4. GEOCHEMISTRY AND SULFUR-ISOTOPIC COMPOSITION OF THE TAG HYDROTHERMAL MOUND, MID-ATLANTIC RIDGE, 26°N¹

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ABSTRACT

Eighty-five bulk samples consisting of varying proportions of pyrite, silica, and anhydrite and 82 mineral separates (pyrite, chalcopyrite) from the TAG hydrothermal mound were analyzed using Neutron Activation Analyses (INAA), Inductively Coupled Plasma Emission Spectrometry (ICP-ES), Inductively Coupled Plasma Mass Spectrometry (ICP-MS), and sulfur-isotopic methods. The samples were collected from five different areas of the Trans-Atlantic Geotraverse (TAG) mound during Ocean Drilling Program Leg 158. The chemistry of the bulk samples is dominated by high Fe (average 30.6 wt%, n = 57) and S concentrations (average 42.0 wt%, n = 50), reflecting the high amount of pyrite in these rocks. High Ca (up to 11.5 wt%, n = 57) and SiO₂ values (up to 49.8 wt%, n = 50) indicate the presence of anhydrite-rich zones in the center of the mound, and pyritesilica breccias, silicified wallrock breccias, and paragonitized basalt breccias deeper in the system. The Cu and Zn concentrations vary from <0.01 to 12.2 wt% Cu (average 2.4 wt%, n = 57) and from <0.01 to 4.1 wt% Zn (average 0.4 wt%, n = 57), with = 57highest values commonly occurring in the uppermost 20 m of the mound. Most trace-element concentrations are relatively low compared to other mid-ocean ridge hydrothermal sites and average 0.5 ppm Au, 43 ppm As, 234 ppm Co, 2 ppm Sb, 14 ppm Se (n = 85), 9 ppm Ag, 11 ppm Cd, and 59 ppm Pb (n = 57). Gold, Ag, Cd, Pb, and Sb behave similarly to Cu and Zn and are enriched close to the surface of the mound. This is interpreted as evidence for zone refining, a process in which elements that are mobilized from previously deposited sulfides in the interior of the mound by later hydrothermal fluids are transported to the surface, where they reprecipitate as a result of mixing with ambient seawater. The trace-element composition of pyrite and chalcopyrite separates is similar to the bulk geochemistry. However, down to about 50 mbsf, Au, As, Sb, and Mo values in pyrite separates are generally higher than in bulk samples and chalcopyrite separates. Below this depth, these elements appear to be enriched in chalcopyrite separates. Cobalt is typically more enriched in pyrite than in chalcopyrite throughout. A major difference between pyrite and chalcopyrite separates is the strong enrichment of Se in chalcopyrite at the top of the mound, whereas pyrite separates show a moderate increase of Se with depth. Sulfur-isotopic values for bulk sulfides from the interior of the TAG mound vary from +4.6‰ to +8.2‰, with an average of +6.4 $\% \delta^{34}$ S (n = 49). These values do not change significantly downhole, but samples collected from the top of the mound appear to have somewhat lower δ^{34} S values than samples from the interior. The average δ^{34} S value for TAG sulfides is about 3‰ higher than for most other sulfides generated at sediment-free mid-ocean ridges (average 3.2‰, n = 501). This is largely attributed to thermochemical sulfate (anhydrite) reduction by hightemperature hydrothermal fluids upwelling through the interior of the TAG mound.

INTRODUCTION

In September-November 1994, Ocean Drilling Program Leg 158 intersected for the first time an active hydrothermal system on a sediment-free mid-ocean ridge. Drilling target was the active Trans-Atlantic Geotraverse (TAG) hydrothermal mound located at a water depth of 3650 m in the TAG hydrothermal field at the Mid-Atlantic Ridge, 26°N. Seventeen holes drilled at five locations on the TAG mound reveal the subsurface nature and lateral heterogeneity of this actively forming deposit and establish the extent of the underlying alteration zone down to a depth of 125 mbsf (Humphris et al., 1995). This paper describes the major- and trace-element geochemistry and the sulfur-isotopic composition of samples recovered from the interior of the TAG hydrothermal mound.

GEOLOGIC SETTING

The TAG hydrothermal field extends over an area of at least 5×5 km and is located at the base and slope of the eastern wall of the Mid-Atlantic Ridge at 26°N (Fig. 1). It consists of presently active low- and high-temperature zones, as well as a number of relict depos-

its that in part may be related to small volcanic centers (Rona et al., 1996). The zone of low-temperature hydrothermal activity occurs between 2400 and 3100 m depth on the eastern wall of the rift valley and includes massive, layered deposits of Mn oxide, amorphous Fe oxide, and nontronite (Rona et al., 1984; Thompson et al., 1988). Two large relict zones are located on the lower east wall. The *Alvin* zone consists of several discontinuous sulfide deposits associated with mound-like features with dimensions similar to the active mound. The *Mir* zone is a large sulfide deposit displaying various stages of seafloor weathering and locally has numerous inactive standing and toppled sulfide chimneys up to 25 m in height (Rona et al., 1993).

The active TAG hydrothermal mound (Fig. 1) is a distinctly circular feature, about 200 m in diameter and 50 m in height, located at a water depth of 3650 m on oceanic crust at least 100 ka (Rona et al., 1986). The mound exhibits two distinct, flat platforms that may represent two phases of active growth (Kleinrock et al., 1996). Radiometric dating of sulfides has been interpreted to indicate that the formation of massive sulfides at the TAG mound started about 50–20 ka, with high-temperature pulses every 5000–6000 years (Lalou et al., 1993). The present high-temperature activity apparently commenced about 60 yr ago.

Numerous submersible studies have described that the dominating hydrothermal feature of the active TAG mound is the Black Smoker Complex which is located on a 10- to 15-m high, 20- to 30m diameter cone located northwest of the center. This complex consists of an unknown number of highly active black smoker chimneys (chalcopyrite-anhydrite-pyrite) venting fluids at temperatures of up to 363°C (Edmond et al., 1995). A group of white smokers (domi-

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Figure 1. SeaBeam bathymetry (50-m contour interval) of the TAG hydrothermal field showing the locations of volcanic domes, the active TAG mound, the low-temperature hydrothermal field (LT) up on the eastern rift valley wall, and the *Alvin* and *Mir* relict hydrothermal zones (after Rona et al., 1993).

nantly sphalerite-pyrite), venting fluids at 260°–300°C, is located approximately 70 m southeast of the Black Smoker Complex (Kremlin area). Mass wasting of the edges of the inner mound results in steep outer slopes covered with pyrite-rich blocks containing trace amounts of amorphous silica, quartz, and goethite, and outer oxidized layers that include atacamite, amorphous Fe oxides, goethite, hematite, amorphous silica, and locally high concentrations of gold (Herzig et al., 1991). The outer mound is surrounded by an apron of carbonate and metalliferous sulfide-oxide sediment that extends up to about 100 m away from the mound.

SUMMARY OF DRILLING RESULTS

Seventeen holes drilled at five locations on the active TAG mound (TAG-1 to 5; Fig. 2) revealed the overall internal structure of the mound and the underlying upflow zone down to a maximum depth of 125 mbsf (TAG-1 area). Based on composite sections for each area (Fig. 2), four major lithologic zones can be distinguished (Humphris et al., 1995; Fig. 3): Zone 1 (0-20 mbsf) consists of massive pyrite and massive pyrite breccias with pyrite clasts up to 5 cm in a matrix of porous, sandy pyrite and is locally overlain by Fe oxyhydroxides and cherts. Zone 2 (20-45 mbsf) contains pyrite-anhydrite breccias with rounded pyrite clasts (up to 2 cm) cemented by anhydrite down to 30 mbsf. This is followed by pyrite-silica-anhydrite breccias, which are made up of clasts of siliceous pyrite, quartz-pyrite aggregates, and granular pyrite in a quartz matrix. The pyrite-silicaanhydrite breccias are commonly crosscut by anhydrite veins up to 45 cm in thickness. Zone 3 (45-100 mbsf) is dominated by pyrite-silica breccias (gray fragments of preexisting mineralized and silicified wallrock and quartz-pyrite clasts in a matrix of fine-grained quartz) grading into silicified wallrock breccias that consist of clasts of basaltic fragments (up to 5 cm) that are recrystallized to quartz, pyrite, and smectite. This zone is interpreted to comprise the upper part of the stockwork zone. Zone 4 (100-125 mbsf) is dominated by altered basalt breccias composed of chloritized and paragonitized, weakly mineralized basalt fragments (up to 5 cm) in a matrix of quartz and pyrite, crosscut by veins of pyrite, quartz, and quartz + pyrite. This zone is thought to represent the lower part of the stockwork and upflow zone beneath the TAG mound.

SAMPLES AND METHODS

A total of 85 bulk samples consisting of varying proportions of pyrite, silica, and anhydrite from areas TAG-1 to 5, and 82 handpicked pyrite and chalcopyrite separates from the TAG-1 area were selected for Neutron Activation Analyses (INAA), Inductively Coupled Plasma Emission Spectrometry (ICP-ES) and Inductively Coupled Plasma Mass Spectrometry (ICP-MS) using standard analytical procedures; sulfur was analyzed with a Leco system. Sulfur-isotopic analyses were conducted on bulk sulfide samples following the method of Ueda and Krouse (1986). Prior to analysis, anhydrite was removed from the samples by dissolution of CaSO₄ using artificial seawater. Following this process, selected samples were analyzed by Atomic Absorption Spectrophotometry (AAS) to prove complete Ca (and thus anhydrite) removal. Sulfur isotope ratios are reported in standard delta notation relative to the Canyon Diablo Troilite (CDT). Replicate analysis of standards yields a standard deviation of less than 0.2%. Sulfur dioxide gas for mass spectrometric analysis was prepared by combustion of sulfides with V₂O₅ and quartz at 950°C and analyzed for sulfur-isotopic ratios using a Finnigan Delta E mass



Figure 2. High-resolution bathymetric map (5-m contour interval) of the active TAG mound (Kleinrock et. al., 1996) showing the upper and lower platforms, the area of black smoker venting (Black Smoker Complex), and the area of white smoker venting (Kremlin area). The location of the holes drilled during Leg 158 in five different areas of the mound (TAG-1 to -5) are also shown.

spectrometer. Sample designation, depth interval, analytical method with detection limits, and the geochemical composition of the samples are given in the data report by Hannington et al. (Chap. 2, this volume) and in Brügmann et al. (Chap. 7, this volume). As indicated in Table 1, the emphasis of this study is the TAG-1 area (in which Hole 957E reached the maximum penetration of 125 mbsf) with 40 bulk samples, 56 pyrite, and 25 chalcopyrite separates analyzed. Selected bulk samples from the TAG-2 to TAG-5 areas were analyzed to document the lateral heterogeneity of sulfide mineralization.

RESULTS

Major- and Trace-Element Geochemistry

The major-element geochemistry of the bulk samples analyzed from holes drilled in the TAG-1 to 5 areas (Tables 1, 2) strongly reflects their mineralogical composition (Knott et al., Chap. 1, this volume). High Fe (3.8–48.1 wt%, average 30.6 wt%) and S (5–53.3 wt%, average 42 wt%) concentrations reflect the predominance of pyrite in the mound. Average Cu and, in particular, Zn concentrations

are relatively low compared to other sediment-free mid-ocean ridge sulfides, reaching only 2.4 wt% Cu and 0.4 wt% Zn (Table 2). Locally, high amounts of Ca (up to 11.5 wt%) and SiO₂ (up to 49.8 wt%) occur in anhydrite-rich zones in the center of the mound and in silicarich zones (pyrite-silica breccias, silicified wallrock breccias, and chloritized and paragonitized basalt breccias) deeper in the system. High SiO₂ concentrations also characterize chert fragments recovered from the surface of the mound (up to 92.7 wt%).

With the exception of Mo, most trace-element concentrations of the TAG bulk samples are relatively low when compared to samples from other sediment-free mid-ocean ridge sites and average 43 ppm As, 14 ppm Se, 11 ppm Cd, <10 ppm Ni, 3.5 ppm Tl, and 234 ppm Co (Table 2). In particular, the average concentrations of Ba (95 ppm), Pb (59 ppm), Ga (8 ppm), In (1 ppm), Sb (2 ppm), and Ag (9 ppm) are much lower than the average values for sulfides from sediment-free mid-ocean ridges (Table 2). Gold concentrations range from < 5 ppb to 3.2 ppm, with an average of only 0.5 ppm Au (n = 85), which is approximately half the average Au content of sulfides from sediment-free mid-ocean ridge sites (0.9 ppm Au, n = 829; Table 2).



Figure 3. Schematic diagram of the TAG hydrothermal mound showing the surface morphology and distribution of venting, as well as the generalized and simplified internal structure based on the results of drilling during Leg 158.

Table 1. Number and types of samples analyzed from Leg 158 drilling areas TAG-1 to -5.

	Bulk samples	Pyrite separates	Chalcopyrite separates
TAG-1 (C, E, F, G) TAG-2 (A, B, H, N) TAG-3 (Q) TAG-4 (I, J, K, M) TAG-5 (O, P)	40 12 4 17 12	56 1	25

Note: Holes drilled in each area are shown in parentheses.

Lateral Heterogeneity of Major- and Trace-Element Compositions

A comparison of major- and trace-element data for the different drilling areas of the TAG mound indicates major differences that are related to variations in lithology (Table 3). The chemical composition of samples from the TAG-1 and TAG-5 areas is relatively similar, reflecting the similarities in the lithologies recovered, including a zone characterized by a relatively high abundance of anhydrite (3 and 2.6 wt% Ca, respectively). Cobalt and Se concentrations are higher than in the TAG-3 and TAG-4 areas, but similar to results obtained for samples from the TAG-2 area (Kremlin), whereas the concentrations of Zn and associated elements (Cd, Au, Ag, Sb, Pb, In, Ga) in the TAG-1 and TAG-5 areas are distinctly lower than in the TAG-2, -3, and -4 areas (Table 3).

Samples from the TAG-2 area (Kremlin) are characterized by the highest average Cu, Ag, Pb, Ga, and In concentrations, and elevated Zn concentrations (0.7 ppm). Relative to the other areas, samples from the TAG-4 area have the highest Zn, As, Cd, Mo, Sb, and Tl concentrations, high Pb, and the lowest Cu and Se concentrations.

Chemical Composition of Lithologic Units

In accordance with the initial shipboard core descriptions, the analyzed samples were grouped into six major lithologies including (1) Fe oxides and cherts recovered from the surface of the mound, (2) massive pyrite and massive pyrite breccia present in the uppermost part of the mound, (3) pyrite-anhydrite-silica breccia located in the central mound, (4) pyrite-silica breccia representing the upper stockwork zone, (5) silicified wallrock breccia, and (6) chloritized and paragonitized basalt breccia from the deeper stockwork zone (Table 4). The Fe oxides and cherts from the uppermost surface of the mound are characterized by relatively low average Fe concentrations (17.6 wt%) compared to the pyrite-bearing assemblages (average up to 34.5 wt% Fe), but high SiO₂ concentrations (average 61.7 wt%) reflecting the abundance of cherts. Copper and Zn in the uppermost surface layer average only 0.7 wt% and 0.5 wt%, respectively. Gold (1.1 ppm), Ag (18 ppm), Cd (17 ppm), Pb (120 ppm), and Sb (4 ppm) in the Fe oxides and cherts have concentrations similar to those found in the massive pyrite and massive pyrite breccia samples (1.1 ppm Au, 24 ppm Ag, 37 ppm Cd, 135 ppm Pb, 4.2 ppm Sb) and, in both units, are generally higher than the average values for the other lithologies. The massive pyrite and massive pyrite breccia samples are significantly enriched in Cu (average 4.2 wt%) and Zn (average 1.3 wt%) relative to the other units. The Cu concentration in the pyriteanhydrite-silica breccias averages 2.9 wt%, whereas Zn concentrations average only 600 ppm. This is accompanied by low values for most trace elements except As, Co, Mo, and Se. The pyrite-silica breccias are typically characterized by high average SiO₂ concentrations (26.5 wt%), low Cu (1.5 wt%), and Zn (1200 ppm), with traceelement concentrations similar to those of pyrite-anhydrite-silica breccias and silicified wallrock breccias. Samples of silicified wallrock breccia and one sample of chloritized and paragonitized basalt

Table 2. Major- and trace-element composition of bulk sulfide samples from the interior of the TAG hydrothermal mound.

			TAG		MC)R
	Method	n	Range	Average	Average	n
Major elements (wt%)						
Fe	ICP-ES	57	3.8-48.1	30.6	24.9	1171
S	Leco	50	5.0-53.3	42.0	34.0	958
Cu	ICP-ES	57	0.01-12.2	2.4	4.0	1102
Zn	ICP-ES	57	< 0.01-4.1	0.4	10.4	1158
SiO ₂	ICP-ES	57	0.3-92.7	19.2	9.9	1021
Ca	ICP-ES	57	0.04-11.5	2.0	2.6	940
Trace elements (ppm)						
Au	INAA	85	< 0.005-3.2	0.5	0.9	829
Ag	ICP-MS	57	0.3-160	9	111	1063
Aš	INAA	85	8-140	43	265	835
Ba	ICP-ES	57	<30-560	95	15500	992
Cd	ICP-ES	57	< 0.5-200	11	293	726
Co	INAA	85	<5-750	234	311	1106
Cr	INAA	85	<10-79	23	25	724
Ga	ICP-MS	57	0.4-95	8	47	218
In	ICP-MS	57	< 0.05-15	1	8.4	87
Mo	INAA	85	6-20	89	89	809
Ni	ICP-ES	57	<10-35	<10	47	970
Pb	ICP-MS	57	4-430	59	1200	1077
Sb	INAA	85	0.1-16	2	42	828
Se	INAA	85	<5-86	14	97	729
T1	ICP-MS	57	0.2-30	3.5	28	158

Notes: The average chemical composition of massive sulfides from hydrothermal sites at sediment-free mid-ocean ridges (MOR) is given for comparison (S. Petersen and Geological Survey of Canada, unpubl. data). n = number of analyses.

 Table 3. Comparison of the chemical composition of bulk sulfides from

 TAG-1 to TAG-5 areas.

	TAG-1	TAG-2	TAG-3	TAG-4	TAG-5
	(n = 25)	(n = 5)	(n = 4)	(n = 13)	(n = 10)
ICP (wt%)					
Fe	31.6	27.8	15.1	33.0	32.5
S	42.1	38.3	41.2	39.9	45.7
Cu	2.0	4.6	2.5	1.1	3.7
Zn	< 0.1	0.7	0.3	1.3	< 0.1
SIO ₂	14.4	24.2	62.3	22.0	7.7
Ca	3.0	1.6	0.1	< 0.1	2.6
ICP (ppm)					
Ag	1	48	9	12	3
Ba	86	74	34	125	112
Cd	<1	19	15	35	2
Ga	2	22	12	16	4
In	0.3	4.3	2.1	1.0	1.0
Pb	21	154	59	115	34
TI	1.8	2.5	1.2	8.8	2.5
	(n = 40)	(n = 12)	(n = 4)	(n = 17)	(n = 12)
INAA (ppm)					
Au	0.2	0.9	1.3	1.0	0.3
As	36	32	31	66	46
Co	254	250	42	113	385
Cr	22	28	11	20	30
Mo	85	70	31	115	104
Sb	0.7	3.0	2.3	4.2	1.0
Se	14	16	<5	<5	34

Note: n = number of analyses.

appear to have similar average major and trace element concentrations.

The Fe and S concentrations clearly indicate the abundance of pyrite in the upper part of the mound down to pyrite-silica breccias, averaging 31.7-34.5 wt% Fe and 40-46.4 wt% S. Low SiO₂ concentrations (except for the surface cherts) are typical for the upper part of the mound, whereas the beginning of the stockwork zone is marked by a strong increase in SiO₂. The average Cu concentration is highest in the massive pyrite and massive pyrite breccias (average 4.2 wt%), but also high in pyrite-anhydrite breccias because of the presence of chalcopyrite selvages on anhydrite veins and disseminated chalcopyrite in massive anhydrite. High concentrations of Cu are found in the massive pyrite and pyrite breccias, and pyrite-anhydrite \pm silica breccias, whereas Zn is only concentrated in the massive pyrite and pyrite breccias (average 1.3 wt%). The Ca values clearly reflect the dominance of anhydrite in the pyrite-anhydrite-silica breccias (average 4.1 wt%). The relatively high Ca content of the silicified wallrock breccias (average 2.4 wt%) is largely the result of the local occurrence of anhydrite veins in these breccias. The variation of Au concentrations is similar to those observed for Cu, with highest concentrations in Feoxides/cherts (1.1 ppm) and the massive pyrite and pyrite breccias (1.1 ppm). The lowest concentrations were measured in the chloritized and paragonitized basalt sample (60 ppb) which, however, is still enriched in Au relative to the average Au content of mid-ocean ridge basalt (MORB; 1 ppb Au; Crocket, 1991). Most trace elements follow the same trend with the exception of Co and Se, which appear to be enriched in the lower parts of the mound.

Downhole Distribution of Major- and Trace-Elements in the TAG-1 to TAG-5 Areas

TAG-1 Area (Black Smoker Complex)

The downhole distribution of selected major elements in the TAG-1 area close to the Black Smoker Complex is given in Figure 4. The Fe and S concentrations are positively correlated and reflect the presence of pyrite-bearing breccias. Silica concentrations are highly variable, but consistently high below 50 mbsf (except for Sample 158-957E-12R-1, 16-20 cm, at 92 mbsf, which contains abundant vein-related pyrite). The Ca concentration is high in samples originating from the upper part of the mound and the pyrite-anhydrite zone, and decreases in the stockwork zone. Copper is enriched in the upper part of the TAG-1 area. Higher values in deeper parts of the mound correspond to the occurrence of disseminated chalcopyrite in anhydrite veins. Zinc concentrations are generally low, but relatively elevated in the upper 45 m. Gold, Ag, Sb, In, and Ga concentrations appear to decrease downhole. Cadmium typically mirrors the downhole distribution of Zn, consistent with its occurrence as a trace component in sphalerite. Lead and As concentrations are generally low, without any downhole variation. The vertical distribution of Co and Mo is erratic. The small increase in Se concentration at the surface of the mound is likely a result of the presence of collapsed chimney fragments, which have been shown to contain high Se contents (Tivey et al., 1995). Most element concentration vs. depth profiles exhibit large variability within the pyrite-anhydrite zone.

A comparison of the chemical composition of bulk samples with pyrite and chalcopyrite separates from the TAG-1 area indicates some contrasting trends (Fig. 5). Similar to the downhole Au distribution in bulk samples, the pyrite separates indicate an enrichment of

Fable 4. Comparison of the chemical composition of	f different lithologic zones identified in	n drill cores from the TAG hy	ydrothermal mound
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	Cherts/ Fe oxides	Massive pyrite + pyrite breccias	Pyrite-anhydrite ± silica breccias	Pyrite-silica breccias	Silicified wallrock breccias	Chloritized basalt breccias
	(n = 6)	(n = 12)	(n = 15)	(n = 15)	(n = 8)	(n = 1)
ICP (wt%)						
Fe	17.6	34.9	33.5	30.3	29.2	29.1
S	5.0	45.7	46.3	40.0	37.7	37.1
Cu	0.7	4.3	3.0	1.5	1.5	>0.1
Zn	0.52	1.44	0.05	0.12	0.01	0.01
SiO ₂	61.7	3.7	4.2	26.5	23.1	32.7
Ca	0.2	1.4	4.3	0.6	2.4	0.2
ICP (ppm)						
Ag	18	26	2	3	1	0.6
Ba	110	108	93	88	81	80
Cd	17	40	1	3	< 0.5	< 0.5
Ga	15	23	3	2.4	1.4	0.4
In	1.5	2.9	0.5	0.5	0.2	< 0.1
Pb	120	141	26	27	19	18
Tl	1.9	9.3	2.4	2.0	1.4	0.9
	(n = 6)	(n = 20)	(n = 22)	(n = 23)	(n = 13)	(n = 1)
INAA (ppm)						
Au	1.3	1.1	0.2	0.2	0.1	0.06
As	49	63	41	33	26	43
Co	11	140	260	326	259	420
Cr	8	23	18	27	31	20
Mo	32	117	96	83	74	62
Sb	4.5	4.3	0.7	0.9	0.6	0.5
Se	3	9	12	19	23	29

Notes: n = number of analyses. Cherts and Fe oxides represent the uppermost part, whereas chloritized basalts are the lowermost lithology encountered during drilling.

gold in the upper part of the mound. Chalcopyrite separates show an additional enrichment below 45 mbsf. A similar pattern is obvious for the downhole distribution of As, Sb, and Mo. Down to about 50 mbsf, Au, As, Sb, and Mo values in pyrite separates are generally higher than in bulk samples and chalcopyrite separates. The distribution of Co in bulk samples and chalcopyrite separates shows no downhole trends, whereas the downhole distribution of Co in pyrite separates appears to show a moderate increase with depth to 75 mbsf. Below this, a drop in Co concentrations is apparent followed again by a downhole increase. High Co concentrations (up to 1200 ppm) are caused by the preferred incorporation of Co in the pyrite lattice. The most pronounced difference between bulk samples and pyrite and chalcopyrite separates is documented by the concentration of Se. Bulk samples and, in particular, pyrite separates indicate an increase in concentration downhole. The Se distribution in pyrite separates is similar to the Co distribution and also shows a drop around 75 mbsf with subsequent increase at depth. The chalcopyrite separates, however, have extremely high concentrations (up to 1000 ppm Se) near the top of the mound that significantly drop to lower concentrations within the upper 20 mbsf and reach background values at depth. This is consistent with high Se values found in chalcopyrite-anhydritepyrite samples collected with Alvin from the Black Smoker Complex (up to 630 ppm Se; Tivey et al., 1995).

TAG-2 Area (Kremlin)

The downhole concentrations of major and trace elements in the TAG-2 area (Kremlin) are shown in Figure 6. Iron and S concentrations are constantly high. The SiO₂ concentrations are high for a chert sample at the top of the mound and for pyrite-silica breccias below 27 mbsf. The Ca peak at 9.3 mbsf corresponds to the presence of anhydrite-cemented pyrite breccias. Striking is the strong enrichment of Cu and Zn, together with Ag, Cd, Pb, Au, Sb, In, and Ga in samples from the surface of the Kremlin area. Thallium is enriched in the uppermost samples and in one sample from deeper in the system. The As concentrations are only insignificantly higher in the upper samples and appear to slightly decrease downhole. The concentrations of Mo are indifferent downhole, whereas Co and Se show an increase in concentration with depth. The change in concentration of some elements at 27 mbsf is caused by the change in lithology from pyrite-anhydrite to pyrite-silica breccias and the associated dilution by silica.

TAG-4 Area

Samples from the west side of the mound are characterized by a good correlation of Fe and S values downhole with the exception of the uppermost Fe oxyhydroxide sample (Fig. 7). The silica distribution strongly increases at 15 mbsf, corresponding to a change in lithology from massive pyrite to pyrite-silica breccias. This effect can be observed in all downhole element profiles in this area. Zinc, Ag, Cd, Pb, Ga, and Tl are enriched near the surface, whereas Cu and Co are enriched below this depth. The concentrations of Au, As, and Sb also largely mirror the downhole distribution of Zn. TAG-4 is the only area in which a downhole increase instead of a decrease of Cu is observed. Indium concentrations appear to follow the depth profile of Cu. The depth profiles of Ga and Cd are largely similar and follow the Zn distribution downhole. This is explained by the preferred incorporation of Ga and Cd in sphalerite.

TAG-5 Area

In samples from the northern part of the mound, Fe and S values are well correlated, similar to other areas (Fig. 8). Silica concentrations increase downhole because of the presence of silica in silicified wallrock breccias and chloritized and paragonitized basalts, whereas Ca concentrations are enriched in anhydrite veins and pyrite-anhydrite breccias occurring close to the seafloor in this area. Copper and Zn show a general decrease in concentration downhole, but are somewhat enriched in massive pyrite samples occurring between 10 and 20 mbsf. The depth profiles of Ag, Cd, Pb, Au, In, Ga, and to some extent, Sb, As, and Tl, largely follow the downhole distribution of Cu and Zn. Indium and Ga profiles show analogies to the depth profile of Ag, whereas the Mo distribution is somewhat similar to Fe. Cobalt appears to increase in concentration downhole, whereas the Se distribution is more erratic.

Element Correlations and Correlation Coefficients

A correlation matrix for all bulk samples analyzed from the TAG-1 to TAG-5 areas (Fig. 9) indicates a statistically significant correlation (99% confidence level) of the elements Zn, Ag, Au, Sb, In, Ga, Pb, and Cd, which are typically of submarine massive sulfides of low-temperature hydrothermal origin (cf. Hannington et al., 1991).

GEOCHEMISTRY AND SULFUR-ISOTOPIC COMPOSITION



Figure 4. Downhole distribution of selected major and trace elements in bulk sulfide samples from the TAG-1 area (Black Smoker Complex: Holes 957C, 957E, 957F, and 957G).



Figure 4 (continued).



