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MILL CITY MINING DISTIRCT

by J. V. Tingley

The Mill City district is on the east flank of the Eugene Mountains in northeastern Pershing County. The site of the old town of Mill City, an 1860's era silver milling camp, is about 8 miles southeast on the Humboldt River. Today, a paved road leads to the tungsten mine area from Interstate 80 at Mill City.

Historically, the Eugene Mountains were included in the Central mining district in what was originally Humboldt County. The Central district was organized in 1862 with the principal activity centered around the 56 Mine on the south end of the range and the Golden Age and other mines on the north end of the range. Within that portion of the old Central district now included in the Mill City district old prospect pits on quartz veins near the Forge mine and along the south edge of the Springer stock may date back to the pre-1900 mining activity. When tungsten was discovered along Stank and Springer Canyons in 1916-1917, the surrounding portion of the southern Eugene Mountains was from then on referred to as the Mill City tungsten district. When Pershing County was formed from the southern half of Humboldt County in 1918, the Mill City district was included within the boundaries of the new county.

History and production

(based on informaion compiled by D. I. Segerstrom, 1971)

As best as can be determined, the tungsten deposits in the Eugene Mountains were discovered in the winter of 1914 by a party of prospectors headed by Emil Stank, then of Lovelock, Nevada. The party was in search of silver ore and, during the 1914 discovery, were not aware that the heavy, brownish white sand they noted in panning samples was scheelite. Stank recalled the material he had found in 1914 when, in 1917, the United States

government issued a call for tungsten minerals. In March, 1917, Stank and others returned to the Eugene Mountains and filed claims on the area now known as Stank Hill. At this same time, Thomas Sutton filed claims on the South Sutton outcrops and another group filed claims on the area that later became the Humboldt Mine. Within sixty days of its location, the Stank discovery had been taken over by a group known as the Pacific Tungsten Company. Thomas Sutton formed the Mill City Tungsten Mining Company to work his claims, and the Nevada-Humboldt Mining Corporation was formed by L. T. Friedman to exploit claims on Humboldt Hill. Thus, by the fall of 1917, three companies were operating in the district. Pacific Tungsten was operating mainly on showings along the southwest margin of the district on Stank Hill; Nevada-Humboldt controlled the tactite occurrences generally along the northwest margin of the Springer stock; and the Mill City Tungsten group was operating on showings along the wastern edge of the stock.

In early 1918, W. J. Loring, a prominent California mining operator, optioned the Pacific Tungsten Company and joined with the Mill City Tungsten Mining Company to form the Pacific Milling Company which then began construction of the 150-tons-per-day Pacific Mill. Loring meanwhile purchased 75 percent of the Mill City Mining Company, and Charles Segerstrom, Sr. purchased the remaining 25 percent. This marked the entrance of the Segerstrom family into the district. Also during 1918, the Nevada-Humboldt Company formed a subsidiary, Tungsten Products Company, which then began construction of the 100-tons-per-day Humboldt (Freidman) Mill.

Also at this time, all three of the operating companies joined together to form a subsidiary, the Mill City Development Company, for the purpose of bringing water and power into the district. A six-inch water line was brought in from a well near the Humboldt river, about 6 miles away, and a power line

was extended from near Oreana to the tungsten district. With both power and water available, the Pacific Mill was started in the first part of November, 1918, and the Humboldt Mill was tuned up in December, 1918. The declaration of World War I Armistice in November of 1918 and the resulting crash in the price of tungsten caught the operating companies at Tungsten (the mine-mill camp was now known as Tungsten) with ore on hand and large construction debts. The companies ceased operations in February of 1919. Later in the spring of 1919, the Nevada-Humboldt holdings were purchased by United States Smelting, Mining, and Refining Co., Hayden, Stone and Co. (investment bankers), and E. A. Clark. Pacific Tungsten, meanwhile, was forced by its creditors to be sold at Sheriff's sale. The Nevada-Massachusetts Company, headed by Charles Segerstrom, Sr. purchased the Pacific Tungsten Company and later also purchased all of the assets of the Nevada-Humboldt Company. By 1925, the Segerstrom-controlled Nevada-Massachisetts Company had thereby consolidated all of the district and from that date until 1958 when operations ceased, the Nevada-Massachusetts Company was the sole operator at Tungsten. During the period between 1919 and 1925, the Humboldt Mill had been partially dismantled and it never operated again. The old Pacific Mill was used by the Nevada-Massachusetts Company who enlarged it to an eventual capacity of 250 tons-per-day. In 1940-41, Nevada-Massachusetts Co. constructed a new, 1000 tons-per-day mill about 1500 feet southeast of the Pacific Mill to retreat tailings from the old mill. This new mill was in operation when the Pacific Mill burned on November 11, 1943. The new mill was adapted to allow it to treat mine ore, and within six months full operations were resumed. Between 1944 and 1958, other than for a few shutdowns due to labor strife and low tungsten prices, the mines at Tungsten operated continuously. In 1944, a post office was established at the mine camp. and the town name officially

became Tungsten, Nevada. Following collapse of the tungsten price in 1957, the operations at Tungsten came to a halt, mining and milling completely stopped in mid-1958. The properties were maintained on standby until 1962 when most of the physical equipment was sold at auction, and the property was placed on caretaker status.

In 1969, the Nevada-Massachusetts Company was dissolved, and the properties at Tungsten were acquired by Tungsten Properties, Ltd., a partnership composed of the heirs of Charles Segerstrom, Sr. The properties at Mill City lay idle until 1971 when the General Electric Company, through its Refractory Metals Products Department of Cleveland, Ohio, negotiated an agreement with Tungsten Properties, Ltd. and began an evaluation program in the district. Following an extensive exploration and development program, General Electric developed sufficient ore reserves to proceed with the construction of a 55 million dollar mine, mill, and chemical processing plant complex. The operation began anew in early 1982, with an announced 13 to 15 years of ore reserves, only to close in late October of that year due to an again depressed tungsten market. The mines at Tungsten are again on standby with their future, in mid-1983, unclear.

The first production from the tungsten mines in the Mill City district, in 1917, was trucked to the Toulon Mill, southwest of Lovelock, Nevada, for treatment. As near as can be ascertained from old reports, the first ores from the district consisted of 525 tons of 3.67 percent WO_3 from the Stank out-croppings, 56 tons of 1.72 percent WO_3 from the Springer, 53 tons of 3.59 percent WO_3 from the Durnan-Kinney (George) lease, and 1611 tons of 2.70 percent WO_3 from the south Sutton No. One Mine. During the first period of company operations, between 1918 and 1919, an additional 14,937 tons of ore containing 1.69 percent WO_3 were shipped to Toulon and, beginning in late

1918, 20,774 tons of ore of 0.84 percent WO_3 were milled in the two mills on the property. The grades given here are recovered grades, mined grades would be higher by an amount depending on individual mill recoveries.

Production during the period of operation by the Nevada-Massachusetts Company, 1925 through 1958, is divided into two time periods, 1925 through September, 1944 and from late 1944 through 1958. The time break is marked by the burning of the old Pacific Mill and the post-1944 production was entirely treated at the new, larger mill. Between 1925 and 1944, a total of 1,049,714 tons of ore averaging 1.17 percent WO_3 were treated, recovering 1,100,773 stu of WO_3. From late 1944 through 1958 an additional 2,073,565 tons of ore containing 0.42 percent WO_3 were mined and milled, resulting in a production of 685,365 stu of WO_3. The drastic drop in mined grade from 1.17 WO_3 to 0.42 percent WO_3 shown in the pre-1944 and post-1944 averages is explained by the shift from the Stank and Humboldt mines to the lower-grade Sutton mines for the bulk of production after 1944, and by the addition of large, low-grade tonnages from the several open pits in the 1950's. The open pit grade, at best, averaged from 0.22 to 0.25 percent WO_3. Total recorded production of the Mill City district, 1917 through 1958 is 3,161,235 tons of ore from which about 2 million units of WO_3 were recovered. This does not, of course, include the small production by General Electric during its short-lived operation in 1982.

Geologic setting

Rocks exposed in the Mill City district are largely composed of a thick section of shales, quartzites, and limestones of Triassic age. In mid-Mesozoic time, regional westwardly-directed folding and thrusting caused the sedimentary section to be folded and overturned to the west. Beginning in late Cretaceous time and extending into early Tertiary time, the Triassic

rocks were invaded by several small stocks, mainly granodiorite in composition, and were locally metamorphosed to hornfels, marble, and tactite. Tungsten mineralization, in the form of scheelite, accompanied or closely followed this igneous activity and the ore bodies at Mill City formed in certain tactite beds, mainly those associated with the Springer granodiorite stock.

