BRIGHAM YOUNG UNIVERSITY RESEARCH SERIES

Geology Series Vol. 5 No. 4 June, 1958

GEOLOGY OF TOOELE AND JUAB COUNTIES, UTAH INDIAN SPRINGS QUADRANGLE

by

Glenn H. Thomas

Brigham Young University
Department of Geology
Provo, Utah

THE GEOLOGY

of

INDIAN SPRINGS QUADRANGLE

TOOELE AND JUAB COUNTIES, UTAH

A Thesis

submitted to

The faculty of the Department of Geology

Brigham Young University

In partial fulfillment

of the requirements for the degree of

Master of Science

by

Glenn H. Thomas

June, 1958

ABSTRACT

The Indian Springs quadrangle treated in this geologic report lies in the southern Simpson Mountains in western Utah, within the Basin and Range Province.

The Precambrian sediments, the Sheeprock series, occupy over half of the bedrock exposure, having a total measured thickness of 9,400 feet. They consist mainly of dark quartzite and slate with an occasional light colored quartzite.

Paleozoic formations mapped include the Cambrian Tintic quartzite, Pioche shale, Cambrian carbonates undifferentiated; Ordovician Pogonip formation, Kanosh shale, Swan Peak quartzite; Ordovician-Silurian Fish Haven-Laketown dolomite; Devonian Sevy and Simonson dolomite.

This Paleozoic section is exposed in a large 2 1/2 mile wide graben with Precambrian strata on either side. East trending fault zones bounding the graben extend across the entire Simpson Mountains, a total length of about 7 miles.

Small intrusives which occur in the Simpson Mountains have evidently controlled the migration of ore-bearing fluids as certain intrusives contain moderate amounts of metal sulfides. Fault structures also have localized small ore deposits where such structures cross favorable calcareous slates in the Sheeprock series. The writer recommends drilling and geophysical surveying in favorable areas to develop the economic potential of the area.

CONTENTS

LIST OF ILLUSTRATIONS

ACKNOWLEDGMENTS

The writer wishes to express appreciation to the following professors of the Brigham Young University who offered pertinent and helpful suggestions for preparation of this manuscript: Dr. Lehi F. Hintze, Dr. Harold J. Bissell, Dr. J. Keith Rigby, Dr. William Revell Phillips, Dr. Kenneth C. Bullock.

Also the writer is appreciative to the Bear Creek Mining Company who defrayed the cost involved in field mapping.

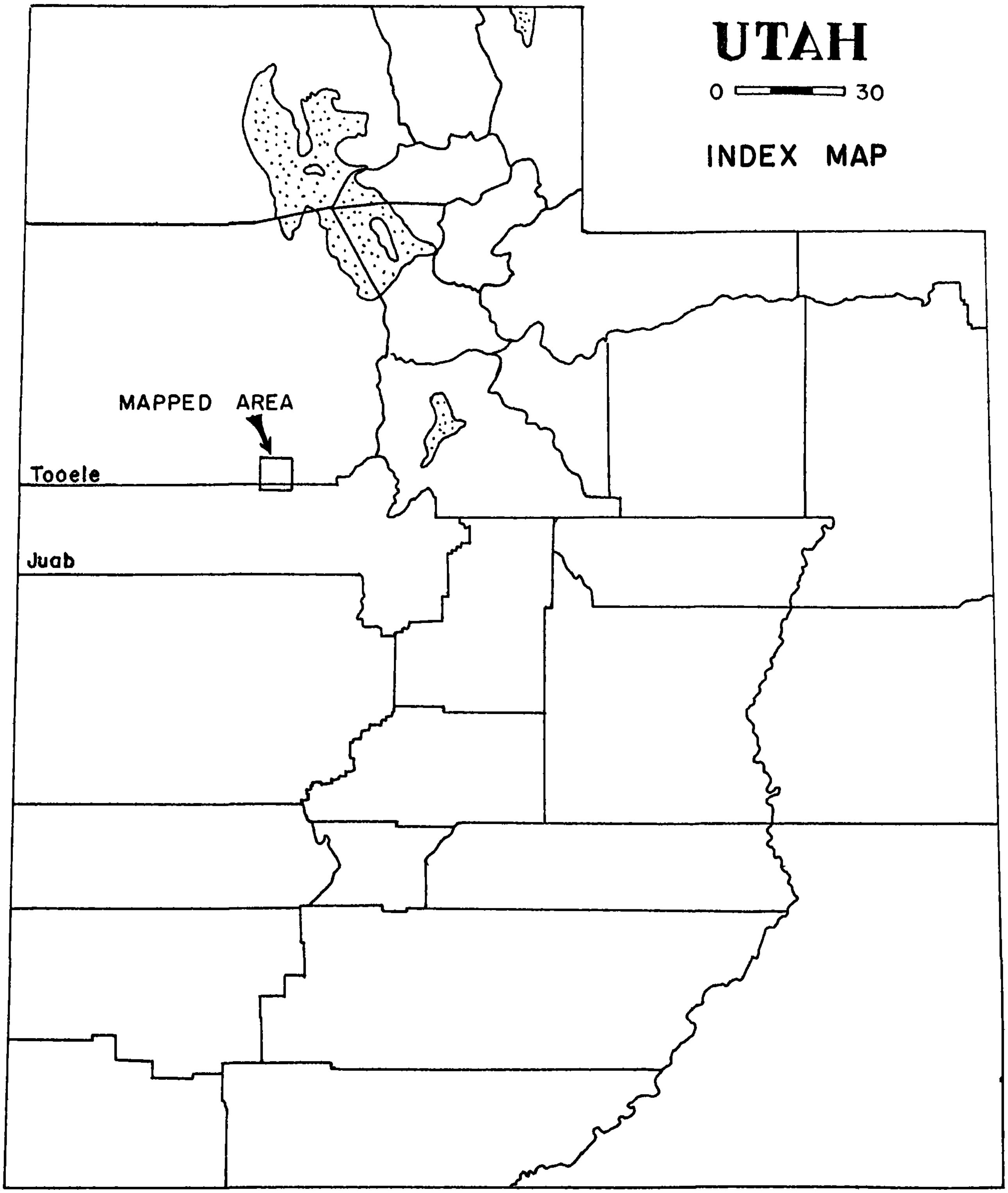


Figure 1

INTRODUCTION

Location

The Indian Springs 7 1/2 minute quadrangle discussed in this report encloses the major portion of the Simpson Mountains, located in Tooele and Juab Counties, Utah (Plate I). The mapped area covers about 50 square miles.

Several gravel roads and jeep trails traverse the south and east portions of the area but only a few roads and jeep trails penetrate any appreciable distance up the canyons in the north and west parts of the area. The nearest settlement to the Simpson Mountains is the town of Vernon (pop. 255) which is about 30 miles east of the range. The main access road is the Simpson Springs-Callao gravel road which passes over the Sheeprock Range via Lookout Pass between the Simpson Mountains and Vernon.

Drainage and Ground Water Resources

The drainage of the mapped area is predominantly south to southeast. The water table in the Simpson Mountains is quite high as creeks flow year round. Also mine workings encounter water at relatively shallow depths. The Bar X Mine located in Death Canyon has developed a considerable flow of water from its workings. The major faults in the area, namely the Indian Springs fault and the Lost Canyon fault, are water courses, and springs occur along their fault trace. The Lost Canyon fault feeds Judd Creek which flows the year round except in the driest years.

The only exploitation of the relatively abundant water resources in the range has been done by Mr. Delbert Chipman, a rancher who has flumed the Indian Springs water down Indian Creek to his ranch house.

Geomorphology

The main divide of the Simpson Range trends north, curving slightly to the west on its northernmost extension. The average width of the exposed bedrock in the range is about five miles. The highest peaks of the area are slightly over 8,200 feet in elevation and the flanks of the mountain slope downward, disappearing into large pediments which surround the entire range. Erosion has sculptured the bedrock surface to a mature stage of dissection.

In gross morphology the Simpson Range is typical of the ranges in the Basin and Range province in that the mountains rise abruptly out of the sea of alluvium which surrounds them. The western part of the range has steeper slopes than the eastern, suggesting a more recent uplift for the easternmost margin. It is very probable the presence of the range is due to uplift along northwest trending, hidden, Basin and Range faults which parallel the western border of the range.

From regional gravity data obtained and compiled by Johnson (1956) on the Simpson Mountain area, no prominent Basin Range faulting is apparent in the mapped area. The Simpson Range and surrounding valleys are quite low in density relief. The gravity contours show a major trend on the northeast extremity of Simpson Range aligned in a northwest direction and another major northwest trend just southwest of the mapped area.

Climate and Vegetation

The rainfall, about 16 inches annually, results in a semiarid climate. This amount of precipitation supports a hardy desert flora of sagebrush, cacti, Rocky Mountain cedar, various grasses and flowering plants.

Previous Work

Butler (1920) described in some detail the mines and associated ore deposits of the Simpson Mountains.

Cohenour (1957) mapped a portion of the Simpson Mountains in connection with his work on the Sheeprock Range to the east. The geology of the western half of the quadrangle has never before been shown on a published map.

Purpose and Scope

The Basin and Range province contains some of the least documented geology in the United States. For this reason the Simpson Mountains were chosen for study, in hopes that this contribution might add significantly to the geologic picture of this province.

Because the Simpson Mountains contain many small ore bodies and intrusives, this area offers an excellent opportunity to study the relationships that exist between the ore deposits and the structure, the host rock, and the intrusives. In addition, the area contains a great volume of Precambrian sediments which, as a whole, has not heretofore been studied in detail.

The purpose of the present geologic work has been to determine the geology of the Simpson Mountains with special emphasis on the structure and host rock favorability as related to ore deposition control; to gain a better understanding of the thickness, distribution, composition, and correlation of the Precambrian and Paleozoic sediments which occur in the Simpson Mountains.

Methods

The base map of this report is the U. S. Geological Survey Indian Springs quadrangle plus a small part of the Çayote Springs quadrangle onto which the writer transferred from aerial photos (1:23,600) the data gathered in the field. The measurements for stratigraphic sections were taken from map data.

GENERAL GEOLOGY

The sedimentary rocks in the Simpson Mountains range in age from Precambrian through Cambrian, Ordovician, Silurian, and Devonian. Quaternary alluvium and Bonneville lake sediments occur in the valley fill areas adjacent to the Simpson Range.

Tertiary volcanic rock crops out in portions of the low foothills of the range and a moderate number of small scattered intrusives occur in the southern half of the mapped area.

The principal structural features of the area are large west to northwest tranding faults which traverse the entire range, dividing it into large segments. Within two of these segments broad shallow folding is evident, trending north and plunging to the north.

