# PRELIMINARY ANALYSES OF COAL REFUSE MATERIAL FROM VANCOUVER ISLAND

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## ABSTRACT

The first period of coal mining on Vancouver Island lasted from 1847 to 1967, and during that period, waste material from the coal cleaning accumulated in a number of areas along the east coast of Vancouver Island. Three of these areas were sampled and analysed for coal related properties, major oxides, and trace metals. Results indicate that the material is generally similar in composition to average shale.

Ryan, B., (2008): Preliminary Analyses of Coal Refuse Material from Vancouver Island; Geoscience Reports 2008, B.C. Ministry of Energy, Mines and Petroleum Resources, pages 99-118.

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Key Words: Waste coal, trace metals, coal refuse, Vancouver Island.

## THE EARLY VANCOUVER ISLAND COAL INDUSTRY

Coal mining on Vancouver Island started in 1847 near Port Hardy on the northeast coast. Subsequently mining moved south to the Nanaimo and Cumberland areas, where activity continued until 1967. This early period of coal mining activity has left a legacy of coal mine waste. There are a number of coal refuse piles on Vancouver Island, especially in the Nanaimo area, and the total accumulation may be as high as 2.5 million tonnes (Gardner 1997).

The early mines removed rock from raw coal using simple wash plants and hand picking tables to remove large rock fragments. This produced a waste product composed of large fragments of rock and high-ash coal and referred to as coarse rejects. In some areas where clean coal was being loaded onto barges, some fell off conveyors or trains to accumulate as finer, cleaner coaly material.

Coal waste in the Ladysmith area originates from the Extension Mine, which opened in the 1890s as an extension of the Wellington Mine. Workers were moved to the new town of Oyster Harbour, later to be called Ladysmith. A wash plant was built in the area, and waste from the plant now forms Slag Point. Coal from the wash plant was shipped out from the harbour.

## THE ENVIRONMENTAL HAZARDS OF COAL REFUSE

Coal in situ contains varying amounts of rock and water in addition to the organic carbon and associated volatile material. It is very difficult to totally separate the included rock and report a weight percent, so the organic material is burnt off and the remaining weight reported as percent ash, which is a bit less than the original weight of included rock. Thermal coals are shipped, after removal of rock, at ash concentrations up to about 15%. Coking coals (metallurgical coals), which are made into coke (the fuel in blast furnaces), are washed to ash contents generally less than 10%. The definition of coal varies, but generally anything over about 50% ash is not considered coal. This means that most coal mines, whether they are mining thermal or coking coal, have to process the coal to remove included rock. These wash plants usually produce two streams of waste material-coarse reject (greater than 0.6 mm) and tailings (less than 0.6 mm). Generally, modern wash plants have a yield of 65% to 85%, which means that 35% to15% of the weight of raw material entering the wash plant becomes waste material dumped somewhere close to the mining activity. It is usually buried or re-contoured and vegetated, but it does represent a concentration of material from a specific geological environment.



Figure 1: Sample locations north (Union Bay) and south (Cedar Cove and Ladysmith) of Nanaimo. UTM grid scale is 1 km.

Most of the concern about coal waste involves the possibility that the coal waste is leaching harmful trace metals into the environment. Coal itself is composed of environmentally benign organic carbon; unfortunately, coal and the rock closely associated with coal seams often contain appreciable amounts of sulphides and some trace elements. Sulphide minerals, predominantly pyrite (FeS<sub>2</sub>), often contain trace amounts of elements other than iron and will oxidize to produce acidic water that releases and mobilizes these elements. There may also be increased concentrations of certain trace elements in rock material associated with coal, which was deposited in conjunction with vegetation in an oxygen-deficient, slightly acid, swamp environment; some trace elements are bound in insoluble forms and concentrated in this type of environment.

It is important to clarify the terms trace metals and trace elements as they are used in literature. The term trace metal may refer either to a metal (element) that is indeed rare or to the amount that occurs in a particular environment. The term is often applied to metallic elements such as iron, magnesium, zinc, copper, chromium, nickel, cobalt, vanadium, arsenic, molybdenum, and selenium. Possibly only selenium and vanadium are actually rare in overall terms. In contrast, the term trace element is broader and generally is used to refer to any element that occurs in very small concentrations in a particular environment.

In 2007, BC coal mines were expected to produce over 25 million tonnes of clean coal and over 5 million tonnes of coarse and fine refuse. This material will be permanently sequestered within mine lease areas in such a way as to not cause environmental problems. The record for safe disposal of this material is good based on the fact that there

has been large-scale surface coal mining in BC for the last 40 years without major environmental problems related to coal waste handling.

## **STUDY AREAS**

Samples were collected in 3 areas along the east coast of Vancouver Island, including Union Bay, Cedar Cove (Canary Cove and Clam Bay), and Ladysmith Slag Point areas (Figure 1). Union Bay was the site of the major wash plant and load-out for coal mined in the Cumberland area. Mining started in the area in 1869 when Baynes Sound Coal Company started operations in the Tsable River area; however, most of the activity soon moved to the Cumberland area, where mining continued until 1953. The Tsable River Mine continued operation, finally by removing coal from mine pillars, until 1967, when it closed as the last operating coal mine on the island.

## SAMPLING AND ANALYSIS

Samples were collected from beaches, exposed banks of waste material, and from the top surface of piles of waste material. Fragment size varied from pebble to fine sand, and the mass of each sample collected varied based on fragment size and ranged from less than 1 kg to about 5 kg. Wherever possible, shallow holes up to 1 m deep were dug so that one or two samples could be collected to represent a simple stratigraphic section. On beaches, this required digging a hole up to 1 m deep (Figure 2). In some banks it was possible to sample a section up to 2 m thick (Figure



Figure 2: Photo; Union Bay intertidal zone, location 646.

3). In some places (Union Bay intertidal zone), there was a heavy iron staining (Figure 4). A total of 43 samples were collected (Table 1). Larger samples were split, with one split screened into 2 sizes to provide coarse-sized and fine-sized samples.

Inspection of samples provided some information on amount of coal in samples, and those that were noticeably coaly were sent for coal-specific analyses as well as x-ray fluorescence (XRF) major oxide and ICP-MS analyses (Table 2). Other samples not visibly coal-rich were sent for ash, XRF (Table 3), and ICP-MS (using a hot aqua-regia digestion; Table 4) analyses.

The XRF analysis provides a good estimate of the amount of organic matter in samples because samples are fused prior to analysis and the loss of weight is a measure of organic carbon and the remaining weight correlates closely to American Society for Testing and Materials (ASTM) ash measurements (Figure 5). It appears that ash concentration determined by XRF is about 0.5% lower, but the correlation between the 2 methods is generally very good.



Figure 3: Photo; Union Bay; bank into waste coal pile, l ocation 662.



Figure 4: Photo; Union Bay intertidal zone, location 646; heavy iron staining on surface.

Sample No		lat	long	Zone 10		Notes
Union Bay			•	easting r	northing	
	641	49-35.209	124-53.083	363773	5494180	Vertical bluff Sample top 40 cm coaly
	642					Vertical bluff Sample middle 1 m down from top coaly
	643					Vertical bluff Sample bottom 2 m down from top coaly
Intertidal zo	one Sa	mpling				
	644	49-35 475	124-52 773	364159	5494663	ton 3cm mdst+coaly
	645	19 30.110	121 02.770	504157	5474005	middle 8-12 cm mdst+coaly
	646					hottom 15-20 cm mdst+coaly
	647	40 35 512	124 52 763	264172	5404722	low inter tidal zone ton 4 cm mdst+coaly
	649	49-55.512	124-52.705	304173	5494752	low inter tidal zone 10, 15 cm middle cample mdst+cooly
	640					low inter tidal zone 10-15 cm middle sample midst+coary
Y	649					low inter tidal zone aprox depth 40 cm mdst+coary
Intertidal	650	10.05.504	124 52 504			
	650	49-35.524	124-52.784	364148	5494754	1 of 3 top heavy iron stain 0-4 cm
	651					middle 10-15 cm black layer
	652					deeper layer 20-30 cm grey/black
	653	49-35.514	124-52.842	364078	5494738	upper inter tidal zone iron cemented surface layer hard pan
	654	49-35.516	124-52.836	364085	5494741	top of coal pile15-20cm mdst
	655					surface top 4 cm coaly mdst
Estuary						
	660	49-35.661	124-53.078	363800	5495017	by creek black sand layer surface sample top 10-20 cm coaly
	661					15-20 cm deep iron stained coaly
	662	49-35.597	124-53.215	363632	5494903	waste coal/rock pile 30 cm down from top mdst
	663					waste coal/rock pile 1.5 m down from top mdst
Top of wast	te Pile					
	664	49-35.564	124-53.000	363894	5495002	top of coal hills 30 cm deepmdst
	665	49-35.564	124-53.1	363769	5494838	Surface sample top 4 cm mdst
Cedar Cove	/Cans	ry Cove	1210011	000103	0 10 1000	Surface sumple top i em mast
Could Core	666	49-05 566	123-48 152	441408	5437850	coal waste nile adjacent to beach surface ton 4 cm coaly
	667	19 05.500	125 10.152	11100	5457655	denth 30,35 cm taken, coal waste nile adjacent to heach coaly
	668	40.05.577	122 48 102	441260	5427000	surface top 4 cm cooly
	660	49-05.577	123-40.192	441300	3437880	65 om deen geelv
1. 11.17	009					os cin deep coary
Intertidal Zo	one	10.05.614	102 40 100			
	670	49-05.614	123-48.188	441365	5437949	surface sample top 4 cm
	671					depth to sample 20 cm coaly
Clam Bay						
	672	49-05.498	123-48.184	441368	5437734	surface top 4 cm coaly
	673					deep sample 30-40 cm hole 80 cm deep coaly
	674	49-05.497	123-48.188	441363	5437732	surface top 4 cm mdst
	675					sample 20 cm deep mdst
Ladysmith S	Slag I	Point				
	676	48-59.706	123-48.537	440824	5427007	beach surface sample top 5 cm coaly
	677					beach asmple 20-30 cm deep coaly
	678	48-59.740	123-48.494	440877	5427070	surface top 5 cm coaly
	679					30 cm deep sample coaly
Intertidal S	E side	e of pile beach o	on ocean side			
	680	48-59.669	123-48.418	440968	5426937	surface sample top 5 cm coaly
	681			110,000	0120707	sample 20 cm deep coaly
Coaly Bluff						sample zo en doop oong
Comy Dian	682	48-59 612	123-48 457	440020	5426922	surfce to 30 cm mdst
	692	10-07.012	120-10.407	440920	3420832	1.5 m down from ton mdet
Decel: Ali	083					1.5 m down nom top mast
Beach Aboy	ve tide		102 40 502			
	684	48-59.698	123-48.522	440842	5426992	surface top 5 cm sandy
	685					50 cm deep Lots of iron/cable debris
Top of Was	te pil	8				
	686	48-59.728	123-48.496	440874	5427047	surface top 5 cm coaly
	687					sample 40 cm deep coaly

## TABLE 1: SAMPLE LOCATIONS AND DESCRIPTIONS.

									F	Forms Of Su	lfur
	Moist								Pyritic	sulphate	Organic
sample	adb	Ash adb	Moist res	VM adb	FC adb	CV db	CV	S%	S%	S%	S%
Union Bay	7										
641	2.14	48.15	1.33	21.18	29.34			0.54			
642	2.12	28.34	1.26	26.27	44.13			0.66	0.235	0.001	0.420
643	1.86	53.13	1.08	20.34	25.45			0.50			
644	1.29	87.49	0.79	9.69	2.03	3506	3478	0.31			
645	1.77	66.37	0.81	16.55	16.27	4431	4395	0.50			
646	1.08	85.80	0.69	8.95	4.56	3401	3378	0.54			
647	1.94	76.27	1.16	13.08	9.49						
648	1.38	67.37	1.07	16.15	15.41						
649	1.17	91.88	0.63	7.72	-0.23						
660	3.40	39.46	1.67	23.95	34.92	4477	4402	0.87			
661	1.50	74.81	1.05	13.67	10.47	979	969	1.22			
Cedar Cov	e										
666	2.75	24.57	1.82	32.10	41.51	5463	5364	0.55			
667	2.51	27.66	1.64	31.06	39.64	5440	5351	0.59			
668	31.17	61.31	1.11	20.16	17.42	2509	2481	0.47			
669	2.42	37.98	1.30	26.44	34.28	4657	4596	0.55			
670	1.92	55.53	1.12	21.07	22.28						
671	1.27	60.00	0.86	21.04	18.10						
672	1.57	69.75	1.03	16.59	12.63						
673	1.60	67.93	0.93	18.19	12.95						
Ladysmith	Slag Poi	int									
676	2.06	60.36	1.07	19.57	19.00						
677	2.02	49.50	1.04	23.82	25.64						
678	1.46	83.89	0.92	11.49	3.70	600	594	0.14			
679	1.67	75.36	1.00	14.48	9.16	981	971	0.31			
680	1.54	75.65	0.94	15.74	7.67						
681	1.52	71.33	1.10	16.61	10.96						
684	1.75	77.94	0.83	12.89	8.34	786	779	0.23			
685	2.14	60.23	1.24	18.93	19.60	2349	2320	0.28			
686	1.61	82.82	0.90	11.87	4.41						
687	1.74	76.44	1.04	14.50	7.03						

TABLE 2: COAL-SPECIFIC ANALYSES OF SOME SAMPLES.



Figure 5: Correlation of ash determined by ASTM standard method and by XRF.

## **ECONOMIC CONSIDERATIONS**

There are a number of coal refuse piles on Vancouver Island, especially in the Nanaimo area, and the total tonnage may be as high as 2.5 million tonnes (Gardner 1997). Portable wash plants exist that can upgrade the material by removing some of the ash until the remaining product has a useable heat value. Generally this means reducing the ash content to less than 15%. A number of companies have investigated the possibility of upgrading material to a marketable thermal coal product, but at present there are no active proposals. Coking coal properties such as fluidity (a measure of coal rheology) or free-swelling index (FSI) are lost as the coal weathers or ages at surface, so that there is no possibility of processing refuse piles to produce a coking coal product.

Most of the samples collected for this study have high ash contents (Table 3) with the exception of samples collected at Cedar Cove. It should be remembered that when

TABLE 3: XRF MAJOR OXIDE ANALYSES.

sample	Ash	SiO2	TiO2	A12O3	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P205	Ba(F)
641	48.5	57.34	1.26	30.63	5.39	0.04	0.49	1.27	0.38	1.43	0.19	0.03
642	29.7	51.54	1.35	29.47	4.57	0.04	0.39	6.16	0.38	1.27	0.26	0.04
643	51.0	57.53	1.30	30.59	4.28	0.02	0.59	1.91	0.34	1.47	0.10	0.03
644	85.9	57.00	0.99	19.71	10.65	0.05	1.81	4.46	2.11	1.08	0.13	0.03
645	64.4	55.80	1.20	24.96	7.02	0.05	1.39	3.74	1.55	1.25	0.12	0.03
646	84.6	57.50	1.03	16.97	8.85	0.07	2.64	6.63	2.62	0.90	0.13	0.03
647	74.5	56.16	1.03	23.26	7.97	0.03	1.32	3.88	1.81	1.33	0.18	0.03
648	67.4	52.38	1.21	23.65	7.59	0.05	1.93	6.40	1.79	1.13	0.16	0.03
649	89,9	53.03	1.06	13.55	8.17	0.10	3.52	12.56	3.08	0.63	0.13	0.02
650	71.5	39.05	0.84	13.89	34.56	0.04	1.80	4.06	2.45	0.67	0.22	0.02
651	74.3	54.30	1.42	23.32	7.19	0.10	2.15	6.17	1.62	0.91	0.15	0.02
652	93.5	51.27	1.19	14.15	9.61	0.13	4.84	12.04	3.16	0.53	0.14	0.01
654	78.0	55.52	1.07	23.61	11.40	0.03	1.57	2.51	1.28	1.35	0.16	0.03
655	85.3	45.75	1.11	17.43	22.68	0.08	2.80	5.15	1.20	0.78	0.21	0.02
662	58.7	56.77	1.11	28.12	3.05	0.01	0.43	2.84	0.56	1.67	0.07	0.06
663	69.0	52 75	1.10	23.92	2 74	0.01	0.34	6.65	0.55	1.57	0.05	0.05
664	54.8	52.75	2 22	26.25	9.84	0.05	2.10	3.42	1.12	0.93	0.13	0.05
665	49.1	57.47	1.67	20.25	6.73	0.03	0.40	0.10	0.52	1.50	0.13	0.05
666	22.0	55.25	1.07	24.55	6.68	0.06	2.60	2.40	0.52	1.50	0.00	0.05
667	22.9	51.71	1.20	24.55	5.51	0.00	2.00	6.61	0.78	1.72	0.99	0.20
669 5	25.5	56.60	0.01	22.07	7.22	0.04	2.70	2.66	1.12	1.50	0.62	0.17
668 T	50.7	55 50	0.91	21.70	6.07	0.07	3.50	4.81	1.12	1.70	0.18	0.05
660 T	39.7	55.59	1.27	21.12	5.97	0.00	2.50	4.01	1.17	1.71	0.21	0.05
660 S	21.5	55.06	1.27	23.49	5.00	0.03	2.60	2.27	1.04	1.05	0.51	0.08
670	51.5	59.00	0.70	19.70	5.27	0.07	2.32	5.02	2.29	1.70	0.55	0.09
671	60.2	54.07	0.79	18.70	5.27	0.05	2.72	5.02	2.28	1.70	0.24	0.00
0/1 672 T	71.1	50.08	0.81	17.45	5.20 9.1 <b>2</b>	0.00	2.89	9.40	2.24	1.40	0.31	0.08
072 1	/1.1	59.98	0.70	17.41	8.12	0.15	2.85	3.94	1.40	1.30	0.22	0.04
072 S	03.3	57.00	0.88	19.84	7.04	0.10	5.45 2.07	2.09	1.70	1.00	0.20	0.05
073 1	70.0	57.88	0.85	18.04	8.31	0.14	3.07	3.98	1.09	1.40	0.21	0.04
073 5	38.3	56.14	0.94	21.10	7.72	0.09	3.03	5.25	1.91	1./1	0.29	0.06
074	07.1	50.12	0.82	18.54	7.50	0.08	3.00	5.99	1.55	1.44	0.29	0.05
075 (76 T	08.1 56.6	55.44	0.79	17.01	9.47	0.07	2.92	0.19	1.45	1.38	0.25	0.05
070 1	50.0	59.51	1.14	24.04	4.11	0.03	2.05	2.45	1.95	1.85	0.13	0.06
070 S	59.2	60.07	1.14	25.00	4.51	0.03	2.10	1.07	1.90	1.85	0.12	0.06
0// 1	40.9	59.12	1.19	25.10	4.06	0.03	2.00	1.20	1.88	1.88	0.13	0.07
6778	49.6	59.25	1.19	24.71	4.06	0.02	2.02	1.69	1.85	1.88	0.13	0.07
678 t	84.4	58.46	1.08	21.86	0.38	0.06	2.58	3.58	1.42	1.72	0.16	0.05
678 S	81.3	58.60	1.09	23.40	5.57	0.05	2.17	3.11	1.09	1.87	0.09	0.05
6791	/4./	58.56	1.10	23.29	5.05	0.05	2.05	3.26	1.69	1.87	0.08	0.05
679 S	74.0	58.55	1.10	24.06	5.03	0.05	2.10	2.72	1.32	1.90	0.10	0.06
680 I	73.9	56.49	1.08	24.81	4.30	0.05	1.94	4.24	1.08	1.86	0.08	0.05
680 S	74.1	56.49	1.06	24.40	3.89	0.04	1.90	4.97	1.19	1.87	0.09	0.05
681 1	69.6	57.47	1.11	25.31	4.08	0.02	1.92	3.54	1.09	1.92	0.08	0.06
681 S	68.6	57.45	1.12	25.09	3.94	0.03	1.90	4.00	1.05	1.93	0.09	0.05
682	77.4	58.90	1.13	25.26	4.11	0.04	1.77	3.50	0.57	1.80	0.12	0.07
683	73.6	57.49	1.10	24.40	4.69	0.05	1.95	4.25	0.53	1.82	0.07	0.06
684 T	74.2	61.32	1.03	22.24	5.05	0.04	2.10	2.63	1.72	1.72	0.10	0.05
684 S	76.6	62.19	0.99	21.80	4.81	0.04	2.11	2.17	1.92	1.74	0.09	0.05
685 T	58.9	60.13	1.24	25.85	4.53	0.03	1.99	0.81	1.27	1.90	0.18	0.06
685 S	58.2	60.04	1.22	25.80	4.59	0.04	2.03	0.88	1.27	1.91	0.12	0.07
686 t	80.8	58.23	1.07	22.67	5.77	0.05	2.50	3.66	1.44	1.78	0.09	0.05
686 S	80.4	58.84	1.08	24.03	5.05	0.04	2.25	2.99	1.10	1.92	0.08	0.05
678 T	76.5	58.25	1.07	23.65	4.89	0.04	2.18	3.67	1.11	1.89	0.11	0.06
678 S	76.3	58.37	1.10	24.47	4.90	0.03	2.17	2.88	1.09	1.92	0.10	0.06

TABLE 4: ICP-MS MAJOR AND MINOR ELEMENT ANALYSES.

