Supplemental[1]. Additional information on analytical methodology

Electron Probe Microanalysis (EPMA)

TABLE S1. Elements analyzed, peak/background positions, count times, standards used and average minimum limits of detection for EPMA analysis of sulfosalts and BMS

Element/line	Diffracting Crystal/Sp#	Peak count time (sec)	Background type/fit	Background points (Lo/Hi)	Background count time (Lo/Hi) (sec)	Standard	Average minimum limits of detection (wt%)
S Kα	LPET/1	15	Multipoint	2/2	10/10	Chalcopyrite	0.057
Pb Mα	LPET/1	15	Multipoint	4/3	10/10	Galena	0.053
As Lα	TAP/2	15	Multipoint	2/2	10/10	Gallium arsenide	0.047
Se Lα	TAP/2	15	Multipoint	2/3	10/10	Bi_2Se_3	0.037
Fe Kα	LLIF/3	15	Multipoint	2/2	10/10	Chalcopyrite	0.024
Cu Kα	LLIF/3	15	Linear	-	10/10	Chalcopyrite	0.030
Sb Lα	LPET/4	15	Multipoint	2/2	10/10	Stibnite	0.037
Ag Lα	LPET/4	15	Multipoint	1/2	10/10	Silver telluride	0.070
Zn Kα	LLIF/5	15	Multipoint	2/2	10/10	Sphalerite	0.032
Te Lα	LLIF/4	15	Multipoint	2/2	10/10	AgTe	0.041
Bi Mα	LPET/1	15	Multipoint	2/2	10/10	Bi_2Se_3	0.119
Cd Lα	LPET/1	15	Multipoint	2/2	10/10	Greenockite	0.061
Hg Lα	LLIF/5	15	Multipoint	3/3	10/10	Cinnabar	0.112

TABLE S2. Elemental overlap corrections used in sulfide package (EPMA)

Element/line	Diffracting crystal	Overlapping line/order	Overlap standard
S Kα	LPET/1	Co III, Sb II, Hg I	Astimex Co metal, Astimex Stibnite, Astimex Cinnabar
Pb Mα	LPET/1	Fe III, As V	P&H block Chalcopyrite, Astimex GaAs
Cd Lα	LPET/1	PbIV, Ag I, Se IV	Astimex Galena, P&H block AgTe, AstimexBi_2Se_3
As Lα	TAP/2	Sb III, Fe V, Co VI	Astimex Stibnite, P&H Chalcopyrite, Astimex Co metal
Se Lα	TAP/2	As I, Te III, Co V, Ni IV	Astimex GaAs, P&H AgTe, Astimex Co metal, Astimex Ni metal
Fe Kα	LLIF/3	Pb II	P&H Galena
Ag Lα	LPET/4	Hg IV, Cu III, Mn II	P&H Cinnabar, P&H Chalcopyrite, P&H Rhodonite
Sb Lα	LPET/4	Bi III	P&H Bi_2Se_3
Te Lα	LPET/4	Sn I, Se III, Ni II	P&H Cassiterite, P&H Bi_2Se_3, Astimex Pentlandite
Bi Mα	LPET/1	Pb I	P&H Galena
Cu	-	-	-
Zn	-	-	/
Ni	-	-	-
Hg	-	-	-

Note: "-"represents no overlapping corrections during calculation.

Laser–ablation inductively coupled plasma mass spectrometry (LA–ICP–MS)

LA–ICP–MS analyses were performed in spot mode using a laser beam of 20 to 40 μm, a repetition rate of 5 Hz, and laser energy of 4.0 to 5.5 J/cm^2. Total acquisition time for each analysis was 70 s, with 30 s background measurement followed by 40 s of sample ablation. Calibration for LA–ICP–MS spot analysis was performed using USGS sulfide standard MASS-1 (Wilson et al. 2002). Monitored isotopes included ^{34}S, ^{55}Mn, ^{57}Fe, ^{59}Co, ^{60}Ni, ^{63}Cu, ^{66}Zn, ^{69}Ga, ^{75}As, ^{77}Se, ^{95}Mo, ^{107}Ag, ^{111}Cd, ^{115}In, ^{118}Sn, ^{121}Sb, ^{125}Te, ^{197}Au, ^{201}Hg, ^{205}Tl, ^{208}Pb, and ^{209}Bi. Internal calibration used measured wt % EPMA data: Fe served for chalcopyrite; Cu for tetrahedrite and

bournonite; ^{208}Pb for giessenite-izoklakeite, jamesonite, robinsonite, boulangerite and galena; and Zn for sphalerite. Detection limits depend on spot size, which governs ablated mineral volume. Average minimum detection limits and dwell time for all elements are listed in Table S3. Data reduction were compiled and processed using Iolite v2.5, a software package for processing LA-ICP–MS data (Paton et al. 2011), as an add-in for the data analysis program Igor (WaveMetrics).

LA–ICP–MS mapping was conducted by ablating sets of parallel lines rastered across an area of the sample using beam sizes ranging from 7 to 10 μm dependent on grain size, at a laser frequency of 10 Hz. Dwell times for all elements are listed in Table S3. Re-deposition during mapping was minimized by pre-ablating each line prior to data collection. Identical raster lines were done on standard MASS-1 at the start and end of each mapping run to correct for instrument drift. Element maps were compiled and processed using Iolite data analysis program Igor.

TABLE S3. Average minimum detection limits and dwell times for LA-ICP-MS spot analysis and mapping

Isotope	dwell time/spot (sec.)	average minimum detection limit/spot/ for sulfosalts (ppm)	average minimum detection limit/spot/ for BMS (ppm)	dwell time/mapping (sec.)
^{34}S	0.005	-	-	0.005
^{55}Mn	0.01	0.47	0.48	-
^{57}Fe	0.005	-	-	0.005
^{59}Co	0.01	0.20	0.98	0.005
^{60}Ni	0.01	0.26	0.06	0.005
^{63}Cu	0.01	-	-	0.01
^{66}Zn	0.01	-	-	0.01
^{69}Ga	0.02	0.04	0.12	-
^{75}As	0.01	-	0.77	0.01
^{77}Se	0.03	2.14	0.26	0.02
^{95}Mo	0.02	0.03	0.01	-
^{107}Ag	0.03	0.44	0.24	0.04
^{111}Cd	0.02	0.16	-	0.01
^{115}In	0.02	0.05	3.63	0.01
^{118}Sn	0.02	0.23	0.04	0.01
^{121}Sb	0.02	-	1.53	0.01
^{125}Te	0.03	0.21	0.07	0.02
^{197}Au	0.03	0.13	0.03	0.04
^{201}Hg	0.005	1.26	3.60	0.005
^{205}Tl	0.02	0.02	0.004	-
^{209}Bi	0.02	-	0.06	0.01

References cited

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