SEDIMENTARY ROCKS

Precambrian System

Within the Precambrian system exhibited in the area, two general lithologic types are recognized: 1) the Sheeprock series, having predominantly dark colored slate, shale, quartzite and dark colored graywacke, and 2) Precambrian undifferentiated sediments consisting of light colored arkosic sandstone and light tan shale.

The Sheeprock series represent most of the Precambrian strata of the mapped area; half or more of the bedrock exposure in the thesis area consists of this thick (9,400 ft) series of sediments. In the extreme north portion of the mapped area the light colored arkosic section of Precambrian sediments occurs. Their Precambrian age is assumed as the sediments underlies the Tintic quartzite strata occurring just north of the mapped area. These Precambrian sediments are separated from the Sheeprock series to the south by an extensive area of Paleozoic sediments. The northernmost Precambrian sediments of light colored quartzites and arkoses are apparently not correlative with the Sheeprock series of dark slates, shales, dark quartzites and graywackes. The light arkose and quartzite sediments at the north end of the map (Plate I) are undifferentiated. However, the Sheeprock series has been subdivided into six units based on lithology and sequence. The writer measured with an Abney hand level unit I and II near the Imperial intrusive area in the southwest portion of the mapped area. Units III, IV, V and VI were measured from the Bar X Mine northeast of Aspen Creek intrusive by map data techniques. These units are described below.

Sheeprock Series

Unit I - The lowermost formation, called Unit 1, is a conglomeratic quartzite containing intercalated, but subordinate slate beds. The quartzite is a massive, light tan, fine-grained to conglomeratic rock which weathers to a reddish tan. The conglomeratic portion contains 1 1/2 inch rounded pebbles from previous fine-grained quartzites along with rounded "bull" quartz pebbles of similar size. The conglomerate beds have a fine-grained quartzitic dark green matrix. The slates are light green to brown and weather tan to lighter green. Usually the slates form talus, which is calcareous, but unweathered fragments are inert to ten percent HCl. The upper contact, although gradational over 50 feet, is taken where the slate beds predominate over quartzitic beds. The total thickness of Unit I exposed from the alluvium to its upper contact with Unit II is 1,200 feet. The bottom contact is not exposed.

Unit II - This unit is predominantly a slate rock (upper portion is a graywacke) characterized by a light olive green color, a more intense green than other slates of this series. It is thin to thick bedded (1 ft to 4 ft) and weathers to broad slopes of light green plates and slabs. The unit is 750 feet thick and contains limey slates, some having up to 31 percent $CaCO_3$ by chemical assay. About 300 feet from its lower contact the unit contains a good mappable marker subunit consisting of a light tan, clean looking, quartzite, 50 to 75 feet thick.

In the upper portion of Unit II dark greenish-black quartzites occur and become progressively more abundant and thicker upsection. The upper contact is gradational and is chosen where the massive thick-bedded quartzites of Unit III appear more predominant than the slate beds.

Unit III - The most characteristic feature of Unit III, a thick-bedded to massive quartzite 600 feet thick, is its black weathered color caused by manganese staining. Fresh breaks in the rock show some of its beds to be light tan to rose color, but a heavy introduction of manganese has blackened every crack and joint so that the formation appears as a black massive quartzite. Like Unit I it contains conglomerate beds, but the cobbles are composed almost entirely of milky quartz about one inch in diameter instead of sandstone cobbles as in Unit I. The pebbles or cobbles of the milky quartz are set in a matrix of dark green to brown, fine-grained quartzite which occurs in beds 5 to 50 feet thick. The top contact is marked by an abrupt change from massive quartzites to thinner (2 ft average) beds of quartzite interbedded with slate-shale.

Unit IV - This unit consists almost entirely of interbedded shale and quartzite; the shales are dark brown to brown and the quartzites vary from dark greenish brown to black. Thickness of the beds is variable, some shales are 150 feet thick and others only 3 inches thick, interbedded with quartzites having similar variations in thickness. Some conglomerates occur in the thicker quartzitic sections and the slates of this unit are thinly bedded containing more sand grains than the slates in the lower portions of the section.

The top of a relatively thick brown slate marks the upper contact of this unit. A light flesh-colored to white quartzite of Unit V overlies this upper contact. The measured thickness of Unit IV is 1,300 feet.

Unit V - This unit is a white to light tan to pink quartzite which is a relative rare color in the usual dark sediments of the Sheeprock series. Near the upper and lower contacts the unit is somewhat darker than the very light colored center portion. It is a good mappable unit and can be distinguished well even at a distance. The upper contact is chosen where interbedded dark quartzites and shales overlie the lighter quartzite of ths unit. Thickness is approximately 950 feet.

Unit VI - Lithologically this unit is very similar to the interbedded brown shale and quartzite sequence of Unit IV. Unit VI is distinguished from Unit IV because the former overlies Unit V, the light colored quartzite; but in addition Unit VI contains relatively thin flesh colored quartzite beds in its upper exposed portion which is distinctly different from the lithology of Unit IV. The unit is cut off by a large east-west fault, but the measured exposed thickness is 4,600 feet.

Precambrian Undifferentiated

About 630 feet of undifferentiated Precambrian strata are exposed in the northernmost portion of the mapped area (Plate I). These rocks consist of an upper, highly ferrugineous, reddish weathering, rather course-grained (2 mm average) quartzite member, underlain by a brown micaceous shale or slate.

The only exposure of tillite in the Simpson Range occurs in the northeast corner of T. 11S., R. 8W., an outcrop area of about 120 acres. The tillite has a dark greenish overall cast, interrupted by large (1 ft maximum) boulders and smaller pebbles showing whiter against the dark bluish-green, fine-grained chloritic-like matrix. The rock shows no sorting or bedding but is characterized by a near complete heterogeneity. The larger cobbles are often composed of quartzite, being somewhat rounded and usually firmly embedded in the fine-grained matrix. Smaller cobbles of rounded to angular vein quartz and angular quartzite and slate fragments are abundant. No striated or grooved fragments were found, but the heterogeneity and non-stratification indicate a glacial origin for the rock.

In the Sheeprock Range, which is about 15 miles east of the Simpson Range, the Precambrian sediments as described by Cohenour (1957) and Harris (1956) are similar to those in the Simpson Range, usually graywackes, slates, graywacke conglomerates, quartzites, etc.; but no distinctive units or sequence of units could be correlated between the two areas in the limited time given to this comparison. The only distinctive unit occurring in both areas is a tillite which, in the Simpson Range, is in fault contact with the surrounding Precambrian sediments, making age relationships dubious between the tillite and the adjacent Precambrian sediments.

The Precambrian tillite and varved slates underlying Tintic quartzite in Cottonwood Canyon of the Wasatch Mountains area, as described by Eardley (1940), are of a different type lithology and it is very doubtful that this tillite is correlative with the heterogeneous tillite in the Simpson Range.

Cambrian System

Tintic Quartzite - The Lower Cambrian Tintic quartzite thickness, as taken from map data, is 2,800 feet thick in the area just north of Lost Canyon. The formation is quite vitreous and ranges from very fine-grained texture to a conglomeratic one. Color ranges from white through red, pink, flesh colored tones, to dark green and dark brown. The total thickness of this formation is probably greater than stated above, but both uppermost and lowermost strata of the Tintic quartzite are in fault contact with succeeding or preceding sediments, which means the total thickness is something greater than the measured thickness.

Pioche Shale - The Pioche shale overlies the Tintic quartzite. The best exposure for section measurement lies just north of the divide separating Indian and Lee Canyons. In this area the formation totals 220 feet, as taken from map data. It consists of cross-bedded dark brown, dark greenish-brown to black quartzite beds (1 ft to 20 ft in thickness) intercalated with micaceous brown fucoidal shale beds of similar thickness. The darker quartzites and lighter colored shales make this formation quite distinctive and mappable. The first one foot thick micaceous shale which occurs above the Tintic quartzite marks the lower contact of the Pioche shale; while an abrupt change from dark greenish-brown quartzites and slates of the Pioche to the overlying micaceous blue-gray limestone marks the upper contact.

No disconformity or angular unconformity is apparent at the upper contact of the Pioche shale even though the contact is sharp and easily observed. Near the top contact a brown quartzite member 35 feet thick occurs which is similar in position and lithology to the upper Pioche of the Sheeprock area as described by Cohenour (1957).

The Cabin shale of the Deep Creek Range, as described by Nolan (1935), is probably equivalent to the Pioche of the Simpson Range area as the two formations occur in similar lithologic sequences and have similar lithologies. In the Simpson Range the Pioche shale contains beds of quartzites 1 foot to 20 feet thick intercalated with similar thicknesses of shale, while the Cabin shale is predominantly shale except for 15 feet of shaly sandstone near the upper contact.

Cambrian Undifferentiated Carbonates - Exposures in the Simpson Range do not reveal the complete sequence of Cambrian rocks from the Tintic quartzite to the Upper Cambrian. The structure is quite complex in the area of Lower Paleozoic exposure (see Plate I) so that many formations of Cambrian age are in fault contact or omitted, complicating any accurate measurement or description of these rocks. For this reason the Cambrian from the top of the Pioche shale to the bottom of the Ordovician Pogonip group is grouped together as undifferentiated. However, a few observations were possible even though structure has complicated the sequence. The Busby quartzite, which overlies the Pioche shale in the Deep Creek Range and the Sheeprock Range, is apparently absent in the Simpson Range. The shales of the Pioche grade rapidly upsection into a very micaceous blue-gray limestone (150 ft. thick) which contains round (1/2 in average diameter) algal balls or pisolites. The Cambrian strata above this is mainly limestone, locally micaceous, which varies in gross lithology from argillaceous limestone to a thinly or thickly bedded dense blue-gray limestone containing dark dolomite beds.

Formation equivalency of the Cambrian carbonates could not be demonstrated between the Simpson Range and the Cambrian section of the Sheeprock Range, House Range, or the Tintic district, due to the complicated structure and poor exposure of the Cambrian strata in the Simpson Range. However, the Cambrian-Ordovician contact is fairly distinguishable and is chosen where the dark gray carbonates of the Upper Cambrian beds abruptly change upsection into light blue-gray, shaley limestones typical of the Ordovician Pogonip group. The total thickness of the Cambrian carbonates as calculated from map data in the area of Rocky Canyon, is 2,300 feet, but this thickness is very likely in error as faulting complicates the existing outcrop areas of Cambrian carbonates that are at all measurable.

