X -Ray Fluorescence Spectroscopy of Silver-Barite Hydrothermal Mineralization in the Central Mojave Silver-Barite District, Mojave Desert, San Bernardino County, CA

by

Jon M. Strom

Department of Geological Sciences

California State Polytechnic University, Pomona

A Senior Thesis Submitted in Partial Fulfillment of
the Requirements for the Degree of
Bachelor of Science
Department of Geological Sciences
California State Polytechnic University, Pomona
August 2003

Abstract

The Central Mojave Silver-Barite District produced over $20,000,000 of silver, from 1880 to 1940. Epithermal silver-barite mineralization generally occurs as veins and disseminations in Miocene volcanics and superjacent volcaniclastic sedimentary units. Smaller pockets of mineralization have also been prospected within the underlying Proterozoic, Waterman Gneiss. The structural setting of the central Mojave is complex involving Holocene strike slip as well as Miocene detachment. A model proposed by Jessey (1996) relates the mineralization to extension and detachment faulting. He suggests that meteoric water circulated to depth along the master detachment fault surface. It was subsequently heated by, and perhaps commingled with, magmatic fluid, then rose upward along high angle faults. Ore deposition occurred at favorable structural loci within upper plate rocks.

This study seeks to examine both minor and trace elements within the Central Mojave District and relate their distribution to the proposed detachment model. Thirty-six samples were collected from trines and prospect pits in upper and lower plate rock units of tour sub-districts (Calico, Mt. General, Waterman Hills and Mitchell Mange). Each sample was crushed, screened and pelletized. Pellets were x-rayed with a Phillips PW 2400 X-Ray Fluorescence Spectrophotometer and trace/minor element concentrations determined with SEMI-Q software.

Two trends can be noted from the x-ray data. Volatile elements (chlorine and fluorine) are concentrated in upper plate rocks, particularly within those sub-districts where boiling of ore fluids has occurred. This is consistent with deposition of ore mineralization from chloride-complexed solutions. During boiling the complex breaks down releasing both the volatiles and complexed metals. Since boiling appears to be adiabatic, those sub-districts where mineralization was emplaced at or near the surface should have greater concentrations of volatiles. Furthermore, as the metal-chloride complexes break clown, there should also be a coincident increase in base metal concentrations (i.e., copper, lead, silver). Available trace element data support this hypothesis. Those sub-districts with no demonstrable boiling should be paragenetically "clean" with only the most insoluble elements deposited (i.e., barium, iron and manganese. As fluids circulated deeply along the detachment fault surface tectonic over-pressure prevented deposition of all but the most insoluble minerals (barite, and Fe-Mn oxides) resulting in the paragenetically simple ores of the lower

plate (e.g., Mitchell Range). As fluids moved upward along upper plate listric faults, pressure dropped, boiling ensued and metals were released from chloride complexes generating the base metals sulfides common in upper plate rocks (e.g., Waterman Hills). This study fails to explain the paragenetically more evolved ores of the Calico District where boiling has not been reported (Rosso, 1992). Perhaps the depth of emplacement of Calico mineralization (>1 km) complicates the model.

Acknowledgments

I am very grateful for the efforts of Dr. Jessey for the unlimited support lie provided for me to complete this research work. In addition, I would like to extend gratitude to Dr.s Tarman, Nourse, Berry and Klasik for their complete cooperation free flow of ideas and information and insight to all aspects of the regional geology of the Central Mojave Silver-Barite District, as well as for my training on the Phillips X-ray fluorescence spectrometer. And finally, a thank you to Kevin Rosso for his extensive work on fluid inclusion studies of which I relied heavily in both format, and fluid depths and temperatures.

I would like to extend a heartfelt thanks to the entire faculty and staff of the Department of Geological Sciences at Cal Poly Pomona to who I am indebted my years of seemingly endless years of education, refining of my abilities and my devotion and creativity to geological sciences.

Table of Contents

List of Figures and Tables

Introduction

Purpose

The purpose of this research is to follow-up previous studies of the paragenetic sequence of the silver-barite vein occurrences in the Central Mojave Silver-Barite District. The X-Ray fluorescence (XRF) spectroscopic analyses of ore sample should exhibit distinct relationships to the paragenetic sequence, and structural setting, and the exclusive accommodation of the Waterman Hills detachment fault (WHDF) network (Figure 1). The elemental associations reveal important trends related to the above variables, and allow refinement of the emplacement model.

The unique paragenetie sequence of the Central Mojave silver-barite mineralization evolved from early oxidizing to later reducing fluids (Rosso, 1992). This is the reverse of typical precipitation of minerals from hydrothermal fluids (Jessey, pers. comm.).

Thirty-six silver-barite samples were x-rayed to provide a representative analysis of the Central Mojave Silver-Barite District. Previous fluid inclusion analysis of the Calico Mining district serve as confirming/complementary data with mineralization concentrations from XRF spectroscopy, and vice versa.

Geologic Setting

The Central Mojave Silver-Barite district occupies an area that stretches from Mt. General, to the west, approximately 2 miles northwest of the city of Barstow, California, to the Calico Mountain range approximately 12 mile northeast of Barstow. The area of study within the district spans some 340 square kilometers, with the Waterman Hills and the Mitchell Range centrally located (Map). A complete description of the regional geologic structures and rock units can be found in Dr. Jessey's (1988), and Dr. Tarman's (1988) research of the eastern Mojave Desert. The area is understood to he composed of two major rock masses, referred to as the upper and lower plates of the WHDF.

The lower plate is composed of the Precambrian mylonitic Waterman Gneiss intruded by Mesozoic diorite, quartz-monzodiorite and granite. These have been overprinted by pervasive chloritization during the detachment process (Figure 2).

The upper plate consists of Miocene Jackhammer and Pickhandle volcanics and the unconformably, super-adjacent mid to late Miocene sedimentary Barstow Formation. The upper plate lies unconformably above the lower plate along the WHDF, a low angle normal fault. As a result of regional early Miocene extension, the upper plate displays high angle listric faults that generally trend to the northwest. Mineralization within the Pickhandle volcanics typically occurs in fractures and listric faults (Figure 1) as both fine grained and coarse-grained assemblages. As extension continued basins formed resulting in the contemporaneous deposition of unlithified, siliciclastic, silty sediments of the Barstow formation. Silver-barite mineralization is mostly disseminated in the Barstow Formation with only minor randomly oriented vein occurrences (Rosso, 1992). The aforementioned listric faults along with the WHDF are believed to serve as the plumbing system for the silver-barite hydrothermal mineralization within the district.

X-Ray Fluorescence Spectroscopy

The Barite Vein Mineralization

Sample Collection

Thirty-six samples were collected from specific vein occurrences that would yield maximum representation of the Central Mojave Silver-Barite district. Sampling was accomplished by picking at barite vein exposures with a common rock hammer. Locations for obtaining vein samples were at, exposed listric faults and at accessible, representative locations at opposite ends along the WHDF and the Calico Fault system within each of the subdistricts: Waterman Hills, Calico, Mitchell Range and Mt. General. Samples selected contained large rusty- pink to nearly clean white crystals, as well as finely layered crystalline masses of mineralization.

Sample Preparation

Average sample weights were approximately 1.5-2.0 lbs. were crushed to approximately coarse sand consistency, separated, and then milled to 6.0 grains. Next, 1.2 grams of cellulose binder was added, and the samples were pressed into their final pellet form for analysis. Pellets were then analyzed using the Phillips Analytical X-ray, Model # PW 2400 X-Ray spectrometer.

Data and Data Reduction: Mineral Compound/Elemental

Percent Concentrations

The mineral assemblages contained elemental barium in biased percentages ranging from 1.441 % to 82.264 %, (Table 1). Samples # 5 and #23 were removed from the data table to reduced excessive adverse biases in compound percentages. The reader should be aware of the continued bias of the sample data in the tables within this study. Table 2 is a revision to the initial data produced by the Phillips x-ray spectrometer. The averages computed are meant to show the occurrences in bulk proportions and should not be used as actual percentage interpretations. Normalizing this data reduces sample bias (see Tables 3 and 4). Normalizing theoretically removes the gangue minerals from each of the samples based on the component percentages of the sample with the highest percentage of barite, the key element of this study. The normalized ratios, as their values increase, represent a reduction in concentration from the chosen normal sample of barite.

The Central Mojave Silver-Barite District

Calico Subdistrict

The Calico subdistrict is composed of Miocene Pickhandle volcanics, sedimentary Barstow Formation and other silicic Miocene sedimentary formations. This subdistrict is entirely upper plate rock units of the WHDF. The right-lateral slip Calico Fault crosscuts the WHDF along the western edge of the Calico Range (Figure 1). The WHDF extends easterly beyond this study's area of research (see Map). Silver-barite mineralization occurs along northwest trending high angle listric faults throughout the subdistrict.

