

05.03.103
Analysis of Two Marine Algae for
Heavy Metals

Analysis of Two Marine Algae
for Heavy Metals

Robin Watkins
September 6, 1994
218-50-1911

Algae have been shown to concentrate heavy metals from the environment. A study in Qatar showed that different marine algae complexed metals to varying extents in the same environment (Kureishy 1991). While some heavy metals, in small amounts, are essential to algal physiology, excessive amounts of metals are known to slow the growth of microalgae (Carpene 1992).

The ability of algae to sequester a wide variety of metals and in greater amounts than necessary biologically has important implications. In addition to potentially decreasing the numbers of algae, which form an important part of the food chain, the metals could become part of the human diet either through the food chain or through the use of seaweed as fertilizer.

Phillips has advocated using the sequestering ability of macroalgae to monitor heavy metals in the environment (Kureishy 1991). Konhauser (1993) has further suggested that algae could be used to slow "heavy metal dispersion" and to search for ore deposits.

For this project, two varieties of marine algae collected along the coast of the Delmarva Peninsula were analyzed for five heavy metals: cadmium, chromium, copper, iron and nickel. The concentrations of sodium, silicon, calcium, magnesium, and aluminum were also measured. In addition to the algae, seawater samples were collected at each location.

A green grass-like algae, tentatively identified as *Enteromorpha*, was collected from the Atlantic Ocean at the mouth of the Indian River (North Inlet) in Delaware. The algae was attached to a rock on the beach, adjacent to a stone jetty lining the entrance to the river. The rock was at the ocean's edge, partially submerged by the waves. (Tidal conditions are indicated in Table 1.)

A lacy, dark red algae, tentatively identified as a Polysiphonia, was collected from Public Landing, Maryland, on the western shore of the estuary Chincoteague Bay. The red algae was removed from wooden steps leading from the pier into the water, approximately three feet deep. Amorphous gray material with yellow or orange "hairs," attached to the red seaweed and assumed to be another algae, was collected along with the red seaweed; it has since been suggested that these were nudibranchs (marine animals). The "red seaweed" samples are therefore non-homogenous and likely contain animal matter.

The elemental analysis was performed using a Lehman Labs Plasma-Spec ICP-AES (Inductively Coupled Plasma-Atomic Energy Spectrometry) instrument. The ICP method uses the heat from an argon plasma, generated by radio frequency fields acting on partially ionized argon, to atomize the sample and excite the atoms of each element to emit characteristic wavelengths of energy. Because of the high temperature (7000-8000K) in the plasma, a wide range of elements can be excited with little chemical interference. This method is well suited to marine samples for several reasons. The plasma easily accomodates aqueous samples and those containing sediment. In addition, the instrument can measure several elements simultaneously and accomodate a wide concentration range, from the major salts in seawater to trace elements. The linear range of concentration is four to six orders of magnitude.

PROCEDURE

Half-gallon freezer bags and 125-ml polyethylene bottles for collecting seaweed and seawater, respectively, were washed with soap and water, dilute (5%) nitric acid, and then D.I. water. (The acid served to exchange hydrogen ions for any metal ions.)

Algae was collected by hand, using latex gloves, and excess water was decanted from the bag. The bags were immediately placed in a cooler with blue-ice packs and later transferred to a freezer to

prevent decay. The location, date, time, latitude, longitude, and tide were noted. Seawater from the same location as the algae was collected in the bottles as follows: the bottles were opened underwater to avoid collecting anomalous surface material, and water was collected twice and discarded before taking the sample.

In the lab, glassware was prepared for the analysis of each sample in triplicate, as well as, a procedural blank in triplicate. A sufficient number of 100-ml beakers and 100-ml volumetric flasks were washed with soap and water, dilute nitric acid, then DI water. The beakers were dried on a hot plate and allowed to cool to room temperature. Silicon carbide boiling chips were added to the beakers, and the beakers were numbered and weighed.

Approximately two grams of seaweed, thawed and drained, were transferred to each beaker using Teflon tongs, and the beakers were weighed. Beakers numbered 1 to 3 contained green seaweed; beakers numbered 4 to 6 contained red seaweed.

To obtain a factor for converting "wet" weight to "dry" weight of seaweed, the following procedure was used: a dry paper towel was weighed. Wet seaweed, drained, was placed on the towel and a weight obtained. The seaweed and towel were placed in a hood and allowed to dry for a week, then were reweighed. The procedure was repeated for each kind of seaweed.

To each beaker, 10 mls of a 3:1 $\text{HNO}_3:\text{HClO}_4$ solution were added and the beakers were covered with Parafilm and allowed to sit at room temperature for several days. The beakers were then heated very gradually on a hot plate until the nitric acid began refluxing, and the refluxing was continued for one-half to one hour. Since there was still undigested matter in the beakers, the beakers were allowed to cool and an additional 10 mls of acid solution was added to each beaker. Refluxing was repeated until

the solutions were clear, except for sediment in the bottom, which was attributed to sand. The heat was increased slightly until the perchloric acid was refluxing, as evidenced by dense white fumes. Refluxing was continued for 5 to 15 minutes, depending on the sample, but not to the point of dryness! The beakers were allowed to cool to room temperature.

DI water was added slowly to each beaker and the liquid was decanted to a numbered volumetric flask. The beakers were rinsed several times with DI water which was transferred to the flask. The flasks were filled to the line with DI water using an acid-washed eye dropper.

A previously made standard solution was used for calibrating the ICP. The standard contained 10 ug/ml (ppm) Al, Cd, Cr, Cu, Fe, and 50 ug/ml Ca, Mg, Na, Ni, and Si.

ICP Procedure:

1. Put the simultaneous detector plate in place. Optimize slit positions, using Hg line.
2. Turn on argon gas and power to the instrument. Set the power of the RF generator at 1 kW. Ignite the torch. Turn on the aspirator pump.
3. Let instrument stabilize 10-15 minutes.
4. Flush DI water through and run it as a "sample" to monitor background stability since the last run.
5. Run DI water as "background." (sets values to zero)
6. Run "standard" solution. (calculates correction factor and sets values to nominal)
7. Perform 3 successive runs for each flask. (Watch for flame color to indicate sample has reached the flame.) Leave approximately one minute between new samples. Run DI water at regular intervals to monitor background stability.

RAW DATA

See attachments for weight data and ICP data. Any ICP data that indicated contamination by a previous sample was omitted from the tables.

SAMPLE CALCULATION

1. Seaweed weight, "wet" weight converted to "dry" weight:

$(\text{Beaker} + \text{Chips} + \text{Seaweed}) - (\text{Beaker} + \text{Chips}) = \text{Wet seaweed weight}$

Wet to dry conversion factor:

$[(\text{Dry Seaweed} + \text{Towel}) - \text{Towel}] / [(\text{Wet Seaweed} + \text{Towel}) - \text{Towel}]$

2. Micrograms of element per gram of dry seaweed:

$\text{ug/ml} = \text{ug/g} = \text{ppm}$

Instrument output (ug/ml) x 100 ml in flask = ug in sample

ug of metal in sample / dry weight (grams) of sample

- A. For each sample run, the instrument averaged 3 readings to produce Average A (Average on print-out).
- B. Each sample was run (aspirated) 3 times successively to provide Average B (Average of A values).
- C. Each sample was part of a triplicate analysis for each type of seaweed producing Average C (Average of B values for the seaweed; Average of A values for the blank).

