University of Nevada

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The Geology of the Weepah Mining District

Esmeralda County, Nevada

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requirements for the degree of Master of Science

in Geology

by

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ABSTRACT

The Weepah mining district of east-central Esmeralda County exemplifies many of the gold camps throughout Nevada--small, sporadic production, and limited geologic information. The discovery of gold by Horton and Traynor in 1927 provided the impetus for what proved to be the last significant "gold rush" in the western United States. The district differs from the typical early western Nevada gold mines in that even with an increase in the price of gold, the deposit was economical only by using open-pit mining methods. Production from the Weepah district between 1904 and 1939 is valued in excess of 1.8 million dollars.

The oldest rocks exposed in the Weepah district are Precambrian pelitic and carbonate strata of the Wyman Formation and Reed Dolomite. The Precambrian units are overlain by allochthonous Lower Cambrian and Middle Ordovician sedimentary rocks. The entire Paleozoic sequence has been intruded by Jurassic(?) to Middle Paleocene granitic and dioritic rocks. Quaternary sediments unconformably overlie the earlier rocks.

The Weepah district is structurally situated along the northeastern limb of a gently dipping, southeast-plunging anticline which is characterized by broad flexures, minor thrusting, and high-angle faults of small displacement. The folding and thrust faulting preceeded,

or was contemporaneous with, the early period of emplacement of the Weepah pluton. A pre-Jurassic age for the thrusting is indicated. The dominant northeast-trending right-lateral rotational shear pattern of the district is typical of Walker Lane tectonics and is probably of Late Mesozoic age. Analysis of structural data within the mapped area suggests that an initial northwest-southeast stress field was gradually rotated to an essentially east-west orientation. Northeast-trending dextral strike-slip faults appear to have been the most intensely dialated, and these were commonly filled with veins of massive quartz. The quartz has been granulated or brecciated by subsequent movement.

The Weepah Nevada deposit is a typical epithermal precious metal vein of the gold-silver type and is considered to be of Late Mesozoic age. Geochemical studies indicate that anomalous values for the typical epithermal assemblage (arsenic, antimony, and mercury) are present in the mine area. The deposit is located along a quartz-filled, northeast-trending, right-lateral shear zone. The sporadic production prior to 1927 appears to have been confined to high-grade pockets of auriferous sulfide ore which occurred as replacement deposits in carbonate strata adjacent to quartz veins. Scattered vein fragments from the older dumps indicate that the primary sulfide was chalcopyrite which subsequently altered to a dense pitch limonite containing both free and intergrown gold. These pockets were enriched at the surface and apparently did not extend more than a few feet in depth. The deposit mined by the Weepah Nevada Mining company from 1935 to 1938 consisted of a low-grade ore taken from the granulated quartz vein filling the Weepah Nevada fault. Gold occurs both free in the quartz matrix and intergrown with dense pseudomorphs of hematite after pyrite. Alteration associated with the deposit is minimal, typical of the gold-silver precious metal veins across the state.

INTRODUCTION

Location

The Weepah mining district is located in T.1N., R.40E. (unsurveyed) of the Silver Peak 15' quadrangle, approximately 19 miles southwest of Tonopah and 23 miles northwest of Goldfield, Nevada, (Figure 1). The now abandoned camp of Weepah, site of major activity in the district, is situated in the foothills southwest of Lone Mountain, 13 miles north-northeast of Silver Peak, Nevada.

The district lies at an average elevation of 6,000 feet with maximum relief of approximately 1,640 feet. The highest point in the immediate area is at an elevation of 7,071 feet.

Access to the district is provided by unpaved roads from U.S. 95 across Big Smokey Valley; from State Route 47, also across Big Smoky Valley; and from the Goldfield-Silver Peak Road, four miles east of State Route 47, in Clayton Valley.

Previous Work

The geology of Esmeralda County has been mapped in preliminary form by Albers and Stewart (1965) at a scale of 1:200,000. The U. S. Geological Survey, in cooperation with the Nevada Bureau of Mines, has published this map as Mineral Investigations Field Studies Map, MF-298. In addition to the preliminary map, both Albers and Stewart

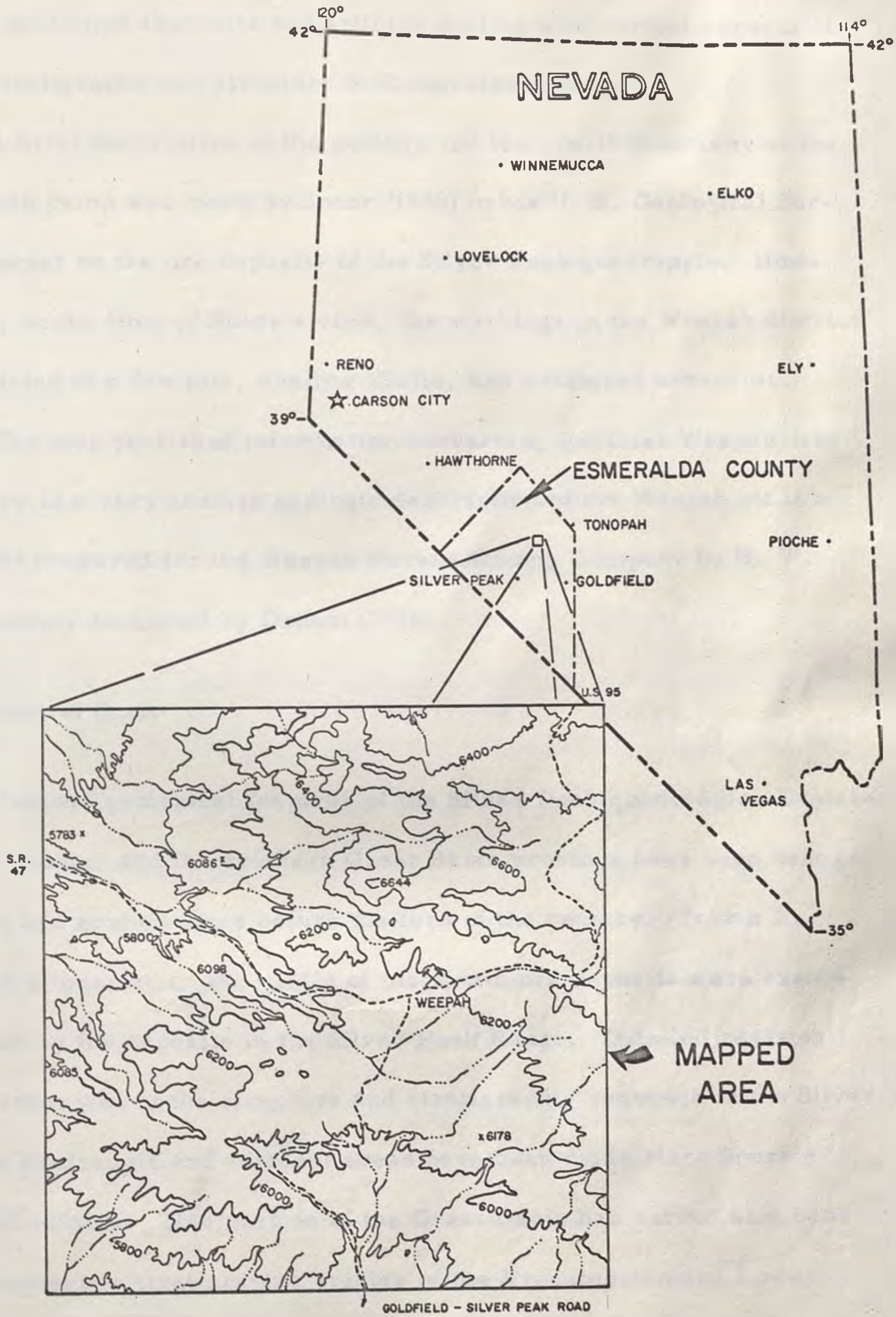


Figure 1 :

LOCATION MAP OF THE WEEPAH MINING DISTRICT have published abstracts and articles dealing with various aspects of the stratigraphy and structure of Esmeralda County.

A brief description of the geology and the pre-1905 activity at the Weepah camp was made by Spurr (1906) in his U. S. Geological Survey paper on the ore deposits of the Silver Peak quadrangle. However, at the time of Spurr's visit, the workings in the Weepah district consisted of a few pits, shallow shafts, and scattered crosscuts.

The only published information concerning the later Weepah discovery is a very concise geologic description of the Weepah pit in a report prepared for the Weepah Nevada Mining Company by H. W. Stotesbury as quoted by Oxnam (1938).

Purpose of Study

Various geological features of the Silver Peak quadrangle, Esmeralda County, and the southern Great Basin province have been recognized and studied since before the turn of the century. Josiah E. Spurr's theories on the origin of magmatic ore deposits were exemplified by the deposits in the Silver Peak Range. Detailed revision and expansion of the structure and stratigraphic sequence in the Silver Peak quadrangle and adjacent areas have been made since Spurr's initial efforts. This portion of the Great Basin has served as a base for numerous stratigraphic studies of the Precambrian and Lower Cambrian sedimentary succession.

Ore deposits in the ranges surrounding the Silver Peak Range are small and have yielded limited production. Very few of these older districts have been studied in detail. Thus, the possibility exists that some of these districts could hold further economic potential if problems in geologic interpretation were resolved and modern exploration concepts and techniques employed.

The possibility of a "Carlin-type" disseminated gold environment was a factor in the selection of the Weepah mining district for this study. The detailed study of the district was undertaken in order to understand the exact nature of the ore deposits. During the investigation approximately nine square miles were mapped at a scale of 1:6000. Selected areas were mapped in the field at a larger scale for clarity. The dominant stratigraphic and structural features in the vicinity of the mine were emphasized to determine the controls of mineralization. A favorable environment for commercial disseminated replacement gold deposits was sought by applying the parameters of the "Carlin" model to the Weepah district.

Acknowledgements

The writer is extremely grateful to many individuals for assistance provided during the preparation of this report. The Weepah district was suggested to the writer by Dr. A. L. Payne who, along with Dr. J. F. Fischer, Dr. E. R. Larson, and H. F. Bonham contributed to several stimulating discussions on various field problems and aspects of regional geology. Numerous associates at the Mackay School of Mines have also assisted the writer by their discussions and helpful comments or criticisms.

A grant from the Mackay School of Mines Research Committee financed most of the petrographic specimens required. Merrill L. Allen and Dr. L. C. Hsu of the Nevada Mining and Analytical Laboratory were extremely helpful with geochemical studies and analytical techniques. John H. Schilling of the Nevada Bureau of Mines provided unpublished information and photographs of the Weepah district from his files.

Aerial photography of the district and for a mapping base was generously furnished by the Minerals Department of Humble Oil and Refining Company. The valuable assistance rendered by Alan R. Jager and personnel of the Reno office is specifically acknowledged.

History

The Weepah (Lone Mountain) district was originally discovered by Indians who worked shallow pockets of gold early in 1902. The name Weepah is of Shoshone derivation and is translated as "rain water".

According to Spurr (1906, p. 80), the district was located by a rancher named James Darrough in 1902. The early excitement drew about 200 persons to the camp for a short time.

> "....A few tons of ore were found in one locality here containing high values, a maximum of $500 to $600 in gold and 100 ounces of silver to the ton is reported. On the strength of this ore the mine is said to have been bonded for $107,000 and $10,000 paid down. It was found, however, that these bunches of ore disappeared entirely within a few feet. An exploration shaft was sunk 35 feet, encountering nothing but country rock. On this account the bond was dropped...."

Except for limited production in 1916, the district lay idle until March, 1927 when, according to Paher (1970, p. 418), Leonard Traynor and Frank Horton, Jr., of Tonopah rediscovered gold at the Weepah site. The discovery reportedly assayed around $70,000 (sic) per ton.

> "....A week after the news broke out, over a thousand adventurers had come, made discoveries and jumped claims left and right. These 'mail order prospectors' fully equipped with squeaky boots, bundled-up bedrolls and new 1927 model cars settled in a hastily laid-out townsite which saw wood-frame structures rising daily amid the sea of tent houses (Figure 2).
>
> The boom grew hotter as March wore on. By the end of the month the three motor roads to Weepah were jammed with cars, western Nevada railroads had to put on extra coaches to handle the throng of gold-seekers, and the new town soon had a population fluctuating from 1500 to 2000. Reporters sent daily special dispatches to their papers, and Pathe' and International movie newsreels featured on-the-site scenes of the wild developments. If Weepah was not the richest gold strike, it certainly was more thoroughly covered by the news media than any other Nevada mining excitement of any era.

Figure 2. Photographs of the Weepah camp during 1927 gold rush, looking south from mine site. Persons in center foreground of upper photo mark site of the Horton-Traynor discovery (From files of John H. Schilling, Nevada Bureau of Mines).

> By April the town....had about sixty frame buildings housing the usual line of businesses (Figure 3) including a post office and over a dozen mining companies. By the first of July most of the excitement had died and most of the incompetent rainbow chasers quit the camp, leaving capable miners to work the most promising claims. Even most of these were gone by the end of 1927...."

