1.Introduction

Arsenic is a toxin as well as a carcinogen linked to numerous forms of skin, bladder and lung cancer (NRC, 1999). The U.S Environmental Protection Agency (EPA) has lowered the maximum concentration limit (MCL) for arsenic in drinking water from 50 ppb to 10 ppb. Groundwater in many countries including Bangladesh, India and Nepal and even parts of United States contain elevated concentrations of arsenic. The major source of soluble arsenic in groundwater comes from aquifer sediments. (FOSTER, 2002).

Arsenic is found naturally in trace amounts in the earth's soils, waters and organisms (SMEDLEY and KINNIBURGH, 2002). Arsenic is perhaps unique among the heavy metalloids and oxyanion-forming elements (e.g. As, Se, Sb, Mo, V, Cr, U, Re) in its sensitivity to mobilization at the pH values typically found in groundwater (pH 6.5 – 8.5) and under both oxidizing and reducing conditions. Arsenic can occur in the environment in several oxidation states (-3, 0, +3 and +5) but in natural waters is mostly found in inorganic form as oxyanions of trivalent arsenite [As(III)] or pentavalent arsenate [Ar(V)] (SMEDLEY and KINNIBURGH, 2002).

Concentrations of arsenic in fresh water vary by more than four orders of magnitude depending on the source, the amount available, and the local geochemical environment (STOLLENWERK, 2003). Under natural conditions, the greatest range and the highest concentrations of As are found in groundwater as a result of the strong influence of water-rock interactions and favorable geochemical conditions in aquifers (SMEDLEY and KINNIBURGH, 2002).

There have been many different approaches to address the problem of arsenic mobility in aquifers. Sequential extraction methods have been routinely used to assess amount of movable arsenic in sediments. Spectroscopic methods, particularly infra-red (IR), X-ray photoelectron spectroscopy (XPS) and X-ray absorption fine structure (XAFS) spectroscopy, have been used to identify different sources of arsenic either as absorbed to surfaces or as a part of individual minerals. However, there has been an information gap on how the mobility of arsenic is affected by coupled mineralogic and geochemical characteristics. First, the reservoir of As depends on mineralogy, as the concentration of arsenic varies significantly in minerals. Second, geochemical conditions will control if and when the arsenic is released from minerals to water. For example, arsenic is released from arsenopyrite through oxidation reactions, but it is released from iron oxides via reductive or desorptive processes. This research focuses on evaluation and prediction of arsenic mobility in aquifers under different geochemical conditions using sequential extraction and microscopic methods. These methods are applied to arsenic contaminated sediments collected from the Brinton Arsenic mine (BAM) site in Floyd County, Virginia.

2. Study site

The Brinton Arsenic mine is located in Floyd County (Pilot quadrangle), Virginia, off route 790 (Lick Ridge Road), approximately 1.5 km north of Terry's Fork (Fig. 1). The mine is located within the Blue Ridge physiographic province composed of metamorphosed igneous and sedimentary rocks. The surrounding watershed is heavily forested with deciduous trees, including white oak (*Quercus alba*), chestnut oak (*Quercus prinus*) and red maple (*Acer rubrum*), as well as the conifer eastern white pine (*Pinus strobes*) (BROWN, 2005). Arsenopyrite was mined for the production of arsenic, which included roasting the ore to generate arsenic trioxide. Over 75 tons of arsenic trioxide were produced during the operational period of the mine between 1903 to 1919 (DIETRICH, 1959). Several heterogeneous mine waste piles of roasted and unprocessed ore remains at the site. Arsenopyrite and scorodite were found in previous studies of the host rock (DOVE and RIMSTIDT, 1985). A second-order headwater stream flows through the mine waste piles. The stream originates about 200 m upstream from the piles (CHAFFIN et al., 2005.; LOTTIG, 2005) and discharges into Purgatory Creek about 1 km downstream of the mine.

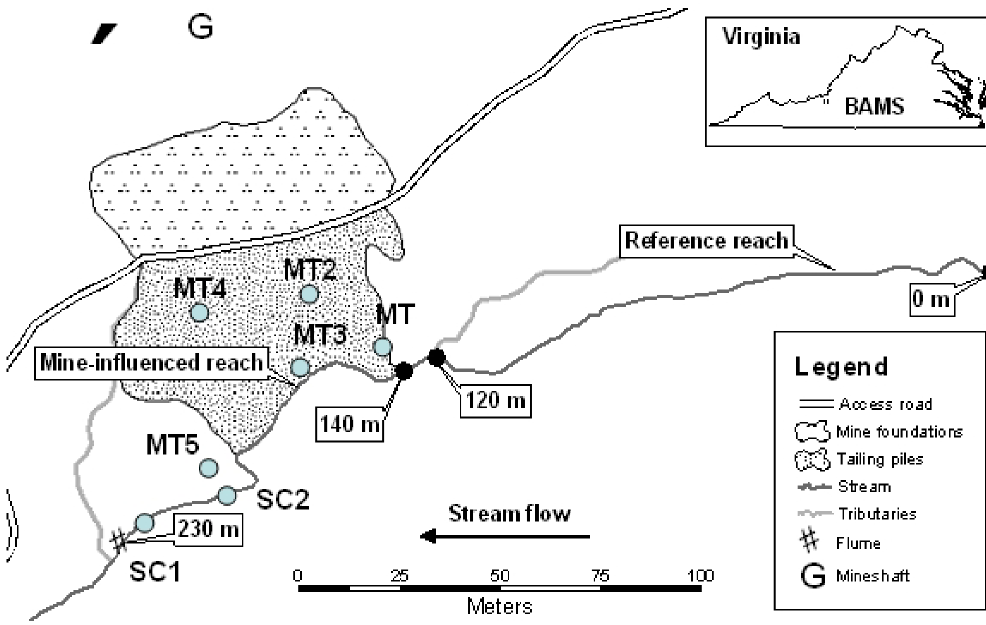

Figure 1: Brinton Arsenic Mine (BAM) site, Floyd county, Virginia. Modified from Lottig, 2005. Blue circles denote sediment sampling locations; MT = mine tailings, SC= stream channel sediments.

3. Methods

This study used both chemical and microscopic methods to evaluate arsenic mobility. Chemical methods include sequential extraction of arsenic from the sediments, total digestion using an autoclave method and total digestion using a microwave digestion method. Microscopic methods include scanning electron microscopy (SEM) for imaging mineral grains and zoning and electron microprobe analysis (EMPA) for elemental mapping of different arsenic bearing minerals.

3.1 Reagents and standards

The chemicals used were at least of analytical grade. Milli-Q (MQ) water (18.2 MΩ) was used for all solution preparation. Standard for arsenic solution was purchased from FisherChemical containing 1 ml= 1 mg As (solute: arsenic trioxide, solvent: 10%

nitric acid). Stock solutions were prepared containing 100-250 mg L^{-1} As using matrix solution (extracting reagents). All glassware used was previously cleaned and soaked in 0.1 N HNO_3 for 2 days and rinsed with MQ water before use.

3.2 Soil and rock sample collection and preparation:

Soil samples were collected from 0-15 cm of soil depth from ore tailings and stream channels at the BAM site using hand augers. After collection, samples were brought to the laboratory in labeled and sealed polyethylene bags. All samples were air-dried, crushed and sieved into two different grain sizes (250-105 µm and 106-45 µm) for analysis. Approximate sampling locations are shown in Figure 1. Thin sections were also prepared from the host rock samples.

3.3 Sequential extraction method:

The sequential extraction scheme for trace elements developed by Tessier et al. (1979) is most commonly used in some modified form for arsenic extraction. Originally the Tessier extraction method included five fractions: (i) exchangeable, (ii) extracted by acetic acid buffer, (iii) extracted by hydroxylamine, (iv) extracted by hydrogen peroxide in nitric acid and (v) residual. Complex schemes using more extraction steps have been developed for detailed sequential extraction of different types of sediments (BOROVEC et al., 1993; HALL et al., 1996; KEON et al., 2001; ZHANG and MOORE, 1997) but they are very laborious and often have a very low precision due to accumulation of errors in the scheme.

This study used the method described by Turpeinen et al. (1999) which is a modified version of the Tessier method. This is a five step sequential extraction method and As is recovered as partitioned to the following phases: (i) exchangeable, (ii) easily reducible metal oxide bound, (iii) easily oxidized, (iv) Fe and Al oxide bound, and (v) residual (Table 1).

Table 1: The Turpeinen Extraction procedure

Steps	Phases or Fractions	Reagents used	Inferred geochemical Process
1	Exchangeable	1 M $MgCl_2$ (25 mL, pH 7); 4 hr (25 ^oC); shaker. +Repeat	Outer-sphere (electrostatic) adsorption
2	Easily reducible metal oxides	0.1 M $NH_2OH.HCl$ (10 mL) + 0.01 M HNO_3 (15 mL); 30 min (25 ^oC); Shaker +Repeat	Released from desorption or moderately reducing conditions.
3	Easily oxidized	0.02 M HNO_3 (22.5 mL) + 30% H_2O_2 (2.5 mL); 2 hr, (85 ^oC), 3 M NH_4Ac (3.5 mL) + 25% HNO_3 (1.5 mL; pH 2.5); 5 hr (85 ^oC) + 30 min (25 ^oC) +Repeat	Susceptible to change under oxidizing conditions
4	Bound to Fe and Al oxides	0.175 M $(NH_4)2C_2O_4$ (12.5 mL) + 0.1 M $C_2H_2O_4$ (12.5 mL); pH 3.25; 30 min (95^oC)	Released from desorption or strongly reducing conditions.
5	Residual	32.5% HNO_3 (10 mL); autoclave 30 min (120 ^oC, 1 atm)	Released under strongly oxidizing or acidic conditions

To determine the total arsenic concentration in the sediments, two different methods were used: autoclave digestion and microwave digestion. The total concentrations were compared to the sum of the sequential extraction concentrations to ensure that all As was accounted for. To extract total arsenic fraction using the autoclave method, 32.5% HNO_3 (10 ml) was added to the 2.5 g sediments and the slurry was autoclaved at 120 ^{o}C (1 atm) for 30 minutes. The autoclaved sediments were then centrifuged for 30 minutes at 3500 rpm. To determine the total As in the sediments using microwave digestion, EPA Method 3050B was used. For this method, 1.5 g of each sample was digested in concentrated HNO_3 in a Milestone microwave. All digested samples were analyzed for total arsenic concentration by GFAAS or ICPMS (see Analytical Methods).

3.4 Modifications of the Turpeinen method

3.4.1 Desorption experiment of As using phosphate solution

In addition to the sequential extraction steps, an independent phosphate extraction was conducted to determine the amount of arsenic adsorbed to the metal oxides. Spectroscopic studies have shown that the surface species formed by phosphate [P(V)] are identical to those formed by As(V) (HIEMSTRA and VAN RIEMSDIJK, 1999; WAYCHUNAS et al., 1993) and that phosphate competes for adsorption sites with arsenate.

To conduct the extraction, phosphate solution was applied after the completion of first step extraction, which removed the easily exchangeable arsenic from the sediments. The 0.5 M PO_4 (pH 2.8) solution was prepared from a 9:1 mixture of 0.5 M $NaH_2PO_4 \cdot H_2O$ and 0.5 M H_3PO_4 (JACKSON and MILLER, 2000). 10 ml of phosphate solution was added to 3 g of sediment and shaken for 4 hours and then centrifuged at 2000 rpm for 20 minutes. An aliquot of 5 ml of extracted solution was filtered (0.45 µm) and analyzed by ICP for extracted As, Fe and S (see analytical methods).

3.4.2 Extraction of arsenopyrite and scorodite

Because the Turpeinen method was developed for soils and not for mine waste, trial extractions were conducted on pure arsenopyrite and scorodite to determine which extraction step released arsenic from these two mineral phases. The same extraction solutions (Table 1) were applied to 2.5 g of pure arsenopyrite fro the Noche Buena mine in Mexico, arsenopyrite separated from the BAM sediments and synthesized scorodite to determine when As is released from those minerals in the overall sequential extraction scheme. The arsenopyrite (specific gravity-6.07 g/cm^3) was separated from the BAM sediments using sodium metatungstate solution (specific gravity-2.82 g/cm^3). To conduct the separation, 25 g of sediments were added to the 10 ml of sodium metatungstate in a centrifuge tube. To separate the arsenopyrite fraction, the solution was centrifuged at 500 rpm for five minutes, and the sodium metatungstate was removed.

3.4.3 Quality control

For complete recovery of arsenic, every extraction step was repeated twice and the wash solution between every step was also saved for arsenic analysis. All standard solutions for arsenic analysis were prepared using the same matrix solution as the particular extraction step to account for matrix and background effects.

3.5 Arsenic analysis

Solutions from each extraction step were filtered through a 0.45-µm filter and were analyzed in the laboratory using a Perkin Elmer Graphite Furnace Atomic Absorption Spectrometer (GFAAS) following EPA methods (USEPA, 1992). Microwave digested solutions were analyzed using Inductively Coupled Plasma-Atomic Emission Spectrometer (ICP-AES). ICP-AES was also used to analyze sulfur and iron in selected samples.

3.6 Imaging and elemental mapping

Fourteen sediment samples (including two different grain sizes for five mine tailing and two stream channel sediments) were embedded in 20 mm of low viscous epoxy. Prior to polishing, all samples were rinsed in de-ionized water and baked in vacuum for approximately 30 min. Polishing was done using Buehler Metaserv Grinder-Polisher instrument. For initial polishing, 600, 800 and 1200 grit polishing papers were used. Buehler Metadi 6 µm and 1µm diamond suspension solutions were used for final polishing of the samples. Fourteen different sections were made from the sediment samples. The rock samples were sent to Spectrum Petrographics Inc. to be made into thin sections. Three thin sections from the host rocks were made. All samples were carbon coated prior to SEM and electron microprobe analysis.

Scanning electron microscopy (SEM) is regularly used for imaging and semi-quantitative analysis of small features at the surface of solids. The CamScan SEM was used to perform surface imaging using secondary electron (SE) as well as back scattered electron (BSE) techniques. The CamScan has an energy dispersive spectroscopy system (EDS) system that allowed rapid semi-quantitative and quantitative chemical analysis and identification elements of soil samples.

The electron microprobe, or EMPA, is a tool for micron-scale chemical analysis of solid specimens. The Cameca SX-50 was used for 2-D imaging of compositional maps of thin sections and for quantitative analysis of As, S and Fe using an arsenopyrite standard with 0.00 iteration limit, 40 degree take off angle at 15 kV and 30 nA condition. All elemental analysis was done using wavelength dispersive spectroscopy (WDS).

4 Results

4.1 Results from sequential extraction

Results from all sequential extractions are presented in Appendix A.

4.1.1 Total digestion results

The sequential extraction results document that the total concentration of arsenic in the tailings and stream channel sediment samples varies from 1666 ppm to 8183 ppm. The total concentration of arsenic determined from sequential extraction method by adding the concentration of every step was compared to the total arsenic concentration determined using both the autoclave and microwave methods. Both methods for total digestion result in similar concentration, suggesting nearly total recovery of arsenic in sequential extractions. Table 2 shows the detailed results of total As concentrations using the sequential extraction, autoclave and microwave methods. Concentrations from the microwave and autoclave methods are always higher (on average about 6%) than the sum of extraction steps.

Table 2: Total digestion data from sequential extraction, autoclave and microwave digestion methods. All concentrations are in ppm. See Figure 1 for location of sediment samples.

Sample and grain size (μm)	Added Concentration in 5 steps (ppm)	Concentration (ppm) from autoclave method	% difference from added total	Concentration (ppm) from microwave digestion	% difference from added total
MT 106-250	4042	4459	9	4501	10
MT 45-105	5377	5426	1	5894	9
MT2 106-250	5274	5742	8	5738	8
MT2 45-105	5911	6226	5	6644	11
MT3 106-250	5873	5577	-5	5168	-14
MT3 45-105	7436	8778	15	7874	6
MT4 106-250	1666	1617	-3	no data	no data
MT4 45-105	3972	3887	-2	4268	7
MT5 106-250	1126	1144	2	1227	8
MT5 45-105	1089	1114	2	1351	19
SC1 106-250	3003	3036	1	3248	8
SC1 45-105	4137	4180	1	4362	5
SC2 106-250	4298	4180	-3	no data	no data
SC2 45-105	8183	8514	4	8716	6
Average	4358	4563	3	4916	6

4.1.2 Distribution of arsenic in different phases

The average distribution of arsenic in mine tailing sediments and stream channel sediments is shown in Figure 2.

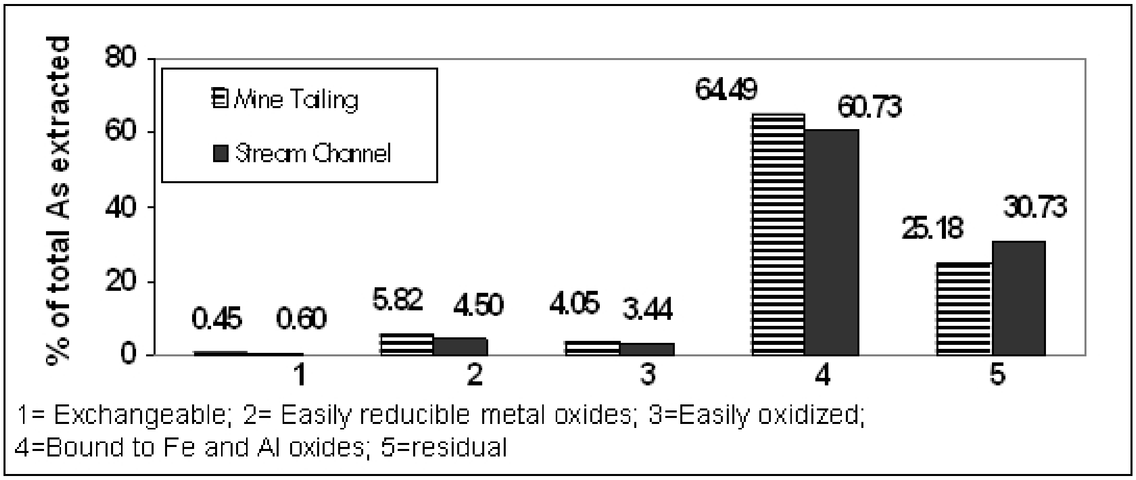

Figure 2: Average distribution of % of arsenic in different phases for mine tailing sediments and stream channel sediments (n= 14).

Figure 2 shows that most of the arsenic in both the mine tailing and stream channel sediments is attached to the iron/ aluminum oxides and to the residual phase. The weight % of As associated with metal oxides (Steps 2 + 4) varies from 60 to 80 % in the sediment samples (Figure 3). There is no statistically significant difference between mine tailing and stream channel sediments. About 25-30% of arsenic is attached to residual phase, which could include scorodite and arsenopyrite (see section 4.1.5). The easily exchangeable arsenic fraction is below 1% of total arsenic concentration in both sediment types.

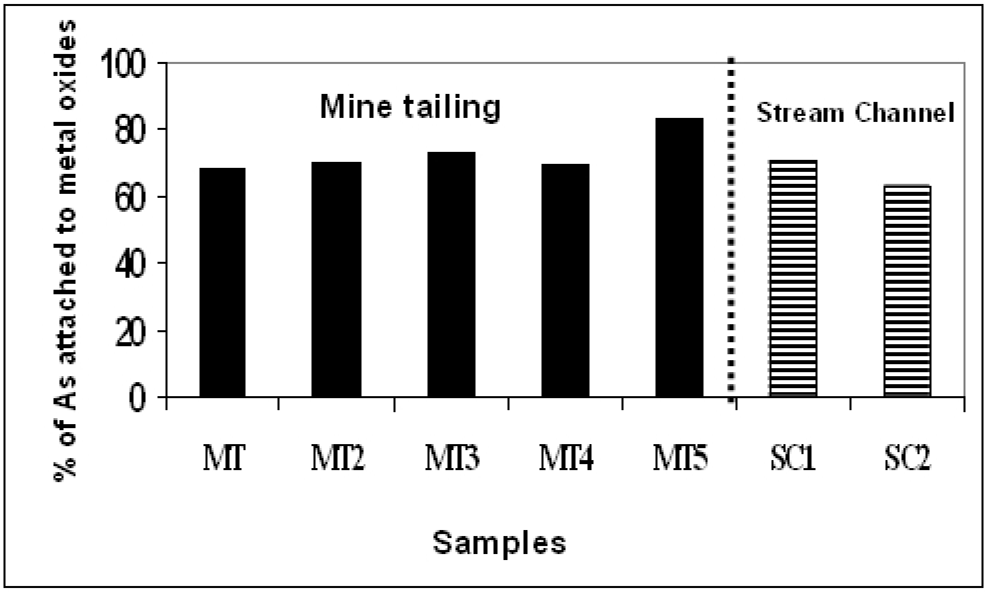

Figure 3: Weight % of As associated with oxides (Step 2+4) in mine tailing and stream sediment samples.