Triassic sedimentary and metamorphic rocks

Metamorphosed sedimentary rocks cropping out within the Mill City tungsten district are assigned to the lower part of the Raspberry formation of upper Triassic age. Fossil remains of the pelycepod Monotis subcircularis, Gabb, have been found in the sedimentary sequence exposed along the eastern range front, generally from the Sutton limestone horizon east. This fossil is characteristic of upper Triassic (Norian) time. The Raspberry Formation in its type locality, in the East Range across the valley to the east of the Eugene Mountains, has an exposed thickness of 3,000 feet (Ferguson and others, 1951). At Tungsten, in the Mill City district, the thickness of the sedimentary sequence in the mine area ranges from 6,000 feet in the north to 6,800 feet in the south. Since there is considerable repetition of beds due to faulting, this thickness could be as much as twice the actual stratigraphic thickness of the Raspberry. Locally, the formation consists of shales, quartzites, and thin limestone horizons. The lime units range from a few feet to more than thirty feet in thickness and, although they are commonly lenticular along both strike and dip, they are stratigraphically persistent, and they can be traced and correlated very successfully within the district.

Unmetamorphosed limestones cropping out in the eastern part of the district are dark gray with some sooty appearing bands. These beds have a uniformly high total carbonate content (75% to 95%) and characteristically

have thin, wavy bedding, with individual beds ranging from a fraction of an inch to a few inches in thickness. This group of limestones includes the important Sutton horizon and also those beds to the east of it, the Mill beds and the beds exposed in the Forge mine area. Lime units exposed in the central portion of the district include the Humboldt-Springer-Stank-O'Byrne bed, the George-Yellow Scheelite, and beds to the west including the Ribbon beds. These beds tend to be more massive, but are otherwise similar in appearance and composition to the eastern limestones. West of the mining area, a third group of limestone horizons crop out. These units have not been metamorphosed to the same degree as those to the east, and they are not known to contain tungsten mineralization. These units, as a group, are more dolomitic, contain less total carbonate (from 50% to 89%), and are generally lighter in color than are the upper (eastern) units.

Those limestone horizons in the western part of the district are oldest, the section is younger to the east. About 1,000 feet of hornfels separates the eastern swarm of thin limestone units from the central limestone croppings, and another 1,500 to 1,600 feet of hornfels lie between these units and the easternmost limestones on the eastern flank of the district. Throughout the district, the predominant rock type is shale, now hornfels where it has been metamorphosed. Compact, blocky, soft brown hornfels predominates, but near the tactite ore bodies, hard, banded chertlike gray and green hornfels is common. In the soft brown hornfels, quartz, biotite, and hornblende predominate; in the hard gray and green hornfels, quartz, actinolite, tremolite, and sometimes epidote and pyroxene, are most abundant.

Units of fine-grained quartzite occur in several horizons within the mine area. Where present, the quartzites have been silicated, and they are difficult to distinguish from some of the hornfels units. Lenticular layers

of pale green and grey silicate rock, sometimes containing garnet, epidote, and some scheelite, occur along at least two former quartzite horizons, one east of the Humboldt limestone-tactite bed and another east of the Sutton horizon. These silicated zones probably represent lenses of calcareous material within the quartzite.

Intrusive rocks

The sedimentary section at Tungsten has been invaded by a series of small granodiorite to quartz monzonite stocks and related dikes, andesite dikes, and some pegmatites. The granodiorites are medium to coarse-grained hypidiomorphic granular rocks, characterized by large books of black biotite.

Although the several granodiorite stocks at Tungsten are of slightly different ages, they are all similar in outward appearance and composition. The three largest granodiorite stocks are, from north to south, the Olson, Uncle Sam, and Springer stocks. To the southwest of Stank hill a group of small outcrops are collectively named the Southwest stocks, and another distinctly separate body outcrops in the wash and hill west of the Forge mine. In order of outcrop size, the Olsen stock is the largest, with the Springer stock the next largest. The tactite ore bodies at Tungsten are spacially if not genetically related to the Springer stock. The Uncle Sam stock is a smaller granodiorite mass lying between the Olsen and Springer outcrops and is probably part of the Springer.

Samples of several of the granodiorites were taken, during the General Electric program in 1972, and were sent to Geochron Laboratories for Potassium-Argon dating. The Olsen stock, and dikes related to it, are the oldest intrusives in the mine area. The stock itself was dated at 86.8 ± 3.2 m.y., a dike to the west of the area was dated at 88.9 ± 3.2 m.y. The Springer stock, at 78.4 ± 2.9 m.y., and the Forge stock, at

78.9 ± 2.9 m.y., are next oldest. Adularia from a pegmatitic vein cutting the Springer gave a date of 76.0 ± 2.7 m.y. and adularia from a scheelite-bearing quartz vein cutting mineralized tactite along the south margin of the Springer stock was dated at 72.0 ± 2.6 m.y., clearly relating tactite formation and later scheelite mineralization to the Springer intrusive event. A sample taken from the small Southwest stock, south of the Codd and O'Byrne mines, was dated at 66.5 ± 2.5 m.y., representing a later and third pulse of intrusive activity.

In addition to the granodiorite bodies, hornblende andesite dikes occur throughout the district. Some of these are probably related to early phases of the granodiorite, and are pre-mineral. Pre-mineral andesite dikes occur locally where they appear to have been intruded as sill-like bodies along bedding. Younger, post-mineral andesite dikes show cross-cutting relationships to tactite bodies in some areas.

Rock alteration

Within the mine area, almost all rocks show silication, alteration to hornfels and tactite. The hornfels is usually green or light gray, with fracture fillings of quartz and epidote. On Sutton, Humboldt, Springer, and Stank hills in the center of the mineralized area, the hornfels itself has been silicified. The areas of silicification roughly coincide with the areas of tungsten mineralization and quartz veining in nearby rocks. Within the originally limestone portion of the section, ~~silicification~~ silication has resulted in the formation of various grades of tactite. The sequence of replacement, from limestone to marble, to light silicate tactite, to dark silicate tactite, is recorded along many of the tactite outcrops in the mine area. Often in a single hand specimen, gray limestone can be observed to grade into bleached white marble containing tremolite and actinolite, then into garnet or epidote

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tactite. Specimens from the O'Byrne Mine indicate that the limestone horizon there was fractured prior to or during replacement, as irregular blocks of limestone occur rimmed by white-silicated marble, and the fracture zones are occupied by epidote veinlets containing scheelite.

Alteration within the intrusive rocks is not apparent as it is within the sedimentary section. Minor kaolinization and sericitization occur in the Forge stock, associated with quartz veining containing minor amounts of molybdenite and chalcopyrite. Similar alteration occurs along quartz and pegmatite veins in sections of the Springer stock. These veins contain some copper minerals, and sometimes have blocky fine-grained tourmaline smeared along the vein walls. Outcrops of dike-like granodiorite masses along Springer gulch, west of the Springer mine, have been sericitized, with all of the original biotite altered to muscovite.

Structure

The general strike of the sedimentary rocks within the district is N. 10° to 30° E. The areas west of the Stank fault, and at the south end of the district near the Forge Mine, the rocks dip steeply east. Along the eastern side of the district, generally east of the Stank fault and north of the Forge Mine, the section dips steeply west. Sedimentary features indicate that the east-dipping beds are right side up, their tops being to the east. The west-dipping beds are overturned, their tops still being to the east, but now facing down.

Various explanations have been formulated over the years, by the numerous workers in the district, to explain the structural relationships across the Stank fault. Recent mapping, along with the dating of the intrusive bodies both intersected by and intersecting the fault, may help in the interpretation of this feature. The Stank is one of many north-south striking faults, with

mainly right lateral offsets, which cut the rocks in this portion of the Eugene Mountains. Many of these faults are pre-mineral, and are known only by offsets of the major tactite ore bodies within the mine area. Known as "sealed faults" to the local mine operators, they are marked by zones of intense silicification around abrupt terminations of tactite bodies in the mines. A fault of this type forms the south end of the Humboldt ore body and the corresponding north end of the Springer ore body; each ore body formed in segments of the same limestone horizon which had been cut and telescoped alongside themselves across the pre-mineral structure.

The Stank fault itself is post-mineral, it cuts and offsets mineralized portions of the Stank-Humboldt-Springer bed, the offset portion of this bed, mined as the Summit-O'Byrne ore bodies, is across the fault some 2,000 feet north of the severed south end of the Stank bed. Mapping has shown that the Stank fault cuts the Olsen granodiorite, it is cut by the Southwest granodiorite stock, and, since it also cuts tactite formed by the Springer granodiorite, movement on the Stank fault post-dated the time of emplacement of the Springer granodiorite. Dating of the granodiorite bodies allows the time of Stank fault movement to the placed between the Springer stock age of about 78 m.y. and the Southwest stock age of about 66.5 m.y. The problem of dip change across the Stank fault reamins unsolved. The eastern margin of the Springer stock, in the area of the deep Sutton workings, has been shown by recent drilling to be nearly conformable to the dip of the intruded rocks. The contact dips to the west and in some areas essentially forms a hanging wall for the Sutton Two tactite occurrences. This infers that the beds had been overturned to their present westerly dips prior to intrusion of the Springer stock. The pattern of right lateral offset, with bed segment being offset south as you move east across the district is apparent from the outcrop

pattern displayed by the mappable limestone horizons. The mill bed horizon, on the eastern edge of the outcrop area, east of the main workings, shows some rotation in strike as well as right lateral offset.

