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UNION CARBIDE NUCLEAR COMPANY

POST OFFICE BOX P
OAK RIDGE, TENNESSEE

ORNL
CENTRAL FILES NUMBER

0
CF-56-3-60

External Transmittal Authorized

COPY NO. 42

DATE: March 12, 1956

SUBJECT: Progress Report: Spectrographic Analysis of Tissues for Trace Elements
July 1, 1955 Through December 31, 1955

TO: K. Z. Morgan

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and K. K. McDaniel

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PROGRESS REPORT: SPECTROGRAPHIC ANALYSIS OF TISSUES
FOR TRACE ELEMENTS - JULY 1, 1955 THROUGH DECEMBER 31, 1955

I.H. Tipton*, M.J. Cook**, R.S. Steiner*,
W.D. Foland*, D.K. Bowman** and K.K. McDaniel**

During the period from July 1, 1955 through December 31, 1955 the collection of normal human tissue has been extended to four more cities in the United States making a total of eight. At the time of autopsy each tissue is placed in a separate polyethylene bag, labeled and frozen immediately. The tissues are packed in dry ice and shipped via air express to Oak Ridge where they are stored in a deep freeze until time for ashing. From the time of shipment until arrival the time in each instance has been less than 24 hours.

During this six month interval 806 tissues have been dry ashed and over 30,000 spectrographic determinations have been made.

The procedure for dry ashing is as follows:

(1) The tissues are trimmed, weighed and washed in ion exchange water.

(2) The samples are put into fused silica dishes and placed in a cold oven. The temperature is brought gradually to 300° C at which temperature the tissues remain for 20 hours.

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(3) At the end of 20 hours the tissues are cooled and reweighed to obtain the dry weight.

(4) Tissues are placed in a cold oven and the temperature is brought gradually to 450° C at which temperature the tissues remain for 24 hours or longer is necessary.

(5) The tissue ashes are cooled and weighed.

(6) The ash is transferred to a polyethylene bottle and ground for 30 minutes.

The analytical method is essentially the same as that described in an earlier report (O.R.N.L. Central Files, 54-12-66) except that two internal standards are employed; indium for the elements bismuth, boron, cadmium, gallium, gold, lead, silver, tin and zinc; and palladium for the elements aluminum, barium, cesium, chromium, cobalt, copper, gold, iron, lanthanum, manganese, molybdenum, nickel, strontium, titanium and vanadium. The upper and lower limits of sensitivity in parts per million of variation in per cent are given in Tables 1 and 2. The coefficients of variation were determined from 16 replicate analyses of a single standard sample.

The improved techniques of collection and ashing make the analyses more meaningful since there is considerably less contamination.

A portion of the results of the analyses of tissues from autopsies of victims of instantaneous death collected from one city are presented. These tables do not include all of the tissues received from these autopsies but only the tissues

analyzed spectrographically prior to December 31, 1955. All of the elements listed were sought and a blank space means that nothing was detected within the limits of sensitivity. Tables 3 through 21 present the data arranged by elements and Tables 22 through 44 present the data arranged by tissues.

MJC:IHT/mgw

TABLE 1
LIMITS OF SENSITIVITY
(ppm in ash)
COEFFICIENTS OF VARIATION
(%)
Soft Tissue

Element	Upper Limit	Lower Limit	Coefficient of Variation
Aluminum	4000	2	15
Barium	400	0.2	20
Bismuth	400	10	
Boron	400	10	
Cadmium	5000	75	4
Cesium	3000	100	
Chromium	1000	0.1	10
Cobalt	400	5	
Copper	1000	25	5
Gallium	20	1	
Gold	400	20	
Iron	150,000	1000	
Lanthanum		100	
Lead	1000	10	15
Manganese	1000	1	10
Molybdenum	1000	10	10
Nickel	1000	10	10
Silver	400	1	15
Strontium	40	1	15
Tin	1000	10	20
Titanium	1000	10	15
Vanadium	1000	10	
Zinc	10,000	400	5

Other elements with lower limits include: Antimony (100),
Arsenic (300), Beryllium (3), Niobium (100), Ruthenium (10),
Thallium (10) and Zirconium (30).

TABLE 2
LIMITS OF SENSITIVITY
(ppm in ash)

<u>Bone</u>		
Element	Upper Limit	Lower Limit
Aluminum	100	4
Barium	200	4
Bismuth		20
Boron		30
Cadmium		200
Cesium		
Chromium		5
Cobalt		10
Copper	100	2
Gallium		5
Gold		15
Iron	4000	100
Lanthanum		
Lead	400	10
Manganese	100	2
Molybdenum		15
Nickel		30
Silver	100	1
Strontium	1000	10
Tin	400	10
Titanium		40
Vanadium		20
Zinc	3000	700

Other elements with lower limits include: Antimony (100), Arsenic (1000), Cesium (400), Lanthanum (400), Niobium (150), Ruthenium (?), Thallium (20) and Zirconium (400).

TABLE 3
CONCENTRATIONS OF ELEMENTS IN WET TISSUE
(Arranged by Elements)

Tissue Adrenal (3 samples analyzed) 0.50 mean per cent ash

Elements	Number of Samples Containing Element		Average Value for Samples Containing Element ($\mu\text{g/g}$)
Aluminum	3		0.70
Barium	3		0.03
Bismuth			
Boron	2	1*	0.17
Cadmium	2		0.41
Cesium			
Chromium	3		0.08
Cobalt	2		0.05
Copper	3		1.1
Gallium			
Gold	2	1*	0.24
Iron	3		28
Lanthanum			
Lead	3		0.08
Manganese	3		0.15
Molybdenum	2	1*	0.17
Nickel	3		0.50
Silver	3		0.03
Strontium	3		0.03
Tin	3		0.24
Titanium	2		0.16
Vanadium			
Zinc	3		7.8
(*) Trace			636 007

Antimony, Arsenic, Beryllium, Niobium, Ruthenium, Thallium and Zirconium were sought in every sample but none were detected.