The Electric Gold Mining Company installed a small mill and made intermittent developments until January, 1934 when, according to Oxnam (1938, p. 300), examinations by H. C. Carlisle and H. W. Stotesbury, and later by E. J. Schrader, resulted in the mine being taken over by the Weepah Nevada Mining Company. A study made by W. Val DeCamp in April, 1935, recommended the open pit mining method used at Weepah.

Construction of the 250 ton per day Weepah Nevada Mining Company flotation plant by the Southwestern Engineering Company of Los Angeles was begun on August 1, 1935, and milling operations were initiated on October 8, 1935. Water for the milling operations was pumped from a company well located seven miles west of the site, and power to the Weepah mill was furnished by the Nevada-California Power Company whose line passed within four and one-half miles of the mine. In December, 1936, Southwestern Engineering Company was contracted to build a 300 ton per day all-slime, modified counter-current cyanide mill in order to improve recovery.

Figure 3. Photographs of thriving businesses during the 1927 Weepah rush. Headframe in center background of lower photo marks site of main shaft and area of initial prospecting (From files of John H. Schilling, Nevada Bureau of Mines).

The mine crew required during the regular open pit operations consisted of a superintendant, a shovel operator, an oiler-mechanic, a powderman, two surface miners, three drivers, a sampler, an assayer, and a clerk on a half-time basis (Oxnam, 1938, p. 301). Wages for labor ranged from $4.50 per day for a general laborer to $9.25 per day for the shovel operator. Equipment used in the open cut included a 1 1/4-yard Lima "101" gasoline shovel, a caterpillar "60" tractor, drills and accessories, a portable Gardner-Denver compressor, and four 3-yard Ford dump trucks. Pit benches averaged 12 feet in height with approximately 15-20 feet of berm width. During the initial stripping operations an extra shift was required to remove the waste.

According to the Minerals Yearbook (1939, p. 405), known ore reserves of the Weepah Nevada Mining Company were depleted, and the company began retreating the impounded flotation tailings during 1938. In 1939, operation was suspended after cyanidization of the remainder of the flotation tailings.

Subsequently, the mill machinery was dismantled and moved to Northumberland. At the present time only five wood frame structures, in various stages of disrepair, and mill foundations mark the site of the Weepah camp.

Production

From its discovery in 1902, through 1939, the Weepah Mining district produced nearly two million dollars in gold and subordinate silver, the bulk of which was accrued during the last five years of operations. Essentially all production stemmed from workings in the immediate area of the present pit. Approximately 280,000 tons of ore were removed, and 58,745 tons of flotation tailings were treated for credited gross value of $1,829,301.

The following table was taken from Couch and Carpenter (1943, p. 52), and the production figures are in close agreement with those listed in respective annual Mineral Yearbooks.

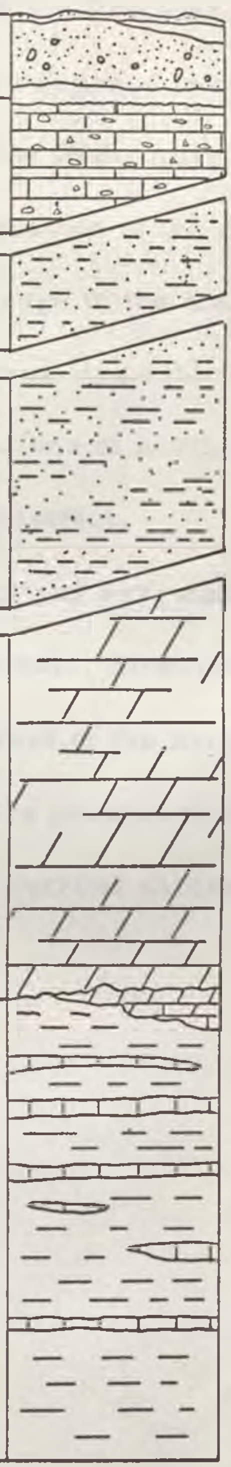
Year	Ore and Tailings (Tons)	Gross Yield
1904	990	$144,642
1905	43	5,423
1906	168	21,895
1907	232	29,504
1916	218	5,525
1927	788	7,276
1934	14,458	60,814
1936	84,361	501,810
1937	98,503	600,832
1938	106,700	391,568
1939	32,282	60,012
Total, 1904-1939	338,743	$1,829,301

GEOLOGY

General Statement

The Precambrian and Cambrian strata of the Weepah district represent initial deposits within the Cordilleran geosyncline laid down near the northeastern edge of a depositional basin which extended westward to the White and Inyo Mountains of California. Rocks of Ordovician age are of limited extent and are allochthonous. A large portion of the mapped area is comprised of, or underlain at shallow depths by, granitic and dioritic intrusive rocks. Quaternary units are represented by an older, poorly sorted and weakly consolidated detrital fan sequence, a thin wedge of reworked lapilli tuff, and by Recent alluvium (channel and fan). Figure 4 shows the stratigraphic column in the Weepah Mining district.

The sequence of upper Precambrian and Lower Cambrian strata has been modified to varying degrees by structural juxtaposition and plutonic activity. The Precambrian is represented by the dominantly pelitic Wyman Formation and the overlying Reed Dolomite. Over 4,000 feet of upper Precambrian strata are absent in the mapped area. The upper portion of the Reed Dolomite, all of the quartzite and carbonate of the Deep Spring Formation, and probably all of the quartzite and siltstone of the Andrews Mountain Member of the Campito Formation have been removed.



SYSTEM SERIES		FORMATION MEMBER	SYMBOL	LITHOLOGY
CENOZOIC Quaternary			Qal Qrt Qoa	Desert sand and gravel. Reworked lapilli tuff Older alluvium, unconsolidated detrital fan sequence.
PALEOZOIC	ORDO-VICIAN	PALMETTO FORMATION	Op	Cherty limestone, dark, thin-bedded, brecciated.
PALEOZOIC	CAMBRIAN	POLETA FM. Middle Member	€p	Thinly interbedded siltstone and quartzite.
PALEOZOIC	CAMBRIAN	CAMPITO FORMATION Montenegro Member	€cm	Interbedded dark quartzitic siltstone and quartzite.
PRECAMBRIAN		REED DOLOMITE	p€r	Massive gray to buff dolomite. Bedding is indistinct except in lower portion.
PRECAMBRIAN		WYMAN FORMATION	p€w	Dominantly green-brown quartzitic siltstone and interbedded carbonates.

FIGURE 4

GENERALIZED STRATIGRAPHIC COLUMN OF THE WEEPAH AREA.

The earliest Cambrian unit, the Montenegro Member of the Campito Formation, overlies the Precambrian strata and is apparently allochthonous everywhere exposed in the mapped area.

Several outcrops of the Ordovician Palmetto Formation are present in the northwestern portion of the district. A single outcrop is noted near the southern edge of the mapped area. The Palmetto Formation, which is correlative with the transitional assemblage Valmy and Vinini Formations of north-central Nevada, appears to be allochthonous within the district.

In the Weepah district and surrounding area, there are no known sediments of upper Paleozoic, Mesozoic, or lower Cenozoic age. However, immediately west of the mapped area, Tertiary volcanic and sedimentary rocks are present over an extended area. Quaternary units of a dominant detrital nature cover approximately 35 percent of the district.

STRATIGRAPHY

Exposures of Precambrian and Lower Cambrian sedimentary rocks in Esmeralda County represent in excess of 13,000 feet of an apparently conformable sequence similar to classic Waucoban sections in the White and Inyo Mountains of California. This locality appears to lie near the central portion of a sedimentary wedge which ranges in thickness from less than 500 feet to over 20,000 feet along the western edge. These strata represent the earliest deposits within the Cordilleran geosyncline, and equivalent units to the south and east reportedly rest unconformably on high-grade metamorphic rocks of older Precambrian age.

Precambrian

Two formations of probable Late Precambrian age are recognized in the Weepah district. These units consist of an unfossiliferous sequence of alternating fine-grained pelitic sediments and carbonate strata that are lithologically similar across the elongate basin in which they were deposited. The base of the stratigraphic section is not exposed in the western Great Basin.

Wyman Formation

The oldest rocks exposed in the Weepah mining district are represented by the Wyman Formation, a name applied by Maxson (1934, p. 311) to the upper portion of interbedded phyllitic and dolomitic strata at the base of the section in Wyman Canyon, Blanco Mountain quadrangle, California. Nelson (1962, p.140) redefined the Wyman to include Maxson's underlying Roberts Formation when mapping did not indicate an unconformity between the two units.

The Wyman Formation is composed dominantly of phyllitic siltstone and lesser amounts of locally arenaceous limestone. The formation has experienced variable degrees of metamorphism with the resultant development of phyllite, schist, marble, dolomitic limestone, and calc-silicate hornfels.

Within the Weepah district the Wyman Formation can be divided into two mappable units: a phyllitic unit ($p\epsilon W_1$) and a carbonate unit ($p\epsilon W_2$). The former incorporates the original pelitic sediments and local, thin limy interbeds; the latter unit includes all of the initial carbonate strata. The carbonate unit has been divided into three subunits consisting of recrystallized dolomitic limestone ($p\epsilon W_2$), marble ($p\epsilon W_{2m}$), and a siliceous to calc-silicate hornfels ($p\epsilon W_{2h}$). The more dolomitic portions of the Wyman closely resemble the grayish dolomite of the overlying Reed Dolomite.

Phyllitic unit ($p\epsilon W_1$)

The phyllite or phyllitic siltstone of the district is dominantly dark greenish-gray (G.S.A. Rock Color Chart Number 5G 6/1) to light olive gray (5Y 5/2) or medium light gray (N6) in color. Locally, a pinkish color is formed by weathering of the micaceous laminae. Where this unit occurs adjacent to intrusive masses or as pendants, a deep reddish-brown (10R 3/4) or rust brown (10R 4/6) discoloration is common. Hand specimens typically contain identifiable fine-grained quartz, muscovite, biotite or chlorite, and occasionally andalusite. In the south-central portion of the mapped area, exposures of this unit are characterized by moderately well-developed porphyroblasts of andalusite (var. chiastolite?). Elsewhere these augen are either incipiently developed or have been altered possibly by retrograde metamorphism. Weathered chips are recognized by their color, "specked" appearance, and phyllitic sheen. Outcrops of this unit are frequently reduced to mounds of thin, wedge-shaped chips due to the fine laminations and closely spaced joints.

The thin limy interbeds are typically poorly expressed due to fracturing and weathering. These bands range from medium gray (N5) to green-gray (5GY 6/1) in color and from 1/2 to 4 inches in thickness. In essentially every occurrence noted, these beds show moderate to strong silicification and individual laminae are considerably deformed.

The phyllitic strata of the Wyman Formation show some degree of metamorphism throughout the district. In general, it appears that this formation experienced a low- to medium-grade regional metamorphism over which was later superimposed weak to moderate metamorphic effects related to the emplacement of the Weepah pluton and its apophyses. The Wyman is dominantly a muscovite-biotite-quartz phyllite or low-grade schist containing "clots" of sericite and clay. Subordinate minerals include chlorite and andalusite. Apatite, epidote, and tourmaline comprise the accessory minerals. Magnetite and rare pyrite grains are noted; the latter almost completely altered to hematite, limonite, and jarosite(?). A semi-schistose-lepidoblastic texture consisting of foliated biotite and granoblastic quartz is typical. The significance of the muscovite-sericite clots is not completely known. However, they apparently indicate retrograde metamorphism in the replacement of andalusite by micaceous minerals. A poorly defined replacement texture and rare traces of andalusite are found in the clots.

Adjacent to the plutonic rocks the Wyman consists of an andalusite-quartz-biotite-muscovite schist containing accessory albite(?), tourmaline, apatite, magnetite, and rutile. Hematite and limonite are alterations of pyrite which typically occur adjacent to minute quartz-clay veinlets. The schistose texture shows two definite periods of deformation. The initial deformation was accompanied by the development of S_1 foliations which are defined by muscovite. The second event is marked by the development of S_2 foliation as crenulations in the S_1 (muscovite) planes. The andalusite and biotite lineations indicate that they were formed in consequence to this second event.

Intermediate between the phyllite and schist facies is an albite-quartz-biotite-muscovite spotted schist containing accessory chlorite, tourmaline, magnetite, apatite, and rutile. A distinct hematite-limonite veinlet cutting the section contains associated zeolites? and traces of pale blue corundum?. The sericitic clots of this facies are smaller and more abundant than in the phyllite. Replacement is indicated by the textural relation of the clots to the surrounding biotite. However, relict minerals are not in evidence.

At individual outcrops, both foliation and schistosity are generally obliterated. Cleavage typically cuts the original laminations at acute angles.

Carbonate unit (p€W_2)

The carbonate unit comprises a subordinate portion of the Wyman Formation. The dominant lithology of this unit is a medium-grained, medium gray (N5) to very light gray (N8), somewhat mottled and recrystallized dolomitic limestone (p€W_2). In general, the color tends to deepen as the unit becomes more dolomitic. These carbonate strata range from several feet to more than 50 feet in thickness. Bedding is typically indistinct in the more massive exposures. In the vicinity of the Weepah pluton, this unit shows moderate to intense recrystallization, accompanied locally by the introduction of silica and sparse sulfides along bedding planes and fractures. The increase in silica tends to restrict or decrease the grain size. Occasional shearing and moderate brecciation subsequent to silicification are observed in several prospects southeast of the mine. The early prospecting was concentrated within this unit in search for replacement sulfides adjacent to quartz veins.