Specific calculation:

BLANK: Average the individual blank ("A") values to obtain Average ("C") and find the standard deviation.

SAMPLE: 1. Subtract the Average ("C") Blank value from each sample run ("A" values) and find the Average ("B") of the resulting values. The standard deviation for each sample equals the square root of the sum of the standard deviation of the 3 sample runs (A values) and the standard deviation of the blank.

2. Multiply the Average ("B") in ug/ml by 100 ml and divide by the dry weight of the seaweed sample in grams.
3. Find the Average ("C") amount of each element in each type of seaweed (red and green) by averaging the 3 samples of each type of seaweed ("B" values) and find the standard deviation.

BACKGR: Calculate the Average ("B") and standard deviation of the DI water values to demonstrate baseline stability.

The results of the calculations are provided in the attachments.

RESULTS

The low standard deviation in the ICP values for DI water showed the baseline was stable throughout the ICP procedure. The procedural blank, which was a DI water/acid solution, showed less than 1 ug/ml of all elements except Ca, which averaged 1.8 ± 0.4 ug/ml.

The green seaweed showed <1 ug/gram of dry seaweed weight of Cd, Cr, Cu and Ni and an average of 10 ug/gram Fe. The other elements (Al, Ca, Mg, Na, and Si), present in large amounts in seawater, showed higher concentrations as expected. The non-homogeneous red seaweed sample showed negligible (<1 ug/gram of dry seaweed weight) Cd, Cr, Cu and Ni, but higher Fe content, averaging 73.1 ug/gram dry weight of seaweed. The source of the iron could have been the foreign material, possibly animal, or the seaweed itself. The Al, Ca, Mg and Si content of the red sample was higher in proportion to the Na content than in the green algae, possibly also due to the foreign material or the seaweed. Unfortunately, there was not time to analyze the seawater samples for comparison with the samples.

The standard deviation for the heavy metals was especially high, since it incorporated uncertainties in both sample and blank.

Sources of systematic error include instrument parameters, make-up of the calibration standard, analyte interferences (usually low with ICP) or spectral interferences. Spectral interferences were minimized by use of a multielement standard to compensate for interelement effects. According to Ingles and Crouch (1988), the detection limits in ng/mL of the elements measured are Al(0.2), Ca(0.0001), Cd(0.07), Cr(0.08), Cu(0.04), Fe(0.09), Mg(0.003), Na(0.1), Ni(0.2), Si(2). Systematic errors are much less likely than random errors in this case.

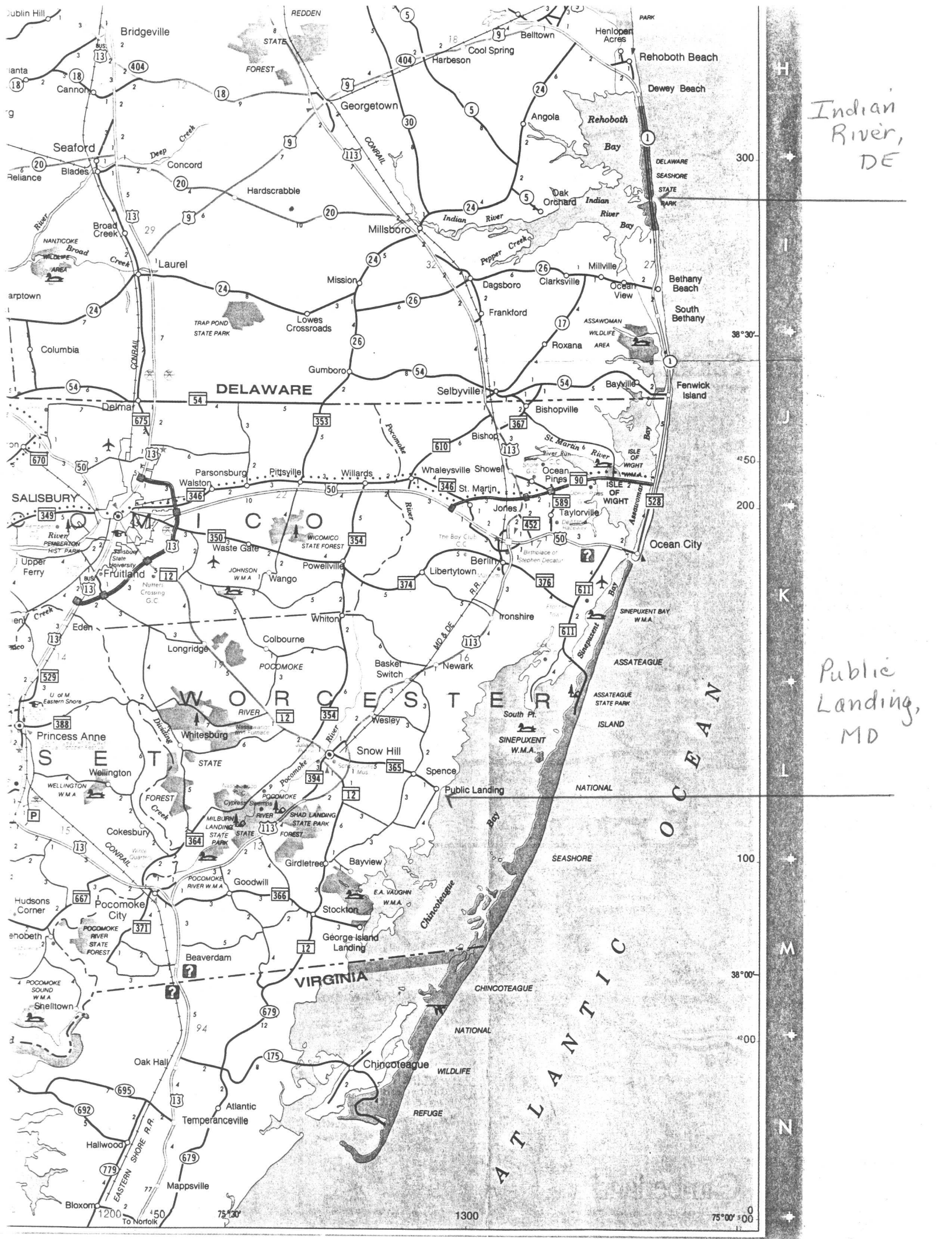
Sources of random error include weighing errors in using the balance and differences in the relative wet and dry weights of the samples and "standard" used to calculate the conversion factor. For example, the green samples were still partially frozen and may have contained more water than the green standard. A large source of error occurred in sample collection of the red algae, which was contaminated with other species and should have been separated before freezing. Other random errors could have occurred during sample preparation, such as insufficiently cleaning the glassware. Another possible source of error was leaving insufficient time between samples in the ICP procedure, resulting in cross-contamination. Finally, other random errors could occur in transposing data into the computer and in learning a new computer program.