TABLE 4
CONCENTRATIONS OF ELEMENTS IN WET TISSUE
(Arranged by Elements)

Tissue Aorta (12 samples analyzed) 0.96 mean per cent ash

Elements	Number of Samples Containing Element		Average Value for Samples Containing Element ($\mu\text{g/g}$)
Aluminum	12		0.87
Barium	12		0.11
Bismuth	3		0.40
Boron	1		0.40
Cadmium	1		0.87
Cesium			
Chromium	4	2*	0.07
Cobalt	2		0.12
Copper	12		1.1
Gallium			
Gold	1	2*	0.24
Iron	12		30
Lanthanum			
Lead	11	1*	0.87
Manganese	12		0.10
Molybdenum			
Nickel	3		0.35
Silver	7	2*	0.06
Strontium	12		0.20
Tin	10	1*	0.30
Titanium	2	1*	0.48
Vanadium		1*	<0.10 T
Zinc	12		16

(*) Trace

636 008

Antimony, Arsenic, Beryllium, Niobium, Ruthenium, Thallium and Zirconium were sought in every sample but none were detected.

TABLE 5
CONCENTRATIONS OF ELEMENTS IN WET TISSUE
(Arranged by Elements)

Tissue Bladder (13 samples analyzed) 0.83 mean per cent ash

Elements	Number of Samples Containing Element		Average Value for Samples Containing Element ($\mu\text{g/g}$)
Aluminum	13		1.1
Barium	10	1*	0.03
Bismuth			
Boron	1	1*	0.30
Cadmium			
Cesium	1	1*	1.7
Chromium	5		0.06
Cobalt			
Copper	13		1.1
Gallium			
Gold		1*	<0.16 T
Iron	13		19
Lanthanum			
Lead	8	1*	0.23
Manganese	11		0.10
Molybdenum			
Nickel	3	1*	0.29
Silver	3	5*	0.008
Strontium	13		0.12
Tin	11		0.20
Titanium	3	1*	1.1
Vanadium			
Zinc	13		21

(*) Trace

636 009

Antimony, Arsenic, Beryllium, Niobium, Ruthenium, Thallium and Zirconium were sought in every sample but none were detected.

TABLE 6
CONCENTRATIONS OF ELEMENTS IN WET TISSUE
(Arranged by Elements)

Tissue Bone (23 samples analyzed) 17.6 mean per cent ash

Elements	Number of Samples Containing Element		Average Value for Samples Containing Element ($\mu\text{g/g}$)
Aluminum	13	5*	0.53
Barium	23		1
Bismuth			
Boron			
Cadmium		1*	
Cesium			
Chromium		1*	<0.8 T
Cobalt			
Copper	23		0.69
Gallium			
Gold			
Iron	23		95
Lanthanum			
Lead	23		4.2
Manganese		1*	<0.35 T
Molybdenum			
Nickel	1		1.8
Silver	1		0.4
Strontium	23		20
Tin	1	1*	3
Titanium			
Vanadium			
Zinc			

(*) Trace

Antimony, Arsenic, Beryllium, Niobium, Ruthenium, Thallium and Zirconium were sought in every sample but none were detected.

TABLE 7
CONCENTRATIONS OF ELEMENTS IN WET TISSUE
(Arranged by Elements)

Tissue Brain (21 samples analyzed) 1.5 mean per cent ash

Elements	Number of Samples Containing Element		Average Value for Samples Containing Element ($\mu\text{g/g}$)
Aluminum	21		0.40
Barium	9		0.04
Bismuth	1*		<0.15 T
Boron	3		0.18
Cadmium			
Cesium			
Chromium	2	2*	0.02
Cobalt			
Copper	21		4.8
Gallium			
Gold			
Iron	21		44
Lanthanum			
Lead	4	5*	0.85
Manganese	21		0.26
Molybdenum	1		0.30
Nickel	1		0.15
Silver	17	3*	0.03
Strontium	21		0.07
Tin		1*	<0.15 T
Titanium			
Vanadium			
Zinc	21		14

(*) Trace

Antimony, Arsenic, Beryllium, Niobium, Ruthenium, Thallium and Zirconium were sought in every sample but none were detected.

TABLE 8
CONCENTRATIONS OF ELEMENTS IN WET TISSUE
(Arranged by Elements)

Tissue Esophagus (8 samples analyzed) 0.94 mean per cent ash

Elements	Number of Samples Containing Element		Average Value for Samples Containing Elements ($\mu\text{g/g}$)
Aluminum	8		1.4
Barium	8		0.04
Bismuth	1	1*	>>>4
Boron			
Cadmium			
Cesium			
Chromium	5	1*	0.03
Cobalt			
Copper	8		1.3
Gallium			
Gold		2*	<0.19 T
Iron	8		32
Lanthanum			
Lead	5	2*	0.09
Manganese	8		0.14
Molybdenum			
Nickel	1		0.09
Silver	6	1*	0.01
Strontium	8		0.13
Tin	7		0.22
Titanium	1	2*	0.17
Vanadium			
Zinc	8		23

(*) Trace

636 012

Antimony, Arsenic, Beryllium, Niobium, Ruthenium, Thallium and Zirconium were sought in every sample but none were detected.

TABLE 9
CONCENTRATIONS OF ELEMENTS IN WET TISSUE
(Arranged by Elements)

Tissue Heart (19 samples analyzed) 1.00 mean per cent ash

Elements	Number of Samples Containing Element		Average Value for Samples Containing Element (ug/g)
Aluminum	19		0.43
Barium	15	2*	0.02
Bismuth		1*	<0.10 T
Boron			
Cadmium			
Cesium			
Chromium	8	1*	0.03
Cobalt	1		0.20
Copper	19		3.1
Gallium			
Gold	1	1*	0.33
Iron	19		46
Lanthanum			
Lead	4	7*	0.68
Manganese	19		0.18
Molybdenum	1		0.30
Nickel	3	1*	0.17
Silver	8	7*	0.01
Strontium	19		0.07
Tin	11	2*	0.18
Titanium			
Vanadium			
Zinc	19		29

(*) Trace

Antimony, Arsenic, Beryllium, Niobium, Ruthenium, Thallium and Zirconium were sought in every sample but none were detected.

