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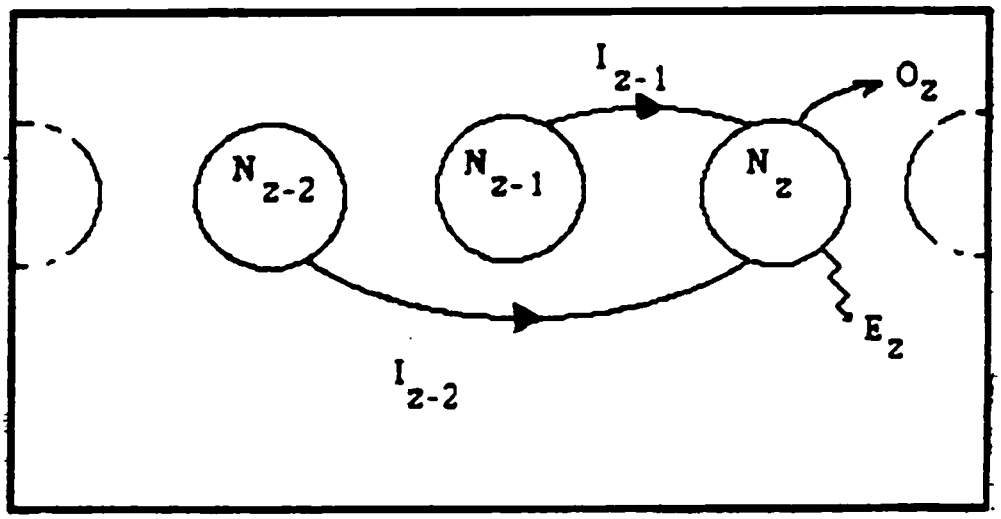

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A GRAPHICAL COMPARISON OF THE OLD AND NEW PERIODIC TABLES

by D. Maurice Gilroy

Abstract

This paper presents a graphical comparison of the traditional (18 position) and the new (32 position) formats of the periodic table. The plots of the four physical properties presented permit the reader to judge the quality of the representations of the periodic nature of the elements provided by the 18 and 32 position formats. After comparing the plots of the data and the positions of silicon and tungsten in the old and new formats, the author concludes that the traditional 18 position periodic table does a better job of illustrating the periodic nature of the elements than that done by the new 32 position table, that the "rare earths" or "lanthanides" do deserve a special place in the periodic table, and that further theoretical work is needed to explain the "nonconformist" tendencies of the rare earth elements.

Introduction

The periodic table of the elements can be a useful tool in developing an understanding of the periodic nature of the physical and chemical properties of the elements. The traditional 18 column periodic table can be found in most chemistry textbooks, handbooks, lecture rooms and laboratories. Fig. 1 is a skeletal example of this format of the periodic table.

A new or revised periodic table with a 32 position format has been introduced into the literature of the reciprocal system. It first appeared on pages 42 and 43 of "The Unmysterious Universe" by Ronald Satz (1971). (Fig. 2 is an adaptation of the Satz table.) It appeared again in a modified form on page 137 of "Nothing but Motion" by Dewey Larson (1979). (Fig. 3 is an adaptation of the Larson table.)

The new or revised periodic table is not a critical part of the reciprocal system. Satz refers to it without comment (page 40 of "UU") as "the table of chemical elements". Larsen comments (pages 136 & 138 of "NBM") that it was being presented "... merely as a convenient graphical method of expressing some portions of that information." ("that information" being the magnetic and electric rotational motions of the elements).

(The text continues on page 5.)

Fig. 1

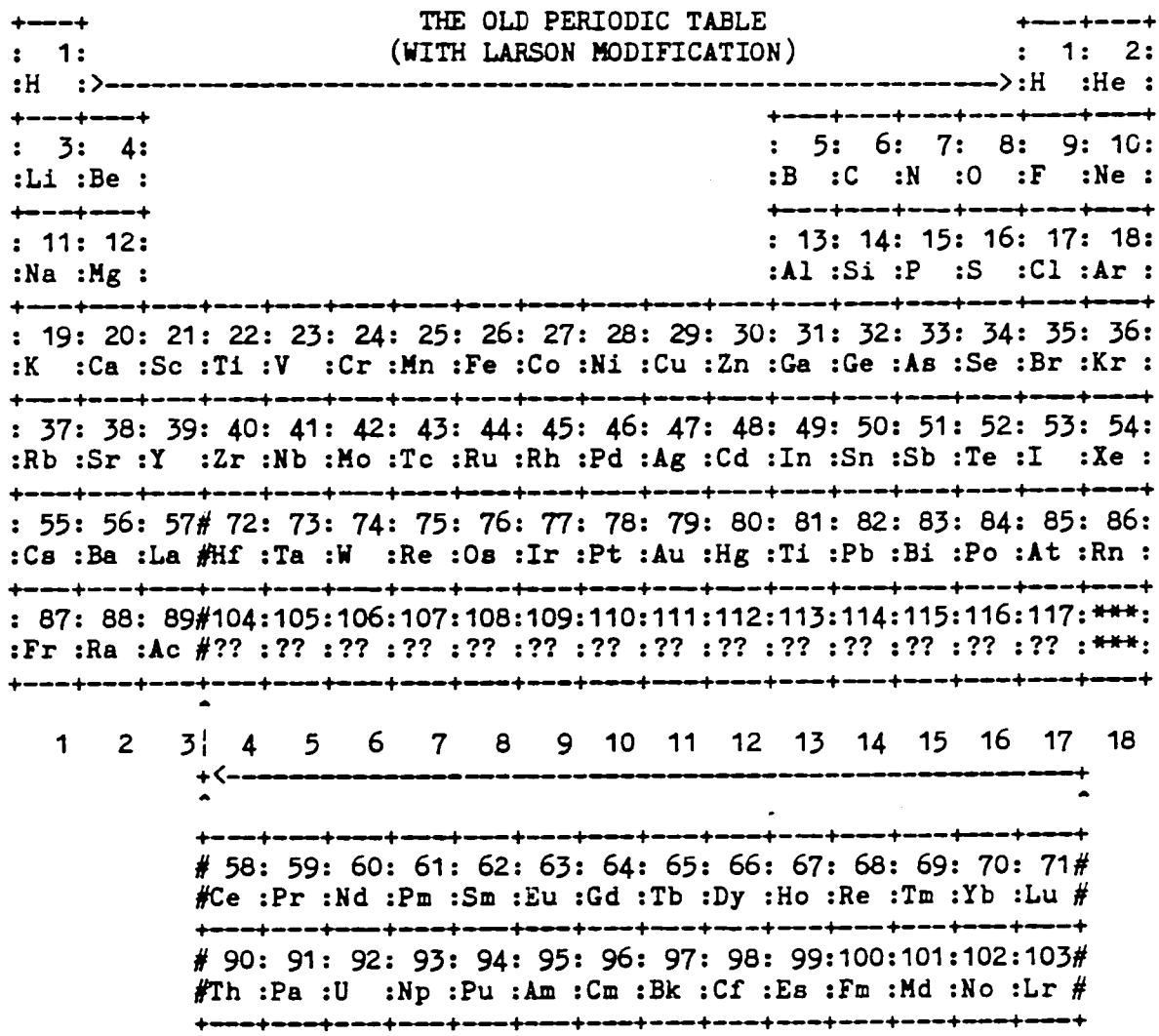

THE OLD PERIODIC TABLE
(WITH LARSON MODIFICATION)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18

Fig. 2

THE NEW PERIODIC TABLE
(SATZ VERSION)
(WITH LARSON MODIFICATION)

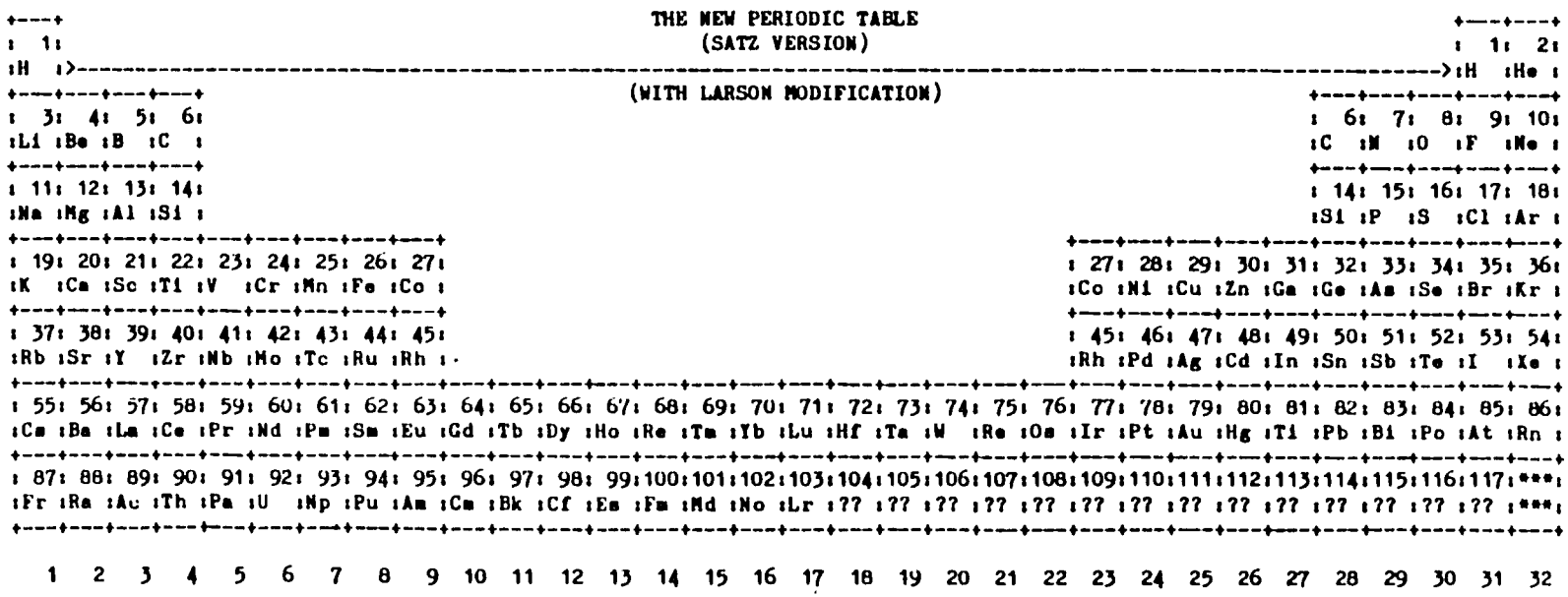
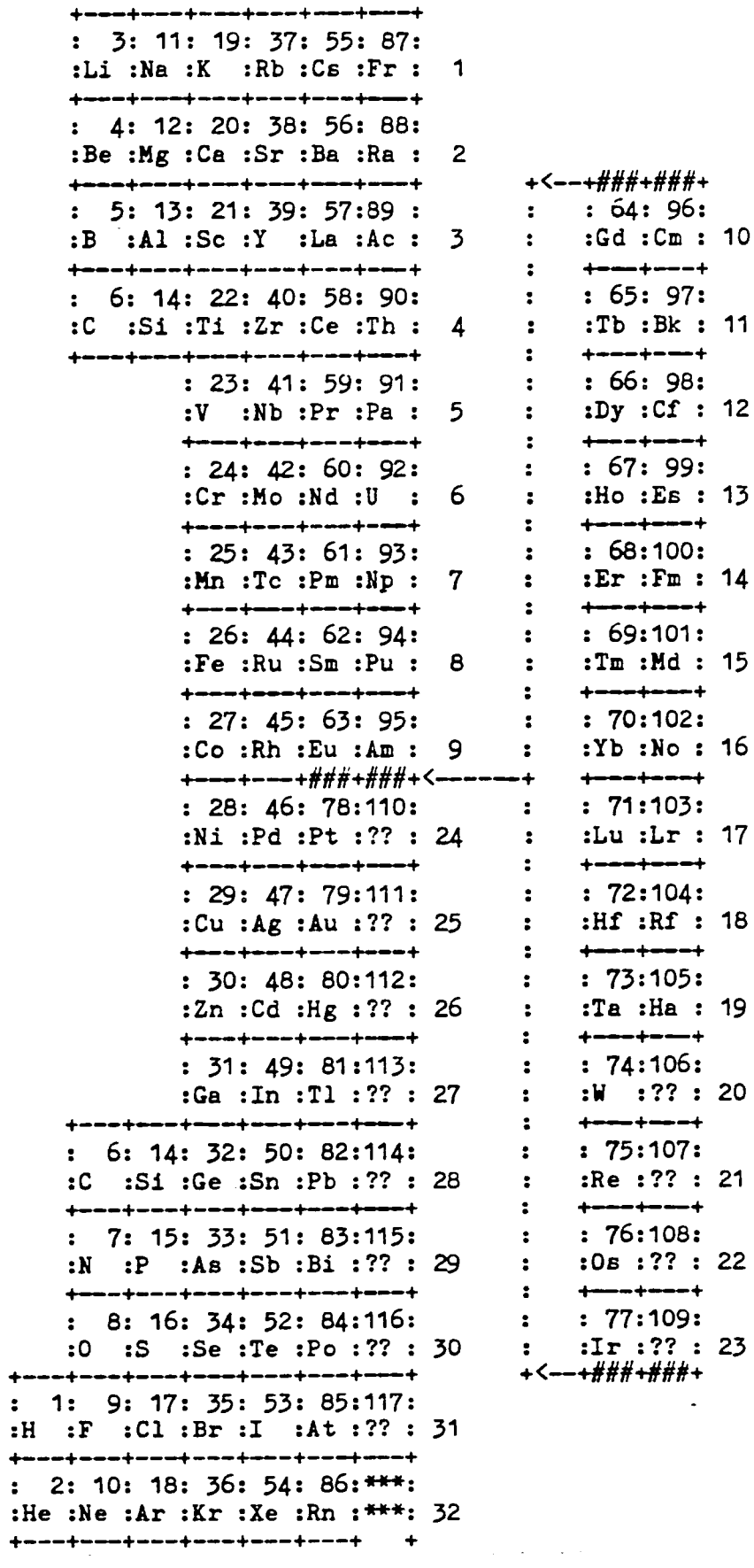


Fig. 3 - THE NEW PERIODIC TABLE (LARSON VERSION)



Introduction (Cont...)

