Mineralogy, assay, and fluid inclusion characteristics of quartz-sulfide veins of the Cusihuiriachic district, Chihuahua, Mexico

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Executive Summary

The sulfide mineralogy of the Cusihuiriachic veins is relatively simple with major sphalerite and galena, with minor pyrite and locally chalcopyrite (mainly as inclusions in sphalerite). Although looked for, no discrete Ag minerals were found by petrographic, XRD, or SEM analysis. Ag assays ranged from 104-474 ppm, for hand selected high-grade samples. This is low for mines that supposedly produced grades of 100s to 1000s of oz/t Ag. It is hypothesized that most of the very high grade material was due to supergene enrichment and some of this material still exists in the shallow workings, such as at La India. The Fe content of sphalerite and fluid inclusion homogenization temperatures point to a relatively low temperature environment of ore formation, with median homogenization temperatures for Mexicana quartz of 230°C and San Antonio sphalerite of 220°C.

Introduction

The following report is based upon a suite of vein samples collected June 15, 2006 at the Cusihuiriachic project. As required by Canadian Investment Regulations, Dia Bras has my permission to use this report for their own purposes, for their website, and for release to the public. Features described in this report are illustrated in an attached PowerPoint presentation (Fig. 1).

Geologic Setting

Historic mining activity in the Cusihuiriachic district exploited a series of planar veins that cut volcanic rocks that appear to be correlative with the volcanic package at Bolivar, with a lower andesitic volcanic unit and an upper rhyolitic unit. The veins occur in northwest and northeast-striking faults that appear to define an overall extensional regime. All of the veins contain quartz with a variety of crustiform and banded textures (Fig. 2) typical of epithermal environments however the veins generally are sulfide-rich (sphalerite>galena>chalcopyrite) which is not typical of epithermal systems. Most historical mining was very shallow, <100m, and appears to have concentrated on supergene-enriched ores including Ag chlorides and native silver. Grades exceeding 1000 oz/t are reported but based upon the size of the old workings, the tonnage must have been small. Apparently, most mining stopped when unoxidized sulfides were encountered.

Vein samples

Mexicana Mine – main adit, 2 cm quartz vein with 5 mm galena>sphalerite selvage on both sides. Three samples collected (Mex-1, Mex-3, Mex-4). Blue tarnish on galena (Fig. 2) was initially thought to be acanthite (Ag_2S) or stromeyerite (AgCuS) but further work confirmed that it is simply tarnished galena. Wall rock is La Bufa rhyolite lithic tuff. This is the upper silicic volcanic formation.

San Antonio Vein – quartz-sphalerite-galena vein and breccia cement of volcanic wall rock (Fig. 2). Vein and breccia zone ranges from 2-50 cm wide. Alteration of volcanic wall rock is minimal, mainly sericitic. Compared to the Mexicana Vein, the San Antonio Vein is wider and has much more sphalerite although galena is locally abundant. Blue tarnish on galena (Fig. 2) was initially

thought to be acanthite (Ag_2S) or stromeyerite (AgCuS) but further work confirmed that it is simply tarnished galena. Wall rock is La Bufa rhyolite lithic tuff. This is the upper silicic volcanic formation.

Sample assays

As a first step towards understanding the distribution of Ag at Cusihuiriachic, three samples of Mexicana vein ore and four samples of San Antonio vein ore were submitted to Chemex Labs for assay. Samples were assayed for multiple elements by ICP-AES with a 4 acid digestion. Au and Ag were analyzed by fire assay with a gravimetric finish. High grade Pb, Zn, and Ag were also assayed by AAS with a 4 acid digestion. The results are summarized in Table 1.

Table 1 Assays of San Antonio and Mexicana vein ore samples

		SA-1	SA-2	SA-3	SA-4	Mex-1	Mex-3	Mex-4
Al	%	1.01	0.14	0.16	0.4	0.37	0.44	0.4
Ca	%	<0.05	<0.05	<0.05	0.05	0.07	0.08	0.06
Fe	%	0.75	0.84	0.81	0.82	0.6	0.78	0.57
K	%	2.2	<0.1	0.1	0.3	0.1	0.2	0.2
Mg	%	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Na	%	0.35	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Ti	%	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
S	%	18.1	17.2	17.3	24.2	8.3	7.2	7.2
Pb	%	6.63	13.1	28.9	13.25	>30.0	27	>30.0
Zn	%	>30.0	>30.0	24	>30.0	5.69	5.71	5.03
Ag	ppm	384	447	433	150	143	108	287
Ag	ppm	426	474	449	208	142	104	287
Ag	ppm	>200	>200	>200	>200	158	125	>200
Au	ppm	0.23	2.61	1.07	0.46	0.86	1.72	1.41
As	ppm	80	90	90	<50	<50	<50	<50
Ba	ppm	300	<100	<100	<100	<100	<100	<100
Be	ppm	<10	<10	<10	<10	50	100	40
Bi	ppm	<20	<20	<20	<20	<20	<20	<20
Cd	ppm	2940	2070	1540	2660	290	340	310
Co	ppm	10	10	10	10	<10	<10	<10
Cr	ppm	30	130	<10	<10	160	10	70
Cu	ppm	700	150	100	90	130	100	180
Mn	ppm	1450	770	490	370	590	640	1060
Mo	ppm	10	10	10	10	<10	<10	<10
Ni	ppm	<10	<10	<10	<10	<10	<10	<10
Pb	ppm	68100	>100000	>100000	>100000	>100000	>100000	>100000
Sb	ppm	<50	170	200	120	120	110	130
Sr	ppm	20	<10	<10	<10	<10	<10	<10
V	ppm	<10	<10	<10	<10	<10	<10	<10
Zn	ppm	>100000	>100000	>100000	>100000	48200	57500	52900
SA Avg						Mex Avg		
32.9	Ag/Pb	64.3	36.2	15.5	15.7	6.1	4.7	3.9	9.6
13.9	Ag/Zn	14.2	15.8	18.7	6.9	33.4	25.0	18.2	57.1
0.6	Pb/Zn	0.2	0.4	1.2	0.4	5.3	5.3	4.7	6.0

