

METEORITIC ENANTIOMER EXCESSES: A MAGNETIC BIAS IN REACTANT ACTIVITY DURING IRRADIATION OF SUGAR PRECURSORS? G. Cooper¹, W. Jackson², A. C. Rios³, K. Yeung³, and C. Dateo¹, ¹Exobiology Branch, NASA-Ames Research Center, MS 239-4, Moffett Field, CA 94035, george.cooper@nasa.gov, ²Department of Chemistry, Univ. of California, Davis, One Shields Avenue, Davis, CA 95616; ³Blue Marble Space Institute of Science, NASA-Ames, ³Blue Marble Space Institute of Science, Exobiology Branch, NASA-Ames.

Introduction: Chiral organic compounds are composed of two non-superimposable mirror images or "enantiomers", analogous to a left and right hand. Such molecules are important in contemporary life because biological polymers (proteins, nucleic acids, etc.) are homochiral, i.e., their chiral monomers usually consist of only one of the two enantiomers. The two most studied classes of meteoritic organic compounds known to carry enantiomer excesses (ee) are sugar acids [1, 2] and amino acids [3-5]. It was previously suggested that ee in the sugar acids could have, at least partly, been derived from irradiation-magnetic processes [6].

There has long been searches for prebiotically plausible mechanisms that could have induced enantiomer excesses in the early solar system [7]. Photo-magnetic effects [10], previously applied to a pre-synthesized chromium-oxalate complex, resulted in small ($\sim 10^+$) ee due to the temporary (and selective) chiral dissociation of the complex. Extremely strong magnetic fields (up to $\sim 15T$) were required for maximum effect. As with today, natural physical forces such as magnetism and radiation are ubiquitous in interstellar space and the early Solar System.

In prebiotic scenarios, formaldehyde and glycolaldehyde are generally regarded as likely sources of sugar derivatives in the early solar system due to their reactions in alkaline aqueous solution [8]. Both compounds are ubiquitous in interstellar environments and were also likely delivered throughout Earth's history: they are found in comets [9] and carbonaceous chondrites [10, 11]. The present project is a continuation of work (12, 13) work that attempts to determine if our previous reaction conditions (mild irradiation, magnetism, etc.), that lead to ee in products [6], could also lead to selective reactant activity.

Methods: Most reaction conditions, analytical methods (including gas chromatography-mass spectrometry (GC-MS) and materials were described previously [6]. Briefly, reaction mixtures are typically placed in magnetic fields of varying strengths: up to $\sim 0.5T$ with concurrent irradiation. In the present case (e.g., results in Fig. 1), two organic reactants were employed; one composed of ^{13}C and the other of ^{12}C .

The GC-MS is an Agilent 6890 GC-5975 quadrupole MS. Compounds (including enantiomers) were separated as their isopropyl-trifluoroacetyl derivatives using an Agilent (Chrompack) Chirasil Dex-CB column (25m x 0.25).

Results: Figure 1 shows an apparent selectivity of reactant (or least, reaction rate) depending on magnetic direction. B represents magnetic direction: + is North-South; - is South-North. L-ribose is shown here because it, and other L enantiomers (not shown), are very rare on Earth and therefore not likely to be contaminants. Multiple compounds and experiments show this effect. In the specific case of the 5-carbon sugars (e.g., ribose (Fig. 1)). We will present further results along these lines as well as the roles of cation complexation in results

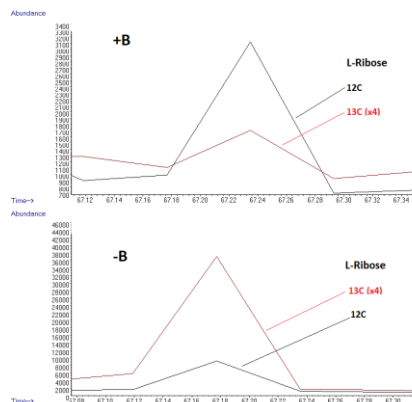


Fig. 1. L-ribose product from two nearly identical experiments: same reactants (one is ^{13}C labeled), magnetic field, irradiation strength and reaction time. Reversed magnetic field is indicated by (+ and - B). Red indicates isotopic label (^{13}C , four atoms) incorporated into ribose.

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