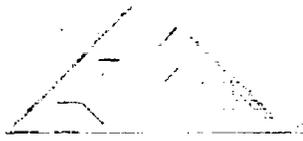


FYI-1199-001366



IDAHO MINING ASSOCIATION

802 W Bannock Street, Suite 301 • Boise, ID 83702
P.O. Box 1660 • Boise, ID 83701
Telephone (208) 342-0031 • Fax (208) 345-4210

RECEIVED
O P T NCIC

1999 NOV 22 AM 11:15



FYI-99-001366

November 19, 1999

MR 29760

Via Federal Express No. 7943044012



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Document Processing Center (Mail Code 7407)
Office of Prevention, Pesticides & Toxic Substances
U.S. Environmental Protection Agency
Room B-607
401 M Street, S.W.
Washington, DC 20460

Contain NO CBI

Re: FYI Notification

Dear Sir or Madam:

The purpose of this letter is to transmit information concerning recent sheep deaths in the Caribou National Forest near Soda Springs, Idaho. On September 19, 1999, twenty-six dead sheep were discovered adjacent to a reclaimed phosphate overburden pile in the Wooley Valley area. On September 22, an additional twenty-eight sheep were found dead on a ridge about one-half mile east of the first site.

Organ and tissue samples from three of the dead sheep were collected by a local veterinarian and sent to the University of Idaho Toxicology Lab in Moscow, Idaho and the Washington Animal Disease and Diagnostic Lab in Pullman, Washington (the lab reports are enclosed). Following the discovery of the sheep, poisonous plants were identified in the area which are known to cause death when consumed by sheep (lupine and chokecherry). Thereafter, the cause of death was determined to be myocardial necrosis and

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99 DEC -7 AM 9:45

degeneration, with resulting pulmonary edema from cardio-vascular collapse. Histopathological samples of the kidney, liver, rumen contents and (unspecified) tissue revealed the presence of selenium at the following levels:

- Kidney- 4.780, 5.160 micrograms per gram.
- Liver-10.900, 7.290 micrograms per gram.
- Rumen contents-9.780, 23.00 micrograms per gram.
- Unspecified tissue-0.643 micrograms per gram.

Analyses of vegetation (also enclosed) growing on and near the phosphate overburden pile and water from a seep exiting the pile also show elevated levels of selenium.

On November 4, Dr. Patricia Talcott, MS, DVM, Ph.D., at the University of Idaho, summarized the results of the reports from the University of Idaho and Washington State University. In her comments (also enclosed), Dr. Talcott affirmed the sheep had died from myocardial necrosis. According to Dr. Talcott, there are several causes of this type of heart failure, including poisonous plants, rhodenticides, feed additives, and excess selenium. "Given the facts surrounding this case, and evidence of higher than normal levels of selenium in various tissues, selenium toxicosis is a possible and reasonable diagnosis," Talcott said. "This does not, however, totally eliminate the possibility that other cardiotoxins, some of which are listed above, could be playing a role in this case."

The Idaho Mining Association (IMA) is submitting this information on an FYI-basis because it is well-known to the U.S. Environmental Protection Agency, among many others, that selenium levels are elevated above background in certain areas of southeastern Idaho associated with the mining of phosphate ore and because it is documented in the scientific literature that selenium can be toxic to sheep in certain circumstances.

The phosphate-producing members of the IMA formed a voluntary Selenium Subcommittee (Subcommittee) in the spring of 1997 and began an extensive field investigation of the entire phosphate lease region in southeastern Idaho. An industry/agency working group (Working Group) was also formed to commission and provide oversight to the investigation. The Working Group includes the following federal, state, local and tribal agencies:

- **United States Forest Service**
- **United States Bureau of Land Management**
- **United States Geological Survey**
- **United States Fish and Wildlife Service**
- **United States Bureau of Indian Affairs**
- **United States Environmental Protection Agency**
- **Idaho Division of Environmental Quality**
- **Idaho Department of Lands**
- **Idaho Department of Fish and Game**
- **Idaho Division of Health**
- **Southeastern District Health Department**
- **Shoshone-Bannock Tribes**

The results of the selenium investigation to date have been shared with the Working Group.

Work completed to date indicates that selenium is present in the shale portion of certain waste rock (generated during the mining of phosphate ore) and can be solubilized and released to the environment as a result of exposure to air and water (i.e., simple oxidation) after mining. Soluble forms of selenium can be absorbed into vegetation, transported through erosion of sediments or carried into surface waters. This coordinated research and analysis has also identified a variety of potential control technologies to immobilize selenium in phosphate mining waste shales. Technologies are still under assessment in the laboratory and through ongoing field studies.