Several small pendants of Wyman carbonates are noted in the vicinity of the dioritic intrusive northeast of the Weepah Nevada mine. These pendants are composed of medium- to very coarse-grained, buff (10YR 8/2) to very light gray (N8) or white marble ($p\text{Є}W_{2m}$). Coarse marble is also found in numerous pendants or outcrops adjacent to the granitic rocks and locally along fault traces. Calcite and rare quartz veining are noted. Limonite occasionally stains the marble a pale yellow to reddish-brown color.

In the vicinity of the Weepah Nevada mine, a thin distinctive subunit is noted ($p\text{Є}W_{2h}$). This unit has a blue-gray (5B 5/1) or greenish-gray (5G 6/1) color and a gnarly weathered surface. It is typically dense, silicated, and contains identifiable quartz, epidote and erratic green-brown garnets. Pyrite, magnetite, rare chalcopyrite and arsenopyrite(?) were locally observed. In thin section, this calc-silicate unit has a typical hornfelsic texture. Coarse-grained green diopsidic pyroxene, granular and coarse-grained epidote-clinozoisite, greenish grossularite garnet, scapolite, quartz, calcite, and fine-grained sphene are the most characteristic minerals. The hornfels interbeds range from one to less than 10 feet in thickness and commonly appear as ribs on the more gentle slopes.

The Wyman Formation attains a maximum thickness of approximately 1,500 feet in the Weepah district, without exposure of the stratigraphic base. However, faulting may have repeated a small portion of the sequence. Stewart (1970, p. 52) indicates that only 1,350 feet of Wyman has been measured in any one continuous exposure. Nelson (1962, p.140) reports in excess of 9,000 feet of Wyman exposed in the Inyo Mountains.

McKee and Moiola (1962, p. 533) consider the Wyman Formation of Esmeralda County to be of Late Precambrian age and correlate it with the type section on the basis of lithologic similarity and position in the stratigraphic column. Nelson (1962, p.140) regards the Wyman as

> ". . . . most probably Precambrian in age because of its distance (more than 4,000 feet) beneath the oldest trilobite faunas and its position beneath a regionally important unconformity (sic); both criteria admittedly are of small chronologic significance."

In the Weepah district the upper contact with the Reed Dolomite appears to be conformable. There does not seem to be any significant discordance in attitudes between the Wyman and Reed. Lack of discordance and gradational contacts indicate that the regional unconformity of Maxson (1934) and Nelson (1962) is not present in the district. McKee and Moiola (1962, p. 533) and Albers and Stewart (1962, p. D26) consider this contact to be conformable throughout most of Esmeralda County.

In the southwest portion of the mapped area, the carbonate unit of the Wyman appears to be gradational into the overlying Reed Dolomite. For this report, the contact was taken as the approximate position of the vertical change from a recrystallized dolomitic limestone to a rather pure massive dolomite with the concurrent absence of pelitic strata. In most cases, this contact can be arbitrarily assigned without changing either the geological interpretation or relative thicknesses to any significant degree. The more prominent outcropping nature of the Reed (Figure 5) aids in placing the contact with reassurance.

Stewart (1970, p. 52, 54) tentatively correlates the Wyman Formation with the A, B, and C members of the Stirling Quartzite and parts, or all, of the underlying Johnnie Formation in the central portion of the southern Great Basin.

Reed Dolomite

The Reed Dolomite was named by Kirk (in Knopf, 1918, p. 24) from Reed Flat, Blanco Mountain quadrangle, California. In the mapped area, the Reed consists of a medium- to coarse-grained, blue-gray (5B 5/1), yellow-gray (5Y 7/2) or buff (10YR 8/2), thick-bedded to massive dolomite and a fine- to medium-grained, light gray (N7) to white (N9) massive dolomite. Attempts at subdividing the Reed on a

Figure 5. Photograph of the Wyman - Reed contact, looking south. Major portion of foreground consists of granitic rocks.

color and textural basis during mapping proved futile due to the lack of persistent lateral boundaries between the members. In most instances the massive, structureless, saccharoidal-weathering nature of the Reed makes it extremely difficult to obtain accurate bedding attitudes.

In thin section, the Reed appears as a dominantly medium-grained mosaic of euhedral to subhedral dolomite granules. In rare instances, pyrite and minor limonite and hematite are found in the Reed. These occurrences, however, are associated with sills and dikes of fine-grained dioritic rocks. Even where in closest proximity to the Weepah pluton, there does not seem to be any distinct change in the physical characteristics of the Reed Dolomite throughout the district, except for color and textural variations. Barite rosettes and blades were noted along fracture surfaces in a single prospect in the east-central portion of the area.

The age of the Reed Dolomite is considered Precambrian by Stewart (1970), McKee and Moiola (1962), and Kirk (in Knopf, 1918). Albers and Stewart (1962) consider it as questionable Precambrian. Cloud and Nelson (1966) consider the Reed to be of possible Cambrian age because of reported mollusc-like fossils in the upper portion of the formation. No fossils were found in the Weepah district; but because of the fact that olenellid trilobites occur over 2,500 feet higher than the Reed in the type section, a Precambrian age is assumed.

A maximum of approximately 900 feet of the Reed Dolomite is exposed in the Weepah District. Stewart (1970, p. 55) reports a probable thickness of about 1, 700 feet east of Lone Mountain. The Hines Tongue, a wedge of clastic material near the center of the Reed, is not recognized in the Weepah Hills or adjacent areas. The upper portion of the Reed is also absent from the mapped area.

The Reed Dolomite has been correlated with the D and E members of the Stirling Quartzite of the central region of the southern Great Basin (Stewart, 1970, p. 55).

Cambrian System

Cambrian strata in the Weepah district are limited to allochthonous occurrences. One definite Cambrian formation, the Campito, is recognized, and a single exposure near the eastern boundary of the mapped area is tentatively assigned to the Poleta Formation.

Campito Formation

The Campito Sandstone was named by Kirk (in Knopf, 1918, p. 27) and was redefined by Nelson (1962, p. 141) as

> "....the approximate 3500 feet of dark gray to black fine-grained quartzitic sandstone and interbedded gray siltstone and shale above the upper dolomite of the Deep Spring Formation and below the thick archeocyathid limestone of the Poleta Formation."

The Campito Formation is divided into two members (Nelson, 1962, p. 141). The basal Andrews Mountain Member is dominantly quartzitic siltstone and quartzite with interbedded siltstone. The upper Montenegro Member is dominantly siltstone with thin blocky quartzite interbeds.

Andrews Mountain Member

No representative exposures of the Andrews Mountain Member were recognized in the Weepah district. The approximate 2,900 feet of this member reported by Nelson (1962, p. 141) and the 1,000 to 2,000 feet estimated by Stewart (1970, p. 163) from the southeastern portion of the Weepah Hills have been structurally removed within the mapped area. A Precambrian - Cambrian age has been assigned to the Andrews Mountain Member on the basis of the lowest occurrence of trilobites which are found near the middle of the section (Stewart, 1970, p. 58).

Montenegro Member

Within the Weepah district the Montenegro Member consists dominantly of a dark greenish-gray (5GY 4/1), olive gray (5Y 4/1), brownish gray (5YR 4/1) or medium dark gray (N4), fine-grained, locally quartzitic, spotted meta-siltstone (Ccm_1). This member characteristically contains irregular blebs of limonite which weather out to give a distinct pocked appearance to weathered surfaces. Several minor variations in the lithology in the southeastern-most portion of the district have an appearance which is similar to the lower portion of the Harkless Formation east of Paymaster Canyon. In thin section, the typical Montenegro is a quartz-biotite-cordierite? hornfels with accessory magnetite and tourmaline. The original sedimentary laminations have not been obliterated by recrystallization. Biotite grains show a poorly defined alignment. Hematite is quite abundant, both as the alteration of magnetite and as small veinlets cutting the section. The limonite-mica clots characteristic of the weathered surface are not diagnostic in thin section.

Another conspicuous lithology of the Montenegro Member is a dense, very fine- to fine-grained, olive gray (5Y 4/1) to dark gray (N3) or grayish black (N2) quartz siltstone or quartzite ($Ꞓcm_2$). This unit commonly exhibits blocky to spheroidal weathering characteristics and has a black to locally reddish-brown weathered surface. A single thin section of this facies is a quartz-albite-biotite-muscovite hornfels containing abundant accessory magnetite and traces of tourmaline and apatite. The recrystallized polygonal mosaic texture has obliterated any initial sedimentary features. Quartz is locally abundant and the hornfels is probably gradational into a contaminated quartzite. These quartzitic units typically occur near the base of the allochthonous sequence and locally their configuration suggests that thrusting may have occurred along the irregular quartzite-siltstone interface.

In the southeastern portion of the district, two distinct lithologies are mappable. Several irregular bands of a dense, very fine-grained, buff (10YR 8/2) hornfels (Ccm_3) are noted. The northern-most exposure of this unit contains rare blebs of chalcopyrite and sparse manganese and copper oxide paint on fracture surfaces. Microscopic study indicates this unit to be a quartz-muscovite-corundum hornfels containing minor biotite, sphene, and a trace of zircon. The polygonal mosaic texture indicates moderate to intense recrystallization.

Farther south, isolated exposures of limestone (€cm_4) are noted. These beds consist of a buff (10YR 8/2) to yellow-gray (5Y 7/2), medium- to coarse-grained, recrystallized dolomitic limestone. Maximum thickness of this unit is approximately 10 feet. No distinctive features were observed.

Stewart (1970, p.162-63) has measured in excess of 2,100 feet of the Montenegro Member in the southern portion of the Weepah Hills. In the mapped area approximately 1,300 feet of this member is exposed. According to McKee and Moiola (1962, p. 534), the Montenegro Member is assigned an Early Cambrian age due to the persistent occurrence of Olenellid trilobites, except where quartzite dominates the lithology. No fossils were found in the Weepah district. However, several deformed fragments, which may represent broken trilobite cephalon borders, were observed in the southeastern-most exposures of the Montenegro Member.

The Campito Formation is correlated with parts of the lower member, all of the middle member, and the lower part of the upper member of the Wood Canyon Formation of the central region in the southern Great Basin (Stewart, 1970, p. 58).

Poleta(?) Formation

In the east-central portion of the mapped area, a thin isolated clastic unit has been tentatively assigned to the Poleta Formation. This assignment is based on the lithologic similarity and weathering characteristics of the Poleta Formation in scattered exposures to the south and east of the Weepah district.

The Poleta Formation, named by Nelson (1962, p.141-142), has been divided into three members. Carbonate sequences comprise the upper and lower members; the middle unit is dominantly clastic with minor carbonate interbeds.

The clastic unit exposed in the mapped area consists of finely laminated siltstone and sandstone. The silty portion is light brown (5YR 6/4) to cream (5Y 8/4) colored, very fine to fine-grained and quartzose. The interbedded coarse silt or fine sand is typically moderate red (5R 5/4) to deep reddish-brown (10R 3/4) and upon weathering tends to give the entire exposure a reddish-brown hue. In thin section, this unit appears to be a laminated, slightly recrystallized quartz-muscovite pelitic sediment containing moderate amounts of granular sphene. Limonite or goethite (after pyrite?) occurs throughout the section, and hemite fills sinuous veinlets. There are no diagnostic characteristics which would confirm or deny the tentative assignment of this unit to the Poleta Formation.

Stewart (1970, p. 59) reports approximately 600 feet of the middle member exposed in the Weepah Hills. However, the outcrop under consideration caps a small knoll and has a maximum thickness of less than 30 feet. This occurrence is considered to be allochthonous and is separated from the underlying Reed Dolomite by approximately 10 feet of medium- to coarse-grained skarn. In thin section, this skarn is seen to consist of abundant diopside, tremolite, calcite, zoisite and minor sphene. The contortions noted in several outcrops were not observed in thin section. Intensity of alteration diminishes downward as marked by a gradual decrease in diopside and tremolite and an increase in calcite toward the dolomite.

The Poleta Formation has been assigned an Early Cambrian age (Nelson, 1962) on the basis of abundant paleontological evidence. Stewart (1970, p. 59) correlates the Poleta Formation with the upper member of the Wood Canyon Formation in the central region of the southern Great Basin.

Ordovician System

Palmetto Formation

Small isolated outcrops of the Palmetto Formation are exposed in the west-central portion of the Weepah district, and a single outcrop was noted at the south-central border of the mapped area. All outcrops are considered as allochthonous occurrences, although they are typically expressed as faulted pendants in the Weepah pluton.

