New technology of separating and continuous monitoring of groundwater and desolved gases in 200 m drilled-hole in Atotugawa Fault

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[Introduction]

It is well known that the two types of fluids exist within earth crust. One is crustal gas, which generally has different chemical composition than that of atmosphere. Another is groundwater, which dissolved various ions and crustal gasses. The fluids preferentially pass through fracture zones along faults being regarded as crustal discontinuities. For this reason, fluid behavior is mainly controlled by fault zone network in the crust. Generally single fault records more than several earthquakes slips. Thus, fault networks are modified when earthquake slip pass through pre-existing fault zones, which also modify the fluid paths. Therefore, continuous chemical monitoring of crustal gas and groundwater within fault zones would be worthwhile to understand change in fluid paths corresponding to earthquakes.

We developed new analyzing system, which enable us to monitor isotopic composition of gasses and chemical composition of groundwater continuously. We applied a patent for this analyzing system and accepted on 6 January 2006 [patent number: 2006-001295].

[Location and analyzing system]

Atotsugawa fault is an active fault with right-lateral strike-slip sense movement, trending WNW-ESE, dipping almost vertical. The Atotsugawa fault is characterized by numbers of micro-earthquakes along the trace, whose hypocenters are concentrated in the region from 0.8 km to 20 km in depth. One of the seismological characteristics of the fault is that there is a region with few micro-earthquakes at the middle of the trace. An activity of micro-seismicity is relatively high at both margins of the region with few micro-earthquakes. We conducted 200 m drilling penetrating the main trace of Atotsugawa fault at Miyagawa area, northern Gihu prefecture, which is located at west of region of few micro-seismicities. We set up observation station close to drilling site and new analyzing system in this station. The system is able to carry fluids (mixture of groundwater and crustal gas) being extracted from the fracture zone at 180 m depth in the drill hole to analyzing system, which prohibits contamination of air and surface water from the ground fluid. This system is able to analyze physical characteristic of groundwater (temperature, pH, conductivity) continuously and crustal gas (gas species and isotope) by using QMS (Quadrupole Mass Spectrometer) continuously. All characteristics with the system were protected by patent.

[Result and Discussion]

All data are not necessarily reliable because of the rather unstable condition of the system. However, during some stable periods, change in gasses ratio were detected clearly. Around 10:00 AM on 25 November, helium and methane increased, while oxygen and nitrogen decreased, and hydrogen and carbon dioxide and ethane show episodic peak in that time. Around the time, micro-earthquake (focal depth is 11km, magnitude is 0.3M) occurred right below this area along the Atotsugawa fault. This result suggests that earthquake may cause gas anomalies. Isotope 3He and 4He were also detected continuously. Value of 3He/4He in drill hole was apparently higher than that of air. Generally 3He/4He is more abundant in mantle than in crust, so high value of 3-He means the gasses includes mantle gasses. As a result, Atotsugawa fault possibly reaches to Moho surface. From the result of water analysis, groundwater in this drill hole dissolved specific ions, which show potential for continuous monitoring of fluid chemistry in future.