TABLE 10
CONCENTRATIONS OF ELEMENTS IN WET TISSUE
(Arranged by Elements)

Tissue Intestine, Duodenum (7 samples analyzed)

0.80 mean per cent ash

Elements	Number of Samples Containing Element	Average Value for Samples Containing Elements ($\mu\text{g/g}$)
Aluminum	7	0.76
Barium	7	0.03
Bismuth	1	>> 4
Boron	2	0.08
Cadmium	2*	< 0.60 T
Cesium		
Chromium	2	0.03
Cobalt		
Copper	7	1.5
Gallium		
Gold		
Iron	7	48
Lanthanum		
Lead	5	0.10
Manganese	7	0.3
Molybdenum		
Nickel	1*	< 0.08 T
Silver	4 3*	0.01
Strontium	7	0.12
Tin	5 1*	0.56
Titanium	1	0.08
Vanadium		
Zinc	7	16

(*) Trace

636 014

Antimony, Arsenic, Beryllium, Niobium, Ruthenium, Thallium and Zirconium were sought in every sample but none were detected.

TABLE 11
CONCENTRATIONS OF ELEMENTS IN WET TISSUE
(Arranged by Elements)

Tissue Intestine, Jejunum and Ileum (20 samples analyzed)
0.92 mean per cent ash

Elements	Number of Samples Containing Element		Average Value for Samples Containing Elements ($\mu\text{g/g}$)
Aluminum	20		0.80
Barium	20		0.05
Bismuth	1	2*	>> 4
Boron	2	2*	0.22
Cadmium	5	5*	0.92
Cesium			
Chromium	6	4*	0.02
Cobalt			
Copper	20		3.0
Gallium			
Gold		1*	<0.18 T
Iron	20		32
Lanthanum			
Lead	15		0.38
Manganese	20		0.43
Molybdenum			
Nickel	4	2*	0.34
Silver	13	6*	0.02
Strontium	20		0.15
Tin	16	1*	0.66
Titanium	2	1*	0.46
Vanadium		1*	<0.09 T
Zinc	20		22
(*) Trace			

Antimony, Arsenic, Beryllium, Niobium, Ruthenium, Thallium
and Zirconium were sought in every sample but none were detected.

TABLE 12
CONCENTRATIONS OF ELEMENTS IN WET TISSUE
(Arranged by Elements)

Tissue Intestine, Large (22 samples analyzed)			0.68 mean per cent ash	
Elements	Number of Samples Containing Element		Average Value for Samples Containing Elements ($\mu\text{g/g}$)	
Aluminum	22		1.0	
Barium	22		0.06	
Bismuth	1	3*	0.07	
Boron	1	4*	0.12	
Cadmium	11			
Cesium				
Chromium	11	2*	0.04	
Cobalt	1		0.12	
Copper	22		1.4	
Gallium				
Gold				
Iron	22		29	
Lanthanum				
Lead	10	6*	0.12	
Manganese	22		0.23	
Molybdenum	1		0.07	
Nickel	9	2*	0.18	
Silver	10	7*	0.01	
Strontium	22		0.13	
Tin	21		0.78	
Titanium	4	1*	0.34	
Vanadium	1		0.34	
Zinc	22		19	

(*) Trace

Antimony, Arsenic, Beryllium, Niobium, Ruthenium, Thallium and Zirconium were sought in every sample but none were detected.

636 016

TABLE 13
CONCENTRATIONS OF ELEMENTS IN WET TISSUE
(Arranged by Elements)

Tissue Kidneys (24 samples analyzed) 1.10 mean per cent ash

Elements	Number of Samples Containing Element		Average Value for Samples Containing Elements (µg/g)
Aluminum	24		0.67
Barium	16	3*	0.06
Bismuth	6		1.1
Boron	1	1*	0.16
Cadmium	24		31
Cesium		2*	< 1.1 T
Chromium	4	2*	0.04
Cobalt		1*	< 0.11 T
Copper	24		2.9
Gallium			
Gold		1*	< 0.22 T
Iron	24		76
Lanthanum			
Lead	24		0.94
Manganese	24		0.56
Molybdenum	24		0.33
Nickel			
Silver	15	5*	0.02
Strontium	24		0.08
Tin	21	2*	0.27
Titanium	5	2*	0.67
Vanadium		1*	< 0.11 T
Zinc	24		48

(*) Trace

Antimony, Arsenic, Beryllium, Niobium, Ruthenium, Thallium and Zirconium were sought in every sample but none were detected.

TABLE 14
CONCENTRATIONS OF ELEMENTS IN WET TISSUE
(Arranged by Elements)

Tissue Liver (24 samples analyzed) 1.23 mean per cent ash

Elements	Number of Samples Containing Element		Average Value for Samples Containing Elements ($\mu\text{g/g}$)
Aluminum	24		0.70
Barium	2	2*	0.04
Bismuth	3		0.90
Boron	3	5*	0.30
Cadmium	22	1*	3.3
Cesium			
Chromium	4	7*	0.03
Cobalt	4	2*	0.12
Copper	24		5.7
Gallium			
Gold			
Iron	24		170
Lanthanum		1*	<1.2 T
Lead	24		1.5
Manganese	24		0.76
Molybdenum	21		1.1
Nickel	2		0.26
Silver	17	7*	0.03
Strontium	24		0.04
Tin	23	1*	0.56
Titanium	2		0.50
Vanadium		2*	<0.12 T
Zinc	24		48

(*) Trace

Antimony, Arsenic, Beryllium, Niobium, Ruthenium, Thallium and Zirconium were sought in every sample but none were detected.

TABLE 15
CONCENTRATIONS OF ELEMENTS IN WET TISSUE
(Arranged by Elements)

Tissue Lung (24 samples analyzed) 1.10 mean per cent ash

Elements	Number of Samples Containing Element		Average Value for Samples Containing Elements ($\mu\text{g/g}$)
Aluminum	24		23
Barium	24		0.26
Bismuth		1*	< 0.11 T
Boron	2	3*	0.14
Cadmium	7	4*	1.1
Cesium	12		3.1
Chromium	23		0.14
Cobalt	3	1*	0.22
Copper	24		1.4
Gallium	2	1*	0.03
Gold			
Iron	24		210
Lanthanum		3*	< 1.1 T
Lead	24		0.63
Manganese	24		0.19
Molybdenum			
Nickel	8		0.33
Silver	8	11*	0.02
Strontium	24		0.13
Tin	24		1.1
Titanium	24		2.8
Vanadium	12	4*	0.27
Zinc	24		17

(*) Trace

Antimony, Arsenic, Beryllium, Niobium, Ruthenium, Thallium and Zirconium were sought in every sample but none were detected.