As exposed within the Weepah district, the Palmetto lithology is dominantly a medium dark gray (N4) to grayish-black (N2), very fine to medium-grained limestone. The southern exposure contains thin, closely-spaced, brownish weathering cherty interbeds. In all outcrops, brecciation and intense folding are recognized. The brecciated areas are annealed with quartz and subordinate calcite. A thin section of the typical lithology shows brecciated fragments of cherty to densely silicated limestone and irregular patches of fine-grained quartz and clay. Calcite blebs occur infrequently throughout the unit.

Maximum thickness of exposed Palmetto Formation is less than 35 feet, although 10 to 15 feet is more common. A Middle Ordovician age has been assigned to the Palmetto by Albers and Stewart (1965). Middle Ordovician graptolites are found in shale members of the Palmetto Formation of south-central Esmeralda County (McKee and Moiola, 1962, p. 537). The Palmetto Formation belongs to the transitional assemblage and is correlative with the Valmy and Vinini Formations of north-central Nevada.

Igneous Rocks

Approximately 30 percent of the area covered by this report consists of intrusive granitic rocks which represent the southwestern portion of the Weepah pluton. Smaller intrusions of diorite, aplite, and basic dike rocks comprise an additional 10 to 15 percent of the district.

Granitic rocks

The intrusive granitic rocks of the Weepah pluton (TJg) are dominantly leucocratic and exhibit a variable textural range including the typical granitic and subordinate porphyritic and aplitic phases. The more prominent outcrops of all phases have a distinct dark surface due to the supergene release of manganese and iron. Mapping in the northern and west-central portions of the district has shown that the pluton is dominantly of a quartz monzonite composition but is characterized by irregular changes to granodiorite and granite. Rarely, small irregular areas of biotite granite are observed. Although moderately recognizable in the field as individual phases or textures, no attempt has been made to distinguish them on Plate 1 due to the erratic, non-definite patterns they present. The compositional variations are apparently the result of local fluctuations in concentrations of sodium, potassium, and phosphorous during cooling. In general, these holocrystalline granitic rocks exhibit a medium- to coarse-grained allotriomorphic-granular texture and frequent porphyritic habit.

Within the district the dominant plutonic phase is a medium- to coarse-grained, allotriomorphic-granular quartz monzonite. The modal mineralogy consists of quartz (37%), plagioclase - An_{25} to An_{40} (31%), orthoclase (30%), chlorite (2%) after biotite, and magnetite (-1%). Accessories include trace amounts of zircon and apatite. The plagioclase, and to a lesser extent the orthoclase, shows minor argillic alteration. Sericite is a minor alteration product of the plagioclase. The opaque magnetite granules are typically surrounded by reddish hematite. Local cataclastic to granulated textures are developed adjacent to minor shear planes. The quartz is distinctly fractured, strained and granulated in these zones, and the plagioclase is likewise fractured and deformed. Other sections show an increase in plagioclase and the mafic constituents, indicating a trend toward a granodiorite composition.

A section of the typical granite shows zoned plagioclase - An_{30} (18%), microcline - microperthite, including minor exsolved albite (55%), quartz (27%), and minor muscovite. Apatite and very rare grains of biotite and monazite are observed. Minor to moderate argillic alteration is commonly seen. This species shows a recrystallized allotriomorphic-granular texture with quartz displaying well-formed triple points and forming polygonal mosaics. The smaller quartz grains are occasionally segregated into irregular patches and vein-like masses. Several of the larger (second generation?) quartz grains show moderate undulatory extinction of strain origin. The plagioclase frequently shows deformed twin lamellae which are locally sericitized. When plagioclase and microcline are adjacent, both tend to develop seriate to finely recrystallized grain boundaries with minor areas of myrmekitic intergrowth. Locally, recrystallization takes place along minute shear zones. Opaque minerals are only rarely observed in the granitic phases of the pluton.

The typical quartz monzonite-granite pluton is gradational into and infrequently cut by a fine-grained, leucocratic aplitic variety which appears to be a slightly later marginal phase of the Weepah pluton. Locally, a sub-parallel alignment of the darker micaceous minerals produces a "gneissoid" flow structure. Dikes, sills, and irregular masses of the aplitic variety are particularly abundant in the south-central portion of the district. They appear to be preferentially concentrated within the phyllite-schist of the Wyman Formation.

In the vicinity of the Weepah Nevada mine, this aplitic variety is the typical intrusive and is the "alaskite" of Spurr (1906) and others. In thin section (Figure 6), this phase consists of plagioclase (23%), microcline and orthoclase (43%), quartz (32%), muscovite (2%), and minor biotite. Magnetite, zircon, and apatite occur in trace amounts; the former having been almost completely altered to hematite. A fine-grained, allotriomorphic granular texture with interpenetrating to lobate grain boundaries is typical. No definite recrystallization textures are apparent, but the "patchy" extinction of several quartz grains suggests the onset of recrystallization. The remaining quartz in the section is strained to some extent and shows undulatory extinction.

Spurr (1906, p.25) dated the granitic plutons of the Silver Peak area as Late Jurassic to Early Cretaceous on the basis of field relations within Esmeralda and Mineral Counties. Schilling (1965, p.35) lists K-Ar age dates (biotite) from quartz monzonite porphyry of the Sylvania Mountains as lower Upper Jurassic (155± 8 m.y.). McKee (1968, p.H27) gives K-Ar dates (biotite) as Middle Jurassic for both quartz monzonite (162± 4 m.y.) and granodiorite (170± 5 m.y.) from the Magruder Mountains. In their preliminary mapping of Esmeralda County, Albers and Stewart (1965) consider the plutonic rocks to be Jurassic to Tertiary in age. According to J. H. Schilling (personal communication, 1971), the Exploration and Production Research

Figure 6. Photomicrograph of fine-grained aplitic border phase of the Weepah pluton. Quartz (q) shows undulatory to patchy extinction throughout the slide suggesting incipient recrystallization. (Approximately 500 diameters, crossed nicols).

Division of Shell Development Company has dated (biotite) a coarse-grained biotite granite from near the top of Lone Mountain as Middle Paleocene (63± 7 m.y.). Considering the Lone Mountain and Weepah plutons to be of similar age, the plutons are Upper Paleocene (56 m.y.) at the youngest and parts of the pluton could possibly be as old as Middle Jurassic (±160 m.y.). In lieu of more adequate age dating, the "TJg" rubric designation of Albers and Stewart (1965) has been followed.

Gradational into and locally subsequent to the development of the aplitic phase, late stage quartz veins, lenses, and irregular masses were emplaced. The most conspicuous of these form prominent outcrops (Figure 7) in the southern and central portions of the district. These lenses and pods are composed of a fine- to medium-grained crystalline quartz and typically exhibit a reddish-brown or yellow-gray color due to the oxidation of pyrite and hematite. They are occasionally brecciated and healed by limonite and translucent quartz. In general, these bold lenses show a strong N 15° E to N 40° E tendency which is more or less conformable to observed shear dilations as well as gross bedding trends within the district. However, this configuration does not hold true for the smaller, irregular quartz-aplite masses of the district.

Slightly later than the granular quartz is a system of dense, translucent to porcellanic white quartz veins which were accompanied by

Figure 7. Typical prominent exposure of massive granular quartz veins throughout the Weepah district.

sparse sulfide mineralization. These veins range from less than one inch to several feet in thickness and typically do not show a preferred orientation. This variety shows a cross-cutting relationship to all other units in the mapped area except for those of Cenozoic age. Where these quartz veins encounter carbonate wallrock, there is a tendency for the quartz to be a bluish-gray color and less porcellanic. This bluish quartz within carbonate wallrock was an ore guide used by early (pre-1927) prospectors in the district. Sulfides typically are more finely disseminated throughout the quartz in the presence of calcareous strata.

Contemporaneous with the early period of the later quartz veining in the Weepah district is a poorly developed quartz-mica pegmatite vein system. These thin (to 6"), irregular veins consist of coarse-grained dull white quartz and silver to lavender mica, containing pyrite and frequent casts of limonite after pyrite. These pegmatite veins generally cannot be traced laterally for more than a few feet, and they become finely fragmented upon weathering. In section they appear to be quite sinuous, typically following bedding and joint trends. The enclosing sediments frequently show a thin (to 2mm), iron-stained border adjacent to the veins.

Dioritic rocks

Plate 1 shows several large areas of dioritic rock cutting the earlier granitic phase of the Weepah pluton. The largest such intrusive occurs at the south edge of the pluton northeast of the mine area. This mass has the gross characteristics of a dike with an axial trend of N 75° W. In detail this dike shows local variation in composition and texture, the classification ranging from diorite to tonalite.

The largest basic intrusions (TJd) are frequently bordered by hornblende diorites or tonalites with a hypidiomorphic-granular texture. In thin section, zoned plagioclase - An_{38-44} (76%), hornblende (13%), quartz (6%), and biotite (3%) are the major constituents. The biotite occurs as a replacement of the hornblende and as discreet grains. Minor constituents include magnetite (2%), sphene and apatite (1%), and trace amounts of potassic feldspar, clinopyroxene (augite) and monazite. The typical rock shows very minor argillic alteration. Alignment of large plagioclase laths and hornblende crystals locally defines a distinct foliation. Lack of recrystallization or deformational textures indicates that the foliation is a flow feature.

The dominant phase of the large basic intrusives is a pyroxene diorite consisting of zoned plagioclase - An_{42-53} (47%), and subhedral to euhedral clinopyroxene (augite - 51%), with minor magnetite and hornblende. Accessory minerals include traces of sphene, apatite, and biotite. Minor argillic alteration of the plagioclase and hematite after magnetite is noted. The pyroxene diorite is typically medium- to coarse-grained with a hypidiomorphic-granular texture. Locally, however, blades of augite to several inches are noted.

Where this pyroxene diorite intrudes carbonate strata (marble), contamination is noted. Zoned plagioclase - An_{36-56} (31%), clinopyroxene (augite - 48%) and orthoclase (9%) comprise the main minerals. Minor and accessory constituents include quartz, hornblende (replacing pyroxene), sphene, calcite, magnetite and apatite. These phases typically have a fine- to medium-grained hypidiomorphic-granular texture. The pyroxene locally shows fine vermicular intergrowths with plagioclase, rare quartz and with replacing hornblende. Argillic and sericitic alteration is minor to moderate across the sections viewed. The contaminated phase is characterized in thin section by abundant interstitial to poikilitic orthoclase, calcite which replaces the plagioclase and occurs interstitially with quartz, and by the vermicular pyroxene-plagioclase texture. Sphene appears to be more abundant locally, and the magnetite shows only trace amounts of oxidation to hematite.

Lamprophyric rocks

Dikes, sills, and irregular masses of typically dark green, fine-grained, basic intrusives (TJb), genetically related to the diorite, are recognized throughout the district. These basic rocks are found in every unit and are usually heavily jointed, commonly breaking into small angular blocks. Those which cut the granitic rocks, however, show a strong tendency for negative, spheroidal weathering. A wide range of textures and genetic distinctions are observed. Minor to moderate variations in mineralogy appear to be partially controlled by the nature of the wall rock. Contacts may be quite sharp (Figure 8) or may be marked by the development of a thin hornfels border. However, both types of contacts can be observed along a single dike or sill. These basic rocks are dominantly classed as spessartite varieties of lamprophyre or microdiorites. The fine-grained nature of these rocks makes field classification difficult.

In thin section, the dominant species of basic dike rocks can be classified as "microspessartite" or fine-grained spessartite lamprophyre. Original euhedral or subhedral plagioclase laths (50%) are almost completely altered to abundant epidote-zoisite, calcite, minor sericite, and kaolinite (Figure 9). Additional major constituents include euhedral microphenocrysts (to 1.2 mm) of brown hornblende (40%), biotite (3%) as distinct grains and partially replaced by chlorite,

Figure 8. Sinuous and branching lamprophyre dike (TJb) cutting Precambrian Reed Dolomite (pЄr) immediately south of mapped area. Note lack of wallrock alteration. Maximum width less than five feet.