4.1.3 Effect of grain size

Results of sequential extraction show that the smaller grain size (106-45 µm) sediments consistently have higher concentrations of arsenic than the larger grain size (250-105 µm) (Table 3). On average the 106-45 µm grain size sediments contain 28% higher concentration of As than the smaller size fraction. While in MT5 the grain size effect is negligible, in the MT4 and SC2 samples, there is more than a 50 % increase in concentration in the smaller grain size.

Table 3: Effect of grain size on total As concentrations in different samples.

SAMPLES	250-105 µm conc. (ppm)	106-45 µm conc. (ppm)	Excess As in 106-45 µm (%)
MT	4459	5426	18
MT2	5742	6226	8
MT3	5577	8778	37
MT4	1617	3887	58
MT5	1144	1114	-3
SC1	3036	4180	28
SC2	4180	8514	51

4.1.4 Desorption of As by phosphate

Results of the phosphate desorption experiments are listed in Table 4. About 80 % of total arsenic attached to the metal oxides (steps 2+4) was extracted by phosphate, indicating that most of the arsenic associated with metal oxides is adsorbed to the surface.

Table 4: Comparison of adsorbed As (as determined by phosphate extraction) with As associated with metal oxides (sequential extraction steps 2+4).

MT3 250-105 µm	**As (ppm)**
Arsenic associated with metal oxides (steps 2+4)	4569
Arsenic adsorbed to the mineral surfaces as determined by phosphate extraction	3642
% of adsorbed As	80 %

4.1.5 Sequential extraction of arsenopyrite and scorodite on sequential extraction

Arsenopyrite and scorodite are present in the host rock and also in the sediments. Arsenopyrite from the Noche Buena mine in Mexico, synthesized scorodite and arsenopyrite separated from the sediments were extracted to check at which extraction steps arsenic was released from these minerals. Figure 4 shows results from sequential extraction of arsenopyrite and scorodite. More than 90% of total arsenic from arsenopyrite and scorodite is released during the final sequential extraction step (residual fraction). Arsenopyrite grains separated from the BAM sediments using sodium metatungstate (HLS Aspy) shows similar results to the Noche Buena arsenopyrite.

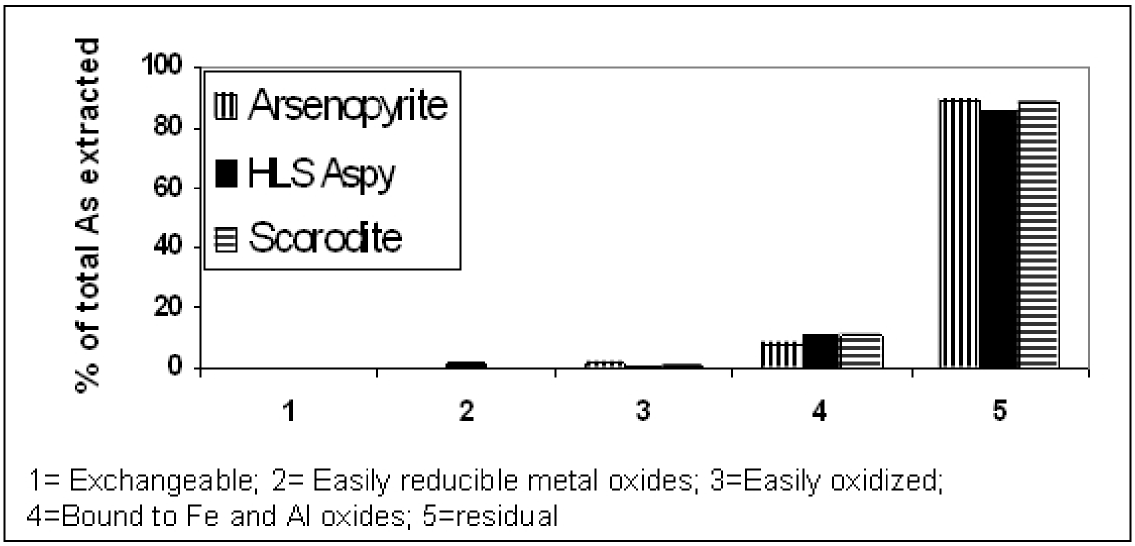

Figure 4: Release of As in sequential extraction from scorodite and arsenopyrite. (HLS= heavy liquid separated arsenopyrite from the sediments)

4.2 Results from imaging, elemental mapping and electron microprobe analysis

Results from SEM and EMPA analysis are presented in Appendix B.

4.2.1 SEM/ EMPA of sediments

Samples from the five different mine tailing and the two stream channel sediments were imaged using SEM and analyzed for As, Fe and S using electron microprobe techniques. Results from SEM/EMPA analysis of BAM sediments show that there are three major type of arsenic bearing minerals: iron oxides, scorodite and arsenopyrite.

Imaging of all minerals was first conducted using back scattered electrons in the SEM. Minerals were tentatively identified based upon elements detected in EDS spectra (Figures 5 D, E and F) prior to EMPA imaging. Mine tailing and stream channel sediments both show an abundance of iron oxides and scorodite (Figures 5 A and B; Table 5). Arsenopyrite (Figure 5 C) is also found in mine tailing sediments but not in stream channel sediments. Pyrite was rarely found in any of the samples. Sediment samples do not show any zoning of scorodite around arsenopyrite, which is a common feature in the host rock. Instead, scorodite appears to exist as an individual mineral (Figure 5 B). Iron oxides, which are also present as individual grains, contain rims of arsenic rich regions around the grains (Figure 5 A).

Figures 5 D, E and F show EDS spectra of the iron oxide with arsenic, scorodite and arsenopyrite. The As peak in the iron oxide grain is very small relative to the iron peak and there is no peak for sulfur. In the scorodite EDS spectra, the As peak is higher than the iron peak; there is no peak for sulfur. In the arsenopyrite, the dominant sulfur peak is present along with prominent As and Fe peaks. EDS spectra show relative abundance of elements in the sample and does not give any information about the actual concentration. However, EDS spectra can be used to identify different minerals by examination of ratios of peak area and peak heights of different elements.

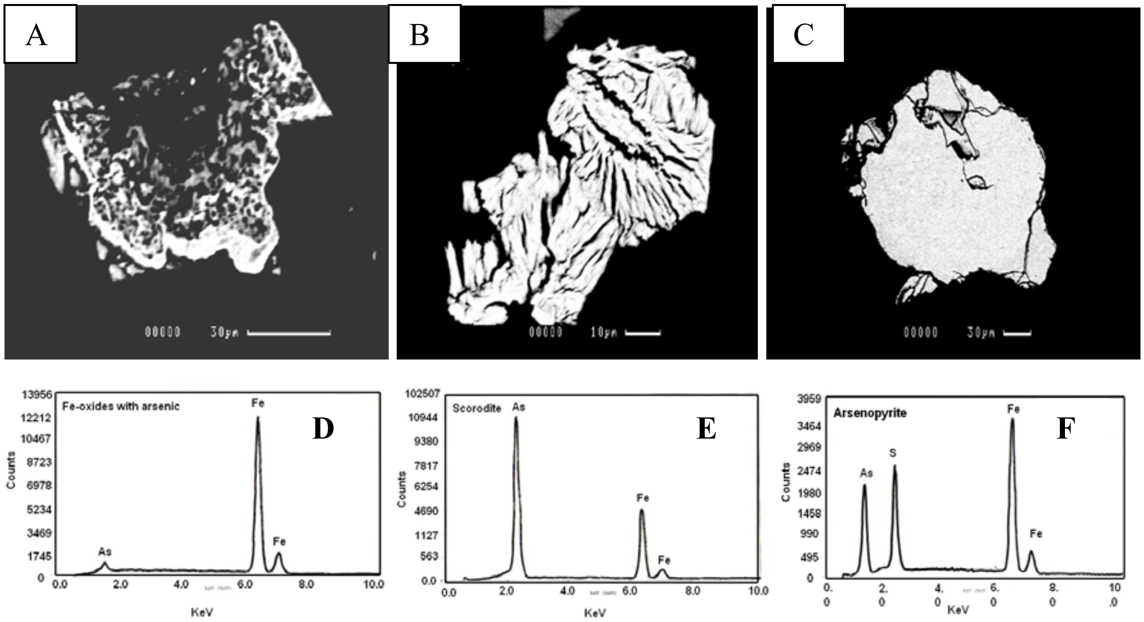

Figure 5: SEM images of grains from sediment samples. A) Iron oxide with bright arsenic rich rim; B) Scorodite; C) Arsenopyrite from mine tailing sediments; D) EDS spectra of iron oxide with arsenic adsorbed to the surface; E) EDS spectra of scorodite; F) EDS spectra of arsenopyrite.

Table 5: Mineral distribution in sediments. (X=present) (Reference Fig 1 for location of samples). Note that g=250-105 µm, s=106-45 µm size fraction)

	Fe oxides	**Scorodite**	**Arsenopyrite**	**Pyrite**
MT (g)	X	X	X	
MT (s)	X	X	X	
MT-2 (g)	X	X	X	X
MT-3 (g)	X	X	X	
MT3 (s)	X	X	X	
MT4 (g)	X	X	X	
MT4 (s)	X	X	X	
MT 5 (g)	X	X	X	
SC-1 (g)	X	X		
SC-1 (s)	X	X		
SC-2 (g)	X	X		

Fe-oxides

The weight % of Fe in was used to identify the type of iron oxide in the sediments. For example, the iron percentage is 69.94% in hematite, 48.20% in goethite and 66.21% in ferrihydrite. From Figure 6, it can be seen that the Fe % shows a normal distribution. The dominant bar in the histogram with 48-55 % Fe content does not match with any common iron oxides, which suggests that the iron oxides at BAM are porous.

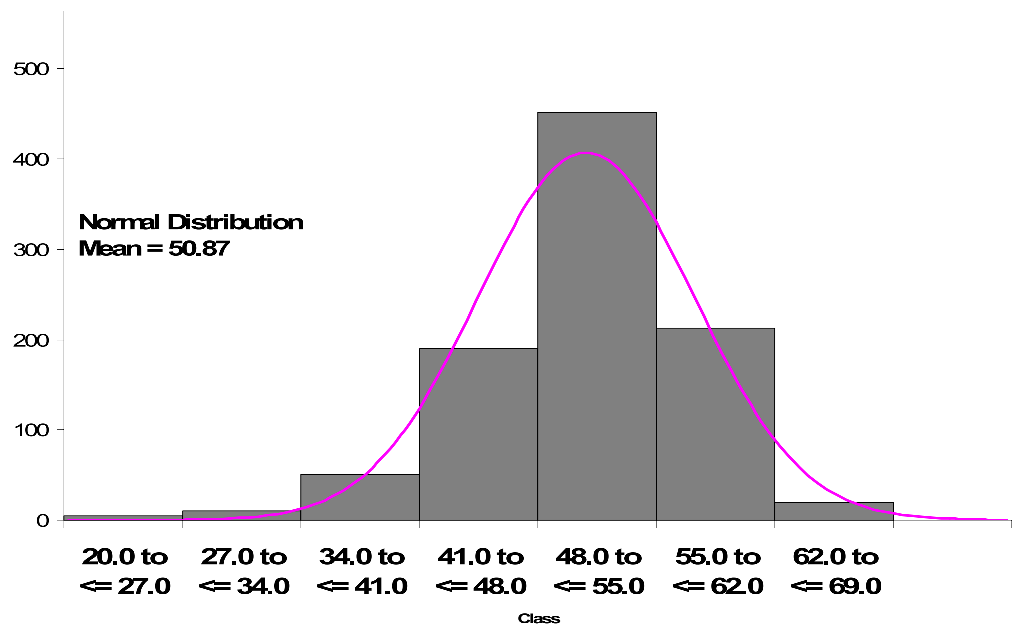

Figure 6: % Fe in iron oxides determined by EMPA. (No. of observations=898). The different mineral phases of iron are shaded in different colors.

Quantitative EMPA analysis reveals that the weight percent of arsenic associated with the iron oxides range from 0 to 13.26 % (Figure 7). The average weight % of arsenic attached to the iron oxides is about 3% (Table 6). In contrast, the weight % of sulfur associated with iron oxides is less than one on average (Table 6).

Figure 7: Weight % As associated with iron oxides determined by EMPA (n=898).

Table 6: Average, maximum and minimum weight % of As, Fe and S associated with Fe-oxide. Values determined by EMPA. bdl= below detection limit (n=900).

	As	S	Fe	Total
AVERAGE	2.75	0.38	51.24	54.45
max	13.26	4.55	67.44	67.47
min	bdl	bdl	20.18	22.88

Scorodite ($FeAsO_4{\cdot}2H_2O$)

Scorodite is also commonly found in tailing sediments, stream channel sediments and in the host rock. In scorodite, the weight % of Fe is 24 and the weight % of As is 32.46. Table 7 shows the average composition of scorodite in sediment samples; the average Fe concentration is 22.13 weight % and the average As concentration is 33.88 weight %, which is very close to pure scorodite. Figure 8 shows the distribution of % of arsenic in scorodite in the samples.

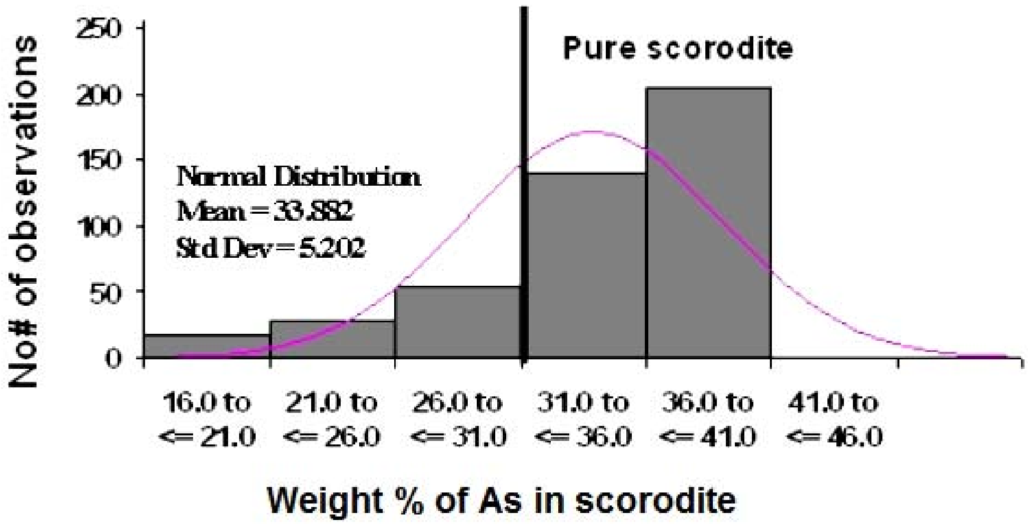

Figure 8: Weight % As associated with scorodite determined by EMPA (n = 446).

Table 7: Average, maximum and minimum weight % of Fe, As and S in scorodite grains determined by EMPA. bdl= below detection limit (n=444).

	As	S	Fe	Total
average	33.88	0.21	22.13	56.22
Max	41.01	4.16	37.97	63.33
Min	16.38	bdl	15.07	37.21
Pure scorodite	32.46	-	24.00	56.46

Arsenopyrite (FeAsS)

Arsenopyrite is abundant in mine tailing sediment samples but was not found in stream channel sediments. On average, the arsenopyrite in the mine tailing and stream channel sediments (Table 8) contains 33.74 % of Fe, 45.69% of As and 18.40 % of sulfur which is very close to pure mineral values (% Fe=34.30, % As= 46.01, % S=19.69). The histogram in Figure 9 shows the distribution of As in arsenopyrite.

Table 8: Average, maximum and minimum % for Fe, As and S in arsenopyrite determined by EMPA. (n=550).

	As	S	Fe	Total
AVERAGE	45.69	18.40	33.76	97.87
max	48.62	30.85	38.02	102.03
min	23.14	11.98	25.94	82.42
Pure FeAsS	46.01	19.69	34.3	100.00

The dominant peak in the histogram in Figure 10 includes 44 to 48% of arsenic which corresponds to the pure phase mineral. There is a small left tail in the histogram which indicates likely weathering of arsenopyrite, although weathering and zoning were not observed in SEM.

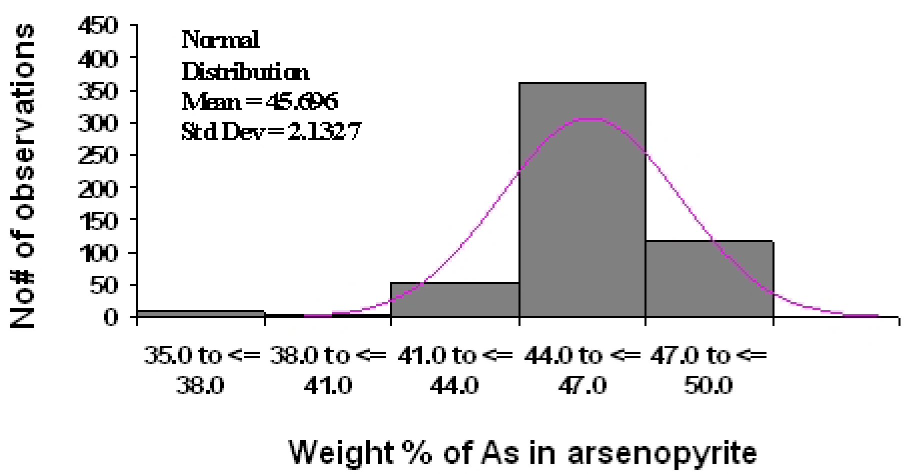

Fig 9: % As associated with arsenopyrite determined by EMPA (n=558).

4.3 SEM/EMPA of host rocks

4.3.1 SEM images

Imaging of host rock minerals was conducted on three polished thin sections using a back scattered electron technique. Arsenopyrite is very abundant in the host rock and is easily distinguishable. Scorodite rims are almost always found around arsenopyrite grains and in fractures (Figure 10). Weathering of arsenopyrite leads to generation of scorodite as described in reaction 1. In some arsenopyrite grains, an intermediate zone of elemental sulfur was identified between the arsenopyrite and the scorodite (Figure 10 C). In contrast to the sediments, scorodite was never found as individual grains in the host rocks. Pyrite was rarely found, and only in a few samples. EDS spectra for each mineral type are shown in Figures 10 D-F.