Figure 5. Comparison of the downhole distribution of selected trace elements in bulk sulfide samples (left), pyrite separates (center), and chalcopyrite separates (right) from the TAG-1 area (Black Smoker Complex: Holes 957C, 957E, 957F, and 957G).



Figure 5 (continued).

GEOCHEMISTRY AND SULFUR-ISOTOPIC COMPOSITION



Figure 6. Downhole distribution of selected major and trace elements in bulk sulfide samples from the TAG-2 area (Kremlin area: Holes 957A, 957B, 957H, and 957N).



Figure 6 (continued).

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Figure 7. Downhole distribution of selected major and trace elements in bulk sulfide samples from the TAG-4 area (west side of the mound: Holes 957I, 957J, 957K, and 957M).



Figure 7 (continued).

GEOCHEMISTRY AND SULFUR-ISOTOPIC COMPOSITION



Figure 8. Downhole distribution of selected major and trace elements in bulk sulfide samples from the TAG-5 area (north side of the mound: Holes 957O, 957P).



Figure 8 (continued).

The best correlations within this group of elements occur for Ag/In (r = 0.92, n = 57), Pb/Sb (r = 0.92, n = 57), Ga/Cd (r = 0.91, n = 37), and Au/Sb (r = 0.89, n = 85). The most significant correlation of the entire data set is found for Sr/Ca (r = 0.98, n = 36) and is explained by the preferred substitution of Sr for Ca in anhydrite. A correlation coefficient of r = 0.87 (n = 37) for Zn/Cd and r = 0.72 (n = 57) for Zn/Tl indicates the presence of Cd and Tl in the sphalerite lattice.

The correlation coefficients (99% confidence level) of particular element pairs show significant differences when compared for the TAG-1, -2,- 4, and -5 areas (Fig. 10). This is also obvious from Table 5, which compares selected element correlations for these areas. In the TAG-1 area, a good correlation within the low-temperature group of elements is obvious. Silica is clearly negatively correlated with this group of elements (Zn, Au, Ag, As, Sb, Tl, Ga, In, and Pb), as well as with Cu, Fe, and S. The strong affinity of Sr and Ca in anhydrite, Fe and S in pyrite, and Zn and Cd in sphalerite is documented by correlation coefficients of r = 0.98 (Sr/Ca, n = 20), r = 0.93 (Fe/S, n = 25), and r = 0.92 (Zn/Cd, n = 9). In the TAG-1 area, Cu correlates positively with Ag, Ga, In, Mo, and Sb.

In the TAG-2 area, only a limited number of samples were analyzed for all elements. However, a positive correlation of the low-temperature element association can also be recognized.

The correlation matrix for the samples from the TAG-4 area indicates that the correlation among the low-temperature suite of elements is less pronounced. In particular, the Au/Ag, Au/Pb, Au/Zn correlations as well as the correlation of In and Ga with other elements of this group, do not exist. Significant correlations occur for Ca/V (0.97, n = 9), Ba/Ca (r = 0.96, n = 12), Cd/Ga (0.94, n = 13), Ba/V (0.92, n = 9), Pb/Tl (0.86, n = 13), and Fe/SiO₂ (r = -0.97, n = 12). In contrast to other areas, a negative correlation of Cu with Ag and Sb is observed.

Elemental correlations for samples originating from the TAG-5 area show a number of close similarities with those of the TAG-1 area. The correlation among elements of the low-temperature association is even better developed as in the TAG-1 area. However, the coefficients for the correlation of Fe, S, and SiO₂ are insignificant. Clearly outstanding are the Zn/Cd (r = 0.99, n = 7), In/Ga (r = 99, n = 10), and Sr/Ca (r = 0.99, n = 10) correlations. Among other pairs, In/Ag (r = 0.98, n = 10), Cd/In (r = 0.97, n = 7), Zn/In (r = 0.96, n = 10), Cd/Ag (r = 0.96, n = 10), Zn/Ag (r = 0.96, n = 10); Cu/In (r = 0.95, n = 10), Au/Ag (r = 0.95, n = 10); and Ga/Ag (r = 0.95, n = 10) also show statistically significant correlations.

The good positive correlation of Cu with Au, Ag, Sb, Cd, In, and Ga is not typical for seafloor hydrothermal systems, whereas elements of the low-temperature assemblage are found to correlate well in many other seafloor hydrothermal sites (cf. Hannington et al., 1991).

SULFUR ISOTOPES

Forty-nine bulk samples from the TAG-1 to TAG-5 areas were investigated for their sulfur-isotopic ratios. The average δ^{34} S values of duplicate analyses are given in Table 6, together with a description of the samples analyzed. All δ^{34} S ratios are within a narrow interval of +4.6‰ to +8.2‰, with an average of +6.4‰ δ^{34} S (n = 49; Fig. 11). The average sulfur-isotope ratios for the TAG-1 to TAG-5 areas are only insignificantly different from each other, ranging from +6.6‰ at TAG-2 to +6.2‰ at TAG-5 (Table 7). The average δ^{34} S ratios for samples from the massive pyrite zone (+5.8‰) and the pyrite-anhydrite zone (+5.9‰) are nearly 1‰ depleted compared to the footwall lithologies, averaging +6.8‰ and +6.7‰ respectively (Table 7).

An increase in the sulfur-isotopic ratio downhole is not obvious in all areas, but is distinct in the depth profiles for the TAG-2 and TAG-4 areas (Fig. 12).

The average δ^{34} S ratios of sulfides from the TAG mound are about 3‰ higher than the average δ^{34} S ratio of sulfides from any other hydrothermal system at sediment-free mid-ocean ridges (Fig. 13). Similar high sulfur-isotopic ratios have so far only been reported from sediment-hosted massive sulfide deposits at the mid-ocean ridges or backarc spreading centers in the southwest Pacific. Here, elevated δ^{34} S values are explained by the contribution of seawater sulfate (+21‰) either through sediments filling the active rift valley and reacting with the upwelling hydrothermal fluids (sedimented midocean ridges) or through subducted sediments and the formation of backarc volcanics with elevated initial δ^{34} S values (backarc rifts).

DISCUSSION

Humphris et al. (1995) and Hannington et al. (Chap. 28, this volume) have pointed out that the internal structure of the TAG mound bears striking similarities to ancient volcanic-hosted massive sulfide deposits preserved in ophiolites, such as the Troodos ophiolite in Cyprus, the Semail ophiolite in Oman, and the Bay of Islands ophiolite in Newfoundland. Similarities between the TAG mound and ancient ophiolitic massive sulfide deposits include the abundance and types of breccia ores and sulfide conglomerates, the occurrence of Fe-bearing cherts, and the size as deduced from the results of drilling. The major- and trace-element geochemistry and the metal distribution within the TAG mound strongly support this analogy.

Similar to the massive pyrite and massive pyrite breccias of the TAG mound, massive ore of the sulfide deposits in the Troodos ophiolite contains more than 40 wt% S and is underlain by a pyrite-silica zone (i.e., pyrite-silica breccia) with 30-40 wt% S and high SiO₂ contents, representing the top of the stockwork zone. The stockwork it-

		85	57	85	54	37	85	77	57	57	85	57	85	41	36	57	78	40	57	57	57	50	50
		Au	Ag	As	Ba	Cd	Co	Cr	Ga	In	Mo	Pb	Sb	Se	Sr	TI	U	V	Cu	Fe	Zn	S	SiO ₂
57	Ag	0.784	1																				
85	As	0.519	0.216	1																			
54	Ba	-0.113	-0.051	0.567	1																		
37	Cd	0.477	0.594	0.278	-0.044	1																	
85	Co	-0.447	-0.344	-0.242	-0.049	-0.395	1																
77	Cr	-0.110	-0.033	-0.236	-0.105	-0.063	-0.017	1															
57	Ga	0.719	0.776	0.330	-0.058	0.907	-0.427	0.063	1														
57	In	0.762	0.924	0.310	-0.064	0.518	-0.234	-0.027	0.742	1													
85	Mo	0.081	0.037	0.468	0.339	0.241	0.009	-0.178	0.076	0.021	1												
57	Pb	0.771	0.866	0.430	0.013	0.734	-0.501	-0.086	0.844	0.813	0.203	1											
85	Sb	0.886	0.873	0.614	0.190	0.558	-0.462	-0.098	0.779	0.757	0.209	0.916	1										
41	Se	-0.261	-0.191	-0.157	0.016	-0.226	0.604	0.029	-0.220	-0.079	0.035	-0.286	-0.254	1									
36	Sr	-0.259	-0.144	-0.181	-0.057	-0.208	0.014	-0.115	-0.213	-0.136	-0.092	-0.248	-0.247	0.115	1								
57		0.183	0.148	0.257	-0.063	0.593	-0.349	-0.072	0.399	0.055	0.494	0.453	0.328	-0.203	-0.212	1							
78	U	0.405	0.160	0.443	0.141	0.059	-0.024	0.051	0.153	0.224	0.278	0.145	0.358	-0.129	-0.234	-0.049	1						
40	v	0.631	0.671	0.152	0.231	0.281	-0.320	0.382	0.548	0.641	-0.150	0.680	0.751	-0.155	-0.186	-0.069	0.199	1					
57	Cu	0.328	0.517	0.257	-0.097	0.154	0.079	-0.092	0.361	0.721	0.191	0.393	0.272	0.244	0.129	-0.085	0.124	0.287	1				
57	Fe 7	-0.103	-0.102	0.599	0.293	0.053	0.255	-0.242	-0.056	-0.103	0.668	0.071	0.119	0.136	-0.128	0.303	0.268	-0.045	-0.022	1			
57	Zn	0.455	0.567	0.275	-0.039	0.874	-0.449	-0.045	0.734	0.440	0.403	0.742	0.559	-0.263	-0.232	0.715	0.011	0.276	0.091	0.117	1		
50	5	0.071	-0.122	0.009	-0.494	0.086	0.003	-0.126	0.022	-0.071	0.458	-0.125	-0.132	0.078	0.056	0.321	0.140	-0.500	0.141	0.091	0.117	1	
50	SiO ₂	0.153	0.041	-0.479	-0.126	-0.062	-0.229	0.042	-0.009	-0.028	-0.628	-0.054	-0.034	-0.198	-0.296	-0.266	-0.179	0.062	-0.326	-0.793	-0.106	-0.474	1
57	Ca	-0.277	-0.146	-0.207	-0.086	-0.216	0.006	-0.117	-0.219	-0.145	-0.117	-0.261	-0.268	0.063	0.977	-0.217	-0.249	-0.203	0.102	-0.143	-0.240	0.085	-0.288

Figure 9. Correlation matrix for the total of samples analyzed from the TAG mound. Correlation coefficients with 99% confidence level are highlighted. The number of samples analyzed is given above and beside the respective element.

