Tungsten Mineralization at the Andrew Curtis Mine, Mount San Antonio Quadrangle, Los Angeles County, California

GEOLOGY AND MINERAL WEALTH OF THE CALIFORNIA TRANSVERSE RANGES © South Coast Geological Society 1982

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SUMMARY

This occurrence is a new world-class scheelite deposit capable of supplying up to 20% of the United States' yearly demand for tungsten. It is located in the rugged San Gabrial Mountains 40 miles east of Los Angeles, in the Sheep Mountain Wilderness Study Area. Total reserves are on the order of 500 million lbs. of tungsten. Of this, 50 million lbs. are in the measured and indicated category and at present-day prices would be valued at about $300 million.

INTRODUCTION

The Andrew Curtis Tungsten Mine is located in the eastern San Gabriel Mountains, approximately forty miles east of Los Angeles, California (Figure 1). The deposit and its processing plant are situated in Cattle Canyon, Sections 12, 13, 14, 22, 23 and 27 of Township 2 North, Range 8 West, San Bernardino Base and Meridian (Figure 2).

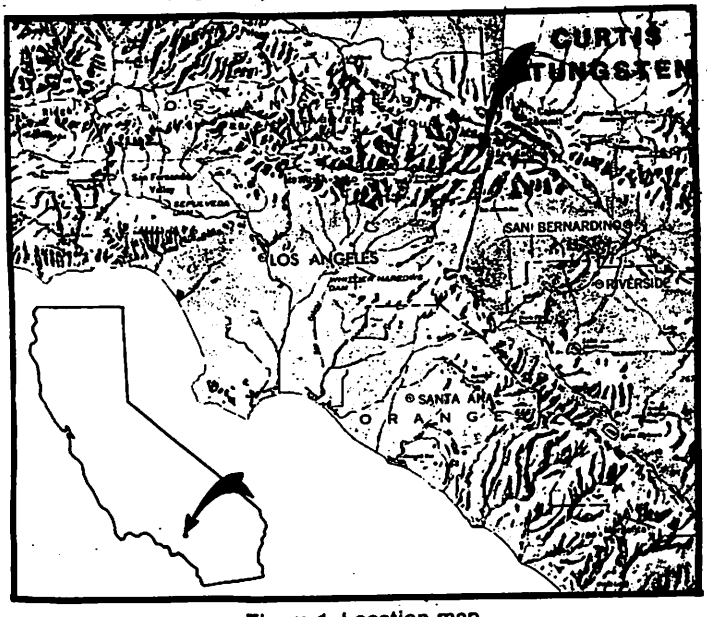


Figure 1. Location map.

The climate of Cattle Canyon is typically sub-alpine with heavy snowfall during winter months and locally severe thunderstorms. Temperatures vary from 0°F to 90°F in the canyon bottom. Generally, nine months out of the year, the mine is accessible from the Glendora Ridge Road via U.S. Forest Service Road #2N06. It may also be reached by Forest Service Road #2N04 through the bottom of San Gabriel Wash, though trucks or heavy traffic cannot use this 4-wheel drive road. Because the Glendora Ridge access road (#2N06) reportedly passes through a Nelson's Big Horn Sheep lambing ground, this truck haul road is closed by the Forest Service from April to June each year.

The deposit is the result of the injection of hot ore-bearing fluids into rocks of the upper plate of the Vincent thrust during the Tertiary. The principal mineral mined is scheelite ($CaWO_4$). Current mining is from talus deposits on the north slope of Cattle Canyon and lode deposits north of the Curtis mill site (Photo 1).

The deposit was located in the late 1950's by Andrew Curtis. Ronald L. Curtis, his son, operates the mine today. Total reserves, indicated, infered and measured (U. S. Bureau of Mines, 1980), amount to 525,000,000 pounds of tungsten. A processing plant on site operates five days a week. By 1985 Curtis Tungsten expects to have production levels of approximately 2,000,000 pounds per year. It is possible that this mine could supply 20% of the total U.S. production by 1990.

GEOLOGIC SETTING

The San Gabriel Mountains consist of uplifted blocks of crystalline metamorphic and igneous rock ranging in age from Precambrian to Miocene. These were uplifted during late Tertiary to the present time (Evans, 1977; Ehlig, 1982).

The great topographic relief is the result of streams cutting into the uplifted fault blocks and forming deep canyons with steep sides and coarse, gravel floors. Most of the canyons are controlled by erosion along faults. There is evidence that Cattle Canyon is at least partially controlled by erosion along a large northeast trending fault zone. The mine area is bounded by four major faults: the San Gabriel fault on the south, the San Antonio fault and Vincent thrust fault to the east and the Weber fault to the west.