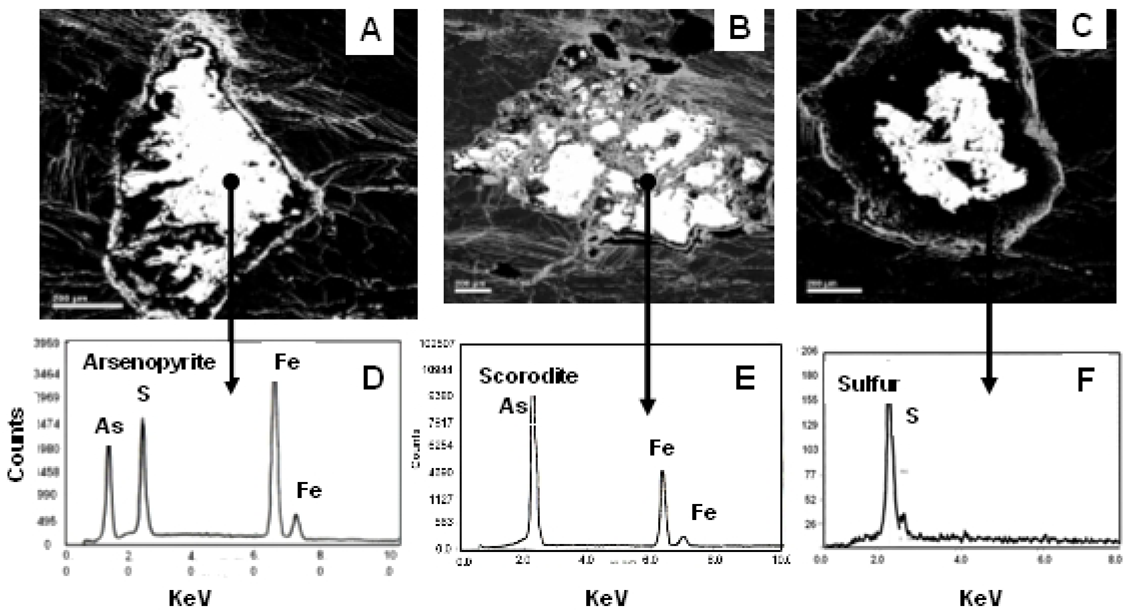

Figure 10: SEM images of A) Scorodite rim around arsenopyrite core; B) Formation of scorodite in fractures within and outside the original arsenopyrite grain; C) Intermediate dark broad zone of elemental sulfur between arsenopyrite core and scorodite rim; D) EDS spectra of arsenopyrite; E) EDS spectra of scorodite; F) EDS spectra of sulfur.

4.3.2 Elemental mapping of host rock minerals

Elemental maps of selected grains in the host rock thin sections were produced using WDS by electron microprobe for arsenic, iron and sulfur. Elemental maps show relative concentration of a particular element over the mapping region. Brighter spots in elemental map indicate higher concentrations while darker spots indicate lower concentrations. Figure 11 shows elemental maps for As, S and Fe for the same grain of arsenopyrite. From Figure 11 A, we can see that the arsenic concentration is very high within the arsenopyrite cores. Arsenic is also present in fractures and rims containing scorodite. Figure 11 B is the elemental map of sulfur and shows that sulfur is only present in the arsenopyrite core. Figure 11 C is an elemental map of iron showing high concentrations in the arsenopyrite core (around 33%) and lower (around 22 %) concentration in the scorodite. Figure 12 shows elemental map of another weathered arsenopyrite grain with rims of scorodite and an intermediate zone of elemental sulfur. Data for the elemental maps in Figure 12 and 13 are provided in Appendix B.

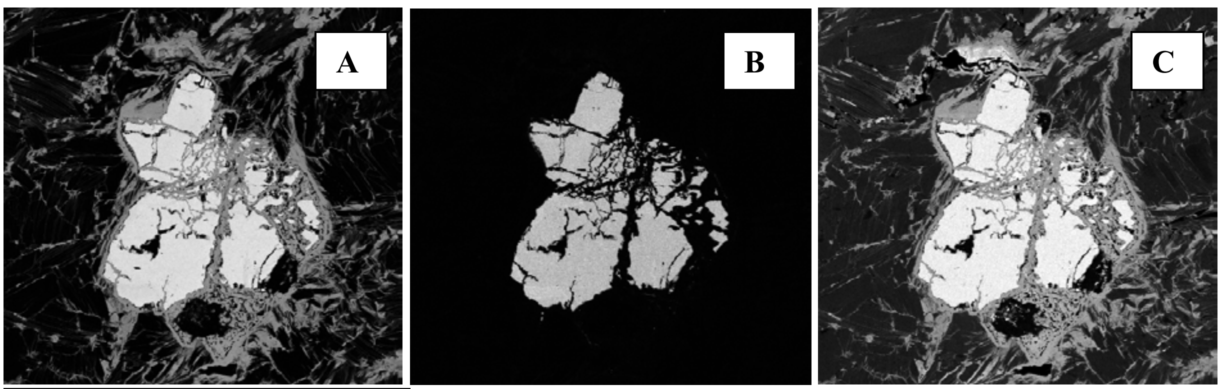

Figure 11: Elemental maps of arsenopyrite with scorodite zoning showing A) As, B) S; C) Fe. Maps generated by WDS.

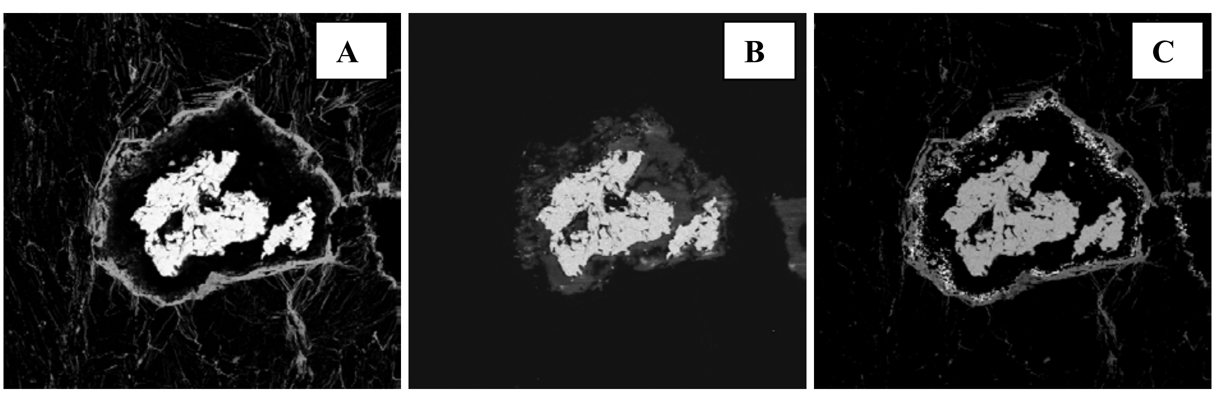

Figure 12: Elemental maps of arsenopyrite grain with scorodite rims and intermediate zone of elemental sulfur A) As; B) S; C) Fe. Maps generated by WDS.

4.3.3 Elemental distribution of arsenic in host rock

Elemental maps produced using WDS do not provide actual concentrations of elements but rather show the relative distribution of one element over the grain. Elemental distribution of As, Fe and S was determined by running traverses over different grains covering actual mineral and zones. Figure 13 A shows an arsenopyrite grain with zones and fractures of scorodite running throughout the grain. Traverse path A-A' was selected to examine the elemental distribution of As, Fe and S along the traverse. Figure 13 B shows the elemental distribution of As, Fe and S along A-A'. The depression region represented by traverse points in between points 1-6, 23-26, 37-44 represent zones of scorodite where the amount of S is negligible. The remaining part of the traverse path shows arsenopyrite, which is identified by a prominent peak for S.

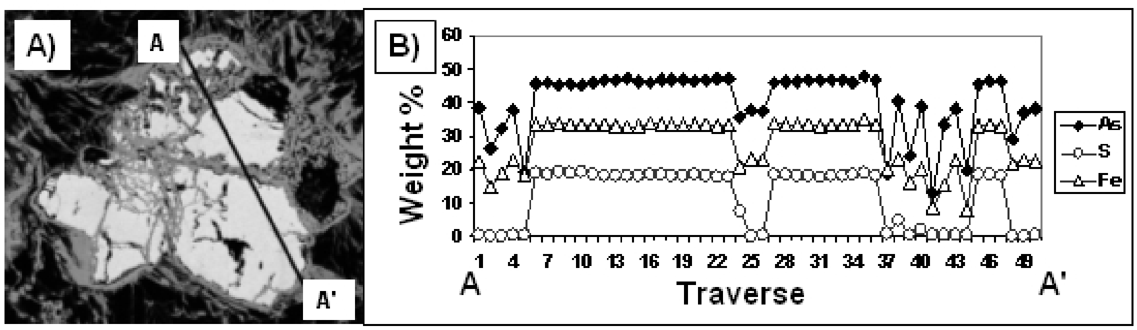

Figure 13: A) Arsenopyrite grain with zones of scorodite. Traverse A-A' cuts across arsenopyrite and scorodite several times. B) Elemental distribution of As, Fe and S along the traverse A-A' showing scorodite precipitation within fractures in the arsenopyrite

Figure 14 shows two different traverses in the arsenopyrite grain with an intermediate zone of elemental S. Figure 14 B shows that rims contain scorodite (represented by moderate weight % of As and Fe and no S). Intermediate zones, which are most distinct in between traverse path 7 to 15 and 44 to 48, show the signature of only S while the most prominent peaks are for arsenopyrite, where a very distinct zone of S but also Fe and As are present. Figure 14 D shows the elemental distribution of As, Fe and S along the traverse path on Figure 14 C, running on the outside rim. The peaks with higher As than S indicates scorodite and smaller As relative to Fe indicates Fe-oxide. For example, traverse path 2 to 5 indicates iron oxides which are next to the zone of scorodite represented by points 6 to 7.

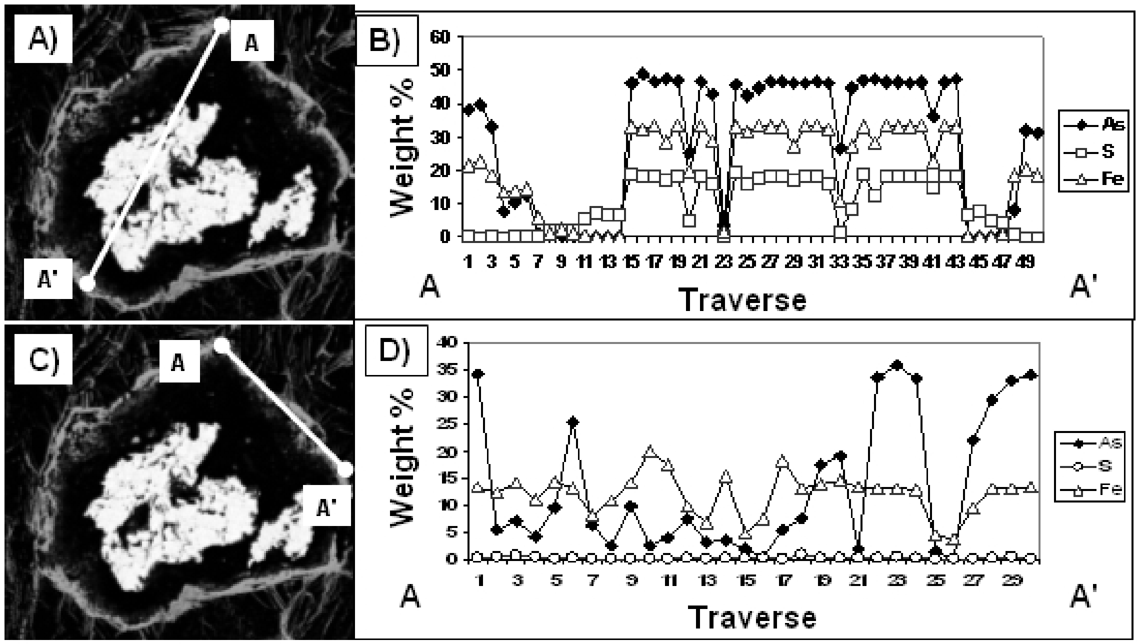

Figure 14: Arsenopyrite grain with outside intermediate zone of sulfur. The outside zone is complex mixture of scorodite and iron oxides. A) Traverse across arsenopyrite, intermediate zone of elemental S and outside zone of scorodite; B) Elemental distribution of As, Fe and S along the traverse; C) Traverse across the outside rim with complex mixture of iron oxides and scorodite; D) Elemental distribution of As, Fe and S along the traverse.

5. Discussion

5.1 Arsenic partitioning in BAM sediments

Arsenic partitioning in BAM sediments was examined using both chemical extraction and microscopic methods. For this study, the Turpeinen sequential extraction method was modified to account for adsorbed As species and to examine in which steps As was released from scorodite and arsenopyrite. Each extraction step was repeated twice along with repeat washes which was important for capturing all As released during step. The modified method presented in the study worked well as the sum of the extraction steps (average value 4358 ppm) were within 3% of the totals as determined by autoclave digestion (average 4563 ppm) and within 6% of the totals from microwave digestion (average 4961) (Table 1). With one exception, the digestion totals were higher, likely due to some incomplete digestion of residual phase. It should be noted that HF is normally used for total digestion of silicate minerals but due to safety reasons, HF was not used in this study.

Between 65 and 70% of arsenic in BAM sediments is associated with metal oxides (steps 2+4) (Figure 3). About 80% of that is adsorbed to the surface sites, based on results of the additional phosphate extraction step (Table 4). The remainder of the As is associated with the residual phase, which most likely consists of arsenopyrite and scorodite, as SEM and EMPA analysis did not identify arsenic in any other residual phases, such as biotite, feldspar or quartz. It is important to note that some As from arsenopyrite and scorodite was extracted in Step 4. Sequential extraction of arsenopyrite and scorodite showed that 90% of As from these two phases was extracted in step 5 (residual) and ~10% was extracted in step 4 (metal oxides). Based on these results, a calculated value of 3-3.5 % of As was released during step 4 from the arsenopyrite and scorodite. Thus, a small amount of arsenic released from step 4 came from arsenopyrite and scorodite, which does not significantly impact the interpretation that metal oxides are the dominant reservoir of arsenic in the BAM sediments.

As shown in Table 1, there is spatial heterogeneity in total As (Table 1), but the partitioning between different phases is similar across the site (Figure 2 and 3). Both types of sediments, mine tailing and stream sediments, show similar trends in arsenic partitioning (Figure 2). Smaller grain sizes contain higher As concentrations, which could be due to As adsorption to larger surface areas (Table 3) as smaller grains have higher surface/volume ratio than larger grains. Higher surface area offers more surface sites for arsenic adsorption (Waychunas et al., 1996). This is important as the smaller particles may dominate overall mass transfer of arsenic in aquifer sediments.

SEM and EMPA analysis demonstrate that in BAM sediments, arsenopyrite, scorodite, goethite, and ferrihydrite were the main minerals identified. Arsenopyrite, the ore mineral, is oxidized by Fe^{+3}, forming scorodite according to reaction 1 (DOVE and RIMSTIDT, 1985):

$$\mathbf{FeAsS + 14\ Fe^{3+} + 10\ H_2O \rightarrow 14\ Fe^{2+} + SO_4^{2-} + FeAsO_4{\cdot}2H_2O + 16\ H^+} \quad (1)$$

Scorodite can dissolve congruently or incongruently depending on pH, producing ferrihydrite according to reaction 2 (incongruent dissolution) and or dissolve via reaction 3 (congruent dissolution) (DOVE and RIMSTIDT, 1985)

$$\mathbf{pH > 4:\ \ FeAsO_4{\cdot}2H_2O + H_2O = H_2AsO_4^- + Fe(OH)_3\,(s) + H^+\ (Incongruent)} \quad (2)$$

$$\mathbf{pH < 4:\ \ FeAsO_4{\cdot}2H_2O = H_2AsO_4^- + Fe(OH)^{2+} + OH^-\ \ (Congruent)} \quad (3)$$

Arsenopyrite is found in the mine tailings but not in the stream channel sediments. Although this may suggest that arsenopyrite is weathered before sediments are deposited in the stream, it should be noted that arsenopyrite has high specific gravity (6.07 g/cm^3) and may accumulate in deeper intervals of the stream sediments. Deeper cores from stream channel sediments might show presence of arsenopyrite also in the stream sediments. In sediments, iron oxide grains were observed to be consistently larger than scorodite and arsenopyrite. In addition, iron oxides are the most abundant arsenic bearing mineral identified in sediments, followed by scorodite and arsenopyrite.

5.2 Arsenic partitioning in host rock

Similar to the sediments, SEM analysis of host rocks shows presence of three major arsenic bearing minerals: arsenopyrite, scorodite and arsenic-rich iron oxides (Table 5). However, in contrast to the sediment analysis, elemental sulfur was also found in zones around several arsenopyrite grains.

The sequence of arsenopyrite weathering reactions in the host rock is visible in the SEM/EMPA imaging of most arsenopyrite grains. Two different types of weathering patterns were observed. In the dominant zoning pattern (Figure 13 A) arsenopyrite is present in the core and surrounded by a scorodite rim. In some samples, there is a thin outer rim of iron oxides around the scorodite as evident from Figure 14 C, where scorodite dissolves incongruently via reaction 2 to form ferrihydrite or goethite. This sequence of weathering can be described by weathering reactions 1 and 2, with arsenopyrite oxidized to form scorodite, and scorodite dissolving to form iron oxides.

In the other type of weathering, elemental S forms as a rim to the arsenopyrite core. This phenomenon has been observed in other studies of arsenopyrite oxidation (MCGUIRE et al., 2001; NESBITT and MUIR, 1998). Nesbitt and Muir (1998) conducted an XPS study on arsenopyrite oxidation and found that diffusion of As to the oxidized surface, combined with the observed production of large amounts of As^{3+} and As^{+} in the near-surface, promoted rapid, selective leaching of arsenic, leaving behind a sulfur enriched layer. The enriched sulfur layer had a coating of oxidized iron and arsenic species. Schaufuss et al. (2000) concluded that such coatings can be formed due to diffusion of As and Fe to the surface driven by a concentration gradient caused by surface oxidation leaving a sulfur enriched underlayer. Supporting these observations, McGuire et al. (2001) proposed a multi-step oxidation reaction in presence of excess ferric ion, where sulfur at the mineral surface forms via a series of sulfoxy anions culminating in thiosulfate, which is finally released to the solution. In this mechanism, thiosulfate forms as an intermediate species and undergoes decomposition reaction in acidic solution to form bisulfite and elemental sulfur (reaction 4 and 5).

$$\mathbf{2FeAsS + 14Fe^{+3} + 9H_2O = 16Fe^{+2} + S_2O_3^{-2} + 2H_3AsO_3 + 12H^{+}} \quad (4)$$

$$\mathbf{S_2O_3^{-2} + H^{+} = HSO_3^{-} + S\ (s)} \quad (5)$$

The Eh-pH diagram shown in Figure 15 delineates a possible weathering reaction path for arsenopyrite at the BAM site. It should be noted that many components were not deemed to be important at the BAM site are suppressed in the diagram. As shown in the diagram, arsenopyrite is stable under reducing conditions. As Eh increases due to the presence of an oxidant, arsenopyrite is oxidized, forming elemental S and dissolved Fe and As species. These reactions produce acidity (see reaction 1). As Eh continues to increase, elemental S will break down to more oxidized S species including SO_4^{-2} and HSO_4^{-}. Under low pH conditions and high Fe and As activities, scorodite can precipitate. Formation of iron oxides, as was observed in this study, occurs as the metastable scorodite undergoes incongruent dissolution at pH > 4 (reaction 2).

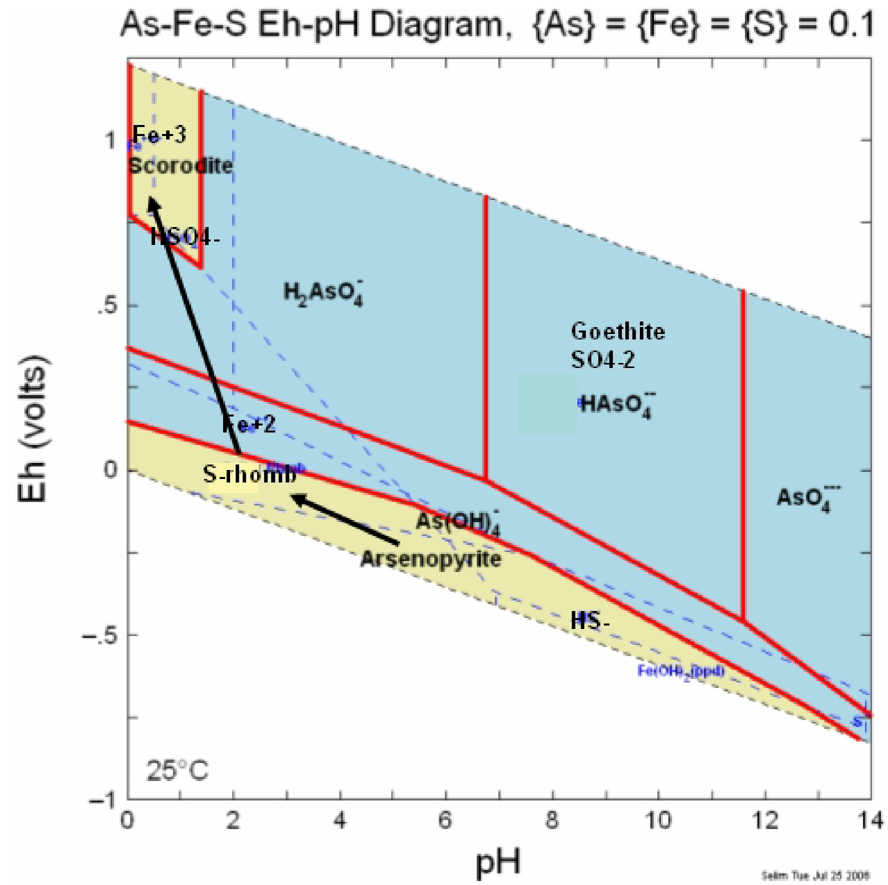

Figure 15: Eh-pH diagram showing a possible reaction path for arsenopyrite weathering. All activities = 0.1. The diagram was produced by suppressing species that are not important at BAM. Suppressed species are $As(OH)_3$, AsO_2OH^{--}, AsS_2^{-}, $H_2S(aq)$, H_3AsO_4, $HAsS_2$, arsenolite, claudetite, FeO(c), hematite, magnetite, orpiment, realgar, and $H_2S(g)$.