sample	Ca %	Fe %	Mg %	Na %	К %	P ppm	S %	Ba ppm	As ppm	Bi ppm	Cd ppm	Co ppm	Cr ppm	Cu ppm	Ga ppm	La ppm	Mn ppm	Mo ppm	Ni ppm	Pb ppm	Sb ppm	Se ppm	Sr ppm	Th ppm	TI ppm	U ppm	V ppm	Zn ppm
Union E 641	Bay 0.81	3.21	0.22	0.05	0.46	514	0.12	118	13	0.3	0.3	11	59	74	16.7	20	395	1.8	217	10.7	0.4	21.1	147	3.8	0.6	1.0	136	70
642	4.08	2.45	0.15	0.04	0.41	1294	1.01	202	17	0.2	0.2	17	69	89	16.4	20	372	2.4	167	12.8	0.4	25.1	332	3.4	0.6	1.2	238	70
643 644	1.21	2.37	0.25	0.04	0.50	418	0.32	137	9	0.2	0.2	16	60 50	72	15.9	21	255	2.1	32	12.7	0.3	22.9	150	3.5	0.4	1.2	187	85 46
645	2.05	4.32	0.57	0.37	0.56	550	0.67	154	10	0.2	0.4	17	88	76	16.5	16	363	1.7	38	10.9	0.2	19.1	164	2.9	0.4	0.9	125	62
646	2.66	5.09	0.77	0.34	0.34	606	0.51	76	12	0.1	0.1	15	100	44	10.6	5	355	1.4	32	5.8	0.1	11	160	1.5	0.2	0.6	112	49
647 648	3.50	5.15 4.83	0.58	0.42	0.59	885 809	0.60	108	23 24	0.2	0.1	6 10	90 101	49 66	14.7	15	276 301	1.8	37	9.8 9.1	0.2	16.3	185 298	2.6	0.3	1.1	117	52 60
649	6.19	3.97	1.06	0.37	0.20	527	0.17	38	11	<.1	<.1	11	91	47	9.2	<2	458	0.8	29	3.1	<.1	9.8	394	0.7	<.1	0.3	120	49
650 651	1.48	19.70	0.55	0.64	0.31	1015 687	0.57	87 59	22	0.1	0.1	3	78 89	55 58	9.7 13.8	8	256 566	13.2	21	6.9	0.3	9.5	162	1.3	0.1	3.1	90	22 48
652	4.80	3.99	1.24	0.26	0.15	584	0.14	29	13	<.1	<.1	16	83	54	9.7	<2	538	0.6	33	2.0	<.1	9	284	0.6	<.1	0.2	115	47
654	0.64	6.55	0.50	0.22	0.44	597	0.20	83	20	0.1	<.1	7	56	48	11.1	13	207	5.4	373	7.6	0.3	11.8	72	2.3	0.1	2.0	96	48
655	2.09	13.39	0.69	0.32	0.51	698 270	0.46	59 89	20	0.1	0.1 <.1	<1	46	18	9.9	10	291	2.6	447	5.8	0.4	9.7	85 243	3.0	0.2	3.5 1.5	93 104	23
663	4.89	1.70	0.15	0.07	0.58	185	3.60	45	25	0.2	<.1	<1	45	15	11.0	14	28	2.3	10	6.0	0.9	11.8	224	2.3	0.6	1.1	77	18
664 665	1.12 0.13	5.37 5.00	0.42 0.20	0.27 0.07	0.39 0.69	535 542	0.10 0.08	389 325	149 79	0.1 0.2	<.1 <.1	6	127 131	55 38	18.6 20.3	16 17	101 39	1.8 2.6	34 28	9.7 12.5	1.1 0.7	15.7 21.5	200 222	2.8 3.7	0.7 0.6	0.8 1.9	204 196	27 31
		Hg all	values le	ess than	20 ppb		Se only	1 value	e greater	than 1	ppm																	
$\vdash$	Са	Fe	Mg	Na	K	Р	S	Ba	As	Bi	Cd	Со	Cr	Cu	Ga	La	Mn	Мо	Ni	Pb	Sb	Sc	Sr	Th	Tl	U	V	Zn
sample	%	%	%	%	%	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
Cedar C 666	ove 1.70	4.08	1.24	0.19	0.80	4914	0.58	394	14	0.3	0.3	13	219	111	17.6	15	487	2.1	140	32.6	0.2	27.7	2317	3.1	0.4	1.3	195	85
667	4.75	3.71	1.55	0.16	0.71	4067	1.23	150	24	0.2	0.2	16	208	113	18.5	7	432	2.4	147	12.5	0.1	28.7	2409	2.9	0.4	1.3	187	75
668 S 668 T	2.74	4.79	1.96	0.35	0.88	961 946	0.58	254 270	9	0.1	0.1	9	180 146	56 55	16.1 15.2	12	614 503	0.8	144 116	15.8 11.1	0.1	21.3 20.8	376 479	2.1	0.2	0.8	145 135	104 79
669 T	1.25	3.25	1.35	0.62	0.90	1499	0.51	421	10	0.2	0.1	Í.	182	99	18.0	14	402	1.7	109	18.4	0.2	24.3	673	2.9	0.2	1.7	175	77
669 S 670	1.59	4.35	1.89	0.93	1.04	2413	0.88	274	14	0.1	0.1	15	254	118	19.3	12	615	2.2	166	11.9	0.2	26.5	1013	2.4	0.2	1.8	217	77
671	6.22	3.15	1.42	0.50	0.67	1522	0.83	303	5 10	0.1	0.1	8	148	44 61	12.9	2	397	1.3	95	13.9	∼.1 0.1	17.5	1073	1.9	0.2	0.8 1.1	127	61
672 T	2.69	5.26	1.58	0.36	0.72	1008	0.71	206	12	0.1	0.1	12	125	45	12.5	15	1018	1.3	112	10.1	0.1	17.5	301	1.9	0.2	0.8	112	92
672 S 673 T	2.44	5.88 6.27	2.11	0.61	0.99	1390 1100	0.64 0.89	309 210	15 26	0.1 0.1	0.1	16 18	192 170	99 57	16.4 13.7	14	878 1248	1.2	158	14.1 9.2	0.1	22.3 20.5	458 284	2.4	0.3	1.0	152	131
673 S	2.24	4.80	1.91	0.58	0.90	1348	0.63	328	21	0.2	0.1	13	167	79	16.9	14	731	1.7	142	12.5	0.1	23.6	567	2.2	0.3	1.0	152	94
674 675	4.35	5.39 8.29	1.68	0.54	0.83	1569 1531	1.10	235	23 44	0.1	0.1	13 15	155 167	55 59	14.1 13.7	10 10	720 722	1.2	127 145	11.2	0.1	19.3	692 640	1.9	0.2	0.9	131	95 114
0.0	0100	Hg all	values le	ess than	20 ppb		Se only	1 value	e greater	than 1	ppm	10								1018		1010	0.0		0.0	011	100	
<u> </u>	Са	Fe	Mg	Na	K	Р	S	Ba	As	Bi	Cd	Со	Cr	Cu	Ga	La	Mn	Мо	Ni	Pb	Sb	Sc	Sr	Th	Tl	U	V	Zn
sample	% ith	%	%	%	%	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
Ladysin	m																											
676 T	1.33	2.16	0.97	0.74	0.95	542	0.38	339	11	0.2	0.2	6	116	87	16.2	19	226	1.4	55	27.3	0.2	20	205	3.0	0.3	1.2	139	114
676 T 676 S 677 T	1.33 0.79	2.16 2.69	0.97	0.74	0.95	542 658	0.38	339 366 470	11 7 7	0.2	0.2	6 8	116 170 207	87 94	16.2 17.3	19 21 21	226 276 240	1.4 1.5	55 67 76	27.3 29.7	0.2	20 20.9	205 178 284	3.0 3.1	0.3 0.3	1.2	139 158	114 134
676 T 676 S 677 T 677 S	1.33 0.79 0.72 0.92	2.16 2.69 2.57 2.48	0.97 1.12 1.10 1.08	0.74 0.74 0.86 0.75	0.95 1.12 1.17 1.08	542 658 707 652	0.38 0.35 0.41 0.41	339 366 470 451	11 7 7 4	0.2 0.2 0.3 0.3	0.2 0.2 0.3 0.3	6 8 10 9	116 170 207 168	87 94 102 94	16.2 17.3 19.3 18.1	19 21 21 20	226 276 240 243	1.4 1.5 5.0 5.6	55 67 76 70	27.3 29.7 24.7 25.7	0.2 0.2 0.2 0.3	20 20.9 24.8 23.1	205 178 284 247	3.0 3.1 3.7 3.5	0.3 0.3 0.4 0.4	1.2 1.2 1.5 1.3	139 158 182 164	114 134 141 122
676 T 676 S 677 T 677 S 678 t	1.33 0.79 0.72 0.92 2.11	2.16 2.69 2.57 2.48 4.26	0.97 1.12 1.10 1.08 1.30	0.74 0.74 0.86 0.75 0.33	0.95 1.12 1.17 1.08 1.04	542 658 707 652 511	0.38 0.35 0.41 0.41 0.20	339 366 470 451 274	11 7 7 4 10	0.2 0.2 0.3 0.3 0.2	0.2 0.2 0.3 <.1	6 8 10 9 10	116 170 207 168 114	87 94 102 94 55	16.2 17.3 19.3 18.1 16.2	19 21 21 20 21	226 276 240 243 500	1.4 1.5 5.0 5.6 1.5	55 67 76 70 73	27.3 29.7 24.7 25.7 17.4	0.2 0.2 0.2 0.3 0.1	20 20.9 24.8 23.1 19	205 178 284 247 142	3.0 3.1 3.7 3.5 2.7	0.3 0.3 0.4 0.4 0.3	1.2 1.2 1.5 1.3 0.6	139 158 182 164 122	114 134 141 122 166
676 T 676 S 677 T 677 S 678 t 678 S 679 T	1.33 0.79 0.72 0.92 2.11 2.03 2.25	2.16 2.69 2.57 2.48 4.26 3.63 3.31	0.97 1.12 1.10 1.08 1.30 1.10 1.08	0.74 0.74 0.86 0.75 0.33 0.33 0.33	0.95 1.12 1.17 1.08 1.04 1.06 1.08	542 658 707 652 511 431 410	0.38 0.35 0.41 0.41 0.20 0.19 0.33	339 366 470 451 274 275 313	11 7 4 10 10 8	0.2 0.2 0.3 0.3 0.2 0.2 0.2	0.2 0.2 0.3 <.1 0.1 0.1	6 8 10 9 10 7 8	116 170 207 168 114 102 115	87 94 102 94 55 56 70	16.2 17.3 19.3 18.1 16.2 15.9 16.8	19 21 20 21 22 22 22	226 276 240 243 500 444 441	1.4 1.5 5.0 5.6 1.5 0.6 0.6	55 67 76 70 73 67 64	27.3 29.7 24.7 25.7 17.4 20.5 20.1	0.2 0.2 0.3 0.1 0.1 0.2	20 20.9 24.8 23.1 19 18.6 20.9	205 178 284 247 142 118 150	3.0 3.1 3.7 3.5 2.7 2.6 2.9	0.3 0.3 0.4 0.4 0.3 0.3 0.3	1.2 1.2 1.5 1.3 0.6 0.7 0.8	139 158 182 164 122 113 128	114 134 141 122 166 178 130
676 T 676 S 677 T 677 S 678 t 678 S 679 T 679 S	1.33 0.79 0.72 0.92 2.11 2.03 2.25 1.90	2.16 2.69 2.57 2.48 4.26 3.63 3.31 3.37	0.97 1.12 1.10 1.08 1.30 1.10 1.08 1.14	0.74 0.74 0.86 0.75 0.33 0.33 0.47 0.50	0.95 1.12 1.17 1.08 1.04 1.06 1.08 1.09	542 658 707 652 511 431 410 484	0.38 0.35 0.41 0.20 0.19 0.33 0.27	339 366 470 451 274 275 313 311	11 7 4 10 10 8 10	0.2 0.2 0.3 0.2 0.2 0.2 0.2 0.2	$\begin{array}{c} 0.2 \\ 0.2 \\ 0.3 \\ <.1 \\ 0.1 \\ 0.1 \\ 0.1 \end{array}$	6 8 10 9 10 7 8 8	116 170 207 168 114 102 115 117	87 94 102 94 55 56 70 72	16.2 17.3 19.3 18.1 16.2 15.9 16.8 17.2	19 21 20 21 22 22 22 22	226 276 240 243 500 444 441 449	$\begin{array}{c} 1.4 \\ 1.5 \\ 5.0 \\ 5.6 \\ 1.5 \\ 0.6 \\ 0.6 \\ 0.6 \end{array}$	55 67 76 70 73 67 64 67	27.3 29.7 24.7 25.7 17.4 20.5 20.1 18.8	0.2 0.2 0.3 0.1 0.1 0.2 0.1	20 20.9 24.8 23.1 19 18.6 20.9 21.7	205 178 284 247 142 118 150 143	3.0 3.1 3.7 3.5 2.7 2.6 2.9 3.1	0.3 0.4 0.4 0.3 0.3 0.3 0.3 0.3	1.2 1.5 1.3 0.6 0.7 0.8 0.7	139 158 182 164 122 113 128 131	114 134 141 122 166 178 130 147
676 T 676 S 677 T 677 S 678 t 678 S 679 T 679 S 680 T 680 S	1.33 0.79 0.72 0.92 2.11 2.03 2.25 1.90 3.30	2.16 2.69 2.57 2.48 4.26 3.63 3.31 3.37 3.10 2.32	0.97 1.12 1.10 1.08 1.30 1.10 1.08 1.14 1.11	0.74 0.74 0.86 0.75 0.33 0.47 0.50 0.48 0.51	0.95 1.12 1.17 1.08 1.04 1.06 1.08 1.09 1.11	542 658 707 652 511 431 410 484 423 371	0.38 0.35 0.41 0.41 0.20 0.19 0.33 0.27 0.51	339 366 470 451 274 275 313 311 300 259	11 7 4 10 10 8 10 12	0.2 0.2 0.3 0.3 0.2 0.2 0.2 0.2 0.2 0.2	0.2 0.2 0.3 <.1 0.1 0.1 0.1 0.1	6 8 10 9 10 7 8 8 8 8	116 170 207 168 114 102 115 117 111 93	87 94 102 94 55 56 70 72 66 63	16.2 17.3 19.3 18.1 16.2 15.9 16.8 17.2 17.6	19 21 20 21 22 22 22 20 21	226 276 240 243 500 444 441 449 391 267	1.4 1.5 5.0 5.6 1.5 0.6 0.6 0.6 0.3 0.3	55 67 76 70 73 67 64 67 74	27.3 29.7 24.7 25.7 17.4 20.5 20.1 18.8 15.9	0.2 0.2 0.3 0.1 0.1 0.1 0.1 0.1	20 20.9 24.8 23.1 19 18.6 20.9 21.7 21.6 20.2	205 178 284 247 142 118 150 143 172	3.0 3.1 3.7 3.5 2.7 2.6 2.9 3.1 3.1	0.3 0.3 0.4 0.4 0.3 0.3 0.3 0.3 0.3 0.5 0.4	1.2 1.2 1.5 1.3 0.6 0.7 0.8 0.7 0.7 0.7	139 158 182 164 122 113 128 131 127	114 134 141 122 166 178 130 147 119
676 T 676 S 677 T 677 S 678 t 678 S 679 T 679 S 680 T 680 S 681 T	1.33 0.79 0.72 0.92 2.11 2.03 2.25 1.90 3.30 3.59 2.73	2.16 2.69 2.57 2.48 4.26 3.63 3.31 3.37 3.10 2.32 2.73	0.97 1.12 1.10 1.08 1.30 1.10 1.08 1.14 1.11 1.02 1.11	0.74 0.74 0.86 0.75 0.33 0.47 0.50 0.48 0.51 0.50	0.95 1.12 1.17 1.08 1.04 1.06 1.08 1.09 1.11 1.05 1.09	542 658 707 652 511 431 410 484 423 371 373	0.38 0.35 0.41 0.20 0.19 0.33 0.27 0.51 0.31 0.42	339 366 470 451 274 275 313 311 300 259 308	11 7 4 10 10 8 10 12 11 13	0.2 0.2 0.3 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2	$\begin{array}{c} 0.2 \\ 0.2 \\ 0.3 \\ <.1 \\ 0.1 \\ 0.1 \\ 0.1 \\ 0.1 \\ 0.1 \\ 0.1 \\ 0.1 \end{array}$	6 8 10 9 10 7 8 8 8 8 5 6	116 170 207 168 114 102 115 117 111 93 115	87 94 102 94 55 56 70 72 66 63 82	16.2 17.3 19.3 18.1 16.2 15.9 16.8 17.2 17.6 16.5 17.2	19 21 20 21 22 22 22 20 21 24	226 276 240 243 500 444 441 449 391 367 322	$\begin{array}{c} 1.4 \\ 1.5 \\ 5.0 \\ 5.6 \\ 1.5 \\ 0.6 \\ 0.6 \\ 0.3 \\ 0.3 \\ 0.4 \end{array}$	55 67 76 70 73 67 64 67 74 55 66	27.3 29.7 24.7 25.7 17.4 20.5 20.1 18.8 15.9 15.8 16.3	0.2 0.2 0.3 0.1 0.1 0.2 0.1 0.1 0.1 0.1	20 20.9 24.8 23.1 19 18.6 20.9 21.7 21.6 20.2 22.1	205 178 284 247 142 118 150 143 172 163 166	3.0 3.1 3.7 3.5 2.7 2.6 2.9 3.1 3.1 3.1 3.1	$\begin{array}{c} 0.3 \\ 0.3 \\ 0.4 \\ 0.4 \\ 0.3 \\ 0.3 \\ 0.3 \\ 0.5 \\ 0.4 \\ 0.3 \end{array}$	1.2 1.2 1.5 1.3 0.6 0.7 0.8 0.7 0.7 0.7 0.7 0.8	139 158 182 164 122 113 128 131 127 118 134	114 134 141 122 166 178 130 147 119 96 114
676 T 676 S 677 T 677 S 678 t 678 S 679 T 679 S 680 T 680 S 681 T 681 S	1.33 0.79 0.72 0.92 2.11 2.03 2.25 1.90 3.30 3.59 2.73 3.14	2.16 2.69 2.57 2.48 4.26 3.63 3.31 3.37 3.10 2.32 2.73 2.66	0.97 1.12 1.10 1.08 1.30 1.10 1.08 1.14 1.11 1.02 1.11 1.12	0.74 0.74 0.86 0.75 0.33 0.47 0.50 0.48 0.51 0.50 0.47 0.50	0.95 1.12 1.17 1.08 1.04 1.06 1.08 1.09 1.11 1.05 1.09 1.10	542 658 707 652 511 431 410 484 423 371 373 438	0.38 0.35 0.41 0.20 0.19 0.33 0.27 0.51 0.31 0.42 0.35	339 366 470 451 274 275 313 311 300 259 308 314	11 7 4 10 10 8 10 12 11 13 7	0.2 0.2 0.3 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2	$\begin{array}{c} 0.2 \\ 0.2 \\ 0.3 \\ 0.3 \\ <.1 \\ 0.1 \\ 0.1 \\ 0.1 \\ 0.1 \\ 0.1 \\ 0.1 \\ 0.1 \\ 0.1 \end{array}$	6 8 10 9 10 7 8 8 8 5 6 7	116 170 207 168 114 102 115 117 111 93 115 120	87 94 102 94 55 56 70 72 66 63 82 84	16.2 17.3 19.3 18.1 16.2 15.9 16.8 17.2 17.6 16.5 17.2 16.7	19 21 20 21 22 22 20 21 24 22	226 276 240 243 500 444 441 449 391 367 322 339	$\begin{array}{c} 1.4 \\ 1.5 \\ 5.0 \\ 5.6 \\ 1.5 \\ 0.6 \\ 0.6 \\ 0.3 \\ 0.3 \\ 0.4 \\ 0.5 \\ 0.4 \end{array}$	55 67 76 70 73 67 64 67 74 55 66 68	27.3 29.7 24.7 25.7 17.4 20.5 20.1 18.8 15.9 15.8 16.3 17.5	0.2 0.2 0.3 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1	20 20.9 24.8 23.1 19 18.6 20.9 21.7 21.6 20.2 22.1 22.1 22.1	205 178 284 247 142 118 150 143 172 163 166 191	3.0 3.1 3.7 3.5 2.7 2.6 2.9 3.1 3.1 3.1 3.1 3.2	$\begin{array}{c} 0.3 \\ 0.4 \\ 0.4 \\ 0.3 \\ 0.3 \\ 0.3 \\ 0.3 \\ 0.5 \\ 0.4 \\ 0.3 \\ 0.4 \\$	1.2 1.5 1.3 0.6 0.7 0.8 0.7 0.7 0.7 0.7 0.7 0.8 0.9	139 158 182 164 122 113 128 131 127 118 134 138	114 134 141 122 166 178 130 147 119 96 114 129
676 T 676 S 677 T 677 S 678 t 678 S 679 T 679 S 680 T 680 S 681 T 681 S 682 683	1.33 0.79 0.72 0.92 2.11 2.03 2.25 1.90 3.30 3.59 2.73 3.14 2.97 3.34	2.16 2.69 2.57 2.48 4.26 3.63 3.31 3.37 3.10 2.32 2.73 2.66 3.00 3.26	0.97 1.12 1.10 1.08 1.30 1.10 1.08 1.14 1.11 1.02 1.11 1.12 1.11 1.16	0.74 0.74 0.86 0.75 0.33 0.47 0.50 0.48 0.51 0.50 0.47 0.12 0.10	0.95 1.12 1.17 1.08 1.04 1.06 1.08 1.09 1.11 1.05 1.09 1.10 1.05 1.03	542 658 707 652 511 431 410 484 423 371 373 438 302 366	0.38 0.35 0.41 0.20 0.19 0.33 0.27 0.51 0.31 0.42 0.35 0.13 0.18	339 366 470 451 274 275 313 311 300 259 308 314 467 371	11 7 4 10 10 8 10 12 11 13 7 11	0.2 0.3 0.3 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2	0.2 0.3 0.3 <.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.3 0.3	6 8 10 9 10 7 8 8 8 5 6 7 8 10	116 170 207 168 114 102 115 117 111 93 115 120 109 123	87 94 102 94 55 56 70 72 66 63 82 84 74 80	16.2 17.3 19.3 18.1 16.2 15.9 16.8 17.2 17.6 16.5 17.2 16.7 19.5 17.8	19 21 20 21 22 22 20 21 24 22 25 24	226 276 240 243 500 444 441 449 391 367 322 339 439 487	$\begin{array}{c} 1.4 \\ 1.5 \\ 5.0 \\ 5.6 \\ 1.5 \\ 0.6 \\ 0.6 \\ 0.3 \\ 0.3 \\ 0.4 \\ 0.5 \\ 0.4 \\ 0.4 \end{array}$	55 67 70 73 67 64 67 74 55 66 68 65 84	27.3 29.7 24.7 25.7 17.4 20.5 20.1 18.8 15.9 15.8 16.3 17.5 15.4 14.7	0.2 0.2 0.3 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.2 0.1	20 20.9 24.8 23.1 19 18.6 20.9 21.7 21.6 20.2 22.1 22.1 22.1 23.4 23.8	205 178 284 247 142 118 150 143 172 163 166 191 151 183	3.0 3.1 3.7 3.5 2.7 2.6 2.9 3.1 3.1 3.1 3.1 3.2 3.2 3.2	$\begin{array}{c} 0.3 \\ 0.3 \\ 0.4 \\ 0.4 \\ 0.3 \\ 0.3 \\ 0.3 \\ 0.5 \\ 0.4 \\ 0.3 \\ 0.4 \\ 0.4 \\ 0.4 \end{array}$	$\begin{array}{c} 1.2 \\ 1.2 \\ 1.5 \\ 1.3 \\ 0.6 \\ 0.7 \\ 0.8 \\ 0.7 \\ 0.7 \\ 0.8 \\ 0.9 \\ 0.6 \\ 0.7 \end{array}$	139 158 182 164 122 113 128 131 127 118 134 138 137 141	114 134 141 122 166 178 130 147 119 96 114 129 139 150
