Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

SCG068-01 Room:104 Time:May 22 14:15-14:30

Focast of natural phenomena and safety analysis for safety of geological disposal

Junichi Goto[1*], Ryuta Hataya[1], Eiichi Ishii[1], Takeshi Ebashi[1], Katsuhiko Ishiguro[1], Hiroyuki Tsuchi[1]

[1]NUMO

Since Japan is located in a tectonically active zone, requirements for implementing the geological disposal system will include selection of the repository site from locations where significant impacts of natural phenomena such as volcanism, fault activity and uplift/erosion can be avoided in the future. Future occurrence of such phenomena should be forecasted based on trends that have occurred around the area in question in the past to forecast whether significant impacts can be avoided in the future. Data on the geological environment of the disposal sites and on long-term geological evolution are then obtained to allow selection of a location with suitable conditions for ensuring long-term post-closure safety.

Forecasts of natural phenomena in the future have been made, based mainly on an extrapolation method. In Japan, there is consensus that forecasting natural phenomena one hundred thousand years into the future will be possible based on geological records for the past hundreds of thousand years. However, for a geological disposal system based on confinement and isolation, the time when the maximum dose occurs may substantially exceed one hundred thousand years and strategies for evaluating natural phenomena further into the future are required. Activities for addressing this issue are ongoing as described later.

Management of uncertainties is a key issue for NUMO's quality assurance activities. Generally, uncertainties associated with site characterization include those associated with data and conceptualization of the geological environment, and with forecasts of natural phenomena. Information on such uncertainties will have to be provided for the repository design and safety assessment. Through coordination of repository design and safety assessment, key structures, geological environment characteristics and phenomena that affect the feasibility of constructing the disposal facility and long-term post-closure safety should be identified and reflected in the investigation plan for the subsequent stage (or phase), which should have the effect of reducing uncertainties.

Activities to support safety assessment from the scientific point of view have started recently in NUMO. Scientific advances in the last decade in areas such as plate movement, volcanism, fault activity and uplift/subsidence have been compiled, together with international perspectives on the evaluation of natural phenomena and safety assessment, to identify issues for discussion. The results of the discussion stimulated a study on the stylization of natural phenomena on an individual area-phenomenon basis. The Tohoku area in northern Japan was subdivided into several regions based on differences in the mode of crustal deformation and trends in uplift/subsidence for each region will be investigated on the very long-term.

Keywords: geological disposal, siting, safety analysis, natural phenomena, future forcast, uncertainty

Japan Geoscience Union Meeting 2011
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SCG068-02 Room:104 Time:May 22 14:30-14:45

Focast of natural phenomena and safety analysis for safety of geological disposal

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In an actual disposal facility, different events will interact in a complex manner and will evolve over a long time frame. Accordingly, it will not be straightforward to realize them all in detail in the context of scientifically demonstrating future conditions. Defining of conditions will thus involve simplifying physical and chemical phenomena and checking the conservativeness of this approach in the context of safety assessment, rather than making efforts to pursue strict scientific correctness, to reduce the number of factors to be considered and reduce coupling between these factors.

In this study, based on the above, the relationship between future prediction in site characterization and scenario classification in safety assessment, and scenario development methodology of natural phenomena are illustrated.

Keywords: geological disposal, siting, safety analysis, natural phenomena, future forcast, uncertainty

Japan Geoscience Union Meeting 2011
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SCG068-03 Room:104 Time:May 22 14:45-15:00

Rethinking of NF concept in crystalline rock

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Since established NF multi-barrier concept in H-12 report, underground research has been conducted and provides realistic data for underground environment. The data and knowledge enable us to develop more realistic NF concept in order to adjust the characterization methodology also to define the barrier function by combination of synthetic barrier materials and natural barrier system. The paper here discuss how we have to rethink to develop the realistic NF concept to for coming on site characterization and safety assessment with compiled URL data set in crystalline rock, in Japan.

Keywords: NF concept, Crystalline rock, Barrier function

Japan Geoscience Union Meeting 2011
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SCG068-04 Room:104 Time:May 22 15:00-15:15

Hydrochemical Characterization at Mizunami Underground Research Laboratory - Adequacy assessment of the result of surfac

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[1]JAEA

Progress of hydrochemical study in MIU project conducted by JAEA is reported in this paper.

