Supplementary Materials for

Incorporation mechanism of structurally bound gold in pyrite: Insights from an integrated chemical and atomic-scale structural study

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Supplementary Materials include:

1. Analytical methods

1.1 Scanning electron microscopes (SEM) and Electron probe microanalysis (EPMA)

Petrological features and chemical compositions of sulfides were determined by SEM (SUPRA 55 SAPPHIRE, ZEISS Company, Germany) and EPMA (JXA-8230, JEOL Company, Japan), respectively. The SEM and EMP analyses were carried out at the State Key Laboratory of Isotope Chemistry and the Key Laboratory of Mineralogy and Metallogeny, Guangzhou Institute of Geochemistry, Chinese Academy of Sciences, respectively. Used X-ray lines, for EPMA analyses, were listed as following: Co (K_α), Hg (L_α), Sb (L_α), As (L_α), Fe (K_α), Au (L_α), Ni (K_α), Cu (K_α), Zn (L_α), S (K_α), Pb (M_α), Bi (M_α), Ag (L_α), Te (L_α) and Se (L_α). Operation conditions included an accelerating voltage of 20 kV and a beam current of 20 nA with wavelength dispersive X-ray spectrometers (WDS). To improve the statistics of the count rates, peak counting times were 20 s for Fe and S, 40 s for Co, Ni, Sb, Cu and Zn, 60 s for As, Ag, Te, Pb, Hg, Bi and Se, and, 120 s for Au. The electron beam is ~ 1μm in diameter. Calibration standards used were pyrite for S and Fe, galena for Pb, sphalerite for Zn, cinnabar for Hg, and alloy or pure metal for Co, Ni, Cu, As, Bi, Sb, Se, Te, Ag and Au. The detection limits for each element were Co (57 ppm), Sb (119 ppm), As (99 ppm), Fe (87 ppm), Au (208 ppm), Ni (52 ppm), Cu (98 ppm), Zn (92 ppm), S (69 ppm), Pb (240 ppm), Ag (49 ppm), Te (99 ppm), Hg (480 ppm), Bi (225 ppm), and Se (93 ppm).

1.2 In-situ trace element analysis by LA-ICP-MS

In-situ trace element analysis of arsenian pyrite was performed using an Agilent 7900 Quadrupole ICP-MS equipped with a Photon Machines Analyte HE 193-nm ArF Excimer Laser Ablation system at the *In-situ* Mineral Geochemistry Lab, Ore deposit and Exploration Centre (ODEC), Hefei University of Technology, China. Detailed analytical protocols were given by previous studies (Liu et al., 2008; Li et al., 2019). Spot analyses were used for individual analyses of various chemical zones known from EPMA data. After measuring the gas blank for 20 s, spot ablation were performed using a beam diameter of 15-25um diameter at 6 Hz with an energy of ~1.5J/cm^2 for 40 s (Li et al., 2019). Helium was used as a carrier gas to enhance the transport efficiency of the ablated material. Helium was applied as the carrier gas (0.9 L/min) and mixed with the Ar carrier gas (0.85 L/min) via a T-connector before entering the ICP (Li et al. 2019). Trace element compositions of sulfide minerals were calibrated using the U.S. Geological Survey (USGS) MASS-1 sulfide reference material were used as an external standard for all analyses, and iron (^{57}Fe) determined by EPMA was used as the internal standard (Wilson et al. 2002; Lorand et al. 2018). The MASS-1 was analyzed after every 5-10 sample analyses. The preferred values of element concentrations for reference standards are from the GeoReM database (http://georem.mpch-mainz.gwdg.de/). Off-line selection and integration of background and sample signals, time-drift correction, and quantitative calibration were performed by the software ICPMSDataCal (Liu et al. 2008). Signals were screened visually for heterogeneities such as micro-inclusions or zoning.

1.3 In-situ Nano secondary ion mass spectroscopy (NanoSIMS)

In order to further explore the Au occurrence in arsenian pyrite, gold and As elemental mapping of pyrite were performed using a Camera NanoSIMS 50L at the Institute of Geology and Geophysics, Chinese Academy of Sciences (IGGCAS) in

Beijing. Samples were polished and coated with carbon for conductivity at high voltage. A Cs^+ beam current of ~7-10 pA with a diameter of 250 nm was rasterized across the sample surface. Before image acquisition, the selected area (25 × 25 μm^2) was sputtered with a high-intensity beam of 1 nA for ~2 min to remove the coating and to implant enough Cs^+ into the sample surface to stabilize the yield of the secondary ions. Images, with a pixel resolution of 256 × 256, were recorded simultaneously from the secondary ions 34S, 63Cu32S, 75As32S, 197Au. Peaks were calibrated using arsenopyrite for AsS, chalcopyrite for CuS and metallic Au.

1.4 Transmission electron microscopy (TEM)

Samples were extracted from thin sections using a focused ion beam (FIB) system and mounted on Cu-grid in the Electron Microscope Unit, The University of Hong Kong. Preliminary TEM observations were carried out using an FEI Talos F200S TEM equipped with energy dispersive X-ray spectrometer (EDS) in the Key Laboratory of Mineralogy and Metallogeny, Guangzhou Institute of Geochemistry, Chinese Academy of Sciences. Z-contrast high-angle annular dark-field scanning transmission microscope (HAADF-STEM) and EDS analyses were carried out using a spherical aberration-corrected scanning TEM (ACSTEM) (JEOL JEM-ARM200F) and operated at 200 kV in the center of analysis, Beijing University of Chemical Technology.

1.5 In-situ micro X-ray absorption near edge structure (μ-XANES) spectroscopy

Au LIII-edge and As K-edge μ-XANES spectra of arsenian pyrite samples were collected on beamline BL15-U1 at Shanghai Synchrotron Radiation Facility (SSRF, operated at 3.5 GeV, 230 mA). BL15U1 is an undulator based multi-technique hard X-ray micro-probe beamline with the energy range of 5-20 keV, providing μ-XANES, μ-XRF and μ-XRD measurements. The gap of the undulator was carefully adjusted to keep the intensity of incoming X-ray relatively stable with the range of 11870 eV to 12070 eV. The photon flux at sample was about 5×10^8 phs/s. The excitation energy was selected using a liquid nitrogen-cooled Si (111) double crystal monochromator. The intensity was monitored using an ion chamber. The beam was focused using a set of Kirkpatrick-Baez (K-B) mirrors and the spot size at the sample surface was about 3 μm× 4 μm. The fluorescence signal was recorded using a Bruker Si drift detector (SDD), which is vertical to the incoming X-ray. A microscope was used to monitor the position of measurement on the sample. The energy was calibrated by defining the first derivative peak of the Au foil spectrum (transmission mode) to be at 11919 eV. The energy drift was monitored by measuring μ-XANES spectra of Au foil each 6 hours and no energy drift was observed. Au L_{III}-edge spectra were recorded with a step size of 2 eV from 11870 eV to 11900 eV, 0.5 eV from 11900 eV to 11950 eV, 1 eV from 11950 eV to 12070 eV. The dwell time of each point was 10 s. While As K-edge spectra were collected with a step size of 0.5 eV from 11820 eV to 12020 eV and the dwell time of 3 s per point. All XANES spectra were normalized using IFEFFIT software package (Newville 2001).