The north-south structures have caused a relative shortening and thickening of the sedimentary section and many of the limestone horizons were effectively doubled by related near-bedding-plane movement. Evidence of a northwest structure of regional importance can also be seen in the southern Eugene Mountains in the mine area. This feature may pre-date some, if not all, of the intrusive activity and may have served as one of the structural features controlling their emplacement. This lineation can be seen on regional aerial photographs of the area, and on areomagnetic maps. Both show a definite northwest pattern of lineations across the center of the old mine camp and the Springer stock. In rock outcrops, these features are expressed by northwest-trending swarms of quartz veins cutting across the Springer stock, and by outcrops of small intrusive bodies and dikes which crop out in a general northwest line beyond the Springer stock. The intersection area of the north-west features and the north-south fault zones is occupied by the Springer stock and the associated mineralized tactite bodies which surround the stock.

Scheelite ore deposits

The scheelite deposits in the district occur in roughly parallel limestone beds that have been altered to tactite. The main production has come from a few distinct beds that cross the district in a general northerly trend. The production zone is about a mile long and about three quarters of a mile wide. The zone is bounded on the north by the Olsen stock, the southern boundary is a gradational limestone-tactite boundary related to distance from the mineralizing Springer stock. Proximity to the Springer stock also

generally controls the eastern and western limits of tungsten mineralization. Three ore bodies within the Humboldt-Springer-Stank bed (the Humboldt, Springer, and Stank mines), and two ore bodies within the Sutton horizon (the Sutton No. One and Sutton No. Two mines), have produced essentially all of the tungsten ore from the district. Small tonnages of ore have been produced from the Yellow Scheelite-West-George bed at Tungsten and from other small occurrences in Pole Canyon, north of Tungsten.

Scheelite is present in the ores as disseminations and fracture coatings in tactite bodies and as irregular blebs and crystal masses in quartz veins which cut granodiorite and tactites. In addition to scheelite, the mineralized zones also contain small amounts of molybdenite, chalcopyrite, rare bismuthinite, and up to several percent pyrite. Powellite occurs, only as a secondary mineral, associated with molybdenite. Some of the scheelite in the ores contains molybdenum and displays the creme to golden yellow fluorescence indicative of a small percentage of molybdenum substituting for tungsten in the mineral. This mineral is still scheelite, however, not powellite as it is sometimes termed. Gangue minerals associated with the tungsten ore bodies are contact silicates, and consist of low temperature silicate zones that contain wollastonite, tremolite, and calcite. In the higher temperature zones, these minerals have been replaced by silicates with higher iron content, including diopside and pale garnet. In the actual tactite zones, the early, light silicate minerals have been mostly replaced by diopside, grossularite garnet, and epidote along with quartz and calcite. In addition to iron, silica, in the form of silicate minerals and vein quartz is the most ubiquitous addition to the contact rocks. The most important scheelite ore bodies are localized in those areas displaying the most intense silication and silicification. Some of the best grade ore, in fact, consists

of scheelite crystals imbedded in glassy quartz and fine-grained epidote. Klepper, 1943, used the term "vitreous scheelite porphyry" to describe this type of ore.

The host rocks at Tungsten are the relatively thin limestone members of the lower Raspberry Formation, specifically those units locally named the Humboldt-Springer-Stank bed, the Yellow Scheelite-George bed, the Sutton beds, and the Mill beds. Other potentially favorable limestones occur in the section both above and below the known productive horizons, but nowhere in outcrop or mine workings are they seen in contact with the igneous source rocks. Intense silication (formation of hornfels and tactite) and silicification (silicification of hornfels and quartz veining in all rock types, including tactite) is closely associated with the main ore occurrences at Tungsten and is largely confined to the margins of the Springer stock. Tactite has also formed in certain areas within the contact aureoles of the Olsen, Forge, and Southwest stocks, but the individual tactite bodies formed in those areas are small, do not display extensive silication or silicification, and are generally low in scheelite content.

Potassium-argon dating of the Springer stock, and of the veins which cut the Springer and of other veins which cut mineralized tactite, provide definite time brackets within which the mineralization occurred. The Springer stock was dated at 78.4 ± 2.9 m.y. Adularia from veins cutting the Springer stock, and which contain scheelite, have been dated at 76.0 ± 2.7 m.y., and adularia from scheelite-bearing veins which cut mineralized tactite in the south Sutton pit were dated at 72.0 ± 2.7 m.y. The scheelite in the Sutton tactite ores contains intergrowths of both blue-white and yellow fluorescing scheelite while the cross-cutting veins contain only scheelite that fluoresces blue-white. Tungsten mineralization is interpreted to have been

contemporaneous with or soon after the emplacement of the Springer stock. There were at least two periods of scheelite formation, the latest at 72.0 ± 2.6 m.y.

Deposits related to the Springer stock

Humboldt bed occurrences

Constantine workings: The Constantine workings are on the northwest segment of the Humboldt bed, and are on the portion in contact with the Olsen stock. As it was under separate ownership, the Constantine was developed separately from the main Humboldt Mine and thereby acquired a separate name. Later, the property was mined underground through the Humboldt workings, and use of the name "Constantine" was dropped.

Humboldt Mine: The portion of the Humboldt bed extending from the Constantine on the north to the south Humboldt pit, south of the Humboldt shaft, is known as the Humboldt Mine. Within the segment of the Humboldt bed, numerous cross faults have caused offset of the mineralized tactite, but mining advanced from outcrop down to the 1800-foot level. Mineralization was confined to a section of tactite extending from the Olsen stock contact south to a pre-mineral fault which offset the bed northwest forming the Springer Mine segment.

Springer Mine: In the Springer portion of the Humboldt bed, mineralization occurred between the pre-mineral fault forming the north boundary, south to the contact with the Springer stock. Early in the life of this part of the mine, ore was removed through the old Springer shaft; later, all mining was done from the Humboldt workings.

Stank Mine: The Stank portion of the Humboldt bed lies between the southern margin of the Springer stock and the Codd workings, south of Stank canyon. The Stank is one of the earliest developments in the district, and has been mined from the surface down to 1,300 feet.

Codd Mine: The Codd portion of the Humboldt bed is actually the southern end of the Stank Mine. Little ore was mined through the old Codd adit and shaft, most ore having been removed through the lower Stank workings. South of the Codd, the Humboldt bed is cut and offset by the Stank fault.

Summit Mine: The Summit Mine is on the faulted, and what would have been the southern extension of the Humboldt bed. The Summit extends from the southwestern or hanging-wall side of the Stank fault in the George Pit, across the top of Stank Hill, and south to a contact with part of the Southwest stock. The Summit segment of the bed has been mined from the adit level to the surface, but produced only a small tonnage of ore.

O'Byrne Mine: South of the Summit workings, the Humboldt bed has been mined as the O'Byrne bed. This segment of the bed has been slightly offset across a portion of the Southwest stock which cuts between the Summit and O'Byrne workings. The bed extends from this point south to its contact with the main portion of the Southwest stock, south of the lower O'Byrne adit. The Humboldt bed has not been mined south of this point, and appears as unmetamorphosed limestone in its outcrop on the ridge south of Stank Canyon.

George Bed Occurrences

The George bed lies 200 to 300 feet stratigraphically below Humboldt bed, and is the next major bed west of the Humboldt-Springer mines. It can be traced from its contact with the Olsen stock, west of the Constantine workings, south to the point where it is cut by the Stank fault in the face of the George Pit.

The Yellow Scheelite bed, lying west of the Stank portion of the Humboldt bed, may correlate with the George bed in that part of the property. Both the Humboldt and George beds have been "bowed out" and offset to the west around the western margin of the Springer stock. This faulting exlains the separation between the north end of the Yellow Scheelite bed and the south end of the George bed. South of the Stank fault, in the offset or hanging-wall block, the George bed is believed to be the partially metamorphosed West bed. As the West bed, it crops out in the saddle west of Stank Hill, in the ravine west of the O'Byrne adit, and on the ridge south of Stank canyon. Only limited mining has been done on the George bed, mostly in the portion of the bed lying immediately west of the Springer Mine.

Ribbon bed occurrences

The Ribbon beds lie 400 to 500 feet down-section to the west of the George bed and are the western-most beds in the section which show traces of metamophism and scheelite mineralization. The Ribbon beds are composed of thin alternating bands of blue-black limestone and hornfels. Although the beds are complexly faulted, they can be traced from the area of the George Pit, across the Stank fault, and south to the Miller's Cabin area.

Other than a few prospect pits sunk on small tactite pods within parts of the beds, no mining has been done on the Ribbon beds.

Sutton bed occurrences

The parallel Sutton beds, the Sutton horizon, can be traced from their contact with the Olsen stock, at the Uncle Sam Pit, south through both of the Sutton Mines, and on south along the eastern front of the range almost to the Forge property. North of the Uncle Sam, segments of the Sutton beds outcrop at the U.S. Mint prospect.

Uncle Sam workings: The Sutton beds exposed in the Uncle Sam Pit show repetition due to faulting. Both of the beds grade into unreplaced blue limestone at their intersection with the Olsen stock indicated the the Olsen intrusive was not responsible for metamorphism and mineralization in limestones to the south. A small tonnage of ore was mined from the Uncle Sam adit and open pit, but most of the lower extension of the Uncle Sam was mined underground from the Sutton No. Two workings.