TABLE 16
CONCENTRATIONS OF ELEMENTS IN WET TISSUE
(Arranged by Elements)

Tissue Muscle (18 samples analyzed) 1.15 mean per cent ash

Elements	Number of Samples Containing Element		Average Value for Samples Containing Elements ($\mu\text{g/g}$)
Aluminum	18		0.50
Barium	12	1*	0.02
Bismuth			
Boron			
Cadmium			
Cesium			
Chromium	3	1*	0.06
Cobalt			
Copper	18		0.90
Gallium			
Gold			
Iron	18		31
Lanthanum			
Lead	2	3*	0.09
Manganese	18		0.06
Molybdenum			
Nickel			
Silver	3	5*	0.02
Strontium	18		0.04
Tin	1	1*	0.12
Titanium			
Vanadium			
Zinc	18		53

(*) Trace

Antimony, Arsenic, Beryllium, Niobium, Ruthenium, Thallium and Zirconium were sought in every sample but none were detected.

TABLE 17
CONCENTRATIONS OF ELEMENTS IN WET TISSUE
(Arranged by Elements)

Tissue Pancreas (21 samples analyzed) 1.16 mean per cent ash

Elements	Number of Samples Containing Element		Average Value for Samples Containing Elements ($\mu\text{g/g}$)
Aluminum	21		0.70
Barium	14	2*	0.06
Bismuth	2	1*	0.36
Boron	4	2*	0.17
Cadmium	9	7*	1.6
Cesium			
Chromium	2	2*	0.04
Cobalt			
Copper	21		1.8
Gallium			
Gold			
Iron	21		43
Lanthanum			
Lead	21		0.63
Manganese	21		0.73
Molybdenum			
Nickel	1		0.36
Silver	10	7*	0.02
Strontium	21		0.08
Tin	6	5*	0.20
Titanium	3	3*	0.36
Vanadium			
Zinc	21		31

(*) Trace

Antimony, Arsenic, Beryllium, Niobium, Ruthenium, Thallium and Zirconium were sought in every sample but none were detected.

636 021

TABLE 18
CONCENTRATIONS OF ELEMENTS IN WET TISSUE
(Arranged by Elements)

Tissue Prostate (8 samples analyzed) 1.25 mean per cent ash

Elements	Number of Samples Containing Element		Average Value for Samples Containing Elements ($\mu\text{g/g}$)
Aluminum	8		0.75
Barium	6	1*	0.08
Bismuth		2*	< 0.13 T
Boron	1	1*	0.24
Cadmium		1*	< 1.0 T
Cesium			
Chromium	2	1*	0.30
Cobalt			
Copper	8		1.9
Gallium			
Gold			
Iron	8		25
Lanthanum			
Lead	1	5*	2.6
Manganese	8		0.30
Molybdenum	1		0.13
Nickel			
Silver	4	2*	0.05
Strontium	7		0.14
Tin	6	2*	0.26
Titanium	2		0.41
Vanadium			
Zinc	8		80

(*) Trace

Antimony, Arsenic, Beryllium, Niobium, Ruthenium, Thallium and Zirconium were sought in every sample but none were detected.

TABLE 19
CONCENTRATIONS OF ELEMENTS IN WET TISSUE
(Arranged by Elements)

Tissue Spleen (22 samples analyzed) 1.33 mean per cent ash

Elements	Number of Samples Containing Element		Average Value for Samples Containing Elements ($\mu\text{g/g}$)
Aluminum	22		2.2
Barium	14	1*	0.04
Bismuth	2		0.36
Boron	1	1*	0.20
Cadmium	1		1.3
Cesium			
Chromium	5	8*	0.05
Cobalt			
Copper	22		1.3
Gallium			
Gold			
Iron	22		280
Lanthanum		6*	< 1.3 T
Lead	21		0.38
Manganese	22		0.13
Molybdenum			
Nickel			
Silver	5	9*	0.06
Strontium	22		0.06
Tin	15	4*	0.27
Titanium	4	1*	1.0
Vanadium		2*	< 0.13 T
Zinc	22		21

(*) Trace

Antimony, Arsenic, Beryllium, Niobium, Ruthenium, Thallium and Zirconium were sought in every sample but only two traces of Ruthenium were detected.

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TABLE 20
CONCENTRATIONS OF ELEMENTS IN WET TISSUE
(Arranged by Elements)

Tissue Stomach (20 samples analyzed) 0.76 mean per cent ash

Elements	Number of Samples Containing Element		Average Value for Samples Containing Elements (µg/g)
Aluminum	20		0.53
Barium	19		0.03
Bismuth	1	1*	» 4
Boron	4	2*	0.13
Cadmium		2*	< 0.64 T
Cesium			
Chromium	6	4*	0.03
Cobalt			
Copper	20		1.5
Gallium			
Gold			
Iron	20		24
Lanthanum			
Lead	14	4*	0.14
Manganese	20		0.25
Molybdenum			
Nickel			
Silver	11	4*	0.02
Strontium	20		0.11
Tin	15		0.24
Titanium		2*	< 0.08 T
Vanadium			
Zinc	20		19

(*) Trace

Antimony, Arsenic, Beryllium, Niobium, Ruthenium, Thallium and Zirconium were sought in every sample but none were detected.

TABLE 21
CONCENTRATIONS OF ELEMENTS IN WET TISSUE
(Arranged by Elements)

Tissue Thyroid (8 samples analyzed) 1.13 mean per cent ash

Elements	Number of Samples Containing Elements	Average Value for Samples Containing Elements ($\mu\text{g/g}$)
Aluminum	8	1.4
Barium	8	0.34
Bismuth	1*	<0.11 T
Boron		
Cadmium	2 1*	1.9
Cesium	1	2.8
Chromium	3 2*	0.06
Cobalt	2	0.26
Copper	8	1.2
Gallium		
Gold		
Iron	8	69
Lanthanum		
Lead	6 2*	0.14
Manganese	8	0.26
Molybdenum		
Nickel	1	0.23
Silver	5 2*	0.06
Strontium	7	0.17
Tin	7	0.35
Titanium	4	1.2
Vanadium		
Zinc	8	28

(*) Trace

Antimony, Arsenic, Beryllium, Niobium, Ruthenium, Thallium and Zirconium were sought in every sample but none were detected.

