CONTACT INFORMATION
Mining Records Curator
Arizona Geological Survey
416 W. Congress St., Suite 100
Tucson, Arizona 85701
602-771-1601
http://www.azgs.az.gov
inquiries@azgs.az.gov

upper Guilmette ore
Zone #1

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JASON E. EVERTS
MINING GEOLOGIST
MINERALS DIVISION
Box 495, East Ely, Nevada, 89315
289-3161

P. O. BOX 239
SALT LAKE CITY, UTAH 84110
BUS. PHONES: 801-364-8453
801-364-8454

PHILLIPS PETROLEUM COMPANY
EXPLORATION & PRODUCTION DEPT.

Home: Box 1092, Ely, Nevada
89301

#10, Silver State Motel

Lower Guillmette Ore Zone

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Ward Dist

May 3, 1973

Mr. B.W. Kliebenstein
Mining Director
Phillips Petroleum Co.
P.O. Box 139
Salt Lake City, Utah 84110

Dear Mr. Kliebenstein:

Thank you for the maps and information I received during my visit to your offices on March 26 and 27, 1973.

After evaluation of this data we have concluded that further work on the Ward District would not be justified at this time. Please keep us informed of future developments at this property.

We are interested in any copper deposits being offered for sale or outside participation.

Very truly yours,

Dennis C. Temple
Senior Geologist

ESSEX INTERNATIONAL, INC.

DCT:td

MEMO TO FILE

April 20, 1973
By: D.C. Temple

SUBJECT: Ward Mining District

On Feb. 7, 1973, Phillips Petroleum Co. submitted for consideration the Ward District properties they control in partnership with Silver King Mines Inc.

A visit was made to their offices in Salt Lake City, Utah, and Ely, Nevada, on March 26 and 27, 1973. Maps and sections were obtained in order to evaluate the results of recent drilling. A geologic report is in our files.

The mineralization is restricted to four bedded replacement horizons and one skarn horizon over a vertical range of 1500 feet. There is a large variation in assays from intercept to intercept within a given horizon. Gross value varies as much as $44.61 between adjoining intercepts. The uppermost replacement bed is intersected by the Paymaster tunnel, approximately 4000 feet from the portal. An impression was developed that mineralization within a horizon will have an irregular patchy distribution similar to that at the well known Park City, Utah, district. No mineralization was reported from quartz monzonite porphyry underlying the district or from dike rocks cutting the sediments.

Two ore reserves, A & B, were calculated from drill hole intercepts. The following parameters were used:

1. Minimum intercept thickness of 6 feet.
2. EM/J, Feb. 1973 values of Ag., $2.24/oz; Pb, $0.15 lb; Zn, $0.19/lb; and Cu, $0.55/lb.
3. Minimum gross value of $20.00/ton.
4. A. Half the distance to the nearest hole and approximately the same outside the holes.
   B. A 50 foot radius around each hole.

- continued

Tabulation of Ward District Ore Reserves

Bed	Tons	Oz Ag	% Pb	% Zn	% Cu	$/Ton	Avg. Thickness
A. Upper Joana Ore Zone	553,036	1.80	2.26	2.66	1.27	$34.89	8.9'
Basal Joana Ore Zone	2,378,173	1.63	0.62	4.65	0.97	33.85	15.5'
Upper Guilmette Ore Zone #1	515,995	.97	0.16	1.76	1.94	30.68	13.4'
Upper Guilmette Ore Zone #2	4,132,232	1.42	0.41	3.27	1.51	33.45	9.3'
Lower Guilmette Ore Zone	1,543,982	1.38	0.09	2.25	1.36	26.87	14.2'
Total & Averages	9,123,418	1.46	0.51	3.33	1.35	$32.30	13.4'
B. Upper Joana Ore Zone	53,168	2.23	1.83	3.39	1.71	$42.18	Same
Basal Joana Ore Zone	203,244	1.82	0.67	4.70	1.72	42.87	
Upper Guilmette Ore Zone #1	31,614	1.07	0.31	1.55	1.72	27.60	
Upper Guilmette Ore Zone #2	188,543	1.36	0.26	2.97	1.49	31.51	
Lower Guilmette Ore Zone	76,716	1.45	0.09	1.88	1.42	26.28	
Total & Averages	553,285	1.60	0.54	3.41	1.60	$35.78	Same

Reserve A represents the ultimate potential of the area drilled.
Reserve B represents the probable ore and should be used for production estimates. The 50' radius used is a reasonable projection for this type of deposit.

Drilling to date has been centered on the most favorable igneous and structural locus. Although the ultimate limits of mineralization have not been located, a decrease in economic potential is to be expected if development is extended beyond the most favorable locus.

Due to the irregular distribution of mineralization, large volume operation is unlikely. It is estimated that 500 tons/day would be an optimum production rate from these properties.

Since no evidence of porphyry copper mineralization or large contiguous tonnage has been developed, it is recommended that no further work be expended on the Ward District at this time.

DCT:td

Phillips Pet.
Plans + Sec. at Ely
Silver King Mine Co. Partner
Heidrich - Geol.

Jason Everts Phillips
Geol.

Cor. 4th So. 3rd E
Blue Bldg. Metro Bldg. 4th
Floor

March 5, 1973

Mr. B.W. Kliebenstein
Mining Director
Phillips Petroleum Co.
P.O. Box 139
Salt Lake City, Utah 84110

Dear Mr. Kliebenstein:

Mr. Paul Eimon has referred your information on the Ward properties to me for evaluation. I will be in Salt Lake City on March 19 and March 26, 1973. Could I make an appointment to review your data concerning this property on one of these dates?

Very truly yours,

Dennis C. Temple
Senior Geologist

DCT:td

cc: P.I. Eimon ✓

File: Ward Mng Dist.
White Pine County, Nev.

January 31, 1973

Mr. R.W. Kliebenstein
Mining Director
Phillips Petroleum Co.
P.O. Box 129
Salt Lake City, Utah 84110

Dear Mr. Kliebenstein:

This will acknowledge your letter of January 11, 1973 to Mr. Howard Lanier concerning your properties owned jointly with Silver King Mines in the Ward Mining District near Ely, Nevada. We are interested in evaluating the data on this property and would like to make an appointment to review it with you.

Essex, as you may know, is a major consumer of copper and our primary interest in exploration is developing sources of copper for Essex. We would appreciate a brief geologic discription of the property by mail prior to making an appointment to review the data. If this is not possible we will be able to have one of our geologists visit your office in Salt Lake City during February or March.

Very truly yours,

Paul I. Eimon
Manager of Exploration

PIE:td

1/30/73

Phillips has been working on this property for 3-4 yrs. They have reported +1 million ton discoveries in S.L.C. news papers.

It is probably worth while to meet with them and determine what results they have in fact. One day or less in S.L.C. will indicate any substantial reserves.

The mine was started on veins in Pal. Lms. A Qtz. Monz. Porph. intrusive is present.

Bud

Paul Eimon — Acknowledge letter. Is it worth investigating. [initials] 1/15/73

SXM

JAN 19 1973

RECEIVED

PHILLIPS PETROLEUM COMPANY
P. O. Box 239
Salt Lake City, Utah 84110

January 11, 1973

RECEIVED
M & M Division
JAN 15 1973

File: K1-7-73-EMD

Mr. Howard Lanier, Manager
Mining and Metallurgical Division
Essex International
1550 Wall Street
Fort Wayne, Indiana 46804

Dear Mr. Lanier:

Phillips Petroleum Company and Silver King Mines have significant ore reserves of copper and silver on their jointly owned properties in the Ward Mining District near Ely, Nevada. Possibly these reserves may be of interest to Essex International. If so, we would be pleased to make our data available for evaluation.

We are enclosing a copy of the understanding which Phillips and Silver King Mines, Inc. have in regard to the Ward Mining District. At the present time, Phillips owns 51% of the District and Silver King 49%.

If you think your company may be interested in these properties, we would appreciate hearing from you.

Very truly yours,

R. W. Kliebenstein

R. W. Kliebenstein
Mining Director

RWK:gb
Enc.
cc: Mr. D. E. Fryhofer

PHILLIPS-SILVER KING PROPERTIES
WARD MINING DISTRICT, NEVADA

Phillips Petroleum Company and Silver King Mines, Inc. own certain mineral properties in the Ward Mining District, White Pine County, Nevada. Phillips and Silver King have agreed to consider any proposal you may desire to submit for acquiring an interest in these properties which incorporates or otherwise reflects the general terms set forth below:

1. There will not be any requirement for initial money consideration.

2. The present operating agreement between Phillips and Silver King will be replaced by a new operating agreement to be negotiated and which will become effective as of the date the purchaser elects to proceed as set out in Item #5 (a) below.

3. An option will be granted for a period of 18 months during which period the purchaser agrees to spend a minimum of $1.5 million.

4. The purchaser may by payment of additional consideration (the amount of which is to be negotiated) extend the 18-month option period up to an additional 6 months.

5. At the end of the 18-month option period (or any applicable extension thereof) the purchaser shall elect to either:

   (a) Proceed to bring the properties into commercial production at the earliest possible time in accord with good minerlike practice; or

   (b) Relinquish all rights in the properties and turn over to Phillips and Silver King all equipment, information, data and reports relating to or used on the properties.

6. At such time as the purchaser has spent a total of $3 million on the properties, it will have earned a 50% interest in the properties.

7. The purchaser could acquire an additional 10% interest in the properties upon terms to be negotiated.

8. The remaining interest retained by Phillips and Silver King is to be a carried working interest and would never be required to make any contributions. The retained carried working interest will be owned by Phillips - 51% and Silver King - 49%.

9. No monies spent by the purchaser to earn a 50% interest and no monies spent by the purchaser under (4) and (7) above are recoverable by the purchaser; however, the purchaser (as operator) will be entitled to recover out of a percentage (to be negotiated) of the net operating income all other expenditures, plus interest thereon, it has made to place the property into production.

A response indicating the extent of your interest will be appreciated.

Please direct your responses to either Phillips Petroleum Company or Silver King Mines, Inc, or both, whichever you prefer.

Very truly yours,

SILVER KING MINES, INC.

By K. L. Stoker

PHILLIPS PETROLEUM COMPANY

By D. E. [illegible]

Silver King Mines, Inc.
1204 Deseret Building
Salt Lake City, Utah 84111

Phillips Petroleum Company
Energy Minerals Division
781 Frank Phillips Building
Bartlesville, Oklahoma 74004

PHILLIPS PETROLEUM COMPANY

P. O. Box 239
Salt Lake City, Utah 84110

SXM
FEB 9 1973
RECEIVED

February 7, 1973

Mr. Paul I. Eimon
Manager of Exploration
Essex International Company
Metallurgical and Mining Division
1704 West Grant Road,
Tucson, Arizona 85705

Dear Mr. Eimon:

As you requested in your letter of January 31, we are enclosing a geologic report on the Ward properties. Also, the report contains a section discussing ore deposits of the Ward Mining District, White Pine County, Nevada.

We will be pleased to have you evaluate the available data we have on the properties.

Very truly yours,

R. W. Kliebenstein
Mining Director

RWK:gb
Enc.

Assey International

I. INTRODUCTION

The Ward Mining District is located in White Pine County, Nevada, on the eastern slope of the Egan Range, about 15 miles south of Ely. The district encompasses about 20 square miles, although most of the mining activity has been concentrated in Sec. 14 and 15, T. 14 N., R. 63 E. Meridian. The district can be reached by traveling south from Ely six miles on Highway 50, then southwest on graveled County Road 46, then west three miles on graded dirt road.

At the eastern edge of the district, the flat expanse of Steptoe Valley, planted in crested wheat grass, yields to the juniper-covered foothills of the Egan Range at an elevation of 6800 feet. Moving westward and upward, the juniper gives way to Pinion Pine; then White Pine and Balsam Pine predominate, until the western edge of the district is reached at the summit of the range. Here, at elevations above 10,000 feet, White Pine and Bristlecone Pine are the only large form of vegetation.

Ore was first discovered in the district in 1866. About 100,000 tons of ore were produced between 1870 and 1883. The town of Ward claimed a population of 5000 during that time, but by 1885 the town was largely deserted, and only ruins remain today.

II. GEOLOGY

A. Regional Setting

The Egan Range lies in the Basin and Range Geomorphic Province, which is characterized by narrow north-trending mountain ranges separated by deep alluvial valleys. This mountain-trough geomorphic expression is the result of north-trending high-angle faults of large displacement, which have formed a series of horsts and grabens.

The Egan Range extends from Ely southward a distance of 60 miles. The range averages six miles in width, and is flanked by Steptoe Valley to the east and White River Valley to the west. The range is composed of Paleozoic sedimentary rocks which dip generally to the east. The paleozoic rocks were intruded by Cretaceous and Tertiary igneous rocks and were overlain in places by Early Tertiary volcanic and non-marine sedimentary rocks. The flanking valleys were filled by a great thickness of alluvium. A U.S.G.S. gravimetric survey indicates that the thickness of the Tertiary and Quarternary sediments and volcanics exceeds 7000 feet in Steptoe Valley east of the Ward district (Carlson and Mabey, 1967).

B. Sedimentary and Volcanic Rocks

1) General

Paleozoic sedimentary rocks in the southern Egan Range extend in age from Cambrian to Permian, and consist predominately of limestone and dolomite with subordinate shale, sandstone and quartzite. The total thickness of Paleozoic rocks exceeds

15,000 feet. These sedimentary rocks are described in several publications.

The oldest formation exposed in the Ward district is Pennsylvanian Ely Limestone; however, Mississippian Chainman Shale and Joana Limestone, Devonian Guilmette Limestone have been penetrated by drill holes (Fig.3). Rock older than Guilmette Limestone is not present in the Ward district, having been replaced or assimilated by the Ward intrusion, and will not be described in this report.

2) Devonian Guilmette Limestone

The Guilmette Limestone, of Devonian age, is exposed in most mountain ranges in White Pine County. It typically consists of 1500 to 2500 feet of fine-grained, bluish-gray, massive cliff-forming limestone, with or without subordinate interbedded dolomite and sandstone. In the Egan Range the Guilmette is distinguished by its thickness (2500); by the thickness of individual beds (up to 50 feet); by its fine-grained, homogeneous nature; and by its scarcity of fossils, except for abundant stromtoperoids (Langenheim et al in Guidebook, P.L15).

Guilmette Limestone crops out four miles west of the Ward district, on the west slope of the Egan Range. (Willow and Water Canyon Localities, Fig.2 and 3). It is 2500 feet thick, and is composed principally of thickbedded, cliff-forming limestone. A thinner-bedded, slightly shaly unit, about 200 feet thick, occurs in the middle. No sandy or dolomitic units are present.

Guilmette Limestone crops out 10 miles east of the Ward district in the Schell Creel Range (Connors Pass Locality, Fig.2) and (Fig.3). The Guilmette here is about 2000 feet thick, and consists primarily of thick-bedded, cliff-forming limestone. Numerous sandstone and dolomite beds occur, mostly near the middle of the formation. These units are discontinuous and lenticular in nature, and the rapid and irregular lateral changes in lithology, coupled with complex faulting, make correlation within the Guilmette difficult (Drews, P.25).

The contact of Guilmette Limestone with overlying Pilot shale requires close examination, because of its ecomomic importance. In the Connors Pass exposure the upper 400 feet of Guilmette consists of silty limestone and limy siltstones (Drews, P.28, unit C). In the Egan Range exposures, the lower 200 feet of Pilot Shale consists of shaly limestone and calcareous siltstone (Langenheim, P.67). This transitional interval, designated as upper Guilmette at Connors Pass and s lower Pilot in the Egan Range is correlated and designated at Ward as the Guilmette transition zone.

Guilmette Limestone does not crop out in the Ward district, but the upper part has been penetrated by approximately 50 diamond drill core holes, drilled over an area of about one square mile. The Guilmette has been intruded and metamorphosed by quartz monzonite porphyry, and only the upper part of the formation, at most 1000 feet, is preserved. In most places the Guilmette can be subdivided into three correlatable metastratagraphic units; the upper 100 to 200 feet, (Guilmette transition zone), is altered to garnet diopside skarn, and is a major ore host. Below the transition zone the Guilmette, is, in most areas of the district, altered to a fine grained, in part, banded marble; near the contact with the Ward intrusion it is altered to garnet-diopside skarn, and is a major ore host. Relict dolomite has bees found in the skarn zone. This dolomite occupies a position in the Guilmette similar to the dolomite beds in the middle of the Guilmette of the Connors Pass exposures.

3) Devonian- Missippian Pilot Shale

The Pilot Shale, of Devonian and Mississippian age, is present throughout most of east-central Nevada. Locally the Pilot is missing, the Mississippian Joana Limestone resting disconformably on the Guilmette Limestone. This has caused some writers to conclude that the Guilmette-Pilot contact, while in appearance (because of its transitional nature), is actually disconformable (Lengenheim, P.71; Drews, P.29). The Pilot Shale is 100 to 400 feet thick, and consists of platy clay shale in the upper part. The formation is rarely well exposed, usually forming gentle slopes and saddles between Guilmette and Joana limestones. These Pilot talus slopes are distinctive and characteristic, consisting of yellow-brown or tan chips and plates of siltstone.

In the Egan Range exposures (Fig.2 and 3), the Pilot Shale consists of two members, each about 200 feet thick. The lower member is composed of shaly limestone and calcareous siltstone (Guilmette transition zone), and the upper member is composed of black fissile shale (Langenheim, P.68-70). On the Connors Pass exposures (Fig. 2 and 3), the Pilot is nowhere well enough exposed to permit careful description. The formation consists of dark gray siltstone and dark gray silty clay shale, the siltstone predominating in the lower part, and the shale predominating in the upper part. The Pilot is 300 to 500 feet thick (Drews, P.34). Drews Pilot is beleived to be equivalent to Langenheim's upper member of the Pilot, since Langenheim's lower member of the Pilot is correlated with Drews unit "C" of the Guilmette (Guilmette transition zone).

The Pilot Shale has been penetrated by about 60 diamond drill core holes in the Ward district, and is exposed in recently driven workings of the Ward Mountain Mine (Fig.7). The Pilot in the district consists of about 200 feet of light cream to light green, brittle, silicified shale. Finely laminated bedding planes are well preserved, but the original fissility of the shale has been destroyed by the silicification. The Pilot Shale was apparently a fairly well indurated and competent formation, and tended to rupture rather than flow or deform during orogenic disturbances. The bedding planes show only local contortion. The brittleness of the rock is evidenced by numerous fractures which are commonly filled with calcite and quartz. Near the contacts with the Guilmette and Joana limestones, the fractures commonly are also filled with pyrite, sphalerite, and galena. The Pilot served as a physical-chemical barrier to hydrothermal solutions, and is not an ore host in the district.

