
The carrier of the P3 noble gas component in nanometre diamonds from primitive meteorites is still enigmatic. On the one hand it was found to be closely associated with the HL carrier: for P3 rich samples Xe-P3/Xe-HL ratio is remarkably constant [1]. As might be expected, these two components are not separable during laboratory chemical treatment, although they are easily resolved by stepped heating [2]. The fact that P3 noble gases are released at low temperature (300-800°C) during pyrolysis led to the suggestion that they are located near diamond surface [3]. Moreover the association of P3 noble gases released with chemically active gases in the same temperature range can be interpreted to indicate that P3 gases are evolved as a result of chemical reactions destroying diamond surface [3]. At the present time it is not absolutely clear what is happening at the diamond surface during stepped pyrolysis. With no added oxygen, we observe CO+CO_2 in the low temperature products in amounts corresponding to 10-15% of the total carbon: we therefore have argued [4] that surface absorbed oxygen is responsible for the reactions. Huss and Lewis [3] supposed that a reaction with hydrogen, also present on the diamond surface, might take place [5] to induce restructuring of the outermost layers during pyrolysis. In our experience, destruction of diamond surface rather than modification is a real fact but how it relates to the release of P3 gases is not quite clear. Incidentally, the release of chemically active gases is observed irrespective of whether or not the P3 component is present in diamond. The same is true for the presence of surface bonded hydrogen and oxygen. Thus, if the mechanism of P3 gas loss under natural conditions is the same as that in the laboratory experiments, then later on the diamond surface acquires a new layer of oxygen and/or hydrogen. In other words the extraneous elements could act as agent(s) for release of P3 noble gases and need not represent a common constituent(s) of the carrier.

Recently we found that in fact the situation is even more complicated: the release pattern of \(^{36}\text{Ar-P3}\) during pyrolysis and combustion is bimodal and does not depend on how much oxygen is available during the experiment [6]. This result is evidence against a location of P3 gases near diamond surfaces at least in terms of oxygen-reactive carbon atoms. Possibly hydrogen plays a more important role for release of the P3 component because it perhaps causes more significant restructuring of diamond surface than does the oxygen.

In order to investigate the roles of surface oxygen and hydrogen in releasing P3 noble gases during pyrolysis, we undertook a simple experiment. We exposed a sample of Orgueil diamond, aliquots of which have been analysed previously [4,6], to an atmosphere of hydrogen at a pressure of a few mbar at 200°C for one hour. We anticipated that such a treatment might lead to replacement of surface oxygen by hydrogen.

The results are shown in figure 1c, together with data for two untreated samples, 1a and 1b, loaded in different ways into the analytical system. There are no major differences observed for the sample treated with hydrogen in the temperature range 200-800°C: relative yield of C and \(^{36}\text{Ar}\) is similar for all the samples; the release profile of \(^{36}\text{Ar-P3}\) is sharper but this could be a function of the different temperature protocol. Carbon is still released as CO and CO_2 which could of course mean that the oxygen for the reaction comes from the quartz of the reaction vessel or the foil, but why this should be available at low temperatures is not obvious. Startling, however, are the results obtained at higher temperatures: 100% of carbon is released from the hydrogen treated sample by 1300°C whilst for untreated specimens this figure is only 20-25%. As a result, the release temperature of Ar-HL for the treated sample is observed to be significantly lower than that for the untreated samples. A second experiment with a different meteorite sample gave similar results although complete acquisition of the data was prevented by a power cut. Neither sample had carbon left over for combustion after the pyrolysis.
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It is difficult to explain the new results at the present time. More experiments need to be done, for instance, with different hydrogen treatment procedures and for other samples. Nevertheless the result seems to indicate that hydrogen plays an important role for the stability of various components in presolar diamonds and the release of noble gases of the P3 and the HL families during stepped heating. As Ed Anders might say: "is this a case of the right experiment done for the wrong reason?"; whatever the explanation, no doubt, as Alice would remark, "things get curiouser and curiouser".