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TABLE 22
CONCENTRATIONS OF ELEMENTS IN WET TISSUE
(Arranged by Tissues)

Element: Aluminum

Tissues	Number of Samples Containing Element		Average Value for Samples Containing Element ($\mu\text{g/g}$)
Adrenal	3	(3)	0.70
Aorta	12	(12)	0.87
Bladder	13	(13)	1.1
Bone	13	5* (23)	0.53
Brain	21	(21)	0.40
Esophagus	8	(8)	1.4
Heart	19	(19)	0.43
Intestine			
Duodenum	7	(7)	0.76
Jejunum and Ileum	20	(20)	0.80
Large	22	(22)	1.0
Kidney	24	(24)	0.67
Liver	24	(24)	0.70
Lung	24	(24)	23
Muscle	18	(18)	0.50
Pancreas	21	(21)	0.70
Prostate	8	(8)	0.75
Spleen	22	(22)	2.2
Stomach	20	(20)	0.53
Thyroid	8	(8)	1.40

(*) Trace

The numbers in parentheses indicate the number of that particular tissue analyzed.

TABLE 23
CONCENTRATIONS OF ELEMENTS IN WET TISSUE
(Arranged by Tissues)

Element: Barium

Tissues	Number of Samples Containing Elements		Average Value for Samples Containing Elements ($\mu\text{g/g}$)
Adrenal	3	(3)	0.03
Aorta	12	(12)	0.11
Bladder	10	1* (13)	0.03
Bone	23	(23)	1
Brain	9	(21)	0.04
Esophagus	8	(8)	0.04
Heart	15	2* (19)	0.02
Intestine			
Duodenum	7	(7)	0.03
Jejunum and Ileum	20	(20)	0.05
Large	22	(22)	0.06
Kidney	16	3* (24)	0.06
Liver	2	2* (24)	0.04
Lung	24	(24)	0.26
Muscle	12	1* (18)	0.02
Pancreas	14	2* (21)	0.06
Prostate	6	1* (8)	0.08
Spleen	14	1* (22)	0.04
Stomach	19	(20)	0.03
Thyroid	8	(8)	0.34

(*) Trace

The numbers in parentheses indicate the number of samples of that particular tissue analyzed.

TABLE 24
CONCENTRATIONS OF ELEMENTS IN WET TISSUE
(Arranged by Tissues)

Element: Bismuth

Tissues	Number of Samples Containing Elements		Average Value for Samples Containing Elements ($\mu\text{g/g}$)
Adrenal		(3)	
Aorta	3	(12)	0.40
Bladder		(13)	
Bone		(23)	
Brain	1*	(21)	< 0.15 T
Esophagus	1 1*	(8)	>>> 4
Heart	1*	(19)	< 0.10 T
Intestine			
Duodenum	1	(7)	>> 4
Jejunum and Ileum	1 2*	(20)	>> 4
Large	1 3*	(22)	0.07
Kidney	6	(24)	1.1
Liver	3	(24)	0.90
Lung	1*	(24)	< 0.11 T
Muscle		(18)	
Pancreas	2 1*	(21)	0.36
Prostate	2*	(8)	< 0.13 T
Spleen	2	(22)	0.36
Stomach	1 1*	(20)	>> 4
Thyroid	1*	(8)	< 0.11 T

(*) Trace

The numbers in parentheses indicate the number of samples of that particular tissue analyzed.

TABLE 25
CONCENTRATIONS OF ELEMENTS IN WET TISSUE
(Arranged by Tissues)

Element: Boron

Tissues	Number of Samples Containing Element			Average Value for Samples Containing Element ($\mu\text{g/g}$)
Adrenal	2	1*	(3)	0.17
Aorta	1		(12)	0.40
Bladder	1	1*	(13)	0.30
Bone			(23)	
Brain	3		(21)	0.18
Esophagus			(8)	
Heart			(19)	
Intestine				
Duodenum	2		(7)	0.08
Jejunum and Ileum	2	2*	(20)	0.22
Large	1	4*	(22)	0.12
Kidney	1	1*	(24)	0.16
Liver	3	5*	(24)	0.30
Lung	2	3*	(24)	0.14
Muscle			(18)	
Pancreas	4	2*	(21)	0.17
Prostate	1	1*	(8)	0.24
Spleen	1	1*	(22)	0.20
Stomach	4	2*	(20)	0.13
Thyroid			(8)	

(*) Trace

The numbers in parentheses indicate the number of samples of that particular tissue analyzed.

TABLE 26
CONCENTRATIONS OF ELEMENTS IN WET TISSUE
(Arranged by Tissues)

Element: Cadmium

Tissues	Number of Samples Containing Element		Average Value for Samples Containing Element ($\mu\text{g/g}$)
Adrenal	2	(3)	0.41
Aorta	1	(12)	0.87
Bladder		(13)	
Bone		(23)	
Brain		(21)	
Esophagus		(8)	
Heart		(19)	
Intestine			
Duodenum	2*	(7)	< 0.60 T
Jejunum and Ileum	5	5* (20)	0.92
Large		(22)	
Kidney	24	(24)	31
Liver	22	1* (24)	3.3
Lung	7	4* (24)	1.1
Muscle		(18)	
Pancreas	9	7* (21)	1.6
Prostate		1* (8)	< 1.0 T
Spleen	1	(22)	1.3
Stomach		2* (20)	< 0.64 T
Thyroid	2	1* (8)	1.9

(*) Trace

The numbers in parentheses indicate the number of samples of that particular tissue analyzed.