ACKNOWLEDGMENTS

I would like to thank Elaine Furbish at Assateague Island National Seashore for her assistance in providing articles on seaweed in the area and for recommending places to find seaweed. I would also like to thank the Virginia Institute of Marine Science for attempting a tentative (long distance) identification of the red "seaweed" sample.

References

- E.Carpene and L.Boni, "Effects of Heavy Metals on the Algae *Nitzschia Closterium* and *Prorocentrum Micans*," Science of the Total Environment, Supplement 1992, Elsevier Science Publishers B.V., Amsterdam, p.921.
- C.H.Day, Life on Intertidal Rocks, Nature Study Guild, 1987.
- E.A.Ghabbour, A.H.Khairi, D.P.Cheney, V.Gross, G.Davies, T.Gilbert, X.Zhang, "Isolation of Humic Acid from the Brown Alga *Pilayella littoralis*," Northeastern University, 1994.
- C.J.Hillson, Seaweeds, The Pennsylvania State University Press, University Park, 1977.
- J.D.Ingle, Jr. and S.R.Crouch, Spectrochemical Analysis, Prentice Hall, Englewood Cliffs, N.J., 1988.
- K.O.Konhauser and W.S.Fyfe, "Biogeochemical Cycling of Metals in Freshwater Algae from Manaus and Carajas, Brazil," Energy Sources, Vol.15, No.4, p.595, 1993.
- T.W.Kureishy, "Heavy Metals in Algae Around the Coast of Qatar," Marine Pollution Bulletin, Vol.22, No.8, p.414, 1991.
- B.McAllister and P.Shea, "Pilayella littoralis, A Trace Metal Analysis," Lab Report, Northeastern University, 1993.
- E.T.Moul, "Algae of Chincoteague Bay, Maryland," from Assateague National Seashore Park Library, 1958.
- C.P.White, Chesapeake Bay, A Field Guide, Nature of the Estuary, Tidewater Publishers, Centreville, Maryland, 1989.
- B.L.Wulff, E.M.T.Wulff, B.H.Robison, J.K.Lowry, and H.J.Humm, "Summer Marine Algae of the Jetty at Ocean City, Maryland," Chesapeake Science, Vol.9, No1, p.56, 1968.
- H.S.Zim and L.Ingle, Seashores, Golden Press, N.Y. 1989.



Indian River, DE

Public Landing, MD

H
I
J
K
L
M
N

300

38°30'

42°50'

200

100

0

38°00'

42°00'

0

75°00' 00"

1300

1200

75°00' 00"

Table 1. Seaweed Collection Parameters

<u>Sample</u>	<u>Date</u>	<u>Time</u>	<u>Place</u>	<u>Latitude/Longitude</u>
Green	7-21-94	5 PM	Indian River, Delaware	38°37' / 75°05'
Red	7-21-94	10 AM	Public Landing, Maryland	38°09' / 75°17'

<u>Location</u>	<u>High Tide</u>	<u>Low Tide</u>
Indian River, DE	7:41 AM 8:04 PM	1:32 AM 1:42 PM
Chincoteague, MD	7:47 AM 8:10 PM	1:54 AM 2:04 PM

Sample	Beaker + Stones	Beaker + Stones + Wet Seaweed	Wet Seaweed	Dry Seaweed
1-Green	30.5605	33.3941	2.8336	0.323
2-Green	30.386	33.0465	2.6605	0.3033
3-Green	27.4985	31.206	3.7075	0.4227
4-Red	30.7312	32.5885	1.8573	0.2396
5-Red	30.5979	34.1	3.5021	0.4518
6-Red	30.243	32.1695	1.9265	0.2485

Weight of seaweed in grams.

Sample	Wet Seaweed	Dry Seaweed	Factor
Green	5.1586	0.586	0.114
Red	3.128	0.4032	0.129

Calculation of factor to convert "wet" to "dry" weight of seaweed.

Elements	DI 1	DI 2a	DI 2b	DI 2c	2 Average	2 Std. Dev.	DI 3a	DI 3b	DI 3c	3 Average	3 Std. Dev.
Al	0	-0.016	-0.012	0.02	-.003	.02	-0.011	0.01	0.007	.002	.011
Ca	0	0.29	0.087	0.045	.141	.131	0.366	0.017	0.01	.131	.204
Cd	0	0.002	0.001	0.001	.001	.001	0.015	0.002	0.004	.007	.007
Cr	0	-0.005	0.001	-0.007	-.004	.004	-0.008	0	-0.008	-.005	.005
Cu	0	-0.003	-0.017	-0.005	-.008	.008	-0.01	0.003	0.003	-.001	.008
Fe	0	0.068	0.018	0.012	.033	.031	0.031	0	0.011	.014	.016
Mg	0	0.215	0.078	0.042	.112	.091	0.014	0.004	0.004	.007	.006
Na	0	1.37	0.668	0.41	.816	.497	0.171	0.176	0.355	.234	.105
Ni	0	0.026	0.018	-0.008	.012	.018	-0.007	0.018	0.011	.007	.013
Si	0	-0.016	0.011	-0.016	-.007	.016	-0.011	-0.034	-0.01	-.018	.014

ICP data and calculation of average ug element/ml with standard deviation to show baseline stability throughout the ICP analysis.

Element	Blank 7b	Blank 7c	Blank 8a	Blank 8b	Blank 8c	Blank Average	Blank Std. Dev.
Al	0.135	0.189	0.215	0.288	0.281	.222	0.064
Ca	1.4	1.31	2.1	2.19	2.17	1.834	0.44
Cd	0.042	0.037	0.068	0.076	0.079	.06	0.02
Cr	0.003	0.001	-0.003	-0.004	0.008	.001	0.005
Cu	-0.002	0.007	0.006	0.009	0.01	.006	0.005
Fe	0.112	0.097	0.143	0.144	0.14	.127	0.021
Mg	0.07	0.039	0.073	0.071	0.069	.064	0.014
Na	0.746	0.373	0.564	0.268	0.512	.493	0.183
Ni	0.039	0.073	0.006	0.009	0.037	.033	0.027
Si	0.002	-0.007	-0.011	-0.004	0.026	.001	0.015

ICP data and calculation of procedural blank average (ug of element/ml) and standard deviation.