Collecting Au L_{III} μ-XANES spectra of arsenian pyrite using a SDD detector is really a challenge because the Au Lα emission (9713 eV) is partly obscured by the intense As Kα line (10543 eV). To improve the quality of μ-XANES spectra, lot of sites on thin sections were measured using EPMA to get Au concentration. Combining Au concentration, the BSE images and optical microscope observation, some positions with high Au concentration were carefully chosen and marked as the candidates for μ-XANES measurements (Fig. A1 (b)). Fig. A1 (a) shows the μ-XRF spectra of 44J-P2, 44J-P3 and 44J-P4. The fluorescence lines of Fe Kα, Fe Kβ, Au Lα and As Kα were assigned. The Au Lα line in all three samples were clearly observed when the measurement sites with high Au concentration were carefully selected. The Au Lα line became very low or completely disappeared when the measurement site was away from the site.

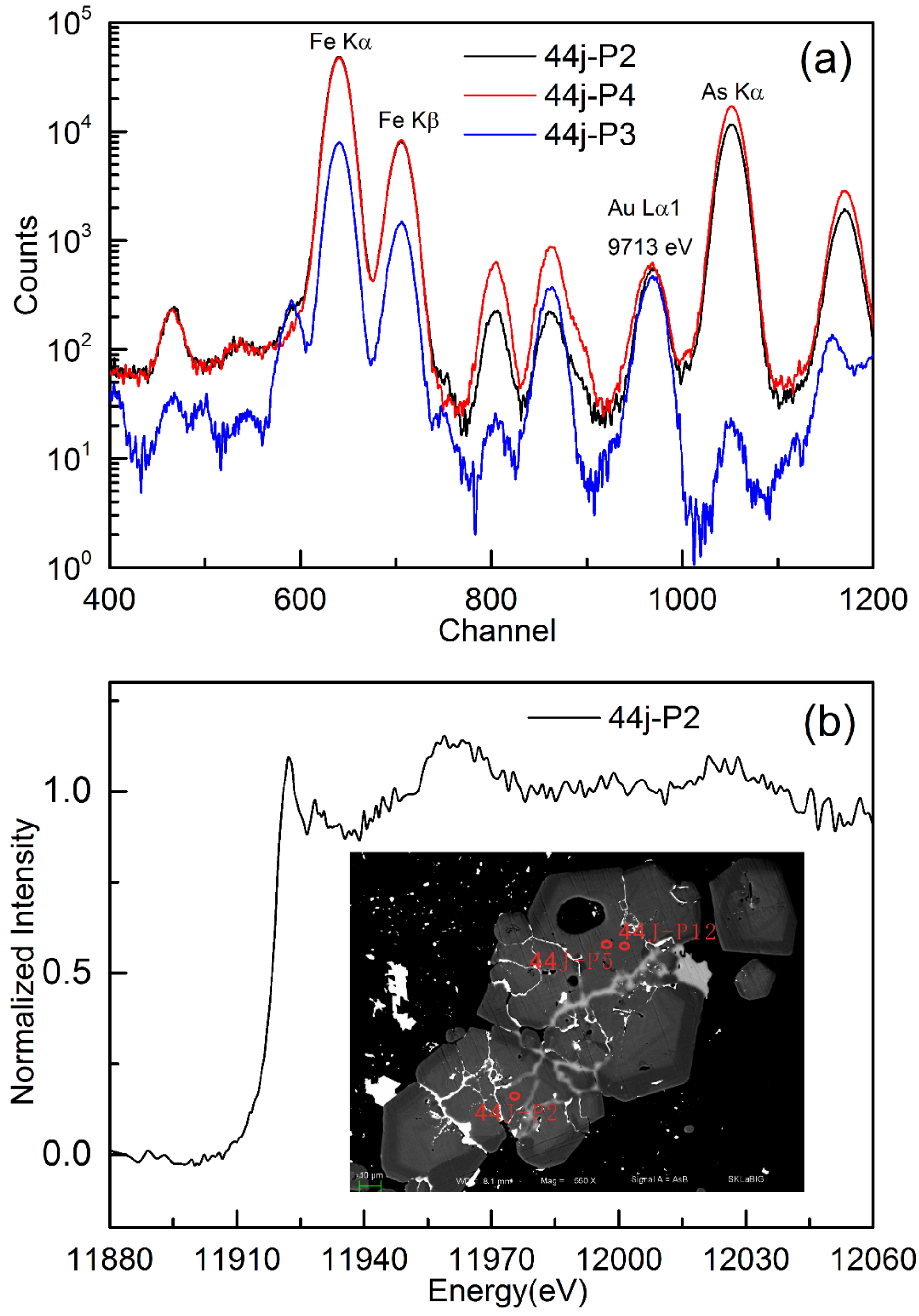

Fig. OM1 (a) The μ-XRF spectra of 44J-P2, 44J-P3 and 44J-P4 sites. The excitation energy of X-ray was 11930 eV. The dwell time was 30 s for each spectrum. The 44J-P2 and P4 were arsenian pyrite, while 44J-P3 was identified as electrum by EPMA. (b) The Au L_{III}-edge μ-XANES spectrum of 44J-P2 and its location on the BSE image.