TABLE 27
CONCENTRATIONS OF ELEMENTS IN WET TISSUE
(Arranged by Tissues)

Element: Cesium

Tissues	Number of Samples Containing Element		Average Value for Samples Containing Element ($\mu\text{g/g}$)
Adrenal		(3)	
Aorta		(12)	
Bladder	1	1* (13)	1.7
Bone		(23)	
Brain		(21)	
Esophagus		(8)	
Heart		(19)	
Intestine			
Duodenum		(7)	
Jejunum and Ileum		(20)	
Large		(22)	
Kidney	2*	(24)	< 1.1 T
Liver		(24)	
Lung	12	(24)	3.1
Muscle		(18)	
Pancreas		(21)	
Prostate		(8)	
Spleen		(22)	
Stomach		(20)	
Thyroid	1	(8)	2.8

(*) Trace

The numbers in parentheses indicate the number of samples of that particular tissue analyzed.

TABLE 28
CONCENTRATIONS OF ELEMENTS IN WET TISSUE
(Arranged by Tissues)

Element: Chromium

Tissues	Number of Samples Containing Element		Average Value for Samples Containing Elements ($\mu\text{g/g}$)
Adrenal	3	(3)	0.08
Aorta	4	2* (12)	0.07
Bladder	5	(13)	0.06
Bone		1* (23)	< 0.8 T
Brain	2	2* (21)	0.02
Esophagus	5	1* (8)	0.03
Heart	8	1* (19)	0.03
Intestine			
Duodenum	2	(7)	0.03
Jejunum and Ileum	6	4* (20)	0.02
Large	11	2* (22)	0.04
Kidney	4	2* (24)	0.04
Liver	4	7* (24)	0.03
Lung	23	(24)	0.14
Muscle	3	1* (18)	0.06
Pancreas	2	2* (21)	0.04
Prostate	2	1* (8)	0.30
Spleen	5	8* (22)	0.05
Stomach	6	4* (20)	0.03
Thyroid	3	2* (8)	0.06

(*) Trace

The numbers in parentheses indicate the number of samples of that particular tissue analyzed.

TABLE 29
CONCENTRATIONS OF ELEMENTS IN WET TISSUE
(Arranged by Tissues)

Element: Cobalt

Tissues	Number of Samples Containing Element		Average Value for Samples Containing Element ($\mu\text{g/g}$)
Adrenal	2	(3)	0.05
Aorta	2	(12)	0.12
Bladder		(13)	
Bone		(23)	
Brain		(21)	
Esophagus		(8)	
Heart	1	(19)	0.20
Intestine			
Duodenum		(7)	
Jejunum and Ileum		(20)	
Large	1	(22)	0.12
Kidney	1*	(24)	<0.11 T
Liver	4	2* (24)	0.12
Lung	3	1* (24)	0.22
Muscle		(18)	
Pancreas		(21)	
Prostate		(8)	
Spleen		(22)	
Stomach		(20)	
Thyroid	2	(8)	0.26

(*) Trace

The numbers in parentheses indicate the number of samples of that particular tissue analyzed.

TABLE 30
CONCENTRATIONS OF ELEMENTS IN WET TISSUE
(Arranged by Tissues)

Element: Copper

Tissues	Number of Samples Containing Element		Average Value for Samples Containing Element ($\mu\text{g/g}$)
Adrenal	3	(3)	1.1
Aorta	12	(12)	1.1
Bladder	13	(13)	1.1
Bone	23	(23)	0.69
Brain	21	(21)	4.8
Esophagus	8	(8)	1.3
Heart	19	(19)	3.1
Intestine			
Duodenum	7	(7)	1.5
Jejunum and Ileum	20	(20)	3.0
Large	22	(22)	1.4
Kidney	24	(24)	2.9
Liver	24	(24)	5.7
Lung	24	(24)	1.4
Muscle	18	(18)	0.90
Pancreas	21	(21)	1.8
Prostate	8	(8)	1.9
Spleen	22	(22)	1.3
Stomach	20	(20)	1.5
Thyroid	8	(8)	1.2

(*) Trace

The number in parentheses indicates the number of samples of that particular tissue analyzed.

TABLE 31
CONCENTRATIONS OF ELEMENTS IN WET TISSUE
(Arranged by Tissues)

Element: Gallium

Tissues	Number of Samples Containing Element	Average Value for Samples Containing Element ($\mu\text{g/g}$)
Adrenal	(3)	
Aorta	(12)	
Bladder	(13)	
Bone	(23)	
Brain	(21)	
Esophagus	(8)	
Heart	(19)	
Intestine		
Duodenum	(7)	
Jejunum and Ileum	(20)	
Large	(22)	
Kidney	(24)	
Liver	(24)	
Lung	2 1* (24)	0.03
Muscle	(18)	
Pancreas	(21)	
Prostate	(8)	
Spleen	(22)	
Stomach	(20)	
Thyroid	(8)	

(*) Trace

The numbers in parentheses indicate the number of samples of that particular tissue analyzed.

TABLE 32
CONCENTRATIONS OF ELEMENTS IN WET TISSUE
(Arranged by Tissues)

Element: Gold

Tissues	Number of Samples Containing Element			Average Value for Samples Containing Elements ($\mu\text{g/g}$)
Adrenal	2	1*	(3)	0.24
Aorta	1	2*	(12)	0.24
Bladder		1*	(13)	<0.16 T
Bone			(23)	
Brain			(21)	
Esophagus		2*	(8)	<0.19 T
Heart	1	1*	(19)	0.33
Intestine				
Duodenum			(7)	
Jejunum and Ileum		1*	(20)	<0.18 T
Large			(22)	
Kidney		1*	(24)	<0.22 T
Liver			(24)	
Lung			(24)	
Muscle			(18)	
Pancreas			(21)	
Prostate			(8)	
Spleen			(22)	
Stomach			(20)	
Thyroid			(8)	

(*) Trace

The number in parentheses indicate the number of samples of that particular tissue analyzed.