The host rocks for this deposit consist of Mesozoic to Pre-Cambrian rocks. They are augen gneiss, biotite gneiss, porphyritic dikes and sills of basaltic to dacitic composition, quartz monzonite and diorite. The structural grain generally strikes north 36° to 40° west and dips 41° to 43° southwest. Slickensides and displacement of dikes indicate multiple faults and fracture zones throughout the area. These strike north 70° to 90° east and dip steeply to the north (Ridenour and Schmauch, 1977). The gneisses are part of the upper plate of the Vincent thrust and are reported (Ehlig, 1982, this volume) to have been thrust into their present position about 60 million years ago, during the Paleocene.

Sheelite veins are found in the Mt. Lowe Granodiorite which intrudes the gneiss in the south. A quartz diorite is found on the north which also has some small sheelite bearing veinlets.

ECONOMIC GEOLOGY

The principal mineral of economic importance on the Curtis Tungsten properties is scheelite ($CaWO_4$) or calcium tungsten. It occurs in three distinct types of deposits: (1) primary lode deposits; (2) talus cone placer deposits; (3) flood plain placer deposits.

Photo 1. View looking north up Cattle Canyon. Mt. San Antonio in background. Photo courtesy of Donald L. Fife, 1982.

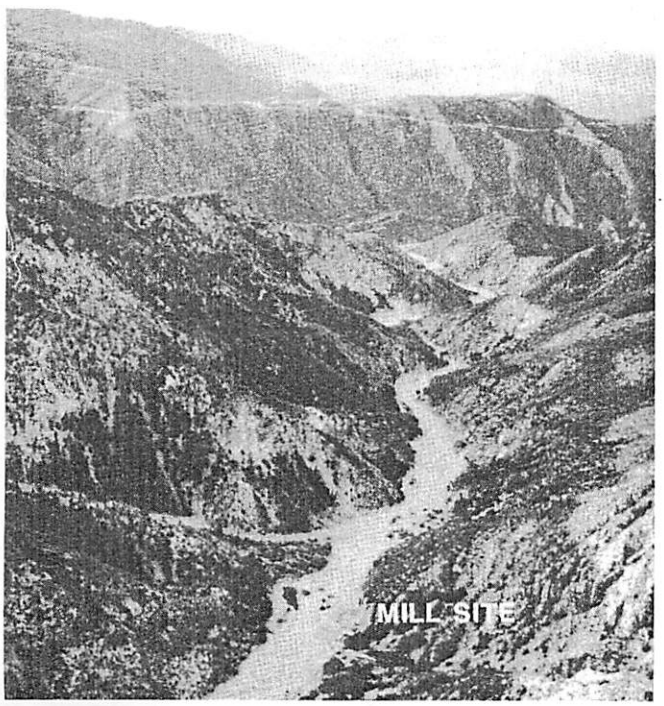


Photo 2. View looking SW down Cattle Canyon. Photo by Donald L. Fife, 1982.

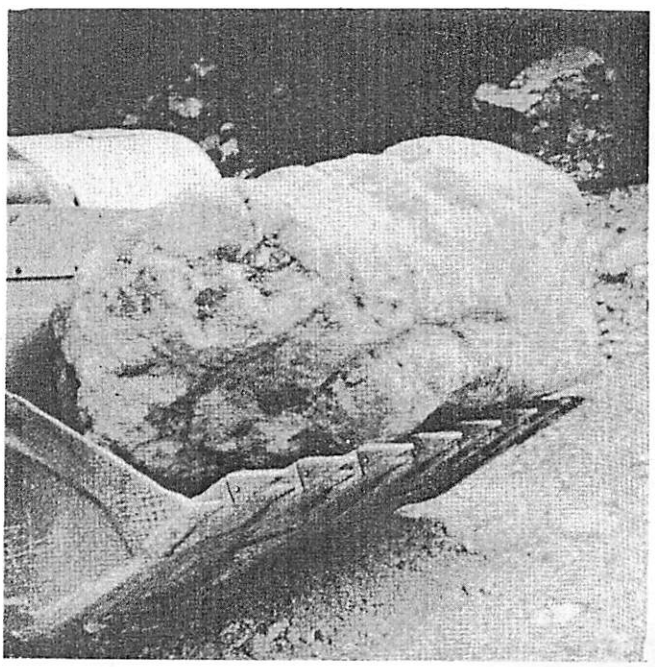


Photo 3. Boulder from talus cone deposit. Boulder contains more than 20% scheelite and sold for more than $8000.00. Photo courtesy of Curtis Tungsten Corp.