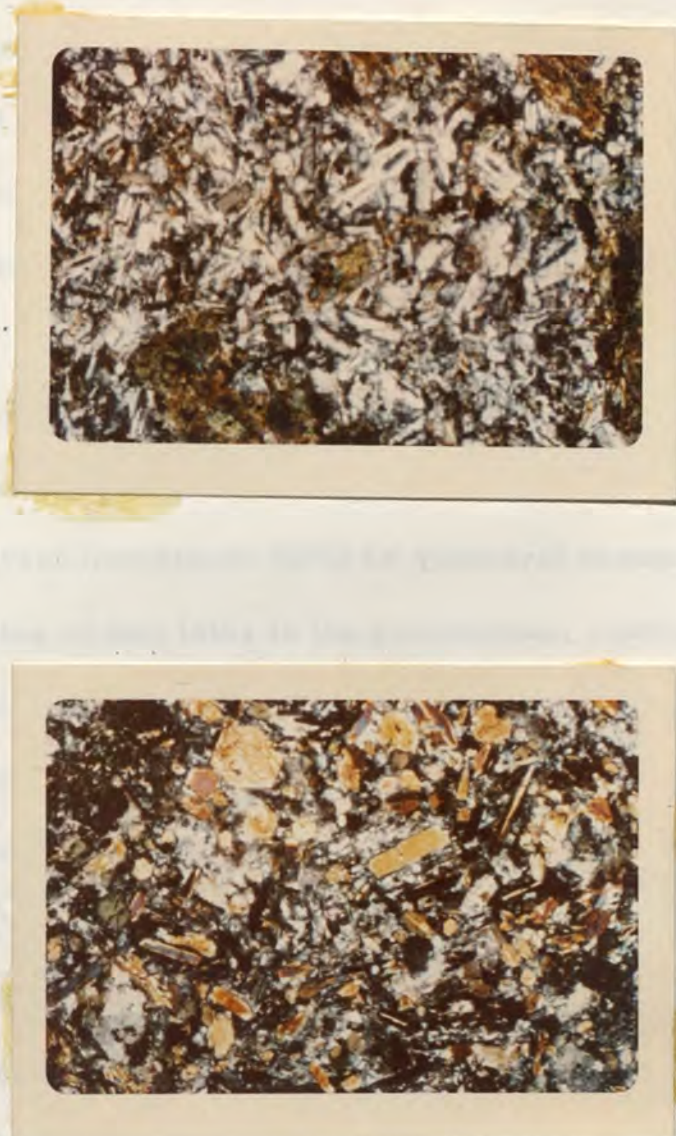


Figure 9. Photomicrographs of typical spessartite lamprophyre dikes of the Weepah mining district. Upper photograph (400 diameters) shows aggregate of strongly zoned plagioclase laths and brown hornblende phenocrysts. The latter are seen to be replaced by disoriented second generation green hornblende. Lower photograph (500 diameters) shows euhedral phenocrysts of brown hornblende and plagioclase. The latter has been almost completely altered to epidote-zoisite, calcite, sericite, and kaolinite. Crossed nicols.

interstitial quartz (3%) and calcite (2%), and magnetite (1-2%). Accessory minerals include abundant euhedral apatite and rare anhedral to subhedral sphene. Trace amounts of hematite after magnetite are noted. The texture is very fine- to fine-grained panidiomorphic granular.

A section from a somewhat coarser variety of spessartite consists of strongly zoned, subhedral laths and plates of plagioclase - An_{38-53} (34%), deep green hornblende (40%) as subhedral phenocrysts and as acicular needles or fine laths in the groundmass, biotite (5%) replacing hornblende and in groundmass, and traces of quartz. Finely divided subhedral grains of magnetite, and possibly of pyrite, are found throughout the section. Accessory minerals are mainly apatite and sphene. The former may represent two generations of crystals marked by stubby euhedral grains and by slender needles. The sphene is quite abundant and is granular to anhedral in occurrence. Trace amounts of opal or devitrified glass? occur interstitially and in corroded plagioclase crystals.

Two distinct generations of hornblende are noted in this coarser hornblende-plagioclase lamprophyre (Figure 9). The initial phenocrysts of hornblende appear to be replaced by a later hornblende generation. These phenocrysts are now composed of interlocking-interpenetrating disoriented patches of green hornblende. The later generation also forms minute slender acicular laths in the groundmass.

The second generation hornblende and apatite probably occurred with the final melt stage of the main diorite mass. The segregation of this late, water-rich melt from the parent intrusive is assumed responsible for the formation of the lamprophyric dikes and dike-like masses. The groundmass plagioclase crystals appear to have been deuterically corroded and locally, rare albite grains have formed during this alteration. The last liquid solidified as a hydrous, mainly interstitial, glass which has since devitrified to patches of brownish-colored glass.

Additional thin sections of other basic dikes in the district appear to be only mineralogical variations of the spessartites described above. A single slide shows a more hypidiomorphic-granular texture with slender plagioclase laths, subhedral to euhedral hornblende grains, interstitial quartz (+3%), interstitial calcite, numerous apatite needles, and abundant magnetite. It closely resembles the microspessartite except that the plagioclase has been entirely replaced by sericite rather than epidote minerals. It is texturally less lamprophyric than the microspessartite and is best classified as a microdiorite.

Spurr (1906) reports that similar dikes in the Silver Peak Range contributed to the gold and silver mineralization. Several assays of these lamprophyric rocks yielded no gold and from 0.02 to 0.13 oz/ton silver. Several prospects in the district explored these dike rocks, but most extend only a few feet in depth. Limonitic jasper, developed adjacent to the lamprophyres in carbonate strata, appears to have been sought by the prospectors. Values are not significantly increased in adjacent skarn or jasper.

At sporadic locations throughout the district, massive veins or dike-like bodies of dense jasper are noted. The majority of these occur in carbonate rocks, and their erratic distribution is similar to the random occurrence of the spessartite lamprophyres or other basic rocks with which they are undoubtedly associated. These jasperoid masses are comprised of brown (5YR 3/4) to deep reddish-brown (10R 3/4) or tan (10YR 6/6) jasper which frequently contains vugs filled with small clouded to milky-colored, terminated quartz crystals. Rare discreet grains of galena and pyrite were observed in the jasper. Earthy to crystalline siderite ($FeCO_3$), massive to dendritic manganese oxide (wad, pyrolusite), granular to crystalline dolomite and calcite, and occasional blades of barite are common.

Small fracture-filled occurrences of malachite were noted at two localities. Chip samples taken from several of these jasperoid veins or dikes were assayed. Values ranged from a trace to 0.01 oz/ton gold and 0.01 to 2.85 oz/ton silver. Lead and zinc values were found to be about 50 ppm and 80 ppm higher respectively than adjacent carbonate strata.

Except for the lack of abundant black calcite, these veins are quite similar to those described by Hewett and Radtke (1967), and others. The higher silver values obtained in several of these jasperoid masses may indicate the presence of argentiferous carbonate minerals. However, the highest silver value noted was from a dense limonitic jasper which contained no recognizable carbonate minerals. The possibility exists that the silver-bearing manganiferous calcite may have been depleted from surface exposures by supergene processes.

Quaternary System

West of the mapped area, Tertiary rocks of late Miocene through Pliocene age are represented by volcanic flows, ash flows, tuff, shale and siltstone. Cenozoic units within the district consist of an older alluvium, a partially reworked tuff, and Recent alluvium.

Older Alluvium

In the southern and northwestern portions of the Weepah district, a sequence of partially stratified, poorly consolidated alluvium and fanglomerate is exposed (Qoa). This unit ranges from a few feet up to several hundred feet in thickness. It consists of angular to subrounded fragments of dominantly gravel to boulder size. Angular blocks of up to four feet in diameter are common, and occasional blocks with diameters exceeding five feet were noted. The larger boulders represent numerous sedimentary lithologies, with recognizable fragments of the Palmetto, Campito, Deep Springs(?) and Harkless(?) Formations. Carbonate fragments tend to be dominantly of gravel size. Rare granitic and dioritic fragments were noted. Numerous dark green to black serpentine and gabbroic gravels are characteristic of this sequence. This unit has a distinct green-brown hue which is easily distinguished even when found as a thin veneer on the flanks of several higher ridges.

Considering the climatic conditions of the Great Basin throughout the Cenozoic Era, the most probable age of this sequence is Late Pliocene to Middle Pleistocene. It apparently overlies the Mio-Pliocene Esmeralda Formation to the west of the mapped area, suggesting an Early to Middle Pleistocene age.

Reworked Lapilli Tuff

Within the older alluvium sequence in the south-central portion of the district, a thin southeast-dipping tongue of pumice lapilli tuff (Qrt) was noted. The tuff thickens from five feet to over 40 feet south of the map boundary. It is extensively weathered and shows marked devitrification accompanied by the development of clay minerals (montmorillonite?). Locally, the tuff appears to have been reworked and is presumed to have been deposited in elongate drainage depressions.

Rounded pebbles, sub-rounded cobbles, and small angular fragments of variable lithology are incorporated in the tuff. These pebbles are generally erratically distributed although a local size gradation is recognizable. The deep weathering prevents positive identification of either loading varves or current ripples around the detrital inclusions. Due to the fact that the tuff is enclosed within the older alluvium sequence, a Middle Pleistocene age is postulated.

Alluvium

A large, well-developed drainage network has been imposed on the Weepah district. Arroyas and channels are alluviated (Qal) to variable thicknesses with coarse sand and gravel. The heads of these alluviated channels tend to be flanked by broad patches of colluvium, and occasional fan veneers are developed.

Immediately north of the mapped area, a widely exposed pediment is forming. Inselbergs decrease in size toward Big Smoky Valley where sand dunes and playa deposits accumulate.

STRUCTURAL GEOLOGY

Generalized Regional Structural Setting

The Weepah mining district and surrounding portion of eastern Esmeralda County are situated in a belt of diverse topography, which marks a zone of convergence between the northwest-trending Sierra Nevada and the northeast-trending ranges of the Great Basin sub-province. This belt can be traced for a distance of over 300 miles and has a maximum width of approximately 50 miles. A distinct topographic low, the Walker Lane lineament (Locke, et al., 1940), marks the eastern edge of this convergent zone.

Detailed investigations in western Nevada and eastern California have presented evidence which indicates that this convergent structural zone represents a belt of significant right-lateral displacement. The dextral offset along the Walker Lane is considered to be on the order of 80 to 120 miles (Albers, 1967, p.151). During this displacement, several ranges west of the Walker Lane were warped into arcuate trends, such as is exemplified by the Silver Peak-Palmetto-Montezuma oroflex (Albers, 1967, p.145). Pluton emplacement along warped or oroflexural trends can be documented by examination of the Geologic Map of Esmeralda County. The trend of the Weepah-Lone Mountain plutons seems to be coincident with that of the Silver Peak-Palmetto-Montezuma oroflex. The deformation responsible for the development of these arcuate ranges may have begun as early as late Early Jurassic, and the bending and strike-slip movement possibly continued into the Early or Middle Miocene (Albers, 1967, p. 151). Megatectonic interpretation of the oroflexural trends indicates that these flexures are inherited from tectonic warping of the crust as a result of drag produced by subcrustal currents.

In all probability, the structural geology of the Weepah Hills was once considerably more complex than presently expressed. Plutonic emplacement and subsequent deroofing has eroded all but the "basement" structural features of the district.

Structural Features of the District

General Statement

The Weepah Hills are comprised of a broad arcuate wedge of Precambrian and Lower Paleozoic sediments which nonconformably overlap the southern edge of the Weepah pluton. The gross structure of these strata is a faulted, southeast-plunging anticline (Figure 10). Within the mapped area, the overall structure appears to be a faulted, southeast dipping homocline. Numerous faults of small displacement offset the Precambrian and Paleozoic units. Rare open folds appear to form broad irregular crenulations in a rather uniformly oriented sedimentary sequence.

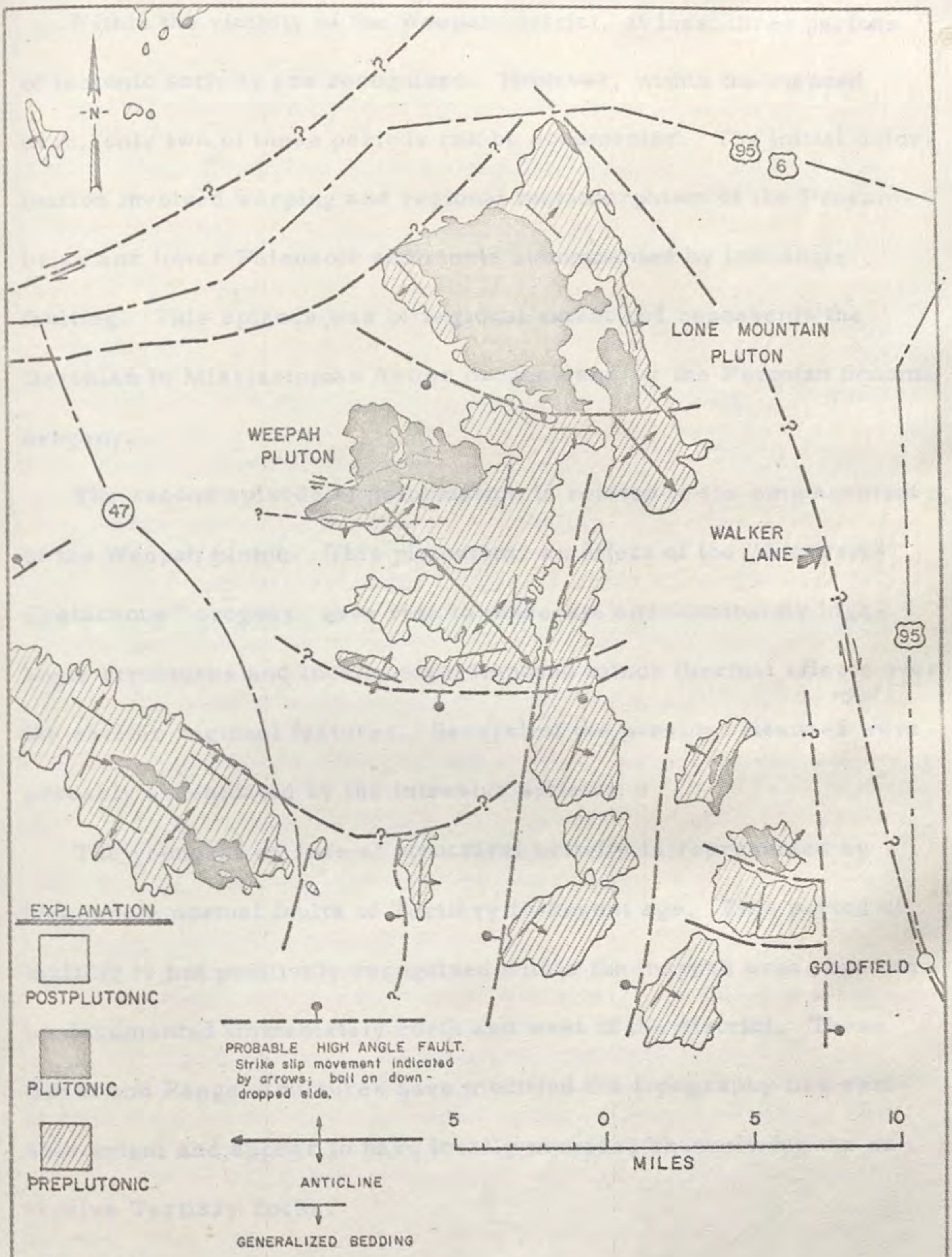


Figure 10.