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TABLE 33
CONCENTRATIONS OF ELEMENTS IN WET TISSUE
(Arranged by Tissues)

Element: Iron

Tissues	Number of Samples Containing Element		Average Value for Samples Containing Element ($\mu\text{g/g}$)
Adrenal	3	(3)	28
Aorta	12	(12)	30
Bladder	13	(13)	19
Bone	23	(23)	95
Brain	21	(21)	44
Esophagus	8	(8)	32
Heart	19	(19)	46
Intestine			
Duodenum	7	(7)	48
Jejunum and Ileum	20	(20)	32
Large	22	(22)	29
Kidney	24	(24)	76
Liver	24	(24)	170
Lung	24	(24)	210
Muscle	18	(18)	31
Pancreas	21	(21)	43
Prostate	8	(8)	25
Spleen	22	(22)	280
Stomach	20	(20)	24
Thyroid	8	(8)	69

(*) Trace

The numbers in parentheses indicate the number of samples of that particular tissue analyzed.

TABLE 34
CONCENTRATIONS OF ELEMENTS IN WET TISSUE
(Arranged by Tissues)

Element: <u>Lanthanum</u>		
Tissues	Number of Samples Containing Element	Average Value for Samples Containing Element ($\mu\text{g/g}$)
Adrenal	(3)	
Aorta	(12)	
Bladder	(13)	
Bone	(23)	
Brain	(21)	
Esophagus	(8)	
Heart	(19)	
Intestine		
Duodenum	(7)	
Jejunum and Ileum	(20)	
Large	(22)	
Kidney	(24)	
Liver	1* (24)	< 1.2 T
Lung	3* (24)	< 1.1 T
Muscle	(18)	
Pancreas	(21)	
Prostate	(8)	
Spleen	6* (22)	< 1.3 T
Stomach	(20)	
Thyroid	(8)	
(*) Trace		

The numbers in parentheses indicate the number of samples of that particular tissue analyzed.

TABLE 35
CONCENTRATIONS OF ELEMENTS IN WET TISSUE
(Arranged by Tissues)

Element: Lead

Tissues	Number of Samples Containing Element			Average Value for Samples Containing Element ($\mu\text{g/g}$)
Adrenal	3		(3)	0.08
Aorta	11	1*	(12)	0.87
Bladder	8	1*	(13)	0.23
Bone	23		(23)	4.2
Brain	4	5*	(21)	0.85
Esophagus	5	2*	(8)	0.09
Heart	4	7*	(19)	0.68
Intestine				
Duodenum	5		(7)	0.10
Jejunum and Ileum	15		(20)	0.38
Large	10	6*	(22)	0.12
Kidney	24		(24)	0.94
Liver	24		(24)	1.5
Lung	24		(24)	0.63
Muscle	2	3*	(18)	0.09
Pancreas	21		(21)	0.63
Prostate	1	5*	(8)	2.6
Spleen	21		(22)	0.38
Stomach	14	4*	(20)	0.14
Thyroid	6	2*	(8)	0.14

(*) Trace

The numbers in parentheses indicate the number of samples of that particular tissue analyzed.

TABLE 36
CONCENTRATIONS OF ELEMENTS IN WET TISSUE
(Arranged by Tissues)

Element: Manganese

Tissues	Number of Samples Containing Element		Average Value for Samples Containing Element ($\mu\text{g/g}$)
Adrenal	3	(3)	0.15
Aorta	12	(12)	0.10
Bladder	11	(13)	0.10
Bone	1*	(23)	0.35 T
Brain	21	(21)	0.26
Esophagus	8	(8)	0.14
Heart	19	(19)	0.18
Intestine			
Duodenum	7	(7)	0.3
Jejunum and Ileum	20	(20)	0.43
Large	22	(22)	0.23
Kidney	24	(24)	0.56
Liver	24	(24)	0.76
Lung	24	(24)	0.19
Muscle	18	(18)	0.06
Pancreas	21	(21)	0.73
Prostate	8	(8)	0.30
Spleen	22	(22)	0.13
Stomach	20	(20)	0.25
Thyroid	8	(8)	0.26

(*) Trace

The numbers in parentheses indicate the number of samples of that particular tissue analyzed.

TABLE 37
CONCENTRATIONS OF ELEMENTS IN WET TISSUE
(Arranged by Tissues)

Element: Molybdenum

Tissues	Number of Samples Containing Element			Average Value for Samples Containing Element ($\mu\text{g/g}$)
Adrenal	2	1*	(3)	0.17
Aorta			(12)	
Bladder			(13)	
Bone			(23)	
Brain	1		(21)	0.30
Esophagus			(8)	
Heart	1		(19)	0.30
Intestine				
Duodenum			(7)	
Jejunum and Ileum			(20)	
Large	1		(22)	0.07
Kidney	24		(24)	0.33
Liver	21		(24)	1.1
Lung			(24)	
Muscle			(18)	
Pancreas			(21)	
Prostate	1		(8)	0.13
Spleen			(22)	
Stomach			(20)	
Thyroid			(8)	

(*) Trace

The numbers in parentheses indicate the number of samples of that particular tissue analyzed.

TABLE 38
CONCENTRATIONS OF ELEMENTS IN WET TISSUE
(Arranged by Tissues)

Element: Nickel

Tissues	Number of Samples Containing Element		Average Value for Samples Containing Element ($\mu\text{g/g}$)
Adrenal	3	(3)	0.50
Aorta	3	(12)	0.35
Bladder	3	1* (13)	0.29
Bone	1	(23)	1.8
Brain	1	(21)	0.15
Esophagus	1	(8)	0.09
Heart	3	1* (19)	0.17
Intestine			
Duodenum		1* (7)	< 0.08 T
Jejunum and Ileum	4	2* (20)	0.34
Large	9	2* (22)	0.18
Kidney		(24)	
Liver	2	(24)	0.26
Lung	8	(24)	0.33
Muscle		(18)	
Pancreas	1	(21)	0.36
Prostate		(8)	
Spleen		(22)	
Stomach		(20)	
Thyroid	1	(8)	0.23

(*) Trace

The number in parentheses indicate the number of samples of that particular tissue.

TABLE 39
CONCENTRATIONS OF ELEMENTS IN WET TISSUE
(Arranged by Tissues.)

