Relationship between occurrence of mercury in groundwater and active faults in Sennan area, Osaka Prefecture

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Thirty one groundwaters containing detectable mercury was found among 4513 groundwaters monitored by Osaka Prefecture based on the Water Pollution Control Law. Most of those were found in the two areas; i.e, northeastern part of the prefecture along the active Ikoma Fault system(Osaka Prefecture, 2009), and the southwestern part of it. The mercury was mostly inorganic and two groundwaters from Hirakata, in the northeastern area had δ^{202}Hg of groundwater was -0.65‰~-0.85‰ indicating geogenic of these mercury(Sakamoto et al., 2016). This study was planned to reveal the origin of mercury in the groundwater of southwestern Osaka Prefecture and the relationship of occurrence of mercury to active faults.

The groundwater was sampled from 27 wells in August 2016 in December in Kishiwada and Izumi cities. All the wells were <10m depth, and the water levels ware 1~2m from the ground.

This study area includes the wide plateau comprising the Pleistocene sedimentary rocks at the center and alluvial low land along Osaka bay, and Ryoke Granite is exposed on the southern Izumi mountains. Sennan fault runs on the border between alluvial low land and plateau along coast of Osaka bay, Uemachi fault runs from north to south in the center of the study area, and Uchihata fault borders the plateau from Ryoke Granite. Many small faults accross these faults. The faults appear has large flexure zones in the Pleistocene stratum. No groundwater contains excess mercury than the value (0.5ppb) in this study, while several ten ppt mercury was detected from 14 wells, and the highest concentration was 200 ppt, of which well was located near the Uemachi fault. The wells containing mercury were found mostly near the Uemachi fault, and aligned along it. Also, some other wells including mercury were found along the Sennan fault.

Major chemistry of the studied groundwaters were Ca^{2+}-HCO_3^- and Na-Cl- (SO_4+NO_3) types, and the waters containing mercury tended to include SO_4^{2-} and NO_3^- more than the others. Such an characteristic is different from the major chemistry of the mercury-detected groundwaters in northeastern part of Osaka Prefecture, previously studied. In that area, mercury concentration of groundwaters including anthropogenic component such as SO_4^{2-} , NO_3^- and Cl^- was lower than Ca^{2+}-HCO_3^- type grandwaters. The NO_3^- and SO_4^{2-} would be oxidants to ionize gaseous mercury in the studied groundwaters. The mercury would be captured in aerobic groundwaters after issuiing from the deep along the faults in this area.

The fluids released from the subducting slab are found in many place of the Japanese islands. It is reported that saline waters were found in such places, where coincidentaly epicenters of Deep low-Frequency earthquakes occurred(Kazehaya, 2014). Deep low-Frequency earthquakes were observed in our studied areas where geogenic mercury was detected in the groundwaters. In this study area, many active faults belonging to the Uemachi fault system including conjugate faults and flexure zones in Osaka group(Pleistocene sedimentary formation). Combining those observations, the mercury would be released in association with dehydration of slab fluid and issue along the active faults. The origin of mercury will be

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revealed by analyzing mercury isotope ratio of groundwater and soil gas.

Keywords: mercury, groundwater, isotope

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Geochemical analysis of shallow and deep end members by use of brine discharging at Kashio area, Nagano prefecture, central Japan

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Hot springs in Japan are classified, mainly in terms of oxygen and hydrogen isotopic ratio of water, into four groups: green tuff type, coastal type, volcanic type, and Arima type. Arima type hot springs are considered to be formed by mixing of deep brine and meteoric water. Chemical and isotopic composition of the deep brine, however, is not revealed, and two hypotheses about the origin of it, “magma water origin” and “slab-related fluid origin”, have conflicted. It is an important goal in studies of hot springs to reveal the composition and origin of the brine. Helium isotopic ratios are as high as mantle component in some water or gas samples from Arima type hot springs, which means mantle is involved in forming or ascending processes of the deep brine. Therefore it is thought that Arima type hot spring is associated with water circulation in subduction zones. In order to understand water mass balance in subduction zones, it is necessary to estimate fluxes of the deep fluids. Kashio hot spring, discharging near the Median Tectonic Line in central Japan, is considered as one of Arima type hot springs. In this study water samples are collected at Kashio area. Then oxygen and hydrogen isotopic ratios ($\delta^{18}O$, δD), Cl^- concentrations, HCO_3^- concentrations, tritium concentrations, rare gas concentrations, and rare gas isotropic ratios of the collected samples are measured. At the same time, flow rates and Cl^- concentration of river waters at Kashio area are measured. By use of seasonal variations of values measured from the samples, it is revealed that water of Kashio hot spring is a mixture of the deep brine and young groundwater originating from meteoric water. With tritium and ^{20}Ne concentrations, chemical and isotopic composition of the Kashio deep brine is estimated as follows: $\delta^{18}O$ = -1‰, δD = -49 ‰, Cl^- = 25000 mg/L. The δD value of the brine is not explained by magma water. This oxygen and hydrogen isotropic composition might be interpreted as a result of oxygen isotopic fractionation between minerals and slab-derived fluid which occurs at relatively shallow depth inside crust. A flux of the Kashio brine is also estimated, using the flow rates and Cl^- concentrations of river waters, at 0.63 L/sec. This value is similar to that of Arima hot spring and Kobe area.