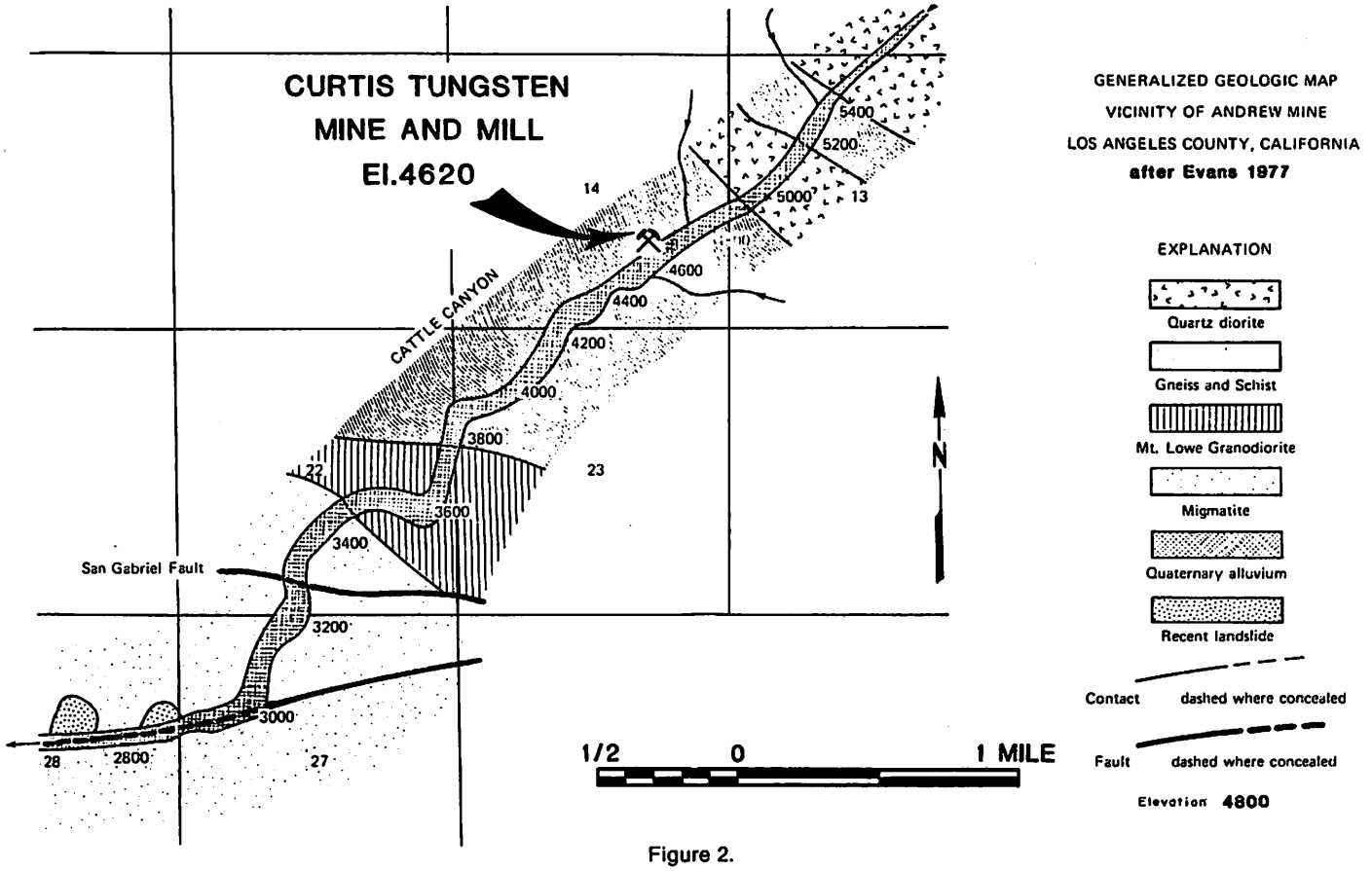


Figure 2.

The Primary Lode Deposits

Primary scheelite occurs in two types of deposits. Both deposits occur over approximately 1 sq. mile area on both sides of upper Cattle Canyon. (Figure 3). The emplacement of these deposits is structurally controlled. In terms of tungsten production there appears to be little significant relationship to the mineralogy of the host gneisses.

First, and most promising, are veins of hard crystalline scheelite 1 to 10 inches wide and traceable for a slope distance of up to 300 ft. (Figure 6). It appears these deposits were formed by the injection of hot ore-forming fluids into two major shear systems.

The attitudes of these faults are N 70-85° dipping E 70-85° and N 70-90° W 55-85°N. Apparently ore emplacement continued along the strike as demonstrated by intermittent exposures for over 2,000 ft. (Figure 4 and 5). Two of these high grade veins have been discovered to date, but large clasts of crystalline scheelite found in Cattle Canyon and smaller secondary canyons indicate the presence of additional occurrences.