Uncle Sam Midway and Baker workings: Both of these names refer to early operations on the Sutton beds north of the Sutton No. Two adit. Both areas were later mined underground as part of the Sutton No. Two Mine, and the older names no longer have significance.

Sutton Two foot wall: Portions of the Sutton beds which have been faulted and moved into position parallel to and east of the Sutton No. Two Mine have been mined as the Sutton Foot Wall beds. These beds represent segments of the main Sutton bed which have been down-dropped to the east and moved across a series of steep faults. Some ore from this part of the mine was taken out from the Sutton Two Mine underground, but most was removed by surface methods from the Sutton Foot Wall Pit.

Sutton No. One and No. Two Mines: The main portion of the Sutton beds, lying along the east margin of the Springer stock, has been mined through the two Sutton shafts.

From the northern (Sutton Two) shaft, the Sutton beds were mined north under the Baker, Sutton Two Footwall, and Uncle Sam areas. From the southern (Sutton One) shaft, mining extended north to the fractured area near the Springer stock contact, and south to the limit of mineralization, near Stank Canyon. Open pit operations were conducted on the faulted portion of the beds north of the Sutton One shaft (Orphan workings) and on the beds south of the Sutton One shaft (Sutton One Pit). At the south end of the Sutton One Pit, the beds are only partially replaced; and they grade into unreplaced limestone south of Stank Canyon.

Mill bed occurrences

The Mill bed is the next limestone unit up-section to the east from the Sutton beds, and lies 1,000 to 1,200 feet stratigraphically above the Sutton beds.

Although no ore has been mined from the Mill bed, it contains tactite and some scheelite in two widely separated areas along strike. One area, north of the old Tungsten town site, was superficially examined by the U.S. Bureau of Mines in the 1950's. The other area is immediately east of the old mill foundations, south of the town site. Neither of these exposures has been fully evaluated.

Along the range south of the town site and extending to the Forge property, the Mill bed is well exposed but shows no trace of replacement or mineralization. North of the area trenched by the U.S. Bureau of Mines, the Mill bed may be represented by several unconnected, faulted segments of limestone which crop out in the pediment area east of Olsen Canyon. Some of

these segments are completely replaced by tactite and show good scheelite mineralization. Due to the complexity of faulting and alluvial cover, no mining has been attempted on these occurrences. To the north, extending to Pole Canyon, the Mill bed is unreplaced and unmineralized and crops out as a dark gray limestone unit.

Pod-like tactite occurrences

At several places within the Tungsten area, prospecting has been done on what seem to be good outcrops of scheelite-bearing epidote tactite. These outcrops, upon close examination, are revealed to be discontinuous, pod-like lenses of epidote which occur within a largely hornfels section. These zones are seen at the same stratigraphic horizons throughout the porperty, and probably represent a part of the section which was originally quartzite containing lenticular pods of limey material. The limey pods have been replaced by epidote tactite and show spotty scheelite mineralization, but due to their lenticular shape and limited tonnage potential, these zones offer little potential for mineable ore.

One such pod horizon occurs below the Humboldt bed and has been prospected east of the Humboldt Mine workings on the flank of Humboldt Hill, and east of the Stank Mine on the nose of Stank ridge.

A second, lower pod horizon lies below the Sutton beds, roughly half way between the Sutton and Mill horizons. This zone has been prospected on the east face of Sutton Hill, the east face of the hill above the old mill site, on the east face of the ridge east of the Sutton No. Two portal, and on the small hill east of the Olsen stock south of Olsen Canyon.

Deposits related to the Olsen stock

Deposits attributed to the Olsen stock contact aureole display less intense silication and silicification than do those deposits related to the Springer stock.

Metasomatic effects are limited, and nowhere appear to extend for great distances from the intrusive contact. Along the southern edge of the stock, metasomatic effects are more intense than they are along the other margins of the stock, but this is explained by the presence of the Springer stock to the south. East of the main Olsen stock, tactite formed in faulted segments of the Mill and Sutton beds may be related to the Springer Stock or they may have formed in the upper, more silicated portion of the Olsen contact zone, and are now down-faulted into their present position.

Florence Hill prospects: These prospects lie along the northeast boundary of the Olsen stock, and represent areas of moderate silication and scheelite mineralization. The tactite at the western Florence Hill prospect is restricted to a few inches in thickness, and rapidly grades into barren limestone along strike away from the contact zone. The main Florence Hill prospects, further east along the contact, display wider tactite zones but they also rapidly grade into barren limestone along strike to the north. There is no record of production from these two areas.

U.S. Mint prospect: The U.S. Mint prospect is in an undeveloped segment of the Sutton beds which lie east of Florence Hill, north of the eastern limb of the Olsen stock. Although the beds in this area are not intensely silicated, as they are further south near the Springer stock, pale garnet tactite has been formed along almost 900 feet of outcrop, and some scheelite is present.

Deposits related to the Forge Stock

The contact zone of the Forge stock displays weak silication similar to that related to the Olsen stock. Limestones cropping out on the Forge property are replaced locally by garnet tactites immediately adjacent to the contact with the intrusive. At the Forge Mine, one long adit and two shorter ones were driven to expose the most promising tactite bodies, but no ore was found.

Deposits related to the Southwest stock

The numerous small outcrops of intrusive rocks lying south of the Stank fault are grouped together and referred to as the Southwest stock. In the few areas where limestone units come into contact with these small intrusives, metasomatism is very limited, and is usually reflected by the formation of a narrow zone of white marble in the limestone. Small marble pods, with minor garnet, have been prospected on the ridge south of Stank Canyon where the southern portions of the Humboldt and George beds are cut by a small intrusive of the southwest group. Further south, near the southern edge of the outcrop area, and east of Miller's Cabin, a small eliptical-shaped intrusive has formed a narrow marble zone in the southern extension of the Ribbon beds. Several old adits and prospect pits are present in this area, but all of them probably pre-date tungsten mining in the area and were dug to explore large, milk-white quartz veins which also occur in the intrusive outcrop.

REFERENCES

Hersey, O. H., 1918, Report on certain properties in the Mill City tungsten district, Humboldt County, Nevada, unpublished private report.

Hyder, F. B., 1922, Report on tungsten mining properties of Pacific Tungsten and Humboldt Corporation, Pershing County, Nevada: unpublished private report.

Johnson, A. C., and Benson, W. T., 1963, Tungsten resources of Nevada: U.S. Bureau of Mines, unpublished report.

Kerr, P. F., 1934, Geology of the Tungsten deposits near Mill City, Nevada: Nevada Bureau of Mines and Geology Bulletin 21.

King, W. H., and Holmes, G. H., Jr., 1950, Investigation of Nevada-Massachusetts tungsten deposits, Pershing County, Nevada, U.S. Bureau of Mines, R.I. 4634.

Klepper, M. R., 1943, Tungsten deposits of the Mill City district, Eugene Mountains, Pershing County, Nevada: U.S. Geological Survey memo, unpublished.

Middlebrook, J., 1957, Geology at Tungsten, Nevada, Emphasizing structural aspects: UNR M.S. thesis, unpublished.

Segerstrom, D. I., 1971, A brief history of the Mill City tungsten mines, Pershing County, unpublished.

Tingley, J. V., 1973, Property evaluation and geologic study, Nevada-Massachusetts property: General ELectric Co., private report.

Van Siclen, M., 1920, Engineer's report of field examination of Claim No. 1062, Nevada-Humboldt Tungsten Mines Company: War Mineral Relief Board, unpublished report.

Chemical or x-ray fluorescence analyses on samples from tactite beds,

Table __.--Anal

Description	V	Cr	Mo	W	Mn	Y	Cd	Co	Nb	U	P
Humboldt Ore Sample	240	--	50	10,000	3700	--	--	--	--	--	10
West Bed	--	--	29	25,000	1400	44	--	--	19	--	46
O'Byrne	--	160	78	22.000	2600	120	120	--	--	--	217
Stank	--	600	78	19,000	3700	--	130	--	--	--	21
George Bed	--	--	84	--	4600	--	--	--	--	--	9
Summit	320	150	340	26,000	2900	29	--	40	--	110	29
Codd	--	440	110	16,000	3300	--	--	--	--	--	98
Sutton #1	--	53	49	1,400	3400	--	--	--	--	--	5
Sutton #2	--	120	150	22,000	4000	78	--	--	--	--	6
Forge	--	74	350	5,500	2800	--	--	--	--	--	14
Springer Bed	--	--	120	11,000	6000	--	--	--	51	--	33
Uncle Sam Bed	230	74	65	7,900	2700	--	--	--	--	--	2

*Wet chemical analysis

Potassium-argon dates, Mill City District

Sample location	Mineral dated	Age
N. W. Dike	muscovite	88.9 ± 3.2 m.y.
Olsen Stock	biotite	86.8 ± 3.2 m.y.
Springer Stock	biotite	78.4 ± 2.9 m.y.
Springer Veins	adularia	76.0 ± 2.7 m.y.
Sutton Pit Veins	adularia	72.0 ± 2.6 m.y.
Southwest stock	biotite	66.5 ± 2.5 m.y.