The phosphate producing members of IMA, working cooperatively with the Working Group, have taken a variety of steps to facilitate the dissemination of information to the public. These have included hiring technical experts to prepare educational information on the agricultural effects of selenium to be distributed to local ranchers, establishment of a public repository both for existing published documents and for documents developed by the Selenium Working Group, and informing regional veterinarians so that they are well prepared to respond to any selenium-related questions or concerns raised by their clients

The federal and state agencies along with the phosphate-producing members of IMA are now negotiating a formal consent order which will ensure the continued voluntary funding of the investigation, remediation and agency oversight costs. The Working Group is currently evaluating new and better mining practices for controlling selenium. Each phosphate mining company in IMA is actively taking steps to develop or implement methods known as Best Management Practices (BMPs) aimed directly at selenium control for active and new mines.

In conclusion, the definitive cause of death of the sheep is still undetermined and the enclosed data is currently under peer review by two independent toxicologists and two independent pathologists. However, given the levels of selenium in the sheep tissues sampled, selenium toxicosis is a possible cause of death. The phosphate-producing members of IMA have committed to federal and state authorities that they will thoroughly study and assess the problem in order to control the release of selenium from phosphate mining. Actions to achieve that end are underway. The IMA will keep EPA advised of further relevant developments concerning selenium as appropriate.

Sincerely,



Jack Lyman
Executive Vice President

Enclosures



Washington State University

Washington Animal Disease Diagnostic Laboratory

Box 2037 College Station
 Pullman, WA 99165-2037
 509-335-9696
 FAX 509-335-7424

To: Mr. Bob Geddes
FAX: 801-596-5911
Email: dkwils@solutia.com

Date: November 4, 1999

From: Patricia A. Talcott, MS, DVM, Ph.D.
 Assistant Professor
 Diplomate, American Board of Veterinary Toxicology

Re: Selenium comments

Text: The cause of death in three adult sheep (whose tissues were collected and submitted to the laboratory for analysis) based on histologic evaluation is acute myocardial necrosis (i.e. heart failure) and degeneration, with resulting pulmonary edema from cardiovascular collapse. There are several causes of myocardial necrosis and degeneration, including plant toxins (e.g. *Cassia* or *Senna*, *Eupatorium*, *Nerium*, *Karwinskia*, *Persea*), feed additives (e.g. monensin, lasalocid), rodenticides (e.g. fluoroacetate), drugs (e.g. adriamycin), and certain elements (e.g. excess cobalt or thallium, excess or deficiency of selenium). Given the facts surrounding the case, and evidence of higher than normal levels of selenium in various tissues, selenium toxicosis is a possible and reasonable diagnosis. This does not, however, totally eliminate the possibility that other cardiotoxins, some which are listed above, could be playing a role in this case.

Historical literature is limited and conflicting in describing selenium toxicosis in sheep, with respect to selenium tissue levels and presence/absence of histologic lesions. In addition, these current findings are quite different from previously gathered data collected from sheep and cattle located in similar areas. Because of this, one should consider that there might be something unique to this incident that we are currently not aware of. The data is currently under peer review by two independent toxicologists and two independent pathologists.

11-01-1999 02:44PM FROM

TO

16098600078 P.02

RECD NOV 01 1999

Case Summary:

On Sunday, September 9, 1999 I was contacted by Rob Squires of Agrium concerning several dead sheep found near the south end of the Rasmussen Ridge mine site. Twenty-six sheep were found dead within a 75-yard radius of the spring as well as 6 more within a half-mile to the east. This spring is located approximately 100 yards east of the section marker of T75 R43 E dividing sections 23, 24, 25, and 26. The animals were starting to decompose and were estimated to have died approximately three days prior. All animals appeared as if they had bedded down and died without paddling or struggling. Two of these animals were necropsied and fresh samples from one ewe were submitted for toxicology. These samples, referred to as #1 in all reports, were too autolyzed to be of diagnostic value for histopathology. Eight additional ewes were found dead along the road between the spring and the sheepherder's new campsite approximately 7 miles to the southwest. Toxicology samples were also taken from one of these ewes (referred to as #2) and from a ram (referred to as #3) and a ewe (referred to as #4) from Soda Springs. Samples were also taken from a ram (referred to as #5) and a ewe (referred to as #6) from the Dredge, delivered to the University of Idaho Toxicology Lab. All toxicology samples collected from these two animals (referred to as #3 and #4) were submitted to the University of Idaho Toxicology Lab. Histopathology samples were submitted to Washington Animal Disease and Diagnostic Lab in Pullman, Washington.