Ordovician System

Pogonip Group - The designation Pogonip group as here used comprises the sediments in the Simpson Range that overlie the Cambrian carbonates and underlie the Kanosh shale. These sediments measured by means of map data in this area east of Rocky Canyon total

760 feet, although this may also be somewhat in error due to undetected displacement on the many faults occurring in the area.

Individual formations within this group were not defined for two reasons. One, the faulting within the outcrop area of the Pogonip group, although not as abundant as that in the Cambrian zone, still inhibits accurate section measurement; and two, because the lithology of this group is quite similar, subdivision would not have greatly helped in revealing structure or enhancing unit mappability.

The exposed Pogonip group of the Simpson Range is predominantly a light to dark blue shaly limestone containing an interweave of light tan colored argillic seams which lend a "chicken wire" appearance to weathered exposures. Darker portions of limestone are mottled with darker "splotches" of argillic material. The group contains subordinate shales, usually brown and micaceous in character. Near its upper contact the group contains abundant fossils, practically a fossil hash of trilobite and crinoid fragments. Also sponges are abundant. Overlying this abundantly fossiliferous zone is a brown to black quartzite 30 to 40 feet thick, which grades upsection into the Kanosh shale. The upper contact of the Pogonip group, as chosen here, lies at the top of the aforementioned quartzite, a ridge former of fair to good mappability.

Kanosh Shale - The Kanosh shale is the next mappable unit upsection overlying the Pogonip group. The formation is relatively thin (55 to 175 feet thickness from map data), and contains trilobite fragments plus well preserved graptolites (Didymograptus artus, Rigby private communication). The Kanosh shale ranges in color from red to blue black to light gray, but it can usually be distinguished by its contained fossils. Southeast of Cherry Springs the Kanosh shale appears thicker, ranging from about 55 feet in the Raul Canyon area to 175 feet in the area 1 1/2 miles southeast of Cherry Springs. However, the thicker section of the Kanosh shale near Cherry Springs is complicated by much faulting and this movement may have thickened the shale by plastic deformation.

Swan Peak Quartzite - The Swan Peak quartzite of Ordovician age overlies the Kanosh shale, and the contact between the two is sharp and easily distinguished. This quartzite is very uniform having a light gray to cream color, and consists of tightly cemented (SiO_2) well rounded, medium-sized sand grains in moderately thick beds. It is distinguished in the field by its pure clean appearance and absence of contained conglomerate facies which occur in similar appearing facies of the Tintic quartzite.

Because the formation forms bold outcrops, relatively accurate thickness measurements were possible. Two measurements taken from map data along its outcrop east of Raul and Rocky Canyons checked very close to 700 feet. Cohenour (1957) found 465 feet of Swan Peak quartzite in the Sheeprock Range; Hintze (1951) reported 249 feet in the Ibex area of Utah and 394 feet in the Pavant Range, Utah. According to Hintze (1951), the 85 feet thick dolomite separates the Eureka and Swan Peak quartzites in the Ibex area. The thickness of the two quartzites, Eureka and Swan Peak, totalling about 780 feet in the Ibex area, suggests both are combined in the 700 foot quartzite section called Swan Peak in this report. The thin dolomite reported in the Ibex area has evidently pinched out and does not extend into the Simpson Range as no dolomite occurs within the quartzite.

Fish Haven-Laketown Dolomites Undifferentiated - Comformably overlying the Swan Peak quartzite in the area southeast of Indian Springs is a thick (1,450 ft) section of limestones and dolomites which has been grouped together as undifferentiated Fish Haven-Laketown formations of Ordovician and Silurian ages. Predominantly these beds are dark gray dolomite, some of which weather gray and others black. Abundant two-inch thick discontinuous seams of black chert occur approximately 3 inches apart near the base of the Fish Haven formation. The lower 500 feet of this formation is a black-weathering, mottled dolomite having a sandpapery weathering texture and is moderately thick bedded to laminated. Alluvium covers the upper portion of the Fish Haven-Laketown formations so that no exposure of the upper contact of the Laketown formation exists in the Simpson Range. The Laketown is the only Silurian formation exposed in the Simpson Range area.

Devonian System

Sevy Dolomite - Small fault blocks within the Indian Springs main fault zone consist of a mouse gray, dense, white to light gray weathering dolomite which is in appearance much like the Sevy dolomite. A similar appearing dolomite which has been tentatively called the Sevy formation occurs in fault contact with the Fish Haven-Laketown formations in the westernmost portion of the map (Section 15 T. 10S., R. 7W).

Simonson Dolomite - A black dolomitic limestone which lithologically appears like the Simonson dolomite overlies the Sevy in this area of Section 15 T. 10S., R. 7W. The formation is black both on weathered and fresh surface, but it does not contain stromotoperoid fossils in this area as the Simonson does in areas just outside the mapped zone. However, typical "spaghetti" beds (stromotoporoid) may occur in the black dolomite of Section 15, but may have been overlooked, as the formation has a relatively small exposure in this area. Because the Sevy and Simonson dolomites outcrop only as small fault blocks, no thickness measurements were taken of these formations.

Quaternary System

At higher elevations on the foothills of the Simpson Range pediment gravels coalesce with fanglomerates and gravels of lower elevations. Many of the intermittent streams carrying these gravels have cut and eroded Lake Bonneville sediments and have deposited alluvium on the valley floors between the mountain ranges of this area. The writer grouped all the above described gravels and alluvium as Quaternary, and they are symbolized on the map under the label of Qal.

Plate IV

GENERALIZED STRATIGRAPHY OF INDIAN SPRINGS QUADRANGLE

SYSTEM	SERIES	FORMATION	THICK	GROSS LITHOLOGY
QUATERNARY		ALLUVIUM	?	Alluvium and colluvium
DEVONIAN		SIMONSON DOLOMITE	?	Dolomite, dark gray to black containing stromatoperoid fossils
		SEVY DOLOMITE	?	Dolomite, fine grained, mouse gray
SILURIAN		LAKETOWN DOLOMITE	1450	Dolomite, light gray, well bedded
ORDOVICIAN		FISH HAVEN DOLOMITE		Dolomite, dark gray, black, containing small white "twigs"
		SWAN PEAK QUARTZITE	700	Quartzite, light cream color
		KANOSH SHALE	55-175	Shale, light gray, brown, rusty red
		POGONIP	760	Limestone, light blue-gray, argillaceous
CAMBRIAN		CAMBRIAN UNDIFF. CARBONATES	2300	Limestone, dark gray, argillaceous
		PIOCHE SHALE	220	Dark shale and quartzite, intercalated
		TINTIC QUARTZITE	2800	Quartzite, conglomeritic, pink to light tan
PRECAMBRIAN	SHEEPROCK	UNIT VI	4600	Dark quartzite and olive-brown shale, interbedded
		UNIT V	950	Quartzite, light tan to pink
		UNIT IV	1300	Dark quartzite and olive-brown shale, interbedded
		UNIT III	600	Quartzite, massive, pink, stained black with MnO_2
		UNIT II	750	Graywacke slate, apple green, contains a light tan medial quartzite 50-75 feet thick
		UNIT I	1200	Quartzite, dark, conglomeritic, containing subordinate slate beds
	PRECAMBRIAN UNDIFF.	UPPER	630	Quartzite, course grained, ferruginous
		LOWER		Shale, olive-brown to tan

IGNEOUS ROCKS

Extrusive Rocks

The Simpson Range area contains one large and several small outcrops of volcanic exposures. The smaller outcrops of rock occur in the extreme northwest corner, and the southeast part of the mapped area. The largest area of extrusive rock, named by the writer the Judd Creek latite, lies in T. 10S., R 7W., and it covers about three square miles in and around sections 16 and 17. Several samples of this igneous rock mass were taken from the central and peripheral areas of the outcrop. Rock samples from the central portion are fine-grained aphanites having a porphyrytic texture. The largest phenocrysts are feldspar, most of which fall into the size of 3 to 5 mm in longest dimension. The rock contains relatively few but easily observed quartz crystals, and biotite is relatively scarce. A few feldspar phenocrysts are vitreous, but the majority are slightly altered giving a chalky appearance to the rock on a fresh surface.

Some of the rock samples taken from the peripheral areas of the Judd Creek latite have a very reddish rusty cast; otherwise they are similar in megascopic appearance to those from the central area. It was thought that perhaps a gradation of coarser textured rock at the center of the extrusive to a fine-grained flow rock in the outer portions might exist. If a marked gradational change did exist, this change might help locate the source of the volcanic flows and help determine the influence of structure on the volcanic rock distribution. A comparison did show a slight gradation of coarse to fine texture from the central area of the extrusive mass to its outer portions. This small change in texture to the coarse size could be attributed to the slower cooling rate in the thicker portion of the volcanic mass.

Thin section studies of all the Judd Creek extrusive samples show the plagioclase phenocrysts to fall in the Ab68/An32 (Albite 68 percent, Anorthite 32 percent) to Ab65/An35 composition range, which is andesine plagioclase. The writer determined this composition of plagioclase by the Fedorow method of feldspar determination (Emmons 1943) using the Universal Stage. Samples from the central area have a very fine-grained groundmass that is faintly anisotropic, but its composition is indeterminate. All feldspars are intensely altered in these rocks; almost completely replaced by kaolin, sericite and calcite. The extremely fine-grained groundmass also shows similar alteration. However, the low quartz content (less than 5 percent) plus the andesine plagioclase composition indicates the rock is intermediate in composition.

Thin sections of the reddish-rusty samples from the peripheral zone show the groundmass heavily stained with iron oxide and the feldspars have the same Ab/An ratio but are quite fresh. The plagioclase phenocrysts of the center samples from the Judd Creek extrusive show heavy alteration. The relatively fresh plagioclase of the peripheral samples in contrast to the central area suggests a deuteric alteration of the center portion of the extrusive but an oxidation and relatively quick cooling process for the outer thinner portions of the mass. In sections 16, 17 and 18 of T. 10 S., R. 7 W. 1, erosion has exposed locally the contact zone formed when the Judd Creek latite flowed out over sedimentary bedrock. This is evidenced by limestone surfaces veneered with silicification which are adjacent to or surrounded by flow rock.

The small exposures of extrusive rock in Raul Canyon are two types, an agglomerate and a porphyritic flows.