Dates by Geochron Laboratories for G.E.

BAKER WORKINGS

Other names ---------- Uncle Sam Midway, Sutton No. Two, North Sutton, New Springer
Location ---------- S26,T34N,R34E
U.T.M. 4,515,920N, 404,780E
Lat. 40°47'30"N, Long. 118°07'45"W
Base map ---------- Woody Canyon 7.5' quadrangle
Tungsten Production --- Combined with Sutton Mines

The Baker workings were on segments of the Sutton beds which were mined through surface and underground workings on the north side of the Sutton No. Two Mine hill, on the southwest side of Olsen Canyon, at an altitude of about 4,900 feet. This area was within the Olsen claim group of the Pacific Tungsten Company, and early development was separate from the main Sutton Mine to the south. After property consolidation by the Nevada Massachusetts Company, in 1925, underground mining was done through the Sutton No. Two Mine. The area is now included in the General Electric Company's new Springer Mine.

CODD MINE

Other names ---------- Stank Mine
Location ---------- S32,T34N,R34E
U.T.M. 4,514,275N, 403,506E
Lat. 40°46'30"N, Long. 118°08'30"W
Base map ---------- Woody Canyon 7.5' quadrangle (1982)
Tungsten Production --- Combined with Stank and other mines

The Codd Mine is on the south side of Stank Canyon at an altitude of about 5,180 feet. Mine workings consist of a shaft and adit but most of the ore was mined through the adjacent Stank Mine workings to the north.

The Codd ore bodies are in the southernmost exposures of the Stank segment of the Humboldt bed. Just south and uphill from the Codd workings the Stank segment is cut and offset by the Stank fault. Outcrops of the Codd ore bodies were of good grade, and some ore estimated to contain 1 percent WO_3 remains on the mine dumps.

CONSTANTINE MINE

Other names ---------- Humboldt Mine
Location ---------- S26,T34N,R34E
U.T.M. 4,515,720N, 404,160E
Lat. 40°47'15"N, Long. 118°08'W
Base map ---------- Woody Canyon 7.5' quadrangle (1982)
Tungsten Production --- Combined with Humboldt and other mines

The Constantine Mine is on the north side of Humboldt Hill at an altitude of about 5,250 feet. The mine was on a claim fraction not owned by the Nevada-Humboldt Corp. and it was developed separately from the Humboldt Mine during the pre-1925 mining period. After property consolidation, in 1925, the Constantine was developed as part of the main Humboldt Mine. It is on the northernmost exposure of the Humboldt tactite bed, just south of the southern margin of the Olsen stock. Mine workings are two adits that were driven on the tactite outcrops of the Humboldt bed.

DANNER MINES

Other names ---------- Red Hawk, Ben H. Jackson Prospect
Location ---------- S16,T34N,R34E
U.T.M. 4,520,000N, 401,600E
Lat. 40°49'30"N, Long. 118°10'W
Base map ---------- Woody Canyon 7.5' quadrangle (1982)
Tungsten Production --- 421 units WO_3 (1956, 1971-74, 1979)

The Danner Mines, or the Danner properties, include a large area on the crest of the Eugene Mountains near the head of Pole Canyon at an altitude of about 6,800 feet. The old Red Hawk and Ben H. Jackson Mines are within the Danner properties as are several prospects at the head of Bonita and Woody Canyons. Danner constructed a small gravity mill above Pole Canyon, just west of its fork in the center of Sec. 16, and in the late 1960's produced an unknown amount of scheelite concentrate which was sold to Kennametal in Fallon, Nevada. In 1971 a Canadian company optioned the Danner properties and conducted a limited mapping and diamond drilling program. Other companies have since continued exploration but the results of this work are unknown.

Tungsten mineralization is confined to thin bands of silicated limestone and tactite which occur in a thick section of hornfels and quartzite. These rocks in general strike N-S, and dip 60°-70° W. Narrow prophyry dikes follow the bedding in several areas on the property, and may be responsible for the weak silication. Spotty, but often high-grade, scheelite occurs in the silicated rock. One band of silicated rock is exposed in the area of the open pit, and has been explored for about 2,000 feet along strike. It extends through the old Red Hawk property and south. Diamond drilling of this band confirmed the presence of spotty scheelite over very narrow widths. Other parallel silicated bands have been explored, on the western side of the crest of the Eugene Mountains, but no extensive mineralization has been found.

FLORENCE HILL PROSPECTS, EAST GROUP

Location ---------- S23,T34N,R34E
U.T.M. 4,517,200N, 405,000E
Lat. 40°48'N, Long. 118°07'30"W
Base map ---------- Woody Canyon 7.5' quadrangle (1982)
Tungsten Production --- Unknown

The East Group, Florence Hill prospects, are between Pole and Olsen Canyons on the east flank of the Eugene Mountains, at an altitude of about 5,100 feet. First developed in 1918 the discovery was reported to be in a blue-gray limestone bed, about 6 feet thick, with garnet and epidote. Bunches of tungsten ore, containing 2.5 to 3.0 percent WO_3, were reported to occur in the garnet-epidote zones. Small quantities of a dark mineral, possibly wolframite or hubnerite(?), were present in the ore. Along a fault exposed in a pit south of the discovery cut bunches of ore containing 10 to 13 percent WO_3 were found and shallow shafts were sunk on these occurrences, but production from these workings is not known.

The eastern group of Florence Hill prospects are on the north contact of the Olsen stock. The limestone beds are in the Raspberry Formation, of Triassic age, and are the same beds as those mineralized at the Nevada-Massachusetts properties to the south. Faulting in the area north of the Olsen stock prevents the exact correlation of these beds, but the mineralized limestone could be the Sutton beds which contain the large ore body of the Sutton (Springer) mines.

FLORENCE HILL PROSPECTS, WEST GROUP

Location ---------- Sections 22 and 27, T34N,R34E
U.T.M. 4,516,850N, 404,070E
Lat. 40°48'N, Long. 118°08'W
Base map ---------- Woody Canyon 7.5' quadrangle (1982)
Tungsten Production --- Unknown

The West Group, Florence Hill prospects, are on the north side of Olsen Canyon on the east flank of the Eugene Mountains, at an altitude of about 5,400 feet. They were first developed in 1918 and are on the north contact of the Olsen stock. A short adit was driven on a limestone bed, from 5 to 6 feet thick, in hornfels. Tactite, with some scheelite is exposed at the south end of the bed, near the contact. This bed strikes N-S and dips 80°-85° W to vertical. Complex faulting, and the presence of the Olsen stock, prevent correlation of the limestone beds to those south of the stock, but they may be extensions of the George or Humboldt beds.

FORGE MINE

Other names ---------- Gold Coin, Iron Forge, Eureka Claims
Location ---------- S38,T33N,R34E
U.T.M. 4,512,350N, 404,600E
Lat. 40°45'30"N, Long. 118°08'W
Base map ---------- Woody Canyon 7.5'quadrangle (1982)
Tungsten Production --- None recorded

The Forge Mine is on the southeast flank of the Eugene Mountains, about a mile south of the old Tungsten townsite, at an altitude of about 4,400 feet. Rocks exposed in the area are shaley hornfels and thin limestone beds of the Raspberry Formation, of Triassic age, intruded and silicated by the Forge granodiorite stock, of Cretaceous age. The granodiorite has been dated at 78.9 (±2.9) m.y. At least six separate, narrow limestone beds have been identified within the largely hornfels section. These limestones probably correlate with the Mill Beds at Tungsten. Here they strike about north and dip 75° to 80° E. Short segments of two or three separate limestone beds are in contact with the margins of the stock, where exposed in the gully in the center of the property. These beds have been converted to massive garnet tactite containing scattered scheelite.

On the west side of the canyon, what appear to be older mine workings explore an area of quartz veins in the granodiorite. The most extensive mine workings are east of the canyon, on the southern point of the small spur-like hill of hornfels which juts away from the range at this point. A long drift adit exposes weakly silicified rock, with pods of garnet which have formed along a limestone bed from 10 to 15 feet thick. Scheelite mineralization is very sparse where exposed in the back of the drift. A fourth limestone bed, with weak silication, crops out east of the adit, and two more unaltered limestone beds crop out further to the east on the lower flank of the hill.

It is possible that a small tonnage of ore was mined from the property and shipped to the mills at Tungsten, but no records exist to confirm this.

The Forge Mine area was the focus of a short-lived molybdenum exploration project in the late 1960's. The property is now held (1983) by General Electric Co. (Utah International) who also control the major tungsten properties directly to the north.