Talking to the sheepherders (Yermano and Ceasar) the sheep had been grazing the area around the springs for approximately 5 to 7 days and the sheep began dying 2 days after moving onto the area. The sheep were moved to new pasture near Trail Canyon the evening of September 18th after the sheep started dying. According to the herders, the ewes would start frothing at the mouth, stumble, lay down and be dead within one hour from the first onset of clinical signs.

Toxicology reports and histopathology reports (including an addendum) are enclosed.

Wayne Cutler D.V.M. 10/28/99

Wayne Cutler D. V. M.
 Soda Springs Animal Clinic
 P. O. Box 58
 Soda Springs, ID 83276
 (208) 547-4981

11-01-1999 02:45PM

FROM

TO

1609660078

P. 03

ANALYTICAL SCIENCES LABORATORY

University of Idaho
Holm Research Center
Moscow, Idaho 83844-2203
Phone (208) 885-7081 FAX (208) 885-8937

Certificate of Analysis - Veterinary Toxicology

Submitted by:

Dr. Cutler
Soda Springs Animal Clinic

P.O. Box 58
Soda Springs

ID 83276

UIASL Case #: VSP99-55
Submitter Case #: 99-T0330
Report Date: 09/30/1999
Date Received: 09/23/1999
Report Status: Final
Species: Sheep
Owner: Cal Dredge

Veterinary Diagnostic Toxicology:

All liver, kidney, and rumen content samples tested contain elevated selenium levels. The spring water sample does not contain an excessive selenium concentration. An acceptable maximum concentration of selenium in water for livestock is considered to be < 10-50 µg/L. Dr. Tim Baszler, pathologist at WADDL, indicated that myocardial necrosis was seen in three sets of tissues submitted from this same case. Myocardial necrosis has been described in the literature in sheep and cattle exposed to high selenium levels via oral or parenteral exposure.

Approximate ranges for the ovine (ppm or µg/g):

	Liver	Kidney	Diet (dry weight)	Skeletal Muscle
Adequate	0.250-1.500	0.900-3.000	0.40-1.00	0.090-0.400
High	2.000-10.000	4.000-6.000	3.00-5.00	0.400-0.500
Toxic	> 15.000	> 6.000	> 5.000	> 0.500

Toxic ranges reported in the literature are quite variable - dependent on form of selenium, route of exposure, and duration of exposure.

Note: The indicated ranges are only guidelines and the analytical results need to be interpreted in conjunction with management and dietary factors, as well as with clinical and/or postmortem observations.


Patricia A. Talcott, MS, DVM, PhD., DABVT
Veterinary Toxicologist

Date: 10.9.99

11-01-1999 02:46PM FROM

TO

1 250630078 P.04

W-70330

Certificate of Analysis - Veterinary Toxicology

UIASL ID: V9903692
Water

Submitter ID: Spring Water	Results	EDL	Units
ICP, Hydride			
Selenium	57.90	0.70	µg/L

UIASL ID: V9903694
Kidney

Submitter ID: #2	RESULTS	EDL	UNITS
TEST			
Selenium	4.780	0.005	µg/g

UIASL ID: V9903695
Kidney

Submitter ID: #3	RESULTS	EDL	UNITS
TEST			
Selenium	5.160	0.005	µg/g

UIASL ID: V9903698
Liver

Submitter ID: #2	RESULTS	EDL	UNITS
TEST			
Selenium	10.900	0.005	µg/g

UIASL ID: V9903699
Liver

Submitter ID: #3	RESULTS	EDL	UNITS
TEST			
Selenium	7.290	0.005	µg/g

UIASL ID: V9903708
Misc. meat

Submitter ID: #4	RESULTS	EDL	UNITS
TEST			
Selenium	0.643	0.005	µg/g

UIASL ID: V9903705
Rumco contents

Submitter ID: #2	RESULTS	EDL	UNITS
TEST			
Selenium	9.780	0.005	µg/g

UIASL ID: V9903710
Rumen contents

Submitter ID: #3	RESULTS	EDL	UNITS
TEST			
Selenium	23.000	0.005	µg/g

Samples will be discarded one month after date of final report, unless otherwise requested.