The agglomerate is light colored, fairly fresh and characterized by well formed biotite crystals and occasional inclusions of lighter flow rock containing vitreous and chalky feldspars. In thin section this rock shows abundant phenocrysts of fresh plagioclase crystals intermixed with moderate to heavily sericitized plagioclase crystals and fairly abundant broken biotite fragments. Quartz phenocrysts, about 5 percent of the rock volume, are resorbed and embayed. The phenocrysts and fragments of this rock are set in an indeterminate but faintly anisotropic groundmass which constitutes from 25 to 40 percent of the rock volume. The composition of the fresh plagioclase in the agglomerate has the range of Ab48-53/An52-47. The altered (sericitized) plagioclase has the composition of Ab74/An26. These data are further evidence that the agglomerate is made up of rocks from more than one source. The agglomerate showed no structural relationships with the surrounding bedrock because alluvium surrounds the only exposed outcrop.

<u>Raul Canyon Basalt</u> - The porphyritic basalt occurs in Raul Canyon. It is a dark, fine-grained rock with feldspar phenocrysts varying from 0.1 mm to 3.0 mm in longest dimension. Flow structure is prominent. Secondary magnetite dust occurs throughout the predominant glassy isotropic groundmass. Eighty-five percent of the groundmass is indeterminate, making accurate classification impossible. The only phenocrysts observable are small 0.1 mm to 1.0 mm plagioclase crystals with occasional larger (3.0 mm) plagioclase crystals and 0.1 mm to 1.0 mm crystals of chlorite which show reaction rims. The plagioclase composition of Ab30/An60 further indicates the rock is basic in nature.

Several outcrops of the porphyritic basalt surrounded by alluvium in Raul Canyon, align themselves along a projected trace of a fault detected in the sedimentary bedrock nearby. Because of this alignment, it seems apparent that this fault controlled the emplacement of the basalt porphyry.

In the vicinity of the divide separating Indian Springs Canyon from Lee Canyon a moderate amount of detrital volcanic rock float occurs. The rock is fine grained and very friable and looks arkosic in hand specimen. In thin section the rock shows rounded and broken fragments of feldspar embedded in a chlorite-sericite matrix of very fine texture. Secondary chlorite has formed in crystals up to 3.0 mm in length. Magnetite is common in the rock.

Intrusive Rocks

Fourteen scattered intrusive outcrops dot the mapped area of the Simpson Range. They are located mainly in the Precambrian sedimentary outcrop which cover approximately the southern half of the map. In general, the rocks of these intrusives cannot be accurately classified due to the very fine-grained indeterminate groundmass. The writer has tentatively classified them on the basis of the phenocryst composition. However, the rocks have been named with reference to their location rather than rock type. In order to find some relationship between the igneous rocks, both extrusive and intrusive, the writer determined the plagioclase composition (Ab/An) of all igneous rock. This procedure offered a means of finding out, 1) if the volcanics were extruded through the small intrusive plugs now isolated by erosion from the extrusive outcrops. (The same type of plagioclase occurring in both extrusive and intrusive would suggest this), and 2) to see if the avenues used by the intrusives were the same as used by ore-forming fluids. Similar alteration of the various intrusive outcrops, to the intrusive rock associated with ore deposits would evidence the validity of this premise. The intrusives of Death Canyon have lead-zinc ores associated with them as past mining operations have shown. If intrusives in unexploited and unproven areas are similar in alteration, composition, etc. to those in productive zones, the intrusives in the unproven zones may also have associated ore deposits.

Table I shows the Ab/An ratio of the different igneous rock outcrops. The extrusive or intrusive nature of the igneous bodies as noted on Table I is deduced from field relationships only. All the samples except one exhibited such a fine-grained groundmass that determination of the intrusive nature of the rock by field criteria was the only dependable method.

Aspen Creek Intrusive - The largest exposed intrusive body, called the Aspen Creek intrusive, located just north of Aspen Creek in section 19, T. 10 S., R. 7 W. exhibits a chill zone and an iron stained aureole which surrounds intrusive. Its shape is roughly elliptical and its dimensions are about 1,400 by 800 feet. The Aspen Creek intrusive rock is a dark green dense, porphyritic rock containing

TABLE I

NO.	ROCK TYPE	MODE	PLAG. COMP. Ab/An	TYPE FELDS. ALT.			PY.	MAG.	AMT. & TYPE QTZ.		BIOTITE CHLORITIZED	SPECIAL FEATURES
				Sericite	Calcite	Kaolin			Embayed	Non-Absorbed		
1	Tj Judd Creek	Ex	62/38	No Data								
2	Tj Judd Creek	Ex	62/38	S	N	S	N	N	N	N	N	
3	Tj Judd Creek	Ex	60/40	S	N	A	N	S	N	N	C	Secondary Qtz.
4	Tj Judd Creek	Ex	63/37	S	A	S	N	S	N	5%	C	
5	Td Death Canyon	Int	65/35	A	N	S	A	S	5%	N	C	Secondary Qtz. Replacing Plag
6	Td Death Canyon	Int	65/35	A	N	S	M	S	5%	N	C	
7	Ta Aspen Creek	Int	65/35	M	A	S	N	S	N	N	C	
8	Tis Iron Spgs.	Int	62/38	A	N	N	M	N	10%	N	M	Limonitized Ground Mass
9	Tos Ox Shoe	Int	100/00 95/5	S	A	N	M	N		5%	M	
10	Tr Raul Canyon	Ex	40/60	A	N	N	N	S	N	N	A	
11	Ti Imperial	Int	40/60	N	S	N	N	M		5%	S	
12	Tb Blaine Cy.	Int	90/10 75/25	A	A	N	S	S	5%		A	
13	Ts Scorpian Ck.	Int	75/25	N	N	S	N	N		5%	N	Embayment of Chlorite into Feldspar

KEY

N - None M - Moderate
S - Slight A - Abundant
C - Complete

feldspar phenocrysts, some vitreous and some with a slightly dulled luster. Apparently long north trending faults which bound the Aspen Creek intrusive on two sides, partially controlled its emplacement. Locally within the intrusive itself massive bull quartz silicification has replaced the igneous rock by penetrating along and spreading from fractures. The largest feldspar pheoncrysts are 4.0 mm in longest dimension and they range from this size to 0.1 mm. Most of the feldspar is plagioclase; very little orthoclase is present in the rock. Phenocrysts having altered to chlorite averaging about 2.0 mm in size and are abundant being easily distinguished with a hand lens.

In thin section the feldspars of the Aspen Creek intrusives show considerable alteration to calcite. The calcite in the plagioclase phenocrysts occurs as isolated but closely spaced irregular zones giving a poikilitic appearance to the crystal. The unreplaced interareas in the crystal are practically free from any alteration. Hornblende has been removed leaving its crystal form outlined with magnetite dust and the voids filled in with calcite. Much calcite occurs as small aggregations in the groundmass also. This high content of calcite (between 15 and 30 percent) suggests an introduction of lime after the magma was intruded or an assimilation of highly calcic rock. However, thin section studies show no veinlets or other evidence suggesting introduction after consolidation, but rather the disseminated nature of the calcite indicates an assimilation process. The abundant chlorite crystals so easily observed in hand specimen appear under the microscope to have a form like that of mica. It is very probable that the alteration of biotite formed the chlorite.

<u>Iron Springs Intrusive</u> - Located in section 29, T. 10S., R. 7W., the Iron Springs intrusive rock, a plug of quite small outcrop (see Plate I), is significant in that it has a relatively high content of quartz; some samples containing up to 10 percent by volume (modal analysis).

The Iron Springs intrusive rock is megascopically an aphanitic porphyry having a dark greenish-brown color closely resembling the color of the shales in Unit VI which this rock intrudes. The quartz phenocrysts contained in the rock are large (1 cm) and megascopically appear abundant. Because of its color similarity to that of the sediments which the Iron Springs mass intrudes, it is probable that more such outcrops exist which have been overlooked inadvertently.

Microscopically the Iron Springs intrusive shows a very fine-grained indeterminate groundmass having grains 0.01 mm in diameter with an occasional quartz crystal 1.0 cm in longest dimension. The plagioclase phenocrysts, the only feldspar observed, vary in size slightly larger or smaller than 2.0 mm in long dimension. The indeterminate groundmass, forming of about 70 to 80 percent of the rock volume is faintly anisotropic, consisting probably of altered feldspar and quartz although definite identification is doubtful.

Sercitization has intensely altered the plagioclase crystals, while the large quartz crystals are deeply embayed and show secondary growth rims on their borders. The rock apparently had not reached equilibrium between the crystallized portion and the molten residual liquid when freezing took place. Replacement and alteration of the plagioclase crystals by calcite is subordinate to absent. The Ab62/An38 ratio of the Iron Springs Rock matches that of the Judd Creek latite which has an Ab62/An38 plagioclase composition. Tentatively the Iron Springs rock has been classified as a latite.

Ox Shoe Intrusive - The Ox Shoe intrusive outcrop area, apparently a plug located in and near section 33, T. 10S., R. 7W., contains plagioclase crystals of a high albite content (Ab95/An5 to Ab100/An00) which is quite different from all the other igneous rocks. However, in many respects this rock is very similar to the Iron Springs rock. Both are olive drab in color, aphanitic, have similar quartz content (5 percent for the Ox Shoe rock) and contain 70 to 80 percent indeterminate groundmass. They are different in their plagioclase composition however; the albite of the Ox Shoe intrusive may be authigenic, but usually albite formed in this manner is quite unaltered. In the Ox Shoe intrusive the albite has been altered by calcite, replacing from one-fourth to one-half of the plagioclase crystals. By way of comparison, sericitization is the principal alteration of the Iron Springs intrusive. Alteration is otherwise the same in the rocks from the two intrusive zones.

Limonite has pervasively stained the groundmass and also has formed pseudomorphs after pyrite in the Ox Shoe intrusive which suggests metalizing solutions introduced the iron probably as the sulfide. No classification was attempted for this rock due to the extreme alteration of essential minerals in samples studied.

Blaine Canyon Intrusive - Near the mouth of Blaine Canyon a group of small intrusive outcrops occur which the author called the Blaine Canyon intrusive group. These outcrops are located close to one another and are probably connected at a shallow depth below the present surface. The rock contains megascopic feldspars which look fairly fresh, having a slightly dull luster, and the mafics, including hornblende and biotite, are completely chloritized. Hornblende, completely replaced by chlorite, appears as chlorite pseudomorphs after hornblende. Quartz is subordinately present and is intensely resorbed. The igneous rock itself has an overall appearance of andesite. Under the microscope the Blaine Canyon rock shows a large volume of indeterminate fine-grained groundmass (75 percent). The only feldspar identifiable is plagioclase and these crystals are almost completely altered to sericite and calcite.

The extreme alteration of the plagioclase crystals inhibited determining an accurate orientation of the 010 crystal face for the 010 pole plot which is so critical in Fedorow method on plagioclase composition determination with the Universal Stage. Several determinations were attempted, but the results varied too widely (Ab90/An10 to Ab75/An25) to be usable.