PRINCIPAL STRUCTURAL FEATURES OF EAST-CENTRAL ESMERALDA COUNTY. (Modified from Albers & Stewart, 1965.)

Within the vicinity of the Weepah district, at least three periods of tectonic activity are recognized. However, within the mapped area, only two of these periods can be documented. The initial deformation involved warping and regional metamorphism of the Precambrian and lower Paleozoic sediments accompanied by low-angle faulting. This episode was of regional extent and represents the Devonian to Mississippian Antler orogeny and/or the Permian Sonoma orogeny.

The second episode of deformation is related to the emplacement of the Weepah pluton. This plutonism, an effect of the "Jurassic-Cretaceous" orogeny, gave rise to moderate and dominantly high-angle structures and locally superimposed minor thermal effects over the earlier regional features. Several of the previous flexures were probably accentuated by the intrusive activity.

The youngest episode of structural activity is represented by high-angle normal faults of Tertiary to Recent age. This period of faulting is not positively recognized within the mapped area, but can be documented immediately north and west of the district. These Basin and Range structures have modified the topography to a variable extent and appear to have locally provided channels for the extrusive Tertiary rocks.

Paleozoic Structural Features

Within the Weepah district the autochthonous Precambrian and allochthonous Cambrian sequence of pelitic and carbonate rocks experienced a regional tectonic force which gave rise to broad open flexures and regional metamorphic effects.

Accompanying or subsequent to the regional compression was the development of a thrust fault of undetermined displacement. This thrusting is marked by the presence of Middle Ordovician transitional assemblage rocks of the Palmetto Formation. Outcrops of the Palmetto in the northwestern portion of the district appear as fault-bounded pendants of what was probably once an extensive thrust sheet. The pattern of this upper plate has been obliterated by the later plutonic activity. Folding within the Palmetto Formation appears to be more intense than in the adjacent Precambrian and Cambrian strata. The axial trend of the folds have a north-south direction and the unit shows intense brecciation.

Field relations in the district only confirm that the Palmetto thrusting is pre-plutonic. Regional configuration of the Palmetto units indicates that thrusting was from the west or northwest. Since both the Antler and Sonoma orogenies were responsible for eastward directed thrusting, one cannot be distinguished from the other in isolated features. Roberts (1964, p. 26) suggests that the Antler orogenic belt cuts across the northern part of Esmeralda County. However, north of Tonopah, Mississippian limestone has been thrust over the Palmetto Formation (H. F. Bonham -- personal communication, 1971) indicating at least local post-Antler (Permo-Triassic?) thrusting. Within the mapped area effects of the Permian Sonoma or younger orogenies, if present, cannot be distinguished from those of the Antler orogeny.

Mesozoic Structural Features

The bulk of thrusting and moderate to high-angle faulting present in the Weepah district is presumed to be the result of the Jurassic to Cretaceous episode of tectonism. A large thrust fault, which dips at about 35° to the southeast, can be traced intermittently from the east-central portion to the southeast edge of the mapped area. The allochthonous Cambrian Campito Formation represents a stratigraphic separation of approximately 4,500 feet where in contact with the Precambrian Reed Dolomite. Several zones within the allochthonous unit show minor differential bedding plane movement, but lack of continuous exposures prevents determination of extent and magnitude.

Where well exposed, the sole of the Campito thrust is not extensively brecciated, and bedding attitudes do not differ from those in the lower plate rocks. Minor contortions near the base are infrequently recognized. Thermal effects related to thrusting have locally altered the underlying Reed Dolomite to a coarse friable dolomitic sand which is occasionally mottled by iron staining. Other areas exhibit a coarse recrystallization. Many areas of the Reed and most of the exposed Wyman Formation show no noticeable change in their typical character along the trace of the Campito thrust.

Folding within the upper plate rocks in general trends N 40° E, essentially parallel to those in the underlying units. The dominant northeast to east-northeast trend of the fold traces suggests compression in a north-northwest -- south-southeast direction. However, it appears that the folds may later have experienced a change in strike to a more east-west trace indicating a change to a more north-south component of compression.

Regional aspects of the Campito thrust indicates movement in a southeast or eastward direction. Within the mapped area it is not possible to date the Campito thrust with assurance. However, it definitely pre-dates the emplacement of the Weepah pluton in that the dioritic intrusive which cuts the granitic pluton also intrudes the thrust trace northeast of the mine area. The Campito thrust is thus considered to be pre-Jurassic in age. The exact age may fall somewhere between Late Permian and Middle Jurassic.

The dominant pattern of the moderate to high-angle faulting in the Weepah district is considered to have formed mainly in response to the emplacement of the Weepah pluton. The pattern is in close agreement with the theoretical configuration of a right-lateral rotational shear. Manipulation of structural fabric data seems to define a conjugate shear system with the primary stress direction oriented essentially northwest-southeast. Figure 11 shows a plot of dominant joint trends within the district, and Figure 12 is a rosette diagram of the major fault traces and photolineament trends across the mapped area. These plots, as well as orientation of fold axes and thrust blocks, verify a primary northwest-southeast stress field.

Primary first-order right lateral shear has a N 80° W attitude and is represented by the well-defined "North" Fault (N 80° W) and the queried "South" Fault (N 75° W?). The latter fault is nowhere exposed with certainty. However, the trend of the lamprophyric masses through the Reed Dolomite appears to be coincident. Second-order right lateral shears are exemplified by the "Ree" fault zone and the "Weepah-Nevada" fault. The "Ree" fault trends approximately N 60° E for the most part with a slight flexure where it traverses the pendant of Wyman Formation (See Plate 1). This fault is iron-stained, brecciated, and within the flexure, reaches a width of up to 11 feet (Figure 13). The Wyman limestone at this point shows moderate recrystallization, and each rib of the shear is marked by a deep reddish-brown limonitic jasper of up to several inches in thickness. No estimate of displacement is possible.

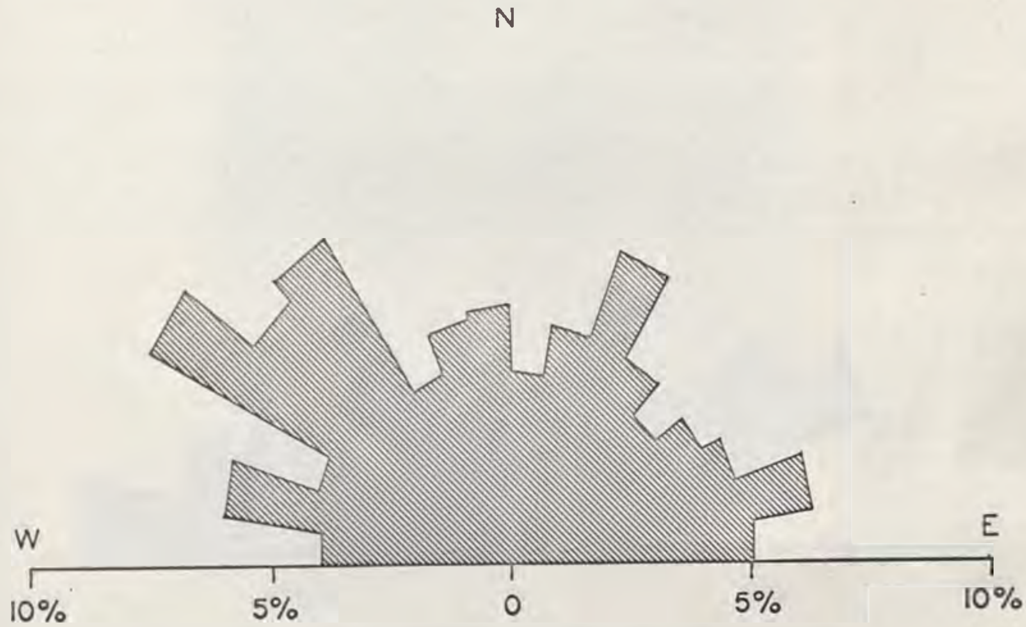


Figure II.

ROSETTE DIAGRAM

PRINCIPAL JOINT TRENDS

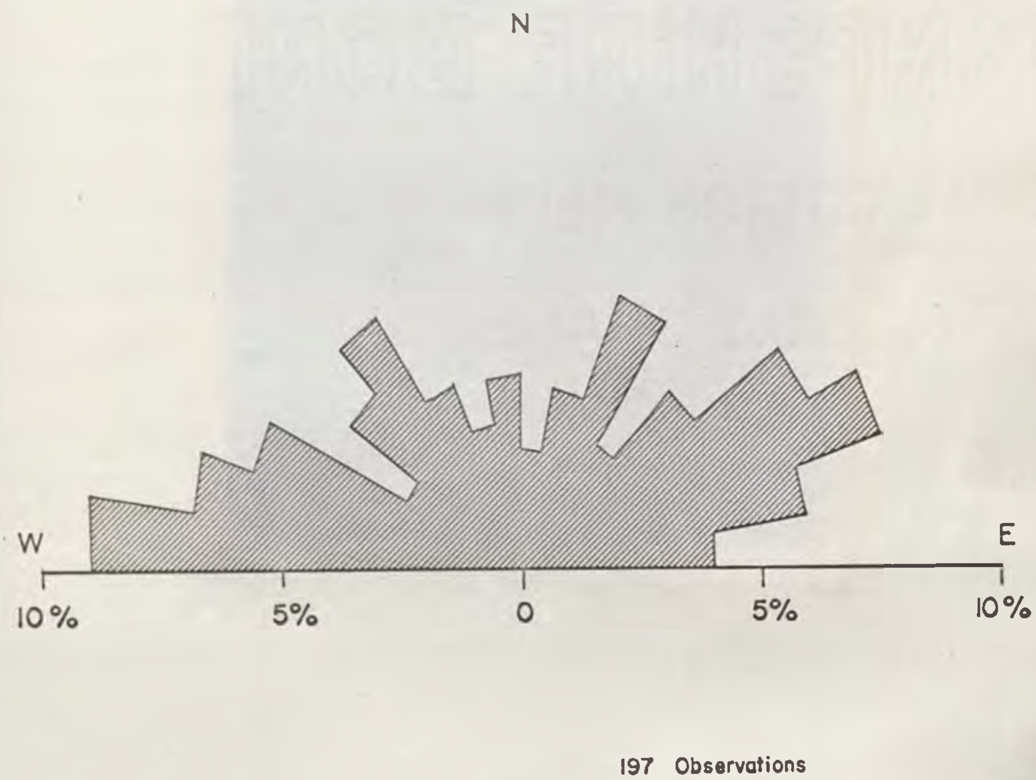


Figure 12.

ROSETTE DIAGRAM

FAULT TRACES AND MAJOR PHOTOLINEAMENTS

Figure 13. "Ree Fault"

Iron-stained shear zone in pendant of Wyman carbonates. Dark brown jasper developed along each wall. Width of zone in prospect is approximately 11 feet.

The "Weepah-Nevada" Fault, a probable second-order shear, trends N 20° E to N 40° E. Within the district, this fault is the most important in that it provided a locus for ore deposition. This fault, as does the "Ree", tends to pinch and widen along strike. The ore deposit mined by the Weepah Nevada Mining Company was situated in a rather broad segment of the fault; a true width in excess of 50 feet was attained locally. Slickensides along the hanging wall of the Weepah Nevada Fault in the mine area indicate shearing along strike. The throw of the fault apparently increases to the southwest.

Another well-defined fault, the "Duke", in the northern part of the area trends N 76° W and has a first-order shear orientation. However, definite recurrent movement along this fault is demonstrated by second-generation brecciation. Both the hanging and footwall of the "Duke" fault are comprised of monzonite, and no estimate of displacement was attempted. It locally attains a width of less than five feet and differs from the "North" fault in not having a steep northerly dip.

