Gas Monitoring by QMS -Present Situation and Future Prospects-

Fumiaki Tsunomori[1)], Sanae Koizumi[1)], Koji Shimada[2)], Tomohiko Saito[3)], Hidemi Tanaka[3)], Kenji Notsu[1)]

1) Laboratory for Earthquake Chemistry, Graduate School of Science, University of Tokyo, 2) Tono Geoscience Center, JAEA,

3) Department of Earth & Planetary Science, Graduate School of Science, University of Tokyo

This paper provides a subject for the potential of gas monitoring by a quadrupole mass spectrometer (QMS) to evaluate tectonic activity such as earthquakes. The gas composition observed at a fault zone and an aquifer should reflect the tectonic situation of the fault, the focal region and a shallow underground. We have been developing an observation system using a QMS for detecting gas composition changes relating to tectonic events. Observation and experimental results by the QMS system will be reviewed in order to improve the detection limit of chemical signals from the crust.

1. Observation and Experimental Results

Spike-like change of methane concentration measured at the Omaezaki 500m-well was described by the first derivative of the water level [1]. This shows that the methane concentration reflects the situation of the aquifer. Methane gas is therefore an important crust-derivative gas as it sometimes responds to earthquakes [2].

We have been studying the methane emission behavior of cylindrical granite under uni-axial compression in order to simulate the methane concentration change relating to the crack generation in the crust [3]. The methane concentration can gradually increase before fracture of a rock, and the behavior depended on the compressive rate. Methane source was presumed to be inclusions in minerals, especially feldspars. The amount of methane released from fault rocks sampled at Atotsugawa active fault exponentially increased with grinding the rocks, that is increasing specific surface area [4]. It therefore remains possible that monitoring of methane concentration by a commercial QMS can detect a precursor of earthquakes.

Helium isotope ratio ($^{3}He/^{4}He$) of hot-spring waters along the Medial Tectonic Line in the Shikoku district, Japan was higher than that of air, and distribution of ratios coincided with a focal region of deep and low frequency microearthquakes [6]. Spring water from Atotsugawa active fault also showed high $^{3}He/^{4}He$ [7]. These show that mantle-derivative helium has potential to estimate structure and situation of underground. A continuous monitoring of $^{3}He/^{4}He$ will be therefore a powerful method for predicting earthquakes in an active fault and constraining deep crustal structure.

2. Development of High-Resolution QMS

Resolving power ($m/\Delta m$) of mass separation to decide $^{3}He/^{4}He$ should be larger than about 500 around m=3. Because, mass weight of HD (hydrogen-deuterium: 3.021825) is very close to that of ^{3}He (3.016030). In addition, the background level of signal should be low because the isotope ratio of air is about 1.4×10^{-6}. We have developing a high resolution, high sensitivity and compact QMS for continuous monitoring of helium isotope ratio at an active fault zone.

References

[1]F. Tsunomori, et al., submitted. [2]R. Sugisaki, et al., EPSL 139, 239-249, 1996. [3]S. Koizumi, et al., preparing. [4]T. Saito, et al., preparing. [6]T. Dogan, et al., Chemical Geology 233, 235-248, 2006. [7]H. Tanaka et al., preparing.