

THE ISOTOPIIC ABUNDANCE RATIO AND ASSAY ANALYSIS OF SELECTED ELEMENTS IN APOLLO 14 SAMPLES; I. L. Barnes, B. S. Carpenter, E. L. Garner, J. W. Gramlich, E. C. Kuehner, L. A. Machlan, E. J. Mainethal, J. R. Moody, L. J. Moore, T. J. Murphy, P. J. Paulsen, K. M. Sappenfield, W. R. Shields, National Bureau of Standards.

We are reporting our results obtained on two samples returned by the Apollo 14 mission. One of these was a sample of the large breccia, 14321,221 and the other a sample of soil, 14163,159. The description of these samples has been published by L.E.P.E.T.[1].

The objective of this investigation was to obtain, on the same sample, precise and accurate isotopic ratios as well as isotope dilution assays for a variety of elements. The elements chosen were, for the most part, those for which well characterized reference standards were available.

Although the investigation for all the elements to be determined is not yet completed we report here the isotopic results for Pb, U, Th, Rb, Sr and Cu and the assay results for these elements as well as for Fe, Ti, Ni, B, Cd and Ag.

[1] The Lunar Sample Preliminary Examination Team, "Preliminary Examination of Lunar Samples from Apollo 14", Science, 173, 681-694 (1971).

Table 1. Isotopic Compositions.

		Sample 321	Sample 163	Terrestrial ^a
Lead ^b	208/206	0.98837	0.94909	
	207/206	0.54773	0.73775	
	204/206	0.001755	0.001945	
Blank		7.72 ng ^c	5.63 ng	
Uranium	238/235	137.80	137.82	137.88 ±.20
	234/235	0.007469	0.007465	0.007495±.00004
Rubidium	85/87	2.5916	2.5921	2.59265 ±.0017
Strontium ^d	88/86	8.3752	8.3752	
	87/86	0.70799	0.71485	
	84/86	0.05655	0.05651	
Copper	63/65	2.2458	2.2417	2.2440 ±.0021

THE ISOTOPIIC ABUNDANCE RATIO AND

I. L. Barnes

p. 42

Table 1. Isotopic Compositions (continued).

- NOTES: ^a NBS Certified values.
^b Normal laboratory limits are 208/206 ±.10%, 207/206 ±.066%, 204/206 ±.10%.
^c ng = 10⁻⁹ gm/gm.
^d Normalized to 86/88 = 0.1194.

Table 2. Concentration Analysis.

	Sample 321	Sample 163
Lead	3.306 ppm ^a	9.757 ppm
Blank	0.021 ppm	0.014 ppm
Uranium	1.550 ppm	3.650 ppm
Blank	0.0007 ppm	0.0008 ppm
Thorium	5.778 ppm	13.21 ppm
Blank	0.0001 ppm	0.0001 ppm
Rubidium	5.964 ppm	15.41 ppm
Blank	0.0031 ppm	0.0031 ppm
Strontium	120.29 ppm	185.50 ppm
Blank	0.117 ppm ^b	0.117 ppm ^b
Copper	77.91 ppm	9.981 ppm
Blank	0.14 ppm	0.034 ppm
		<u>9.86 ppm^c</u>
Iron (as Fe)	11.50% ^d	7.736% ^d
Titanium	1.31% ^d	0.978% ^d
Nickel	145 ppm ^d	333 ppm ^d
Boron	---	2.19 ppm ^e
Cadmium	0.50 ppm ^c	≤0.3 ^c
Silver	≤0.007 ppm ^c	0.018 ppm ^c

^a ppm = 10⁻⁶ gm/gm.

^b Procedure subsequently changed, current Sr blank 0.002.

^c Determined by spark source mass spectrometry.

^d Determined by differential polarography.

^e Determined by nuclear track counting.

For those elements for which isotopic compositions have been measured thus far a number have compositions which are considered to be essentially constant in nature. These are uranium, thorium, rubidium and copper. In each case the measured ratio/s are, within experimental error equal to those found previously in terrestrial materials.

THE ISOTOPIIC ABUNDANCE RATIO AND

I. L. Barnes

p. 43

A small correction for the blank lead (208=52.34%, 207=22.08%, 206=24.14%, 204=1.42% (and the remaining lead corrected for lead of troilite composition as listed by Oversby[4]. The resulting composition as well as the apparent lead-uranium ages are listed in Tables 3 and 4.

Table 3

Sample No.	Atom Percent			
	208	207	206	204
	(after blank correction)			
321	38.825	21.531	39.348	0.05771
163	35.265	27.415	37.177	0.07147
	(after troilite correction)			
321	37.154	20.941	38.8086	---
163	33.1952	26.6848	36.5095	---

Table 4

Sample No.	Apparent Age (BY)			
	207/206	206/238	207/235	208/232
321	4.416	4.375	4.404	4.379
163	4.861	4.923	4.881	4.910

The rubidium and strontium data also permit the calculation of a model age with some assumptions about the $^{87}\text{Sr}/^{86}\text{Sr}$ initial value. Papanastassiou and Wasserburg have recently published[5] data for initial values of these two samples of 0.69942 (basalt clast) and 0.69898 (BABI) for the fines. Using these values "ages" of 4.18 BY and 4.60 BY are obtained for 321 and 163 respectively. Thus the Rb-Sr ages are consistently lower in this case as has been shown generally. This is particularly conclusive since both "ages" in this case were determined on the identical sample fraction. Both samples show discordant lead-uranium-thorium ages. A line joining the two intersects the concordia line at 4.75 BY.

- [4] Oversby, V.M., "The Isotopic Composition of Lead in Ion Meteorites", *Geochim. et Cosmochim. Acta*, 34 65-75 (1970).
 [5] Papanastassiou, D. A. and G. J. Wasserburg, "Rb-Sr Ages of Igneous Rocks from the Apollo 14 Mission and the Age of the Fra Mauro Formation," *Earth Planet. Sci. Letters*, 12, 36-48 (1971).