GEORGE MINE

Other names ---------- George Pit, Hard Luck George, Durnan Lode
Location ---------- Sections 27 and 34, T34N,R34E
U.T.M. 4,515,500N, 403,910E
Lat. 40°47'N, Long. 118°08'15"W
Base map ---------- Woody Canyon 7.5' quadrangle (1982)
Tungsten Production --- Combined with Humboldt and other mines

The George Mine is west of Humboldt Hill, on the east flank of the Eugene Mountains, at an altitude of about 5,250 feet. The original George shaft is in sec. 27 and the George open pit is about 1,500 feet to the south in sec. 34. The George limestone-tactite bed is 200 to 300 feet west of the Humboldt-Springer bed in theis area, and can be traced from its contact with the Olsen stock south to where it is cut by the Stank fault, in the south face of the George pit. Along this nearly 2,000 feet of outcrop, several small open pits and shafts have been developed. During 1918, at the south end of the George bed outcrop, on what was then known as the Durnan Lode, about 53 tons of ore containing 3.59 percent WO_3 were mined and shipped to Toulon for milling. Segments of the George bed, immediately west of the Springer mine, were mined through the Humboldt mine train tunnel and the deep Humboldt shaft during the 1940's and 1950's. The George open pit was developed and mined during the early 1950's. The George bed ranges from 3 to 30 feet thick and it is cut and offset by numberous faults along its strike. Mineralization is spotty and zones of good ore alternate with zones that are almost barren marble or unreplaced limestone.

HUMBOLDT MINE

Other names ---------- Friedman, Humboldt-Springer, Constantine
Location ---------- Sections 26 and 27, T34N,R34E
U.T.M. 4,515,400N, 404,010E
Lat. 40°47'N, Long. 118°08'W
Base map ---------- Woody Canyon 7.5' quadrangle (1952)
Tungsten Production --- Combined with other mines

The Humboldt Mine is on the northwest side of Humboldt Hill, on the east side of the Eugene Mountains between Springer and Olsen Canyons, at an altitude of about 5,100 feet. Claims were staked here in 1916, on outcrops of mineralized tactite which cropped out along the western summit of Humboldt Hill. By February 1917 the area had been acquired from the original claim holders by the Nevada Humboldt Corp., and by October 1918 about 8,075 tons of ore containing 2 percent WO_3 were mined and shipped to the Toulon custom mill for treatment. A mill was built on the property during 1918 and between October 1918 and April 1919 a total of 15,220 tons of ore averaging 0.68 percent WO_3 were milled. Following consolidation of the Nevada Humboldt Corp. with the Nevada-Massachusetts Co. in 1925, the Humboldt Mine production was not reported separately from the district total. After 1925 mining on the Humboldt Mine segment of the Humboldt bed was done mainly through the deep Humboldt shaft. This shaft, a sometimes unstable opening which was collared in the outcrop of the ore body in the canyon between Humboldt and Springer Hills, followed the Humboldt bed down dip to 1,850 feet. The mine was developed on a segment of the Humboldt limestone and tactite bed, 2,000 feet in length, which lies between the southern margin of the Olsen stock (the Constantine Mine area) and the southern Humboldt pit on Springer Hill. The narrow Humboldt bed, limited on the north by the south-dipping Olsen stock and on the south by a gently north-dipping premineral fault, assumed the shape of a triangle with depth, and each working level became shorter. The ore grade was maintained around 0.6 percent WO_3, but the depth of the workings,

condition of the shaft, and the ever shrinking length of the mineable bed caused the ore tonnage contribution of the Humboldt Mine to decline by the early 1950's. The Springer segment of the Humboldt bed was mined through the Humboldt workings after 1925, but the Springer orebody also became very narrow with increasing depth, and was offset by faulting, both factors which contributed to cessation of mining on the Springer segment as well. During the period of open pit mining on the property, in the early 1950's, open pits were developed on the outcrop areas of the Humboldt bed on both Humboldt and Springer Hills. These operatons were relatively high cost, as the ore horizons were narrow, vertical beds and stripping ratios were high.

At the time of closure of the mine in 1958, it was estimated that about 50,000 to 70,000 units of WO_3 still remained in the Humboldt Mine. This ore is mainly below the old 1800 level of the mine.

IMLAY VIEW MINE

Other names ---------- Whinery Tungsten, Temple Group Mines
Location ---------- Sections 11 and 12, T33N,R33E
U.T.M. 4,510,400N, 397,300E
Lat. 40°44'30"N, Long. 118°13'W
Base map ---------- Imlay 15' quadrangle (1956)
Tungsten Production --- None recorded

The Imlay View Mine is near the southeast end of the Eugene Mountains, about 7 miles northwest of Imlay, at an altitude of about 5,300 feet. Located in 1939 by Emil Stank and Ira Stanley the property is developed by several cuts, a shallow shaft, and three short adits. There has been no recorded production of tungsten from the property.

The mine area is underlain by a series of hornfels, slates, and quartzites that strike N. 10° E. to N. 85° W., and dip form 30° W. to vertical. These rocks have been intruded by a hornblend-andesite dike and by thin aplitic sills. The sills have been intensely kaolinized and sericitized. Broken pieces of blue limestone breccia are exposed in a cut on the north end of the property.

Scheelite occurs along joints in the kaolinized aplite sills, disseminated in quartzite, and sparsely scattered along narrow seams in hornfels. In an open cut in front of one adit, scheelite is sparsely disseminated throughout sheared, oxidized hornfels and breccia. A height of 21 feet is exposed that averages 0.2 percent WO_3. Inside the adit in several quartzite ribs, that average about 1.5 feet wide, scheelite occurs in concentrations up to 1 percent WO_3.

KEYES MINE

Location ---------- S34,T34N,R34E
U.T.M. 4,514,715N, 403,585E
Lat. 40°46'30"N, Long. 118°08'30"W
Base map ---------- Woody Canyon 7.5' quadrangle (1982)
Tungsten Production --- None recorded

The Keyes shaft is on the northeast flank of Stank Hill, on the southwest side of Springer Canyon, at an altitude of about 5,400 feet. The shaft was sunk before the 1925 period of mining activity and no work has been done since. It was sunk on a narrow, discontinuous bed of silicated hornfels that occurs west of the Yellow Scheelite bed on Stank Hill. There is no recorded production of tungsten ore from the shaft.

KEYSTONE MINES

Other names ---------- Nevada Keystone, Old Central
Location ---------- S12,T34N,R34E
U.T.M. 4,521,700N, 406,200E
Lat. 40°50'30"N, Long. 118°07'W
Base map ---------- Cosgrave 7.5' quadrangle (1982)
Tungsten Production --- None recorded

The Keystone Mines are on the east flank of the Eugene Mountains, on the north side of the mouth of Central Canyon, at an altitude of about 4,950 feet. First explored for silver in 1872 but no production was reported until 1937. Between 1937 and 1943 about 1700 tons of sorted ore were shipped that averaged 32.5 ounces of silver, and 0.04 ounce of gold per ton, with a little copper, zinc, and lead.

The property is underlain by slightly metamorphosed limestone, hornfels, and shales of Triassic age intruded by granodiorite. The silver-lead veins occur in shear zones in a northeast trending granodiorite dike that cuts the shale and hornfels. The chief ore minerals are argentiferous galena, pyrite, and sphalerite. The gangue is sericitized, silicified, kaolinized, pyrite-impregnated granodiorite.

In 1940, 3 diamond drill holes were drilled to explore a granodiorite dike southwest of the mine in search for silver and lead mineralization. None was encountered, but the cores were saved and 2 years later were lamped for scheelite. Scheelite was found to be present in sericitized, silicified granodioite for 22 feet along the core from a depth of 135 feet beneath the surface. A section of core was reported to assay 2.25 percent WO_3 and another section contained 0.4 percent WO_3. This zone has not been found at the surface, and an examination of the open mine workings in 1943 disclosed only a few traces of scheelite.

MAJOR DAVIS CLAIM

Other names ---------- Danner Mines, Ben H. Jackson prospect
Location ---------- S17,T34N,R34E
U.T.M. 4,518,950N, 400,820E
Lat. 40°49'N, Long. 118°10'30"W
Base map ---------- Woody Canyon 7.5' quadrangle (1982)
Tungsten Production --- Included with Danner Mines

The Major Davis claim is on the east side of the Eugene Mountains, near the head of Pole Canyon, at an altitude of about 6,660 feet. Mine workings consist of several cuts and an adit which explore a bed of scheelite bearing tactite, 12 feet wide, in hornfels. The bed strikes N-S and dips 70° W. About 1 ton of sorted ore, that contained 2 percent WO_3, was mined from the adit in 1944. The Major Davis was later included in the Danner Mines property and production was included with other ore produced by Danner Mines. Some additional work was done during the period 1960-1970.

ORPHAN MINE

Other names ---------- Sutton No. One North, South Sutton, Springer (New)
Location ---------- S35,T34N,R34E
U.T.M. 4,514,540N, 404,350E
Lat. 40°46'30"N, Long. 118°08'W
Base map ---------- Woody Canyon 7.5' quadrangle (1982)
Tungsten Production --- Combined with Sutton Mines

The Orphan Mine workings are on the faulted segments of the Sutton beds which are north of the main South Sutton Mine, on the slope south of the Springer stock. Structural relationships here are complicated and the beds may actually extend under the granodiorite at depth. No mining is recorded in this area prior to 1925, but Klepper (1943), credits the Orphan area with production of about 10,000 tons of ore containing 0.75 percent WO_3, up to the time of his report.

