Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

SCG63-01 Room:418 Time:May 2 14:15-14:35

Investigation on the temporal change in attenuation within ruptured fault zone of the 1999 Chi-Chi, Taiwan earthquake

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Attenuation, noted as 1/Q, had been considered as a geophysical parameter related to the fluid content, temperature and fracture of the medium. The attenuation parameter related to S-wave named as Qs has more significant indication to the factors indicated above. The damage zone of a large earthquake was often considered as a fracture zone, especially the hanging wall of a thrust faulting earthquake, which suggests a zone with possible high attenuation (decrease in Q). Earlier Qp and Qs tomography studies revealed the feature with high attenuation on the hanging wall of the ruptured Chelungpu fault of the 1999 Chi-Chi earthquake. To examine the attenuation character in the rupture fault, we further investigate the temporal variation of the attenuation, specifically in Qs, within the hanging wall before, following and after the earthquake. We observed a decreasing in Qs within the fault rupture zone two years following the 1999 Chi-Chi earthquake by Qs tomography images and an analysis of single-path Qs near the Chelungpu fault. The synthetic and sensitivity tests of the Qs determination were carried out accordingly to justify the temporal variation. A Qs value within the hanging wall above the hypocenter was determined to be 157 two years following the Chi-Chi earthquake, which is significantly lower than the values of 238 and 289 prior to and two years after the main shock, respectively, from the Qs tomography. Similar values using a signal-path Qs analysis, from events within the ruptured fault zone to stations along the fault were obtained. The corresponding Qs values were 247 prior to the Chi-Chi earthquake. After the earthquake, we obtained the Qs values of 158 and 318 for the time, two years following and two years after the earthquake, respectively. Considering the two independent methods in determination of Qs, the reduction in Qs of 89 two years following the Chi-Chi earthquake in both method is significant. Along with 1% Vs reduction revealed by the analysis of repeating earthquakes, our studies suggested possible reduction both in Vs and Qs within the fault zone after the Chi-Chi earthquake. The observation of temporal changes in Qs after the Chi-Chi earthquake implies variations of pore fluid saturation in the ruptured fault zone. The reduction in Qs two years following the Chi-Chi earthquake might indicates high pore-fluid saturation within fractured fault zone rocks due to post-seismic redistribution of the fluid.

Keywords: attenuation, fault zone, temporal variation, earthquake rupture

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SCG63-02 Room:418 Time:May 2 14:35-14:50

Chemical characteristics of hot springs in Southwestern part of Taiwan

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Taiwan is located at the junction of the Ryukyu Trough and the Manila Trench which are the boundaries of the Philippine Sea Plate and the Eurasian plate. While the Philippine Sea plate is subducting beneath the Eurasian plate at the offshore of eastern Taiwan, the Eurasian plate is subducting beneath the Philippine Sea plate at Manila Trench at the south offshore of western Taiwan. The plate boundary is riding on the Taiwan Island in the vicinity of Kaohsiung, southern Taiwan, and the plate boundary appears as active faults to the north. Many faults striking NE - SW have been developed, and there are some hot springs and mud volcanoes (Hamada et al., 2009) along those faults.

We focused on the hot springs around Chiayi and Tainan, southwestern Taiwan in this study. These hot springs show temperature around 34 - 70 ℃ which are distributed about 20 km apart from the active faults to the east, arranging from north to south. We have conducted chemical analyses for the hot spring water taken from these springs and report the results of these analyses in this presentation.

Keywords: Taiwan, hot springs

Japan Geoscience Union Meeting 2014
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SCG63-03 Room:418 Time:May 2 14:50-15:05

Estimate of isotopic composition and flux of Arima type fluid

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It has been well known that change in chemical compositions of ground water is associated with crustal activities including large earthquakes. Research for change in chemical compositions of fluids associated with earthquakes is still continuing all over the world. However, reasons to choose the location of wells to measure the chemical and isotopic compositions of the fluids, and to choose particular chemical and isotopic compositions for measurements have not been unambiguous so far.

Because no deterministic theory has been established to predict large earthquake from anomalous chemical precursor signals so far, and fluid-monitoring research to explore earthquake precursor is significantly declined in the community, it would be less meaning to collect more chemical precursors of the earthquakes by repeating procedure in future.

Instead, there are some meaning if observed chemical change can be explained by physical and chemical process in the crust associated with crustal activities. At present, following three subjects are especially important. First, establishing the reliable basis to choose proper fluids and wells, second, designing and constructing the mass-spectrometer which has sufficient performance for fluid continuous monitoring at on-site close to the fault zone, and finally, establishing and improvement of diagnostic theory of fault zone fluid.

