

ON THE ISOTOPIC COMPOSITION OF METEORITIC RUTHENIUM

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MOTIVATION

Apparent positive abundance anomalies of ^{26}Mg , ^{107}Ag , and ^{129}Xe are generally ascribed to the decay of now-extinct ^{26}Al ($T_{1/2}=0.71$ My), ^{107}Pd ($T_{1/2}=6.5$ My) and ^{129}I ($T_{1/2}=15.7$ My), respectively. In view of the importance of such results for understanding the early history of the solar system - or of events in the time before its formation - searches have been undertaken for evidence for the decay products of other radionuclides with comparable half lives. The results reported so far have been negative or tentative (1,2,3). In order to add to this list we report our first data for the isotopic composition of ruthenium.

Ru appeared to be an interesting element because it might contain evidence for the former existence of $^{98,99}\text{Tc}$ which decay into $^{98,99}\text{Ru}$ with half lives of 4.2 My and 0.21 My, respectively. In the standard model of nucleosynthesis ^{98}Tc would have an origin in a p-process, ^{99}Ru in an s- or r-process. Furthermore, the seven stable Ru isotopes comprise two p-only isotopes (96, 98), one s-only (100), one r-only (104), and three of mixed s+r origin (99, 101, 102). Hence, even if there were no evidence for the decay of freshly-synthesized $^{98,99}\text{Tc}$ the perfectness of the mixing of the three different nucleosynthetic components of Ru itself might be of interest - in particular since the discovery that inclusions in carbonaceous chondrites contain tiny Fremdlinge with Ru contents up to 20 % (4,5,6,7).

TECHNIQUE

The samples analysed are two aliquots of an acid-resistant residue (0.5 weight %) of bulk Allende, two Type B coarse-grained inclusions from Allende (3531-D and EK 25-S2-3, kindly supplied by Dr.A.El Goresy), and one from Leoville (Leo 1). The inclusions were crushed in a steel mortar and separated by means of a hand magnet into a magnetic and a non-magnetic fraction. However, only in one instance (All 3531-D) was there sufficient Ru in the magnetic fraction to yield meaningful data.—Samples were fluxed with KOH-KNO_3 (5:1), dissolved in H_2SO_4 (2 N), and distilled after addition of $\text{Ce}(\text{SO}_4)_2$. Ru was collected in HCl -ethanol and finally purified by means of a cation exchange column.— RuCl_3 was loaded, together with 1 μl silicagel and 1 μl boric acid, onto a V-shaped zone-refined Re filament. Measurements were performed with a VARIAN MAT 261 mass spectrometer, using a Faraday collector (single collector mode) and a $10^{11}\ \Omega$ resistor. Ion currents of 5×10^{-12} Amps (total), lasting for several hours, could be obtained with 100 ng samples, corresponding to about one collected ion per 2000 atoms. 80-120 complete spectra were taken in all instances.—Standards were prepared from Ru metal (Koch&Light), using the same procedure as for the meteoritic samples.

RESULTS

Variations in the mass-dependent fractionation effects were removed by normalizing all data to $^{96}\text{Ru}/^{101}\text{Ru} \equiv 0.324\ 851$, which is the mean of 12 terrestrial standard measurements. The corrections amounted to less than 1.1 permil per mass unit; Rayleigh's law was assumed to hold. The ensuing weighted means of the standard ratios are listed in the table; they agree within the limits of error with the considerably less precise ones reported by (8). The errors given are one standard deviation in both cases. The unusually large errors in the

ISOTOPIC COMPOSITION OF METEORITIC RUTHENIUM

Pothe H. et al.

$^{100}\text{Ru}/^{101}\text{Ru}$ and $^{104}\text{Ru}/^{101}\text{Ru}$ ratios are due to occasional compromising interferences at masses 100 and 104 for which we have not yet found a reliable and sufficiently accurate correction procedure.—For the meteorite samples the results are expressed as deviations from the terrestrial standard, in units of 10^{-4} . In no case is there an anomaly in excess of two standard deviations. The two ratios $^{98}\text{Ru}/^{101}\text{Ru}$ and $^{99}\text{Ru}/^{101}\text{Ru}$ where there might have been a radiogenic anomaly are normal to within 8×10^{-4} and 2×10^{-4} , respectively. Apparently, the contribution to the abundance of ^{98}Ru and ^{99}Ru from their radioactive isobars has been the same to within 8×10^{-4} and 2×10^{-4} , respectively, in terrestrial ruthenium and in the meteoritic ruthenium analysed so far.

	$\frac{^{98}\text{Ru}}{^{101}\text{Ru}}$	$\frac{^{99}\text{Ru}}{^{101}\text{Ru}}$	$\frac{^{100}\text{Ru}}{^{101}\text{Ru}}$	$\frac{^{102}\text{Ru}}{^{101}\text{Ru}}$	$\frac{^{104}\text{Ru}}{^{101}\text{Ru}}$
Allende 3531 residue 1	0.0 ± 2.5	0.0 ± 1.5	-1.8 ± 3.1	0.3 ± 1.0	-0.3 ± 2.8
Allende 3531 residue 2	1.7 ± 2.5	0.9 ± 1.2	-0.7 ± 2.6	-0.1 ± 1.2	-0.8 ± 3.5
Allende 3531-D magnetic	-1.1 ± 5.6	-0.8 ± 1.9	0.6 ± 5.0	3.9 ± 2.0	0.3 ± 5.2
Allende EK 25-S2-3	-2.6 ± 6.5	-0.1 ± 1.7	5.9 ± 3.0	2.2 ± 1.4	5.4 ± 4.2
Leoville (LE01) non-magnetic	0.9 ± 7.8	-0.3 ± 1.4	3.9 ± 6.1	2.0 ± 1.7	5.7 ± 6.1
terrestrial (this work)	$0.109 \ 551$ $\pm \ 11$	$0.747 \ 759$ $\ 34$	$0.738 \ 594$ 161	$1.849 \ 961$ 138	$1.092 \ 319$ 300
(8) [*]	$0.109 \ 313$ $\pm \ 190$	$0.747 \ 118$ 335	$0.740 \ 388$ 750	$1.851 \ 761$ $1 \ 570$	$1.094 \ 337$ $1 \ 490$

* The ratios of (8) are the "less perturbed" ones; they have been renormalized and corrected for fractionation to make them comparable with the ones obtained in this study.

REFERENCES: (1) F. Begemann and W. Stegmann, *Nature* 259, 549 (1976); (2) J.C. Huneke et al., *Lunar Planet. Sci.* XII, 482 (1981); (3) J. Jordan and E. Pernicka, *Meteoritics* 16, 332 (1981); (4) H. Palme and F. Wlotzka, *EPSL* 33, 45 (1976); (5) D.A. Wark and J.F. Lovering, *Lunar Sci.* VII, 912 (1976); (6) M. Blander et al., *GCA* 44, 217 (1980); (7) H. Palme et al., *EPSL* 61, 1 (1982); (8) C. Devillers et al., *Adv. Mass Spectr.* 7a, 553 (1978).