4) Mississippian Joana Limestone

The Joana Limestone, of Mississippian age, is present throughout most of east-central Nevada, ranging from 200 to 1000 feet in thickness. It overlies, disconformably, The Pilot Shale (Langenheim, P.77). The Joana in most exposures consists of a basal massive, cliff-forming crinoidal limestone member, a middle, thin-bedded, in part crinoidal, shaly limestone member, and an upper thick-bedded, cliff-forming, crinoidal limestone member (Langenheim, P.78). The basal member commonly contains nodular chert. The Joana's coarse, vuggy, permeable nature, and its isolation between impermeable shale formations, makes it susceptable to introduction of hydrothermal solutions. The Joana has been jasperized over wide areas, notably in the Hamilton Mining District, and has been extensively replaced by pyrite and the base-metal sulfides in the Robinson Mining District (J.S.Vanderpool, personal communication), and in the Ward district.

In the Egan Range exposures (Fig. 2 and 3), the Joana is 380 feet thick. The basàl massive member is 125 feet thick, the middle member, shaly, is 140 feet thick, and the upper massive member is 65 feet thick (langenheim, P.151).

In the Connors Pass exposures (Drews, P.35-37), five units were recognized within the Joana. The lowermost unit (20 feet thick), and the uppermost unit (60 feet thick) consist of platy, silty, in part crinoidal limestone. Drews middle three units correspond with Langenheim's three units, and in a typical exposure are, from basàl to upper, 200, 30-50, and 150 feet thick. The Joana in the Connors Pass Quadrangle totals 300 to 400 feet thick.

The Joana Limestone has been penetrated by 60 diamond drill holes in the Ward district, and is exposed in the recently driven workings of the Ward Mountain Mine (Fig. 7). The Joana has a maximum thickness in the district of about 200 feet, but thins locally to 20 feet or less. The sequence found on out crop, of coarse-grained, thick-bedded limestone at top and base separated by thin-bedded limestone in the middle, is not recognized. The Joana is everywhere altered by metamorphism and meatsomatism, which has formed four distinct mineral assemblages; 1. coarse-grained in part, banded marble; 2. green garnet-diopside skarn; 3. white wollastonite skarn with minor green and brown garnet; 4. jasperoid a rock composed entirely of quartz, in most places containing a high percentage of open spaces, but locally dense and massive. The distribution of these rock types varies within the formation, but normally the marble occurs in the middle, and jasperoid zones occur at the upper and lower contacts of Joana and Chainman, and Pilot Shale. The garnet-diopside skarn occurs most commonly near the base, and is the most favorable host rock for ore deposits in the Joana. The skarn, in places, has been altered to jasperoid which retains "ghost" garnet outlines. The wollastonite skarn is erratic in distribution; most commonly it occurs in the middle of the Joana.

The thinning of the Joana occurs at the top of the formation, and may be in part the result of a "scouring" effect of the Joana-Chainman bedding-plane fault, or thrust-fault contact. (See Structures Section). This thinning, however, is not a common feature of the Joana where the formation crops out.. Most of the thinning probably is caused by solution and removal of calcium carbonate and partial replacement by jasperoid at the top of the Joana. The upper few tens of feet of Joana, in most places in the district contain solution breccia and slump blocks of Chainman Shale. As a result of the partial thinning, the Joana has a flat base and a highly irregular, undulatory top.

5) Mississippian Chainman Shale

The Chainman Shale, of Mississippian age, is found in a broad belt covering the eastern half of Nevada and the western one fifth of Utah (Sadlick, P.86). It ranges in thickness from 1800 feet on the east to 7600 feet on the west, and in White Pine County, probably averages 2000 to 2500 feet. It disconformably overlies the Joana Limestone. The Chainman is a garbage-pile of predominately clastic sediments derived from erosion of rocks uplifted during the "Wendover Phase" of the Antlre Orogeny (Sadlick, P.81) and contains conglomerates, sandstones, shales, and some limestone beds. In White Pine County, the Chainman consists principally of eixinic black fissile shale with subordinate thin quartzite beds throughout, and commonly a 100 to 500 foot sandstone or quartzite member at the top. The Chainman is by far the least competent unit in the Paleozoic section, and during periods of diastrophism served as a lubricant between the thick Paleozoic carbonate sequences above and below. The Chainman is in many places greatly thinned by plastic deformation, and bedding is usually contorted and deformed.

Where the Chainman Shale crops out in the Egan Range exposures (Fig. 2 and 3), it is about 1000 feet thick, and consists of black, fissile shale, except for a 50 foot basal member of calcareous siltstone and an upper 100 to 500 foot quartzite member (Scotty Wash Quartzite). Only the upper part of the formation, which is protected beneath the cliff-forming Ely Limestone, is well enough exposed to permit accurate description. According to Heidrick (P. 10 and 11), this partial section represents a gradational transition from typical dark brown weathering sandy shale at the base to a sequence 140 feet thivk of dark brown to rusty brown weathering quartzites that are intercalated with black to brown weathering sandy shale beds. Immediately above the quartzite ledges, brown to black weathering fissile shales become interbedded with dark to yellowish-brown weathering silty bioclastic limestone. The Chainman-Ely contact is placed above the upper most persistant bed of the transition zone.

In the Connors Pass exposure (Fig. 2 and 3), the Chainman is about 1100 feet thick, and is subdivided by Drews as carefully as exposures permit, into three units: a lower shale and siltstone unit 200 to 400 feet thick; a middle shale unit 500 feet thick, which contains a few sandstone beds; and an upper shale unit 300 feet thick, which contains many sandstone and quartzite lenses. The upper 40 to 60 feet of the Chainman is gradational into Ely Limestone, being composed of interbedded black shale and sandy bioclastic limestone (Drews, P.29). No distinct quartzite unit, correlative with the Scotty Wash Quartzite is present in the area.

The Chainman Shale has been penetrated in about 60 diamond core holes in the Ward District. It is exposed in the bottom of an open pit in the Caroline area (Fig. 6), and is exposed in workings of the Ward Mountain Mine (Fig. 7). It averages about 700 feet in thickness, and consists of black fissile shale, with well defined bedding laminations which are typically contorted. The formation contains many thin, discontinuous quartzite lenses, especially in the upper part, but the thick Scotty Wash Quartzite member is not present. The upper and lower contacts of the Chainman are bedding-plane fault of possible large displacement, and the lower fault contact, at least, might be classified as a thrust fault because of it scouring effect on the Joana. Mapping of the underground exposures of the Chainman lead to the impression that the formation as a whole was involved in thrust faulting; strikes and dips are rarely consistant over distances exceeding a few feet, and the bedding is commonly contorted, and in many places overturned. The Chainman near the Welcome Stranger Dike (Fig. 6) is intensely silicified, though here the earlier incompetent nature of the formation is revealed by relict contorted bedding. The Chainman was an unreactive and impermeable host rock, and mineralization in the Chainman is restricted to veins and fossil trash beds near its top and base.

6) Pennsylvanian Ely Limestone

The Ely Limestone is present throughout White Pine County, the eastern half of Elko County, Necada, and a portion of westernmost Utah. It is about 2500 feet thick in White Pine County, and consists of thick bedded, cliff-forming, fossiliferous to bioclastic limestone, slabby, slop-forming, shaly limestone, and calcareous shale.

The Ely is the oldest formation naturally exposed in the Ward district and it forms most of the surface topography. The Ely has been intensively studied and carefully described by Heidrick. The formation consists of 2400 feet of gray, medium bedded, ledge forming limestone, that cyclically alternates with thin bedded, slope forming silty and argillaceous limestone. The most diagnostic feature of the formation is the wide variety of nodular, semi-bedded, and bedded multicolored cherts that are often silty, arenaceous or calcareous. The bulk of the limestones and cherta are composed largely of brachiopod, bryozoan, and crinoid detritus. Limy shale beds occur throughout the formation, and are most abundant in the basal 600 feet and in the upper 400 feet.

The Ely rests conforably on the Chainman Shale, and is transitional with the Chainman over a 50 foot thickness. The transition zone consists of several four-to-five foot thick beds of bioclastic limestone separated by two-to-five foot thick beds of black fissile shale. This transition zone is placed within the Ely and the contact is palced below the lower bioclastic limestone bed. The limestone beds within this transition zone were locally metamorphosed to garnet-diopside skarn, and then were selectively replaced by base metal sulfide minerals. The earliest known ore deposits in the district were found in these beds.

The upper contact of the Ely is a regional disconformity at the Pennsylvanian-Permian systemic boundary, and is marked by a thin bed of dolomitic limestone-conglomerate-breccia, which is overlain by a 20 foot thick bed of Permian fusilinid coquina (Heidrick).

7) Permian Sedimentary Rocks

Post-Pennsylvanian sedimentary rocks in White Pine County have been carefully described by Heidrick, Drews, Steele, and other writers. No ore deposits have been found in these rocks in the vivinity of the Ward district. These younger rocks will herein be described only briefly.

The Permian rocks in the Ward district include the Riepe Springs Limestone, a 230 foot thick, chert free, thick bedded coralline limestone; the Rib Hill Sandstone, about 1200 feet thick, consisting of poorly consolidated slope-forming sandstone and siltstone, with a bioclastic limestone marker bed near its center; the 3000 foot thick Arctures formation, consisting of a lower unit of cliff-forming, medium bedded limestone which alternates with thin beds of silty sandstone, and an upper unit of thin bedded, platy, silty limestone, and siltstone that is nonresistant,,and form lowlands and rolling slopes. A few thin mineralized veins in Permian rocks have been explored by shallow prospect pits in the past, and one diamond drill hole collared south of the Ward Gulch Fault (Fig.6) penetrated a narrow vein of argentiferous galena in the Reipe Springs Limestone.

8) Tertiary Sedimentary and Volcanic Rocks

All Tertiary sedimentary and volcanic rocks, so far as is known, are younger than the Ward intrusion, associated dikes and sills, and hydrothermal solutions. No base mineral prospects are prospects are known in these Tertiary rocks.

The Sheep Pass formation, of Eocene age, consists of 350 feet of non-marine, molluscan-bearing limestone and conglomerate breccia (Heidrick). The Sheep Pass unconformably overlies the Permian Arctures formation and is present only in the lowlands in the eastern part of the Ward district.

Extrusive igneous rocks of Oligocene age overlir with slight unconfority the Sheep Pass formation. The extrusives consist of crystal and lithic tuff, slightly welded and commonly showing distinct banding. The extrusive rocks are classified by Heidrick as quartz latite in composition, and are very similar chemically and petrographically to most of the intrusive rocks in the district. No genetic relationship has been established between the intrusive and extrusive rocks.

9) Late Tertiary and Quaternary Alluvium

Pediment gravels of Late Tertiary age overlap the Early Tertiary rocks on the east side of the district, and are in turn dissected by Quaternary washes which are filled with younger alluvium. The total thickness of Tertiary and Quaternary rocks may exceed 7000 feet in the center of Steptoe Valley, two miles to the east of the Ward district.

C. Intrusive Rocks

1) Ward Intrusion

a) Distribution

A U.S.G.S. high-level areomatic survey run in 1963 (Carlson and Maybe) outlined a magnetic high beneath the Egan Range, in and west of the Ward district. The anomaly is connected by a shoulder with the Ruth porphyry, the host rock for the copper deposits being mined by Kennecott Copper Company, in the Robinson Mining District (Fig. 2a). The anomaly is strongest in the low foothills on the west side of the range, weakens progressively eastward, and terminates in the Ward district. Carlson and Maybe estimated that the top of the intrusion was at elevation 3000 feet at its highest point. A core hole drilled by another company near the center of the anomaly was collared at 8500 feet and drilled to 3500 foot depth, without penetrating igneous rock or hydrothermal alteration.

In the Ward district, where the anomaly is weaker, a body of quartz monzonite porphyry, herein called the Ward intrusion, has been penetrated by about 40 diamond core holes. The top of the porphyry is found at an average depth of 1800 feet below the surface, at elevations ranging from 7500 feet on the west side of the district to 6000 feet on the east side. The porphyry is at least 1100 feet thick, and it becomes coarser grained and less altered with depth of penetration. This body was inferred to be the intrusion indicated by the magnetic data; however, potassium-argon age dating of the rock indicates an age of 35 plus or minus 1.3 my, much younger than the 110 my age of the Ruth intrusion. This age discrepency, coupled with the anomalously shallow depth of occurance, suggests that the Ward intrusion is not the one causing the anomaly, although it may be a later pulse from the same chamber, and likely was intruded into the same zone of weakness which controlled the emplacement of the older intrusion.

b) Composition

The Ward porphyry intrusion is classed as quartz monzonite in composition, consisting of 20 to 25 % quartz, 30 to 35 % orthoclase, 20 to 25% plagioclase, 2% biotite, 1% amphibole and 1 to 3% pyrite. The quartz most commonly occurs as rounded eyes, two to fivemm in diameter, which are commonly embayed, Zoning caused by overgrowth is normal. Orthoclase and plagioclase occur as subhedral to euhedral crystals which normally range in length from 2 to 5 mm; crystals up to 20 mm are common, and up to 50 mm have been observed. Phenocrysts of ferromagnesium minerals are small, seldom exceeding 1 mm. The fine-grained ground mass consists of quartz and orthoclase with subordinate plagioclase.

c) Alteration

Alteration of the igneous rock is most intense near its contact with the Guilmette Limestone, and decreases with distance from the contact. Alteration is most intense in and near fracture zones, decreasing with distance from the fractures. The alteration consists of quartz-flooding, calcitization, kaolinization, sericitization, and chloritization, and in degree probably belongs in the argillic zone. Quartz veims and stockworks are ubiqitous in the rock, and in places appear to represent 50% of it. Much of the plagioclase is altered to fine-grained calcite, clay minerals and sericite. Most, but not all, of the biotite has been altered to chlorite minerals. Pyrite is everywhere present as disseminated crystals, but nowhere constitutes a major portion of the rock. Molybdenite and chalcopyrite occur as very fine-grained masses in association with the quartz veins, but rarely constitute more than a few tenths of one percent of the rock as a whole.

2) Dikes and Sills of Intermediate Composition

Dikes and sills of qyartz-monzonite porphyry and quartz latite porphyry occupy a broad northwesterly-trending fault and fracture system in the district, and crop out over an area three miles long and up to one mile wide (fig. 4). Evidence to date indicates that these dikes and sills are closely related genetically to the Ward intrusion, and some at least can be traced, by drill holes, into the intrusion. The width of the individual dikes and the number of dikes, decrease with distance from the intrusion. Sills are very abundant, particularily in the Chainman Shale. The apparent bukge in the outcrop of the Townsite dike is actually a sill, and the porphyry body which extends transversly from the Mammoth dike in the Defiance area is a sill (Fig. 6).

The dike system consists of three principal dike sets: the Mammoth-Welcome Stranger; Goodluck; and Townsite. The Townsite dike ceases to crop out about 3000 feet northwest of the Ward Gulch fault; the other two extend an additional 2½ miles northwesterly, gradually narrowing and converging as progressively younger rock is exposed.

The Welcome Stranger dike (Fig. 6 and 8), while narrow at the surface, broadens rapidly with depth and becomes an upward bulge of the Ward intrusion. This dike has metamorphosed adjacent sediments more intensely than have the other dikes (see Metamorphism and Metasomatism), and greatly effects ore distribution (see Ore Deposits).

Alteration, classed as argillic, is somewhat more intense in the dikes and sills than in the Ward intrusive, commonly affecting the full thickness of the body rather than being restricted to the edge, and to the fracture zones. Pyrite is disseminated throughout the rock, but chalcopyrite and molybdenite are rare.

3) Rhyolite Dikes and Sills

A rhyolite porphyry dike and associated sille occur in the western part of the Mammoth dike set (Fig. 6). The rock consists of phenocrysts of quartz and sanidine, 2 to 5 mm in diameter, in a fine grained groundmass of orthoclase with subordinate plagioclase and quartz (Heidrick, P.51-52). Pyrite is sparsely disseminated throughout the rock, and chalcopyrite and molybdenite are rare. The rhyolite dike is intensely silicified, and is slightly argillically altered. Joana Limestone adjacent to this dike is more completely silicified than elsewhere in the district. This jasperization is clearly later than the metamorphism which altered the limestone to garnet skarn. Euhedral garnet "ghost" outlines are common in the jasperoid. The rhyolite seems to represent the latest stage of intrusion in the district, and was probably nearly contemporaneous with the hydrothermal-mineralizing stage. The rhyolite dikes have not been observed cross-cutting other intrusive rock; this relationship, if it can be found, will substantiate the theorized late time of rhyolite emplacement.

D. Geologic History

The Egan Range is a typical mountain mass in the Basin and Range Geomorphic Province: a north-trending, easterly dipping horst bounded east and west by graben valleys. Three principal periods of tectonic activity have affected the rocks of the range and have been responsible for its present geomorphic form. A review of the geologic history of the area is necessary for bettr understanding of the structural environment.

Deposition in the Eastern Great Basin was nearly continuous throughout Paleozoic time. Interruptions of deposition were caused by regional uplift, resulting in periods of non-deposition and minor erosion, but little tilting or other orogenic movements. During a part of Mississippian time the Chainman "garbage pile" was deposited as debris from the uplift to the west known as the Wendover Phase of the Antler orogeny. This orogeny did not extend into the Eastern Great Basin (Misch. P.33). Deposition of marine sediments continued into the Mesozoic Era and probably into the Jurassic, although the record is almost completely missing in White Pine County (Wheeler et al, Nelson, ref. from Misch, P.33).

In Mid-Mesozoic time, a profound orogeny began, having strong east-to-west compressive forces which deformed the Paleozoic sedimentary sequence into broad, north-trending, asymmetrical folds, commonly overturned, and forced development of decllement type thrust faults, which strike northerly and have throws measured in tens of miles.

In late Jurassic time, probably following closely the compressive orogeny, a period of tension accompanied by widespread igneous intrusion began. This period has been loosely designated as the Laramide orogeny. Two prominent sets of normal faults developed during this period, a north to north-northwest set and an east to northeast set. The intrusions in the Eastern Great Basin were predominately intermediate in composition, and were accompanied by or rapidly followed by hydrothermal alteration and metallization.

Following the Laramide orogeny, continental-type sedimentary rocks, and extrusive volcanic rocks, were desposited in parts of the Great Basin. The source of the sediments was the highlands produced by the orogeny. The volcanic rocks are similar in chemical composition to the earlier intrusive rocks, and may have originated from the same source. In late Tertiary time, a second period of tension began, which produced high-angle, north-trending faults of large displacement. These faults defined the present Basin and Range geomorphology of the area.

E. Structure

The structure of the Ward area has been mapped and described by Brokaw, et al, 1963, and Heidrick, 1965; A brief review of their work will be presented, with modifications and additions developed during the current mapping, drilling, and underground development program at Ward.

1) Mid-Mesozoic Compressional Structures

The mid-Mesozoic orogeny compressed the rocks of the Egan Range into a series of tight overturned folds which ruptured to form at least two imbricate thrust faults (Fig. 5). The faults strike northerly and dip moderately to the west. The oldest formation exposed in the lowest thrust plate in the Devonian Guilmette Limestone. Rocks exposed in the upper thrust plates range in age from Silurian to Pennsylvanian. The thrust faults crop out on the west side of the range, thus only lower plate rocks are present on the east side of the range, in the Ward district.