The author's concern about the new 32 position format of the periodic table is both theoretical and practical.

The theoretical concern is that the new format table implies that the rare earth elements do not deserve a special place in the periodic table of the elements (and in the theory of the fundamental rotational motions that establish the nature of the elements). If this implication is wrong, and the rare earths do not fit into the patterns of the physical properties of the other elements in the atomic number sequence, then more fundamental theoretical work needs to be done to explain the special nature of the rare earth elements.

The practical concern is that the new format tables give what the author judges to be a small benefit for a larger cost. The benefit is the illustration of the periodic nature of the theoretical rotational motions within the atoms. The cost is a radical change from the form of the table that every chemistry student has studied, to an unfamiliar form that could be one more obstacle to broader acceptance of the reciprocal system of physical theory.

Periodic Table Element Placement

Before going on to the physical property data plots it may be helpful to point out two differences in the placement of the elements in the old and new formats of the periodic table.

In the traditional table carbon (6), silicon (14) and germanium (32) are in column 14. In the new periodic table these three elements share column 28. In addition carbon and silicon also share column 4 with Titanium (22). In the traditional periodic table chromium (24), molybdenum (42), tungsten (74) and element 106 share column 6. In the new periodic table tungsten shares column 20 with element no. 106.

One of the simple beauties of the periodic table is that it groups elements with similar physical or chemical properties together. Silicon and germanium are the semiconductors of solid state electronics. Silicon has little in common with titanium which is the light, high strength metal used in the construction of supersonic aircraft. Molybdenum and tungsten are the high melting point metals of the atomic number series. If a periodic table is to express the periodic nature of the elements by grouping like elements together, then silicon should not be in the group with titanium, and tungsten should be in the group with molybdenum.

The Physical Property Data

Table 1 is a tabulation of the physical property data that appears in the data plots that follow. The columns of data and their sources are as follows:

Heading	Description and Source
ATNO	Atomic Number (X axis location for "96 wide" data plot)
AS	Atomic Symbol
NAME	Element Name
P32W	X Axis location for "32 wide" data plot
P18W	X Axis location for "18 wide" data plot
PSW	A "plot switch" used to suppress plotting of the rare earth data in the 18 wide data plot.
MP	Melting point data from a table on an inside cover of the CRC Handbook of Chemistry and Physics
IAD	Interatomic distance data from chapters of The Basic Properties of Matter by Dewey B. Larson printed in the Winter 1981-1982 and Autumn 1983 issues of Reciprocity
WF59	Electron work function data from "Photoionization and Photomagnetization" by Ronald W. Satz published in the Winter 1981-1982 issue of Reciprocity (This data tabulation appears to be selections from Table CIX (pages 120-121) of The Structure of the Physical Universe by Dewey B. Larson published in 1959.)
WF77	Electron work function data from a tabulation on pages E-83 & E-84 of the 61st edition of the CRC Handbook of Chemistry and Physics compiled by Herbert B. Michaelson in 1977
MAGS	Magnetic susceptibility data from a tabulation on pages E-109 & E-114 of the 61st edition of the CRC Handbook of Chemistry and Physics

(The text continues on page 9.)

Table 1 - The Physical Property Data

ATNO	AS	NAME	P32M	P18M	PSM	MP	IAD	MF59	MF77	MAGS
1	H	HYDROGEN	31.1	17.1	1	-259.14	1.00	.	.	-4.0
2	HE	HELIUM	32.1	16.1	1	-272.20	1.09	.	.	-1.9
3	LI	LITHIUM	1.2	1.2	1	180.54	3.03	2.280	2.90	14.2
4	BE	BERYLLIUM	2.2	2.2	1	1278.00	2.28	3.920	4.98	-9.0
5	B	BORON	3.2	13.2	1	2300.00	1.74	4.400	4.45	-6.7
6	C	CARBON	28.2	14.2	1	3550.00	1.54	4.341	5.00	-5.9
7	N	NITROGEN	29.2	15.2	1	-209.86	1.06	.	.	-12.0
8	O	OXYGEN	30.2	16.2	1	-218.40	1.15	.	.	3449.0
9	F	FLOURINE	31.2	17.2	1	-219.62	1.44	.	.	.
10	NE	NEON	32.2	18.2	1	-248.67	3.20	.	.	-6.7
11	NA	SODIUM	1.3	1.3	1	97.81	3.71	2.250	2.75	16.0
12	MG	MAGNESIUM	2.3	2.3	1	648.80	3.21	3.780	3.66	13.3
13	AL	ALUMINUM	3.3	13.3	1	660.37	2.86	3.430	4.28	16.5
14	SI	SILICON	28.3	14.3	1	1410.00	2.35	4.200	4.85	-3.9
15	P	PHOSPHORUS	29.3	15.3	1	44.10	2.20	.	.	20.8
16	S	SULFUR	30.3	16.3	1	112.80	2.07	.	.	-15.5
17	CL	CHLORINE	31.3	17.3	1	-100.98	1.82	.	.	-40.5
18	AR	ARGON	32.3	18.3	1	-189.20	3.84	.	.	-19.6
19	K	POTASSIUM	1.4	1.4	1	63.65	4.50	2.120	2.30	20.8
20	CA	CALCIUM	2.4	2.4	1	839.00	3.98	3.200	2.87	40.0
21	SC	SCANDIUM	3.4	3.4	1	1539.00	3.20	.	3.50	315.0
22	TI	TITANIUM	4.4	4.4	1	1660.00	2.92	3.950	4.33	153.0
23	V	VANADIUM	5.4	5.4	1	1890.00	2.62	3.950	4.30	255.0
24	CR	CHROMIUM	6.4	6.4	1	1857.00	2.72	4.370	4.50	180.0
25	MN	MANGANESE	7.4	7.4	1	1244.00	2.58	3.760	4.10	529.0
26	FE	IRON	8.4	8.4	1	1535.00	2.57	3.910	4.50	.
27	CO	COBALT	23.4	9.4	1	1495.00	2.51	3.900	5.00	.
28	NI	NICKEL	24.4	10.4	1	1453.00	2.49	3.670	5.15	.
29	CU	COPPER	25.4	11.4	1	1083.40	2.55	3.850	4.65	-5.5
30	ZN	ZINC	26.4	12.4	1	419.58	2.91	3.890	4.33	-11.4
31	GA	GALLIUM	27.4	13.4	1	29.78	2.80	3.800	4.20	-24.4
32	GE	GERMANIUM	26.4	14.4	1	937.40	2.43	4.290	5.00	-76.8
33	AS	ARSENIC	29.4	15.4	1	817.00	2.44	5.110	3.75	-5.5
34	SE	SELENIUM	30.4	16.4	1	217.00	2.32	4.420	5.90	-25.0
35	BR	BROMINE	31.4	17.4	1	-7.20	2.27	.	.	55.4
36	KR	KRYPTON	32.4	18.4	1	-156.60	4.02	.	.	-28.8
37	RB	RUBIDIUM	1.5	1.5	1	38.89	4.67	2.160	2.16	17.0
38	SR	STRONTIUM	2.5	2.5	1	769.00	4.26	2.740	2.59	92.0
39	Y	YTTRIUM	3.5	3.5	1	1522.00	3.63	.	3.10	2.2
40	ZR	ZIRCONIUM	4.5	4.5	1	1852.00	3.23	3.730	4.05	122.0
41	NB	NIOBIUM	5.5	5.5	1	2468.00	2.85	3.960	4.30	195.0
42	MO	MOLYBDENUM	6.5	6.5	1	2617.00	2.72	4.080	4.60	89.0
43	TC	TECHNETIUM	7.5	7.5	1	2172.00	2.73	.	.	250.0
44	RU	RUTHENIUM	8.5	8.5	1	2310.00	2.70	4.520	4.71	43.2
45	RH	RHODIUM	23.5	9.5	1	1966.00	2.69	4.570	4.98	111.0
46	PD	PALLADIUM	24.5	10.5	1	1552.00	2.74	4.490	5.12	567.4
47	AG	SILVER	25.5	11.5	1	961.93	2.88	4.330	4.26	-19.5
48	CD	CADMIUM	26.5	12.5	1	320.90	3.26	3.730	4.22	-19.8
49	IN	INDIUM	27.5	13.5	1	156.61	3.37	.	4.12	-64.0
50	SN	TIN	28.5	14.5	1	231.97	2.80	3.620	4.42	3.1
51	SB	ANTIMONY	29.5	15.5	1	630.74	2.87	4.140	4.55	-99.0

Table 1 - The Physical Property Data (Cont...)

ATNO	AS	NAME	P32K	P18K	PSK	MP	IAU	WF59	WF77	MAGS
52	TE	TELLURIUM	30.5	16.5	1	449.50	2.66	4.70	4.95	-39.5
53	I	IODINE	31.5	17.5	1	113.50	2.70	.	.	-88.7
54	XE	XENON	32.5	18.5	1	-111.90	4.41	.	.	-43.9
55	CS	CESIUM	1.6	1.6	1	28.40	5.24	1.96	2.14	29.0
56	BA	BARIUM	2.6	2.6	1	725.00	4.34	2.11	2.70	20.6
57	LA	LANTHANUM	3.6	3.6	0	920.00	3.74	3.30	3.50	118.0
58	CE	CERIUM	4.6	3.6	0	798.00	3.63	2.84	2.90	5160.0
59	PR	PRASEODYMIUM	5.6	3.6	0	931.00	3.64	2.70	.	5010.0
60	ND	NEODYMIUM	6.6	3.6	0	1010.00	3.65	3.30	3.20	5628.0
61	PM	PROMETHIUM	7.6	3.6	0	1080.00	.	.	.	.
62	SM	SAMARIUM	8.6	3.6	0	1072.00	3.62	3.20	2.70	1860.0
63	EU	EUROPIUM	9.6	3.6	0	822.00	3.96	.	2.50	34000.0
64	GD	GADOLINIUM	10.6	3.6	0	1311.00	3.62	.	3.10	755000.0
65	TB	TERBIUM	11.6	3.6	0	1360.00	3.59	.	3.00	.
66	DY	DYSPROSIUM	12.6	3.6	0	1409.00	3.58	.	.	103500.0
67	HO	HOLMIUM	13.6	3.6	0	1470.00	3.56	.	.	.
68	ER	ERBIUM	14.6	3.6	0	1522.00	3.53	.	.	44300.0
69	TM	THULIUM	15.6	3.6	0	1545.00	3.52	.	.	.
70	YB	YTTERBIUM	16.6	3.6	0	824.00	3.87	.	.	249.0
71	LU	LUTETIUM	17.6	3.6	1	1656.00	3.50	.	3.30	1.1
72	HF	HAFNIUM	18.6	4.6	1	2227.00	3.36	3.53	3.00	75.0
73	TA	TANTALUM	19.6	5.6	1	2996.00	2.86	3.96	4.25	154.0
74	W	TUNGSTEN	20.6	6.6	1	3410.00	2.74	4.35	4.55	59.0
75	RE	RHENIUM	21.6	7.6	1	3180.00	2.77	5.00	4.96	67.6
76	OS	OSMIUM	22.6	8.6	1	3045.00	2.73	4.55	4.83	9.9
77	IR	IRIDIUM	23.6	9.6	1	2410.00	2.71	4.50	5.27	25.6
78	PT	PLATINUM	24.6	10.6	1	1772.00	2.77	4.09	5.65	201.9
79	AU	GOLD	25.6	11.6	1	1064.43	2.88	4.46	5.10	-28.0
80	HG	MERCURY	26.6	12.6	1	-38.87	3.00	4.50	4.49	-24.1
81	TL	THALLIUM	27.6	13.6	1	303.50	3.45	3.84	3.84	-50.9
82	PB	LEAD	28.6	14.6	1	327.50	3.49	3.94	4.25	-23.0
83	BI	BISMUTH	29.6	15.6	1	271.30	3.47	4.31	4.22	-280.1
84	PO	POLONIUM	30.6	16.6	1	254.00	3.40	.	.	.
85	AT	ASTATINE	31.6	17.6	1	302.00	.	.	.	.
86	RN	RADON	32.6	18.6	1	-71.00	.	.	.	.
87	FR	FRANCIUM	1.7	1.7	0	27.00	.	.	.	.
88	RA	RADIUM	2.7	2.7	0	700.00	.	.	.	.
89	AC	ACTINIUM	3.7	3.7	0	1050.00	3.76	.	.	.
90	TH	THORIUM	4.7	3.7	0	1750.00	3.56	.	3.40	.
91	PA	PROTACTINIUM	5.7	3.7	0	1600.00	3.24	.	.	.
92	U	URANIUM	6.7	3.7	0	1132.30	2.85	.	3.63	395.0
93	NP	NEPTUNIUM	7.7	3.7	0	640.00	3.46	.	.	.
94	PU	PLUTONIUM	8.7	3.7	0	641.00	3.15	.	.	610.0
95	AM	AMERICIUM	9.7	3.7	0	994.00	3.46	.	.	1000.0
96	CM	CURIUM	10.7	3.7	0	1340.00	3.10	.	.	.