The second type of deposit consists of crystalline scheelite emplaced in the fractures of several shear zones throughout the area. The two major shear systems which control the mineralization trend N 55-85° E, 50-85° N and N 70-90°W, 70-85° N and range in areal extent from less than 1 ft. to over 100 ft. wide and from a few feet to over 1,000 ft. long (Figures 3 and 4). These fractures range in size from 1/16 inch to 1/2 inch wide and 2 inches to 5 ft. in length.

Although the percentage of the scheelite-bearing fractures is generally less than 0.5%, the percentage of scheelite appears to increase locally at the intersections of two or more shear zones.

Evidence varying from fused scheelite vein contacts with no hydrothermal reaction zone to displays of localized low- to moderate-temperature hydrothermal alteration suggests that these deposits were formed by contemporaneous injections of hot pressurized ore fluids into anastamosing faults and shear systems. Lower temperature, scheelite-bearing, hydrothermal solutions (still under pressure though reduced from initial pulses) followed. Also brecciated scheelite within the vein deposits and the presence of slickensides show the movement along these mineralized faults to be both syn- and post-genetic with respect to the deposition of the ore body (Figure 4).

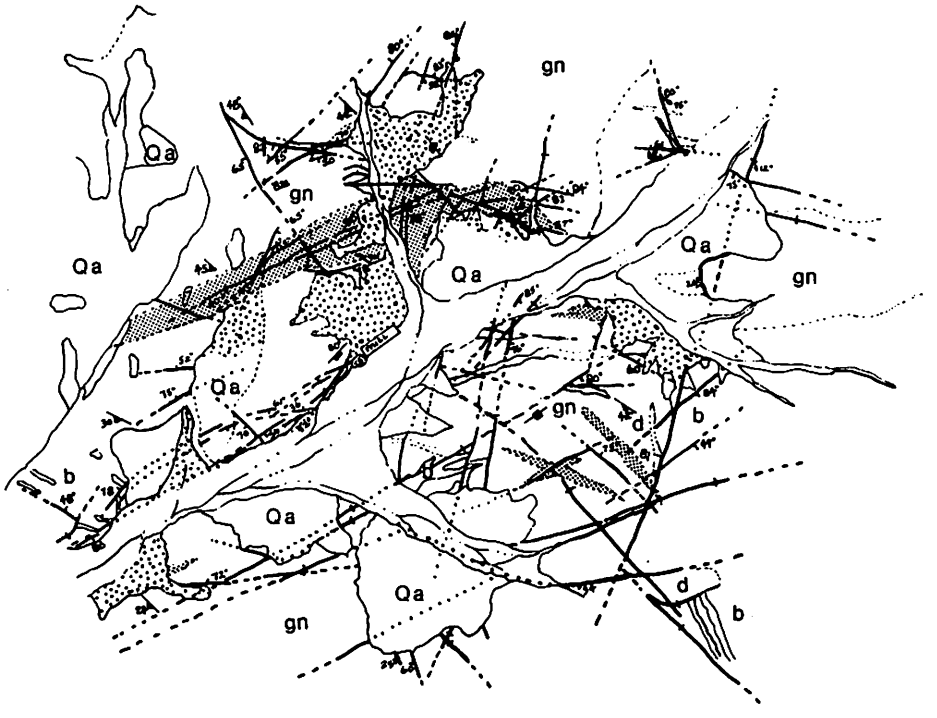
The absolute age of this ore body is uncertain. However some field observations suggest a late Tertiary possible Miocene Age. The assignment of an age younger than early Tertiary suggests the possibility that the tungsten-bearing intrusive body penetrated the Vincent Thrust fault. The proximity of the scheelite occurrences to pegmatites and quartz monzonite outcrops at different localities suggest a genetic relationship.

As another possibility Ehlig (1982) proposes that dehydration reactions associated with thrusting may have been the source for the ore bearing solutions which formed the gold deposits in the San Gabriel Mountains. The gold-bearing fluids in the upper plate of the Vincent thrust formed thick veins which fill dilatant fractures. This is similar to those occurrances containing scheelite at the Curtis Tungsten deposit. The gold deposits and this tungsten occurrence may be equivalent in age.

PLACER DEPOSITS

The *talus cone tungsten deposits* are slopes of detrital material deposited between the walls of Cattle Canyon and the canyon floor. They are formed by the erosion and rapid collection in talus cones of rock and mineral material from the crystalline rock.

Geology and Tungsten Mineralization of the Curtis Tungsten Andrew Mine Area



Explanation

Scheelite Vein Deposits----------

Scheelite Bearing Fracture Zones--

Joints and Fractures----------

Foliation----------

Faults----------

Scheelite Bearing Talus Cones-----

Qa Quaternary Alluvium

b Basalt and Andesite Porphry Dikes

d Dacite Porphry Dikes and Sills

Otz. Monzonite Intrusive

Diorite Intrusive

gn Granodiorite Augen Gneiss

Feldspathic Hornblende Qtz. Biotite Gneiss

N 15°

0 1000ft.