In the Ward district, major effects of the mid-Mesozoic orogeny are limited to Chainman and younger rocks; pre-Chainman rocks were perhaps buffered by the plastic Chainman, and acted as a single competent structural unit. At least two and probably several bedding plane faults of large throw occur in the Chainman Shale. The bedding plane faults at the contacts of the Chainman with Ely and Joana form 50 to 100 feet of chaotic structure; slivers and boulders of limestone in a groundmass of shale and breccia gouge, all cut by later calcite veins. The bedding plane fault at the base of the Chainman may scallop the top of the Joana Limestone, but fails, in the district, to break through and become a decollement thrust fault.

Numerous north-northwest trending, tight folds, in places overturned and related thrust faults are exposed in Pennsylvanian and Permian rocks (Heidrick, P.69). The folding and thrusting of the upper structural unit (Chainman and younger) coupled with the less-disturbed nature of the older rocks, must have caused considerable shortening in the upper unit relative to the lower unit.

2) "Laramide" Tensional Structures

Two prominent sets of normal faults and joints developed in the Ward district during the Laramide orogeny: an east to northeast set, dominated by the Ward Gulch-Rowe Creek fault system and the North Ward fault zone; and a north-northwest set, which is the shear zone into which the Mammoth-Goodluck-Townsite dike system was intruded (Fig. 4). These two prominent fractures sets and their intersection are felt to be the channelways for introduction of hydrothermal solutions into the Ward district.

a) East to Northeast Fracture Set

The Ward Gulch-Rowe Creek fault system is one of many transverse structures in Nevada which were major controls of igneous intrusion and hydrothermal activity. The Ward Gulch segment, which crosses the Ward district, dips 50° to the south, and has maximum displacement of 2000 feet, down on the south. The Rowe Creek fault segment, on the west slope of the Egan Range, has the opposite dip and displacement, dipping steeply north, with the north side down 1000 to 1500 feet. The Ward Gulch-Rowe Creek fault system is thus a scissor, and at the hinge is impossible to trace; however, the two fault segments distinctly cleave the range, and are beleived to be one structure.

The Ward Gulcg fault segment offsets the Goodluck and Mammoth dikes, and a branch of it may offset the very recent Basin and Range type faults on the east edge of the district (Heidrick), (P. 75) Fig. 6. Evidence indicates, however, that the first movement on the fault was pre-dike and pre-ore. In one core hole, a dike was found to have intruded along the fault; limited data suggests the ore zones thicken near the fault; and a northeast set of joints beleived related to the Ward Gulch fault are clearly ore controlling structures.

Several other faults belonging to the northeasterly set cut the rocks of the Ward district. The North Ward fault zone strikes N 40-50 E across the northwest corner of the central Ward district (Fig. 4 and 6). It consists of three or four normal faults within a 1000 foot wide zone, which have a net displacement of about 1500 feet, down to the northwest. Heidrick (P. 73) beleives that the first movement on these faults was pre-ore, probably contemporaneous with the first movement on the Ward Gulch fault, and that the faults were important ore controls.

b) Northwesterly Fracture Set

The Mammoth-Goodluck-Townsite shear zone, into which the porphyry dike system was intruded, trends northwesterly across the Ward district. It terminates against the Ward Gulch fault on the south, and can be traced on outcrop three miles northwesterly. The shear zone is one mile wide at its south end, and narrows progressively northwesterly as younger rocks are exposed. In the central Ward district, the shear zone comtains many individual faults, most of them high-angle with small displacement, except for a few which were reactivated during the late Tertiary period of faulting. A few of the faults have reverse movements. Innumerable small faults and joints parallel the major faults in the shear zone.

3) Late Tertiary Tensional Structures

The final period of deformation was the Basin and Range normal faulting period. This faulting began in Late-Tertiary time, after the Tertiary continental sediments and volcanic rocks were deposited, and is active to the present time. North-trending high-angle, normal faults of large displacement developed, elevating ranges relative to valleys, and establishing the present geomorphology of the Great Basin. The Egan Range is tilted easterly suggesting that the faults on the west side of the range had a greater displacement than those on the east; however, a part or all of this tilt could have occured during the mid-Mesozoic compressive orogeny, by the action,repeated thrust movements where plates from the west rode against and over eastern plates.

The Basin and Range stresses in some cases reactivated faults which were developed during the Laramide orogeny, but in many palces new breaks were formed. The fault which bounds the western edge of the Townsite dike probably was active early, and had major offset later. A large Basin and Range fault developed just west of this fault (Fig. 4,5,6, and 7), which has offset up to 3000 feet, down on the east, and exerted strong drag on the beds in the footwall, tilting them nearly vertical. The Ward Gulch fault probably was reactivated during Late Tertairy time. It appears that the east end of the fault splits into three strands, two of which turn northeast out of Ward Gulch and join a Basin and Range fault near the sill bulge in the Townsite dike (Fig. 6). A strand of the Ward Gulch fault may continue easterly in Ward Gulch.

The Basin and Range faulting completed the closure of the Central Ward dome. The dome is bounded on the south by the Ward Gulch fault segment; where the north block is up relative to the south; bounded on the northeast by the North Ward fault system, where the southeast block is up relative to the northwest; and bounded on the east by the Basin and Range faults, where the west blocks are up relative to the east. Heidrick suggests that the hydrothermal solutions were channeled into and restricted to this dome.

F) Metamorphism and Metasomatism

1) General

The Ward intrusion caused widespread and intense metamorphism of the rocks of the Ward district (Fig. 3). Heat from the intrusion marmorized the Joana Limestone, and marmorized all but the transitional upper part of the Guilmette Limestone, and baked the shales and shaly limestones. As the intrusion invaded the northeast and northwest shear zones, hot solutions infiltered the permeable carbonate rocks, metasomatizing them to skarn. The skarn consists predominately of garnet, diopside-hedenbergite, and minor epidote-clinozoisite, thulite, penninite, and idocrase. Massive wollastonite skarn with scattered metacrysts of garnet occuring locally.

2) Ely Limestone

The basal bioclastic limestone beds of the Ely Limestone were metasomatized to an assemblage of calc-silicate minerals, predominately epidote-clinozoisite, garnet and diopside, with minor thulite, penninite, allanite, and shpene (Heidrick, P. 61-62). The interbedded shales, and the underlying Chainman Shale, were baked and silicified, and a few discontinuous lenses of fossil trash in the upper part of the Chainman were altered to skarn. The metasomatism of the Ely beds occured only in close proximity to through-going structures, especially the faults near and parallel to the northwest-trending dikes.

3) Joana Limestone

The Joana Limestone was marmorized by heat from the enroaching Ward intrusion before metasomatism began, and much marble remains in the Joana. Throughout the district, the Joana was then metasomatizes near its contacts with the overlying Chainman Shale and the underlying Pilot Shale, to a calc-silicate assemblage consisting of green garnet and diopside-hedenbergite with minor fine-grained wollastonite, epidote-clinozoisite, and thulite. The Joana was originally a rather pure limestone, and the metasomatism must have been accomplished by hydrothermal solutions introduced along fissures, or fractures, and impeded by the overlying and underlying shales. Typically, the upper and lower 30 feet of the Joana was altered to skarn, while the middle 100 feet remained as marble. Adjacent to the upward bulge in the Ward intrusion, which narrows upward and crops out as the Welcome Stranger dike, the middle, marble portion of the Joana was in part altered to wollastonite skarn, with scattered garnet metacrysts. Apparently sufficient heat was available here to effect the metasomatism, but metasomatizing solutions carrying elements such as aluminum, iron, and magnesium were in contact with the carbonate rocks for a shorted time, perhaps because no impervious shales were present to impede the solutions.

The Joana was in part altered to jasperoid throughout the Ward district. Jasperization is normally restricted to the upper and lower few feet of the formation, but adjacent to the rhyolite Mammoth dike the entire Joana has been jasperized. Thesilica replaced earlier skarn. "Ghost" outlines of garnet metacrysts are common in the jasperoid.

4) Guilmette Limestone

Alteration in the Guilmette Limestone was similar to alteration in the Joana, and is pervasive throughout the district. The Guilmette, except for the Guilmette transition zone, was marmorized by heat from the enroaching Ward intrusion. The Guilmette within two hundred feet of the intrusion was then metasomatized to an assemblage of brown and green garnet, diopside-hedenbergite, and minor fine-grained epidote and thulite. Brown garnet predominates near the porphyry contact, yielding to green garnet with distance from the contact. The Guilmette transition zone was metasomatized to an assemblage of green garnet and diopside-hedenbergite, with minor fin-grained epidote and thulite. The Guilmette marble away from the porphyry contact was not further altered, except in proximity to the Welcome Stranger bulge in the Ward intrusion. Here the marble was metasomatized to skarn, consisting of wollastonite, garnet, diopside-hedenbergite, and minor epidote (Fig. 8).

III ORE DEPOSITS

A. Mining History

Ore was discovered in the Ward district in 1866. The early dicoveries were enriched argentiferous plumbojarosite in the basal beds of the Ely Limestone. Between 1866 and 1885, about 50,000 tons of ore, averaging 40 ounces of silver per ton, and 50,000 tons averaging 12% lead and 12 ounces of silver per ton, were produced from the district. Production was from many small mines, but the bulk was from the Goodluck area. Shallow ore was extracted from shafts and adits in the Goodluck are (Fig. 6); deeper ore was extracted from the Mountain Pride tunnel (Fig. 6 and 7). The Mountain Pride tunnel treminated under the Goodluck area about 50 feet below the base of the Ely Limestone in barren Chainman Shale, at elevation 8200 feet. The stratigraphic control of the ore was not understood at the time, and numerous workings were driven in the Chainman in an attempt to locate the "faulted extension of the Goodluck ores". Subsequently, in 1879, the Paymaster tunnel was collared at elevation 7800 feet, and was driven 3200 feet northwesterly to a point beneath the Goodluck ore body. The tunnel penetrated the Ely-Chainman contact 1600 feet from the portal, and at its terminus was deep into the Chainman (Fig. 7). No ore was found in the Paymaster, and a 700 foot inclined raies was driven to the Mountain Pride level. The remainder of the ore from the Goodluck deposit was delivered through the Paymaster to a smelter near the tunnel portal. Production ceased about 1885. except for a few small leasing operations.

In 1906, the Paymaster tunnel was cleaned out and some exploratory drifting work was carried out, but no ore was found. Several small leassors mined and shipped small quantities of enriched silver ore in the 1930's, and many of the old dumps were reworked.

gDuring the 1940's, Newmont Mining Company reopened the Mountain Pride tunnel and did extensive drifting and long-hole drilling to explore contacts between porphyry dikes and Chainman Shale, without discovering ore.

From 1952 to 1955 the Walker Corporation did similar work, in the Chainman Shale from the Mountain Pride level without discovering ore. Walker also drilled several holes from the Defiance tunnel westward, to prospect the are beneath the basal Ely deposits in the Defiance area, without success (Fig. 6 and 7).

In 1962 the Shasta Mineral and Chemical Company acquired control of the district, and a new company, Silver King Mines Inc., was formed to explore the district. Extensive down-the-hole percussion drilling (hammer drilling) increased the reserves of the Goodluck plumbojarosite deposit, and blocked out a shallow lead-silver-zinc sulfide deposit at the base of the Ely Limestone in the Caroline area (Fig. 6). Small tonnages of high-grade sulfide was mined from workings of the Welcome Stranger Mine, then from 1964 through 1966, 70,000 tons of low-grade were mined by open-pit methods from the Caroline deposit, and were milled at the company's 250 ton-per-day flotation mill five miles north of Ely.

In 1966 Phillips Petroleum Company obtained an option to acquire 51% of the Ward property and other properties in the White Pine County area of Nevada, and Shasta County, California. The option was excercised in 1968, and the work commitment was completed in 1971. Phillips interest in the district was a result of two features; the presence of a large intrusive mass beneath the district, indicated by the U.S.G.S. aeromatic survey published in 1963 (Carlson and Maybe), and the expected presence of favorable Mississippian and Devonian sedimentary carbonate formations (Joana and Guilmette) beneath the district. These favorable conditions for possible accumulation of sulfide ore depsoits were first recognized by Heidrick (1965), in his comprehensive Master's Thesis on the geology, Ely ore deposits of the district.

2) Geophysical Surveys

The high-level, U.S.G.S., aeromahnetic survey was lacking in detail, and a lower-level survey was run (1000 foot height, draped congifuration) to better define the anomaly (Fig. 4b). The surveys were run using the ground-level magnetometer traverses as a check, which confirmed, but did not improve the detail of the low-level aeromagnetic survey.

Four resistivity-I.P. traverses were run, each from the volcanic cover on the east edge of the district to the Guilmette outcrop west of the district (Fig. 4b). The surveys were run using the dipole-dipole method on 1000 foot centers, and using grequencies of 3 and 0.05 cps. The data revealed a clear-cut, moderately strong anomaly beneath the western part of the dike system (including the Mammoth and Goodluck dike sets) and smaller, wealer anomalies to the east in the area of the Townsite dike set. All drilling done to date has been within the main anomaly, and all holes penetrated alteration and sulfide mineralization. Therefore, the correlation between I.P. response and metallization cannot yet be evaluated. Correspondence between degree of I.P response and intensity of metallization is not apparent.

3) Geochemical Surveys

Extensive geochemical sampling was done by T.L.Heidrick (P.118-141). He collected about 200 samples of jasperoid, gossan, fault gouge, joint filling, and fault breccia; and analyzed the samples for 51 elements. Strongly anomalous concentrations of tellurium, silver, lead, copper, zinc, tin, and mercury were found in the area of the Mammoth, Goodluck and Townsite dike sets; for the first five elements, moderately anomalous concentrations were found throughout the intervening areas, and extend southward into Permian rocks south of the Ward Gulch fault (Fig. 4c and 4d). The widespread distribution of tellurium is further discussed in "vertical zoning". Weaker and less-dispersed anomalies for cadmium, molybdenium, and bismuth occur over the Mammoth and Goodluck dike sets. Predictably, the strongest concentrations of all elements tested occur where the Caroline sulfide deposit and the Defiance and Goodluck plumbojarosite crops out. The next strongest concentrations are in areas of strong hydrothermal alteration.

Additional geochemical sampling has been done in the area of the Townsite dike. Fifty soil samples were collected, on 200 foot grid spacing, and analyzed for copper and silver. Strongly anomalous concentrations were found to be restricted to the area of the fault which bounds the west side of the dike (Fig. 4c and 4d).

The Ely ore deposits can themselves be considered metallic dispersion haloes over much more extensive Joana and Guilmette ore deposits. Ore was emplaced in the Ely only where through going faults were able to penetrate the thick, impervious Chainman Shale blanket, mainly near the northwest-trending dikes.

4) Surface Drilling

A surface drilling program was started in the Ward district in 1966, concurrently with the geophysical program. Shallow down-the-hole percussion drilling (hammer drilling) verified the size of the Goodluck jarosite deposit. Two deeper hammer drill holes were drilled to begin evaluation of the sulfide potential of the deeper formations of the district. Both rotary holes penetrated sulfide mineralization in skarn zones, and a wireline core drilling program was started in late 1966. To date 62 holes have been completed, most of them drilled into the Ward intrusion. The holes are spaced over an area of nearly one square mile, on an average of 500 foot spacing. Improved hammer drilling design, including air compressors in series capable of delivering 700 cfm at 250 psi, and improved technique, including use of detergent foam in combination with chemical mud additives, permit spudding holes to the base of the Chainman Shale (or to a maximumof 1000 feet) before core drilling begins.

5) Underground Exploration

Phillips, in 1968, began reopening the Paymaster tunnel to its original length of 3200 feet, where it had been stopped in the Chainman Shale. The production raise connecting the Paymaster with the Mountain Pride level was opened to improve ventilation, and the tunnel was extended to its present length of 4600 feet, cross-cutting the full thickness of the Joana Limestone, and entering the Pilot Shale (Fig. 7). Long holes were drilled and several drifts and raises were driven in the Joana to prospect mineralized areas, but no ore was blocked out (see Ore Controls).

B, Ore Controls

Deposition of ore in the Ward district was controlled by structure and by metastratigraphy. The east to northeast fracture set provided the channelways for introduction of hydrothermal solutions into chemically favorable, metasomatized carbonate beds in the district. Ore was deposited where fractured, chemically favorable beds were in contact with unfavorable rock, such as shale, and apparently marble.

1) Structural Ore Controls

The east to northeast fracture set includes as its most important structure the Ward-Rowe Creek fault system, beleived to be the surface expression of a deep rooted shear zone into which the Ward quartz monzonite porphyry was intruded. The north-northwest to northwest fracture set is the zone of structural weakness into which the Mammoth-Goodluck-Townsite dike system was intruded. Both of these structures, and possibly the North Ward fault (Heidridk) (P. 73), provided the channelways by which metasomatic and hydrothermal solutions were introduced into the Paleozoic sedimentary rocks. The northwest set contains many more through-going structures than the northeast set, and evidence to date indicates that the northwest set is the prime control of individual ore deposits: 1. Drilling results in the Goodluck and Caroline areas suggest that the thickest ore was deposited in fracture zones parallel to and within a few hundred feet of northwesterly trending dikes, in favorable beds in the Ely, Joana, and Guilmette (Fig. 6c, 6d, and 6e); 2. The northwest structural control is dominate 9n deposits in the Ely which have been examined in surface excavations and underground workings; 3. The Defiance tunnel penetrated the Joana Limestone at a point between the Mammoth and Goodluck dike sets. Many northeast fractures, but few northwest fractures, were mapped underground. No ore was found in the workings, and drilling in this area penetrated only thin zones of mineralization in the favorable Joana and Guilmette beds. This indirect evidence tends to support the dominance of the northwest fracture system.

The northeast fracture set exerts a secondary but important ore control. In the Ely deposits the best grade and thickest ore in the northwest trends occurs where northeast fracturing is most abundant. Narrow ore-grade shoots extend from the northwest oriented ore bodies along northeast faults, and in a few places alteration and mineralization has extended a short distance from northwest-reiented ore bodies along close-spaced northeast joints. Similar structural control of the Joana and Guilmette ore deposits is predicted.

2) Metastratigraphic Ore Controls

The ore deposits of the district occur in metamorphosed limestone beds in the basal Ely Limestone, in the upper and lower Joana Limestone, in the Guilmette transition zone, and in the Guilmette Limestone in contact with the Ward intrusion (Fig. 3). The ore occurs in near contact with impermeable shale in the Ely, Joana and the top of the Guilmette transition zone; and occurs in contact with marble in the base of the transition zone and in the Guilmette porphyry contact zone. The shales are unfavorable host rocks because they are impermeable and are unreactive chemically, the marble is unfavorable, possible because it is relatively impermeable.

The importance of unfavorable, non-reactive rocks to ore accumulation should not be underestimated. In the Eastern Great Basin, large ore deposits are found in carbonate rocks in the lower Cambrian, and in the upper Devonian-Mississippian-Lower Pennsylvanian; Both these sections are characterized by interbedded clastic rocks, mostly shales and carbonate rocks. The thick limestone dolomite section from Upper Cambrian to Devonian contains generally small, vein type deposits, but rarely large deposits. The shales at Ward acted as barriers to metal-rich hydrothermal solutions, impeding and "ponding" them, and, therefore, increasing their time of reaction with chemically favorable host rocks. The shales, particularly the Chainman, were probably water-saturated, and could have acted as a source of water supply to the hydrothermal solutions.