The Data Plots

Each of the four physical properties is plotted in three ways:

1 - In atomic number sequence (96 wide)

2 - In the new periodic table format (32 wide) that includes the rare earth element data

3 - In the traditional periodic table format (18 wide) that excludes the rare earth element data

An atomic number sequence plot of the 1977 work function data is included for comparison purposes. The 1969 work function data is used in the periodic table comparison plots.

Plots of both untruncated and truncated values of the magnetic susceptibility data are presented in atomic number sequence. The truncated data is used in the periodic table comparison plots.

The Melting Point Data Plots

Figures 4, 5 & 6 which follow are the plots of the melting point data.

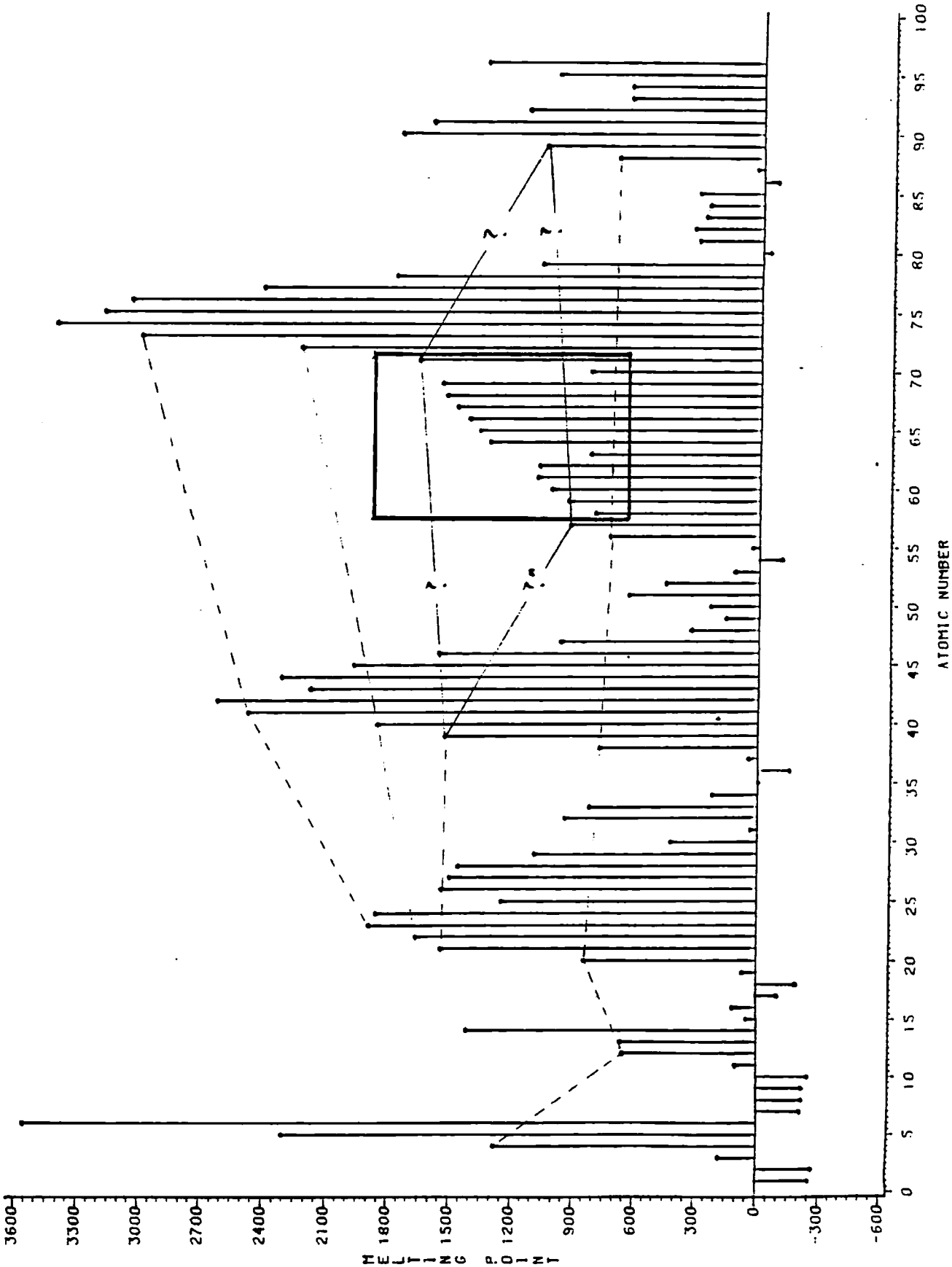
Please note that in the atomic number sequence plot the melting points of elements 58 to 71 (in box) form an uneven "stairstep" pattern, with two missing "steps", that does not conform to the 18 wide "tall building" pattern of the other elements.

Also note that in the 18 wide periodic table plot the melting points of the elements in column 6 (chromium, molybdenum and tungsten) form a pattern similar to the elements in columns 4, 5, 7 & 8.

And please note the overall pattern of the 18 wide periodic table plot and the relative appearance of the 32 and 18 wide periodic table plots.

(The text continues on page 13.)

Fig. 4 - MELTING POINTS OF THE ELEMENTS



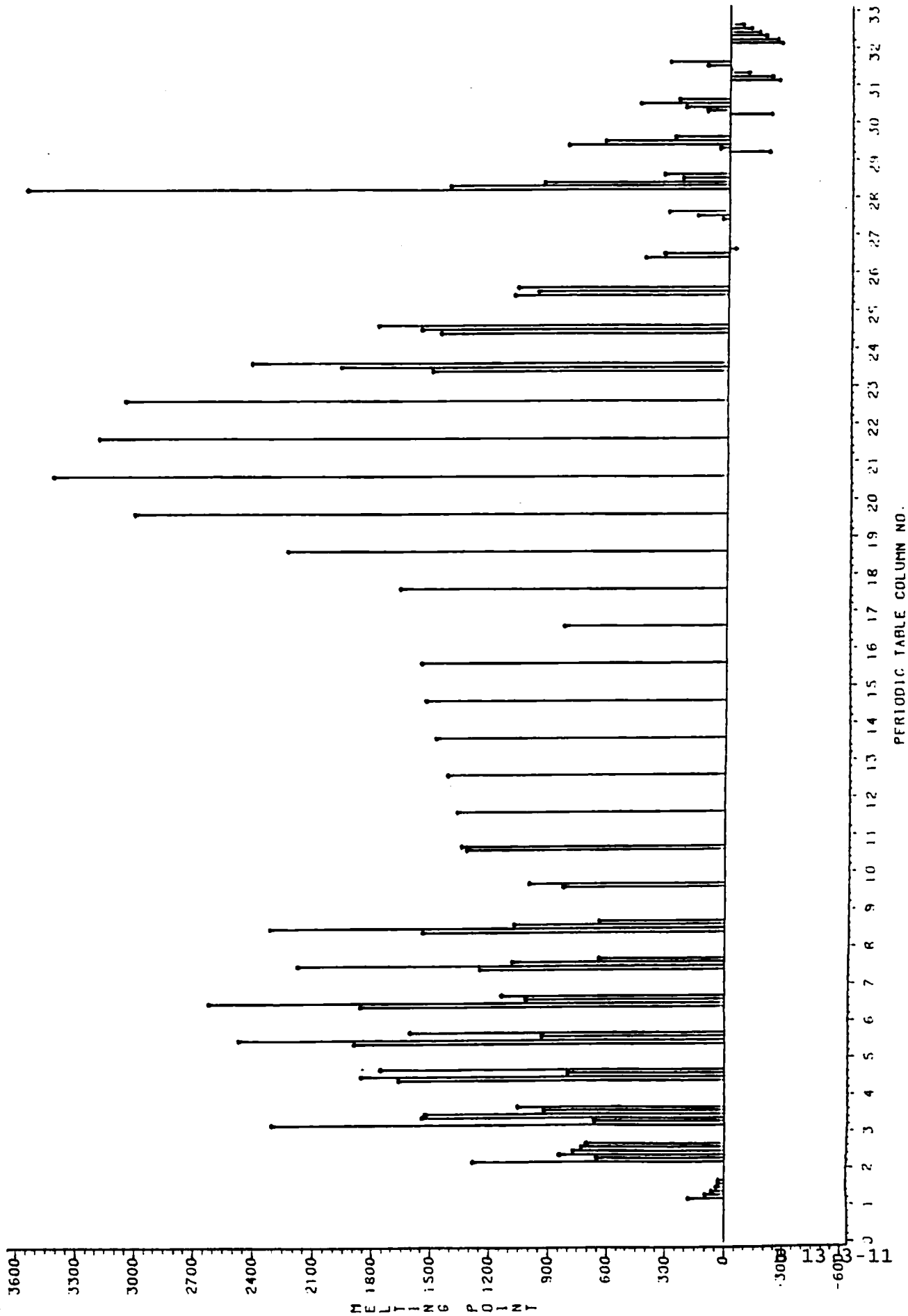
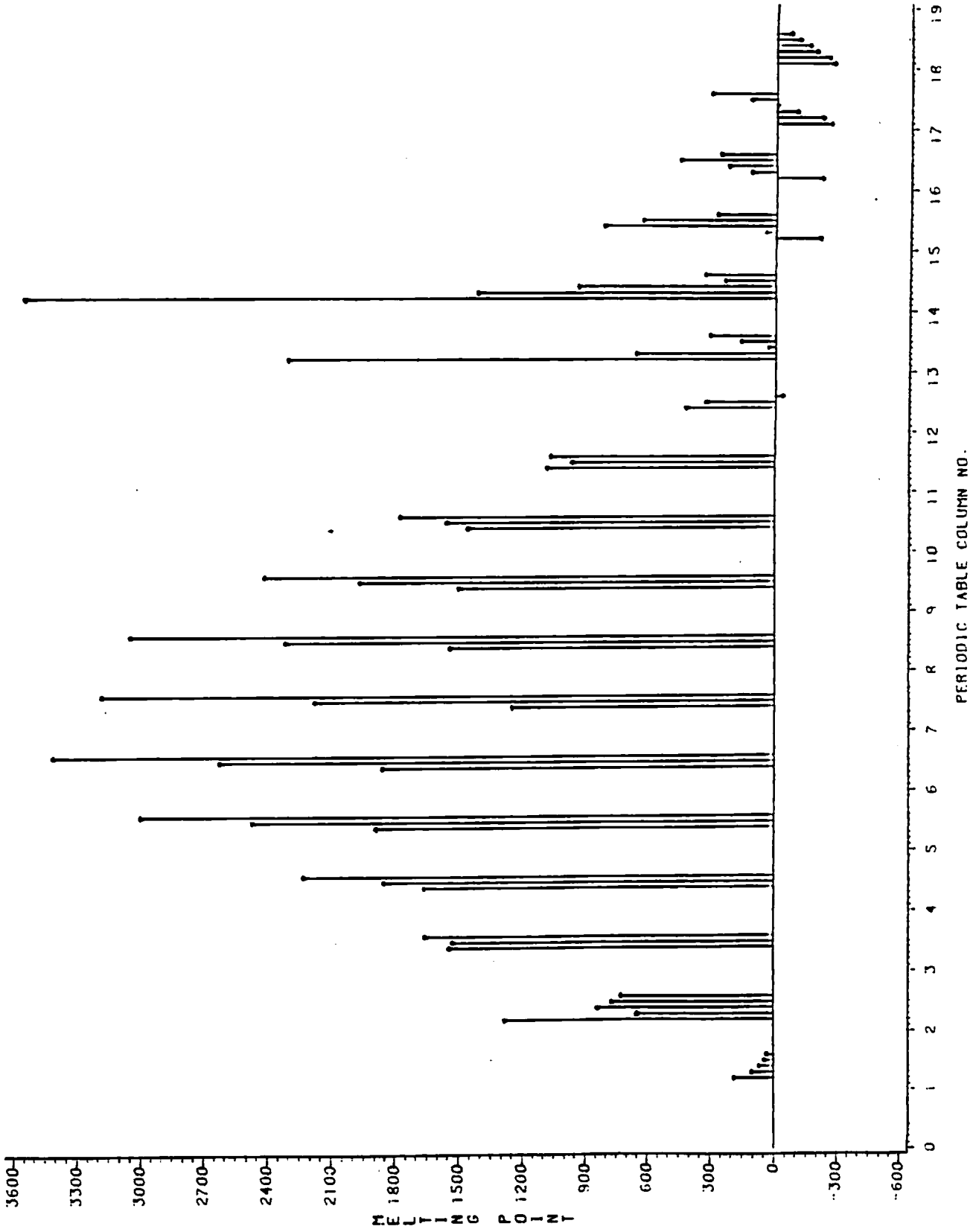


Fig. 5 - MELTING POINTS OF THE ELEMENTS

Fig. 6 - MELTING POINTS OF THE ELEMENTS



The Interatomic Distance Data Plots

Figures 7, 8 & 9 which follow are the plots of the interatomic distance data.

