ISOTOPIC ABUNDANCE RATIOS AND CONCENTRATIONS OF SELECTED ELEMENTS IN APOLLO 17 SAMPLES, I.L. Barnes, E.L. Garner, J.W. Gramlich, L.A. Machlan, J.R. Moody, L.J. Moore, T.J. Murphy and W.R. Shields, National Bureau of Standards, Institute for Materials Res., Analytical Chemistry Div., Washington, D.C. 20234

Introduction In previous reports [1,2] we have presented the results of multielement analyses of samples returned by the Apollo 14, 15 and 16 missions. We have now extended this work to include samples from the Apollo 17 mission. The objective was, as before to obtain concentration and isotopic ratio data for a variety of elements on the same identical sample so that all effects of subsampling could be removed and the analytical results for all elements directly related. The elements determined include lead, uranium, thorium, rubidium, strontium, potassium and nickel.

Analytical Procedures The detailed analytical procedures have been described [1,2]. The appropriate Standard Reference Material (SRM) was analyzed with each elemental analysis so that the error limits normally associated with the standard analysis are directly applicable. Three or more blanks were prepared and analyzed for each elemental analysis and where deemed appropriate separate isotopic composition blanks were analyzed.

Results The analytical results for the analyses of Pb, U, Th, Rb and Sr are shown in Table 1. Shown are the data for the lead isotopic ratios as measured, corrected for a blank contribution and as corrected for an initial troilite lead of the composition as given by Tatsumoto et al. [3]. Also shown are the elemental concentrations of Pb, U, Th, Rb, Sr and the $^{87}Sr/^{86}Sr$ ratio. The model ages calculated from these data are also shown in Table 1.

In Table 2 is shown the data for the isotopic composition and concentration of nickel in these samples. The isotopic composition and concentration of potassium is shown in Table 3. The values determined for the blanks are shown in the respective tables, in all other cases the blanks were so low as to be of no significance.

Discussion The isotopic ratios of rubidium and the more refractory elements uranium and nickel showed no evidence of fractionation and were identical within experimental error with those found for terrestrial materials. The Pb-U-Th model ages for 72501 soil from the South Massif area are nearly concordant at 4460 MY and are nearly identical for those found for 15495 while those for 75081 (Camelot) show extensive reversed discordance [$^{206}Pb/^{238}U > ^{207}Pb/^{206}Pb$] falling between those found for 64801 and 68501.

As found for all soil samples previously analyzed the Apollo 17 samples show potassium isotopic fractionation of up to 1% of the $^{39}K/^{41}K$ ratio. If the mechanism for fractionation of potassium involved ionization as a result of temperatures generated by meteoritic impact then it might be expected that, because of the very similar ionization potentials of Rb and K (4.1 and 4.3 eV), similar fractionation would be expected (though to a somewhat lesser degree for Rb due to the higher mass). We have not found any evidence for Rb isotopic fractionation.

If a diffusion mechanism is involved then it becomes even more difficult to explain the fractionation of K and not Rb since, as has been shown by Gibson et al. [4], Rb is at least as volatile as K, if not more so, in these soils. There also is a suggestion in the available data that the fractionation of K is dependent on the geographical location of the sampling site becoming greater nearest the lunar poles. It is possible that the amount of K fractionation may be used to correct for the losses of other volatile elements from a particular sample but much additional work must be done before this may be realized.

References

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[2] Barnes, I.L., E.L. Garner, J.W. Gramlich, L.A. Machlan, J.R. Moody, L.J. Moore, T.J. Murphy and W.R. Shields, (1973), Isotopic Abundance Ratios and Concentrations of Selected Ratios and Concentrations of Selected Elements in Some Apollo 15 and 16 Samples, Proc. Fourth Lunar Sci. Conf., Geochim. Cosmochim. Acta, Suppl. 4, Vol. 2, pp. 1197-1207, Pergamon Press.

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[4] Gibson, E.K., M.J. Hubbard, H. Wiesmann, B.M. Bansal and G.W. Moore, (1973), How to Lose Rb, K, and Change the K/Rb Ratio: An Experimental Study, Proc. Fourth Lunar Sci. Conf., Geochim. Cosmochim. Acta, Suppl. 4, Vol. 2, pp. 1263-1273, Pergamon Press.

Table 1. Pb-U-Th-Rb-Sr Data on Some Apollo Samples

	Determination	SAMPLE 72501 (Soil)	SAMPLE 75081 (Soil)
Raw Data	208/206	0.97221	1.0625
	207/206	0.59892	0.75141
	204/206	0.002230	0.008039
After Blank Correction	208/206	0.97048	1.0583
	207/206	0.59847	0.75079
	204/206	0.002148	0.007848
After Troilite Correction[a] (Atom %)	208	36.8285	34.1180
	207	23.3984	34.6409
	206	39.7751	38.2411
Blank (% of Comp. Sample)		0.2326	0.5515
Element Concentration (ppm)	Lead	1.9224	0.8002
	Uranium	0.8501	0.2381
	Thorium	3.1160	0.8549
Model Ages[b] (m.y.)	207/206	4479	5880
	206/238	4604	5084
	207/235	4518	6186
	208/232	4587	4777
Element Ratios	Pb/U	2.26	
	238/204	137.0	
	232/238	3.79	
Rubidium Strontium Data	Rb (ppm)	4.172	1.252
	Sr (ppm)	154.5	164.6
	$^{87}Sr/^{86}Sr$[c]	0.70439	0.70042
Model Age (m.y.)[d]		4806	4607

[a] See text for discussion of troilite lead values

[b] Units used in age calculations:
$\lambda\ ^{238}U = 0.155125 \times 10^{-9}\ yrs^{-1}$;
$\lambda\ ^{235}U = 0.984850 \times 10^{-9}\ yrs^{-1}$;
$\lambda\ ^{232}Th = 0.049475 \times 10^{-9}\ yrs^{-1}$;
$\lambda\ ^{87}Rb = 1.39 \times 10^{-11}\ yrs^{-1}$;
$^{238}U/^{235}U = 137.88$

[c] Normalized to $^{86}Sr/^{88}Sr = 0.1194$

[d] $(^{87}Sr/^{86}Sr)_I = 0.6990$

Table 2. Relative Isotopic Ratios and Concentrations of Nickel

Sample	58/60	61/60	62/60	64/60
SRM 986	2.6164 ±0.0026	0.04346 ±0.00043	0.13769 ±0.00034	0.03464 ±0.00035
72501,37 (Soil)	2.6151	0.04328	0.13780	0.03486
75081,11 (Soil)	2.6175	0.04336	0.13761	0.03489

Concentration (ppm)

Sample	Concentration	
72501,37	322.0 320.9	Average 321.45
75081.11	119.3 119.5	Average 119.4

Table 3. Relative Concentration of Potassium

Sample	39/41	40/41
SRM 985	14.015 ±0.014	0.001845 ±0.000038
72501,37	13.9380	0.001862
75081,11	13,9156	0.001829

Concentration (ppm)

Sample	Concentration	
72501,37	1362.8 1362.3	Average 1362.55
75081,11	639.4 639.9	Average 639.65