Figure 3. Geology and Tungsten Mineralization of the Andrew Curtis Tungsten Mine area.

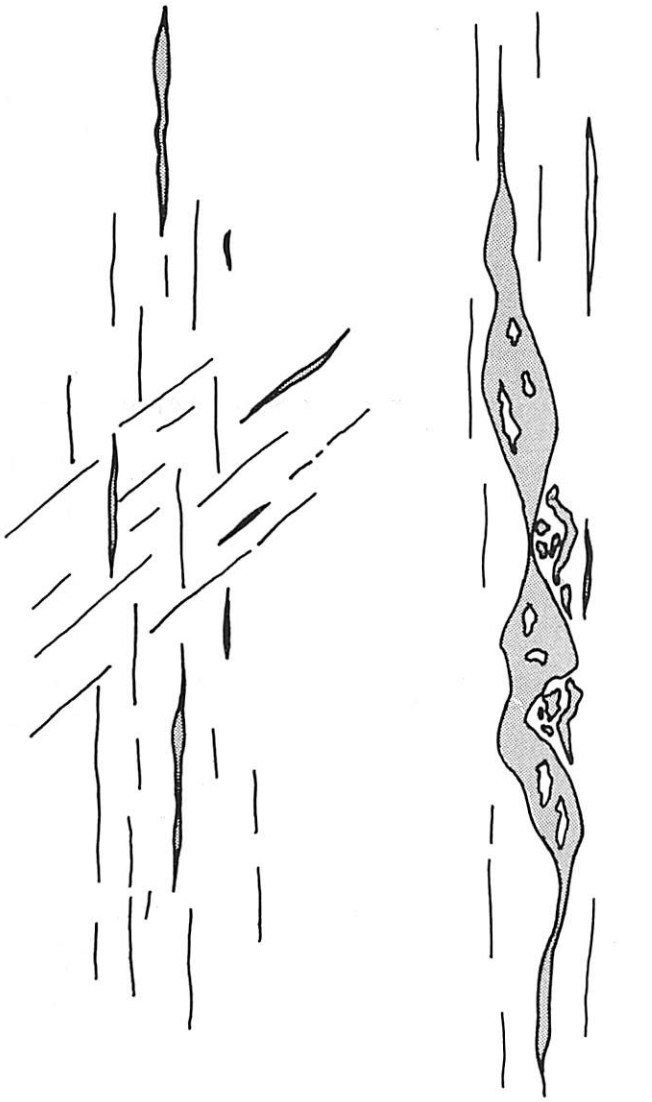


Figure 4.

There are several of these deposits along the edges of Cattle Canyon (Figure 3 and Photo 4). Active headward erosion along the northeast trending faults and shear zones apparently controlled the formation of the canyon, has resulted in these talus cones. The cones are the major source at this time for the scheelite processed at the Andrew Curtis tungsten Mine (Photo 4).

The *flood plain placer deposits* are formed by the deposition of detrital rock and mineral material (including scheelite placers) along the canyon floor. During the winter season, the flood waters from torrential rains and melting snows transport the gravels and placers a distance greater than two miles down the canyon from the source. This mechanism of rapid, long distance transport of the scheelite placers through intermittent flooding has formed a massive low-grade tungsten deposit in upper Cattle Canyon.

It is interesting to note that the Curtis Tungsten talus cone placer deposit has several aspects in common with another large placer tungsten mine in southern California, the "spud patch" of Atolia (Steward, 1957). Both deposits are derived from scheelite in quartz veins unlike the majority of deposits in the U.S. which are tactites associated with limestone bodies. Like the Atolia

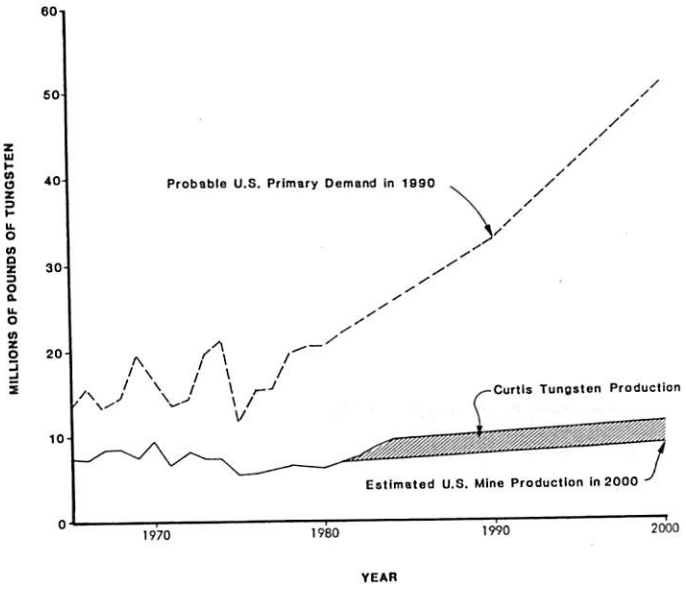


Figure 5.