In gross detail, the dominant structural fabric in the northern portion of the Weepah district is indicative of gradual rotational shearing. Those structures assigned a second-order role may actually define a change in the primary shear direction from N 80° W to N 40°-60° E. This rotational (oroflexural) concept appears to be substantiated by a composite density plot for numerous joints

(Figure 14) in the vicinity of the structural trend. A line connecting maxima of points defines a gradually diminishing intensity of rotation to the northeast. Analyses of individual structural domains along this trend also give similar girdles of intensity which decrease from an east-west to northeast direction.

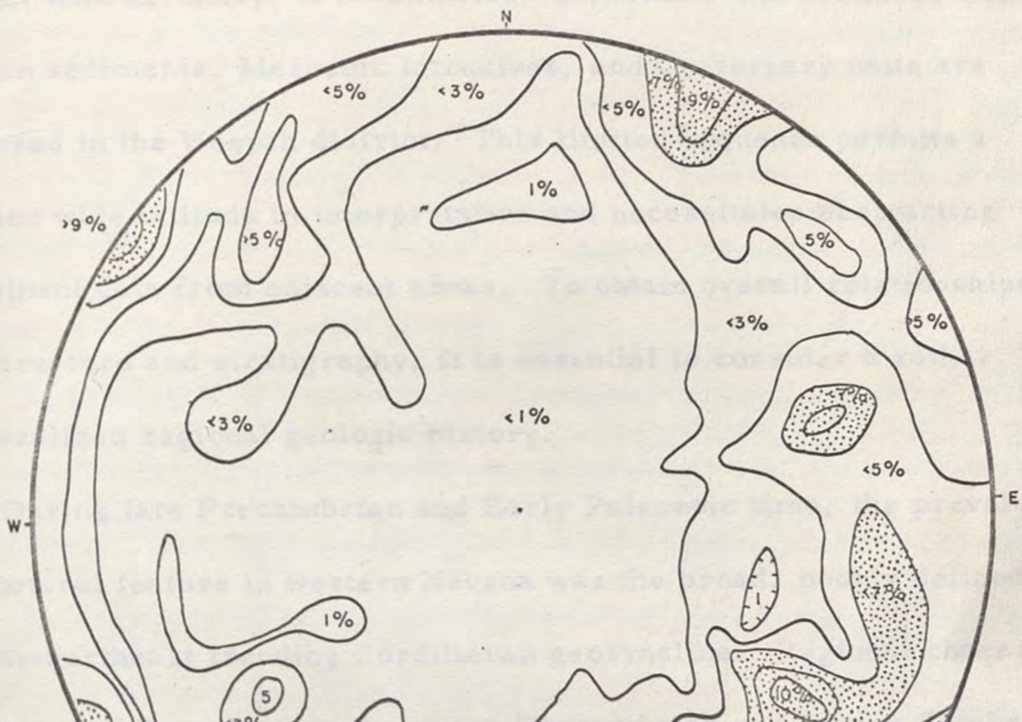


Figure 14.

COMPOSITE DENSITY PLOT
POLES OF JOINTS TO LOWER HEMISPHERE EQUAL AREA CONTOUR

395 Observations

GEOLOGIC HISTORY

The geologic history in this portion of Nevada is difficult to reconstruct with certainty. Precambrian, Cambrian, and scattered Ordovician sediments, Mesozoic intrusives, and Quaternary units are exposed in the Weepah district. This limited sequence permits a rather wide latitude in interpretation and necessitates abstracting pertinent data from adjacent areas. To obtain overall relationships of structure and stratigraphy, it is essential to consider a rather generalized regional geologic history.

During late Precambrian and Early Paleozoic time, the prevalent structural feature in western Nevada was the broad, poorly defined, north-northeast trending Cordilleran geosyncline. Regional characteristics of deposition in the upper Precambrian and Lower Cambrian strata indicate a rather uniform tectonic and sedimentary environment. Stewart (1970, p. 64-68) indicates a westward or northwestward direction of sediment transport, the cratonic area to the east supplying granitic material from which this sequence was derived. In the Weepah Hills vicinity, moderately shallow and stable marine conditions prevailed in Late Precambrian time as marked by the deposition of over 3,000 feet of fine-grained pelitic sediments and thin carbonate interbeds of the Wyman Formation. Continued subsidence of the geosyncline in Late Precambrian permitted the deposition of close to 2,000 feet of massive carbonate represented by the Reed Dolomite.

The continuity of the depositional record in the mapped area is concluded with the Reed Dolomite. In all probability, deposition in the district continued into the Early Paleozoic with only minor interruptions. Approximately 13,000 feet of the Precambrian and Lower Cambrian sequence accumulated in a northerly-trending subsiding trough through Esmeralda County.

Extrapolation of available data from surrounding areas and mapping within the Weepah district are not conclusive in ascertaining the deposition of post-Cambrian strata. In any event, there are no definite occurrences of autochthonous post-Cambrian sedimentary rocks within the district or immediately adjacent areas. Their existance, however, cannot be precluded.

Near the end of the Devonian period, epeirogenic uplift of the geosynclinal trough is marked by the appearance of the north-northeast trending Manhattan Geanticline or Antler orogenic belt. The Antler orogeny (late Devonian to Early Pennsylvanian) was accompanied by the shedding of early Paleozoic and Precambrian sediments in the vicinity of Esmeralda County. In northern and north-central Nevada, this orogenic belt is marked by widespread eastward thrusting which includes the Roberts Mountain overthrust and numerous, less extensive thrust faults. Sediments derived from the southwestern emergent area probably contributed significantly to the late Paleozoic (Pennsylvanian) overlap assemblage which was deposited along the leading edge of the Roberts Mountain thrust in the Chainman-Diamond Peak trough of eastern Nevada. The Antler belt was extensively reduced by late Paleozoic (Middle Pennsylvanian) time and, except for isolated positive areas, probably began to be covered by sediments. The lack of Paleozoic sediments in the district and surrounding areas suggests that this portion of Esmeralda County remained mostly emergent.

Near the end of the Paleozoic Era (Late Permian), the western portion of the Antler orogenic belt was reactivated, and a second period of tectonic activity, the Sonoma orogeny, was initiated and resulted in additional eastward thrusting. In the Weepah district it is not possible to demonstrate either an Antler or Sonoma origin for the allochthonous Ordovician blocks. Roberts (1964) suggests the continuation of the Antler orogenic belt through Esmeralda County. Recent studies in the western Great Basin, however, indicate that Late Paleozoic and Mesozoic tectonism may be dominant (Burchfield and Davis, 1971).

Effects of the Sonoma orogeny probably continued intermittently into the Early Mesozoic. Lower Mesozoic strata are rare south of the 38th parallel, but are locally present in excess of 10,000 feet to the north. The Late Permian and Early Triassic rocks of western

Nevada (north of Esmeralda County) are represented by altered volcanic rocks and volcanic-derived sediments, indicating a period of shallow and submarine volcanism and a change in depositional facies from eugeosyncline to miogeosyncline. Marine sediments of lower Middle Triassic through Early Jurassic age were deposited in basins or embayments of western Nevada and probably did not accumulate in the mostly emergent area of northern Esmeralda County. The deposition of Early and Middle Jurassic strata commenced with the initial stages of folding and thrusting associated with the widespread Mesozoic orogeny (Ferguson and Muller, 1949, p.13).

In most interpretations, the "Jurassic and Cretaceous" orogeny of Silberling and Roberts (1962, p. 39), is considered to have been a period of intermittent orogenic activity initiated in Early or Middle Jurassic and continuing into the Cenozoic. Active thrusting to the southeast accompanied this period of tectonic activity in the Hawthorne and Tonopah quadrangles (Ferguson and Muller, 1949). The thrusting of the Cambrian Campito Formation from the northwest presumedly took place during this Late Mesozoic period of tectonism.

Structural relationships within the mapped area indicate that thrusting preceeded or accompanied the emplacement of the Weepah pluton. In surrounding areas, imbricate thrusting and intense folding took place in response to the plutonic activity. Overturned, northeast-southwest-trending folds and numerous faults of small displacement are noted between Weepah and Clayton Valley. It is assumed that similar structural complications were imposed on the Weepah district. However, the complexity has been mostly obliterated by the rapid deroofing of the pluton.

The geological records for the Tertiary period are essentially absent from the Weepah district. However, to the west, volcanic activity is much in evidence, and Basin and Range normal faulting of Tertiary to Recent age is recognized. The Miocene-Pliocene pyroclastics and lacustrine sediments of the Esmeralda Formation comprise considerable portions of both Clayton and Big Smoky Valleys.

Quaternary history of the district is reflected by thick accumulations of mostly unconsolidated detrital material resulting from moderately rapid erosion during the torrential rainfalls of Late Pliocene to Middle Pleistocene time. Volcanism during the Pleistocene is recorded by the presence of a thin volcanic ash. This pumice lapilli tuff was probably concentrated in narrow drainage channels by subsequent rainfall and runoff. Recent deposits are represented by unconsolidated desert alluvium and locally by dune sand.

ORE DEPOSITS

The entire production of the Weepah mining district was taken from the area immediately surrounding the site of the open pit. Production in the district can be readily divided into two periods, 1902-1927 and 1927-1938. In a similar manner, the nature of the ore deposits and mining methods employed can be separated.

The nature of the ore deposits worked prior to 1927 is summarized by Spurr (1906, p. 81) as follows:

> ". . . . The country rock here is gently dipping limestone which has been altered to a fine-grained marble and in places more or less silicified, especially along certain zones. In this limestone there are small bunches of bluish quartz which show a faint copper stain. Calcite is also present. A thin section of the ore shows it to have the typical retiform structure of jasperoid. It has been formed by replacement of the original limestone by silica. The ore contains a black sulfide showing red, yellow, and green alteration products. It is very likely that this is the "black metal" which contains copper and silver in considerable amounts and is one of the characteristic ore minerals of this whole district. Under the microscope free gold was observed, both intergrown with the black mineral and separate from it. This gold is inclosed in the quartz and is apparently original."

From Spurr's description, it appears that the ore mined up to the time of his visit (1904) came mainly from the shafts and prospects to the east and south of the present pit. During the earlier period of production (1904-1907), and in the intervening years prior to 1927, approximately 1,650 tons of ore were mined at a credited gross yield of nearly $207,000. This production, with values in gold, silver, copper and lead, had a value of slightly over $125 per ton. Apparently only the high-grade ore pockets were developed. These enriched lenses of ore were surficial concentrations and did not extend more than a few feet in depth (Spurr, 1906, p.80). In all probability, the Indians and early prospectors were attracted to the deposit by vivid supergene oxidation colors of the "black metal" which Spurr had noted throughout the Silver Peak district. This "black metal", referred to as being ubiquitous to the region, had earlier been termed stetefeldite $(Ag_{1-2}Sb_{2-1})(O, OH, H_2O)$. Rare segments of the copper-stained quartz veins mentioned by Spurr were found in the older dumps. Stetefeldite was not identified either in hand specimen or by x-ray diffraction. Samples consist mainly of remanent chalcopyrite surrounded by a dense, glazed pitch limonite and cut by numerous malachite-filled veinlets. Several of the fragments have thin fracture coatings of a yellow, earthy powder which is probably a mixture of antimony oxides and jarosite. The small amount of powder noted prevented x-ray determination, but trace analysis for antimony indicated anomalous amounts (2000 ppm). Assay of these vein fragments ran 0.005 oz/ton gold and 0.10 oz/ton silver.

Following the discovery at Weepah by Horton and Traynor in 1927, an ore deposit of a different nature was recognized. The deposit, marked by the site of the Weepah Nevada open pit, was confined to a 30 to 70 foot thick granulated fault zone which trends N 20° E and dips from 43° to 52° to the northwest. The ore occurred both as free gold and intergrown with pyrite. The wallrock adjacent to the fault is a green-gray phyllite or schist which shows only minor alteration effects.

The vein reportedly cropped out on the surface with negative expression. In all probability, this zone had been prospected at the time of Spurr's visit to the property, but was interpreted as a zone of alteration associated with the alaskite (1906, p. 81):

> ". . . . This alteration is associated with fine-grained cellular quartz, which constitutes the mineral exploited in these prospects. Examined microscopically, the quartz is a moderately fine-grained idiomorphic aggregate containing some pyrite. It is reported that this ore was of very low grade, so low as not to be available for mining."

Interpretation of the above statement must take into consideration the fact that at the time it was written gold had a value of only $20.67 per ounce.

Subsequent to the 1927 discovery, significant underground development (Figure 15) was performed by the Electric Gold Mining Company and later by the Weepah Nevada Mining Company. The open pit mining method was determined to be economically feasable in 1935, and further underground development was suspended.