Element: Silver

Tissues	Number of Samples Containing Element			Average Value for Samples Containing Element ($\mu\text{g/g}$)
Adrenal	3		(3)	0.03
Aorta	7	2*	(12)	0.06
Bladder	3	5*	(13)	0.008
Bone	1		(23)	0.4
Brain	17	3*	(21)	0.03
Esophagus	6	1*	(8)	0.01
Heart	8	7*	(19)	0.01
Intestine				
Duodenum	4	3*	(7)	0.01
Jejunum and Ileum	13	6*	(20)	0.02
Large	10	7*	(22)	0.01
Kidney	15	5*	(24)	0.02
Liver	17	7*	(24)	0.03
Lung	8	11*	(24)	0.02
Muscle	3	5*	(18)	0.02
Pancreas	10	7*	(21)	0.02
Prostate	4	2*	(8)	0.05
Spleen	5	9*	(22)	0.06
Stomach	11	4*	(20)	0.02
Thyroid	5	2*	(8)	0.06

(*) Trace

The numbers in parentheses indicate the number of samples of that particular tissue analyzed.

TABLE 40
CONCENTRATIONS OF ELEMENTS IN WET TISSUE
(Arranged by Tissues)

Element: Strontium

Tissues	Number of Samples Containing Element		Average Value for Samples Containing Element ($\mu\text{g/g}$)
Adrenal	3	(3)	0.03
Aorta	12	(12)	0.20
Bladder	13	(13)	0.12
Bone	23	(23)	20
Brain	21	(21)	0.07
Esophagus	8	(8)	0.13
Heart	19	(19)	0.07
Intestine			
Duodenum	7	(7)	0.12
Jejunum and Ileum	20	(20)	0.15
Large	22	(22)	0.13
Kidney	24	(24)	0.08
Liver	24	(24)	0.04
Lung	24	(24)	0.13
Muscle	18	(18)	0.04
Pancreas	21	(21)	0.08
Prostate	7	(8)	0.14
Spleen	22	(22)	0.06
Stomach	20	(20)	0.11
Thyroid	7	(8)	0.17

(*) Trace

The numbers in parentheses indicate the number of samples of that particular tissue analyzed.

TABLE 41
CONCENTRATIONS OF ELEMENTS IN WET TISSUE
(Arranged by Tissues)

Element: Tin

Tissues	Number of Samples Containing Element		Average Value for Samples Containing Element ($\mu\text{g/g}$)
Adrenal	3	(3)	0.24
Aorta	10	1* (12)	0.30
Bladder	11	(13)	0.20
Bone	1	1* (23)	3
Brain		1* (21)	< 0.15 T
Esophagus	7	(8)	0.22
Heart	11	2* (19)	0.18
Intestine			
Duodenum	5	1* (7)	0.56
Jejunum and Ileum	16	1* (20)	0.66
Large	21	(22)	0.78
Kidney	21	2* (24)	0.27
Liver	23	1* (24)	0.56
Lung	24	(24)	1.1
Muscle	1	1* (18)	0.12
Pancreas	6	5* (21)	0.20
Prostate	6	2* (8)	0.26
Spleen	15	4* (22)	0.27
Stomach	15	(20)	0.24
Thyroid	7	(8)	0.35

(*) Trace

The numbers in parentheses indicate the number of samples of that particular tissue analyzed.

TABLE 42
CONCENTRATIONS OF ELEMENTS IN WET TISSUE
(Arranged by Tissues)

Element: Titanium

Tissues	Number of Samples Containing Element			Average Value for Samples Containing Element ($\mu\text{g/g}$)
Adrenal	2		(3)	0.16
Aorta	2	1*	(12)	0.48
Bladder	3	1*	(13)	1.1
Bone			(23)	
Brain			(21)	
Esophagus	1	2*	(8)	0.17
Heart			(19)	
Intestine				
Duodenum	1		(7)	0.08
Jejunum and Ileum	2	1*	(20)	0.46
Large	4	1*	(22)	0.34
Kidney	5	2*	(24)	0.67
Liver	2		(24)	0.50
Lung	24		(24)	2.8
Muscle			(18)	
Pancreas	3	3*	(21)	0.36
Prostate	2		(8)	0.41
Spleen	4	1*	(22)	1.0
Stomach		2*	(20)	< 0.08 T
Thyroid	4		(8)	1.2

(*) Trace

The numbers in parentheses indicate the number of samples of that particular tissue analyzed.

TABLE 43
CONCENTRATIONS OF ELEMENTS IN WET TISSUE
(Arranged by Tissues)

Element: Vanadium

Tissues	Number of Samples Containing Element		Average Value for Samples Containing Element ($\mu\text{g/g}$)
Adrenal		(3)	
Aorta	1*	(12)	< 0.10 T
Bladder		(13)	
Bone		(23)	
Brain		(21)	
Esophagus		(8)	
Heart		(19)	
Intestine			
Duodenum		(7)	
Jejunum and Ileum	1*	(20)	< 0.09 T
Large	1	(22)	0.34
Kidney	1*	(24)	< 0.11 T
Liver	2*	(24)	< 0.12 T
Lung	12 4*	(24)	0.27
Muscle		(18)	
Pancreas		(21)	
Prostate		(8)	
Spleen	2*	(22)	< 0.13 T
Stomach		(20)	
Thyroid		(8)	

(*) Trace

The numbers in parentheses indicate the number of samples of that particular tissue analyzed.

TABLE 44
CONCENTRATIONS OF ELEMENTS IN WET TISSUE
(Arranged by Tissues)

Element: Zinc

Tissues	Number of Samples Containing Element		Average Value for Samples Containing Element ($\mu\text{g/g}$)
Adrenal	3	(3)	7.8
Aorta	12	(12)	16
Bladder	13	(13)	21
Bone		(23)	
Brain	21	(21)	14
Esophagus	8	(8)	23
Heart	19	(19)	29
Intestine			
Duodenum	7	(7)	16
Jejunum and Ileum	20	(20)	22
Large	22	(22)	19
Kidney	24	(24)	48
Liver	24	(24)	48
Lung	24	(24)	17
Muscle	18	(18)	53
Pancreas	21	(21)	31
Prostate	8	(8)	80
Spleen	22	(22)	21
Stomach	20	(20)	19
Thyroid	8	(8)	28

(*) Trace

The numbers in parentheses indicate the number of samples of that particular tissue analyzed.

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