The formation of solid phases from arsenopyrite weathering must also be examined with respect to volume. The molar volumes of arsenopyrite, sulfur, and scorodite are 26.42, 15.5 and 69.13 cm^3/mol, respectively. Complete weathering of 1 mol of arsenopyrite can not accommodate generation of 1 mol of sulfur and 1 mol of scorodite, as 1 mol sulfur takes up 15.5 cm^3 of space leaving only 10.91 cm^3 for scorodite. There are two possible ways to accommodate this weathering: a) not all As and Fe from arsenopyrite form scorodite; some leaches to the host rock as dissolved species; or b) not all sulfur forms elemental S; some forms dissolved sulfur species (McGuire et al., 2001) and leaches into the host rock.

5.3 Reservoirs and possible release mechanism for As at BAM

The presence of extensive mining activity has led to multiple sources of arsenic at the BAM site, including arsenopyrite, scorodite and arsenic-rich iron oxides. The release of arsenic by the dissolution and oxidation of these minerals depends on hydrologic and biogeochemical conditions. Sequential extraction showed that less than 1% of arsenic in sediments is weakly bound to minerals. Thus, the amount of arsenic in BAM sediment that can be easily mobilized from sediments is relatively small.

Arsenic associated with easily reducible metal oxides, which was extracted using a mildly acidic reductant, accounts for ~5% of total arsenic in sediments. The greatest amount of arsenic was released during step 4, in which metal oxides were dissolved. The phosphate extraction suggested that 80 % of the arsenic released in step 4 is adsorbed to the metal oxides. Thus, any biogeochemical process that can result in desorption of arsenic or in the dissolution of metal oxides, can potentially release a significant amount of arsenic into solution.

Under moderately oxidizing conditions, ~ 5% of arsenic could be released from the sediments, as documented by 30% H_2O_2 treatment. Based on results of the sequential extraction, arsenic release from arsenopyrite and scorodite requires oxidizing and/or acidic conditions. As shown by the SEM and EMPA data, weathering of these minerals is actively occurring at the BAM site.

Arsenopyrite in the host rock showed extensive weathering to scorodite, iron oxides, and in some cases, elemental sulfur. While in the host rock the abundance of arsenic-bearing minerals is arsenopyrite > scorodite > iron oxides, the abundance of these minerals are reversed in the sediments (iron oxides > scorodite >arsenopyrite). Thus, although arsenopyrite and scorodite have much higher weight % of arsenic within their structures than do the iron oxides, due to their abundance, iron oxides are the largest primary reservoir of arsenic at BAM, and thus should be the primary concern for controlling arsenic mobility at the site.

6. Conclusions

The study evaluated the partitioning of arsenic in different phases in both sediments and host rock at the Brinton arsenic mine. A modified Turpeinen extraction scheme was used to determine association of arsenic in different phases in mine tailing and stream channel sediments. SEM and EMPA methods were used to determine major arsenic bearing minerals in sediments and the host rock. The results showed that there is high spatial variability of arsenic concentration in the sediments, although the partitioning of arsenic in different phases is similar in both mine tailing and stream channel sediments.

Arsenic release and partitioning is a complex process governed by many factors such as pH, oxidation-reduction reactions, precipitation-dissolution reactions, and the activity of microorganisms. The major source of arsenic can vary depending on the geochemical conditions of the environment. At the BAM site, there are three dominant arsenic-bearing minerals: arsenopyrite, scorodite, and iron oxide. Arsenopyrite, the primary ore mineral, has weathered to form scorodite and goethite. In addition to aiding to document this weathering pathway, SEM/EMPA imaging and microanalysis also detected the presence of elemental sulfur rim around arsenopyrite, suggesting that oxidative leaching may be occurring. This elemental sulfur is likely to be metastable, and can be oxidized to form dissolved sulfur species.

Although arsenopyrite and scorodite control arsenic concentrations in ground and surface waters at the BAM site, based on combined results of sequential extraction and microprobe analysis, the largest reservoir of arsenic in the BAM sediments is iron oxide, which contains a relatively low weight % of arsenic compared to scorodite and arsenopyrite, but due to abundance, contains the majority of arsenic in sediment. Arsenic can be released from iron oxides under reducing conditions, which could occur if the sediment is buried or to desorption reactions, which could include changes in pH, or the presence of oxyanions that compete with arsenic for adsorption sites.

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APPENDICES

APPENDIX A: Results from sequential extractions

STEPS	As (ppm) MT 106-250	As (ppm) MT 45-105
Exchangeable	25	38
Easily reducible metal oxides	232	322
Easily oxidized	563	242
Fe and Al oxides/hydroxides	2414	3473
Residual	808	1303
Total	4042	5378
Total Digestion (Autoclave)	4459	5426
Total Digestion (microwave)	4501	5894

STEPS	As (ppm) MT2 106-250	As (ppm) MT2 45-105
Exchangeable	28	32
Easily reducible metal oxides	285	310
Easily oxidized	257	309
Fe and Al oxides/hydroxides	3348	3863
Residual	1356	1398
Total	5275	5911
Total Digestion (Autoclave)	5742	6226
Total Digestion (microwave)	5738	6644

STEPS	As (ppm) MT3 106-250	As (ppm) MT3 106-250 (Repeat)	As (ppm) MT3 45-105
Exchangeable	11	14	15
Easily reducible metal oxides	256	298	443
Easily oxidized	94	83	117
Fe and Al oxides/hydroxides	4313	4180	4308
Residual	1200	1145	2554
Total	5874	5719	7436
Total Digestion (Autoclave)	5577	5577	8778
Total Digestion (microwave)	5168	5168	7874

STEPS	As (ppm) MT4 106-250	As (ppm) MT4 106-250 (Repeat)	As (ppm) MT4 45-105
Exchangeable	9	11	21
Easily reducible metal oxides	122	264	224
Easily oxidized	120	125	115
Fe and Al oxides/hydroxides	1291	1423	1564
Residual	124	302	2048
Total	1666	2125	3972
Total Digestion (Autoclave)	1617	1617	3887
Total Digestion (microwave)	No data	No data	4268

STEPS	As (ppm) MT5 106-250	As (ppm) MT5 106-250 (Repeat)	As (ppm) MT5 45-105
Exchangeable	12	10	3
Easily reducible metal oxides	76	72	39
Easily oxidized	13	5	1
Fe and Al oxides/hydroxides	870	828	715
Residual	156	175	155
Total	1127	1090	914
Total Digestion (Autoclave)	1144	1144	940
Total Digestion (microwave)	1227	1351	1153

STEPS	As (ppm) SC1 106-250	As (ppm) SC1 45-105
Exchangeable	36	39
Easily reducible metal oxides	321	386
Easily oxidized	222	250
Fe and Al oxides/hydroxides	1805	2561
Residual	620	902
Total	3004	4138
Total Digestion (Autoclave)	3036	4180
Total Digestion (microwave)	3248	4362

STEPS	As (ppm) SC2 106-250	As (ppm) SC2 45-105
Exchangeable	17	27
Easily reducible metal oxides	93	83
Easily oxidized	73	129
Fe and Al oxides/hydroxides	2709	4843
Residual	1406	3102
Total	4299	8184
Total Digestion (Autoclave)	4180	8514
Total Digestion (microwave)	no data	8716

APPENDIX B: Results from EMPA analysis

B.1.Quantitative Analysis Declaration

Standard used: allpyrite

Type: normal

Take off angle: 40

Iteration limit: 0.000

Condition # 1: 15.0 kV   30.0 nA

B.2. Microprobe analysis of all mine tailing and stream channel sediments.

All spot analysis data of arsenopyrite grains from all mine tailing and stream channel samples. All data are in weight %.

n	As	S	Fe	Total		n	As	S	Fe	Total
1	44.40	20.22	31.78	96.40		26	44.62	19.52	31.63	95.77
2	45.57	18.69	30.97	95.23		27	45.35	19.33	31.83	96.51
3	45.47	19.62	31.21	96.30		28	45.50	19.36	31.70	96.56
4	46.85	18.80	31.83	97.49		29	45.43	19.40	31.87	96.69
5	46.55	19.06	31.59	97.19		30	45.53	19.65	31.40	96.58
6	47.00	18.87	31.42	97.28		31	46.55	18.50	31.32	96.37
7	47.23	18.76	31.51	97.50		32	46.69	18.89	31.53	97.11
8	43.86	15.62	25.94	85.42		33	47.56	18.21	31.20	96.98
9	44.82	16.55	29.80	91.16		34	45.80	19.24	34.04	99.09
10	44.98	18.69	31.19	94.86		35	45.86	18.87	34.43	99.16
11	46.72	18.73	31.04	96.49		36	46.08	18.97	34.66	99.71
12	44.39	19.25	31.18	94.81		37	46.39	19.02	34.21	99.62
13	45.04	19.94	32.19	97.17		38	45.83	18.93	34.11	98.87
14	45.27	19.91	32.17	97.36		39	46.35	17.75	33.11	97.21
15	41.12	17.52	31.11	89.75		40	46.86	18.09	33.30	98.24
16	44.75	20.25	32.08	97.08		41	47.65	18.33	33.22	99.19
17	47.69	18.27	31.06	97.01		42	44.10	19.77	34.46	98.33
18	47.34	18.58	30.66	96.57		43	43.96	20.12	34.37	98.45
19	46.87	18.12	30.40	95.39		44	44.55	19.58	34.80	98.94
20	46.19	19.09	31.50	96.77		45	44.79	19.85	34.71	99.35
21	46.16	18.74	31.57	96.48		46	44.29	19.64	34.49	98.42
22	46.35	19.04	31.40	96.79		47	46.44	18.29	34.05	98.77
23	46.00	18.80	31.61	96.41		48	46.88	18.14	34.28	99.30
24	46.26	19.08	31.63	96.97		49	46.73	18.13	34.18	99.04
25	44.82	19.52	31.50	95.84		50	47.17	18.11	33.84	99.11

n	As	S	Fe	Total	n	As	S	Fe	Total
51	47.19	17.94	33.83	98.97	76	47.49	17.83	33.92	99.24
52	47.29	17.96	33.95	99.21	77	47.21	17.78	34.00	98.99
53	43.49	20.33	34.78	98.61	78	47.30	17.82	34.04	99.15
54	46.24	18.64	34.46	99.34	79	47.09	17.99	33.77	98.85
55	43.76	20.47	34.91	99.15	80	46.59	18.08	34.23	98.90
56	43.75	20.32	34.67	98.76	81	47.12	17.91	34.07	99.10
57	44.05	20.29	34.84	99.19	82	47.40	17.55	33.73	98.68
58	44.26	19.91	34.91	99.09	83	47.39	17.98	34.04	99.42
59	43.93	20.34	34.56	98.84	84	47.58	17.79	33.83	99.20
60	44.15	19.97	34.81	98.94	85	47.72	17.43	33.69	98.83
61	43.90	20.38	34.95	99.24	86	47.14	17.79	33.62	98.55
62	43.93	20.36	34.87	99.16	87	46.19	18.35	34.20	98.74
63	44.03	20.19	34.66	98.89	88	46.42	18.65	34.22	99.30
64	43.86	20.28	35.02	99.16	89	44.43	18.58	34.14	97.15
65	43.41	20.61	34.96	98.98	90	47.10	17.74	34.02	98.86
66	43.73	20.14	34.76	98.63	91	47.00	18.08	34.32	99.39
67	47.35	17.67	34.28	99.32	92	46.40	18.51	33.89	98.80
68	47.21	17.88	34.21	99.31	93	46.81	18.24	34.35	99.39
69	47.48	17.78	33.85	99.12	94	46.55	18.15	34.36	99.06
70	46.80	17.70	33.99	98.50	95	46.54	18.39	34.18	99.11
71	47.02	18.17	33.78	98.98	96	46.39	18.44	34.37	99.20
72	47.42	18.04	34.02	99.49	97	46.57	18.47	34.28	99.32
73	47.06	18.00	33.87	98.94	98	46.50	18.45	34.12	99.07
74	47.03	17.96	33.96	98.96	99	46.73	18.33	34.25	99.32
75	47.32	18.02	33.73	99.08	100	46.94	18.18	34.09	99.21

n	As	S	Fe	Total		n	As	S	Fe	Total
101	46.49	17.77	33.74	98.00		126	42.61	20.17	34.67	97.45
102	46.31	18.23	34.00	98.53		127	43.98	20.16	34.82	98.95
103	45.77	18.82	34.21	98.80		128	37.65	15.41	33.03	86.10
104	46.60	18.33	34.06	98.99		129	43.94	20.02	34.91	98.87
105	46.79	17.92	33.98	98.69		130	43.82	19.83	35.04	98.69
106	46.74	18.16	34.05	98.95		131	43.49	20.45	35.10	99.04
107	46.87	18.00	33.89	98.76		132	44.55	19.84	34.83	99.22
108	46.87	18.06	34.01	98.94		133	44.26	19.97	34.71	98.94
109	46.18	18.59	33.81	98.58		134	43.94	19.60	33.00	96.53
110	46.64	18.45	34.08	99.17		135	44.39	20.41	34.30	99.09
111	46.80	18.18	33.86	98.84		136	44.51	20.35	34.46	99.32
112	47.36	17.99	34.17	99.52		137	43.53	21.31	34.53	99.37
113	46.32	18.09	33.92	98.33		138	44.03	20.58	34.31	98.92
114	47.42	18.31	33.89	99.62		139	43.74	20.08	34.05	97.87
115	46.35	17.72	34.20	98.27		140	44.21	20.13	34.44	98.78
116	46.30	17.73	33.71	97.73		141	44.60	20.41	34.43	99.43
117	47.12	17.66	34.03	98.81		142	43.93	20.44	34.67	99.04
118	46.28	17.98	34.10	98.35		143	43.69	20.39	34.72	98.79
119	46.85	17.96	34.06	98.87		144	45.25	19.93	34.27	99.45
120	47.28	17.52	33.67	98.47		145	44.14	20.44	34.52	99.11
121	47.10	17.78	33.84	98.72		146	44.60	20.46	34.44	99.49
122	46.31	17.82	34.08	98.21		147	44.34	20.16	34.22	98.72
123	39.54	13.03	30.28	82.86		148	43.81	20.09	34.04	97.94
124	46.50	18.05	33.88	98.43		149	42.72	20.45	33.11	96.28
125	43.87	20.03	34.86	98.77		150	44.44	20.23	34.23	98.89

n	As	S	Fe	Total		n	As	S	Fe	Total
151	43.95	20.19	34.09	98.23		176	46.85	18.31	34.46	99.63
152	44.45	20.40	34.81	99.67		177	47.18	18.13	34.28	99.60
153	44.20	19.97	34.14	98.32		178	46.24	18.96	34.48	99.68
154	45.05	19.97	34.36	99.38		179	48.26	18.10	35.44	101.80
155	45.15	19.64	33.68	98.46		180	48.51	17.92	35.14	101.58
156	45.35	19.47	34.05	98.86		181	47.37	18.52	35.80	101.69
157	45.46	19.81	34.51	99.79		182	47.09	18.25	34.17	99.53
158	45.57	19.62	34.19	99.37		183	45.07	19.41	34.33	98.88
159	45.32	19.50	34.27	99.09		184	41.63	18.76	34.68	95.08
160	44.63	19.56	33.30	97.48		185	35.27	12.84	35.17	83.30
161	45.23	19.72	34.14	99.10		186	36.36	14.32	35.80	86.52
162	45.15	20.41	36.46	102.03		187	39.12	12.85	34.68	86.65
163	45.43	20.17	36.08	101.69		188	47.15	18.66	34.39	100.19
164	45.31	20.40	36.22	101.94		189	46.96	18.14	33.77	98.88
165	45.03	20.62	36.13	101.77		190	47.30	18.06	34.14	99.52
166	45.07	20.49	36.26	101.83		191	47.59	18.19	34.34	100.13
167	44.74	20.47	36.54	101.76		192	47.76	18.33	33.94	100.05
168	45.12	20.65	36.10	101.88		193	47.25	18.40	34.26	99.95
169	44.01	20.68	35.33	100.04		194	45.57	17.59	34.20	97.41
170	44.21	20.24	35.21	99.67		195	41.59	15.54	32.91	90.12
171	44.69	20.52	36.52	101.75		196	47.06	18.14	34.63	99.84
172	44.90	20.47	35.84	101.22		197	40.45	13.47	33.06	87.16
173	46.09	19.05	34.54	99.69		198	41.53	14.14	32.99	89.02
174	45.43	18.69	33.56	97.80		199	44.48	20.37	34.71	99.59
175	46.48	18.69	34.02	99.20		200	39.93	13.08	32.29	85.60

n	As	S	Fe	Total		n	As	S	Fe	Total
201	47.43	18.18	34.22	99.84		226	47.33	18.04	34.06	99.52
202	23.14	26.86	36.57	86.61		227	45.03	19.35	33.76	98.14
203	29.70	30.86	38.03	98.60		228	46.41	18.32	33.27	98.00
204	45.05	18.92	34.37	98.38		229	46.97	18.32	33.30	98.58
205	44.14	17.81	33.44	95.43		230	46.68	18.14	33.37	98.20
206	43.68	18.76	34.50	96.97		231	46.53	18.13	33.71	98.36
207	45.08	19.56	34.28	98.94		232	46.87	18.26	33.38	98.51
208	45.41	19.71	34.94	100.07		233	46.49	18.34	33.56	98.40
209	44.23	18.40	34.00	96.72		234	46.47	18.35	33.50	98.33
210	44.05	18.59	33.57	96.74		235	46.35	18.57	34.18	99.10
211	45.37	19.24	34.31	98.95		236	45.97	18.62	33.21	97.80
212	45.20	19.18	34.36	98.76		237	46.16	18.49	33.56	98.21
213	44.72	19.92	34.62	99.28		238	46.37	18.61	33.21	98.19
214	39.95	14.81	30.29	85.28		239	47.52	17.52	33.66	98.69
215	44.39	17.94	34.15	96.53		240	47.12	17.59	33.60	98.31
216	46.37	18.31	34.11	98.80		241	46.75	18.01	33.39	98.15
217	47.08	18.22	33.89	99.21		242	46.68	17.98	33.71	98.37
218	46.54	18.19	33.43	98.17		243	45.42	17.49	33.19	96.10
219	46.83	17.86	33.71	98.41		244	46.83	18.07	33.97	98.86
220	44.37	20.03	34.65	99.08		245	46.31	17.98	33.50	97.79
221	43.74	19.52	34.60	97.89		246	46.37	17.86	33.27	97.49
222	42.84	20.85	35.02	98.75		247	46.58	18.44	33.38	98.40
223	46.01	18.30	34.64	98.98		248	46.51	18.10	34.24	98.84
224	46.23	18.45	34.31	99.02		249	46.48	17.77	33.77	98.02
225	46.39	18.63	34.56	99.60		250	46.88	17.52	33.86	98.26