Barite occurs as large, (>1 cm.), euhedral crystals as well as tine banded crystalline aggregate. Fluid inclusion studies show no evidence for boiling within this subdistrict. Barite homogenization temperatures average 277 degrees Celsius (Russo, 1992) with hydrothermal fluid salinity of 2-4% (Jessey, 1996).

Samples were collected from volcanic rock hosting barite veins at the Silver Bow mine, Silver Bow #S extension, and several prospect workings between the Silver Bow and the St. Louis mines.

Waterman Hills Subdistrict

The Waterman Hills consist of upper plate Tertiary sedimentary and volcaniclastic rock units of unknown affinity. Barite is found along two northwest trending listric (?) faults comprising the Waterman mine. The WHDF outcrops less than one kilometer to the north of the veins. Projection of the fault places the WHDF plane at less than 400 meters below the current surface (Ireland, 1993). The dextral slip Harper Lake Fault crosscuts the WHDF along the western edge of the Waterman Hills range (Figure 1). Barite vein occurrences sampled were within the Miocene sedimentary units.

Barite samples were collected from veins displaying coarse-grained aggregates as well as from areas of extensive brecciation. Fluid inclusion studies establish barite homogenization temperatures ranging; from 180-270 degrees Celsius (Ireland, 1993). Inclusions in this district were distinctively smaller than in the other districts and would not allow establishment of salinity information. Type II inclusions were common suggesting repeated evidence for boiling (Jessey, 1996). Samples of barite mineralization were obtained along the northwest trend of the accessible exposures of the Waterman mine openings and from breccia exposed along one mine access road.

Mt. General Subdistrict

The Mt. General subdistrict consists of both upper and lower plate rock units of the WHDF. Limited mapping of local geology has been done by Patt (1996). The WHDF underlies Mt. General while the mountain itself is comprised of Miocene (?) volcanics (Figure 1). Barite occurrences within this district are the most enigmatic. Mineralization has been sheared and brecciated, with dark cloudy masses containing few usable fluid inclusions to analyze. Salinity studies have been unsuccessful, and only a dozen inclusions within this district yielding a non-representative homogenization temperature of 208 degrees Celsius are available (Jessey, 1996).

Samples were generally selected along the northwest trending; faults, while one sample (A404-5) way selected from the only northeasterly trending fault within the upper plate rocks at a mine opening located immediately northwest of the Melody mine. One sample was also obtained from the crush zone talus at the Pedry mine opening and another along the same trend at a location to the southeast. Samples A404-1 and 2, and A404-OP1 thru OP3 were collected from accessible exposures of barite veins and talus ore piles (OP-1 to 3) along the southwestern foothills of the Mt. General Range and within the lower plate of the WHDF.

Mitchell Range Subdistrict

Geology of the Mitchell Range subdistrict is somewhat similar to the Waterman Hills. However, unlike the Waterman Hills, rock units representing the lower plate rocks are surrounded by outcrops of Miocene Pickhandle Formation. The Mitchell Range itself is composed almost entirely of lower plate rocks. Barite occurs within faults that postdate the mylonitic fabric of the lower plate Waterman Gneiss and display slickensides.

Barite occurrences are massive, clean, cream-white, euhedral to fresh pinkish/orange rosettes, combs and platelettes graduating to a deep tawny sheen where iron is most prevalent. Fluid inclusion data indicates no evidence for boiling, with homogenization temperatures ranging from l80-270 degrees Celsius. Salinity studies have yet, to be undertaken. Samples were chosen from open exposures along the faults within the workings of the Barium Queen mine.

Data Analysis

Waterman Hills

Vein samples A404-6,-8,-9 and -10 were selected from a single northwest trending nein in the upper plate sedimentary units. Table 5 shows a reduced concentration of barite. Copper is present in samples A404-6, -8, and -9. Fluorine and chlorine are also present, paralleling fluid inclusion studies that show evidence for boiling. Tables 1 thru 3 all show the appearance of middle stage paragenetic heavy metals demonstrating Rosso's (1992) silver-barite paragenetic sequence model (Figure 2).

The Calicos

Vein samples S-1 thru S-10 were selected from northwest trending veins within the Pickhandle volcanics throughout the district. Note that sample S-4 was used as the standard for normalizing the XRF concentration data Tables 3-5. Silver occurs only in the Calico subdistrict samples. Early and middle stage silver-barite metals are present in the XRF data Tables 4-5. Copper and chlorine occurrences are predominant within the Calico subdistrict. The cumulative appearance of silver, copper and chlorine in Table 3 supports the paragenetie sequence (Figure 2) established by Russo (1992) and Jessey (1996). Fluid inclusion studies from Rosso (1992) show no evidence for boiling with hydrothermal fluid salinities of 2-4%. This also agrees well with the absence of fluorine in Table 5 in the samples drawn from this subdistrict.

Mt. General

This subdistrict is composed of both upper and lower plate rock units. Samples A404-1,-2,-5 and A404-OP-1 thru -3 were collected from the upper plate Miocene rock units. Samples A404-3, -3FL, and -4 were selected from lower plate rocks. Sample A404-5 was anomalous in that it was the only sample selected from a northeast trending fault.

Table 5 indicates an absence of silver and virtually no copper, however, the bulk of chlorine (both plates) and fluorine (upper plate exclusively) are present. Late stage paragenesis is demonstrated by the presence of lead and chlorine within both plates and fluorine appearance exclusively an upper plate occurrence (Tables 4-5). This supports the paragenetie sequence established by Rosso (1992) and Jessey (1996). (Copper occurs only in one sample, A404-4).

Mitchell Range

Vein samples A404-11 thru A404-17 were selected from northwest trending faults within the lower plate of the Waterman Gneiss. All barite within this subdistrict lies entirely in the lower plate Waterman Gneiss. Samples collected from the Barium Queen Mine vein were the cleanest of all the silver-barite specimens (Tables 4-3). Early and middle stage silver-barite paragenesis (Figure 2) is demonstrated with the presence of barium, and the iron and magnesium. Finally, the presence of Pb suggests the beginning of the late stage paragenetic sequence. Samples A404-11 thru -13 were collected from lower sections of the Barium Queen mine vein and show the presence of Mn, and chlorine in -11 and -13. This data suggests the hydrothermal fluids in this region carried precious metals and halogens in solution (salinity relatively higher) to be transported and deposited later in shallower vein regions within the upper plate rock units. (No salinity studies exist for this subdistrict at the time of this research work.)

A General Comparison of Element/Compound Occurrences within the Central Mojave Silver-Barite District

Table 5 shows halogen/fluorine precipitation within Mt. General and the Waterman Hills exclusively. Note also that evidence for boiling is revealed in fluid inclusion studies of the silver-barite mineralization (Ireland, 1993) in the Waterman Hills. Halogen chlorine is less exclusive in occurrence, but can be generalized as occurring primarily north and west of the Calico and Barium Queen mines. Silver is exclusively found in the Calico subdistrict with co-occurrences of copper. Copper occurrences are distributed within the northern regions of the Calicos, Mt. General, and the Waterman Hills.

Barium and heavy metals of the early and middle stages of silver. barite paragenesis (Figure 2) occur in both upper and lower plate rock units (Tables 4-5). The late stage paragenesis is best represented in the samples extracted from upper plate rock units of the Calico and Waterman Hills subdistricts. Tables 4 and 5 exhibits the older Waterman Gneiss rock unit as host rock with clean hydrothermal emplacements of silver-barite ore. The Miocene volcanic rock units of the upper plate contain the more complex hydrothermal emplacements with the presence of silver, copper, chlorine and fluorine (fluorine, exclusively upper plate).

Listric faults within the upper plate Miocene volcanic rock units contain nearly all the halogen occurrences. When the cross section of the entire district is examined, the relationship of the silver-barite occurrences to the WHDF can be readily identified (Figure 1). The detachment fault can be traced below each of the subdistricts, absent in the open expanses between the subdistricts. It is in these areas that no silver-barite emplacement occurs. Then by logical reasoning, where the WHDF can be projected below the Central Mojave Silver-Barite District, there are silver-barite veins in the above rock units that are either the upper or lower plate rock masses. Where the WHDF lies below, there are silver-barite veins above.

Geochemistry of the Silver-Barite Ore deposits

Upper and Lower Plate Associations

Barite is associated with both upper and lower plate, naturally. The essential relationship to absorb from Table 4 is the occurrences of each stage of the paragenetic sequence established by Dr. Jessey. The latest stage of the paragenetic sequence occurs exclusively in the upper plate rock masses.