There are several striking trends. The San Antonio samples had a much higher sulfide content (25-75% sulfide with sphalerite>galena>>pyrite) and not surprisingly have much higher total S and Zn

values. Three of the four samples contained >30% Zn and the other 24% Zn. These samples also had higher Cd (1500-3000 ppm) and Ag (208-474 ppm) than the Mexicana samples. Given the hand selected, high grade nature of these samples the Ag values are surprisingly low considering that bulk mined ore was said to have run 100s to 1000s of oz/t Ag. The Mexicana vein samples contained more quartz and galena than the San Antonio vein samples, hence the lower S and much higher Pb (27->30% Pb). Given that no discrete silver minerals were identified and that Ag normally occurs in solid solution in galena, it is surprising that the Ag values of the Mexicana vein samples are half of the San Antonio vein samples. The metal ratios at the bottom of Table one are consistent with the individual assay values. Ag/Pb is higher at San Antonio whereas Ag/Zn and Pb/Zn are higher at Mexicana.

Mineralogy

As a first step towards identification of the ore mineralogy in the Mexicana and San Antonio samples, several pieces with relatively high Ag assays (200-400 ppm) were analyzed by X-ray diffraction (XRD). The technique involves grinding the sample to a powder and spreading on a glass slide. This is inserted into the XRD and irradiated while the spectrometer scans the sample. This results in a characteristic X-ray spectra displayed as a function of intensity versus the angle 2ø. The spectra peaks correspond to the crystal structure of the minerals present and provide very clear evidence for the presence of quartz (Fig. 3), galena (Fig. 4), and sphalerite (Fig. 5). These three minerals account for all of the observed peaks. The characteristic peaks for acanthite, argentite, and stromeyerite were absent. Thus, there is high confidence that these minerals are less the 1% of the sample and probably absent. This was confirmed by normal petrographic observations which indicated that sphalerite, galena, pyrite, and chalcopyrite are the only sulfide minerals present in the samples examined.

The samples were also examined with a scanning electron microscope (SEM) as illustrated in Figures 6, 8, 10, 11, 13 and 14. With the instrument set for Ag, the samples were imaged with a 1 µ beam and no silver minerals were found, consistent with XRD and petrographic observation. Energy dispersive analyses of sphalerite showed that in addition to the major elements Zn and S, only Fe and Mn are present above the limit of detection (~1000 ppm). The Fe content was analyzed because the Fe content of sphalerite varies as a function of temperature and sulfur fugacity. For all samples measured the Fe content of sphalerite ranged from 0.07-0.27 wt. % Fe with the Mexicana samples slightly higher than the San Antonio samples (Figs. 7, 9, 12, and 15). This is consistent with a relatively low temperature of formation. In contrast, sphalerite Fe content in skarn deposits ranges from 1-5% in relatively low temperature Zn skarns to 5-15% in higher temperature Cu and W skarn deposits. In contrast, high temperature Sn-W vein deposits can have sphalerite Fe contents >20%.

Fluid Inclusions

Fluid inclusions were measure in quartz (Fig. 16) and sphalerite (Fig. 17) grains from both the Mexicana (Fig. 16) and San Antonio (Fig. 17) samples. All fluid inclusions are liquid rich two phase inclusions which homogenized to a liquid. No salt daughter minerals were observed. Except for a few outliers, all homogenization temperatures ranged from 175-300°C in Mexicana quartz and from 180-255°C for San Antonio sphalerite. The median homogenization temperature for inclusions in Mexicana quartz is 230°C and 220°C for San Antonio sphalerite. Both the range and

median homogenization temperatures are slightly high than typically measured for precious metal epithermal systems but are exactly what would be expected for base metal vein systems, the interpreted classification for the Cusihuiriachic district. As previously described, the Groundhog vein system is an appropriate analog for the Cusihuiriachic district (Hawksworth and Meinert, 1990).

Summary

Veins in the Cusihuiriachic district consist of banded, crustiform, and brecciated quartz with bands, disseminations, and massive zones of sulfide-rich ore. Except for supergene oxidized and enriched ore, such as at La India, sphalerite and galena are present in all ore zones. Thus, the Cusihuiriachic district should be thought of as a high level base metal vein system that overlies or is peripheral to a buried intrusion. This intrusion may be mineralized and the presence of carbonate rocks in the sub-surface makes the presence of skarn ore likely.

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References:

Hawksworth, M.A., and Meinert, L.D., 1990, Alteration and fluid inclusion study of the Groundhog vein system, Central Mining District, New Mexico, Economic Geology, v. 85, 1825-1839.