GREEN SEAWEED

1

Elements	1a	1b	1c	1a - Blank	1b - Blank	1c - Blank	1 Average	1 Std. Dev.	1 Av./Dry Wt.
Al	2.33	2.34	2.35	2.108	2.118	2.128	2.118	.272	6.557
Ca	18.2	18.3	18.4	16.366	16.466	16.566	16.466	.735	50.978
Cd	0.12	0.097	0.097	0.06	0.037	0.037	.045	.182	.138
Cr	0.076	0.063	0.057	0.075	0.062	0.056	.064	.121	.199
Cu	0.053	0.039	0.033	0.047	0.033	0.027	.036	.124	.11
Fe	3.27	3.3	3.34	3.143	3.173	3.213	3.176	.237	9.834
Mg	39.6	40.1	40.4	39.536	40.036	40.336	39.969	.647	123.744
Na	198	201	202	197.507	200.507	201.507	199.84	1.505	618.701
Ni	0.302	0.153	0.161	0.269	0.12	0.128	.172	.333	.534
Si	0.724	0.543	0.448	0.723	0.542	0.447	.571	.394	1.767

2

Elements	2a	2b	2c	2a - Blank	2b - Blank	2c - Blank	2 Average	2 Std. Dev.	2 Av./Dry Wt.
Al	1.8	1.87	1.81	1.578	1.648	1.588	1.605	.319	5.291
Ca	17.5	17.6	17.4	15.666	15.766	15.566	15.666	.735	51.652
Cd	0.109	0.106	0.111	0.049	0.046	0.051	.049	.15	.16
Cr	0.068	0.059	0.055	0.067	0.058	0.054	.06	.108	.197
Cu	0.015	0.014	0.016	0.009	0.008	0.01	.009	.077	.03
Fe	2.77	2.78	2.75	2.643	2.653	2.623	2.64	.19	8.703
Mg	40.3	40.9	40.6	40.236	40.836	40.536	40.536	.56	133.65
Na	205	208	204	204.507	207.507	203.507	205.174	1.505	676.471
Ni	0.148	0.148	0.136	0.115	0.115	0.103	.111	.184	.366
Si	0.468	0.476	0.442	0.467	0.475	0.441	.461	.181	1.52

3

Elements	3a	3b	3c	3a - Blank	3b - Blank	3c - Blank	3 Average	3 Std. Dev.	3 Av./Dry Wt.
Al	3.55	3.42	3.47	3.328	3.198	3.248	3.258	.36	7.708
Ca	30.4	29.8	29.9	28.566	27.966	28.066	28.199	.873	66.712
Cd	0.399	0.401	0.393	0.339	0.341	0.333	.338	.155	.799
Cr	0.097	0.101	0.09	0.096	0.1	0.089	.095	.103	.225
Cu	0.042	0.03	0.032	0.036	0.024	0.026	.029	.107	.068
Fe	5.42	5.32	5.34	5.293	5.193	5.213	5.233	.272	12.38
Mg	60.6	59.8	60.1	60.536	59.736	60.036	60.103	.647	142.188
Na	302	295	296	301.507	294.507	295.507	297.174	1.992	703.037
Ni	0.258	0.23	0.238	0.225	0.197	0.205	.209	.204	.494
Si	0.768	0.724	0.712	0.767	0.723	0.711	.734	.211	1.736

ICP data and calculation of ug of element/gram of dry seaweed (green).

RED SEAWEED

#4

Elements	4a	4b	4c	4a - Blank	4b - Blank	4c - Blank	4 Average	4 Std. Dev.	4 Av./Dry Wt.
Al	8.56	8.93	9.14	8.338	8.708	8.918	8.655	.598	36.121
Ca	36.2	36.6	37.2	34.366	34.766	35.366	34.833	.971	145.378
Cd	0.073	0.054	0.056	0.013	-0.006	-0.004	.001	.174	.004
Cr	0.063	0.054	0.045	0.062	0.053	0.044	.053	.118	.221
Cu	0.045	0.048	0.04	0.039	0.042	0.034	.038	.095	.16
Fe	12.7	13.1	13.4	12.573	12.973	13.273	12.94	.61	54.005
Mg	26.6	24.7	25.1	26.536	24.636	25.036	25.403	1.008	106.021
Na	141	133	135	140.507	132.507	134.507	135.84	2.085	566.946
Ni	0.075	0.121	0.119	0.042	0.088	0.086	.072	.23	.301
Si	0.946	0.983	0.999	0.945	0.982	0.998	.975	.205	4.069

#5

Elements	5a	5b	5c	5a - Blank	5b - Blank	5c - Blank	5 Average	5 Std. Dev.	5 Av./Dry Wt.
Al	26.1	27.2	27.3	25.878	26.978	27.078	26.645	.854	58.974
Ca	45.9	47.5	47.6	44.066	45.666	45.766	45.166	1.181	99.969
Cd	0.064	0.07	0.064	0.004	0.01	0.004	.006	.153	.013
Cr	0.133	0.143	0.138	0.132	0.142	0.137	.137	.1	.303
Cu	0.091	0.089	0.089	0.085	0.083	0.083	.084	.078	.185
Fe	39	40.6	40.7	38.873	40.473	40.573	39.973	.987	88.475
Mg	49.3	51.3	51.5	49.236	51.236	51.436	50.636	1.109	112.076
Na	247	256	257	246.507	255.507	256.507	252.84	2.385	559.629
Ni	0.189	0.218	0.21	0.156	0.185	0.177	.173	.205	.382
Si	3.54	3.75	3.73	3.539	3.749	3.729	3.672	.362	8.128

#6

Elements	6a	6b	6c	6a - Blank	6b - Blank	6c - Blank	6 Average	6 Std. Dev.	6 Av./Dry Wt.
Al	20.4	20.7	20.3	20.178	20.478	20.078	20.245	.522	81.467
Ca	68.5	69.5	68.6	66.666	67.666	66.766	67.033	.995	269.749
Cd	0.066	0.066	0.066	0.006	0.006	0.006	.006	.141	.024
Cr	0.073	0.089	0.074	0.072	0.088	0.073	.078	.118	.313
Cu	0.072	0.075	0.071	0.066	0.069	0.065	.067	.084	.268
Fe	19.1	19.4	19.2	18.973	19.273	19.073	19.106	.417	76.887
Mg	29.3	29.6	29.4	29.236	29.536	29.336	29.369	.408	118.186
Na	141	143	141	140.507	142.507	140.507	141.174	1.157	568.103
Ni	0.172	0.153	0.178	0.139	0.12	0.145	.135	.2	.542
Si	1.54	1.54	1.48	1.539	1.539	1.479	1.519	.223	6.113

ICP data and calculation of ug of element/gram of dry seaweed (red).

Elements	Green Seaweed			Average	St. Dev.
	1 Av/Dry	2 Av/Dry	3 Av/Dry		
Al	6.557	5.291	7.708	6.52	1.21
Ca	50.978	51.652	66.712	56.4	8.9
Cd	0.138	0.16	0.799	.366	.375
Cr	0.199	0.197	0.225	.207	.016
Cu	0.11	0.03	0.068	.069	.04
Fe	9.834	8.703	12.38	10.3	1.88
Mg	123.744	133.65	142.188	133.	9.23
Na	618.701	676.471	703.037	666.	43.1
Ni	0.534	0.366	0.494	.465	.088
Si	1.767	1.52	1.736	1.67	.135

Elements	Red Seaweed			Average	St. Dev.
	4 Av/Dry	5 Av/Dry	6 Av/Dry		
Al	36.121	58.974	81.467	58.9	22.7
Ca	145.378	99.969	269.749	172.	87.9
Cd	0.004	0.013	0.024	.014	.01
Cr	0.221	0.303	0.313	.279	.05
Cu	0.16	0.185	0.268	.204	.057
Fe	54.005	88.475	76.887	73.1	17.5
Mg	106.021	112.076	118.186	112.	6.08
Na	566.946	559.629	568.103	565.	4.6
Ni	0.301	0.382	0.542	.408	.123
Si	4.069	8.128	6.113	6.1	2.03

Average ug of element/g dry seaweed for 3 green seaweed samples and 3 red seaweed samples with standard deviation for each.