Pyrite and magnetite are present in small discrete grains. The grain size range, which includes most of the phenocrysts, is 0.01 mm to 2.0 mm. A few of the phenocrysts, plagioclase predominantly, occur in the 4.0 mm to 6.0 mm range.

Death Canyon Intrusive - The Death Canyon intrusive rocks are probably the most significant economically, as they are closely related, at least spatially, to known base metal deposits which occur in this area.

The most striking megascopic feature of these intrusive rocks, especially those occurring near the Bar X Mine, is the abundant contained pyrite cubes and limonite pseudomorphs after pyrite, varying from 1.0 to 3.0 mm in dimension. The color of the rock is light tan to very light gray and its texture is porphyritic, having very fine-grained groundmass with rare larger (4.0 mm) phenocrysts of plagioclase. Microscopically the groundmass, 60 to 80 percent of the volume, is indeterminate for the most part; but portions appear as a mosaic of small (0.01 mm) grains of quartz displaying sutured crystal boundaries. This fine-grained quartz is probably introduced silica, as large (2 to 3 mm) phenocrysts of quartz contained in the same slide show much resorption and embayment, indicating the liquid (now represented by the fine-grained groundmass) of the partially crystallized melt was quartz hungry, as it resorbed contained quartz crystals. In light of this evidence, it is assumed the present silica of the groundmass has been introduced since the primary crystallization of the igneous rock now exposed as the Death Canyon intrusive.

The groundmass contains abundant sericite which also replaces almost completely the few contained plagioclase crystals. Chlorite is subordinate but has replaced all primary mafics. Orthoclase is absent as phenocrysts. Because the plagioclase contained in the Death Canyon intrusive has a composition very near that of the Judd Creek latite, the Death Canyon is tentatively classed as latite also.

Imperial Intrusive - The Imperial intrusive rock, so named because of its location near the old Imperial Mine workings, occurs as an eight foot wide dike in the southwest part of the mapped area. This outcrop is the only one in the whole mapped area which is crystalline enough to accurately classify. According to Johannsen's classification, the rock is a Syenodiorite (2211H).

Megascopically this syenodiorite looks like a basalt porphyry as it is very dark and fine grained, containing abundant phenocrysts. In thin section, however, the rock has a hypautomorphic granular texture having 60 percent of its volume as plagioclase of the composition Ab41/An59 to Ab40/An60. The plagioclase crystals are the largest contained crystals, some being 1 cm in their longest dimension. Orthoclase, 15 percent by volume, occurs as very small interstitial grains. The pyribole composition is varied, but it constitutes 10 percent of the rock. Magnetite makes up 5 percent of the total constituents, but no pyrite is present. Calcite is present up to 5 percent, but it is probably derived from the slightly altered labradorite.

North of Scropion Creek a small intrusive dike occurs called the Scorpion dike. Megascopically this rock looks much like a rhyolite prophyry. Feldspars are the largest and most abundant phenocrysts and are light cream in color showing no alteration. The next largest and abundant phenocryst is primary quartz which shows no resorption or embayment. The groundmass is light gray in color, dense and aphanitic.

Under the microscope thin section samples show the rock to have a porphyritic texture. The indeterminate groundmass which occupies 85 to 90 percent of the rock volume, is microlitic in texture. The rock contains very few plagioclase phenocrysts, mostly orthoclase, but the plagioclase composition is Ab75/An25, which supports the tentative rhyolitic classification. No mafics appear in the thin section.

Comments on Petrographic Investigations of Igneous Rocks

The igneous rocks of the Simpson Range can be grouped into four types based on their contained plagioclase crystal composition.

Group I, so called for convenience, includes the Judd Creek latite mass, Death Canyon intrusives, Aspen Creek intrusive, and the Iron Springs intrusives. All rocks of this group contain plagioclase with compositions falling within the narrow range of Ab60/An40 to Ab65/An35. It is significant that these same rocks also contain the same alteration products in their unweathered fresh samples. All have moderate to complete chloritization of contained biotite; and calcite and/or sericite alteration has replaced the plagioclase crystals in varying degrees. The outcrops of Group I also are spacially grouped together as they fall in a broad three-mile wide zone extending from Death Canyon northeast to the large Judd Creek extrusive mass. It is probable that rocks in this zone are contemporaneous and the small intrusive necks, presently eroded and exposed, were feeders for extrusives similar to the present Judd Creek extrusive mass.

It is also very probable that the ore associated with the Death Canyon intrusives has migrated upwards through the same conduits as the igneous intrusions because abundant pyrite with a trace of lerite occurs locally in these igneous rocks. It is probable that the igneous rocks of the entire group may all be associated with ore somewhere below the present ground surface as they have similar mineral composition and alteration products. These plugs of similar characteristics may have been the major openings available to emanating ore fluids at the time of metallization and ore emplacement.

Group II includes the Imperial intrusive and the Raul Canyon intrusive. These two widely separated rock outcrops have a plagioclase composition of Ab40/An60 (labradorite) and are quite similar in megascopic appearance. They occur on the extreme west side of the mapped area, but the Raul Canyon rock is approximately six miles north of the Imperial outcrops. It is possible that more similar type rocks were overlooked inadvertently in the area between the two known outcrops.

Group III includes the Scorpion Creek dike rock and portions of the agglomerate found in Raul Canyon. The plagioclase composition varies from Ab75/An25 to Ab74/An26 in this group. The Blaine Canyon intrusive has a dubious plagioclase composition similar to this group, but alteration has proceded too far for accurate determination.

The Ox Shoe intrusive, which has a high albite content (Ab95/An05 to Ab100/An00) makes up Group IV. This rock is rather an anomaleous in plagioclase composition, but the area of intrusion outcrop is relatively large (see Plate I) therefore it is considered as a distinct type.

STRUCTURE

General

The Simpson Range contains a large and gentle north-trending fold, cut and offset by major east-west faults that cross the whole Simpson Range. In the northeast portion of the mapped area, complex faulting trends in many directions, but predominantly in a north-south direction. The north-south faulting occurs in close proximity to the large Judd Creek extrusive mass. This extrusion may be an uppermost portion of a deeper seated intrusive which could have shouldered aside the sediments, produced the complex faulting nearby. Large east-west faults broadly divide the range into three major fault blocks; the center block is a large graben, but topographically it is the higher part of the range. An area of complex faulting occurs predominantly in the graben block and indicates tectonism to the east which exerted pressure from the east causing long north-trending shear faults and east-west to north-east trending reverse faults.

Faults

North Fault - North Fault is one of the three larger east-west trending faults which divides the Simpson Range into large fault blocks. It crosses the range in the extreme northwest zone of the mapped area. Precambrian rocks on the north of the fault are abutted against Cambrian rocks on the south. Total displacement is unknown but stratigraphic displacement of the units involved is 8,000 feet. It is probable that more displacement has taken place but no continuous stratigraphic section from Precambrian to Cambrian is available for measurement to ascertain the total throw.

The North Fault marks the northern boundary of the large graben in the Simpson Range described above.

Indian Springs Fault - About one mile south of the North Fault is the east-west trending Indian Springs Fault, the trace of which follows the Indian Canyon. The Indian Springs, which flow the year round, occur along the fault trace. A continuous exposed stratigraphic section has been measured elsewhere in the Simpson Range between the different age sedimentary rocks occurring on opposite sides of the fault. From these measurements the calculation of displacement along this fault amounts to approximately 3,700 feet plus or minus. The fault occurs within the large graben and demonstrates a step block in the north side of the graben.

Silicification occurs along the fault zone with quartz veins criss-crossing the country rock and massive bull quartz has replaced limestones and dolomites locally on both the north and south sides of the Indian Springs fault. Some of the quartz veins are up to eight inches in width showing well developed comb structure or quartz crystals.

Lost Canyon Fault - The southern boundary of the large graben crossing the Simpson Range is delineated by the east-west trending Lost Canyon fault. The fault is steeply dipping to the south; its steepness attested by the slight affect the steep topography has on its nearly straight trace. South of this fault the Precambrian Sheeprock series occur exclusively. North of the fault the youngest rock abutting against the Sheeprock series is the Swan Peak quartzite of Ordovician age. The total measured stratigraphic thickness between these two units is 16,000 feet. It seems improbable that all of this stratigraphic displacement is entirely attributable to dip slip movement; although this may be the case, but most steeply dipping faults have some diagonal slip movement.

Examination of the fault along its trace revealed no drag of the adjacent sediments to indicate movement direction. Slickensides or mullion structure which would also help in determination of fault movement were not apparent as colluvium covers the fault trace where distinctly different lithologies occur on either side of the fault. If the Lost Canyon fault had a sizeable strike slip component which displaced, large deep troughed folds, this fortuitous circumstance could help account for the seemingly large stratigraphic displacement. No known formation occurring on both sides of the fault, showing horizontal displacement was found within the exposed bedrock cut by the fault. If considerable strike slip movement did occur, then it has displaced the strata involved a greater distance than the length of the fault trace as exposed in the bedrock outcrop. The only thing definitely known about the movement on the Lost Canyon fault is that units occurring on each side of the fault are 16,000 feet apart stratigraphically.

Smaller Faults - The complex zone of faulting in and east of section 6 and 7 T. 10 S., R. 7 W., reflects a compressive force from the east which has caused steep reverse faulting in a north and northwent trend.

All of this zone of complex faulting occurs within the large graben in the central portion of the range. South of the graben, faulting is less complex and it trends predominantly north-northeast with occasional north-south breaks.

Folding

In general the structure in the Simpson Range is homoclinal. In Death Canyon a very shallow broad anticline occurs, having a northerly plunge, its axial trace trending along Death Canyon drainage which trends almost due north. This fold extends north to the Lost Canyon fault where it is cut off. North of this fault in the Raul, Rock and Grassy Canyon drainages, the configuration of the strata suggests the presence of a north trending anticline; faulting has offset and abutted this structure against the Death Canyon anticline. Both anticlines trend north and could be offset portions of the same structure.

SUMMARY OF GEOLOGIC HISTORY

The Sheeprock series represent the first sedimentary deposition discernable in the mapped area. Undoubtedly the Simpson Range and the nearby Sheeprock Mountains were the site of a eugeosynclinal trough of deposition in Precambrian time. Cohenour (1957) reports 10,924 feet of Sheeprock series accumulated in the Sheeprock Range and the writer measured 9,400 feet in the Simpson Range.