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TAG-1																							
		40	25	40	25 De	9	40	40	25	25	40	25	40	17	20	25	33	16	25	25	25	25	22
25	4.0	AU	Ag	AS	Da	Ca	00	G	Ga	in	NO	PD	30	Se	31		0	v	Cu	re	Zn	5	SIO ₂
25 40	As	0.658	0.523	1																			
25	Ba	0.678	0.286	0.629	1																		
9	Cd	0.455	0.228	0.606	0.282	1																	
40	Co	-0.163	0.158	-0.093	0.139	-0.209	1																
40	Cr	-0.165	-0.143	-0.240	-0.205	-0.143	0.305	0 426	1														
25	In	0.500	0.510	0.411	0.290	0.324	-0.376	-0.420	0.748	1													
40	Mo	0.516	0.308	0.489	0.499	0.169	-0.037	-0.148	0.318	0.408	1												
25	Pb	0.669	0.426	0.658	0.563	0.326	-0.119	-0.174	0.486	0.489	0.327	1											
40	Sb	0.766	0.554	0.602	0.556	0.481	-0.149	-0.377	0.591	0.752	0.448	0.518	1										
17	Se	-0.171	0.138	-0.147	0.025	-0.188	0.482	0.399	-0.218	-0.062	-0.099	-0.403	-0.093	1									
20	Sr TI	-0.144	0.334	-0.122	-0.462	0.144	-0.343	-0.284	0.253	0.3//	-0.083	-0.132	0.000	-0.137	0 1 4 6	1							
33	Ü	0.288	0.531	0.395	0.401	-0.048	0.034	-0.002	0.451	0.421	0.208	0.438	0.074	-0.134	0.027	0.113	1						
16	V	0.041	0.177	-0.085	0.288	-0.190	0.192	0.265	0.102	0.027	0.066	-0.125	-0.050	0.218	-0.026	-0.024	0.283	1					
25	Cu	0.324	0.600	0.342	0.294	0.137	-0.251	-0.469	0.789	0.811	0.514	0.356	0.626	0.030	0.361	0.416	0.312	0.077	1				
25	Fe 7-	0.639	0.254	0.701	0.931	0.316	-0.025	-0.218	0.335	0.393	0.500	0.665	0.631	-0.018	-0.502	0.777	0.341	0.111	0.341	1			
25	s	0.489	0.163	0.681	0.424	0.922	-0.312	-0.1//	0.377	0.535	0.249	0.482	0.508	-0.278	0.022	0.747	0.020	-0.138	0.202	0.490	0 5 7 7	1	
20	siO.	0.073	0.500	0.755	0.070	0.445	0.045	0.407	0.044	0.302	0.502	0.701	0.702	0.110	-0.133	0.010	0.423	0.110	0.305	0.320	0.540	0.000	
22	Ca	-0.594	0.249	-0.665	-0.672	-0.445	-0.433	-0.290	0.241	0.752	-0.502	-0.042	-0.693	-0.184	0.983	-0.740	0.421	-0.139	0.288	-0.707	-0.542	-0.908	-0 232
TAG-2																							
		13	5	13	5	5	13	13	5	5	13	5	13	13	5	5	13	5	5	5	5	5	5
		Au	Ag	As	Ba	Cd	Co	Cr	Ga	In	Mo	Pb	Sb	Se	Sr	ΤI	U	V	Cu	Fe	Zn	S	SiO ₂
5	Ag	0.874	1																				
13	As	0.855	0.905	1																			
5	Cd	-0.672	-0.244	-0.606	-0.666	1																	
13	Co	-0.831	-0.756	-0.674	0.736	-0.893	1																
13	Cr	-0.221	0.101	-0.516	0.612	-0.170	-0.044	1															
5	Ga	0.978	0.945	0.973	-0.539	0.985	-0.876	-0.092	1														
5	In	0.677	0.940	0.745	0.069	0.663	-0.581	0.230	0.780	1													
13	Ph	-0.211	-U.251	0.963	0.898	-0.571	0.340	-0.020	-U.481	-U.U35	-0.417	1											
13	Sb	0.948	0.956	0.780	-0.497	0.978	-0.736	-0.068	0.998	0.798	-0.103	0.999	1										
13	Se	-0.577	-0.673	-0.566	0.574	-0.714	0.693	0.267	-0.727	-0.592	0.541	-0.706	-0.452	1									
5	Sr	-0.286	-0.358	-0.399	0.212	-0.428	0.098	-0.643	-0.402	-0.221	0.014	-0.412	-0.431	0.035	1								
5		0.794	0.669	0.717	-0.596	0.866	-0.583	0.029	0.817	0.403	-0.294	0.801	0.827	-0.279	-0.589	1							
5	v	0.813	0.982	0.819	-0.403	0.931	-0.755	-0.310	0.976	0.880	-0.183	0.985	0.704	-0.733	-0.386	0.694	0 989	1					
5	Cu	0.361	0.673	0.441	0.341	0.288	-0.382	0.096	0.437	0.867	0.068	0.488	0.446	-0.528	0.199	-0.080	0.596	0.553	1				
5	Fe	-0.597	-0.182	-0.579	0.974	-0.588	0.709	0.580	-0.464	0.102	0.945	-0.395	-0.418	0.627	0.235	-0.460	-0.359	-0.318	0.326	1			
5	Zn	0.976	0.802	0.939	-0.758	0.990	-0.893	-0.243	0.953	0.554	-0.637	0.926	0.940	-0.695	-0.425	0.882	0.875	0.890	0.166	-0.678	1		
5	5	-0.528	-0.610	-0.731	0.452	-0.605	0.507	-0.544	-0.600	-0.619	0.381	-0.603	-0.599	0.611	0.722	-0.328	-0.675	-0.588	-0.483	0.558	-0.598	1	
5	SIO ₂	0.353	0.051	0.387	-0.774	0.437	-0.340	-0.058	0.307	-0.233	-0.603	0.255	0.289	-0.244	-0.683	0.531	0.198	0.177	-0.590	-0.813	0.525	-0.628	1
5	Ca	-0.257	-0.353	-0.379	0.164	-0.399	0.069	-0.678	-0.381	-0.233	-0.022	-0.394	-0.411	0.021	0.999	-0.556	-0.375	-0.374	0.174	0.193	-0.390	0.728	-0.652
TAG-4																						4.0	
TAG-4		17	13	17	12	13	17	13	13	13	17	13	17	2	2	13	16	9	13	13	13	10	12
TAG-4	A =	17 Au	13 Ag	17 As	12 Ba	1 3 Cd	17 Co	1 3 Cr	13 Ga	13 In	17 Mo	13 Pb	1 7 Sb	2 Se	2 Sr	13 TI	16 U	9 V	1 3 Cu	13 Fe	1 3 Zn	10 S	12 SiO ₂
13	Ag	17 Au 0.611	13 Ag 1	17 As	12 Ba	13 Cd	17 Co	1 3 Cr	13 Ga	13 In	17 Mo	13 Pb	17 Sb	2 Se	2 Sr	13 TI	16 U	9 V	13 Cu	13 Fe	13 Zn	10 S	12 SiO ₂
TAG-4 13 17 12	Ag As Ba	17 Au 0.611 0.553 -0.187	13 Ag 1 0.339 -0.131	17 As 1 0.588	12 Ba 1	1 3 Cd	17 Co	1 3 Cr	13 Ga	13 In	17 Mo	13 Pb	17 Sb	2 Se	2 Sr	13 TI	16 U	9 V	13 Cu	13 Fe	13 Zn	10 S	12 SiO ₂
TAG-4 13 17 12 13	Ag As Ba Cd	17 Au 0.611 0.553 -0.187 0.461	13 Ag 1 0.339 -0.131 0.529	17 As 1 0.588 0.095	12 Ba 1 -0.021	13 Cd	17 Co	13 Cr	13 Ga	13 In	17 Mo	13 Pb	17 Sb	2 Se	2 Sr	13 TI	16 U	9 V	13 Cu	13 Fe	13 Zn	10 S	12 SiO ₂
TAG-4 13 17 12 13 17	Ag As Ba Cd Co	17 Au 0.611 0.553 -0.187 0.461 -0.100	13 Ag 1 0.339 -0.131 0.529 -0.337	17 As 1 0.588 0.095 -0.145	12 Ba 1 -0.021 -0.259	13 Cd 1 -0.331	17 Co 1	13 Cr	13 Ga	13 In	17 Mo	13 Pb	17 Sb	2 Se	2 Sr	13 TI	16 U	9 V	13 Cu	13 Fe	13 Zn	10 S	12 SiO ₂
TAG-4 13 17 12 13 17 13 13	Ag As Ba Cd Co Cr	17 Au 0.611 0.553 -0.187 0.461 -0.100 -0.055	13 Ag 1 0.339 -0.131 0.529 -0.337 0.286 0 500	17 As 1 0.588 0.095 -0.145 -0.221 0.241	12 Ba 1 -0.021 -0.259 -0.128 0.071	13 Cd 1 -0.331 -0.008	17 Co 1 0.259 0.227	13 Cr 1	13 Ga	13 In	17 Mo	13 Pb	17 Sb	2 Se	2 Sr	13 TI	16 U	9 V	13 Cu	13 Fe	13 Zn	10 S	12 SiO ₂
13 17 12 13 17 13 13 13	Ag As Ba Cd Co Cr Ga In	17 Au 0.611 0.553 -0.187 0.461 -0.100 -0.055 0.604 0.851	13 Ag 1 0.339 -0.131 0.529 -0.337 0.286 0.500 0.356	17 As 1 0.588 0.095 -0.145 -0.221 0.241 0.587	12 Ba -0.021 -0.259 -0.128 -0.071 -0.252	13 Cd 1 -0.331 -0.008 0.937 0.116	17 Co 1 0.259 -0.237 0.247	13 Cr 1 -0.146 -0.275	13 Ga 1 0.388	13 In	17 Mo	13 Pb	17 Sb	2 Se	2 Sr	13 TI	16 U	9 V	13 Cu	13 Fe	13 Zn	10 S	12 SiO ₂
13 17 12 13 17 13 13 13 13 13	Ag As Ba Cd Cr Ga In Mo	17 Au 0.611 0.553 -0.187 0.461 -0.100 -0.055 0.604 0.851 0.180	13 Ag -0.339 -0.131 0.529 -0.337 0.286 0.500 0.356 0.630	17 As 0.588 0.095 -0.145 -0.221 0.241 0.241 0.587 0.197	12 Ba -0.021 -0.259 -0.128 -0.071 -0.252 0.147	13 Cd 1 -0.331 -0.008 0.937 0.116 0.336	17 Co 1 0.259 -0.237 0.247 -0.187	13 Cr 1 -0.146 -0.275 0.551	13 Ga 1 0.388 0.171	13 In 1-0.010	17 Mo	13 Pb	17 Sb	2 Se	2 Sr	13 TI	16 U	9 V	13 Cu	13 Fe	13 Zn	10 S	12 SiO ₂
TAG-4 13 17 12 13 17 13 13 13 17 13 17 13	Ag As Ba Cd Co Cr Ga In Mo Pb	17 Au 0.611 0.553 -0.187 0.461 -0.100 -0.055 0.604 0.851 0.180 0.287	13 Ag 0.339 -0.131 0.529 -0.337 0.286 0.500 0.356 0.630 0.698	17 As 0.588 0.095 -0.145 -0.221 0.241 0.241 0.587 0.197 0.318	12 Ba -0.021 -0.259 -0.128 -0.071 -0.252 0.147 0.319	13 Cd 1 -0.331 -0.008 0.937 0.116 0.336 0.686	17 Co 1 0.259 -0.237 0.247 -0.187 -0.652	13 Cr 1 -0.146 -0.275 0.551 -0.027	13 Ga 1 0.388 0.171 0.592	13 In -0.010 -0.040	17 Mo 1 0.519	13 Pb	17 Sb	2 Se	2 Sr	13 TI	16 U	9 V	13 Cu	13 Fe	13 Zn	10 S	12 SiO ₂
TAG-4 13 17 12 13 17 13 13 17 13 17 13 17 13 17	Ag As Ba Cd Co Cr Ga In Mo Pb So	17 Au 0.611 0.553 -0.187 0.461 -0.100 -0.055 0.604 0.851 0.180 0.287 0.816	13 Ag 1 0.339 -0.131 0.529 -0.337 0.286 0.500 0.356 0.630 0.698 0.527	17 As 0.588 0.095 -0.145 -0.221 0.241 0.587 0.197 0.318 0.777	12 Ba -0.021 -0.259 -0.128 -0.071 -0.252 0.147 0.319 0.482	13 Cd 1 -0.331 -0.008 0.937 0.116 0.336 0.686 0.546	17 Co 1 0.259 -0.237 0.247 -0.187 -0.652 -0.360	13 Cr -0.146 -0.275 0.551 -0.027 -0.124	13 Ga 1 0.388 0.171 0.592 0.629	13 In -0.010 -0.040 0.515	17 Mo 1 0.519 0.317	13 Pb 1 0.629	17 Sb	2 Se	2 Sr	13 TI	16 U	9 V	13 Cu	13 Fe	13 Zn	10 S	12 SiO ₂
TAG-4 13 17 12 13 17 13 13 13 17 13 17 2 2	Ag As Ba Cd Co Cr Ga In Mo Pb Sb Sc Sr	17 Au 0.611 0.553 -0.187 0.461 -0.100 -0.055 0.604 0.851 0.180 0.287 0.816 -	13 Ag 1 0.339 -0.131 0.529 -0.337 0.286 0.500 0.356 0.630 0.698 0.527	17 As 0.588 0.095 -0.145 -0.221 0.241 0.241 0.241 0.241 0.241 0.241 0.241 0.241 0.241 0.241 0.241 0.2777	12 Ba -0.021 -0.259 -0.128 -0.071 -0.252 0.147 0.319 0.482 -	13 Cd 1 -0.331 -0.008 0.937 0.116 0.336 0.686 0.546 -	17 Co 1 0.259 -0.237 0.247 -0.187 -0.652 -0.360 -	13 Cr -0.146 -0.275 0.551 -0.027 -0.124 -	13 Ga 1 0.388 0.171 0.592 0.629 -	13 In -0.010 -0.040 0.515 -	17 Mo 1 0.519 0.317 -	13 Pb 1 0.629 -	17 Sb 1 -	2 Se 1	2 Sr	13 TI	16 U	9 V	13 Cu	13 Fe	13 Zn	10 S	12 SiO ₂
TAG-4 13 17 12 13 17 13 13 13 17 13 17 13 17 13 17 2 13 17 2 13	Ag As Ba Cd Co Cr Ga In Mo Pb Se Sr TI	17 Au 0.611 0.553 -0.187 0.461 -0.100 -0.055 0.604 0.851 0.180 0.287 0.816 - 0.163	13 Ag 1 0.339 -0.131 0.529 -0.337 0.286 0.500 0.356 0.630 0.698 0.527 - - 0.753	17 As 0.588 0.095 -0.145 -0.221 0.241 0.241 0.241 0.241 0.241 0.241 0.241 0.241 0.277 0.055	12 Ba -0.021 -0.259 -0.128 -0.071 -0.252 0.147 0.319 0.482 - - -0.069	13 Cd 1 -0.331 -0.008 0.937 0.116 0.336 0.546 - - 0.591	17 Co 1 0.259 -0.237 0.247 -0.187 -0.652 -0.360 - - -0.505	13 Cr 1 -0.146 -0.275 0.551 -0.027 -0.124 - -	13 Ga 1 0.388 0.171 0.592 0.629 - - 0.466	13 In -0.010 -0.040 0.515 - -	17 Mo 1 0.519 0.317 - - 0.617	13 Pb 1 0.629 - - 0.859	17 Sb 1 - 0.303	2 Se 1 -	2 Sr 1	13 TI	16 U	9 V	13 Cu	13 Fe	13 Zn	10 S	12 SiO ₂
TAG-4 13 17 12 13 17 13 13 13 17 13 17 12 2 13 17 2 13 16	Ag As Ba Co Cr Ga In Pb Se Sr Ti U	17 Au 0.611 0.553 0.187 0.461 -0.100 -0.055 0.604 0.851 0.180 0.287 0.816 - 0.163 0.549	13 Ag 1 0.339 -0.131 0.529 -0.337 0.286 0.500 0.356 0.630 0.698 0.527 - - - 0.753 -0.120	17 As 1 0.588 0.095 -0.145 -0.221 0.241 0.241 0.318 0.777 - - -0.055 0.403	12 Ba -0.021 -0.259 -0.072 -0.252 0.147 0.319 0.482 - - -0.069 0.068	13 Cd 1 -0.331 -0.008 0.937 0.116 0.336 0.686 0.546 - - 0.591 -0.173	17 Co 1 0.259 -0.237 0.247 -0.187 -0.652 -0.360 - - - 0.505 0.459	13 Cr -0.146 0.551 -0.027 -0.124 - - 0.279 0.279 0.279	13 Ga 1 0.388 0.171 0.592 0.629 - - 0.466 -0.043	13 In -0.010 -0.040 0.515 - - -0.124 0.514	17 Mo 1 0.519 0.317 - - 0.617 0.077	13 Pb 1 0.629 - - - 0.859 -0.286	17 Sb 1 0.303 0.391	2 Se 1 -	2 Sr 1 -	13 TI 1 -0.405	16 U	9 V	13 Cu	13 Fe	13 Zn	10 S	12 SiO ₂
TAG-4 13 17 12 13 17 13 13 13 17 13 17 2 13 16 9 2	Ag Ba Cd Co Cr Ga In Mo Pb Sse Sr TI U V ℃	17 Au 0.611 0.553 0.187 0.461 -0.100 -0.055 0.604 0.851 0.180 0.287 0.816 - 0.163 0.549 -0.284 0.549	13 Ag 1 0.339 -0.131 0.529 -0.337 0.286 0.500 0.356 0.630 0.630 0.698 0.527 - - - 0.753 -0.120 -0.306 0.025	17 As 1 0.588 0.095 -0.145 -0.221 0.241 0.587 0.197 0.318 0.777 - - 0.0555 0.403 0.593	12 Ba -0.021 -0.259 -0.0712 -0.252 0.147 0.319 0.482 - - -0.069 0.068 0.924 0.021	13 Cd 1 -0.331 -0.008 0.937 0.116 0.336 0.546 - - 0.591 -0.173 -0.224 0.024	17 Co 1 0.259 -0.237 -0.247 -0.187 -0.652 -0.360 - - - -0.505 0.459 -0.200	13 Cr -0.146 0.275 0.551 -0.027 -0.124 - - 0.279 0.151 -0.257	13 Ga 1 0.388 0.171 0.592 0.629 - - 0.466 -0.043 -0.192	13 In -0.010 -0.040 0.515 - - - -0.124 0.514 -0.169	17 Mo 1 0.519 0.317 - - 0.617 0.077 -0.136 0.027	13 Pb 1 0.629 - - - - - - - - - - - - - - - - - - -	17 Sb 1	2 Se 1 - -	2 Sr 1 -	13 TI -0.405 -0.306	16 U	9 V	13 Cu	13 Fe	13 Zn	10 S	12 SiO ₂
TAG-4 13 17 12 13 17 13 13 13 17 13 13 17 2 13 16 9 13 12 2 13 16 9 13 12 2 13 16 9 13 17 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	Ag Ba Co Co Cr Ga In Mo B Sse Sr TI U ∨ Cu a	17 Au 0.611 0.553 -0.187 0.461 -0.100 0.055 0.604 0.851 0.180 0.287 0.816 - - - 0.163 0.549 -0.284 0.484 0.484	13 Ag 0.339 -0.131 0.529 -0.337 0.286 0.500 0.356 0.698 0.527 - 0.753 -0.753 -0.120 -0.306 -0.022 0.692	17 As 1 0.588 0.095 -0.145 -0.221 0.241 0.241 0.587 0.197 0.318 0.777 - - - 0.055 0.403 0.593 0.324 0.724	12 Ba -0.021 -0.259 -0.128 -0.071 -0.252 0.147 0.319 0.482 - - -0.069 0.068 0.924 -0.250 0.672	13 Cd 1 -0.331 -0.008 0.937 0.116 0.336 0.546 - - 0.591 -0.173 -0.224 -0.382	17 Co 1 0.259 -0.237 0.247 -0.187 -0.562 -0.360 - - -0.505 0.459 -0.200 0.754 0.409	13 Cr -0.146 -0.275 0.551 -0.027 -0.124 - 0.279 0.151 -0.257 -0.257 -0.056 0.120	13 Ga 1 0.388 0.171 0.592 0.629 - 0.466 -0.043 -0.192 -0.159	13 In -0.010 -0.040 0.515 - - -0.124 -0.514 -0.514 -0.5169 0.709 0.709	17 Mo 1 0.519 0.317 - 0.617 0.077 -0.136 -0.085	13 Pb 1 0.629 - 0.859 -0.286 0.086 -0.457 0.657	17 Sb 1 - 0.303 0.391 0.387 0.024 0.024	2 Se 1 - - -	2 Sr 1 - -	13 TI -0.405 -0.306 -0.402	16 U 10.061 0.573 0.573	9 V	13 Cu 1 0.002	13 Fe	13 Zn	10 S	12 SiO ₂
TAG-4	Ag BaCd CoCrGa In MoPb SbesSrTIU ∨ CuFe Zn	17 Au 0.611 0.553 -0.187 0.461 -0.100 0.055 0.604 0.851 0.180 0.287 0.816 - - 0.163 0.548 0.284 0.489 0.319	13 Ag 0.339 -0.131 0.529 -0.337 0.286 0.507 0.356 0.698 0.527 - 0.753 -0.120 -0.306 -0.022 0.639 0.699	17 As 1 0.588 0.095 -0.145 -0.221 0.241 0.241 0.587 0.197 0.318 0.777 - - - 0.055 0.403 0.403 0.593 0.324 0.766 0.022	12 Ba -0.021 -0.259 -0.128 -0.071 -0.252 0.147 0.319 0.482 - - -0.069 0.068 0.924 -0.250 0.573 0.021	13 Cd 1-0.331 -0.008 0.937 0.116 0.336 0.686 0.546 - - 0.591 -0.173 -0.224 -0.382 0.342 0.342 0.777	17 Co 1 0.259 -0.237 0.247 -0.187 -0.360 - - -0.505 -0.459 -0.200 0.754 -0.199 -0.430	13 Cr -0.146 -0.275 0.551 -0.027 -0.124 - - 0.279 0.151 -0.257 -0.257 -0.056 0.170 0.260	13 Ga 1 0.388 0.171 0.629 0.466 -0.043 -0.192 -0.159 0.341 0.558	13 In -0.010 0.515 - - 0.124 0.514 -0.169 0.709 0.306 -0.143	17 Mo 1 0.519 0.317 - 0.617 0.077 -0.136 -0.085 0.692 0.651	13 Pb 1 0.629 - 0.286 0.086 -0.286 0.086 -0.457 0.657 0.718	17 Sb 1 - 0.303 0.391 0.387 0.024 0.812 0.411	2 Se - - - - -	2 Sr 1 - - -	13 TI -0.405 -0.306 -0.402 0.453 0.729	16 U 1 0.061 0.573 0.206 -0.338	9 V 1 -0.146 0.362 -0.270	13 Cu 1 0.092 -0.475	13 Fe 1 0.448	13 Zn	10 S	12 SiO ₂
TAG-4 13 17 12 13 17 13 17 13 17 13 17 2 13 17 2 13 13 17 13 17 13 13 17 13 13 17 13 13 17 13 13 17 13 13 13 13 13 17 13 13 13 13 13 13 13 13 13 13	Ag As Ba CC CC Ga In Mo Pb Bs SS TIUV CU FZ NS	17 Au 0.611 0.553 0.481 -0.100 -0.055 0.604 0.851 0.851 0.816 - - 0.816 - - 0.816 0.549 -0.284 0.444 0.489 0.319 0.624	13 Ag -0.339 -0.131 0.286 0.337 0.286 0.336 0.630 0.698 0.698 0.698 0.527 - - - 0.753 -0.120 -0.306 -0.306 -0.306 -0.303 0.639 0.639 0.639	17 As 0.588 0.095 -0.145 -0.221 0.241 0.587 0.197 0.318 0.777 - - - - - 0.055 0.403 0.593 0.593 0.593 0.324 0.766 0.022	12 Ba -0.021 -0.259 -0.128 -0.071 -0.252 0.147 0.319 0.482 - - - -0.069 0.068 0.924 -0.250 0.573 0.021 -0.250 0.573 0.021 -0.250	13 Cd 1-0.331 -0.008 0.937 0.116 0.336 0.686 0.546 - - 0.591 -0.173 0.224 -0.382 0.342 0.342 0.777 0.489	17 Co 1 0.259 -0.237 0.237 -0.452 -0.360 - - - 0.459 0.459 0.200 0.754 -0.148	13 Cr -0.146 -0.275 0.551 -0.027 -0.124 - - 0.279 0.151 -0.257 -0.056 0.170 0.260 0.260 0.260 0.273	13 Ga 1 0.388 0.171 0.592 0.629 - - 0.466 -0.043 - 0.192 -0.159 0.341 0.558	13 In -0.010 -0.040 0.515 - - -0.124 0.514 0.514 0.514 0.506 0.306 0.378	17 Mo 1 0.519 0.317 - - 0.617 0.077 -0.136 -0.085 0.692 0.651	13 Pb 1 0.629 - - 0.859 -0.286 0.086 -0.457 0.657 0.718	17 Sb - 0.303 0.391 0.387 0.024 0.812 0.411 -0.077	2 Se 1 - - - - - - - - - - -	2 Sr - - - -	13 TI -0.405 -0.306 -0.402 0.453 0.729 0.638	16 U 1 0.061 0.573 0.206 -0.338	9 V 1 -0.146 0.362 -0.270 -0.888	13 Cu 1 0.092 -0.475 -0.131	13 Fe 1 0.448 -0.013	13 Zn 1 0.591	10 S	12 SiO ₂
TAG-4 13 17 12 13 17 13 13 17 13 13 17 2 2 13 16 9 13 13 13 13 17 2 2 13 16 9 13 13 17 2 2 13 16 17 12 13 13 17 12 13 13 17 13 13 17 13 13 17 13 13 17 13 13 17 13 13 17 13 13 17 13 13 17 13 13 17 13 13 17 13 13 17 13 13 17 13 13 17 13 13 17 13 13 17 2 2 13 16 9 13 13 13 13 16 9 13 13 16 9 13 13 13 13 13 13 16 9 13 13 13 13 13 13 13 16 9 13 13 13 13 13 13 13 13 16 9 13 13 13 13 13 13 13 13 13 13	Ag As Ba CC CC CG a In Mo Pb Bs SS TI U ∨ Cu Fe Tn S SiO₂	17 Au 0.611 0.553 -0.187 0.461 0.604 0.851 0.180 0.287 0.816 - - - - - - - - - - - - - - - - - - -	13 Ag 10.339 -0.131 0.529 -0.337 0.286 0.500 0.356 0.630 0.698 0.527 - - - 0.753 -0.120 -0.302 0.639 0.690 0.705 -0.752	17 As 0.588 0.095 -0.145 -0.221 0.587 0.197 0.318 0.777 -0.055 0.403 0.593 0.324 0.766 0.022 -0.578 -0.565	12 Ba -0.021 -0.259 -0.128 -0.071 -0.252 0.147 0.319 0.482 0.069 0.068 0.924 -0.250 0.573 0.021 -0.250 0.573 0.021	13 Cd 1 -0.331 -0.008 0.937 0.116 0.336 0.546 - - 0.591 -0.173 -0.282 0.342 0.342 0.342 0.342 0.489 -0.486	17 Co 10.259 0.237 0.247 -0.187 -0.652 -0.360 - - -0.505 0.459 -0.200 0.754 -0.199 -0.430 -0.148	13 Cr 1 -0.146 -0.275 0.551 -0.027 -0.124 - - 0.279 0.151 -0.257 -0.056 0.170 0.260 0.373 -0.326	13 Ga 1 0.388 0.171 0.592 0.629 - 0.466 -0.043 -0.159 0.341 0.558 0.341 0.558 0.409 -	13 In -0.010 -0.040 0.515 - - - - - 0.124 0.514 0.516 - 0.709 0.306 - 0.378 - 0.378	17 Mo 1 0.519 0.317 - - 0.617 0.077 -0.136 -0.085 0.692 0.692 0.609 -0.767	13 Pb 10.629 - - 0.859 -0.286 0.086 -0.457 0.657 0.718 0.324 -0.670	17 Sb 1 0.303 0.391 0.387 0.024 0.812 0.411 -0.077 -0.764	2 Se - - - - - - - - - - - -	2 Sr - - -	13 TI -0.405 -0.306 -0.402 0.453 0.729 0.638 -0.546	16 U 1 0.061 0.573 0.206 -0.328 -0.052 -0.219	9 V -0.146 0.362 -0.270 -0.888 -0.146	13 Cu 1 0.092 -0.475 -0.131 -0.135	13 Fe 1 0.448 -0.013 -0.973	13 Zn 1 0.591 -0.547	10 S 1 -0.393	12 SiO ₂
TAG-4 13 17 12 13 17 13 17 13 13 17 13 17 2 2 13 16 9 13 13 13 10 12 13	Agg Ba CCO CCA In Mo Pb Sb Ss SrTI U V CuFe In S SiO₂ Ca	17 Au 0.611 0.553 -0.187 0.461 0.100 -0.055 0.604 0.851 0.287 0.816 - - - - - - - - - - - - - - - - - - -	13 Ag 10.339 -0.131 0.529 -0.337 0.286 0.356 0.630 0.698 0.527 - - - 0.753 -0.120 -0.306 -0.022 0.639 0.690 0.705 - 0.755 -0.752 -0.752 -0.752 -0.220	17 As 0.588 0.095 -0.145 -0.221 0.587 0.197 0.317 -0.055 0.403 0.593 0.324 0.324 0.324 0.766 0.022 -0.578 -0.665 0.581	12 Ba -0.021 -0.259 -0.128 -0.071 -0.252 0.147 0.482 - - -0.069 0.068 0.924 -0.250 0.573 0.021 -0.760 -0.389 0.959	13 Cd -0.331 -0.008 0.937 0.116 0.336 0.546 0.591 -0.591 -0.173 -0.224 0.342 0.342 0.342 0.342 0.342 0.342 0.342 0.342 0.342 0.342 0.342 0.342	17 Co 1 0.259 -0.237 -0.247 -0.187 -0.652 -0.360 - - -0.505 0.459 -0.200 0.754 -0.754 -0.199 -0.430 -0.131 -0.148 -0.1325	13 Cr -0.146 -0.275 0.551 -0.027 -0.124 - 0.279 0.151 -0.257 -0.056 0.170 0.260 0.170 0.260 0.373 -0.266 -0.276	13 Ga 1 0.388 0.171 0.592 0.629 - 0.466 -0.043 -0.159 0.341 0.558 0.341 0.558 0.409 -0.425 -0.137	13 In -0.010 -0.040 0.515 - - -0.124 0.514 -0.169 0.709 0.306 -0.143 0.378 -0.359 -0.329	17 Mo 1 0.519 0.317 - 0.617 0.077 -0.136 -0.085 0.692 0.651 0.609 -0.767 -0.043	13 Pb 1 0.629 - 0.859 -0.286 0.0457 0.657 0.657 0.718 0.324 -0.670 0.257	17 Sb 1 0.303 0.391 0.387 0.024 0.812 0.411 -0.077 0.764 0.435	2 Se 1 - - - - - - - - - - - - - - -	2 Sr - - - - -	13 TI -0.405 -0.306 -0.402 0.453 0.729 0.638 -0.546 -0.125	16 U 1 0.061 0.573 0.206 -0.338 -0.052 -0.219 -0.245	9 V 1-0.146 0.362 -0.270 -0.146 0.971	13 Cu 1 0.092 -0.475 -0.135 -0.234	13 Fe 0.448 -0.013 0.451	13 Zn 0.591 -0.547 -0.145	10 S -0.393 -0.799	12 SiO ₂
TAG-4 13 17 12 13 17 13 17 13 13 13 17 13 17 2 13 16 9 13 13 13 13 10 12 13	Agg Ba CCO CCA INMO Pb Sb SS STI U V CuFe Zn S SO2 Ca	17 Au 0.611 0.553 0.461 0.180 0.055 0.604 0.851 0.180 0.287 0.816 	13 Ag 10.339 -0.131 0.529 -0.337 0.286 0.500 0.356 0.630 0.630 0.698 0.527 - - - 0.753 - 0.753 - 0.120 -0.306 -0.022 0.639 0.630 0.630 0.022 0.639 0.630 -0.136 -0.220	17 As 0.588 0.095 -0.145 -0.221 0.241 0.587 0.318 0.777 - - - - 0.055 0.403 0.593 0.593 0.324 0.766 0.022 -0.578 - 0.665 0.581	12 Ba -0.021 -0.259 -0.128 -0.071 -0.252 0.147 0.319 0.482 - - - -0.069 0.068 0.924 -0.250 0.573 0.021 -0.760 -0.389 0.959	13 Cd 1 -0.331 0.937 0.116 0.336 0.686 0.546 - - 0.591 -0.173 -0.224 -0.342 0.342 0.342 0.342 - 0.342 0.342 0.342 - 0.342 0.342 0.342 - 0.342 - 0.341 - 0.224 - 0.341 - 0.341 - 0.336 - 0.224 - 0.342 - 0.341 - 0.336 - 0.224 - 0.342 - 0.342 - 0.346 - 0.336 - 0.624 - 0.224 - 0.342 - 0.342 - 0.346 - 0.346 - 0.336 - 0.546 - 0.347 - 0.124 - 0.347 - 0.124 - 0.346 - 0.346 - 0.346 - 0.346 - 0.346 - 0.346 - 0.347 - 0.147 - 0.224 - 0.342 - 0.342 - 0.346 - 0.346 - 0.346 - 0.346 - 0.342 - 0.224 - 0.342 - 0.342 - 0.346 - 0.346 - 0.346 - 0.346 - 0.346 - 0.346 - 0.346 - 0.346 - 0.346 - 0.346 - 0.346 - 0.346 - 0.347 - 0.346 - 0.346 - 0.346 - 0.346 - 0.346 - 0.342 - 0.346 - 0.346 - 0.346 - 0.346 - 0.346 - 0.346 - 0.346 - 0.346 - 0.346 - 0.346 - 0.346 - 0.346 - 0.347 - 0.342 - 0.345 - 0 0.345 - 0 0.335 - 0 0.335 - 0 - 0.33	17 Co 1 0.259 -0.237 0.247 -0.652 -0.360 0.505 0.459 -0.200 0.754 -0.199 -0.199 -0.430 -0.148 0.131 -0.325	13 Cr -0.146 -0.275 0.527 -0.027 -0.124 - - 0.257 -0.257 -0.257 -0.256 0.170 0.260 0.373 -0.268 -0.276	13 Ga 1 0.388 0.171 0.592 0.629 - - 0.0463 -0.192 -0.192 -0.159 0.341 0.558 0.409 -0.425 -0.137	13 In 1-0.010 0.040 0.515 	17 Mo 0.519 0.617 0.617 0.617 0.617 0.607 0.651 0.609 0.652 0.692 0.692	13 Pb 1 0.629 - 0.286 0.086 -0.457 0.657 0.657 0.657 0.718 0.324 -0.670 0.257	17 Sb 0.303 0.391 0.387 0.024 0.812 0.411 -0.077 -0.764 0.435	2 Se - - - - - - - - - -	2 Sr - - - -	13 TI -0.405 -0.306 -0.402 0.453 0.729 0.638 -0.546 -0.125	16 U 10.061 0.573 0.206 -0.338 -0.052 -0.219 -0.045	9 V -0.146 0.362 -0.270 -0.888 -0.146 0.971	13 Cu 0.092 -0.475 -0.131 -0.135 -0.234	13 Fe 1 0.448 -0.013 -0.973 0.451	13 Zn 0.591 -0.547 -0.145	10 S -0.393 -0.799	12 SiO ₂
TAG-4 13 17 12 13 17 13 13 17 13 13 17 13 17 2 2 13 16 9 13 13 13 13 16 9 13 13 13 13 17 12 13 17 13 13 17 13 13 17 13 13 17 13 13 17 13 13 17 13 13 17 13 13 17 13 13 17 13 13 17 13 13 17 13 13 17 13 13 17 13 13 17 13 13 17 13 13 17 13 13 16 17 13 13 16 17 13 13 16 17 13 13 16 19 13 13 16 13 13 16 9 13 13 13 13 13 16 9 13 13 13 13 13 13 13 13 13 13	Ag As Ba Co Co Ca In Mo B Sse ST IU V Cu Fe T S SO₂ Ca	17 Au 0.611 0.553 -0.187 0.461 -0.100 -0.055 0.604 0.851 0.287 0.816 	13 Ag 1 0.339 0.131 0.529 0.326 0.500 0.356 0.630 0.630 0.638 0.639 0.639 0.639 0.639 0.639 0.639 0.639 0.639 0.639	17 As 0.588 0.095 -0.145 0.241 0.587 0.241 0.587 0.318 0.777 - - 0.055 0.403 0.318 0.777 - - 0.553 0.403 0.593 0.224 0.558 0.022 - 0.558 0.022 - 0.558 0.025	12 Ba 1 -0.021 -0.259 0.071 -0.252 0.047 -0.069 0.0319 0.0482 -0.068 0.924 -0.250 0.021 -0.760 0.924 -0.250 0.021	13 Cd 1 -0.331 0.116 0.336 0.546 0.546 0.546 0.546 0.546 0.342 0.3	17 Co 0.259 0.237 0.247 -0.360 0.652 -0.360 0.459 -0.200 0.754 -0.200 0.754 -0.200 0.459 -0.200 0.754 -0.200 0.430 -0.430 -0.430 -0.430 -0.430 -0.430 -0.430 -0.430 -0.430 -0.430 -0.430 -0.430 -0.445 -0.259 -0.459 -0.247 -0.147 -0.147 -0.143	13 Cr 1-0.146 -0.275 0.551 -0.027 -0.124 0.257 0.151 -0.256 0.170 0.260 0.373 -0.268 -0.276	13 Ga 0.388 0.171 0.592 0.629 0.466 0.043 0.0192 0.159 0.341 0.409 0.4558 0.409 0.425 0.425	13 In -0.010 0.040 0.515 0.124 0.514 0.514 0.514 0.306 0.709 0.306 0.709 0.306 0.709 0.306 0.709 0.306 0.709 0.306	17 Mo 1 0.519 0.317 - 0.617 0.077 -0.136 0.692 0.651 0.654 0.654 0.654 0.654	13 Pb 0.629 0.286 0.086 0.086 0.086 0.086 0.086 0.086 0.324 0.718 0.324	17 Sb 0.303 0.391 0.387 0.024 0.387 0.024 0.387 0.024 0.411 -0.077 -0.764 0.435	2 Se 1 - - - - - - - - -	2 Sr - - - -	13 TI -0.405 -0.306 -0.402 0.453 0.729 0.638 -0.546 -0.125	16 U 0.061 0.573 0.052 -0.219 -0.045	9 V 1-0.146 0.270 -0.288 -0.146 0.971	13 Cu 1 0.092 -0.475 -0.131 -0.135	13 Fe 0.448 -0.013 0.451	13 Zn 10.591 -0.547 -0.145	10 S 1 -0.393 -0.799	12 SiO ₂ 1 -0.240
TAG-4 13 17 13 17 13 13 13 17 13 13 17 13 13 17 13 13 17 13 13 17 13 13 17 13 13 10 12 13 13 TAG-5	Agg Asa CoCoCoa In Monbo SbossorTIU ∨ Cu Fe Zn S SiO₂	17 Au 0.611 0.553 0.187 0.461 -0.100 0.055 0.604 0.851 0.180 0.287 0.816 - - 0.6163 0.549 0.549 0.549 0.319 0.624 - 0.279	13 Ag 10.339 -0.131 0.529 -0.337 0.286 0.520 0.536 0.527 -0.753 -0.120 0.639 0.626 0.527 0.753 0.753 0.639 0.639 0.639 0.626 0.529 0.753 0.753 0.752 0.639 0.753 0.752 0.75	17 As 0.588 0.095 0.145 0.221 0.241 0.587 0.197 0.318 0.777 - - 0.055 0.403 0.592 0.324 0.766 0.324 0.766 0.558 0.558 1	12 Ba 1-0.021 -0.128 -0.071 -0.128 -0.147 0.482 	13 Cd 1 -0.331 -0.008 0.937 0.116 0.336 0.586 - - 0.591 -0.173 0.342 0.777 0.342 0.777 0.489 -0.489 -0.139	17 Co 1 0.259 -0.237 -0.652 -0.360 -0.430 0.754 -0.199 -0.430 0.754 -0.148 0.131 -0.325	13 Cr 1-0.146 0.275 0.027 0.124 - 0.279 0.151 -0.257 0.124 - 0.268 0.276 0.373 -0.268 0.373	13 Ga 0.388 0.171 0.592 0.466 -0.0432 0.341 0.558 0.341 0.5139 0.409 -0.425 -0.137	13 In 10.010 0.040 0.515 - 0.124 0.514 0.515 0.306 0.3768 0.3769 0.3789 0.379 0.378	17 Mo 10.519 0.317 - 0.617 0.617 0.652 0.652 0.669 0.669 0.669 0.669 0.767 -0.043	13 Pb 1 0.629 -0.286 0.086 0.085 0.0457 0.657 0.718 0.324 -0.670 0.324	17 Sb 1 0.303 0.391 0.827 0.411 0.435 12	2 Se 1 - - - - - - - - - - - - - - - - - -	2 Sr - - - - - - - - - - - - - - - - - -	13 TI -0.405 -0.306 0.402 0.453 0.729 0.638 -0.546 -0.125	16 U 1 0.061 0.573 0.206 -0.338 -0.052 -0.219 -0.045	9 V 1 -0.146 0.362 -0.270 -0.270 -0.288 -0.146 0.371	13 Cu 1 0.092 -0.475 -0.475 -0.234	13 Fe 1 0.448 -0.013 -0.973 0.451	13 Zn 1 0.591 -0.547 -0.145	10 S -0.393 -0.799	12 SiO ₂ 1 -0.240