RED HAWK MINE

Other names ---------- Danner, Tungsten Lead
Location ---------- S16,T34N,R34E
U.T.M. 4,519,300N, 401,280E
Lat. 40°49'N, Long. 118°10'W
Base map ---------- Woody Canyon 7.5' quadrangle (1982)
Tungsten Production --- 742 units WO_3 (1917, 1942-44, 1953)

The Red Hawk Mine is near the crest of the Eugene Mountains, near the head of Pole Canyon, at an altitude of about 6,700 feet. The first work on the property was in 1917, when a crosscut adit 40 feet long with a drift of 35 feet and a winze 20 feet deep, were driven on a thin tactite band in hornfels. Forty tons of ore, containing 2.5 percent WO_3, were shipped to the mill at Toulon. No additional work was done on the property until 1942 when 286 tons of ore, containing 1 percent WO_3, were produced. Some additional development and mining were done in 1953 by the Tungsten Lead Company.

By 1956, R. E. Danner had obtained control of the property and other nearby prospects. A small gravity concentrating plant was installed, west of the fork in Pole Canyon. During the late 1960's and early 1970's, Danner produced some scheelite concentrate that was sold to Kennemetal in Fallon. Most of the production during this period was from a small open pit along the north boarder of sec. 16, north of the old Red Hawk adit.

The tactite band exposed in the Red Hawk workings is about 4 feet wide and is a medium-grained crystalline aggregate of pale brown garnet, green epidote, quartz, gray-green pyroxene, sphalerite, and scheelite. The band strikes N. 10° E., dips 60° NW., and forms discontinuous lenses in a thick section of hornfels. Tactite has been reported along strike, both NE and SW of the Red Hawk, and the tactite in the open pit to the NE may be on the same lense.

SPRINGER MINE (NEW G. E. CO. MINE)

Other names ---------- Includes all old Sutton Mines
Location ---------- S35,T34N,R34E
U.T.M. 4,515,020N, 404,500E
Lat. 40°47'N, Long. 118°08'W
Base map ---------- Woody Canyon 7.5'quadrangle (1982)
Tungsten Production --- Small start-up production in 1982

The name Springer Mine was adopted by the General Electric Company to designate their new operation on the old Sutton Mines. The Springer project, including the construction of a mine, mill, and chemical processing plant is at the site of the former Nevada-Massachusetts Mine camp, but the new Springer Mine will be developed within the old Sutton No. One and Sutton No. Two sections of the property.

SPRINGER MINE (ORIGINAL)

Other names ---------- Humboldt-Springer, Humboldt Mine
Location ---------- S34,T34N,R34E
U.T.M. 4,515,140N, 403,680E
Lat. 40°47'N, Long. 118°08'30"W
Base map ---------- Woody Canyon 7.5' quadrangle (1982)
Tungsten Production --- Combined with other mines in district

The original Springer Mine, developed through the old Springer shaft on the southwest side of Springer Hill, included workings on the segment of the Humboldt tactite bed lying generally between Springer and Stank Hills. This area was on claims controlled by the Pacific Tungsten Company, and the earliest mining was done separately from the Nevada Humboldt Corporation's Humboldt Mine to the north.

During the first period of production, through 1919, the Springer Mine was credited with 1,356 tons of ore containing 1.32 percent WO_3. Some of this ore was shipped to the Toulon Mill and the remainder was milled on the property at the Pacific Mill. After property consolidation in 1925, all mining on the Springer segment of the Humboldt bed was done through the Humboldt shaft, and production was included with that of the Humboldt Mine.

The Springer segment of the Humboldt bed is 200 to 250 feet west of the main Humboldt bed in the area where the two segments overlap due to faulting. The north end of the Springer segment abuts against a pre-mineral fault which has displaced the bed segment to the northeast, relative to the segment of the bed present in the Humboldt Mine. The fault-tactite bed intersection rakes to the northeast and forms the north limit of the Springer orebody as well as the south limit of the Humboldt orebody. On the surface, the Springer bed can be traced from the north slope of Springer Hill, across Springer Canyon, to the north slope of Stank Hill where the bed is in contact with the northwest margin of the Springer stock, a distance of more than 1,800 feet. The Springer bed is irregular in thickness, and averaged only

about 3 feet thick over its mined length. The Springer ore shoot was stoped from the surface to the 1,100 level of the mine, a vertical depth of 1,080 feet. In the 1950's some mining was done by open pits on the outcrop of the Springer bed along the western slope of Springer Hill.

STANK MINE

Other names ---------- Stank and Forge Lease
Location ---------- S34,T34N,R34E
U.T.M. 4,514,500N, 403,700E
Lat. 40°46'30"N, Long. 118°08'30"W
Base map ---------- Woody Canyon 7.5' quadrangle (1982)
Tungsten Production --- Combined with other mines in area

The Stank Mine is on the east side of Stank Hill at an altitude of about 5,250 feet. It was discovered by Emil Stank, in 1914, who found a heavy white mineral (scheelite) while panning gravel in what was later named Stank Canyon. However, Stank was prospecting for silver and ignored the scheelite. According to story Stank recalled his findings when, in 1917, tungsten became a sought-after war material. He and others returned to the district and staked claims on Stank Hill. These early claims, and others to the east on Sutton Hill, were acquired by Pacific Tungsten Company. The original outcrop of the Stank orebody was of very good grade, and by selective mining at the time the Stank orebody was credited with yielding 11,225 tons of ore that contained 3.10 percent WO_3. A large part of this ore was shipped to the Toulon Mill for treatment but some, during 1919, was milled on the property at the new Pacific Tungsten Mill.

After consolidation of the district in 1925, the Stank Mine was operated by the Nevada-Massachusetts Co., and became one of the three major mines in the district. It was developed and mined through a two compartment inclined shaft that followed the tactite bed down dip. The shaft was kept within the orebody and stoping was carried right up to the shaft. No shaft pillars were left, at least in the upper levels, and the shaft suffered from alignment problems throughout its working life. The shaft extended from the surface to the 700 level in a single lift, then an internal shaft, offset from the first, extended from the 700 level to the 1,200 level. A third section of shaft,

again offset, was sunk from the 1,200 level to the 1,350 level. The deepest working level was the 1300.

The Stank segment of the Humboldt bed is traceable by surface outcrops from the western margin of the Springer stock, at the foot of Stank Hill, through the saddle west of Stank Hill, across Stank Canyon, and up slope to the south where it is cut and offset by the Stank fault south of the Codd Mine workings. The Stank segment of the Humboldt bed has more than 2,000 feet of strike length. The Stank fault dips to the southwest and the southern extension of the tactite bed therefore moves to the south with depth in the mine. To the north the northern boundary of the bed is formed by the contact with the Springer stock. This contact also dips to the south, giving the Stank tactite body the shape of a parallellogram that rakes to the south. The bed ranges from 3 to 7.5 feet thick and averages 4.5 feet. Although parts of the orebody were of very good grade, large blocks of low grade, unaltered limestone, and marble, occur within the limits of the orebody. Underground the ore bed is cut by two major granodiorite dikes, and an andesite dike, as well as both pre-mineral and post-mineral faults. This faulting, in addition to adding complications to the mining plans, made the two shaft offsets necessary. The shaft was collared in tactite outcrop, and following the bed down dip to the 700 level where granodiorite was intersected. The bed, cut by a pre-granodiorite fault, was found to the south and the internal shaft was sunk on the offset segment. Granodiorite was again intersected on the 1200 level, and the bed was again found to have been cut and offset by a pre-granodiorite structure. Mining was concentrated in the lowest segment at the time operations ceased in 1958. The extent of the mineralized tactite in the Stank bed below the lowest mine workings has not been determined.

SUMMIT-O'BYRNE MINE

Other names ---------- O'Byrne Mine, Summit Mine
Location ---------- S34,T34N,R34E
U.T.M. 4,514,500 N, 403,400E
Lat. 40°46'30"N, Long. 118°08'30"W
Base map ---------- Woody Canyon 7.5' quadrangle (1982)
Tungsten Production --- Combined with other mines in district

The Summit-O'Byrne Mine is on Stank Hill, between Springer and Stank Canyons, at an altitude of about 5,400 feet. The Summit-O'Byrne bed extends from the south rim of the George Mine pit, across Stank Hill and into Stank Canyon where it comes in contact with the small Southwest stock. Between the George pit and the summit of Stank Hill, where the bed is slightly offset across a small body of granodiorite, the bed was mined as the Summit orebody. This segment of the bed was mined from a shaft and two adits, which are now just above the rim of the George pit. South of the Summit segment of the bed, between the small granodiorite body and the contact with the Southwest stock in Stank Canyon, the bed was developed and mined as the O'Byrne Mine. Two adits and a connecting winze developed this section of the bed. South of the lower O'Byrne adit the bed is mainly unaltered limestone.

The Summit-O'Byrne bed is on the west side of the Stank fault, and is the offset portion of the Humboldt-Springer-Stank bed. The fault strikes just west of N-S, and dips to the SW. The Summit-O'Byrne bed strikes NE and dips steeply to the SE. Ore in the tactite body was therefore limited to a triangular segment of the bed lying between the surface and the plane of the Stank fault. Ore on the south was limited by the gradational limestone-tactite boundary.