The unique order of the district's paragenetie sequence is reinforced by the relationship of the halogen gases occurring primarily in the upper plate rock masses, (Table 3). Chlorine has minimal occurrence in the lower plate, but is demonstrated as upper plate emplacement. Fluorine is demonstrated as exclusively upper plate occurrence without exception. This compliments the relationship between the silver-barite paragenetic sequence and its geographic location. Volatiles are confined to shallow subdistricts characterized by fluid boiling (Table 4). Structurally deeper subdistricts with no evidence for boiling, (e.g., Calicos and Mitchell Range) lack one of two volatile trace elements. This suggests that boiling expelled volatiles, and in some cases base metals. The result was elementally more complex ore deposits in upper plate rocks. Note the Calico subdistrict appears to be an exception to this rule. Evidence for boiling is minimal but ores are complex. The explanation for this anomaly may be related to fluid pressure and depth of emplacement.

Silver Chloride Complexes-Sulfide Precipitation

Paragenetic studies of the Barstow and Pickhandle ore assemblages establish silver base metal occurrences in the latest stage of hypogene mineralization, (Fletcher, 1986 and Jessey, 1988). The change in fluid conditions to allow silver chloride complexes to favor hydrogen sulfide gas release with accompanying silver sulfide precipitation in the upper plate are clearly established by Henley (1985) and Brown (1985) and are as follows: pH, temperature, and pressure. Tables 2 and 3 demonstrate the overall trend among compound/element concentrations within the district's hydrothermal fluids as cooling; exclusively in the upper plate.

The sequence of mineral deposition provides evidence to support the unique of barite out of hypogene solutions prior to silver chloride complexes reacting in solution to yield silver/base metal sulfides. This research lends further support to the reduction of hydrostatic pressures while fluids sustained relatively constant temperatures during deposition of barite and before precious metals and volatiles were released from solution.

Conclusions

This research provides general, supporting data/supplementary information for existing models of silver-barite emplacement within the Central Mojave Silver-Barite district,

- X- Ray fluorescence spectroscopy of ore samples is indispensable in demonstrating the delicate balance of the geochemistry within the mineralization ores deposited by hydrothermal fluids. Tables 1 thru 5 demonstrate and provide further evidence to support for models that establish the silver-barite paragenetic sequence in the Central Mojave Silver-Barite district.
- Data reflected in the tables presented in this study support fluid inclusion work by Jessey (1988), Fletcher (1986), and Rosso (1992) that conclude nearly all boiling of hydrothermal fluids is an upper plate phenomena. The position of fluid boiling is demonstrated in Tables 1 thru 5. There is a high probability that boiling occurred in the veins within Mt. General due to the presence and exclusivity of volatile fluorine.
- Mineralizing fluid had been shown to change from an early oxidizing solution to a later reducing mineralizing solution during the Central Mojave silver-barite paragenesis. This study in conjunction with previous works provides evidence that

confirms this change in fluid environment during silver-barite ore deposition.

- This research provides further evidence that silver-barite vein emplacement is controlled specifically by the framework created by the WHDF.

References

Barton, P.B., 1984, Redox Reactions in Hydrothermal Fluids, in Henley, R.W., Truesdell, A.H., Barton, P.B., Fluid-mineral equilibria in hydrothermal systems, Reviews in Economic Geology, v. l, Society of Economic Geologists, pp. 99-113.

Fletcher, D.I., 1986, Geology and genesis of the Waterloo and Langtree silver-barite deposits, California: unpublished Ph.D. Dissertation, Stanford University, 138 p.

Glazner, Allen F., Bartley, Join M., and Walker, J. Douglas, l988, Geology of the Waterman hills Detachment Fault, Central Mojave Desert, California, in This Extended Land, Geological Journeys in the Southern Basin and Rare, Field Trip Guidebook, Geological Society of America Cordilleran Section Meeting, Las Vegas Nevada, 1988, pp 223-236.

Henley, R.W., 1984, Chemical Structure of Geothermal Systems, in Henley, R.W., Truesdell, A.H., Barton, 11'.B., Fluid-mineral equilibria in hydrothermal systems, Reviews in Economic Geology, v.1, Society of Economic Geologists, pp. 9-28.

Henley, R.W., 1985, The Geothermal Framework of Epithermal Deposits, in Berger, B.R., & Bethke, P.M., Geology and Geochemistry of Epithermal Systems, Reviews in Economic Geology, v. 2, Society of Economic Geologists, 298 p.

Ireland, Mary C., 1993, Barite mineralization, alteration and geochemistry of the Waterman Mine, San Bernardino County, CA: Unpublished Senior Thesis, California Polytechnic University-Pomona, 40 p.

Jessey, D.R., 1988, Silver-barite mineralization of the Calico mining District, in Geologic excursions in the eastern Mojave desert, National Association of Geology Teachers-Far West Section, spring conference field guide, 137 p.

Krauskopf, Konrad B. and Bird, Dennis, B., 1995, Distribution of Elements in Igneous Rocks, Introduction to Geochemistry, 3'a edition, pp. 538-543, and Table 20-3.

Patt, Gary, 1996, Geology of the Mt. General Area, CA: unpublished B.S. Senior Thesis, Cal Poly Pomona University

Reed, M.H., 1985, Boiling, Cooling, and Oxidation in Epithermal Systems: A Numerical Approach, in Berger, H.R., & Bethke, P.M., Geology and Geochemistry of Epithermal Systems, Reviews in Economic Geology, v. 2, Society of Economic Geologists, pp. 249-272.

Rosso, Kevin M., 1992, Fluid Inclusion Microthermometry and Geochemistry of Silver-Barite Mineralization in the Calico Mining District, San Bernardino County, CA: unpublished B. S. Senior Thesis, Cal Poly Pomona University, 31 p.

Tarman, D. W., 1988, Silver-barite mineralization of the Calico mining District, in Geologic excursions in the eastern Mojave desert, National Association of Geology Teachers-Far West Section, spring conference field guide, 137 p.