Please note that in the atomic number sequence plot the interatomic distances of the elements 58 to 71 (in box) form a pattern that is something of a "rounded knoll" with two "flag poles" on it. This pattern does not conform to the 18 wide "spire and roof" pattern of the other elements.

And again, please compare the relative appearance of columns 4 through 8 of the 32 and 18 wide periodic table plots.

(The text continues on page 17.)

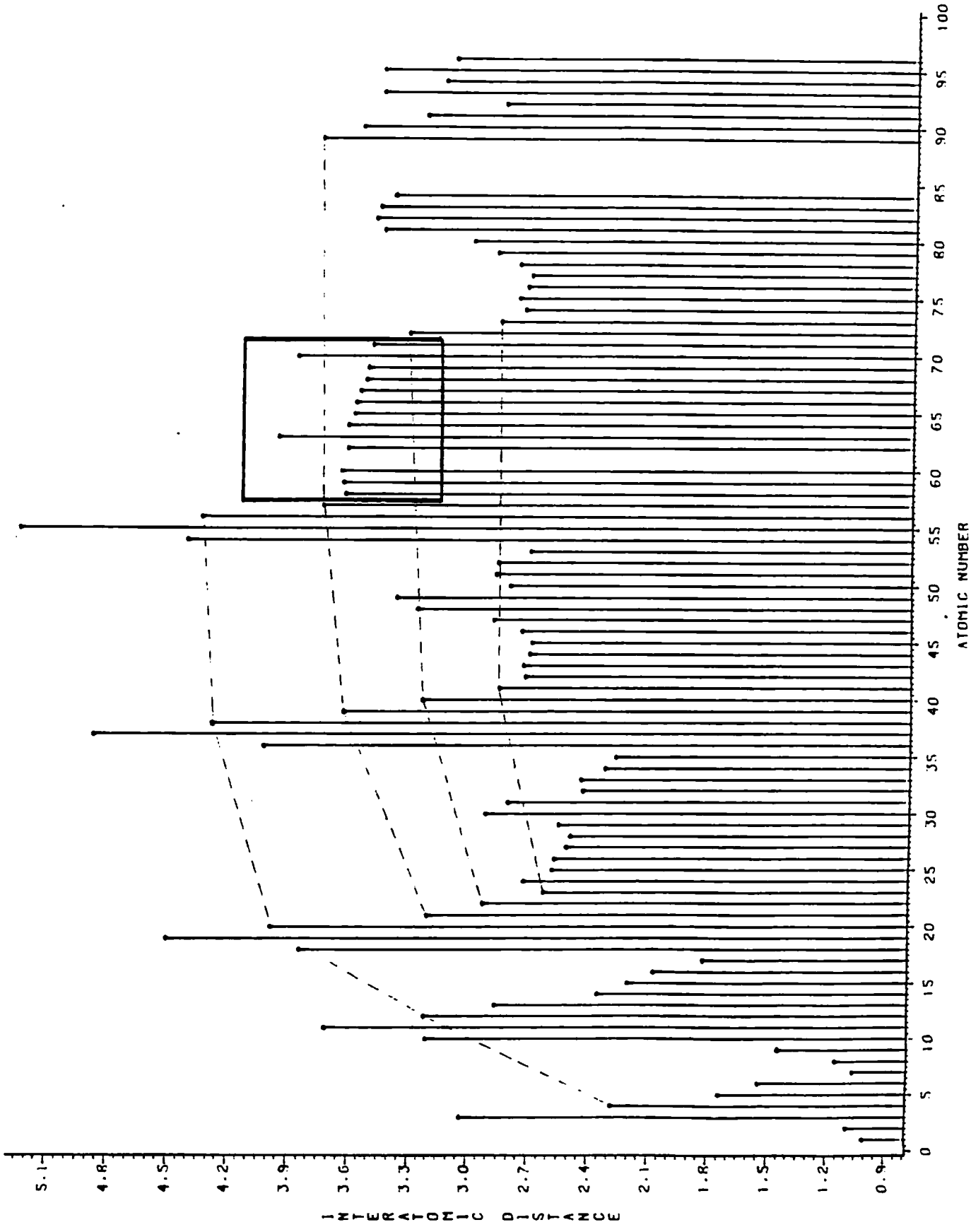


Fig. 7 - INTERATOMIC DISTANCES OF THE ELEMENTS

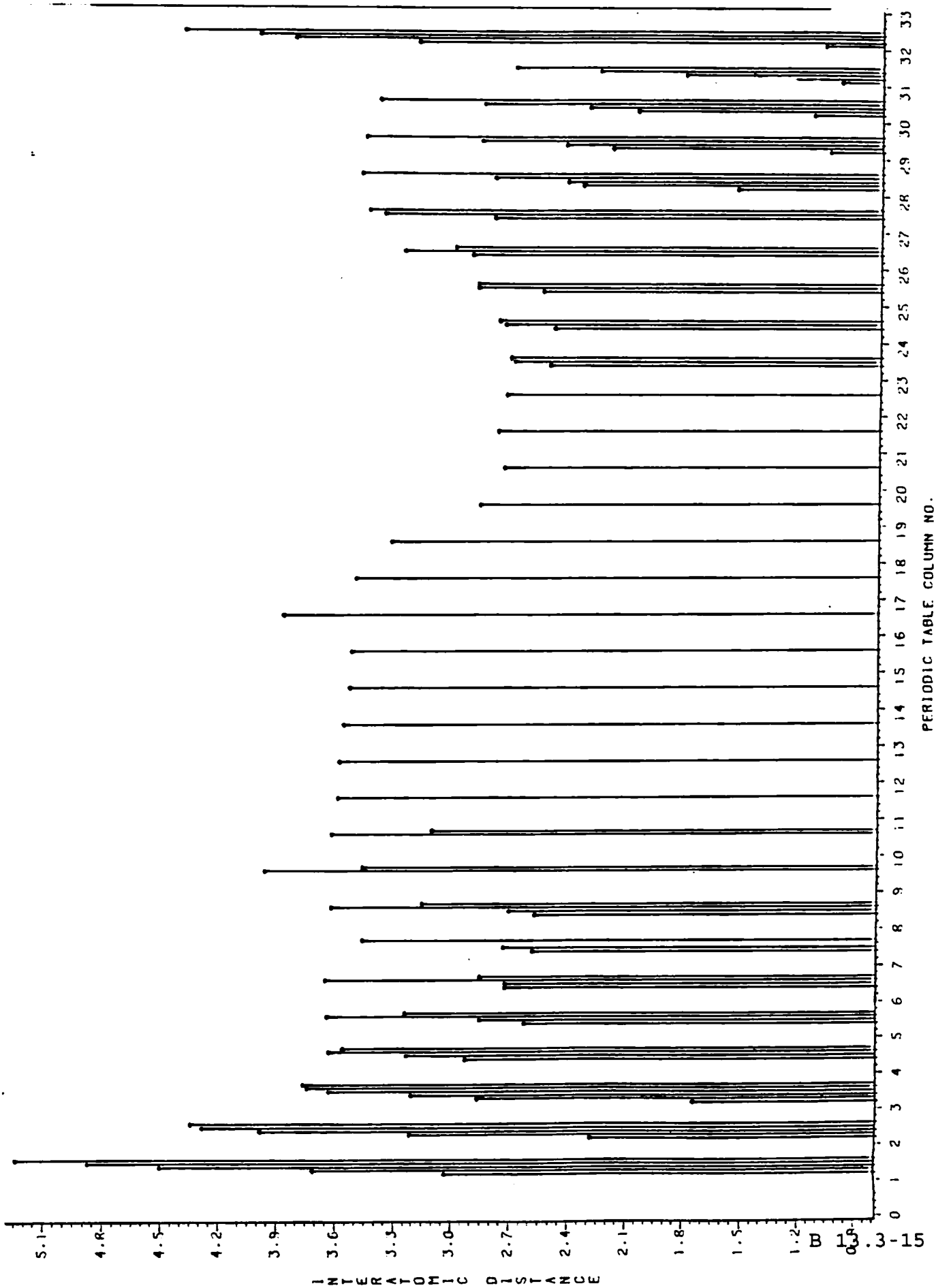
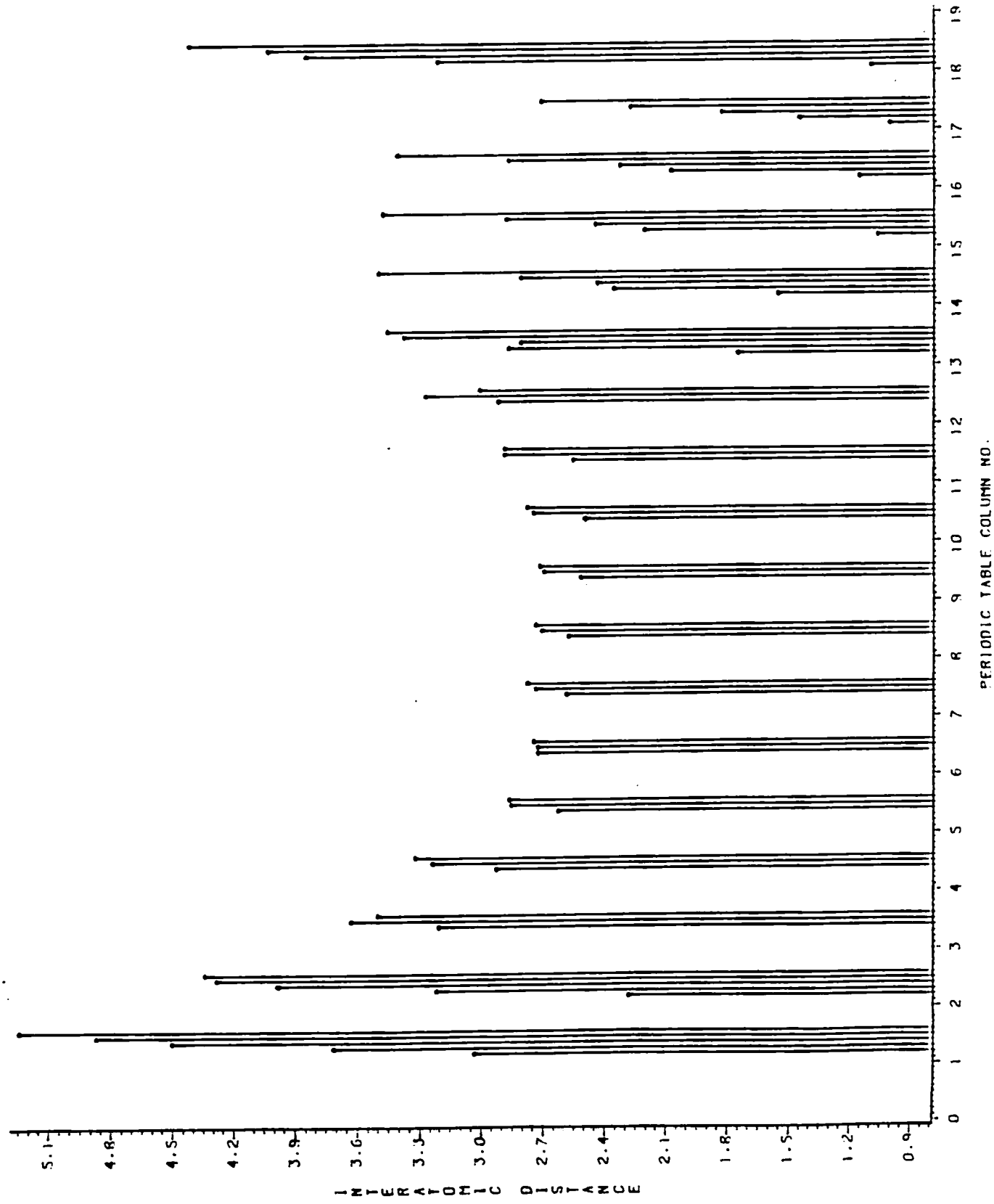


Fig. 8 - INTERATOMIC DISTANCES OF THE ELEMENTS

Fig. 9 - INTERATOMIC DISTANCES OF THE ELEMENTS



The Electron Work Function Data Plots

Figures 10, 11, 12 & 13 which follow are the plots of the electron work function data.

Atomic number sequence plots of both the 1959 and 1977 tabulations of work function data are included. The 1977 tabulation has a few more values than that of 1959, but the later tabulation should not be considered to be more accurate. Many of the values included in this later tabulation were marked as questionable or estimated.