Keywords: MIU, hydrochemistry, influence of shaft construction

Japan Geoscience Union Meeting 2011
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SCG068-05 Room:104 Time:May 22 15:15-15:30

Natural analogue study using U, Th, REEs to identify the pragmatic hydrogeological structure in sedimentary rock

Teruki Iwatsuki[1*], Teruyuki Honda[2], Hiroaki Murakami[1]

[1]Japan Atomic Energy Agency, [2]Tokyo City University

U, Th and REEs abundances in sedimentary rocks were analyzed to understand the long-term mobility of these elements and to develop the evaluation method of the pragmatic solutes transport path at Horonobe area, Japan. The abundances of U, Th and REEs in rock matrix were generally homogeneous suggesting that no large-scale movement occurred in spite of distinct hydro-chemical condition in the sedimentary rocks. The detail analysis of peculiar points such as fracture and fault as a possible solutes transport path shows the accumulation and leaching of U, Th and REEs at some faults with connection and continuousness at specific depth. The fault and accompanied alteration possibly facilitates to leach and move the heavy-REEs (HREEs) from primary rock. Then those elements seem to have a tendency to concentrate into carbonate mineral vein in the fracture. The some clay-rich fault parts enriches in U, Th and light to medium-REEs (LREE˜MREEs) compared with background rock. The clay minerals in the fault would entrap those elements and delay its transport though the fault can become a solutes transport path. From the viewpoint of solutes transport, remarkable transport path is fracture and fault (fracture media) rather than rock matrix (porous media) in sedimentary rocks at the area. Analysis of the heterogeneity of analogue elements around fault (fracture) is efficient method for the screening of pragmatic solutes transport path from the innumerable faults and fractures.

Keywords: horonobe area, sedimentary rock, solute transport path, natural analogue, rare earth element

Japan Geoscience Union Meeting 2011
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SCG068-06 Room:104 Time:May 22 15:30-15:45

Hydrogeological investigations for validation of groundwater flow modelling

Kazuyuki Matsusue[1*], Masahiro Munakata[1], Kimikazu Hisada[1], Hideo Kimura[1]

[1]Nuclear Safety Research Center, JAEA

It is necessary to evaluate the influence on the environment by the groundwater flow analysis in the safety assessment of geological disposal of the radioactive waste.

We studied to acquire the new data to validate the large area groundwater flow model in the Horonobe region, Hokkaido.

A borehole of 700m and 2 boreholes of 150m were excavated respectively on the east side of the Horonobe Underground Research Laboratory and the west side.

We acquired the hydrogeologic data of the hydraulic head, the hydraulic conductivity, and the groundwater chemistry, etc.

Keywords: groundwater flow model, borehole, hydraulic conductivity, groundwater chemistry, hydraulic head

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SCG068-07 Room:104 Time:May 22 15:45-16:00

Study of chlorine-36 dating of groundwater in the SAB-2 borehole, Horonobe, Hokkaido

Kimikazu Hisada[1*], Masahiro Munakata[1], Kazuyuki Matsusue[1], Hideo Kimura[1]

[1]Nuclear Safety Research Center, JAEA

A deep drilling project (SAB-2 borehole, 710m deep) has been conducted in the Horonobe area, Hokkaido, Japan for the safety assessment of geological disposal of radioactive waste. We report a result of investigation of groundwater age using chlorine-36.

Keywords: chlorine-36, groundwater age, Horonobe

Japan Geoscience Union Meeting 2011
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SCG068-08 Room:104 Time:May 22 16:00-16:15

Estimation of groundwater retention time by Carbon-14 in the sedimentary rocks at the Horonobe study site

Hiroaki Murakami[1*], Yuki Amano[1], Yoko Saito-Kokubu[1], Teruki Iwatsuki[1]

[1]Japan Atomic Energy Agency

Dissolved inorganic carbon (DIC), $d^{13}C$ and $^{14}C/^{12}C$ ratio in sedimentary rocks were measured to understand the residence time of groundwater at Horonobe area, Japan. Siliceous mudstone of Wakkanai Formation and diatomaceous mudstone of Koetoi Formation containing fossil water and methane gas are distributed at the study area. Groundwater samples were collected at 140m and 250m depth. Groundwater samples were enough to overflow. After NaOH and $SrCl_2$ were added to the samples to induce $SrCO_3$ precipitation, the precipitated $SrCO_3$ was converted to CO_2 by reacting with phosphoric acid in a vacuum line. All samples were analyzed by an Accelerator Mass Spectrometer (JAEA-AMS-TONO).

Measured values of DIC, $d^{13}C$, $^{14}C/^{12}C$ in the groundwater samples were from 430 to 690 mg/L, from +19.3 to +21.8 permil and from 0.39 to 1.04 pMC (percent Modern Carbon), respectively. If all ^{14}C in samples were originated from CO_2 in the air, large quantities of air contact with the sample. This shows that; ^{14}C in the samples are not contamination. As a result of simply calculation, the ^{14}C ages were about 40,000 year BP. However, ^{14}C activity is diluted by non-active carbon (’dead carbon’) from various carbon sources which are carbonates or organics. Thus, it is necessary to clarify the isotopic attenuation by dead carbon and process of isotopic fractionation in this area and to correct the ^{14}C ages.

