We have prepared HC1/HF resistant residues from fractions of the Orgueil C2 carbonaceous chondrite which remained colloidal after disintegration in concentrated LiNO3 solution. The C-rich separates are fine-grained (<100 Å) and susceptible to chemical contamination by dissolved minerals. Thorough washing during ultrasonic agitation greatly reduces the amount of this contamination. The material is amorphous except for scant (<5%) amounts of hexagonal crystalline flakes, which show Si, Mg, and Cl in energy-dispersive x-ray analyses under the SEM, but otherwise have proven impossible to identify despite our trying numerous analytical techniques. Special diligence was applied, to no avail, in search for a possible FeNiCr sulfide (mineral "Q", postulated by Anders and coworkers [1] as the richest host phase for heavy planetary noble gases). This material, which we can thus best characterize as being amorphously carbonaceous, has proven to be exceptionally rich in planetary rare gases, like similar material isolated from Allende and various type C2 carbonaceous chondrites [1, 2, 3]. We have studied the rare gases released from this Orgueil "carbon" in stepwise heating. We report here on the release patterns and on isotopic results for xenon.

Release patterns: Similar bimodal release patterns (Fig. 1) were observed for the 3 heaviest rare gases with the first outgassing maximum occurring in the first temperature step (300°C) but the second peak not until about 1000°C. The release patterns are similar to this for He and Ne except that the low temperature release is greatly attenuated as if by previous escape. In all respects the patterns are similar to those observed for "carbon" from the C2 meteorite Murray which has been discussed [3] by saying that it seems unlikely that these patterns arise from diffusion of gases from host minerals of differing retentivity; more likely the gases are released as the result of chemothermal decomposition of at least two components. This conclusion was supported by results of vacuum pyrolysis on aliquots, as studied by high resolution mass spectrometry[4]. No matter how interpreted, the exceedingly fine-grained soot-like material exhibits a surprising thermal retentivity for the light gases.

Xenon isotopic patterns: Other isotopic results will be reported elsewhere. In Fig. 2 are plotted the δ-values for all Xe isotopes during stepwise release. We summarize a few striking features: (a) The straight line correlations seen for δ(M/130) and δ(136/130) convincingly depict mixing of two components, except for M = 131 and 132 where there is significant and correlated evidence for a higher degree of complexity. The xenon released up to 700°C is predominantly planetary Xe of "ordinary" composition whereas xenon released between 900° and 1300° is highly enriched in an "anomalous" component. Atmospheric Xe does not contribute significantly and solar Xe in typical meteoritic concentrations would be masked by the large planetary abundances. Despite the similarity between Orgueil and Murray in the release patterns, the isotopic effects for xenon are very different: the "ordinary" component is always predominant in stepwise heating analyses of Murray "carbon" [3]. (b) Parameters in the equations δ(M/130) = A + B \cdot δ(136/130)
for the Orgueil data are almost identical with those obtained for various Allende (Chicago and Berkeley data [1,5]) and Murchison separates [6].

(c) These parameters as determined by least squares fits [7] are dissimilar (see Table) to those for correlation lines based on intermediate temperature points (600° to 1300°C) for stepwise release from bulk samples of Orgueil, Murray, Murchison, and Cold Bokkeveld (renormalized data from [8,9,10]).

(d) The δ(129/130) versus δ(136/130) line for the Orgueil separate is horizontal within errors, indicating that both components have similar 129Xe/130Xe ratios. Usually 129Xe cannot be systematized with the other xenon isotopes because of special effects related to long-lived 129I.

We have summarized some of the isotopic features of Xe in carbonaceous chondrites in Fig. 3, using 128 for M. The shaded area includes all data points available for stepwise heating of bulk samples of Orgueil, Murray, Murchison and Cold Bokkeveld. If one examines only points between 600° and 1300°C, they define the bold line directed towards "CCF" within the error of fit indicated on the "anchor point" at the left. Points below this line in the shaded zone may be partially contaminated by atmospheric xenon. The composition of "AVCC" xenon with errors defines the white square, so labeled [11]. The correlation lines based upon data obtained with "carbon" samples from Allende and Orgueil are depicted by the finer solid lines. In each case they trend upward and to the right from an anchor point (showing typical errors of fit) which is the most "southwesterly" data point. Mass 128 is atypical in one respect: for most isotopes the "carbon" lines do not pass through the "solar" composition when extended. In view of our results, the simple isotopic trends for the data from stepwise heating of bulk samples is presently inexplicable. Certainly the early CCF hypothesis was an oversimplification of the facts. Our guesses about the origin of the patterns in the "carbon" samples appear in other abstracts in this volume. This work has been supported in part by NASA and ERDA.

References:
5. Frick and Reynolds, this volume.
6. Srinivasan (1976) submitted to JGR.
PLANETARY NOBLE GAS COMPONENTS

Frick, U. et al.

Fig. 1. Release during stepwise heating of Orgueil "carbon". The total area corresponds to 100% release in each case.

Fig. 2. Xenon isotopic correlation. For some isotopes the shaded areas indicate 600° - 1300°C temperature release for CI and CII bulk meteorites, the open bars the approximate fit. The star symbol stands for "solar".

Fig. 3. Isotopic patterns for xenon from carbonaceous chondrites. Three correlation lines are depicted; errors on the leftmost (data) point show the goodness of fit. Xenon from bulk samples between 600° and 1300°C defines the "CCF" line. Xenon from the "carbon" samples defines the other two lines with data also farther to the right. In order to hold all data from bulk samples, the shaded area is needed, as if air contamination was sometimes present. Compatibility of lines with the "solar" point is true for mass 128, but not in general.