Uplift, with gentle folding and erosion followed. This erosional period probably includes glaciation as evidenced by the tillite found in the Sheeprock series of the Simpson Range. The thick deposition of dark sediments (slate, graywacke, quartzite) of the Sheeprock series is overlain (as shown by relationships noted outside of mapped area) by a light colored arkosic quartzite which indicates an uplift of crystalline rock nearby. The dumping of arkosic sediments into the site of deposition was followed by continued sand deposition now known as the Tintic quartzite. The shores of the old sea in this area at this time were probably the site of vigorous washing and sorting as shown by clean and sorted sand of the thick Tintic quartzite. The shoreline moved eastward after the deposition of the Lower Cambrian Tintic quartzite and the sea accumulated the overlying Pioche shale. The sea increased more in depth with continued quiescence through the deposition of the Cambrian and Ordovician carbonates. During the deposition of the Kanosh shale and Swan Peak quartzite the Ordovician sea was shallow in the Simpson Range area, but abruptly the sea deepened slightly after the Swan Peak deposition to collect the Fish Haven dolomite. Slight uplift and erosion followed with subsequent inundation which allowed the Laketown dolomite of Middle Silurian age to accumulate. Still later the Middle Devonian Sevy and Simonson dolomites were deposited with little tectonic evidence of an erosion epoch which separates the Devonian from the Silurian. The post Devonian history is not represented by rocks in the mapped area.

After Devonian, but before Tertiary time, the Simpson Mountain area suffered folding, uplift, followed by intense faulting aligned mostly in an east-west direction. Erosion and dissection of the area then occurred after which further uplift took place along north to northwest trending faults probably during the rise of the Mesocordilleran Geanticline sometime in Late Jurassic to Early Tertiary time. This was followed by intrusion of the accumulated sediments by plugs which gave rise to lava flows that spread over the surface of the eroded sediments probably in Early Tertiary time. Continued erosion which partially stripped off ~~the veneer~~ of flow rock, and subsequent periodic renewal of uplift along northwest trending Basin and Range faults has taken place up to recent time. Lake Bonneville sediments have been deposited around the periphery of the uplifted Simpson Mountains and Quaternary alluvium has collected in the drainages and valleys adjacent to the range.

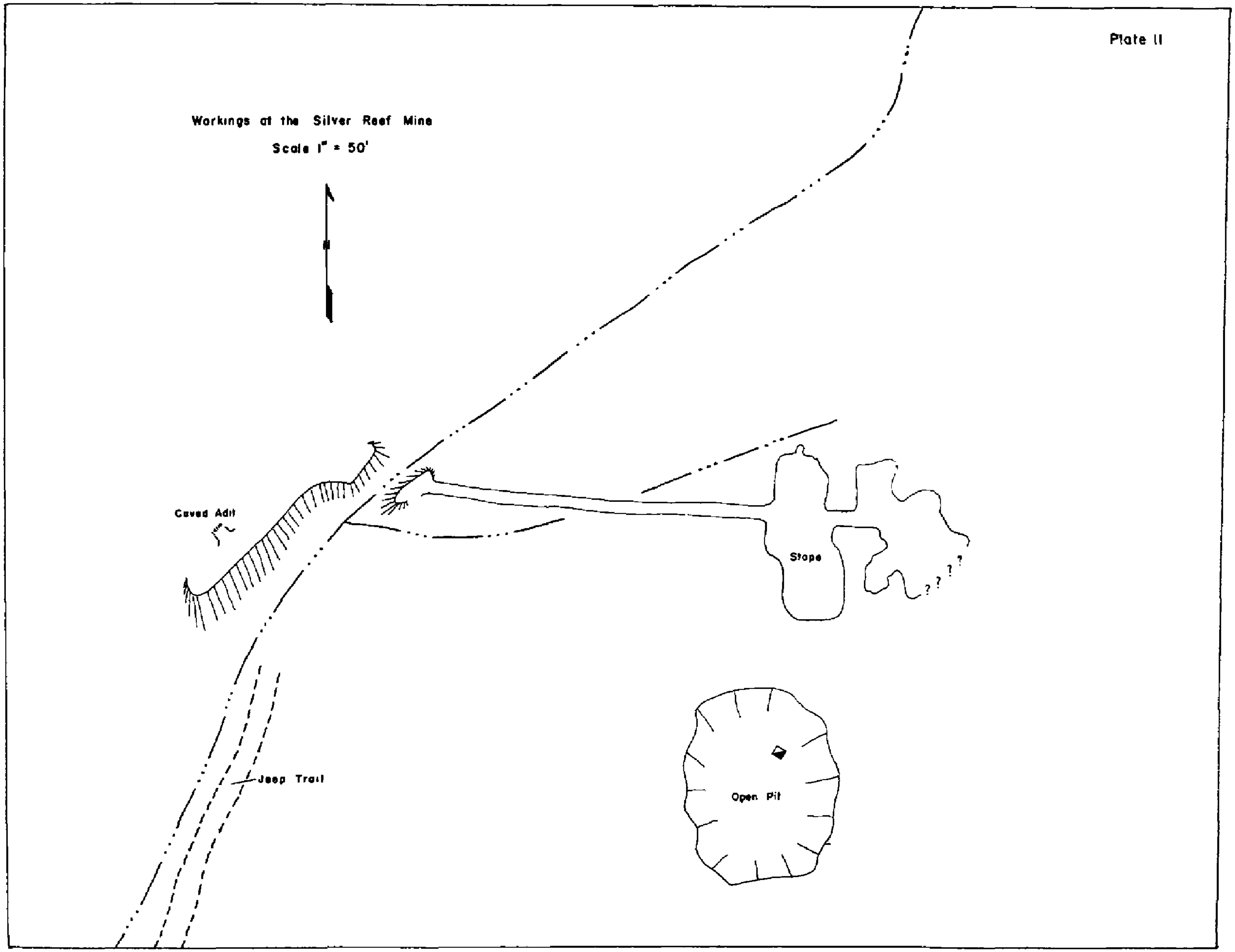


Plate II
Workings at the Silver Reef Mine
Scale 1" = 50'
Caved Adit
Stope
? ? ? ?
Jeep Trail
Open Pit

ECONOMIC GEOLOGY

General Statement

The major ore deposits of the Simpson Range are centered around Death and Blaine Canyons in the south of the mapped area and near Indian Springs in the north. These two areas of major metalization are included in the Erickson mining district, which extends across the valley eastward to include the west slope of the Sheeprock Range and northward to Government Creek.

Production has mainly come from marginal lead-zinc mines in Death Canyon. However exceptionally high values of silver have been found occurring in small isolated pockets near Indian Springs. Prospecting and mining began in this area sometime in the late 1880's. The total production since that time is unknown as early records are incomplete. However, since 1932 production has totaled more than $240,000 mostly for the Bar X Mine.

Silver Reef Mine

According to Mr. Rydalch of Tooele, his grandfather, Mr. Adams, in 1912 found a small high-grade ore body containing silver antimonides and cerargyrite in a quartzose gangue. This property yielded a carload of ore averaging 400 oz. per ton of silver, with a trace of gold and small percentages of copper. This later (1916) became the Silver Reef Mine of the O.K. Silver Mining and Milling Company, which is reported to have produced from this and other nearby prospects an unspecified amount of silver ore during the period from 1916 to 1920. This company also owned the O.K. Mine and the Indian Chief prospect, all located within one-half mile of Indian Springs.

The writer visited all of these properties, but only in the Silver Reef Mine are underground workings accessible; these consisted of one adit which entered an intensely silicified limestone dipping about 30° northeast (see Plate II). The blue-gray limestone, assigned to Lower to Middle Cambrian because of its stratigraphic proximity to the nearby Pioche and Tintic formations, has been replaced completely by white, milky vein quartz which in turn has been replaced by rust-streaked dark ore zones. About 100 feet from the portal the adit opens up into 3 large stopes, each about 50 feet to the back and 60 feet wide. The stope walls are composed of white vein quartz and dark veins and veinlets of ore from one inch to 2 feet in width criss-crossing the quartz rock. The author sampled the veins and assay results show the highest grade ore runs $16.00 in silver and a trace of gold per ton.

G. F. Loughlin (1920) visited the properties of the O.K. Silver Mining and Milling Company in 1912. A small open cut, just opened at the time of Loughlin's visit, had exposed some silver-rich oxidized material in quartz gangue. Later in 1916 Loughlin reported two shipments of ore from this body, one yielding 488 oz. of silver and 0.235 oz. gold to the ton and 0.15 percent copper; the other shipment he reported as containing 405 oz. silver and 0.02 oz. of gold to the ton.

The latest reported mining activity (Rydalch, personal communication) in the Indian Springs area consisted of a Mr. H. B. Huber, lessee, shipping the dump of the O.K. Mine. Mr. Huber obtained his lease from the Tribune-Kearns Corporation for this project in 1949. He realized a $10,000 gross income from the silver values in the dump material. As far as the writer could ascertain, the Indian Springs area has had no activity since that time.

Bar X Mine

The Bar X Mine, formerly owned and operated by Mr. Pheno Tedesco of Salt Lake City, has recently been merged with the Zuma Uranium Company. The property consists of 31 patented claims (Esther Group) located about midway up Death Canyon.

The ore deposits in the Bar X Mine have apparently been controlled by the intersection of faults with calcareous slates and/or graywackes. At the time the writer visited the property, the two inclined shafts, through which the ore was mined, were full of water; but an examination of the Bar X Mine underground maps indicated a structural lithological control. A flat-lying, ore-making strata lies stratigraphically just below the medial quartzite of Unit II. In the Death-Blaine Canyon area nearly all the surface ore pockets worked in earlier days of mining, occur in or near this favorable zone and its intersection with mineralized fractures or faults. The writer determined the relative content and absence or presence of lead contained in these small ore showings and dumps by use of a small portable lead testing kit.

One analysis made of the apparently favorable bed showed it contained 31 percent calcium carbonate; although rocks of high carbonate content are rare in the area of Precambrian outcrop.

The Bar X Mine has produced over 6,500 tons of lead-zinc ore (sulphides) containing subordinate copper, gold and silver; the ore having a gross value of $242,076.78. By far the major part of this amount was produced during the years 1947 to 1952. The property is now idle.

Blackrock Mines

Near the head of Death Canyon a large 8 to 20 foot wide, near vertical, vein of black manganiferous ore occurs which has been successfully worked at a profit by a lessee named H. H. Ellerbeck. The vein trends just south of east, crossing at right angles the axis of the anticline in Death Canyon. This canyon cuts the vein, separating the vein outcrops by about 100 feet where exposures occur on either side of the canyon. Although the writer spent only a short time examining the vein exposed in the workings in the west side of the canyon, it appears that the vein thins and flattens in dip along its extension to the west. The east side workings were inaccessible. The host rock for the vein is a pink quartzite of Unit III which has been pervasively stained by MnO_2, giving it a black colored weathering surface.