TAG-4 13 17 12 13 17 13 13 17 13 17 13 16 9 13 13 10 12 13 TAG-5	Ag As BaCdo CrCa In Mo Pb Bs Ss SrTI U ∨ Cu Fe Zn S SiO₂ Ca	17 Au 0.611 0.553 0.187 0.461 0.100 0.055 0.604 0.851 0.287 0.816 - - 0.163 0.549 -0.284 0.444 0.449 0.319 0.624 -0.587 -0.279	13 Ag 10.339 0.131 0.529 0.336 0.520 0.356 0.500 0.630 0.630 0.630 0.753 0.753 0.753 0.752 0.720 0.639 0.639 0.639 0.639 0.639 0.639 0.639 0.639 0.752 0.752 0.752 0.752	17 As 0.588 0.0595 -0.241 0.587 -0.221 0.241 0.797 	12 Ba 1-0.021 0.259 0.0725 0.0252 0.0252 0.0252 0.0252 0.0252 0.024 -0.250 0.0482 0.068 0.924 0.0573 0.021 -0.760 0.924 0.959 0.959	13 Cd 1 -0.331 -0.088 0.686 0.546 - - 0.546 - - 0.546 - - 0.546 - - 0.546 - - 0.546 - - 0.546 - - 0.546 - - 0.342 0.777 0.489 0.342 0.342 - - - - - - - - - - - - - - - - - - -	17 Co 10.259 -0.237 -0.652 -0.360 -0.187 -0.652 -0.360 -0.459 -0.200 -0.459 -0.200 -0.148 -0.754 -0.131 -0.325	13 Cr -0.146 -0.275 -0.027 -0.151 -0.257 -0.151 -0.257 -0.151 -0.256 -0.279 -0.151 -0.257 -0.151 -0.256 -0.276 -0.276 -0.276 -0.276 -0.276 -0.276 -0.276 -0.276 -0.276 -0.276 -0.276 -0.276 -0.275 -0.275 -0.151 -0.275 -0.151 -0.275 -0.151 -0.275 -0.151 -0.275 -0.151 -0.275 -0.151 -0.275 -0.151 -0.275 -0.151 -0.275 -0.275 -0.151 -0.275 -0.275 -0.275 -0.275 -0.275 -0.275 -0.275 -0.275 -0.275 -0.275 -0.275 -0.275 -0.275 -0.275 -0.275 -0.275 -0.275 -0.275 -0.275 -0.277 -0.275 -0.277 -0.275 -0.277 -0.276 -0.277 -0.277 -0.227 -0.277 -0.276 -0.277 -0.	13 Ga 1 0.388 0.171 0.592 0.466 0.0463 0.460 0.460 0.409 0.409 0.409 0.409 0.425 0.409 0.425 0.431 0.409 0.425 0.4310 0.4310 0.4310 0.43100000000000000000000000000000000000	13 In 1 -0.1010 -0.040 0.515 - -0.124 0.514 -0.169 0.306 0.378 -0.359 -0.359 -0.359 -0.359 - -0.359 - - - - - - - - - - - - -	17 Mo 10.519 0.317 - 0.617 0.657 0.659 0.659 0.659 0.659 0.659 0.659 0.659 12 Mo	13 Pb 1 0.629 - 0.286 0.04866 0.04866 0.04866 0.04866 0.04866 0.04866 0.04866 0.04866 0.04866 0.04866 0.04866 0.00	17 Sb 1 0.303 0.391 0.337 0.337 0.337 0.431 0.431 0.435	2 Se 1	2 Sr - - - - - - - - - - - - - - - - - -	13 TI -0.405 -0.306 -0.402 0.638 -0.546 -0.546 -0.545 TI	16 U 0.061 0.573 0.206 0.338 0.052 -0.045 12 U	9 V 1-0.146 0.362 -0.270 0.362 -0.270 0.371	13 Cu 1 0.092 -0.475 -0.135 -0.234 10 Cu	13 Fe 1 0.448 -0.013 0.451 10 Fe	13 Zn 1 0.591 -0.547 -0.145 10 Zn	10 S 1 -0.393 -0.799 10 S	12 SiO ₂ 1-0.240 6 SiO ₂
TAG-4 13 17 12 13 17 13 13 17 13 13 17 13 13 17 13 16 9 13 13 10 12 13 13 10 12 13 TAG-5 10	Agg Bababababababababababababababababababab	17 Au 0.611 0.553 0.461 0.624 0.010 0.0554 0.851 0.816 0.287 0.816 0.287 0.816 0.389 0.319 0.444 0.459 0.319 0.444 0.459 0.319 0.444 0.459 0.444 0.459	13 Ag 0.339 0.0.131 0.520 0.356 0.527 0.753 0.753 0.753 0.752 0.366 0.022 0.6390 0.705 0.690 0.705 0.690 0.705 10 0.690 0.7520	17 As 1 0.588 0.095 0.145 0.221 0.241 0.587 0.318 0.397 0.318 0.393 0.324 0.766 0.583 0.324 0.765 0.558 0.324 0.765 0.558 1.2 As	12 Ba 1-0.021 0.259 0.259 0.252 0.252 0.252 0.252 0.024 -0.252 0.069 0.068 0.924 -0.250 0.924 -0.760 0.959 10 Ba	13 Cd 1 -0.331 -0.008 0.336 0.546 0.546 0.546 0.546 0.546 0.544 0.322 0.342 0.342 0.342 0.342 0.342 0.342 0.342 0.342 0.342 0.342 0.342 0.342 0.342 0.342 0.342 0.342 0.342 0.344 0.344 0.344 0.346 0.342 0.346 0.346 0.346 0.346 0.346 0.347 0.346 0.346 0.346 0.346 0.347 0.346 0.346 0.346 0.347 0.346 0.347 0.346 0.347 0.346 0.347 0.346 0.347 0.	17 Co 0.259 0.237 0.247 0.187 0.652 0.450 0.754 0.360 0.754 0.131 0.430 0.430 0.430 0.148 0.131 0.325	13 Cr 1 -0.146 0.255 0.255 0.0551 -0.027 0.056 0.170 0.257 0.056 0.170 0.257 0.056 0.170 0.373 -0.268 -0.276 12 Cr	13 Ga 1 0.388 0.171 0.592 0.466 0.043 0.341 0.5159 0.341 0.341 0.341 0.409 0.425 0.137 10 Ga	13 In -0.010 -0.040 0.515 -0.124 0.515 -0.124 0.306 0.709 0.306 0.0143 0.378 0.359 -0.229 10 In	17 Mo 1 0.519 0.0317 0.651 0.085 0.692 0.651 0.651 0.651 0.651 0.651 1.043	13 Pb 1 0.629 0.0859 0.0286 0.457 0.657 0.657 0.224 0.257 10 Pb	17 Sb 1 - - - - - - - - - - - - - - - - - -	2 Se 1	2 Sr - - - - - - - - - - - - - - - - - -	13 TI -0.405 -0.306 -0.402 0.453 -0.546 -0.125 10 TI	16 U 0.061 0.573 0.206 -0.338 -0.052 -0.219 -0.045 U U	9 V -0.146 -0.270 -0.888 -0.146 0.971	13 Cu 1 0.092 -0.475 -0.131 -0.135 -0.234 10 Cu	13 Fe 1 0.448 -0.013 -0.973 0.451 10 Fe	13 Zn 10.591 -0.547 -0.145 10 Zn	10 S -0.393 -0.799 10 S	12 SIO ₂ 1-0.240 6 SIO ₂
TAG-4 13 17 13 17 13 13 13 17 13 13 17 13 13 17 13 13 17 13 13 17 13 13 10 12 13 10 12 13 TAG-5 10 12	Agg BaCcOCrGa In MoPb Sb SesrTIU ∨ CuFe Zn S SiCa Agg	17 Au 0.611 0.553 0.553 0.553 0.553 0.654 0.654 0.604 0.604 0.604 0.604 0.613 0.643 0.624 0.489 0.624 0.489 0.624 0.489 0.624 0.489 0.623 0.631 0.629 0.629 0.655 0.657 0.6290 0.6290 0.6290 0.6290 0.629000000000000000000000000000000000	13 Ag 0.339 0.500 0.500 0.500 0.500 0.527 0.528 0.527 0.753 0.698 0.698 0.698 0.698 0.698 0.690 0.639	17 As 1 0.588 0.095 -0.145 -0.241 0.241 0.587 0.318 0.587 0.403 0.533 0.324 0.403 0.533 0.324 0.403 0.532 0.403 0.587 1 2 As 12 As	12 Ba 1-0.021 0.259 0.0.259 0.0.252 0.047 0.052 0.0482 0.319 0.482 0.068 0.924 0.068 0.9250 0.068 0.9250 0.0573 0.027 0.071 0.057 0.025 0.0579 0.959	13 Cd 1 -0.331 -0.008 0.937 0.332 0.591 -0.591 -0.591 -0.591 -0.173 -0.224 0.777 0.342 0.777 0.342 0.777 0.342 0.777 0.342 0.777 0.342 0.777 0.342 0.777 0.342 0.342 0.342 0.342 0.342 0.342 0.342 0.342 0.342 0.342 0.342 0.342 0.591 -0.116 0.591 -0.117 0.591 -0.117 0.591 -0.117 0.591 -0.117 0.591 -0.117 0.591 -0.117 0.591 -0.117 0.591 -0.117 0.591 -0.117 0.591 -0.117 0.591 -0.117 0.591 -0.117 0.591 -0.117 0.591 -0.117 0.591 -0.117 0.591 -0.117 0.342 0.777 0.242 0.777 0.342 0.777 0.342 0.342 0.342 0.342 0.342 0.342 0.342 0.342 0.591 -0.117 0.342 0.342 0.342 0.342 0.342 0.777 0.242 0.342 0.342 0.342 0.342 0.777 0.242 0.3	17 Co 0.257 0.237 0.247 0.360 0.247 0.360 0.247 0.360 0.247 0.360 0.754 0.459 0.200 0.754 0.199 0.430 0.131 0.325	13 Cr 1 -0.146 -0.275 -0.551 -0.277 -0.124 -2.79 -0.151 -0.257 -0.056 -0.276 -0.276 -0.276 -0.276 -0.276 -0.275 -0.276 -0	13 Ga 1 0.388 0.171 0.629 0.629 0.629 0.629 0.629 0.0431 0.558 0.341 0.558 0.341 0.558 0.341 0.558 0.341 0.558 0.341 0.3	13 In 10.010 0.040 0.515 0.709 0.709 0.306 0.306 0.308 0.338 0.338 0.339 0.229	17 Mo 1 0.519 0.317 -0.136 0.077 -0.136 0.651 0.085 0.651 0.085 0.651 0.085 12 0.617 -0.043	13 Pb 0.629 0.850 0.0286 0.0457 0.718 0.657 0.718 0.657 0.324 -0.670 0.2257	17 Sb 0.303 0.391 0.341 0.411 0.412 0.411 0.435	2 Se 1 - - - - - - - - - - - - - - - - - -	2 Sr - - - - - 8 Sr	13 TI -0.405 -0.306 -0.402 0.453 0.729 0.453 0.729 0.453 0.729 0.453 1.0 TI	16 U 1 0.061 0.573 0.206 -0.338 -0.052 -0.219 -0.045 U U	9 V -0.146 0.362 -0.270 0.888 -0.146 0.971	13 Cu 1 0.092 -0.475 -0.131 -0.135 -0.234	13 Fe 1 0.448 -0.013 0.451 10 Fe	13 Zn 1 0.591 -0.547 -0.145 10 Zn	10 S 1 -0.393 -0.799 10 S	12 SiO ₂ 1 -0.240 6 SiO ₂
TAG-4 13 17 12 13 17 13 13 13 17 13 17 13 16 9 13 13 10 12 13 10 12 13 TAG-5 10 12 12 10 12 12 10 12 12 12 12 12 12 12 12 12 12 12 12 12	Agas Back CoCroan MoPobolesSrTUV ∨ CrentsSiCa Agas Back	17 Au 0.611 -0.053 0.553 -0.187 -0.050 0.604 0.604 0.604 0.810 0.810 0.810 0.649 -0.284 0.489 0.319 -0.284 0.489 0.319 0.549 -0.284 0.624 -0.587 -0.279	13 Ag 0.337 0.0131 0.520 0.636 0.636 0.636 0.6527 0.753 0.639 0.639 0.639 0.639 0.639 0.639 0.639 0.700 0.752 0.752 0.752 0.752 0.552	17 As 1 0.588 0.095 0.145 0.221 0.241 0.241 0.587 0.403 0.318 0.318 0.318 0.318 0.318 0.318 0.318 0.316 0.403 0.326 0.593 0.766 0.665 0.581 12 As 1 0.639	12 Ba 1-0.021 0.259 0.128 0.071 0.319 0.0482 0.068 0.068 0.068 0.068 0.068 0.068 0.068 0.0573 0.021 0.760 0.553 0.021 0.760 0.559 0.359	13 Cd 1 -0.331 0.937 0.116 0.686 0.546 - 0.591 -0.173 0.322 0.591 -0.173 0.342 0.342 - 0.591 -0.173 0.342 0.342 - 7 Cd	17 Co 0.259 0.237 0.652 0.247 0.652 0.360 0.200 0.754 0.459 0.200 0.754 0.139 0.139 0.131 0.325 12 Co	13 Cr 1 -0.146 -0.275 0.027 -0.027 -0.027 -0.027 -0.026 0.227 0.260 0.373 0.260 0.373 0.276 0.276 0.276 0.276 0.276 0.276 0.275 0.276 0.276 0.276 0.276 0.276 0.276 0.276 0.276 0.276 0.276 0.276 0.277 0.276 0.277 0.276 0.277 0.276 0.277 0.276 0.277 0.276 0.277 0.276 0.277 0.276 0.277 0.276 0.277 0.276 0.276 0.277 0.276 0.277 0.276 0.276 0.277 0.276 0.27	13 Ga 1 0.388 0.171 0.592 - 0.466 0.0433 0.409 0.341 0.558 0.409 0.341 0.558 0.409 10.341 0.548 0.409 0.341 0.548 0.425 0.435 0.4550 0.455	13 In 10.010 0.040 0.0515 	17 Mo 1 0.519 0.317 -0.087 0.692 0.6551 0.692 0.6551 0.692 0.692 0.692 0.694 0.692 0.694 0.692 0.694 0.692 0.694 0.694 0.694 0.694 0.694 0.694 0.694 0.694 0.694 0.694 0.694 0.694 0.694 0.694 0.694 0.694 0.694 0.697 0.677 0.0770 0.07700 0.07700 0.07700 0.07700 0.07700 0.07700 0.07700000000	13 Pb 0.629 -0.286 0.08500 0.08500 0.08500 0.0850000000000	17 Sb 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5	2 Se 1	2 Sr - - - - - - - - - - - - - - - - - -	13 TI -0.405 -0.306 -0.402 0.453 0.729 0.638 -0.125 10 TI	16 U U 1 0.061 0.573 0.206 -0.338 -0.629 -0.219 -0.045 U U	9 V -0.146 0.362 -0.270 -0.888 0.971 6 V	13 Cu 1 0.092 -0.475 -0.135 -0.234 10 Cu	13 Fe 1 0.448 -0.013 -0.973 0.451 10 Fe	13 Zn 1 0.591 -0.547 -0.145 10 Zn	10 S -0.393 -0.799 10 S	12 SIO ₂ 1 -0.240 6 SIO ₂
TAG-4 13 17 12 13 17 13 13 17 13 13 17 13 13 17 13 13 17 13 16 9 13 13 10 12 13 13 10 12 13 TAG-5 10 12 10 7 10 7 12 10 7 12 10 7 12 10 10 7 12 10 10 7 12 10 10 12 10 1 1 1 1	Agasadoo Coroa In Monobo Soses T⊺U ∨ Core Zn Sosoo Coroa Agasadoo Sosoo Agasadoo Sos	17 Au 0.611 0.553 -0.187 0.640 0.653 0.604 0.806 0.800 0.800 0.800 0.800 0.800 0.810 0.810 0.849 0.489 0.499 0.499 0.499 0.499 0.499 0.499 0.499 0.490 0.499 0.0490000000000	13 Ag 0.339 0.339 0.339 0.500 0.500 0.500 0.500 0.638 0.527 - 0.753 0.753 0.753 0.752 0.3752 0.022 0.6390 0.690 0.002 0.690 0.002 0.690 0.002 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.000000	17 As 1 0.588 0.095 -0.241 0.587 0.587 0.587 0.587 0.587 0.587 0.587 0.585 0.581 0.766 0.022 0.022 0.022 0.558 0.5581 12 As 1 0.639 0.549	12 Ba 1 -0.021 -0.259 -0.725 -0.071 -0.252 -0.071 -0.319 -0.482 - -0.069 0.0319 -0.250 0.042 - 0.069 0.021 0.760 0.924 - 0.021 - 0.025 - 0.0319 - 0.259 - 0.0319 - 0.259 - 0.319 - 0.259 - 0.319 - 0.259 - 0.319 - 0.259 - 0.319 - 0.325 - 0.059 - 0.319 - 0.259 - 0.319 - 0.259 - 0.059 - 0.319 - 0.025 - 0.059 - 0.059 - 0.319 - 0.025 - 0.059 - 0.025 - 0.059 - 0.025 - 0.059 - 0.025 - 0.059 - 0.025 - 0.	13 Cd 1 -0.331 -0.008 0.337 0.116 0.336 0.594 0.594 0.594 0.594 0.594 0.594 0.594 0.594 0.382 0.342 0.342 7 Cd	17 Co 10.259 0.247 0.327 0.652 0.360 0.505 0.200 0.459 0.200 0.754 0.754 0.148 0.131 0.325 12 Co	13 Cr 1 -0.146 -0.275 0.551 -0.027 0.027 0.027 0.027 0.056 0.170 0.056 0.170 0.260 0.0276 12 Cr	13 Ga 1 0.388 0.171 0.388 0.171 0.466 0.0463 0.466 0.0463 0.341 0.558 0.341 0.558 0.341 0.558 0.340 0.409 0.0425 0.137	13 In 1 -0.010 0.040 0.515 - 0.124 0.306 -0.124 0.306 -0.143 0.378 -0.359 -0.229 10 In	17 Mo 1 0.519 0.317 - 0.617 0.617 0.625 0.652 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.657 0.659 0.657 0.659 0.657 0.659 0.657 0.659 0.657 0.659 0.657 0.659 0.657 0.659 0.657 0.659 0.657 0.659 0.65700000000000000000000000000000000000	13 Pb 10.629 -0.286 0.859 0.286 0.859 0.286 0.085 0.0857 0.0324 0.657 0.0324 -0.670 0.257	17 Sb 30 .0303 0.0391 0.0324 0.812 0.024 0.812 0.411 -0.077 -0.764 0.435 12 Sb	2 Se 1	2 Sr - - - - - 8 Sr	13 TI -0.405 -0.306 0.402 0.403 0.403 0.403 0.403 0.403 0.403 0.403 0.403 0.403 0.403 0.403 0.404 0.405 1.40 0.405 0.400	16 U 10.061 0.573 0.206 -0.338 -0.052 -0.219 -0.045 U U	9 V 1 -0.146 0.362 -0.270 -0.270 -0.288 0.971 5 V	13 Cu 10.092 -0.475 -0.131 -0.35 -0.234 10 Cu	13 Fe 1 0.448 -0.013 0.451 10 Fe	13 Zn 10.591 -0.547 -0.145 10 Zn	10 S -0.393 -0.799 10 S	12 SIO ₂ 1-0.240 6 SIO ₂
TAG-4 13 17 13 17 13 13 13 17 13 13 17 13 13 17 13 13 17 12 2 13 16 9 13 13 10 12 13 13 10 12 13 10 12 13 10 12 13 10 12 13 10 12 13 10 12 13 10 12 13 10 12 13 10 12 13 10 12 13 10 12 12 10 7 12 10 12 12 10 12 12 10 12 12 12 12 12 12 12 12 12 12 12 12 12	Ag as a clob Croatin Monobological view of the clob o	17 Au 0.611 0.553 0.553 0.553 0.553 0.553 0.654 0.654 0.600 0.604 0.600 0.604 0.615 0.648 0.624 0.489 0.624 0.489 0.624 0.489 0.624 0.489 0.624 0.489 0.624 0.639 0.627 0.627 0.627 0.627 0.627 0.627 0.648 0.6270 0.62700 0.62700 0.62700 0.62700000000000000000000000000000000000	13 Ag 0.339 -0.131 0.529 0.350 0.550 0.550 0.650 0.650 0.650 0.630 0.630 0.630 0.630 0.639 0.630 0.752 -0.220 10 Ag 0.752 0.752 0.752 0.752 0.752	17 As 10.588 0.095 -0.221 0.587 0.221 0.593 0.324 0.777 -0.055 0.593 0.324 0.766 0.022 0.578 0.581 12 As 1 0.639 0.549 0.549	12 Ba -0.021 -0.259 -0.128 -0.071 -0.252 -0.071 -0.319 0.0482 -0.250 0.0482 -0.250 0.924 -0.250 0.924 -0.389 0.959 10 Ba 10 Ba	13 Cd -0.331 -0.038 0.937 0.116 0.937 0.586 -0.591 -0.173 0.342 0.345 0.346 0.347 0.346 0.346 0.347 0.346 0.346 0.347 0.346 0.347 0.346 0.347 0.346 0.347 0.346 0.347 0.346 0.347 0.346 0.347 0.346 0.346 0.347 0.346 0.346 0.347 0.346 0.346 0.347 0.346 0.346 0.346 0.347 0.346 0.346 0.347 0.346 0.347 0.346 0.346 0.347 0.346 0.347 0.	17 Co 0.257 0.247 0.625 0.360 0.450 0.754 0.655 0.450 0.754 0.430 0.754 0.430 0.732 12 Co	13 Cr 1 0.146 0.275 0.0551 0.0551 0.057 0.150 0.279 0.150 0.279 0.056 0.170 0.0260 0.373 0.260 0.3736 0.276 0.376 0.276 0.376 0.276 0.376 0.276 0.277 0.267 0.277 0.267 0.277 0.267 0.277 0.277 0.267 0.2770 0.27700 0.27700 0.27700 0.27700 0.27700 0.27700 0.2770000000000	13 Ga 1 0.388 0.629 0.629 0.629 0.629 0.629 0.0466 0.043 0.049 0.0558 0.400 0.341 0.558 0.400 0.341 0.455 0.401 0.341 0.455 0.	13 In 10.010 0.040 0.515 0.124 0.514 0.306 0.306 0.306 0.3059 0.3229 10 In	17 Mo 0.519 0.317 - 0.651 0.652 0.652 0.652 0.654 0.655 0.657 0.657 0.657 0.657 0.7570 0.7570 0.7570 0.7570000000000	13 Pb 0.629 0.859 0.718 0.324 0.657 0.718 0.324 0.527	17 Sb 0.303 0.391 0.0387 0.412 0.411 0.077 0.764 0.435	2 Se 1 - - - - - Se	2 Sr - - - - - - 8 Sr	13 TI -0.036 -0.405 -0.402 0.453 0.729 0.638 -0.125 10 TI	16 U 0.061 0.573 0.206 -0.338 -0.052 -0.219 -0.045 U U	9 V V 0.362 -0.270 0.362 -0.270 0.362 V V	13 Cu 0.092 -0.475 -0.234 10 Cu	13 Fe 1 0.448 0.013 0.013 0.451 10 Fe	13 Zn 1 0.591 -0.547 -0.145 10 Zn	10 S -0.393 -0.799 10 S	12 SiO ₂ 1 -0.240 6 SiO ₂
TAG-4 13 17 12 13 13 13 13 17 13 13 17 13 16 9 13 16 9 13 10 12 13 10 12 13 TAG-5 10 12 10 7 12 12 10 7 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	A g a sa co croa in Mohob So Sor⊺i U > Cu Fe Zn S Soca Ag a sa co co croa	17 Au 0.611 0.553 0.451 0.451 0.654 0.654 0.641 0.600 0.800 0.810 0.810 0.810 0.489 0.319 0.489 0.319 0.489 0.319 0.549 0.329 0.489 0.329 0.489 0.329 0.527 0.527 0.527 0.527 0.527 0.527 0.527 0.52 0.52 0.53 0.55 0.55 0.55 0.55 0.55 0.55 0.55	13 Ag 13 0.339 0.131 0.520 0.350 0.500 0.650 0.650 0.650 0.650 0.650 0.753 0.120 0.753 0.720 0.753 0.720 0.753 0.752 0.753 0.7550 0.7550000000000	17 As 10.588 0.095 0.241 0.587 0.241 0.587 0.403 0.593 0.593 0.593 0.593 0.593 0.593 0.524 12 As 10 0.559	12 Ba -0.021 -0.259 -0.128 -0.071 -0.250 0.044 0.069 0.068 0.924 0.0250 0.924 0.0250 0.9250 0.9259 10 Ba 10 Ba	13 Cd 1-0.331 0.937 0.116 0.686 0.686 0.596 -0.173 -0.224 0.777 Cd 1-0.382 0.742 0.7	17 Co 0.259 0.247 0.0.237 0.0.452 0.0.505 0.0.505 0.0.505 0.0.505 0.0.200 0.0.200 0.0.200 0.0.430 0.148 0.131 0.325 12 Co	13 Cr 1 -0.146 -0.275 -0.027 -0.124 - -0.251 -0.251 -0.251 -0.256 -0.170 -0.151 -0.056 0.170 -0.056 0.170 -0.056 -0.276 	13 Ga 1 0.388 0.171 0.592 0.629 - 0.466 0.043 0.341 0.192 0.341 0.345 0.341 0.358 0.409 0.425 0.3137 10 Ga	13 In 1 0.010 0.040 0.515 - 0.124 0.514 0.309 0.306 0.378 0.378 0.378 0.229 10 In	17 Mo 0.519 0.317 - 0.617 0.677 0.651 0.692 0.651 0.659 0.651 0.655 0.65	13 Pb 1 0.629 - 0.286 0.0486 0.0486 0.0457 0.716 0.657 0.324 -0.670 0.324 Pb	17 Sb 1 0.303 0.391 0.024 0.812 0.431 0.435 12 Sb	2 Se 1	2 Sr - - - - - - 8 Sr	13 TI -0.405 -0.306 -0.402 0.453 -0.546 -0.125 10 TI	16 U 1 0.061 0.573 0.206 -0.038 -0.052 -0.219 -0.045 U U	9 V V -0.146 0.362 -0.270 -0.888 -0.146 0.971 6 V	13 Cu 0.092 -0.475 -0.131 -0.234 10 Cu	13 Fe 1 0.448 -0.013 0.451 10 Fe	13 Zn 10.591 -0.547 -0.145 10 Zn	10 S -0.393 -0.799 10 S	12 SiO ₂ 1 -0.240 6 SiO ₂
TAG-4 13 17 12 13 17 13 13 17 13 13 17 13 13 17 13 16 9 13 13 10 12 13 13 10 12 13 10 12 13 10 12 10 7 12 10 10 7 12 10 10 10 12 10 10 10 12 10 10 12 10 10 12 10 10 10 12 10 10 10 12 10 10 10 12 10 10 10 12 12 10 10 10 12 10 10 10 12 10 10 10 12 10 10 10 12 10 10 10 12 10 10 10 12 10 10 10 12 10 10 10 10 10 10 10 10 10 10 10 10 10	Ag a sa cCorcaa In Monbo books SrTIU ≻ CuFeZn S SiO2 Ag as Bac Corcaa In	17 Au 0.611 0.553 -0.187 0.461 0.653 0.604 0.804 0.804 0.804 0.849 0.319 0.816 0.489 0.319 0.489 0.319 0.489 0.319 0.489 0.319 0.489 0.319 0.653 0.779 12 Au 0.955 0.955	13 Ag 0.339 0-0.131 0.529 0.550 0.550 0.550 0.550 0.630 0.630 0.630 0.632 0.753 0.753 0.752 0.753 0.752 0.753 0.752 0.913 0.913 0.913 0.942 0.947 0.944 0.947 0.94	17 As 1 0.588 0.095 0.241 0.587 0.241 0.587 0.403 0.593 0.593 0.777 0.0558 0.5581 12 As 12 12 As 1 1 As 12 As 12 As 12 As 12 As 12 As 12 As 12 As 1 As 1 As 1 As 1 As 1 As 1 As 1 As 1 As 1 As 1 As 1	12 Ba 1 0.021 0.0258 0.021 0.0258 0.024 0.0257 0.0348 0.924 0.068 0.924 0.959 0.959 10 Ba 10 Ba 10 0.959 0.959	13 Cd -0.331 -0.008 0.937 0.116 0.937 0.336 0.546 -0.342 0.747 0.342 0.3	17 Co 1 0.259 0.237 0.247 0.652 0.459 0.459 0.459 0.459 0.459 0.450 0.754 0.459 0.200 0.754 0.459 0.200 0.754 0.201 0.148 0.325 12 Co	13 Cr 1-0.146 0.275 0.257 0.0551 0.257 0.0527 0.0561 0.257 0.0260 0.276 0.267 0.267 0.268 0.276 0.276 0.268 0.276	13 Ga 1 0.388 0.171 0.592 0.463 0.0192 0.152 0.341 0.558 0.409 0.341 0.558 0.409 0.341 0.529 2 0.341 0.529 2 0.341 0.529 0.341 0.529 0.341 0.529 0.341 0.529 0.520	13 In 1 0.010 0.040 0.515 - 0.124 0.516 0.708 0.306 0.306 0.338 0.338 0.338 0.338 10 In	17 Mo 10.519 0.617 0.077 -0.136 0.651 0.659 0.659 0.659 0.659 12 Mo	13 Pb 1 0.629 -0.286 0.086 0.046 0.657 0.657 0.324 0.627 0.324 10 Pb	17 Sb 0.303 0.391 0.387 0.024 0.435 12 Sb	2 Se 1	2 Sr - - - - - - 8 Sr	13 TI -0.0405 -0.306 0.453 0.729 0.638 -0.125 10 TI	16 U 0.573 0.206 0.324 0.026 0.338 0.052 0.052 0.029 0.045 U U	9 V 11 -0.146 0.362 -0.270 0.888 8-0.146 0.971	13 Cu 1 0.092 -0.475 -0.135 -0.234 10 Cu	13 Fe 1 0.448 -0.013 0.451 10 Fe	13 Zn 10.591 -0.547 -0.145 10 Zn	10 S -0.393 -0.799 10 S	12 SiO ₂ 1 -0.240 6 SiO ₂
TAG-4 13 17 13 17 13 13 13 17 13 13 17 13 13 17 13 13 17 12 2 13 16 9 13 13 10 12 13 10 12 13 10 12 13 10 12 13 10 12 10 12 10 12 10 10 12 12 10 10 12 12 10 10 12 12 10 10 12 12 10 10 12 12 10 10 12 12 10 10 12 12 10 10 12 12 10 10 12 12 10 10 12 12 10 10 12 12 12 10 12 12 12 12 10 12 12 12 12 12 12 12 12 12 12 12 12 12	A ga a Back Coordon In Mon Poblo Sao Sar TUV V Cife In Social A ga sa Back Coordon In Mon	17 Au 0.611 0.553 0.553 0.553 0.553 0.553 0.654 0.654 0.604 0.604 0.604 0.604 0.6163 0.624 0.489 0.624 0.489 0.624 0.489 0.624 0.489 0.625 0.627 0.6279 12 Au 0.653 0.654 0.654 0.654 0.654 0.654 0.654 0.654 0.655 0.655 0.654 0.655 0.555 0.55	13 Ag 0.339 -0.131 0.529 0.350 0.550 0.550 0.650 0.650 0.650 0.630 0.630 0.630 0.753 0.630 0.639 0.639 0.752 -0.220 10 Ag 0.752 0.75	17 As 1 0.588 0.095 -0.221 0.581 0.241 0.587 0.241 0.581 0.241 0.581 0.241 0.581 0.241 0.593 0.324 0.593 0.593 0.526 0.581 12 As 1 0.639 0.549 0.529 0.529 0.529	12 Ba 1 -0.021 -0.252 -0.128 -0.071 -0.252 -0.068 0.924 -0.068 0.925 0.021 0.760 0.959 10 Ba 10 Ba 10 0.944 -0.348 0.944 -0.348 0.944	13 Cd 1-0-331 0-008 0.937 0.116 0.636 0.686 0.686 0.686 0.686 0.636 0.648 0.0489 0.0499 0.0490 0.0499 0.0490000000000	17 Co 0.237 0.247 0.652 0.360 0.450 0.450 0.754 0.450 0.450 0.450 0.450 0.430 0.754 0.4300 0.4300 0.4300 0.4300 0.430000000000	13 Cr 1 0.146 0.255 0.0551 0.0551 0.057 0.056 0.170 0.260 0.276 0.276 0.276 0.276 0.276 0.276 0.276 0.276 0.276 0.276 0.276 0.276 0.276 0.276 0.276 0.276 0.276 0.276 0.277 0.277 0.257 0.277 0.257 0.2770 0.27700 0.27700 0.27700 0.27700 0.27700 0.27700 0.2770000000000	13 Ga 1 0.388 0.171 0.592 0.629 0.629 0.0466 0.043 0.558 0.409 0.341 0.558 0.409 0.341 0.558 0.409 Co.137 10 Ga	13 In 1 0.010 0.040 0.515 0.124 0.514 0.306 0.306 0.306 0.3229 10 In 10 10 10 10 10 10 10 10 10 10	17 Mo 10.519 0.317 - 0.085 0.692 -0.085 0.699 -0.767 -0.043 12 Mo	13 Pb 0.859 0.0856 0.086 0.086 0.0850 0.0850 0.0457 0.457 0.324 -0.670 0.324 -0.670 0.324 -0.577	17 Sb 	2 Se 1 - - - - - - - - - - - - - - - - - -	2 Sr - - - - - - 8 Sr	13 Tl -0.05 -0.405 -0.402 -0.425 0.453 0.729 0.636 -0.125 10 Tl	16 U 10.061 0.573 0.206 -0.338 -0.052 -0.219 -0.045 U	9 V -0.146 0.362 -0.270 -0.270 0.888 -0.146 0.971 6 V	13 Cu 0.092 -0.475 -0.131 -0.135 -0.234 10 Cu	13 Fe 0.448 -0.013 -0.973 0.451 10 Fe	13 Zn 10.591 -0.547 -0.145 10 Zn	10 S -0.393 -0.799 10 S	12 SiO ₂ 1 -0.240 6 SiO ₂
TAG-4 13 17 12 13 13 13 13 17 13 13 17 13 17 2 2 13 16 9 13 16 9 13 10 12 13 10 12 13 10 12 13 10 12 10 10 7 12 12 10 10 10 12 12 10 10 12 12 10 10 12 12 12 13 10 12 12 12 12 13 10 10 12 12 12 12 12 13 10 10 12 12 12 12 12 12 12 12 12 12 12 12 12	Ag a Ba Cd Co Cr Ca l⊨ Mo Po bo Sos Sr Ti U > Ci Fe Zi So Ca Ag a Sa Cd Co Cr Ca l⊨ Mo Po bo	17 Au 0.611 0.553 0.451 0.451 0.654 0.654 0.641 0.604 0.800 0.800 0.800 0.800 0.800 0.489 0.310 0.489 0.310 0.489 0.310 0.489 0.310 0.489 0.329 0.489 0.329 0.489 0.527 0.624 4.0.537 0.624 0.624 0.624 0.624 0.627 0.627 0.629 0.641 0.649 0.624 0.629 0.624 0.629 0.629 0.629 0.649 0.629 0.629 0.649 0.629 0.629 0.629 0.649 0.629 0.649 0.629 0.629 0.649 0.629 0.629 0.649 0.629 0.649 0.629 0.649 0.629 0.649 0.629 0.649 0.649 0.649 0.629 0.64900000000000000000000000000000000000	13 Ag 0.339 0.131 0.529 0.350 0.520 0.550 0.550 0.5527 0.286 0.0527 0.752 0.75	17 As 1 0.588 0.095 -0.145 0.221 0.587 0.221 0.583 0.324 0.403 0.324 0.403 0.324 0.403 0.324 0.403 0.324 0.403 0.326 0.581 1 2 As 1 0.659 0.551 0.551 0.5596 0.5597	12 Ba 1 -0.021 -0.259 -0.128 -0.071 0.071 0.147 0.0482 - -0.068 0.924 0.068 0.924 0.068 0.924 0.0573 0.021 -0.389 0.959 10 Ba 10 0.944 0.934 0.934 0.934	13 Cd 1-0.331 0.008 0.937 0.116 0.686 0.686 0.596 1- 0.737 0.224 0.777 Cd 7 Cd 1 -0.332 0.732 0.74200000000000000000000000000000000000	17 Co 0.259 0.237 0.247 0.525 0.247 0.525 0.247 0.505 0.240 0.754 0.139 0.430 0.131 0.325 12 Co 12 0.321 0.148 0.131 0.325 0.249 0.237 0.247 0.2	13 Cr -0.146 -0.276 -0.257 -0.257 -0.256 -0.276 -0.276 -0.276 -0.276 -0.276 -0.276 -0.268 -0.276 -0.276 -0.268 -0.276 -0.268 -0.276 -0.268 -0.276 -0.268 -0.276 -0.276 -0.268 -0.276 -0.	13 Ga 1 0.388 0.171 0.592 0.0430 0.043 0.0430 0.341 0.558 0.341 0.558 0.341 0.469 0.341 0.558 0.341 0.409 0.341 0.388 0.874 0.425 0.338 0.874 0.338 0.874 0.338 0.874	13 In 1 -0.010 -0.040 -0.0515 -0.124 -0.169 -0.514 -0.514 -0.514 -0.306 -0.306 -0.335 -0.329 10 In 10 -0.338 0.856 -0.856 -0.338 -0.856 -0.856 -0.338 -0.856 -0.856 -0.338 -0.856 -0.338 -0.856 -0.856 -0.338 -0.856 -0.856 -0.338 -0.856 -0.338 -0.856 -0.338 -0.359 -0.597	17 Mo 1 0.519 0.317 - 0.307 -0.136 0.085 0.077 -0.136 0.692 0.767 -0.043 12 Mo	13 Pb 1 0.629 - 0.286 0.0457 0.286 0.0457 0.257 10 Pb	17 Sb 0.301 0.391 0.024 0.411 0.411 0.413 5b	2 Se 1	2 Sr - - - - 8 Sr	13 TI -0.405 -0.306 -0.402 0.453 0.729 -0.638 -0.638 -0.546 TI 10 TI	16 U 0.061 0.373 -0.326 -0.338 -0.052 -0.052 -0.052 U U	9 V -0.146 0.362 -0.270 0.888 -0.146 0.971 6 V	13 Cu 1 0.092 -0.475 -0.131 -0.135 -0.234 10 Cu	13 Fe 1 0.448 -0.013 0.451 10 Fe	13 Zn 1 0.591 -0.547 -0.145 10 Zn	10 S -0.393 -0.799 10 S	12 SiO ₂ 1 -0.240 6 SiO ₂
TAG-4 13 17 12 13 17 13 13 13 17 13 13 17 13 13 17 13 16 9 13 13 10 12 13 10 12 12 10 12 10 12 10 12 12 10 12 10 12 12 12 10 12 12 12 10 12 12 12 12 12 12 12 12 12 12 12 12 12	Aga abado Corosa In MoPoboles Sr Ti∪ > Cu Fernis Go Ga Aga abado Corosa In MoPoboles Sr Ti∪ > Cu Fernis Go Ca Aga abado Corosa In MoPoboles Se	17 Au 0.611 0.553 -0.187 0.653 0.553 -0.187 0.654 0.604 0.826 0.849 0.349 0.489 0.349 0.489 0.499 0.490 0.490 0.490 0.490 0.490 0.490 0.489 0.490 0.489 0.490 0.40	13 Ag 13 Ag 13 0.339 0.337 0.286 0.529 0.550 0.550 0.550 0.630 0.630 0.630 0.627 0.753 0.752 0.75	17 As 1 0.588 0.095 0.241 0.587 0.241 0.587 0.403 0.241 0.593 0.324 0.593 0.593 0.777 0.0558 0.5581 12 As 12 As 12 As 10 0.559 0.596 0.596 0.596 0.597 0.598 0.598 0.599	12 Ba 1 0.021 0.258 0.071 0.258 0.071 0.071 0.042 0.068 0.924 0.068 0.924 0.573 0.021 0.573 0.021 0.760 0.959 10 Ba 10 Ba 10 Ba 10 Ba 10 0.859 0.959 0.045 0.959 0.959 0.959 0.959 0.959 0.959 0.920 0.924 0.929 0.959	13 Cd -0.331 -0.088 0.937 0.116 0.937 0.336 0.686 0.546 -0.322 0.7173 -0.224 0.342 0.7479 -0.342 0.7489 -0.436 -0.139 7 Cd 1 -0.323 0.737 0.969 0.969 0.969 0.969 0.969 0.969	17 Co 1 0.259 0.237 0.247 0.652 0.0.187 0.6505 0.459 0.459 0.459 0.459 0.459 0.450 0.159 0.450 0.159 0.450 0.1320 12 Co 11 0.566 0.320 0.138 0.320 0.320 0.320 0.320 0.320 0.320 0.320 0.325 0.355 0.3	13 Cr 1-0.146 0.275 0.0551 0.0551 0.0551 0.0257 0.0562 0.257 0.250 0.268 0.276 0.268 0.276 0.268 0.276 0.268 0.276 0.268 0.276 0.268 0.276 0.268 0.276 0.261 0.279 0.260 0.279 0.261 0.279 0.261 0.279 0.261 0.279 0.261 0.279 0.261 0.279 0.261 0.279 0.261 0.279 0.261 0.279 0.261 0.279 0.261 0.279 0.261 0.279 0.261 0.279 0.261 0.279 0.261 0.276 0.276 0.276 0.276 0.276 0.276 0.276 0.276 0.276 0.276 0.276 0.277 0.267 0.267 0.277 0.267 0.267 0.277 0.267 0.277 0.267 0.276 0.276 0.276 0.276 0.276 0.276 0.276 0.276 0.276 0.267 0.277 0.267 0.277 0.277 0.277 0.277 0.277 0.277 0.277 0.277 0.277 0.277 0.277 0.277 0.277 0.277 0.277 0.27700 0.27700 0.27700 0.27700 0.27700 0.27700 0.2770000000000	13 Ga 1 0.388 0.171 0.592 0.463 0.0192 0.152 0.341 0.558 0.409 0.341 0.558 0.409 0.341 0.558 0.409 0.341 0.562 0.341 0.558 0.409 0.341 0.387 0.307	13 In 1 0.010 0.040 0.515 - 0.124 0.515 - 0.124 0.306 0.306 0.306 0.306 0.338 0.338 0.338 0.338 0.338 0.338 0.338 0.338 0.338 0.338 0.338 0.338 0.328 0.229 10 10 0.328 0.229 10 0.856 0.856 0.857 0.856 0	17 Mo 10.519 0.617 0.651 -0.085 0.659 0.659 0.659 0.659 0.659 12 Mo	13 Pb 1 0.629 -0.286 0.0866 0.718 0.657 0.257 10 Pb	17 Sb 0.303 0.391 0.411 0.415 0.412 Sb	2 Se 1	2 Sr - - - - - - 8 Sr	13 TI -0.0405 -0.306 -0.402 0.453 0.729 0.638 -0.125 10 TI	16 U 10.061 0.573 0.206 0.328 0.052 -0.045 U U	9 V 11 -0.146 0.362 -0.270 -0.888 0.971 6 V	13 Cu 1 0.092 -0.475 -0.131 -0.135 -0.234 10 Cu	13 Fe 1 0.448 0.451 10 Fe	13 Zn 10.591 -0.547 -0.145 10 Zn	10 S -0.393 -0.799 10 S	12 SiO ₂ 1 -0.240 6 SiO ₂
