

SCG066-P01

Room:Convention Hall

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## Mass transport in a fault zone: effects of fracturing and host rock lithology

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Fault zone development has the potential to impact regional groundwater flow (e.g. Caine et al., 1996, *Geology*). Groundwater flow plays an important role in mass transport and nuclide migration. Thus understanding mass transport along fault zones is one of the major subjects for topical issues such as geological disposal of radioactive waste. Here we analyzed whole-rock chemical composition of fault rocks from well-studied outcrops of the Atera Fault in central Japan, using XRF and ICP-MS, to elucidate chemical composition changes associated with fault activities.

The fault zone studied includes a smectite-rich fault core between two clearly distinguishable damage zones of cataclasite of the Naegi-Agematsu Granite and fault breccia of the Nohi Rhyolite on opposite sides of the fault core (Niwa et al., 2009, *Island Arc*). Black fragments of mafic volcanic rocks are included in the fault core. The fragments, derived from the Ueno Basalts of 1.5 Ma, are characteristically coated with carbonates.

On the basis of the whole-rock chemical composition analyses, we identified the concentration of heavy rare earth elements (HREE) and U in the fault core. Intense brecciation and subsequent fragment size reduction due to fault fracturing increase surface area and enhance potential for water-rock interaction and clay mineral formation (e.g. Wintsch et al., 1995, *JGR*). In addition, the radical reaction on new fracture surfaces during brecciation of silicate minerals generates hydrogen ions, which may facilitate further chemical reaction of fluids with silicate minerals to form clay minerals (Kameda et al., 2003, *GRL*). Assuming that the concentration of HREE and U in the fault core was caused by fault activities, sorption on clay minerals could be one of the dominant concentration mechanisms. The sorption reaction is mainly controlled by ion-exchange and/or complexation on mineral surfaces. In the case of ion-exchange reaction, light REEs (LREE) are more selectively-sorbed in 2:1 clay mineral such as smectite than HREE, because LREE have smaller hydrated radii than HREE (Otani et al., 2005, *Resour. Geol.*). On the other hand, REE tends to form complexes with carbonates, hydroxides or organic matters. These complexes are more stable for HREE than LREE (Shikazono et al., 2006, *Resour. Geol.*). It is possible for HREE to concentrate in the fault core together with the carbonate coated with the black fragments. Although REE and U is also concentrated by the sorption on iron oxide or iron hydroxide (Akagawa et al., 2004, *J. Geol. Soc. Jpn.*), these elements in the studied outcrop seems to be less correlated with composition changes of Fe.

The REE and U concentrations is also influenced by the dissolution and/or precipitation of minerals including these elements. The Naegi-Agematsu Granite is rich in radioactive minerals such as zircon and monazite (Ishihara and Wu, 2001, *Bull. Geol. Surv. Jpn.*), however, compositions of HREE and U in the fault rocks are less correlated with those of Zr and P. Thus their concentration could not be caused by the distribution of radioactive minerals. Moreover, there has a low likelihood of simple HREE precipitation in the fault core, because they are precipitated only in lower pH than LREE except tetravalent cerium. Th/U-Ce/U plots show that the fault core is under a reductive environment (poor in Ce and rich in U). The fault core shows sulfur concentration, as well as carbonate concentration in the fragments of mafic volcanic rocks. It is possible that uranium dissolved in groundwater could be migrated as complex ions binding to carbonate or sulfate ions, and precipitated in the reductive fault core (Kobayashi, 1989, *Mining Geol.*).

As discussed above, heterogeneity of host rock lithology presented as mixing of fragments of mafic volcanic rocks in the fault core has a great influence on the concentrations of specific elements, through surface complexation of HREE and uranium precipitation in the reductive environment.

Keywords: fault zone, mass transport, rare earth element, clay mineral, carbonate

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## Zircon thermochronology of fault zones:Case study of the Mozumi-Sukenobu fault, central Japan

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Quantitatively understanding of heat generation and transformation associated with faulting is a key to understand not only dynamics of faults but also heat budget, temperature structure and range records. To understand thermal history along faults, geologic thermometers such as thermochronometers, homogenization temperatures of fluid inclusions and vitrinite reflectances have been used. Zircon fission-track thermochronology has been one of the most powerful tools to reveal thermal history along faults (e.g., Murakami et al., 2004; Tagami and Murakami, 2007). Zircon fission-track thermochronology has advantages as below: (1) fission tracks are annealed only by heating, (2) zircon is physically robust and chemically stable and can occur along fracture zones, and (3) short-term annealing kinetics of zircon fission tracks is well understood based on laboratory experiments.

In the Mozumi-Sukenobu fault, the strongest thermal anomalies were detected between two fracture zones identified in the tunnel by using zircon fission track methods. This secondary heating is attributed to ore deposit water probably sourced from the Kamioka mine on the basis of spatial distribution of ZFT and ZHe ages, numerical calculations using the 1-D thermal diffusion equation, geological observations and ZFT inversion calculations.

Keywords: thermochronology, fault, Atotsugawa fault group

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## Temporal change and factor analysis of radon concentrations in discharged gas of an active volcano

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Clarifying geologic structure and property is important to resource exploration, utilization of underground space and disaster prevention against earthquake. In this study, we adapted radioactive surveying, which has been widely for investigations of active fault, surface geology, groundwater, and geothermal to identify predominant factors on radionuclide concentration in the top soils in tectonically active areas. Possible factors are earthquake, tide, groundwater, temperature and pressure at deep parts, and fault. These factors are contained in active volcano areas and therefore, a fumaroles site at the western side of Mt. Aso was selected. Target nuclide was Radon ( $^{222}\text{Rn}$ ), which is inactive chemically and can exist in only gas condition among all radioactive nuclides. Ionization chamber method was used to detect alpha rays accompanying the decay of Rn: electric charge and current are detected as output signal of electric voltage by ionization effect. Rn gas was pumped up from 1 m depth and Rn concentrations had been measured continuously at 10 minute interval from 11 September 2001 to 15 January 2004.

Rn concentrations showed large and periodical change with time and had strong correlation with daily average temperature. The effect of temperature was removed from the original data and the residual components were assumed to be determined by tectonic factors. By comparing the residual components with the main nine components of earth tide calculated using GOTIC2 (Matsumoto *et al.*, 2001), the tidal force was clarified to have strong effect on Rn concentration because the residual components became large generally with the increase of the tidal force. In addition, a relationship between the volcanic earthquakes and the rise of residual components was found.

To confirm the effect of tidal force on Rn concentration, a laboratory experiment was conducted using granitic soils filled in a box and a granite sample as a Rn source in the soils. Rn concentrations on surface were measured and confirmed to have a relationship with the earth tide. Consequently, control factors on Rn concentration were identified as earthquake activity and earth tide in deep depths, and the temperature was considered to change Rn concentration near the surface by affecting the velocity of gas rise.

Keywords: radon, temperature, volcanic earthquake, earth tide, Mt. Aso

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## Introduction of a new groundwater and gas monitoring system

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We developed a Quadrupole Mass Spectrometer into a groundwater and gas monitoring system in order to measure gasses under ground continuously. Advantages of the system are following, 1) Gases can be measured anywhere the system can stand in an area of 1 m x 1 m because the size of the system was reduced, 2) The operation is unattended during observations by a working of an automatic gas collecting and dehydrating unit. Here, we introduce a new groundwater and gas monitoring system (Groundwater data analyzing system; GROWDAS).