n	As	S	Fe	Total		n	As	S	Fe	Total
251	46.62	17.94	33.72	98.27		276	47.25	17.58	33.62	98.44
252	46.62	17.84	33.98	98.45		277	45.31	16.43	33.56	95.30
253	46.79	17.59	34.11	98.49		278	42.88	15.41	31.67	89.96
254	46.38	18.00	33.99	98.38		279	46.39	17.53	33.63	97.55
255	45.59	18.03	33.17	96.79		280	41.56	15.70	32.88	90.14
256	44.64	16.98	33.06	94.67		281	46.57	17.70	33.80	98.07
257	46.91	17.83	33.52	98.26		282	46.43	17.56	33.68	97.66
258	46.54	17.87	33.58	98.00		283	46.49	17.52	33.54	97.55
259	46.72	17.76	33.72	98.20		284	46.91	17.47	33.86	98.24
260	46.80	17.67	33.77	98.24		285	46.87	17.63	33.80	98.30
261	46.47	18.21	33.39	98.07		286	47.46	17.63	33.44	98.53
262	46.47	18.03	33.46	97.96		287	46.58	17.72	33.40	97.70
263	46.35	17.52	33.70	97.57		288	46.89	17.48	33.58	97.95
264	46.89	17.68	33.71	98.28		289	46.93	17.77	33.68	98.38
265	46.80	17.62	33.56	97.98		290	45.35	17.78	33.23	96.36
266	46.02	17.03	32.98	96.04		291	46.10	17.92	33.45	97.48
267	45.73	17.24	33.19	96.16		292	43.97	19.90	34.07	97.95
268	46.70	17.70	33.79	98.18		293	44.33	19.69	34.30	98.32
269	47.08	17.54	33.68	98.30		294	35.07	14.14	36.71	85.91
270	46.56	17.72	33.53	97.81		295	44.08	19.54	33.87	97.48
271	46.27	17.44	33.47	97.17		296	44.56	19.34	34.22	98.13
272	47.13	17.73	33.31	98.17		297	44.20	20.09	34.23	98.52
273	46.40	17.81	33.73	97.93		298	44.35	19.81	34.06	98.21
274	47.03	17.58	33.92	98.52		299	44.22	19.91	34.01	98.14
275	46.84	17.58	33.83	98.25		300	44.04	19.95	34.38	98.38

n	As	S	Fe	Total		n	As	S	Fe	Total
301	43.66	20.14	34.13	97.93		326	45.31	19.31	33.72	98.33
302	43.03	20.09	33.88	97.01		327	45.39	19.32	33.54	98.24
303	43.52	20.04	34.31	97.87		328	45.49	19.28	33.75	98.52
304	43.83	20.25	34.37	98.45		329	45.11	18.88	33.47	97.46
305	44.39	19.65	33.80	97.83		330	45.49	18.86	33.71	98.05
306	43.65	20.32	34.34	98.31		331	45.63	19.04	33.34	98.01
307	43.48	20.44	34.23	98.16		332	45.03	18.74	33.70	97.47
308	44.13	20.27	34.11	98.52		333	45.63	19.23	33.62	98.48
309	37.92	18.08	32.83	88.83		334	45.51	19.07	33.44	98.01
310	47.78	17.46	33.19	98.42		335	44.81	18.66	33.31	96.77
311	46.33	18.41	33.31	98.05		336	45.79	18.71	33.84	98.34
312	43.50	19.67	33.92	97.09		337	45.78	18.79	33.76	98.33
313	44.20	20.01	34.22	98.42		338	46.10	18.58	33.56	98.23
314	44.75	19.41	33.96	98.12		339	46.12	18.73	33.91	98.76
315	44.82	19.48	34.00	98.29		340	43.28	20.36	34.54	98.18
316	44.90	19.29	34.06	98.25		341	44.00	19.62	34.69	98.31
317	44.73	19.41	33.92	98.06		342	46.51	18.44	33.81	98.77
318	44.73	19.55	33.81	98.09		343	46.32	16.86	32.83	96.00
319	44.73	19.34	33.95	98.02		344	46.88	18.24	33.26	98.38
320	45.20	18.48	33.44	97.12		345	42.30	15.97	31.52	89.78
321	45.25	19.12	33.84	98.20		346	47.24	18.08	33.42	98.74
322	45.46	18.82	33.56	97.85		347	42.91	16.58	31.78	91.27
323	45.43	19.13	33.69	98.25		348	44.66	17.14	32.57	94.37
324	45.57	19.13	33.58	98.29		349	47.13	17.74	33.42	98.28
325	45.42	19.05	33.75	98.21		350	46.04	18.17	33.64	97.85

n	As	S	Fe	Total		n	As	S	Fe	Total
351	46.26	17.84	33.50	97.61		376	46.52	17.97	33.60	98.09
352	41.77	15.45	31.25	88.47		377	46.31	18.02	33.92	98.26
353	46.83	18.06	33.70	98.59		378	46.45	17.93	33.23	97.61
354	47.30	17.52	33.78	98.60		379	46.60	17.88	33.25	97.73
355	46.23	17.59	33.42	97.23		380	46.79	18.04	33.27	98.10
356	42.61	12.51	30.23	85.35		381	47.02	18.07	33.67	98.76
357	46.90	17.82	33.85	98.56		382	47.11	17.75	33.03	97.89
358	45.99	16.62	33.05	95.66		383	46.75	17.93	33.37	98.04
359	47.25	17.82	33.89	98.95		384	45.39	18.41	34.30	98.11
360	46.84	17.72	33.63	98.19		385	45.60	17.79	33.40	96.78
361	41.56	12.56	28.30	82.42		386	45.22	18.69	33.99	97.90
362	45.90	18.08	33.99	97.97		387	45.45	18.31	34.30	98.07
363	42.47	15.65	31.08	89.20		388	46.76	18.09	34.26	99.11
364	47.25	17.62	33.94	98.81		389	46.75	18.12	33.78	98.64
365	47.14	17.81	33.91	98.86		390	46.23	18.23	33.98	98.44
366	43.76	17.63	33.65	95.03		391	46.67	17.95	33.64	98.26
367	44.78	18.12	34.23	97.12		392	46.07	18.16	34.16	98.39
368	44.73	18.52	33.88	97.13		393	46.65	17.90	33.92	98.47
369	44.41	18.14	34.08	96.63		394	46.32	18.36	34.13	98.81
370	47.03	17.62	33.77	98.42		395	46.87	18.21	33.98	99.06
371	46.19	18.09	33.99	98.27		396	46.40	18.16	33.94	98.50
372	45.98	17.96	33.81	97.75		397	46.44	18.18	33.88	98.50
373	46.27	17.50	33.81	97.57		398	45.35	18.73	33.37	97.45
374	46.33	17.90	33.60	97.82		399	45.15	18.67	33.06	96.87
375	46.92	17.67	33.82	98.40		400	44.94	18.74	33.05	96.73

n	As	S	Fe	Total		n	As	S	Fe	Total
401	44.23	18.68	32.78	95.69		426	46.48	18.15	33.64	98.26
402	45.06	18.89	32.86	96.80		427	45.63	14.14	29.23	88.99
403	45.40	18.72	32.82	96.93		428	46.57	18.51	34.03	99.10
404	46.20	19.05	34.23	99.49		429	37.98	11.98	32.49	82.46
405	45.15	18.77	33.04	96.96		430	46.43	18.37	33.89	98.68
406	45.70	18.66	33.29	97.66		431	44.78	17.61	33.43	95.82
407	45.60	18.88	33.34	97.81		432	42.74	16.52	33.34	92.59
408	45.30	18.79	33.00	97.09		433	44.28	19.85	34.54	98.68
409	45.19	18.85	33.16	97.19		434	44.84	19.14	33.89	97.86
410	45.38	18.90	32.91	97.18		435	45.33	19.00	33.20	97.53
411	45.20	18.52	32.95	96.66		436	47.17	17.81	33.57	98.55
412	45.74	18.44	32.06	96.23		437	43.97	18.72	33.99	96.68
413	46.99	17.67	33.76	98.42		438	45.37	18.30	33.48	97.15
414	47.67	17.46	33.81	98.94		439	46.61	17.85	33.94	98.39
415	47.09	17.82	34.07	98.98		440	47.25	18.06	33.98	99.28
416	47.16	17.66	34.12	98.94		441	47.13	18.03	34.30	99.46
417	46.24	18.08	34.06	98.37		442	47.36	18.09	34.10	99.55
418	43.31	14.69	31.72	89.73		443	46.76	18.22	34.09	99.07
419	46.71	17.53	34.00	98.23		444	46.92	18.18	34.10	99.20
420	47.19	17.55	33.74	98.47		445	47.15	18.20	34.05	99.39
421	46.59	17.31	33.20	97.10		446	47.15	18.23	34.20	99.57
422	46.53	18.05	33.41	97.99		447	47.36	18.02	34.24	99.61
423	46.55	18.52	34.14	99.20		448	47.37	18.10	34.08	99.55
424	46.80	18.12	33.88	98.80		449	47.04	18.06	34.27	99.38
425	46.69	18.04	33.74	98.48		450	46.89	18.06	34.45	99.41

n	As	S	Fe	Total		n	As	S	Fe	Total
451	47.14	18.15	33.95	99.23		476	46.98	17.86	33.89	98.73
452	46.71	18.09	34.19	98.99		477	47.14	18.15	33.93	99.22
453	46.90	18.15	34.15	99.19		478	46.98	18.49	33.93	99.40
454	47.34	18.12	34.10	99.55		479	47.12	18.60	34.09	99.80
455	47.48	18.22	34.07	99.77		480	46.71	18.26	33.79	98.76
456	46.77	17.81	33.61	98.19		481	46.09	19.06	34.42	99.57
457	46.92	18.26	33.75	98.94		482	46.90	18.16	34.21	99.26
458	36.26	14.81	32.79	83.85		483	46.90	17.40	33.92	98.22
459	46.24	16.69	33.25	96.19		484	47.44	17.44	33.85	98.73
460	46.70	18.16	34.06	98.92		485	46.99	18.11	34.18	99.29
461	45.93	18.85	34.58	99.36		486	46.96	18.20	34.08	99.25
462	46.44	18.42	34.22	99.08		487	47.41	17.95	33.86	99.22
463	47.06	18.22	33.96	99.24		488	46.56	17.85	34.19	98.60
464	45.57	19.05	33.93	98.56		489	47.90	17.64	33.78	99.33
465	45.75	19.13	33.81	98.69		490	47.56	17.84	33.95	99.36
466	45.70	18.67	34.25	98.62		491	46.43	18.55	34.35	99.32
467	47.32	17.68	33.63	98.63		492	48.06	17.49	33.77	99.31
468	47.34	18.07	34.09	99.50		493	47.51	17.95	33.74	99.20
469	47.12	17.91	33.72	98.75		494	48.63	17.38	33.70	99.71
470	47.16	18.10	34.13	99.40		495	46.99	18.44	34.20	99.63
471	47.60	18.00	33.77	99.37		496	47.25	18.14	34.10	99.48
472	47.27	17.95	33.98	99.20		497	47.11	17.96	33.85	98.92
473	47.24	17.92	33.79	98.95		498	47.27	18.07	33.93	99.26
474	46.77	18.14	33.94	98.85		499	46.78	18.28	34.19	99.24
475	47.15	18.14	34.12	99.42		500	46.98	17.91	34.13	99.02

n	As	S	Fe	Total		n	As	S	Fe	Total
501	46.98	18.00	34.04	99.03		526	47.33	17.84	33.94	99.12
502	47.08	18.20	33.71	98.98		527	46.93	18.10	34.05	99.08
503	47.46	18.07	34.02	99.55		528	46.51	18.13	34.27	98.91
504	47.10	18.01	33.68	98.79		529	46.66	18.41	34.38	99.45
505	47.23	17.92	34.19	99.34		530	46.89	18.34	33.90	99.12
506	47.53	17.66	33.67	98.86		531	46.78	18.10	34.16	99.04
507	46.14	18.76	33.96	98.86		532	46.39	17.83	33.87	98.09
508	47.29	17.92	33.98	99.19		533	46.63	17.92	34.01	98.56
509	47.21	18.08	33.84	99.13		534	47.15	18.05	33.82	99.03
510	46.88	18.08	34.05	99.01		535	47.32	17.59	34.04	98.96
511	47.25	17.95	34.44	99.64		536	47.27	17.78	33.92	98.97
512	47.02	18.10	34.13	99.25		537	47.24	17.60	33.71	98.55
513	46.64	18.26	34.00	98.89		538	46.94	17.79	33.96	98.69
514	45.44	18.73	34.36	98.54		539	46.57	17.88	34.13	98.58
515	45.60	19.22	34.25	99.07		540	46.53	18.29	34.29	99.12
516	45.04	19.16	34.27	98.47		541	46.84	18.22	34.09	99.14
517	45.83	18.50	34.31	98.64		542	46.66	17.98	33.82	98.47
518	45.40	18.37	34.08	97.85		543	46.97	18.19	33.96	99.11
519	46.73	18.10	33.94	98.77		544	46.91	17.93	33.76	98.60
520	46.26	18.90	34.23	99.38		545	46.62	18.18	33.42	98.22
521	46.15	18.30	33.92	98.37		546	46.81	18.34	33.54	98.69
522	46.64	18.31	34.07	99.02		547	47.08	17.92	32.38	97.38
523	46.99	18.14	33.91	99.04		548	46.84	18.07	33.19	98.10
524	47.04	17.91	33.92	98.87						
525	47.10	18.23	33.76	99.09						

	As	S	Fe	Total
AVERAGE	45.696	18.409	33.763	97.874
max	48.628	30.857	38.025	102.03
min	23.14	11.984	25.942	82.423

Spot analysis data for scorodite grains from all mine tailing and stream channel samples. All data are in weight %.

n	As	S	Fe	Total		n	As	S	Fe	Total
1	23.95	0.12	17.98	42.05		26	32.16	0.06	21.02	53.24
2	27.67	0.11	22.97	50.75		27	32.15	0.18	21.66	53.99
3	24.38	0.11	21.09	45.58		28	31	0.83	22.44	54.26
4	18.64	0.69	31.88	51.21		29	30.13	2.01	22.39	54.53
5	36.94	0.08	20.16	57.17		30	30.3	1.9	22.18	54.38
6	38.94	0.04	22.11	61.09		31	30.87	1.55	22.63	55.04
7	37.99	0.06	21.25	59.31		32	30.06	0.66	23.46	54.17
8	35.76	0.06	21.31	57.14		33	27.8	0.22	25.05	53.07
9	32.85	0.03	19.7	52.58		34	32.16	0.15	22.7	55.01
10	34.65	0.1	18.42	53.17		35	37.86	0.03	21.51	59.39
11	38.02	0.06	22.2	60.28		36	27.08	0	21.78	48.86
12	39.56	0.07	22.34	61.96		37	33.56	0.04	22.61	56.21
13	20.99	0.37	28.11	49.48		38	34.14	0.06	20.78	54.98
14	20.46	0.32	32.49	53.27		39	34.22	0.02	21.01	55.25
15	23.49	0.06	20.41	43.95		40	32.22	0.02	22.61	54.85
16	36.25	0.21	18.56	55.02		41	26.69	0.49	20.71	47.89
17	38.9	0.06	19.95	58.9		42	25.68	0.4	20.62	46.7
18	39.34	0.17	21.07	60.58		43	24.92	0.92	23.94	49.77
19	37.57	0.58	21.93	60.08		44	24.95	0.97	23.79	49.71
20	40.87	0.02	19.58	60.47		45	21.88	1.54	23.39	46.8
21	37.44	0.44	21.6	59.47		46	25.33	0.83	25.32	51.47
22	38.68	0.32	21.3	60.29		47	22.19	0.97	21.99	45.15
23	29.71	0.08	22.1	51.88		48	37.94	0.21	20.99	59.13
24	31.72	0.06	21.79	53.57		49	37.23	0.36	20.94	58.53
25	32.09	0.03	21.56	53.68		50	36.8	0.21	20.48	57.49

n	As	S	Fe	Total		n	As	S	Fe	Total
51	32.5	0.03	23.13	55.66		76	34.3	0.08	21.02	55.4
52	32.09	0.03	23.36	55.48		77	33.3	0.22	19.57	53.1
53	29.68	0.27	25.49	55.43		78	22.88	0.15	19.81	42.84
54	20.68	0.93	32.81	54.41		79	37.21	0.13	22.28	59.62
55	23.42	0.59	28.62	52.63		80	37.21	0.11	21.97	59.29
56	17.09	0.49	21.5	39.08		81	35.63	0.13	21.21	56.97
57	30.91	0.48	21.81	53.2		82	37.32	0.12	21.43	58.87
58	31.33	0.84	22.17	54.34		83	35.78	0.12	22.54	58.43
59	17.52	0.94	36	54.45		84	36.96	0.08	22.05	59.1
60	35.36	0.19	21.76	57.32		85	36.7	0.09	22.59	59.39
61	36.49	0.09	21.93	58.51		86	35.83	0.13	22.4	58.36
62	36.16	0.1	22.24	58.5		87	37.48	0.15	22.73	60.36
63	36.39	0.1	21.99	58.47		88	36.49	1.03	23.04	60.56
64	37.82	0.1	22.8	60.72		89	34.93	0.82	20.41	56.16
65	36.9	0.11	22.85	59.86		90	36.63	0.85	22.38	59.85
66	37.51	0.06	22.35	59.92		91	36.7	0.96	21.73	59.39
67	34.96	0.15	21.24	56.35		92	37.29	0.68	21.75	59.71
68	36.14	0.17	22.37	58.67		93	35.66	0.94	22.88	59.48
69	35.64	0.16	21.87	57.67		94	23.15	0.75	16.42	40.32
70	28.51	0.13	23.94	52.59		95	36.61	0.9	21.9	59.41
71	24.87	0.13	20.83	45.83		96	35.36	0.91	21.71	57.98
72	27.22	0.14	25.69	53.05		97	36.18	0.74	20.38	57.31
73	34.87	0.12	21.65	56.63		98	35.88	0.76	20.47	57.1
74	37.6	0.08	22.86	60.53		99	36.23	0.63	20.51	57.36
75	36.59	0.1	22.06	58.75		100	35.4	0.76	20.49	56.65

n	As	S	Fe	Total		n	As	S	Fe	Total
101	35.21	0.78	20.33	56.32		126	36.81	0.07	23.7	60.58
102	36.03	0.71	20.35	57.09		127	30.52	0.04	23.38	53.93
103	39.15	0.09	21.5	60.74		128	27.6	0.12	18.93	46.65
104	38.65	0.11	21.57	60.33		129	29.51	0.01	23.07	52.59
105	36.71	0.09	19.99	56.79		130	21.47	0.48	31.25	53.2
106	38.12	0.04	21.67	59.83		131	33.61	0.06	22.7	56.36
107	38.35	0.09	21.63	60.07		132	35.35	0.05	24.57	59.97
108	34.42	0.09	18.36	52.87		133	34.73	0.07	23.89	58.69
109	28.55	0.07	15.07	43.69		134	36.42	0.04	24.36	60.83
110	35.89	0.03	20.39	56.32		135	35.5	0.03	24.49	60.02
111	37.89	0.1	21.18	59.17		136	35.21	0.18	17.34	52.73
112	37.35	0.07	20.16	57.58		137	40.47	0.02	19.61	60.1
113	34.85	0.09	20.1	55.04		138	26.44	0.11	20.82	47.37
114	37.24	0.1	21.12	58.46		139	30.93	0.08	27.13	58.14
115	37.18	0.12	21.1	58.39		140	26.86	0.05	26.28	53.19
116	37.13	0.14	20.75	58.02		141	31.35	0.05	26.34	57.74
117	37.62	0.12	21.69	59.43		142	29.72	0.05	26.16	55.93
118	36.15	0.13	22.71	58.99		143	32.92	0.01	23.77	56.71
119	36.42	0.1	22.98	59.49		144	34.99	0.04	24.82	59.85
120	37.82	0.11	22.55	60.47		145	31.14	0.01	24.16	55.3
121	36.01	0.08	21.14	57.24		146	30.8	0.01	24.1	54.91
122	37.09	0.1	22.83	60.01		147	29.37	1.7	26.77	57.84
123	32.73	0.17	22.46	55.36		148	29.33	0.47	25.34	55.14
124	32.23	0.13	23.07	55.43		149	29.62	0.41	22.61	52.64
125	32.36	0.11	24	56.47		150	26.81	1.82	23.47	52.1