A 11

11/03/99 08:49 FAX 801 586 5743

LITTLE AMERICA

008

11-01-1999 02:46PM FROM

TO

16098600078 P.05

Washington Animal Disease Diagnostic Lab

P.O. Box 2037, College Station
Pullman, WA 99165-2037
Telephone : (509)335-8896
Fax : (509)335-7424

TEST RESULTS REPORT

Case#: 99-110127
Report Date: 10/13/99

Cutler, Wayne
Soda Springs Animal Clin
P.O. Box 1058
Soda Springs, ID 83276

Submital Date: 09/24/99
Owner: Calvin Dredge

Species: Domestic Sheep
Breed:

Age:
Sex: Female

Histopathology

Tissue(s) Examined - Verified on: 09/29/99

Animal Id	Result See Attached Report	Specimen Container of Tissue(s)

11-01-1999 02:46PM FROM

TO

16299680078

P.06

WADDL 99-110127

HISTOPATHOLOGY REPORT

09-29-99

Sections from three adult sheep are similar and are described together.

Heart: Multifocal, medium to large areas of myocardial necrosis and minimal leukocyte infiltration are within all sections of heart examined. The affected myofibers are throughout the myocardium and are variably swollen to shrunken and hypereosinophilic. Shrunken fibers are often fragmented and have multiple contraction bands. Most of the affected fibers have numerous adjacent plump satellite cells. A loose reticulum of thin fibers with associated satellite cells and rare lymphocytes often replaces shrunken myofibers. There are slightly increased numbers of lymphocytes, rare macrophages, and neutrophils associated with vessels in the myocardium. Numerous thick walled protozoal cysts containing elongate zoites, and ranging from 70-175 um in length are within myofibers throughout the section (likely *Sarcocystis* sp.).

Lung: Sections from two sheep have multifocal to coalescing severe pulmonary edema and occasional fibrin aggregates in most alveolar spaces. The affected alveolar spaces contain abundant proteinaceous fluid, occasional small fibrin aggregates, and rare hemorrhage. Many of the spaces have few to moderate numbers of macrophages and rare neutrophils. The alveolar septal capillaries and many larger vessels throughout the sections are variably congested. Few, small perivascular and peribronchiolar aggregates of lymphocytes are present.

Spleen: Sections from two sheep have prominent fragmentation of lymphoblasts in periarteriolar sheaths (likely apoptosis). These periarteriolar sheaths occasionally are surrounded by a thin rim of congestion admixed with slightly increased numbers of neutrophils. There are few small aggregates of neutrophils throughout the red pulp.

Kidney: A single section from one sheep has multiple, small areas of tubular necrosis and associated lymphocyte infiltration in the distal medulla. These areas are often associated with small amounts of interstitial hemorrhage.

Sections of liver, kidney (two animals), and skeletal muscle (one animal), are examined and considered normal.

HISTOLOGIC DIAGNOSES:

1. Myocardial necrosis and myodeneration, acute, multifocal to coalescing, severe, heart, all animals
2. Pulmonary edema, diffuse, severe, acute, lungs, two animals
3. Renal tubular necrosis, multifocal, moderate, kidney medulla

COMMENTS: The cause of death in all three animals is acute myocardial necrosis and myodeneration with subsequent heart failure. The pulmonary lesions are likely secondary to the cardiovascular collapse and in one animal, have been present long enough for some vascular leakage to occur. The kidney lesion in one animal may be unrelated to the heart lesions. The sarcocysts are incidental findings. Toxins are a likely cause of the myocardial necrosis including potential plant toxins. Additional sources of toxicosis are possible and I am currently consulting with the WSA's toxicologist, Dr. Patricia Talcott, to determine if and what additional tests are needed. Fresh samples were submitted directly to her lab and these results will not be included in this WADDL case number.

Dr. V. T. Hamilton/TVB/dlg/dw
4205, 3115
Phoned and discussed results with Dr. Cudor on 9/26/99. Left a voice mail message for Dr. Talcott on 9/28/99.

11-01-1999 02:47PM FROM

TO

16098600078 P.07

ADDENDUM

10-13-99

WADDL 899-110127

The cause of death in the three sheep based on histologic evaluation can definitively be identified. Death is attributed to the severe, acute myocardial necrosis present in all three animals with resulting pulmonary edema from cardiovascular collapse. The cause of the myocardial necrosis and degeneration cannot be determined by histopathologic exam only. I have reviewed the toxicologic reports from the University of Idaho (UIASL case # VSP99-55a) submitted on the sheep from WADDL case #99-110127. Given the high levels of selenium in various organs and the rumen contents, the history of acute illness and sudden death, and the myocardial lesions, selenium toxicosis is a reasonable and likely cause of death in these three animals. The selenium levels in all submitted organ samples are high, as are the levels in the rumen contents. Selenium levels from the water source are within normal range. Literature searches, and review of this case with the University of Idaho veterinary toxicologist, Dr. Patricia Talcott, indicate acute (and to a lesser extent, chronic) selenium toxicosis has been reported in ruminants as a cause of myocardial lesions consistent with the cases seen in these animals. The source of potentially toxic levels of selenium is unclear. High selenium levels in rumen contents suggest the source is ingestion.

