PREPARATION AND ANALYSIS OF A NEW SET OF GRAIN-SIZE FRACTIONS OF NANODIAMONDS FROM KAINSAZ. A. B. Verchovsky[1], A. V. Fisenko[2], L. F. Semjonova[2] and I. P. Wright[1], [1]PSSRI, Open University, Walton Hall, Milton Keynes MK7 6AA, UK (a.verchovsky@open.ac.uk) [2]Vernadsky Institute of Geochemistry and Analytical Chemistry RAS, 19 Kosygin st., Moscow 117975, Russia.

Introduction: In this paper we present new results of our long-term project on investigations of meteoritic nanodiamonds using grain-size analysis. The main goal of the project is to identify and characterize nanodiamond populations with different origin. The idea that meteoritic nanodiamonds can be represented by more than one population has been discussed for long time, almost since their discovery. The pointers to multiple populations include variations in carbon isotopic composition during stepped combustion of the nanodiamonds and variations between samples from meteorites with different metamorphic histories [1, 2]. The latter suggests that the different nanodiamond populations have varying level of resistance to the parent body metamorphic alterations (grades and environment where it takes place). In other words, notwithstanding what could have been an initial homogeneity in the diamond ensemble, a certain separation between populations occurred in different parent bodies (or at different places within individual parent bodies) during metamorphism under natural conditions. Laboratory grains-size separation of the nanodiamonds by means of centrifugation show that carbon isotopic composition varies systematically with size of the diamond grains [3]. The total range of carbon isotope variations significantly increased and the effect of metamorphism considerably enhanced in the size fractions compared to unseparated samples so that it became possible to create a model from which carbon isotopic compositions of the pure populations can be found. In an early stage of the investigations we identified only two populations for the bulk grain-size fractions of Efremovka, Krymka and Boriskino [4], though the stepped combustion data suggested that a third populations may also be present. Recently we developed centrifugation procedures that have allowed us to produce the coarsest fractions. Applying these procedures to nanodiamonds from Orgueil we were able to identify a third high-temperature population with relatively heavy carbon isotopic composition (concentrated mostly in the coarsest fractions) which is associated with the P6 noble gas component [5]. The other two populations we tentatively identified with the other known noble gas components: HL and P3. The new data we are going to discuss here are obtained for nanodiamonds from Kainsaz. In contrast to Orgueil this meteorite experienced a much stronger metamorphism under oxidising conditions, resulting in an extremely low SiC content relative to that for nanodiamonds [6]. Since SiC (with a relatively heavy carbon isotopic composition) always represents a possible source of contamination of nanodiamonds, this sample gives us an opportunity to constrain the nature of the heavy carbon already identified in Orgueil (i.e. and rule out the presence of SiC as a factor).

Sample preparations: Nanodiamonds have been extracted from the bulk Kainsaz sample (provided by Russian Academy of Sciences) using standard chemical procedures and colloidal separation:

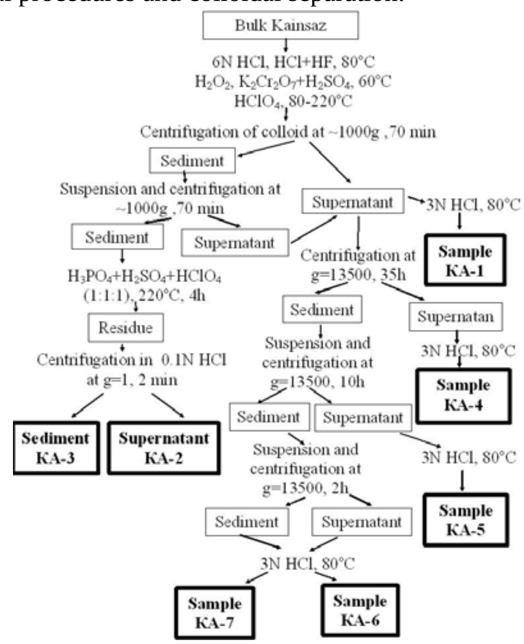

Fig. 1. Schematic of sample preparation procedures.

According to the procedures the samples KA-2 and 3 contain the coarse material which includes oxides, SiC and other insoluble phases. KA-1 represents bulk nanodiamonds. The other samples are the grain-size fractions in which size of grains increases in the sequence: KA-4, 5, 6, 7. The sequence and centrifugation conditions during separation of the Kainsaz sample are similar to those used to produce Orgueil nanodiamonds. Therefore we expect the coarsest fraction KA-7 to be similar to that of OD-15, the coarsest fraction produced for the Orgueil nanodiamonds.

Results: According to the carbon isotope data none of the Kainsaz fractions shows a significant amount of SiC to be present. In the fractions KA-2 and 3, where the highest concentration of SiC is expected, $\delta^{13}C$ remains <-10‰ in all the temperature range of carbon release. In contrast, in the corresponding fractions of Orgueil the value approaches +900‰. Thus, Kainsaz indeed contains by far less SiC than Orgueil. And we do not expect it to be present in the colloidal nanodiamond fractions.