Please note that in the atomic number sequence plot the incomplete work function data for the elements 58 to 71 (in boxes) form the beginnings of a pattern that is lower than the irregular 18 wide patterns formed by the data for the other elements.

And again, please compare columns 4 through 8 of the 32 and 18 wide periodic table plots.

(The text continues on page 22.)

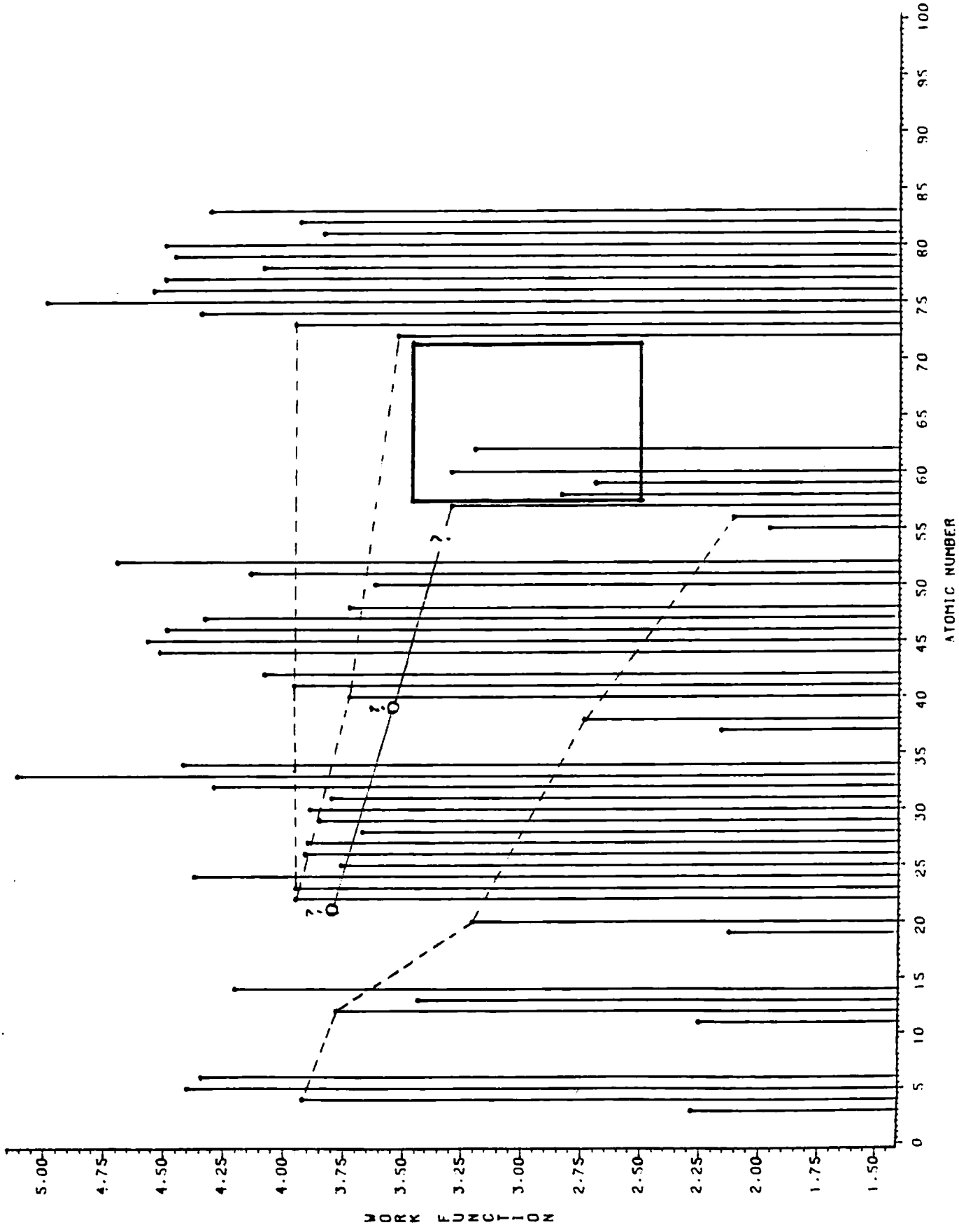


Fig. 10 - WORK FUNCTIONS OF THE ELEMENTS

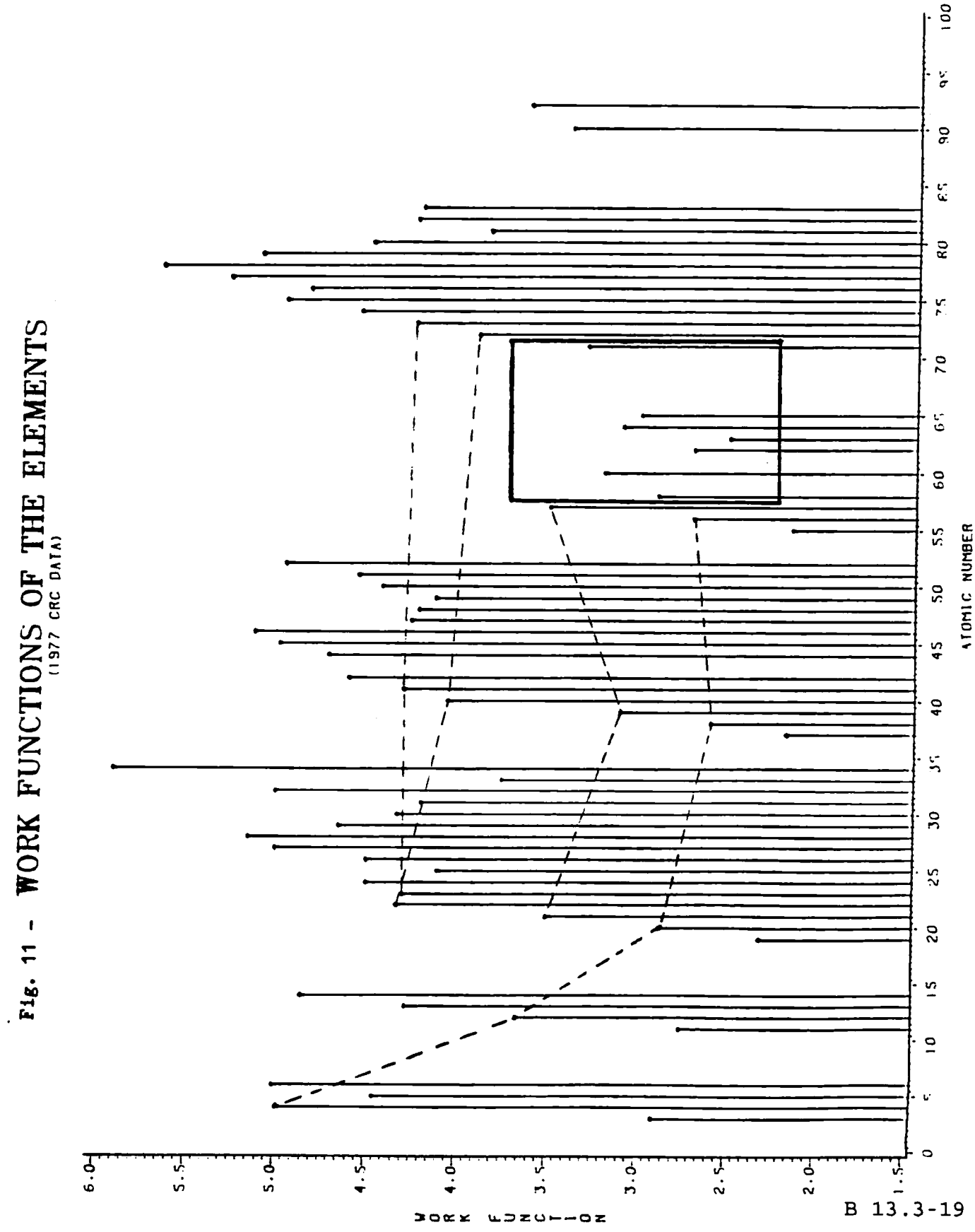


Fig. 11 - WORK FUNCTIONS OF THE ELEMENTS
(1977 CRC DATA)

