ABOUT BIMODAL RELEASE OF THE NOBLE GASES DURING PYROLYSIS OF THE METEORITIC NANODIAMONDS

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Introduction

The bimodal release of noble gases during pyrolysis up to 2000 ^oC of the unequilibrium meteoritic nanodiamonds is one of the basic their features [1]. Maxima of release are observed in intervals of temperatures 400-800 ^oC and 1100-1600 ^oC. The noble gases in these temperature intervals essentially differ by isotopic compositions, namely, the low-temperature gases are less anomalous, than high-temperature. It is caused by different ratio of the P3 and HL a component of the noble gases. The P3 component has the isotopic and elemental compositions like to those for planetary gases. The isotopic composition of noble gases HL components is anomalous, especially anomalous the xenon (Xe-HL). According to work [1] this xenon is reached by ^{124}Xe and ^{136}Xe isotopes almost twice concerning its solar composition.

Current hypothesis, that a source of superfluous *p*-and *r*-isotopes of xenon in Xe-HL are the processes of the nucleogenesis in shells of supernova at its explosion. At the same time, the Xe-HL formation remains uncertain till now. This is connected by that *p*-and *r*-isotopes of the xenon could be mixed with xenon, e.g., normal isotopic composition, either before implantation in nanodiamond grains, or directly during release of gases during destruction of nanodiamond grains.

In the first variant of Xe-HL formation the bimodal release of the noble gases is results of comparable of the contents of the P3 and HL noble gases and of the sharp distinction of the desorption parameters for these gases. Note the isotopic compositions of P3 and HL noble gases have been identified on the basis of distinction of the release kinetics [1].

In the second variant of Xe-HL formation both of release peak of the gases can be basically caused by one component, namely, by the P3 component [2]. Therefore the anomalous isotopic composition of high-temperature gases is the consequence of presence of a small amount of the gas, which is strong enriched by the *p*- and *r*-isotopes, formed by supernova nucleogenesis processes. I.e. here it is supposed, the initial Xe-HL (it is designated by us as Xe-hl) before mixture with Xe-P3 during pyrolysis is extremely anomalous as a result of greater excesses of the *p*- and *r*-isotopes.

Apparently, the interpretation of the release kinetics of noble gases during pyrolysis of the meteoritic nanodiamonds essentially depends on the point of view on Xe-HL formation.

Is the isotopic composition of the Xe-hl extreme?

This question can be solved in the following way [3, 4]. The isotopic compositions of the noble gases in meteoritic nanodiamonds depends, basically, from of P3 and HL proportion. Therefore the value of ratio $(^{136}Xe/^{132}Xe)_{hl}$ in the released gas during of pyrolysis can be estimated on the basis of the following equations:

$$(^{136}Xe/^{132}Xe)_m = [(^{136}Xe/^{132}Xe)_{hl} + (^{136}Xe/^{132}Xe)_{P3}\ \text{Ч}\ R] / (1+R)$$
$$(^{36}Ar/^{132}Xe)_m = [(^{36}Ar/^{132}Xe)_{hl} + (^{36}Ar/^{132}Xe)_{P3}\ \text{Ч}\ R] / (1+R),$$

where indexes m and P3 designate the measured values and ratio for P3 component, accordingly, R – the ^{132}Xe-P3/^{132}Xe-hl ratio. Eliminating R, we have:

$$(^{136}Xe/^{132}Xe)_{hl} = \{(^{136}Xe/^{132}Xe)_m\ \text{Ч}\ (^{36}Ar/^{132}Xe)_{P3} - (^{36}Ar/^{132}Xe)_{hl}\ \text{Ч}\ [(^{136}Xe/^{132}Xe)_m - (^{136}Xe/^{132}Xe)_{P3}] - (^{136}Xe/^{132}Xe)_{P3}\ \text{Ч}\ (^{36}Ar/^{132}Xe)_m\} / [(^{36}Ar/^{132}Xe)_{P3} - (^{36}Ar/^{132}Xe)_m]$$

As the value of $(^{36}Ar/^{132}Xe)_{hl}\ \text{Ч}\ [(^{136}Xe/^{132}Xe)_m - (^{136}Xe/^{132}Xe)_{P3}]$ cannot be negative the maximal value of the ratio $(^{136}Xe/^{132}Xe)_{hl}$ is equal:

$$(^{136}Xe/^{132}Xe)_{hl} = [(^{136}Xe/^{132}Xe)_m\ \text{Ч}\ (^{36}Ar/^{132}Xe)_{P3} - (^{136}Xe/^{132}Xe)_{P3}\ \text{Ч}\ (^{36}Ar/^{132}Xe)_m] / [(^{36}Ar/^{132}Xe)_{P3} - (^{36}Ar/^{132}Xe)_m] \qquad (1)$$

The $(^{36}Ar/^{132}Xe)_{P3}$ ratio in works [3, 4] was calculated using the contents of the noble gases releasing during pyrolysis of nanodiamond samples up to 700 ^{o}C. But for all that did not take into consideration their possible elemental fractionation. In the given work the value of the ratio $(^{36}Ar/^{132}Xe)_{P3}$ is certain on linear dependence of $^{36}Ar/^{132}Xe$ vs. $^{136}Xe/^{132}Xe$ (fig. 1).