The shaded area of Fig. 6b shows a belt in which the marble portion of the Guilmette Limestone has been altered to a textureless garnet-diopside-wollastonite skarn. This belt parallels the upward bulge in the Ward intrusion, which narrows upward and crops out as the Welcome Stranger dike (Fig. 8). The typical Guilmette sequence of skarn - marble - skarn, from base to top, is thus altered, and the favorability of the Guilmette has evidently been destroyed. The typical Joana sequence of skarn - marble - skarn has not been appreciably changed, but no continuous ore zones occur in the Joana in this belt either.

The Joana and Guilmette ore deposits in the Ward district ehibit symmetry on either side of the unfavorable belt, with stratigraphically lower ore zones being emplacad farther from the unfavorable center (Fig. 8). Ely deposits may also show this symmetry, though they are more restricted than are the lower deposits.

C) Temterature Zoning

The sulfide ore bodies in the Ward Mining District are zoned vertically, from the lead-silver ore of the Ely to the copper-molybdenum ores of the Guilmette near its contact with the quartz monzonite porphyry intrusion. Table I summerizes the characteristics of this zoning. Since the deposits throughout this stratigraphic interval of nearly 2000 feet are emplaced in host rocks quite similar in petrology, the zoning would appear to reflect differences in the composition of the ore bearing solutions, or else differences in the environment of deposition; the most likely difference would be temperature. Some overlapping of zones occured, which can be related to mineral paragenesis. For example, the basal Joana Limestone and Guilmette transition zones contain an early stage, fine-grained intergrowth of marmatitic sphalerite and chalcopyrite, and a late stage, coarse-grained intergrowth of iron-poor sphalerite and galena. The late-stage, lower temperature assemblage is similar to the full mineral assemblage in most of the deposits in the Ely.

The geochemical survey by Heidrick (P. 120) detected a broad tellurium halo in the Ward district. Concentration of from 0.1 to 5.0 ppm occur south of the Ward Gulch fault. Concentrations of from 5 to 50 ppm are common over the sulfide deposit in the Caroline Pit, and the plumbojarosite deposit in the Goodluck area, both of which are in the Ely Limestone. Heidrick identified gold and silver tellurides in the ore of the Caroline Pit (Heidrick, P. 95-99). Tellurium, generally considered to be a low temperature mineral, has not been found by assays of the Joana and Guilmette ores; tellurium is apparemtly restricted to the latest (?), lowest temperature stage of ore deposition.

D) Sulfide Ore Deposits

1) Basal Ely Limestone

a) Ore Minerals and Paragenesis

Sulfide ore deposits in the basal Ely Limestone have been carefully described by Heidrick (P. 79-117). Bioclastic beds in the basal Ely were metasomatized to an assemblage consisting mainly of epidote, garnet and diopside. The skarn was replaced, first by a high-temperature assemblage of fine-grained, massive pyrrhotite and pyrite, followed by a lower temperature assemblage of sphalerite, argentiferous galena, and minor chalcopyrite, followed by gold and silver tellurides. The last minerals to be deposited were calcite, quartz and fluorite, with a second stage of coarse-grained pyrite.

A small mineral deposit which was found in the Welcome Stranger mine may have been deposited during the high-temperature pyrrhotite-pyrite stage. This deposit consists of very fine-grained, massive, marmatitic sphalerite, and was emplaced in a fracture zone in a basal Ely Limestone bed, within a few feet of the Welcome Strander dike. This dike broadens rapidly with depth, merging with the upward bulge in the Ward intrusion, and has caused higher temperature metasomatic effects than have the other dikes in the district; thus a higher temperature ore mineral assemblage near the Welcome Stranger dike is not unexpected. This deposit is similar to the high-temperature marmatitic sphalerite deposits in the Joana and Guilmette (see below).

b) Distribution

Ore grade sulfide deposits in the Ely are small and of relatively minor economic importance. Ore is restricted to zones of strong northwesterly shearing in the Caroline, Goodluck, and Defiance areas. Some high-grade ore occured in veins, which locally persisted downward a few feet into the Chainman Shale.

c) Oxidation

In the Goodluck area, a lead-zinc-silver sulfide deposit in the base of the Ely Limestone has been oxidized to plumbojarosite. Relict pods of argentiferous galena and sphalerite are found locally. The deposit occupies a well-developed northwest-trending shear zone within the Goodluck dike set, and is enclosed by quartz monzonite porphyry sills above and below, and by dikes on three sides. The deposit rests on the Chainman Shale, and is up to 200 feet thick. The ore crops out in one place in the Goodluck area. The original mineralogy of this deposit cannot be reconstructed conclusively. If it were similar to that of the sulfide deposits in the Caroline Pit, the lead and silver would have been enriched, zinc depleated, and copper remained about the same during oxidation. This deposit is many times larger than any sulfide deposit found in the Ely Limestone of the district.

Smaller, but similar, plumbojarosite deposits occur elsewhere in the district, mainle in the Defiance area.

According to old mining records, the earliest ore mined in the district was silver-rich "pipes" of ore within porphyry dikes. The ore was not assayed for other metals, and no ore of this kind is now available for examination. Extensive modern prospecting has failed to find ore in the dikes, although silver-enriched areas in the plumbojarosite deposits of the basal Ely have been found. This ore occurs in skarn which is so intensely oxidized that it could be mistaken for altered porphyry, and it may be that the high-grade silver ore mined in the past was of this type.

2) Joana Limestone

a) Ore Mineralogy

The Joana Limestone typically consists of skarn and jasperoid, at its top and base, with marble in the middle of the formation. The skarn is composed of green garnet euhedra in a groundmass of diopside-hedenbergite and calcite, with minor epidote, thulite, and fluorite. Sulfide ore minerals and pyrite replace the groundmass (Fig. 9), and in areas of high-grade ore, also replace the garnets. Texture of the skarn and ore minerals in places crudely reflect the original bedding planes of the limestone. Metallization of the jasperoid is most commonly by open-space filling, though some replacement has occured. Jasperoid is more abundant at the top of the Joana than at the base.

Ore minerals consist of marmatitic sphalerite and chalcopyrite, with minor galena, covelitte, and chalcocite. Pyrite is locally abundant. Galena is more abundant in the top of the formation than in the base, and is argentiferous. No silver mineral has been identified, silver content in the ore varies, generally with copper content, averaging one ounce of silver per percent of contained copper.

b) Paragenesis

The earliest hydrothermal solutions were highly silicic, and converted muck of the skarn, particularyl near the Mammoth dike, to jasperoid. Relict outlines of replaced garnet crystals are in places preserved. The jasperoid is typically vuggy, but in places is very dense, and was impervious to later metallization. Locally, fine-grained pyritization accompanied the jasperization.

Slightly cooler solutions then deposited marmatitic sphalerite and chalcopyrite, as finely intergrown, sommthly interlocking crystals (Fig. 10). All sphalerite found in the district contains chalcopyrite as exsolution blebs along cleavage planes (Fig. 10). Some pyrite was deposited at this time, as large cubic crystals. A second stage of metallization followed, consisting of chalcopyrite smoothly intergrown with galena. Fractures in the earlier marmatitic sphalerite were filled with galena and chalcopyrite (Fig. 11 and 12), and open spaces in jasperoid were filled with coarse euhedra of chalcopyrite and galena. A second generation od sphalerite, iron-poor, was deposited during this period (Fig. 13). This assemblage is similar to the main-stage mineralization of the Ely. A later stage of pyrite, calcite, and quartz, with minor fluorite followed (Fig. 10, 12 and 14).

Massive fine-grained magnetite is locally found in the upper Joana deposits. Its paragenesis has not been fully studied, but it appears to be later than or contemporaneous with chalcopyrite. Sphalerite is less abundant where magnetite occurs.

c) Alteration and Oxidation

In some parts of the deposit, chalcopyrite has been altered to bornite, covellite, and chalcocite (Fig. 9), succesive alteration rims are locally preserved. The alteration caused significant enrichment of the ore. In places, iron oxide (hematite ?) rims chalcopyrite, or the later enriched copper minerals.

A distictive feature of the Joana deposits is the abundant occurance of red, earthy hematite in some parts of the zones. The hematite typically fills all open spaces remaining after the metallizing phase was completed, and may cositute 20% of the rock. The hematite may be an oxidation product of the magnetite.

In a few places, a white oxide zinc mineral, probably smithsonite, has been observed. In a bulk sample of Joana ore, one to two percent of the total copper is acid-soluble though no malachite or azurite has been observed in the ore.

d) Distribution

Ore occurs near the top and near the base of the Joana Limestone. Mineralization in the basal Joana ore zone appears, from evidence to date, to be semi-continuous within the district. Approximately 75% of the drill-hole intercepts of this zone are well mineralized. The mineralization is visualized as being an extensive, but thin, flat-bottomed manto, resting on, or near, the Pilot Shale. Mineralization improves to ore-grade in the vicinity of northwesterly-striking shear zones, and increases in average thickness to 30 feet (Fig. 6c). Locally within these shear zones it exceeds 70 feet in thickness, probably where shear zones are intersected by close-spaced northeast joints.

The upper few feet of the Pilot Shale, below Joana ore bodies, is intensely fracture and silicified, and in veins of ore sulfides persist downward five to ten feet into the Pilot

Deposits in the upper Joana ore zone are less continuous and less extensive than are those of the basal zone. The upper Joana is chaotic, because of the thrust, or bedding plane, fault at the Joana-Chainman contact, the volume reduction, and the replacement caused by hydrothermal solutions. Slivers of Joana are thrust into the Chainman Shale, slump blocks of Chainman have dropped into the Joana, and much solution breccia is present. This chaotic condition apparently reduced lateral permeability for ore bearing solutions, and therefore, ore is more closely restricted to favorable northwesterly or northeasterly structures. Ore bodies in the upper Joana are less tabular and more irregular than ore bodies in other zones, because of the irregularity of the Joana Chainman contact.

3) Guilmette Transition Zone

a) Ore Mineralogy

The ore deposits in the Guilmette transition zone are similar, mineralogically and in distribution, to the deposits in the basal Joana, except that galena is much less abundant; sphalerite is about half as abundant, and enriched copper minerals are more abundant.

The ore minerals replace skarn, which is similar to the skarn in the Joana; green garnet euhedra in a groundmass of diopside-hedenbergite and calcite, and lesser amounts of epidote and thulite (Fig. 15). Replacement is usually of the groundmass, but locally the garnet metacrysts are also replaced. The skarn is prominently banded, resulting from metamorphism of an originally interbedded sequence of thin-bedded limestone and shale. The banding is in places retained after replacement of the skarn by the ore minerals, giving the ore a distinct feather bedded-replacement appearance. Metallization of the jasperoid is primarily by replacement. The jasperoid is much less abundant in the Guilmette than in the Joana.

The ore minerals consist of iron-rich sphalerite, and chalcopyrite, with subordinate bornite, covellite, and chalcocite, with sparse galena. Pyrite is always present, but seldom abundant. Silver content of the ore follows variation in copper content; approximately one ounce of silver per percent of copper, but no silver mineral has been identified.

b) Pagagenesis

The early, silicic hydrothermal solutions which converted much of the Joana skarn to jasperoid were not as evident in the Guilmette.

Solutions of the main hydrothermal stage deposited mermatitic sphalerite and chalcopyrite as finely intergrown (Fig. 16) smoothly interlocking crystals. The sphalerite, as in other zones, contains chalcopyrite as exsolution blebs along cleavage planes (Fig. 17). Pyrite accompanied this stage, commonly intergrown with the sphalerite and chalcopyrite.

The later hydrothermal solutions, which deposited chalcopyrite and galena in the Joana, also metallized the Guilmette transition zone, but relatively less galena was deposited. The galena and chalcopyrite occur as intergrown crystals, which fill fractures in earlier marmatitic sphalerite. A small amount of iron poor sphalerite was also deposited. The mineralogy of this late stage is similar to the main stage in the Ely.

The latest hydrothermal stage deposited pyrite, calcite, and quartz, with sparse fluorite (Fig. 13 and 18). Magnetite occurs locally, but not in association with sulfide minerals, and its paragenesis is not known.

c) Alteration and Oxidation

Chalcopyrite and pyrite were altered to bornite, covellite, and chalcocite, in much of the Guilmette transition zone (Fig. 19 and 200. Reaction rims of these alteration products, in places are commonly rimmed by hematite. In one drill hole, near the Ward Gulch fault, chalcocite has been replaced by native copper (Fig. 21).

The red, earthy hematite, which is abundant in the Joana, is sparse in the Guilmette; the only siginficant occurance found to date is in a belt just west of, and parallel to, the Mammoth dike, half way between the Caroline Pit and the Defiance area (Fig. 6). In this belt virtually no sulfide ore minerals occur, contrary to the normal condition in the Joana, and it is possible that this hematitic belt represents oxidation of a pyrite or magnetite rich zone. In one drill hoel, sphalerite has been in part oxidized to smithsonite, and a few blebs of malachite can be seen replacing chalcopyrite.

d) Distribution

Ore deposits occur near the top and at the base of the Guilmette transition zone. Mineralization in the basal zone is semi-continuous within the district; 75% of the drill holes which intercepted this zone are well mineralized. The ore most commonly rests directly on the Guilmette marble, where the marble is present, and the veins of ore sulfides locally extend downward a few feet into the marble. The pure Guilmette marble formed either a physical or chemical barrier to replacement-type ore bodies.

The ore zone at the top of the Guilmette transition zone is less continuous than the basal zone. The ore occurs about 50 feet below the top of the transition zone, whose contact with the overlying Pilot Shale can be located only approximately, because the contact is gradational and is obscured by metamorphism.

Both upper Guilmette zones have the shape of mantos. Mineralization improves to ore grade in the vicinity of northwest shear zones, and increases to 25-40 feet in thickness. Mineralization in places exceeds 100 feet in thickness, perhaps indicating intersection of the northwest shear zones with close-spaced northeast-striking joints.

4) Porphyry-Guilmette Contact Zone

a) Ore Mineralogy and Paragenesis

The ore deposits of the porphyry-Guilmette contact zone are distinctly different from the deposits of the other zones in the Ward district. The skarn is similar to that in the higher zones: metacrysts of green and brown garnet in a groundmass of diopside, quartz, calcite, and minor epidote. The skarn replaced Guilmette marble, which most commonly was massive and featureless but may have been locally banded. Metallic minerals consist of pyrrhotite, magnetite, chalcopyrite, and molybdenite, with minor pyrite, bornite, covellite, and chalcocite. The skarn and metallic minerals are in places distinctlybanded, possibly indicating they replaced marble which was originally banded.

In one drill hole metallization in this zone consists entirely of coarse-grained cubes of pyrite.

The earliest hydrothermal stage was high temperature, depositing a fine-grained assemblage of pyrrhotite, magnetite, and pyrite. A second stage, nearly contemporaneous with the first, deposited chalcopyrite and molybdenite. Alteration of chalsopyrite to bornite, covellite, and chalcocite, is common as in the higher zones. Study of the paragenesis and alteration in this zone is still in progress.

b) Distribution

The porphyry-Guilmette contact zone occupies the upper part of the garnet skarn shell which caps the Ward intrusion, and is terminated at its top by the Guilmette marble. The marble apparently acted as a physical or chemical barrier to ore replacement. The lower limit of the ore is generally where skarn becomes a dense, almost pure brown garnet, near the intrusion. The ore locally extends downward through dense skarn into the intrusion itself. The top of the intrusion is irregular, as is the skarn envelope, and the replacing ore is classed as irregular replacement type.

The lateral distribution of the ore in this zone is poorly understood. The ore lies farther from the center of the district as defined by the unfavorable central skarn zone, and only a few drill holes have penetrated the zone where favorable for ore accumulation. The limited data suggests that ore in this zone may be thicker than in the higher zones, perhaps averaging 30 to 40 feet in thickness, with mineralized intervals exceeding 100 feet in thickness.

PROGRAM

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		2	X	0	7	0	
		3	HALT	4	0	1	Punch 10
		4	PRNT X	0	2	6	
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		1	X	0	7	0	
		2	HALT	4	0	1	Punch 1
		3	PRNT X	0	2	6	
		4	$\bar{\bar{\Sigma}}_8$	0	2	3	
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NO.______ PAGE 4 OF ___

DATE______ MODEL______

Branch Point	ADDRESS (P COUNT)			COMMAND	CODE			REMARKS												
								E	A	M	0	1	2	3	4	5	6	7	8	9
6	1	4	0	TO(7)	7	4	7													
			1	RCL 7	4	6	6													
			2	PRNT X	0	2	6													
			3	RCL 8	4	6	7													
			4	PRNT X	0	2	6													
			5	RCL 4	4	6	3													
			6	PRNT X	0	2	6													
			7	RCL 2	4	6	1													
	1	5	0	PRNT X	0	2	6													
			1	RCL (0)	4	7	7													
			2	PRNT X	0	2	6					TO (7)								
			3	TO (0)	7	4	0					TO (7)								
			4																	
			5																	
			6																	
			7																	
7.	1	6	0	CLR X	0	1	5													
			1		5	1	2													
			2		5	1	4													
			3		5	1	4													
			4		5	1	4													
			5		5	1	4													
			6		5	1	4													
			7		5	1	4													
	1	7	0		5	7	5													
			1		5	1	7													
			2		5	3	4													
			3		6	7	6													
			4		5	7	7													
			5		6	7	1													
			6		0	2	6													
			7		5	5	7													

MONROE
THE CALCULATOR COMPANY
A DIVISION OF LITTON INDUSTRIES

Programmed by ______

1498-S PRINTED IN U.S.A.

PROGRAM

NO. ____ PAGE 3 OF ____

DATE ____ MODEL ____

Branch Point	ADDRESS (P COUNT)			COMMAND	CODE			REMARKS (E A M 0 1 2 3 4 5 6 7 8 9)
4	1	0	0	RCL(9)	4	7	0	
			1	X	0	7	0	
			2	HALT	4	0	1	Punch + = 070
			3	PRNTX	0	2	6	
			4	STO(1)	4	4	0	
			5	+	0	6	0	
			6	RCL(0)	4	7	7	
			7	=	0	2	0	
	1	1	0	STO(0)	4	5	7	
			1	TO(5)	7	4	5	
			2					
			3					
			4					
			5					
			6					
			7					
5	1	2	0	TO(7)	7	4	7	
			1	RCL 9	4	7	0	Σ V
			2	PRNTX	0	2	6	
			3	RCL 6	4	6	5	Σ V x Ay
			4	PRNT X	0	2	6	
			5	RCL 5	4	6	4	Σ
			6	PRNTX	0	2	6	
			7	RCL 3	4	6	2	
	1	3	0	PRNTX	0	2	6	
			1	RCL 1	4	6	0	
			2	PRNTX	0	2	6	
			3	TO(7)	7	4	7	
			4	TO (0)	7	4	0	
			5					
			6					
			7					

QMP 35.1 MY

Mez. recumbent fold w to E

Int. + vol. at neck inter min.