PEAK 39216 14:01 16 AUG 94
APER X 152
APER Y 97

ID SEQ 1135 14:07 16 AUG 94
SIMULTANEOUS MULTI PROGRAM A A

	AVG	S.D.	1	2	3	4	5
CU	-.008	.010	.001	-.019	-.006		
NI	.002	.007	-.003	-.000	.010		

DI water
run as sample

ID D.I. SEQ 1136 14:09 16 AUG 94
SIMULTANEOUS MULTI PROGRAM A A

	AVG	S.D.	1	2	3	4	5
AL	.203	.068	.131	.208	.258		
CA	-.370	.000	-.370	-.370	-.370		
CD	-.829	.000	-.828	-.829	-.829		
CR	-.170	.003	-.168	-.174	-.169		
CU	-.005	.007	.000	-.002	-.014		
FE	-.002	.004	.001	-.007	-.002		
MG	-.039	.000	-.040	-.039	-.039		
NA	.157	.007	.153	.167	.152		
NI	-.008	.010	.002	-.009	-.018		
SI	-.154	.010	-.151	-.166	-.145		

DI water
run as background

SEQ 1137 14:10 16 AUG 94
SIMULTANEOUS MULTI PROGRAM A A

UPDATE 1 ~~BLANK~~ BACKGROUND

	AVG	S.D.	CORR	OLD	NEW	STND
AL	.220	.013	-.220	.201	-.000	.000
CA	-.031	.000	.031	-.370	.000	.000
CD	-.012	.000	.012	-.829	.000	.000
CR	-.000	.000	.000	-.177	.000	.000
CU	.000	.001	-.000	.000	.000	.000
FE	-.006	.004	.006	-.006	.000	.000
MG	-.039	.000	.039	-.039	.000	.000
NA	.058	.009	-.058	.058	-.000	.000
NI	-.001	.007	.001	-.001	.000	.000
SI	-.119	.018	.119	-.119	.000	.000

ID STD SEQ 1138 14:12 16 AUG 94
SIMULTANEOUS MULTI PROGRAM A A

SIMULTANEOUS MULTI PROGRAM A A

	AVG	S.D.	CORR	OLD	NEW	STND
AL	.220	.013	-.220	.201	-.000	.000
CA	-.031	.000	.031	-.370	.000	.000
CD	-.012	.000	.012	-.829	.000	.000
CR	-.000	.009	.000	-.177	.000	.000
CU	.000	.001	-.000	.000	.000	.000
FE	-.006	.004	.006	-.006	.000	.000
MG	-.039	.000	.039	-.039	.000	.000
NA	.058	.099	-.058	.058	-.000	.000
NI	-.001	.007	.001	-.001	.000	.000
SI	-.118	.018	.118	-.118	.000	.000

	AVG	S.D.	1	2	3	4	5
AL	7.17	.033	7.16	7.22	7.15		
CA *	44.3	.311	44.0	44.6	44.5		
CD	2.77	.017	2.76	2.79	2.77		
CR	5.01	.027	4.98	5.02	5.03		
CU	9.22	.086	9.12	9.29	9.24		
FE	5.79	.059	5.72	5.84	5.80		
MG	29.5	.204	29.2	29.6	29.5		
NA	40.8	.453	40.3	41.2	40.9		
NI	23.1	.192	22.8	23.2	23.2		
SI	31.8	.219	31.5	31.9	31.9		

UPDATE 2		STD				
	AVG	S.D.	CORR	OLD	NEW	STND
AL	7.74	.137	29.1%	7.08	10.0	10.0
CA *	49.3	.902	1.28%	44.2	50.0	50.0
CD	3.72	.077	168.2%	2.80	10.0	10.0
CR	5.94	.114	68.1%	5.03	10.0	10.0
CU	9.20	.184	8.62%	9.20	10.0	10.0
FE	5.80	.122	72.2%	5.80	10.0	10.0
MG	29.5	.583	68.9%	29.5	50.0	50.0
NA	40.9	.887	22.1%	40.9	50.0	50.0
NI	23.2	.545	115.2%	23.2	50.0	50.0
SI	31.6	.684	57.8%	31.6	50.0	50.0

ID 1 SEQ 1140 14:16 16 AUG 94
SIMULTANEDUS MULTI PROGRAM A A

[illegible]

	AVG	S.D.	1	2	3	4	5
AL	23.2	.547	18.2	23.2	50.0	50.0	50.0
SI	31.6	.684	27.8	31.6	50.0	50.0	50.0

ID 1 SEQ 1140 14:16 16 AUG 94
SIMULTANEOUS MULTI PROGRAM A A

	AVG	S.D.	1	2	3	4	5
AL	2.33	.054	2.28	2.32	2.39		
CA	18.2	.176	18.4	18.1	18.2		
CD	.120	.013	.135	.113	.111		
CR	.076	.012	.090	.071	.067		
CU	.053	.002	.051	.055	.052		
FE	3.27	.009	3.28	3.26	3.27		
MG	39.6	.192	39.8	39.4	39.6		
NA	198.	2.10	200.	196.	198.		
NI	.302	.028	.335	.279	.294		
SI	.724	.046	.776	.711	.685		

ID 1 SEQ 1141 14:16 16 AUG 94
SIMULTANEOUS MULTI PROGRAM A A

	AVG	S.D.	1	2	3	4	5
AL	2.34	.050	2.30	2.40	2.32		
CA	18.3	.357	18.1	18.8	18.2		
CD	.097	.003	.099	.100	.093		
CR	.063	.006	.057	.069	.062		
CU	.039	.008	.030	.042	.045		
FE	3.30	.085	3.24	3.40	3.27		
MG	40.1	.664	39.6	40.8	39.8		
NA	201.	4.74	198.	206.	199.		
NI	.153	.044	.162	.191	.104		
SI	.543	.033	.582	.528	.520		

ID 1 SEQ 1142 14:17 16 AUG 94
SIMULTANEOUS MULTI PROGRAM A A

	AVG	S.D.	1	2	3	4	5
AL	2.35	.048	2.40	2.30	2.34		
CA	18.4	.412	18.5	18.0	18.8		
CD	.097	.010	.106	.086	.097		
CR	.057	.006	.062	.061	.049		
CU	.033	.001	.034	.034	.031		
FE	3.34	.062	3.34	3.27	3.40		
MG	40.4	.815	40.5	39.6	41.2		
NA	202.	4.43	203.	198.	207.		
NI	.161	.012	.175	.149	.160		
SI	.448	.038	.464	.404	.476		

