Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

SCG61-P01 Room:Convention Hall Time:May 27 18:15-19:30

Coseismic discharge of hot spring water due to the 2014 Northern Nagano earthquake

SATO, Tsutomu[1*] ; OCHI, Tadafumi[1] ; TAKAHASHI, Masaaki[1] ; MATSUMOTO, Norio[1] ; KAZAHAYA, Kohei[1] ; TAKAHASHI, Hiroshi[1] ; INAMURA, Akihiko[1] ; HANDA, Hiroko[1] ; MORIKAWA, Noritoshi[1] ; NAKAMA, Atsuko[1]

[1]Geological Survey of Japan, AIST

On November 22, 2014, the Mw6.2 (Mj6.7) earthquake occurred in the northern part of Nagano Prefecture. Next morning, an anomalous discharge of hot spring water and gas was found in 8 km north of the epicenter. As the result of our survey on December 2, the water temperature was 26.4 degree-C, and the flow rate was 75 L/min. The major chemical composition of hot spring water and gas were sodium bicarbonate and methane, respectively.

Keywords: the 2014 Northern Nagano earthquake, hot spring water discharge, coseismic hydrological change

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Tsunami, land subsidence, and groundwater level-change in the southwesternmost of Shikoku caused by the Ansei Nankai EQ

HIROSE, Fuyuki[1*] ; NAKANISHI, Ichiro[2]

[1]Meteorological Research Institute, [2]Graduate School of Science, Kyoto University

The 1854 Ansei Nankai Earthquake caused widespread damage from Kii peninsula to Kyushu region with Japanese seismic intensities of V to VI. A large amount of descriptions related to this earthquake are found in the archives ”New Collection of Historical Documents on Earthquakes in Japan” compiled by ERI (1987). The no. 5 of supplements to vol. 5 has collected documents related to the Ansei Tokai Earthquake (Nov. 4th), Ansei Nankai Earthquake (Nov. 5th), and the largest aftershock in the Bungo channel (Nov. 7th), whose total number of pages amounts to 2,528. This collection books have quoted from many historical documents published by local governments, and reprinted from original historical texts related to the earthquakes. However, when the published books were used, no reprint of original texts was made.

Purpose of this study is to reprint original photocopy of a private record reprinted in some historical documents adopted in the ”New Collection of Historical Documents on Earthquakes in Japan, vol. 5, supplementary no. 5”. Furthermore, we compare our reprinted text with published ones, and investigate natural phenomena (seismic ground motion, tsunami, and crustal movement) and damage by the Ansei Nankai earthquake in detail. In addition, we apply a standard geophysical method to natural phenomena revealed by organizing information which historical documents have. In practice, we re-read and analyzed for the description about original photocopy, it is obscure, of record related to the Anasei Nankai Earthquake handed down to Warabioka family who is a village headman at Masaki area of Ainan-town in the southernmost of Ehime Prefecture in Southwestern Japan. In addition, we compared it with seven historical documents of Uwajima-Date family who had governed this area at that time in order to evaluate the accuracy and amount of information of private historical documents which the village headman wrote. As a result of comparison, there is no contradiction about descriptions of tsunami damage. However, there is no description about inland natural phenomena and damage such as ground water dried up and rock fall in the historical documents of Uwajima-Date family even though it was written in the record of Warabioka family. According to the survey about not only seismic motions, tsunami, and land uplift and subsidence in coast areas in Shikoku island related to the Hoei, Ansei, and Showa Nankai earthquakes conducted up to now, but also groundwater change, land-slide, and liquefaction in inland areas, the investigation will be expanded from linear along the coast to an area including inland. It suggests the possibility to make the information of seismic faults improved qualitatively.

Keywords: Ansei Nankai Earthquake, Shikoku, Ainan-town in Ehime Prefecture, Crustal deformation, Landscape evolution, Fault model

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Relationship between crustal strain and groundwater level at wells in Hokkaido, Japan

SHIBATA, Tomo[1*] ; FUJIO, Akita[2] ; IKEDA, Ryuji[3] ; MATSUMOTO, Norio[4]

[1]Institute for Geothermal Sciences, Graduate School of Science, Kyoto University, [2]Geological Survey of Hokkaido, Hokkaido Research Organization, [3]Graduate School of Science, Hokkaido University, [4]Tectono-Hydrology Research Group, Geological Survey of Japan, National Institute of Advanced Industr

The natural fluctuation of groundwater level depends not only on the stress applied to an aquifer but also on the type of rock that comprises it. Linear poroelasticity provides a compelling relationship between fluid pressure and deformation of fluid-saturated rock, and is an excellent parameter for analyzing hydraulic phenomena. One linear poroelastic response, coseismic change in groundwater level, has been studied for many years (e.g., Igarashi and Wakita, 1991).

We have long-term data on groundwater levels measured at 19 wells in Hokkaido, Japan, an area where large earthquakes occur frequently (Akita and Matsumoto, 2004; Shibata et al, 2010). In addition, we have data on the coseismic changes due to six earthquakes with magnitude seven (M 7) or greater in the Hokkaido region from 1993 to 2004: the 1993 Kushiro-oki (M 7.6), the 1993 Hokkaido-Nansei-oki (M 7.8), the 1994 Hokkaido-Toho-oki (M 8.1), the 1994 Sanriku-Haruka-oki (M 7.5), the 2003 Tokachi-oki (M 8.0), and the 2004 Kushiro-oki (M 7.1).