3-4000' burial at min. top of basal porph.

Thinning in cent of graben

QMP cut by dikes.

Hole 75 farthest west.

½ IP anomaly has not been drilled.

Perameters

6' Thickness

Value	March E/MJ	Ave. prices Feb.
Ag	\$2.24 / oz	\$2.24 / oz
Pb	.15 / lb	3.00 / %
Zn	.19 / lb	3.80 / %
Cu	.55 / lb	11.00 / %

\$20.00 / ton cut off.

A. Half distance to nearest hole.

Approximately same distance to outside of holes.

Rectangular blocks.

B. 50' radius

JOINT VENTURE OF PHILLIPS PETROLEUM AND SILVER KING MINES, INC:- A total of 53 holes have been completed in a drilling program commenced in April 1966 in the Ward Mountain Mining District, White Pine County, Nevada. They are confined to an area 4000 feet long and 3600 feet wide with depth ranging from 900 to 3000 feet and spaced 200 to 850 feet apart - covering approximately 25% of the presently established geophysical anomalous area. K. L. Stoker, president and general manager of Silver King Mines said that of the 53 holes drilled, 40 encountered ore, 7 are mineralized and 6 are barren. It is estimated that 71% of the drilled area is underlain by ore. Stoker said a minimum intercept of 7 feet of ore, assaying $15 or more per ton in gross metal values was encountered in the 40 ore holes, and that overall thickness of ore in the 40 holes is over 22 feet. He said also that calculated ore reserves within this drilled area are in excess of 11½ million tons with an average gross metal value of about $30 per ton. The calculated ore reserve does not include the very large tonnage of mineralized material assaying between $4 and $15 per ton in copper, zinc, lead and silver.

Stoker said limits of ore deposits have not yet been established in any direction and before a major development program can be started, the eastern limits of the ore bodies must be defined by additional drilling to locate the site for a large incline shaft which will be driven in a westerly direction into the mountain at a minus 10% slope. A proposed concentrating plant will be constructed near the portal of the shaft and Stoker said, "We believe sufficient ore reserves have now been established to justify going ahead with these major development and milling projects."

Xerox from September 15, 1970 NEWS LETTER - NEVADA MINING ASSOC.
Number 210

PHILLIPS PETROLEUM COMPANY and SILVER KING MINES, INC:- have verified a second and larger ore zone at their jointly owned Ward Mountain silver-copper-zinc mine 18 miles south of Ely, White Pine County, Nevada. W. W. Keeler, chairman of the board and chief executive officer of Phillips, and K. L. Stoker, president and general manager of Silver King Mines, said core drilling during the past 15 months has also extended the limits of the first zone, substantially increasing estimated reserves of ore. Since drilling started in May 1966, commercial mineralization has been encountered in 25 out of 35 holes drilled. Drilling shows that the two ore zones range in thickness from 7 to 69 feet and 9 of the holes will be deepened to penetrate the second ore zone. To gain access to the ore deposits, extensive underground development projects, including two tunnels, are being worked 3 shifts per day and work on an underground shaft is scheduled to commence in the near future. Approximately 13,000 acres are equally held by Phillips and Silver King in the Ward Mountain district.

WARD DISTRICT, NEVADA WHITE PINE CO.

J.M.Hill,1916,Notes on some mining districts in eastern Nevada,USGS Bull. 648,p. 180-186.

Like Cherry Creek,on E front of Egan Range but farther south. Country rock thin-bedded Carboniferous ls.intruded by dikes and large dike-like masses of quartz monzonite. The limestone beds dip gently east,although dips up to 45 are shown on the plan. Alluvium of Steptoe Valley adjoins the district on the east. District production about $7,000,000.

The ore bodies were closely associated with the larger masses of quartz monzonite,occurring along the contacts as replacements in the limestone, and as veins both in the intrusive and limestone. One large ore body was in a limestone roof pendant in the middle of the largest porphyry mass.

Rich ore mined in early days was argentiferous lead carbonate;silver in part as chloride. Sulfide zone came in at 160-180'.Sulfide ores were sphalerite,pyrite & galena.

Here also there is probably a rock pediment under the alluvium. If a sizable mass of quartz monzonite could be located here,depth to bedrock were moderate,and geopysical and/or geochemical anomolies found,this would be a hood bet.

XL1 B-2

GEOLOGY OF THE WARD MOUNTAIN AREA, ELY QUADRANGLE, WHITE PINE COUNTY, NEVADA

GSA Bull vol. 70 p. 1730

R. L. Langenheim, Jr., F. T. Barr, S. E. Shank, L. J. Stensaas, and E. C. Wilson
Univ. of California, Berkeley, Calif.

1959

[redacted]

Basal Joana Ore Zone

0•000000000	00	*
0•000000000	00	*
0•000000000	00	*
0•000000000	00	*
0•000000000	00	*
0•000000000	00	*
0•000000000	00	*
0•000000000	00	*
0•000000000	00	*
0•000000000	00	*
0•000000000	00	*
0•000000000	00	*
0•000000000	00	*
0•000000000	00	*

PW 71,70 .... pw40

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2•245320000	06	x
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2•400000000	02	x
2•400000000	02	x
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4•400000000	-01	x
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1•287440000	05	x
6•437200000	04	x
3•291750000	05	x
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7•000000000	00	x
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4•000000000	02	x
2•090000000	00	x
0•000000000	00	x
4•560000000	00	x
1•600000000	00	x
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1•053360000	06	x
0•000000000	00	x
2•298240000	06	x
8•064000000	05	x
••••••••••••	00	x
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2•900000000	02	x
4•000000000	02	x
5•500000000	-01	x
1•600000000	-01	x
8•800000000	00	x
6•000000000	-01	x
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••••••••••••	00	x

Upper Coulmette Ore Zone #2

[illegible]

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1.940000000	00	X
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3.700000000	02	X
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8.000000000	-02	X
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6.055560000	05	X
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7.200000000	02	X
6.500000000	-01	X
8.000000000	-02	X
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7.600000000	-01	X
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• • • • • • • • • • •	00	
• • • • • • • • • • •	00	

Upper Joana Ore Zone

10.00	X
320.00	X
420.00	X
1.31	X
0.29	X
0.00	X
2.27	X
· · · · · · · · · · ·	X
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1760640.00	X
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0.00	X
3050880.00	X
· · · · · · · · · · ·	X
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430.00	X
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5.79	X
5.58	X
0.27	X
· · · · · · · · · · ·	X
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2022720.00	X
8365392.00	X
8061984.00	X
390096.00	X
· · · · · · · · · · ·	X
9.00	X
340.00	X
380.00	X
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639540.00	X
· · · · · · · · · · ·	X
6.00	X
340.00	X
420.00	X
3.31	X
0.00	X
0.00	X
2.06	X
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2836008.00	X
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0.00	X
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60.00	X
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3.09	X
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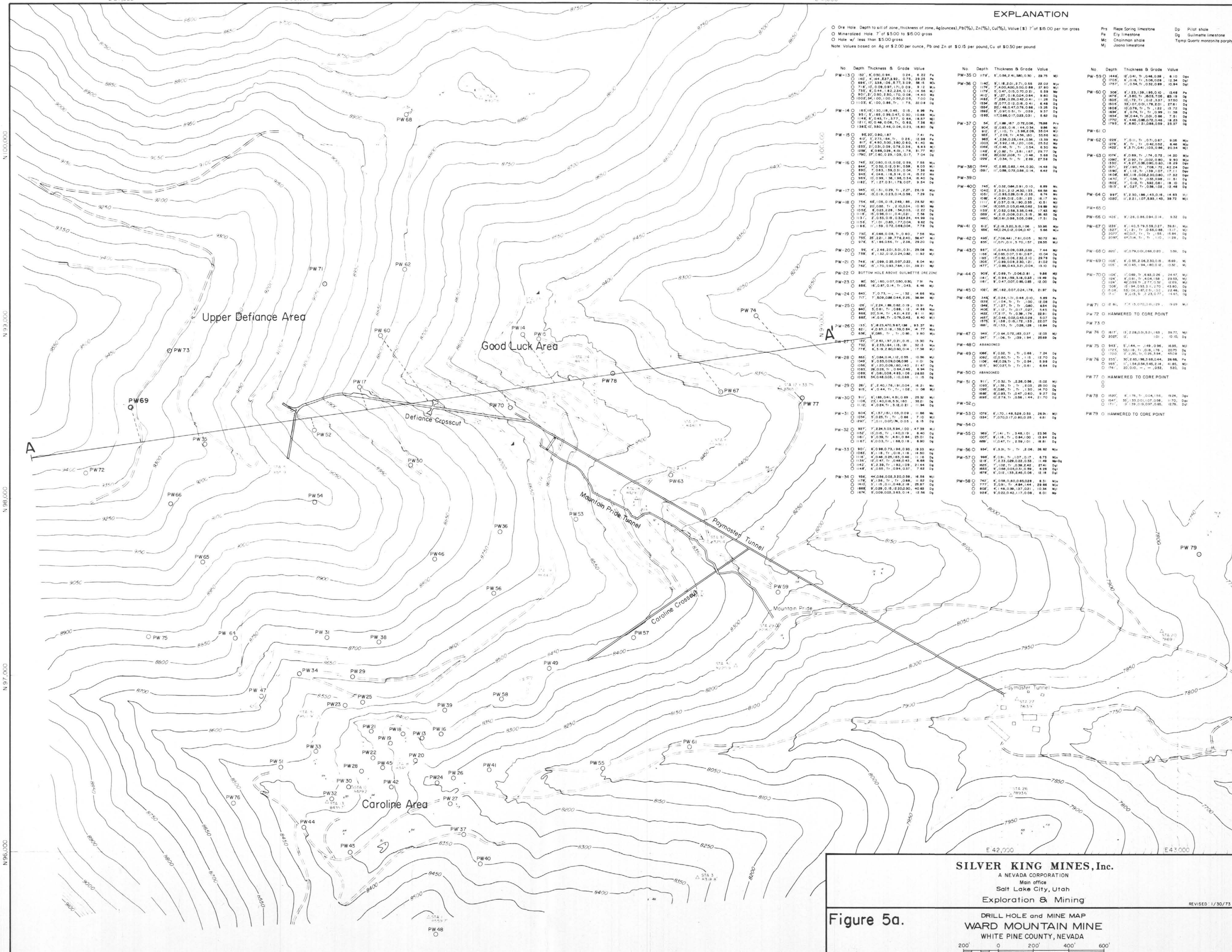
532350.00	X
166950.00	X
908775.00	X
486675.00	X
· · · · · · · · · · ·	X
9.00	X
210.00	X
270.00	X
2.18	X
3.20	X
3.13	X
1.06	X
· · · · · · · · · · ·	X
510300.00	X
1112454.00	X
1632960.00	X
1597239.00	X
540918.00	X
· · · · · · · · · · ·	X
9.00	X
160.00	X
230.00	X
2.33	X
1.64	X
1.15	X
1.91	X
· · · · · · · · · · ·	X
331200.00	X
771696.00	X
543168.00	X
380880.00	X
632592.00	X
· · · · · · · · · · ·	X
6.00	X
200.00	X
230.00	X
1.90	X
1.20	X
7.19	X
0.71	X
· · · · · · · · · · ·	X
276000.00	X
524400.00	X
331200.00	X
1984440.00	X
195960.00	X
· · · · · · · · · · ·	X
· · · · · · · · · · ·	X
6083400.00	X
10955628.00	X
13766658.00	X
16165902.00	X
7701669.00	X
· · · · · · · · · · ·	X
· · · · · · · · · · ·	X



EXPLANATION

○ Ore Hole: Depth to sill of zone, thickness of zone, Ag(ounces), Pb(%), Zn(%), Cu(%), Value ($) 7' of $15.00 per ton gross
○ Mineralized Hole: 7' of $5.00 to $15.00 gross
○ Hole w/ less than $5.00 gross
Note: Values based on Ag at $2.00 per ounce, Pb and Zn at $0.15 per pound, Cu at $0.50 per pound

Prs	Riepe Spring limestone
Pe	Ely limestone
Mc	Chainman shale
Mj	Joana limestone
Dp	Pilot shale
Dg	Guilmette limestone
Tqmp	Quartz monzonite porphyry

