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Grade-Tonnage Data for Detachment-Fault Related Polymetallic Deposits

by

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Introduction

Long (1992) reported grade and tonnage data for detachment-fault related polymetallic deposits using production data gathered by the U.S. Bureau of Mines and summarized by Keith and others (1983). Subsequent analysis of that data show that they are incomplete and generally represent hand-sorted concentrates sent directly to smelters. To obtain more complete data that better reflects the grades and tonnages of ore as developed and mined, records of the former Anaconda Copper Co. (now held in the International Archive of Economic Geology, American Heritage Center, University of Wyoming) were examined. Production and reserve data found in property submittals and subsequent Anaconda geologists' reports, however, provide insufficient information to construct a grade-tonnage model.

Data

This section provides background information on the grade and tonnage data listed in Table 1. Production data from the U.S. Bureau of Mines, and reported by Keith and others (1983), give the amount of metals contained in sorted ore and concentrates shipped to smelters, and do not represent the amount of metal in the ore as mined. Representative grades cannot be computed from such data. For direct shipping ores that were hand-sorted prior to shipment, such production data underestimate the tonnage and overestimate the true grade of ore-in-place. Only a portion of the metals contained in milling ores is recovered during processing. These recoveries can be as poor as 50%, particularly for byproducts such as gold and silver. Using metals contained in concentrates will underestimate the grade of ores that were milled.

Alamo District, La Paz Co. AZ

Spencer and Welty (1989) identified this district as detachment-fault related. The geology and mineral deposits of the Alamo district have been described by Spencer and Welty (1985, 1989), and Tosdal and others (1990a).

Production: Spencer and Welty (1989) give total reported production from 1902 to 1958 as 824 st ore, 22 st Cu, 27 st Pb, 66 troy oz Au, and 984 troy oz Ag, all from the Blue Bell subdistrict. Production for the Alamo West and Ives Peak subdistricts has not been reported. It is not known if copper, lead, gold, and silver were recovered from all of the ore produced, or what was the proportion of metals recovered. A breakdown of production data is given by Keith (1978):

•	Dates	st ore	% Cu	% Pb	oz/st Ag	oz/st Au
Mine						
Montana-Arizona	1902-37	170	6		0.8	0.1
Bernarde	1912-36	138	1		0.1	0.1
Mystery Hill	?-1945	>500	3	0.5	2.0	0.1

Reserves: Tosdal and others (1990a) report an inferred subeconomic resource at the Bernard mine of 400,000 st with 0.4% Cu, 0.07 troy oz/st Au, and 0.2 troy oz/st Ag. An unnamed mine southeast of the Bernard has an inferred subeconomic resource of 20,000 st with 0.15% Cu, 0.02 troy oz/st Au, and 0.05 troy oz/st Ag. A nearby unnamed prospect has an inferred subeconomic resource of 90,000 st with 0.7% Cu, 0.05 troy oz/st Au, and 0.2 troy oz/st Ag.

Grade and Tonnage: Given the small production, the resource data reported by Tosdal and others (1990a) are used to represent the grade and tonnage of the Alamo district: 510,000 st (460,000 mt) ore containing 0.4% Cu, 0.2 troy oz/st (62 g/mt) Ag, and 0.06 troy oz/st (1.9 g/mt) Ag.

Artillery Peak District, La Paz Co. AZ

Welty and others (1989) classified this district as detachment-fault related.

Production: Keith and others (1983) give total reported production from 1954 to 1979 as 500 st ore, 13,000 lbs Cu, 600 troy oz Ag, and "minor" Au. It is not known if copper, gold, and silver were recovered from all of the ore produced, or what was the proportion of metals recovered. The original production data would seem to have been rounded.

Grade and Tonnage: Lacking any production data from before the 1950's, it is unlikely that the reported production represents more than a small part of the Artillery Peak district production or original reserves.

Bullard District, Yavapai Co. AZ

Spencer and Welty (1986) identified this district as detachment-fault related. The geology and mineral deposits of the district are described by Spencer and Welty (1985,1989) and Roddy and others (1988).