Based on the idea mentioned above, the results of examination of fluid of hot springs at Arima area are presented. There are several hot spring sources which are flown out continuously to the surface. After hot spring drillings at the 1940 to 1950's constant amounts and quality of these hot springs are maintained by branch of coal government office of Kobe City. Many researches have been done for the hot springs so far, including surface geology, shallow underground structure, source of fluids and fluids paths. Fluid paths are inferred to be fracture zones of particular fault zones by results of geological survey and resistivity analysis. It is important to recognize these kinds of fluids as "fault zone fluids", since identification whether monitored fluids flow through fault zone or not is important issue to examine the crustal activities from the chemical and isotopic compositions of the fluids. It is also well known that fluids from Arima hot springs show specific isotopic compositions which is inferred to be very deep origin. In this presentation, we discuss about quantity of flux of deep source fluids of Arima hot spring which is important issue to answer the question why we need to observe the fluids for crustal activities and where? and compare the results between this and previous studies.

Keywords: crustal fluids, Arima type Hot spring, fluid flux, saline water, isotopic composition

Japan Geoscience Union Meeting 2014
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SCG63-04 Room:418 Time:May 2 15:05-15:20

Basic experiments for continuous monitoring of CH3 in the field by Mass spectrometer

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Continuous gas monitoring in the field is important issue for various purposes such as for heat trapping gas monitoring, poisonous gas monitoring and scientific objective. In order to analyze the gas in the field, small-sized gas analyzer using mass spectrometer have been developed in our group. In the field, identifying the location of the emitted gas is needed. To detect gas-emission in distant places from the analyzer, we made basic laboratory experiments using methane gas. In this presentation, we introduce the results of the experiment.

Keywords: Mass spectrometer, methane, monitoring, in the field

Japan Geoscience Union Meeting 2014
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SCG63-05 Room:418 Time:May 2 15:20-15:35

Geophysical Research of Tachikwa Fault Zone by Rn-222 and Cl- Concentration in Groundwater

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The 2011 off the Pacific coast of Tohoku Earthquake enhanced the probability of earthquake in Tachikawa Fault Zone. To evaluate the physical condition of Tachikawa fault zone, we researched Rn-222 concentration in groundwater, which is known as a precursory anomaly of earthquake. Additionally, we focused on the connection between the concentration of chloride ion in groundwater and fault damage zone and measured chloride ion in groundwater as well. Our purpose in this paper is to detect suitable groundwater for continuous measurement: (1) The depth of aquifer is deep enough to reach the bedrock. (2) Water contains much enough radon to monitor. (3)Water contains chloride ion whose concentration is controlled by the condition of fault damage zone.

Radon concentration in confined aquifer is supplied by alpha decay of radium in the surface of the grain. If the specific surface area of the grain changes according to physical condition of fault, radon concentration in the groundwater would change. The upper edge of bedrocks, main source of radon, has a depth of under 2,000 m around Tachikawa Fault Zone and it deepen in the west.

We focus on the distribution of chloride ion around Ayasegawa Fault is similar to one around Tachikawa Fault Zone. Low concentration of chloride ion in groundwater around Ayasegawa Fault is affected by fault damage zone, and we expect that groundwater around Tachikawa Fault Zone also shows low concentration of chloride ion due to fault damage zone. We use RTM1688(SARAD) for radon measurement, and ion chromatography for chloride ion measurement.

As a result, samples around the fault show high concentration of radon and low chloride ion. This suggests that the well around fault reach the bedrock and contain low concentration of chloride ion due to fault damage zone. These samples would show concentration change according to earthquake.

Keywords: radon, chloride ion, Tachikawa Falut Zone, spring water

Japan Geoscience Union Meeting 2014
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SCG63-06 Room:418 Time:May 2 15:35-15:50

Precursory Change of Radon Concentration in Groundwater before 2011 Tohoku Earthquake

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We will report characteristics of radon concentration changes in groundwater at the Nakaizu observatory around the Tohoku earthqauke, 2011.

Radon concentration in groundwater sometimes responds to crustal deformation before the earthquakes. The phenomenon was well known in 1980, and many scientists tried to detect such anomalous signals in order to find a chemical indicator of earthquakes. However few researches have studied a mechanism of the phenomenon. Nonetheless a lot of anomalies of the radon concentration relating to earthquakes are reported every year, thus it is important to clarify the fundamental process of radon concentration change in an aquifer. We would like to report the characteristics of radon concentration change around the 2011 Tohoku earthquake, and to discuss a fundamental model of the radon concentration change in an aquifer.

An anomalous increase in radon concentration was measured at the Nakaizu observatory on the Izu Peninsula prior to the 2011 Tohoku earthquake using a custom-made radon counter. Since the increase was more than three times the standard deviation of radon concentration variations over 35 years of recorded data, it is considered likely that it is a precursor to the earthquake. Following the earthquake, the radon concentration decreased exponentially to the background level. The anomalous increase is explained using a modified volatilization model containing three important aquifer parameters: the groundwater saturation ratio, the fracture surface area per unit volume, and the porosity. The modified model can also explain the radon concentration behavior prior to the 1978 Izu-Oshima-Kinkai earthquake.