n	As	S	Fe	Total		n	As	S	Fe	Total
151	16.99	0.36	35.95	53.29		176	38.01	0.07	21.95	60.03
152	22.08	0.76	30.43	53.27		177	33.42	0.08	18.42	51.92
153	30.61	0.24	20.8	51.64		178	38.5	0.11	22.11	60.73
154	27.9	0.37	27.82	56.09		179	37.96	0.1	22.24	60.3
155	18.18	0.51	34.91	53.6		180	35.15	0.1	20.08	55.33
156	18.56	0.57	21.92	41.06		181	30.74	0.09	18.18	49
157	29.69	0.25	23.67	53.61		182	36.78	0.12	21.04	57.94
158	23.32	0.57	21.53	45.42		183	31.7	0.08	22.12	53.89
159	27.94	3.98	24.53	56.44		184	33.86	0.08	22.56	56.5
160	20.57	0.57	32.01	53.15		185	33.57	0.11	22.42	56.1
161	30.13	1.42	23.47	55.02		186	34.13	0.05	22.11	56.3
162	30.67	0.47	22.57	53.71		187	33.84	0.07	22.72	56.63
163	36.82	0.14	20.28	57.24		188	33.6	0.05	22.46	56.11
164	36.86	1.25	19.74	57.84		189	33.42	0.01	22.12	55.54
165	33.48	1.55	18.97	54		190	33.89	0.05	22.41	56.35
166	27.83	4.17	17.36	49.35		191	34.04	0.05	22.63	56.73
167	35.02	0.09	19.68	54.79		192	33.83	0.12	21.78	55.73
168	37.35	0.13	21.32	58.8		193	36.85	0.04	20.58	57.47
169	35.91	0.12	20.54	56.57		194	36.71	0.1	21.81	58.62
170	34.13	0.1	20.07	54.3		195	38.43	0.03	21.38	59.83
171	37.76	0.12	22.6	60.49		196	33.47	0.09	22.68	56.25
172	36.96	0.07	21.3	58.33		197	36.95	0.05	22.03	59.03
173	35.16	0	20.16	55.32		198	20.12	0.13	16.96	37.22
174	35.19	0.11	19.81	55.11		199	37.93	0.02	22.36	60.32
175	31.17	0.11	18.63	49.91		200	38.56	0.04	22.55	61.14

n	As	S	Fe	Total		n	As	S	Fe	Total
201	38.74	0.02	22.44	61.2		226	36.3	0.11	20.16	56.56
202	36.61	0.08	22.18	58.86		227	37.36	0.11	20.54	58.01
203	38.81	0.04	23.01	61.85		228	37.15	0.08	20.13	57.36
204	23.01	0.9	29.66	53.57		229	31.05	0.15	17.39	48.59
205	24.25	0.36	25.76	50.37		230	39.49	0.03	21.63	61.15
206	18.29	1.4	34.93	54.62		231	37.58	0.05	20.26	57.89
207	16.39	1.83	36.95	55.17		232	37.38	0.06	20.49	57.94
208	25.19	0.47	27.32	52.98		233	37.63	0.09	19.47	57.19
209	37.69	0.1	22.44	60.23		234	30.38	0.15	18.38	48.9
210	36.34	0.12	21.05	57.51		235	34.92	0.07	21.53	56.52
211	33.31	0.11	22.23	55.65		236	37.31	0.07	21.46	58.83
212	36.27	0.09	22.48	58.83		237	37.75	0.04	21.53	59.32
213	36.4	0.06	23.2	59.66		238	38.49	0.04	21.92	60.45
214	37.89	0.06	21.25	59.2		239	38.48	0.05	22.57	61.1
215	36.91	0.08	20.57	57.56		240	38.48	0.06	22.15	60.69
216	39.38	0.05	21.53	60.95		241	32.03	0.14	19.84	52.01
217	38.24	0.03	21.75	60.01		242	39.07	0.08	22.36	61.5
218	38.96	0.07	21.04	60.06		243	38.44	0.09	22.03	60.55
219	38.06	0.1	21.63	59.8		244	37.54	0.16	22.38	60.08
220	30.59	0.14	15.96	46.68		245	36.94	0.13	21.88	58.95
221	37.51	0.08	21.35	58.93		246	37.56	0.12	21.35	59.04
222	38.8	0.05	21.72	60.57		247	35.92	0.13	20.24	56.29
223	37.96	0.07	21.98	60		248	35.19	0.13	20.86	56.18
224	39.14	0.04	22.15	61.34		249	38.23	0.14	21.91	60.29
225	37.83	0.08	20.98	58.88		250	40.01	0.03	18.23	58.26

n	As	S	Fe	Total		n	As	S	Fe	Total
251	39.66	0.02	18.71	58.39		276	38.25	0.07	22.88	61.2
252	39.41	0.04	18.77	58.21		277	36.24	0.11	23	59.35
253	40.41	0.04	18.47	58.91		278	34.75	0.09	22.23	57.07
254	39.9	0.04	18.86	58.8		279	38.78	0.05	22.34	61.17
255	40.23	0.02	17.97	58.22		280	34.59	0.1	21.66	56.34
256	33.44	0.17	19.53	53.13		281	37.98	0.05	21.48	59.51
257	39.98	0.04	17.96	57.98		282	35.69	0.06	21.27	57.02
258	36.7	0.07	19.89	56.66		283	38.21	0.07	22	60.28
259	39.46	0.03	20.79	60.28		284	26.53	0.05	15.99	42.56
260	39.19	0.05	21.19	60.43		285	35.4	0.11	22.08	57.59
261	39.28	0.04	20.23	59.54		286	34.72	0.1	20.3	55.12
262	35.3	0.04	19.85	55.2		287	32.3	0.08	28.46	60.84
263	38.84	0.07	20.43	59.34		288	34.28	0.1	22.34	56.72
264	37.05	0.05	20.69	57.79		289	32.51	0.13	19.47	52.12
265	39.29	0.05	21.87	61.21		290	34.47	0.11	20.48	55.06
266	38.67	0.05	20.4	59.12		291	35.82	0.1	19.78	55.69
267	39.32	0.05	22.44	61.81		292	36.07	0.1	20.01	56.18
268	37.83	0.08	21.88	59.79		293	29.89	0.08	17.1	47.07
269	33.4	0.06	17.81	51.26		294	36.93	0.08	20.91	57.91
270	35.46	0.05	20.04	55.55		295	37.9	0.06	21.21	59.17
271	38.12	0.05	20.92	59.09		296	36	0.1	20.51	56.61
272	40.45	0.06	20.95	61.46		297	23.32	0.1	21.22	44.65
273	37.87	0.1	21.16	59.12		298	29.18	0.15	23.63	52.96
274	38.22	0.07	22.47	60.76		299	33.78	0.08	24.02	57.88
275	38.34	0.11	21.62	60.07		300	38.86	0.09	22.94	61.89

n	As	S	Fe	Total		n	As	S	Fe	Total
301	35.23	0.09	19.33	54.65		326	27.54	0.02	27.2	54.76
302	38.89	0.05	22.16	61.09		327	27.62	0.02	23.92	51.56
303	36.3	0.37	21.88	58.55		328	29.44	0.04	26.15	55.63
304	32.53	0.12	23.92	56.57		329	30.02	0.02	25.34	55.39
305	36.88	0.14	23.43	60.45		330	30.27	0.02	24.77	55.05
306	35.48	0.07	20.29	55.85		331	26.69	0.04	28.41	55.13
307	24.64	0.07	16.45	41.17		332	37.42	0.06	21.92	59.41
308	35.91	0.03	22.11	58.05		333	36.14	0.05	21.15	57.33
309	35.01	0.08	19.75	54.85		334	37.22	0.07	21.39	58.68
310	39.99	0.04	23.08	63.1		335	35.4	0.05	21.04	56.5
311	32.44	0.11	18.18	50.73		336	37.35	0.05	22.34	59.74
312	33.79	0.06	19.58	53.42		337	35.76	0.08	21.6	57.44
313	35.1	0.11	17.79	53		338	22.73	0.12	31.96	54.82
314	36.3	0.06	20.88	57.23		339	21.84	0.13	33.06	55.02
315	39.14	0.05	21.01	60.21		340	36.9	0.08	21.39	58.36
316	36.23	0.1	19.49	55.82		341	36.5	0.08	21.75	58.33
317	35.8	0.07	20.22	56.08		342	37.42	0.08	22.14	59.63
318	36.23	0.07	20.12	56.42		343	35.67	0.09	23.33	59.08
319	20.1	1.03	35.49	56.61		344	23.81	0.14	31.97	55.92
320	26.66	0.45	27.42	54.54		345	35.45	0.07	23.29	58.81
321	19.02	0.12	36.92	56.06		346	38.36	0.1	23.18	61.64
322	25.46	0.28	29.83	55.57		347	38.11	0.09	21.43	59.63
323	17.23	0.2	37.97	55.41		348	27.5	0.04	24.86	52.39
324	20.84	0.25	24.84	45.94		349	19.42	0.05	31.43	50.89
325	26.53	0.04	26.58	53.14		350	24.08	0.02	29.04	53.14

n	As	S	Fe	Total		n	As	S	Fe	Total
351	24.52	0.09	28.86	53.47		376	35.16	0.07	21.72	56.95
352	35.39	0.12	19.92	55.43		377	34.48	0.05	26.99	61.52
353	36.08	0.1	20.53	56.72		378	33.92	0.03	25.01	58.97
354	36.54	0.11	20.99	57.63		379	31.21	0.09	20.14	51.44
355	35.23	0.06	20.4	55.69		380	36.21	0.06	22.67	58.95
356	34.68	0.13	19.98	54.79		381	23.56	0.14	29.2	52.9
357	36.52	0.11	20.49	57.11		382	39.21	0.08	22.75	62.05
358	36.82	0.09	21.34	58.25		383	34.46	0.18	20.78	55.42
359	29.86	0.15	20.85	50.85		384	41.01	0	20.73	61.74
360	34.92	0.04	20.46	55.42		385	37.3	0.03	20.29	57.61
361	36.71	0.09	21.55	58.35		386	40.28	0.01	21.45	61.73
362	36.1	0.09	21.17	57.36		387	35.76	0.02	20.73	56.51
363	37	0.1	21.57	58.66		388	33.16	0.04	19.38	52.58
364	37.51	0.03	22.21	59.75		389	25.4	0.09	17.62	43.1
365	37.84	0.03	22.79	60.65		390	31.54	0.05	21.16	52.75
366	35.45	0.05	15.97	51.46		391	32.94	0.14	16.04	49.12
367	35.05	0.03	16.18	51.26		392	34.48	0.18	19.97	54.63
368	37.27	0.05	22.57	59.88		393	34.07	0.2	19.19	53.45
369	38.2	0.04	23.64	61.88		394	34.1	0.21	17.24	51.56
370	37.5	0.06	22.62	60.17		395	34.23	0.19	19.81	54.23
371	37.09	0.06	23.06	60.2		396	34.63	0.21	18.07	52.91
372	36.26	0.06	21.57	57.88		397	31.47	0.19	17.38	49.04
373	34.8	0.06	21.53	56.39		398	33.61	0.21	20.53	54.36
374	30.24	0.11	26.56	56.91		399	33.53	0.21	15.42	49.16
375	36.12	0.04	23.38	59.55		400	36.93	0.08	19.75	56.77

n	As	S	Fe	Total		n	As	S	Fe	Total
401	35.64	0.04	20.51	56.19		426	35.85	0.06	20.29	56.2
402	33.73	0.93	21.52	56.17		427	36.33	0.05	21.5	57.88
403	37.22	0.05	21.34	58.61		428	38.73	0.13	22.48	61.35
404	32.36	0.06	17.75	50.17		429	37.09	0.12	21.67	58.87
405	37.82	0.1	16.67	54.59		430	37.44	0.1	22.49	60.03
406	35.99	0.11	21.26	57.36		431	28.04	0.04	22.33	50.41
407	38.31	0.12	22.71	61.14		432	31.55	0.05	21.43	53.03
408	39.64	0.12	23.58	63.33		433	37.28	0.05	24.72	62.05
409	38.18	0.09	22.68	60.96		434	34.74	0.08	23.24	58.07
410	38.18	0.09	22.95	61.21		435	36.87	0.04	22.21	59.11
411	37.82	0.11	22.58	60.51		436	39.19	0.03	22	61.22
412	38.76	0.1	22.79	61.65		437	36.72	0.07	21.1	57.88
413	37.96	0.16	22.26	60.38		438	38.56	0.02	23.46	62.04
414	35.25	0.08	21.25	56.58		439	36.98	0.02	20.83	57.83
415	38.33	0.15	23.21	61.69		440	31.82	0.09	16.06	47.97
416	33.47	0.09	23.28	56.84		441	32.76	0.1	16.82	49.67
417	36.67	0.03	20.47	57.17		442	33.4	0.08	20.51	54
418	33.79	0.08	21.49	55.36		443	39.67	0.06	22.7	62.42
419	35.94	0.04	20.49	56.47		444	39.85	0.07	22.6	62.52
420	29.12	0.08	16.8	46		445	35.63	0.06	20.74	56.43
421	29.95	0.07	18.08	48.11		446	39.08	0.03	22.29	61.4
422	36.6	0.06	20.05	56.71						
423	36.11	0.07	20.16	56.33						
424	35.99	0.07	20.69	56.76						
425	36.83	0.05	20.32	57.19						

n	As	S	Fe	Total
average	0.0552	47.316	45.62	92.991
max	0.409	49.33	46.282	95.612
min	0	36.058	44.869	81.336

Spot analysis data for iron oxide grains from all mine tailing and stream channel samples. All data are in weight %.

N	As	S	Fe	Total		n	As	S	Fe	Total
1	2.448	0.08	43.61	46.133		26	6.061	0.04	50.84	56.94
2	4.598	0.275	52.87	57.743		27	6.082	0.053	52.05	58.186
3	7.632	0.271	48.53	56.433		28	8.977	0.038	46.77	55.782
4	4.554	0.081	50.51	55.143		29	7.821	0.032	49.83	57.687
5	6.579	0.041	43.73	50.348		30	9.106	0.032	45.78	54.919
6	4.962	0.071	48.31	53.344		31	7.449	0.113	49.29	56.854
7	5.943	0.058	41.25	47.247		32	8.037	0.04	47.6	55.676
8	4.876	0.063	41.24	46.178		33	10.971	0.13	42.4	53.496
9	5.796	0.077	51.3	57.169		34	8.358	0.095	35.15	43.598
10	4.841	0.721	50.06	55.62		35	8.372	0.117	35.76	44.251
11	13.26	2.931	35.85	52.042		36	9.911	0.117	43.07	53.099
12	5.504	0.163	52.04	57.703		37	8.106	0.185	42.47	50.757
13	6.394	0.376	50.59	57.357		38	9.25	0.102	43.19	52.539
14	6.51	0.186	52.44	59.139		39	9.181	0.129	43.41	52.716
15	6.224	0.176	52.1	58.495		40	9.298	0.125	43.76	53.184
16	5.289	0.107	53.19	58.588		41	9.408	0.132	43.46	52.998
17	7.998	0.188	47.98	56.165		42	9.556	0.118	42.93	52.608
18	6.916	0.18	51.44	58.535		43	9.467	0.162	42.56	52.193
19	3.799	0.059	54.95	58.803		44	0.293	0.022	54.11	54.426
20	7.546	0.024	47.81	55.383		45	1.231	0.036	54.38	55.642
21	8.335	0.042	45.36	53.737		46	4.371	0.109	48.56	53.036
22	8.325	0.034	44.87	53.227		47	0.747	0.007	54.65	55.402
23	5.133	0.047	50.79	55.966		48	0.19	0.006	54.42	54.62
24	5.791	0.037	50.86	56.692		49	0.031	0.008	56.18	56.223
25	7.391	0.054	48.89	56.337		50	5.858	0.062	25.98	31.897

n	As	S	Fe	Total		n	As	S	Fe	Total
51	1.093	0.036	54.14	55.269		76	0.562	0.183	56.71	57.455
52	0.077	0.007	55.55	55.634		77	1.13	0.098	51.22	52.45
53	8.71	0.016	49.9	58.621		78	1.197	0.214	56.59	57.998
54	1.932	2.17	42.66	46.765		79	2.007	0.371	53.28	55.658
55	0.484	0.568	58.22	59.272		80	0.804	0.134	57.42	58.355
56	0.524	0.21	57.91	58.648		81	0.913	0.176	45.98	47.068
57	0.869	1.946	54.41	57.225		82	0.689	0.162	50.14	50.989
58	0.628	0.152	56.69	57.468		83	0.712	0.19	55.24	56.145
59	0.843	1.226	55.6	57.669		84	0.962	0.216	50.41	51.583
60	0.715	0.221	55.7	56.638		85	0.155	0.025	58.39	58.573
61	0.734	0.191	56.98	57.907		86	0.084	0.016	59.21	59.313
62	0.602	0.6	56.98	58.177		87	0.167	0.047	58.54	58.757
63	0.44	0.163	58.52	59.124		88	0.105	0.17	62	62.275
64	0.392	0.13	59.67	60.193		89	0.028	0.03	61.89	61.944
65	1	0.675	53.07	54.743		90	0.024	0.031	63.86	63.912
66	0.683	2.354	55.19	58.231		91	0.014	0.003	60.35	60.365
67	1.052	0.818	44.74	46.606		92	0.191	0.058	51.68	51.932
68	0.779	0.286	56.71	57.775		93	0.206	0.038	55.8	56.046
69	1.226	0.336	51.6	53.166		94	0	0.026	66.69	66.713
70	1.047	1.825	47.37	50.245		95	0.071	0.034	59.7	59.804
71	0.441	0.224	55.66	56.328		96	0.027	0.044	61.54	61.61
72	0.552	0.237	55.84	56.627		97	0.081	0.049	60.28	60.406
73	0.323	0.163	59.21	59.699		98	1.296	0.189	56.48	57.964
74	0.705	0.803	53.34	54.843		99	1.885	0.224	55.3	57.409
75	0.634	0.157	56.62	57.412		100	2.016	0.265	54.35	56.633

n	As	S	Fe	Total		n	As	S	Fe	Total
101	1.067	0.105	56.52	57.696		126	0.11	0.084	60.36	60.55
102	1.701	0.208	49.86	51.769		127	0.599	0.483	57.74	58.817
103	1.609	0.178	54.17	55.953		128	0.057	0.015	61.94	62.015
104	1.22	0.111	54.39	55.718		129	0.365	0.065	58.55	58.979
105	1.311	0.129	51.43	52.874		130	0.52	1.651	58.23	60.405
106	1.343	0.182	41.29	42.818		131	0.133	0.128	62.47	62.729
107	0.774	0.048	58.08	58.905		132	0.058	0.099	63.43	63.582
108	1.78	0.168	48.99	50.939		133	0.056	0.043	61.84	61.94
109	0.89	0.103	57.68	58.675		134	0.242	0.048	57.72	58.007
110	2.107	0.154	49.6	51.859		135	2.819	0.115	54.4	57.337
111	0.744	0.083	57.74	58.565		136	0.316	0.031	57.91	58.254
112	1.81	0.183	52.44	54.431		137	0.325	0.199	51	51.52
113	1.322	0.112	57.34	58.771		138	0.116	0.018	60.39	60.524
114	1.077	0.138	42.65	43.866		139	0.37	0.138	58.8	59.31
115	0.989	0.073	57.55	58.607		140	0.249	0.008	58.33	58.583
116	1.451	0.123	52.12	53.697		141	0.457	0.028	59.07	59.559
117	1.949	0.13	46.97	49.049		142	0.252	0.026	57.97	58.248
118	1.748	0.155	52.01	53.916		143	0.753	0.051	53	53.807
119	1.84	0.181	51.84	53.86		144	0.859	0.082	33.05	33.992
120	2.105	0.21	51.09	53.409		145	1.088	0.066	53.38	54.531
121	1.978	0.165	47.75	49.89		146	1.199	0.03	55.1	56.33
122	1.304	0.072	56.12	57.498		147	1.088	0.058	51.58	52.726
123	0.295	0.044	58.9	59.242		148	2.867	0.322	52.73	55.914
124	0.179	0.077	59.05	59.309		149	2.612	0.216	53.48	56.305
125	0.042	0.062	62.13	62.234		150	3.102	0.406	51.53	55.037