Percent Compounds/Elements Concentrations

% Concentrations of Compounds in Barite Samples																					
			Plate of	Compounds Present (%)																	
Item #	Sample #	Location	Emplacement	Ba	K2O	CaO	Na2O	MgO	Al2O3	SiO2	P2O5	MnO	Fe2O3	Ni	Cl	F	Pb	Ag	Cu	Zn	Sr
1	S-1	Calico Mtns.	Upper Plate	77.254	0.023	0.023	F0	0.047	0.613	14.108	0	0.065	0.942	0	0.025	0	0	0	0.021	0.013	0.483
2	S-2	Calico Mnts.	Upper Plate	70.751	0.444	0.067	0.371	0.083	1.754	16.96	0.037	0	2.076	0	0	0	0	0	0	0	0.556
3	S-3A	Calico Mnts.	Upper Plate	76.037	0.358	0.051	F0	0.066	0.978	12.494	0.019	0	0.491	0	0	0	0.067	0.043	0	0	0.753
4	S-3B	Calico Mnts.	Upper Plate	76.007	0.031	0.046	0.371	0.02	0	18.2	0	0	0.041	0	0	0	F0	0	0	0	0.457
5	S-3C	Calico Mnts.	Upper Plate	1.441	8.3	3.976	0.147	0.187	8.441	44.076	0.135	0.061	2.345	0	0.015	0	F0	0	<<	0.007	0.017
6	S-3D	Calico Mnts.	Upper Plate	81.11	0	0.059	F0	F0	0.508	7.418	0.033	0	0.846	0	0.029	0	0.262	0.075	0	0	0.607
7	S-4	Calico Mnts.	Upper Plate	82.264	0.038	0.042	F0	0.044	0.397	2.142	0.011	1.15	5.812	0	0	0	0.042	0	<<	0.759	0.606
8	S-5	Calico Mnts.	Upper Plate	80.005	0.191	2.501	F0	0.097	0.695	4.358	0	0.379	2.688	0	0	0	0	0	0	0.011	0.899
9	S-6	Calico Mnts.	Upper Plate	78.857	0	1.344	F0	0.183	0.66	6.095	0.015	0.619	3.904	0	0	0	0.114	<<	0	0.153	0.743
10	S-8	Calico Mnts.	Upper Plate	70.732	0.908	0.054	F0	0.041	1.754	12.728	0.021	0.057	1.021	0	0	0	<<	0	0.027	0.014	0.496
11	S-9	Calico Mnts.	Upper Plate	71.848	0.289	4.315	F0	0.103	0.91	13.185	0.053	0.568	2.43	0	0	0	0	0	0	<<	0.737
12	S-10	Calico Mnts.	Upper Plate	82.105	0.438	0.107	F0	0.083	1.147	4.818	0.018	0	0.644	0	0.02	0	0	0	<<	0	0.795
13	329-110	Calico Mnts.	Upper Plate	60.858	0.533	0.067	0.367	0.029	1.035	24.97	0.018	0.527	6.7	0	0.017	0	0.162	0	<<	0.075	0.511
14	407-111	Calico Mnts.	Upper Plate	81.056	0.094	0.534	0.492	0.081	0.668	4.927	0.024	0.139	1.129	0	0.025	0	0.035	0	0	0.014	1.013
15	407-112	Calico Mnts.	Upper Plate	78.878	0.124	0.372	F0	0.052	0.678	5.488	0.037	0.508	3.108	0	0.015	0	0.122	0	0.038	0.056	1.03
16	A404-1	MT General	Upper Plate	74.368	0.889	8.494	F0	0.108	1.8	4.883	0.025	0.552	1.066	<<	0.029	0	0.076	0	0	0.03	0.764
17	A404-2	MT General	Upper Plate	72.651	0.088	0.213	F0	F0	0.434	17.315	0.008	0	1.761	0	0.038	0	0.045	0	0	0	0.737
18	A404-3	MT General	Lower Plate	65.663	0.434	0.435	F0	0.335	2.438	24.456	0.059	0	1.379	0	0.025	0	0.282	0	0	0.046	0.51
19	A404-3FL	MT General	Lower Plate	71.524	0.018	0.09	F0	0.04	0.294	19.662	0	0	0.744	0	0	0	0.097	0	0	0.041	0.545
20	A404-4	MT General	Lower Plate	54.599	0	0.067	F0	F0	0.526	23.414	0.049	0	15.582	0	0.022	0	1.422	0	0.04	0.175	0.439
21	A404-5	MT General	Upper Plate	75.776	0.257	1.836	F0	0.085	0.691	9.536	0.016	0	1.874	0	0.05	0.47	0.072	0	0	0.024	1.148
22	A404-6	Waterman Hills	Upper Plate	72.176	0.084	1.474	0.557	0.094	0.401	8.689	0	0.971	6.692	<<	0.02	0.516	0.018	0	0.029	0	1.002
23	A404-7	Waterman Hills	Upper Plate	34.501	0.311	0.974	0.203	0.056	1.067	56.866	0.027	0.236	4.839	0	0.022	0.28	0.043	0	0.054	0.009	0.401
24	A404-8	Waterman Hills	Upper Plate	69.558	0.221	5.106	F0	0.043	0.758	10.935	0	0.427	4.628	0.017	0.009	1.68	0	0	0.06	0	1.123
25	A404-9	Waterman Hills	Upper Plate	72.702	0.097	1.968	F0	0.04	0.484	9.322	0.011	1.217	6.432	0	0.026	0.325	0.021	0	0.025	0	1.067
26	A404-10	Waterman Hills	Upper Plate	74.58	0	7.58	F0	0.065	0.515	4.183	0	0	0.415	0	0.037	2.155	0	0	0	0	1.57
27	A404-11	Barium Queen	Lower Plate	56.804	0.66	0.166	F0	0.05	1.329	20.944	0.037	0.072	13.359	0	0.017	0	0.027	0	0	0.007	0.491
28	A404-12	Barium Queen	Lower Plate	61.101	3.053	9.993	0.372	0.109	4.673	14.868	0.058	0.933	1.005	0.02	0	0	0.56	0	0	0.024	0.787
29	A404-13	Barium Queen	Lower Plate	77.069	0.034	0.212	F0	0.106	0	11.496	0.009	0	1.394	0	0.027	0	0.102	0	0	0	0.623
30	A404-14	Barium Queen	Lower Plate	73.504	0.104	0.048	F0	0	0	12.905	0	0	2.545	0	0	0	0.184	0	0	0	0.613
31	A404-15	Barium Queen	Lower Plate	78.908	0.142	0.248	F0	0.061	1.029	10.281	0.011	0	0.443	0	0	0	0.029	0	0	0.013	0.578
32	A404-16	Barium Queen	Lower Plate	79.09	0.08	0.252	F0	0.06	0.491	9.369	0.022	0	0.981	0	0	0	0.072	0	0	<<	0.492
33	A404-17	Mitchell Range	Lower Plate	53.968	0.438	0.898	F0	0.231	1.499	36.214	0.072	0	3.378	0	0	0	0.074	<<	0	0	0.518
34	A404-OP1	MT General	Upper Plate	71.103	0.95	1.557	F0	0.358	2.284	13.467	0.017	0.155	1.473	0	0.024	0.274	0.068	0	0	0.062	0.894
35	A404-OP2	MT General	Upper Plate	72.16	0.539	6.552	F0	0.507	1.79	8.917	0.009	0.265	1.795	0	0.024	0.274	0.131	0	0	0.08	0.887
36	A404-OP3	MT General	Upper Plate	77.939	0.279	1.441	0.528	0.111	0.928	7.772	0.013	0.087	1.256	0	0.037	0.274	0.864	0	0	0.312	0.927

TABLE 1

Percent Compound/Element Concentrations
Upper Plate and Lower Plate Highlighted
Concentration Averages of Biased samples Computed

% Concentrations of Compounds in Barite Samples — Compounds Present (%)