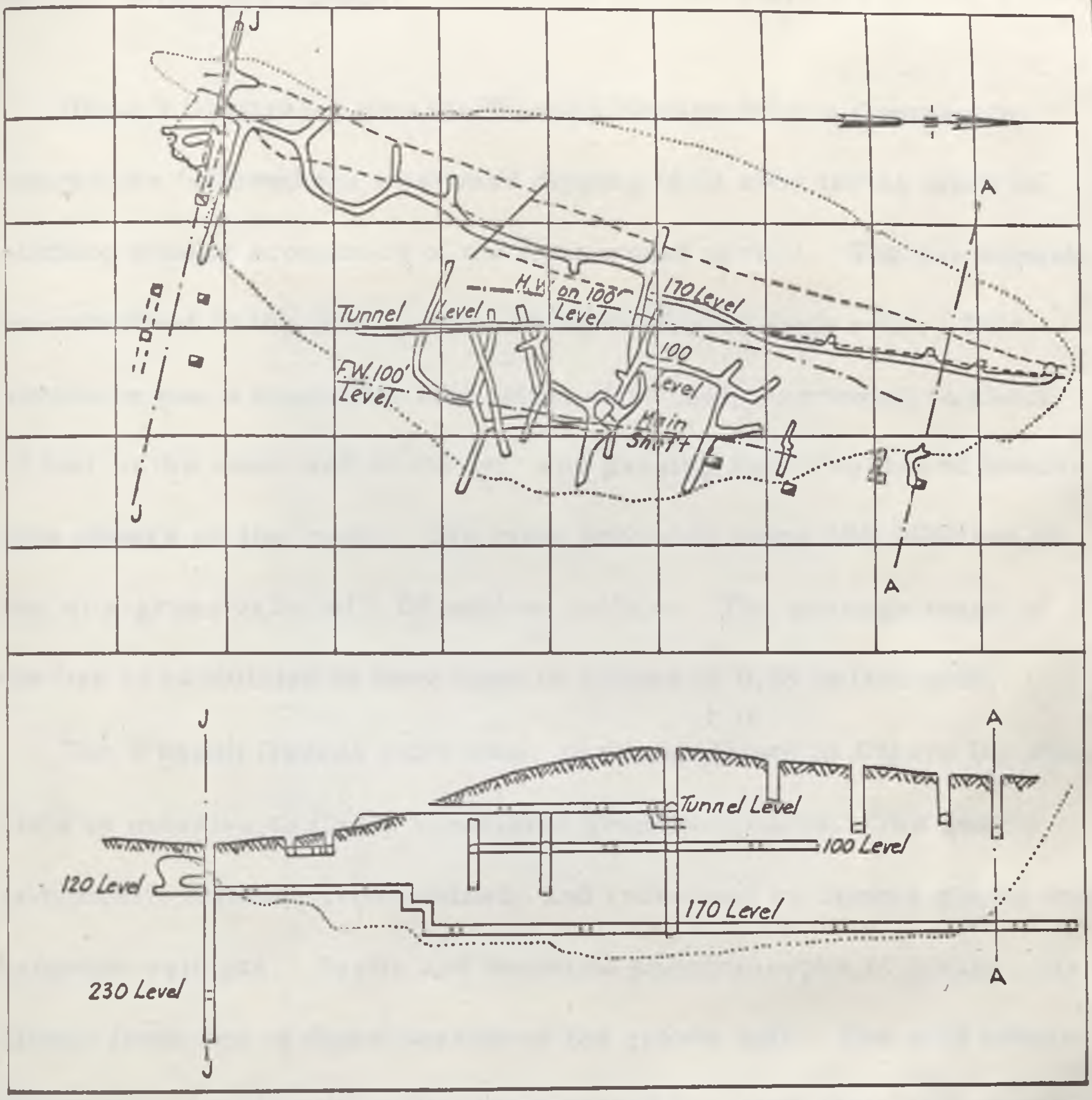


Figure 15.

Composite plan (above) and longitudinal section of the underground workings at the Weepah Nevada mine showing extent of development work completed prior to the start of open-pit operations. (After Oxnam, 1938). Dotted line shows approximate limits of mining.

Nature of the Ore Deposit

Plate 3 illustrates that the Weepah Nevada Mining Company's operations followed the westward dipping fault zone for as much as surface mining economics of the time would permit. The ore deposit was confined to the limits of the Weepah Nevada fault zone. This structure has a maximum true width of 55 feet, narrowing to about 10 feet in the south end of the pit, and passing into a series of imbricate shears on the north. The mine produced some 280,000 tons of ore at a gross value of 1.62 million dollars. The average tenor of the ore is calculated to have been in excess of 0.15 oz/ton gold.

The Weepah Nevada fault zone, partially shown in Figure 16, consists of massive to finely brecciated granular quartz. The quartz is typically friable, iron-stained, and traversed by minute quartz and hematite veinlets. Pyrite and hematite pseudomorphs of pyrite constitute from one to three percent of the quartz unit. The gold mineralization is found both finely disseminated in a free state and contained within the pyrite pseudomorphs. The fault boundary is marked by a thin slickensided fault gouge which occasionally contains brecciated fragments of the wallrocks.

The Weepah Nevada fault is offset approximately seven feet by a normal, northwest-trending cross fracture near the center of the pit (Figure 17). The depth and width of mining were increased due to this cross structure. Values apparently do not extend into the

Figure 16. Photograph of westward dipping Weepah Nevada fault. Greenish phyllitic strata of the Wyman Formation in the hangingwall shows only moderate deformation. Granulated brownish quartz marks the fault zone and is separated from the hangingwall by a thin gouge zone.

Figure 17. Photograph of northwest trending cross fault of the main Weepah Nevada structure. Displacement is less than 10 feet. Hangingwall shows moderate to locally intense deformation.

contorted phyllitic hanging wall. Several other structures of smaller magnitude are noted along the base of the hanging wall. However, except for the above mentioned cross-fault, none of the structural features in the walls contribute significantly to the configuration of the ore deposit.

In thin section, the fault vein is seen to consist of a polygonal mosaic of recrystallized quartz. Sericite typically marks the grain boundaries and fills intervening septae. Granular hematite, hematite veinlets, and jarosite are abundant.

Geochemical analyses show the Weepah Nevada fault to be distinctly anamalous. Table 1 shows a comparison of average values obtained from the fault zone and from enclosing phyllitic strata of the Wyman Formation.

TABLE 1: COMPARISON OF AVERAGE GEOCHEMICAL VALUES BETWEEN VEIN AND WALLS ALONG THE WEEPAH-NEVADA FAULT.

	Au*	Ag*	As	Sb	Hg
Vein	0.04	0.25	15,000	21	0.480
H. Wall	0.00	0.00	120	2	0.045
F. Wall	0.00	0.01	600	5	0.085

*Values for Au and Ag are in oz/ton; other values are given in parts per million.

The gold values in the fault vein are found free in the granulated quartz matrix, within concentrations of limonitic material, and integral with the pyrite or hematite-limonite pseudomorphs after pyrite. A large composite sample taken from the fault zone was separated. The tails were assayed and values of 0.015 oz/ton gold and 0.012 oz/ton silver were obtained. Sparse colors were obtained by panning the tails. The heads, consisting mainly of the hematite-limonite casts and pyrite, were assayed and a polished surface was prepared. Assay of the heads gave 0.34 oz/ton gold and 2.02 oz/ton silver, a weight ratio of 1:6. Several of the grains in polished surface show gold to be intergrown in the hematite pseudomorphs (Figure 18). Its lighter than usual color may indicate a natural alloy with silver.

Values in the hanging and footwalls are nil except where traversed by small sinuous quartz or quartz-mica pegmatite veinlets. In such occurrences higher values are recognized to be related either to primary disseminated sulfides or to concentrations of limonitic material. The footwall of the Weepah Nevada fault locally exhibits moderate alteration within several feet of the vein. In addition, the gouge zone may have been somewhat thicker than along the hangingwall. Along the footwall the phyllitic Wyman strata have been bleached, iron-stained, and locally abundant sericite and kaolinite have developed. Typically, unless the material is extremely iron-stained,

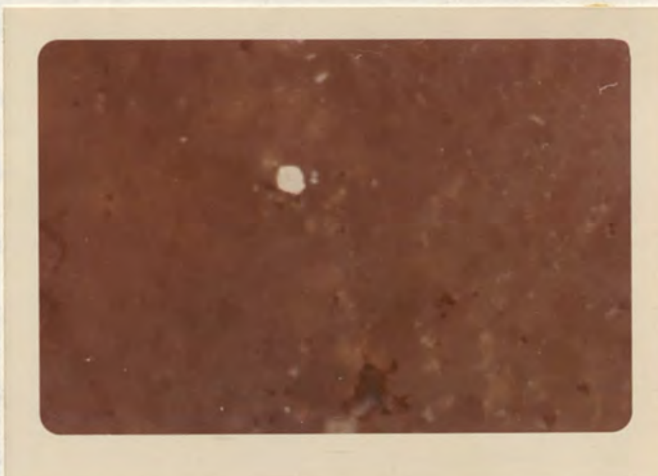


Figure 18. Photomicrograph showing gold contained in hematite pseudomorph after pyrite (1000 diameters, plane light). Lighter color suggests electrum rather than pure gold.

values are minimal. Along the footwall, the thin limy interbeds within the phyllitic strata have been converted to a quartz-diopside-epidote-grossularite hornfels. Locally, heavy concentrations of black tourmaline needles coat fracture surfaces and occasionally bedding planes.

Pyrite and rare arsenopyrite are the only identifiable primary sulfides. These minerals constitute less than one-half percent of the fault vein. Silver minerals are unknown. It is assumed that the gold is in electrum. The pyrite has been oxidized to hematite which typically alters to limonite and jarosite. Erinite ($Cu_3As_2O_8 \cdot 2Cu(OH)_2$), a pale emerald green mammillated copper arsenate of supergene origin, and extremely rare fracture coatings of blue-green acicular chalcophyllite ($20CuO \cdot Al_2O_3 \cdot 2As_2O_5 \cdot 3SO_3 \cdot 25H_2O$) were noted. These minerals, as well as supergene quartz, are also observed to the north of the small traverse fault. Rare minute veinlets, fracture coatings, and dendrites of manganese are common throughout the fault zone.

The massive quartz pods along and adjacent to the Weepah Nevada fault contain from a trace to 0.015 oz/ton gold and 0.03 oz/ton to 8.81 oz/ton silver. Galena, probably argentiferous, occurs as distinct grains. Pyrite cubes and hematite pseudomorphs are typical.

Sporadically cutting the granulated fault vein are slightly later translucent quartz veins to several feet thick. Primary sulfide minerals observed in these sinuous structures include pyrite, subordinate galena, and rare arsenopyrite. These veins are occasionally coarsely fractured and infrequently show a random development of irregular spongy masses of dark rust to reddish-brown limonite and quartz boxworks. The indigenous limonite is typically that of pyrite. Lack of conspicuous angularity of the boxwork cells indicates that only minor, if any, chalcopyrite or galena was present. A single occurrence of probable chalcopyrite limonite was found associated with these veins. The persistence of limonite in a nonreactive, highly acid, strongly oxidizing environment suggests that copper might have been present, probably as limonite-forming chalcopyrite. Pyrite is present either as unoxidized cubes or as dense hematite pseudomorphs. Fluffy fringing limonite frequently surrounds the hematite pseudomorphs. Galena tends to occur as rather discreet grains, commonly rimmed by a thin film of cerussite.

These sulfide-bearing quartz veins average 0.01 oz/ton gold and 0.12 oz/ton silver. Fracture surfaces typically have thin coatings of iron oxide and rarely thin flakes of specular hematite. Several of the quartz-limonite boxworks yielded gold values from 0.01 oz/ton to 0.10 oz/ton and silver values from 0.01 oz/ton to 1.74 oz/ton. The higher silver values are due either to argentiferous galena or to electrum. The limonite pods frequently have cavities filled with earthy, yellow-brown jarosite. Scattered fracture surfaces are also coated with drusy jarosite.

Discussion of the Ore Deposits

The ore deposit of the Weepah Mining district is a typical epithermal precious metal deposit of the gold-silver type. [The ore was localized along a shear dilation formed in response to the emplacement of the Weepah pluton, probably in Late Mesozoic time. The Weepah Nevada fault zone was locally filled by massive quartz veins which were subsequently brecciated and granulated by recurrent movement. Subsequently, siliceous fluids rich in gold, silver, and the typical epithermal assemblage were released along the structural channelway provided by the granulated fault zone. Locally, the width of the vein and attendant porosity provided a zone for rapid release of pressure. The fluids appear to have preferentially silicated the thinner carbonate interbeds while converting the more massive carbonate units to marble or coarsely crystalline dolomitic limestone. In the Weepah Nevada mine area, the gold and sulfide-bearing fluids encountered the non-reactive phyllitic to schistose wallrocks of the Wyman Formation. The porous fault zone and rare branching quartz veinlets provided the only suitable loci of deposition. The carbonate portions of the Wyman trapped the sulfides along thin quartz veins. These sulfides were subsequently enriched locally by supergene processes. Wallrock alteration is minimal, typical of the gold-silver class of epithermal deposits. Bleaching and iron-staining commonly indicate maximum alteration.

Exploration for another Weepah Nevada type deposit within the district would not be difficult. Recognition of parameters such as shear dilations, quartz veining, porosity, etc., is basic; however, the discontinuous nature of the fault veins must also be considered. Future targets may be further defined by anomalous values for arsenic, antimony, and mercury across zones of suspected mineralization. Present economics indicate that the Weepah mining district offers limited potential for commercial deposits.

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