676 T 676 S 677 T 677 S 678 t 678 S 679 T 679 S 680 T 680 S 681 T 681 S 682 683 684 T	1.33 0.79 0.72 0.92 2.11 2.03 2.25 1.90 3.30 3.59 2.73 3.14 2.97 3.34 1.17	2.16 2.69 2.57 2.48 4.26 3.63 3.31 3.37 3.10 2.32 2.73 2.66 3.00 3.26 3.07	0.97 1.12 1.10 1.08 1.30 1.10 1.08 1.14 1.11 1.02 1.11 1.12 1.11 1.16 0.94	0.74 0.74 0.86 0.75 0.33 0.47 0.50 0.48 0.51 0.50 0.47 0.12 0.10 0.38	0.95 1.12 1.17 1.08 1.04 1.06 1.08 1.09 1.11 1.05 1.09 1.10 1.05 1.03 0.87	542 658 707 652 511 431 410 484 423 371 373 438 302 366 509	0.38 0.35 0.41 0.41 0.20 0.19 0.33 0.27 0.51 0.31 0.42 0.35 0.13 0.18 0.18	339 366 470 451 274 275 313 311 300 259 308 314 467 371 255	11 7 4 10 10 8 10 12 11 13 7 11 10 10	0.2 0.3 0.3 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.3 0.2	0.2 0.3 0.3 <.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.3 0.3 0.3 0.3	6 8 10 9 10 7 8 8 8 5 6 7 8 10 6	116 170 207 168 114 102 115 117 111 93 115 120 109 123 132	87 94 102 94 55 56 70 72 66 63 82 84 74 80 74	16.2 17.3 19.3 18.1 16.2 15.9 16.8 17.2 17.6 16.5 17.2 16.7 19.5 17.8 14.0	19 21 20 21 22 22 20 21 24 22 25 24 18	226 276 240 243 500 444 441 391 367 322 339 439 487 329	$\begin{array}{c} 1.4 \\ 1.5 \\ 5.0 \\ 5.6 \\ 1.5 \\ 0.6 \\ 0.6 \\ 0.6 \\ 0.3 \\ 0.3 \\ 0.4 \\ 0.5 \\ 0.4 \\ 0.4 \\ 0.4 \\ 0.4 \\ 0.6 \end{array}$	55 67 76 70 73 67 64 67 74 55 66 68 65 84 59	27.3 29.7 24.7 25.7 17.4 20.5 20.1 18.8 15.9 15.8 16.3 17.5 15.4 14.7 22.3	0.2 0.2 0.3 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.2 0.1 0.1	20 20.9 24.8 23.1 19 18.6 20.9 21.7 21.6 20.2 22.1 22.1 23.4 23.8 17.2	205 178 284 247 142 118 150 143 172 163 166 191 151 183 129	3.0 3.1 3.7 3.5 2.7 2.6 2.9 3.1 3.1 3.1 3.1 3.2 3.2 3.2 2.4	$\begin{array}{c} 0.3 \\ 0.4 \\ 0.4 \\ 0.3 \\ 0.3 \\ 0.3 \\ 0.5 \\ 0.4 \\ 0.3 \\ 0.4 \\ 0.4 \\ 0.4 \\ 0.4 \\ 0.4 \\ 0.5 \\ 0.4 \\ 0.4 \\ 0.5 \\ 0.4 \\ 0.4 \\ 0.5 \\$	$\begin{array}{c} 1.2 \\ 1.2 \\ 1.5 \\ 1.3 \\ 0.6 \\ 0.7 \\ 0.8 \\ 0.7 \\ 0.7 \\ 0.7 \\ 0.7 \\ 0.8 \\ 0.9 \\ 0.6 \\ 0.7 \\$	139 158 182 164 122 113 128 131 127 118 134 138 137 141 122	114 134 141 122 166 178 130 147 119 96 114 129 139 150 137
676 T 676 S 677 T 677 S 678 t 678 S 679 T 679 S 680 T 680 S 681 T 681 S 682 683 684 T 684 S 685 T	1.33 0.79 0.72 0.92 2.11 2.03 2.25 1.90 3.30 3.59 2.73 3.14 2.97 3.34 1.17 0.68 0.40	2.16 2.69 2.57 2.48 4.26 3.63 3.31 3.37 3.10 2.32 2.73 2.60 3.26 3.00 3.26 3.07 2.81 3.02	0.97 1.12 1.10 1.08 1.30 1.10 1.08 1.14 1.11 1.02 1.11 1.12 1.11 1.16 0.94 0.91 0.98	0.74 0.74 0.86 0.75 0.33 0.47 0.50 0.48 0.51 0.50 0.47 0.12 0.10 0.38 0.43 0.44	0.95 1.12 1.17 1.08 1.04 1.06 1.08 1.09 1.11 1.05 1.09 1.10 1.05 1.03 0.87 0.85 0.98	542 658 707 652 511 431 410 484 423 371 373 438 302 366 509 462 641	0.38 0.35 0.41 0.20 0.19 0.33 0.27 0.51 0.31 0.42 0.35 0.13 0.18 0.19 0.17 0.13	339 366 470 451 274 275 313 311 300 259 308 314 467 371 255 202 371	11 7 4 10 10 8 10 12 11 13 7 11 10 10 12 11	0.2 0.2 0.3 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2	0.2 0.3 0.3 <.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.3 0.3 0.1 <.1	6 8 10 9 10 7 8 8 8 5 6 7 8 10 6 9	116 170 207 168 114 102 115 117 111 93 115 120 109 123 132 121 136	87 94 102 94 55 56 70 72 66 63 82 84 74 80 74 70 107	16.2 17.3 19.3 18.1 16.2 15.9 16.8 17.2 17.6 16.5 17.2 16.7 19.5 17.8 14.0 12.9 15.6	19 21 20 21 22 22 20 21 24 22 25 24 18 16 20	226 276 240 243 500 444 441 449 391 367 322 339 439 487 329 316 397	$\begin{array}{c} 1.4 \\ 1.5 \\ 5.0 \\ 5.6 \\ 1.5 \\ 0.6 \\ 0.6 \\ 0.3 \\ 0.3 \\ 0.4 \\ 0.5 \\ 0.4 \\ 0.4 \\ 0.6 \\ 0.6 \\ 1.0 \end{array}$	55 67 70 73 67 64 67 74 55 66 68 65 84 59 53 70	27.3 29.7 24.7 25.7 17.4 20.5 20.1 18.8 15.9 15.8 16.3 17.5 15.4 14.7 22.3 25.4 55.3	0.2 0.2 0.3 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.2 0.1 0.1 0.1 0.1 0.2	20 20.9 24.8 23.1 19 18.6 20.9 21.7 21.6 20.2 22.1 22.1 23.4 23.8 17.2 15.6 20.8	205 178 284 247 142 118 150 143 172 163 166 191 151 183 129 94 163	3.0 3.1 3.7 3.5 2.7 2.6 2.9 3.1 3.1 3.1 3.1 3.2 3.2 3.2 3.2 2.4 2.4 3.0	$\begin{array}{c} 0.3 \\ 0.3 \\ 0.4 \\ 0.4 \\ 0.3 \\ 0.3 \\ 0.3 \\ 0.5 \\ 0.4 \\ 0.3 \\ 0.4 \\ 0.4 \\ 0.4 \\ 0.4 \\ 0.3 \\ 0.2 \\ 0.3 \end{array}$	$\begin{array}{c} 1.2 \\ 1.2 \\ 1.5 \\ 1.3 \\ 0.6 \\ 0.7 \\ 0.8 \\ 0.7 \\ 0.7 \\ 0.7 \\ 0.8 \\ 0.9 \\ 0.6 \\ 0.7 \\ 0.7 \\ 0.7 \\ 0.7 \\ 1.7 \end{array}$	139 158 182 164 122 113 128 131 127 118 134 138 137 141 122 112 154	114 134 141 122 166 178 130 147 119 96 114 129 139 150 137 165 124
676 T 676 S 677 T 677 S 678 t 678 S 679 T 679 S 680 T 680 S 681 T 681 S 682 683 684 T 684 S 685 T 685 S	1.33 0.79 0.72 0.92 2.11 2.03 2.25 1.90 3.30 3.59 2.73 3.14 2.97 3.34 1.17 0.68 0.40 0.37	2.16 2.69 2.57 2.48 4.26 3.63 3.31 3.37 3.10 2.32 2.73 2.66 3.00 3.26 3.07 2.81 3.02 2.47	0.97 1.12 1.10 1.08 1.30 1.10 1.08 1.14 1.11 1.02 1.11 1.12 1.11 1.16 0.94 0.91 0.98 0.95	0.74 0.74 0.86 0.75 0.33 0.47 0.50 0.48 0.51 0.50 0.47 0.12 0.10 0.38 0.43 0.44 0.42	0.95 1.12 1.17 1.08 1.04 1.06 1.08 1.09 1.11 1.05 1.09 1.10 1.05 1.03 0.87 0.85 0.98 0.97	542 658 707 652 511 431 410 484 423 371 373 438 302 366 509 462 641 583	$\begin{array}{c} 0.38\\ 0.35\\ 0.41\\ 0.20\\ 0.19\\ 0.33\\ 0.27\\ 0.51\\ 0.31\\ 0.42\\ 0.35\\ 0.13\\ 0.18\\ 0.19\\ 0.17\\ 0.13\\ 0.11\\ \end{array}$	339 366 470 451 274 275 313 311 300 259 308 314 467 371 255 202 371 337	11 7 4 10 10 8 10 12 11 13 7 11 10 10 12 11 10	0.2 0.2 0.3 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2	$\begin{array}{c} 0.2 \\ 0.2 \\ 0.3 \\ 0.1 \\ 0.1 \\ 0.1 \\ 0.1 \\ 0.1 \\ 0.1 \\ 0.1 \\ 0.3 \\ 0.3 \\ 0.1 \\ <.1 \\ <.1 \\ 0.1 \end{array}$	6 8 10 9 10 7 8 8 8 5 6 7 8 10 6 9 9 9	116 170 207 168 114 102 115 117 111 93 115 120 109 123 132 121 136 127	87 94 102 94 55 56 70 72 66 63 82 84 74 80 74 80 74 70 107 104	16.2 17.3 19.3 18.1 16.2 15.9 16.8 17.2 17.6 16.5 17.2 16.7 19.5 17.8 14.0 12.9 15.6 16.8	19 21 20 21 22 22 20 21 24 22 25 24 18 16 20 20	226 276 240 243 500 444 441 449 391 367 322 339 439 439 439 487 329 316 397 350	$\begin{array}{c} 1.4 \\ 1.5 \\ 5.0 \\ 5.6 \\ 1.5 \\ 0.6 \\ 0.6 \\ 0.3 \\ 0.4 \\ 0.5 \\ 0.4 \\ 0.4 \\ 0.6 \\ 0.6 \\ 1.0 \\ 1.1 \end{array}$	55 67 70 73 67 64 67 74 55 66 68 65 84 59 53 70 61	27.3 29.7 24.7 25.7 17.4 20.5 20.1 18.8 15.9 15.8 16.3 17.5 15.4 14.7 22.3 25.4 55.3 73.0	$\begin{array}{c} 0.2 \\ 0.2 \\ 0.3 \\ 0.1 \\ 0.1 \\ 0.2 \\ 0.1 \\ 0.1 \\ 0.1 \\ 0.1 \\ 0.1 \\ 0.2 \\ 0.1 \\ 0.1 \\ 0.2 \\ 0.3 \\ \end{array}$	20 20.9 24.8 23.1 19 18.6 20.9 21.7 21.6 20.2 22.1 22.1 23.4 23.8 17.2 15.6 20.8 22.2	205 178 284 247 142 118 150 143 172 163 166 191 151 183 129 94 163 154	3.0 3.1 3.7 3.5 2.7 2.6 2.9 3.1 3.1 3.1 3.2 3.2 3.2 3.2 2.4 2.4 3.0 3.3	$\begin{array}{c} 0.3 \\ 0.4 \\ 0.4 \\ 0.3 \\ 0.3 \\ 0.3 \\ 0.5 \\ 0.4 \\ 0.4 \\ 0.4 \\ 0.4 \\ 0.4 \\ 0.3 \\ 0.2 \\ 0.3 \\ 0.3 \\ 0.3 \end{array}$	$\begin{array}{c} 1.2 \\ 1.2 \\ 1.5 \\ 1.3 \\ 0.6 \\ 0.7 \\ 0.8 \\ 0.7 \\ 0.7 \\ 0.7 \\ 0.8 \\ 0.9 \\ 0.6 \\ 0.7 \\ 0.7 \\ 0.7 \\ 1.7 \\ 1.9 \end{array}$	139 158 182 164 122 113 128 131 127 118 134 138 137 141 122 112 154 136	114 134 141 122 166 178 130 147 119 96 114 129 139 150 137 165 124 108
676 T 676 S 677 T 678 t 678 S 679 T 679 S 680 S 680 S 681 T 681 S 682 683 684 T 684 S 685 T 685 S 686 t 686 t	1.33 0.79 0.72 0.92 2.11 2.03 2.25 1.90 3.30 2.73 3.14 2.97 3.34 1.17 0.68 0.40 0.37 1.81 1.72	2.16 2.69 2.57 2.48 4.26 3.63 3.31 3.37 3.10 2.32 2.73 2.66 3.00 3.26 3.00 3.26 3.07 2.81 3.02 2.47 3.09 2.78	0.97 1.12 1.10 1.08 1.30 1.10 1.08 1.14 1.11 1.02 1.11 1.12 1.11 1.12 1.11 1.16 0.94 0.91 0.98 0.95 1.02 1.01	0.74 0.74 0.86 0.75 0.33 0.47 0.50 0.48 0.51 0.50 0.47 0.12 0.10 0.38 0.43 0.44 0.42 0.27 0.26	0.95 1.12 1.17 1.08 1.04 1.06 1.08 1.09 1.11 1.05 1.09 1.10 1.05 1.09 1.10 1.05 1.03 0.87 0.85 0.98 0.97 0.88 0.95	542 658 707 652 511 431 410 484 423 371 373 438 302 366 509 462 641 583 427 337	0.38 0.35 0.41 0.20 0.19 0.33 0.27 0.51 0.31 0.42 0.35 0.13 0.18 0.19 0.17 0.13 0.11 0.16 0.15	339 366 470 451 274 275 313 311 300 259 308 314 467 371 255 202 371 337 223 221	11 7 4 10 10 8 10 12 11 13 7 11 10 10 12 11 10 10 11	0.2 0.2 0.3 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2	0.2 0.2 0.3 0.3 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1	6 8 10 9 10 7 8 8 8 5 6 7 8 10 6 9 9 7 6	116 170 207 168 114 102 115 117 111 93 115 120 109 123 132 121 136 127 87 87	87 94 102 94 55 56 70 72 66 63 82 84 74 80 74 80 74 107 107 104 49 55	16.2 17.3 19.3 18.1 16.2 15.9 16.8 17.2 17.6 16.5 17.2 16.7 19.5 17.8 14.0 12.9 15.6 16.8 15.2 14.9	19   21   20   21   22   22   20   21   22   20   21   24   25   24   25   24   25   24   20   21   24   25   24   25   24   18   16   20   21   23	226 276 240 243 500 444 441 367 322 339 439 439 439 439 316 397 350 354 328	$\begin{array}{c} 1.4\\ 1.5\\ 5.0\\ 5.6\\ 1.5\\ 0.6\\ 0.6\\ 0.6\\ 0.3\\ 0.3\\ 0.4\\ 0.6\\ 0.4\\ 0.6\\ 1.0\\ 1.1\\ 0.5\\ 0.4\end{array}$	55 67 76 70 73 67 64 67 74 55 66 68 65 84 59 53 70 61 57 57	27.3 29.7 24.7 25.7 17.4 20.5 20.1 <b>18.8</b> 15.9 15.8 16.3 17.5 15.4 14.7 22.3 25.4 55.3 73.0 31.5 20.0	0.2 0.2 0.2 0.3 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1	20 20.9 24.8 23.1 19 18.6 20.9 21.7 21.6 20.2 22.1 23.4 23.8 17.2 15.6 20.2 20.8 21.7 21.6 23.8 17.2 15.6 20.2 21.5 15.6 20.9 21.7 21.8 21.8 20.9 21.7 21.6 20.8 20.7 21.7 21.6 20.8 20.7 21.7 21.6 20.8 20.7 21.7 21.6 20.8 20.7 21.7 21.7 21.7 21.6 20.8 20.7 21.7 21.7 20.8 20.7 20.7 20.7 20.7 20.7 20.7 20.7 20.7	205 178 284 247 142 118 150 143 172 163 166 191 151 151 183 129 94 163 154 125 112	3.0 3.1 3.7 3.5 2.7 2.6 2.9 3.1 3.1 3.1 3.1 3.2 3.2 2.4 2.4 4 3.0 3.3 2.8 2.8 2.6	$\begin{array}{c} 0.3 \\ 0.4 \\ 0.4 \\ 0.3 \\ 0.3 \\ 0.3 \\ 0.3 \\ 0.5 \\ 0.4 \\ 0.3 \\ 0.4 \\ 0.4 \\ 0.4 \\ 0.4 \\ 0.3 \\ 0.2 \\ 0.3 \\ 0.3 \\ 0.3 \\ 0.3 \end{array}$	$\begin{array}{c} 1.2\\ 1.2\\ 1.5\\ 1.3\\ 0.6\\ 0.7\\ 0.8\\ 0.7\\ 0.7\\ 0.7\\ 0.7\\ 0.7\\ 0.7\\ 0.7\\ 0.7$	139 158 182 164 122 113 128 131 127 118 134 134 138 137 141 122 112 154 136 95 94	114 134 141 122 166 178 130 147 119 96 114 129 139 150 137 165 124 108 134
676 T 676 S 677 T 678 t 678 S 679 T 679 T 680 T 680 S 681 T 681 S 682 T 683 684 T 684 S 685 T 685 T 685 S 686 t 686 S	1.33 0.79 0.72 2.11 2.03 2.25 1.90 3.30 3.59 2.73 3.14 2.97 3.34 1.17 0.68 0.40 0.40 0.47 1.81 1.72	2.16 2.69 2.57 2.48 4.26 3.63 3.31 3.37 3.10 2.32 2.73 2.66 3.00 3.26 3.00 3.26 3.07 2.81 3.02 2.47 3.09 2.78 Hg all	0.97 1.12 1.10 1.08 1.30 1.10 1.08 1.14 1.11 1.02 1.11 1.12 1.11 1.12 1.11 1.16 0.94 0.91 0.98 0.95 1.02 1.01 values lo	0.74 0.74 0.75 0.33 0.33 0.47 0.50 0.47 0.50 0.47 0.12 0.10 0.38 0.43 0.44 0.44 0.44 0.27 0.26	0.95 1.12 1.17 1.08 1.04 1.04 1.04 1.09 1.10 1.05 1.09 1.10 1.05 1.09 1.10 0.87 0.88 0.98 0.98 0.98 0.98 0.98 0.98	542 658 707 652 511 431 410 484 423 371 373 438 302 366 509 462 641 583 427 337	0.38 0.35 0.41 0.41 0.20 0.19 0.33 0.27 0.51 0.31 0.42 0.35 0.13 0.13 0.13 0.13 0.14 0.17 0.13 0.11 0.15	339 366 470 451 274 275 313 311 300 259 308 314 467 371 255 202 202 371 337 223 221 Se only	11 7 7 4 10 10 8 10 12 11 13 7 11 10 10 12 11 10 10 11 11	0.2 0.2 0.3 0.3 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2	0.2 0.2 0.3 0.3 <.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0	6 8 10 9 10 7 8 8 8 8 8 8 5 6 7 8 8 10 6 6 9 9 7 6 9 9 7 6	116 170 207 168 114 102 115 117 111 93 115 120 109 123 132 121 136 127 87 87	87 94 102 94 55 56 70 72 66 63 82 84 74 80 74 70 107 104 49 55	16.2 17.3 19.3 18.1 16.2 15.9 16.8 17.2 16.6 16.5 17.2 16.7 19.5 17.8 14.0 12.9 15.6 16.8 15.2 14.9	19 21 20 21 22 22 20 21 24 22 25 24 18 16 20 20 21 23	226 276 240 243 500 444 441 367 322 339 439 439 439 316 329 316 350 354 328	$\begin{array}{c} 1.4 \\ 1.5 \\ 5.0 \\ 5.6 \\ 1.5 \\ 0.6 \\ 0.6 \\ 0.3 \\ 0.4 \\ 0.5 \\ 0.4 \\ 0.6 \\ 0.6 \\ 1.0 \\ 1.1 \\ 0.5 \\ 0.4 \\ 0.4 \\ 0.5 \\ 0.4 \\ 0.4 \\ 0.5 \\ 0.4 \\ 0.4 \\ 0.5 \\ 0.4 \\ 0.4 \\ 0.5 \\ 0.4 \\ 0.4 \\ 0.5 \\ 0.4 \\ 0.4 \\ 0.5 \\ 0.4 \\ 0.4 \\ 0.5 \\ 0.4 \\ 0.4 \\ 0.5 \\ 0.4 \\ 0.4 \\ 0.5 \\ 0.4 \\ 0.4 \\ 0.5 \\ 0.4 \\ 0.4 \\ 0.4 \\ 0.4 \\ 0.5 \\ 0.4 \\ 0.4 \\ 0.4 \\ 0.5 \\ 0.4 \\ 0.4 \\ 0.4 \\ 0.5 \\ 0.4 \\$	55 67 76 70 73 67 64 67 74 55 66 68 65 84 59 53 70 61 57 57	27.3 29.7 24.7 25.7 17.4 20.5 20.1 18.8 16.3 17.5 15.4 14.7 22.3 73.0 31.5 20.0	0.2 0.2 0.2 0.3 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1	20 20.9 24.8 23.1 19 18.6 20.9 21.7 21.6 20.2 22.1 23.4 23.8 17.2 15.6 20.8 22.2 17.5 18.5	205 178 284 247 142 118 150 143 172 163 166 191 151 183 129 94 163 154 125 112	3.0 3.1 3.7 3.5 2.7 2.6 2.9 3.1 3.1 3.1 3.2 3.2 2.4 2.4 3.0 3.3 2.8 2.6	$\begin{array}{c} 0.3 \\ 0.3 \\ 0.4 \\ 0.4 \\ 0.3 \\ 0.3 \\ 0.3 \\ 0.3 \\ 0.5 \\ 0.4 \\ 0.3 \\ 0.4 \\ 0.4 \\ 0.4 \\ 0.4 \\ 0.3 \\ 0.2 \\ 0.3 \\$	$\begin{array}{c} 1.2 \\ 1.2 \\ 1.5 \\ 1.3 \\ 0.6 \\ 0.7 \\ 0.8 \\ 0.7 \\ 0.7 \\ 0.7 \\ 0.7 \\ 0.8 \\ 0.9 \\ 0.6 \\ 0.7 \\ 0.7 \\ 0.7 \\ 0.7 \\ 0.7 \\ 0.7 \\ 0.7 \\ 0.7 \\ 0.6 \\ 0.6 \\ 0.6 \\ \end{array}$	139 158 182 164 122 113 128 131 127 118 134 137 134 137 141 122 154 136 95 94	114 134 141 122 166 178 130 147 119 96 114 129 139 150 137 165 137 165 137 165 134 124 108 134 141
