

Novel microbes and genes identified by direct sequencing of environmental DNA

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It was indicated by microscopic observation or comparison of 16S rDNA sequence that many extremophiles were surviving in many extreme environments including the hot water. But it is generally said that over 99 % of total microbes are now uncultivable. Thus, we planned to identify uncultivable microbes through direct sequencing of environmental DNA. At first, shotgun plasmid libraries were directly constructed with the DNA molecules prepared from mixed microbes collected from low-temperature hydrothermal water at RM24 in the Southern East Pacific Rise (S-EPR). Randomly selected plasmid clones were used for determination of nucleotide sequence of these clones. It was shown that the sequences of some number of clones had feature like intron in eukaryote or contained short tandem repetitive sequence, which was identified at 5' region of genes for some human familiar diseases. The results indicated that many organisms with eukaryotic feature were present in low temperature water from hydrothermal vent in S-EPR. Secondly, shotgun plasmid libraries were constructed from the environmental DNA prepared from Beppu hot springs. In the sequence data, the ORFs encoding the aminoacyl-tRNA synthetase, which is generally present in all organisms, was isolated by similarity. The phylogenetic analysis of aminoacyl-tRNA synthetase identified indicated that an archaeon, which was separated before establishment of euryarchaeota and crenarchaeota, should be present in the hot spring. Also it was shown by comparison of sequence of aminoacyl-tRNA synthetase that a bacterium, which had a deeply phylogenetic position, should be present in same hot spring. Thirdly, the plasmid libraries were now under construction from the DNA isolated from the high temperature thermal-vent water at Suiyo seamount. It is notable that the G+C contents of clones determined entire sequence from low-temperature hydrothermal water are approximate 40 %, these of clones from seawater are higher than 60 %. Our work indicates that environmental genomics, direct cloning and sequencing of environmental DNA, is powerful approach to collect novel uncultivable microbes or novel genes.

Geochemical studies linked to the reduction of volcanic gas hazard

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Geochemical techniques such as chemical and isotopic analyses, monitoring and modeling have covered numerous geologic events and processes, and give useful information on forecasting or predicting natural hazardous events. Here I present a topic in recent geochemical studies especially focused on volcanic gas hazards and show how geochemical techniques can be used for contribution to understanding volcanic activities and forecasting of gas hazard.

Hazardous volcanic gas components are CO₂, SO₂, H₂S and HCl, those of which are major species in volcanic gases of magmatic origin. Carbon dioxide (CO₂) is known to be emitted as directly from the volcanic vents and also from the volcanic flank diffusively. In case of Mammoth Mountain, California, cold magmatic CO₂ has degassing since 1990 following earthquake swarms associated with a shallow magma intrusion in 1989. Detailed study reveals large quantities of CO₂ degassing which affected the vegetation. Lake Nyos disaster has occurred as a result of rollover, that is an overturn event of lake water caused by heat supply to the bottom of the lake. If gas has been accumulated under pressure in a lower layer of lake water, an overturn makes explosive gas release. Sulfur dioxide (SO₂) is well-monitored species from active degassing volcanoes. Flux measurements have been done mainly with COSPEC instruments and the SO₂ fluxes have been recorded between hundreds and thousands of tons in a day from each volcano. Miyakejima, a volcanic island in Japan, has erupted in 2000, and started to release magmatic gases with gigantic amount. Airborne COSPEC monitoring showed that over 40,000 tons/day of SO₂ has emitted in 2000, which far exceeds global SO₂ emission from volcanoes of 26,000 tons/day. Gas monitoring station at the coastal area of the island often recorded SO₂ concentration greater than 20 ppmv. This new type gas hazard affected over 4,000 local residents who still remained to be evacuated so far.

Characteristic feature in each volcano sometimes disturbs general understanding of gas-bearing magma processes which occur inside volcanos. However, recent progresses on geochemical study of magmatic volatiles provided several methods for treating quantitative processes of magma, which explains some important problems, for example, how CO₂ can be emitted from an edifice of volcanoes or how can such an amount of SO₂ be released continuously. Magmatic activity modeling based on geochemical studies is indispensable to predicting volcanic phenomena and reducing volcanic hazards.