2. Supplementary Tables

Table OM1 Locations and analytical methods of samples used for this study

Sample No.	Grain	Vein	Level	Stage	Ore Minerals	Analyses
SG32-2T	SG32-2T-g3	I_{12}	666	Stage 2	Pyrite	SEM-EDS, EPMA
SG44J	SG44J-g1	I_{12}	626	Stage 2	Pyrite	SEM-EDS, LA-ICP-MS
SG44J	SG44J-g2	I_{12}	626	Stage 2	Pyrite	SEM-EDS, LA-ICP-MS
SG44J	SG44J-g3	I_{12}	626	Stage 2	Pyrite	SEM-EDS, LA-ICP-MS
SG44J	SG44J-g4	I_{12}	626	Stage 2	Pyrite	SEM-EDS, LA-ICP-MS
SG44J	SG44J-g5	I_{12}	626	Stage 2	Pyrite	SEM-EDS, EPMA, LA-ICP-MS, TEM, XANES
SG44J	SG44J-g6	I_{12}	626	Stage 2	Pyrite	SEM-EDS, EPMA, LA-ICP-MS, XANES
SG44J	SG44J-g7	I_{12}	626	Stage 2	Pyrite	SEM-EDS, EPMA
SG44J	SG44J-g8	I_{12}	626	Stage 2	Pyrite	SEM-EDS, EPMA
SG44J	SG44J-g9	I_{12}	626	Stage 2	Pyrite	SEM-EDS, EPMA, TEM, XANES
SG44J	SG44J-g10	I_{12}	626	Stage 2	Pyrite	SEM-EDS, EPMA, XANES
SG44J	SG44J-g11	I_{12}	626	Stage 2	Pyrite	SEM-EDS, EPMA
SG44J	SG44J-g12	I_{12}	626	Stage 2	Pyrite	SEM-EDS, EPMA, LA-ICP-MS
SG44J	SG44J-g13	I_{12}	626	Stage 2	Pyrite	SEM-EDS, EPMA, LA-ICP-MS
SG44J	SG44J-g14	I_{12}	626	Stage 2	Pyrite	SEM-EDS, EPMA
SG44J	SG44J-g15	I_{12}	626	Stage 2	Pyrite	SEM-EDS, EPMA, XANES
SG44J	SG44J-g16	I_{12}	626	Stage 2	Pyrite	SEM-EDS, XANES
SG44J	SG44J-rg1	I_{12}	626	Stage 2	Pyrite	SEM-EDS, EPMA, LA-ICP-MS
SG44J	SG44J-rg2	I_{12}	626	Stage 2	Pyrite	SEM-EDS, EPMA, LA-ICP-MS
SG44J	SG44J-rg3	I_{12}	626	Stage 2	Pyrite	SEM-EDS, EPMA, LA-ICP-MS
SG44J	SG44J-rg4	I_{12}	626	Stage 2	Pyrite	SEM-EDS, EPMA, LA-ICP-MS
SG44J	SG44J-rg5	I_{12}	626	Stage 2	Pyrite	SEM-EDS, EPMA, LA-ICP-MS
SG87J	SG87J	V	870	Stage 2	Pyrite	SEM-EDS, XANES
SG44-1T	SG44-1T-g14	I_{12}	626	Stage 2	Pyrite	EPMA
SG44-1T	SG44-1T-g15	I_{12}	626	Stage 2	Pyrite	EPMA
SG44-1T	SG44-1T-g18	I_{12}	626	Stage 2	Pyrite	EPMA
SG44-1T	SG44-1T-g19	I_{12}	626	Stage 2	Pyrite	EPMA
SG44-1T	SG44-1T-g23	I_{12}	626	Stage 2	Pyrite	SEM-EDS, EPMA,TEM
SG44-1T	SG44-1T-g24	I_{12}	626	Stage 2	Pyrite	SEM-EDS, EPMA
SG44-1T	SG44-1T-g25	I_{12}	626	Stage 2	Pyrite	SEM-EDS, EPMA, TEM, NanoSIMS
SG44-1T	SG44-1T-g29	I_{12}	626	Stage 2	Pyrite	SEM-EDS, EPMA, NanoSIMS
SG44-1T	SG44-1T-g30	I_{12}	626	Stage 2	Pyrite	SEM-EDS, EPMA, NanoSIMS
SG48-1T	SG48-1T-g1	I_{12}	586	Stage 2	Pyrite	SEM-EDS, EPMA
SG48-1T	SG48-1T-g3	I_{12}	586	Stage 2	Pyrite	SEM-EDS, EPMA
SG48-6T	SG48-6T-g1	I_{12}	586	Stage 2	Pyrite	SEM-EDS, EPMA
SG48-6T	SG48-6T-g3	I_{12}	586	Stage 2	Pyrite	SEM-EDS, EPMA
SG48-6T	SG48-6T-g4	I_{12}	586	Stage 2	Pyrite	SEM-EDS, EPMA
SG48-6T	SG48-6T-g7	I_{12}	586	Stage 2	Pyrite	SEM-EDS, EPMA
SG103-1T	SG103-1T-g2	I_{12}	586	Stage 2	Pyrite	SEM-EDS, EPMA

Table OM2 EPMA data for Py1, Py2 and Py3 (in wt. %)

Sample No.	Type	Analysis No.	Au	As	S	Fe	Zn	Ni	Co	Ag	Te	Cu	Sb	Total
Detection limit			208 ppm	99 ppm	69 ppm	87 ppm	92 ppm	52 ppm	57 ppm	49 ppm	99 ppm	98 ppm	119 ppm	
SG44J-g6	Py2	SG44-D1	0.25	2.88	51.11	45.17	bdl	bdl	0.07	bdl	0.04	0.14	bdl	99.66
SG44J-g6	Py2	SG44-D2	0.40	4.20	50.20	44.85	bdl	bdl	0.07	0.02	bdl	0.02	bdl	99.75
SG44J-g7	Py2	SG44-D4	0.38	3.16	50.80	45.01	bdl	bdl	0.08	bdl	0.02	0.04	bdl	99.50
SG44J-g7	Py2	SG44-D5	0.38	3.60	50.25	44.64	0.02	bdl	0.08	bdl	0.02	0.12	bdl	99.10
SG44J-g5	Py2	SG44-D8	0.40	3.49	51.14	45.11	bdl	bdl	0.09	bdl	0.02	0.05	bdl	100.29
SG44J-g9	Py2	SG44-D9	0.40	3.00	51.42	45.28	bdl	bdl	0.08	bdl	0.02	0.02	bdl	100.24
SG44J-g10	Py2	SG44-D10	0.49	3.76	50.99	44.84	bdl	bdl	0.07	0.13	0.07	0.06	bdl	100.40
SG44J-g9	Py2	SG44-D11	0.40	4.56	50.04	44.61	0.05	bdl	0.07	0.02	0.03	0.12	bdl	99.89
SG44J-g5	Py2	SG44-D12	0.30	2.80	51.25	45.68	bdl	bdl	0.07	0.01	bdl	0.09	bdl	100.22
SG44J-g8	Py2	SG44-D13	0.45	3.72	51.06	44.94	bdl	bdl	0.08	0.01	0.06	0.02	bdl	100.35
SG44J-g10	Py2	SG44-D17	0.39	3.48	50.87	44.98	bdl	bdl	0.08	0.02	0.02	0.12	bdl	99.95
SG44J-g5	Py2	SG44-D24	0.34	3.31	50.92	45.12	0.01	bdl	0.08	0.01	0.03	0.12	bdl	99.93
SG44J-g5	Py2	SG44-D25	0.39	3.10	51.39	45.33	bdl	bdl	0.07	bdl	0.04	0.02	bdl	100.35
SG44J-g5	Py2	SG44-D26	0.45	4.25	50.18	44.75	bdl	bdl	0.09	0.01	0.02	bdl	bdl	99.75
SG44J-g5	Py2	SG44-D27	0.48	4.45	50.02	44.65	bdl	bdl	0.07	0.02	0.02	bdl	bdl	99.71
SG44J-g9	Py2	SG44-D30	0.17	0.97	52.08	46.21	bdl	bdl	0.08	bdl	bdl	0.04	bdl	99.55
SG44J-g9	Py2	SG44-D32	0.13	0.76	52.07	46.39	bdl	bdl	0.08	0.01	bdl	0.03	bdl	99.47
SG44J-g9	Py2	SG44-D33	0.31	3.48	50.54	44.91	bdl	bdl	0.08	0.02	0.03	0.14	bdl	99.49
SG44J-g9	Py2	SG44-D34	0.08	0.86	52.35	46.32	bdl	bdl	0.07	bdl	bdl	0.05	bdl	99.73
SG44J-g9	Py2	SG44-D36	0.14	1.31	52.00	46.01	bdl	bdl	0.08	0.02	bdl	0.06	bdl	99.62
SG44J-g9	Py2	SG44-D37	0.16	1.27	51.85	46.25	bdl	bdl	0.08	bdl	0.02	0.07	bdl	99.69
SG44J-g9	Py2	SG44-D38	0.11	1.23	51.88	46.24	bdl	bdl	0.09	bdl	bdl	0.06	bdl	99.61