SUTTON NO. ONE MINE

Other names ---------- Sutton One South, South Sutton, Springer (New)
Location ---------- S35,T34N,R34E
U.T.M. 4,514,540N, 404,350E
Lat. 40°46'30"N, Long. 118°08'W
Base map ---------- Woody Canyon 7.5' quadrangle (1982)
Tungsten Production --- Combined with other mines in district

The Sutton No. One Mine, or South Sutton, is on the south side of Springer Canyon, at an altitude of about 4,900 feet. It includes all of the mine workings on the Sutton limestone-tactite beds which lie between the south margin of the Springer stock and Stank Canyon to the south. The main Sutton One Mine was developed on the eastern two of the three Sutton beds that crop out on Sutton Hill. The western bed, important at the Sutton No. Two Mine to the north, is too thin to mine here and was not developed. Faulted segments of the Sutton beds, north of Sutton One but south of the Springer stock, were developed separately as the Orphan Mine. The Sutton One open pit, directly above the old mine workings, was developed during the early 1950's. The Sutton One Mine was developed through two parallel adits, one on each of the two tactite beds. A vertical shaft, 350 feet deep, sunk in the canyon north of Sutton Hill connected with 3 underground mining levels on the main beds and drifts extended to the north under the Orphan Mine workings.

The Sutton beds are well mineralized at the north end of the Sutton One Mine, but the tactite grades into marble, then limestone, within about 1,000 feet to the south. Faulting has offset the mineralized beds, and in some areas faulting has moved bed segments alongside other segments and effectively doubling ore thickness.

The first claims were staked on the Sutton One outcrops in March 1917 by Thomas Sutton. He formed the Mill City Tungsten Mining Company, and by the spring of 1918 had shipped 1,611 tons of ore, that contained 2.70 percent WO_3, to the Toulon Mill. No additional production was credited to the Sutton One

from that time until operations were assumed by the Nevada-Massachusetts Company. Both the Sutton One underground and open pit workings were producing ore until all mining ceased in 1958.

During the salvage operations in 1962, when mine equipment was being sold and removed from the property, the Sutton One shaft burned, closing access to the lower levels of the mine. A substantial tonnage of ore remains in the Sutton One part of the Sutton beds. This ore will probably be mined through levels which will connect with the General Electric's new Springer shaft.

SUTTON NO. TWO MINE

Other names ---------- North Sutton, new Springer Mine
Location ---------- Sections 26 and 35, T34N,R34E
U.T.M. 4,515,140N, 404,650E
Lat. 40°47'N, Long. 118°07'45"W
Base map ---------- Woody Canyon 7.5' quadrangle (1982)
Tungsten Production --- Combined with other mines in district

The Sutton No. Two Mine is on the north side of Springer Canyon, at an altitude of about 4,850 feet. The original claims were located in 1917 by Thomas Sutton. His company, the Mill City Tungsten Mining Company, concentrated their efforts at the Sutton No. One deposit and no production was credited to the Sutton Two area until after the Nevada-Massachusetts Company began production in the 1920's. The Nevada-Massachusetts Co. mined all of the Sutton bed occurrences north of the Springer stock contact in Springer Canyon as the Sutton No. Two Mine. This included the main Sutton Two area under and north of Springer Canyon, the Baker, Uncle Sam, the fault segments east of the Baker (the Sutton Footwall), and the small open pits in the Baker and Uncle Sam areas. The main production was carried out through the Sutton Two adit which extends from a portal on the north side of Springer Canyon about 700 feet north along the strike of the deposit and connects with an inclined shaft 850 feet deep. Production levels were developed at 100 foot levels both north and south along the three Sutton beds. These beds were thought to be generally lower in grade than the Humboldt-Stank beds to the west, and they were not developed as early as the Humboldt and Stank mines. When the Humboldt amd Stank mines reached their deeper levels in the late 1940's, and began to experience high mining costs, the Sutton deposits were phased into production. By the end of the Nevada-Massachusetts Co. production era, in 1958, the Sutton Two mine was contributing the major portion of the production in the district. Exploration work, by the General Electric Co. between 1972 and 1976, confirmed the existence of large ore reserves remaining in the

Sutton Two Mine. These reserves, along with those in the Sutton One Mine, will be mined as part of the new Springer Mine.

TOM CAT CLAIMS

Location ---------- S26,T34N,R34E
U.T.M. 4,516,550N, 404,750E
Lat. 40°48'N, Long. 118°07'45"W
Base map ---------- Woody Canyon 7.5' quadrangle (1982)
Tungsten Production --- None recorded

The Tom Cat claims are on the north side of Olsen Canyon at an altitude of about 5,000 feet. The claim area was prospected in 1918 but no significant deposits were found. The area is in the central part of the Olsen stock and includes shallow pendants of hornfels on the eastern edge of the stock. The single shallow prospect shaft in the central claim area explores a quartz vein in the granodiorite.

UNCLE SAM MINE

Other names ---------- North Sutton, Sutton No. Two, Springer Mine (New)
Location ---------- S26,T34N,R34E
U.T.M. 4,515,950N, 404,750E
Lat. 40°47'N, Long. 118°07'45"W
Base map ---------- Woody Canyon 7.5' quadrangle (1982)
Tungsten Production --- Combined with other mines

The Uncle Sam Mine is on the southwest side of Olsen Canyon at an altitude of about 4,900 feet. It is on the northernmost segment of the Sutton limestone-tactite beds exposed south of the Olsen stock. About 200 feet of the beds are exposed in the Uncle Sam open pit, and a short adit intersects the beds beneath the level of the pit. The northern workings of the main Sutton No. Two Mine extend under the Uncle Sam, and future mining of this portion of the Sutton beds will be through the new Springer shaft to the south.

The Uncle Sam area is within what was known as the Olsen claim group in 1917. The Olsen claims were controlled by the Pacific Tungsten Co. and they were developed separately from the Mill City Tungsten Mining Co. Sutton Mines.

Drilling by the U.S. Bureau of Mines in 1941 gave indications of ore reserves in the Uncle Sam area, and work by General Electric Co. in 1973-74 confirmed that mineable reserves are present. The area is included in the new Springer Mine.

U.S. MINT PROSPECT

Location ---------- Sections 23 and 24, T34N,R34E
U.T.M. 4,517,000N, 405,800E
Lat. 40°48'N, Long. 118°07'W
Base map ---------- Cosgrave 7.5' quadrangle (1982)
Tungsten Production --- None recorded

The U.S. Mint prospect is on the southeast flank of Florence Hill at an altitude of about 4,800 feet. The prospect was located by Emil Stank in 1918 and shallow prospect pits were dug on an outcrop of silicated limestone. Sparse, yellowish fluorescing, scheelite occurs with diopside, epidote, and pale garnet in tactite formed in two parallel limestone beds. These beds are northern extensions of the Sutton limestone beds developed in the Sutton mines to the southwest. No production has been reported from this prospect.

YELLOW SCHEELITE MINE

Other names ---------- Wayne Lode
Location ---------- S34,T34N,R34E
U.T.M. 4,514,650N, 403,560E
Lat. 40°46'45"N, Long. 118°08'30"W
Base map ---------- Woody Canyon 7.5' quadrangle (1982)
Tungsten Production --- Combined with other mines

The Yellow Scheelite Mine is west of the Stank Mine, on the east side of Stank Hill, at an altitude of about 5,500 feet. The name was applied because the scheelite found in the deposit was thought to fluoresce a more yellow color than that from the nearby mines. The Yellow Scheelite tactite-limestone bed is about 200 feet west of the Stank bed and occupies the same relative position to the Stank bed as does the George bed to the north in the Humboldt-Springer area. The Yellow Scheelite and George beds are probably faulted segments of the same bed. According to Klepper (1943) the bed was present in the Yellow Scheelite Mine only between the surface and the 200 foot level, and it extended from the Springer stock to the pre-granodiorite fault at the north end of the Stank Mine. The bed averaged about 2 feet thick and contained 0.5 to 0.75 percent WO_3.

WILD CAT PROSPECT

Location ---------- S11,T34N,R33E
U.T.M. 4,520,800N, 396,500E
Lat. 40°50'N, Long. 118°13'30"W
Base map ---------- Woody Canyon 7.5' quadrangle (1982)
Tungsten Production --- None recorded

The Wild Cat prospect is on the west side of the Eugene Mountains, in Woody Canyon, at an altitude of about 5,400 feet. In 1942 and 1943 R. E. Danner and others located 15 tungsten claims in the area.

Rocks in the area consist mainly of slates and hornfels interbedded with quartzites and thin limestone beds. These rocks strike north and dip steeply east. They are intruded by granodiorite and by aplite, pegmatite, and porphyritic dikes and sills.

Scheelite occurs in thin quartz veins in the granodiorite as small crystals with a little magnetite and some copper staining. The veins are 10 to 15 feet apart, from 4 to 20 inches thick, strike N. 30°-70° E., and dip 55° E. Samples of the vein material average about 0.01 percent WO_3.