Item #	Sample #	Location	Plate of Emplacement	Epoch	Ba	K_2O	CaO	TiO_2	Na_2O	MgO	Al_2O_3	SiO_2	P_2O_5	SO_3	MnO	Fe_2O_3	Ni	Cl	F	Pb	Ag	Cu	Zn	Rb	Sr	As
1	S-1	Calico Mtns.	Upper Plate	Miocene Vol.	1.085	0.023	0.023	0	F0	0.047	0.613	14.108	0	25.441	0.065	0.942	0	0.027	0	0	0	0.022	0.013	0.004	0.483	0
2	S-2	Calico Mnts.	Upper Plate	Miocene Vol.	1.16	0.444	0.067	0	0.371	0.083	1.754	16.96	0.037	23.789	0	2.076	0	0	0	0	0	0.000	0	0.005	0.556	0
3	S-3A	Calico Mnts.	Upper Plate	Miocene Vol.	1.082	0.358	0.051	0	F0	0.066	0.978	12.494	0.019	26.617	0	0.491	0	0	0	0.075	0.047	0.000	0	0.005	0.753	F0
4	S-3B	Calico Mnts.	Upper Plate	Miocene Vol.	1.082	0.031	0.046	0	0.371	0.02	0	18.2	0	23.24	0	0.041	0	0	0	F0	0	0.000	0	<<	0.457	F0
6	S-3D	Calico Mnts.	Upper Plate	Miocene Vol.	1.014	0	0.059	0	F0	F0	0.508	7.418	0.033	26.802	0	0.846	0	0.029	0	0.266	0.076	0.000	0	0	0.607	F0
7(N)	S-4	Calico Mnts.	Upper Plate	Miocene Vol.	1	0.038	0.042	0	F0	0.044	0.397	2.142	0.011	26.423	1.15	5.812	0	0	0	0.042	0	<<	0.759	0.005	0.606	F0
8	S-5	Calico Mnts.	Upper Plate	Miocene Vol.	1.028	0.191	2.501	0	F0	0.097	0.695	4.358	0	26.3	0.379	2.688	0	0	0	0	0	0.000	0.011	0.005	0.899	0
9	S-6	Calico Mnts.	Upper Plate	Miocene Vol.	1.043	0	1.344	0	F0	0.183	0.66	6.095	0.015	25.742	0.619	3.904	0	0	0	0.119	<<	0.046	0.153	0.005	0.743	F0
10	S-8	Calico Mnts.	Upper Plate	Miocene Vol.	1.163	0.908	0.054	0	F0	0.041	1.754	12.728	0.021	24.102	0.057	1.021	0	0	0	<<	0	0.031	0.014	0.007	0.496	<<
11	S-9	Calico Mnts.	Upper Plate	Miocene Vol.	1.145	0.289	4.315	0	F0	0.103	0.91	13.185	0.053	23.433	0.568	2.43	0	0	0	0	0	0.000	<<	0.005	0.737	0
12	S-10	Calico Mnts.	Upper Plate	Miocene Vol.	1.002	0.438	0.107	0	F0	0.083	1.147	4.818	0.018	28.167	0	0.644	0	0.02	0	0	0	<<	0	0.005	0.795	0
13	329-110	Calico Mnts.	Upper Plate	Miocene Vol.	1.35	0.533	0.067	0	0.367	0.029	1.035	24.97	0.018	21.361	0.527	6.7	0	0.023	0	0.219	0	<<	0.075	0.004	0.511	F0
14	407-111	Calico Mnts.	Upper Plate	Miocene Vol.	1.015	0.094	0.534	0	0.492	0.081	0.668	4.927	0.024	29.402	0.139	1.129	0	0.025	0	0.035	0	0.000	0.014	0	1.013	F0
15	407-112	Calico Mnts.	Upper Plate	Miocene Vol.	1.043	0.124	0.372	0	F0	0.052	0.678	5.488	0.037	27.885	0.508	3.108	0	0.016	0	0.127	0	0.040	0.056	0.005	1.03	F0
16	A404-1	MT General	Upper Plate	Miocene	1.106	0.889	8.494	0	F0	0.108	1.8	4.883	0.025	25.375	0.552	1.066	<<	0.032	0	0.084	0	0.000	0.03	0.006	0.764	F0
17	A404-2	MT General	Upper Plate	Miocene	1.2	0.088	0.213	0	F0	F0	0.434	17.315	0.008	26.665	0	1.761	0	0.046	0	0.054	0	0.000	0	0.003	0.737	F0
18	A404-3	MT General	Lower Plate	Precambrian	1.253	0.434	0.435	0	F0	0.335	2.438	24.456	0.059	22.816	0	1.379	0	0.031	0	0.353	0	0.000	0.046	0.003	0.51	F0
19	A404-3FL	MT General	Lower Plate	Precambrian	1.151	0.018	0.09	0	F0	0.04	0.294	19.662	0	25.475	0	0.744	0	0	0	0.112	0	0.000	0.041	0.004	0.545	0.04
20	A404-4	MT General	Lower Plate	Precambrian	1.506	0	0.067	0	F0	F0	0.526	23.414	0.049	20.578	0	15.582	0	0.033	0	2.142	0	0.802	0.175	0	0.439	0.04
21	A404-5	MT General	Upper Plate	Miocene	1.088	0.257	1.836	0	F0	0.085	0.691	9.536	0.016	27.25	0	1.874	0	0.054	0.51	0.078	0	0.000	0.024	0	1.148	F0
22	A404-6	Waterman Hills	Upper Plate	Miocene	1.14	0.084	1.474	0	0.557	0.094	0.401	8.889	0	27.042	0.971	6.692	<<	0.023	0.585	0.021	0	0.033	0	0.004	1.002	F0
24	A404-8	Waterman Hills	Upper Plate	Miocene	1.182	0.221	5.106	0	F0	0.043	0.758	10.935	0	24.942	0.427	4.628	0.017	0.011	1.986	0	0	0.071	0	0.004	1.123	0
25	A404-9	Waterman Hills	Upper Plate	Miocene	1.13	0.097	1.968	0	F0	0.04	0.484	9.322	0.011	25.301	1.217	6.432	0	0.029	0.387	0.024	0	0.028	0	0.005	1.067	F0
26	A404-10	Waterman Hills	Upper Plate	Miocene	1.103	0	7.58	0	F0	0.065	0.515	4.183	0	27.334	0	0.415	0	0.041	2.38	0	0	0.000	0	0.005	1.57	0
27	A404-11	Barium Queen	Lower Plate	Precambrian	1.447	0.66	0.166	0	F0	0.05	1.329	20.944	0.037	23.358	0.072	13.359	0	0.017	0	0.039	0	0.000	0.007	0.004	0.491	0.117
28	A404-12	Barium Queen	Lower Plate	Precambrian	1.346	3.053	9.993	0	0.372	0.109	4.673	14.868	0.058	20.361	0.933	1.005	0.02	0	0	0.754	0	0.000	0.024	0.011	0.787	F0
29	A404-13	Barium Queen	Lower Plate	Precambrian	1.067	0.034	0.212	0	F0	0.106	0	11.496	0.009	27.158	0	1.394	0	0.029	0	0.109	0	0.000	0	0	0.623	F0
30	A404-14	Barium Queen	Lower Plate	Precambrian	1.119	0.104	0.048	0	F0	0	0	12.905	0	28.014	0	2.545	0	0	0	0.206	0	0.000	0	0	0.613	0.061
31	A404-15	Barium Queen	Lower Plate	Precambrian	1.043	0.142	0.248	0	F0	0.061	1.029	10.281	0.011	26.264	0	0.443	0	0	0	0.03	0	0.000	0.013	0.004	0.578	F0
32	A404-16	Barium Queen	Lower Plate	Precambrian	1.041	0.08	0.252	0	F0	0.06	0.491	9.369	0.022	28.455	0	0.981	0	0	0	0.072	0	0.000	<<	0.005	0.492	F0
33	A404-17	Mitchell Range	Lower Plate	Precambrian	1.524	0.438	0.898	0.377	F0	0.231	1.499	36.214	0.072	19.767	0	3.378	0	0	0	0.113	0	0.000	0	0.005	0.518	0.034
34	A404-OP1	MT General	Upper Plate	Miocene	1.157	0.95	1.557	0	F0	0.358	2.284	13.467	0.017	25.545	0.155	1.473	0	0.028	0.317	0.079	<<	0.000	0.062	0.005	0.894	F0
35	A404-OP2	MT General	Upper Plate	Miocene	1.14	0.539	6.552	0	F0	0.507	1.79	8.917	0.009	24.172	0.265	1.795	0	0.027	1.94	0.149	0	0.000	0.08	0.004	0.887	F0
36	A404-OP3	MT General	Upper Plate	Miocene	1.056	0.279	1.441	0	0.528	0.111	0.928	7.772	0.013	26.415	0.087	1.256	0	0.039	0.444	0.912	0	0.000	0.312	0.255	0.927	F0
		Calico District	Upper Plate		1.085143	0.28646					0.91176		0.016042	25.78104167	0.32025	2.467666667				0.10382			0.0697	0.015	0.62021	
		MT General	Upper Plate		1.124167	0.4963					1.2279		0.0317	24.2246	0.1005	4.081				0.393			0.034	0.0036	0.5596	
		Waterman Hills	Upper Plate		1.13875																					
	>>	Ave. Barite %	Upper Plate		1.103833																					
		MT General	Lower Plate		1.303333																					
		Barium Queen	Lower Plate		1.177167																					
		Mitchel Range	Lower Plate		1.524																					
	>>	Ave. Barite %	Lower Plate		1.2497																					

	Upper Plate	Lower Plate
CaO	1.908458333	1.2409
SiO_2	9.262666667	18.3609
Cl	0.019583333	0.011
F	0.3555	0
Ag	0.005347626	<<
Cu	0.01292381	0.0602

Table 2

Normalized Percent Compound/Element Concentrations
Upper Plate is Fluorine Exclusive

% Concentrations of Compounds in Barite Samples

Item #	Sample #	Location	Plate of Emplacement	Epoch	Compounds Present (%) Ba	Cl	F	Pb	Ag	Cu
1	S-1	Calico Mtns.	Upper Plate	Miocene Vol.	77.254	0.025	0	0	0	0.021
2	S-2	Calico Mnts.	Upper Plate	Miocene Vol.	70.751	0	0	0	0	0
3	S-3A	Calico Mnts.	Upper Plate	Miocene Vol.	76.037	0	0	0.067	0.043	0
4	S-3B	Calico Mnts.	Upper Plate	Miocene Vol.	76.007	0	0	F0	0	0
6	S-3D	Calico Mnts.	Upper Plate	Miocene Vol.	81.11	0.029	0	0.262	0.075	0
7	S-4	Calico Mnts.	Upper Plate	Miocene Vol.	82.264	0	0	0.042	0	<<
8	S-5	Calico Mnts.	Upper Plate	Miocene Vol.	80.005	0	0	0	0	0
9	S-6	Calico Mnts.	Upper Plate	Miocene Vol.	78.857	0	0	0.114	<<	0
10	S-8	Calico Mnts.	Upper Plate	Miocene Vol.	70.732	0	0	<<	0	0.027
11	S-9	Calico Mnts.	Upper Plate	Miocene Vol.	71.848	0	0	0	0	0
12	S-10	Calico Mnts.	Upper Plate	Miocene Vol.	82.105	0.02	0	0	0	<<
13	329-110	Calico Mnts.	Upper Plate	Miocene Vol.	60.858	0.017	0	0.162	0	<<
14	407-111	Calico Mnts.	Upper Plate	Miocene Vol.	81.056	0.025	0	0.035	0	0
15	407-112	Calico Mnts.	Upper Plate	Miocene Vol.	78.878	0.015	0	0.122	0	0.038
16	A404-1	MT General	Upper Plate	Miocene	74.368	0.029	0	0.076	0	0
17	A404-2	MT General	Upper Plate	Miocene	72.651	0.038	0	0.045	0	0
18	A404-3	MT General	Lower Plate	Precambrian	65.663	0.025	0	0.282	0	0
19	A404-3FL	MT General	Lower Plate	Precambrian	71.524	0	0	0.097	0	0
20	A404-4	MT General	Lower Plate	Precambrian	54.599	0.022	0	1.422	0	0.04
21	A404-5	MT General	Upper Plate	Miocene	75.776	0.05	0.47	0.072	0	0
22	A404-6	Waterman Hills	Upper Plate	Miocene	72.176	0.02	0.516	0.018	0	0.029
24	A404-8	Waterman Hills	Upper Plate	Miocene	69.558	0.009	1.68	0	0	0.06
25	A404-9	Waterman Hills	Upper Plate	Miocene	72.702	0.026	0.325	0.021	0	0.025
26	A404-10	Waterman Hills	Upper Plate	Miocene	74.58	0.037	2.155	0	0	0
27	A404-11	Barium Queen	Lower Plate	Precambrian	56.804	0.017	0	0.027	0	0
28	A404-12	Barium Queen	Lower Plate	Precambrian	61.101	0	0	0.56	0	0
29	A404-13	Barium Queen	Lower Plate	Precambrian	77.069	0.027	0	0.102	0	0
30	A404-14	Barium Queen	Lower Plate	Precambrian	73.504	0	0	0.184	0	0
31	A404-15	Barium Queen	Lower Plate	Precambrian	78.908	0	0	0.029	0	0
32	A404-16	Barium Queen	Lower Plate	Precambrian	79.09	0	0	0.072	0	0
33	A404-17	Mitchell Range	Lower Plate	Precambrian	53.968	0	0	0.074	<<	0
34	A404-OP1	MT General	Upper Plate	Miocene	71.103	0.024	0.274	0.068	0	0
35	A404-OP2	MT General	Upper Plate	Miocene	72.16	0.024	1.703	0.131	0	0
36	A404-OP3	MT General	Upper Plate	Miocene	77.939	0.037	0.42	0.864	0	0