Continue Table OM2

Sample No.	Type	Analysis No.	Au	As	S	Fe	Zn	Ni	Co	Ag	Te	Cu	Sb	Total
SG44J-g9	Py2	SG44-D39	0.11	1.38	51.73	45.89	bdl	bdl	0.09	bdl	bdl	0.05	bdl	99.26
SG44J-g9	Py2	SG44-D40	0.12	1.59	51.78	45.99	bdl	bdl	0.08	bdl	bdl	0.08	bdl	99.63
SG44J-g9	Py2	SG44-D42	0.18	1.65	51.47	45.92	0.04	bdl	0.07	bdl	bdl	0.08	bdl	99.41
SG44J-g10	Py2	SG44-D44	0.21	2.03	51.31	45.65	bdl	bdl	0.06	bdl	0.02	0.08	bdl	99.37
SG44J-g10	Py2	SG44-D45	0.20	2.22	51.88	45.67	bdl	bdl	0.07	bdl	bdl	0.13	bdl	100.19
SG44J-g10	Py2	SG44-D46	0.31	2.40	51.66	45.63	0.03	bdl	0.07	0.02	0.01	0.07	bdl	100.19
SG44J-g10	Py2	SG44-D48	0.32	3.16	51.18	44.93	bdl	bdl	0.09	bdl	0.04	0.14	bdl	99.86
SG44J-g5	Py2	SG44-D52	0.33	3.46	50.62	45.06	0.02	bdl	0.07	bdl	0.02	0.10	0.02	99.70
SG44J-g9	Py2	SG44-D54	0.18	1.91	51.75	45.59	0.03	bdl	0.08	bdl	0.03	0.08	bdl	99.65
SG44J-g9	Py2	SG44-D55	0.14	1.54	51.89	46.03	bdl	bdl	0.08	bdl	bdl	0.08	bdl	99.76
SG44J-g9	Py2	SG44-D57	0.20	1.91	51.62	45.56	0.03	bdl	0.08	bdl	0.02	0.06	bdl	99.48
SG44J-g9	Py2	SG44-D58	0.15	1.23	52.40	46.30	bdl	bdl	0.07	bdl	bdl	0.06	bdl	100.20
SG44J-g9	Py2	SG44-D59	0.28	1.94	51.33	45.32	bdl	bdl	0.08	0.02	bdl	0.07	bdl	99.04
SG44J-g9	Py2	SG44-D60	0.24	1.90	51.60	45.47	bdl	bdl	0.09	0.02	bdl	0.08	bdl	99.39
SG44J-g9	Py2	SG44-D60-1	0.21	1.88	51.83	45.60	bdl	bdl	0.08	bdl	bdl	0.07	bdl	99.67
SG44J-g11	Py2	SG44-D61	0.48	4.44	50.86	45.12	bdl	bdl	0.07	0.01	bdl	bdl	bdl	100.99
SG44J-g13	Py2	SG44-D66	0.42	4.15	50.97	44.88	0.01	bdl	0.07	0.02	0.03	bdl	bdl	100.55
SG44J-g13	Py2	SG44-D67	0.42	2.88	51.32	45.29	bdl	bdl	0.09	0.02	bdl	0.03	bdl	100.04
SG44J-g14	Py2	SG44-D71	0.23	1.88	51.90	45.76	bdl	bdl	0.08	bdl	bdl	0.09	bdl	99.97
SG44J-g14	Py2	SG44-D72	0.22	2.84	50.83	45.46	bdl	bdl	0.09	bdl	bdl	0.06	bdl	99.51
SG44-1T-g15	Py2	SG44-1-F16	0.05	0.39	53.08	46.45	bdl	bdl	0.05	bdl	bdl	bdl	0.02	100.04
SG44-1T-g19	Py2	SG44-1-F28	0.20	2.42	51.90	46.01	bdl	0.01	0.05	0.03	0.06	0.04	bdl	100.72
SG44-1T-g24	Py2	SG44-1-F42	0.61	4.39	51.05	44.88	0.01	bdl	0.05	0.01	bdl	bdl	bdl	101.02