Production: Keith and others (1983) give total reported production from 1931 to 1964 as 17,000 st ore, 610,000 lbs Cu, 3,600 troy oz Au, and 6,000 troy oz Ag. It is not known if copper, gold, and silver were recovered from all of the ore produced, or what was the proportion of metals recovered. The original production data would seem to have been rounded.

Grade and Tonnage: Lacking any production data from before the 1930's, it is unlikely that the reported production represents more than a small part of the Bullard district production or original reserves.

Burnt Well District, La Paz Co. AZ

Spencer and Welty (1986) identified this district as detachment-fault related. The geology and mineral deposits of the Burnt Well district have been described by Spencer and Welty (1985, 1989).

Production: None reported to the U.S. Bureau of Mines.

Cienaga District, La Paz Co. AZ

Spencer and Welty (1986) identified this district as detachment-fault related. The geology and mineral deposits of the Cienaga district have been described by Spencer and Welty (1985, 1989) and Zambrano (1965).

Production: Spencer and Welty (1989) give total reported production from 1870 to 1969 as 19,092 st ore, 1,713,533 lbs Cu, 12,011 troy oz Au, and 1,596 troy oz Ag. It is not known if copper, lead, gold, and silver were recovered from all of the ore produced, or what was the proportion of metals recovered. Elsing and Heineman (1936) reported production from 1909 to 1933 as 6,084 st ore, $87,055 in Au, 1,878 troy oz Ag, 1,212,767 lbs Cu, and 288 lbs Pb, but these figures may include production from other districts. The Copper Queen and other mines in 1913 shipped 237 st yielding 112.76 troy oz Au, 56 troy oz Ag, and 31,549 lbs Pb (Mineral Resources of the U.S., 1913, p. 706). In 1917 the Mavis shipped 14 st with 19 to 30% Cu, $15-18/st Au (Weed, 1920, p. 401); the Carnation had developed ore containing 5% Cu and $5/st Au, with a 10 ft pay streak with ore containing 10% Cu and $6/st Au (Weed, 1920, p. 393); the McGinnis mine had shipped several cars of ore containing 10% Cu and $8/st Au (Weed, 1920, p. 393-394); the Billie Mack shipped 489 st ore containing 8% Cu and 1.1 troy oz/st Ag (Weed, 1920, p. 399). Keith (1978) reported production by mine as follows:

Mine	Dates	st ore	% Cu	oz/st Au	oz/st Ag
Arizona McGinnis	1926-27	170	9.0	0.60	0.10
Billy Mack	1909-19, 1943-60	~3,000	4.5	0.60	0.20
Carnation	1900's-70's	~8,000	4.0	0.20	0.05
Golden Ray	1940-41, 1949-50	175	1.5	0.56	0.20
Lion Hill	1917-20, 1928-33, 1937-38, 1943	700	0.4	2.40	0.20
Rio Vista North	1918-19, 1929-33	>100	5.0	0.50	0.30
Rio Vista South	1900's-50's	>100	8.0	0.40	0.10
Sue	?-1963	400	3.5	0.20	0.10

Reserves: Reported reserves at Cienaga in 1921 were 400,000 st with 5.5 to 20% Cu, $2 to $4/st (0.1-0.2 oz/st) Au and $2 to $10/ st (2.4-12 oz/st) Ag (Neale, 1926, p. 216).

Grade and Tonnage: Most of the production postdates the reserve estimate but recovered somewhat less Cu (4 to 5 percent) and significantly less Ag (0.1 to 0.2 oz/st) than the reserve estimate would indicate. The low Ag recoveries may be explained by the failure to recover Pb from most of the production, assuming most of the Ag values occur in the lead minerals found in the ore. A grade-tonnage estimate may thus be given as: 400,000 st ore containing 5% Cu, 2 oz/st Ag, and 0.1 oz/st Au.

Clara District, La Paz Co. AZ

Spencer and Welty (1986) identified this district as detachment-fault related. The geology and mineral deposits of the Clara district are described by Spencer and Welty (1985, 1989).