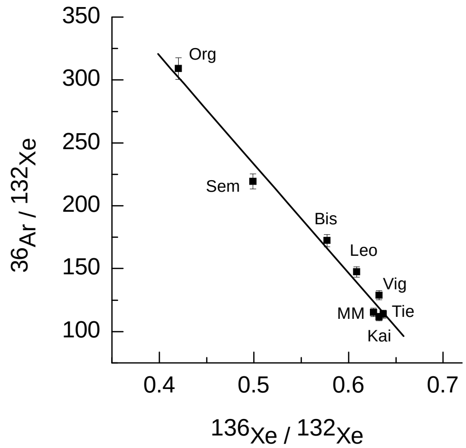

Fig.1. Linear dependence of $^{36}Ar/^{132}Xe$ vs. $^{136}Xe/^{132}Xe$. Designations: Org – Orgueil CI, Sem – Semarkona LL3.0, Bis – Bishunpur LL3.1, Leo – Leoville CV3, Vig – Vigarano CV3, MM – Mezo Madaras L3.5, Tie – Tieschitz H3.6, Kai – Kainsaz CO3.2

This dependence was formed using the contents of noble gases in bulk samples of meteoritic nanodiamonds. We used data in [1]. However the data for Allende CV3 and Indarch EH3-4 were not used. These meteorites underwent stronger thermal metamorphism and therefore the noble gases in nanodiamonds could suffer elemental fractionation.

Using the parameters of linear dependence on fig. 1 it is possible to calculate the value of the ratio $^{36}Ar/^{132}Xe$ for P3 component. At $^{136}Xe/^{132}Xe$ is equal 0.31 [1] we have, that this ratio is equal 396±22. Within error limits of calculations this value coincides with value 400±20 determined in [5].

The maxima values of the ratio $(^{136}Xe/^{132}Xe)_{hl}$ for the meteorites on fig. 1 are given in tab. 1.

Table 1

The values of the ratio $^{136}Xe/^{132}Xe$ for Xe-hl for some meteoritic nanodiamonds

Meteorite	$^{136}Xe/^{132}Xe$	$^{36}Ar/^{132}Xe$	$(^{136}Xe/^{132}Xe)_{hl}$
Orgueil CI	0.4202±0.0011	309±9	0.81±0.25
Semarkona LL3.0	0.4988±0.0012	219±6	0.73±0.11
Bishunpur LL3.1	0.5771±0.0014	172±5	0.78±0.10
Mezo Madaras L3.5	0.6265±0.0016	115±3	0.76±0.08
Tieschitz H3.6	0.6367±0.0016	114±3	0.77±0.08
Leoville CV3	0.6088±0.0015	148±4	0.79±0.09
Vigarano CV3	0.6325±0.0016	129±4	0.79±0.08
Kainsaz CO3	0.6324±0.0016	112±3	0.76±0.07
Average			0.77±0.04

They were calculated from the equation (1) at $(^{36}Ar/^{132}Xe)_{P3}$ and $(^{136}Xe/^{132}Xe)_{P3}$ are 396±22 and 0.31, respectively. On an average the value of the $(^{136}Xe/^{132}Xe)_{hl}$ ratio should not exceed 0.77±0.04. This value can be also obtained by extrapolation of mixing line on fig. 1 before intersection with an axis of abscissa.

The calculated greatest value of $(^{136}Xe/^{132}Xe)_{hl}$ ratio is essential smaller, than, e.g., the value of ratio $^{136}Xe/^{132}Xe$ for formed by mini *r*- process xenon - 2.85 [6]. At the same time it coincides within ±2σ with the value of the ratio $^{136}Xe/^{132}Xe$ for Xe-HL, identified in [1]. Hence, Xe-HL has been formed before implantation in nanodiamond grains as a result of mixture *p*- and *r*- isotopes of xenon with xenon, e.g., normal isotopic composition. Therefore the contents of the Xe-HL in released gases during pyrolysis of the meteoritic nanodiamonds can make an essential share, especially in high-temperature range. This is confirmed true results of calculations of component compositions of the noble gases, which are released during pyrolysis of the meteoritic nanodiamonds in work [5]. In this work the value of the ratio $(^{136}Xe/^{132}Xe)_{HL}$ was postulated equal 0.7.

Conclusions

The xenon of noble gases HL components on isotopic composition is not extreme as it is supposed in work [2]. Therefore the bimodal release of noble gases during pyrolysis of the nanodiamonds of unequilibrium meteorites is caused by correlated compositions P3 and HL component, which parameters desorption sharply differ each from other.

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