New Data for the Lunar 20 Core and a Survey of Published Chemical Data

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The new analyses were obtained at Vernadsky Institute using a spark source mass spectrometer and a new method of analysis. About 10 mg of sample was pressed in an Al cup without the addition of an electrically conducting material (ref. 1). The opposing electrode was of Ta and served as the cathode. The analyses were corrected with the assistance of a device to cut off the arc stage of the discharge (refs. 2 and 3). This provides simpler spectra because of the resulting large reduction of complex ions and also provides stabilization of the sensitivity coefficients from sample to sample. Intersample precision is considered to be ± 5 to 15 percent.

At the start of analyses, three lunar soil samples—10084, 12070, and 14163—were chosen as control samples and geological samples W–1, BCR–1, and AGV–1 were to be standards. However, the first round of analyses demonstrated that only the lunar soil samples could serve as standards because the sensitivity coefficients for the geological standards often had prohibititively large scatter. Therefore the new data were taken relative to 12070. The new and published data for the fine fraction of the Luna 20 core are given in table 1 so that the readers can draw their own conclusions about the quality and interlaboratory biases of the results. Figure 1 shows the subdivision of the Luna 20 core, the corresponding Soviet sample numbers, and the relative position of the American sample. All samples analyzed in the U.S.S.R. were from the less than 83μ fraction, while the American samples were from the less than 125μ fraction.

The analytical results for the four zones of the Luna 20 core suggest that the core is nonuniform with depth (fig. 2). The higher concentrations of Ce, Sc, Ba, La, Co, Sr, and Zr in zone 2001 may be connected with the presence in this zone of a basaltic rock type seldom seen in the other zones (ref. 13). That is, about half of the basaltic fragments in the large size fractions in zone 2001 are of a specific porphyritic breccia-like type. Anorthositic fragments containing a noteable amount of metallic iron are basically limited to zone 2004 and probably explain the lower concentrations of Ce, Rb, Ba, La, and perhaps Co in this zone.

We also confirm the high concentrations of Ag and Ce found by Laul and Schmitt (ref. 7) and also by Morgan et al. (ref. 8). Although Ag is at nearly the same concentration in all four zones of the core, Cd in the core is the result of local enrichment. In particular, in zone 2004 the concentration of Cd may be as high as 10 ppm in a sample size of 0.01 mg.

Table 1.—*New Spark Source Mass Spectrometric Data for the Four Zones of the Luna 20 Core Tube and a Survey of Published Data*

Element	Helmke et al. (ref. 5)	Jerome and Philpotts (ref. 6)	Laul and Schmitt (ref. 7)	Morgan et al. (ref. 8)	Nava and Philpotts (ref. 9)	Bansal et al. (ref. 10)	Best Values 1–6	Surkov et al. (ref. 11) 2004	Yakovlev et al. (ref. 12) 2004	New Trace Element Data [ω]			
										Zone 2001	Zone 2002	Zone 2003	Zone 2004
	1	2	3	4	5	6	7	8	9	10	11	12	13
SiO_2	—	—	—	—	45.4	—	—	—	—	—	45.8	—	44.4
FeO	—	7.78	8.1	—	7.37	—	—	—	—	—	7.02	—	7.03
Al_2O_3	—	22.73	22.8	—	23.44	—	—	—	—	—	21.6	—	22.9
MgO	—	—	10	—	9.19	—	—	—	—	—	9.85	—	9.70
CaO	—	15.81	14.2	—	13.38	—	—	—	—	—	14.9	—	15.2
TiO_2	—	0.43	0.49	—	0.47	0.47	0.47	—	—	—	0.533	—	0.56
Na_2O	—	0.38	0.334	—	0.29	0.41	—	—	—	—	0.46	—	0.55
K_2O	—	—	0.076	—	0.0666	0.0691	—	—	—	—	0.10	—	0.10
P_2O_5	—	—	—	—	0.06	—	—	—	—	—	0.17	—	0.14
MnO	—	0.105	0.104	—	0.10	—	0.10	—	—	—	0.13	—	0.12
S	—	—	—	—	—	—	—	—	—	—	0.08	—	0.08
Sc	16	16.2	16.5	—	—	—	16.2	20	—	18.5	15	16.3	15.5
Co	26	34	27	—	—	—	27	25	—	32	40	24	18.6
Ni	—	—	260	—	—	—	—	—	—	315	262	243	280
Zn	35 ± 14	—	21.0	21.5	—	—	21	—	—	14.4	21.4	16	28
Rb	2.0	—	1.6	1.5	1.6	1.6	1.6	—	—	1.35	1.31	1.49	0.86
Sr	—	—	—	—	144	140	142	—	—	231	150	145	162
Zr	—	—	—	—	94	115	110	—	—	143	109	87	167
Y	—	—	—	—	—	—	—	—	—	22	15.8	19.8	18.0
Ba	—	—	—	—	93.8	87.3	90.6	—	—	134	116	126	85
La	6.7	6.4	6.2	—	—	6.13	6.13	6.0	6.5	6.9	5.8	5.5	4.3
Ce	15.8	20.3	16	—	16.1	17.7	17.0	15	13.7	21.4	19.7	19.9	14.8
Pr	—	—	—	—	—	—	—	2.1	2.06	—	—	—	—
Nd	10.5	11.1	—	—	10.6	10.3	10.5	12	11.4	—	—	—	—