Certain plants and feed additives also can cause similar myocardial lesions independent of selenium, but these plants and/or feed additives are not likely to be available to the sheep in question. Possible plants which may cause similar myocardial lesions include *Nerium* sp. (oleander), *Passiflora* sp. (tropicana), *Convallaria* sp. (lily of the valley), *Eupatorium* sp. (white snakeroot), *Cassia* or *Senna* sp. (sicklepod), *Isocome* or *Haplopappus* sp. (rayless goldenrod), all of which are not typically found in the area the sheep were grazing. Additionally *Digitalis* (foxglove) may cause this lesion but this plant is not common in the area and would not typically be found at this time of year. Gossypol (found in cottonseed) as a feed supplement, ionophores found in feed and excess cobalt also may cause similar lesions, but no history of supplemental feed or source of excess cobalt is given.

Dr. V.T. Hamilton TVB/PAT/dlg/tvb

1. Bucik WB and Osweiler GD: 1976 Selenium. In Clinical and Diagnostic Veterinary Toxicology. 1st ed., p 345-54. Ed. GA Van Gelder. Kendall/Hunt Publishing Co., Dubuque, IA.
2. Yangner MJ, Rogg DN, Koller L, Fraser TL, Hurley DJ and Palmer IS: 1958, The effects of subclinical selenium toxicosis on pregnant beef cattle. J Vet Diag Inv. 10:268-73.
3. Shochridge ER, O'Hara PJ, and Marshall PM: 1971, Acute selenium poisoning in cattle. NZ Vet J 19:47-50.
4. Morrow DA: 1968, Acute selenite toxicosis in lambs. JAVMA 152(11):1625-29.

Utah State UNIVERSITY

UTAH VETERINARY DIAGNOSTIC LABORATORY
 950 East 1400 North
 Logan, Utah 84322-5700
 Telephone: (435) 797-1895

November 1, 1999

Submitting Veterinarian: Dr. Panter

Owner:

Our Case Number: L99-2836

Sample: One water, One Sheep Liver, and Ten plant Samples

Sample	Results	Charges
Forage and Tissue Digestions	11 @ \$5.00/sample	\$55.00
Water	ICP-MS Mineral analyses (See Attached Results)	\$25.00
Liver	ICP-MS Mineral analyses (See Attached Results)	\$25.00
Plants (10)	ICP-MS Mineral analyses (\$25.00/sample) (See Attached Results)	\$250.00
Total Toxicology Charges -		\$355.00
No/Charge: PPRL		

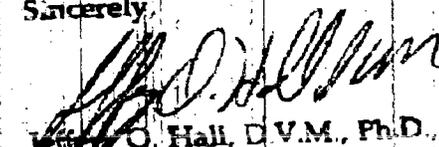
One water, one sheep liver, and ten plant samples were hand delivered to this laboratory on October 5, 1999. This submission was assigned case number L99-2836. ICP mineral analyses were requested. The history indicated sudden death of numerous sheep.

The samples were digested in trace mineral nitric acid. The digests were then diluted with ultra-pure water to a final nitric acid concentration of 5%, which provided a matrix match for the analytical standards. The diluted samples were then analyzed by inductively coupled plasma-mass spectroscopy (ICP-MS) and assessed against concentration curves of known standards. The results are attached.

The selenium concentrations were high in the forage and water samples. The "sheep liver" sample was very autolyzed and had a very large amount of lipid in the digestion vessel; thus, the sample may not have been liver.

If you have any questions, please feel free to call me.

