

Shock effects on frozen DNA samples

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Background and Experiments

Inter-planetary migration of life or life materials is a possible explanation of the origin of life on the earth. In case of "soft landing" above process is conceivable, however breakdown of life materials in shock impact have not been studied yet. In this research, shock effects on frozen DNA samples were studied to know the deactivation ratio of DNA or breakdown of double helix structure.

λ -DNA (48 kbp; base pair) and plasmid-DNA (6.6kbp) samples in buffer solution (10 mM Tris-HCl, DNA concentration ca. 0.3-0.6 $\mu\text{g}/\mu\text{l}$) were separately injected in stainless steel capsules with the bore volume of 500 μl . Then the capsules were cooled at -20°C and shocked with a plasma-rail gun, which can accelerate a polycarbonate projectile of 1 g to 7 km/s. Shocked DNA samples were recovered from the capsules and studied by UV-spectroscopy and electrophoresis.

Results and Discussion

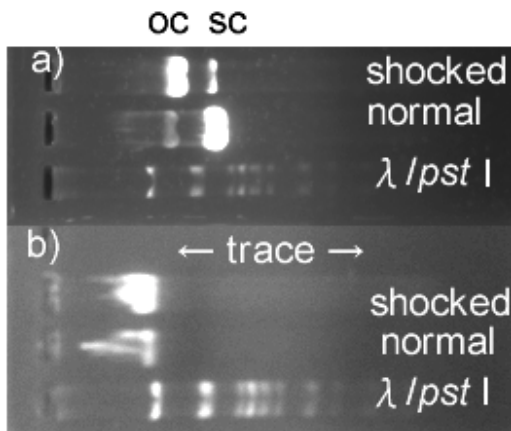


Fig.1. Typical electrophoresis images of shocked DNA samples. a) plasmid-DNA, projectile weight of 0.79 g and speed at 7.02 km/s, b) λ -DNA, projectile of 0.83 g and at 7.06 km/s. λ /PSTI : λ -DNA treated by the restriction enzyme and bands are used as indicators.

Fig-1a) clearly indicates that plasmid-DNA changed the form from its super coil (sc) structure to the open-circle (oc). Fig1-b) shows a weak continuous luminous band extending to the right direction (indicated as "trace") for shocked sample. This means the length of relatively long λ -DNA was variously cut from normal length of 48 kbp to 1k-0.1 kbp by shock impact. Considerable amount of unaltered DNA might be partly attributed to non-uniform shockwave in the bore volume. However, the obtained results are reasonable considering fractal features in destruction.

Sulfur isotope constraint on the provenance of salinity in confined aquifer system in Nobi Plain, central Japan

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This study aims to comprehend the provenance of salinity in confined aquifer system in Nobi Plain, central Japan, by using water quality and sulfur isotopic ratios ($\delta^{34}\text{S}$) as indicators. High Cl content groundwater ($>1000\text{mg/L}$) is distributed in tongue-shape in Nobi Plain and has fairly low SO_4/Cl ratios and high $\delta^{34}\text{S}$ values ($\sim 79\%$) than those of present seawater.

Assuming that present seawater induces the salinization of confined groundwater, intruded SO_4 with Cl is expected to be reduced in confined aquifer where is in anaerobic condition. The $\delta^{34}\text{S}$ values of the saline groundwater would be well explained by following Rayleigh distillation model, in which initial SO_4 has $\delta^{34}\text{S} = 21\%$ of the seawater:

$$\delta^{34}\text{S} = 21 + \epsilon \ln f \quad (1)$$

where ϵ is the isotopic enrichment factor and f is the fraction of initial SO_4 remaining in groundwater. Based on previous field studies of sulfate reduction, -20% can be adopted as ϵ for the model. The f is calculated by following equation using SO_4/Cl content ratio of present seawater:

$$f = \text{SO}_4 / (\text{Cl} \times 2700/19000) \quad (2)$$

A part of the saline groundwater samples along Ibi-Nagara Rivers can be well explained by this Rayleigh distillation model, which allows us to interpret that mass fraction of present seawater in the groundwater dominates 10.7% as maximum and reduced SO_4 from the groundwater is up to 350mg/L. However, the most of saline groundwater plotted on smaller f field than theoretical line of the model on $f - \delta^{34}\text{S}$ diagram. This is derived from overestimation of initial SO_4 concentrations (i.e., $\text{Cl} \times 2700/19000$) on Equation (2) and is strongly indicating another Cl source without SO_4 in addition to present seawater. Fossil seawater trapped in aquiclude layer for hundreds years is the most plausible candidate for the Cl source, since SO_4 can be completely reduced in anaerobic stagnant conditions. Then, volume fraction of fossil seawater is also recalculated by Rayleigh distillation model, in which the mixed seawater is used as initial substance, and consequently is estimated at 9.4% as maximum.