Long-range atmospheric transport of terrestrial organic matter over the western North Pacific

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In order to better understand the long-range atmospheric transport of terrestrial organic matter over the open ocean, marine aerosol samples were collected on a biweekly basis from 1990 to 1993 in a remote island, Chichi-Jima, in the western North Pacific. The samples were analyzed for lipid class compounds using a capillary gas chromatography (GC) and GC/mass spectrometry (GC/MS). A homologous series of n-alkanes (C_{20}-C_{40}), alcohols (C_{13}-C_{34}), fatty acids (C_9-C_{34}) and α,ω-dicarboxylic acids (C_7-C_{28}) were detected in the aerosol samples. Distributions of n-alkanes (0.17-14 ngm^{-3}, av. 1.7 ngm^{-3}) are characterized by a strong odd-carbon number predominance (CPI ratios, av. 4.5) with a maximum at C_{29} or C_{31}, indicating that n-alkanes are mainly derived from terrestrial higher plant waxes. Fatty alcohols (0.19-23 ngm^{-3}, av. 2.0 ngm^{-3}) show an even-carbon number predominance with a maximum generally at C_{26} or C_{28}, again indicating a contribution from terrestrial higher plants. On the other hand, fatty acids (2.5-38 ngm^{-3}, av. 14 ngm^{-3}) show a bimodal distribution with two maxima at C_{16} and C_{24} or C_{28}. Lower molecular weight fatty acids (generally < C_{20}) that are mainly derived from marine organisms showed higher concentrations in summer. In contrast, higher molecular weight fatty acids (C_{21}-C_{34}) derived from terrestrial higher plants, together with C_{25}-C_{35} alkanes, C_{20}-C_{34} alcohols and C_{20}-C_{28} dicarboxylic acids, generally showed higher concentrations in winter to spring seasons. This seasonal trend is most likely interpreted as atmospheric transport of terrestrial organic matter from Asian continent in winter/spring, when westerly winds dominate over the western North Pacific. Backward trajectory analyses supported the long-range atmospheric transport of higher plant- and soil-derived organic matter from the Asian continent over the Pacific Ocean. This study also suggested that the atmospheric transport is the main pathway for the terrestrial lipid compounds that are abundantly present in the deep-sea sediments in the Central Pacific.

Is the RNA world hypothesis consistent with hydrothermal origins of life?

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Discovery of the catalytic activity of RNA has suggested that RNA molecules played important roles in the emergence of life. However, the RNA world hypothesis seems to be in conflict with hydrothermal origins of life, since RNA is labile at high temperatures. Few studies have been done on the RNA world from viewpoints of the hydrothermal origin of life, since the real-time observation of hydrothermal reactions was difficult. As a solution, we have developed a new monitoring method for hydrothermal reactions that enables real-time monitoring within 0.002 - 150 s at 315 ºC. On the other hand, kinetics on the temperature dependence of the prebiotic formation of RNA has been investigated to elucidate the reasons that RNAs do not form easily at high temperatures. The possibility of an RNA world under the hydrothermal conditions is going to be discussed.

According to our studies, the half-lives of the degradation of ribose phosphodiester bond are 0.003 - 0.2 s at 350 ºC, 2 - 70 s at 200 ºC, and 0.4 - 19 h at 110 ºC. These high temperatures could have frequently appeared on the primitive earth conditions, and the half-lives seem to be so short compared to our perception or the geological time scale. However, it should be careful to conclude that phosphodiester bond is too labile to form long oligonucleoides at high temperatures. First, it does not mean that any organisms cannot survive at 110 ºC while the half-lives determined by laboratory experiments are regarded to be fairly short from our perception. In the same manner, the half-lives at high temperatures such as 240 and 350 ºC should be considered from this point of view. Second, in thermodynamically open systems, the accumulation of RNA is determined by both the formation and decomposition rates of RNA. Our kinetic analyses on the prebiotic formation of RNA at elevated temperatures suggested that the formation rates of phosphodiester bond are possible to be faster than those of decomposition. For example, the ratio (k_{form}/k_{hy}) of the rate constants of the template-directed formation of oligo(G) on poly(C) (k_{form}) to that of hydrolysis (k_{hy}) was estimated to be 8.1 for $(pG)_3$ and 22 for $(pG)_4$ at 100 ºC. This implies that the prebiotic formation of RNA was possible under the hydrothermal conditions.

References

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