placers, the Curtis placers also contain large "spud-size" or even boulder-size "nuggets" that are commonly over 50% scheelite (Photo 3). A cobble-size "spud" from Andrew Curtis Tungsten mine is shown on the back cover of this volume. The veins in the crystalline basements of each mine are generally narrow. Both are in close proximity to gold deposits; Atolia with the Randsburg mines and the Curtis deposit with the Stanley Miller and Allison Mines. Finally both deposits are found near the contact with what may be the same thrust fault (Ehlig, 1982).

MARKET DATA

Approximately 32% of the U.S. demand for tungsten is supplied by domestic production (Figure 5). The remainder of domestic consumption must be supplied from sources vulnerable to interruption, China, Bolivia, Peru, etc. The estimated full production of the Andrew mine could provide 20% of domestic production, lessening the U.S. dependence on foreign supplies by that amount. U. S. consumption increased by about 8% in 1981 (U.S. Bureau of Mines Mineral Commodities Summaries, 1982). The largest use of tungsten, accounting for 78%, is the manufacture of metalworking and construction equipment. Other uses include transportation (9%), lamps and lighting (6%), and electrical (4%). The estimated 1981 average price per short ton unit of WO_4 in the U.S. markets was $130.00. Though most of the tungsten used in the U.S. is used on the east coast, the Curtis Tungsten deposit is near Los Angeles, the second largest metropolitan and industrial center in the United States (Fife, 1982, this volume). Tungsten is a strategic material for national defense; the Federal governmental encourages domestic mining of tungsten by granting a 22% depletion allowance.

PRODUCTION

The most current geologic data has defined the following types of mineral reserves. Values are estimated by Curtis Tungsten using definitions from U.S. Bureau of Mines, 1980, Circular #831.