676 T 676 S 677 T 678 t 678 S 679 T 680 T 680 S 681 T 681 S 682 683 684 T 684 S 685 S 685 S 685 S 686 t 685 S	1.33 0.79 0.72 0.92 2.11 2.03 2.25 1.90 3.30 3.59 2.73 3.34 1.17 0.68 0.40 0.37 1.81 1.72	2.16 2.69 2.57 2.48 4.26 3.63 3.31 3.37 2.66 3.00 3.26 3.00 3.26 3.00 2.81 3.02 2.81 3.02 2.81 3.02 2.73 4.81 3.02 2.78 Hg all	0.97 1.12 1.10 1.08 1.30 1.10 1.08 1.10 1.08 1.11 1.12 1.11 1.12 1.11 1.12 1.11 1.12 1.11 0.94 0.95 1.02 1.01 values le	0.74 0.74 0.86 0.75 0.33 0.47 0.50 0.48 0.51 0.50 0.47 0.50 0.48 0.51 0.40 0.44 0.42 0.27 0.27 0.28 than	0.95 1.12 1.17 1.08 1.04 1.08 1.09 1.11 1.05 1.09 1.10 1.05 1.09 1.10 1.05 1.03 0.87 0.98 0.97 0.98 0.97 20 ppb K.	542 658 707 652 511 431 410 484 423 371 373 366 509 462 641 583 427 337	0.38 0.35 0.41 0.41 0.20 0.20 0.19 0.33 0.27 0.51 0.33 0.42 0.35 0.42 0.35 0.13 0.13 0.13 0.11 0.15 8 8 5	339 366 470 451 274 313 311 300 259 308 314 467 371 255 202 371 337 223 356 only Ba	11 7 4 10 10 8 10 12 11 13 7 11 10 10 12 11 10 10 12 11 10 10 12 11 1 7 8 8 7 7 4 8 8 7 8 7 8 7 8 7 8 7 8 8 8 8	0.2 0.2 0.3 0.3 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2	0.2 0.2 0.3 0.3 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.3 0.3 0.3 0.3 0.1 <.1 0.1 v.1 0.1 v.1 0.1 0.1 0.1 0.3 0.3 v.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0	6 8 10 9 10 7 8 8 8 8 8 8 8 8 8 8 5 6 7 8 10 6 6 9 9 9 7 6 9 9 7 6 7 7 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8	116 170 207 168 114 102 115 117 111 93 115 120 09 123 121 136 127 87 87 Cr	87 94 102 94 55 56 70 72 66 63 82 84 74 80 74 70 107 104 49 55	16.2 17.3 19.3 18.1 16.2 15.9 16.8 17.2 17.6 16.5 17.2 16.7 17.2 16.7 17.8 14.0 12.9 15.6 16.8 15.2 14.9	19 21 21 20 21 22 22 20 21 24 22 25 24 18 16 20 20 21 23 24 23	226 276 240 243 500 444 441 449 391 367 322 339 439 439 439 316 329 316 350 354 328 Mn	1.4 1.5 5.0 5.6 1.5 0.6 0.6 0.6 0.3 0.3 0.4 0.5 0.4 0.4 0.4 0.6 0.6 1.0 1.1 1.0 5 0.4 0.4 0.4 0.4 0.4 0.4 0.4 0.4 0.4 0.4	55 67 76 70 73 67 64 67 74 55 66 68 84 59 53 70 61 57 57 Ni	27.3 29.7 24.7 25.7 17.4 20.5 20.1 18.8 15.9 15.8 16.3 17.5 15.4 14.7 22.3 25.4 55.3 73.0 31.5 20.0 Pb	0.2 0.2 0.2 0.3 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1	20 20.9 24.8 23.1 19 18.6 20.9 21.7 21.6 20.2 22.1 23.4 17.2 15.6 20.8 23.8 17.2 15.6 20.8 22.2 17.5 18.5	205 178 284 247 142 118 150 143 172 163 166 191 151 151 151 129 94 163 154 125 112 Sr	3.0 3.1 3.7 3.5 2.7 2.6 2.9 3.1 3.1 3.1 3.1 3.2 3.2 2.4 2.4 2.4 3.0 3.3 2.8 2.6 Th	0.3 0.3 0.4 0.4 0.3 0.3 0.3 0.3 0.5 0.4 0.4 0.4 0.4 0.4 0.4 0.4 0.4 0.3 0.2 0.3 0.3 0.3 0.3 0.3 0.3	1.2 1.2 1.5 1.3 0.6 0.7 0.7 0.7 0.7 0.7 0.7 0.7 0.7 0.7 0.7	139 158 182 164 122 113 128 131 127 141 138 134 138 137 141 122 154 136 95 94	114 134 141 122 166 178 130 147 119 96 114 129 139 130 137 165 124 108 134 141 224 228
676 T 676 T 677 T 677 T 677 S 678 t 678 t 679 S 680 T 680 S 681 T 681 S 682 T 683 684 T 684 S 685 T 685 S 686 t 685 S 686 t 685 S	1.33 0.79 0.72 0.92 2.11 2.03 3.25 1.90 3.30 3.59 2.73 3.34 1.17 0.68 0.40 0.37 1.81 1.72	2.16 2.69 2.57 2.48 4.26 3.63 3.31 3.37 2.66 3.00 3.26 3.00 2.81 3.02 2.47 3.02 2.47 3.02 2.47 3.02 2.47 3.02 2.47 3.02 2.47 3.02 2.47 4.81 4.84 4.84 4.84 5.85 2.55 2.55 2.55 2.55 2.55 2.55 2.55	0.97 1.12 1.10 1.08 1.30 1.10 1.08 1.10 1.08 1.11 1.12 1.11 1.12 1.11 1.12 1.11 1.12 0.94 0.94 0.95 1.02 1.09 0.94 0.94 0.95 1.02 1.01 0.94 0.95 1.02 1.01 0.94 0.95 1.02 1.01 0.94 0.95 1.02 1.01 0.98 0.94 0.95 0.02 0.02 0.04 0.94	0.74 0.74 0.75 0.75 0.33 0.47 0.50 0.47 0.50 0.47 0.12 0.10 0.48 0.48 0.43 0.44 0.42 0.27 50 0.44 0.42 0.26 53 st han 54 0.42 0.26 55 55 that 56 55 that 56 56 57 56 56 57 56 56 57 56 57 56 56 57 56 56 57 56 56 57 56 56 56 56 56 56 56 56 56 56 56 56 56	0.95 1.12 1.17 1.08 1.04 1.06 1.09 1.11 1.05 1.09 1.10 1.05 1.09 1.00 1.05 1.03 0.87 0.98 0.97 0.95	542 658 707 652 511 431 410 484 423 371 373 438 302 366 641 583 427 337 P	$\begin{array}{c} 0.38\\ 0.35\\ 0.41\\ 0.41\\ 0.20\\ 0.19\\ 0.30\\ 0.51\\ 0.31\\ 0.31\\ 0.31\\ 0.35\\ 0.13\\ 0.13\\ 0.13\\ 0.13\\ 0.13\\ 0.13\\ 0.11\\ 0.16\\ 0.15\\ \end{array}$	339 366 470 451 274 275 313 311 300 259 308 314 467 371 337 223 255 202 371 337 225 202 371 337 223 221 Se only	11 7 4 10 10 8 10 8 10 12 11 13 7 11 10 10 12 11 10 10 12 11 10 10 12 11 1 0 0 0 0	0.2 0.2 0.3 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2	0.2 0.2 0.3 0.3 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1	6 8 10 9 10 7 8 8 8 8 8 5 6 7 8 8 10 6 6 9 9 9 7 6 9 9 7 6 0 7 7 8 7 8 7 7 8 8 7 7 8 8 7 7 8 8 7 7 8 8 8 8 8 8 8 8 8 8 8 8 7 7 7 7 7 8	116 170 207 168 114 112 115 117 111 119 120 109 123 132 121 136 127 87 87 Cr ppm	87 94 102 94 55 56 70 72 66 63 82 84 74 80 74 74 70 107 107 104 49 55	16.2 17.3 19.3 18.1 16.2 15.9 16.8 17.2 17.6 16.5 17.2 17.6 16.5 17.2 17.6 17.2 17.6 19.5 17.8 14.0 12.9 15.6 16.8 15.2 14.9 <b>Ga</b> ppm	19 21 20 21 22 22 20 21 24 22 25 24 24 22 25 24 18 16 20 20 21 23	226 276 240 243 500 444 441 449 391 367 322 339 439 437 329 316 397 350 354 328 Mn ppm	1.4 1.5 5.0 5.6 0.6 0.6 0.6 0.3 0.3 0.4 0.4 0.4 0.4 0.6 0.4 0.4 0.6 0.4 0.5 0.4 0.5 0.4 0.5 0.4 0.5 0.4 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5	55 67 76 70 73 67 64 67 74 55 66 68 65 84 59 53 70 61 57 57 Ni ppm	27.3 29.7 24.7 25.7 20.5 20.1 17.4 20.5 20.1 18.8 15.9 15.8 16.3 17.5 15.4 14.7 22.3 22.3 22.3 23.4 55.3 73.0 31.5 20.0 Pb	0.2 0.2 0.2 0.3 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.2 0.1 0.1 0.2 0.1 0.1 0.2 0.1 0.1 0.2 0.3 0.2 0.2 0.3 0.1 0.1 0.1 0.1 0.1 0.2 0.2 0.3 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1	20 20.9 24.8 23.1 19 18.6 20.9 21.7 21.6 20.2 22.1 22.1 22.1 22.1 23.4 23.4 23.8 17.2 15.6 20.8 22.2 17.5 18.5	205 178 284 247 142 163 166 191 151 183 129 94 163 154 125 112 Sr ppm	3.0 3.1 3.7 3.5 2.7 2.6 2.9 3.1 3.1 3.1 3.1 3.2 2.2 2.4 2.4 3.0 3.3 2.2 2.4 2.4 2.4 3.0 3.3 2.8 2.6	0.3 0.3 0.4 0.4 0.3 0.3 0.3 0.3 0.3 0.4 0.4 0.4 0.4 0.4 0.4 0.4 0.3 0.2 0.3 0.3 0.3 0.3 10.3 0.3	1.2 1.2 1.5 1.3 0.6 0.7 0.7 0.7 0.8 0.7 0.7 0.7 0.9 0.6 0.7 0.7 1.7 1.9 0.6 0.6 0.6	139 158 182 164 122 113 128 131 127 118 134 137 141 122 154 136 95 94	114 134 141 122 166 178 130 147 119 96 114 129 150 137 165 124 108 134 141 22n ppm
676 T 677 S 677 S 677 S 678 L 678 S 678 T 679 S 680 S 680 S 681 T 681 S 682 S 684 T 684 S 685 S	1.33 0.79 0.72 0.92 2.11 2.03 2.25 1.90 3.30 3.59 2.73 3.14 2.97 3.34 1.17 0.68 0.40 0.37 1.81 1.72 Ca % ith 1.33	2.16 2.69 2.57 2.48 4.26 3.63 3.31 2.32 2.73 2.73 2.73 2.73 2.73 3.00 3.26 3.00 2.81 3.02 2.47 8.02 2.47 Hg all Fe % 2.16 6 2.69 2.59 2.48 4.26 5.25 7.25 7.48 4.26 7.25 7.25 7.48 4.26 7.25 7.25 7.25 7.48 4.26 7.25 7.25 7.25 7.25 7.25 7.25 7.25 7.25	0.97 1.12 1.10 1.08 1.30 1.10 1.08 1.30 1.10 1.01 1.11 1.12 1.11 1.12 1.11 1.12 0.94 0.95 1.02 1.09 0.98 0.95 1.02 1.02 1.02 1.02 1.02 1.02 1.02 1.03 0.98 1.03 1.14 1.11 1.12 1.12 1.14 1.12 1.14 1.12 1.12 1.14 1.12 1.14 1.12 1.12 1.14 1.12 1.12 1.12 1.14 1.12 1.12 1.14 1.12 1.14 1.12 1.12 1.12 1.12 1.12 1.12 1.12 1.12 1.12 1.12 1.12 1.12 1.14 1.14 1.12	0.74 0.74 0.75 0.75 0.33 0.47 0.50 0.48 0.48 0.48 0.48 0.48 0.48 0.48 0.4	0.95 1.12 1.17 1.08 1.04 1.06 1.09 1.10 1.05 1.09 1.10 1.05 1.09 1.03 0.87 0.85 0.98 0.97 0.85 0.98 0.97 0.85 0.98 K % 0.95 1.12 0.12 1.12 1.12 1.12 1.12 1.12 1.12 1.12 1.12 1.12 1.12 1.12 1.12 1.12 1.12 1.04 1.04 1.04 1.04 1.05 1.09 1.10 1.05 1.03 0.87 0.85 0.98 0.97 0.85 0.98 0.97 0.85 0.98 0.95 0.98 0.95 0.98 0.95 0.98 0.95 0.95 1.12 1.12 1.12 1.13 1.03 1.03 0.87 0.85 0.98 0.95 1.04 1.05 1.05 1.03 0.87 0.98 0.95 1.05	542 658 707 652 511 431 410 484 423 371 373 438 302 540 641 583 337 P ppm	0.38 0.35 0.41 0.41 0.20 0.20 0.19 0.33 0.27 0.51 0.31 0.42 0.35 0.13 0.14 0.19 0.17 0.13 0.19 0.17 0.13 0.11 0.15 0.15 0.12 0.13 0.11 0.12 0.14 0.20 0.20 0.20 0.20 0.20 0.21 0.21 0.21	339 366 470 451 274 275 313 311 300 259 308 314 467 371 371 233 252 202 371 337 233 221 Se only Ba ppm 339	111 7 4 10 10 8 10 12 11 13 7 11 10 10 12 11 10 10 12 11 10 10 10 11 11 10 10 12 11 11 0 10 12 11 13 7 11 10 10 8 8 10 10 12 11 10 10 12 11 10 10 12 11 10 10 12 11 10 10 10 10 12 11 10 10 10 10 12 11 10 10 10 10 10 10 10 10 10 10 10 10	0.2 0.2 0.3 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2	0.2 0.2 0.3 0.3 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1	6 8 10 9 10 7 8 8 8 8 5 6 7 8 8 8 8 5 6 7 8 8 10 6 6 9 9 9 7 6 7 8 0 7 6 6 9 9 9 9 7 6 6 7 8 8 8 8 5 5 6 7 9 10 7 7 8 8 8 8 5 5 7 9 10 7 7 8 8 8 8 5 5 7 8 8 8 8 5 5 7 8 8 8 8	116 170 207 168 114 112 115 117 111 93 115 120 109 93 123 123 122 121 136 127 87 87 Cr ppm	87 94 102 94 55 56 70 72 66 63 82 84 74 80 74 74 70 107 107 104 49 55	16.2 17.3 19.3 18.1 16.2 15.9 16.8 17.2 17.6 16.5 17.2 16.5 17.2 16.5 17.2 16.5 17.2 16.5 17.2 16.5 17.2 16.5 17.6 14.0 12.9 15.6 6 6.8 15.9 14.9 15.9 14.9 15.9 14.9 15.9 14.9 15.9 14.9 15.9 14.9 15.9 14.9 15.9 14.9 15.9 14.9 15.9 14.9 15.9 16.2 17.6 16.2 17.6 16.2 17.6 16.5 17.2 17.6 16.5 17.2 17.6 16.5 17.2 17.6 16.5 17.2 17.6 16.5 17.2 17.6 17.5 17.2 17.6 17.2 17.6 17.2 17.6 17.2 17.6 17.2 17.6 17.2 17.6 17.2 17.6 17.2 17.6 17.2 17.6 17.2 17.6 17.2 17.6 17.2 17.6 17.2 17.6 17.2 17.6 17.2 17.6 17.2 17.6 17.2 17.6 17.9 17.6 17.2 17.6 17.9 17.6 16.5 17.2 17.6 17.2 17.6 17.2 17.6 17.2 17.6 17.2 17.6 17.2 17.6 17.2 17.6 17.2 17.6 17.2 17.6 17.2 17.6 17.2 17.6 17.2 17.6 17.2 17.6 17.2 17.6 17.6 17.2 17.6 17.6 17.2 17.6 17.6 17.2 17.6 17.6 17.2 17.6 17.6 17.2 17.6 17.8 17.6 17.2 17.6 17.8 17.6 17.2 17.6 17.2 17.6 17.8 17.6 17.8 17.2 17.6 17.8 17.2 17.7 17.8 17.2 17.7 17.8 17.2 17.7 17.8 17.2 17.7 17.7 17.7 17.7 17.7 17.7 17.7	19 21 20 21 22 22 20 21 24 22 25 24 18 16 20 21 23 20 21 23 21 23 21 24 22 25 24 18 16 20 20 21 21 22 22 22 22 22 22 20 21 21 22 22 22 22 22 22 22 22 22 22 22	226 276 240 243 500 444 441 449 391 367 322 339 439 439 316 397 320 316 397 350 354 328 Mn ppm	1.4 1.5 5.0 5.6 0.6 0.6 0.6 0.3 0.3 0.4 0.5 0.4 0.4 0.6 0.4 0.4 0.6 0.4 0.5 0.4 1.1 0.5 0.4	55 67 76 73 67 64 67 467 467 467 467 55 66 68 84 59 53 70 61 57 57 87 87 87 87 87 87 87 87 87 87 87 87 87	27.3 29.7 24.7 25.7 25.7 20.1 17.4 20.5 20.1 18.8 16.3 17.5 15.8 16.3 17.5 15.4 14.7 22.3 25.4 25.3 73.0 31.5 20.0 9 Pb ppm 27.3 29.7	0.2 0.2 0.2 0.3 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1	20 20.9 24.8 23.1 19 18.6 20.9 21.7 21.6 20.2 22.1 22.1 23.4 23.8 20.2 21.7 23.4 23.8 20.8 20.2 21.7 21.5 6 20.8 20.9 20.8 20.9 20 20 20 20 20 20 20 20 20 20 20 20 20	205 178 284 247 142 118 150 143 172 163 166 3 166 3 161 183 129 94 163 154 125 112 <b>Sr</b> ppm	3.0 3.1 3.7 3.5 2.7 2.6 2.9 3.1 3.1 3.1 3.2 3.2 3.2 2.4 2.4 2.4 3.3 3.3 2.8 2.6 Th ppm	0.3 0.3 0.4 0.4 0.3 0.3 0.3 0.3 0.3 0.4 0.4 0.4 0.4 0.4 0.4 0.3 0.2 0.3 0.3 0.3 0.3 0.4 0.4 0.4 0.4 0.3 0.4 0.4 0.4 0.4 0.3 0.4 0.4 0.3 0.5 0.4 0.4 0.3 0.5 0.5 0.4 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5	1.2 1.2 1.5 1.3 0.6 0.7 0.7 0.7 0.8 0.7 0.7 0.7 0.7 0.7 0.7 0.7 0.7 0.7 0.7	139 158 182 164 122 113 128 131 127 118 134 138 137 141 122 154 136 95 94 V ppm	114 134 141 122 166 178 130 147 19 96 114 129 139 150 0 147 137 165 124 108 134 141 141 141
676 T 677 S 677 S 677 S 678 L 678 S 678 T 679 S 680 S 681 T 681 S 682 S 684 T 684 S 685 S 685 S 685 S 685 S 685 S 685 S 685 S 685 S 686 S 5 686 S 5 687 T 676 T 677 S 677 T 676 S 677 T 676 S 677 T 677 S 677 S 677 S 678 S 677 S 67	1.33 0.79 0.72 0.92 2.11 2.03 2.25 1.90 2.73 3.34 2.97 3.34 2.97 3.34 1.17 0.68 0.40 0.37 1.81 1.72 Ca % 0.79 0.72	2.16 2.69 2.57 2.48 4.26 3.63 3.31 2.32 2.73 2.73 2.73 3.00 3.26 3.00 3.26 3.00 2.81 3.02 2.47 3.02 2.47 Hg all Fe & % 2.78 2.78 2.78 2.78 2.78 2.78 2.78 2.78	0.97 1.12 1.10 1.08 1.30 1.08 1.30 1.08 1.30 1.08 1.30 1.08 1.01 1.02 1.11 1.12 1.11 1.12 1.11 1.12 1.11 1.12 1.11 1.12 1.11 1.12 1.11 1.12 1.11 1.12 1.11 1.12 1.11 1.12 1.12 1.12 1.02 1.03 1.02 1.12 1.12 1.12 1.03 1.03 1.04 1.04 1.02 1.12 1.11 1.12 1.11 1.12 1.11 1.12 1.09 1.09 1.09 1.09 1.09 1.00 1.09 1.00 1.00 1.00 1.01 1.02 1.02 1	0.74 0.74 0.86 0.75 0.33 0.33 0.47 0.50 0.50 0.48 0.51 0.50 0.48 0.42 0.42 0.42 0.44 0.42 0.26 css than Na 9 0.74 0.74 0.86	0.95 1.12 1.17 1.08 1.04 1.06 1.09 1.01 1.05 1.03 0.87 0.95 20 ppb K % 0.95 1.12 1.17	542 658 652 511 431 410 484 423 371 373 366 509 462 641 583 427 337 P ppm 542 658	$\begin{array}{c} 0.38\\ 0.35\\ 0.41\\ 0.20\\ 0.19\\ 0.31\\ 0.27\\ 0.51\\ 0.31\\ 0.42\\ 0.35\\ 0.13\\ 0.18\\ 0.19\\ 0.17\\ 0.16\\ 0.15\\ \hline \\ 8\\ \%\\ 0.35\\ 0.35\\ 0.41\\ \hline \end{array}$	339 366 470 451 274 275 313 311 325 202 371 337 223 221 Se only Ba ppm 339 366 470	111 7 4 10 10 8 10 12 11 13 7 11 10 10 10 10 10 11 10 10 11 10 10 11 11	0.2 0.2 0.3 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2	0.2 0.2 0.3 (-1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.	6 8 10 9 10 7 8 8 8 8 8 8 8 8 8 8 7 8 10 6 6 9 9 7 6 7 8 7 6 9 9 7 6 8 10 7 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8	116 170 207 168 114 102 115 117 111 93 115 120 109 123 132 121 136 127 87 87 87 87 87 116 170 207	87 94 102 55 56 70 72 66 63 82 84 74 70 107 104 49 55 55 Cu ppm 87 94 102	16.2 17.3 19.3 18.1 16.2 15.9 16.8 17.2 17.6 16.5 17.2 16.7 17.8 16.5 17.2 16.7 17.8 15.0 12.9 15.6 16.8 15.2 14.9 15.2 14.9 16.2 17.3 19.3	19 21 20 21 22 22 20 21 24 22 25 24 18 16 20 20 21 23 20 21 24 22 25 24 18 16 20 21 22 22 20 21 24 22 22 20 21 24 22 25 24 25 24 25 24 25 24 25 24 25 25 26 27 26 27 27 26 27 27 26 27 27 27 27 27 27 27 27 27 27	226 276 240 500 444 441 367 322 339 439 439 439 439 439 316 332 339 3350 350 354 328 Mn ppm 226 6 276 240	1.4 1.5 5.0 5.6 0.6 0.6 0.6 0.3 0.4 0.4 0.4 0.4 0.4 0.4 0.4 0.4	55 67 76 73 67 64 67 64 67 4 74 55 66 68 65 84 59 53 70 61 57 57 77 87 76	27.3 29.7 24.7 25.7 17.4 20.5 20.1 17.4 20.5 20.1 18.8 16.3 17.5 15.4 16.3 17.5 15.4 16.3 17.5 22.3 25.4 25.3 73.0 31.5 20.0 21.7 20.0 21.7 20.7 29.7 29.7 29.7 29.7 29.7 29.7 29.7 29	0.2 0.2 0.2 0.3 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1	20 20.9 24.8 23.1 19 18.6 20.9 21.7 21.6 20.2 22.1 23.4 23.8 20.2 22.1 17.2 15.6 20.8 22.2 17.5 18.5 Sc ppm 20.9 20.9 20.9 20.9 20.9 20.9 20.9 20.9	205 178 284 247 142 118 150 143 163 166 191 151 183 166 191 151 183 154 163 154 152 112 Sr ppm 205 Sr 778 284	3.0 3.1 3.7 3.5 2.7 2.6 2.9 3.1 3.1 3.1 3.2 3.2 2.4 2.4 3.0 3.3 2.8 2.4 2.4 3.0 3.3 2.8 2.4 2.4 3.0 3.3 2.8 2.4 3.1 3.1 3.1 3.1 3.1 3.1 3.1 3.1	0.3 0.3 0.4 0.4 0.3 0.3 0.3 0.3 0.5 0.4 0.4 0.4 0.4 0.4 0.4 0.4 0.3 0.3 0.3 0.3 0.3 0.3 0.3 0.3 0.3 0.3	1.2 1.2 1.5 1.3 0.6 0.7 0.8 0.7 0.7 0.7 0.7 0.7 0.7 0.7 0.7 0.7 0.7	139 158 182 164 122 113 128 131 127 141 134 134 134 134 134 134 134	114 134 141 122 166 178 130 147 119 96 114 129 150 137 165 124 108 134 134 141