TAG-4 13 17 13 17 13 13 13 17 13 13 17 13 13 17 12 2 13 16 9 13 13 10 12 13 10 12 13 10 12 13 10 12 10 10 7 12 10 10 12 10 10 12 12 10 10 12 12 12 10 10 12 12 12 18	A g a a a d d d c r a in Mo Po 5b & ぶ T U > C u Fe T s G 2 A A a a d d d c r a in Mo Po 5b & ぶ T	17 Au 0.611 0.553 0.553 0.553 0.553 0.553 0.654 0.654 0.604 0.604 0.604 0.604 0.624 0.489 0.624 0.489 0.624 0.489 0.624 0.489 0.624 0.489 0.625	13 Ag 0.339 0.131 0.529 0.326 0.529 0.356 0.630 0.630 0.630 0.630 0.630 0.627 0.022 0.630 0.620 0.620 0.752 0.220 0.752 0.220 0.420 0.527 0.220 0.420 0.527 0.220 0.420 0.527 0.220 0.420 0.527 0.220 0.527 0.220 0.527 0.220 0.527 0.220 0.527 0.220 0.527 0.220 0.527 0.220 0.527 0.220 0.529 0.527 0.220 0.529 0.520 0.527 0.520 0.529 0.520 0.527 0.522 0.520 0.522	17 As 10.588 0.095 -0.425 0.221 0.587 0.403 0.590 0.403 0.578 0.324 0.766 0.022 0.403 0.578 0.558 12 As 1 0.639 0.596 0.596 0.598 0.599 0.596 0.599 0.596 0.599 0.596 0.599 0.596 0.599 0.596 0.599 0.596 0.599 0.596 0.599 0.596 0.599 0.596 0.599 0.596 0.599 0.596 0.599 0.	12 Ba 1 -0.021 -0.252 -0.128 -0.071 -0.252 -0.068 0.924 -0.250 0.021 0.068 0.924 -0.389 0.959 10 Ba 10 Ba 10 0.944 -0.346 0.944 -0.346 0.944 -0.346 0.944 -0.346 0.944 -0.346 0.944 -0.346 0.944 -0.346 0.944 -0.346 0.944 -0.346 0.944 -0.346 0.944 -0.346 0.944 -0.346 0.944 -0.346 0.944 -0.346 0.944 -0.346 -0.346 0.944 -0.346	13 Cd 1-0.331 0.686 0.591 0.591 0.591 0.592 0.777 0.489 0.499 0.49	17 Co 0.259 0.237 0.247 0.652 0.0.652 0.0.652 0.0.505 0.459 0.459 0.430 0.148 0.131 0.325 12 Co 0.148 0.131 0.325 12 Co 0.148 0.131 0.325	13 Cr 	13 Ga 1 0.388 0.171 0.592 0.466 0.629 - 0.043 0.042 0.043 0.043 0.043 0.045 0.043 0.358 0.358 0.358 0.358 0.358 0.368 0.409 0.400 0.409 0.400 0.409 0.	13 In -0.010 -0.040 -0.040 -0.0515 -0.0124 -0.0514 -0.0514 -0.0709 -0.0229 10 In 10 10 10 0.857 0.2829	17 Mo 1 0.519 0.317 - 0.085 0.077 -0.085 0.699 -0.767 -0.043 12 Mo	13 Pb 10.629 - 0.859 0.086 0.086 0.086 0.086 0.026 0.0286 0.0286 0.0286 0.0287 0.324 0.657 0.324 10 Pb	17 Sb 1 0.303 0.391 0.024 0.411 -0.077 0.764 0.435 12 Sb	2 Se 1 - - - - - - - - - - - - - - - - - -	2 Sr - - - - - - - - - - - - - - - - - -	13 TI -0.405 -0.306 0.402 0.402 0.402 0.429 0.638 -0.546 -0.125	16 U 0.061 0.573 0.206 -0.338 -0.052 -0.219 -0.045 U U	9 V V 1-0.146 0.362 -0.270 0.270 0.288 -0.146 0.971 6 V	13 Cu 10.092 -0.475 -0.131 -0.135 -0.234 10 Cu	13 Fe 0.448 -0.013 0.451 10 Fe	13 Zn 10.591 -0.547 -0.145 10 Zn	10 S -0.393 -0.799 10 S	12 SiO ₂ 1 -0.240 6 SiO ₂
TAG-4 13 17 12 13 13 13 13 17 13 13 17 13 17 2 2 13 16 9 13 10 12 13 10 12 13 10 12 13 10 12 10 10 7 12 12 10 10 12 12 10 10 12 12 8 10 12 12 8 10 12 12 8 10 12 12 8 10 12 12 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	A g s a d d c r g s l M P b b s r T U ∨ C F Z n S S C a g s s a d d c r g s l M P b b s r T U ∨ C F Z n S S C a A g s s a d d c r g s l M P b b s r T I	17 Au 0.611 0.553 0.451 0.553 0.553 0.553 0.451 0.654 0.810 0.480 0.480 0.480 0.489 0.310 0.489 0.310 0.489 0.310 0.489 0.329 12 Au 0.953 0.761 0.679 0.879 0.879 0.870 0.925 0.488 0.766 0.948 0.769 0.879 0.879 0.925 0.879 0.925 0.879 0.925 0.879 0.925 0.879 0.925	13 Ag 0.339 0.131 0.529 0.350 0.520 0.550 0.550 0.557 0.286 0.0527 0.752 0.752 0.752 0.752 0.752 0.752 0.752 0.752 0.752 0.913 0.913 0.913 0.913 0.912 0.913 0.912 0.913 0.929 0.637 0.912 0.913 0.912 0.913 0.912 0.913 0.921 0.913 0.921 0.914 0.912 0.914 0.912 0.91400000000000000000000000000000000000	17 As 1 0.588 0.095 -0.145 0.221 0.587 0.221 0.587 0.403 0.241 0.593 0.324 0.403 0.324 0.403 0.324 0.403 0.324 0.403 0.326 0.593 0.581 1 2 As 1 0.663 0.596 0.597	12 Ba 1 -0.221 -0.259 -0.128 -0.071 0.128 0.071 0.147 0.319 0.0482 0.924 0.068 0.924 0.0573 0.021 0.0573 0.027 0.0573 0.0573 0.0573 0.0579 0.959 10 0.944 0.0344 0.0341 0.0414 0.0314 0.0414 0.0314 0.0414 0.0414 0.0414 0.0414 0.0414 0.0414 0.0414 0.0414 0.0414 0.0414 0.0414 0.0414 0.0444 0.0414 0.0414 0.0414 0.0414 0.0414 0.0414 0.0414 0.044400000000	13 Cd 1-0.331 0.937 0.336 0.686 0.596 -0.733 0.224 0.777 Cd 1-0.382 0.742 0.742 0.742 0.742 0.742 0.742 0.742 0.742 0.742 0.742 0.742 0.742 0.742 0.742 0.742 0.742 0.742 0.751 0.95	17 Co 0.259 0.237 0.247 0.525 0.247 0.505 0.240 0.754 0.360 0.754 0.139 0.430 0.131 0.325 12 Co 112 Co 0.321 12 Co 0.321 0.325 0.247 0.138 0.325 0.247 0.325 0.247 0.325 0.247 0.325 0.247 0.326 0.325 1.2 0.247 0.325 0.247 0	13 Cr -0.146 -0.276 -0.257 -0.257 -0.256 -0.276 -0.276 -0.268 -0.276 -0.268 -0.276 -0.268 -0.276 -0.268 -0.268 -0.276 -0.268 -0.276 -0.268 -0.276 -0.268 -0.276 -0.268 -0.276 -0.268 -0.276 -0.268 -0.276 -0.268 -0.276 -0.268 -0.276 -0.268 -0.276 -0.268 -0.276 -0.276 -0.268 -0.276 -0.268 -0.276 -0.268 -0.268 -0.268 -0.268 -0.268 -0.268 -0.373 -0.268 -0.373 -0.268 -0.378 -0.268 -0.378 -0.268 -0.378 -0.378 -0.378 -0.378 -0.378 -0.378 -0.268 -0.378 -0.378 -0.378 -0.378 -0.378 -0.378 -0.378 -0.268 -0.378 -0.268 -0.378 -0.268 -0.378 -0.268 -0.378 -0.268 -0.378 -0.268 -0.378 -0.268 -0.378 -0.348 -0.	13 Ga 1 0.388 0.171 0.592 0.0430 0.043 0.043 0.043 0.341 0.558 0.341 0.558 0.341 0.469 0.341 0.562 0.341 0.558 0.341 0.400 0.338 0.873 0.307 0.307	13 In 1 -0.010 -0.040 -0.040 -0.0515 -0.124 -0.169 -0.0514 -0.169 -0.0306 -0.338 -0.338 0.356 0.338 0.856 0.289 -0.229	17 Mo 1 0.519 0.317 - 0.077 -0.136 0.077 -0.136 0.077 -0.043 0.659 0.229 0.320 12 Mo	13 Pb 1 0.629 - 0.286 0.0457 0.286 0.0457 0.257 10 Pb 10 0.324 -0.670 0.324 10 Pb	17 Sb 0.301 0.391 0.391 0.024 0.411 0.037 12 Sb 12 Sb	2 Se 1 - - - - - - - - - - - - - - - - - -	2 Sr 1 - - - - - - - - - - - - - - - - - -	13 TI -0.405 -0.306 -0.402 -0.453 -0.453 -0.546 -0.125 10 TI	16 U 0.061 0.373 -0.326 -0.338 -0.052 -0.052 -0.052 U U	9 V -0.146 0.362 -0.270 0.888 -0.146 0.971 6 V	13 Cu 1 0.092 -0.475 -0.131 -0.135 -0.234 10 Cu	13 Fe 1 0.448 -0.013 0.451 10 Fe	13 Zn 10.591 -0.547 -0.145 10 Zn	10 S -0.393 -0.799 10 S	12 SiO ₂ 1 -0.240 6 SiO ₂
TAG-4 13 17 12 13 17 13 13 17 13 13 17 13 13 17 13 16 9 13 13 16 9 13 13 10 12 13 10 12 13 TAG-5 10 12 10 12 10 12 10 12 10 12 10 12 10 12 10 12 10 12 10 12 10 12 12 8 10 12 12 8 10 12 12 8 10 12 12 8 10 12 12 8 10 12 12 8 10 12 12 8 10 12 12 8 10 12 12 8 10 12 12 8 10 12 12 8 10 12 12 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	A g a sac do croa in Monbob se sr⊺i∪ > cife Zi s oo2 A g a sac do croa in Monbob se sr⊺i∪ > cife Zi s oo2	17 Au 0.611 0.553 -0.187 0.461 0.553 0.553 0.604 0.8200 0.8200 0.8200 0.8200 0.820000000000	13 Ag 0.339 0-0.131 0.529 0.286 0.520 0.550 0.550 0.550 0.527 0.286 0.630 0.630 0.630 0.630 0.630 0.630 0.630 0.630 0.630 0.752 0.75	17 As 1 0.588 0.095 0.241 0.587 0.405 0.241 0.587 0.405 0.241 0.593 0.324 0.593 0.593 0.593 0.766 0.593 0.565 0.5881 12 As 12 As 10.639 0.596 0.599 0.596 0.599 0.596 0.597 0.598 0.599 0.596 0.599 0.	12 Ba 1 0.021 0.259 0.028 0.071 0.259 0.071 0.071 0.047 0.0482 0.068 0.924 0.068 0.924 0.0573 0.929 0.959 10 Ba 10 0.959 0.959 0.959 0.959 0.959 0.924 0.959 0.924 0.959 0.924 0.959 0.959 0.924 0.959 0.924 0.924 0.924 0.924 0.959 0.959 0.959 0.924 0.924 0.959 0.959 0.959 0.924 0.924 0.959 0.959 0.959 0.924 0.924 0.959 0.959 0.924 0.924 0.959 0.959 0.924 0.924 0.959 0.959 0.924 0.924 0.924 0.959 0.924 0.924 0.959 0.924 0.924 0.924 0.959 0.924 0.924 0.924 0.924 0.924 0.924 0.924 0.924 0.959 0.924 0.929 0.927 0.929 0.924 0.924 0.929 0.924 0.929 0.924 0.929 0.924 0.929 0.924 0.924 0.929 0.924 0.926 0.924 0.927 0.929 0.927 0.924 0.927 0.924 0.924 0.927 0.929 0.924 0.927 0.929 0.927 0.924 0.927 0.927 0.928 0.927 0.927 0.928 0.927 0.928 0.927 0.928 0.927 0.928 0.927 0.928 0.927 0.928 0.927 0.928 0.927 0.928 0.927 0.928 0.927 0.928 0.927 0.928 0.927 0.928 0.928 0.927 0.9288 0.9288 0.9288 0.9288 0.9288 0.9288 0.9288 0.9288	13 Cd 1-0.331 0.088 0.937 0.116 0.686 0.546 0.546 0.546 0.7173 0.322 0.342 0.777 0.342 0.342 0.342 0.342 0.342 0.342 0.342 0.342 0.342 0.342 0.342 0.342 0.342 0.342 0.342 0.342 0.342 0.343 0.345 0.343 0.345 0.355 0.3	17 Co 11 0.259 0.237 0.247 0.652 0.459 0.459 0.459 0.459 0.459 0.459 0.459 0.459 0.459 0.459 0.4131 0.320 1.148 0.325 12 Co 0.148 0.3210 0.321 0	13 Cr 1-0.146 0.275 0.0551 0.027 0.124 - 0.257 0.056 0.227 0.257 0.260 0.267 0.268 0.276 0.276 0.276 0.268 0.276 0.373 0.268 0.276 0.373 0.268 0.276 0.373 0.268 0.276 0.373 0.268 0.276 0.373 0.268 0.276 0.373 0.268 0.276 0.373 0.268 0.276 0.373 0.266 0.276 0.373 0.268 0.276 0.373 0.266 0.276 0.373 0.266 0.276 0.276 0.276 0.276 0.276 0.276 0.276 0.276 0.276 0.276 0.276 0.276 0.276 0.276 0.277 0.267 0.277 0.268 0.277 0.268 0.277 0.277 0.268 0.277 0.277 0.277 0.268 0.277 0.268 0.277 0.277 0.268 0.277 0.268 0.277 0.268 0.277 0.268 0.277 0.268 0.277 0.268 0.277 0.268 0.277 0.268 0.277 0.268 0.277 0.268 0.277 0.268 0.276 0.276 0.267 0.277 0.268 0.277 0.268 0.276 0.267 0.267 0.268 0.276 0.267 0.268 0.276 0.268 0.276 0.267 0.268 0.276 0.267 0.268 0.276 0.267 0.268 0.276 0.267 0.268 0.276 0.267 0.268 0.276 0.267 0.268 0.276 0.267 0.276 0	13 Ga 1 0.388 0.171 0.592 0.462 0.043 0.043 0.043 0.043 0.043 0.043 0.043 0.043 0.043 0.043 0.043 0.043 0.043 0.043 0.043 0.043 0.043 0.043 0.043 0.037 0.037 0.037 0.037 0.038 0.039 0.038 0.039 0.038 0.039 0.038 0.039 0.038 0.039 0.039 0.039 0.039 0.039 0.039 0.039 0.039 0.039 0.039 0.039 0.039 0.039 0.039 0.030 0.039 0.030 0.039 0.030 0.039 0.0300 0.030 0.0300 0.0300 0.0300 0.0300000000	13 In 1 0.010 0.040 0.515 - 0.124 0.516 0.708 0.306 0.306 0.336 0.336 0.3378 0.3359 10 In 1 0.338 0.359 0.229 10 0.856 0.857 0.289 0.299	17 Mo 10.519 0.617 0.077 -0.036 0.659 0.659 0.659 0.767 -0.043 12 Mo	13 Pb 1 0.629 - 0.286 0.0867 0.286 0.0867 0.286 0.0867 0.257 10 Pb 10 .0.657 0.324	17 Sb 0.303 0.387 0.324 0.411 0.411 0.413 0.425 Sb 12 Sb	2 Se 1 - - - - - - - - - - - - - - - - - -	2 Sr - - - - - - - - - - - - - - - - - -	13 TI -0.0405 -0.306 -0.402 0.453 0.729 10 TI 10 TI	16 U 1 0.061 0.573 -0.206 -0.338 -0.219 -0.045 U U	9 V 1 -0.146 0.362 -0.270 0.888 -0.146 0.971	13 Cu 1 0.092 -0.475 -0.135 -0.234 10 Cu	13 Fe 1 0.448 0.013 0.013 0.451 10 Fe	13 Zn 10.591 -0.547 -0.145 10 Zn	10 S -0.393 -0.799 10 S	12 SiO ₂ 1 -0.240 6 SiO ₂
TAG-4 13 17 13 17 13 13 13 17 13 13 17 12 2 13 16 9 13 13 10 12 13 10 12 13 10 12 13 10 12 10 12 10 12 10 12 10 12 10 12 10 12 12 10 10 12 12 10 12 12 10 12 12 12 12 10 12 12 12 10 12 12 12 12 12 1 1 1 1	A g as Ba Cd Co Cr Ca In Mo Po Sb So So Ti U > Cu Fe Ti os Go Ca A g as Ba Cd Co Cr Ca In Mo Po Sb So So Ti U > Co	17 Au 0.611 0.553 0.553 0.553 0.553 0.553 0.650 0.650 0.600 0.600 0.600 0.680 0.489 0.489 0.489 0.489 0.489 0.489 0.489 0.489 0.489 0.489 0.489 0.489 0.489 0.489 0.657 0.657 0.657 0.657 0.657 0.657 0.657 0.657 0.657 0.657 0.657 0.657 0.657 0.657 0.657 0.657 0.657 0.429 0.652 0.659 0.659 0.659 0.659 0.659 0.659 0.659 0.629 0.629 0.629 0.629 0.659 0.659 0.629 0.629 0.629 0.629 0.659 0.629 0.639 0.629 0.639 0.639 0.639 0.639 0.639 0.639 0.639 0.639 0.639 0.639 0.639 0.639 0.639 0.639 0.6390 0.64900 0.64900000000000000000000000000000000000	13 Ag 13 Ag 13 0.339 0.339 0.529 0.356 0.527 0.286 0.630 0.630 0.630 0.630 0.630 0.630 0.627 0.022 0.356 0.620 0.752 0.220 0.3752 0.620 0.752 0.220 0.420 0.527 0.220 0.320 0.690 0.527 0.220 0.320 0.690 0.690 0.527 0.220 0.320 0.690 0.690 0.527 0.220 0.320 0.690 0.964 0.9527 0.964 0.954 0.964 0.954 0.964 0.954 0.954 0.964 0.9557 0.9557 0.9557 0.9557 0.9557 0.9557 0.9557 0.9557 0	17 As 10.588 0.095 -0.425 0.221 0.587 -0.221 0.318 0.403 0.549 0.558 12 As 10.558 12 As 10.558 12 0.558 12 0.558 0.5581 0.5581 0.5581 0.5581 0.559 0.559 0.590 0.599 0.5	12 Ba 1 -0.021 -0.252 -0.128 -0.071 -0.252 -0.068 0.924 -0.068 0.924 -0.329 0.959 0.959 10 Ba 10 Ba 10 Ba 10 0.944 -0.348 -0.3488 -0.348	13 Cd 1-0.331 0.008 0.937 0.116 0.686 0.686 0.596 0.596 0.596 0.0489 0.499 0.490 0.499 0.4	17 Co 0.259 0.237 0.247 0.652 0.0.187 0.652 0.0.05 0.459 0.459 0.459 0.430 0.148 0.131 0.325 12 Co 0.148 0.131 0.325 12 Co 0.148 0.131 0.325 0.141 0.325 0.247 0.430 0.325 0.259 0.247 0.249 0.0430 0.0430 0.0321 0.326 0.321 0.354 0.354 0.354 0.326 0.326 0.321 0.354 0.326 0.354 0.326 0.357	13 Cr 	13 Ga 1 0.388 0.171 0.592 0.466 0.043 0.043 0.043 0.043 0.043 0.043 0.043 0.043 0.043 0.043 0.043 0.043 0.043 0.045 0.0338 0.873 0.338 0.873 0.338 0.873 0.338 0.873 0.338 0.873	13 In -0.010 -0.040 -0.040 -0.0515 -0.0124 -0.0514 -0.0514 -0.0514 -0.0709 -0.229 10 In 10 10 In 1 0.338 0.8557 0.289 0.289 0.2857 0.289 0.2857 0.289 0.2857 0.29577 0.29577 0.29577 0.295777 0.295777 0.295777 0.295777777777 0.2957777777777777777777777777	17 Mo 1 0.519 0.317 - 0.085 0.077 -0.085 0.699 -0.767 -0.043 12 Mo 1 0.559 0.229 0.559 0.229 0.3510 0.559	13 Pb Pb 0.8529 0.8569 0.718 0.324 0.657 0.324 0.324 0.324 0.324 0.324 0.324 0.324 0.324 0.324 0.324 0.324 0.324 0.324 0.324 0.324 0.324 0.324 0.329 0.324 0.324 0.324 0.327 0.324 0.329 0.324 0.327 0.329 0.324 0.327 0.329 0.324 0.327 0.327 0.327 0.327 0.327 0.327 0.327 0.327 0.327 0.327 0.327 0.324 0.327 0.324 0.327 0	17 Sb 10.391 0.391 0.024 0.411 -0.077 0.764 0.435 12 Sb 12 Sb	2 Se 1 - - - - - - - - - - - - - - - - - -	2 Sr - - - - - - - - - - - - - - - - - -	13 TI -0.405 -0.306 -0.402 0.453 0.729 0.638 -0.546 -0.125 10 TI 10 TI -0.262 -0.089	16 U U 0.673 0.206 -0.338 -0.052 -0.219 -0.045 U U	9 V V 1-0.146 0.362 -0.270 0.270 0.270 0.270 0.270 V V	13 Cu 10.092 -0.475 -0.131 -0.234 10 Cu	13 Fe 0.448 -0.013 0.451 10 Fe	13 Zn 10.591 -0.547 -0.145 10 Zn	10 S -0.393 -0.799 10 S	12 SiO ₂ 1 -0.240 6 SiO ₂
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TAG-4 13 17 12 13 17 13 13 17 13 13 17 13 13 17 13 16 9 13 13 10 12 13 10 12 13 10 12 10 12 10 12 10 12 10 12 10 12 10 12 10 12 10 12 10 12 10 12 10 12 10 12 12 10 10 12 12 10 10 12 12 10 10 12 12 1 10 10 12 12 1 10 10 12 12 1 10 10 12 12 1 10 10 12 1 1 1 1	A g As Ba C d C C C Ga In M Ph Sh Se Sr T U > C J Fe Zn S SiC A g A S Ba C d C C C Ga In M Ph Sh Se Sr T U > C J Fe Zn	17 Au 0.611 0.553 -0.187 0.461 0.553 -0.187 0.654 0.604 0.8287 0.816 0.489 0.319 0.489 0.490 0.489 0.490 0.4	13 Ag 13 Ag 13 0.339 0.337 0.286 0.529 0.250 0.550 0.550 0.753 0.753 0.725 0.753 0.725 0.753 0.720 0.306 0.0220 10 0.592 0.306 0.0220 0.306 0.639 0.752 0.943 0.964 0.951 0.955	17 As 1 0.588 0.095 0.241 0.587 0.405 0.241 0.587 0.405 0.241 0.593 0.324 0.593 0.593 0.777 0.0593 0.766 0.593 0.766 0.5581 12 As 12 As 12 0.639 0.596 0.599 0.596 0.597 0.598 0.596 0.598 0.599 0.596 0.599	12 Ba 1 0.021 0.258 0.071 0.259 0.071 0.057 0.071 0.482 0.068 0.924 0.068 0.924 0.959 0.959 10 Ba 10 0.959 0.324 0.959 0.324 0.959 0.324 0.929 0.324 0.929 0.324 0.929 0.324 0.068 0.921 0.329 0.929 0.324 0.329 0.329 0.329 0.324 0.329 0.329 0.324 0.329 0.329 0.324 0.329 0.329 0.324 0.32900000000000000000000000000000000000	13 Cd 1-0.331 0.088 0.937 0.116 0.546 0.546 0.546 0.546 0.342 0.773 0.342 0.343 0.345 0.34	17 Co 1 0.259 0.237 0.247 0.652 0.459 0.459 0.200 0.754 0.459 0.200 0.754 0.459 0.45	13 Cr 1-0.146 0.275 0.0551 0.0277 0.154 0.257 0.0561 0.257 0.0260 0.257 0.268 0.276 0.268 0.276 0.373 0.268 0.276 0.373 0.268 0.276 0.373 0.268 0.373 0.268 0.373 0.343 0.489 0.489 0.489	13 Ga 1 0.388 0.171 0.592 0.4629 0.152 0.462 0.043 0.0192 0.341 0.558 0.341 0.558 0.341 0.529 0.341 0.529 0.341 0.529 0.341 0.529 0.341 0.529 0.341 0.529 0.341 0.529 0.341 0.529 0.341 0.529 0.341 0.529 0.341 0.5420 0.5420 0.5420	13 In 1 0.010 0.040 0.515 - 0.124 0.515 - 0.124 0.516 0.709 0.306 0.306 0.306 0.336 0.336 0.3378 0.3359 0.229 10 In 1 0.3856 0.857 0.289 0.299 0.290 0.299	17 Mo 0.519 0.617 0.077 -0.036 0.659 0.659 0.659 0.659 0.659 0.659 0.220 0.220 0.380 0.550 0.220 0.460	13 Pb 10.629 -0.286 0.086 0.718 0.657 0.257 10 Pb 10.673 0.257 10 Pb 0.324 -0.670 0.257 0.324 -0.670 0.257 0.324 -0.670 0.324 -0.339 0.296 0.339 0.296 0.886	17 Sb 0.303 0.387 0.324 0.411 0.411 0.413 0.412 Sb 12 Sb 12 Sb	2 Se Se 1 1 - - - - - - - - - - - - - - - - - -	2 Sr Sr - - - - - - - - - - - - - - - - -	13 TI -0.0405 -0.306 -0.402 0.453 0.729 -0.638 -0.546 -0.125	16 U 1 0.061 0.573 0.206 0.326 0.026 12 U U 12 U 0.645 0.219 0.045 0.219 0.045	9 V -0.146 0.362 -0.270 0.888 -0.146 0.971 0.139	13 Cu 1 0.092 -0.475 -0.234 10 Cu 1 -0.135 -0.234	13 Fe 1 0.445 10 Fe 1 -0.445	13 Zn 10.591 -0.547 -0.145 10 Zn	10 S -0.393 -0.799 10 S	12 SiO ₂ 1 -0.240 6 SiO ₂
TAG-4 13 17 13 17 13 13 13 17 13 13 17 13 13 17 12 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	A g & a a d o c roa in M pb 5b & & r T U > c i F z n s oo c a A g & a d o c roa in M pb 5b & & r T U > c i F z n s	17 Au 0.611 0.553 0.553 0.553 0.553 0.553 0.553 0.653 0.650 0.604 0.604 0.604 0.624 0.489 0.490 0	13 Ag 13 Ag 0.339 0.529 0.356 0.529 0.630 0.630 0.630 0.630 0.630 0.627 0.022 0.630 0.62	17 As 10.588 0.095 -0.425 0.221 0.321 0.241 0.241 0.241 0.324 0.403 0.549 0.324 0.766 0.324 0.766 0.324 0.766 0.324 0.766 0.558 10.324 0.558 12 As 10.639 0.596 0.599 0.596 0.599 0.	12 Ba 1 -0.021 -0.252 -0.128 -0.071 -0.252 -0.068 0.924 -0.068 0.924 -0.068 0.925 0.021 0.021 0.021 0.959 0.959 10 Ba 10 Ba 10 0.944 -0.316 0.944 -0.346 0.944 -0.326 0.944 -0.326 0.944 -0.326 0.944 -0.346 0.944 -0.346 0.944 -0.346 0.944 -0.346 0.944 -0.346 0.944 -0.346 0.944 -0.346 0.944 -0.346 0.944 -0.346 0.944 -0.346 -0.346 0.944 -0.346 0.944 -0.346 0.944 -0.346 0.944 -0.346 0.944 -0.346 0.944 -0.346 0.944 -0.346 0.944 -0.346 0.944 -0.346 0.944 -0.346 0.944 -0.326 0.944 -0.326 0.944 -0.326 0.944 -0.326 0.944 -0.326 0.944 -0.326 0.944 -0.326 0.944 -0.326 0.944 -0.326 0.944 -0.326 0.944 -0.326 0.944 -0.326 0.944 -0.326 0.021 -0.327 0.021 -0.326 0.021 -0.2211 -0.2211 -0.2211 -0.2211 -0.2211 -0.2211 -0.2211 -0.2211 -0.2211 -0.2211 -0.2211 -0.2211 -0.	13 Cd 1-0.331 0.686 0.937 0.116 0.596 	17 Co 0.259 0.247 0.247 0.652 0.0.187 0.652 0.0.059 0.459 0.459 0.459 0.430 0.148 0.131 0.325 12 Co 0.148 0.131 0.325 12 Co 0.148 0.131 0.325 0.141 0.325 0.141 0.325 0.164 0.321 0.325 0.164 0.158 0.0.158 0.0.598 0.0.158 0.0.158 0.0.598 0.0.158 0.0.598 0.0.158 0.0.598 0.0.158 0.0.598 0.0.2010 0.0.598 0.0.2010 0.0.598 0.0.2010 0.0.598 0.0.2010 0.0.598 0.0.20100000000000000000000000000000000	13 Cr -1 -0.146 -0.275 -0.275 -0.255 -0.274 -0.257 -0.256 -0.277 -0.256 -0.277 -0.256 -0.277 -0.256 -0.277 -0.256 -0.277 -0.256 -0.277 -0.256 -0.277 -0.256 -0.276 -0.266 -0.276 -0.267 -0.266 -0.276 -0.267 -0.266 -0.276 -0.267 -0.2777 -0.2777 -0.2777 -0.2777 -0.2777 -0.2777 -0.2777	13 Ga 1 0.388 0.171 0.592 0.466 0.043 0.043 0.043 0.043 0.043 0.043 0.043 0.043 0.043 0.043 0.043 0.043 0.043 0.043 0.043 0.043 0.043 0.0338 0.873 0.336 0.873 0.336 0.873 0.338 0.873 0.338 0.873 0.338 0.873 0.338 0.873 0.338 0.873 0.338 0.873 0.338 0.992 0.0237 0.0237 0.0237 0.0237 0.0237 0.0237 0.0237 0.0237 0.0237 0.0237 0.0237 0.0237 0.0237 0.0237 0.0237 0.0237 0.0237 0.0257 0.0277 0.0257 0.0277 0.0277 0.0277 0.0277 0.0277 0.0277 0.0277 0.0277 0.0277 0.0277 0.0277 0.0277 0.0277 0.0277 0.0277 0.0277 0.0277 0.0277 0.02777 0.02777 0.02777 0.02777 0.02777 0.027777 0.0277777 0.027777777777	13 In -0.010 -0.040 -0.040 -0.0515 - -0.124 -0.0514 -0.0514 -0.0514 -0.0514 -0.0709 -0.229 10 In 10 10 In 1 0.338 0.8557 0.2829 -0.222 0.419 0.8557 0.2829 -0.222 0.419 0.2857 0.2829 -0.124 0.3857 0.2829 -0.222 0.419 0.2857 0.	17 Mo 10.519 0.317 - 0.085 0.097 -0.085 0.699 -0.767 -0.043 12 Mo 12 Mo 0.559 0.229 0.559 0.229 0.559 0.220 0.559 0.220 0.559	13 Pb 10.629 - 0.859 0.856 0.086 0.086 0.086 0.086 0.026 0.324 0.657 0.324 0.324 0.324 0.324 0.324 10 Pb	17 Sb 0.301 0.391 0.321 0.024 0.411 -0.077 0.764 0.435 12 Sb 12 Sb 0.767 0.248 0.377 0.282 0.077 0.282 0.378	2 Se Se 1 -0.010 -0.207 -3 - - - - - - - - - - - - - - - - - -	2 Sr - - - - - - - - - - - - - - - - - -	13 TI -0.405 -0.306 -0.402 0.402 0.402 0.402 0.402 -0.402 -0.638 -0.546 -0.125 10 TI 10 TI 10 TI	16 U U 0.651 0.573 0.206 -0.338 -0.052 U U U 12 U U 0.569 -0.289 0.281	9 V V 1-0.146 0.362 -0.270 0.270 0.270 0.270 0.270 0.270 V V 1 0.101 1-0.043 0.133	13 Cu 0.092 -0.475 -0.131 -0.135 -0.234 10 Cu	13 Fe 1 0.448 -0.013 -0.973 0.451 10 Fe	13 Zn 10.591 -0.547 -0.145 10 Zn	10 S 1 -0.393 0.799 10 S	12 SiO ₂ 1 -0.240 6 SiO ₂
TAG-4 13 17 12 13 13 13 17 13 13 17 13 17 2 2 13 16 9 13 13 10 12 13 10 12 13 10 12 13 TAG-5 10 10 12 12 10 10 12 12 8 10 10 12 12 8 10 10 12 12 8 10 10 12 12 8 10 10 12 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	A g a sa d Co Cr Ga In Mo Po Sa Sar Ti U > Cu Fe Ta S Go Ca A g a sa d Co Cr Ga In Mo Po Sa Sar Ti U > Cu Fe Ta S Go Ca A g a sa d Co Cr Ga In Mo Po Sa Sar Ti U > Cu Fe Ta S Go Ca A g a sa d Co Cr Ga In Mo Po Sa Sar Ti U > Cu Fe Ta S Go Ca A g a sa d Co Cr Ga In Mo Po Sa Sar Ti U > Cu Fe Ta S Go Ca A g a sa d Co Cr Ga In Mo Po Sa Sar Ti U > Cu Fe Ta Sar Co Cr Ga In Mo Po Sa Sar Ti U > Cu Fe Ta Sar Co Cr Ga In Mo Po Sa Sar Ti U > Cu Fe Ta Sar Co Cr Ga In Mo Po Sa Sar Ti U > Cu Fe Ta Sar Co Cr Ga In Mo Po Sa Sar Ti U > Cu Fe Ta Sar Co Cr Ga In Mo Po Sa Sar Ti U > Cu Fe Ta Sar Co Cr Ga In Mo Po Sa Sar Ti U > Cu Fe Ta Sar Co Cr Ga In Mo Po Sa Sar Ti U > Cu Fe Ta Sar Co Cr Ga In Mo Po Sa Sar Ti U > Cu Fe Ta Sar Co Cr Ga In Mo Po Sa Sar Ti U > Cu Fe Ta Sar Co Cr Ga In Mo Po Sa Sar Ti U > Cu Fe Ta Sar Co Cr Ga In Mo Po Sa Sar Ti U > Cu Fe Ta Sar Co Cr Ga In Mo Po Sa Sar Ti U > Cu Fe Ta Sar Co Cr Ga In Mo Po Sa Sar Ti U > Cu Fe Ta Sar Co Cr Ga In Mo Po Sa Sar Ti U > Cu Fe Ta Sar Co Cr Ga In Mo Po Sar Co Cr Ga In Mo Po Sar Co Cu Fe Ta Sar Co Cr Ga In Mo Po Sar Co Cu Fe Ta Sar Co Cr Ga In Mo Po Sar Co Cu Fe Ta Sar Co Cr Ga In Mo Po Sar Co Cu Fe Ta Sar Co Cu	17 Au 0.611 0.553 0.451 0.553 0.451 0.553 0.451 0.654 0.816 0.820 0.489 0.319 0.489 0.319 0.489 0.319 0.489 0.310 0.489 0.349 0.353 0.624 0.353 0.624 0.537 0.629 0.857 0.897 0.994 0.359 0.992 0.394 0.309 0.353 0.489 0.359 0.629 0.579 0.897 0.994 0.359 0.992 0.394 0.359 0.394 0.359 0.394 0.394 0.359 0.359 0.394 0.357 0.394 0.357 0	13 Ag 0.339 0.131 0.529 0.350 0.520 0.520 0.520 0.520 0.520 0.527 0.286 0.022 0.0527 0.220 0.630 0.630 0.630 0.630 0.630 0.630 0.630 0.630 0.630 0.630 0.630 0.630 0.630 0.630 0.630 0.630 0.620 0.752 0.220 0.752 0.220 0.637 0.752 0.220 0.637 0.220 0.630 0.630 0.639 0.630 0.632 0.630 0.632 0.630	17 As 1 0.588 0.095 -0.145 0.221 0.587 0.221 0.583 0.324 0.403 0.593 0.324 0.403 0.593 0.324 0.403 0.593 0.324 0.403 0.593 0.596 0.596 0.596 0.596 0.596 0.680 0.3837 0.596 0.596 0.596	12 Ba 1 -0.221 -0.259 -0.128 0.071 0.128 0.071 0.147 0.051 0.068 0.924 0.068 0.924 0.068 0.924 0.068 0.924 0.0573 0.021 0.0573 0.025 0.959 0.959 10 Ba 10 0.944 0.944 10.944 10.944 0.951 0.921 0.924 0.925	13 Cd 1-0.331 0.686 0.937 0.116 0.686 0.586 0.596 0.596 0.797 0.224 0.777 Cd 1-0.332 0.742 0.742 0.742 0.742 0.742 0.742 0.742 0.742 0.742 0.742 0.742 0.750 0.742 0.750000000000	17 Co 1 0.259 0.237 0.247 0.525 0.247 0.505 0.240 0.360 0.754 0.139 0.430 0.459 0.200 0.754 0.139 0.430 0.148 0.131 0.325 12 Co 0.321 12 Co 0.321 12 Co 0.321 12 Co 0.321 12 0.325 0.325 0.147 0.325 0.247 0.3250 0.325 0.325 0.32500 0.32500 0.325000 0.32500000000000000000000000000000000000	13 Cr -0.146 -0.276 -0.257 -0.257 -0.256 -0.276 -0.276 -0.268 -0.268 -0.276 -0.268 -0.268 -0.268 -0.276 -0.268 -0.268 -0.276 -0.268 -0.268 -0.267 -0.268 -0.373 -0.268 -0.373 -0.268 -0.373 -0.268 -0.373 -0.268 -0.373 -0.269 -0.373 -0.373 -0.373 -0.373 -0.373 -0.373 -0.373 -0.373 -0.373 -0.393 -0.	13 Ga 1 0.388 0.171 0.592 - 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0.286 0.086 0.0457 0.718 0.657 0.718 0.324 -0.670 0.324 -0.670 0.324 -0.670 0.324 -0.577 0.324 -0.324 0.324 -0.525 -0.329 0.525 -0.329 -0.537 0.855 -0.286 0.296 -0.286 0.296 -0.286 0.324 -0.527 -0.324 -0.527 -0.324 -0.527 -0.324 -0	17 Sb 0.301 0.391 0.391 0.412 0.414 0.435 12 Sb 12 Sb 12 Sb 12 Sb 12 Sb	2 Se 1 - - - - - - - - - - - - - -	2 Sr Sr 	13 TI 1-0.405 -0.306 -0.402 -0.306 -0.453 0.729 -0.453 0.729 -0.453 -0.453 -0.453 -0.453 -0.546 -0.125 TI 10 TI 1 -0.089 0.276 0.595 -0.314 -0.195 -0.314 -0.195 -0.314 -0.195 -0.314 -0.195 -0.314 -0.195 -0.314 -0.495 -0.314 -0.495 -0.316 -0.495 -0.316 -0.495 -0.316 -0.495 -0.316 -0.495 -0.316 -0.495 -0.316 -0.495 -0.316 -0.495 -0	16 U U 10.061 0.573 0.206 0.338 -0.052 U U 12 U U 1 0.365 -0.189 U 0.569 -0.281	9 V V 1-0.146 0.362 -0.270 0.888 -0.146 0.971 V V 1 0.043 0.133 0.0227	13 Cu 0.022 -0.475 -0.131 -0.131 -0.135 -0.234 10 Cu 1 0.891 0.030 0.379	13 Fe 1 0.448 -0.013 0.451 10 Fe 10 .754 -0.375	13 Zn 1 0.591 -0.547 -0.145 10 Zn 10.056 -0.193	10 S -0.393 -0.799 10 S	12 SiO ₂ 1-0.240 6 SiO ₂