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Exploration of Tachikawa Fault by Groundwater Radon Concentration

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We explored Tachikawa fault by use of groundwater radon concentration. Radon concentrations in shallow groundwater samples around the fault were comparable to that expected from the geology on the Kanto plane, and they were consistent with previous studies. Almost of all radon concentrations in deep groundwater from the bedrock-deep aquifer were also comparable to that in shallow groundwater. However radon concentrations in groundwater samples that were obtained at wells close to the fault were markedly higher than the expected radon concentration. This disparity can be explained by the existence of fracture zones spreading on both sides of the fault. The radon concentration distribution of deep groundwater samples suggests that a fault exists even at the southern part of the traditional line of Tachikawa fault.

Keywords: Radon, Groundwater, Tachikawa fault

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Helium isotope anomalies in the San-in shear zone

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A concentration zone of deformation corresponding to the active zone of microseismicity has been identified in an eastern part of the San-in region. This deformed zone, called “San-in shear zone”, is more than 200 km long along the coast of the Japan Sea and accommodates right-lateral shear motion. Its width is variable, that is, less than 20 km in the eastern part of Tottori Prefecture and 50~70 km in a western part of Tottori Prefecture and the eastern part of Shimane Prefecture. Elevated 3He/4He ratios in groundwaters sampled from hot spring and drinking water wells are observed around the shear zone, suggesting the emission of mantle-derived helium. The deformation may be attributed to the low viscosity in the crust because the concentrated supply of mantle fluids with high 3He/4He ratios may weaken the lower crust.

Keywords: helium isotope, San-in shear zone

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Crustal resistivity structure beneath the source region of 2014 northern Nagano earthquake

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In this study we have determined two dimensional (2-D) resistivity structure beneath the source region of 2014 northern Nagano earthquake. Seventeen magnetotelluric (MT) stations were deployed in the study area. The MT data were collected using five component wide-band MT instruments (Phoenix MTU-5 system). A simultaneous remote reference measurement was carried out at the Sawauchi site (400 km northeast of the study area). The observed apparent resistivity and phase data were inverted simultaneously using the 2-D inversion code of Ogawa and Uchida [1996]. The obtained resistivity model through the inversion show as follows: (1) The mainshock hypocenter is located in a prominent conductive zone. (2) This anomaly is imaged in the depth range of 3 to 20 km. (3) These results indicate that the conductive zone may be due to crustal fluids that contributed to the occurrence of the large earthquake.

Keywords: 2014 northern Nagano earthquake, resistivity structure, crustal fluids

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Changes in P and S wave velocity associated with the two-staged reflood of the underground galleries

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We detected changes in P and S wave velocity of the Toki granite around the Tono mine observed by the seismic ACROSS signal during the back-filling of underground galleries. The back-filling in the underground galleries at the Tono mine was started in March 2012. The main drainage pump (altitude 160 m) was stopped on December 9, 2014, and the closure of the galleries and the vertical shafts were completed in March 2015. After the termination of the main drain pump, the reflood started in the buried galleries and the remarkable change in S-wave travel time was observed at the borehole accelerometer installed in the Toki granite, where is located beneath the ACROSS transmitter [Kunitomo et al.(2016)JpGU]. In this study, we analyzed the data of the TRIES borehole observation network and Hi-net and investigated the velocity change of P waves as well as S waves around the mine from a distance. As a result, the advance of the P wave traveltimes were detected from the middle of 2014 at the north and south observation points. Around June 2014, the water level rose from the level of the lower gallery (altitude 152 m) to the upper galleries (altitude 160 m) caused by the failure of the pump in the lower gallery. It is thought that the increase of the P wave velocity of the surrounding rock was caused by the penetration of groundwater.

Keywords: seismic ACROSS, seismic velocity change, groundwater

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