676 T 677 S 677 S 677 S 678 L 678 S 678 T 679 S 680 S 680 S 681 T 681 S 682 S 684 T 684 S 685 S 685 S 685 S 686 S 568 S 56	1.33 0.79 0.72 0.92 2.11 2.03 1.90 3.30 3.59 2.73 3.34 2.97 3.34 2.97 3.34 2.97 3.34 1.17 0.68 0.68 0.68 0.40 0.37 1.81 1.72 0.68 0.40 0.72 0.92 2.11 1.72 0.72 2.75 1.90 3.74 2.97 3.74 2.97 3.74 2.97 3.74 2.97 3.74 2.97 3.74 2.97 3.74 2.97 3.74 2.97 3.74 2.97 3.74 2.97 3.74 2.97 3.74 2.97 3.74 3.74 3.74 3.74 3.74 3.74 3.74 3.7	2.16 2.69 2.57 2.48 4.26 3.63 3.31 3.37 2.66 3.00 2.81 3.02 2.73 2.66 3.00 2.81 3.02 2.81 3.02 2.47 3.09 2.78 Hg all Fe % 2.47 2.47 3.09 2.57 2.48 4.24 3.09 2.57 2.48 4.24 3.00 2.57 2.48 4.24 3.00 2.57 2.48 4.24 3.01 2.57 2.48 4.24 3.01 2.57 2.48 4.24 3.01 3.01 2.57 2.48 3.01 3.01 2.57 2.48 3.01 3.01 2.52 2.73 2.66 3.00 2.73 2.66 3.00 2.73 2.66 3.00 2.57 2.48 3.00 2.57 2.48 3.00 2.57 2.73 3.00 2.73 3.00 2.73 3.00 2.48 3.00 2.57 3.00 2.57 3.00 2.57 3.00 2.57 3.00 2.57 3.00 2.57 3.00 2.57 3.00 2.57 3.00 2.57 3.00 2.57 3.00 2.57 3.00 2.57 3.00 2.57 3.00 2.57 3.00 2.57 3.00 2.57 3.00 2.57 3.00 2.57 3.00 2.48 3.00 2.48 3.00 2.48 3.00 2.48 3.00 2.48 3.00 2.48 3.00 2.48 3.00 2.48 3.00 2.47 3.44 3.44 3.44 3.44 3.44 3.44 3.44 3	0.97 1.12 1.10 1.08 1.30 1.10 1.08 1.10 1.11 1.12 1.11 1.12 1.11 1.12 1.11 1.12 1.11 1.12 0.94 0.94 0.95 1.02 1.01 values lc Mg 0.97 1.12 1.10 0.97 1.12 1.10 0.97	0.74 0.74 0.86 0.75 0.33 0.43 0.51 0.50 0.48 0.51 0.40 0.47 0.42 0.42 0.44 0.42 0.26 Sss than Na 9%	0.95 1.12 1.17 1.08 1.04 1.06 1.09 1.11 1.05 1.09 1.11 1.05 1.03 0.85 0.98 0.97 0.98 0.97 0.98 0.97 K % 0.95 1.12 1.17 1.08 1.17 1.08 1.04 1.04 1.04 1.04 1.04 1.05 1.03 1.03 1.03 1.03 1.04 1.05 1.03 1.05 1.03 1.05 1.03 1.05 1.03 1.05 1.03 1.05 1.03 1.05 1.03 1.05 1.03 1.05 1.03 1.05 1.03 1.05 1.03 1.05 1.03 1.05 1.03 1.05 1.11 1.05 1.03 1.05 1.11 1.05 1.03 1.05 1.03 1.05 1.03 1.05 1.11 1.15 1.03 1.05 1.11 1.15 1.13 1.05 1.13 1.15 1.13 1.15 1.13 1.15 1.13 1.15 1.13 1.15 1.13 1.15 1.13 1.15 1.13 1.15 1.13 1.15 1.13 1.15 1.11 1.15 1.13 1.15 1.13 1.15 1.13 1.15 1.13 1.15 1.17 1.17 1.17 1.17 1.16 1.17 1.17 1.16 1.17 1.17 1.16 1.17 1.16 1.17 1.16 1.17 1.16 1.17 1.16 1.17 1.16 1.17 1.16 1.17 1.16 1.17 1.16 1.17 1.16 1.17 1.16 1.16 1.17 1.16 1.16 1.17 1.16 1.16 1.17 1.16 1.16 1.16 1.16 1.17 1.16 1.17 1.16 1.16 1.17 1.17 1.17 1.17 1.17 1.17 1	542 658 707 652 511 431 410 410 484 423 371 373 302 366 509 9 2366 641 583 427 337 9 ppm 542 658 707 552	0.38 0.35 0.41 0.20 0.19 0.27 0.51 0.31 0.42 0.35 0.13 0.13 0.13 0.14 0.15 S % 0.35 0.13 0.15	339 366 470 451 274 451 274 275 313 300 259 308 314 467 371 225 303 314 467 371 202 301 304 467 314 467 303 304 467 304 304 204 304 304 304 205 308 309 309 308 307 307 307 307 307 307 307 307	111 7 4 10 10 8 10 12 11 13 7 11 10 10 12 11 11 10 10 10 12 11 11 0 10 12 11 17 7 4 4 10 7 7 4 4 10	0.2 0.2 0.3 0.3 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2	0.2 0.2 0.3 (.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0	6 8 10 9 10 7 8 8 8 8 8 8 8 5 6 7 8 10 6 9 9 9 7 6 20 9 9 7 6 20 9 9 9 7 6 8 8 10 7 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8	116 170 207 168 114 102 115 117 117 111 93 115 120 109 123 132 121 136 127 87 87 87 87 116 120 120 121 136 127 187 87	87 94 102 55 56 70 72 66 63 82 84 74 80 74 70 107 104 49 55 <b>Cu</b> ppm <b>87</b> 94 102 94 55	16.2 17.3 19.3 18.1 16.2 15.9 16.8 17.2 17.6 16.5 17.2 17.6 16.5 17.8 14.0 12.9 15.6 16.8 15.2 14.9 15.6 16.8 15.2 14.9 16.2 17.3 18.1 19.3 18.1 19.3	19 21 21 22 22 22 20 21 24 22 24 24 24 24 24 25 24 18 16 20 20 21 23 21 23 21 23 21 23 22 23 23 23 23 23 23 23 23 23 23 23	226 276 240 500 444 441 350 444 441 367 322 439 439 439 439 439 439 439 316 350 354 328 Mn ppm 226 6276 240 252 250 243 354 354 350 354 350 354 350 354 350 350 444 444 445 367 367 350 350 445 367 367 367 367 367 367 367 367 367 367	1.4 1.5 5.0 5.6 0.6 0.6 0.6 0.3 0.3 0.4 0.4 0.6 0.6 0.4 0.6 0.6 1.0 0.4 0.4 0.5 0.4 1.1 0.5 0.4 1.1 0.5 0.4 1.1 0.5 0.4 1.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0	55 67 76 70 73 67 64 77 455 66 65 84 55 66 65 84 59 53 70 61 57 77 77 77 77 77 77 77 77 77 77 77 77	27.3 29.7 24.7 17.4 20.5 20.1 18.8 16.3 15.9 15.8 16.3 15.4 14.7 22.3 73.0 31.5 20.0 15.4 14.7 22.3 73.0 31.5 20.0 20.7 22.7 7 20.7 20.7 7 20.7 20.7	0.2 0.2 0.2 0.3 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1	20 20.9 24.8 19 18.6 20.9 21.7 21.6 20.2 22.1 12.2 15.6 20.8 22.2 17.5 18.5 8 c ppm 20 20.9 20.9 20.9 20.9 20.9 20.9 20.9 2	205 178 284 247 142 118 150 143 163 166 191 151 163 166 191 151 183 129 94 163 154 125 112 8r ppm 205 8r 284 225 178	3.0 3.1 3.7 3.5 2.7 2.6 2.9 3.1 3.1 3.1 3.2 2.4 2.4 3.0 3.2 2.4 2.4 3.0 3.2 2.4 2.4 3.0 3.2 2.4 3.2 3.2 2.4 3.1 3.1 3.2 3.2 2.4 3.1 3.1 3.2 3.2 2.4 3.2 3.2 3.2 3.2 3.2 3.2 3.2 3.2	0.3 0.3 0.4 0.4 0.3 0.3 0.3 0.3 0.5 0.4 0.4 0.4 0.4 0.4 0.4 0.4 0.2 0.3 0.3 0.3 0.3 0.3 0.3 0.3 0.3 0.4 0.4 0.4 0.4 0.4 0.4 0.4 0.4 0.4 0.5 0.5 0.4 0.5 0.5 0.5 0.4 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5	1.2 1.2 1.5 1.3 0.6 0.7 0.8 0.7 0.7 0.7 0.7 0.7 0.7 0.7 0.7 0.7 0.7	139 158 182 164 122 113 128 131 127 138 134 138 134 134 134 134 134 134 135 94 V ppm 139 158 182 164 122 113 128 131 127 138 137 141 122 113 128 137 141 129 138 137 141 129 138 137 141 129 138 137 141 129 138 137 141 129 138 137 141 138 137 141 138 138 137 141 138 138 138 137 141 138 138 138 138 138 138 138 13	114 134 141 122 166 178 130 96 114 147 119 96 114 129 139 150 137 165 124 108 134 141 141 141 134
676 T 677 S 677 S 677 S 678 L 678 S 679 T 679 S 680 S 681 T 681 S 682 S 684 T 684 S 685 S 685 S 685 S 685 S 686 S 5 686 S 5 686 S 5 687 T 688 S 688 S 688 S 688 S 688 S 687 T 688 S 688 S	1.33 0.79 0.72 0.92 2.11 2.03 1.90 3.30 3.59 2.73 3.34 1.17 3.34 0.68 0.68 0.68 0.68 0.68 0.68 0.40 0.37 1.81 1.72 2.75 1.90 0.72 0.72 0.72 0.72 0.72 0.72 0.72 0.7	$\begin{array}{c} 2.16\\ 2.69\\ 3.63\\ 3.63\\ 3.31\\ 3.37\\ 3.10\\ 2.32\\ 2.73\\ 2.66\\ 3.07\\ 2.81\\ 3.02\\ 2.73\\ 3.02\\ 2.73\\ 3.02\\ 2.73\\ 3.02\\ 2.73\\ 3.02\\ 2.78\\ Hg all\\ \hline Fe\\ \frac{9}{2.57}\\ 2.48\\ 4.26\\ 3.63\\ 3.6$	0.97 1.12 1.10 1.08 1.30 1.10 1.08 1.14 1.11 1.02 1.01 1.11 1.12 1.11 1.12 1.11 1.12 1.11 1.12 0.94 0.95 1.02 1.01 Wg 0.95 1.02 1.01 0.95 1.02 1.01 0.95 1.02 1.00 1.02 1.01 0.95 1.02 1.01 0.05 1.02 1.01 0.05 1.02 1.01 0.05 1.00 0.05 1.02 1.01 0.05 1.02 1.01 1.01 1.01 1.01 1.01 1.01 1.01	0.74 0.74 0.86 0.75 0.33 0.47 0.50 0.48 0.51 0.50 0.48 0.47 0.12 0.10 0.48 0.42 0.42 0.26 0.26 ss than Na 96 0.74 0.74 0.74 0.26 0.26 0.26 0.42 0.26 0.42 0.26 0.44 0.42 0.26 0.26 0.44 0.42 0.26 0.44 0.44 0.45 0.45 0.45 0.45 0.45 0.45	0.95 1.12 1.17 1.08 1.04 1.06 1.09 1.11 1.05 1.09 1.11 1.05 1.03 0.87 0.98 0.97 0.98 0.97 0.95 20 ppb K % 0.95 1.12 1.17 1.17 1.08 1.12 1.17 1.12 1.12 1.12 1.12 1.14 1.04 1.04 1.04 1.04 1.04 1.04 1.04 1.04 1.04 1.04 1.05 1.09 1.09 1.01 1.05 1.03 0.87 0.98 0.97 0.95 1.12 1.17 1.17 1.12 1.12 1.12 1.12 1.12 1.13 1.05 1.03 1.09 1.11 1.05 1.03 0.85 0.95 1.12 1.17 1.12	542 658 707 652 511 431 441 444 423 371 438 302 464 333 306 650 9 462 641 333 9 P P P P P P P P P P P P P P P P P	$\begin{array}{c} 0.38\\ 0.35\\ 0.41\\ 0.20\\ 0.41\\ 0.20\\ 0.51\\ 0.33\\ 0.27\\ 0.51\\ 0.33\\ 0.27\\ 0.51\\ 0.35\\ 0.42\\ 0.35\\ 0.41\\ 0.16\\ 0.15\\ \hline \end{array}$	339 366 470 451 274 451 275 313 300 259 308 467 371 225 303 314 467 371 202 371 337 223 221 Se only Ba ppm 339 366 470 451 274 275 221 221 221 221 221 221 221 22	11 7 7 4 10 10 8 10 12 11 13 7 11 10 10 12 11 10 10 11 10 10 11 10 10 11 17 7 4 10 7 10 10 10 10 10 8 8 9 9 9 10 10 10 10 10 10 10 10 10 10 10 10 10	0.2 0.2 0.3 0.3 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2	0.2 0.2 0.3 0.3 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.3 0.3 0.3 0.1 <.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.3 0.3 0.3 0.3 0.3 0.3 0.3 0.3 0.3 0.3	6 8 9 10 7 8 8 8 8 5 6 6 7 8 8 10 6 6 9 9 7 6 6 9 9 7 6 0 9 7 6 8 8 10 7 6 8 10 7 7 8 8 8 8 8 7 7 8 8 8 8 8 7 8 8 8 8	116 170 207 168 114 102 115 117 117 111 93 115 120 109 123 132 121 136 127 87 87 87 87 116 127 87 116 120 121 136 127 187 87 116	87 94 102 94 55 56 66 63 82 84 74 80 74 80 74 80 74 107 104 49 55 56 87 94 102 94 55 56	16.2 17.3 19.3 18.1 16.2 15.9 16.8 17.2 17.6 16.5 17.2 17.6 16.5 17.2 17.6 16.7 17.8 14.0 12.9 15.6 16.8 15.2 14.9 16.2 17.3 19.3 18.1 16.2 15.9	19 21 21 22 22 22 22 20 21 24 22 24 24 22 24 18 16 20 20 21 23 21 23 21 23 21 23 21 23 21 21 21 21 22 22 22 22 22 22 22 22 22	226 276 240 500 444 441 449 391 367 322 339 439 316 329 316 350 350 354 328 <b>Mn</b> ppm 226 266 240 243 500	1.4 1.5 5.0 5.6 1.5 0.6 0.6 0.6 0.3 0.3 0.4 0.4 0.4 0.4 0.4 0.6 0.4 0.4 0.4 0.4 0.4 0.4 0.4 0.4	55 67 76 70 73 67 64 55 66 67 74 55 66 65 84 59 53 70 61 57 57 57 76 77 67 76 70 3 35 67 73 67	27.3 29.7 24.7 17.4 20.5 20.1 18.8 16.3 15.9 15.8 16.3 15.4 14.7 22.3 73.0 31.5 20.0 Pb ppm 27.3 29.7 24.7 24.7 24.7 25.4	0.2 0.2 0.2 0.3 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1	20 20.9 24.8 19 18.6 20.9 21.7 21.6 20.2 22.1 12.2 15.6 20.8 22.2 17.5 18.5 20.8 20.8 20.8 20.8 20.8 20.9 20.9 20.9 20.9 20.9 20.9 20.9 20.9	205 178 284 247 142 150 143 151 151 151 151 154 163 154 154 125 112 205 178 205 178 284 284 247 142 118	3.0 3.1 3.7 2.6 2.9 3.1 3.1 3.1 3.1 3.2 3.2 2.4 3.0 3.3 2.8 2.6 Th ppm 3.0 3.1 3.7 3.5 5.2,7 2.6 2.9 3.1 3.1 3.2 2.2 4 3.0 5 3.2 2.4 5 3.2 2.2 3.2 2.2 3.2 2.2 3.2 3.2 3.2 3.2	0.3 0.3 0.4 0.4 0.3 0.3 0.3 0.3 0.4 0.3 0.4 0.4 0.4 0.4 0.4 0.4 0.3 0.2 0.3 0.3 0.3 0.3 0.3 0.3 0.3 0.3 0.3 0.3	1.2 1.2 1.5 1.3 0.6 0.7 0.7 0.7 0.7 0.7 0.7 0.7 0.7 0.7 0.7	139 158 182 164 122 113 128 131 127 118 137 141 136 95 94 V ppm 139 158 182 164 122 113 127 18 18 18 19 19 19 19 19 19 19 19 19 19	114 134 141 122 166 178 130 147 119 96 114 129 139 150 137 165 124 108 134 141 141 141 141 122 2n ppm
676 T 677 S 677 S 677 S 678 L 678 S 679 T 679 S 680 S 681 T 681 S 682 S 684 T 684 S 685 S 685 S 685 S 685 S 685 S 685 S 687 T 677 T 677 S 678 L 677 T 678 S 677 T 677 S 678 C 678 S 677 T 677 S 678 C 678 S 677 T 677 S 678 C 678 S 677 T 677 S 678 C 678 S 678 C 678 C 679 C 678 C 679 C 679 C 679 C 677 C 678 C 678 C 679 C 679 C 677 C 678 C 678 C 679 C 679 C 679 C 677 C 678 C 679 C 679 C 679 C 677 C 678 C 679 C 679 C 679 C 678 C 679 C 678 C 679 C 679 C 679 C 679 C 678 C 679 C 679 C 679 C 679 C 678 C 679 C 67	1.33 0.79 0.72 2.092 2.11 2.03 3.59 3.30 3.59 3.34 1.17 3.34 1.17 2.73 3.34 0.68 0.68 0.68 0.68 0.68 0.68 0.67 0.672 0.72 0.72 0.72 0.72 0.72 0.72 0.72 0.	2.16 2.69 2.57 2.48 4.26 3.63 3.31 3.37 2.66 3.00 2.81 3.02 2.73 2.66 3.00 2.81 3.02 2.81 3.02 2.81 3.02 2.47 3.09 2.78 Hg all Fe % 9.2.57 2.48 4.26 3.01 2.31 2.47 2.47 3.09 2.57 2.48 4.26 3.01 2.32 3.01 2.32 2.47 2.48 3.02 2.47 2.48 4.26 3.01 2.32 2.47 2.48 3.02 2.47 2.48 3.02 3.02 2.48 3.02 3.02 2.48 3.02 2.48 3.02 3.02 2.48 3.02 2.48 3.02 2.48 3.02 4.47 3.09 2.48 3.02 4.47 3.09 2.48 3.02 4.47 3.09 2.48 3.02 4.47 3.09 2.48 3.02 4.47 3.09 2.47 3.24 3.24 3.24 3.24 3.24 3.24 3.24 3.24	0.97 1.12 1.10 1.08 1.30 1.10 1.08 1.30 1.11 1.12 1.11 1.12 1.11 1.12 1.11 1.12 1.11 1.12 0.94 0.95 1.02 1.01 Values le 0.95 1.02 1.01 Values le 0.95 1.02 Values le 0.95 1.02 Values le 0.95 1.02 Values le 0.95 1.02 Values le 0.95 1.02 Values le 0.95 1.02 Values le 0.95 1.02 Values le 0.95 1.02 Values le 0.95 Values le 0.95 Values le 0.95 1.02 Values le 0.95 Values le 0.95 V	0.74 0.74 0.86 0.86 0.75 0.33 0.33 0.47 0.50 0.47 0.50 0.47 0.50 0.40 0.51 0.50 0.42 0.20 0.42 0.22 0.22 0.22 0.42 0.4	$\begin{array}{c} 0.95\\ 1.12\\ 1.17\\ 1.08\\ 1.04\\ 1.06\\ 1.08\\ 1.09\\ 1.11\\ 1.05\\ 1.09\\ 1.11\\ 1.05\\ 1.09\\ 1.10\\ 1.05\\ 0.88\\ 0.95\\ 0.98\\ 0.95\\ 0.97\\ 0.88\\ 0.95\\ 0.97\\ 0.88\\ 0.95\\ 1.12\\ 1.17\\ 1.08\\ 1.12\\ 1.17\\ 1.08\\ 1.12\\ 1.17\\ 1.08\\ 1.04\\ 1.06\\ 1.08\\ 1.04\\ 1.06\\ 1.08\\ 1.06\\ 1.08\\ 1.06\\ 1.08\\ 1.06\\ 1.08\\ 1.06\\ 1.08\\$	542 658 707 652 511 431 441 444 423 371 438 302 464 433 306 6509 462 641 337 337 583 3427 337 583 427 337 583 427 337	$\begin{array}{c} 0.38\\ 0.35\\ 0.41\\ 0.41\\ 0.20\\ 0.41\\ 0.20\\ 0.51\\ 0.33\\ 0.27\\ 0.51\\ 0.33\\ 0.27\\ 0.51\\ 0.35\\ 0.42\\ 0.35\\ 0.41\\ 0.16\\ 0.15\\ \hline \end{array}$	339 366 470 451 274 275 313 311 300 259 308 314 467 225 202 223 221 8 8 e only 337 223 221 8 8 e only 451 255 202 223 221 337 223 221 337 223 221 223 221 223 221 223 221 223 223	11 7 7 4 10 10 8 10 12 11 13 7 11 10 10 12 11 10 10 11 10 10 11 11 7 7 4 4 10 10 8 8 ppm	0.2 0.2 0.3 0.3 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2	0.2 0.2 0.3 0.3 0.3 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.3 0.3 0.3 0.3 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.3 0.3 0.3 0.3 0.3 0.3 0.3 0.3 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1	6 8 9 10 7 8 8 8 5 6 7 8 8 10 6 6 9 9 7 6 9 9 7 6 9 9 7 6 8 8 7 6 8 10 9 9 7 6 6 8 10 7 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8	116 170 207 168 114 102 115 117 117 111 119 123 121 136 123 121 132 121 136 87 87 87 87 87 87 116 87 127 117 117 117	87 94 102 94 55 56 67 66 63 82 72 66 63 82 74 80 74 87 70 107 104 49 55 55 87 94 102 94 102 94 55 56 70	16.2 17.3 19.3 19.3 18.1 16.2 15.9 16.8 17.2 17.6 16.5 17.2 16.7 19.5 16.7 17.8 15.2 14.0 12.9 15.6 15.2 14.9 16.8 15.2 14.9 16.8 15.2 17.3 18.1 16.8 15.2 17.3 18.3 18.1 16.8 15.2 17.3 18.3 18.1 16.8 15.2 17.3 18.3 18.1 16.8 15.2 17.3 18.3 16.8 15.2 17.3 16.8 15.2 17.3 15.2 17.3 16.8 15.2 17.3 15.2 17.3 15.2 17.3 15.2 17.3 15.2 17.3 15.2 17.3 15.2 17.3 15.2 17.3 15.2 17.3 15.2 17.3 15.2 17.3 15.2 17.3 15.2 17.3 15.2 17.3 15.2 17.3 15.2 17.3 15.2 17.3 15.2 17.3 17.3 15.2 17.3 15.2 17.3 18.1 16.8 15.2 17.3 17.3 18.1 16.8 15.2 17.3 17.3 18.3 17.3 18.3 17.3 18.3 18.3 17.3 18.3 17.3 18.3 17.3 18.3 17.3 18.3 18.3 17.3 18.3 17.3 18.3 18.3 17.3 18.3 17.3 18.3 18.3 17.3 18.3 17.3 18.3 17.3 18.3 17.3 18.3 17.3 18.3 17.3 18.3 17.3 18.3 17.3 18.3 17.3 17.3 17.3 18.3 17.3 17.3 17.3 17.3 17.3 17.3 17.3 17	19 21 21 22 22 22 22 20 21 24 24 22 24 18 16 20 21 23 24 18 16 20 21 23 24 12 22 24 25 24 12 25 24 26 27 27 26 27 27 27 27 27 27 27 27 27 27	226 276 240 500 444 441 449 391 367 322 339 439 316 329 316 350 354 328 <b>Mn</b> ppm 226 626 240 243 554 328	1.4 1.5 5.0 5.6 1.5 0.6 0.6 0.3 0.3 0.4 0.4 0.4 0.4 0.6 1.0 1.1 0.5 0.4 1.0 1.1 1.0 0.5 5.0 0.4 0.4 0.4 0.4 0.4 0.4 0.4 0.4 0.4 0	55 67 76 70 73 67 64 64 67 74 55 66 68 85 59 53 70 61 57 57 84 57 76 76 70 73 67 67 67 67 67	27.3 29.7 24.7 25.7 17.4 20.5 17.4 20.1 18.8 15.9 15.8 17.5 15.4 17.5 15.4 17.5 22.3 25.4 25.3 25.4 20.0 21.3 25.4 20.0 21.5 20.0 21.7 22.7 73.0 31.5 20.0 21.7 22.7 73.0 21.7 22.7 73.0 21.7 22.7 73.0 21.7 22.7 73.0 21.7 22.7 73.0 21.7 22.7 73.0 21.7 22.7 73.0 21.7 22.7 73.0 21.7 22.7 73.0 21.7 22.7 22.7 22.7 22.7 22.7 23.7 22.7 24.7 22.7 24.7 22.7 24.7 22.7 24.7 22.7 24.7 22.7 24.7 22.7 25.7 20.1 22.7 22.7 22.7 22.7 22.7 22.7 22.7 22	0.2 0.2 0.2 0.3 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.2 0.3 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2	20 20.9 24.8 23.1 19 18.6 20.9 21.7 21.6 20.2 21.1 22.1 22.1 22.1 22.1 23.4 23.8 21.7 21.5 18.5 20.9 20.9 20.9 20.9 20.9 20.9 20.9 20.9	205 178 284 247 142 150 143 150 143 172 163 166 191 151 151 151 154 163 154 163 154 125 112 205 178 284 284 247 217 8 178	3.0 3.1 3.7 2.6 2.7 2.6 2.9 3.1 3.1 3.1 3.1 3.2 3.2 2.4 3.0 3.3 2.8 2.6 Th ppm 3.0 3.1 3.7 3.5 2.7 2.6 2.9 3.1 3.1 3.2 2.2 4.3 0 3.3 3.2 2.2 2.4 5.5 3.2 3.2 3.2 3.2 3.2 3.2 3.2 3.2 3.2 3.2	0.3 0.3 0.4 0.4 0.3 0.3 0.3 0.3 0.3 0.4 0.4 0.4 0.4 0.4 0.4 0.4 0.3 0.2 0.3 0.3 0.3 0.3 0.3 0.3 0.3 0.3 0.3 0.3	1.2 1.2 1.5 1.3 0.6 0.7 0.7 0.7 0.7 0.7 0.7 0.7 0.7	139 158 182 164 122 113 128 131 127 118 137 141 138 137 141 138 137 141 138 137 141 122 154 136 95 94 V ppm 158 158 158 158 158 158 158 158	114 134 141 122 166 67 178 130 147 119 96 139 96 137 165 124 141 129 139 150 137 165 124 141 141 129 139 147 147 147 147 147 147 147 147 147 147