Figure 10. Correlation matrix for samples analyzed from the TAG-1, -2, -4, and -5 areas. Correlation coefficients with 99% confidence level are highlighted. The number of samples analyzed is given above and beside the respective element. Dashes indicate insufficient number of analyses to calculate correlation factors.

Table 5. Statistically significant element correlations for Au, Zn, Cu, and other elements based on the chemical composition of drill core samples from the TAG mound.

	TAG-1	TAG-2	TAG-4	TAG-5
Gold	Au/Sb Au/As Au/In Au/Pb Au/Ag	Au/Sb Au/As — Au/Pb — Au/Zn Au/Ga	Au/Sb (Au/As) Au/In 	Au/Sb Au/As Au/In Au/Pb Au/Ag Au/Zn Au/Ga
Zinc	Zn/Cd Zn/In Zn/As	Zn/Cd 	Zn/Cd Zn/Ag 	Zn/Cd Zn/In Zn/Ag Zn/Sb Zn/Ga
Copper	Cu/In Cu/Ag Cu/Ga 		Cu/In Cu/Co 	Cu/In Cu/Ag Cu/Ga Cu/Au
Others	Sr/Ca As/Sb Pb/Sb 	Sr/Ca As/Sb Pb/Sb Cd/Sb Cd/Ga	Sr/Ca As/Sb Cd/Sb Cd/Ga	Sr/Ca As/Sb Pb/Sb Cd/Sb Cd/Ga

Notes: Correlations are with a 99% confidence level. Those with 95% confidence level are given in parentheses. — = no correlation.

self contains less than 30 wt% S and consists of highly altered wallrock with disseminated and vein-type sulfides (Constantinou, 1980).

The average Cu content of bulk samples from the interior of the TAG mound is 2.4 wt% and thus is well within the range of the Cu content of massive sulfide deposits in the Troodos ophiolite, which range from less than 0.5 to about 4.5 wt% Cu (Constantinou, 1980; Spooner, 1980). Similar to TAG, elevated Zn contents are only rarely reported for the Cyprus deposits (e.g., Agrokipia B: Constantinou and Govett, 1973; Herzig, 1988). Copper is erratically distributed in the different parts of individual orebodies in Cyprus, but generally tends to increase at the upper levels of the massive ore, which is similar to the Cu enrichment in the upper 20 m of the TAG mound. Constantinou and Govett (1973) have suggested that the enrichment of Cu in the upper zones of the Cyprus sulfide deposits is the result of a submarine enrichment process involving leaching of cupreous pyrite. This may be analogous to TAG, where the enrichment of Cu and other elements at the top of the mound is attributed to zone refining, a process in which elements that are mobilized from previously deposited sulfides in the interior of the mound by later hydrothermal fluids are transported to the surface where they reprecipitate because of mixing with ambient seawater. This leaching process ultimately results in barren pyrite mineralization without significant base metal contents as found in the TAG drill core and as described from the Troodos ophiolite (Constantinou, 1980).

Cupreous pyrite ores of the Cyprus type are generally poorly zoned in comparison to volcanogenic massive sulfide deposits in the Archean greenstone belts of Canada (e.g., Noranda, Matagami, Timmins, and Mattabi districts), the Kuroko type massive sulfide deposits in Japan, western Tasmania, Newfoundland, and the Bathurst district in New Brunswick (Large, 1977). This is also obvious from the metal distribution at the TAG mound. Here, the only metal zoning is the occurrence of a zone enriched in Cu and Zn, as well as a number of other elements such as Au, at the top of the TAG mound.

One of the most striking features of the cores recovered during Leg 158 is the abundance of anhydrite preserved within the interior of the active TAG mound, resulting in Ca concentrations of up to 11.5 wt% (Table 2). Because of its retrograde solubility, anhydrite commonly dissolves in seawater at temperatures of less than 150°C and seafloor pressures (Haymon and Kastner, 1981). The retrograde solubility of anhydrite is in part responsible for the instability and ultimate collapse of large inactive sulfide chimneys and explains why anhydrite and high Ca concentrations are absent from most ancient volcanogenic massive sulfide deposits.

A comparison of the major- and trace-element geochemistry of bulk sulfides from the interior of the TAG mound with the chemical composition of samples recovered by submersible or surface ship from the surface of seafloor hydrothermal deposits indicates important differences. The concentrations of most elements in samples from various seafloor deposits are much higher than those in samples from the interior of the TAG mound (Table 2; Herzig and Hannington, 1995). This is consistent with enrichment of surface sulfides by zone refining. Base-metal–rich chimney fragments, which are preferentially sampled by submersible or dredge, are obviously not representative for seafloor polymetallic sulfide deposits as a whole.

Sulfur-isotopic studies of seafloor massive sulfide deposits forming at the mid-ocean ridges have shown a range of δ^{34} S ratios from +0.7‰ to +6.3‰. A compilation of 501 analyses from different sediment-free mid-ocean ridge sites yields an average of +3.2% $\delta^{34}S$ (for references see Fig. 13). These data are explained by the fact that the sulfur originates from two different sources: mid-ocean ridge basalt (MORB, $\delta^{34}S = +0.1\%$; Sakai et al., 1984) and seawater ($\delta^{34}S =$ +20.9%; Rees et al., 1978). Arnold and Sheppard (1981) have calculated that the sulfur-isotopic composition of massive sulfides from the East Pacific Rise 21°N (+2.1‰ δ^{34} S) can be explained by nonequilibrium mixing of about 10% reduced seawater sulfate with about 90% sulfide of basaltic origin. A δ^{34} S value of +6‰ for example would result in a seawater/basalt sulfur ratio of 30:70. Thus, the variation in sulfur-isotopic ratios of seafloor massive sulfides are explained by varying proportions of mixing between hydrothermal fluid and seawater. Anhydrite and barite associated with the precipitation of sulfides from seafloor hydrothermal fluids usually have the sulfur-isotopic composition of contemporaneous seawater.

The sulfur-isotopic ratios of +4.6% to +8.2%, with an average of +6.4‰ δ^{34} S determined for bulk samples from the TAG mound are, on average, about 3‰ heavier than the average value for all other sediment-free mid-ocean ridge sulfides, but are similar to the average of stockwork pyrite from Cyprus (average +6.4‰ δ^{34} S; Alt, 1994) and pyrite from massive sulfide deposits in the Troodos ophiolite (+4‰ to +7‰ δ^{34} S; Alt, 1994). In some areas of the TAG mound, the δ^{34} S ratios appear to increase downhole. Sulfur-isotope studies by Knott et al. (Chap. 1, this volume) and Gemmell and Sharpe (Chap. 5, this volume) also indicate an increase of δ^{34} S ratios with depth. Furthermore, both studies reveal heavy sulfur isotope ratios (+8% to +10‰) for disseminated pyrite in chloritized and paragonitized basalt fragments and lighter δ^{34} S values for vein-related pyrite of the stockwork zone. Thus, the bulk sulfide δ^{34} S ratios determined in this study likely show an average of heavy sulfur in disseminated sulfides and light vein-related sulfides, obviously masking the increase of sulfur-isotopic ratios of bulk sulfides with depth.