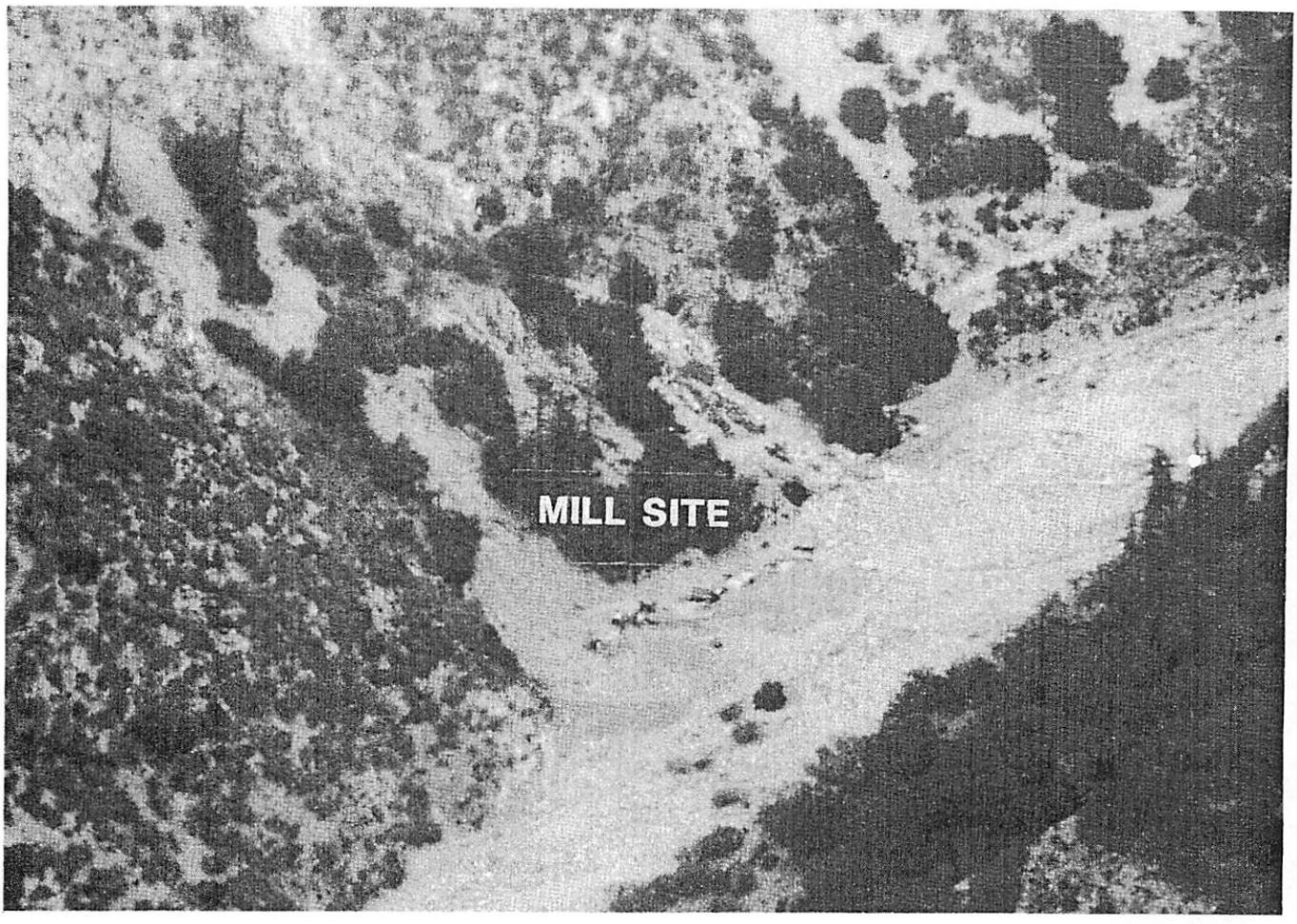


Photo 4. View looking northwest at Curtis Tungsten Mill. Note large talus cone deposit behind mill (photo courtesy of Robert W. Ruff).

Measured: The total scheelite available is in excess of $80,000,000. Total pounds of Tungsten (W) is 13,300,000.

Indicated: This category is based on one lode formation. Extensive mapping, sampling and mill recovery tests have determined the gross value to be $226,800,000. Total pounds of tungsten (W) is 37,800,000 pounds.

Inferred: This category is based on extensive mapping (scale 1″ to 12,000 feet, and 1″ to 1,200 feet). Samples are far apart, but geologic structure is consistent. Total pounds of tungsten (W) is 475,000,000.

Production of scheelite concentrates started in the latter part of 1973 and is continuing. Production from 1973 to 1978 was the result of an extensive sampling program, and two pilot plant operations (9 yards per hour), built and operated in 1977 and the first part of 1978.

The flood of February 15, 1978 destroyed both pilot plants, but the company had collected enough data by that time to proceed with the construction of a larger plant (Photo 5). This plant is located near several of the lode formations located during later mapping programs. The present plant's capacity is 40 tons per hour (gravity separation). The plant was built to process one of several talus cones. Ore concentrates containing 35% WO_3 have been shipped from this plant. It is planned that production from this site will finance future development of the mine area.

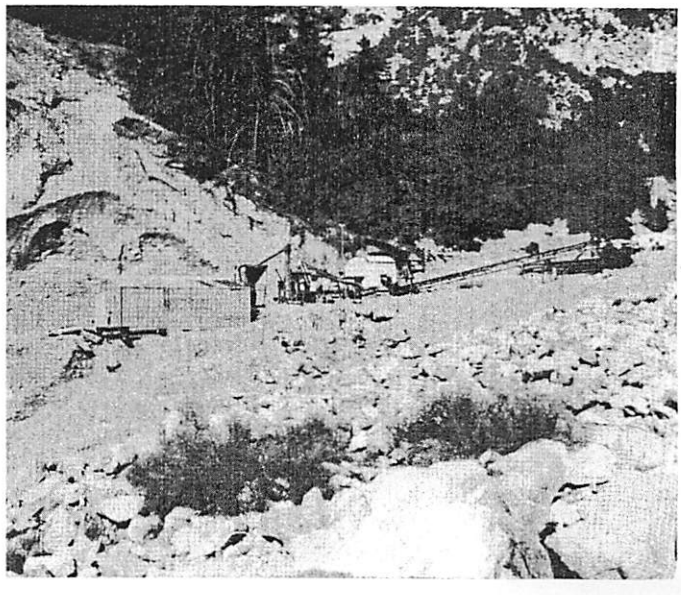


Photo 5. Andrew Curtis Tungsten Mine in Cattle Canyon. Portions of massive scheelite placer in foreground. Talus cone deposit in background. Photo courtesy of Curtis Tungsten Corp.