Production: Spencer and Welty (1989) give total reported production from 1911 to 1956 as 49,728 st ore, 4,668,908 lbs Cu, 35 troy oz Au, and 1,738 troy oz Ag. It is not known if copper, lead, gold, and silver were recovered from all of the ore produced, or what was the proportion of metals recovered. Carpenter (1942) describes in detail the history of the district and gives a complete accounting of production up to 1937:

1870's	District discovered. An estimated 5,000 st of 20% Cu ore produced.
1908-1911	About 40,000 st of 2.5% Cu ore mined and smelted by Clara Conslolidated
1912-1913	About 16,000 st of 3-3.4 % Cu ore mined by Swansea Consolidated
1914-1916	About 100,000 st mined by lessees yielding about 5 million lbs of Cu.
1917-1919	More than 5,441 st mined yielded more than 155,566 lbs Cu.
1922-1923	3,050 st mined by Southeast Metals Co. yielded 1,697,004 lbs Cu at a recovery of 96-98% Cu.
1927-1929	Lessees mined about 60,000 st 3.5% Cu ore and shipped an additional 150 cars of 4.1% Cu.
1929-1930	Asarco mined about 20,000 st.
1937	Asarco shipped 2,348 st concentrates with 22-23% Cu acheiving a 93-95% recovery of Cu from about 19,111 st ore milled.

Keith (1978) reported the following production, in addition to a minor amount of gold and silver:

Mine	Dates	st ore	% Cu
Clara	1911-40	50,000	~4.7
Moro	?-1950's	2,300	~3.0

Reserves: Estimated in 1923 by Southeast Metals as 90,000 st with 3-3.5% Cu and in 1927 by Asarco at 149,147 st with 3.02% Cu (Carpenter, 1942).

Grade and tonnage: Production through 1937 can be summarized as about 490,000 st of 4% Cu ore with negligible Au and Ag recovery.

Cleopatra District, Mohave Co. AZ

Spencer and Welty (1986) identified this district as detachment-fault related. The geology and mineral deposits of the Cleopatra district are described by Spencer and Welty (1985, 1989), and Tosdale and others (1990a).

Production: Spencer and Welty (1989) give total reported production from 1905 to 1962 as 20,089 st ore, 476,962 lbs Cu, 462 lbs Pb, 1,730 troy oz Au, and 11,669 troy oz Ag. It is not known if copper, lead, gold, and silver were recovered from all of the ore produced, or what was the proportion of metals recovered. The district has been divided into subdisricts by Spencer and Welty (1989) with the following production reported to the U.S. Bureau of Mines:

Subdistrict	st ore	lbs Cu	lbs Pb	oz Ag	oz Au
Cleopatra	14,744	430,879	none	3,339	1,624
Kimble	4,482	30,783	none	124	52
Lola	none	none	none	none	none
Silverfield	863	15,300	462	8,206	54

Reserves: Reserves for the Cleopatra-Palo Verde (Cleopatra subdistrict) reported in 1917 were 600,000 st with up to 2.9% Cu, $1.32/st Au, 0.3 troy oz/st Ag, and (*sic*) 4.5% (45%?) Fe (Weed, 1920, p. 250). Tosdal and others (1990a) report a subeconomic resource at the Big Kimble mine (Kimble subdistrict) of 200,000 st ore with 0.2% Cu, 0.02 troy oz/st Au, 0.04 troy oz/st Ag.

Grade and tonnage: Summing the resource estimates for the Cleopatra and Kimble subdistricts yields: 800,000 st ore containing 45% Fe, 1.2% Cu, 0.15 oz/st Ag, and 0.05 oz/st Au.

Harquahala District, Maricopa and La Paz Cos. AZ

Allen (1985) described and identified the base and precious metal deposits in the eastern Harquahala Mountains as detachment-fault related.