Drilling results have indicated the presence of pyrite-anhydrite breccias at 20–45 mbsf with pyrite clasts cemented by anhydrite down to 30 mbsf. This is followed by pyrite-silica-anhydrite breccias, which are commonly crosscut by anhydrite veins up to 45 cm in thickness. The presence of anhydrite within the mound is likely explained by conductive heating of seawater close to the high-temperature feeder zone (Hannington et al., Chap. 28, this volume) and, at least to some extent, through mixing of seawater with upwelling high-temperature hydrothermal fluids (Humphris et al., 1995). At the same time, these fluids may be responsible for the thermochemical reduction of pre-existing anhydrite at temperatures well above 300° C. Part of the reduced sulfate will be carried as H₂S in the upwelling hydrothermal fluid which may explain the heavy sulfur isotopic signature found in the TAG sulfides (cf. Janecky and Shanks,

Area section, interval (cm) Sample type (mbst) $\delta^{34}S_{CDT}/Rel TAG-1 957C-5N-1, 15-48 Massive pyrite-anhydrite breccia 15.25 6.6 957C-7N-1, 52-56 Nodular siliceous pyrite-anhydrite breccia 21.45 5.5 957C-7N-2, 61-69 Nodular siliceous pyrite-anhydrite breccia 31.18 5.9 957C-1N-1, 52-56 Nodular siliceous pyrite-anhydrite breccia 31.45 5.6 957C-1N-1, 53-59 Massive pyrite-breccia 36.46 6.5 957C-1N-1, 53-59 Massive pyrite-anhydrite breccia 36.46 6.3 957C-1N-1, 33-86-100 Pyrite-silica-anhydrite breccia 36.44 6.2 957C-1N-1, 38-610 Pyrite-silica breccia 40.53 6.0 957C-1N-1, 38-640 Pyrite-silica breccia 41.67 6.5 957C-1N-1, 38-48 Pyrite-silica breccia 45.70 7.4 957C-1N-1, 38-48 Pyrite-silica breccia 47.59 6.7 957C-1N-1, 18-12 Silicified wallrock breccia 47.50 6.7 957C-1N-1, 18-12 Pyrite-silica breccia 47.57 $			Hole, core,		Depth	Average
TAG-1 97C-5N-1, 15-48 Massive pyrite-anhydrite breccia 15.25 6.6 97C-7N-2, 61-69 Nodular siliceous pyrite-anhydrite breccia 20.04 5.1 97C-7N-2, 61-69 Nodular siliceous pyrite-anhydrite breccia 21.45 5.5 97C-1N-1, 12-22 Massive pyrite-shibcracia 31.80 5.6 97TC-1N-1, 58-61 Pyrite-silica-anhydrite breccia 31.61 6.6 97TC-1N-1, 53-59 Massive pyrite-shibcracia 31.61 6.3 97TC-1N-1, 53-59 Pyrite-silica-anhydrite breccia 36.16 6.3 97TC-1N-1, 13-40 Pyrite-silica-anhydrite breccia 41.67 6.6 95TC-1N-1, 13-21-10 Silicified wallrock breccia 45.54 6.4 95TC-1N-1, 13-21-10 Silicified wallrock breccia 45.54 6.4 95TC-1N-1, 13-21-10 Silicified wallrock breccia 47.75 6.7 95TC-1N-2, 12-21-5 Silicified wallrock breccia 47.79 6.6 95TC-1N-1, 13-25 Nodular pyrite-silica breccia 47.39 6.6 95TC-1N-1, 13-24 Silicified wallrock breccia 47.39		Area	section, interval (cm)	Sample type	(mbsf)	$\delta^{34}S_{CDT}[\%]$
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937C-108-2, 01-92 Notimal striceous pyrite-singuine function 23.3 957C-108-1, 21-22 Massive pyrite-breccia 28.86 6.5 957C-118-1, 58-61 Pyrite-silica-anhydrite breccia 31.450 5.6 957C-128-1, 68-75 Pyrite-silica-anhydrite breccia 36.45 5.9 957C-128-3, 68-75 Pyrite-silica-anhydrite breccia 36.16 6.3 957C-128-3, 68-75 Pyrite-silica-anhydrite breccia 36.34 6.2 957C-148-1, 12-20 Pyrite-silica breccia 41.67 6.5 957C-148-1, 76-87 Pyrite-silica breccia 41.67 6.5 957C-158-1, 36-40 Pyrite-silica breccia 42.54 6.4 957C-158-1, 36-10 Silicified wallrock breccia 47.79 7.4 957C-168-2, 14-23 Silicified wallrock breccia 47.79 6.6 957C-168-2, 94-95 Pyrite-silica breccia 48.56 7.5 957E-188-1, 16-19 Massive granular pyrite 78.16 6.3 957E-188-1, 16-19 Massive granular pyrite 1.31 5.7 957E-188-1, 16-19 Massive granul			957C-7N-1, 52-56	Nodular siliceous pyrite-annydrite breccia	20.04	5.1
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927C-12N-3, 86-100 Pyrite-silica-anhydrite breccia 36.94 62.1 957C-12N-3, 36-100 Pyrite-silica breccia 36.94 62.1 957C-13N-1, 12-20 Pyrite-silica breccia 40.53 60.9 957C-14N-2, 76-87 Pyrite-silica breccia 41.67 6.5 957C-15N-3, 132-150 Silicified wallrock breccia 42.50 6.4 957C-18N-4, 8-10 Silicified wallrock breccia 45.54 6.4 957C-18N-4, 8-10 Silicified wallrock breccia 47.75 6.6 957C-18N-4, 8-10 Silicified wallrock breccia 47.75 6.7 957C-18N-2, 94-95 Pyrite-silica breccia 47.75 6.7 957C-18N-2, 94-95 Pyrite-silica breccia 31.70 7.9 957E-18R-1, 16-20 Silicified wallrock breccia 91.95 6.5 957F-18R-1, 16-20 Silicified wallrock breccia 91.95 6.7 957F-18R-1, 27-30 Chloritized basalt breccia 9.30 6.2 957F-18R-1, 3-95 Pyrite, iron oxides, and chert; drill cuttings 0.00 5.4 957H-1N-1, 60-73			957C 12N 2 68 75	Purite silice annudrite braccia	36.16	63
977C-13N-1, 12-20 Pyrite-anhydrite breecia 37.31 5.5 977C-13N-1, 12-20 Pyrite-anhydrite breecia 40.53 6.0 957C-14N-1, 33-41 Pyrite-silica breecia 41.67 6.5 957C-14N-2, 76-87 Pyrite-silica breecia 42.50 6.4 957C-15N-3, 136-40 Pyrite-silica breecia 42.50 6.4 957C-15N-3, 132-150 Silicified wallrock breecia 45.54 6.4 957C-16N-4, 8-10 Silicified wallrock breecia 47.39 6.6 957C-16N-2, 14-23 Silicified wallrock breecia 47.56 6.7 957C-16N-2, 14-23 Silicified wallrock breecia 48.56 7.5 957E-18R-1, 16-19 Massive granular pyrite 78.16 6.3 957E-12R-1, 16-10 Silicified wallrock breecia 10.67 6.7 957F-18R-1, 32-55 Nodular pyrite breecia 10.31 5.7 957F-18R-1, 3-95 Pyrite, iron oxides, and chert; drill cuttings 0.00 5.4 957H-1N-1, 61-64 Nodular pyrite breecia 27.30 7.3 7AG-3 957Q-1R-3, 70-100<			957C-12N-2, 06-75	Pyrite-silica-anhydrite breccia	36.94	6.2
957C-14N-1, 33-41 Pyrite-silica breccia 40.53 6.0 957C-14N-2, 76-87 Pyrite-silica breccia 40.53 6.0 957C-15N-2, 12-15 Silicified wallrock breccia 42.50 6.4 957C-15N-2, 12-15 Silicified wallrock breccia 45.54 6.4 957C-15N-3, 132-150 Silicified wallrock breccia 45.54 6.4 957C-16N-2, 14-23 Silicified wallrock breccia 47.39 6.6 957C-16N-2, 14-23 Silicified wallrock breccia 47.75 6.7 957C-16N-2, 14-23 Silicified wallrock breccia 11.70 7.9 957E-18L, 1, 18-125 Pyrite-silica breccia 11.70 7.9 957E-18L, 1, 16-19 Massive granular pyrite 91.95 6.5 957E-18L, 1, 16-20 Silicified wallrock breccia 91.95 6.5 957E-18L, 1, 6-30 Silicified wallrock breccia 91.95 6.5 957E-18L, 1, 6-30 Silicified wallrock breccia 91.00 5.4 957E-18L, 1, 6-30 Silicified wallrock breccia 91.3 5.7 957B-18L, 16-30 Pyrit			957C-13N-1 12-20	Pyrite-anhydrite breccia	37 31	5.5
957C-14N-2, 76-87 Pyrite-silica breccia 41.67 6.5 957C-14N-2, 76-87 Pyrite-silica breccia 42.50 6.4 957C-15N-1, 36-40 Pyrite-silica breccia 43.28 7.1 957C-15N-2, 12-15 Silicified wallrock breccia 45.54 6.4 957C-15N-3, 132-150 Silicified wallrock breccia 45.70 7.4 957C-16N-1, 118-125 Pyrite-anhydrite breccia 47.39 6.6 957C-16N-2, 94-95 Pyrite-silica breccia 48.56 7.5 957E-18R-1, 16-19 Massive granular pyrite 78.16 6.3 957E-18R-1, 16-19 Massive granular pyrite 78.16 6.3 957E-18R-1, 27-30 Chloritized basalt breccia 106.77 6.7 957B-18R-1, 3-95 Pyrite, iron oxides, and chert; drill cuttings 0.00 5.4 957H-1N-1, 60-73 Porous nodular pyrite breccia 27.30 7.3 957H-1N-1, 16-00 Pyrite, iron oxide; drill cuttings 3.75 7.3 957H-1N-1, 3-40 Porous massive pyrite marcasite 9.30 6.2 957K-1N-1, 3-41			957C-14N-1 33-41	Pyrite-silica breccia	40.53	6.0
957C-15N-1, 36-40 Pyrite-silica breccia 42.50 6.4 957C-15N-2, 12-15 Silicified wallrock breccia 43.28 7.1 957C-15N-3, 132-150 Silicified wallrock breccia 45.54 6.4 957C-15N-4, 8-10 Silicified wallrock breccia 45.70 7.4 957C-16N-2, 14-23 Silicified wallrock breccia 47.39 6.6 957C-16N-2, 14-23 Silicified wallrock breccia 47.39 6.6 957C-16N-2, 14-23 Silicified wallrock breccia 47.75 6.7 957E-18L-1, 13-25 Nodular pyrite-silica breccia 91.95 6.5 957E-118L-1, 6-20 Silicified wallrock breccia 91.95 6.5 957E-118L-1, 6-23 Nodular pyrite breccia 106.77 6.7 957E-18L-1, 60-73 Porte inon oxides, and chert; drill cuttings 0.00 5.4 957H-1N-1, 60-73 Porous nodular pyrite breccia 9.30 6.2 957H-1N-1, 60-73 Porous colloform pyrite-marcasite 0.21 4.6 957Q-1R-3, 70-100 Pyrite, iron oxide; drill cuttings 3.75 7.3 TA			957C-14N-2, 76-87	Pyrite-silica breccia	41.67	6.5
957C-15N-2, 12-15 Silicified wallrock breccia 43.28 7.1 957C-15N-4, 8-10 Silicified wallrock breccia 45.54 64 957C-15N-4, 8-10 Silicified wallrock breccia 45.70 7.4 957C-16N-1, 118-125 Pyrite-anhydrite breccia 47.39 66 957C-16N-2, 14-23 Silicified wallrock breccia 47.75 67 957C-16N-2, 14-23 Silicified wallrock breccia 47.67 67 957C-16N-2, 14-23 Nodular pyrite-silica breccia 106.77 67 957E-18R-1, 23-26 Nodular pyrite-silica breccia 106.77 67 957E-18R-1, 27-30 Chloritized basalt breccia 106.77 67 957F-1N-1, 32-35 Nodular pyrite breccia 27.30 7.3 957F-2N-1, 11-19 Massive granular pyrite 1.31 5.7 957F-18R-1, 3-95 Pyrite, iron oxides, and chert; drill cuttings 0.00 5.4 957H-1N-1, 61-64 Modular pyrite breccia 27.30 7.3 957H-1N-1, 13-40 Porous nodular pyrite breccia 27.30 7.3 957Q-1R-3, 70-100			957C-15N-1, 36-40	Pyrite-silica breccia	42.50	6.4
957C-15N-3, 132-150 957C-16N-4, 8-10 957C-16N-2, 14-23 957C-16N-2, 14-23 957C-16N-2, 94-95 957C-16N-2, 94-95 957C-16N-2, 94-95 957E-12R-1, 23-26 Nodular pyrite-silica breccia 957E-12R-1, 23-26 Nodular pyrite-silica breccia 957E-12R-1, 16-20 957E-12R-1, 16-20 957E-12R-1, 16-20 957E-12R-1, 16-20 957E-12R-1, 16-20 957E-12R-1, 16-20 957E-12R-1, 16-20 957E-12R-1, 16-20 957E-12R-1, 10-20 957E-12R-1, 10-20 957E-12R-1, 10-20 957E-12R-1, 10-20 957E-12R-1, 10-20 957E-12R-1, 10-20 957E-12R-1, 10-20 957F-2N-1, 11-19 Massive granular pyrite 957B-12R-1, 3-95 957F-2N-1, 11-19 957B-12R-1, 3-95 957H-1N-1, 60-73 957H-1N-1, 60-73 957H-1N-1, 60-73 957H-1N-1, 60-73 957H-1N-1, 60-73 957H-1N-1, 60-73 957H-1N-1, 61-64 Nodular pyrite-silica breccia 9.30 6.2 957R-12R-1, 14-19 97rte-18R-1, 3-95 957R-12R-1, 14-19 97rte-18R-1, 3-95 957R-12R-1, 14-19 97rte-18R-1, 3-95 957R-12R-1, 14-19 97rte-18R-1, 3-95 957R-12R-1, 14-19 97rte-18R-1, 3-95 957R-12R-1, 12-12P 97rte-18R-12R-12R-12R-12R-12R-12R-12R-12R-12R-12			957C-15N-2, 12-15	Silicified wallrock breccia	43.28	7.1
$\begin{array}{cccccccccccccccccccccccccccccccccccc$			957C-15N-3, 132-150	Silicified wallrock breccia	45.54	6.4
957C-16N-1, 118-125 Pyrite-anhydrite breccia 47,39 6.6 957C-16N-2, 94-95 Pyrite-silica breccia 48.56 7.5 957C-16N-2, 94-95 Pyrite-silica breccia 48.56 7.5 957E-18L-1, 23-26 Nodular pyrite-silica breccia 31.70 7.9 957E-17L-1, 16-19 Massive granular pyrite 78.16 6.3 957E-12R-1, 16-20 Silicified wallrock breccia 91.95 6.5 957E-13R-1, 27-30 Chloritized basalt breccia 106.77 6.7 957F-1-N.1, 32-35 Nodular pyrite breccia 1.31 5.7 957B-17L-N.1, 32-35 Pyrite-, iron oxides, and chert; drill cuttings 0.00 5.4 957H-1N-1, 60-73 Porous nodular pyrite breccia 9.30 6.2 957H-1N-1, 61-64 Nodular pyrite-silica breccia 31.34 7.5 TAG-3 9 9 9 9 9 7.3 957Q-1R-3, 70-100 Pyrite-, iron oxide; drill cuttings 3.75 7.3 957K-1X-1, 24-29 Porous massive pyrite with silica 14.482 6.0			957C-15N-4, 8-10	Silicified wallrock breccia	45.70	7.4
957C-16N-2, 14-23 Silicified wallrock breccia 47.75 6.7 957C-16N-2, 94-95 Pyrite-silica breccia 48.56 7.5 957E-1R-1, 23-26 Nodular pyrite-silica breccia 31.70 7.9 957E-1R-1, 16-19 Massive granular pyrite 78.16 6.3 957E-1R-1, 16-20 Silicified wallrock breccia 91.95 6.5 957E-1R-1, 27.30 Chloritized basal breccia 106.77 6.7 957F-1N-1, 32-35 Nodular pyrite breccia 1.31 5.9 957F-1N-1, 11-19 Massive granular pyrite 1.31 5.7 957F-2N-1, 11-19 Massive granular pyrite 1.31 5.7 957F-1N-1, 60-73 Porous nodular pyrite breccia 2.30 6.2 957H-1N-1, 60-73 Porous nodular pyrite-silica breccia 31.34 7.5 TAG-3 957Q-1R-3, 70-100 Pyrite, iron oxide; drill cuttings 3.75 7.3 TAG-4 957K-1N-1, 37-41 Massive granular pyrite 10.37 5.7 957K-1N-1, 37-41 Massive granular pyrite 9.30 7.4 957M			957C-16N-1, 118-125	Pyrite-anhydrite breccia	47.39	6.6
957C-16N-2, 94-95 Pyrite-silica breccia 48.56 7.5 957E-1R-1, 23-26 Nodular pyrite-silica breccia 31.70 7.9 957E-1R, 1, 16-19 Massive granular pyrite 78.16 6.3 957E-12R-1, 16-20 Silicified wallrock breccia 91.95 6.5 957E-13R, 1, 27-30 Chloritized basalt breccia 106.77 6.7 957F-1N-1, 32-35 Nodular pyrite breecia 1.13 5.9 957F-1N-1, 32-35 Nodular pyrite breecia 9.30 6.2 957H-1N-1, 60-73 Porous nodular pyrite breecia 9.30 6.2 957H-1N-1, 61-64 Nodular pyrite-silica breecia 27.30 7.3 957H-6N-1, 14-19 Pyrite, iron oxide; drill cuttings 3.75 7.3 TAG-3 9 957Q-1R-3, 70-100 Pyrite, iron oxide; drill cuttings 3.75 7.3 TAG-4 9 9 Porous colloform pyrite-marcasite 0.21 4.6 957K-1X-1, 24-29 Porous massive pyrite 9.30 7.4 957K-3X-1, 36-38 Massive granular pyrite 9.30 7.4			957C-16N-2, 14-23	Silicified wallrock breccia	47.75	6.7
957E-1R-1, 23-26 Nodular pyrite-silica breccia 31.70 7.9 957E-13R-1, 16-19 Massive granular pyrite 78.16 6.3 957E-13R-1, 16-20 Silicified wallrock breccia 91.95 6.5 957E-13R-1, 27-30 Chloritized basalt breccia 106.77 6.7 957F-1N-1, 32-35 Nodular pyrite breccia 1.13 5.9 957F-1N-1, 32-35 Nodular pyrite breccia 1.31 5.7 TAG-2 957F-1N-1, 60-73 Porous nodular pyrite breccia 9.30 6.2 957H-1N-1, 60-73 Porous nodular pyrite-silica breccia 27.30 7.3 957H-6N-1, 14-19 Pyrite-silica breccia 31.34 7.5 TAG-3 957Q-1R-3, 70-100 Pyrite, iron oxide; drill cuttings 3.75 7.3 957K-1N-1, 33-40 Porous massive pyrite-marcasite 9.31 5.7 957K-1N-1, 33-40 Porous massive pyrite 10.37 5.7 957K-2N-1, 37.41 Massive granular pyrite 10.37 5.7 957K-3N-1, 2.5 Porous massive pyrite 9.30 7.4 957M-3R-1, 2.5 Porous			957C-16N-2, 94-95	Pyrite-silica breccia	48.56	7.5
957E-9R-1, 16-19 Massive granular pyrite 78.16 6.3 957E-12R-1, 16-20 Silicified wallrock breecia 91.95 6.5 957E-15R-1, 27-30 Chloritized basalt breecia 91.95 6.5 957F-15R-1, 7-30 Nodular pyrite breecia 1.13 5.9 957F-17-2N-1, 11-19 Massive granular pyrite 1.31 5.7 TAG-2 957B-1R-1, 3-95 Pyrite, iron oxides, and chert; drill cuttings 0.00 5.4 957H-1N-1, 60-73 Porous nodular pyrite breecia 9.30 6.2 957H-1N-1, 61-64 Nodular pyrite breecia 27.30 7.3 957H-1N-1, 61-64 Nodular pyrite breecia 27.30 7.3 957H-1N-1, 14-19 Pyrite, iron oxide; drill cuttings 3.75 7.3 TAG-3 957Q-1R-3, 70-100 Pyrite, iron oxide; drill cuttings 3.75 7.3 TAG-4 957K-1X-1, 24-29 Porous colloform pyrite-marcasite 9.33 5.7 957K-2N-1, 37-41 Massive granular pyrite 10.37 5.7 957M-3R-1, 2-5 Porous massive pyrite 9.30 7.4<			957E-1R-1, 23-26	Nodular pyrite-silica breccia	31.70	7.9
957E-12R-1, 16-20 Silicified wallrock breccia 91.95 6.5 957E-15R-1, 27-30 Chloritized basalt breccia 106.77 6.7 957F-1N-1, 32-35 Nodular pyrite breccia 1.13 5.9 957F-2N-1, 11-19 Massive granular pyrite 1.31 5.7 TAG-2 957B-1R-1, 3-95 Pyrite, iron oxides, and chert; drill cuttings 0.00 5.4 957H-1N-1, 60-73 Porous nodular pyrite breccia 9.30 6.2 957H-1N-1, 61-64 Nodular pyrite-silica breccia 27.30 7.3 957H-1N-1, 14-19 Pyrite-silica breccia 31.34 7.5 TAG-3 957Q-1R-3, 70-100 Pyrite, iron oxide; drill cuttings 3.75 7.3 TAG-4 957K-1X-1, 24-29 Porous colloform pyrite-marcasite 9.33 5.7 957K-2N-1, 37-41 Massive granular pyrite 10.37 5.7 957K-3N-1, 57-60 Massive granular pyrite 14.82 6.0 957M-3R-1, 57-60 Massive granular pyrite 14.87 6.3 957M-3R-1, 89-91 Pyrite-silica breccia 15.80 7.2 <td></td> <td></td> <td>957E-9R-1, 16-19</td> <td>Massive granular pyrite</td> <td>78.16</td> <td>6.3</td>			957E-9R-1, 16-19	Massive granular pyrite	78.16	6.3
957E-15R-1, 27-30 957F-1-N-1, 32-35 957F-2N-1, 11-19 Chloritized basalt breccia Nodular pyrite breccia 106.77 1.13 6.7 5.9 5.9 TAG-2 957B-1R-1, 3-95 Pyrite, iron oxides, and chert; drill cuttings 957H-5N-1, 61-64 Nodular pyrite breccia 9.30 6.2 957H-5N-1, 61-64 Nodular pyrite-silica breccia 27.30 7.3 957H-5N-1, 61-64 Nodular pyrite-silica breccia 27.30 7.3 957H-6N-1, 14-19 Pyrite, iron oxide; drill cuttings 3.75 7.3 7AG-3 957Q-1R-3, 70-100 Pyrite, iron oxide; drill cuttings 3.75 7.3 7AG-4 957K-1X-1, 24-29 Porous massive pyrite-marcasite 9.33 5.7 957K-2N-1, 37-41 Massive granular pyrite 10.37 5.7 957M-3R-1, 12-5 Porous massive pyrite 9.30 7.4 957M-3R-1, 12-125 Pyrite-silica breccia 14.87 6.3 957M-3R-1, 12-125 Pyrite-silica breccia 15.80 7.2 957M-3R-1, 12-125 Pyrite-silica breccia 15.80 7.2 957M-3R-1, 0-4 Massive granular pyrite 14.87 6.4 </td <td></td> <td></td> <td>957E-12R-1, 16-20</td> <td>Silicified wallrock breccia</td> <td>91.95</td> <td>6.5</td>			957E-12R-1, 16-20	Silicified wallrock breccia	91.95	6.5
957F-1-N-1, 32-35 957F-2N-1, 11-19 Nodular pyrite breccia 1.13 5.9 TAG-2 957B-1R-1, 3-95 957H-1N-1, 60-73 957H-5N-1, 61-64 Pyrite, iron oxides, and chert; drill cuttings 957H-5N-1, 61-64 0.00 5.4 957H-1N-1, 60-73 957H-6N-1, 14-19 Pyrite, iron oxides, and chert; drill cuttings 957Q-1R-3, 70-100 9yrite-silica breccia 27.30 7.3 TAG-3 957Q-1R-3, 70-100 Pyrite, iron oxide; drill cuttings 3.75 7.3 TAG-4 957K-1X-1, 24-29 Porous massive pyrite-marcasite 9.33 5.7 957K-2N-1, 37-41 Massive granular pyrite 10.37 5.7 957K-2N-1, 37-41 Massive granular pyrite 10.37 5.7 957K-3X-1, 36-38 Massive pyrite 9.30 7.4 957M-2R-1, 2-5 Porous massive pyrite 9.30 7.4 957M-3R-1, 123-125 Pyrite-silica breccia 15.49 6.4 957M-3R-1, 123-125 Pyrite-silica breccia 25.18 8.2 957M-3R-1, 123-125 Pyrite-silica breccia 15.49 6.4 957M-3R-1, 14 Pyrite-anhydrite breccia 0.43 6.1 </td <td></td> <td></td> <td>957E-15R-1, 27-30</td> <td>Chloritized basalt breccia</td> <td>106.77</td> <td>6.7</td>			957E-15R-1, 27-30	Chloritized basalt breccia	106.77	6.7
957F-2N-1, 11-19 Massive granular pyrite 1.31 5.7 TAG-2 957B-1R-1, 3-95 Pyrite, iron oxides, and chert; drill cuttings 0.00 5.4 957H-1N-1, 60-73 Porous nodular pyrite breccia 9.30 6.2 957H-1N-1, 61-64 Nodular pyrite-silica breccia 27.30 7.3 957H-6N-1, 14-19 Pyrite-silica breccia 31.34 7.5 TAG-3 957Q-1R-3, 70-100 Pyrite, iron oxide; drill cuttings 3.75 7.3 TAG-4 957K-1X-1, 24-29 Porous massive pyrite-marcasite 9.33 5.7 957K-2N-1, 37-41 Massive granular pyrite 10.37 5.7 957K-3N-1, 36-38 Massive granular pyrite 10.37 5.7 957K-3N-1, 36-38 Massive granular pyrite 9.30 7.4 957M-2R-1, 2-5 Porous massive pyrite 9.30 7.4 957M-3R-1, 12-125 Pyrite-silica breccia 15.49 6.4 957M-3R-1, 123-125 Pyrite-silica breccia 15.49 6.4 957M-3R-1, 123-125 Pyrite-silica breccia 15.49 6.4			957F-1-N-1, 32-35	Nodular pyrite breccia	1.13	5.9
TAG-2 957B-1R-1, 3-95 Pyrite, iron oxides, and chert; drill cuttings 0.00 5.4 957H-1N-1, 60-73 Porous nodular pyrite breccia 9.30 6.2 957H-5N-1, 61-64 Nodular pyrite-silica breccia 27.30 7.3 957H-6N-1, 14-19 Pyrite-silica breccia 31.34 7.5 TAG-3 957Q-1R-3, 70-100 Pyrite, iron oxide; drill cuttings 3.75 7.3 TAG-4 957I-1N-1, 33-40 Porous massive pyrite-marcasite 9.33 5.7 957K-2N-1, 37-41 Massive granular pyrite 10.37 5.7 957K-3X-1, 36-38 Massive pyrite with silica 14.82 6.0 957N-3R-1, 57-60 Massive pyrite with silica 14.82 6.3 957M-3R-1, 57-60 Massive granular pyrite 14.87 6.3 957M-3R-1, 123-125 Pyrite-silica breccia 15.49 6.4 957M-3R-1, 0-4 Massive granular pyrite 14.87 6.3 957M-3R-1, 0-4 Massive granular pyrite 38.30 6.0 TAG-5 970-2R-1, 22-24 Nodular pyrite breccia 0.43 6.1 9570-5R-1, 89-91 Pyrite-anhydrite breccia			957F-2N-1, 11-19	Massive granular pyrite	1.31	5.7
957B-1R-1, 3-95 Pyrite, iron oxides, and chert; drill cuttings 0.00 5.4 957H-1N-1, 60-73 Porous nodular pyrite breccia 9.30 6.2 957H-5N-1, 61-64 Nodular pyrite-silica breccia 27.30 7.3 957H-6N-1, 14-19 Pyrite-silica breccia 31.34 7.5 TAG-3 957Q-1R-3, 70-100 Pyrite, iron oxide; drill cuttings 3.75 7.3 TAG-4 957K-1X-1, 33-40 Porous massive pyrite-marcasite 9.21 4.6 957K-2N-1, 37-41 Massive granular pyrite 10.37 5.7 957K-3X-1, 36-38 Massive pyrite with silica 14.82 6.0 957M-3R-1, 2-5 Porous massive pyrite 9.30 7.4 957M-3R-1, 123-125 Pyrite-silica breccia with silica 14.82 6.0 957M-3R-1, 123-125 Pyrite-silica breccia 25.18 8.2 957M-3R-1, 123-125 Pyrite-silica breccia 25.18 8.2 957M-3R-1, 49-91 Pyrite-silica breccia 25.18 8.2 957M-3R-1, 49-91 Pyrite-silica breccia 0.43 6.1 957D-1R-1, 44-46 Pyrite-anhydrite breccia 0.43 6.1		TAG-2				
957H-1N-1, 60-73 Porous nodular pyrite breccia 9.30 6.2 957H-1N-1, 61-64 Nodular pyrite-silica breccia 27.30 7.3 957H-6N-1, 14-19 Pyrite-silica breccia 27.30 7.3 957H-6N-1, 14-19 Pyrite-silica breccia 31.34 7.5 TAG-3 957Q-1R-3, 70-100 Pyrite, iron oxide; drill cuttings 3.75 7.3 TAG-4 957K-1X-1, 24-29 Porous colloform pyrite-marcasite 0.21 4.6 957K-1X-1, 24-29 Porous colloform pyrite-marcasite 0.21 4.6 957K-1X-1, 24-29 Porous colloform pyrite-marcasite 0.21 4.6 957K-1X-1, 24-29 Porous massive pyrite 0.37 5.7 957K-1X-1, 24-29 Porous massive pyrite 0.31 5.7 957K-1X-1, 37-41 Massive granular pyrite 10.37 5.7 957K-3X-1, 36-38 Massive pyrinular pyrite 14.82 6.0 957M-3R-1, 125 Pyrite-silica breccia 14.82 6.0 957M-3R-1, 123-125 Pyrite-silica breccia 25.18 8.2 957M-18R-		1110 2	957B-1R-1 3-95	Pyrite iron oxides and chert: drill cuttings	0.00	54
957H-5N-1, 61-64 Nodular pyrite-silica breccia 27.30 7.3 957H-5N-1, 61-64 Nodular pyrite-silica breccia 27.30 7.3 957H-6N-1, 14-19 Pyrite-silica breccia 31.34 7.5 TAG-3 957Q-1R-3, 70-100 Pyrite, iron oxide; drill cuttings 3.75 7.3 TAG-4 957I-1N-1, 33-40 Porous massive pyrite-marcasite 9.33 5.7 957K-1X-1, 24-29 Porous colloform pyrite-marcasite 0.21 4.6 957K-3X-1, 37-41 Massive granular pyrite 10.37 5.7 957K-3X-1, 36-38 Massive granular pyrite 9.30 7.4 957M-3R-1, 2-5 Porous massive pyrite 9.30 7.4 957M-3R-1, 12-5 Porite-silica breccia with late marcasite 15.49 6.4 957M-3R-1, 12-125 Pyrite-silica breccia 15.80 7.2 957M-3R-1, 12-14 Pyrite-silica breccia 15.80 7.2 957M-5R-1, 89-91 Pyrite-silica breccia 16.35 5.9 957P-18-1, 44-46 Pyrite-anhydrite breccia 0.43 6.1 95			957H-1N-1 60-73	Porous nodular pyrite breccia	9 30	62
957H-6N-1, 14-19 Pyrite-silica breccia 31.34 7.5 TAG-3 957Q-1R-3, 70-100 Pyrite, iron oxide; drill cuttings 3.75 7.3 TAG-4 9571-1N-1, 33-40 Porous massive pyrite-marcasite 9.33 5.7 957K-1X-1, 24-29 Porous colloform pyrite-marcasite 0.21 4.6 957K-2N-1, 37-41 Massive granular pyrite 10.37 5.7 957K-3X-1, 36-38 Massive pyrite with silica 14.82 6.0 957M-3R-1, 2-5 Porous massive pyrite 9.30 7.4 957M-3R-1, 123-125 Pyrite-silica breccia 14.87 6.3 957M-3R-1, 123-125 Pyrite-silica breccia 15.49 6.4 957M-3R-1, 89-91 Pyrite-silica breccia 25.18 8.2 957M-5R-1, 89-91 Pyrite-silica breccia 25.18 8.2 9570-74R-1, 22-24 Nodular pyrite breccia 16.35 5.9 9570-74R-1, 44-46 Pyrite-anhydrite breccia 0.43 6.1 957P-FR-1, 9-13 Pyrite-anhydrite breccia 0.43 6.1 957P-12R-1, 15-100			957H-5N-1, 61-64	Nodular pyrite-silica breccia	27.30	7.3
TAG-3 957Q-1R-3, 70-100 Pyrite, iron oxide; drill cuttings 3.75 7.3 TAG-4 957K-1X-1, 24-29 Porous massive pyrite-marcasite 9.33 5.7 957K-1X-1, 24-29 Porous colloform pyrite-marcasite 0.21 4.6 957K-2N-1, 37-41 Massive granular pyrite 10.37 5.7 957K-3X-1, 36-38 Massive granular pyrite 10.37 5.7 957K-3X-1, 36-38 Massive pyrite with silica 14.82 6.0 957M-2R-1, 2-5 Porous massive pyrite 9.30 7.4 957M-3R-1, 57-60 Massive granular pyrite 14.87 6.3 957M-3R-1, 123-125 Pyrite-silica breccia with late marcasite 15.49 6.4 957M-3R-1, 123-125 Pyrite-silica breccia 25.18 8.2 957M-3R-1, 123-125 Pyrite-silica breccia 25.18 8.2 957M-3R-1, 48-91 Pyrite-silica breccia 25.18 8.2 957M-3R-1, 0-4 Massive granular pyrite 38.30 6.0 TAG-5 9570-2R-1, 22-24 Nodular pyrite breccia 0.43 6.1 957P-1R-1, 44-46 Pyrite-anhydrite breccia 0.43 6			957H-6N-1, 14-19	Pvrite-silica breccia	31.34	7.5
TAG-5 957Q-1R-3, 70-100 Pyrite, iron oxide; drill cuttings 3.75 7.3 TAG-4 957I-1N-1, 33-40 Porous massive pyrite-marcasite 9.33 5.7 957K-1X-1, 24-29 Porous colloform pyrite-marcasite 0.21 4.6 957K-1X-1, 24-29 Porous colloform pyrite-marcasite 0.21 4.6 957K-1X-1, 24-29 Porous colloform pyrite-marcasite 0.21 4.6 957K-1X-1, 36-38 Massive granular pyrite 10.37 5.7 957K-3X-1, 36-38 Massive pyrite with silica 14.82 6.0 957M-2R-1, 2-5 Porous massive pyrite 9.30 7.4 957M-3R-1, 12-5 Pyrite-silica breccia with late marcasite 15.49 6.4 957M-3R-2, 1-4 Pyrite-silica breccia 15.80 7.2 957M-5R-1, 89-91 Pyrite-silica breccia 25.18 8.2 957M-5R-1, 9-10 Pyrite-silica breccia 16.35 5.9 957D-1R-1, 45-50 Pyrite-anhydrite breccia 0.43 6.1 957D-1R-1, 45-50 Pyrite-anhydrite breccia 0.43 6.1 957D-1R-1, 44-46 Pyrite-anhydrite breccia 0.43 6.1		TAC 2	,	5		
957Q-1R-3, 70-100 Pyrite, iron oxide; drill cuttings 3.75 7.3 TAG-4 957I-1N-1, 33-40 Porous massive pyrite-marcasite 9.33 5.7 957K-1X-1, 24-29 Porous colloform pyrite-marcasite 0.21 4.6 957K-2N-1, 37-41 Massive granular pyrite 10.37 5.7 957K-3X-1, 36-38 Massive pyrite with silica 14.82 6.0 957M-3R-1, 2-5 Porous massive pyrite 9.30 7.4 957M-3R-1, 57-60 Massive granular pyrite 14.87 6.3 957M-3R-1, 123-125 Pyrite-silica breccia with late marcasite 15.49 6.4 957M-3R-1, 123-125 Pyrite-silica breccia 15.80 7.2 957M-3R-1, 123-125 Pyrite-silica breccia 15.80 7.2 957M-3R-1, 104 Pyrite-silica breccia 25.18 8.2 957M-8R-1, 0-4 Massive granular pyrite 38.30 6.0 TAG-5 9570-2R-1, 22-24 Nodular pyrite breccia 16.35 5.9 957P-1R-1, 44-46 Pyrite-anhydrite breccia 0.43 6.1 957P-1R-1, 9-13 Pyrite-anhydrite breccia 0.43 6.1 <		IAG-3	0570 ID 2 70 100		2.75	7.2
TAG-4 9571-1N-1, 33-40 Porous massive pyrite-marcasite 9.33 5.7 957K-1X-1, 24-29 Porous colloform pyrite-marcasite 0.21 4.6 957K-2N-1, 37-41 Massive granular pyrite 10.37 5.7 957K-3X-1, 36-38 Massive pyrite with silica 14.82 6.0 957M-3R-1, 2-5 Porous massive pyrite 9.30 7.4 957M-3R-1, 123-125 Pyrite-silica breccia with late marcasite 15.49 6.4 957M-3R-1, 123-125 Pyrite-silica breccia 15.80 7.2 957M-3R-1, 123-125 Pyrite-silica breccia 25.18 8.2 957M-3R-1, 123-125 Pyrite-silica breccia 25.18 8.2 957M-3R-1, 0-4 Massive granular pyrite 38.30 6.0 TAG-5 7 7 7 7 9570-2R-1, 22-24 Nodular pyrite breccia 16.35 5.9 9570-1R-1, 44-46 Pyrite-anhydrite breccia 0.43 6.1 957P-1R-1, 44-46 Pyrite-anhydrite breccia 0.43 6.1 957P-1R-1, 1.5-100 Drill cuttings; pyrite-anhydrite sand 54.40 6.5 957P-12R-1, 1.5-100			95/Q-1R-3, /0-100	Pyrite, iron oxide; drill cuttings	3.75	7.3
957I-1N-1, 33-40 Porous massive pyrite-marcasite 9.33 5.7 957K-1X-1, 24-29 Porous colloform pyrite-marcasite 0.21 4.6 957K-1X-1, 24-29 Porous colloform pyrite-marcasite 0.21 4.6 957K-2N-1, 37-41 Massive gnular pyrite 10.37 5.7 957K-3X-1, 36-38 Massive pyrite with silica 14.82 6.0 957M-2R-1, 2-5 Porous massive pyrite 9.30 7.4 957M-3R-1, 57-60 Massive granular pyrite 14.87 6.3 957M-3R-1, 123-125 Pyrite-silica breccia with late marcasite 15.49 6.4 957M-3R-2, 1-4 Pyrite-silica breccia 15.80 7.2 957M-3R-1, 89-91 Pyrite-silica breccia 25.18 8.2 957M-4R-1, 49-91 Pyrite-silica breccia 38.30 6.0 TAG-5 9570-2R-1, 22-24 Nodular pyrite breccia 0.43 6.1 957P-1R-1, 44-46 Pyrite-anhydrite breccia 0.43 6.1 957P-1R-1, 44-46 Pyrite-anhydrite breccia 0.43 6.1 957P-1R-1, 1.3 Pyrit		TAG-4				
957K-1X-1, 24-29 Porous colloform pyrite-marcasite 0.21 4.6 957K-2N-1, 37-41 Massive granular pyrite 10.37 5.7 957K-2N-1, 37-41 Massive granular pyrite 10.37 5.7 957K-3X-1, 36-38 Massive pyrite with silica 14.82 6.0 957M-3R-1, 2-5 Porous massive pyrite 9.30 7.4 957M-3R-1, 57-60 Massive granular pyrite 14.87 6.3 957M-3R-1, 123-125 Pyrite-silica breccia 15.80 7.2 957M-3R-2, 1-4 Pyrite-silica breccia 15.80 7.2 957M-5R-1, 89-91 Pyrite-silica breccia 25.18 8.2 957M-5R-1, 89-91 Pyrite-silica breccia 25.18 8.2 957M-5R-1, 89-91 Pyrite-silica breccia 25.80 8.0 957O-2R-1, 22-24 Nodular pyrite breccia 16.35 5.9 957D-1R-1, 44-46 Pyrite-anhydrite breccia 0.43 6.1 957P-1R-1, 9-13 Pyrite-anhydrite breccia 21.57 5.7 957P-10R-1, 1.5-100 Drill cuttings; pyrite-anhydrite sand 54.			957I-1N-1, 33-40	Porous massive pyrite-marcasite	9.33	5.7
957K-2N-1, 37-41 Massive granular pyrite 10.37 5.7 957K-3X-1, 36-38 Massive pyrite with silica 14.82 6.0 957M-3R-1, 25 Porous massive pyrite 9.30 7.4 957M-3R-1, 57-60 Massive granular pyrite 14.87 6.3 957M-3R-1, 123-125 Pyrite-silica breccia with late marcasite 15.49 6.4 957M-3R-2, 1-4 Pyrite-silica breccia 15.80 7.2 957M-5R-1, 89-91 Pyrite-silica breccia 25.18 8.2 957M-7B-81, 9-4 Massive granular pyrite 38.30 6.0 TAG-5 9 9 9 7 4 9570-2R-1, 22-24 Nodular pyrite breccia 16.35 5.9 9570-1R-1, 44-46 Pyrite-anhydrite breccia 0.43 6.1 957P-1R-1, 9-13 Pyrite-anhydrite breccia 21.57			957K-1X-1, 24-29	Porous colloform pyrite-marcasite	0.21	4.6
957K-3X-1, 36-38 Massive pyrite with silica 14.82 6.0 957M-2R-1, 2-5 Porous massive pyrite 9.30 7.4 957M-3R-1, 57-60 Massive granular pyrite 14.87 6.3 957M-3R-1, 57-60 Massive granular pyrite 14.87 6.3 957M-3R-1, 123-125 Pyrite-silica breccia with late marcasite 15.49 6.4 957M-3R-2, 1-4 Pyrite-silica breccia 15.80 7.2 957M-5R-1, 89-91 Pyrite-silica breccia 25.18 8.2 957M-8R-1, 0-4 Massive granular pyrite 38.30 6.0 TAG-5 9570-18-1, 45.50 Pyrite-anhydrite breccia 0.43 6.1 9570-18-1, 45-50 Pyrite-anhydrite breccia 0.43 6.1 957P-18-1, 9-13 Pyrite-anhydrite breccia 0.43 6.1 957P-18-1, 44-46 Pyrite-anhydrite breccia 21.57 5.7 957P-18-1, 9-13 Pyrite-anhydrite breccia 0.43 6.1 957P-18-1, 9-13 Pyrite-anhydrite breccia 21.57 5.7 957P-12R-1, 1.5-100 Drill cuttings; pyrite-anhydrite sand 54.40<			957K-2N-1, 37-41	Massive granular pyrite	10.37	5.7
957M-2R-1, 2-5 Porous massive pyrite 9.30 7.4 957M-3R-1, 57-60 Massive granular pyrite 14.87 6.3 957M-3R-1, 123-125 Pyrite-silica breccia with late marcasite 15.49 6.4 957M-3R-1, 123-125 Pyrite-silica breccia with late marcasite 15.49 6.4 957M-3R-2, 1-4 Pyrite-silica breccia 15.80 7.2 957M-5R-1, 89-91 Pyrite-silica breccia 25.18 8.2 957M-5R-1, 89-91 Pyrite-silica breccia 25.18 8.2 957M-18R-1, 0-4 Massive granular pyrite 38.30 6.0 TAG-5 7 9570-18R-1, 45-50 Pyrite-anhydrite breccia 0.43 6.1 957P-18R-1, 44-46 Pyrite-anhydrite breccia 0.43 6.1 957P-18R-1, 9-13 Pyrite-anhydrite breccia 21.57 5.7 957P-10R-1, 1-3 Massive pyrite 45.40 6.5 957P-12R-1, 15-100 Drill cuttings; pyrite-anhydrite sand 54.40 6.5 957P-12R-4, 53-57 Massive porous pyrite with pyrite-silica 57.61 6.3 6.3 957P-12R-4, 5			957K-3X-1, 36-38	Massive pyrite with silica	14.82	6.0
957M-3R-1, 57-60 Massive granular pyrite 14.87 6.3 957M-3R-1, 123-125 Pyrite-silica breccia with late marcasite 15.49 6.4 957M-3R-2, 1-4 Pyrite-silica breccia 15.80 7.2 957M-3R-1, 189-91 Pyrite-silica breccia 25.18 8.2 957M-5R-1, 89-91 Pyrite-silica breccia 25.18 8.2 957M-5R-1, 90-91 Massive granular pyrite 38.30 6.0 TAG-5 7 9570-2R-1, 22-24 Nodular pyrite breccia 8.10 5.6 9570-4R-1, 45-50 Pyrite-anhydrite breccia 0.43 6.1 5.9 957P-1R-1, 44-46 Pyrite-anhydrite breccia 0.43 6.1 957P-5R-1, 9-13 Pyrite-anhydrite breccia 21.57 5.7 957P-10R-1, 1-3 Massive pyrite 45.10 5.4 957P-12R-1, 15-100 Drill cuttings; pyrite-anhydrite sand 54.40 6.5 957P-12R-2, 25-28 Pyrite-silica breccia 55.89 8.1 957P-12R-4, 53-57 Massive porous pyrite with pyrite-silica 57.61 6.3			957M-2R-1, 2-5	Porous massive pyrite	9.30	7.4
957M-3R-1, 123-125 Pyrite-silica breccia with late marcasite 15.49 6.4 957M-3R-2, 1-4 Pyrite-silica breccia 15.80 7.2 957M-3R-1, 89-91 Pyrite-silica breccia 25.18 8.2 957M-3R-1, 0-4 Massive granular pyrite 38.30 6.0 TAG-5 7 9570-2R-1, 22-24 Nodular pyrite breccia 16.35 5.9 957D-1R-1, 44-46 Pyrite-anhydrite breccia 0.43 6.1 957P-1R-1, 44-46 Pyrite-anhydrite breccia 21.57 5.7 957P-1R-1, 1, 44-46 Pyrite-anhydrite breccia 21.57 5.7 957P-1R-1, 1, 44-46 Pyrite-anhydrite breccia 21.57 5.7 957P-1R-1, 1, 44-46 Pyrite-anhydrite breccia 21.57 5.7 957P-1R-1, 1-3 Massive pyrite 45.10 5.4 957P-12R-1, 15-100 Drill cuttings; pyrite-anhydrite sand 54.40 6.5 957P-12R-2, 25-28 Pyrite-silica breccia 55.89 8.1 957P-12R-4, 53-57 Massive porous pyrite with pyrite-silica 57.61 6.3 957			957M-3R-1, 57-60	Massive granular pyrite	14.87	6.3
957M-3R-2, 1-4 Pyrite-silica breccia 15.80 7.2 957M-3R-1, 89-91 Pyrite-silica breccia 25.18 8.2 957M-5R-1, 89-91 Pyrite-silica breccia 25.18 8.2 957M-3R-1, 0-4 Massive granular pyrite 38.30 6.0 TAG-5 9570-2R-1, 22-24 Nodular pyrite breccia 8.10 5.6 9570-1R-1, 45-50 Pyrite-anhydrite breccia 0.43 6.1 957P-1R-1, 44-46 Pyrite-anhydrite breccia 0.43 6.1 957P-1R-1, 44-46 Pyrite-anhydrite breccia 21.57 5.7 957P-1R-1, 1, 44-46 Pyrite-anhydrite breccia 21.57 5.7 957P-1R-1, 1, 1-3 Massive pyrite 45.40 6.5 957P-12R-1, 15-100 Drill cuttings; pyrite-anhydrite sand 54.40 6.5 957P-12R-1, 15-100 Drill cuttings; pyrite-anhydrite sand 54.40 6.5 957P-12R-4, 53-57 Massive porous pyrite with pyrite-silica 57.61 6.3 957P-12R-4, 53-57 Massive porous pyrite with pyrite-silica 57.61 6.3 <			957M-3R-1, 123-125	Pyrite-silica breccia with late marcasite	15.49	6.4
957M-5R-1, 89-91 Pyrite-silica breccia 25.18 8.2 957M-5R-1, 0-4 Massive granular pyrite 38.30 6.0 TAG-5 9570-2R-1, 22-24 Nodular pyrite breccia 8.10 5.6 9570-4R-1, 45-50 Pyrite-anhydrite breccia 16.35 5.9 9570-1R-1, 44-46 Pyrite-anhydrite breccia 0.43 6.1 957P-10R-1, 1-3 Massive pyrite 45.10 5.4 957P-10R-1, 1-3 Massive pyrite 45.10 5.4 957P-10R-1, 1-3 Massive pyrite-anhydrite sand 54.40 6.5 957P-10R-1, 1-3 Massive pyrite with pyrite-silica 57.89 8.1 957P-12R-2, 25-28 Pyrite-silica breccia 55.89 8.1 957P-12R-4, 53-57 Massive porous pyrite with pyrite-silica 57.61 6.3 957P-12R-4, 53-57 Pyrite-anhydrite sand; drill cuttings 15.00 6.5			957M-3R-2, 1-4	Pyrite-silica breccia	15.80	7.2
957M-8R-1, 0-4 Massive granular pyrite 38.30 6.0 TAG-5 9570-2R-1, 22-24 Nodular pyrite breccia 8.10 5.6 9570-4R-1, 45-50 Pyrite-anhydrite breccia 16.35 5.9 957P-1R-1, 44-46 Pyrite-anhydrite breccia 0.43 6.1 957P-1R-1, 44-46 Pyrite-anhydrite breccia 21.57 5.7 957P-10R-1, 1-3 Massive pyrite 45.10 5.4 957P-10R-1, 1-5 Drill cuttings; pyrite-anhydrite sand 54.40 6.5 957P-12R-1, 5-100 Drill cuttings; pyrite-anhydrite sand 54.40 6.5 957P-12R-2, 25-28 Pyrite-silica breccia 55.89 8.1 957P-12R-4, 53-57 Massive porous pyrite with pyrite-silica 57.61 6.3 clasts 957P-13W-1, 50-58 Pyrite-anhydrite sand; drill cuttings 15.00 6.5			957M-5R-1, 89-91	Pyrite-silica breccia	25.18	8.2
TAG-5 9570-2R-1, 22-24 Nodular pyrite breccia 8.10 5.6 9570-4R-1, 45-50 Pyrite-anhydrite breccia 16.35 5.9 957P-1R-1, 44-46 Pyrite-anhydrite breccia 0.43 6.1 957P-3R-1, 9-13 Pyrite-anhydrite breccia 21.57 5.7 957P-10R-1, 1-3 Massive pyrite 45.10 5.4 957P-12R-1, 15-100 Drill cuttings; pyrite-anhydrite sand 54.40 6.5 957P-12R-1, 55-100 Drill cuttings; pyrite-anhydrite sand 55.89 8.1 957P-12R-4, 53-57 Massive porous pyrite with pyrite-silica 57.61 6.3 957P-12R-4, 53-57 Massive porous pyrite with pyrite-silica 57.61 6.3 957P-13W-1, 50-58 Pyrite-anhydrite sand; drill cuttings 15.00 6.5			957M-8R-1, 0-4	Massive granular pyrite	38.30	6.0
9570-2R-1, 22-24 Nodular pyrite breccia 8.10 5.6 9570-4R-1, 45-50 Pyrite-anhydrite breccia 16.35 5.9 957P-1R-1, 44-46 Pyrite-anhydrite breccia 0.43 6.1 957P-5R-1, 9-13 Pyrite-anhydrite breccia 21.57 5.7 957P-10R-1, 1-3 Massive pyrite 45.10 5.4 957P-12R-1, 15-100 Drill cuttings; pyrite-anhydrite sand 54.40 6.5 957P-12R-2, 25-28 Pyrite-ainhydrite breccia 55.89 8.1 957P-12R-4, 53-57 Massive porous pyrite with pyrite-silica 57.61 6.3 clasts 957P-13W-1, 50-58 Pyrite-anhydrite sand; drill cuttings 15.00 6.5		TAG-5				
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957P-5R-1, 9-13 Pyrite-anhydrite breccia 21.57 5.7 957P-10R-1, 1-3 Massive pyrite 45.10 5.4 957P-12R-1, 15-100 Drill cuttings; pyrite-anhydrite sand 54.40 6.5 957P-12R-2, 25-28 Pyrite-silica breccia 55.89 8.1 957P-12R-4, 53-57 Massive porous pyrite with pyrite-silica 57.61 6.3 957P-13W-1, 50-58 Pyrite-anhydrite sand; drill cuttings 15.00 6.5			957P-1R-1, 44-46	Pyrite-anhydrite breccia	0.43	6.1
957P-10R-1, 1-3 Massive pyrite 45.10 5.4 957P-12R-1, 15-100 Drill cuttings; pyrite-anhydrite sand 54.40 6.5 957P-12R-2, 25-28 Pyrite-silica breccia 55.89 8.1 957P-12R-4, 53-57 Massive porous pyrite with pyrite-silica 57.61 6.3 957P-13W-1, 50-58 Pyrite-anhydrite sand; drill cuttings 15.00 6.5			957P-5R-1, 9-13	Pyrite-anhydrite breccia	21.57	5.7
957P-12R-1, 15-100Drill cuttings; pyrite-anhydrite sand54.406.5957P-12R-2, 25-28Pyrite-silica breccia55.898.1957P-12R-4, 53-57Massive porous pyrite with pyrite-silica57.616.3clasts957P-13W-1, 50-58Pyrite-anhydrite sand; drill cuttings15.006.5			957P-10R-1, 1-3	Massive pyrite	45.10	5.4
957P-12R-2, 25-28 Pyrite-silica breccia 55.89 8.1 957P-12R-4, 53-57 Massive porous pyrite with pyrite-silica 57.61 6.3 957P-13W-1, 50-58 Pyrite-anhydrite sand; drill cuttings 15.00 6.5			957P-12R-1, 15-100	Drill cuttings; pyrite-anhydrite sand	54.40	6.5
957P-12R-4, 53-57Massive porous pyrite with pyrite-silica57.616.3057P-13W-1, 50-58Pyrite-anhydrite sand; drill cuttings15.006.5			957P-12R-2, 25-28	Pyrite-silica breccia	55.89	8.1
clasts clasts 957P-13W-1, 50-58 Pyrite-anhydrite sand; drill cuttings 15.00 6.5			957P-12R-4, 53-57	Massive porous pyrite with pyrite-silica	57.61	6.3
957P-13W-1, 50-58 Pyrite-anhydrite sand; drill cuttings 15.00 6.5				clasts		
			957P-13W-1, 50-58	Pyrite-anhydrite sand; drill cuttings	15.00	6.5