	Calico District	Upper Plate	76.26871	0.09541
	MT General	Upper Plate	73.9995	0.2849
	Waterman Hills	Upper Plate	72.254	
>>	Ave. Barite %	Upper Plate	75.03229	
	MT General	Lower Plate	63.92867	
	Barium Queen	Lower Plate	71.07933	
	Mitchel Range	Lower Plate	53.968	
>>	Ave. Barite %	Lower Plate	67.223	

TABLE 3

Normalized Percent Compound/Element Concentrations
Ratio established using Item #7(NS)
Silver-Barite Paragenesis in the Central Mojave Silver-Barite District

% Concentrations of Compounds in Barite Samples

Item #	Sample #	Subdistrict Location	Plate of Emplacement	Epoch	Compounds Present (%)								
					Ba	MnO	Fe2O3	Pb	Ag	Cu	Cl	F	
1	S-1	Calico Mtns.	Upper Plate	Miocene Vol.	1.065	0.065	0.942	0	0	0.022	0.027	0	
2	S-2	Calico Mnts.	Upper Plate	Miocene Vol.	1.16	0	2.076	0	0	0.000	0	0	
3	S-3A	Calico Mnts.	Upper Plate	Miocene Vol.	1.082	0	0.491	0.075	0.047	0.000	0	0	
4	S-3B	Calico Mnts.	Upper Plate	Miocene Vol.	1.082	0	0.041	F0	0	0.000	0	0	
6	S-3D	Calico Mnts.	Upper Plate	Miocene Vol.	1.014	0	0.846	0.266	0.076	0.000	0.029	0	
7(NS)	S-4	Calico Mnts.	Upper Plate	Miocene Vol.	1	1.15	5.812	0.042	0	<<	0	0	Ba= 82.264
8	S-5	Calico Mnts.	Upper Plate	Miocene Vol.	1.028	0.379	2.688	0	0	0.000	0	0	
9	S-6	Calico Mnts.	Upper Plate	Miocene Vol.	1.043	0.619	3.904	0.119	<<	0.046	0	0	
10	S-8	Calico Mnts.	Upper Plate	Miocene Vol.	1.163	0.057	1.021	<<	0	0.031	0	0	
11	S-9	Calico Mnts.	Upper Plate	Miocene Vol.	1.145	0.568	2.43	0	0	0.000	0	0	
12	S-10	Calico Mnts.	Upper Plate	Miocene Vol.	1.002	0	0.644	0	0	<<	0.02	0	
13	329-110	Calico Mnts.	Upper Plate	Miocene Vol.	1.35	0.527	6.7	0.219	0	<<	0.023	0	
14	407-111	Calico Mnts.	Upper Plate	Miocene Vol.	1.015	0.139	1.129	0.035	0	0.000	0.025	0	
15	407-112	Calico Mnts.	Upper Plate	Miocene Vol.	1.043	0.508	3.108	0.127	0	0.040	0.016	0	
16	A404-1	MT General	Upper Plate	Miocene	1.106	0.552	1.066	0.084	0	0.000	0.032	0	
17	A404-2	MT General	Upper Plate	Miocene	1.2	0	1.761	0.054	0	0.000	0.046	0	
18	A404-3	MT General	Lower Plate	Precambrian	1.253	0	1.379	0.353	0	0.000	0.031	0	
19	A404-3FL	MT General	Lower Plate	Precambrian	1.151	0	0.744	0.112	0	0.000	0	0	
20	A404-4	MT General	Lower Plate	Precambrian	1.506	0	15.582	2.142	0	0.602	0.033	0	
21	A404-5	MT General	Upper Plate	Miocene	1.086	0	1.874	0.078	0	0.000	0.054	0.51	
22	A404-6	Waterman Hills	Upper Plate	Miocene	1.14	0.971	6.692	0.021	0	0.033	0.023	0.588	
24	A404-8	Waterman Hills	Upper Plate	Miocene	1.182	0.427	4.628	0	0	0.071	0.011	1.986	
25	A404-9	Waterman Hills	Upper Plate	Miocene	1.13	1.217	6.432	0.024	0	0.028	0.029	0.367	
26	A404-10	Waterman Hills	Upper Plate	Miocene	1.103	0	0.415	0	0	0.000	0.041	2.38	
27	A404-11	Barium Queen	Lower Plate	Precambrian	1.447	0.072	13.359	0.039	0	0.000	0.017	0	
28	A404-12	Barium Queen	Lower Plate	Precambrian	1.346	0.933	1.005	0.754	0	0.000	0	0	
29	A404-13	Barium Queen	Lower Plate	Precambrian	1.067	0	1.394	0.109	0	0.000	0.029	0	
30	A404-14	Barium Queen	Lower Plate	Precambrian	1.119	0	2.545	0.206	0	0.000	0	0	
31	A404-15	Barium Queen	Lower Plate	Precambrian	1.043	0	0.443	0.03	0	0.000	0	0	
32	A404-16	Barium Queen	Lower Plate	Precambrian	1.041	0	0.981	0.072	0	0.000	0	0	
33	A404-17	Mitchell Range	Lower Plate	Precambrian	1.524	0	3.378	0.113	<<	0.000	0	0	
34	A404-OP1	MT General	Upper Plate	Miocene	1.157	0.155	1.473	0.079	0	0.000	0.028	0.317	
35	A404-OP2	MT General	Upper Plate	Miocene	1.14	0.265	1.795	0.149	0	0.000	0.027	1.94	
36	A404-OP3	MT General	Upper Plate	Miocene	1.056	0.087	1.256	0.912	0	0.000	0.039	0.444	
						0.32025	2.4677	0.10382					
						0.1005	4.081	0.393					
		Calico District	Upper Plate		1.085143								
		MT General	Upper Plate		1.124167								
		Waterman Hills	Upper Plate		1.13875								
	>>	Ave. Barite %	Upper Plate		1.103833								
		MT General	Lower Plate		1.303333								
		Barium Queen	Lower Plate		1.177167								
		Mitchel Range	Lower Plate		1.524								
	>>	Ave. Barite %	Lower Plate		1.2497								

TABLE 4

Normalized Percent Compound/Element Concentrations
Ratio established using Item #7(NS)
Silver-Barite Paragenesis in the Central Mojave Silver-Barite District