Production: Keith and others (1983) give total reported production from 1905 to 1981 as 21,000 st ore, 61,000 lbs Cu, 1,500 lbs Pb, 2,800 troy oz Au, and 7,300 troy oz Ag. Production in 1981 consisted of reprocessed tailings. It is not known if copper, lead, gold, and silver were recovered from all of the ore produced, or what was the proportion of metals recovered. These production figures appear to be rounded. Keith (1978) gave production by mine as:

Mine	Dates	st ore	oz/st Au	oz/st Ag	Other
Blue Eagle-Bunker Hill	?-1956	430	0.4	0.6	
Gold Leaf	1930-41	400	0.6	0.2	minor Cu
Hercules	?-1950	2,670	0.25	0.27	1.25 st Cu
Hidden Treasure	1932-67	1,775	0.95	3.9	minor Cu Pb Zn
Mars and Mescal	1916-18	110	0.15	0.3	11% Cu
San Marcos Group	?-1934	300	2	0.3	minor Cu
Socorro	?-1960	4,800	0.2	0.1	minor Pb
Why Not	1932-39	370	3.3	1.8	1.8% Cu

Bancroft (1911) reported that the San Marcos Group milled 300 st of ore in 1909 valued at $8/st and had produced ores valued at $10,000 up to May of 1906.

Reserves: In 1917 it was reported that 3,000 st ore worth $15/st were on the dumps of the Carmelita mine (Weed, 1920, p. 238).

Grade and tonnage: From the production data it is not possible to determine what portion of the reported production consists of reprocessed tailings.

Lead Pill District, Mohave Co. AZ

Identified as a detachment-fault related deposit by Spencer and Welty (1989). The geology and mineralization of the Lead Pill district are described by Spencer and Welty (1985, 1989)

Production: Spencer and Welty (1989) give reported production from 1923 to 1948 as 1,451 st ore yielding 27,973 lbs Cu, 404,986 lbs Pb, 530 troy oz Au, and 2,227 troy oz Ag. It is not known if copper, lead, gold, and silver were recovered from all of the ore produced, or what was the proportion of metals recovered.

Grade and tonnage: The production data yield grade estimates of 9.6% Cu and 14% Pb which clearly represent the tonnage and grade of concentrates sent to smelters.

Mammon District, La Paz Co. AZ

Spencer and Welty (1986) identified this district as detachment-fault related. The geology and mineral deposits of the Mammon district are described by Spencer and Welty (1985, 1989) and Eppinger and others (1990).

Production: Spencer and Welty (1989) give total reported production from 1909 to 1955 as 841 st ore, 86,993 lbs Cu, 60 troy oz Au, and 142 troy oz Ag. It is not known if copper, gold, and silver were recovered from all of the ore produced, or what was the proportion of metals recovered. Keith (1978) gave production from 1901 as 800 st with 4.5% Cu, 0.07 oz/st Au, and 0.16 oz/st Ag. Weed (1920, p. 400-401) gave production to 1917 as 500 st. Johnson (1958) estimated production to 1958 as 20,000 to 30,000 st ore, worked as follows:

1904	Several carloads shipped
1905-1917	Worked by E.S. Osborne who shipped about 500 st ore from 1913-1917.
1917-1921	Worked
1958	Several car loads 4-5% Cu ore shipped.

Reserves: Johnson (1958) reported developed reserves in 1917 as about 2,000 st with 3% Cu. About 200 st were stockpiled on the mine dumps which contained about 5% Cu, 0.01 troy oz/st Au and 0.1 troy oz/st Ag. Drilling in 1917 revealed 25 ft of 0.25 to 1% Cu. These reserves were likely mined out between 1917 and 1958.

Grade and tonnage: As much as 30,000 st of ore containing 4 to 5% Cu may have been mined. Drilling data indicates that much low grade (<1% Cu) ore exists outside the mined out areas.

Midway District, La Paz Co. AZ

Spencer and Welty (1986) identified this district as detachment-fault related. The geology and mineral deposits of the Midway district are described by Spencer and Welty (1985, 1989).