Keywords: Radon, Groundwater

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SCG63-P01 Room:Poster Time:May 2 16:15-17:30

Cooling history of a fracture zone in the Kojyaku granite, Tsuruga area: Constraints from multi-system thermochronology

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Ages of faulting are generally estimated from ages of displaced geomorphic markers, e.g., terrace surfaces, alluvial deposits, or artificial structures. However, these markers are not always available, such as for faults in basement rocks. Such faults have been attempted to date by detecting chronological anomalies (e.g., Ikeya et al., 1982; Murakami and Tagami, 2004; Yamada et al., 2013; Gansawa et al., 2013) or dating hydrothermal veins or clay minerals formed after faulting (e.g., Zwingmann et al., 2004; Watanabe et al., 2008; Siebel et al., 2009; Yamasaki et al., 2013). However, definitive procedures to determine faulting ages based on such geochronological methods have not been established because thermogenesis and mass transport along fault zones are not simple. More basic and case studies are desirable to improve these methods.

We introduce an attempt to date a fracture zone observed in the northwestern part of the Tsuruga peninsula, southwest Japan, by constraining its cooling history from fission-track (FT), K-Ar, and U-Pb thermochronometries. In the northern part of the Kinki Triange, including the Kohoku and Tsuruga bay areas, NE-SW or NW-SE strike-slip faults such as the Kohokusanchi and Nosaka-Shufukuji fault zones, are dominant (e.g., The Headquarters for Earthquake Research Promotion, 2003a, b). Strike-slip faults in mountainous areas are generally difficult to date by using geomorphic markers. The fault we study is a strike-slip fault formed in the Tsuruga body of the Kojyaku granite (Kurimoto et al., 1999), along which no gromorphic marker is available. We dated 1) the fault gauge, 2) uncrushed host granitic rock, and 3) dolerite intruding within a few meters from the fault. The dispersions between zircon U-Pb ages and zircon fission-track ages of 1) and 2) are not significant at 2 sigma level and both of the zircon fission-track lengths are not shortened, implying 1) and 2) shared the cooling histories between closure temperatures of zircon U-Pb (>900 deg. C) and zircon fission-track methods (210-350 deg. C). On the other hand, apatite fission-track ages of 50.8 +/- 18.5 Ma for 2) and 28.4 +/- 13.6 Ma for 1) may be interpreted to be reflections of different cooling histories below 90-120 deg. C, closure temperature of apatite fission track method. Although the younger age of a) is attributable to the faulting during the Neogene/Quaternary or intrusion of the dolerite at 19.1-18.8 Ma inferred from plagioclase and whole-rock K-Ar ages, definitive conclusions are difficult to be drawn because of the wide error bars of the apatite FT ages and luck of apatite fission-track length data. In this presentation, we are going to give more precise discussions based on apatite fission-track length analyses.

Keywords: dating of a fault, fission-track thermochronology, K-Ar dating method, U-Pb dating method, Kojyaku granite

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SCG63-P02 Room:Poster Time:May 2 16:15-17:30

Chemical and isotopic examinations of Arima-type high saline hotspring water in south-west Japan

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Many researches have been conducted to explore component source, heat source and water source of hot spring in Japan. Matshubaya et al.,(1974) classified hot springs into four types by isotopic ratio of hydrogen and oxygen in water and geology (1) volcanic type, (2) Arima type, (3) coastal type, (4)Green tough type. Of these, Arima type is said to have deep origin source because hydrogen and oxygen isotope ratios suggests that the origin is mixture of meteoric water and magmatic water, and dissolving gas have abnormally high He isotopic ratio.

Sugimoto (2012) selected 180 hot springs that seem to be classified as Arima type from 6058 hot springs in Japan, using Li/Cl and Br/Cl values. Li/Cl is used as index of temperature of water was experienced (You et al., 1996). Br/Cl expresses influence from sea water and biological effect (Hurwitz et al., 2005: Uemura et al., 1988). He selected hot springs which have more Li/Cl and less Br/Cl as Arima type. But, his discussion was only about dissolving ion and not discussed hydrogen and oxygen isotope ratios used in the definition of Arima type.

So, we reselected 185 hot springs that seems to Arima type by Sugimoto (2012) method from 9887 hot springs in Japan and sampled 67 hot springs for isotopic analysis and ion analysis. As a result, the hot spring with the isotope shift in the same way as Arima hot spring is found along Median Tectonic Line (MTL) at Kinki, Western Shikoku and Central Japan (Kashio) districts. All mixing lines are converged to one point. Thus, we refer the fluid with this isotopic composition as origin water of Arima type. Since they converge to one point in the relationship of the hydrogen isotope ratio of the chloride ion concentration, the composition of the original water is as δD = -35 ‰, δ18O = 5 ‰, Cl- = 42g/l. The method to determine the isotopic composition and the resultant value of δD and δ18O is more convincing than those from previous results. Because shift lines from several regions are coincided at one point.

Keywords: Arima hot spring, Oxygen Isotope, Hydrogen Isotope, Brine fluids, original composition