

Formation of fatty acids in formose-type reaction in carbonaceous asteroids

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Fatty acids are the most abundant type of soluble organic matter (SOM) in carbonaceous chondrites. Several models and environments have been proposed for the formation of fatty acids in meteorites. However, it remains unclear. Recently, formation of fatty acids by the reaction related to the sugar-forming formose reaction was proposed. However, previous experiments did not demonstrate the processes of fatty acid synthesis through the reaction and limited in the demonstration of short fatty acids. In this study, thermal maturation experiments of aldehydes (i.e., formaldehyde and glycolaldehyde), which are regarded to be contained in carbonaceous asteroids, were conducted to investigate the formation of fatty acids. The effects of cations (i.e. Na, Ca, Mg), pH, and glycolaldehyde concentration that are known to influence the formose reaction were investigated on the formation of fatty acids. As a result, the formation of saturated linear fatty acids from acetic acid (C2) to heptanoic acid (C7) was confirmed. The rate of fatty acid formation increased with increasing pH. The abundance of Ca promoted fatty acid formation more than Na and Mg. These are characteristics of the sugar synthesis by formose reaction. Therefore, it is clear that the formation of fatty acids from formaldehyde and glycolaldehyde is via the formose reaction. The amounts of product fatty acids were smaller in smaller fatty acids. This characteristic in the product amounts shows a similarity to the relative fatty acid content in meteorites, further supporting that fatty acids were formed in the meteorite parent body by formose-type reaction.

Keywords: Fatty acids, Formose-type reaction, Carbonaceous asteroid