No.	Depth	Thickness & Grade	Value	
PW-13	132',	8', 0.50, 0.94, 0.24,	6.22	Pe
	140',	4', 1.44, 2.37, 3.92, 0.75,	29.25	Pe
	696',	17', 3.38, 1.06, 5.77, 3.09,	58.15	Mju
	718',	10', 0.09, 0.97, 1.71, 0.09,	9.12	Mju
	735',	6', 0.44, 1.82, 2.34, 0.12,	14.56	Mjl
	901',	21', 0.50, 2.50, 1.70, 0.08,	14.40	Mp
	1002',	34', 1.00, 1.00, 0.50, 0.05,	7.00	Dg
	1103',	6', 1.00, 0.86, Tr, 1.75,	22.08	Dg
PW-14	165',	115', 1.30, 1.18, 0.45, 0.15,	8.99	Pe
	951',	5', 1.65, 0.99, 0.47, 0.30,	10.68	Mju
	1148',	6', 0.43, Tr, 3.77, 0.64,	18.57	Mjl
	1211',	10', 0.49, 0.06, Tr, 0.62,	7.36	Mjl
	1383',	10', 3.50, 2.46, 0.04, 0.23,	16.80	Dg
PW-15	95',	20', 0.90, 1.87	7.41	Pe
	412',	3', 2.73, 1.64, Tr, 0.26,	12.98	Pe
	817',	6', 4.80, 5.00, 3.60, 0.60,	41.40	Mc
	1253',	21', 0.31, 0.09, 0.78, 0.36,	6.83	Mjl
	1259',	6', 0.68, 0.26, 4.01, 1.76,	31.77	Mjl
	1790',	37', 0.60, 0.29, 1.09, 0.17,	7.04	Dg
PW-16	745',	33', 0.60, 0.13, 0.02, 0.59,	7.55	Mju
	844',	7', 0.52, 0.12, 0.91, 0.39,	8.03	Mjl
	890',	7', 0.63, 1.59, 0.31, 0.04,	7.36	Mp
	945',	4', 0.46, 1.16, 3.14, 0.14,	15.22	Mp
	969',	10', 0.99, 1.38, 1.96, 0.34,	16.40	Dg
	1182',	7', 1.27, 0.31, 1.79, 0.07,	9.54	Dg
PW-17	945',	10', 1.31, 0.29, Tr, 2.27,	26.19	Mju
	1344',	13', 0.19, 0.23, 0.14, 0.58,	7.29	Dg
PW-18	754',	69', 1.05, 0.15, 2.49, 1.86,	28.52	Mjl
	774',	20', 0.55, Tr, 2.10, 0.34,	10.80	Mp
	1052',	8', 0.23, 2.28, 1.54, 0.03,	12.22	Dg
	1118',	15', 0.96, 0.11, 0.41, 0.21,	5.58	Dg
	1131',	2', 0.53, 0.19, 0.32, 4.24,	44.99	Dg
	1156',	7', 1.01, 0.83, 1.77, 0.04,	9.62	Dg
	1186',	11', 1.59, 0.72, 0.68, 0.04,	7.78	Dg
PW-19	730',	8', 0.66, 0.08, Tr, 0.60,	7.56	Mju
	755',	25', 2.21, 1.39, 7.76, 2.40,	56.47	Mjl
	978',	5', 1.86, 0.56, Tr, 2.38,	29.20	Dg
PW-20	99',	4', 2.46, 2.01, 5.01, 0.31,	29.08	Mc
	759',	8', 1.32, 0.12, 0.24, 0.82,	11.92	Mjl
PW-21	748',	16', 0.99, 0.25, 0.37, 0.22,	6.04	Mjl
	762',	15', 1.70, 0.93, 7.64, 1.01,	39.21	Mjl
PW-22	BOTTOM HOLE ABOVE GUILMETTE ORE ZONE			
PW-23	80',	50', 1.60, 0.07, 0.50, 0.30,	7.91	Pe
	858',	16', 0.87, 0.14, Tr, 0.43,	6.46	Mjl
PW-24	643',	7', 0.73, —, —, 1.32,	14.66	Mju
	717',	7', 5.09, 0.88, 0.44, 2.25,	38.64	Mjl
PW-25	126',	11', 2.24, 1.89, 0.62, 0.19,	13.91	Pe
	840',	5', 0.81, Tr, 0.68, 1.12,	14.86	Mju
	868',	20', 3.14, Tr, 4.21, 4.22,	61.11	Mjl
	882',	14', 0.96, Tr, 0.76, 0.42,	8.40	Mjl
PW-26	133',	5', 18.23, 4.70, 9.67, 1.38,	93.37	Mc
	621',	4', 0.83, 0.18, 1.39, 0.84,	14.77	Mju
	636',	9', 0.85, Tr, Tr, 0.86,	9.80	Mju
PW-27	122',	17', 2.63, 1.97, 0.21, 0.16,	13.30	Pe
	732',	9', 2.33, 1.64, 1.15, 1.91,	32.13	Mju
	778',	6', 3.19, 2.60, 0.60, 0.14,	17.38	Mjl
PW-28	853',	5', 0.84, 0.14, 1.12, 0.55,	10.56	Mjl
	1049',	9', 0.53, 0.09, 0.06, 0.96,	11.01	Dg
	1056',	8', 1.20, 0.09, 1.60, 1.40,	21.47	Dg
	1083',	26', 0.26, Tr, 0.64, 0.45,	6.94	Dg
	1089',	6', 0.61, 0.08, 4.83, 1.06,	26.55	Dg
	1089',	54', 0.48, 0.03, 1.10, 0.68,	11.15	Dg
PW-29	261',	2', 2.40, 1.76, 1.91, 0.04,	16.21	Mc
	915',	4', 0.44, Tr, Tr, 1.02,	11.08	Mjl
PW-30	911',	6', 1.83, 0.41, 4.51, 0.69,	25.32	Mjl
	1108',	23', 1.40, 0.16, 5.31, 1.60,	35.21	Dg
	11.12',	4', 0.24, Tr, 3.12, 0.21,	11.94	Dg
PW-31	604',	6', 1.57, 1.51, 1.03, 0.09,	11.66	Mc
	1034',	5', 0.25, Tr, Tr, 0.66,	7.10	Mjl
	1297',	7', 0.11, 0.07, 1.74, 0.05,	6.15	Dg
PW-32	927',	7', 2.24, 5.03, 5.94, 1.00,	47.39	Mjl
	1152',	13', 0.15, Tr, 1.40, 0.19,	6.40	Dg
	1161',	9', 0.39, Tr, 4.61, 0.84,	23.01	Dg
	1167',	6', 0.03, Tr, 1.68, 0.18,	6.90	Dg
PW-33	901',	6', 0.98, 0.73, 1.96, 0.93,	19.33	Mjl
	1083',	8', 1.18, Tr, 0.18, 1.16,	14.50	Dg
	1116',	4', 0.46, 0.25, 1.63, 0.46,	11.16	Dg
	1136',	12', 0.47, Tr, 0.48, 0.43,	6.68	Dg
	1142',	6', 2.39, Tr, 1.92, 1.09,	21.44	Dg
	1148',	6', 0.55, Tr, 0.94, 0.37,	7.62	Dg
PW-34	936',	44', 0.56, 0.02, 3.20, 0.58,	16.58	Mjl
	1178',	8', 1.36, Tr, Tr, 0.88,	11.62	Dg
	1410',	3', 1.15, 0.11, 0.48, 2.18,	25.87	Dg
	1669',	9', 0.29, 0.15, 12.20, 0.30,	40.63	Dg
	1674',	5', 0.09, 0.03, 3.63, 0.14,	12.56	Dg
PW-35	1179',	5', 0.56, 2.41, 3.80, 0.30,	29.75	Mjl
PW-36	1140',	9', 1.18, 2.01, 2.71, 0.55	22.02	Mju
	1174',	7', 4.00, 4.00, 3.00, 0.88,	37.80	Mjl
	1179',	5', 0.47, 0.15, 0.70, 0.21,	5.59	Mp
	1410',	9', 1.27, 0.18, 0.04, 0.84,	9.60	Dg
	1483',	7', 2.56, 0.26, 0.42, 0.41,	11.26	Dg
	1534',	15', 0.77, 0.12, 0.16, 0.41,	6.48	Dg
	1564',	20', 1.48, 0.47, 0.76, 0.66,	13.25	Dg
	1593',	5', 0.97, 0.51, Tr, 0.59,	9.37	Dg
	1593',	117', 0.66, 0.17, 0.23, 0.31,	5.62	Dg
PW-37	54',	2', 11.89, 16.7, 0.72, 0.06,	76.88	Prs
	904',	13', 0.83, 0.16, 1.44, 0.34,	9.86	Mjl
	912',	2', 1.10, Tr, 3.98, 2.09,	35.04	Mjl
	923',	7', 2.09, Tr, 4.56, 1.60,	33.86	Mjl
	963',	4', 2.36, 0.25, 1.44, 0.36,	13.39	Mp
	1003',	14', 3.92, 1.16, 1.20, 1.06,	25.52	Mp
	1069',	13', 0.45, Tr, Tr, 0.54,	6.30	Mp
	1148',	6', 0.82, Tr, 3.81, 1.67,	29.77	Dg
	1168',	20', 0.32, 0.08, Tr, 0.48,	5.68	Dg
	1229',	4', 0.34, Tr, Tr, 2.69,	27.58	Dg
PW-38	1349',	10', 2.85, 0.82, 1.44, 0.20,	14.48	Dg
	1391',	11', 0.59, 0.72, 0.56, 0.14,	6.42	Dg
PW-39				
PW-40	745',	6', 0.32, 0.84, 0.91, 0.10,	6.89	Mc
	1040',	3', 3.01, 2.12, 14.30, 1.33,	68.56	Mc
	1051',	11', 0.93, 0.28, 0.18, 0.35,	6.74	Mc
	1082',	4', 0.89, 0.12, 0.51, 1.25,	16.17	Mc
	1111',	8', 0.37, 0.19, 1.90, 0.35,	10.51	Mjl
	1134',	15', 0.55, 0.05, 10.48, 0.62,	38.89	Mjl
	1139',	5', 0.52, 0.58, 3.35, 0.48,	17.63	Mjl
	1369',	4', 2.13, 0.08, 0.21, 3.15,	36.63	Dg
	1460',	56', 0.61, 0.08, 3.05, 0.69,	17.51	Dg
PW-41	612',	9', 2.18, 3.20, 3.13, 1.06	33.96	Mju
	656',	44', 0.24, 0.12, 0.04, 0.47	5.66	Mju
PW-42	495',	2', 7.08, 4.41, 7.61, 0.05	50.72	Mc
	835',	11', 0.71, 0.11, 3.70, 1.57,	28.55	Mjl
PW-43	987',	11', 0.44, 0.09, 0.33, 0.53,	7.44	Mjl
	1168',	14', 0.65, 0.07, 0.61, 0.67,	10.04	Dg
	1185',	17', 0.82, 0.06, 2.32, 2.10,	29.78	Dg
	1205',	7', 0.89, 0.08, 2.30, 1.21,	21.02	Dg
	1477',	7', 0.89, 0.43, 3.21, 0.04,	13.10	Dg
PW-44	909',	6', 0.69, Tr, 0.06, 0.81	9.86	Mjl
	1141',	6', 0.94, 1.59, 3.18, 0.33,	19.49	Dg
	1161',	9', 0.47, 0.07, 0.85, 0.83,	12.00	Dg
PW-45	1021',	25', 1.62, 0.07, 0.24, 1.78,	21.97	Dg
PW-46	348',	8', 0.24, 1.01, 0.46, 0.10,	5.89	Pe
	1339',	11', 1.04, Tr, Tr, 1.00,	12.08	Dg
	1349',	7', 1.27, Tr, Tr, 0.60,	8.54	Dg
	1405',	9', 1.12, Tr, 0.17, 0.27,	5.45	Dg
	1422',	17', 2.17, Tr, 0.39, 1.74,	22.91	Dg
	1457',	21', 0.46, 0.02, 0.43, 0.28,	5.07	Dg
	1575',	9', 1.58, 0.15, 1.72, 1.33,	22.07	Dg
	1681',	15', 1.53, Tr, 0.26, 1.28,	16.64	Dg
PW-47	949',	7', 0.64, 0.72, 1.63, 0.37	12.03	Mjl
	1247',	7', 1.06, Tr, 1.39, 1.94,	25.69	Dg
PW-48	ABANDONED			
PW-49	1086',	8', 0.32, Tr, Tr, 0.66,	7.24	Dg
	1092',	10', 0.60, Tr, Tr, 1.15,	12.70	Dg
	1106',	48', 0.29, Tr, Tr, 0.54,	5.98	Dg
	1215',	90', 0.27, Tr, Tr, 0.61,	6.64	Dg
PW-50	ABANDONED			
PW-51	911',	7', 0.32, Tr, 2.26, 0.56,	13.02	Mjl
	1093',	9', 1.35, Tr, Tr, 2.03,	23.00	Dg
	1095',	15', 0.85, Tr, Tr, 1.30,	14.70	Dg
	1685',	18', 0.93, Tr, 0.47, 0.60,	9.27	Dg
	1695',	10', 2.78, Tr, 0.58, 1.44,	21.70	Dg
PW-52				
PW-53	1076',	6', 1.70, 1.48, 5.28, 0.53,	28.91	Mjl
	1334',	7', 0.70, 0.17, 0.80, 0.25,	6.81	Dg
PW-54				
PW-55	969',	7', 1.41, Tr, 3.48, 1.01,	23.36	Dg
	1007',	8', 1.16, Tr, 0.84, 1.00,	13.84	Dg
	1669',	11', 0.47, Tr, 2.59, 1.01,	18.81	Dg
PW-56	934',	6', 3.31, Tr, Tr, 2.06,	26.62	Mju
PW-57	998',	8', 0.91, Tr, 1.07, 0.17,	6.73	Mju
	1218',	7', 2.33, 0.29, 0.22, 0.53,	11.49	Mp-Dg
	1625',	7', 1.02, Tr, 0.39, 2.42,	27.41	Dgl
	1653',	9', 0.68, 0.03, 0.31, 0.59,	8.28	Dgl
	1678',	6', 0.12, 1.33, 2.45, 0.06,	12.18	Dgl
PW-58	742',	6', 0.58, 0.60, 0.85, 0.28,	8.31	Mju
	777',	3', 0.91, Tr, 4.84, 1.44,	29.66	Mju
	802',	4', 1.48, 0.39, 1.37, 0.21,	10.34	Mjl
	928',	9', 0.22, 0.42, 1.17, 0.08,	6.01	Mp
PW-59	1446',	12', 0.41, Tr, 0.46, 0.39,	6.10	Dgu
	1705',	6', 0.18, Tr, 3.06, 0.28,	12.34	Dgl
	1757',	11', 0.54, Tr, 0.32, 0.89,	10.94	Dgl
PW-60	308',	8', 1.23, 1.39, 1.95, 0.10,	13.48	Pe
	1476',	4', 3.80, Tr, 15.03, 7.06,	123.19	Dg
	1505',	10', 1.72, Tr, 0.12, 3.37,	37.50	Dg
	1505',	33', 1.07, 0.01, 1.78, 2.01,	27.61	Dg
	1608',	10', 0.76, Tr, Tr, 1.22,	13.72	Dg
	1634',	8', 0.74, Tr, Tr, 0.99,	11.38	Dg
	1634',	36', 0.44, Tr, 0.01, 0.66,	7.51	Dg
	1770',	6', 4.46, 0.86, 0.72, 0.46,	18.23	Dg
	1795',	6', 6.60, 1.21, 0.88, 0.59,	25.37	Dg
PW-61				
PW-62	1228',	7', 0.11, Tr, 0.71, 0.67,	9.06	Mju
	1278',	8', Tr, Tr, 0.42, 0.52,	6.46	Mju
	1422',	6', 3.71, 0.41, 1.03, 0.86,	20.34	Mjl
PW-63	1074',	8', 0.89, Tr, 1.74, 0.72,	14.20	Mju
	1090',	9', 0.92, Tr, 0.02, 0.80,	9.90	Mju
	1330',	4', 6.27, 0.36, 0.90, 0.20,	18.29	Dgu
	1371',	22', 1.90, Tr, 7.08, 1.72,	42.24	Dgu
	1390',	8', 1.12, Tr, 1.39, 1.07,	17.11	Dgu
	1408',	83', 1.18, 0.02, 2.30, 0.80,	17.32	Dgu
	1470',	7', 0.36, Tr, 0.33, 0.98,	11.51	Dg
	1502',	7', 0.12, Tr, 3.92, 0.61,	18.10	Dg
	1513',	8', 0.27, Tr, 0.58, 1.02,	12.48	Dg
PW-64	997',	5', 2.30, 1.86, 1.43, 0.16,	14.63	Mjl
	1020',	11', 2.21, 1.07, 5.93, 1.43,	39.72	Mjl
PW-65				
PW-66	1426',	9', 1.26, 0.86, 0.94, 0.14,	9.32	Dg
PW-67	1228',	8', 1.40, 5.79, 5.58, 0.27,	39.61,	Mju
	1327',	4', 1.21, Tr, 0.65, 0.88,	13.17,	Mjl
	2077',	40', 0.17, Tr, Tr, 1.55,	15.84,	Dg
	2097',	68', 0.14, Tr, Tr, 1.10,	11.28,	Dg
PW-68	1820',	12', 0.79, 0.01, 0.66, 0.20,	5.59,	Dg
PW-69	1105',	8', 0.55, 2.06, 2.30, 0.16,	15.69,	Mj
	1105',	18', 0.45, 1.94, 1.80, 0.12,	13.32,	Mj
PW-70	1106',	11', 0.69, Tr, 6.83, 0.26,	24.47,	Mjl
	1124',	8', 0.81, Tr, 4.04, 1.58,	29.53,	Mjl
	1124',	42', 0.59, Tr, 2.77, 0.32,	12.69,	Mjl
	1508',	15', 1.94, 0.93, 3.11, 2.70,	43.80,	Dg
	1508',	53', 1.06, 0.87, 2.61, 1.02,	22.46,	Dg
	1711'	9', 0.13, Tr, 2.23, 0.77,	14.65,	Dg
PW 71	1281',	7', 6.13, 0.70, 0.81, 1.29,	19.69	Mjl
PW 72	HAMMERED TO CORE POINT			
PW 73				
PW 74	1617',	13', 2.28, 0.31, 5.21, 1.63,	38.77,	Mjl
	2027',	12', 1.01,	10.10,	Dg
PW 75	943',	5', 1.44, —, 1.49, 0.96,	16.95,	Mjl
	1723',	50, 1.18, Tr, 0.18, 1.78,	20.70	Dg
	1700',	9', 2.95, Tr, 0.26, 3.84,	45.08	Dg
PW 76	255',	30', 2.65, 1.98, 3.68, 0.44,	26.68,	Pe
	993',	11', 1.54, 0.54, 5.45, 2.14,	41.85,	Mjl
	1741',	20', 0.10, —, —, 0.52,	5.20,	Dg
PW 77	HAMMERED TO CORE POINT			
PW 78	1520',	8', 1.76, Tr, 0.04, 1.56,	19.24,	Dgu
	1547',	35', 1.33, 0.01, 1.07, 0.58,	11.70,	Dgu
	1711',	9', 1.39, 0.19, 0.97, 0.65,	12.76,	Dgl
PW 79	HAMMERED TO CORE POINT			

SILVER KING MINES, Inc.
A NEVADA CORPORATION
Main office
Salt Lake City, Utah
Exploration & Mining

REVISED: 1/30/73

Figure 5a. DRILL HOLE and MINE MAP
WARD MOUNTAIN MINE
WHITE PINE COUNTY, NEVADA

200' 0 200' 400' 600'

	Vol.	Tons	Ag	Pb	Zn	Cu	Vol x Ag	Vol x Pb	Vol x Zn	Vol x Cu		$/ton	Ave. Heigth
Upper Joana Ore Zone	16083400	553036	180	226	266	127	10955628	13766658	16165902	7701669		3489	89
Basal Joana Ore Zone	26159900	2378173	163	62	465	97	42583792	16253927	121559586	25338435		3385	155
Upper Guilmette Ore Zone #1	5675940	515995	97	16	176	194	5528171	931619	9989582	11011778		3068	134
Upper Guilmette Ore Zone #2	45454550	4132232	142	41	327	151	64730422	18508696	148469777	68550013		3345	93
Lower Guilmette Ore Zone	16983800	1543982	138	09	225	136	23518286	1526385	38220721	23136458		2687	142
	100357590	9123418	146	51	333	135	147316299	50987285	334405568	135738353		3230	134

58 intercepts

	Vol.	Tons	Ag	Pb	Zn	Cu	Vol x Ag	Vol x Pb	Vol x Zn	Vol x Cu		$/ton	Ave. Heigth
Upper Joana Ore Zone	584825	53168	223	183	339	171	1303885	1072467	1980516	998794		4218	
Basal Joana Ore Zone	2235680	203244	182	67	470	172	4071912	1499060	10513764	3834623		4287	
Upper Guilmette Ore Zone #1	347755	31614	107	31	155	172	373472	106179	538887	599426		2760	
Upper Guilmette Ore Zone #2	2073970	188543	136	26	297	149	2824193	549044	6159781	3098866		3151	
Lower Guilmette Ore Zone	843875	76716	145	09	188	142	1223384	78185	1584484	1199912		2628	
	6086105	553285	161	54	341	160	9796846	3304935	20777432	9731621		3578	

To 6 Besome

4813 : Buff
5813 : Blue
8813 : Green

Upper Soana Ore Zone	Thick	Width π	Length 50² (78 50)	Vol.	Ag	Pb	Zn	Cu	Vol x Ag	Vol x Pb	Vol x Zn	Vol x Cu
PW 17	10	314	2500	78500	131	29	tr.	227	102835	22765	0	178195
PW 67	8			62800	140	579	558	27	87920	363612	350424	16956
PW 36	9			70650	120	201	278	55	84780	142007	196407	38857
PW 56	6			47100	331	tr.	tr.	206	155901	0	0	97026
PW 13	175			137375	338	106	577	309	464327	145617	792654	424489
PW 41	9			70650	218	320	313	106	154017	226080	221135	74889
PW 27	9			70650	233	164	115	191	164615	115866	81247	134941
PW 40	6			47100	190	120	719	71	89490	56520	338649	33441
				584825					1303885	1072467	1980516	998794
			Tons	53168	223	183	339	171				

Basal Soana Ore Zone	Thick	Width π	Length 50²	Vol.	Ag	Pb	Zn	Cu	Vol x Ag	Vol x Pb	Vol x Zn	Vol x Cu
PW 71	7			54950	653	79	63	30	358823	43411	34619	16485
PW 70	17			133450	46	Tr.	435	26	61387	0	580507	34697
	8			62800	81	Tr.	404	162	50868	0	253712	101736
PW 36	7			54950	396	404	304	88	217602	221998	167048	48356
PW 53	6			47100	170	148	528	53	80070	69708	248688	24963
PW 64	11			86350	221	107	593	143	190833	92395	512055	123481
PW 34	125			98125	55	06	567	61	53969	5887	556369	59856
PW 25	20			157000	314	tr.	421	422	492980	0	660970	662540
PW 21	10			78500	210	135	996	123	164850	105975	781860	96555
PW 18	69			541650	105	15	249	185	568733	81247	1348709	1002053
PW 19	25			196250	221	139	776	246	433713	272787	1522900	482775
PW 13	175			137375	338	106	577	309	464327	145617	792654	424489
PW 33	6			47100	98	73	196	93	46158	34383	92316	43803
PW 76	11			86350	154	54	545	214	132979	46629	470607	184789
PW 30	63			49455	185	41	451	69	91492	20277	223042	34124
PW 32	7			54950	224	503	594	100	123088	276399	326403	54950
PW 42	11			86350	71	11	370	157	61309	9499	319495	135569
PW 24	7			54950	509	88	44	225	279695	48356	24178	123637
PW 37	7			54950	209	Tr.	456	160	114845	0	250572	87920
PW 40	195			153075	55	16	880	60	84191	24492	1347060	91845
				2235680					4071912	1499060	10513764	3834623
			Tons	203244	182	67	470	172				

Upper Guilmette Ore Zone #1	Heigth	Width π	Length 50²	Vol.	Ag	Pb	Zn	Cu	Vol × Ag	Vol × Pb	Vol × Zn	Vol × Cu
PW 19	6			47100	127	42	Tr.	182	59817	19782	0	85722
PW 28	68			53380	127	07	166	155	67793	3737	88611	82739
PW 51	9			70650	135	Tr.	Tr.	203	95377	0	0	143419
PW 44	6			47100	94	159	318	33	44274	74889	149778	15543
PW 43	165			129525	82	06	232	210	106211	7771	300498	272003
				347755					373472	106179	538887	599426
			Tons	31614	107	31	155	172				
Upper Guilmette Ore Zone #2												
PW 60	33			259050	107	01	177	201	277183	2591	458519	520691
PW 70	35			274750	112	122	331	151	307720	335195	909423	414873
PW 78	8			62800	176	Tr.	Tr.	156	110528	0	0	97968
PW 74	13			102050	228	31	521	163	232674	31635	531681	166341
PW 63	22			172700	190	Tr.	708	172	328130	0	1222716	297044
PW 36	85			66725	237	100	124	68	158138	66725	82739	45373
PW 46	165			129525	217	Tr.	39	174	281069	0	50515	225373
PW 47	7			54950	106	Tr.	139	194	58247	0	76381	106603
PW 33	6			47100	239	Tr.	192	109	112569	0	90432	51339
PW 30	23			180550	140	16	531	160	252770	28888	958721	288880
PW 45	25			196250	162	07	24	178	317925	13737	47100	349325
PW 13	62			48670	100	86	Tr.	175	48670	41856	0	85173
PW 43	7			54950	89	08	230	121	48905	4396	126385	66489
PW 37	6			47100	82	Tr.	381	167	38622	0	179451	78657
PW 40	6			47100	117	07	636	103	55107	3297	299556	48513
	33			259050	65	08	309	76	168383	20724	800465	196878
PW 32	9			70650	39	Tr.	461	84	27553	0	325697	59346
				2073970					2824193	549044	6159781	3098866
			Tons	188543	136	26	297	149				
Lower Guilmette Ore Zone												
PW 60	6			47100	660	121	88	59	310860	56991	41448	27789
PW 46	9			70650	158	15	172	133	111627	10597	121518	93965
PW 63	7			54950	12	Tr.	392	61	6594	0	215404	33519
PW 57	7			54950	99	Tr.	39	232	54401	0	21431	127484
PW 55	95			74575	51	Tr.	277	113	38033	0	206573	84270
PW 75	50			392500	118	Tr.	18	178	463150	0	70650	698650
PW 34	9			70650	29	15	1220	30	20489	10597	861930	21195
PW 51	10			78500	278	Tr.	58	144	218230	0	45530	113040
				843875					1223384	78185	1584484	1199912
			Tons	76716	145	09	188	142				