676 T f 677 S 677 S 677 S 678 L 678 S 679 T 679 S 680 S 681 T 681 S 682 S 684 T 684 S 685 S 687 T 677 S 677 T 677 S 678 L 678 S 678 L 678 S	$\begin{array}{c} 1.33\\ 0.79\\ 0.72\\ 0.92\\ 2.11\\ 2.03\\ 3.59\\ 2.25\\ 1.90\\ 3.30\\ 2.25\\ 1.90\\ 3.30\\ 3.59\\ 2.73\\ 3.14\\ 1.77\\ 0.68\\ 0.40\\ 0.37\\ 1.81\\ 1.72\\ \hline \\ \hline \\ \frac{C_a}{\gamma_b} \\ \frac{C_a}{\gamma_b} \\ 0.72\\ 0.92\\ 2.11\\ 2.03\\ 2.25\\ 1.90\\ 3.30\\ \hline \end{array}$	2.16 2.69 2.57 2.48 4.26 3.63 3.31 3.37 2.66 3.00 2.81 3.02 2.73 2.66 3.00 2.81 3.02 2.81 3.02 2.81 3.02 2.47 3.09 2.78 Hg all Fe % 9.2.57 2.48 4.26 3.31 3.02 2.57 2.48 3.03 3.02 2.57 2.48 4.26 3.03 3.02 2.57 2.48 3.02 2.57 2.48 4.26 3.03 3.02 2.57 2.48 3.02 2.57 2.48 4.26 3.02 2.57 2.48 3.02 2.57 2.48 3.02 2.57 2.48 3.02 2.57 2.48 3.02 2.57 2.48 3.02 2.57 2.48 3.02 2.57 2.48 3.02 2.57 2.48 3.02 2.57 2.48 3.02 2.57 3.02 3.02 3.02 3.02 3.02 3.02 3.02 3.02	0.97 1.12 1.10 1.08 1.30 1.10 1.08 1.14 1.11 1.02 1.01 1.14 1.11 1.12 1.11 1.12 1.11 1.12 1.11 1.12 0.94 0.95 1.02 1.01 Values le 0.95 1.02 1.01 Values le 0.97 1.12 1.01 Values le 0.97 1.12 1.01 Values le 0.97 1.12 1.01 1.03 Values le 0.97 1.12 1.01 1.03 Values le 0.97 1.12 1.01 1.03 1.03 1.03 1.03 1.03 1.03 1.03	0.74 0.74 0.86 0.86 0.75 0.33 0.33 0.47 0.50 0.47 0.50 0.47 0.50 0.48 0.43 0.44 0.42 0.26 0.42 0.22 0.22 0.22 0.42 0.42 0.42 0.42	$\begin{array}{c} 0.95\\ 1.12\\ 1.17\\ 1.08\\ 1.04\\ 1.06\\ 1.08\\ 1.09\\ 1.11\\ 1.05\\ 1.09\\ 1.11\\ 1.05\\ 0.87\\ 0.85\\ 0.95\\ 0.98\\ 0.95\\ 0.97\\ 0.88\\ 0.95\\ 0.97\\ 0.88\\ 0.95\\ 0.97\\ 1.12\\ 1.17\\ 1.08\\ 1.12\\ 1.17\\ 1.08\\ 1.04\\ 1.06\\ 1.08\\ 1.09\\ 1.11\\ 1.11\\ 1.01\\ 1.01\\ 0.08\\ 1.01\\$	542 658 652 511 431 441 444 423 371 438 302 464 433 306 6509 462 641 337 337 583 3427 337 583 427 337 583 427 583 427 583 427 337	$\begin{array}{c} 0.38\\ 0.35\\ 0.41\\ 0.41\\ 0.20\\ 0.41\\ 0.20\\ 0.51\\ 0.33\\ 0.27\\ 0.51\\ 0.33\\ 0.27\\ 0.51\\ 0.35\\ 0.42\\ 0.35\\ 0.41\\ 0.16\\ 0.15\\ \hline \end{array}$	339 366 470 451 274 275 313 311 300 259 308 314 467 225 202 223 221 8 8 e only 337 223 221 8 8 e only 451 275 337 223 221 337 223 221 337 337 223 221 223 221 233 314 467 467 255 202 259 202 314 207 467 205 209 209 209 209 209 209 209 209 209 209	11 7 7 4 10 10 8 10 12 11 13 7 11 10 10 12 11 10 10 11 10 10 11 11 7 7 4 4 10 10 8 8 ppm	0.2 0.2 0.3 0.3 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2	0.2 0.2 0.3 0.3 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1	6 8 9 10 7 8 8 8 5 6 7 8 8 9 9 7 6 6 9 9 7 6 7 8 8 7 6 7 8 8 10 9 9 7 6 8 10 7 7 8 8 8 8 7 8 8 8 8 7 8 8 8 8 8 8 7 8	116 170 207 168 114 102 115 117 117 111 132 120 109 123 132 121 136 127 87 87 87 87 87 87 116 127 170 170 120 171 187 187 171 114	87 94 102 94 55 56 63 82 84 74 74 80 07 107 107 107 104 49 55 56 70 94 102 94 102 94 55 56 70 25 66	16.2 17.3 19.3 19.3 18.1 16.2 15.9 16.8 17.2 16.6 17.2 16.7 17.8 17.2 16.7 17.8 15.0 12.9 15.6 15.2 14.0 15.2 14.9 15.2 14.9 16.8 15.2 14.9 16.8 15.2 14.9 16.8 15.2 17.3 18.1 16.8 15.2 17.3 18.3 18.1 16.8 15.2 17.3 18.3 18.1 16.8 15.2 17.3 18.3 18.1 16.8 15.2 17.3 15.2 17.3 18.3 17.3 18.3 17.3 18.1 16.8 17.3 17.5 17.5 17.5 17.5 17.5 17.5 17.5 17.5	19 21 20 21 22 20 21 24 22 22 23 24 18 16 20 20 21 24 25 24 18 16 20 20 21 21 22 22 22 22 22 22 22 22	226 276 240 441 441 449 391 367 322 339 439 316 329 316 350 354 328 <b>Mn</b> ppm 226 240 243 350 240 243 354 328	1.4 1.5 5.0 0.6 0.6 0.3 0.3 0.4 0.4 0.6 0.0 0.4 0.4 0.4 0.6 0.4 0.4 0.4 0.4 0.4 0.5 0.4 1.0 1.1 1.5 0.4 0.4 0.6 0.6 0.6 0.6 0.6 0.6 0.6 0.5 0.6 0.6 0.5 0.6 0.6 0.5 0.6 0.6 0.6 0.6 0.5 0.6 0.6 0.6 0.5 0.6 0.6 0.6 0.6 0.5 0.6 0.6 0.6 0.6 0.6 0.5 0.6 0.6 0.6 0.6 0.5 0.6 0.6 0.6 0.6 0.5 0.6 0.6 0.6 0.5 0.6 0.6 0.6 0.6 0.5 0.6 0.6 0.6 0.6 0.6 0.6 0.6 0.6 0.6 0.6	55 67 76 70 73 67 64 66 66 68 65 59 53 70 61 57 57 84 57 57 84 70 61 57 57 76 76 76 76 76 70 73 67 76 74 74 77 70 73 70 70 70 70 70 70 70 70 70 70 70 70 70	27.3 29.7 24.7 25.7 17.4 20.5 15.8 15.9 15.8 15.9 15.8 17.5 15.4 22.3 25.4 55.3 21.5 20.0 21.3 22.4 73.0 31.5 20.0 21.7 22.7 73.0 31.5 20.0 11.4 27.7 22.7 73.0 20.7 24.7 25.7 20.7 15.8 20.7 15.8 20.7 15.8 20.7 20.7 20.7 20.7 20.7 20.7 20.7 20.7	0.2 0.2 0.2 0.3 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1	20 20.9 24.8 23.1 19 18.6 20.9 21.7 21.6 20.2 21.1 22.1 22.1 22.1 23.4 23.8 20.8 21.7 21.6 20.8 21.7 21.5 18.5 20.9 20.9 20.9 20.9 20.9 20.9 20.9 20.9	205 178 284 142 118 150 143 172 163 172 163 166 191 151 151 154 125 112 205 5 r ppm 205 284 247 217 8 284 247 178 284 247 178 284 247 178 284 247 150 154 150 154 150 154 150 155 150 155 155 155 155 155 155 155	3.0 3.1 3.7 2.6 2.9 3.1 3.1 3.2 2.2 2.4 2.4 3.0 3.3 2.8 2.6 Th ppm 3.0 3.1 3.2 2.4 2.4 2.4 3.0 3.3 3.2 2.4 2.4 2.4 3.0 3.3 3.2 2.5 5.2 7 7 2.6 5.5 3.1 3.1 3.1 3.2 3.2 2.2 7 3.1 3.1 3.1 3.2 3.2 5.5 3.1 3.1 3.1 3.2 3.2 7 7 7 7 7 8 .2 9 9 3.1 3.1 3.2 7 7 7 7 8 .2 9 9 3.1 3.1 3.2 7 7 7 7 8 .2 9 9 3.1 3.1 3.2 7 7 7 7 8 .2 9 9 3.1 3.1 3.1 3.2 2.2 7 7 7 7 8 .2 9 9 3.1 3.1 3.1 3.2 2.2 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7	0.3 0.3 0.4 0.4 0.3 0.3 0.3 0.3 0.4 0.3 0.4 0.4 0.4 0.4 0.4 0.4 0.3 0.2 0.3 0.3 0.3 0.3 0.3 0.3 0.3 0.3 0.3 0.3	1.2 1.2 1.3 1.3 0.6 0.7 0.7 0.7 0.7 0.7 0.7 0.7 0.7 0.7 0.7	139 158 182 164 122 113 128 131 127 118 134 134 134 134 134 134 134 135 141 122 112 154 95 94 <b>V</b> <b>P</b> <b>P</b> <b>M</b> <b>V</b> <b>V</b> <b>P</b> <b>M</b> <b>M</b> <b>M</b> <b>M</b> <b>M</b> <b>M</b> <b>M</b> <b>M</b>	114 134 141 122 166 178 130 147 119 96 139 96 137 165 124 14 129 139 150 137 165 124 14 141 122 2npm 144 141 122 166 130 147 119 129 147 147 147 147 147 147 147 147 147 147
676 T 677 S 677 S 677 S 678 L 678 S 679 T 679 S 680 S 681 T 681 S 682 S 684 T 684 S 685 S 685 S 685 S 685 S 685 S 685 S 687 T 677 T 677 S 678 L 678 S 677 T 677 S 678 S 677 T 678 S 678 S 678 S 677 T 678 S 678 S 677 T 678 S 677 T 678 S 677 T 678 S 678 S 67	1.33 0.79 0.72 0.92 2.11 2.03 3.20 2.25 1.90 2.25 1.90 2.73 3.14 2.97 3.34 1.17 0.68 0.40 0.37 1.81 1.72 $\frac{C_{a}}{V_{a}}$ 0.72 0.92 2.11 2.03 2.25 1.90 0.37 1.81 1.72 $\frac{C_{a}}{V_{a}}$ 2.73 3.14 2.97 1.81 1.72 $\frac{C_{a}}{V_{a}}$ 2.73 3.14 2.97 1.81 1.72 $\frac{C_{a}}{V_{a}}$ 2.73 3.14 2.97 1.81 1.72 $\frac{C_{a}}{V_{a}}$ 2.73 3.14 2.97 1.81 1.72 $\frac{C_{a}}{V_{a}}$ 3.54 2.73 3.14 2.97 1.81 1.72 $\frac{C_{a}}{V_{a}}$ 3.54 2.73 3.14 2.97 1.81 1.72 $\frac{C_{a}}{V_{a}}$ 3.54 2.73 3.14 2.97 1.81 1.72 $\frac{C_{a}}{V_{a}}$ 3.54 2.97 3.34 1.72 $\frac{C_{a}}{V_{a}}$ 3.54 2.97 3.34 3.34 2.97 3.34 3.34 3.59 2.92 3.34 3.59 3.59 2.93 3.34 3.59 2.93 3.34 3.59 2.93 3.34 3.59 3.59 2.93 3.34 3.59 3.59 3.59 3.59 3.59 3.59 3.59 3.59	2.16 2.69 2.57 2.48 4.26 3.63 3.31 3.37 2.66 3.00 2.81 3.02 2.73 3.02 2.73 3.02 2.73 3.02 2.73 3.02 2.73 4.247 3.09 2.78 Hg all Fe % 9.257 2.48 4.26 3.31 3.02 2.77 2.48 3.02 2.77 2.48 3.02 2.77 2.48 3.02 2.77 2.48 3.02 2.77 2.77 2.48 3.02 2.77 2.77 2.77 2.77 2.77 2.77 3.02 2.77 2.77 3.02 2.77 3.02 2.77 2.77 3.02 2.78 4.47 3.02 2.77 2.27 3.02 2.77 2.27 3.02 2.77 2.27 3.02 2.77 3.277 2.2777 2.2777 2.2777 2.27777 2.277777777	0.97 1.12 1.10 1.08 1.30 1.10 1.08 1.14 1.11 1.02 1.01 1.14 1.11 1.12 1.11 1.12 1.11 1.12 1.11 1.12 0.94 0.95 1.02 1.01 Values le 0.95 1.02 1.01 Values le 0.95 1.02 1.01 Values le 0.95 1.02 1.01 Values le 0.95 1.02 1.01 Values le 0.95 1.02 1.01 Values le 0.95 1.02 1.01 Values le 0.95 1.02 1.01 Values le 0.95 1.02 1.01 Values le 0.95 1.02 1.01 Values le 1.01 Values le 0.95 1.02 1.01 Values le 0.97 1.12 1.01 1.03 Values le 0.97 1.12 1.01 Values le 0.112 Values le 0.112 Values le 0.111 Values le 0.1111 Values le 0.11111 Values le 0.1111 Values le 0.1	0.74 0.74 0.86 0.86 0.75 0.33 0.33 0.47 0.50 0.47 0.50 0.47 0.50 0.48 0.43 0.43 0.44 0.42 0.26 0.27 0.26 0.42 0.27 0.26 0.42 0.42 0.42 0.42 0.42 0.42 0.42 0.42	$\begin{array}{c} 0.95\\ 0.95\\ 1.12\\ 1.17\\ 1.08\\ 1.04\\ 1.06\\ 1.08\\ 1.09\\ 1.11\\ 1.05\\ 1.09\\ 1.11\\ 1.05\\ 0.88\\ 0.95\\ 0.98\\ 0.97\\ 0.88\\ 0.95\\ 0.97\\ 0.88\\ 0.95\\ 1.12\\ 1.07\\ 1.08\\ 1.12\\ 1.07\\ 1.08\\ 1.04\\ 1.06\\ 1.08\\ 1.09\\ 1.11\\ 1.05\\ 1.08\\ 1.04\\ 1.08\\ 1.04\\ 1.08\\ 1.09\\ 1.08\\$	542 658 652 511 431 441 444 423 371 438 302 464 433 306 6509 462 641 337 337 542 658 570 7652 658 707 652 511 410 484 423 337	$\begin{array}{c} 0.38\\ 0.35\\ 0.41\\ 0.41\\ 0.20\\ 0.41\\ 0.20\\ 0.51\\ 0.33\\ 0.27\\ 0.51\\ 0.33\\ 0.27\\ 0.51\\ 0.35\\ 0.42\\ 0.35\\ 0.41\\ 0.16\\ 0.15\\ \hline \end{array}$	339 366 470 451 274 275 313 311 300 259 308 314 467 225 202 23 311 255 202 223 221 8 8 e only 337 223 221 8 8 e only 451 255 202 259 202 337 223 221 23 337 223 221 23 337 223 221 23 337 223 221 23 337 223 221 23 337 223 221 23 337 223 221 23 337 223 221 23 337 223 221 23 337 223 221 23 337 223 221 23 337 223 221 223 221 223 221 223 221 223 221 223 221 223 221 223 221 223 221 223 221 223 221 223 221 223 221 223 221 223 221 223 221 223 221 223 221 233 337 223 221 233 337 223 221 233 337 223 221 233 223 22	11 7 7 4 10 10 10 12 11 13 7 11 10 10 12 11 10 10 10 11 10 10 10 11 10 10	0.2 0.2 0.3 0.3 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2	0.2 0.2 0.3 0.3 0.3 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1	6 8 9 10 7 8 8 8 8 5 6 6 7 8 8 10 6 6 9 9 7 6 9 9 7 6 9 9 7 6 8 8 10 7 8 8 10 7 8 8 10 7 8 8 8 5 5 6 6 7 8 8 8 8 5 7 8 8 8 8 8 8 7 8 8 8 8 8 8	116 170 207 168 114 102 115 117 111 117 113 120 109 123 121 132 121 132 121 132 123 123 123	87 94 102 94 55 56 63 82 84 74 74 80 07 107 107 107 104 49 55 56 70 94 102 94 102 94 55 56 60 382 82 82 82 82 82 82 82 82 82 82 82 82 8	16.2 17.3 19.3 19.3 18.1 16.2 15.9 16.8 17.2 17.6 16.5 17.2 16.7 17.8 15.0 12.9 15.6 15.2 14.0 12.9 15.6 15.2 14.9 15.2 14.9 16.8 15.2 14.9 16.8 15.2 17.3 18.1 16.8 15.2 17.3 18.3 18.1 16.8 15.2 17.3 18.3 18.1 16.8 15.2 17.3 18.3 18.1 16.8 15.2 17.3 18.3 17.3 18.3 17.3 18.3 17.3 18.3 17.3 18.3 17.3 18.3 17.3 18.3 17.3 18.3 17.3 18.3 17.3 18.3 17.3 18.3 17.3 18.3 17.3 18.3 17.3 18.3 17.3 18.3 17.3 18.3 17.3 18.3 17.3 18.3 18.3 17.3 18.3 18.3 17.3 18.3 18.3 17.3 18.3 17.3 18.3 17.3 18.3 18.3 17.3 18.3 18.3 18.3 18.3 18.3 18.3 18.3 17.3 18.3 18.3 17.3 18.3 18.3 17.3 18.3 18.3 18.3 17.3 18.3 18.3 18.3 17.3 18.3 18.3 18.3 18.3 17.3 18.3 18.3 17.3 18.3 18.3 17.3 18.3 18.3 17.3 18.3 17.3 18.3 17.3 18.3 17.3 18.3 17.3 18.3 17.3 18.3 17.3 17.3 17.3 17.3 17.3 17.3 17.3 17	19 21 20 21 22 20 21 24 22 25 24 18 16 20 20 21 23 24 19 21 21 23 24 25 24 25 24 20 21 22 22 22 22 22 22 22 22 22	226 276 240 441 449 391 367 322 339 439 316 329 316 350 350 354 328 <b>Mn</b> ppm 2266 240 243 350 240 243 354 328	1.4 1.5 5.0 5.6 1.5 0.6 0.6 0.6 0.3 0.3 0.4 0.5 0.4 0.6 0.0 0.4 0.5 0.4 1.1 0.5 0.4 1.5 0.5 0.4 1.5 0.6 0.6 0.6 0.6 0.6 0.6 0.6 0.6 0.6 0.6	55 67 76 70 73 67 64 66 67 74 55 66 68 84 59 53 70 61 57 57 87 87 76 76 70 73 67 67 76 76 76 76 76 76 67 76 76 70 84 70 84 70 70 70 70 70 70 70 70 70 70 70 70 70	27.3 29.7 24.7 25.7 17.4 20.5 15.8 15.9 15.8 15.9 15.8 17.5 15.4 22.3 25.4 25.3 25.4 25.3 20.0 27.3 20.0 27.3 20.7 24.7 25.7 73.0 31.5 20.0 15.8 20.0 15.8 20.7 20.7 21.7 25.7 20.7 20.7 20.7 20.7 20.7 20.7 20.7 20	0.2 0.2 0.2 0.3 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1	20 20.9 24.8 23.1 19 18.6 20.9 20.9 21.7 21.6 20.2 21.1 22.1 22.1 23.4 23.8 20.9 21.7 21.6 20.8 21.7 21.5 18.5 20.9 20.9 20.9 20.9 20.9 20.9 20.9 21.7 17.5 18.6 20.9 20.9 20.9 21.7 21.6 20.9 20.9 20.9 20.9 21.7 21.6 20.9 20.9 20.9 20.9 20.9 20.9 20.9 20.9	205 178 284 142 118 150 143 172 163 166 191 151 151 154 125 112 205 5 r ppm 205 278 284 247 142 284 247 148 284 247 148 284 247 148 284 247 158 159 154 159 154 159 159 159 159 159 159 159 159 159 159	3.0 3.1 3.7 3.5 2.7 2.6 2.9 3.1 3.1 3.1 3.2 2.2 2.4 2.4 2.4 3.0 3.3 2.8 2.6 Th ppm 3.1 3.1 3.2 2.4 2.4 2.4 3.0 3.3 3.2 2.4 2.4 2.4 3.0 3.3 3.2 2.5 7 7 7 6 6 6 9 9 9 9 9 9 9 1 1 3.1 3.1 3.2 2.2 7 7 7 6 6 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9	0.3 0.3 0.4 0.4 0.3 0.3 0.3 0.3 0.4 0.3 0.4 0.4 0.4 0.4 0.4 0.4 0.3 0.2 0.3 0.3 0.3 0.3 0.3 0.3 0.3 0.3 0.3 0.3	1.2 1.2 1.5 1.3 0.6 0.7 0.7 0.7 0.7 0.7 0.7 0.7 0.7 0.7 0.7	139 158 182 164 122 113 128 131 127 118 134 134 134 134 135 141 122 112 154 95 94 V ppm 159 158 132 134 136 134 134 135 134 134 134 135 134 134 135 134 136 136 137 138 137 141 138 137 141 138 137 141 138 137 141 138 137 141 138 137 141 138 137 141 138 136 137 141 138 136 137 141 136 136 136 136 136 136 136 13	114 134 141 122 166 178 130 147 119 96 139 144 129 139 150 137 165 124 14 129 139 150 137 165 124 141 129 139 141 141 129 150 137 165 124 141 129 150 147 147 147 147 147 147 147 147 147 147