n	As	S	Fe	Total		n	As	S	Fe	Total
151	3.253	0.388	50.95	54.592		176	1.736	0.064	51.17	52.966
152	2.441	0.252	53.49	56.178		177	2.439	0.029	51.61	54.079
153	2.618	0.23	52.77	55.619		178	2.688	0.108	48.42	51.217
154	2.111	0.173	55.58	57.861		179	1.403	0.111	47.3	48.812
155	2.294	0.135	51.85	54.279		180	1.087	0.067	46.08	47.236
156	2.157	0.17	53.09	55.414		181	1.434	0.072	47.68	49.189
157	2.233	0.149	52.98	55.361		182	2.396	0.098	47.17	49.664
158	2.182	0.125	54.45	56.752		183	1.447	0.068	49.43	50.942
159	1.662	0.145	55.01	56.814		184	1.299	0.117	44.06	45.479
160	2.093	0.219	51.61	53.923		185	2.222	0.117	43.27	45.606
161	2.181	0.234	52.98	55.39		186	1.013	0.09	47.92	49.026
162	2.486	0.202	52.63	55.314		187	1.179	0.057	42.74	43.971
163	2.201	0.268	53.23	55.698		188	1.669	0.109	46.18	47.959
164	3.098	0.291	51.44	54.832		189	1.876	0.099	41.67	43.645
165	2.452	0.166	52.93	55.547		190	1.29	0.054	47.86	49.199
166	2.701	0.187	52.56	55.446		191	2.954	0.093	52.16	55.206
167	2.673	0.19	52.49	55.351		192	1.532	0.202	52.75	54.481
168	2.177	0.146	53.27	55.596		193	4.481	1.25	47.01	52.739
169	2.522	0.2	49.24	51.963		194	1.242	0.151	50.95	52.34
170	1.32	0.104	55.35	56.777		195	2.093	1.44	49.21	52.743
171	1.545	0.112	43.91	45.562		196	0.922	0.509	51.65	53.077
172	1.912	0.1	48.62	50.633		197	4.267	0.7	47.11	52.072
173	1.52	0.094	51.04	52.657		198	2.149	0.92	45.47	48.539
174	2.658	0.104	50.29	53.047		199	1.646	0.901	45.91	48.46
175	1.554	0.099	48.95	50.604		200	1.564	1.423	47.28	50.266

n	As	S	Fe	Total		n	As	S	Fe	Total
201	2.465	0.664	43.5	46.626		226	0.113	0.1	59.81	60.021
202	1.7	1.43	44.7	47.834		227	0.135	0.221	59.58	59.932
203	0.849	0.231	42.21	43.291		228	0.032	0.025	62.95	63.005
204	2.674	0.309	53.77	56.75		229	6.174	0.134	51.08	57.383
205	3.602	0.367	46.57	50.535		230	2.981	0.086	52.77	55.833
206	3.39	0.26	51.33	54.981		231	8.68	0.382	47.27	56.335
207	3.511	0.364	51.85	55.726		232	9.039	0.558	47.71	57.303
208	3.005	0.222	52.93	56.156		233	6.462	0.315	50.68	57.454
209	3.945	0.322	48.99	53.259		234	6.598	0.589	49.62	56.809
210	4.708	0.297	47.16	52.168		235	9.284	2.718	45.16	57.165
211	3.82	0.34	48.88	53.037		236	8.899	0.598	47.84	57.333
212	4.722	0.39	46.58	51.695		237	4.978	0.314	53.3	58.595
213	3.777	0.291	50.53	54.596		238	9.919	0.381	45.88	56.179
214	4.342	0.345	48.3	52.989		239	9.014	0.565	48.07	57.651
215	4.86	0.467	43.05	48.378		240	7.147	0.51	48.81	56.469
216	3.58	0.36	49.62	53.56		241	5.151	0.375	27.28	52.807
217	1.381	0.144	56.78	58.301		242	1.237	0.214	42.09	43.545
218	2.76	0.297	52.95	56.006		243	1.472	0.231	45.84	47.545
219	1.979	0.246	55.55	57.77		244	1.252	0.189	53.21	54.647
220	0	0.015	66.33	66.346		245	1.391	0.194	49.66	51.248
221	0.015	0.052	65.24	65.302		246	0.919	0.144	34.47	35.533
222	0.053	0.075	60.27	60.397		247	1.234	0.168	51.65	53.055
223	0.92	0.166	55.56	56.648		248	1.601	0.259	40.46	42.32
224	0.076	0.053	61.51	61.639		249	1.119	0.201	44.43	45.754
225	0	0.029	67.44	67.472		250	3.582	0.047	56.89	60.521

n	As	S	Fe	Total		n	As	S	Fe	Total
251	2.802	0.398	48.82	52.016		276	5.612	0.278	50.86	56.753
252	3.978	0.076	53.07	57.126		277	0.416	0.035	57.64	58.086
253	0.437	0.023	56.18	56.641		278	0.582	0.021	57.35	57.95
254	0.463	0.021	53.91	54.393		279	0.421	0.038	56.81	57.264
255	0.479	0.012	54.68	55.169		280	0.438	0.024	56.05	56.513
256	0.461	0.035	50.63	51.121		281	0.316	0.046	56.44	56.799
257	0.366	0.021	51.52	51.909		282	4.738	0.039	49.49	54.27
258	0.375	0.048	51.83	52.25		283	4.259	0.07	45.8	50.126
259	0.411	0.018	52.07	52.497		284	3.965	0.052	49.13	53.146
260	0.429	0.024	53.88	54.336		285	4.13	0.04	51.2	55.367
261	0.356	0.01	52.15	52.517		286	4.37	0.065	46.71	51.146
262	6.132	0.329	49.56	56.016		287	3.951	0.043	46.33	50.322
263	5.102	0.247	51.6	56.945		288	3.932	0.048	45.87	49.853
264	4.267	0.214	53.48	57.965		289	4.009	0.045	48.3	52.35
265	5.145	0.262	53.01	58.421		290	3.976	0.032	44.31	48.319
266	4.589	0.256	53.42	58.268		291	3.877	0.051	39.32	43.244
267	3.679	0.181	53.71	57.574		292	4.28	0.035	50.94	55.253
268	3.265	0.187	54.79	58.246		293	3.926	0.042	47.38	51.352
269	2.318	0.124	56.49	58.928		294	3.543	0.06	49.06	52.658
270	3.095	0.194	53.27	56.559		295	4.126	0.05	51.35	55.524
271	3.389	0.172	54.78	58.337		296	3.806	0.045	47.2	51.055
272	7.84	0.407	43.28	51.526		297	3.885	0.039	48.28	52.208
273	4.823	0.273	52.02	57.112		298	4.131	0.018	48.83	52.978
274	5.388	0.301	52.1	57.784		299	4.177	0.074	45.56	49.806
275	4.237	0.214	52.93	57.378		300	6.04	0.036	48.94	55.014

n	As	S	Fe	Total		n	As	S	Fe	Total
301	2.659	0.049	42.7	45.404		326	6.187	0.166	41.48	47.83
302	2.648	0.082	43.64	46.365		327	7.566	0.159	37.08	44.801
303	4.512	0.041	42.04	46.592		328	9.4	0.134	38.97	48.507
304	6.649	0.072	45.85	52.571		329	9.413	0.115	46.57	56.099
305	0.038	0.029	61.92	61.985		330	9.728	0.12	46.49	56.338
306	0.162	0.032	61.76	61.949		331	11.001	0.139	45.06	56.197
307	5.856	0.358	34.58	40.797		332	9.899	0.146	38.76	48.804
308	0.316	0.015	61.09	61.423		333	9.353	0.16	38.98	48.494
309	3.579	0.322	54.04	57.938		334	7.849	1.272	43.57	52.689
310	3.28	1.078	55.14	59.495		335	3.495	0.81	26.3	30.601
311	2.665	0.579	59.09	62.334		336	3.697	2.663	35.91	42.266
312	5.413	1.154	53.84	60.41		337	5.812	1.219	43.98	51.015
313	5.339	0.831	49.46	55.631		338	5.039	0.144	53.52	58.703
314	5.097	0.608	50.79	56.49		339	10.315	0.404	46.98	57.702
315	3.678	0.186	55.11	58.971		340	8.291	0.2	50.6	59.093
316	1.499	0.076	57.17	58.749		341	7.628	0.274	51.36	59.257
317	0.272	0.023	57.64	57.936		342	11.014	0.391	48.68	60.087
318	0.374	0.04	58.99	59.406		343	5.024	0.137	55.19	60.355
319	2.361	0.085	53.87	56.319		344	8.446	0.282	49.66	58.391
320	0.675	0.06	57.92	58.653		345	4.783	0.302	34.59	39.677
321	4.614	0.172	34.26	39.046		346	2.749	0.066	55.84	58.655
322	4.487	0.143	45.24	49.874		347	4.871	1.227	47.92	54.022
323	2.468	0.112	25.76	28.343		348	5.818	1.721	44.69	52.228
324	3.174	0.027	54.95	58.148		349	3.709	1.42	40.14	45.271
325	3.776	0.052	54.36	58.192		350	4.84	0.828	51.73	57.394

n	As	S	Fe	Total		n	As	S	Fe	Total
351	5.546	0.342	52.05	57.939		376	1.293	0.144	44.31	45.751
352	4.322	0.26	51.94	56.525		377	2.347	0.187	51.18	53.716
353	4.88	0.447	50.22	55.547		378	2.19	0.154	55.53	57.877
354	6.2	0.724	43.47	50.389		379	2.546	1.009	52.65	56.209
355	3.599	0.289	51.54	55.431		380	1.453	0.107	54.33	55.887
356	3.93	0.365	49.54	53.837		381	2.246	0.178	51.29	53.716
357	5.818	0.459	42.38	48.655		382	1.984	0.16	46.3	48.444
358	9.265	0.594	36.26	46.114		383	0.584	0.302	57.78	58.668
359	7.489	0.576	38.27	46.335		384	0.789	0.414	57.28	58.485
360	0.603	2.962	47.4	50.961		385	0.38	0.687	60.16	61.228
361	0.774	0.105	52.09	52.971		386	0.758	1.108	56.55	58.416
362	0.818	0.073	56.01	56.897		387	0.539	0.771	58.53	59.839
363	1.943	0.149	51.51	53.604		388	0.383	1.004	58.25	59.636
364	2.447	0.163	47.12	49.732		389	0.513	1.707	57.69	59.912
365	1.963	0.174	52.16	54.298		390	0.818	2.32	55.25	58.391
366	2.58	0.208	27.68	30.471		391	0.27	3.291	54.06	57.618
367	3.524	0.669	52.5	56.696		392	0.293	2.031	58.78	61.108
368	5.591	0.587	49.98	56.153		393	0.241	1.338	56.74	58.319
369	7.107	0.746	43.48	51.33		394	0.574	0.457	58.08	59.107
370	4.847	0.726	51.01	56.581		395	1.034	2.503	51.34	54.878
371	1.287	0.163	52.43	53.875		396	1.122	1.139	56.02	58.28
372	1.436	0.19	44.61	46.231		397	0.471	1.228	58.2	59.902
373	0.821	0.115	55.7	56.632		398	0.323	1.503	59.93	61.757
374	0.678	0.091	56.08	56.844		399	0.649	0.073	44.4	45.126
375	4.019	0.278	47.14	51.438		400	0.451	0.08	55.88	56.413

n	As	S	Fe	Total		n	As	S	Fe	Total
401	0.267	0.065	51.36	51.694		426	0.071	0.107	47.03	47.204
402	0.717	0.058	42	42.773		427	0.072	0.058	51.4	51.532
403	0.181	0.061	59.14	59.381		428	0.081	0.01	55.89	55.984
404	0.536	0.048	54.1	54.686		429	0.015	0.067	47.88	47.965
405	4.865	0.813	51.21	56.887		430	0.116	0.04	56	56.158
406	5.326	1.208	42.95	49.484		431	0.098	0.066	56.22	56.385
407	4.661	0.469	49.11	54.241		432	0.055	0.025	57.68	57.762
408	4.981	0.272	52.72	57.976		433	0.079	0.018	54.15	54.248
409	3.138	0.269	54.88	58.287		434	0.033	0	58.11	58.138
410	4.027	0.29	53.69	58.008		435	0.082	0.064	55.01	55.158
411	6.043	0.367	51.74	58.148		436	0.051	0.044	51.49	51.581
412	4.295	0.266	54.57	59.133		437	0.078	0.06	37.99	38.125
413	3.834	1.395	52.22	57.453		438	0.094	0.044	52.54	52.673
414	4.877	2.16	45	52.041		439	0.104	0.031	55.16	55.294
415	1.584	0.29	56.34	58.21		440	0.012	0.649	62.7	63.358
416	1.184	0.412	57.78	59.374		441	0.031	0.007	60.27	60.305
417	4.189	1.564	50.06	55.815		442	0.011	0.017	60.71	60.735
418	1.339	0.524	58.22	60.081		443	0	0.009	63.92	63.932
419	1.834	0.798	57.01	59.641		444	0	0.016	64.24	64.256
420	1.354	0.507	58.33	60.19		445	3.378	1.13	50.85	55.357
421	0.579	0.191	59.33	60.102		446	3.205	0.475	49.85	53.533
422	0.854	0.133	58.23	59.218		447	3.979	0.688	48.33	52.999
423	0.201	0.033	60.44	60.677		448	3.475	0.713	49.28	53.463
424	0.647	0.108	57.66	58.419		449	2.65	0.151	53.21	56.014
425	0.1	0.028	57.82	57.949		450	9.464	0.139	47.61	57.211

n	As	S	Fe	Total		n	As	S	Fe	Total
451	10.73	0.127	45.42	56.268		476	3.186	2.036	48.93	54.15
452	7.661	0.15	49.2	57.007		477	6.724	0.148	47.81	54.686
453	8.254	0.06	36.57	44.881		478	3.73	0.142	49.05	52.926
454	7.074	0.099	49.91	57.08		479	3.493	0.122	49.47	53.088
455	9.642	0.135	46.97	56.745		480	2.986	0.099	51.51	54.591
456	11.3	0.134	43.52	54.952		481	3.203	0.155	50.13	53.483
457	6.195	0.08	49.5	55.778		482	2.737	0.221	47.83	50.787
458	1.057	0.081	54.63	55.766		483	5.854	0.402	43.28	49.532
459	2.326	0.125	48.9	51.353		484	4.252	0.385	46.84	51.473
460	2.336	0.116	45.18	47.635		485	6.002	0.807	44.59	51.401
461	1.275	0.141	54.48	55.897		486	6.661	1.066	45.32	53.051
462	2.291	0.095	49.69	52.078		487	3.164	0.514	50.55	54.224
463	1.776	0.09	51	52.861		488	4.615	1.235	49.14	54.992
464	1.927	0.085	51.19	53.198		489	6.082	0.265	49.41	55.756
465	1.75	0.106	51.08	52.932		490	6.5	0.138	48.17	54.812
466	1.842	0.092	51.24	53.176		491	7.394	1.748	46.48	55.622
467	1.587	0.076	51.07	52.729		492	9.219	2.057	37.71	48.984
468	1.82	0.077	51.71	53.61		493	4.153	2.028	44.15	50.328
469	2.054	0.089	50.89	53.031		494	4.368	0.419	50.79	55.581
470	3.745	1.355	49.4	54.502		495	3.007	2.364	46.27	51.643
471	2.838	1.365	52.75	56.95		496	3.53	0.383	50.36	54.275
472	2.193	2.328	50.36	54.881		497	3.307	0.979	47.96	52.242
473	3.656	2	48.41	54.063		498	3.261	1.804	49.75	54.814
474	4.167	1.097	50.14	55.406		499	6.077	0.047	48.14	54.261
475	5.214	0.753	48.66	54.628		500	4.075	0.048	52.93	57.053

n	As	S	Fe	Total		n	As	S	Fe	Total
501	4.782	0.028	45.79	50.604		526	2.391	0.074	54.7	57.169
502	5.046	0.033	48.31	53.393		527	2.446	0.087	56.38	58.917
503	5.946	0.065	48.27	54.276		528	3.131	0.044	56.14	59.318
504	1.528	0.157	53.92	55.608		529	2.896	0.08	50.08	53.051
505	1.365	0.088	55.27	56.721		530	2.173	0.097	47.06	49.331
506	0.5	0.197	58.21	58.91		531	2.504	0.092	46.26	48.855
507	0.809	0.071	56.17	57.048		532	2.491	0.108	49.79	52.388
508	2.913	0.12	52.59	55.624		533	1.472	0.069	47.1	48.641
509	3.177	0.501	56.77	60.447		534	2.138	0.064	54.85	57.048
510	4.753	0.1	54.95	59.8		535	2.167	0.079	55.95	58.196
511	5.484	0.156	52.37	58.005		536	2.79	0.082	51.45	54.324
512	1.939	0.044	58.75	60.733		537	3.046	0.098	50.49	53.631
513	7.573	0.114	51.4	59.083		538	0	0.011	51.77	51.785
514	0.317	1.947	59.46	61.719		539	0	0.021	54.49	54.51
515	0.288	0.754	62.71	63.751		540	0	0.012	54.1	54.107
516	0.865	2.355	57.07	60.294		541	0	0.025	58.83	58.854
517	0.194	0.653	59.58	60.423		542	0	0	47.82	47.816
518	0.456	2.427	52.55	55.436		543	0	0.018	50.67	50.687
519	7.426	0.595	46.75	54.768		544	0	0.114	49.08	49.193
520	6.221	0.549	44.7	51.471		545	0.006	0.053	52.51	52.571
521	6.161	0.551	36.15	42.863		546	0	0.038	60.54	60.577
522	3.643	0.258	51.09	54.987		547	0	0.003	53.72	53.727
523	10.04	0.854	37.58	48.475		548	0	0.006	56.12	56.128
524	10.38	0.488	38.61	49.477		549	8.343	0.066	51.05	59.455
525	3.299	0.053	53.23	56.585		550	5.539	0.034	53.98	59.551

n	As	S	Fe	Total		n	As	S	Fe	Total
551	7.485	0.051	52.33	59.862		576	3.9	2.768	47.91	54.576
552	2.99	1.405	52.77	57.161		577	4.791	2.328	47.9	55.023
553	1.894	0.079	57.78	59.748		578	0.779	4.05	49.05	53.874
554	2.887	1.338	51.86	56.085		579	3.88	0.656	53.48	58.019
555	7.107	2.401	44.12	53.626		580	4.118	0.771	52.04	56.924
556	3.53	3.147	44.76	51.434		581	3.038	0.455	54.88	58.37
557	2.591	2.665	51.18	56.435		582	3.731	1.124	51.95	56.801
558	3.198	0.121	53.03	56.347		583	4.329	1.563	50.11	56.004
559	4.331	2.456	46.67	53.456		584	3.314	0.994	53.39	57.696
560	2.351	0.159	55.45	57.958		585	3.284	1.07	53.27	57.627
561	3.124	1.211	47	51.333		586	2.731	0.826	54.49	58.043
562	1.9	0.906	49.98	52.789		587	3.168	0.768	53.6	57.536
563	1.978	1.108	41.4	44.483		588	3.107	1.059	53.65	57.818
564	4.496	1.941	41.26	47.701		589	2.759	0.909	54.69	58.353
565	3.226	2.688	43.72	49.636		590	6.981	2.656	41.26	50.893
566	1.328	0.697	52.31	54.334		591	6.653	2.704	43.65	53.009
567	1.044	0.802	54.67	56.52		592	7.121	2.86	41.83	51.812
568	1.508	0.712	22.46	24.683		593	6.623	2.954	41.1	50.677
569	2.195	0.505	20.19	22.888		594	4.495	1.089	50.19	55.776
570	1.993	0.918	49.8	52.711		595	3.839	0.552	52.81	57.204
571	3.192	1.631	46.26	51.082		596	7.739	2.746	40.23	50.711
572	0.83	1.127	56.36	58.32		597	3.676	0.754	53.04	57.469
573	1.087	0.718	53.57	55.373		598	7.121	2.86	41.83	51.812
574	1.185	2.206	53.09	56.485		599	6.623	2.954	41.1	50.677
575	1.724	1.974	50.73	54.427		600	4.495	1.089	50.19	55.776