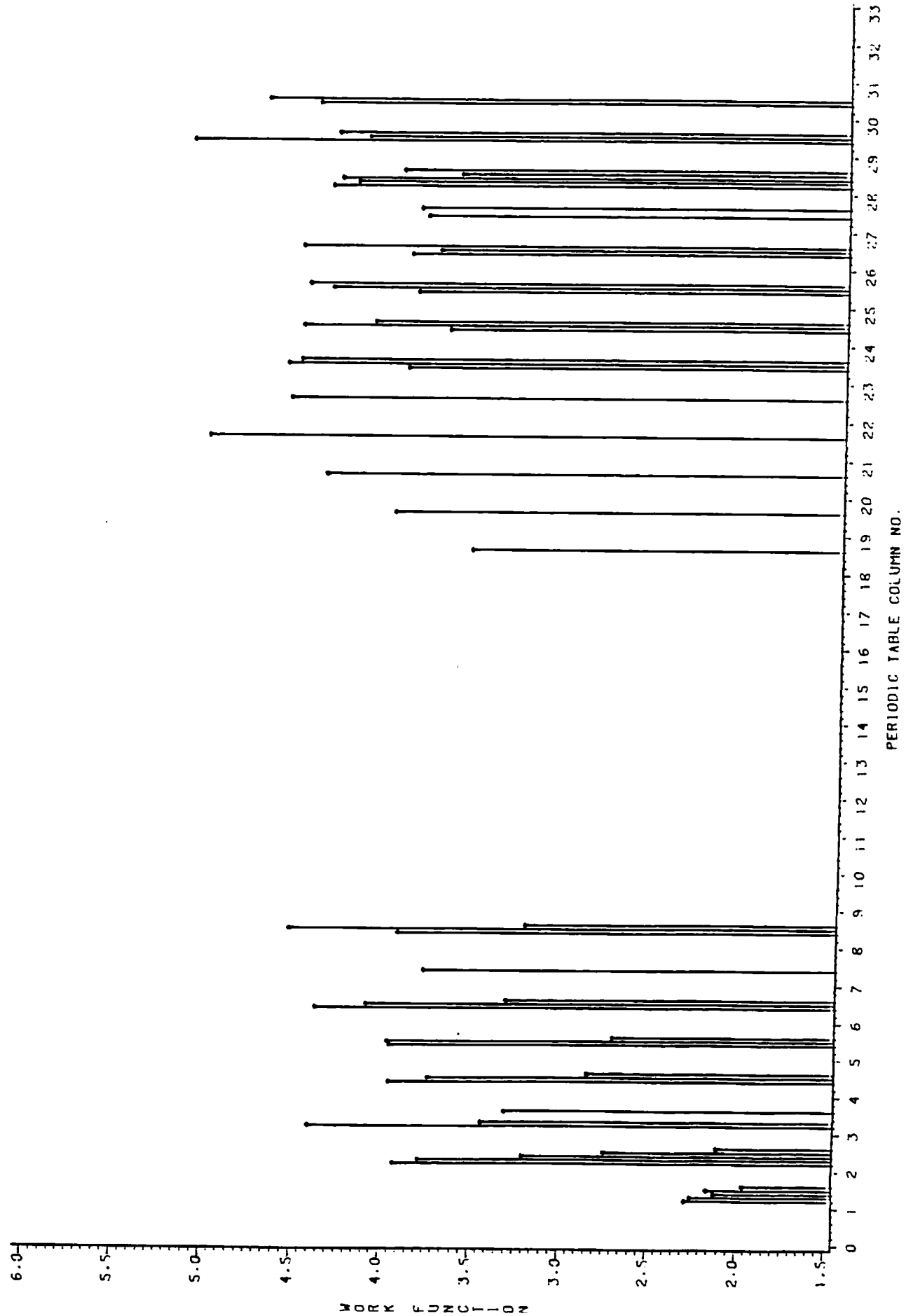


Fig. 12 - WORK FUNCTIONS OF THE ELEMENTS

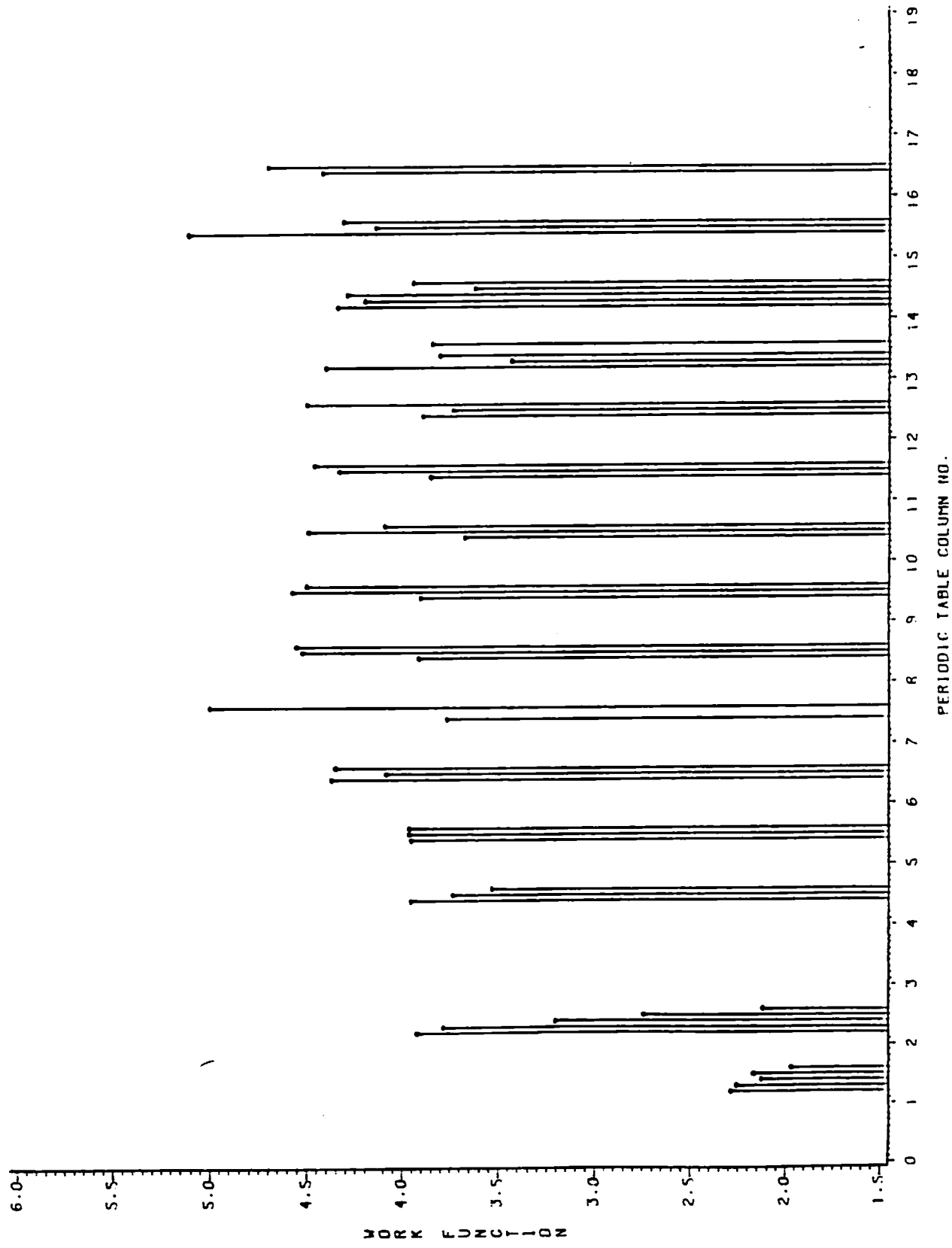


Fig. 13 - WORK FUNCTIONS OF THE ELEMENTS

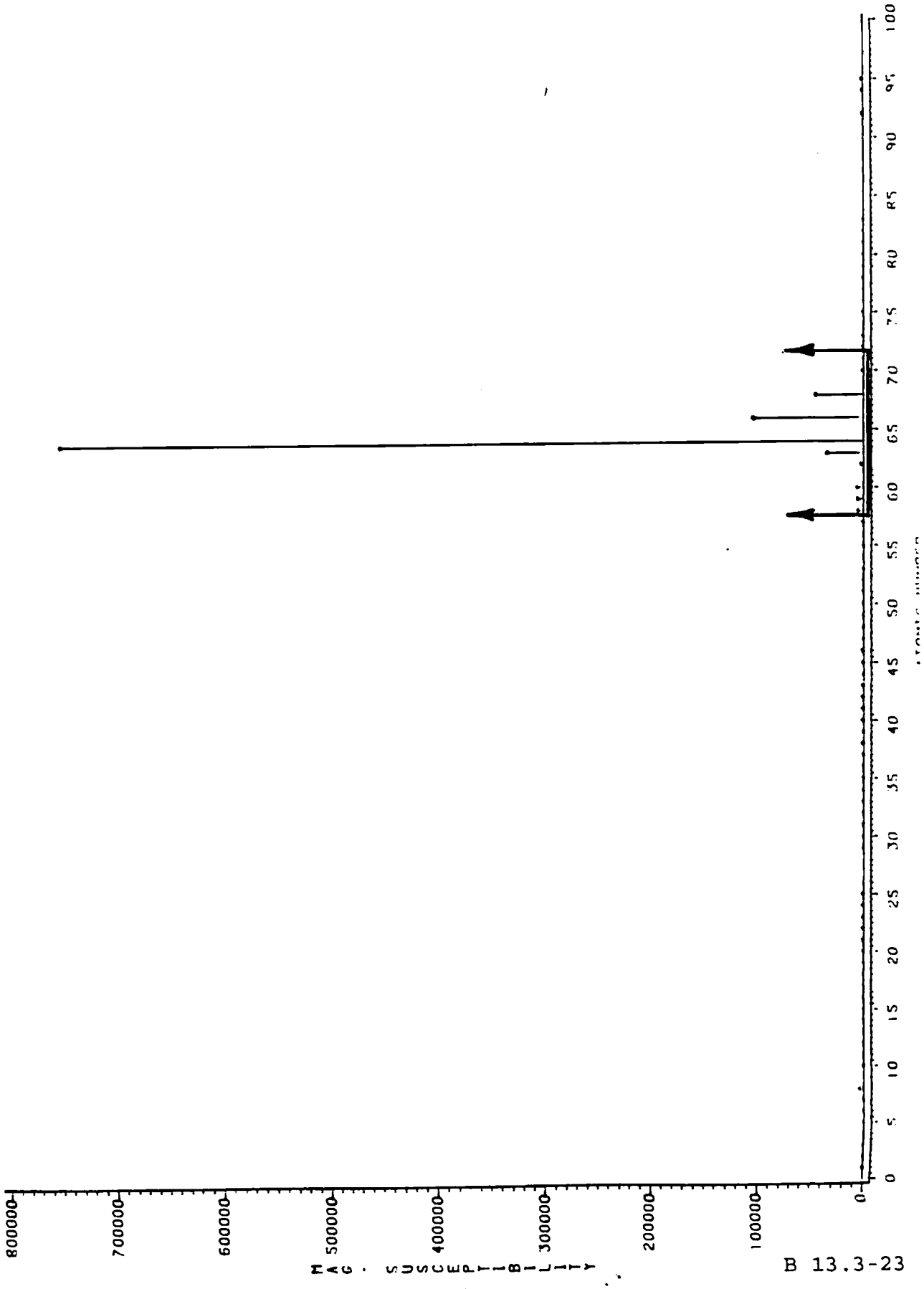
The Magnetic Susceptibility Data Plots

Figures 14, 15, 16 & 17 which follow are the plots of the magnetic susceptibility data.

An atomic number sequence plot of the untruncated magnetic susceptibility data (Fig. 14) is included to better illustrate the "nonconformist" nature of the rare earth elements for which magnetic susceptibility data is available. The data for figures 15, 16 and 17 have been truncated to a maximum value of 750 to permit the relatively small magnetic susceptibility values of the other elements to be seen.

(The text continues on page 27.)

Fig. 14 - MAGNETIC SUSCEPTIBILITY OF THE ELEMENTS



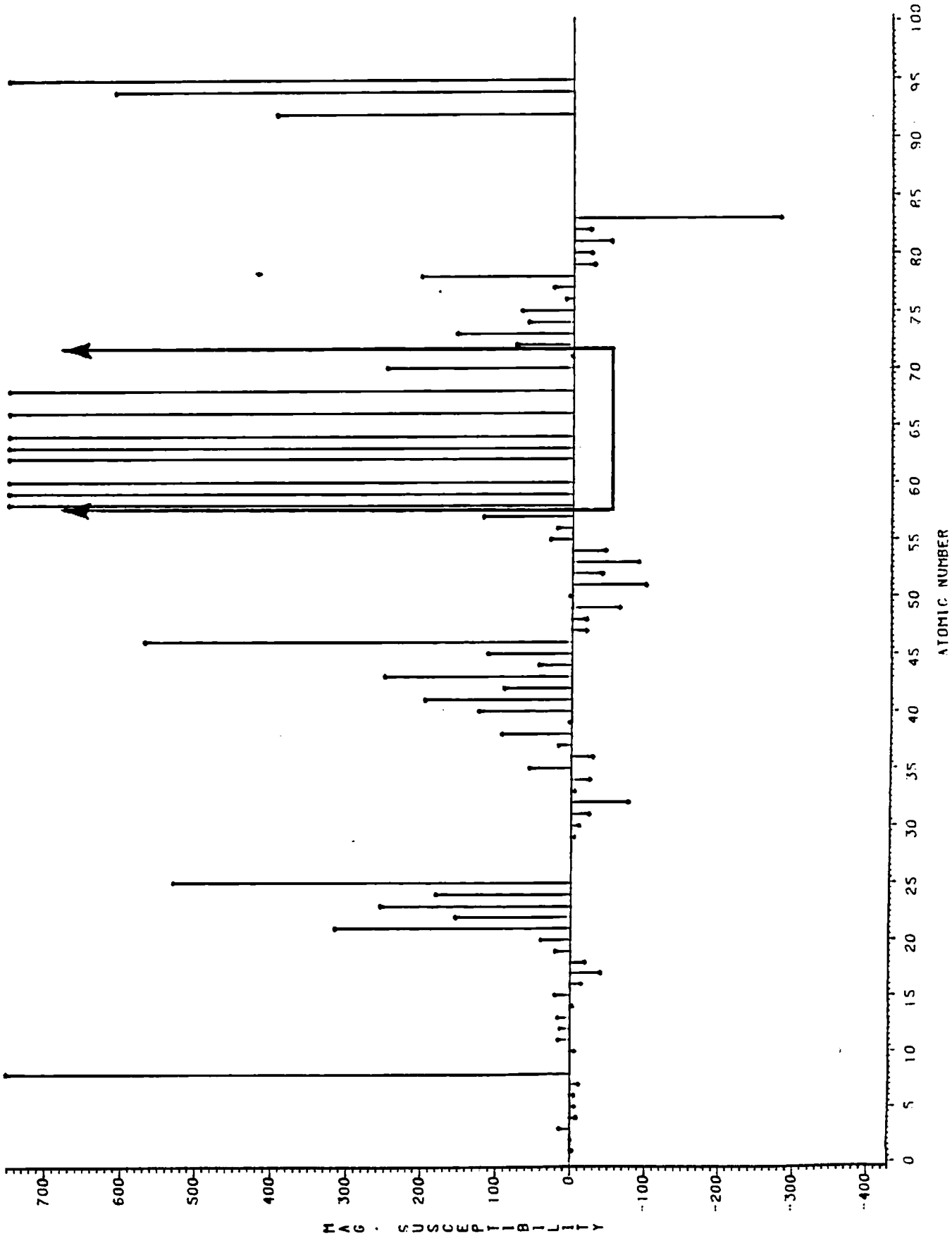


Fig. 15 - MAGNETIC SUSCEPTIBILITY OF THE ELEMENTS
(TRUNCATED)

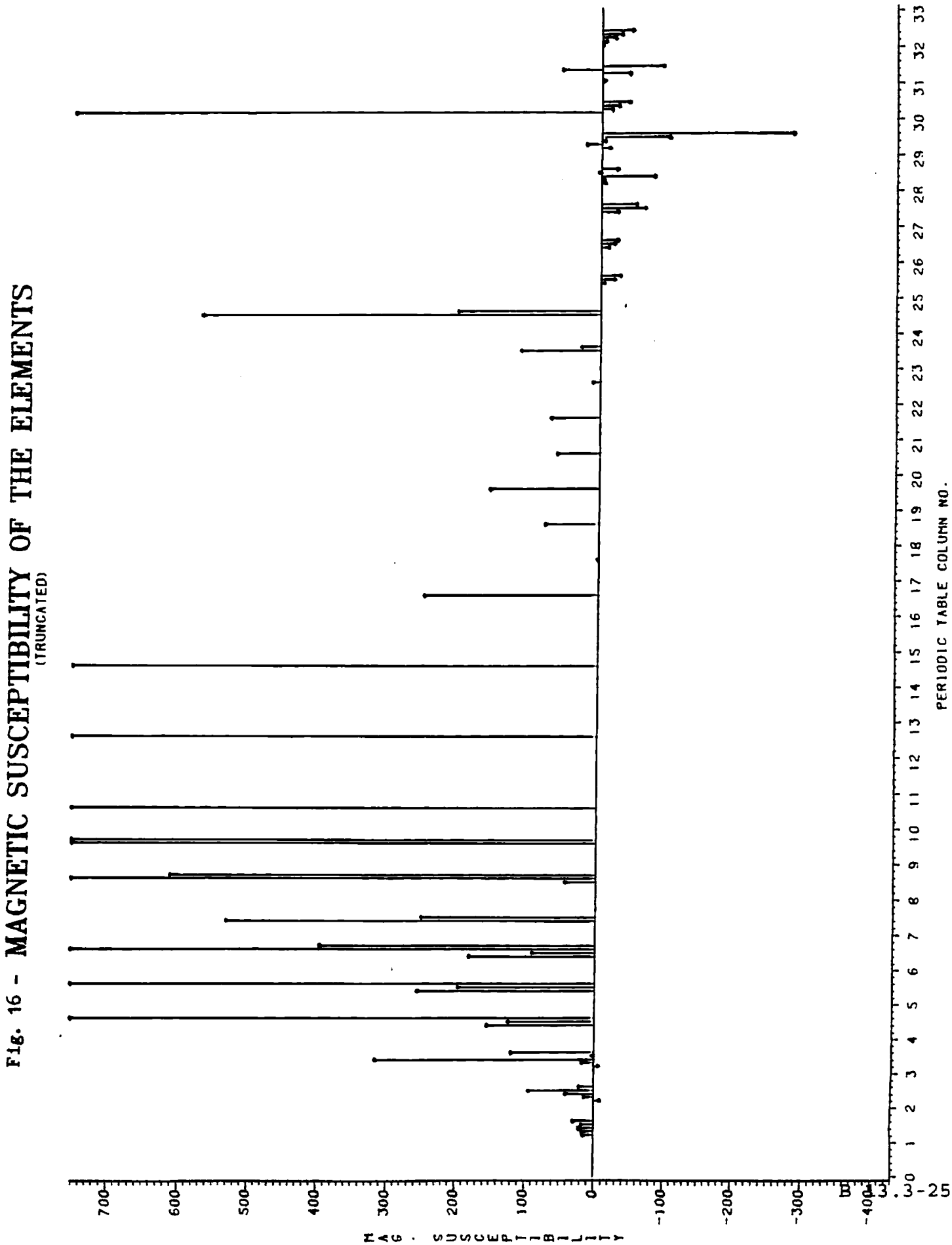


Fig. 16 - MAGNETIC SUSCEPTIBILITY OF THE ELEMENTS
(TRUNCATED)