Sincerely,



Jeffrey O. Hall, D.V.M., Ph.D., Diplomat A.B.V.T.
 Diagnostic Veterinary Toxicologist
 Utah Veterinary Diagnostic Laboratory
 Utah State University

B 01

11-12-1999 10:07AM

FROM RHONEPOULENC

TO

16096600078

P. 02

USU Case #
Sample

L99-2836
FMC
Lupine

L99-2836
C. Maculosa - C. Maculosa
Veg. *Sheet 1*

L99-2836
Root

L99-2836
Ras
Ridge Grass

L99-2836
Sweet Clover

L99-2836
Lupine
Li. Leucoph. *Unit 1*

Concentration Concentration Concentration Concentration Concentration Concentration

Element

Element	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)
Ag	0.009	0.034	0.261	0.017	0.012	0.023
Al	68.258	46.038	239.270	240.854	36.789	145.289
As	0.163	0.960	2.589	0.715	0.562	0.341
B	25.828	21.534	12.601	14.195	25.091	16.565
Ba	19.163	10.218	10.804	20.491	6.149	24.550
Bb	0.005	0.011	0.055	0.016	0.003	0.017
Ca	11502.286	9522.339	9409.211	6623.256	8794.381	12428.207
Ca	0.205	1.190	4.961	0.215	1.117	0.295
Co	0.096	0.098	0.527	0.343	0.073	0.181
Cr	2.962	4.744	17.943	3.779	9.031	4.114
Cu	3.166	11.030	14.431	17.518	13.886	13.763
Fe	152.783	202.518	1072.191	489.113	142.015	337.444
K	11088.168	10757.809	7896.097	20079.495	11202.367	12385.000
Li	0.285	6.319	3.008	8.815	7.501	8.109
Mg	1984.797	1347.718	1326.015	1776.079	1883.521	3219.242
Mn	64.285	24.735	67.088	439.601	19.710	45.157
Mo	0.287	4.132	6.285	0.479	7.740	0.452
Na	11.494	32.837	59.557	108.097	48.719	36.129
Ni	3.283	5.114	25.243	2.882	3.083	4.714
P	1690.193	1669.775	2837.232	1717.587	1395.981	1712.388
Pb	0.167	5.123	1.632	8.435	8.965	8.211
Sb	0.021	0.166	0.499	0.201	0.297	0.084
Se	4.772	47.682	35.307	30.342	26.244	0.921
Si	126.045	128.888	163.089	291.180	150.488	137.705
Sn	0.013	0.709	0.354	0.620	1.058	0.744
Str	39.592	32.369	40.128	13.890	27.911	42.421
Tl	0.013	0.141	1.166	0.015	0.411	0.024
V	0.545	2.590	24.896	1.243	0.487	1.348
Zn	29.745	29.572	146.854	28.167	29.307	34.192

Sheet 1

Handwritten: 11/13/99
12/1/99
12/1/99

USU Case #
Sample

L99-2836
Sharp Liver

L99-2836
FMC
Curly Dock

L99-2836
FMC
Mayweed

L99-2836
FMC
Willow Weed

L99-2836
FMC
Canada Vetch

Element	Concentration (ppm)				
Ag	0.001	<0.001	0.038	0.055	0.024
Al	0.08	0.018	13.462	1384.001	1027.158
As	0.004	0.030	0.033	1.322	2.903
B	0.001	0.151	19.036	28.479	20.681
Ba	0.009	0.001	18.511	19.057	18.507
Be	<0.001	<0.001	0.098	0.108	0.071
Bi	0.255	16.350	12184.099	17258.339	11983.823
Cd	0.001	0.004	2.046	4.098	1.020
Co	<0.001	0.007	11054	0.727	0.776
Cr	<0.001	0.600	7.139	11.508	5.856
Cu	0.001	0.185	8.261	8.508	6.403
Fe	0.308	0.817	1890.881	1509.512	936.948
K	1.222	22.186	6987.882	2000.000	9134.918
Li	0.007	0.042	3.150	3.000	2.021
Mg	21.720	28.930	2382.114	3641.167	3870.288
Mn	0.008	0.196	157.873	255.075	216.855
Mo	<0.001	0.024	0.738	1.018	0.651
Na	8.543	758.618	216.796	138.173	82.183
Ni	0.025	0.008	11.350	9.285	7.974
P	0.008	367.574	5101.850	3813.542	2469.990
Pb	<0.001	0.001	2.135	1.028	1.381
Sb	0.003	0.002	0.082	0.023	0.074
Se	0.088	1.904	251.013	3.633	1.899
Si	6.385	16.859	105.747	175.043	120.041
Sn	<0.001	<0.001	0.030	0.050	0.095
Sr	0.259	0.157	23.217	43.386	30.107
Tl	<0.001	<0.001	0.100	0.106	0.045
V	0.001	0.030	7.458	9.466	4.280
Zn	0.303	3.502	52.451	52.181	35.432