Continue Table OM2

Sample No.	Type	Analysis No.	Au	As	S	Fe	Zn	Ni	Co	Ag	Te	Cu	Sb	Total
SG44-1T-g25	Py2	SG44-1-F45	0.38	2.21	52.57	45.81	bdl	bdl	0.06	0.01	bdl	bdl	bdl	101.05
SG44-1T-g29	Py2	SG44-1-F50	0.78	4.60	50.76	44.37	0.03	bdl	0.03	0.04	0.13	0.27	bdl	101.00
SG48-1T-g1	Py1	SG48-1-F2	0.02	bdl	53.92	46.81	bdl	bdl	0.05	0.01	0.04	bdl	bdl	100.88
SG48-1T-g3	Py1	SG48-1-F16	bdl	0.01	53.17	46.40	bdl	0.03	0.06	bdl	0.07	bdl	bdl	99.84
SG48-6T-g4	Py1	SG48-6-F14	bdl	0.04	53.78	46.31	bdl	bdl	0.05	bdl	bdl	bdl	bdl	100.20
SG48-6T-g4	Py1	SG48-6-F15	bdl	0.04	53.78	46.42	bdl	bdl	0.06	bdl	bdl	bdl	bdl	100.33
SG103-1T-g2	Py1	SG103-1-F8	0.02	0.10	53.83	46.60	0.02	bdl	0.05	bdl	0.04	bdl	bdl	100.65
SG103-1T-g2	Py1	SG103-1-F11	bdl	0.87	52.50	45.82	bdl	bdl	0.03	bdl	bdl	bdl	0.02	99.25
SG44-1T-g14	Py1	SG44-1-F5	bdl	0.20	53.37	46.35	bdl	0.01	0.06	bdl	bdl	bdl	bdl	99.98
SG44-1T-g15	Py1	SG44-1-F15	0.02	0.80	53.29	46.42	bdl	bdl	0.04	bdl	0.01	0.01	bdl	100.60
SG44-1T-g15	Py1	SG44-1-F19	bdl	0.94	52.97	46.34	bdl	bdl	0.05	0.01	0.02	bdl	bdl	100.36
SG44-1T-g19	Py1	SG44-1F27	0.03	0.03	53.79	46.57	bdl	bdl	0.05	bdl	bdl	bdl	bdl	100.48
SG44-1T-g23	Py1	SG44-1-F40	0.02	0.01	54.24	46.39	bdl	0.01	0.06	bdl	0.07	bdl	bdl	100.81
SG44-1T-g14	Py3	SG44-1-F8	bdl	bdl	54.19	46.35	bdl	bdl	0.05	bdl	bdl	bdl	0.02	100.62
SG44-1T-g15	Py3	SG44-1-F18	bdl	0.12	54.01	46.38	bdl	bdl	0.04	bdl	bdl	0.01	bdl	100.56
SG44-1T-g18	Py3	SG44-1-F22	bdl	0.05	54.01	46.65	0.02	bdl	0.04	bdl	bdl	bdl	bdl	100.78
SG44-1T-g23	Py3	SG44-1-F39	bdl	0.08	54.19	46.15	bdl	bdl	0.05	bdl	0.03	bdl	bdl	100.51
SG44-1T-g25	Py3	SG44-1-F46	bdl	bdl	54.14	46.40	0.02	bdl	0.04	bdl	bdl	bdl	bdl	100.60
SG48-1T-g1	Py3	SG48-1-F5	bdl	0.02	52.90	45.54	bdl	0.01	0.07	bdl	bdl	bdl	bdl	98.55
SG48-6T-g1	Py3	SG48-6-F2.1	0.02	0.05	54.69	46.55	0.01	bdl	0.05	bdl	0.03	bdl	0.03	101.43
SG48-6T-g3	Py3	SG48-6-F10	bdl	0.03	54.01	46.11	bdl	0.07	0.03	bdl	0.08	bdl	bdl	100.34
SG48-6T-g4	Py3	SG48-6-F17	bdl	0.02	53.73	46.23	bdl	bdl	0.05	bdl	bdl	0.03	0.03	100.09
SG48-6T-g7	Py3	SG48-6-F40	bdl	0.04	53.96	46.52	bdl	bdl	0.05	bdl	bdl	bdl	bdl	100.58

Continue Table OM2

Sample No.	Type	Analysis No.	Au	As	S	Fe	Zn	Ni	Co	Ag	Te	Cu	Sb	Total
SG48-6T-g7	Py3	SG48-6-F41	bdl	0.38	53.65	46.62	bdl	bdl	0.03	bdl	0.01	0.29	bdl	101.00
SG103-1T-g2	Py3	SG103-1-F17	bdl	bdl	53.46	46.48	bdl	0.01	0.06	bdl	0.01	bdl	bdl	100.04
SG32-2T-g3	Py3	SG32-2-F18	bdl	0.32	54.40	46.68	bdl	0.01	0.05	bdl	0.02	bdl	bdl	101.50

Note: (1) bdl denotes below detection limit; (2) Hg, Pb, Bi, Se < bdl

Table OM3 EPMA data for Py1, Py2 and Py3 (in at. %)

Sample No.	Analysis No.	Type	Au	As	S	Fe	Zn	Ni	Co	Ag	Te	Cu	Sb	S+As
SG44J-g6	SG44-D1	Py2	0.05	1.57	65.15	33.07	bdl	bdl	0.05	bdl	0.01	0.09	bdl	66.72
SG44J-g6	SG44-D2	Py2	0.08	2.31	64.47	33.07	bdl	bdl	0.05	0.01	bdl	0.01	bdl	66.78
SG44J-g7	SG44-D4	Py2	0.08	1.73	65.02	33.08	bdl	bdl	0.06	bdl	0.01	0.03	bdl	66.75
SG44J-g7	SG44-D5	Py2	0.08	1.98	64.76	33.03	0.01	bdl	0.05	bdl	0.01	0.08	bdl	66.74
SG44J-g5	SG44-D8	Py2	0.08	1.90	65.00	32.92	bdl	bdl	0.06	bdl	0.00	0.03	bdl	66.90
SG44J-g9	SG44-D9	Py2	0.08	1.63	65.23	32.98	bdl	bdl	0.06	bdl	0.00	0.01	bdl	66.86
SG44J-g10	SG44-D10	Py2	0.10	2.05	64.92	32.78	bdl	bdl	0.05	0.05	0.02	0.04	bdl	66.97
SG44J-g9	SG44-D11	Py2	0.08	2.51	64.31	32.92	0.03	bdl	0.05	0.01	0.01	0.07	bdl	66.82
SG44J-g5	SG44-D12	Py2	0.06	1.52	65.02	33.28	bdl	bdl	0.05	0.00	bdl	0.06	bdl	66.54
SG44J-g8	SG44-D13	Py2	0.09	2.02	64.96	32.83	bdl	bdl	0.06	0.01	0.02	0.01	bdl	66.98
SG44J-g10	SG44-D17	Py2	0.08	1.90	64.92	32.96	bdl	bdl	0.05	0.01	0.01	0.08	bdl	66.82
SG44J-g5	SG44-D24	Py2	0.07	1.80	64.94	33.04	0.01	bdl	0.05	0.00	0.01	0.07	bdl	66.74
SG44J-g5	SG44-D25	Py2	0.08	1.68	65.16	33.00	bdl	bdl	0.05	bdl	0.01	0.01	bdl	66.84
SG44J-g5	SG44-D26	Py2	0.09	2.34	64.48	33.02	bdl	bdl	0.06	0.00	0.01	bdl	bdl	66.82
SG44J-g5	SG44-D27	Py2	0.10	2.45	64.38	33.00	bdl	bdl	0.05	0.01	0.01	bdl	bdl	66.83
SG44J-g9	SG44-D30	Py2	0.03	0.52	65.83	33.54	bdl	bdl	0.06	bdl	bdl	0.02	bdl	66.35