n	As	S	Fe	Total		n	As	S	Fe	Total
601	3.839	0.552	52.81	57.204		626	0.169	0.041	42.88	43.093
602	7.739	2.746	40.23	50.711		627	0.185	0.024	49.63	49.843
603	3.676	0.754	53.04	57.469		628	0.134	0.054	36.45	36.642
604	4.465	0.621	52.54	57.63		629	0.15	0.031	56.81	56.994
605	4.867	1.011	48.38	54.262		630	0.174	0.071	49.13	49.371
606	4.892	0.428	52.13	57.445		631	0.24	0.058	53.1	53.402
607	5.446	0.418	52.47	58.334		632	0.219	0.057	50.49	50.761
608	4.819	0.703	52.57	58.087		633	1.899	0.176	54.35	56.428
609	3.698	0.589	54.86	59.15		634	2.988	0.178	52.26	55.424
610	5.375	0.329	52.44	58.147		635	4.434	0.879	53.74	59.052
611	0.255	0.043	52.58	52.874		636	4.436	0.897	53.27	58.601
612	0.212	0.046	48.31	48.568		637	1.847	4.551	59.41	65.808
613	0.22	0.033	50.83	51.084		638	2.819	0.489	43.54	46.845
614	0.26	0.033	55.9	56.193		639	1.745	0.501	58.21	60.451
615	0.193	0.014	52.62	52.826		640	9.267	0.996	45.29	55.551
616	0.863	0.09	45.63	46.583		641	11.146	0.886	28.45	40.482
617	0.343	0.048	54.35	54.738		642	0.225	0.048	50.22	50.497
618	0.225	0.056	51.7	51.976		643	0.186	0.031	50.81	51.024
619	0.173	0.064	38.8	39.033		644	0.182	0.075	46.07	46.324
620	0.126	0.058	52.84	53.028		645	0.196	0.078	42.59	42.868
621	0.216	0.073	49.12	49.406		646	0.244	0.072	50.71	51.026
622	0.163	0.072	40.12	40.357		647	0.183	0.063	52.71	52.958
623	0.165	0.051	51.57	51.79		648	0.308	0.082	37.37	37.76
624	0.203	0.055	54.57	54.831		649	0.235	0.051	49.71	50
625	0.141	0.045	46.48	46.669		650	0.244	0.074	47.67	47.99

n	As	S	Fe	Total		n	As	S	Fe	Total
651	0.314	0.056	52.41	52.784		676	1.342	0.166	56.34	57.85
652	0.349	0.069	47.25	47.666		677	1.55	0.387	56.72	58.654
653	0.367	0.075	50.9	51.342		678	3.555	0.142	52.68	56.376
654	0.344	0.039	52.63	53.015		679	1.181	0.3	56.45	57.927
655	1.971	0.039	50.19	52.202		680	0.854	0.093	58.38	59.329
656	0.715	0.065	45.82	46.597		681	0.166	0.057	60.3	60.524
657	0.774	0.088	46.7	47.566		682	0.317	0.056	55.94	56.309
658	1.51	0.053	54.9	56.465		683	0.123	0.254	63.31	63.685
659	0.651	0.056	47.19	47.9		684	2.057	0.679	55	57.74
660	0.994	0.032	50.97	51.999		685	0.804	0.358	56.28	57.445
661	0.689	0.029	51.85	52.564		686	0.145	0.166	60.64	60.954
662	0.643	0.054	45.29	45.989		687	0.179	0.159	61.25	61.591
663	0.437	0.022	53.42	53.879		688	0.762	0.342	55.18	56.28
664	0.467	0.047	51.23	51.745		689	0.237	0.169	61.7	62.107
665	0.783	0.045	49.78	50.612		690	0.151	0.103	60.94	61.189
666	0.8	0.023	51.58	52.399		691	0.17	0.072	57.37	57.608
667	0.841	0.068	50.75	51.662		692	0.05	0.001	57.18	57.226
668	2.665	0.158	47.66	50.484		693	0.076	0.024	57.75	57.85
669	2.812	0.129	51.45	54.395		694	0.618	2.154	54.31	57.086
670	3.936	2.4	56.08	62.419		695	0.089	0.358	61.53	61.973
671	1.405	0.168	54.9	56.47		696	0.211	0.565	59.13	59.901
672	1.82	0.208	53.19	55.217		697	0.273	0.684	58.67	59.628
673	1.931	0.195	53.77	55.891		698	0.092	0.618	60.31	61.021
674	0.996	0.106	56.08	57.181		699	0.071	0.024	59.31	59.408
675	1.561	0.095	34.35	36.003		700	0.034	0.146	62.37	62.549

n	As	S	Fe	Total		n	As	S	Fe	Total
701	0.504	1.575	42.65	44.73		726	0.067	0.017	62.46	62.547
702	0.135	0.256	60.68	61.073		727	0.244	0.006	58.58	58.825
703	0.342	1.691	47.27	49.303		728	0.096	0.015	58.76	58.87
704	0.426	2.577	52.62	55.619		729	0.105	0.007	58.93	59.043
705	0	0.042	63.19	63.231		730	0.124	0	59.15	59.273
706	0.03	0.067	61.02	61.121		731	0.061	0.027	60.96	61.051
707	0.088	0.031	57.25	57.364		732	0.176	0.019	59.32	59.512
708	0.058	0.035	58.11	58.207		733	0.052	0.014	62.18	62.244
709	0.281	0.117	52.36	52.755		734	0.425	0.015	57.33	57.771
710	0.289	0.136	47.34	47.767		735	6.137	0.06	51.46	57.654
711	0.35	0.457	52.9	53.706		736	3.924	0.038	51.55	55.511
712	2.006	0.081	52.7	54.791		737	3.995	0.028	50.81	54.83
713	1.972	0.133	51.88	53.98		738	5.788	0.047	51.18	57.013
714	0.879	0.05	55.42	56.344		739	4.157	0.038	51.61	55.804
715	1.818	0.085	49.67	51.575		740	4.077	0.032	50.99	55.1
716	1.938	0.083	53.87	55.887		741	4.098	0.049	52.04	56.182
717	0.741	0.039	55.92	56.696		742	5.591	0.054	49.17	54.813
718	0.901	0.048	57.14	58.089		743	0.95	0.066	54.48	55.493
719	0.951	0.056	55.9	56.909		744	0.906	0.047	51.89	52.846
720	2.02	0.073	53.48	55.576		745	1.286	0.026	54.01	55.324
721	1.475	0.044	54.59	56.107		746	1.279	0.078	54.84	56.199
722	0.448	0.026	57.43	57.906		747	1.604	0.135	47.44	49.177
723	0.061	0	58.79	58.852		748	1.608	0.155	45.74	47.507
724	0.067	0.012	60.33	60.409		749	0.963	0.053	54.42	55.433
725	0.046	0.018	62.63	62.695		750	1.522	0.066	53.71	55.3

n	As	S	Fe	Total	n	As	S	Fe	Total
751	1.107	0.057	54.23	55.389	776	3.961	2.116	47.47	53.543
752	0.81	0.066	55.04	55.912	777	7.316	0.824	46.55	54.687
753	0.768	0.041	56.07	56.882	778	6.917	0.129	50.81	57.856
754	0.802	0.037	55.44	56.279	779	3.749	2.067	47.38	53.2
755	0.899	0.083	52.54	53.517	780	9.403	0.115	44.98	54.496
756	1.599	0.055	53.65	55.305	781	3.243	2.478	50.35	56.07
757	1.453	0.108	52.51	54.074	782	5.013	0.182	52.89	58.081
758	0.767	0.101	55.33	56.193	783	4.176	0.317	50.49	54.98
759	0.99	0.062	48.98	50.035	784	3.352	0.098	*54.26*	57.714
760	1.349	0.101	47.81	49.257	785	4.153	0.093	*52.98*	57.223
761	1.444	0.068	52.97	54.481	786	3.419	0.129	*42.04*	45.591
762	2.238	0.118	50.85	53.209	787	1.916	0.349	*43.95*	46.211
763	2.47	0.12	50.7	53.289	788	0.703	0.018	*55.72*	56.439
764	1.313	0.082	53.94	55.331	789	0.733	1.084	*38.72*	40.534
765	1.544	0.062	52.16	53.764	790	1.094	0.437	*48.62*	50.148
766	2.224	0.115	45.44	47.779	791	0.424	0.023	*55.79*	56.235
767	2.012	0.126	51.06	53.201	792	0.198	0.011	*59.32*	59.533
768	1.309	0.092	52.99	54.386	793	0.252	0.093	*53.56*	53.9
769	1.597	0.08	51.04	52.713	794	0.835	0.093	*47.59*	48.522
770	1.76	0.079	51.48	53.321	795	0.863	0.981	*54.36*	56.205
771	1.232	0.086	49.32	50.64	796	0.897	0.058	*51.52*	52.472
772	0.984	0.036	55.2	56.22	797	0.143	0.03	*58.54*	58.715
773	1.4	0.06	52.1	53.561	798	0.546	0.26	*55.14*	55.943
774	11.92	0.129	38.83	50.878	799	1.218	1.563	*50.45*	53.231
775	3.582	0.968	48.77	53.322	800	1.456	0.99	*49.32*	51.769

n	As	S	Fe	Total		n	As	S	Fe	Total
801	0.761	0.089	50.36	51.208		826	0.704	0.048	58.4	59.155
802	0.695	1.43	56.95	59.075		827	2.979	0.062	53.26	56.297
803	0.938	0.662	50.11	51.711		828	1.863	0.066	55.53	57.458
804	0.354	0.031	49.87	50.25		829	2.518	0.069	53.39	55.976
805	0.803	0.179	48.03	49.015		830	2.458	0.121	50.48	53.055
806	0.66	0.225	56.92	57.804		831	2.474	0.072	50.49	53.033
807	0.457	0.069	55.79	56.318		832	2.254	0.083	54.89	57.222
808	0.787	0.257	51.81	52.856		833	2.065	0.071	54.99	57.127
809	2.175	0.86	50.9	53.934		834	2.689	0.102	52.54	55.33
810	2.946	0.294	50.59	53.827		835	2.128	0.063	53.21	55.402
811	3.283	0.09	52.31	55.686		836	2.674	0.054	49.69	52.416
812	5.787	0.138	47.49	53.411		837	2.733	0.088	51.74	54.56
813	0.391	0.016	58.28	58.69		838	2.521	0.08	52.87	55.469
814	0.312	0.076	38.88	39.271		839	1.974	0.088	51.95	54.008
815	0.463	0.058	52.34	52.864		840	2.576	0.084	52.11	54.765
816	0.391	0.053	50.37	50.81		841	2.153	0.083	53.68	55.913
817	0.435	0.068	43.94	44.438		842	1.079	0.101	55.4	56.576
818	0.406	0.042	44.45	44.894		843	0.95	0.085	55.17	56.209
819	0.533	0.046	42.65	43.227		844	1.873	0.784	51.55	54.205
820	0.287	0.035	39.84	40.164		845	1.052	0.105	56.48	57.639
821	0.427	0.044	47.03	47.503		846	1.023	0.73	52.32	54.07
822	0.594	0.04	50.96	51.597		847	1.06	0.145	44.08	45.288
823	0.095	0.027	61.62	61.744		848	0.933	0.144	51.93	53.006
824	0.015	0.028	62.47	62.512		849	1.098	0.197	52.95	54.246
825	5.366	0.103	46.06	51.527		850	1.026	0.182	52.26	53.464

n	As	S	Fe	Total		n	As	S	Fe	Total
851	1.393	0.046	52.89	54.331		876	3.081	0.059	52.69	55.834
852	1.219	0.09	53.67	54.975		877	4.57	0.035	52.08	56.683
853	3.999	0.039	52.58	56.615		878	3.478	0.04	49.51	53.023
854	4.066	0.056	52.5	56.624		879	2.426	0.035	57.81	60.27
855	3.993	0.038	53.73	57.76		880	3.698	0.025	49.19	52.915
856	4.409	0.055	53.21	57.678		881	2.297	1.112	56.57	59.974
857	4.604	0.042	52.8	57.445		882	7.283	1.983	46.59	55.855
858	5.188	0.032	51.69	56.907		883	4.346	0.076	42.81	47.228
859	5.138	0.058	52.36	57.554		884	4.572	0.107	53	57.676
860	4.996	0.021	52.74	57.757		885	7.348	0.778	49.1	57.228
861	4.019	0.05	52.14	56.206		886	5.035	0.447	53.47	58.955
862	2.771	0.042	52.31	55.119		887	7.583	0.635	41.1	49.318
863	5.758	0.064	40.95	46.768		888	6.177	0.559	48.94	55.671
864	9.188	0.04	49.13	58.356		889	3.78	0.695	40.78	55.251
865	6.771	0.056	51.75	58.574		890	1.058	0.62	41.9	53.578
866	8.455	0.08	49.33	57.866		891	6.573	0.617	50.85	58.042
867	7.138	0.049	51.41	58.597		892	1.879	0.684	43.17	55.73
868	7.563	0.045	51.47	59.076		893	8.381	0.561	48.68	57.621
869	2.634	0.057	53.45	56.139		894	0.357	0.405	42.21	52.971
870	2.893	0.037	53.75	56.68		895	7.922	0.506	48.86	57.284
871	2.153	0.052	42.55	44.751		896	6.042	0.532	51.85	58.423
872	2.858	0.049	52.24	55.147		897	7.333	0.823	42.33	50.483
873	1.671	0.632	54.09	56.389		898	5.161	0.412	52.94	58.517
874	3.892	0.075	50.85	54.82						
875	3.125	0.04	53.08	56.241						

n	As	S	Fe	Total
average	2.753	0.383	51.25	54.452
max	13.26	4.551	67.44	67.472
min	0	0	20.19	22.888

B.3. Data for host rock samples:

Data for Figure 14. A: traverse AA', All data are in weight %.

n	As	S	Fe	Total		n	As	S	Fe	Total
1	38.47	0.23	22.4	61.099		26	37.168	0.467	22.83	60.46
2	26.39	0.077	15.09	41.559		27	45.92	18.36	33.54	97.824
3	32.13	0.084	19.01	51.219		28	46.168	18.53	33.4	98.096
4	37.67	0.206	22.81	60.69		29	46.355	17.93	33.39	97.676
5	19.19	0.343	18.18	37.711		30	46.695	18.02	33.34	98.054
6	45.39	18.87	33.45	97.712		31	46.545	17.74	32.96	97.249
7	45.69	18.6	33.46	97.754		32	46.726	18.04	33.17	97.935
8	45.17	19.13	33.67	97.973		33	46.672	17.99	33.32	97.977
9	45.38	18.77	33.19	97.335		34	46.071	18.51	33.29	97.867
10	45.02	19.39	33.41	97.816		35	47.873	18.72	35.09	101.68
11	45.79	18.46	33.36	97.61		36	46.494	17.92	33.28	97.695
12	46.5	18.13	33.18	97.799		37	18.27	0.662	19.84	38.767
13	46.81	18.03	33.04	97.881		38	40.23	4.713	23.32	68.261
14	46.94	18.2	32.73	97.875		39	24.071	0.302	16.21	40.578
15	46.33	18.02	33.07	97.415		40	38.692	1.878	19.89	60.46
16	45.79	18.58	33.57	97.931		41	12.982	0.519	8.566	22.067
17	46.63	18.34	33.14	98.107		42	33.369	0.279	15.21	48.857
18	46.49	17.89	33.34	97.714		43	37.879	0.384	22.59	60.851
19	46.66	17.94	33.35	97.953		44	19.775	0.384	8.026	28.185
20	46.29	18.3	33.28	97.868		45	45.464	18.31	33.13	96.896
21	46.82	17.95	33.22	97.994		46	46.086	18.29	33.43	97.804
22	46.88	17.83	33.02	97.741		47	46.44	18.14	33.07	97.645
23	47.23	17.8	33.2	98.238		48	29.099	0.185	21.39	50.674
24	35.87	7.322	20.66	63.843		49	36.928	0.178	22.81	59.919
25	37.83	0.19	23.07	61.087		50	37.967	0.269	22.43	60.665

Data for Figure 15. A: traverse AA'. All data are in weight %.

n	As	S	Fe	Total		n	As	S	Fe	Total
1	38.1	0.23	21.65	59.982		26	44.574	17.57	33.48	95.628
2	39.61	0.117	22.52	62.249		27	46.401	18.64	33.15	98.193
3	33.13	0.23	18.45	51.81		28	46.587	18.13	33.27	97.983
4	7.771	0.1	13.5	21.372		29	46.062	17.06	27.46	90.584
5	10.28	0.377	13.76	24.417		30	46.327	18.36	33.42	98.107
6	12.69	0.208	14.5	27.402		31	46.452	18.26	33.35	98.058
7	0.959	0.28	5.755	6.994		32	46.05	16.16	32.19	94.404
8	0.502	1.957	1.217	3.676		33	26.678	1.629	10.88	39.183
9	0.154	2.011	2.337	4.502		34	44.483	8.333	27.35	80.164
10	0.068	2.166	0.963	3.197		35	46.799	18.73	33.16	98.688
11	0.036	5.389	0.573	5.998		36	47.172	12.36	28.04	87.572
12	0.025	7.205	0.07	7.3		37	46.66	18.44	33.53	98.631
13	0	6.695	0.097	6.792		38	46.587	18.24	33.21	98.029
14	0.027	6.591	0.118	6.736		39	46.156	18.56	33.12	97.84
15	46.21	18.79	32.91	97.9		40	46.58	18.37	33.29	98.24
16	48.77	18.51	32.47	99.752		41	36.162	14.57	22.62	73.347
17	46.63	18.41	33.44	98.482		42	46.529	18.34	33.34	98.205
18	47.14	17.03	28.49	92.656		43	47.12	18.33	32.94	98.394
19	46.83	18.22	33.41	98.458		44	0.099	6.49	0.26	6.849
20	25.26	5.155	19.6	50.017		45	0.076	7.759	0.076	7.911
21	46.7	18.11	33.52	98.327		46	0.047	4.888	0.087	5.022
22	42.55	15.65	28.87	87.063		47	1.103	4.541	0.912	6.556
23	3.53	0.454	1.379	5.363		48	8.207	0.657	18.54	27.406
24	45.71	19.06	32.95	97.72		49	31.755	0.123	20.27	52.152
25	42.37	16.21	31.48	90.06		50	31.208	0.139	18.32	49.671

Data for Figure 15. C: traverse AA'. All data are in weight %.

N	As	S	Fe	Total
1	34.21	0.188	13.33	47.729
2	5.303	0.346	12.24	17.885
3	7.065	0.623	14.17	21.853
4	4.095	0.339	10.94	15.373
5	9.631	0.087	14.22	23.937
6	25.23	0.136	13.01	38.378
7	6.296	0.081	8.076	14.453
8	2.546	0.027	10.81	13.382
9	9.784	0.063	14.01	23.854
10	2.448	0.054	19.81	22.309
11	3.908	0.065	17.46	21.437
12	7.379	0.16	9.647	17.186
13	3.013	0.067	6.627	9.707
14	3.439	0.135	15.4	18.976
15	1.784	0.185	4.688	6.657
16	0.486	0.197	7.42	8.103
17	5.478	0.07	18.24	23.789
18	7.541	0.748	13.07	21.357
19	17.41	0.121	13.95	31.482
20	19.06	0.131	14.41	33.602
21	1.78	0.204	13.29	15.274
22	33.58	0.298	12.96	46.84
23	35.91	0.361	12.96	49.228
24	33.31	0.267	12.91	46.49
25	1.523	0.042	4.304	5.869
26	0.085	0.016	3.745	3.846
27	21.94	0.09	9.56	31.592