Production: Spencer and Welty (1989) give total reported production from 1907 to 1971 as 214 st ore, 9,410 lbs Cu, 45 troy oz Au, and 35 troy oz Ag. It is not known if copper, gold, and silver were recovered from all of the ore produced, or what was the proportion of metals recovered. Spencer and Welty (1989) divided the district into sub-districts for which the following production was reported to the U.S. Bureau of Mines:

Subdistrict	st ore	lbs Cu	oz Ag	oz Au
Battleship	15	1,200	1	none
Green Streak	189	4,800	21	37
Mammoth	10	3,264	13	8
Midway NE	none	none	none	none

Keith (1978) reported Green Streak production from 1953-54 as 200 st with 1.3% Cu, 0.2 oz/st Au, and 0.1 oz/st Ag. The Mammoth and Chicago (Mammoth

subsdistrict) produced a small tonnage in 1907 with 16% Cu, 0.8 oz/st Au, and 1.3 oz/st Ag.

Grade and tonnage: The data indicate shipments of high grade ores and concentrates.

Moon Mountains District, La Paz AZ

Classified as detachment-fault related by Welty and others (1989). The geology and mineralization of the Moon Mountains district and the Copperstone mine are described by Spencer and others (1988).

Production: Keith and others (1987) give total reported production from 1938 to 1950 as 300 st ore, 800 troy oz Au, and 100 troy oz Ag. It is not known what was the proportion of metals recovered. These production figures appear to be rounded. Keith (1978) reported that the Apache mine produced from 1935 to 1950 some 330 st ore containing 2.4 oz/st Au and 0.4 oz/st Ag.

Reserves: The Copperstone mine had open-pit minable reserves of 6 million st with 0.075 troy oz/st Au, and an underground minable reserve of 1 million st with 0.17 troy oz/st Au (Eppinger and others, 1990). Wilkins (1984) gave a geologic reserve estimate of 10 million st with 0.04 troy oz/st Au. The ore seems to contain between 1 and 3 percent Cu.

Grade and tonnage: Wilkins geologic resource estimate indicates about 10 million st ore containing 2% Cu and 0.04 troy oz/st Au.

Northern Plomosa District, La Paz Co. AZ

Spencer and Welty (1986) identified this district as detachment-fault related. The geology and mineral deposits of the district are described by Duncan (1990).

Production: Keith and others (1983) give total reported production from 1901 to 1955 as 7,500 st ore, 346,000 lbs Cu, 25,000 lbs Pb, 5,000 troy oz Au, and 7,000 troy oz Ag. It is not known if copper, lead, gold, and silver were recovered from all of the ore produced, or what was the proportion of metals recovered. These production figures appear to be rounded. In 1909 the Little Butte mine produced 22 carloads (about 990 st) ore with 7.6% Cu, $6.65/st (0.32 oz/st) Au, and 2.4 troy oz/st Ag (Bancroft, 1911). Keith (1978) reported production by mine as:

Mine	Dates	st ore	% Cu	% Pb	oz/st Au	oz/st Ag
Bullion	1915-18	>50	11		0.09	
Coronation	1940's-50's	115	1.8		0.07	0.13
Dutchman	?-1941	1,050		1	0.8	0.1
Hearts Desire	?-1914	200	7	2	1.6	3
Little Butte	?-1955	5,800	2		0.45	0.16
Old Maid	?-1938	150	0.1		2.6	0.6

Weed (1920, p. 406) reported shipments from the Little Butte mine in 1917 as 388 st valued at $20.72/st. A previous owner recovered 73,400 lbs Cu from ore containing 9.9% Cu, 20% Fe, 32.4% SiO_2, and $7.60/st Au.

Grade and tonnage: Production data indicate that much of the ore shipped was in the form of concentrates.

Osborne District, Maricopa Co. AZ

Allen (1985) described and identified this district as detachment-fault related.