Upper Joana Ore Zone	Thick	Width	Length	Vol.	Ag	Pb	Zn	Cu	Vol x Ag	Vol x Pb	Vol x Zn	Vol x Cu
PW 17	10	320	420	1344000	131	29	Tr	227	1760640	389760	0	3050880
PW 67	8	420	430	1444800	140	579	558	27	2022720	8365392	8061984	390096
PW 36	9	340	380	1162800	120	201	278	55	1395360	2337228	3232584	639540
PW 56	6	340	420	856800	331	Tr	tr	206	2836008	0	0	1765008
PW 13	175	60	150	157500	338	106	577	309	532350	166950	908775	486675
PW 41	9	210	270	510300	218	320	313	106	1112454	1632960	1597239	540918
PW 27	9	160	230	331200	233	164	115	191	771696	543168	380880	632592
PW 40	6	200	230	276000	190	120	719	71	524400	331200	1984440	195960
				6083400					10955628	13766658	16165902	7701669
			Tons	553036	180	226	266	127				
Basal Joana Ore Zone												
PW 71	7	390	690	1883700	653	79	63	30	12300561	1488123	1186731	565110
PW 70	17	480	850	6936000	46	Tr	435	26	3190560	0	30171600	1803360
	8	480	850	3264000	81	Tr	404	162	2643840	0	13186560	5287680
PW 36	7	400	520	1456000	396	404	304	88	5765760	5882240	4426240	1281280
PW 53	6	440	520	1372800	170	148	528	53	2333760	2031744	7248384	727584
PW 64	11	300	610	2013000	221	107	593	143	4448730	2153910	11937090	2878590
PW 34	125	280	460	1610000	55	06	567	61	885500	96600	9128700	982100
PW 25	20	120	170	408000	314	tr	421	422	1281120	0	1717680	1721760
PW 21	10	60	210	126000	210	135	996	123	264600	170100	1254960	154980
PW 18	69	50	260	897000	105	15	249	185	941850	134550	2233530	1659450
PW 19	25	90	240	540000	221	139	776	246	1193400	750600	4190400	1328400
PW 13	175	90	150	236250	338	106	577	309	798525	250425	1363163	730013
PW 33	6	240	240	345600	98	73	196	93	338688	252288	677376	321408
PW 76	11	210	370	854700	154	54	545	214	1316238	461538	4658115	1829058
PW 30	63	150	310	292950	185	41	451	69	541957	120109	1321205	202135
PW 32	7	180	300	378000	224	503	594	100	846720	1901340	2245320	378000
PW 42	11	240	240	633600	71	11	370	157	449856	69696	2344320	994752
PW 24	7	110	190	146300	509	88	44	225	744667	128744	64372	329175
PW 37	7	180	400	504000	209	Tr	456	160	1053360	0	2298240	806400
PW 40	195	290	400	2262000	55	16	880	60	1244100	361920	19905600	1357200
				26159900					42583792	16253927	121559586	25338435
			Tons	2378173	163	62	465	97				

	Heigth	Width	Length	Vol.	Ag	Pb	Zn	Cu	Vol.x Ag	Vol.x Pb	Vol. x Zn	Vol. x Cu
Upper Guilmette Ore Zone #1												
PW 19	6	180	380	410400	127	42	tr.	182	521208	172368	0	746928
PW 28	68	180	210	257040	127	07	166	155	326441	17993	426686	398412
PW 57	9	320	350	1008000	135	tr.	tr.	203	1360800	0	0	2046240
PW 44	6	210	260	327600	94	159	318	33	307944	520884	1041768	108108
PW 43	165	420	530	3672900	82	06	232	210	3011778	220374	8521128	7713090
				5675940					5528171	931619	9989582	11011778
			Tons	515995	97	16	176	194				
Upper Guilmette Ore Zone #2												
PW 60	33	410	490	6629700	107	01	177	201	7093779	66297	11734569	13325697
PW 70	35	540	620	11718000	112	122	331	151	13124160	14295960	38786580	17694180
PW 78	8	470	670	2519200	176	Tr.	tr.	156	4433792	0	0	3929952
PW 74	13	460	610	3647800	228	31	521	163	8316984	1130818	19005038	5945914
PW 63	22	470	560	5790400	190	Tr.	708	172	11001760	0	40996032	9959488
PW 36	85	410	630	2195550	237	100	124	68	5203453	2195550	2722482	1492974
PW 46	165	360	410	2435400	217	Tr.	39	174	5284818	0	949806	4237596
PW 47	7	230	420	676200	106	tr.	139	194	716772	0	939918	1311828
PW 33	6	230	370	510600	239	tr.	192	109	1220334	0	980352	556554
PW 30	23	160	320	1177600	140	16	531	160	1648640	188416	6253056	1884160
PW 45	25	110	270	742500	162	07	24	178	1202850	51975	178200	1321650
PW 13	62	100	200	124000	100	86	Tr.	175	124000	106640	0	217000
PW 43	7	270	360	680400	89	08	230	121	605556	54432	1564920	823284
PW 37	6	190	740	843600	82	Tr.	381	167	691752	0	3214116	1408812
PW 40	6	190	720	820800	117	07	636	103	960336	57456	5220288	845424
	33	190	720	4514400	65	08	309	76	2934360	361152	13949496	3430944
PW 32	9	140	340	428400	39	Tr.	461	84	167076	0	1974924	359856
				45454550					64730422	18508696	148469777	68550013
			Tons.	4132232	142	41	327	151				
Lower Guilmette Ore Zone												
PW 60	6	310	500	930000	660	121	88	59	6138000	1125300	818400	548700
PW 46	9	330	340	1009800	158	15	172	133	1595484	151470	1736856	1343034
PW 63	7	290	720	1461600	12	Tr.	392	61	175392	0	5729472	891576
PW 57	7	330	710	1640100	99	Tr.	39	232	1623699	0	639639	3805032
PW 55	95	440	590	2466200	51	Tr.	277	113	1257762	0	6831374	2786806
PW 75	50	320	370	5920000	118	Tr.	18	178	6985600	0	1065600	10537600
PW 34	9	430	430	1664100	29	15	1220	30	482589	249615	20302020	499230
PW 51	10	430	440	1892000	278	Tr.	58	144	5259760	0	1097360	2724480
				16983800					23518286	1526385	38220721	23136458
			Tons	1543982	138	09	225	136				

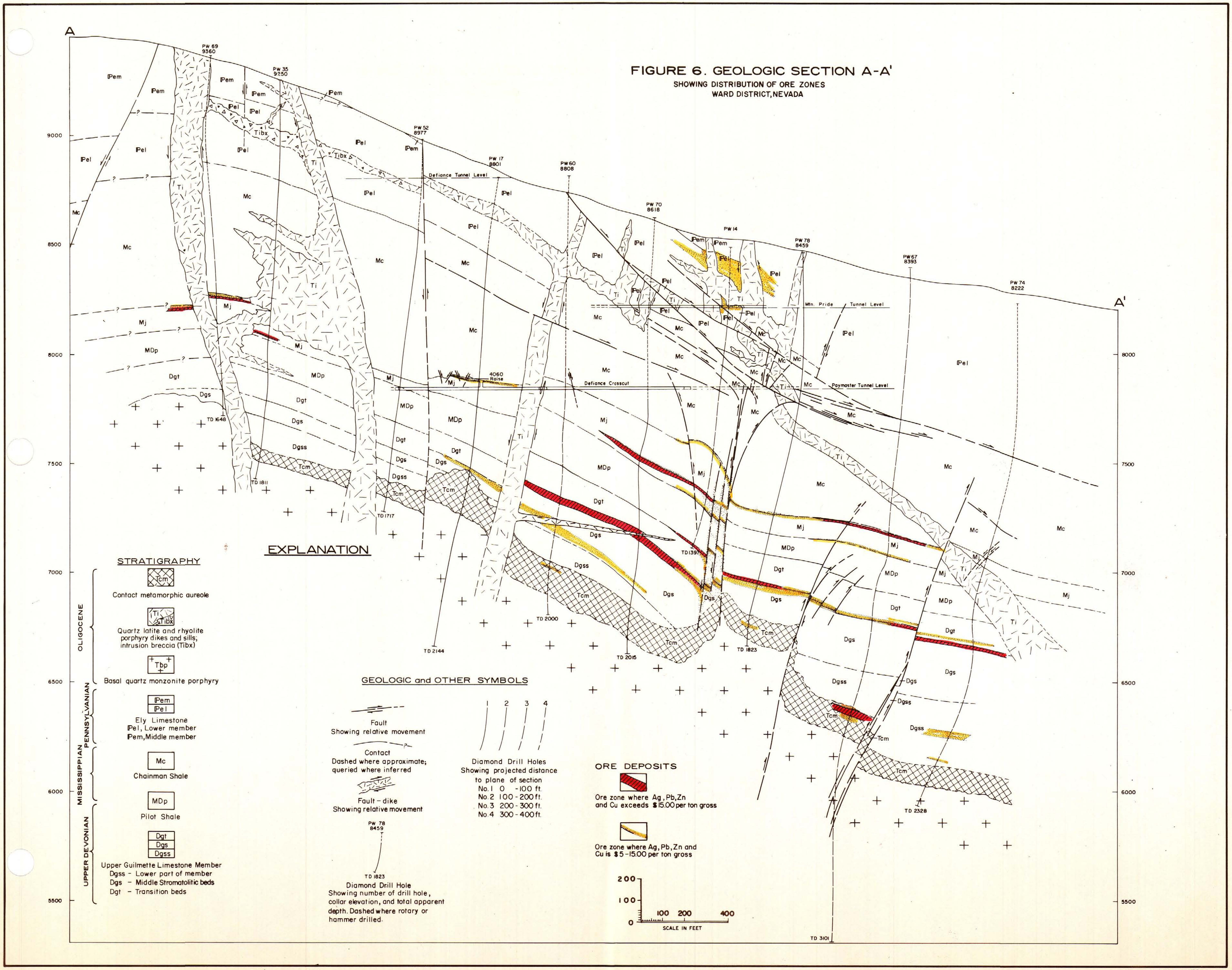


FIGURE 6. GEOLOGIC SECTION A-A'
SHOWING DISTRIBUTION OF ORE ZONES
WARD DISTRICT, NEVADA

Tom L. Heidrick, 1972

FIGURE 3. Geologic map of the Ward District, White Pine County, Nevada.

Geology by Tom L. Heidrick (1963, '64, '71, '72)

EXPLANATION

STRATIGRAPHY

QUATERNARY
- Qal — Alluvium
- Qtg — Terrace and alluvial fan deposits
- Qdf — Debris flow
- Qde — Debris and earthflows und.
- Qog — Older lacustrine limestone conglomerate and breccia.

UNCONFORMITY

OLIGOCENE
- Tvt — Unmineralized ash flow tuff
- Tit — Intrusive quartz latite crystal - victric tuffs

DISCONFORMITY

- Tva — Mineralized ash flow tuff
- Tvto — Mineralized quartz latite crystal - lithic tuff (?) in part intrusive
- Tibx — Quartz latite intrusive breccia
- Ti — Quartz latite and rhyolite porphyry dikes und.

ANGULAR UNCONFORMITY

EOCENE
- Tsp_2 — Sheep Pass lacustrine limestone
- Tsp_1 — Sheep Pass limestone - pebble conglomerate

ANGULAR UNCONFORMITY

PERMIAN
- Pau, Pam, Pal — Arcturus Formation: Upper Member, Middle Member, Lower Member
- Prh — Rib Hill Sandstone
- Prs — Riepe Springs Limestone

DISCONFORMITY

PENNSYLVANIAN
- IPeu, IPem, IPel — Ely Limestone: Upper Member, Middle Member, Lower Member

MISSISSIPPIAN
- Mc — Chainman Shale
- MDp — Pilot Shale
- Mja, Mj — Joana Limestone: annealled; und, or unannealled

DEVONIAN
- Dgu, Dgm, Dgl — Guilmette Limestone: Upper Member, Middle Member, Lower Member
- Dsi — Simonson Dolomite
- Ds — Sevy Dolomite

SILURIAN
- Slu, Slm, Sll — Laketown Dolomite: Upper Member, Middle Member, Lower Member

ORDOVICIAN
- Oes — Ely Springs Dolomite
- Oe — Eureka Quartzite
- Ol — Lehman Formation

1000 0 1000 2000 3000 Feet

N

STRUCTURE (Abbrev.)

77

Contact
Showing direction of dip

63 73 U D

Fault (und.)
Showing bearing of dip and slickensides; U, upthrown side, D, downthrown side

28

Thrust fault
Showing bearing of dip, sawteeth on hanging wall

57

Reverse fault
Showing bearing of dip, reversed sawteeth on upthrown hanging wall

42 52

Normal fault
Showing bearing of dip and slickensides, hachures on downthrown side

60

Fault-dike
Showing bearing of dip

Basal glide plane
Restricted to landslide deposits (Qls)

66 75 (c, cbx, q, cqbx, j, jc, jl, jcg, jcc)

Fracture-filling
Showing bearing of dip and slickensides; c, calcite; cbx, calcite breccia; q, quartz; cqbx, calcite-quartz breccia; j, jasperoid und; jc, cherty jasperoid; jl, limonitic jasperoid; jcq, cherty jasperoid showing quartz crackle breccia; jcc, cherty jasperoid showing calcite crackle breccia

5 45

Anticline
Showing trace of axial plane with bearing and plunge of axis and dip of axial plane

5 45

Syncline
See anticline explanation

45 35

Overturned anticline
Showing trace of axial plane and direction of dips of limbs. Bearing of axis and dip of axial plane as in anticline explanation

35 45

Overturned syncline
See overturned anticline explanation

Faulted overturned axial plane
Showing hachures on downthrown side

Faulted overturned axial plane
Showing sawteeth on hanging wall of thrust fault

30 45 32

Bearing and plunge of axis for minor syncline, anticline and chevron fold

53 90 45

Dip and strike of upright, horizontal, vertical and overturned beds

33 60 60

Strike and dip of foliation and plunge of lineation

Strike of vertical foliation

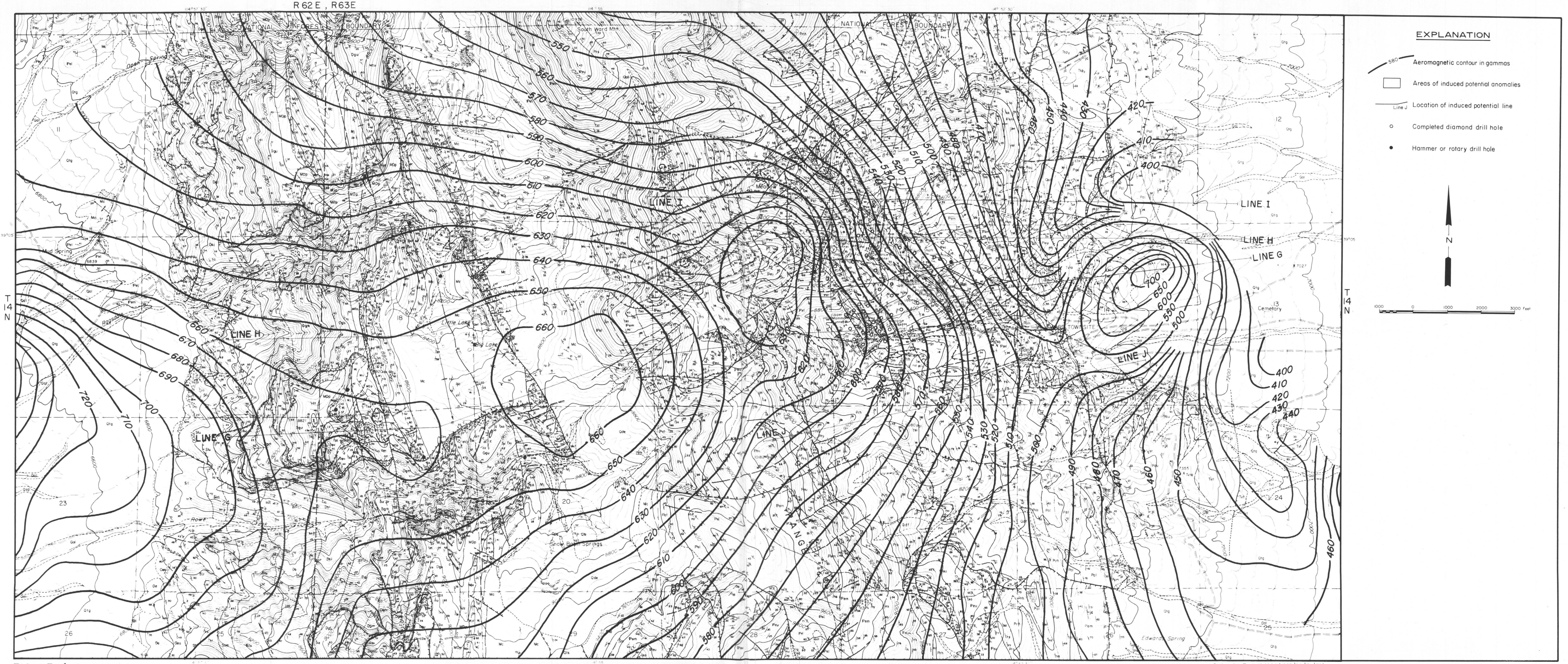


FIGURE 4. Geologic map, low level aeromagnetic map, areas of anomalous induced potential-metal factor and drill hole locations, Ward District, Nevada. See Fig. 3 for geologic map explanation.