ID 2 SEQ 1143 14:18 16 AUG 94
SIMULTANEOUS MULTI PROGRAM A A

	AVG	S.D.	1	2	3	4	5
AL	1.80	.038	1.75	1.82	1.82		

4
m

AL	40.7	.015	4.43	203.3	41.2
NA	202.	4.43	203.	198.	207.
NI	.161	.012	.175	.149	.160
SI	.448	.038	.464	.404	.476

ID 2 SEQ 1143 14:18 16 AUG 94
SIMULTANEOUS MULTI PROGRAM A A

	AVG	S.D.	1	2	3	4	5
AL	1.80	.038	1.75	1.82	1.82		
CA	17.5	.113	17.4	17.6	17.4		
CD	.109	.001	.109	.110	.107		
CR	.068	.010	.055	.072	.076		
CU	.015	.001	.013	.016	.015		
FE	2.77	.037	2.80	2.78	2.73		
MG	40.3	.392	40.0	40.7	40.3		
NA	205.	1.61	203.	206.	204.		
NI	.148	.027	.166	.116	.162		
SI	.468	.072	.425	.552	.427		

ID 2 SEQ 1144 14:18 16 AUG 94
SIMULTANEOUS MULTI PROGRAM A A

	AVG	S.D.	1	2	3	4	5
AL	1.87	.026	1.88	1.89	1.84		
CA	17.6	.105	17.5	17.7	17.6		
CD	.106	.012	.094	.118	.105		
CR	.059	.013	.073	.046	.058		
CU	.014	.004	.009	.018	.016		
FE	2.78	.010	2.76	2.79	2.78		
MG	40.9	.178	40.7	41.0	40.9		
NA	208.	1.21	206.	208.	208.		
NI	.148	.020	.138	.135	.172		
SI	.476	.050	.418	.504	.507		

ID 2 SEQ 1145 14:19 16 AUG 94
SIMULTANEOUS MULTI PROGRAM A A

	AVG	S.D.	1	2	3	4	5
AL	1.81	.042	1.76	1.81	1.85		
CA	17.4	.150	17.2	17.4	17.5		
CD	.111	.003	.108	.111	.115		
CR	.055	.007	.056	.063	.047		
CU	.016	.006	.013	.023	.012		
FE	2.75	.019	2.73	2.76	2.77		
MG	40.6	.399	40.2	40.8	41.0		
NA	204.	1.02	203.	204.	205.		
NI	.136	.021	.157	.114	.136		
SI	.442	.030	.441	.411	.472		

SEQ 1146 14:20 16 AUG 94
SIMULTANEOUS MULTI PROGRAM A A

27 16 AUG 94
A A 4 5

26.1
45.9
.063
.144
.094
39.1
49.5
046.

	205	205	205	205	205
AL	.136	.021	.157	.114	.136
SI	.442	.030	.441	.411	.472

ID 3 SEQ 1146 14:20 16 AUG 94
SIMULTANEOUS MULTI PROGRAM A A

	AVG	S.D.	1	2	3	4	5
AL	3.55	.121	3.65	3.58	3.41		
CA	30.4	.325	30.7	30.3	30.1		
CD	.399	.016	.411	.406	.380		
CR	.097	.013	.102	.082	.108		
CU	.042	.011	.030	.052	.044		
FE	5.42	.032	5.46	5.42	5.40		
MG *	60.6	.524	61.2	60.5	60.2		
NA	302.	4.21	307.	300.	299.		
NI	.258	.007	.263	.261	.250		
SI	.768	.009	.779	.761	.765		

ID 3 SEQ 1147 14:21 16 AUG 94
SIMULTANEOUS MULTI PROGRAM A A

	AVG	S.D.	1	2	3	4	5
AL	3.42	.110	3.48	3.48	3.29		
CA	29.8	.103	29.7	29.8	29.9		
CD	.401	.005	.395	.406	.402		
CR	.101	.005	.098	.098	.108		
CU	.030	.002	.030	.028	.033		
FE	5.32	.017	5.31	5.31	5.34		
MG *	59.8	.153	59.6	59.8	59.9		
NA	295.	1.01	294.	296.	295.		
NI	.230	.015	.227	.247	.217		
SI	.724	.014	.707	.736	.728		

ID 3 SEQ 1148 14:21 16 AUG 94
SIMULTANEOUS MULTI PROGRAM A A

	AVG	S.D.	1	2	3	4	5
AL	3.47	.075	3.38	3.52	3.50		
CA	29.9	.392	30.1	30.2	29.5		
CD	.393	.009	.405	.389	.387		
CR	.090	.011	.086	.082	.103		
CU	.032	.007	.024	.038	.033		
FE	5.34	.079	5.36	5.40	5.25		
MG *	60.1	.759	60.1	60.8	59.3		
NA	296.	3.36	298.	299.	292.		
NI	.238	.005	.239	.232	.242		
SI	.712	.042	.716	.752	.667		

ID 4 SEQ 1149 14:22 16 AUG 94
SIMULTANEOUS MULTI PROGRAM A A

	AVG	S.D.	1	2	3	4	5
--	-----	------	---	---	---	---	---

	291.	292.	293.	294.	295.	296.
NI	.238	.005	.139	.232	.242	
SI	.712	.042	.716	.752	.667	

ID 4 SEQ 1149 14:22 16 AUG 94
SIMULTANEOUS MULTI PROGRAM A A

	AVG	S.D.	1	2	3	4	5
AL	8.56	.446	8.05	8.88	8.74		
CA *	36.2	.930	35.2	37.0	36.5		
CD	.073	.024	.101	.060	.058		
CR	.063	.001	.061	.063	.064		
CU	.045	.002	.043	.048	.044		
FE	12.7	.590	12.0	13.0	13.0		
MG	26.6	1.64	28.3	26.5	25.0		
NA	141.	6.88	147.	141.	133.		
NI	.075	.019	.053	.084	.089		
SI	.946	.047	.906	.998	.933		

ID 4 SEQ 1150 14:23 16 AUG 94
SIMULTANEOUS MULTI PROGRAM A A

	AVG	S.D.	1	2	3	4	5
AL	8.93	.179	8.85	9.14	8.81		
CA *	36.6	.650	36.5	37.3	36.0		
CD	.054	.003	.051	.056	.056		
CR	.054	.004	.051	.050	.059		
CU	.048	.013	.032	.055	.055		
FE	13.1	.187	13.1	13.3	12.9		
MG	24.7	.382	24.6	25.1	24.3		
NA	133.	2.83	133.	136.	130.		
NI	.121	.019	.138	.101	.124		
SI	.983	.007	.978	.992	.980		

ID 4 SEQ 1151 14:24 16 AUG 94
SIMULTANEOUS MULTI PROGRAM A A

	AVG	S.D.	1	2	3	4	5
AL	9.14	.232	8.95	9.40	9.08		
CA *	37.2	.413	36.8	37.6	37.3		
CD	.056	.008	.054	.049	.065		
CR	.045	.005	.049	.048	.039		
CU	.040	.003	.039	.037	.044		
FE	13.4	.160	13.3	13.6	13.5		
MG	25.1	.257	24.8	25.3	25.2		
NA	135.	1.64	134.	137.	136.		
NI	.119	.017	.099	.123	.134		
SI	.999	.012	.997	.987	1.01		

ID D.I. SEQ 1152 14:25 16 AUG 94
SIMULTANEOUS MULTI PROGRAM A A

	AVG	S.D.	1	2	3	4	5
AI	.015	.000	.011	.010	.000		

CR	.045	.003	.049	.048	.039
CU	.040	.003	.039	.037	.044
FE	13.4	.160	13.3	13.6	13.5
MG	25.1	.257	24.8	25.3	25.2
NA	135.	1.64	134.	137.	136.
NI	.119	.017	.099	.123	.134
SI	.999	.012	.997	.987	1.01