Production: Keith and others (1983) give total reported production from 1916 to 1957 as 86,000 st ore, 1,369,000 lbs Cu, 7,710,000 lbs Pb, 13,000 troy oz Au, and 195,000 troy oz Ag. It is not known if copper, lead, gold, and silver were recovered from all of the ore produced, or what was the proportion of metals recovered. These production figures appear to be rounded. Allen (1985) gives additional details of production:

1926-1957	Tonopah-Belmont produced more than 50,000 st ore yielding 1 million lbs Cu, 150,000 troy oz Ag, and 8,500 troy oz Au.
1942-1949	Scott mine produced 17 st ore yielding 12,000 lbs Pb, 500 lbs Zn, amd 100 oz Ag. Morning Star mine produced 31 st ore.
1943	The U.S. mine had 4,500 st on dump with 0.5 to 0.75% Cu and 0.128 troy oz/st Au.
1961	U.S. Mine produced 133 st ore with 2.01% Cu and 0.091 troy oz/st Au.

Reserves: Reported reserve in 1984 was 565,000 st ore with 0.09 troy oz/st Au (Allen, 1985, p. 99).

Grade and tonnage: Combining the reserve and production data yields 650,000 st ore containing about 0.8% Cu and 0.09 oz/st Au. Assuming that the Au to Ag ratio (1:18) for the Tonopah-Belmont mine production is representative, the Ag grade can be estimated as 1.6 oz/st. The large Pb production reported by Keith and others (1987) is not substantiated by other sources and may be a tabulation error.

Owens District, Mohave Co. AZ

Spencer and Welty (1989) identified this district as detachment-fault related. The geology and mineral deposits of the Owen district are described by Spencer and Welty (1989) and Tosdal and others (1990b).

Production: Spencer and Welty give reported production from 1921 to 1956 as 792 st ore yielding 1,692 lbs Cu, 62,617 lbs Pb, 110 lbs Zn, 105 troy oz Au, and 10,326 troy oz Ag. It is not known if copper, lead, zinc, gold, and silver were recovered from all of the ore produced, or what was the proportion of metals recovered. Tosdal and others (1990b) reported finding ore in an ore bin which assayed 3.6% Cu and less than 15% Fe.

Reserves: An Anaconda geologist (Woodward, 1941) found a 300 by 500 foot zone of spotty mineralization in an area that was supposed to host about 300,000 st of ore. Dumps contained ore with 0.61% Cu, 0.3 oz/st Ag, and 0.038 oz/st Au.

Grade and tonnage: There appears to be a substantial tonnage of low grade ore but insufficient data exists to estimate its grade.

Owl Head District Pinal Co. AZ

Wilkins and others (1986) identified this district as detachment-fualt related. The geology and mineral deposits of the Owl Head district are described by Barter (1962), Iles (1966), and Applebaum (1975).

Production: Keith and others (1987) give reported production from 1911 to 1974 as 1,600 st ore yielding 41,000 lbs Cu, 8,000 troy oz Ag, and some Au. It is not known if copper, gold, and silver were recovered from all of the ore produced, or what was the proportion of metals recovered. These production figures appear to be rounded. Weed (1920, p. 312-313) reported that ore grades varied from 0.5 to 3% Cu and 1 to 3 oz/st Ag.

Grade and tonnage: The relatively large amount of Ag recovered relative to Cu suggests that some of the ore mined was treated solely for its Ag content.

Picacho District, Pinal Co. AZ

Wilkins and others (1986) identified this district as detachment-fualt related. The geology of the Picacho district is described by Brooks (1987) and Kerrich and Rehrig (1987).

Production: Keith and others (1983) give reported production in 1939 as 100 st ore yielding 2,400 lbs Cu, 100 troy oz Ag, and 100 troy oz Au. It is not known if copper, gold, and silver were recovered from all of the ore produced, or what was the proportion of metals recovered. These production figures appear to be rounded.

Grade and tonnage: Gold recovery from the small tonnage mined ran roughly 1 troy oz/st suggesting that concentrated ores were shipped.