We estimate strain sensitivities in two ways: (a) using the well response to tidal strain and (b) using coseismic changes in groundwater level based on historical data. The strain sensitivities estimated by the two different methods have good linear correlation. We also estimate loading efficiency using observational records and calculate bulk moduli from the loading efficiencies and strain sensitivities. The bulk moduli obtained in this manner are roughly consistent with laboratory values.

Reference

Akita & Matsumoto, GRL, 31, doi:10.1029/2004GL020433, 2004
Igarashi & Wakita, JGR, 96, 4269-4278, 1991.
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Keywords: change of groundwater level, crustal strain, thermal water, aquifer, Hokkaido

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Anomalous change in atmospheric radon concentration induced by crustal movement

IWATA, Daichi[1*] ; NAGAHAMA, Hiroyuki[1] ; MUTO, Jun[1] ; YASUOKA, Yumi[2] ; MIURA, Satoshi[3] ; OHTA, Yusaku[3]

[1]Dept. Geol., Grad. Sch. Sci., Tohoku Univ., [2]Inst. Radioisot. Res., Kobe Pharm. Univ., [3]RCPEVE, Tohoku University

Radon is a radioactive gas which occurs naturally. Radium (^{226}Ra) decays to radon (^{222}Rn), which belongs to uranium series, by emitting an alpha particle. Radon (^{222}Rn) has a half-life of about 3.8 days. Radon (^{222}Rn) is released from the ground and observed as atmospheric radon concentration.

It is known that the anomalous change in atmospheric radon concentration with earthquakes can be observed. For example, prior to the 1995 Kobe earthquake, the anomalous increase in atmospheric radon concentration was observed at Kobe Pharmaceutical University. It is considered that the changes in atmospheric radon concentration related to large earthquakes are caused by the crustal strain resulting in radon exhalation from ground (Yasuoka et al., 2008). In the report of anomalous increase in atmospheric radon concentration before the Kobe earthquake, it is shown that there is a correlation between radon concentration anomaly and variation of crustal strain measured at the Rokko-Takao station of Kyoto University, located about 10 km west of the Kobe Pharmaceutical University. In this case, crustal strain is measured as local crustal strain. If radon exhalation from the ground and atmospheric radon concentration anomaly reflects crustal strain changes, it is expected that there is a correlation between atmospheric radon concentration change and “wide area strain” .

In this study, we compared the atmospheric radon concentration and area strain near the radon observation point. We used data of atmospheric radon concentration measured at the radioisotope institutes of Sapporo Medical University and Fukushima Medical University (Hatanaka et al., 2013). We calculated wide area strain around the two RI institutes by GPS data.

In the result, a correlation can be seen between the anomalous change in atmospheric radon concentration after the 2003 Tokachi oki earthquake (September 26, 2003, Mw 8.0) and the variation of the area strain near the Sapporo Medical University. Moreover, there is a correlation between the variation of the area strain and atmospheric radon concentration anomaly observed around 2008 Ibaraki-ken oki earthquake (May 8, 2008, Mj 7.0), Fukushima-ken oki earthquake (July 19, 2008, Mj 6.9), 2010 Fukushima-ken oki earthquake (March 14, 2010, Mj 6.7) at the Fukushima Medical University.

These results indicated that atmospheric radon concentration is sensitive to variation of area strain of the order of 10^{-7} to 10^{-8}. It is considered that crustal strain change causes the change in flowing condition of radon and radon flux in the ground.

Keywords: atmospheric radon concentration, crustal movement, GPS, area strain

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Groundwater and crustal activity observations in Gifu Pref., Central Japan

ASAI, Yasuhiro[1*] ; ISHII, Hiroshi[1]

[1]TRIES, ADEP

In order to investigate the relationship between groundwater and crustal activity observation, Tono Research Institute of Earthquake Science has installed the multi-component borehole instruments at the bottom of nine borehole sites in Tono Region, Gifu Prefecture, Central Japan.

We investigated the strain and groundwater level changes observed at TGR350/165 borehole site which are located at vicinity of Mizunami Underground Research Laboratory (Japan Atomic Energy Agency Tono Geoscience Center).

The following results were obtained:

1) Crustal strain changes (10^{-6} order) associated with pore-pressure disturbances which are produced in Mizunami Underground Research Laboratory.

2) Direction of Maximum shear strain changes of TGR350 are SSE direction in case of groundwater level UP, and NNW direction in case of groundwater level drop. At the TGR165, Direction of Maximum shear strain changes are NW direction in case of groundwater level UP, and SE direction in case of groundwater level drop.

We will present the detail of above-mentioned result and qualitative model of strain changes due to groundwater changes.

Keywords: Ishii-type borehole strainmeter, Relationship between groundwater and strain, Maximum shear strain change, pore-pressure disturbance