Supporting Information

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SI Text

Solvent Extracts of Hydrothermally Treated CR2 Grave Nunataks 95229 (GRA)-Insoluble Organic Material (IOM). Solvent extracts of GRA-IOM hydrothermal residues released a diverse suite of alkyl and aromatic hydrocarbons in picomole amounts. Linear hydrocarbons were detected with 10- to 25-carbon chain length, the most abundant is heptadecane (at 440 pmoles/mg^{-1} IOM) and their amounts become vanishing low after C-20. Table S1 gives an overview of the major aromatic compounds identified. Many more were detected, several correspond to hydrated or partially hydrated species, e.g., tetrahydro-naphthalenes, whereas others contain saturated rings, such as indanes. All appear to be extensively branched. The only aromatic compounds with mass larger than those listed in the Table S1 were four perylene/benzopyrene/benzofluoranthene isomers in less than picomole amounts. Table S2 shows heteroatom-containing compounds in the extracts. N-containing aromatics such as carbazoles, quinolines, and substituted pyridines were searched for but not found. Smaller S-containing thiophenols, abundant in the extracts of other carbonaceous chondrites (CC)-IOM, were not detected as well.

Estimation of the compound's abundances was based on comparison of their total and/or single ion peak areas with yields obtained from commercial standards. When compounds had poor resolution in the chromatograms, such as in the case of the numerous branched-chain linear hydrocarbons, their combined area was assessed based on the unit area value of a compound of similar m/z in a standard calibration curve. A similar approach was used for unknown peaks if standards were not available, and the general type of the compound was known from its mass spectrum and/or retention time.

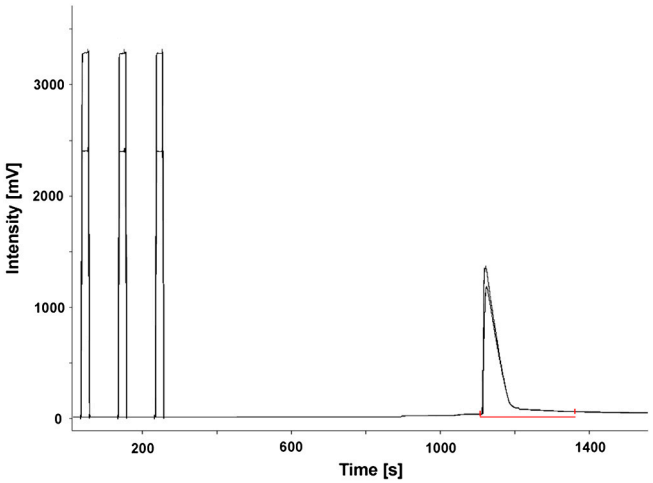

Fig. S1. $^{14}N^{14}N$ and $^{14}N^{15}N$ elution traces (external and inside trace, respectively) of GRA-IOM ammonia in one gas chromatography–isotope ratio mass spectrometry analysis. Reference standards are shown to the left.

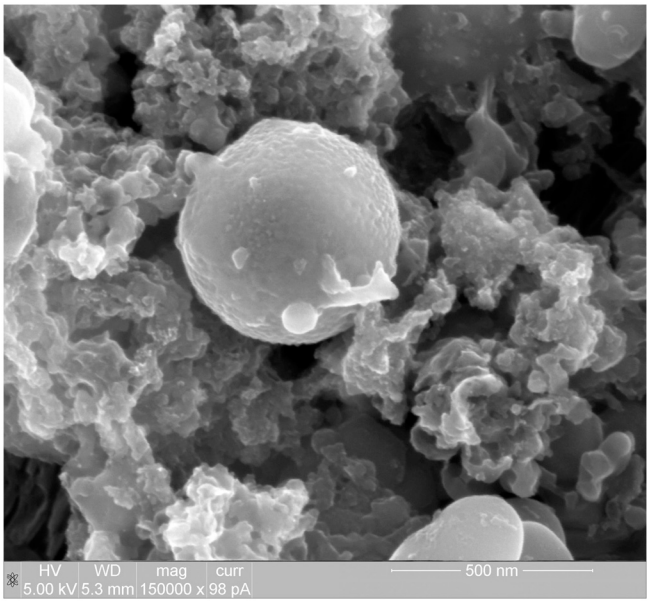

Fig. S2. Scanning electron microscope image of GRA-IOM showing a hollow nanoglobule and amorphous macromolecular material.

Table S1. Aromatic hydrocarbons detected in the solvent extracts of GRA-IOM hydrothermal residues

Compounds (n)*<u>*pmole/mg IOM*</u>	Relative† abundance
C_2-benzene (3)	++
C_3-benzenes (6)	++
C_4-benzenes (18)	++
C_5-benzenes (30)	+
Naphthalene‡ <u>*230*</u>	++++
C_1-Naphthalenes‡ (2) <u>*246*</u>	++++
C_2-Naphthalenes (12)	++++
C_3-Naphthalenes (15)	+++
Biphenyl‡ <u>*23*</u>	++
C_1-Biphenyl (3)	++
Acenaphthene‡ <u>*8*</u>	+
Phenanthrene‡ <u>*17*</u>	++
Antracene‡ <u>*3*</u>	+
C_{1-3}-phenanthrene/antracenes (28)	+
Fluoranthene‡ (Flt) <u>*17*</u>	+
Pyrene‡ <u>*16*</u>	+
C_{1-2}-Flt/Pyrene/BenzoFlt (10)	+

*Number of compounds within the group.
†++++ >200 picomole/mg IOM; +++ >100 pm/mg, ++ 100 – 10 pm/mg, and + <10 pm/mg.
‡Identification and amount estimate based on standards.

Table S2. Heteroatom-containing hydrocarbons detected in the solvent extracts of GRA-IOM hydrothermal residues

O-containing (n)* *pmole/mg IOM*	Relative† abundance
Phenol‡ *20*	++
C_1-phenols (2) *60*	++
C_2-phenols (5)	+++
C_{3-4}-phenols (32)	++
S-containing (n)	
Benzothiophene *60*	++
C_1-benzothiophenes‡ (5) *150*	+++
C_2-benzothiophenes‡ (10) *180*	+++
C_3-benzothiophenes‡ (16) *300*	++++
C_4-benzothiophenes (22) *125*	+++
Dibenzothiophene & isomers‡ (3)	+++
C_1-dibenzothiophene/isomers (12)	++
C_2-dibenzothiophenes/isomers (4)	+

*Number of compounds within the group.

†++++ >200 picomole/mg IOM; +++ >100 pm/mg, ++ 100 – 10 pm/mg, and + <10 pm/mg.

‡Identification and amount estimate based on standards.