676 T 677 S 677 S 677 S 678 L 678 S 679 T 679 S 680 S 681 T 681 S 682 S 684 T 684 S 685 S 685 S 685 S 685 S 685 S 685 S 685 S 685 S 687 T 677 T 677 S 678 L 678 L 678 S 677 T 677 S 678 L 678 S 677 T 677 S 678 L 678 S 677 T 677 S 678 L 678 S 677 T 678 S 678 L 678 S 678 T 678 S 678 S 67	1.33 0.79 0.72 0.92 2.11 2.03 3.20 2.25 1.90 2.25 1.90 2.73 3.14 2.97 3.34 1.17 0.68 0.40 0.37 1.81 1.72 $\frac{C_{a}}{V_{a}}$ 0.73 0.72 0.92 2.11 2.25 1.90 0.37 1.81 1.72 $\frac{C_{a}}{V_{a}}$ 2.73 3.14 2.97 1.81 1.72 $\frac{C_{a}}{V_{a}}$ 2.73 3.14 2.97 1.81 1.72 $\frac{C_{a}}{V_{a}}$ 2.73 3.34 1.17 0.68 0.37 1.81 1.72 0.72 0.72 0.72 2.11 1.72 0.73 3.34 1.72 0.72 0.72 0.72 0.72 0.72 2.73 3.34 1.77 0.72 0.72 0.72 0.72 0.72 0.73 3.34 1.77 0.72 0.72 0.72 0.72 0.73 3.34 1.77 0.72 0.72 0.72 0.72 0.73 3.34 1.77 0.72 0.72 0.72 0.72 0.72 0.72 0.72 0	2.16 2.69 2.57 2.48 4.26 3.63 3.31 3.37 2.66 3.00 2.81 3.02 2.73 3.02 2.73 3.02 2.73 3.02 2.73 3.02 2.73 3.02 2.73 3.02 2.73 3.02 2.78 Hg all Fe % 9.2.57 2.48 4.26 3.07 2.81 3.02 2.47 3.09 2.78 4.24 3.09 2.57 2.48 4.26 3.07 2.48 4.26 3.01 2.47 3.02 2.47 3.02 2.47 3.02 2.47 3.02 2.47 3.02 2.47 3.02 2.47 3.02 2.47 3.02 2.47 3.02 2.47 3.02 2.47 3.02 2.48 3.02 2.48 3.02 2.48 3.02 2.48 3.02 2.48 3.02 2.48 3.02 2.48 3.02 2.48 3.02 2.48 3.02 2.48 3.02 2.48 3.02 2.48 3.02 3.02 2.48 3.02 2.47 3.09 2.48 3.09 2.48 3.09 2.47 3.09 2.47 3.09 2.47 3.09 2.48 4.46 3.07 3.00 2.47 3.09 2.47 3.09 2.47 3.09 2.47 3.00 2.47 3.03 3.01 2.47 3.03 3.01 2.47 3.03 3.01 2.47 3.03 3.01 2.47 3.03 3.01 2.47 2.47 3.03 3.01 2.47 3.03 3.01 2.47 2.47 3.03 3.01 2.47 2.47 2.47 2.47 2.47 2.47 2.47 2.47	0.97 1.12 1.10 1.08 1.30 1.10 1.08 1.14 1.11 1.02 1.01 1.11 1.12 1.11 1.12 1.11 1.12 1.11 1.12 1.11 1.12 0.94 0.95 1.02 1.01 values le 0.95 1.02 1.01 Values le 0.97 1.12 1.01 Values le 1.01 Values le 1.01 Values le 1.01 Values le 1.01 Values le 1.01 Values le 1.01 Values le 1.02 Values	0.74 0.74 0.86 0.86 0.75 0.33 0.33 0.47 0.50 0.47 0.50 0.47 0.50 0.48 0.43 0.44 0.42 0.26 0.27 0.26 0.42 0.22 0.22 0.42 0.42 0.42 0.42 0.42	$\begin{array}{c} 0.95\\ 1.12\\ 1.17\\ 1.08\\ 1.04\\ 1.06\\ 1.09\\ 1.11\\ 1.05\\ 1.09\\ 1.11\\ 1.05\\ 1.09\\ 1.10\\ 1.05\\ 1.09\\ 1.10\\ 1.05\\ 1.12\\ 1.07\\ 1.08\\ 1.04\\ 1.06\\ 1.08\\ 1.09\\ 1.11\\ 1.05\\ 1.09\\ 1.11\\ 1.05\\ 1.09\\ 1.11\\ 1.05\\ 1.09\\ 1.11\\ 1.05\\ 1.09\\ 1.11\\ 1.05\\ 1.09\\ 1.11\\ 1.05\\ 1.09\\ 1.11\\ 1.05\\ 1.09\\ 1.09\\ 1.09\\ 1.09\\ 1.00\\$	542 658 652 511 431 441 444 423 371 373 438 302 464 433 376 509 462 641 337 337 542 658 570 7652 551 511 410 484 423 337	$\begin{array}{c} 0.38\\ 0.35\\ 0.41\\ 0.20\\ 0.41\\ 0.20\\ 0.51\\ 0.33\\ 0.27\\ 0.51\\ 0.33\\ 0.27\\ 0.51\\ 0.35\\ 0.42\\ 0.35\\ 0.41\\ 0.16\\ 0.15\\ \hline \\ 8\\ \\ 9\\ 0.38\\ 0.41\\ 0.41\\ 0.41\\ 0.41\\ 0.41\\ 0.41\\ 0.41\\ 0.41\\ 0.41\\ 0.41\\ 0.41\\ 0.41\\ 0.35\\$	339 366 470 451 274 275 313 311 300 259 308 314 467 202 255 202 337 223 221 8 8 e only 339 339 339 339 339 339 470 451 275 313 339 339 339 339 339 339 339 339 339	11 7 7 4 10 10 10 12 11 13 7 11 10 10 12 11 10 10 10 11 10 10 10 10 11 10 10	0.2 0.2 0.3 0.3 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2	0.2 0.2 0.3 0.3 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1	6 8 9 10 7 8 8 8 8 5 6 7 8 8 10 6 6 9 9 7 6 9 9 7 6 7 8 8 8 10 9 9 7 6 8 10 7 8 8 8 8 5 5 6 7 8 8 8 8 7 8 8 8 8 8 8 8 8 8 8 8 8 8	116 170 207 168 114 102 115 117 111 117 113 120 109 123 123 121 132 121 136 127 87 87 87 87 87 87 116 170 120 707 168 81 14 102 170 171 18 175 120 103 115 120 120 121 120 123 123 120 123 123 124 124 125 120 123 124 124 125 126 127 127 127 127 127 127 127 127 127 127	87 94 102 94 55 56 63 82 84 74 70 72 66 382 84 74 70 107 107 107 104 49 55 56 56 70 94 102 94 94 55 56 63 82 84 84 84 84 85 84 84 84 84 84 85 85 84 85 84 84 84 85 84 84 84 85 84 84 84 84 84 84 84 84 84 84 84 84 84	16.2 17.3 19.3 19.3 18.1 16.2 15.9 16.8 17.2 17.6 16.5 17.2 16.7 17.8 15.0 12.9 15.6 15.2 14.0 12.9 15.6 15.2 14.9 15.2 14.9 16.8 15.2 14.9 16.8 15.2 17.3 18.1 16.8 15.2 17.3 18.3 18.1 16.8 15.9 16.8 15.9 16.5 17.3 18.1 16.5 17.3 18.1 16.5 17.3 17.3 18.1 16.5 17.3 17.3 18.1 16.5 17.3 17.3 18.1 16.5 17.3 17.3 18.1 16.5 17.3 17.5 17.5 17.5 17.5 17.5 17.5 17.5 17.5	19 21 20 20 21 22 22 20 24 24 24 24 24 18 16 20 21 23 20 21 23 20 21 23 20 21 23 20 21 23 20 21 24 22 22 22 20 21 24 22 22 22 20 21 24 22 22 22 22 22 22 22 24 24 24 24 24	226 276 240 441 441 449 391 367 322 339 439 316 329 316 350 350 354 328 <b>Mn</b> ppm 2266 240 243 350 240 243 354 328	1.4 1.5 5.0 5.6 1.5 0.6 0.6 0.6 0.3 0.3 0.4 0.5 0.4 0.6 0.6 0.0 4 0.5 0.4 1.1 0.5 0.4 1.5 0.5 0.4 1.5 0.6 0.6 0.6 0.6 0.6 0.3 0.4 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5	55 67 76 70 73 67 64 66 68 65 84 55 53 70 61 57 57 84 57 57 84 70 61 57 57 76 67 76 76 67 76 73 67 67 66 66 84 55 57 84 84 57 84 84 85 84 85 84 85 85 84 85 85 84 85 85 84 85 85 85 85 85 85 85 85 85 85 85 85 85	27.3 29.7 24.7 25.7 17.4 20.5 15.8 15.9 15.8 16.3 17.5 15.4 22.3 25.4 55.3 21.5 20.0 27.3 20.0 27.3 29.7 25.7 17.4 20.5 20.0 21.5 20.1 18.8 29.7 21.7 21.7 22.7 21.7 21.7 21.7 21.7 21	0.2 0.2 0.2 0.3 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1	20 20.9 24.8 23.1 19 18.6 20.9 20.9 22.1 22.1 22.1 23.4 23.8 20.9 21.7 21.6 20.8 21.7 21.6 20.8 21.7 21.5 18.5 20.9 20.9 20.9 20.9 20.9 21.7 17.5 18.6 20.9 20.9 20.9 21.7 21.6 20.9 20.9 20.9 20.9 21.7 21.6 20.9 20.9 20.9 20.9 20.9 20.9 20.9 20.9	205 178 284 142 142 150 143 172 163 166 191 151 153 129 94 163 154 125 112 205 5 r ppm 205 284 247 142 247 247 154 154 154 154 154 154 154 155 154 154	3.0 3.1 3.7 2.6 2.9 3.1 3.1 3.2 2.2 2.4 2.4 3.0 3.3 2.8 2.6 7 Th ppm 3.0 3.1 3.2 2.4 2.4 2.4 2.4 3.0 3.3 2.8 2.6 7 7 7 6 6 6 9 9 9 3.1 3.1 3.2 2.4 7 7 7 7 8 2.6 7 7 7 8 .6 9 9 9 9 9 1 1 3.1 3.2 7 7 7 7 7 8 .6 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9	0.3 0.3 0.4 0.4 0.3 0.3 0.3 0.3 0.4 0.4 0.4 0.4 0.4 0.4 0.4 0.4 0.3 0.2 0.3 0.3 0.3 0.3 0.3 0.3 0.3 0.3 0.3 0.3	1.2 1.2 1.5 1.3 0.6 0.7 0.7 0.7 0.7 0.7 0.7 0.7 0.7 0.7 0.7	139 158 182 164 122 113 128 131 127 118 134 134 134 137 141 122 112 154 95 94 V ppm 159 158 136 136 137 141 138 137 141 138 137 141 138 137 141 138 137 141 138 137 141 138 137 141 138 137 141 138 137 141 138 137 141 138 137 141 138 137 141 138 137 141 138 136 95 94 158 158 158 158 158 158 158 158	114 134 122 166 178 130 147 119 96 139 144 129 139 150 137 165 124 14 129 139 150 137 165 124 141 129 139 141 141 122 166 61 14 141 122 166 61 147 147 199 96 61 147 147 147 147 147 147 147 147 147 14
676 T 677 S 677 S 677 S 678 L 678 S 679 T 679 S 680 S 681 T 681 S 682 S 684 T 684 S 685 S 685 S 685 S 685 S 685 S 685 S 685 S 685 S 687 T 677 S 677 T 677 S 677 T 677 S 677 T 678 S 677 T 678 S 677 T 678 S 687 T 678 S 687 S 688 S 688 S 688 S 688 S 688 S 688 S 687 T 678 S 687 S 688 S 688 S 688 S 688 S 688 S 688 S 688 S 677 T 678 S 677 T 678 S 677 T 678 S 677 T 678 S 677 T 678 S 678 S 688 S 68	1.33 0.79 0.72 0.92 2.11 2.03 3.20 2.25 1.90 2.25 1.90 2.25 1.90 2.73 3.14 2.97 3.34 1.17 0.68 0.40 0.40 0.37 1.81 1.72 0.72 0.92 2.11 2.03 2.25 1.90 0.37 1.81 1.72 0.72 0.72 0.72 0.72 0.72 2.73 3.34 2.75 1.90 0.37 1.81 1.72 0.72 0.72 2.73 3.34 1.72 0.72 0.72 2.73 3.34 1.72 0.72 0.72 2.73 3.34 1.72 0.72 0.72 2.73 3.34 1.72 0.72 0.72 2.73 3.34 1.77 0.72 0.72 0.72 2.73 3.44 1.77 0.72 0.72 0.72 0.72 0.73 3.44 1.77 0.72 0.72 0.72 0.72 0.73 3.34 1.77 0.72 0.72 0.72 0.72 0.72 0.73 3.34 1.77 0.72 0.72 0.72 0.72 0.72 0.72 0.72 0	2.16 2.69 2.57 2.48 4.26 3.63 3.31 3.37 2.66 3.00 2.81 3.02 2.73 3.02 2.73 3.02 2.73 3.02 2.73 3.02 2.73 3.02 2.73 3.02 2.78 Hg all Fe 9 2.57 2.48 4.26 3.01 2.57 2.48 3.02 2.57 2.48 4.26 3.00 2.57 2.48 3.02 2.57 2.48 3.02 2.57 2.48 3.02 2.57 2.48 3.02 2.57 2.48 3.02 2.57 2.48 3.02 2.57 3.03 2.57 3.02 2.57 3.02 2.57 2.24 3.03 3.02 2.57 2.24 3.03 3.02 2.57 2.24 3.03 3.02 2.57 2.24 2.57 2.57 2.57 2.57 2.57 2.57 2.57 2.57	0.97 1.12 1.10 1.08 1.30 1.10 1.08 1.10 1.08 1.11 1.12 1.01 1.11 1.12 1.11 1.12 1.09 4 0.94 0.95 1.02 1.01 1.01 1.01 0.95 1.02 1.01 1.01 1.01 1.01 1.02 1.01 1.01	0.74 0.74 0.86 0.86 0.75 0.33 0.33 0.47 0.50 0.47 0.50 0.47 0.50 0.48 0.43 0.42 0.26 0.26 0.26 0.42 0.27 0.42 0.27 0.42 0.42 0.42 0.42 0.42 0.42 0.42 0.42	0.95 1.12 1.07 1.08 1.04 1.06 1.09 1.11 1.05 1.09 1.11 1.05 1.09 1.10 1.05 0.97 0.88 0.95 0.97 0.88 0.97 0.97 0.88 0.97 0.97 0.88 0.97 0.97 0.88 0.97 0.97 0.88 0.97 0.97 0.88 0.97 0.97 0.88 0.97 0.97 0.97 0.97 0.88 0.97 0.97 0.12 1.17 1.06 1.07 0.97 0.12 1.17 1.08 1.07 0.98 0.97 1.12 1.17 1.08 1.09 1.12 1.17 1.08 1.09 1.12 1.17 1.08 1.09 1.12 1.17 1.09 1.09 1.12 1.17 1.09 1.09 1.12 1.17 1.09 1.09 1.12 1.17 1.09 1.09 1.12 1.17 1.08 1.09 1.12 1.17 1.08 1.04 1.06 1.09 1.12 1.17 1.08 1.04	542 658 707 652 511 431 441 444 423 371 373 373 438 302 641 509 462 641 337 337 542 658 509 462 641 337 542 658 511 410 484 423 337 542 542 542 542 542 542 542 542 542 542	0.38 0.35 0.41 0.41 0.20 0.51 0.33 0.27 0.51 0.33 0.27 0.51 0.42 0.35 0.13 0.19 0.17 0.13 0.19 0.13 0.19 0.13 0.19 0.13 0.11 0.16 0.15 0.35 0.35 0.35 0.35 0.35 0.35 0.35 0.3	339 366 470 451 274 275 313 311 300 259 308 314 467 223 221 337 223 221 Ba Bap pag 339 339 339 339 337 223 221 337 223 221 337 223 221 337 223 221 337 223 221 337 223 221 337 223 221 337 223 221 337 223 221 337 223 221 337 223 221 337 223 221 337 223 221 339 339 339 339 339 339 339 33	11 7 7 4 10 10 10 12 11 13 7 11 10 10 12 11 10 10 12 11 10 10 12 11 10 10 12 11 13 7 11 10 10 10 10 10 10 10 10 10	0.2 0.2 0.3 0.3 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2	0.2 0.2 0.3 0.3 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 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0.35\\ 0.42\\ 0.35\\ 0.41\\ 0.16\\ 0.15\\ \hline \\ 0.38\\ 0.38\\ 0.41\\ 0.41\\ 0.41\\ 0.41\\ 0.41\\ 0.41\\ 0.41\\ 0.41\\ 0.41\\ 0.41\\ 0.41\\ 0.41\\ 0.41\\ 0.41\\ 0.35\\ 0.31\\ 0.35\\ 0.31\\ 0.31\\ 0.35\\ 0.31\\ 0.35\\ 0.13\\ 0.35\\ 0.13\\ 0.13\\ 0.13\\ 0.13\\ 0.13\\ 0.14\\ 0.10\\ 0$	339 366 470 451 274 275 313 311 300 259 308 314 467 223 221 8 8 e only 8 7 8 7 8 7 8 7 8 7 8 7 8 7 8 7 7 223 221 8 7 8 7 7 7 223 221 223 221 223 221 223 221 223 221 223 221 223 221 223 221 223 221 225 8 225 223 221 223 223	11 7 7 4 10 10 10 12 11 13 7 11 10 10 12 11 10 10 11 10 10 11 10 10 10	0.2 0.2 0.3 0.3 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2 0.2	0.2 0.2 0.3 0.3 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1	6 8 9 10 7 8 8 8 8 5 6 7 8 8 9 9 7 6 6 9 9 7 6 9 9 7 6 7 8 8 10 9 9 7 6 8 8 10 7 8 8 8 5 5 6 7 8 8 8 9 9 7 8 8 8 8 8 8 8 8 8 8 8 8 8	116 170 207 168 114 102 115 117 117 111 132 120 109 123 132 121 136 127 87 87 87 87 87 87 116 102 127 178 87 87 117 102 102 179 102 102 114 102 102 102 115 114 117 117 117 117 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175 175 175 175 175 175 175 175	3.0 3.1 3.7 2.6 2.9 3.1 3.1 3.1 3.2 2.2 2.4 2.4 2.4 3.0 3.3 2.8 2.6 Th ppm 3.0 3.1 3.2 2.4 2.4 2.4 3.0 3.3 3.2 2.4 2.4 3.5 5 2.7 7 2.6 5 2.9 3.1 3.1 3.2 2.2 3.2 2.4 2.4 3.3 3.5 5 2.4 7 3.1 3.1 3.2 3.2 2.2 3.2 2.4 3.1 3.1 3.1 3.2 2.4 3.2 3.2 2.4 3.1 3.1 3.2 2.4 3.1 3.1 3.2 2.4 3.1 3.1 3.2 2.4 3.1 3.1 3.2 2.4 3.1 3.1 3.2 2.4 3.1 3.1 3.2 2.4 3.1 3.1 3.1 3.2 2.4 3.3 3.5 3.2 2.4 3.1 3.1 3.1 3.2 2.4 3.3 3.5 3.2 2.4 3.1 3.1 3.1 3.1 3.2 2.4 3.3 3.3 2.4 3.3 3.3 2.4 3.3 3.5 2.4 3.1 3.1 3.1 3.1 3.1 3.1 3.2 3.2 3.2 3.3 3.3 3.3 3.3 3.5 2.4 3.3 3.3 2.4 3.3 3.5 2.4 3.1 3.1 3.1 3.1 3.1 3.1 3.1 3.2 2.4 3.3 3.3 2.4 3.3 3.3 2.4 3.1 3.1 3.1 3.7 3.5 2.4 3.3 3.3 2.2 3.2 3.2 3.3 3.3 3.3 3.7 3.5 2.7 3.5 2.4 3.1 3.3 3.3 3.3 3.3 3.3 3.3 3.3 3.4 3.4 3.3 3.3	0.3 0.3 0.4 0.4 0.3 0.3 0.3 0.3 0.4 0.4 0.4 0.4 0.3 0.2 0.3 0.4 0.4 0.3 0.3 0.3 0.3 0.3 0.3 0.3 0.3 0.3 0.3	1.2 1.2 1.5 1.3 0.6 0.7 0.7 0.7 0.7 0.7 0.7 0.7 0.7 0.7 0.7	139 158 182 164 122 113 128 131 127 118 134 134 137 141 122 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1.12 1.10 1.00 0.97 1.12 1.10 1.00 0.97 1.12 1.10 0.94 1.10 0.94 1.10 0.97 1.12 1.10 0.97 1.12 1.10 0.95 1.10 0.95 1.10 0.97 1.12 1.10 0.95 1.10 0.95 1.10 0.97 1.12 1.10 0.95 1.10 0.95 1.10 0.95 1.10 0.95 1.10 0.97 1.12 1.10 0.95 1.10 0.95 1.10 0.95 1.10 0.95 1.10 0.97 1.12 1.10 0.95 1.10 0.95 1.10 0.95 1.11 1.11 1.11 1.11 1.11 1.11 1.11 1	0,74 0,74 0,86 0,86 0,75 0,33 0,47 0,50 0,48 0,51 0,50 0,47 0,50 0,47 0,50 0,47 0,48 0,44 0,42 0,27 0,26 0,74 0,74 0,74 0,74 0,75 0,33 0,33 0,33 0,33 0,47 0,50 0,47 0,50 0,47 0,50 0,48 0,42 0,50 0,47 0,50 0,44 0,51 0,50 0,44 0,51 0,50 0,44 0,50 0,47 0,42 0,42 0,42 0,42 0,42 0,43 0,43 0,44 0,42 0,42 0,43 0,43 0,43 0,43 0,43 0,44 0,42 0,42 0,43 0,43 0,44 0,42 0,51 0,51 0,51 0,51 0,51 0,51 0,51 0,51	0.95 1.12 1.17 1.08 1.04 1.06 1.09 1.11 1.05 1.09 1.11 1.05 0.88 0.95 0.95 0.95 1.12 1.17 1.08 K % 0.95 1.12 1.17 1.08 K % 0.95 1.12 1.17 1.08 1.02 0.97 0.88 0.97 1.12 1.17 1.08 0.97 0.88 0.97 1.12 1.17 1.08 0.97 1.12 1.17 1.08 0.97 1.12 1.17 1.09 1.10 0.87 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57	27.3 29.7 24.7 25.7 17.4 20.5 15.8 15.9 15.8 15.9 15.8 17.5 15.4 22.3 25.4 55.3 21.5 20.0 21.3 22.4 73.0 31.5 20.0 27.3 20.7 25.7 17.4 20.5 20.0 27.3 20.7 24.7 25.7 17.4 25.7 20.5 20.0 11.8 8 15.9 20.7 25.7 20.7 25.7 17.4 25.7 20.7 25.7 20.1 20.1 27.5 20.7 27.7 27.7 27.7 27.7 27.7 27.7 27.7	0.2 0.2 0.2 0.3 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1	20 20.9 24.8 3.1 19 18.6 20.9 21.7 21.6 20.9 22.1 22.1 22.1 22.1 23.4 23.8 20.9 21.7 21.6 20.9 21.7 21.6 20.9 21.7 21.5 18.5 20.9 21.7 21.6 20.9 21.7 21.6 20.9 21.7 21.6 20.9 21.7 21.6 20.9 21.7 21.7 21.6 20.9 21.7 21.6 20.9 21.7 21.6 20.9 21.7 21.6 20.9 21.7 21.6 20.9 21.7 21.6 20.9 21.7 21.6 20.9 21.7 21.6 20.9 21.7 21.6 20.9 21.7 21.6 20.9 21.7 21.6 20.9 21.7 21.7 21.6 20.9 21.7 21.7 21.6 20.9 21.7 21.7 21.6 20.9 21.7 21.7 21.7 21.6 20.9 21.7 21.7 21.7 21.6 20.9 21.7 21.7 21.7 21.7 21.7 21.7 21.7 21.7	205 178 284 142 142 150 143 172 163 172 163 172 163 172 163 172 163 154 125 112 205 284 247 247 247 247 247 247 247 247 247 24	3.0 3.1 3.7 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141 141 122 166 137 144 141 122 166 137 144 141 129 150 137 165 124 141 129 139 139 147 141 147 147 147 147 147 147 147 147