The Four Subdistricts

% Concentrations of Compounds in Barite Samples

Item #	Sample #	Subdistrict Location	Plate of Emplacement	Epoch	Compounds Present (%) Ba	MnO	Fe2O3	Pb	Ag	Cu	Cl	F	
1	S-1	Calico Mtns.	Upper Plate	Miocene Vol.	1.065	0.065	0.942	0	0	0.022	0.027	0	
2	S-2	Calico Mnts.	Upper Plate	Miocene Vol.	1.16	0	2.076	0	0	0.000	0	0	
3	S-3A	Calico Mnts.	Upper Plate	Miocene Vol.	1.082	0	0.491	0.075	0.047	0.000	0	0	
4	S-3B	Calico Mnts.	Upper Plate	Miocene Vol.	1.082	0	0.041	F0	0	0.000	0	0	
6	S-3D	Calico Mnts.	Upper Plate	Miocene Vol.	1.014	0	0.846	0.266	0.076	0.000	0.029	0	
7(NS)	S-4	Calico Mnts.	Upper Plate	Miocene Vol.	1	1.15	5.812	0.042	0	<<	0	0	Ba= 82.264
8	S-5	Calico Mnts.	Upper Plate	Miocene Vol.	1.028	0.379	2.688	0	0	0.000	0	0	
9	S-6	Calico Mnts.	Upper Plate	Miocene Vol.	1.043	0.619	3.904	0.119	<<	0.046	0	0	
10	S-8	Calico Mnts.	Upper Plate	Miocene Vol.	1.163	0.057	1.021	<<	0	0.031	0	0	
11	S-9	Calico Mnts.	Upper Plate	Miocene Vol.	1.145	0.568	2.43	0	0	0.000	0	0	
12	S-10	Calico Mnts.	Upper Plate	Miocene Vol.	1.002	0	0.644	0	0	<<	0.02	0	
13	329-110	Calico Mnts.	Upper Plate	Miocene Vol.	1.35	0.527	6.7	0.219	0	<<	0.023	0	
14	407-111	Calico Mnts.	Upper Plate	Miocene Vol.	1.015	0.139	1.129	0.035	0	0.000	0.025	0	
15	407-112	Calico Mnts.	Upper Plate	Miocene Vol.	1.043	0.508	3.108	0.127	0	0.040	0.016	0	
16	A404-1	MT General	Upper Plate	Miocene	1.106	0.552	1.066	0.084	0	0.000	0.032	0	
17	A404-2	MT General	Upper Plate	Miocene	1.2	0	1.761	0.054	0	0.000	0.046	0	
18	A404-3	MT General	Lower Plate	Precambrian	1.253	0	1.379	0.353	0	0.000	0.031	0	
19	A404-3FL	MT General	Lower Plate	Precambrian	1.151	0	0.744	0.112	0	0.000	0	0	
20	A404-4	MT General	Lower Plate	Precambrian	1.506	0	15.582	2.142	0	0.602	0.033	0	
21	A404-5	MT General	Upper Plate	Miocene	1.086	0	1.874	0.078	0	0.000	0.054	0.51	
22	A404-6	Waterman Hills	Upper Plate	Miocene	1.14	0.971	6.692	0.021	0	0.033	0.023	0.588	
24	A404-8	Waterman Hills	Upper Plate	Miocene	1.182	0.427	4.628	0	0	0.071	0.011	1.986	
25	A404-9	Waterman Hills	Upper Plate	Miocene	1.13	1.217	6.432	0.024	0	0.028	0.029	0.367	
26	A404-10	Waterman Hills	Upper Plate	Miocene	1.103	0	0.415	0	0	0.000	0.041	2.38	
27	A404-11	Barium Queen	Lower Plate	Precambrian	1.447	0.072	13.359	0.039	0	0.000	0.017	0	
28	A404-12	Barium Queen	Lower Plate	Precambrian	1.346	0.933	1.005	0.754	0	0.000	0	0	
29	A404-13	Barium Queen	Lower Plate	Precambrian	1.067	0	1.394	0.109	0	0.000	0.029	0	
30	A404-14	Barium Queen	Lower Plate	Precambrian	1.119	0	2.545	0.208	0	0.000	0	0	
31	A404-15	Barium Queen	Lower Plate	Precambrian	1.043	0	0.443	0.03	0	0.000	0	0	
32	A404-16	Barium Queen	Lower Plate	Precambrian	1.041	0	0.981	0.072	0	0.000	0	0	
33	A404-17	Mitchell Range	Lower Plate	Precambrian	1.524	0	3.378	0.113	<<	0.000	0	0	
34	A404-OP1	MT General	Upper Plate	Miocene	1.157	0.155	1.473	0.079	0	0.000	0.028	0.317	
35	A404-OP2	MT General	Upper Plate	Miocene	1.14	0.265	1.795	0.149	0	0.000	0.027	1.94	
36	A404-OP3	MT General	Upper Plate	Miocene	1.056	0.087	1.256	0.912	0	0.000	0.039	0.444	
						0.32025	2.4677	0.10382					
						0.1005	4.081	0.393					

	Calico District	Upper Plate	1.085143
	MT General	Upper Plate	1.124167
	Waterman Hills	Upper Plate	1.13875
>>	Ave. Barite %	Upper Plate	1.103833
	MT General	Lower Plate	1.303333
	Barium Queen	Lower Plate	1.177167
	Mitchel Range	Lower Plate	1.524
>>	Ave. Barite %	Lower Plate	1.2497