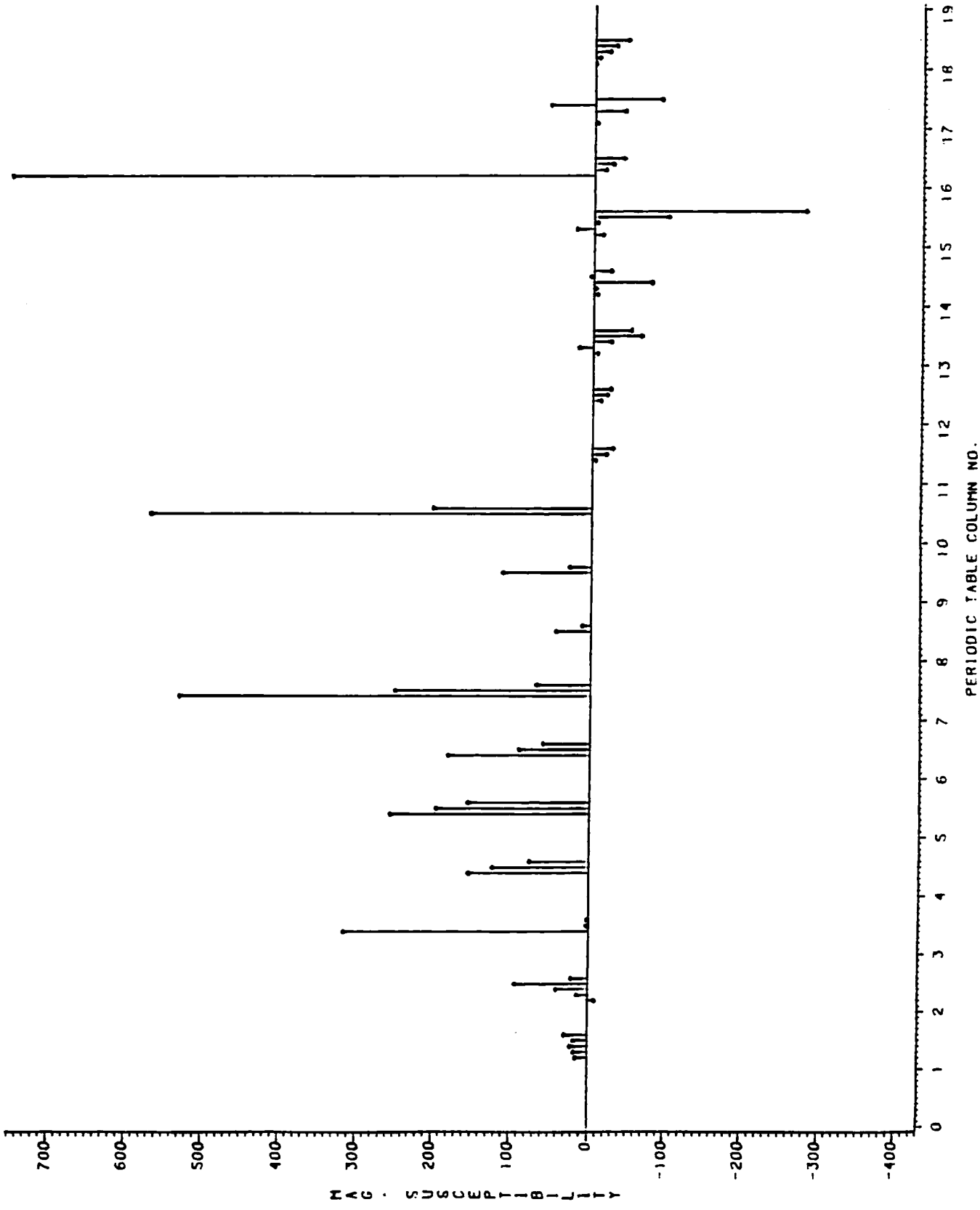


Fig. 17 - MAGNETIC SUSCEPTIBILITY OF THE ELEMENTS (TRUNCATED)

Observations

When the plots of the observed melting point, interatomic distance, electron work function and magnetic susceptibility data are examined the following patterns in the data (and deviations from the patterns) can be observed:

1 - Starting around element no. 18 (argon) the physical property data form three large patterns, and where the data is more complete, the beginning of a fourth.

2 - The first two patterns are 18 elements wide. The beginning or end of the third pattern is distorted by the presence of the distinctly different properties of the 14 elements (nos. 58 to 71) known as the rare earths or lanthanides. The resultant third pattern is 32 elements wide.

3 - In both the melting point and the interatomic distance data two of the elements in the 58 to 71 group (nos. 63 and 70) exhibit anomalous property values. Their melting points are lower and their interatomic distances are higher than the adjacent members of the group.

4 - The elements 63 and 70 are eight elements apart in the atomic number sequence.

5 - The four elements with the highest reported magnetic susceptibility are in this 63 to 70 subgroup. (For three of the eight elements no data were reported.)

Conclusions

Based on a careful review of the data plots the author has reached the following conclusions:

1 - The traditional 18 column wide periodic table with the 14 rare earth elements shown separately is more in harmony with the physical property data and better illustrates the periodic nature of the elements.

2 - The 14 element group from 58 to 71 and the 8 element subgroup from 63 to 70 are a unique atomic phenomenon that does not fit into the patterns established by the rest of the atomic series.

3 - If the reciprocal system of physical theory does not currently predict the occurrence of the uniquely different rare earth elements in the natural sequence of the elements, then more fundamental theoretical work needs to be done on the rotational motions of the atoms.

RELATIVE ABUNDANCE OF THE ELEMENTS

by K.V.K. Nehru

A general physical theory, like the Reciprocal System, should satisfy two types of criteria in order to establish its truth. Firstly, it should be able to explain completely those physical phenomena that remained recalcitrant without explanation in the previous theories. More desirably, it should lead to predictions which are definitely in conflict with those of the preceding theories but can be validated by observation or experimentation. The second type of requirement to be satisfied by the general theory is that it is not inconsistent with any of the definitely established physical facts. This may be called the negative criterion, whereas the previous one may be called the positive criterion.

It can be seen that the positive criterion, being more powerful in establishing the new theory, demands greater attention (and challenge) from the point of view of its proponents. The negative criterion, on the other hand, is a rather weak condition for positively establishing the new theory. Further, in view of the extremely vast number of genuine physical facts that were recognized, it is neither possible nor worthwhile to bestow more than a limited amount of consideration — especially in the early stages of the development of the new theory — to showing that the theory is not inconsistent with any of these facts. However, the negative criterion, though a weak one in establishing the new theory, is all-powerful in invalidating it if a single instance of inconsistency is found. For this reason the adherents of the conventional theory not infrequently, tend to invoke the negative criterion, having already armed themselves with some sort of explanations for some of these facts. They often ask how the new theory accounts for some of such recognized facts. In such instances — especially when information of a quantitative nature is involved — it is incumbent on the proponents of the new theory to pay more consideration and work out the details to demonstrate that the negative criterion is well satisfied.

I wish to bring to your attention two such questions which lectures on the astronomical aspects of the Reciprocal System invariably seem to elicit. The first one of these is about the genesis of the elements and their relative cosmic abundance. The second concerns the background microwave radiation and the value of its temperature. These, therefore, seem to warrant greater consideration in working out the details in the context of the Reciprocal System. The detailed study of the cosmic abundance problem is also important from the point of view of stellar evolution and energy generation processes.

In the following I attempt a cursory analysis of the cosmic abundance problem, giving nothing more than a general outline of the argument.

According to the Reciprocal System (i) the element building process starts with the formation of hydrogen from the decay products of cosmic matter — namely, the massless neutrons and their equivalents — ejected into the material sector;[1] (ii) the assembling of the elements with higher atomic numbers then continues by the successive additions of the positive rotational displacement units (PDU).[2] Let:

N_d = the total number of PDU in the material sector of the universe, locked up in the material atoms

N_t = the total number of atoms in the material sector

N_e = the number of rotational displacement units ejected into the cosmic sector from the material sector

= the number of rotational displacement units ejected into the material sector from the cosmic sector (under steady state conditions)

N_n = the number of free PDU in the material universe involved in transmuting the elements

N_z = the number of atoms of the element with atomic number Z

a_z = the relative cosmic abundance of the element $Z = N_z/N_t$

We will consider the element with atomic number Z. We find that its population, N_z, is being increased by the atoms that get transmuted to element Z from lower Z values. At the same time N_z is being decreased by those atoms that get transmuted to atomic numbers higher than Z. In addition, some atoms of element Z are lost through Type II explosions. Since the universe as a whole is under steady state, the number N_z can be taken as constant. This means that the inflow must be equal to the outflow.

Total PDU

The total number of the positive rotational displacement units contained in all the atoms in the material sector is given by

$$N_d = \Sigma_z \; Z*N_z = N_t \; \Sigma \; Z*a_z \qquad (1)$$

Transmutation, Outgoing

O_z, the number of atoms of element Z that are outgoing by getting transmuted to element(s) of higher atomic number by combining with the free PDU can be arrived at as follows:

Let D_z be the number of PDU captured by the atoms of element Z, out of N_n, the total number of PDU available for transmutation. Then, the ratio D_z/N_n must be equal to the ratio of the PDU locked up in all the atoms of element Z to the total number of PDU in the material sector. That is,

$$D_z/N_n = Z*N_z/N_d, \text{ or } D_z = Z \; (N_t*a_z) \; N_n/N_d \qquad (2)$$

Now, the major portion of the outgoing atoms from element Z end up as atoms of element Z+1. This involves the capture of a single PDU by each atom. Let this number of atoms be ${}_1O_z$. In addition, it is also probable that a small fraction of the atoms capture simultaneously two PDU, resulting in transmutation to element Z+2. Let this number be ${}_2O_z$. Thus O_z is made up of two parts, ${}_1O_z$ and ${}_2O_z$, such that

$$ {}_1O_z = k*O_z \text{ and } {}_2O_z = (1-k)*O_z \tag{3} $$

where k is a distribution fraction.