a sample is ashed, there is a loss of weight from the mineral matter, so that a concentration of approximately 85% ash corresponds to a mineral matter concentration of 100% (i.e., no organic carbon content).

## **RESULTS AND DISCUSSION**

#### Major Elements in Coal Waste

Sulphur occurs in coal as sulphides, as sulphates, or as organic sulphur. Trace metals may be associated with sulphur if the sulphur is present as sulphides. These sulphides may be dispersed in coal or associated with ash. Sulphur has a negative correlation with ash and no correlation with Fe (Figure 6), indicating that a lot of the sulphur is occurring as organic or sulphate sulphur associated with the coal. This is probably because sulphides originally present in the coal waste have oxidized and released SO<sub>3</sub>. Trace metals would also be released and mobilized by the acidic water.

One of the advantages of pairing XRF and ICP-MS analyses is that it provides information on what proportion of major elements may be in a soluble form. XRF measures the total amount present, whereas ICP-MS measures the amount that is soluble in a hot acid leach. The amount of Fe detected by ICP-MS is similar to that detected by XRF, indicating that most of the iron is probably soluble and probably occurs in sulphides, carbonates, or hydroxides. A similar comparison for Ca, K, and Na indicates that lower percentages of these elements are potentially soluble and mobile (Figure 7).

#### Trace Elements in Coal Waste

As a starting point, it is important to understand how trace elements are distributed in coal. Coal is not 100% organic carbon-even when washed it contains an amount of included mineral matter analysed as ash. Consequently concentrations of trace elements in coal can have either an ash or an organic carbon affinity. To complicate the picture further, a lot of trace elements are associated with sulphide minerals in coal, and these sulphide minerals (mainly pyrite) may be associated with ash in the seam or with coal in the seam. In coals with varying ash contents, one should try to assign an affinity of the trace elements to either the organic material, the ash, or the sulphides (if present in reasonable amounts). Average trace element concentrations in shales and continental crust are shown in Figure 8. There are some data for coals from Vancouver Island (Van De Flier-Keller and Dumais 1988) and for coals from northeastern and southeastern British Columbia (Grieve 1991) (Figure 9). It is obvious from Figures 8 and 9 that the distribution of trace elements in crustal rocks,



Figure 6: Association of sulphur with ash and iron; data from Union Bay, Cedar Cove, and Slag Point.

shales, and coals is similar. It appears that average element concentrations for coal waste are generally similar to world coal values (Figure 9) and a bit higher than Vancouver Island fresh coal values. The waste coal material has much higher ash concentrations than these suites of coal samples and probably should be compared to the average shale data (Figure 8).

There is no evidence of major enrichment or depletion of elements in the waste coal material, except for possibly enrichment in copper and chromium, which are both higher than the average values for Vancouver Island and world coals (Figure 9).

#### **Trace Element Associations**

The association of trace elements for the various areas is demonstrated using linear correlation matrixes. This works well in most cases but can be misleading when the data contain a few very high or low values that overly influence linear correlations. Correlation matrixes are constructed for the 3 study areas-Union Bay, Cedar Cove, and Ladysmith (Tables 5, 6, and 7). These tables help identify elements that have an ash association or a sulphur (possibly pyrite) association. Most of the elements have a negative association with ash, indicating a coal or sulphide association. Plots for copper (Figure 10) indicate that copper has a weak negative correlation with ash and a correlation with sulphur that is possibly positive at low concentrations but negative at high concentrations (secondary sulphate sulphur). Copper also has no correlation with iron (Figure 10), which does not support a sulphide association. The association of copper in samples is therefore not clear, but it may have been released from sulphides and since bound to the organic material. The association of chromium is not



Figure 7: Comparison of Fe, Ca, Na, and K analyses by XRF and ICP-MS.

clear; it has a negative correlation with ash and no correlation with sulphur (Tables 5 and 6), though it does correlate with other trace metals. Copper may have been bound to the organic material after being released from sulphides.

Mercury is a trace element of general concern; however, in this study only 2 analyses were above the detection limit of 10 ppb, and they were both less than 20 ppb.

Arsenic is often associated with pyrite, and in this study there is no correlation with ash and, except for the 2 high values for samples 664 and 665 (Table 4), only a weak correlation with sulphur (Figure 11). There is no explanation for the 2 high arsenic values.

Only 2 elements (chromium and copper) are above both world averages (Clarke and Sloss 1992) and values from the Nanaimo and Comox Basins (Van Der Flier-Keller and Dumais 1988) (Figure 9). These elements do not correlate with sulphur or ash but appear to correlate with other trace metals (Tables 5, 6, and 7). It appears that they are not present in sulphides but may be bound to the organic material.



Figure 8: Average trace element data from Clark and Sloss (1992).



Figure 9: Trace elements concentrations in coals and waste material (BC and world data).

## Depth Profile Data

A number of small trench samples were collected at Union Bay, Cedar Cove, and Ladysmith. At each location a sample was collected at surface, a second at about 20 cm, and sometimes a third at about 50 cm depth. Data available for the sets of samples include total ash, major oxide, and trace metal concentrations. The data from Union Bay are displayed in a number of plots (Figure 12 a, b, c, d, and e). Major elements are plotted for some of the profiles—these are concentrations determined by ICP-MS and therefore represent the soluble component of the total concentration. Comparing the total concentration of iron and calcium (by XRF) to the ICP-MS concentration does not indicate a change in concentrations with depth or a change in the proportions extracted by acid leach and ICP-MS analysis



Figure 10: Copper versus sulphur, ash, and iron.



Figure 11: Relationship of arsenic with ash and sulphur.

(Figure 7). For both elements, most of the iron and calcium is acid-leacheable. Trace element concentrations do not vary much with depth, indicating a lack of mobility or that any mobile component has already moved on. Ash contents of all samples are high, with little variation with depth.

## TABLE 5: CORRELATION MATRIX FOR TRACE ELEMENTS, UNION BAY AREA.

x	ash	As	Ba	Bi	Cd	Co	Cr	Cu	Ga	Mo	Ni	Р	Pb	Sb	Sc	Sr	Th	U	S	Zn
ash	1.00																			
As	-0.65	1.00																		
Ba	-0.79	0.92	1.00																	
Bi	-0.42	-0.20	-0.07	1.00																
Cd	0.11	-0.50	-0.24	0.29	1.00															
Co	0.48	-0.35	-0.20	-0.41	0.68	1.00														
Cr	-0.33	0.61	0.73	-0.27	-0.12	0.28	1.00													
Cu	0.06	0.05	0.23	-0.34	0.56	0.78	0.56	1.00												
Ga	-0.80	0.66	0.87	0.09	0.03	-0.08	0.72	0.44	1.00											
Mo	-0.39	0.19	0.24	0.18	-0.27	-0.51	-0.21	-0.35	0.29	1.00										
Ni	0.07	0.17	0.33	-0.47	0.37	0.78	0.75	0.95	0.47	-0.37	1.00									
Р	0.22	-0.04	0.08	-0.35	0.11	0.49	0.54	0.72	0.33	-0.22	0.74	1.00								
Pb	-0.86	0.43	0.70	0.46	0.22	-0.20	0.40	0.23	0.87	0.41	0.18	0.18	1.00							
Sb	-0.61	0.80	0.64	0.09	-0.48	-0.52	0.30	-0.23	0.43	0.20	-0.15	-0.40	0.17	1.00						
Sc	-0.75	0.36	0.66	0.35	0.30	-0.03	0.56	0.44	0.93	0.32	0.41	0.34	0.92	0.16	1.00					
Sr	0.12	-0.06	-0.15	0.10	-0.28	-0.07	0.13	0.00	-0.15	-0.61	0.03	-0.02	-0.34	0.27	-0.16	1.00				
Th	-0.91	0.47	0.69	0.54	0.06	-0.38	0.29	0.05	0.84	0.59	0.01	0.01	0.96	0.41	0.88	-0.37	1.00			
U	-0.73	0.23	0.43	0.48	-0.21	-0.54	0.16	-0.19	0.64	0.69	-0.18	0.00	0.77	0.19	0.74	-0.18	0.86	1.00		
S	-0.05	-0.28	-0.43	0.39	-0.09	-0.49	-0.72	-0.61	-0.37	0.25	-0.72	-0.64	-0.20	0.23	-0.29	-0.03	0.01	0.12	1.00	
Zn	0.46	-0.46	-0.27	-0.28	0.62	0.85	0.26	0.83	0.04	-0.41	0.77	0.78	-0.05	-0.66	0.17	0.04	-0.24	-0.28	-0.49	1.00

TABLE 6: CORRELATION MATRIX FOR TRACE ELEMENTS, CEDAR COVE AREA.

х	ash	As	Ba	Bi	Cd	Co	Cr	Cu	Ga	Mo	Ni	Р	Pb	Sb	Sc	Sr	Th	U	S	Zn
ash	1.00																			
As	0.16	1.00																		
Ba	-0.36	-0.53	1.00																	
Bi	-0.74	-0.02	0.53	1.00																
Cd	-0.72	0.01	0.22	0.82	1.00															
Co	-0.13	0.66	-0.28	0.11	0.17	1.00														
Cr	-0.78	0.04	0.25	0.40	0.46	0.44	1.00													
Cu	-0.86	0.00	0.39	0.62	0.54	0.45	0.88	1.00												
Ga	-0.82	-0.09	0.40	0.57	0.41	0.34	0.82	0.90	1.00											
Mo	-0.84	0.16	0.17	0.67	0.59	0.49	0.73	0.86	0.74	1.00										
Ni	-0.21	0.51	-0.17	0.10	0.18	0.88	0.64	0.53	0.54	0.44	1.00									
Р	-0.85	0.12	0.15	0.77	0.93	0.31	0.67	0.73	0.58	0.80	0.32	1.00								
Pb	-0.59	-0.16	0.64	0.79	0.81	-0.06	0.43	0.48	0.40	0.35	0.05	0.68	1.00							
Sb	-0.74	-0.31	0.65	0.54	0.41	-0.02	0.66	0.68	0.64	0.59	0.09	0.50	0.63	1.00						
Sc	-0.89	0.00	0.32	0.72	0.64	0.44	0.82	0.92	0.94	0.86	0.56	0.78	0.49	0.60	1.00					
Sr	-0.84	0.08	0.08	0.72	0.88	0.18	0.60	0.67	0.52	0.77	0.18	0.97	0.59	0.38	0.73	1.00				
Th	-0.87	-0.14	0.49	0.82	0.72	0.30	0.66	0.86	0.82	0.74	0.31	0.76	0.67	0.68	0.90	0.70	1.00			
U	-0.76	-0.19	0.47	0.41	0.25	0.27	0.75	0.79	0.73	0.75	0.26	0.45	0.27	0.82	0.71	0.41	0.69	1.00		
S	0.11	0.90	-0.67	-0.19	-0.03	0.45	0.05	-0.04	-0.17	0.13	0.31	0.13	-0.24	-0.29	-0.11	0.16	-0.25	-0.19	1.00	
Zn	0.45	0.54	-0.19	-0.20	-0.16	0.70	-0.03	-0.05	-0.08	-0.20	0.66	-0.21	-0.10	-0.37	-0.08	-0.36	-0.11	-0.28	0.26	1.00

## TABLE 7: CORRELATION MATRIX FOR TRACE ELEMENTS, LADYSMITH AREA.

х	ash	As	Ba	Bi	Cd	Co	Cr	Cu	Ga	Mo	Ni	P	Pb	Sb	Sc	Sr	Th	U	S	Zn
ash	1.00																			
As	0.05	1.00																		
Ba	-0.11	-0.04	1.00																	
Bi	0.17	0.19	0.82	1.00																
Cd	0.20	0.00	0.88	0.62	1.00															
Co	0.41	-0.29	0.35	0.04	0.64	1.00														
Cr	-0.32	-0.43	0.37	-0.15	0.32	0.66	1.00													
Cu	-0.86	-0.13	0.49	0.12	0.31	-0.06	0.59	1.00												
Ga	-0.19	0.35	0.84	0.81	0.68	0.13	0.10	0.44	1.00											
Mo	0.70	-0.17	-0.30	-0.14	-0.28	0.48	0.09	-0.52	-0.38	1.00										
Ni	0.06	-0.16	0.28	-0.18	0.52	0.82	0.75	0.20	0.07	0.12	1.00									
Р	0.32	-0.14	-0.68	-0.54	-0.72	0.17	0.02	-0.42	-0.53	0.69	0.00	1.00								
Pb	0.27	-0.14	-0.46	-0.20	-0.58	-0.21	-0.30	-0.36	-0.33	0.34	-0.43	0.62	1.00							
Sb	0.10	-0.14	0.57	0.67	0.31	0.06	-0.06	0.08	0.54	-0.07	-0.30	-0.38	0.20	1.00						
Sc	-0.63	0.06	0.76	0.42	0.71	0.18	0.52	0.85	0.78	-0.56	0.35	-0.58	-0.54	0.24	1.00					
Sr	-0.67	-0.27	0.26	-0.15	0.27	0.12	0.56	0.66	0.11	-0.43	0.43	-0.42	-0.76	-0.23	0.60	1.00				
Th	-0.68	0.25	0.37	0.31	0.24	-0.24	0.06	0.69	0.69	-0.52	-0.11	-0.28	-0.25	0.13	0.77	0.37	1.00			
U	-0.68	-0.24	-0.32	-0.38	-0.57	-0.47	0.10	0.52	-0.19	-0.27	-0.26	0.19	0.41	-0.05	0.11	0.18	0.38	1.00		
s	-0.57	0.28	-0.46	-0.44	-0.69	-0.43	-0.04	0.19	-0.12	-0.32	-0.18	0.19	0.07	-0.23	0.01	0.26	0.29	0.57	1.00	
Zn	0.60	0.19	0.02	0.05	0.22	0.56	0.14	0.40	0.14	0.60	0.27	0.45	0.46	0.02	0.22	0.59	0.40	0.28	0.60	1.00



Figure 12a: Depth profile data for major and trace elements for locations Union Bay. Relative depths are surface and approximately 20 cm and 50 cm.





Figure 12b: Depth profile data for major and trace elements for locations Union Bay. Relative depths are surface and approximately 20 cm and 50 cm.



Figure 12c: Depth profile data for major and trace elements for locations Cedar Cove. Relative depths are surface and approximately 20 cm and 50 cm.



Figure 12d: Depth profile data for major and trace elements for locations Ladysmith. Relative depths are surface and approximately 20 cm and 50 cm.



Figure 12e: Depth profile data for major and trace elements for locations Ladysmith. Relative depths are surface and approximately 20 cm and 50 cm.

Union Bay beach is characterized by heavy iron staining and samples (644, 645, 646) (647, 648, 649), and (650, 651, 652) were collected at different depths in 3 test holes dug on this beach. There are no major changes in trace or major element chemistry with depth down to about 0.7 m at the bottom of the holes. Samples of the heavily rust-stained section at the surface have higher concentrations of iron and molybdenum, and in all 3 profiles sulphur decreases with depth. The material is weathered refuse from which most of the pyrite probably has been oxidized to yield sulphates and iron oxides. Samples generally have high ash contents, and this influences major oxide and trace metal concentrations in terms of comparisons to coal with less ash. Swaine (1990) provides a table of average trace element concentration in coal, soils, and shale, and Van Der Flier-Keller and Goodarzi (1992) provide average trace element and major oxide contents for coals from the Comox and Nanaimo coalfields. Data from these sources are plotted with average data from Union Bay (Figure 13). It is apparent that the Union Bay data plot in between average coal and average shale and have higher contents of most elements than do the Nanaimo and Comox coals. This is probably because the Union Bay samples have higher ash contents, which range from 30% to 94% and are generally higher than the coal samples analysed by Van Der Flier-Keller and Goodarzi (1992).



Figure 13: Comparison of trace metal data for Union Bay and Comox and Nanaimo coals.

#### Sized Data

A number of samples were split, and one split from each sample was screened into coarse and fine fractions (8-mesh). Both the original split and the fine-fraction split were analysed by XRF and ICP-MS. Comparing analyses for the original and fine-fraction splits should provide indications of fractionation of elements by particle size and possible mobility of trace elements out of fine fractions. Data (Figure 14 a and b) do not indicate any consistent pattern of element distribution. Major element concentrations change little from the original split (numbered 1 on the x axis in the figures) to the fine-fraction split (numbered 2 on the x axis in the figures). Trace element concentrations are more variable but still do not provide a consistent pattern.

#### Heat Value

The heat value of coal is dependent on organic carbon and volatile matter contents of samples. It decreases with oxidation of coal and destruction of volatile matter, but generally the decrease is not large. In this study, the heat value of the samples has not been degraded, based on a plot of calorific value (dry basis) versus ash (dry basis) (Figure 15), which compares heat values for fresh coals from the Comox and Nanaimo Basins (Coal Quality Catalogue 1992) to the samples in this study. The zero-ash heat value for all samples averages about 7929 kcal/kg, compared to 7993 kcal/kg for fresh coal samples from Nanaimo and Comox coal basins. The main influences on heat value of coal are ash and moisture contents. A sample with 20% ash (dry basis) and 10% water would have a gross calorific value of 5555 kcal/kg (Figure 15). This is a useable heat value, though the ash chemistry becomes important, because boilers must handle and remove large quantities of fly ash or slag.

As an aside, it is important to understand the difference between measured heat values (gross as-received, or GAR) and useable heat (net as-received, or NAR). In a power plant, the moisture associated with the coal is heated and then converted to steam when the coal is burnt. This heat is generally lost, and this is part of the reason that NAR heating value is less than GAR heating value. A gram of water at 20 °C will require 620 calories if it is heated and turned into steam. Consequently, coal with 10% moisture will lose, when burnt, about 62 calories because of water. This means that a 40% ash sample with about 5000 kcal/kg air-dried basis (adb) will actually have about 6% less useable heat, in part because there is 10% less material and in part because of the lost 62 calories.

Tidal samples from Union Bay appear to have higher heat values than other samples at comparable ash contents (Figure 15). These samples (644, 645, and 646) were collected from a flat area of beach covered by a prominent iron-oxide staining. The heat value may be influenced by recent organic matter.















Figure 14a: Comparison trace metal data from original samples and fine fraction of samples.



Figure 14b: Comparison trace metal data from original samples and fine fraction of samples.



Figure 15: Heat value of fresh Vancouver Island coals and weathered samples from Union Bay, Cedar Cove, and Lady-smith Slag Point.

## CONCLUSIONS

The data provide some background information on the major and trace element chemistry of the coal refuse material on and near beaches along the east coast of Vancouver Island. Generally, coal waste is fairly benign, unless it contains high concentrations of pyrite that can release trace metals and generate acid-rock drainage. Samples collected in this study generally do not have abnormally high concentrations of trace metals or high concentrations of pyrite. There is no indication that they are releasing metals into the environment. It is possible that all or most of the pyrite is already oxidized and trace metals released and migrated out of the samples.

## ACKNOWLEDGEMENTS

Samples were collected in conjunction with a study by Remi Odense, Risk Assessment and Remediation, Ministry of the Environment, BC Government. Warren Walsh assisted with sampling in the field, and Jessica Verhagen helped with sample preparation.

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