Condensation sequence of SiC and graphite grains around carbon stars

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It is known from the isotopic studies that one of the plausible birth places of presolar SiC and graphite grains is the outflowing gas around carbon-rich AGB stars (carbon stars). The infrared observations of carbon stars have revealed the 11-micron emission feature, indicating the presence of SiC grains. However, the equilibrium condensation theory predicts that the condensation temperature of SiC is always lower than that of graphite in the plausible physical conditions of the carbon star envelopes. This implies that SiC grains do not condense around carbon stars, because carbon atoms are consumed up by condensation of graphite and no carbon is available to form SiC.

We have found that the temperature difference between the gas and the grains is one of the keys to the formation (stabilization) of SiC grains, and that formation of SiC grains precedes that of graphite grains under certain circumstances (see, Fig. 1). The difference of temperatures results from the difference of the optical properties of grain materials. The physical conditions of carbon star envelopes are divided into the following three types depending on the C/O abundance ratio and the mass loss rate: 1) SiC grains and graphite grains form simultaneously, 2) only SiC grains form and 3) only graphite grains form.

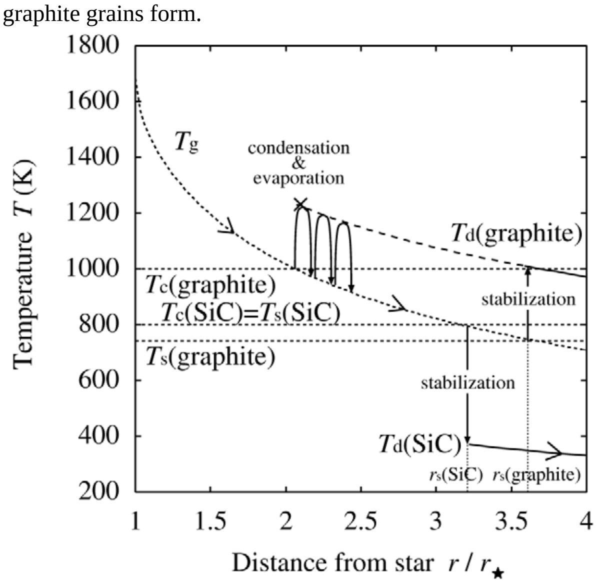

Figure 1: Condensation and stabilization of SiC and graphite grains. Radial distribution of temperatures for the outflowing gas is labeled by T_g, SiC temperatures by T_d(SiC) and graphite temperatures by T_d(graphite). Condensation and stabilization temperatures are labeled by T_c and T_s.

Carbon and hydrogen isotopic fractionations during lipid biosyntheses in higher plants

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Knowledge of isotopic compositions of individual lipid biomolecules in primary producers is biologically and geochemically significant. Isotopic compositions of lipid biomolecules should be closely related to the isotopic fractionations during biosynthetic pathways.

The purpose of this study is to investigate compound-specific carbon and hydrogen isotopic compositions of typical lipid biomolecules extracted from various terrestrial and aquatic higher plants in natural environment. Furthermore, this study will clarify carbon and hydrogen isotopic fractionations associated with various lipid biosynthetic pathways.

Results and discussion

All lipid biomolecules are depleted in both ^{13}C (up to 14.7‰) and D (up to 324‰) relative to bulk tissue and ambient water, respectively. For example, in *Cryptomeria jaonica* (Fig. 1), *n*-alkyl lipids associated with the acetogenic pathway are depleted in ^{13}C relative to bulk tissue by 2.4-9.9‰ and depleted in D relative to ambient water by 91-152‰. C_{15}- and C_{30}-isoprenoid lipids associated with the mevalonic-acid (MVA) pathway are depleted in ^{13}C relative to bulk tissue by 1.7-3.1‰ and depleted in D relative to ambient water by 212-238‰. C_{20}-isoprenoid lipids associated with the 2-C-methyl-D-erythritol-4-phosphate (MEP) pathway are depleted in ^{13}C relative to bulk tissue by 4.6-5.9‰ and depleted in D relative to ambient water by 238-303‰. Phytol is significantly depleted in D by up to 65‰ relative to other C_{20}-isoprenoid lipids. Though this isotopic trend among the acetogenic, MVA and MEP pathways is common to all plants, the magnitude of ^{13}C- and D-depletion is distinctive depending on plant classes.

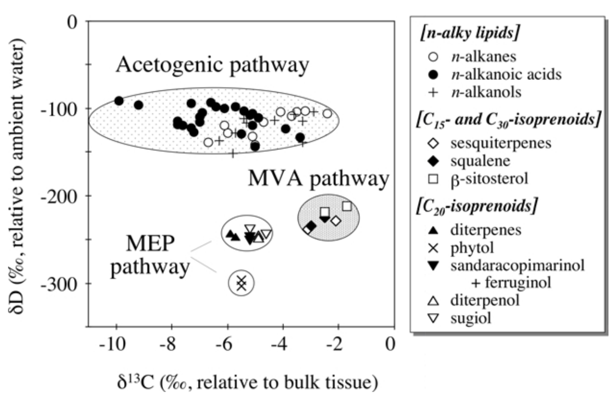

Fig.1. Carbon and hydrogen isotopic fractionation of various lipid biomolecules in *C. japonica*.