100 feet west of the road.

The country rock is quartz monzonite; it contains the large potassium feldspar porphyroblasts typical of the western part of the Stanley uranium area. The quartz monzonite is cut by narrow reddish aplite dikes striking north and dipping 45° W, and by fractures striking N 62° E and dipping 58° N. At least two of the fractures are slightly mineralized. Where the mineralized fractures intersect a certain aplite dike, small pods of uranium "ore," less than six inches by twelve inches, are found. The pods are radioactive up to 20 X background, and contain yellow chalcedony, muscovite, and sericite.

No ore is evident on the Lower Harden claims, but the geologic relations are informative. Weak uranium mineralization has taken place along northwest fractures. Where the fractures intersect aplite dikes, uranium was concentrated to form high-grade pods of "ore." The occurrence, on a small scale, is a duplication of one way uranium ore bodies may have been formed in the Stanley uranium area.

Mandate

The Mandate claims are on the ridge between Lower Harden Creek and American Creek, in the NW 1/4 sec. 24, T 11 N, R 14 E. The claims are near a trail which leaves the Lower Harden road 1.5 miles north of U. S. Highway 93. From the top of the ridge, the claims lie approximately 2,000 feet south of the trail. There are at least two claims in the group. The Mandate No's. 1 and 2 were staked by C. F. Weaver, John Weidman, and A. W. Shrank on May 27, 1958. The center lines trend easterly, and Mandate No. 1 is joined by Mandate No. 2 on the north.

No ore is known to have been produced. Two shallow pits and an old caved shaft in granitic rock have no anomalous radioactivity. One pit exposes a fault which strikes N 80° W and dips 48° N. The deepest development found is the discovery pit on the Mandate No. 1 claim. The pit is 10 feet deep and 120 feet by 16 feet in area. An alluvial channel is exposed in the north wall of the pit. The channel is cut in arkosic conglomerate and filled with a poorly consolidated heterogenous mixture of boulders, cobbles, pebbles,and granitic gravel. The channel does not appear in the south wall, and was probably faulted away. The arkosic conglomerate in the floor of the pit is intensely brecciated. Fractures strike in all directions and the attitude of any major fault is obscured by the brecciation. The arkosic conglomerate is more heavily stained with iron oxides than is any other rock exposed in the Stanley area. The rock is composed of angular breccia fragments of altered and leached arkosic conglomerate in a "limonite" matrix, and the rock resembles a gossan. Close examination indicates, however, that the "limonite" probably is transported, rather than residual after iron sulfides. No open spaces representing dissolved iron sulfides are found. The rock probably is not a true gossan. Assays found no gold or silver in the material. The breccia is radioactive to the extent of 3 X background. No secondary uranium minerals are seen, and the anomalous radioactivity is fairly uniformly distributed through the rock. A sample of breccia contains 0.06 percent eU_3O_8.

Evidently there is a strong westerly striking fault in the discovery pit, possibly parallel to the N 80° W fault seen in the shallow pit to the north. In view of the extreme brecciation, two or more faults probably intersect at this point. In spite of the seemingly favorable conditions, no uranium ore has been found.

RECOMMENDATIONS FOR EXPLORATION

The known uranium deposits in the Stanley area are confined to a northwesterly trending belt nine miles long and two miles wide (Pls. 1 and 4). Ground within the belt is especially favorable for further prospecting. Prospecting in the Stanley area has been concentrated in the belt, however, and areas outside the belt have received less attention; this fact can at least partially account for the existence of the belt. Therefore, the belt of known deposits is probably not exactly coincident with a belt of favorable ground. The limits of the area in which the geology is favorable for uranium deposits have not yet been determined.

The ore controls as revealed by this investigation can be used as guides to predict where new uranium deposits may be found in the Stanley area. The following classification of areas according to their favorability for further exploration is based on three criteria:

(1) The belt of known deposits is favorable.

(2) Fractures, especially those which strike northwest, are essential to the formation of an ore body. Deposits may be found in the future where the ore in arkosic conglomerate has been laterally displaced from the feeding fractures by ground water.

(3) The presence of a potential host rock, such as the arkosic conglomerate at the base of the Challis Formation or silicic intrusive rock, is favorable.

Class I - areas within the belt of known deposits where the arkosic conglomerate is present at or near the base of the Challis Formation, especially if fractures are conspicuous in the area. There probably are many occurrences of arkosic conglomerate which have not been found, partly because they are not exposed but mostly because no one has looked for them. Within the belt, all known bodies of arkosic conglomerate lie at elevations between 6,600 feet and 7,400 feet. On ridge tops at these elevations, arkosic conglomerate may be covered by till.