Mr. Ellerbeck worked the property in 1952 and 1953 and produced 5,635 tons of ore averaging 29.17 percent manganese. He shipped most of this ore to Geneva Steel Plant in Provo, Utah, but he also shipped some ore to the Western Electrochemical Company plant at Henderson, Nevada, where it was processed into synthetic battery grade manganese.

Blackjack and Ida Groups

These properties, located in and near the mouth of Blaine Canyon, are in the control of Mr. Walter Morgan of Santiquin, Utah.

At the Ida group workings a small homemade gravity separation mill has been set up to enrich the galena ores mined there. Although it upgrades the ore appreciably, as inspection of the heads compared to the concentrates indicates, the mill's capacity appears too small to be practical. This may be the reason it is presently abandoned. The nearby adit, which supplied the ores for the mill, was not examined by the writer; although it appears accessible. However, the adit is reported to have intersected a two foot vein of galena ore which, when followed, gradually pinched out. The location of this vein is roughly at the intersection of the favorable ore-making strata of Unit II and a mapped fault. This loci further emphasizes the structural-lithologic ore control in the Death-Blaine Canyon area.

Farther south in Blaine Canyon are the workings of the Blackjack group, accessible through a 70° inclined shaft. The writer did not descend the shaft, but the latest dumped material showed no indication of lead when tested with a portable field testing kit. The workings in Blaine Canyon are presently (1957) all idle and appear semi-abandoned as some valuable but long unused equipment still remains at the workings. Production data are scanty, but the Blackjack group is reported to have produced 99 tons of lead-zinc ore of unspecified tenor in 1953.

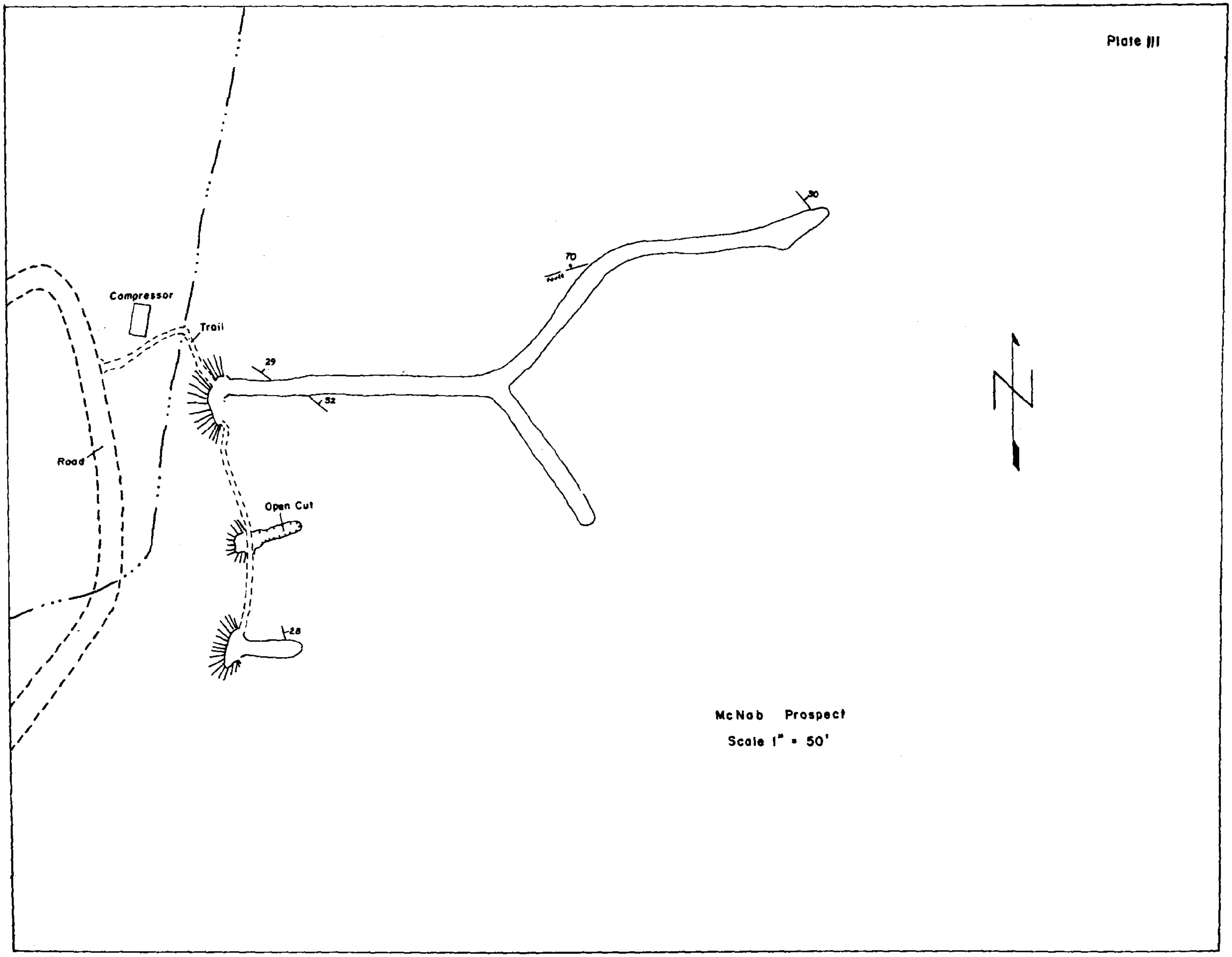


Plate III
Compressor
Trail
Road
Open Cut
29
52
70
30
28
McNab Prospect
Scale 1" = 50'

McNab Prospect

At present (1957) the only mining activity in the Simpson Range is the McNab prospect (see Plate III). A Mr. Willard McNab of Salt Lake City has two men driving an exploratory adit on a leased property in upper Death Canyon. No shipping ore appears on the working faces, but traces of oxidized lead were detected by portable field kit test at several places in the workings.

ECONOMIC POSSIBILITIES AND RECOMMENDATIONS FOR FUTURE ORE EXPLORATION

Indian Springs Area

Because small but high-grade silver ore bodies have deposited in the Indian Springs area, it seems probable that other such ore bodies might exist which have not been found. It is evident from previous discussion that the metallizing fluids deposited their metals along with and after the milky white vein or bull quartz which occurs in this area. This association suggests ore depositing fluids rose from depth along the same zones of weakness as the quartz depositing fluids used. The writer considers this close spacial relationship a useable tool to designate potential ore-producing zones.

By mapping all such zones of silicification and noting their relationship to any conduits such as faults, fractures, inclined beds, etc., the most favorable areas for drilling and geophysical prospecting can be delineated. This significant type quartz occurs at the head of Lee Canyon along the Indian Springs fault zone and in the Silver Reef Mine. The largest zone of bull quartz occurs in the Fish Haven-Laketown limestones and dolomites at the head of Lee Canyon. These sediments dip about 40° to the east into the north trending Lee fault that abuts Cambrian limestone against the Ordovician-Silurian carbonates. Near Lee fault the silicification has replaced the Fish Haven-Laketown carbonates almost completely, but updip to the west, silification gradually disappears leaving these formations unaltered. This intensity of silification near Lee fault suggests the silica-depositing fluids emanated from this conduit. Alluvium covers the bedrock and the trace of Lee fault.

In order to see if sulphide or chloride bodies of ore are associated with the bull quartz in Lee fault, the writer recommends a series of self-potential or resistivity geophysical traverses across Lee fault spaced every 500 feet or less. An ore body of the Silver Reef type in the quartz, which is just below the shallow alluvium, would show a marked contrast in conductivity with the surrounding quartz and thus can be easily detected. If any such anomalies should be found, drilling would then be in order. If ore bodies exist along the Lee fault and if past mining experience in this area is a guide, it is probable such ore bodies will be spotty and discontinuous. Therefore, mining operation should be kept small and any ore bodies should be roughly blocked out first by core drilling before sinking access shafts.

Aspen Creek-Death Canyon Area

This area, comprising a zone three miles wide extending from Death Canyon to the Aspen Creek intrusive, includes most of the igneous intrusive rocks of Group I (see page 19). Because the lead-zinc ore produced from the Death Canyon area is so closely associated spatially with the intrusives in that area and because the Aspen Creek intrusive is very similar in nature and alteration to the intrusive in Death Canyon, it seems possible that ore conduits may exist in the area of the Aspen Creek intrusive.

Geochemical analysis for heavy metals from sediments of streams draining the Aspen Creek area would offer one of the best means of cheaply checking for the presence of lead-zinc ore bodies in this area. A simple and cheaply conducted test for copper, lead, and zinc is the Cold Citrate test as developed by Bloom (1953).

In the Death Canyon area, the Blackrock Mine suggests economic possibilities. The present ore in the vein is MnO_2 with traces of lead and zinc. Many of the better lead-zinc producing veins in Death Canyon area show at their surface outcrop sizeable amounts of MnO_2. At depths the manganese gradually disappears and lead and zinc sulfides predominate. The excessively large amount of manganese in the outcrop of the Blackrock manganese vein may indicate similarly excessive content of lead and zinc sulfides at depth.

The vein flattens in northward dip along its westward extension; this flattening is probably controlled by the gently dipping beds on the plunging nose of the Death Canyon anticline. To test for the presence of higher grade lead-zinc ore, the writer would recommend shallow drilling just north of the westernmost outcrop of the Blackrock manganese vein.

In lower Death Canyon further discoveries of small ore bodies are probable if the ore-making zone found just below the medial quartzite of Unit II were mapped in detail, and all faults crossing this zone noted. Geochemical tests of samples taken of the favorable zone at each of these fault intersections would indicate presence or absence of metalization in these crossing structures. This work followed by an electromagnetic or self-potential survey of the geochemically richer zones might indicate the presence of profitable ore bodies. In Death Canyon the slopes are steep which would facilitate testing surface indications by drifting at lower elevation under the surface prospects to be tested.

LITERATURE CITED

Bloom, Harold, 1953, Additional Field Methods Used in Geochemical Prospecting by the U.S.G.S.: U.S. Geological Survey Open File Report, September 16, 1953, pp. 28-31.

Cohenour, R. E., 1957, The Geology of the Sheeprock Mountains, Tooele and Juab Counties, Utah: Unpublished Ph. D. Thesis, University of Utah.

Eardley, A. J. and Hatch, R. A., 1940, Proterozoic (?) Rocks in Utah: Bulletin Geological Society of America, Vol. 51, pp. 795-844.