Geology by Tom L. Heidrick (1963,'64,'71,'72)

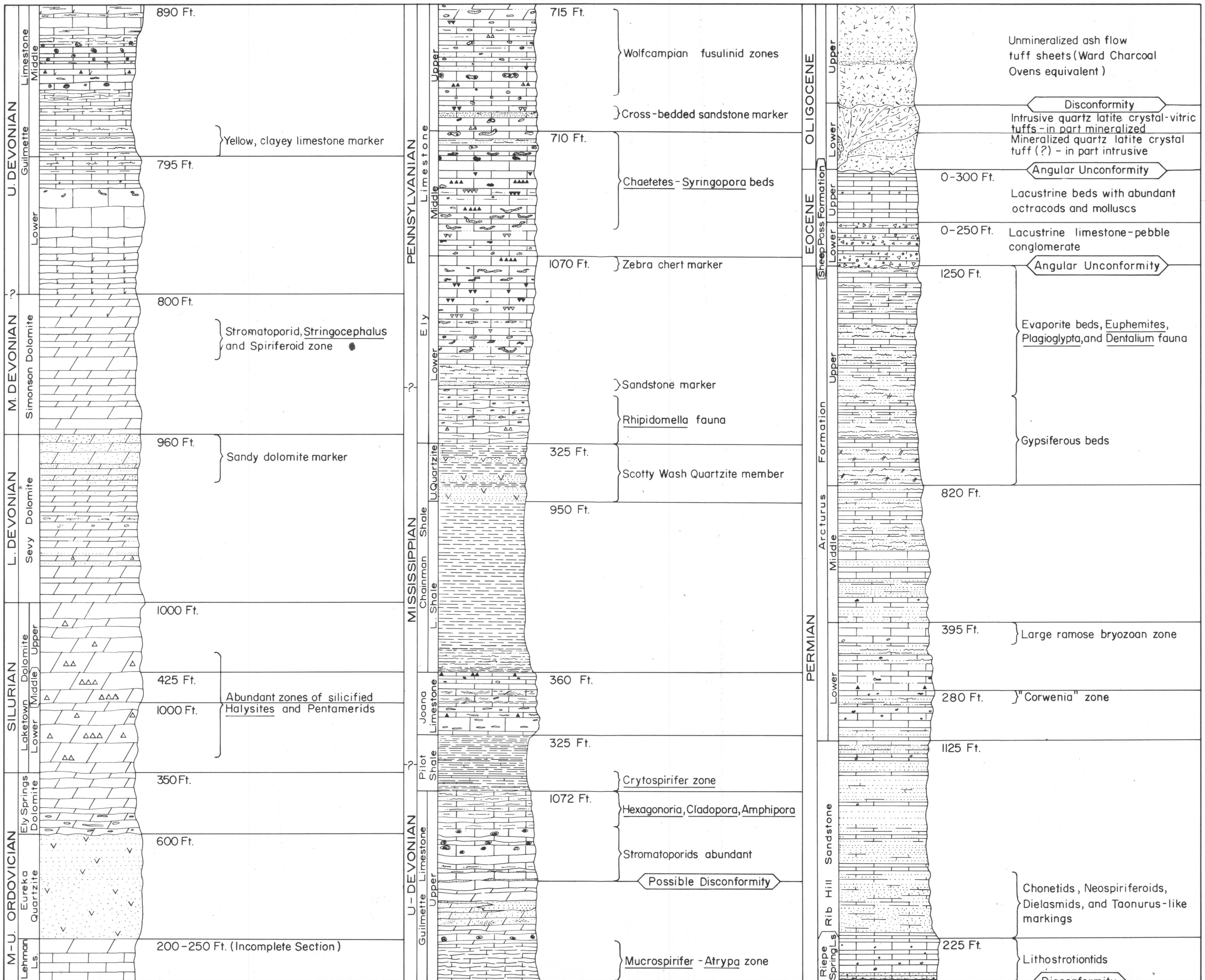
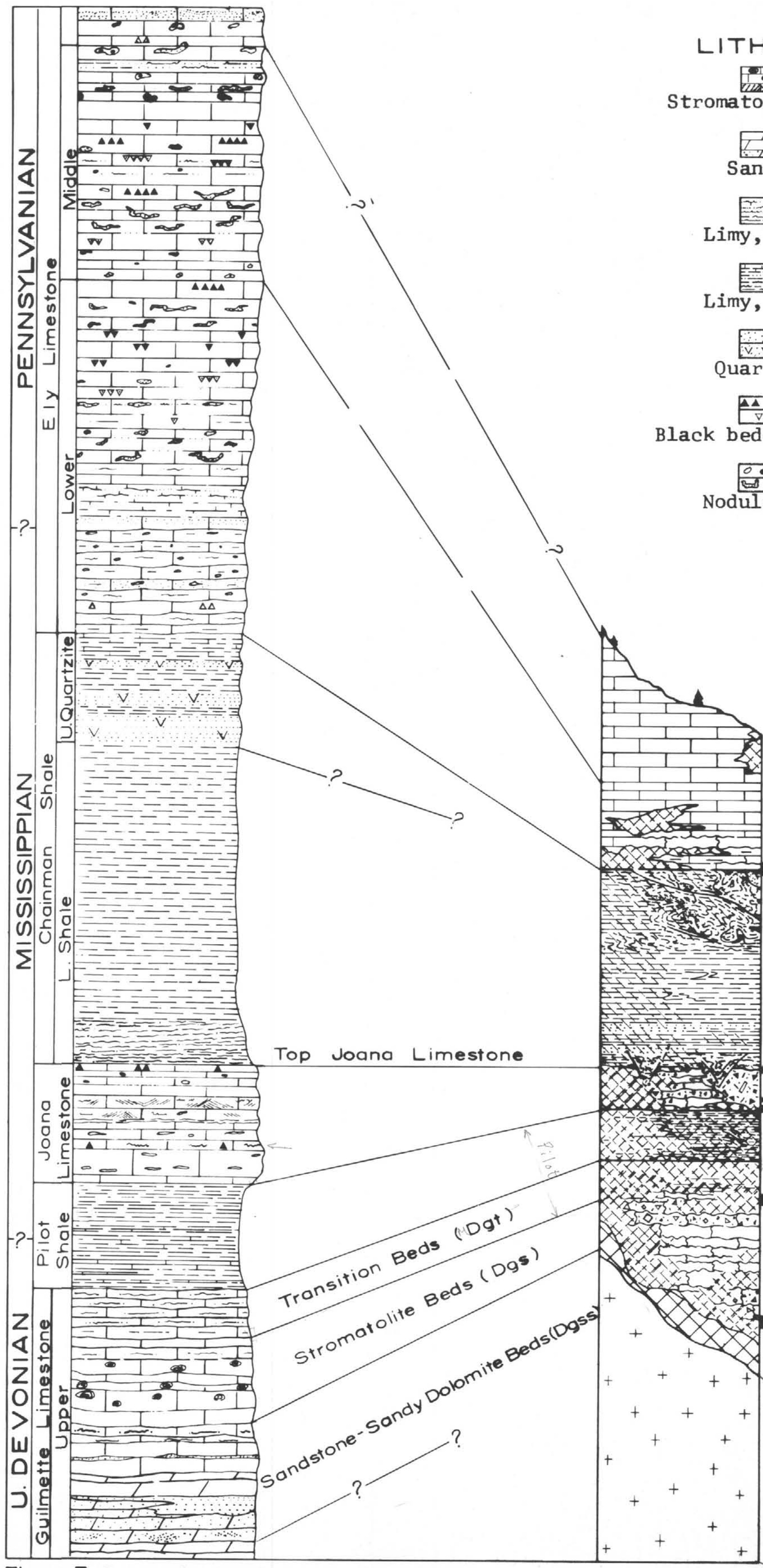


Figure 2 ,Generalized Stratigraphic Column, Ward District, Nevada.

Tom L. Heidrick (1965,1972)



EXPLANATION

LITHOLOGY

- Limestone — Stromatolitic, cross-bedded
- Dolomite — Sandy toward base
- Siltstone — Limy, sandy and silty
- Shale — Limy, sandy and silty
- Sandstone — Quartzitic at base
- Chert — Black bedded and semi-bedded
- Chert — Nodular and irregular

ALTERATION

- Marble
- Marble breccia
- Albite-epidote hornfels
- Garnet-diopside-epidote skarn
- Wollastonite-garnet-diopside skarn
- Contact metamorphic aureole — Andradite-wollastonite-diopside skarn

STRUCTURE

- Bedding
- Gravity fault
- Chaos
- Mesoscopic drag fold
- Collapse structures und.
- Silica breccia
- Siliceous intrusion breccia

0 200 400 800
APPROXIMATED VERTICAL SCALE

Caroline-Good Luck Ore Zone
Crudely tabular mantos and small ill-defined cylindrical pods of high-grade ore localized along fault zones and dike contacts. All orebodies are found within garnet-epidote-clinozoisite-diopside skarn. Ores contain appreciable amounts of pyrite, galena, sphalerite, pyrrhotite, hessite and chalcopyrite accompanied by subordinate amounts of calaverite, empressite, and stuetzite. Assayed metal ratios for Ag (oz):Pb(%):Zn(%):Cu(%):Mo(%) are 8:8:8:1:0.

Carbonaceous shale crosscut by numerous calcite-quartz veins dominate areas bordering the zone of intense alteration-mineralization. Within and peripheral to the barren core and mineralized areas epidote-chlorite-plagioclase-actionlite hornfels pervades the entire section. No significant ore intercepts known.

Upper and Lower Joana Ore Zones
Impure limestone that is everywhere either marmorized, metasomatized, or silicified. Jasperoid, jasperoid breccia, and skarn occur as selective replacements along the bounding shale-limestone contacts. Skarn assemblages involve green andradite, gray diopside, wollastonite, and plagioclase. Ores consisting of pyrite, sphalerite, chalcopyrite, and galena with lesser amounts of pyrrhotite, tetrahedrite and petzite occur as mantos localized within the zones of jasperoid breccia and skarn. The Upper Ore Zone is generally ill-defined and irregular while the lower zone shows much greater ore continuity. Assayed metal ratios for Ag(oz):Pb(%):Zn(%):Cu(%):Mo(%) for the Upper and Lower Ore Zones are 1.4:1.3:1.9:1:0 and 1.1:0.5:3.0:1:0 respectively.

Guilmette Transition Ore Zone
Mantos within either brown-green andradite-wollastonite-vesuvianite-thulite skarns after shaly-silty Dgt or within the silicified marble breccia at the top of Dgs. Ore mineralogy consists of pyrite, sphalerite, chalcopyrite, galena, tetrahedrite, and chalcocite with lesser amounts of enargite, cubanite II, pyrrhotite, hessite, covellite, and marcasite. Assayed metal ratios for Ag(oz):Pb(%):Zn(%):Cu(%):Mo(%) are 0.8:0.1:1.8:1:0.

Porphyry-Guilmette Ore Zone
Contact metamorphic aureole consisting of massive brown andradite, green diopside, wollastonite, anhydrite, and quartz. Ore zones occur either within this aureole (PW-67) or at its interface with overlying marble breccia (PW-75) Characteristic ore mineralogy is relatively simple consisting of magnetite, pyrrhotite, chalcopyrite, cubanite II, pyrite, bornite, enargite, sphalerite, and molybdenite. Assayed metal ratios for Ag(oz):Pb(%):Zn(%):Cu(%):Mo(%) are 0.5:0.1:0.1:1:.03.

Composite aplitic biotite quartz monzonite porphyry, porphyritic biotite quartz monzonite, and "hybrid" quartz monzonite porphyry showing weak propylitic to phyllic alteration. Disseminated pyrite and chalcopyrite common. Microfractures and veinlets contain minor amounts of pyrite, chalcopyrite, molybdenite, sphalerite, and bornite. No significant ore intercepts noted to date.

Figure 7. Composite stratigraphic sections showing unaltered and altered-mineralized equivalents, Ward District, Nevada.

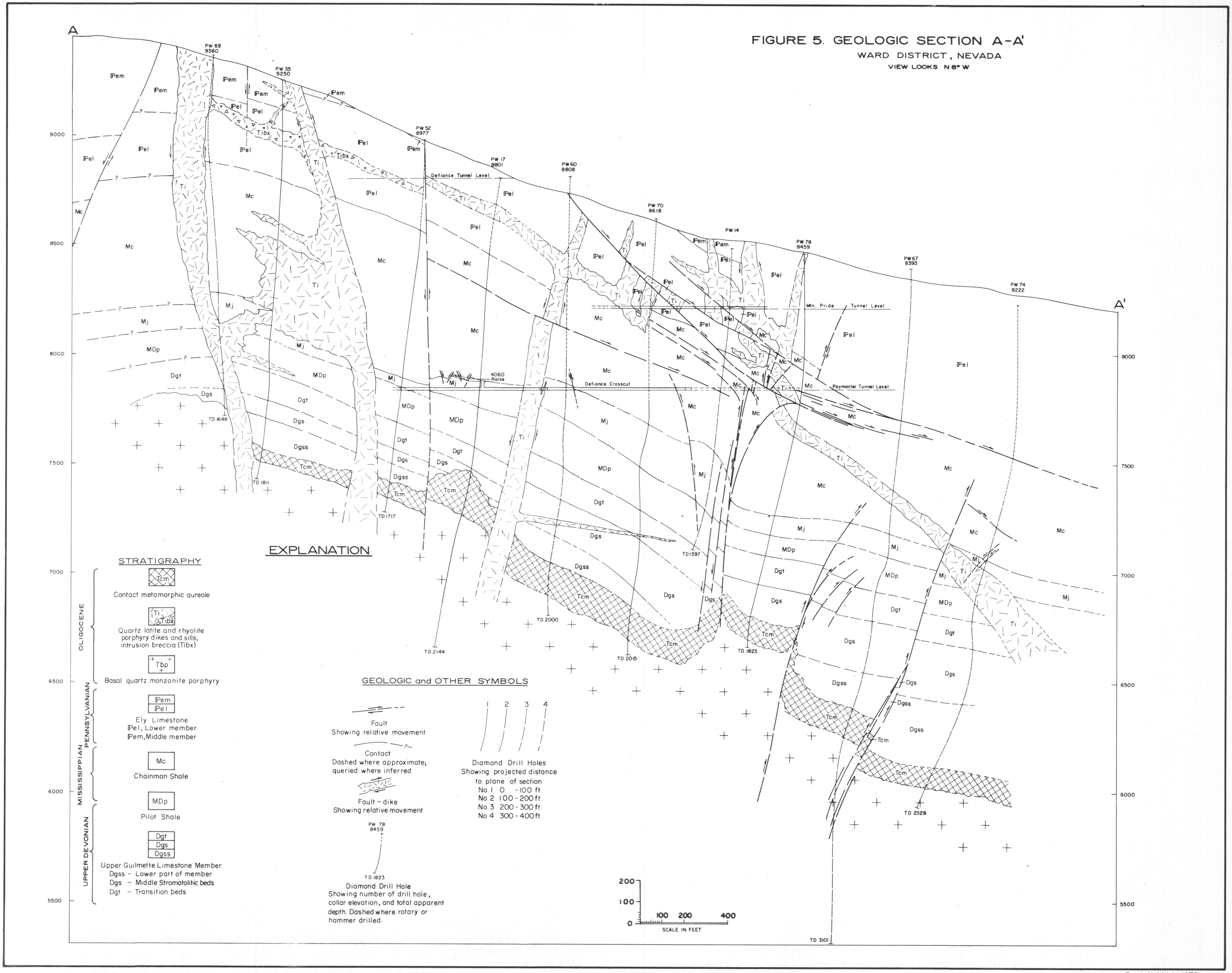


FIGURE 5. GEOLOGIC SECTION A-A'
WARD DISTRICT, NEVADA
VIEW LOOKS N 8° W

Tom L. Heidrick, 1972

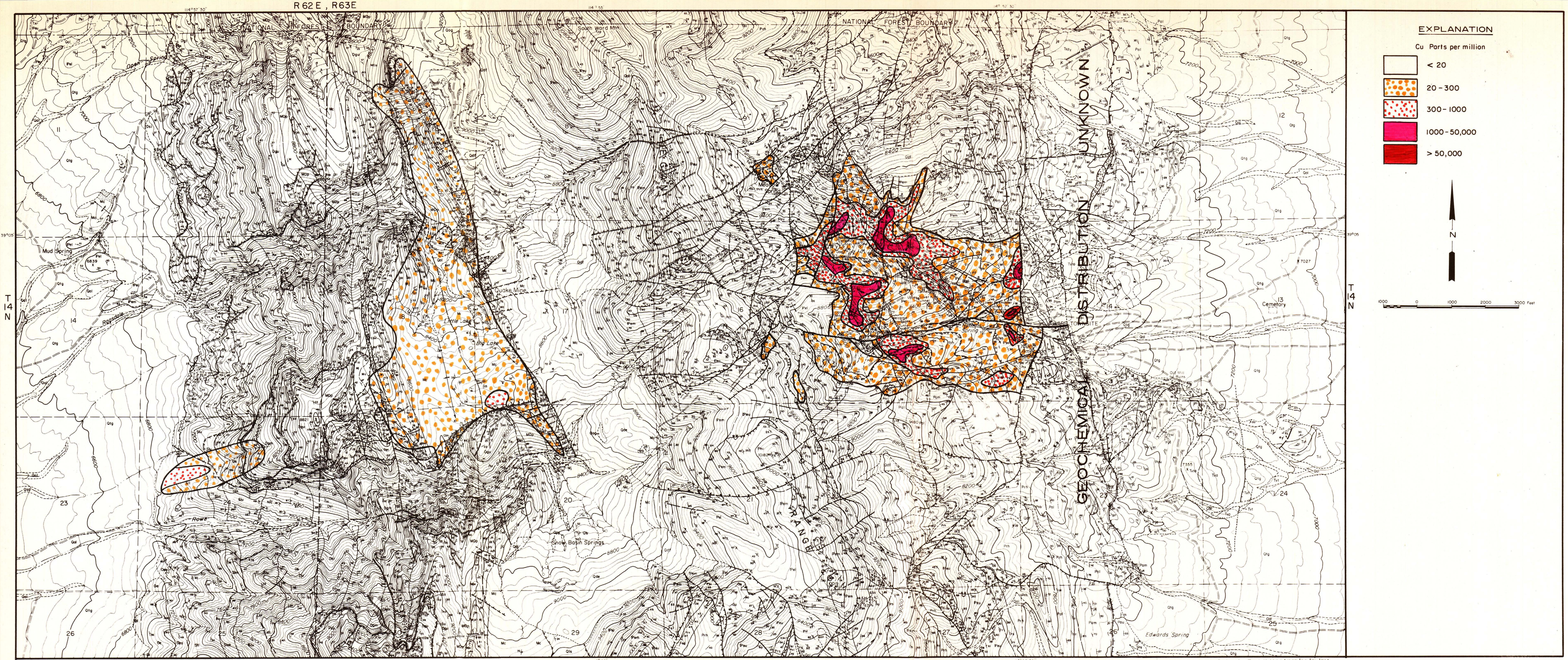


FIGURE 11. Geologic map of the Ward District showing the geochemical distribution of copper contoured in ppm. Data adapted from Brokaw, et al, 1962 and Heidrick, 1965. See Fig. 3 for geologic map explanation.

Geology by Tom L. Heidrick (1963, '64, '71, '72)