Of the number of D_z, we take that the number of PDU involved in the single capture event is ${}_1D_z$ and the number involved in the double capture event is ${}_2D_z$. Then ${}_1D_z = {}_1O_z$, whereas ${}_2D_z = 2* {}_2O_z$. Using eq. (3) we have

$$ D_z = {}_1D_z + {}_2D_z = {}_1O_z + 2*{}_2O_z = [k+2(1-k)]O_z = (2-k)*O_z $$

Substituting for D_z from eq. (2),

$$ O_z = [N_t*N_n/N_d(2-k)]*Z*a_z \tag{4} $$

Transmutation, Incoming

From what has been said above, it can be seen that the number of atoms, I, coming in by getting transmuted to element Z from elements of lower atomic number comprises two separate streams: I_{z-1}, the number that is coming in from element Z-1 due to single capture, and I_{z-2}, the number coming in from element Z-2 due to double capture (see fig. 2). From eq. (3) we note that

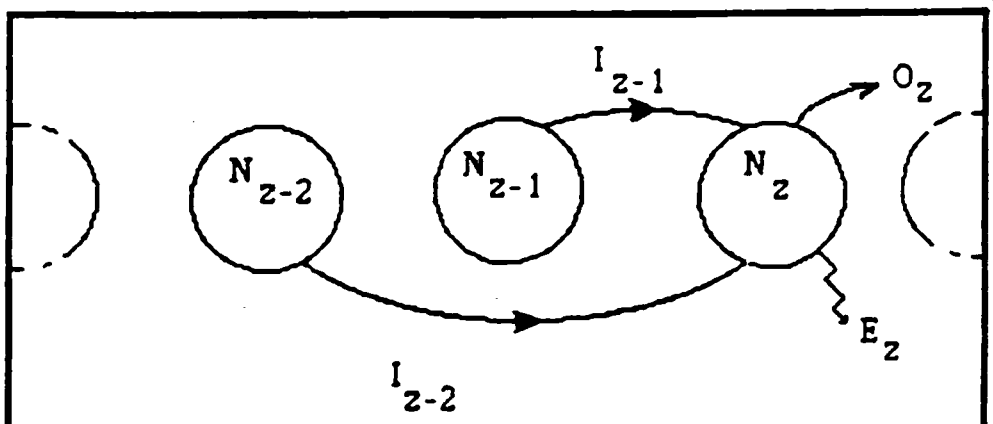


Fig. 2. Population Flow to and from Element Z

$I_{z-2} = {}_2O_{z-2} = (1-k)*O_{z-2}$ and

$I_{z-1} = {}_1O_{z-1} = k*O_{z-1}$

Thus, the total number of incoming atoms adding to the population of element Z is, (substituting Z+2 and Z+1 respectively, for Z in eq. (4))

$$I = I_{z-2} + I_{z-1}$$

$$= [N_t*N_n/N_d(2-k)]*[(1-k)(Z-2)a_{z-2} + k(Z-1)a_{z-1}] \quad (5)$$

Ejection

We will assume that the relative abundance in the matter that is ejected to the c-sector by the Type II explosions is the same as that in the material sector of the universe in general. If E_z is the number of atoms of element Z that are ejected, we have the total number of PDU that are leaving the material sector by way of ejection as

$$N_e = \Sigma_z \, Z^*E_z \tag{6}$$

If the matter is uniformly distributed, we have E_z proportional to N_z; that is, $E_z = g^*N_z$, where g is a fraction less than 1.0. Then

$$E_z = g^*N_t^*a_z \tag{7}$$

Therefore, from eq. (6) above,

$$N_e = \Sigma Z^*(g^*N_t^*a_z) = g^*N_t\Sigma Z^*a_z$$

Hence, from eq. (1), $N_e = g^*N_d$, or $g = N_e/N_d$. Finally, from eq. (7),

$$E_z = (N_t^*N_e/N_d)a_z$$

$$= [N_t^*N_n/N_d(2-k)] \; [N_e(2-k)/N_n]^*a_z \tag{8}$$

Equilibrium

By steady state we mean, in the material sector, uniformity with respect to time. Under steady state conditions, therefore, the relative abundance does not vary. That is, N_z, the number of atoms of the element Z is constant.

In other words, $I = O_z + E_z$ (see fig. 2). Thus, from eqs. (4), (5) and (8),

$$[N_t^*N_n/N_d(2-k)][(1-k)(Z-2)a_{z-2} + k(Z-1)a_{z-1}]$$

$$= [N_t^*N_n/N_d(2-k)][Z^*a_z + (N_e(2-k)/N_n)a_z]$$

Or

$$a_z = \frac{(1-k)(Z-2)a_{z-2} + k(Z-1)a_{z-1}}{Z + \sigma} \tag{9}$$

where $\sigma = N_e(2-k)/N_n$ (10)

Hydrogen

Since with Z = 1, hydrogen is the first element, the case of inflow from elements of lower atomic number does not arise. On the other hand, the displacement units ejected from the c-sector form the incoming flow. Since, of the N_e displacement units entering the material sector, N_n PDU are used up for the purpose of transmutation, the number of PDU that eventually transform to hydrogen atoms is $N_e - N_n$. Therefore, from eqs. (4) and (8), balancing the inflow and the outflow,

$$N_e - N_n = [N_t * N_n / N_d(2-k)][1 * a_1 + (N_e(2-k)/N_n)a_1]$$

Or,

$$\frac{N_e - N_n}{N_n}(2-k)\frac{N_d}{N_t} = (1+\sigma)a_1$$

Substituting from eqs. (1) and (10),

$$a_1 = \frac{\sigma - (2-k)}{\sigma + 1}\Sigma Z * a_z \tag{11}$$

Since a_z is a function of a_1, a_1 cancels out from both sides of the equation (11). The equation, therefore, serves as the compatibility

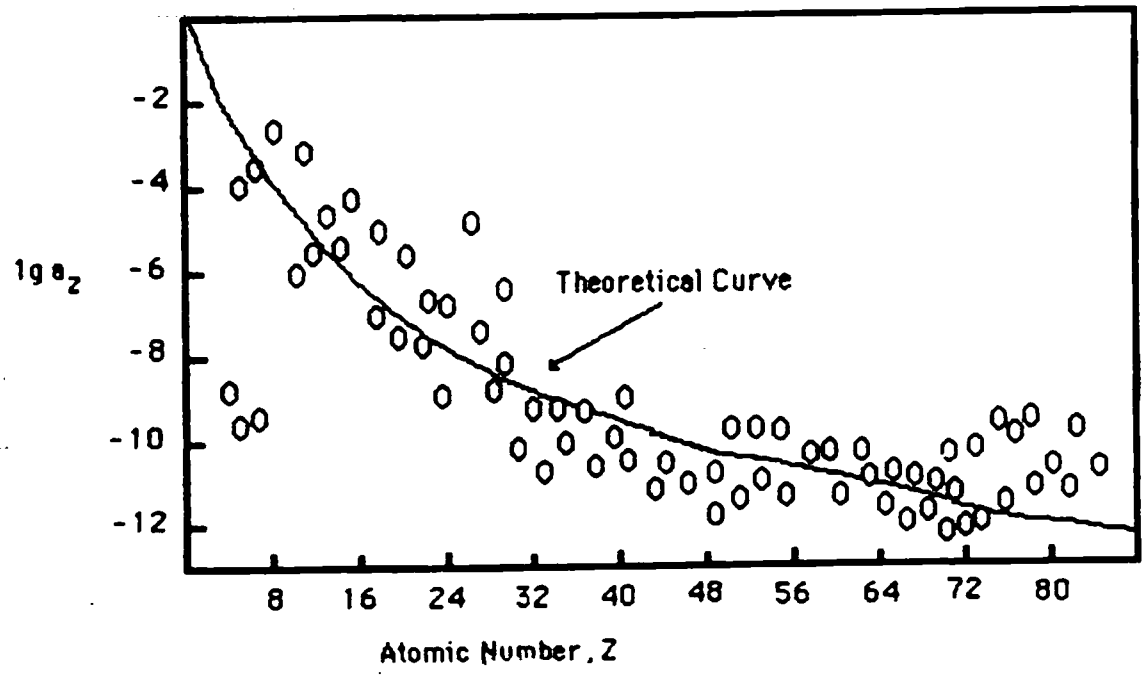
criterion between values of σ and k.
Further, since $N_t = \Sigma N_z$,

$$\Sigma a_z = 1 \tag{12}$$

Eq. 12 is the normalizing condition which fixes the value of a_1, and hence of all a_z, for given values of σ and k.

Comparison with Empirical Data

The values of the two parameters σ and k in the above equations are to be arrived at by logical processes from the postulates of the Reciprocal System. This still remains to be done. Meanwhile, a good agreement with the empirical values of the relative cosmic abundance[3] can be demonstrated by appropriate choice of σ and k. The theoretical curve is plotted in Fig. 1, with σ = 9.5 and k = 0.9.



It must be noted that, in the figure, the abundance values are plotted on a logarithmic scale and hence the discrepancy between the theoretical and the observational values wherever it occurs should not be underestimated. However, it is clear that, as far as it goes, the trend of the theoretical curve conforms well to the actual.

Further refinement is in order in considering the possibility of transmutation by triple or multiple capture of PDU, which have a non-zero probability at the higher Z values. In fact, the comparatively higher abundance of the Even-Z elements over those of the Odd ones can be explained on the basis of the corresponding distribution in the values of k for the single, double, or higher multiple capture events. Remembering that the atomic number is the net total electric displacement units, and Even Z can be seen to correspond to an Odd speed 1/(1+Z). As Larson explains, Odd speeds (like 1/3 or 1/5) are the direct result of scalar directional reversals, whereas Even speeds (like 1/4 or 1/6) are obtained only by way of compounding two Odd speeds. As such, the probability of an Odd speed (Even Z) is comparatively higher than that of an Even speed (Odd Z).

Among the assumptions made, the first is that the relative abundance is uniform in the universe. The second one is that the magnetic ionization level is zero. This may be true only in the case of interstellar and intergalactic matter, most of which lies undetected. Consequently, the contribution of this matter to the cosmic abundance is not reflected adequately in the observational values. The zero ionization level assumption, therefore, is likely to give rise to a large error in the predicted values, especially at the higher atomic numbers. Evaluation based on the consideration of the atomic weight rather than the atomic number will be more appropriate to the situation as it takes care of the

rotational displacement present as the gravitational charge as well.

Another important factor that has not been taken into account in this preliminary analysis is the disintegration of matter that occurs on attaining the destructive thermal limit (as in the stellar energy generation process). Also to be considered is the effect of supernova explosions on the abundance of the Fe group of elements, and the possibility that the relative abundance in the matter ejected out of the material sector in Type II explosions is considerably different from that applicable at large.

References

[1] D. B. Larson, *Nothing But Motion*, (Portland, Or. : North Pacific Publishers, 1979), p. 215.

[2] D. B. Larson, *The Structure of the Physical Universe* (Portland, Or., : North Pacific Publishers, 1959), pp. 105-108.

[3] *American Institute of Physics Handbook*, 1963

[4] D. B. Larson, *Nothing But Motion*, *op. cit.*, p. 98.

THE PROPERTIES OF MATERIALS: A CLASSIFICATION

by

Ronald W. Satz

I. INTERACTIONS OF ATOMS

A. Interaction of Atoms of Same Kind

1. Solid state

a. mechanical properties

1) structural

a) geometrical configuration
b) interatomic distance and density
c) internal pressure and cohesive energy
d) grain size
e) structural defects

2) moduli

a) modulus of bulk
b) modulus of rigidity
c) modulus of elasticity
(1) in tension
(2) in compression
(3) in flexure

3) strengths

a) elastic limit
b) yield strength
c) fatigue-endurance limit
d) Izod impact strength
e) ultimate strength
(1) in tension
(2) in compression
(3) in flexure
(4) in shear

4) dimensional change

a) Poisson's ratio
b) elongation
c) reduction of area

5) hardness and surface treatment

a) Moh's hardness
b) Brinell hardness
c) Rockwell hardness
d) Shore hardness
e) friction

b. thermal properties

1) temperature and specific heat
2) thermal coefficient of expansion
3) phase changes

2. Liquid state

a. mechanical properties

1) structural
2) volume relations and bulk modulus

b. thermal properties

1) fusion temperature
2) latent heat of fusion
3) specific heat
4) viscosity
5) surface tension

3. Gaseous State

a. mechanical properties

1) structural
2) volume relations

b. thermal properties

1) evaporation temperature
2) latent heat of vaporization
3) gas constant and molecular mass
4) triple point
5) critical point
6) viscosity

4. Vapor State

(see list of properties for gaseous state)

B. Interaction of Atoms of Different Kinds

1. Solid solutions

a. mechanical properties

1) structural

a) valence and chemical composition
b) formation of compounds, alloys, mixtures
c) geometric configuration
d) interatomic distance and density
e) internal pressure and cohesive energy
f) structural defects
g) corrosion

2) moduli

a) modulus of bulk
b) modulus of rigidity
c) modulus of elasticity
(1) in tension
(2) in compression
(3) in flexure

3) strengths

a) elastic limit
b) yield strength
c) fatigue endurance limit
d) Izod impact strength
e) ultimate strength
(1) in tension
(2) in compression
(3) in flexure
(4) in shear

4) dimensional change

a) Poisson's ratio
b) elongation
c) reduction of area

5) hardness and surface treatment

a) Moh's hardness
b) Brinell hardness
c) Rockwell hardness
d) Shore hardness
e) friction

b. thermal properties

1) temperature and specific heat
2) thermal coefficient of expansion
3) phase changes

2. Liquid solutions

a. mechanical properties

1) structural
2) volume relations and bulk modulus

b. thermal properties

1) fusion temperature
2) latent heat of fusion
3) specific heat
4) viscosity
5) surface tension

3. Gas solutions

a. mechanical properties

1) structural
2) volume relations

b. thermal properties

1) evaporation temperature
2) latent heat of vaporization
3) gas constant and molecular mass
4) triple point
5) critical point
6) viscosity

4. Vapor solutions

(see list of properties for gas solutions)

II. INTERACTIONS OF ATOMS WITH OTHER PHYSICAL EXISTENTS

A. Interactions with Space-Time

B. Interactions with Photons

1) Spectroscopy and color
2) Work function
3) Reflection coefficient
4) Absorption coefficient
5) Transmission coefficient
6) Index of refraction

C. Interactions with Electrons and Positrons

1) Positron absorption
2) Electrical resistivity
3) Dielectric constant
4) Thermal conductivity
5) Ionic creation

D. Interactions with Neutron Group

1) Neutron absorption cross section
2) Isotopes
3) Magnetism