Planet District, La Paz Co. AZ

Spencer and Welty (1986) identified this district as detachment-fault related. The geology and mineral deposits of the district are described by Lehman and Spencer (1989), Spencer and Welty (1989), and Wilkins and Heidrich (1982)

Production: Spencer and Welty (1989) have divided the district into sub-districts and have given reported production as follows:

Subdistrict	st ore	lbs Cu	oz Ag	oz Au
Mineral Hill	970,756	13,222,300	49	2
Planet	39,015	6,280,712	219	315
total	1,009,771	19,503,012	268	317

It is not known if copper, lead, zinc, gold, and silver were recovered from all of the ore produced, or what was the proportion of metals recovered. Weed (1920, p. 402-403) reported production for the Planet mine from 1864 to 1874 as greater than $0.5 million of 15 to 40% Cu ore. Bancroft (1911) gives production of the Planet mine to 1877 as 8,000 st ore. Stevens (1901, p. 334-335) reported that more than 40,000 st ore with 10% Cu and 1 oz/st Ag had been stockpiled at the Planet mine. Keith (1978) reports production by mine as:

Mine	Dates	st ore	%Cu	oz/st Au	oz/st Ag
Angelos	1930's	<100		1	0.2
Argus & Maryland	1916	250	3	0.4	0.2
Mineral Hill		~1,000,000	1.7	unknown	unknown
Planet	1863-1937	>60,000	~10	minor	minor

Reserves: The polymetallic deposits of the Planet district have been extensively drilled by several mining companies without delineating a commercial deposit. The results of these exploration efforts have not been made public. Weed (1920, p. 402-403) reported a reserve of about 0.5 million st of 60% Fe ore at the Planet mine. Keith (1978) reported that the Planet mine had a resource of 1.25 million st ore containing 60% Fe. The relationship between the copper and iron ore resources is not known.

Grade and tonnage: Based on production statistics, the grade and tonnage of the Planet district may be put at about a million st of ore containing 60% Fe, 1.7% Cu, and little Au and Ag.

Pride District, La Paz Co. AZ

Spencer and Welty (1986) identified this district as detachment-fault related. The geology and mineral deposits of the Pride district are described by Spencer and Welty (1985, 1989) and Fernandez (1965).

Production: Spencer and Welty (1989) give reported production from1911 to 1912 as 38 st ore yielding 21 lbs Cu, 78 troy oz Au, and 6 troy oz Ag. Keith (1978) reported that the Arizona Pride mine shipped a few 10's of st of ore in the early 1900's containing a little Cu and 0.2 oz/st Au and 2 oz/st Ag.

Reserves: Eppinger and others (1990) reported that an outcropping copper-bearing hematite orebody was 100 ft long and 20 to 35 ft wide. Samples from this orebody averaged 26% Fe, 0.66% Cu, and 11 to 150 ppb Au.

Grade and tonnage: Although a substantial tonnage of low-grade ore is indicated, there is insufficient data to calculate grade and tonnage.

Rawhide District, Mohave Co. AZ

Spencer and Welty (1989) identified this district as detachment-fault related. The geology and mineral deposits of the Pride district are described by Spencer and Welty (1985, 1989).

Production: Spencer and Welty (1989) give reported production from 1921 to 1958 as 708 st ore yielding 10,548 lbs Cu, 260,145 lbs Pb, 22,900 lbs Zn, 38 troy oz Au, and 8,124 troy oz Ag. It is not known if copper, lead, zinc, gold, and silver were recovered from all of the ore produced, or what was the proportion of metals recovered.

Grade and tonnage: Production data indicate that small tonnages of concentrated ores were shipped. The large Pb and Zn production are not substantiated by other sources.

Swansea District, La Paz Co. AZ

Spencer and Welty (1986) identified this district as detachment-fault related. The geology and mienral deposits of the Swansea district are described by Wilkins and Heidrich (1982), Spencer and Welty (1985, 1989), and Eppinger and others (1990).