ID D.I. SEQ 1152 14:25 16 AUG 94
SIMULTANEOUS MULTI PROGRAM A A

	AVG	S.D.	1	2	3	4	5
AL	-.016	.022	-.041	-.010	.002		
CA	.290	.124	.424	.267	.178		
CD	.002	.004	.007	-.000	.000		
CR	-.005	.015	-.009	.011	-.018		
CU	-.003	.004	-.007	-.004	.001		
FE	.068	.024	.092	.067	.044		
MG	.215	.083	.305	.199	.140		
NA	1.37	.310	1.72	1.13	1.26		
NI	.026	.016	.039	.030	.008		
SI	-.016	.035	-.014	-.052	.018		

ID *DI* SEQ 1153 14:25 16 AUG 94
SIMULTANEOUS MULTI PROGRAM A A

	AVG	S.D.	1	2	3	4	5
AL	-.012	.055	.051	-.052	-.036		
CA	.087	.012	.100	.088	.074		
CD	.001	.004	.000	.006	-.002		
CR	.001	.008	-.002	-.004	.011		
CU	-.017	.003	-.014	-.020	-.017		
FE	.018	.010	.030	.010	.014		
MG	.078	.010	.087	.080	.067		
NA	.668	.036	.638	.709	.657		
NI	.018	.035	.034	.043	-.021		
SI	.011	.038	.009	.051	-.025		

ID *DI* SEQ 1154 14:26 16 AUG 94
SIMULTANEOUS MULTI PROGRAM A A

	AVG	S.D.	1	2	3	4	5
AL	.020	.068	.071	-.056	.047		
CA	.045	.004	.049	.046	.040		
CD	.001	.000	.000	.001	.000		
CR	-.007	.021	.017	-.020	-.018		
CU	-.005	.009	-.009	.005	-.012		
FE	.012	.002	.015	.009	.011		
MG	.042	.004	.046	.042	.037		
NA	.410	.051	.385	.377	.469		
NI	-.008	.011	-.020	-.005	.001		
SI	-.016	.028	-.039	.016	-.025		

FE	.012	.002	.015	.009	.011
MG	.042	.004	.046	.042	.037
NA	.410	.051	.385	.377	.469
NI	-.008	.011	-.020	-.005	.001
SI	-.016	.029	-.039	.016	-.025

ID 5 SEQ 1155 14:27 16 AUG 94
SIMULTANEDOUS MULTI PROGRAM A A

	AVG	S.D.	1	2	3	4	5
AL	26.1	.574	25.6	26.7	26.1		
CA *	45.9	.974	44.9	46.8	45.9		
CD	.064	.002	.062	.067	.063		
CR	.133	.013	.118	.136	.144		
CU	.091	.004	.093	.085	.094		
FE	39.0	.877	38.0	39.8	39.1		
MG	49.3	.996	48.2	50.2	49.5		
NA	247.	6.18	241.	253.	246.		
NI	.189	.022	.215	.174	.178		
SI	3.54	.101	3.43	3.61	3.59		

ID 5 SEQ 1156 14:27 16 AUG 94
SIMULTANEDOUS MULTI PROGRAM A A

	AVG	S.D.	1	2	3	4	5
AL	27.2	.321	26.9	27.2	27.6		
CA *	47.5	.344	47.2	47.5	47.9		
CD	.070	.001	.072	.068	.069		
CR	.143	.008	.141	.136	.152		
CU	.089	.005	.084	.087	.095		
FE	40.6	.295	40.4	40.6	41.0		
MG	51.3	.332	51.0	51.3	51.7		
NA	256.	2.34	254.	256.	259.		
NI	.218	.046	.205	.180	.269		
SI	3.75	.022	3.77	3.76	3.72		

ID 5 SEQ 1157 14:28 16 AUG 94
SIMULTANEDOUS MULTI PROGRAM A A

	AVG	S.D.	1	2	3	4	5
AL	27.3	.124	27.2	27.4	27.2		
CA *	47.6	.265	47.4	47.9	47.4		
CD	.064	.002	.061	.065	.066		
CR	.138	.007	.147	.133	.135		
CU	.089	.013	.088	.076	.104		
FE	40.7	.268	40.5	41.0	40.6		
MG	51.5	.339	51.2	51.8	51.3		
NA	257.	1.25	256.	258.	256.		
NI	.210	.050	.158	.257	.216		
SI	3.73	.058	3.67	3.79	3.72		

ID 6 SEQ 1158 14:29 16 AUG 94
SIMULTANEDOUS MULTI PROGRAM A A

FE	40.7	.268	40.5	41.0	40.6
MG	51.5	.339	51.2	51.8	51.3
NA	257.	1.25	256.	258.	256.
NI	.210	.050	.158	.257	.216
SI	3.73	.058	3.67	3.79	3.72

ID 6 SEQ 1158 14:29 16 AUG 94
SIMULTANEOUS MULTI PROGRAM A A

	AVG	S.D.	1	2	3	4	5
AL	20.4	.468	20.1	20.1	20.9		
CA *	68.5	1.18	68.0	67.6	69.8		
CD	.066	.002	.063	.068	.068		
CR	.073	.009	.062	.077	.081		
CU	.072	.003	.070	.069	.075		
FE	19.1	.319	19.0	18.9	19.5		
MG	29.3	.444	29.0	29.0	29.8		
NA	141.	3.38	139.	138.	145.		
NI	.172	.010	.165	.166	.183		
SI	1.54	.059	1.52	1.61	1.49		

ID 6 SEQ 1159 14:30 16 AUG 94
SIMULTANEOUS MULTI PROGRAM A A

	AVG	S.D.	1	2	3	4	5
AL	20.7	.139	20.7	20.5	20.8		
CA *	69.5	.378	69.7	69.1	69.7		
CD	.066	.007	.074	.066	.059		
CR	.089	.004	.091	.092	.084		
CU	.075	.004	.070	.075	.079		
FE	19.4	.145	19.5	19.2	19.4		
MG	29.6	.111	29.7	29.5	29.6		
NA	143.	1.29	144.	141.	144.		
NI	.153	.039	.191	.153	.113		
SI	1.54	.078	1.56	1.46	1.62		

ID 6 SEQ 1160 14:31 16 AUG 94
SIMULTANEOUS MULTI PROGRAM A A

	AVG	S.D.	1	2	3	4	5
AL	20.3	.225	20.5	20.1	20.3		
CA *	68.6	.363	69.0	68.3	68.6		
CD	.066	.003	.063	.065	.069		
CR	.074	.006	.069	.072	.082		
CU	.071	.010	.082	.062	.068		
FE	19.2	.167	19.4	19.0	19.1		
MG	29.4	.159	29.5	29.2	29.3		
NA	141.	1.54	143.	140.	141.		
NI	.178	.018	.166	.199	.170		
SI	1.48	.038	1.52	1.47	1.44		