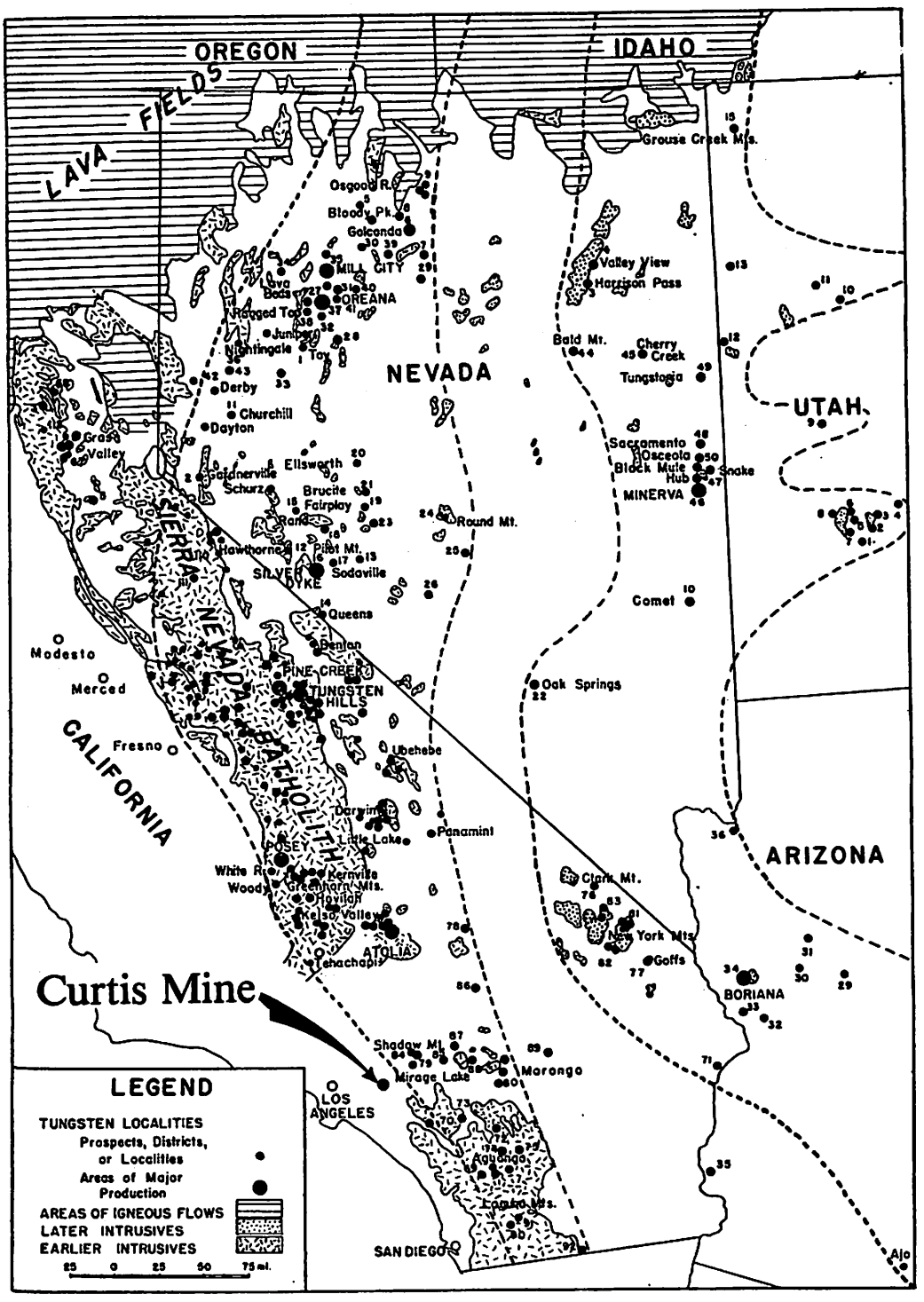


Figure 6. Geographic relationship between Andrew Curtis Tungsten Mine and tungsten localities of the western U.S. (after Kerr, 1946).

CONCLUSIONS

The mine is a potentially important domestic producer of a strategic mineral of which almost 70% of our current consumption is dependent on foreign supplies. Note that most of the known world reserves of this strategic mineral are found in communist or third world countries that are potentially hostile to the United States. In times of national emergency these sources may be extremely unreliable or non-existent.

When environmental problems are resolved and mining operations in Cattle Canyon can produce year round, the Andrew Curtis Tungsten Mine will be an important producer and potentially a world class tungsten deposit.

Kerr (1946) published a synthesis of western Cordilleran tungsten deposits. As part of that work he compiled a map (Figure 6) which indicates a zone or belt of tungsten mineralization trending north-south through eastern California. A casual comparison appears to represent an extension of the western Cordilleran belt of tungsten mineralization (Kerr, 1946) westward into the California Transverse Ranges (Figure 6). This strongly suggests that similar deposits may exist in adjacent areas of the Transverse Range province.

ACKNOWLEDGEMENTS

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