NOTIZEN

Comment on the Age of the Elements

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Reynolds [1] has recently discovered that the isotopic composition of xenon in the chondrite Richardton is different from that of atmospheric xenon. The most prominent deviation from terrestrial xenon is an excess of Xe^{129} of about $1.3 \cdot 10^{-10}$ ccSTP/g, produced from the decay of I^{129} (half-life $17 \cdot 10^6$ years). By assuming that this Xe was produced inside the Richardton meteorite, Reynolds deduced that the maximum time which elapsed between the synthesis of the elements and the formation of Richardton was $3.5 \cdot 10^8$ years.

In this note we wish to stress some arguments which would favour an alternative conclusion with respect to the time of formation of the elements. All the xenon, including the excess Xe^{129}, could be trapped primeval gas from an atmosphere in which the decay of the I^{129} contributed relatively more Xe^{129} than in our atmosphere.

Table 1 shows the light rare gases in some stone meteorites. In chondrites all of them, except A^{36}, can be explained by radioactive decay or spallation [2, 3]. The reaction $Cl^{35}(n, \gamma)Cl^{36} \rightarrow A^{36}$ might provide for some of the excess A^{36}. To explain the total A^{36} excess in some of the meteorites (Bjurböle, Richardton), however, the required thermal neutron fluxes would have to be high and could hardly be provided by cosmic ray interactions. Also, the low He^3/A^{38} ratio of Bjurböle is not explained, because the reaction $Cl^{37}(n, \gamma)Cl^{38} \rightarrow A^{38}$ has a much too low cross-section.

A possible explanation would be that small amounts of primeval argon were trapped in the crystals during the formation of the meteorites. In fact, Gerling and Levskii [5] found in the Pesyanoe achondrite large amounts of primeval helium, neon, and argon and the excessive amount of A^{36} in Richardton is only about 1% of the primeval A^{36} in Pesyanoe. The content of rare gases in Pesyanoe shows that this meteorite was formed in an atmosphere in which the rare gases had a high partial pressure. Furthermore, from the abundances of helium and neon relative to A^{36}, it is evident that greater fractionation has occured in the terrestrial atmosphere than in the "Pesyanoe atmosphere" (Table 2). If the excess A^{36} is primeval, the absence of measurable amounts of primeval neon in Richardton would require a still greater fractionation, in agreement with a relatively high ratio Xe/A^{36} in Richardton.

The evidence available so far seems to indicate that the occurence of trapped primeval gas has to be taken into account. It also seems quite reasonable that primeval xenon may have different Xe^{129} contents in different enviroments. Therefore, we think the assumption, that the excess Xe^{129} was formed inside the meteorite, cannot be made with certainty at present, and the time between nucleogenesis and meteorite formation may have been longer than $0.35 \cdot 10^9$ years.

	He^4	Ne^{20}	A^{36}	Kr	Xe
Richardton	—	$<.2$	1	—	$\leqslant .05$
Pesyanoe	4000	14	1	—	—
Terrestrial atmosphere	—	.52	1	.032	.0025
Cosmic abundance	2.4×10^4	62	1	.00041	.000032

Table 2. Relative Abundance of "Primeval Gases". Primeval gas contents calculated from Table 1 and from Reynolds [1]. Composition of the terrestrial atmosphere from Rankama and Sahama [6], cosmic abundances from Suess and Urey [7].

		A^{36} $\times 10^{-8}$ ccSTP/g	A^{36}/A^{38}	Ne^{20} $\times 10^{-8}$ ccSTP/g	Ne^{20}/Ne^{21}	He^4 $\times 10^{-6}$ ccSTP/g	He^3/A^{38}
Holbrook	(Ch)	1.26	1.18	6.45	.965	18.3	26
St. Michel	(Ch)	1.94	1.83	7.95	.97	6.25	30
Richardton	(Ch)	2.83	2.44	9.10	.96	15.1	29
Bjurböle	(Ch)	4.62	3.80	4.40	.99	16.7	14
Furnas County	(A)	1.83	.93	56.5	.965	14.1	
Pasamonte	(A)	.66	.72	—	—	61	
Pesyanoe	(A)	165	5	2200	110	6500	
Terrestrial atmosphere		—	5.35	—	350	—	

Table 1. Light rare gases in some stone meteorites. Ch = chondrite; A = achondrite. Argon data from Geiss and Hess [2]; neon from P. and A. Eberhardt [4]; helium from Eberhardt and Hess [3]. All data of Pesyanoe from Gerling and Levskii [5].

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