ID 7 SEQ 1161 14:32 16 AUG 94
SIMULTANEOUS MULTI PROGRAM A A

AL	18.2	.16	1.1	18.6	19.1
MG	29.4	.159	29.5	29.2	29.3
NA	141.	1.54	143.	140.	141.
NI	.178	.018	.168	.199	.170
SI	1.48	.038	1.52	1.47	1.44

ID 7 SEQ 1161 14:32 16 AUG 94
SIMULTANEOUS MULTI PROGRAM A A

	AVG	S.D.	1	2	3	4	5
AL	.539	.333	.887	.508	.222		
CA	2.84	1.10	3.88	2.30	1.74		
CD	.041	.005	.048	.036	.040		
CR	.001	.013	.001	.011	.014		
CU	.007	.008	.002	.016	.002		
FE	.452	.290	.778	.355	.222		
MG	.579	.455	1.08	.430	.217		
NA	2.75	2.00	4.99	2.12	1.12		
NI	.021	.008	.027	.011	.026		
SI	.031	.008	.033	.021	.038		

ID 7 SEQ 1162 14:32 16 AUG 94
SIMULTANEOUS MULTI PROGRAM A A

	AVG	S.D.	1	2	3	4	5
AL	.135	.049	.181	.142	.082		
CA	1.40	.034	1.43	1.38	1.37		
CD	.042	.003	.039	.041	.046		
CR	.003	.007	.004	.005	.010		
CU	-.002	.010	.011	.005	.008		
FE	.112	.011	.117	.119	.099		
MG	.070	.013	.084	.069	.057		
NA	.746	.108	.847	.631	.760		
NI	.039	.038	.082	.027	.009		
SI	.002	.015	.014	.009	.013		

ID 7 SEQ 1163 14:33 16 AUG 94
SIMULTANEOUS MULTI PROGRAM A A

	AVG	S.D.	1	2	3	4	5
AL	.189	.032	.227	.178	.164		
CA	1.31	.026	1.34	1.32	1.28		
CD	.037	.001	.037	.038	.035		
CR	.001	.001	.000	.000	.002		
CU	.007	.006	.001	.008	.014		
FE	.097	.010	.106	.100	.085		
MG	.039	.002	.042	.039	.037		
NA	.373	.170	.253	.568	.297		
NI	.073	.015	.091	.061	.067		
SI	-.007	.016	.006	.025	.003		

ID 8 SEQ 1164 14:34 16 AUG 94
SIMULTANEOUS MULTI PROGRAM A A

	AVG	S.D.	1	2	3	4	5
AL	.281	.029	.310	.283	.251		
CA	2.17	.020	2.19	2.16	2.15		
CD	.079	.007	.087	.076	.075		
CR	.008	.006	.015	.003	.006		
CU	.010	.003	.008	.014	.009		
FE	.140	.004	.139	.145	.137		
MG	.069	.000	.069	.069	.069		
NA	.512	.266	.743	.220	.574		
NI	.037	.006	.031	.044	.037		
SI	.026	.036	.046	.048	.016		

ID 9 SEQ 1167 14:36 16 AUG 94
SIMULTANEOUS MULTI PROGRAM A A

	AVG	S.D.	1	2	3	4	5
AL	.192	.011	.194	.181	.203		
CA	4.28	.152	4.11	4.41	4.31		
CD	.179	.002	.175	.180	.180		
CR	.007	.014	.023	.005	.005		
CU	.017	.005	.013	.015	.024		
FE	.358	.010	.349	.356	.369		
MG	.091	.002	.087	.092	.092		
NA	.397	.160	.439	.220	.532		
NI	.029	.015	.023	.017	.046		
SI	-.023	.014	-.006	.033	.029		

ID 9 SEQ 1168 14:37 16 AUG 94
SIMULTANEOUS MULTI PROGRAM A A

	AVG	S.D.	1	2	3	4	5
AL	.192	.082	.287	.134	.157		
CA	4.26	.148	4.36	4.09	4.33		
CD	.172	.004	.173	.168	.177		
CR	.001	.021	.018	.023	.008		
CU	.005	.005	.011	.002	.001		
FE	.354	.020	.363	.330	.369		
MG	.092	.002	.093	.089	.095		
NA	.537	.247	.739	.261	.613		
NI	.015	.005	.016	.021	.010		
SI	-.038	.047	.023	.000	.091		

ID 9 SEQ 1169 14:37 16 AUG 94
SIMULTANEOUS MULTI PROGRAM A A

	AVG	S.D.	1	2	3	4	5
AL	.173	.026	.191	.185	.143		
CA	4.34	.043	4.38	4.29	4.34		
CD	.180	.000	.186	.170	.183		
CR	.000	.000	.009	.006	.003		
CU	.010	.010	.003	.022	.005		
FE	.367	.003	.364	.366	.371		
MG	.094	.001	.095	.093	.094		
NA	.595	.292	.902	.565	.319		
NI	.017	.021	.007	.002	.041		
SI	-.004	.047	.002	.052	.042		

CU	.010	.010	.003	.022	.005
FE	.367	.003	.364	.366	.371
MG	.094	.001	.095	.093	.094
NA	.595	.292	.902	.565	.319
NI	.017	.021	.007	.002	.041
SI	-.004	.047	-.002	.052	.042

ID DI SEQ 1170 14:38 16 AUG 94
SIMULTANEOUS MULTI PROGRAM A A

	AVG	S.D.	1	2	3	4	5
AL	-.011	.037	-.010	.025	-.048		
CA	.366	.381	.799	.218	.080		
CD	.015	.021	.039	.010	-.002		
CR	-.008	.003	-.010	-.010	-.003		
CU	-.010	.004	-.011	-.014	-.004		
FE	.031	.039	.077	.009	.007		
MG	.014	.008	.024	.011	.008		
NA	.171	.025	.142	.180	.191		
NI	-.007	.012	-.012	-.017	.006		
SI	-.011	.015	-.029	.001	-.006		

ID DI SEQ 1171 14:39 16 AUG 94
SIMULTANEOUS MULTI PROGRAM A A

	AVG	S.D.	1	2	3	4	5
AL	.010	.052	.000	.066	-.037		
CA	.017	.002	.020	.015	.015		
CD	.002	.003	.000	.000	.006		
CR	.000	.014	-.014	.001	.015		
CU	.003	.006	.000	-.002	.010		
FE	.000	.006	-.001	-.004	.008		
MG	.004	.000	.004	.004	.004		
NA	.176	.062	.231	.189	.109		
NI	.018	.023	.042	.017	-.004		
SI	-.034	.039	-.079	.015	-.006		

ID DI SEQ 1172 14:40 16 AUG 94
SIMULTANEOUS MULTI PROGRAM A A

	AVG	S.D.	1	2	3	4	5
AL	.007	.041	.054	-.025	-.006		
CA	.010	.001	.012	.010	.010		
CD	.004	.004	.000	.008	.005		
CR	-.008	.004	.014	-.006	-.005		
CU	.003	.003	.006	.000	.003		
FE	.011	.007	.002	.016	.016		
MG	.004	.000	.004	.003	.004		
NA	.355	.144	.339	.507	.220		
NI	.011	.014	.018	.021	-.005		
SI	-.010	.012	-.022	.002	-.010		