Production: Spencer and Welty (1989) give reported production for the Swansea sub-district from 1909 to 1962 as 544,918 st ore yielding 26,457,302 lbs Cu, 507 troy oz Au, and 33,112 troy oz Ag. No production was reported to the U.S. Bureau of Mines from the Copper Penny and Squaw Creek sub-districts. It is not known if copper, gold, and silver were recovered from all of the ore produced, or what was the proportion of metals recovered. Bancroft (1911) reported that the grade of the main orebody at the Swansea mine was about 2.5% Cu. Keith (1978) reported the following mine production from the Swansea subdistrict:

Mine	Dates	st ore	% Cu	oz/st Ag	oz/st Au
Revenue	1910's	200	~2		unknown
Signal	?-1944	352,000	~3	0.09	minor

Reserves: An Anaconda geologist (Anaconda, 1970) in 1942 thought that some 100,000 to 200,000 st of 4 to 5% Cu ore could be developed at the Swansea mine. Later, in 1970, Anaconda geologists (Anaconda, 1970) reported that the Bagdad Copper Co. had estimated reserves of 3 million st of 1% sulfide ore in a zone 75 to 135 feet thick and less than 400 feet deep. About 250,000 st of 1% sulfide material was found on the mine dumps.

Grade and tonnage: Adding the Bagdad Copper Co. reserve estimate to past production yields about 3.5 million st ore containing 30% Fe and 1% Cu.

Whipple Mountains (Copper Basin), San Bernadino Co. CA

Spencer and Welty (1986) identified this district as detachment-fault related. The geology and mineral deposits of the Whipple Mountians are described by Wilkins and Heidrick (1982) and Marsh and others (1988).

Production: Spencer and Welty (1989) and Marsh and others (1988) give reported production for all mines in the Whipple Mountains as 5,123 st ore yielding 230,000 lbs Cu, 200 lbs Zn, 1,300 troy oz Au, and 9,500troy oz Ag. Production from deposits not related to detachment faults are likely included in this figure. It is not known if copper, zinc, gold, and silver were recovered from all of the ore produced, or what was the proportion of metals recovered. The Copper Basin mine produced 40,000 lbs Cu from 1930 to 1966 (Marsh and others, 1988). The American Eagle Group from 1915-17 produced 571 st of 10.7% Cu ore (Weed, 1920, p. 466-467).

Reserves: Louisiana Land and Exploration Co. reported delineating 50 million st ore with 0.5% Cu and trace Au in 1985 at the Copper Basin mine. Dravo Corp. in 1974 reported 7 to 11 million st ore with 1 to 2% Cu (Marsh and others, 1988) at the Copper Basin mine. The American Eagle Group (Eagle Sulphide Copper Co.) reported a reserve of about 90,000 st of 3.8% Cu ore in 1917 (Mines Handbook, v. 17).

Grade and Tonnage: The reserve estimate of Louisiana Land and Exploration Co. indicates 50 million st ore containing 0.5% Cu.

Conclusions

A review of available grade tonnage data indicate that detachment-fault related polymetallic deposits are generally small in size and low to middling in copper, gold, and silver grades (Table 1). These data must be used with caution, however. Past production centered on the higher grade portions of the deposits which could be easily hand-sorted or otherwise concentrated into a salable product. Only a few of the deposits have been explored by modern methods in order to delineate large, low-grade ores amenable to heap-leaching operations. The Moon Mountains district, whose reported production amounted to some 300 st of high-grade ore, has proven to host some 7 million st of ore minable by modern methods. The 50 million st Copper Basin deposit indicates that fairly substantial deposits are possible. Given the vagaries of these data, construction of a grade-tonnage model is not justified.

Table 1. Grade and tonnage data for detachment-fault related base and precious metal deposits. See text for sources.

Deposit	MMmt	% Fe	% Cu	g/t Ag	g/t Au
Alamo	0.46		0.4	6	1.9
Cienaga	0.36		4.0	62	3.1
Clara	0.44	50	4.0	low	low
Cleopatra	0.72	45	1.2	5	1.5
Copperstone	9.07		2.0		1.2
Osborne	0.59		0.8	50	2.8
Planet	0.91	60	1.7	low	low
Swansea	3.31	30	1.0		
Whipple Mountains	45.00		0.5		trace

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