Continue Table OM3

Sample No.	Analysis No.	Type	Au	As	S	Fe	Zn	Ni	Co	Ag	Te	Cu	Sb	S+As
SG44J-g9	SG44-D32	Py2	0.03	0.41	65.82	33.67	bdl	bdl	0.05	0.00	bdl	0.02	bdl	66.23
SG44J-g9	SG44-D33	Py2	0.06	1.91	64.80	33.07	bdl	bdl	0.05	0.01	0.01	0.09	bdl	66.71
SG44J-g9	SG44-D34	Py2	0.02	0.46	65.94	33.50	bdl	bdl	0.05	bdl	bdl	0.03	bdl	66.40
SG44J-g9	SG44-D36	Py2	0.03	0.71	65.75	33.41	bdl	bdl	0.06	0.01	bdl	0.04	bdl	66.46
SG44J-g9	SG44-D37	Py2	0.03	0.69	65.58	33.59	bdl	bdl	0.06	bdl	0.01	0.05	bdl	66.27
SG44J-g9	SG44-D38	Py2	0.02	0.67	65.62	33.59	bdl	bdl	0.06	bdl	bdl	0.04	bdl	66.29
SG44J-g9	SG44-D39	Py2	0.02	0.75	65.68	33.46	bdl	bdl	0.06	bdl	bdl	0.03	bdl	66.43
SG44J-g9	SG44-D40	Py2	0.02	0.86	65.57	33.44	bdl	bdl	0.05	bdl	bdl	0.05	bdl	66.44
SG44J-g9	SG44-D42	Py2	0.04	0.90	65.42	33.52	0.03	bdl	0.05	bdl	bdl	0.05	bdl	66.32
SG44J-g10	SG44-D44	Py2	0.04	1.11	65.36	33.39	bdl	bdl	0.04	bdl	0.01	0.05	bdl	66.47
SG44J-g10	SG44-D45	Py2	0.04	1.20	65.51	33.11	bdl	bdl	0.05	bdl	bdl	0.08	bdl	66.71
SG44J-g10	SG44-D46	Py2	0.06	1.30	65.37	33.15	0.02	bdl	0.05	0.01	0.00	0.04	bdl	66.66
SG44J-g10	SG44-D48	Py2	0.07	1.72	65.19	32.86	bdl	bdl	0.06	bdl	0.01	0.09	bdl	66.91
SG44J-g5	SG44-D52	Py2	0.07	1.89	64.79	33.11	0.01	bdl	0.05	bdl	0.01	0.07	0.01	66.68
SG44J-g9	SG44-D54	Py2	0.04	1.04	65.61	33.18	0.02	bdl	0.05	bdl	0.01	0.05	bdl	66.64
SG44J-g9	SG44-D55	Py2	0.03	0.84	65.61	33.42	bdl	bdl	0.05	bdl	bdl	0.05	bdl	66.45
SG44J-g9	SG44-D57	Py2	0.04	1.04	65.57	33.24	0.02	bdl	0.05	bdl	0.01	0.04	bdl	66.61
SG44J-g9	SG44-D58	Py2	0.03	0.66	65.83	33.40	bdl	bdl	0.04	bdl	bdl	0.04	bdl	66.49
SG44J-g9	SG44-D59	Py2	0.06	1.06	65.54	33.23	bdl	bdl	0.06	0.01	bdl	0.04	bdl	66.60
SG44J-g9	SG44-D60	Py2	0.05	1.03	65.61	33.20	bdl	bdl	0.06	0.01	bdl	0.05	bdl	66.64
SG44J-g9	SG44-D60-1	Py2	0.04	1.02	65.67	33.17	bdl	bdl	0.05	bdl	bdl	0.05	bdl	66.69
SG44J-g11	SG44-D61	Py2	0.10	2.41	64.55	32.88	bdl	bdl	0.05	0.00	bdl	bdl	bdl	66.96
SG44J-g13	SG44-D66	Py2	0.09	2.26	64.82	32.77	0.01	bdl	0.05	0.01	0.01	bdl	bdl	67.07

Continue Table OM3

Sample No.	Analysis No.	Type	Au	As	S	Fe	Zn	Ni	Co	Ag	Te	Cu	Sb	S+As
SG44J-g13	SG44-D67	Py2	0.09	1.56	65.21	33.05	bdl	bdl	0.06	0.01	bdl	0.02	bdl	66.78
SG44J-g14	SG44-D71	Py2	0.05	1.02	65.60	33.21	bdl	bdl	0.06	bdl	bdl	0.06	bdl	66.62
SG44J-g14	SG44-D72	Py2	0.05	1.55	64.95	33.35	bdl	bdl	0.06	bdl	bdl	0.04	bdl	66.50
SG44-1T-g15	SG44-1-F16	Py2	0.01	0.21	66.38	33.36	bdl	bdl	0.03	bdl	bdl	bdl	0.01	66.59
SG44-1T-g19	SG44-1-F28	Py2	0.04	1.31	65.31	33.25	bdl	0.00	0.03	0.01	0.02	0.02	bdl	66.62
SG44-1T-g24	SG44-1-F42	Py2	0.13	2.39	64.75	32.69	0.01	bdl	0.04	0.00	bdl	bdl	bdl	67.14
SG44-1T-g25	SG44-1-F45	Py2	0.08	1.18	65.78	32.91	bdl	bdl	0.04	0.01	bdl	bdl	bdl	66.96
SG44-1T-g29	SG44-1-F50	Py2	0.16	2.51	64.63	32.44	0.02	bdl	0.02	0.01	0.04	0.17	bdl	67.13
													Average	66.68
													Minimum	66.23
													Maximum	67.14
													Variance (σ)	0.23
SG48-1T-g1	SG48-1-F2	Py1	0.00	bdl	66.69	33.25	bdl	bdl	0.04	0.00	0.01	bdl	bdl	66.69
SG48-1T-g3	SG48-1-F16	Py1	bdl	0.01	66.55	33.35	bdl	0.02	0.04	bdl	0.02	bdl	bdl	66.56
SG48-6T-g4	SG48-6-F14	Py1	bdl	0.02	66.88	33.07	bdl	bdl	0.03	bdl	bdl	bdl	bdl	66.89
SG48-6T-g4	SG48-6-F15	Py1	bdl	0.02	66.82	33.11	bdl	bdl	0.04	bdl	bdl	bdl	bdl	66.84
SG103-1T-g2	SG103-1-F8	Py1	0.00	bdl	66.72	33.17	0.01	bdl	0.03	bdl	0.01	bdl	bdl	66.77
SG103-1T-g2	SG103-1-F11	Py1	bdl	0.47	66.28	33.22	bdl	bdl	0.02	bdl	bdl	bdl	0.01	66.76
SG44-1T-g14	SG44-1-F5	Py1	bdl	0.11	66.63	33.23	bdl	0.00	0.04	bdl	bdl	bdl	bdl	66.73
SG44-1T-g15	SG44-1-F15	Py1	0.00	0.43	66.34	33.19	bdl	bdl	0.03	bdl	0.00	0.01	bdl	66.77
SG44-1T-g15	SG44-1-F19	Py1	bdl	0.50	66.19	33.25	bdl	bdl	0.03	0.00	0.01	bdl	bdl	66.69
SG44-1T-g19	SG44-1F27	Py1	0.01	0.02	66.75	33.19	bdl	bdl	0.03	bdl	bdl	bdl	bdl	66.77
SG44-1T-g23	SG44-1-F40	Py1	0.00	0.01	67.01	32.91	bdl	0.01	0.04	bdl	0.02	bdl	bdl	67.02