Table 6. Sulfur-isotopic composition of bulk sulfide samples from TAG-1 to TAG-5 areas at the TAG hydrothermal mound.

Table 7. Sulfur-isotopic composition of bulk sulfide samples from TAG-1 to TAG-5 areas and different lithologic zones, with averages for all samples analyzed from the TAG mound.

Area or lithologic zone	n	Range	Average
TAG-1	25	5.10-7.90	6.4
TAG-2	4	5.35-7.47	6.6
TAG-3	1	7.30	7.3
TAG-4	10	4.60-8.15	6.3
TAG-5	9	5.40-8.13	6.2
TAG	49	4.60-8.15	6.4
Massive pyrite + pyrite breccias	11	4.60-7.10	5.8
Pyrite-anhydrite ± silica breccias	14	5.10-6.60	5.9
Pyrite-silica breccias	14	5.40-8.15	6.8
Silicified wallrock breccias	8	6.25-7.50	6.8
Chloritized basalt breccias	1	6.70	6.7

Note: n = number of samples.

1988; Shanks et al., 1995). Simple mixing of end-member hydrothermal fluids with a δ^{34} S ratio close to the initial basalt values (+0.1‰, Sakai et al., 1984) with seawater cannot account for the elevated δ^{34} S values of the TAG sulfides. High δ^{34} S ratios for bulk sulfides have also been found for massive sulfides from the relict *Mir* and *Alvin* zones with in the TAG hydrothermal field, ranging from +2.2‰ to +7.3‰ δ^{34} S (average +5.9‰, n = 6). This suggests that elevated sulfur-isotope ratios are not limited to the active TAG mound, but are a common phenomenon in the TAG hydrothermal system.

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Figure 11. Frequency distribution of sulfur-isotopic ratios for 49 bulk sulfide samples analyzed from the interior of the TAG hydrothermal mound (‰ δ^{34} S). n = number of samples.

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Figure 12. Downhole distribution of δ^{34} S ratios in bulk sulfide samples from the TAG-1, -2, -4, and -5 areas.

Figure 13. Sulfur-isotopic ratios in various types of seafloor massive sulfide deposits, including sedimenthosted mid-ocean ridge sulfides, backarc sulfides, and sediment-free mid-ocean ridge sulfides. The sulfurisotopic ratios determined for drill core sulfides from the TAG hydrothermal field are shown for comparison (‰ δ^{34} S). References: Red Sea = Blum and Puchelt (1991); Guaymas Basin = Peter and Shanks (1992); Escanaba Trough = Koski et al. (1988), Zierenberg et al. (1993), Böhlke and Shanks (1994); Middle Valley = Goodfellow and Blaise (1988), Duckworth et al. (1994), Zierenberg (1994); Stuart et al., (1994); Okinawa Trough = Halbach et al. (1989); Lau Basin = Herzig et al. (in press); Manus Basin = Lein et al. (1993); Mariana Trough = Kusakabe et al. (1990); Axial Seamount = Hannington and Scott (1988); Galapagos Rift = Skirrow and Coleman (1982); Knott et al. (1995); Southern Juan de Fuca Ridge (SJFR) = Shanks and Seyfried (1987); 11°N East Pacific Rise (EPR) = McConachy (1988); Bluth and Ohmoto (1988); 13°N EPR = Bluth and Ohmoto (1988), Stuart et al. (1995); 21°N EPR = Hekinian et al. (1980), Arnold and Sheppard (1981), Styrt et al. (1981), Kerridge et al. (1983), Zierenberg et al. (1984), Woodruff and Shanks (1988); Stuart et al., (1994); EPR South = Marchig et al. (1990); Snakepit = Kase et al. (1990); Stuart et al., (1994); Broken Spur = Duckworth et al. (1995); TAG surface = Stuart et al. (1994); Lein et al., 1991; TAG subsurface = this study.

