**NANODIAMOND OF METEORITES: IS THE SIC-X PHASE A CARRIER OF THE ISOTOPICALLY ANOMALOUS COMPONENT Xe-pr2?.** A. V. Fisenko and L. F. Semjonova, Vernadsky Institute of Geochemistry and Analytical Chemistry RAS, Kosygin Street 19, Moscow, Russia ( anat@chgnet.ru )

**Introduction:** Successful modeling of the measured xenon isotopic composition in enriched by nanodiamond of fractions (designated as ENF) of Orgueil and Indarch meteorites as a result of mixing the isotopically normal Xe-P3 component with sharply isotopically anomalous xenon components (designated as Xe-pr1 and Xe-pr2) shows that these Xe components are potentially primary (initial) components [ 1, 2]. The determination of the isotopic composition of Xe-pr1 and Xe-pr2 was carried out under the assumption that the isotopically normal subcomponent of xenon in the Xe-HL and Xe-P6e components is Xe-P3. The origin of the Xe-pr1 and Xe-pr2components sharply enriched in $^{124,\,126}$Xe, and $^{134,136}$Xe isotopes is explained by p- and r-processes of nucleosynthesis during supernova type II explosion, while the source of the population of diamond grains with Xe-P3 is assumed to be a molecular cloud. We also assume that each of the above Xe components is contained in an individual population of nanodiamond grains with different thermal-oxidative resistance. In this work, we present the results of calculating the abundances and kinetics of the release of these possible initial xenon components in the DM fraction isolated from the ENF of the Allende [3]. This fraction is depleted in the largest and finest grains and, by weight, makes up the bulk of the ENF of the Allende meteorite. In addition, the contents and isotopic composition of xenon were measured with very high accuracy in [3] during the stepwise pyrolysis of the DM fraction. The obtained results of calculations are compared with the component compositions of xenon in bulk samples of the ENF of the Orgueil, Indarch and Allende meteorites.

**Determination of xenon component contents in meteorite nanodiamonds:** Calculations of the xenon component contents Xe-P3, Xe-pr1, Xe-pr2 were carried out on the basis of the measured contents of xenon and its isotopic composition in DM fraction Allende, and also for xenon bulk in ENF of the Orgueil (CI) and Indarch (EH4), Allende (CV3) meteorites in [3. 4].

In the calculations, it was taken into account that the noble gases in the separated diamond-enriched fractions also contain Xe-S, the phase, carriers of which are the SiC nanograins. The calculations were carried out using the following equations:

$$X + Z + Y + V = [^{132}\mathrm{Xe}]_m \quad ;$$
$$(^{130}\mathrm{Xe}/^{132}\mathrm{Xe})_{P3}\times X + (^{130}\mathrm{Xe}/^{132}\mathrm{Xe})_S\times V = (^{130}\mathrm{Xe}/^{132}\mathrm{Xe})_m\times[^{132}\mathrm{Xe}]_m$$
$$(^{134}\mathrm{Xe}/^{132}\mathrm{Xe})_{P3}\times X + (^{134}\mathrm{Xe}/^{132}\mathrm{Xe})_{pr2}\times Z + (^{134}\mathrm{Xe}/^{132}\mathrm{Xe})_{pr1}\times Y + (^{134}\mathrm{Xe}/^{132}\mathrm{Xe})_S\times V = (^{134}\mathrm{Xe}/^{132}\mathrm{Xe})_m\times[^{132}\mathrm{Xe}]_m \quad ;$$
$$(^{136}\mathrm{Xe}/^{132}\mathrm{Xe})_{P3}\times X + (^{136}\mathrm{Xe}/^{132}\mathrm{Xe})_{pr2}\times Z + (^{136}\mathrm{Xe}/^{132}\mathrm{Xe})_{pr1}\times Y + (^{136}\mathrm{Xe}/^{132}\mathrm{Xe})_S\times V = (^{136}\mathrm{Xe}/^{132}\mathrm{Xe})_m\times[^{132}\mathrm{Xe}]_m ,$$

where X, Z, Y, V variables are the contents of $^{132}$Xe-P3, $^{132}$Xe-pr2, $^{132}$Xe-pr1 and $^{132}$Xe-S, respectively. The subscripts P3, pr2, S, and pr1 relate to the isotopic compositions of xenon components (Table 1), while m corresponds to the $^{132}$Xe content and xenon isotopic ratios, which we used on the basis of the measured in [3. 4] at the pyrolysis of meteoritic nanodiamond.