Emmons, R. C., 1943, The Universal Stage: Geologic. Society of America, Memoir No. 8.

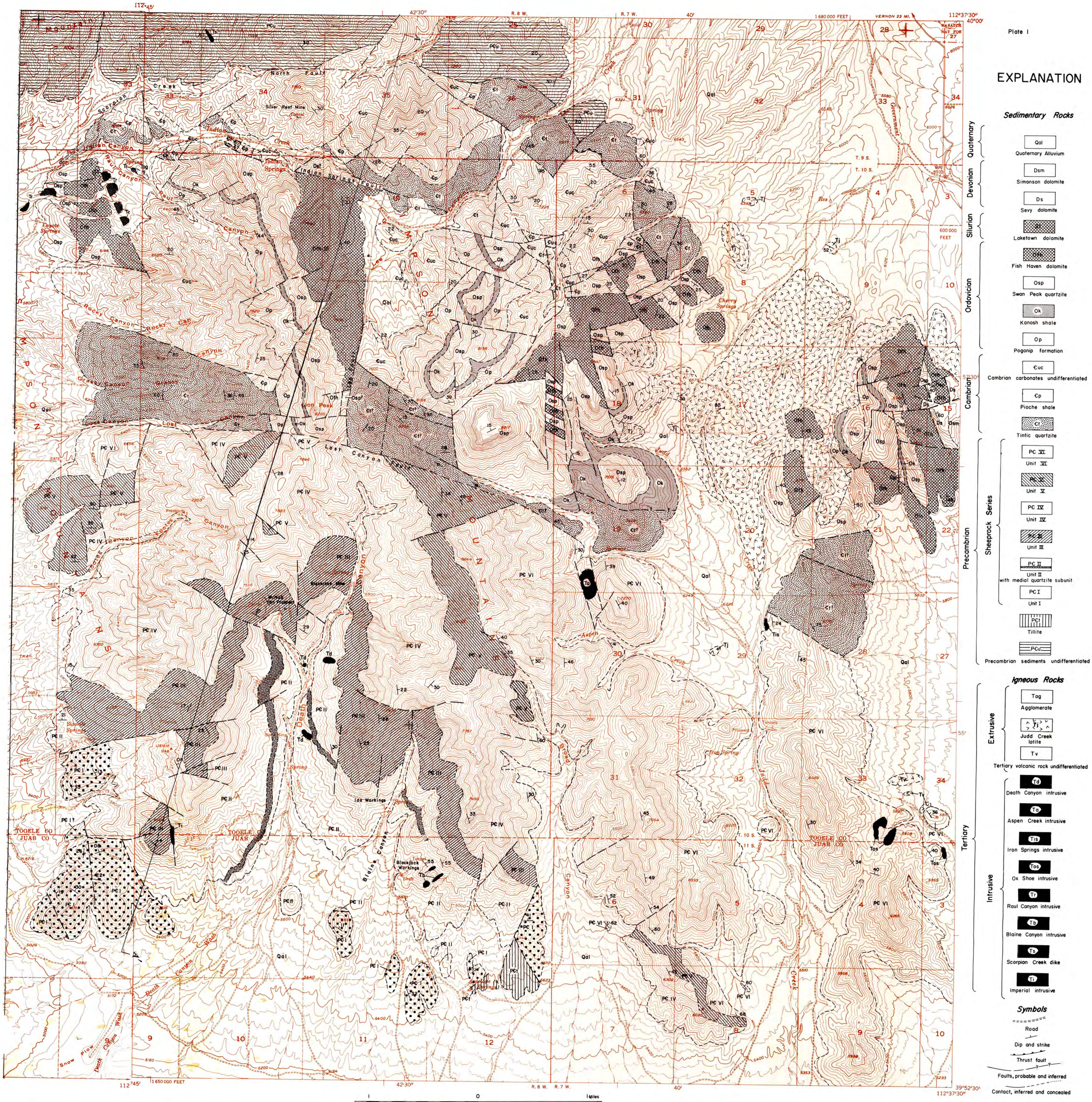
Harris, DeVerle, 1958, Geology of Dutch Peak Area, Sheeprock Range, Tooele County, Utah: Brigham Young University Research Studies, Geology Series, Vol. 5, No. 1.

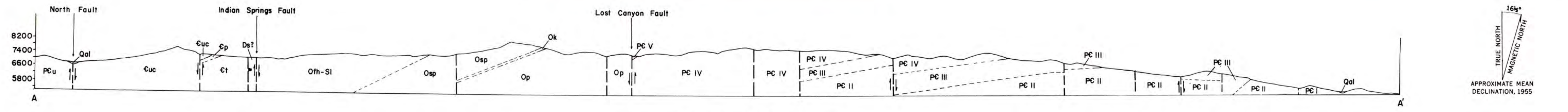
Hintze, L. F., 1951, Ordovician Stratigraphy: in Geology of Canyon House and Confusion Ranges, Millard County, Utah: Guidebook to Geology of Utah, No. 6.

Johnson, J. B., 1956, Regional Gravity Survey of Parts of Tooele, Juab, and Millard Counties, Utah: Unpublished Ph. D. Thesis, University of Utah.

Loughlin, G. F., Butler, B. S., Heikes, V. C., and others, 1920, The Ore Deposits of Utah: U. S. Geological Survey Professional Paper 111, 627 p.

Nolan, T. B., 1935, Gold Hill Mining District: U. S. Geological Survey Professional Paper 177, p. 9.





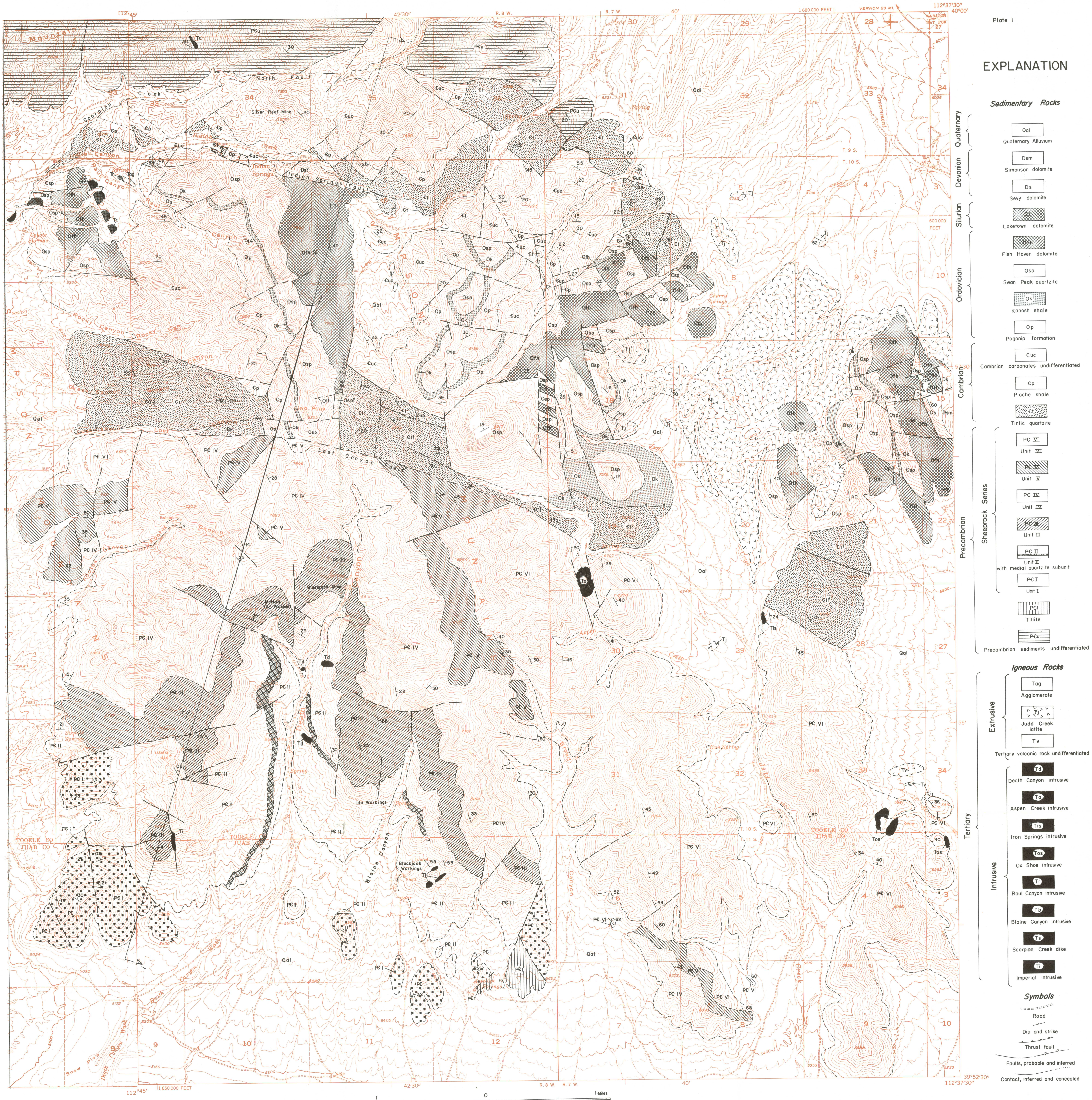
Section A A'

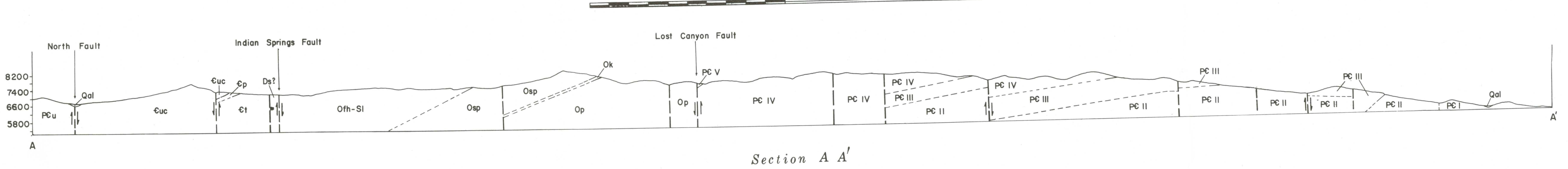
GEOLOGY OF THE INDIAN SPRINGS QUADRANGLE, TOOELE & JUAB COUNTIES, UTAH

Glenn H. Thomas

June 1958

Plate I





Section A A'

GEOLOGY OF THE INDIAN SPRINGS QUADRANGLE, TOOELE & JUAB COUNTIES, UTAH

Glenn H. Thomas

June 1958