

STABLE HYDROGEN AND CARBON ISOTOPE RATIOS OF EXTRACTABLE HYDROCARBONS IN THE MURCHISON METEORITE: R. V. Krishnamurthy and

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The presence of hydrocarbons in the Murchison meteorite has been known for a long time [1-5]. Much of the study has focussed on the identification of the various types of hydrocarbons [6]. While recent advances in analytical techniques have made it possible to extract and identify small quantities of specific chemical entities in extra-terrestrial materials, these studies have also generated controversy as to the degree of contamination by terrestrial sources. Previously, stable isotope analysis, especially the D/H ratio, proved to be of exceptional value in identifying the extra-terrestrial origin of amino acid extracts in the Murchison meteorite [7]. We therefore adopted a similar approach for the analysis of hydrocarbons extracted from two different specimens of the Murchison meteorite.

The two specimens were obtained from the Field Museum, Chicago and the Center for Meteorite Studies, Arizona State University. The hydrocarbons were extracted using freeze-thaw cycles, hot water, acid digestion as well as column chromatography. For the latter, the meteorite was first extracted with 9:1 benzene-methanol in a sealed tube. The extract was concentrated, desulfurized and redissolved in hexane. The hexane solution was applied to a dry silica-gel column and sequentially eluted with hexane (for aliphatic hydrocarbons), benzene (for aromatic hydrocarbons) and methanol (for heterocyclic compounds). The eluates were concentrated and divided into aliquots for isotopic and other analysis. The entire process of column chromatography on the sample obtained from the Center for Meteorite Studies was carried out in a He-glove box in order to eliminate exposure to the environment as much as possible.

Extensive runs of blanks and standards were carried out to perfect the extraction steps involved in the isotopic analysis. Blanks represent the steps which mimic the whole chemical extraction procedure to which the meteorite was subjected. As an improvement over the previous methods, the quartz tubes in which the samples were combusted were subjected to a secondary heating in the vacuum extraction line so as to completely recover all of the water produced in the combustion.

The results of our analysis is given in Table 1. The δD values range from +103‰ to +957‰ and the $\delta^{13}C$ from -12‰ to +17‰. Based on the δD values, the hydrocarbons eluted by methanol which are the heterocyclic compounds, appear to be the most pristine to the meteorite. The hydrocarbons eluted by hexane which are the aliphatic hydrocarbons are the lightest and may indicate the greatest degree of terrestrial contamination. Indeed, this assumes that the lower δD values are the results of contamination by terrestrial sources. In any case the D/H ratios are unusual enough to preclude a terrestrial origin for these compounds or their pre-cursors. One likelihood is that these compounds or some of part of them were formed in interstellar space by ion-molecule reactions at low temperatures, a process that is capable of resulting in the isotope composition observed by us. The highest $\delta^{13}C$ of +17‰ was obtained for the hydrocarbons released by acid treatment, but this fraction does not directly correlate with the highest δD value. The $\delta^{13}C$ of other volatile hydrocarbons are similar to those reported earlier by Yuen *et al* [8].

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Refs:[1]Kvenvolden K *et al*(1970) *Nature* 228,923-926.[2] Oro J *et al*(1971) *Nature* 230,105-106.[3] Studier M L *et al*(1972) *Geochim Cosmochem Acta* 36,189-215.[4] Hayatsu R and Anders E (1981) *Topics in Current Chemistry* 99,1-37.[5] Pering K and Ponnamperna C (1971) *Science* 173,237-239.[6] Cronin J R and Pizzarello S (1990) *Geochim Cosmochem Acta* 54,2859-2868.[7] Epstein S *et al* (1987) *Nature* 326,477-479.[8]Yuen G U *et al* (1984) *Nature* 307,252-254.

Table 1. Elemental and isotopic composition of fractionated and unfractionated hydrocarbons isolated from the Murchison meteorite. Blank represent runs that were carried exactly through all the steps involved in the isolation of each of the compounds.

Sample	Extraction procedure	N ₂ (μmoles)	CO ₂ (μmoles)	H ₂ (μmoles)	δ ¹³ C(‰)	δD(‰)
<i>Aliph</i> hydrocarbons	Si gel chromatography	-	42	18	-12	+263
ALH	elutant Hexane	-	2	4	-26	-98
Blank (ALH)	As above, but	-	14	14	-5	+103
Blank	using a He Glove	-	3	2	-23.8	-103
<i>Arom</i> hydrocarbons	Si gel chromatography	-	30	18	-4.5	+402
(ARH)	elutant Benzene	-	3	2	-24.3	-39
Blank ARH	As above, but	-	21	14	-5	+244
Blank	using a He Glove	-	2	4	-25	-44
<i>Het cyc</i> compounds	Si gel chromatography	2.5	156	112	+6	+945
(HTC)	elutant Methanol	-	8	6	-25.3	-54
Blank HTC	As above, but	1.9	105	74	+5	+747
Blank	using a He Glove	-	7	5	-25.8	-55
<i>Volatile</i> hydrocarbons	Freeze-thaw cycles	0.5	2	3	+10	+414
Blank		0.4	1	3	-23.8	-102
<i>Light</i> hydrocarbons	Hot water extraction	-	2	1	+6	+273
<i>Light</i> hydrocarbons	Treatment	-	4	5	+17	+410
Blank	with sulphuric acid	-	1	1	-	-6
Unfractionated hydrocarbons	Methanol extraction of hot water extracted meteorite	1	126	76	+4	+957
As above	Benzene-methanol extraction of hot water extracted meteorite	0.5	77	42	0	+744
Blank		-	3	7	-25.7	-87