When calculating the component content of xenon, the measured isotope ratios with their errors according to the data in [3. 4] were used to normalize the above equations . At the same time, the isotopic composition of Xe components (Table 1) was used without errors in their calculations. The results of calculating the component composition of xenon in the ENF of various meteorites are shown in Tables 2 and 3 .

**Result and discussion:** Comparison of the calculated contents of the initial xenon components in the ENF of different meteorites (Table 2) reveals the following features of changes in these components depending on the conditions of thermal metamorphism of the meteorites parent bodies. The Xe-P3 and Xe-pr1 contents in ENF at the transition from weakly thermally metamorphosed to strongly thermally metamorphosed meteorites change in different directions. The influence of the oxidizing properties of the environment on the Xe-P3 content can be seen when comparing the data of Allende and Indarch, which underwent high-temperature metamorphism under oxidizing and reducing conditions, respectively. This influence on the content of Xe-pr2 has not yet been revealed due to the relatively high calculation error of this component. All these features could arise if, for example, the surface layer (border) of diamond grains has a diamond-like crystal structure [ 4 ], the thermal stability of which is significantly lower than that of the main part of the grains. In this case, the Xe-P3 component should be contained both in the border and in the inner part of the grains, while the Xe-pr1 component - only in the inner part of the grains. The destruction of this border during the thermal metamorphism of the parent bodies of meteorites leads to the observed above different directions of changes in the contents of the Xe-P3 and Xe-pr1 components ( tabl.2). The changes in the Xe-pr2 abundances follow other trend, namely: the Xe-pr2 content in the ENF in the Orgueil and Allende meteorites that underwent metamorphism under oxidizing conditions is almost 2 times lower than in the Indarch meteorite that underwent metamorphism under reducing conditions. The same trend is observed for the Xe-S abundances, despite the high relative error in their measurements ( Tabl.2). The similarity between the Xe-pr2 and Xe-S components is also observed in the kinetics of their release during the stepwise pyrolysis of the Allende fraction DM (Table 3). It can be seen that, in contrast to Xe-P3 and Xe-pr1, the release of the main amount of Xe-pr2 and Xe-S components begins at a higher temperature and the temperatures of the maxima of their release coincide. Based on the data obtained for Xe-pr2 and Xe-S, it can be assumed that they are contained in one carrier phase , namely, in SiC grains, as;the most identified carrier phase of the Xe-S. Since Xe-pr2 is formed in a type 2 supernova explosion, these SiC grains can be classified as SiC-X grains formed as a result of the evolution of a type 2 supernova (for example, [7]) The SiC-X grains assumed by us should be of submicron size and have free valence carbon bonds for the formation of a colloidal suspension in a weakly alkaline solution. Different values of the Xe-pr2 / Xe-S ratio at temperatures of 1800 and 2000 °C, equal to 2.4 ± 1.12 and 0.67 ±0.11, respectively, may indicate that the implantation of Xe-pr2 and Xe-S into SiC-X grains occurred under different conditions. It is possible, for example, that the implantation of Xe-pr2 into SiC-X grains containing Xe-S occurred in a turbulent mixing zone of fragments of the outer and inner shells of a type II supernova after its explosion.

**Conclusion:** As a result of the analysis of the calculated contents of the potentially initial (primary) components Xe-P3, Xe-pr1, Xe-pr2 and Xe-S in fractions of meteorites enriched in nanodiamonds of different chemical classes and petrological types, the following main conclusion was drawn. The Xe-pr2 component is probably contained in submicron SiC-X grains formed as a result of the evolution of a type II supernova. These grains can form a colloid-like suspension in a weakly alkaline environment due to their small size and the presence of free valence carbon bonds. At the same time, it is currently impossible to exclude a different nature of the Xe-pr2 carrier phase, which has properties close to submicron SiC grains found in nanodiamond-enriched meteorite fractions.