Similar to the grain-size fractions from other meteorites, Kainsaz samples show a systematic increase of Xe concentrations with increasing grain size for both P3 and HL components. Xe isotopic compositions of the fraction KA-7, also similar to OD-15, is clearly enriched with Xe-P6 (Fig. 2).

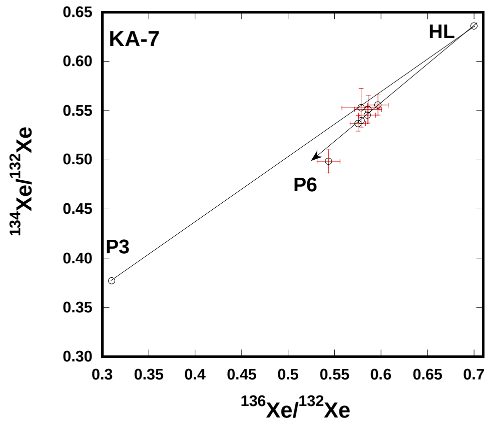

Fig. 2. Xe isotopic composition in the combustion steps of KA-7.

The carbon isotope variations observed in combustion steps of size fractions (Fig. 3) and between the fractions reveal similar relationships with grain sizes as have been observed for nanodiamond samples from other meteorites: the finest grain size-fraction (KA-4) has more or less uniform and heavier carbon, than the coarser fractions (KA-5 and 6). However KA-6, which is coarser than KA-5, shows slightly isotopically heavier carbon than observed in KA-5. And the fraction KA-7 has even heavier carbon than other fractions (across the whole range of carbon release). It is also significantly heavier than in the coarsest fraction of Orgueil (OD-15) in the low temperature combustion steps (Fig. 3).

Discussion: The observed isotope variations of carbon in the nanodiamond grain-size fractions obtained from Kainsaz can be explained in terms of a mixture of three populations with different average grain sizes and carbon isotopic compositions. This follows from the observed variations in carbon isotopic compositions during combustion where we see heavy carbon in the low and high temperatures steps and relatively light carbon in between. Furthermore, if we just consider the overall δ^{13}C of the size fractions taken as a whole, then carbon isotopic compositions are seen to very from heavy to light and back to heavy again, with increasing grain size. And since the high temperature heavy carbon in the Kainsaz samples is obviously not associated with SiC this is likely to be true for the similar fractions of Orgueil and in particular for the sample OD-15 which shows high temperature δ^{13}C values similar to those of KA-7 (Fig. 3).

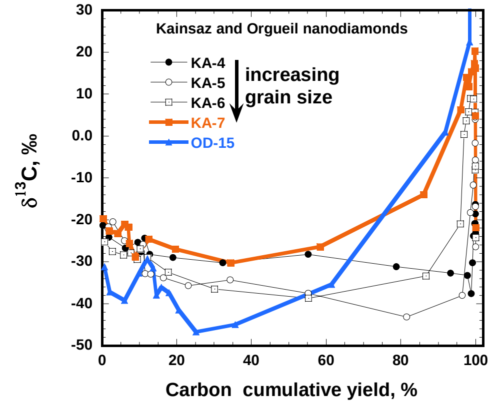

Fig. 3. Carbon isotope variations during combustion of Kainsaz and Orgueil grain-size fractions of nanodiamonds.

The nanodiamond populations respond differently to parent body metamorphism. The isotopically light component seems to be the most susceptible to metamorphism, as can be seen (Fig. 3) from comparison between similar grain-size fractions of Orgueil (OD-15) and Kainsaz (KA-7). We identify this component with the P3 noble gas carrier which is known to be the most sensitive to metamorphism [7]. The high-temperate heavy carbon in the coarsest nanodiamond fractions (KA-7 and OD-15) for both Orgueil and Kainsaz is clearly associated with the P6 noble gas carrier (Fig. 2) and therefore can be considered as another separate population. By default we can provisionally identify the HL noble gas carrier with the third population which is combusted at low temperature (and has a relatively heavy carbon).

Apart from the fact that the populations have different carbon isotopic compositions, grain sizes and size distributions, their also are present in different relative amounts and exhibit variations in their resistance to oxidation. These parameters cannot be found directly from the observed carbon isotopic variations. However at certain assumptions it is possible to create a mixing model from which a possible range of carbon isotopic compositions for the pure populations can be found. We will discuss this in the presentation.

References [1] Russell S. S. et al (1991) *Science, 254*, 1188. [2] Clayton. D. D. et al. (1995) *ApJ*, 447, 894. [3] Verchovsky A. B. at al. (1998) *Science*, 281, 1165. [4] Verchovsky A. B. et al. (2004) *LPSC* XXXV, abstr#1673. [5] Verchovsky A. B. et al. (2006) *MAPS* 41, A181. [6] Huss G. R and Lewis R. S. (1995) *GCA*, *59*, 115. [7] Huss G. R and Lewis R. S. (1994) *Meteoritics* 29, 791.