Continue Table OM3

Sample No.	Analysis No.	Type	Au	As	S	Fe	Zn	Ni	Co	Ag	Te	Cu	Sb	S+As
SG44-1T-g14	SG44-1-F8	Py3	bdl	bdl	67.04	32.92	bdl	bdl	0.03	bdl	bdl	bdl	0.01	67.04
SG44-1T-g15	SG44-1-F18	Py3	bdl	0.06	66.91	32.99	bdl	bdl	0.02	bdl	bdl	0.01	bdl	66.97
SG44-1T-g18	SG44-1-F22	Py3	bdl	0.02	66.80	33.13	0.01	bdl	0.03	bdl	bdl	bdl	bdl	66.83
SG44-1T-g23	SG44-1-F39	Py3	bdl	0.04	67.10	32.81	bdl	bdl	0.03	bdl	0.01	bdl	bdl	67.14
SG44-1T-g25	SG44-1-F46	Py3	bdl	bdl	66.99	32.97	0.01	bdl	0.03	bdl	bdl	bdl	bdl	66.99
SG48-1T-g1	SG48-1-F5	Py3	bdl	0.01	66.87	33.06	bdl	0.01	0.04	bdl	bdl	bdl	bdl	66.88
SG48-6T-g1	SG48-6-F2.1	Py3	0.00	0.03	67.11	32.80	0.00	bdl	0.04	bdl	0.01	bdl	0.01	67.14
SG48-6T-g3	SG48-6-F10	Py3	bdl	0.02	67.03	32.86	bdl	0.05	0.02	bdl	0.02	bdl	bdl	67.04
SG48-6T-g4	SG48-6-F17	Py3	bdl	0.01	66.89	33.05	bdl	bdl	0.03	bdl	bdl	0.02	0.01	66.89
SG48-6T-g7	SG48-6-F40	Py3	bdl	0.02	66.85	33.09	bdl	bdl	0.03	bdl	bdl	bdl	bdl	66.87
SG48-6T-g7	SG48-6-F41	Py3	bdl	0.20	66.44	33.15	bdl	bdl	0.02	bdl	0.00	0.18	bdl	66.64
SG103-1T-g2	SG103-1-F17	Py3	bdl	bdl	66.66	33.28	bdl	0.01	0.04	bdl	0.00	bdl	bdl	66.66
SG32-2T-g3	SG32-2-F18	Py3	bdl	0.17	66.84	32.93	bdl	0.01	0.04	bdl	0.01	bdl	bdl	67.01

Note: (1) bdl denotes below detection limit; (2) Hg, Pb, Bi, Se < bdl

Table OM4 Atomic proportions for Py1, Py2 and Py3 were calculated on the basis of 2 anions per formula unit (apfu)

Sample No.	Type	Analysis No.	Au	As	S	Fe	Zn	Ni	Co	Ag	Te	Cu	Sb	N_{2-S}/N_{As}	$N_{(S+As)}$	∑anions
SG44J-g6	Py2	SG44-D1	0.0015	0.0470	1.9523	0.9909	bdl	bdl	0.0015	bdl	0.0003	0.0027	bdl	1.0147	1.9993	1.9997
SG44J-g6	Py2	SG44-D2	0.0025	0.0691	1.9308	0.9904	bdl	bdl	0.0014	0.0003	bdl	0.0003	bdl	1.0003	2.0000	2.0000
SG44J-g7	Py2	SG44-D4	0.0023	0.0519	1.9478	0.9909	bdl	bdl	0.0017	bdl	0.0002	0.0008	bdl	1.0063	1.9997	1.9998
SG44J-g7	Py2	SG44-D5	0.0024	0.0594	1.9402	0.9895	0.0004	bdl	0.0016	bdl	0.0002	0.0024	bdl	1.0056	1.9997	1.9998
SG44J-g5	Py2	SG44-D8	0.0025	0.0568	1.9429	0.9841	bdl	bdl	0.0018	bdl	0.0001	0.0009	bdl	1.0050	1.9997	1.9999
SG44J-g9	Py2	SG44-D9	0.0025	0.0488	1.9510	0.9865	bdl	bdl	0.0017	bdl	0.0001	0.0004	bdl	1.0059	1.9997	1.9999

Continue Table OM4

Sample No.	Type	Analysis No.	Au	As	S	Fe	Zn	Ni	Co	Ag	Te	Cu	Sb	N_{2-S}/N_{As}	$N_{(S+As)}$	∑anions
SG44J-g10	Py2	SG44-D10	0.0030	0.0611	1.9375	0.9783	bdl	bdl	0.0013	0.0015	0.0007	0.0011	bdl	1.0216	1.9987	1.9993
SG44J-g9	Py2	SG44-D11	0.0025	0.0751	1.9244	0.9851	0.0009	bdl	0.0015	0.0002	0.0002	0.0022	bdl	1.0064	1.9995	1.9998
SG44J-g5	Py2	SG44-D12	0.0019	0.0458	1.9541	1.0002	bdl	bdl	0.0015	0.0001	bdl	0.0018	bdl	1.0021	1.9999	2.0000
SG44J-g8	Py2	SG44-D13	0.0028	0.0604	1.9385	0.9797	bdl	bdl	0.0017	0.0002	0.0005	0.0004	bdl	1.0180	1.9989	1.9995
SG44J-g10	Py2	SG44-D17	0.0024	0.0568	1.9428	0.9864	bdl	bdl	0.0016	0.0002	0.0002	0.0023	bdl	1.0061	1.9997	1.9998
SG44J-g5	Py2	SG44-D24	0.0021	0.0541	1.9455	0.9899	0.0003	bdl	0.0016	0.0001	0.0002	0.0022	bdl	1.0089	1.9995	1.9998
SG44J-g5	Py2	SG44-D25	0.0024	0.0503	1.9489	0.9871	bdl	bdl	0.0014	bdl	0.0004	0.0003	bdl	1.0167	1.9992	1.9996
SG44J-g5	Py2	SG44-D26	0.0028	0.0699	1.9297	0.9881	bdl	bdl	0.0018	0.0001	0.0002	bdl	bdl	1.0047	1.9997	1.9998
SG44J-g5	Py2	SG44-D27	0.0030	0.0734	1.9263	0.9874	bdl	bdl	0.0014	0.0003	0.0002	bdl	bdl	1.0042	1.9997	1.9999
SG44J-g9	Py2	SG44-D30	0.0010	0.0158	1.9842	1.0109	bdl	bdl	0.0017	bdl	bdl	0.0007	bdl	1.0000	2.0000	2.0000
SG44J-g9	Py2	SG44-D32	0.0008	0.0123	1.9877	1.0168	bdl	bdl	0.0016	0.0001	bdl	0.0005	bdl	1.0000	2.0000	2.0000
SG44J-g9	Py2	SG44-D33	0.0019	0.0572	1.9423	0.9912	bdl	bdl	0.0016	0.0003	0.0002	0.0027	bdl	1.0084	1.9995	1.9998
SG44J-g9	Py2	SG44-D34	0.0005	0.0140	1.9860	1.0089	bdl	bdl	0.0015	bdl	bdl	0.0009	bdl	1.0000	2.0000	2.0000
SG44J-g9	Py2	SG44-D36	0.0009	0.0213	1.9787	1.0053	bdl	bdl	0.0017	0.0002	bdl	0.0011	bdl	1.0000	2.0000	2.0000
SG44J-g9	Py2	SG44-D37	0.0010	0.0207	1.9790	1.0136	bdl	bdl	0.0017	bdl	0.0002	0.0014	bdl	1.0148	1.9997	1.9998
SG44J-g9	Py2	SG44-D38	0.0007	0.0201	1.9799	1.0134	bdl	bdl	0.0019	bdl	bdl	0.0011	bdl	1.0000	2.0000	2.0000
SG44J-g9	Py2	SG44-D39	0.0007	0.0226	1.9774	1.0073	bdl	bdl	0.0019	bdl	bdl	0.0009	bdl	1.0000	2.0000	2.0000
SG44J-g9	Py2	SG44-D40	0.0007	0.0260	1.9740	1.0067	bdl	bdl	0.0016	bdl	bdl	0.0015	bdl	1.0000	2.0000	2.0000
SG44J-g9	Py2	SG44-D42	0.0011	0.0271	1.9728	1.0107	0.0008	bdl	0.0014	bdl	bdl	0.0015	bdl	1.0043	1.9999	1.9999
SG44J-g10	Py2	SG44-D44	0.0013	0.0333	1.9663	1.0045	bdl	bdl	0.0013	bdl	0.0002	0.0015	bdl	1.0122	1.9996	1.9998
SG44J-g10	Py2	SG44-D45	0.0012	0.0360	1.9638	0.9927	bdl	bdl	0.0014	bdl	bdl	0.0025	bdl	1.0058	1.9998	2.0000
SG44J-g10	Py2	SG44-D46	0.0019	0.0389	1.9608	0.9945	0.0005	bdl	0.0014	0.0003	0.0001	0.0013	bdl	1.0069	1.9997	1.9999
SG44J-g10	Py2	SG44-D48	0.0020	0.0514	1.9478	0.9818	bdl	bdl	0.0018	bdl	0.0004	0.0027	bdl	1.0153	1.9992	1.9996