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**References:** [1]. Fisenko A.V. and Semjonova L. F. (2021) . *LPS, LII* , Abstract #1016. [2] Fisenko A.V. and Semjonova L. F. (2022) *Geochemistry International, in press*.[ 3]. Lewis R.S and Anders E. (1998 ) , *LPS, XIX* , 679-680. [4].Huss G.R. and Lewis R.S. (1994) *Meteoritics & Planet. Sci.,* 29,. 791–810. .[5] Lewis R.S. et al. (1994) *Geochim. Cosmochim. Acta.*, 58, 471–494. [6] Huss G.R. and Lewis R.S. (1994) *Meteoritics & Planet. Sci.,* 29,. 811-829 [7] Hoppe P., et al, (2019), . *Astrophys. J,* 887, 1-10.

Table 1 Isotopic composition of xenon components ($^{132}$Xe = 100)

| Component | $^{124}$Xe | $^{126}$Xe | $^{128}$Xe | $^{129}$Xe | $^{130}$Xe | $^{131}$Xe | $^{134}$Xe | $^{136}$Xe |
|---|---|---|---|---|---|---|---|---|
| Xe-HL[1] | 0.842(9) | 0.569(9) | 9.05(6) | 105.6(2) | 15.44(3) | 84.42(13) | 63.61(13) | 70 |
| Xe-P3[1] | 0.451(6) | 0.404(4) | 5.06(2) | 104.2(4) | 15.91(2) | 82.32(10) | 37.70(10) | 31.0 |
| Xe-S[2] | 0 | 0.033(19) | 21.59(14) | 11.8(1.1) | 48.26(42) | 18.6(1.2) | 2.22(53) | 0.34 |
| Xe-P6e[1] | 0.687(8) | 0.521(8) | 8.99(5) | 107.8(2) | 15.89(3)[3] | 83.55(13) | 51.80(13) | 55 |
| Xe-pr1 | 13.68 | 5.99 | 41.57 | 151.6 | 0 | 153.4 | 914.8 | 1351 |
| Xe-pr2 | 47.38 | 20.49 | 193.0 | 820.1 | 0 | 326.9 | 2842 | 4804 |

[1] – [4, [2] –[5], [3]– at calculation $^{132}$Xe=15.83

Table 2 Calculated contents of xenon components in ($10^{-8}$ cm$^3$/ g) in ENF of various meteorites

| T*, C | $^{132}$Xe** | Xe-P3 | Xe-pr1 | Xe-pr2 | Xe-S |
|---|---|---|---|---|---|
| Orgueil (C1) | | | | | |
| 100 | 49.79 | 49.37(6) | 0.36(3) | 0.016(9) | 0.05(3) |
| Allende (CV3) | | | | | |
| 600 | 25.12 | 24.591(31) | 0.477((13) | 0.0493(41) | 0.003(18) |
| Indarch (EH 3,4) | | | | | |
| 630 | 30.91 | 30.204(67) | 0.462(39) | 0.088(12) | 0.155(3) |
| Allende (CV3) DM fraction | | | | | |
| 600 | 24.66 | 24.11(1) | 0.476(2) | 0.0471(13) | 0.024(7) |

* Metamorphism temperature[ 6 ] ** measured total contents of $^{132}$Xe from data [3, 4]

Table 3 Calculated contents of xenon components in DM fraction Allende ($10^{-8}$ cm$^3$ / g)

| T,°C | $^{132}$Xe* | Xe-P3 | Xe-pr1 | Xe-pr2 | Xe-S |
|---|---|---|---|---|---|
| 800 | 0.94 | 0.915(2) | 0.025(1) | 0(0.0003) | 0(0.0008) |
| 1000 | 0.72 | 0.700(2) | 0.018(1) | 0(0.0003) | 0.0009(9) |
| 1200 | 0.96 | 0.934(2) | 0.0258(12) | 0(0.0004) | 0(0.0013) |
| 1400 | 2.80 | 2.720(4) | 0.077(21) | 0.0006(7) | 0.0012(22) |
| 1600 | 12.00 | 11.709(16) | 0.2658(76) | 0.0181(23) | 0.0061(92) |
| 1800 | 6.30 | 6.209(8) | 0.0556(40) | 0.0248(12) | 0.0103(48) |
| 2000 | 0.94 | 0.923(2) | 0.0076(11) | 0.0035(3) | 0.0052(7) |
| Total | 24.66 | 24.11(1) | 0.476(2) | 0.0471(13) | 0.024(7) |

* measured contents of $^{132}$Xe according to data in [3]