TABLE 5

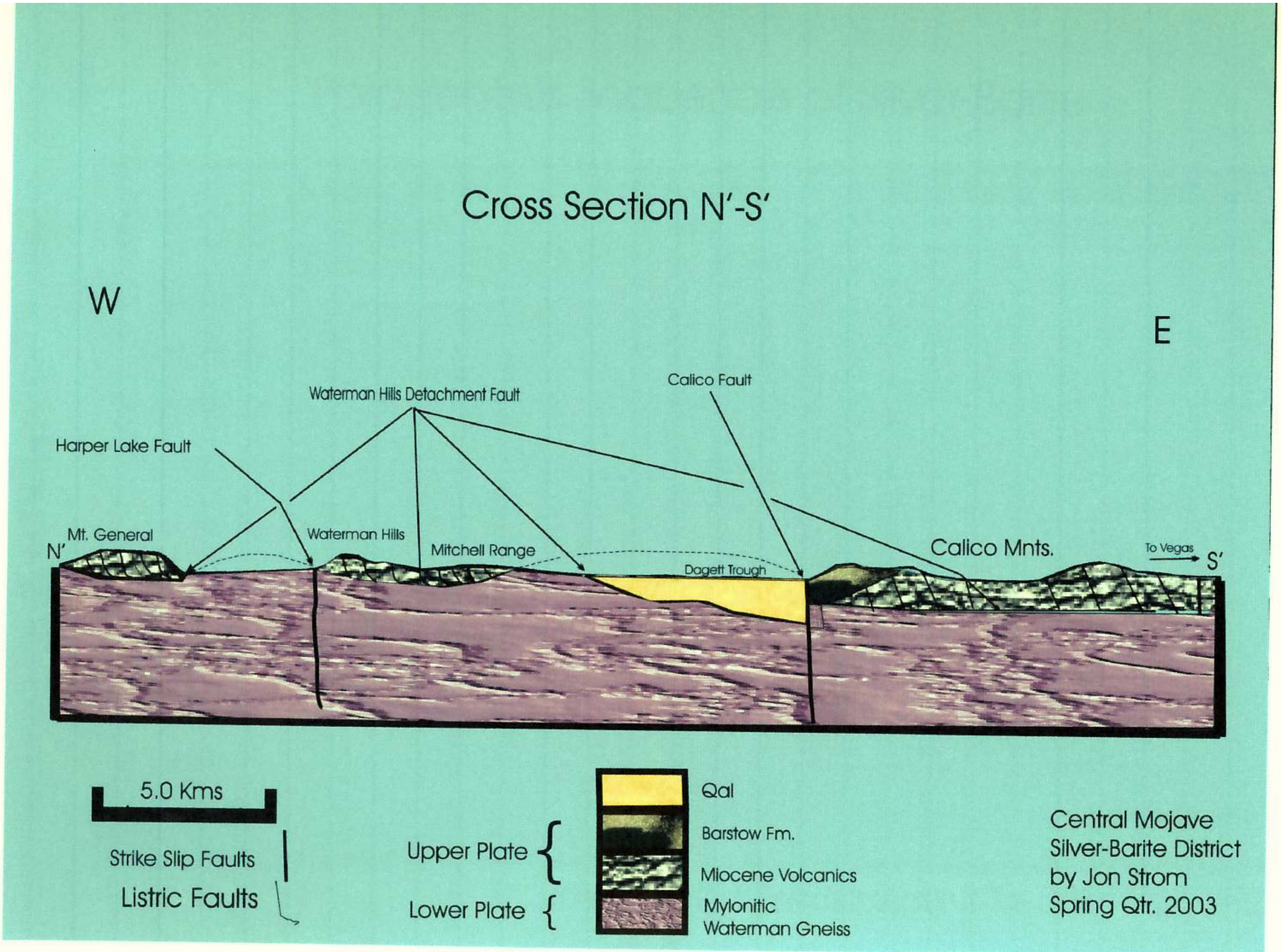
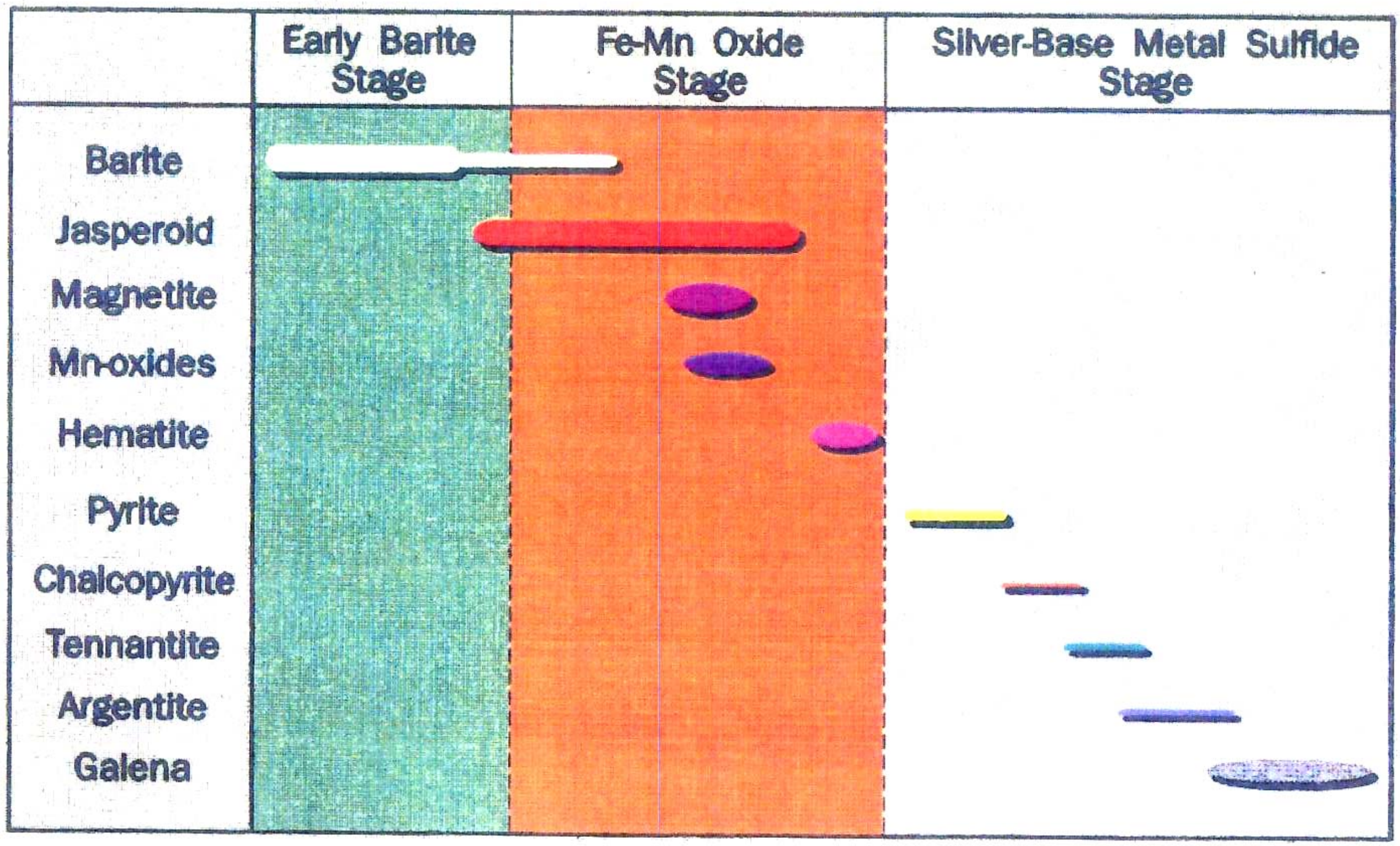

Cross Section N'-S'
W
E
Harper Lake Fault
Waterman Hills Detachment Fault
Calico Fault
N'
Mt. General
Waterman Hills
Mitchell Range
Dagett Trough
Calico Mnts.
To Vegas
S'
5.0 Kms
Strike Slip Faults
Listric Faults
Upper Plate
Lower Plate
Qal
Barstow Fm.
Miocene Volcanics
Mylonitic
Waterman Gneiss
Central Mojave
Silver-Barite District
by Jon Strom
Spring Qtr. 2003

Figure 1

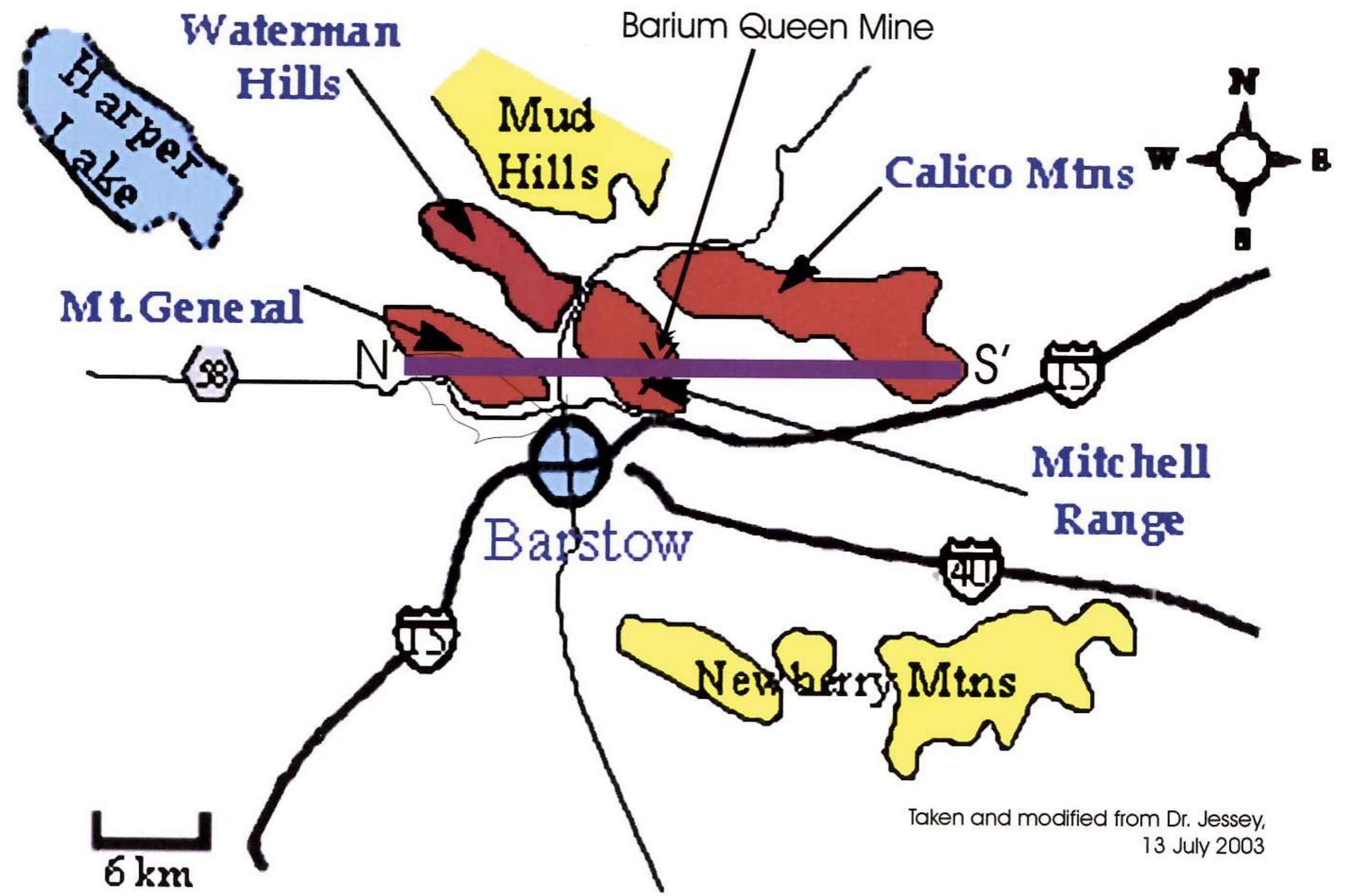
Paragenesis Sequence of Silver-Barite



Taken from Kevin Rosso's research in the Calico Mnts., 1992

Figure 2

Index Map



Taken and modified from Dr. Jessey, 13 July 2003