Continue Table OM4

Sample No.	Type	Analysis No.	Au	As	S	Fe	Zn	Ni	Co	Ag	Te	Cu	Sb	$N_{2\text{-}S}/N_{As}$	$N_{(S+As)}$	∑anions
SG44J-g5	Py2	SG44-D52	0.0020	0.0568	1.9428	0.9930	0.0003	bdl	0.0014	bdl	0.0002	0.0020	0.0002	1.0061	1.9997	2.0001
SG44J-g9	Py2	SG44-D54	0.0011	0.0311	1.9683	0.9956	0.0006	bdl	0.0016	bdl	0.0003	0.0015	bdl	1.0197	1.9994	1.9997
SG44J-g9	Py2	SG44-D55	0.0009	0.0252	1.9748	1.0059	bdl	bdl	0.0016	bdl	bdl	0.0015	bdl	1.0000	2.0000	2.0000
SG44J-g9	Py2	SG44-D57	0.0013	0.0311	1.9685	0.9978	0.0006	bdl	0.0016	bdl	0.0002	0.0012	bdl	1.0123	1.9996	1.9998
SG44J-g9	Py2	SG44-D58	0.0009	0.0198	1.9801	1.0047	bdl	bdl	0.0013	bdl	bdl	0.0012	bdl	1.0048	1.9999	2.0000
SG44J-g9	Py2	SG44-D59	0.0017	0.0318	1.9681	0.9979	bdl	bdl	0.0017	0.0002	bdl	0.0013	bdl	1.0030	1.9999	2.0000
SG44J-g9	Py2	SG44-D60	0.0015	0.0310	1.9690	0.9963	bdl	bdl	0.0018	0.0002	bdl	0.0015	bdl	1.0000	2.0000	2.0000
SG44J-g9	Py2	SG44-D60-1	0.0013	0.0306	1.9694	0.9948	bdl	bdl	0.0016	bdl	bdl	0.0014	bdl	1.0000	2.0000	2.0000
SG44J-g11	Py2	SG44-D61	0.0030	0.0720	1.9279	0.9822	bdl	bdl	0.0015	0.0001	bdl	bdl	bdl	1.0021	1.9998	2.0000
SG44J-g13	Py2	SG44-D66	0.0026	0.0673	1.9322	0.9768	0.0003	bdl	0.0015	0.0002	0.0002	bdl	bdl	1.0071	1.9995	1.9998
SG44J-g13	Py2	SG44-D67	0.0026	0.0469	1.9531	0.9897	bdl	bdl	0.0018	0.0002	bdl	0.0006	bdl	1.0012	1.9999	2.0000
SG44J-g14	Py2	SG44-D71	0.0014	0.0306	1.9693	0.9971	bdl	bdl	0.0017	bdl	bdl	0.0018	bdl	1.0050	1.9998	1.9999
SG44J-g14	Py2	SG44-D72	0.0014	0.0466	1.9534	1.0032	bdl	bdl	0.0019	bdl	bdl	0.0011	bdl	1.0000	2.0000	2.0000
SG44-1T-g15	Py2	SG44-1-F16	0.0003	0.0063	1.9937	1.0018	bdl	bdl	0.0010	bdl	bdl	bdl	0.0002	1.0000	2.0000	2.0002
SG44-1T-g19	Py2	SG44-1-F28	0.0012	0.0392	1.9597	0.9976	bdl	0.0001	0.0009	0.0003	0.0006	0.0007	bdl	1.0291	1.9989	1.9995
SG44-1T-g24	Py2	SG44-1-F42	0.0037	0.0711	1.9289	0.9738	0.0002	bdl	0.0011	0.0001	bdl	bdl	bdl	1.0005	2.0000	2.0000
SG44-1T-g25	Py2	SG44-1-F45	0.0023	0.0354	1.9646	0.9830	bdl	bdl	0.0011	0.0002	bdl	bdl	bdl	1.0000	2.0000	2.0001
SG44-1T-g29	Py2	SG44-1-F50	0.0048	0.0746	1.9230	0.9651	0.0006	bdl	0.0005	0.0004	0.0012	0.0052	bdl	1.0327	1.9976	1.9988
													Average	1.01	1.9997	1.9999
													Minimum	1.00	1.9976	1.9988
													Maximum	1.03	2.0000	2.0002
													Variance (σ)	0.01	0.0004	0.0002

Note: (1) bdl denotes below detection limit; (2) Hg, Pb, Bi, Se < bdl

3. References

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