Class II - areas outside the belt of known deposits which have similar geology to those of Class I. Any locality in which the northwest or southeast extension of the belt intersects the base of the Challis Formation should be examined for beds of arkosic conglomerate. Occurrences of arkosic conglomerate outside the belt and its extensions should also be prospected. In this regard, I have seen outcrops of Challis rocks west of the mapped area, across Stanley Creek.

Class III - areas within the belt where conspicuous fractures or zones of fractures, especially if the fractures are anomalously radioactive, intersect large bodies of silicic intrusive rock. Such fracture zones should be traced as far as possible, to determine if they intersect a favorable host rock.

Class IV - areas outside the belt where fractures intersect silicic intrusive rocks as in Class III.

It is extremely difficult to predict where vein deposits in batholithic rock, similar to the Alta and Lightning deposits, may be found. Deposits of this type are susceptible to discovery by systematic radioactivity prospecting. Areas of intense fracturing are probably the most favorable for such deposits.

Some further recommendations are as follows:

(1) General and geologic mapping, especially mapping of the contact between the Idaho batholith and the Challis Formation, can be expedited by the use of aerial photos. I was unable to detect the contact on the available U. S. Forest Service black and white photos, but the contact is easily detected when viewed in natural color from an airplane. Colored aerial photographs might be of considerable value in regional mapping. Before incurring the expense of having the entire area flown and photographed commercially, the value of color photos could be tested by taking a few oblique color photos from the air, using a good-quality camera which produces a large negative. The color photos then could be compared with the black and white photos, and the data which are visible only on the color photos could be transferred to the more planimetrically correct vertical photos. The photographing operation might be combined with an aerial radioactivity survey, in search of

large areas of anomalous radioactivity. If large areas are to be investigated, all short-cut techniques should be considered. Certainly the photos which are currently available should be obtained.

(2) More drilling is critically needed. All properties are accessible to at least a small, portable percussion ("wagon") drill. The feasibility of further exploration on several prospects probably could be determined from the results gained from a minimum of drilling.

(3) Before large expenditures are contemplated, the claims under consideration should be surveyed to determine the major fractions and overlaps. Care should be taken to insure that all discoveries fulfill the requirements of the law.

SUMMARY AND CONCLUSIONS

Uranium ore deposits in the Stanley area consist of steeply dipping, fracture-controlled vein deposits and flat-lying deposits which are controlled both by fractures and by favorable host rocks. Vein deposits are found in quartz monzonite and granodiorite of the Idaho batholith. The veins are in fractures, commonly faults, which strike in various directions and dip steeply. Vein deposits also occur in fractures in silicic rocks which intrude the batholith. The silicic intrusive rocks are favorable for uranium ore formation. Stratigraphically controlled deposits are found in arkosic conglomerate beds at the base of the Challis Formation. Mineralized fractures are present in the granitic rock below the arkosic conglomerate, indicating that fracture control localized the ore. The fractures of most frequent occurrence as ore controls belong to a major set which strikes N 45° W.

The definite vein structure of some deposits; the presence of uraninite, marcasite, and stibnite in some ores; the control of the deposits by fractures; and the presence of hydrothermal alteration minerals and chalcedony gangue lead to the conclusion that the uranium deposits are of hydrothermal (epithermal or leptothermal) origin. Subsequent weathering produced supergene minerals near the surface. The grouping of the deposits in one area, the similar controls of the deposits, and the approximately accordant elevations of the deposits are considered evidence that the deposits are contemporaneous. They are younger than the sedimentary rocks of the Challis Formation, and are probably the same age as the volcanic rocks.

Mineralized fractures are present in all deposits; fractures are considered essential to the formation of an ore body in the Stanley area. Arkosic conglomerate at the base of the Challis Formation serves as a host for many of the deposits and is very favorable to ore deposition. If a major fracture zone intersects the base of the Challis Formation, the intersection should be thoroughly prospected. Intersections of fractures with silicic intrusive rocks are also favorable. The belt in which the known deposits are located is especially favorable. However, further exploration is required to determine the limits of the favorable zone. Areas outside the belt, particularly those in which strong fractures are present near the base of the Challis Formation, warrant prospecting. The known ore controls should be used in future exploration. The region surrounding the Stanley area deserves at least a reconnaissance investigation. Available aerial photographs should be obtained and the applicability of colored photos to geologic mapping should be determined. Aerial radioactivity surveying may be able to find large areas of anomalous radioactivity in the general region, but individual deposits are not likely to be revealed by such methods.

The average grade of the ore so far produced is less than 0.30 percent U_3O_8. The relative isolation of the Stanley area and the apparent small size of the known deposits require that as high a grade as possible be maintained. If sufficient reserves are developed, the feasibility of up-grading the ores should be investigated.

Exploration in the Stanley area has barely begun; a well-planned exploration program has a reasonable expectancy of discovering more ore. There is no evidence which indicates that large ore bodies are to be expected.

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