Sm	3.23	3.2	3.1	—	2.98	2.97	2.93	3.0	2.68	—	—	—	—
Eu	0.94	0.96	0.92	—	0.94	0.922	0.931	0.88	0.88	1.00	0.93	1.12	0.71
Gd	4.4	—	—	—	3.81	3.80	3.81	4.0	4.02	—	—	—	—
Tb	0.68	0.66	0.63	—	—	—	0.66	0.6	0.66	—	—	—	—
Dy	4.48	—	4.0	—	4.08	4.23	4.16	3.7	4.2	—	—	—	—
Ho	0.85	—	—	—	—	—	—	0.9	0.86	—	—	—	—
Eu	3.0	—	—	—	2.40	2.66	2.53	2.4	2.77	—	—	—	—
Tm	—	0.35	—	—	—	—	—	0.35	0.48	—	—	—	—
Yb	2.38	2.30	2.6	—	2.36	2.54	2.40	1.9	2.65	—	—	—	—
Lu	0.349	0.37	0.43	—	0.38	0.375	0.37	0.36	0.34	—	—	—	—
Cr	1370	1250	1232	—	953	1663	—	—	—	—	—	—	—
Sb	—	—	0.760	0.0098	—	—	—	—	—	—	—	—	—
In	—	—	0.010	0.0039	—	—	—	—	—	—	—	—	—
Hf	2.9	2.1	2.5	—	2.7	—	2.6	—	—	—	—	—	—
Cs	0.05	—	0.07	0.07	—	—	0.070	—	—	—	—	—	—
Br	—	—	—	0.140	—	—	—	—	—	—	—	—	—
Se	—	—	0.200	0.209	—	—	0.205	—	—	—	—	—	—
Ge	—	—	—	0.430	—	—	—	—	—	20.4	18.2	30.2	18.2
V	—	—	47 ± 7	—	—	—	—	—	—	—	—	—	—
Cd	—	—	19.4	1.74	—	—	—	—	—	0.3	1.8	0.81	0.61
Ag	—	—	0.72	3.08	—	—	—	—	—	0.1	0.18	0.18	0.22

NOTE: (1) Data for major elements (SiO_2 through S) for zones 2002 and 2004 are from Vinogradov (ref. 4).

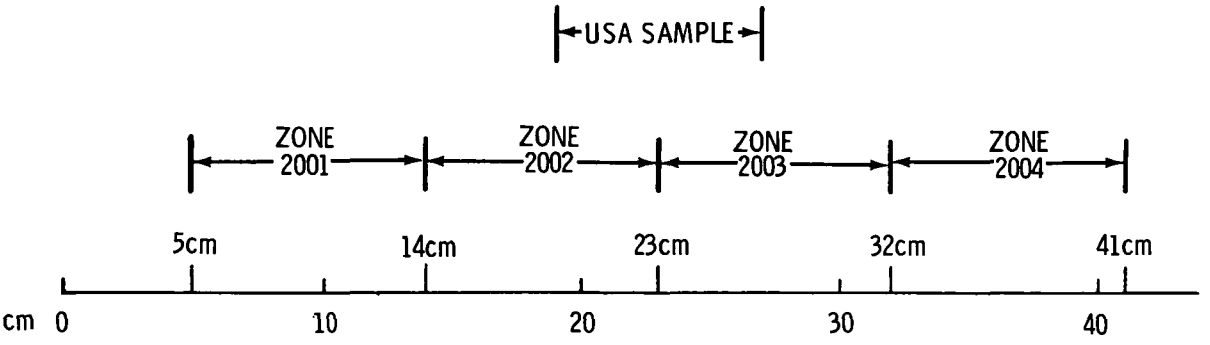

Figure 1.—*This figure shows the relative positions of the four zones of the Luna 20 core tube and the Soviet numbers for those zones relative position of the American sample. The centimeter values refer to distance along the tray into which the core was extruded, not to depths in the core tube.*

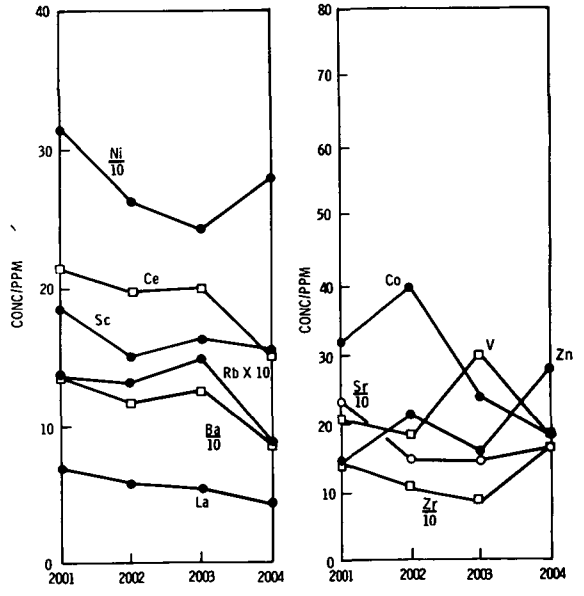

Figure 2.—*The concentrations of several elements in the four zones of the Luna 20 core tube.*

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