Keywords: groundwater, retention time, isotope, 14C

Japan Geoscience Union Meeting 2011
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SCG068-09 Room:104 Time:May 22 16:30-16:45

Study on Preparation methods for Validation data of Groundwater Flow System in a Sedimentary Rock Area

Ryutaro Sakai[1*], Masahiro Munakata[1], Hideo Kimura[1]

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In the safety assessment for a geological disposal of radioactive waste, it is important to establish validation methods for regional groundwater flow system more than 300m at depth to estimate radionuclide migration to human environment through groundwater flow system. The study discussed application of data and assessment methods for model validation based on multiple indicators such as hydrology, groundwater chemistry, temperature and age of groundwater in case of the Hamasato in Horonobe area where a lot of in-situ data about groundwater were measured.

This results show that multiple indicators such as hydrology, groundwater chemistry, temperature and age of groundwater are applicable to validate the groundwater flow property and groundwater flow boundary.

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SCG068-10 Room:104 Time:May 22 16:45-17:00

Study on Temporal Change of Hydraulic Conductivity for Long-term Groundwater Flow Analysis

Masahiro Munakata[1*], Kimikazu Hisada[1], Hideo Kimura[1]

[1]Nuclear Safety Research Center, JAEA

We studied the temporal change of hydraulic conductivity to be considered in the safety assessment of geological disposal facility. Based on the measured geological properties performed in Horonobe area, it is appeared that the correlation between the depth and hydraulic conductivity. Then, we estimated the temporal change of hydraulic conductivity in this area.

Keywords: Geologic Disposal, Safety Assessment, Groundwater Analysis

Japan Geoscience Union Meeting 2011
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SCG068-11 Room:104 Time:May 22 17:00-17:15

Effect of confining pressure on the chemico-osmotic property of sedimentary rock

Mikio Takeda[1*], Mitsuo Manaka[1], Kazumasa Ito[1]

[1]AIST

Precise characterization of groundwater flow system is necessary for performance assessment of geological disposal of radioactive waste. In low-permeability sedimentary formations in coastal regions, heterogeneous salinity distributions may induce chemical osmosis, causing fluid pressure anomalies from hydrostatic pressures. In order to characterize the groundwater flow systems with salinity gradients, the magnitude of chemical osmosis needs to be identified by an approach with the combination of experiments and numerical modeling. This study developed a laboratory apparatus for chemical osmosis experiments that simulates in-situ lithostatic pressures, and performed a series of experiments using a siliceous mudstone, taken from Horonobe area in Hokkaido, under confining pressures ranging from 1 to 20 MPa. The measured pressure differences between the ends of disc-shaped rock sample range from 9.1 to 26.4 kPa. The salinity differences are almost consistent in a series of experiments, and range from 0.110 to 0.118 M NaCl. From the measured salinity and pressure differences, the reflection coefficients approximated from van't Hoff equation ranges from 0.020 to 0.049, and show the correlation with the confining pressure. Based on the results derived from this study, potential osmotic pressures induced by the salinity differences between fresh and saline waters should be examined using the field scale numerical model for further studies.

Keywords: sedimentary rock, chemical osmosis, osmotic pressure, laboratory experiment

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omparison of pore water chemistry after extraction from sedimentary rock by different methods

Reo Ikawa[1*], Seiji Nishizaki[1], Isao Machida[1], Masaru Koshigai[1], Atsunao Marui[1], Narimitsu Ito[1]

[1]Geological Survey of Japan, AIST

It is difficult to obtain physical data in sedimentary rock with low permeability, because the groundwater velocity reduces as the depth increases. In regions with this type of rock, geochemical data is very important to understand the groundwater flow conditions. However, in situ groundwater sampling is very difficult because of the sampling schedule, cost, and technical requirements. Many previous studies have suggested that geochemical data from pore water could be used in these cases. Squeezing, centrifugation, leaching, and direct equilibration have been proposed as major extraction methods for pore water. Among these methods, squeezing has been used in the widest range of studies. However, water sampling by squeezing needs to be conducted under appropriate pressure conditions, because rock failure from excessive pressure can influence the chemical and isotopic composition of the pore water. In this regard, centrifugal extraction is advantageous, because it is not influenced by rock failure. However, the application range of this method to rock samples is small, and isotopic fluctuation can occur because of the long exposure time of the sample to the air. To date, the pore water chemistry after centrifugal and squeezing extraction has not been compared in detail for Japanese soft sedimentary rock.

The purpose of this study was to clarify the advantages and disadvantages of both extraction methods based on chemical analysis of the pore water. Both methods altered the isotopic composition of the pore water rather than its chemical composition. For water samples extracted by the same method, extraction conditions such as pressure and rotational speed also influenced what specific ions were present in pore water. The latest results from this study will be reported.

Keywords: pore water, squeezing, centrfugation, water chemistry, stable isotopic raio

Japan Geoscience Union Meeting 2011
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SCG068-13 Room:104 Time:May 22 17:30-17:45

Effect of microorganisms on migration of radionuclide - Sorption of actinides on microbial cells in aerobic condition -

Toshihiko Ohnuki[1*], Wakari Iwai[1], Naofumi kozai[1], Yohey Suzuki[2]

[1]JAEA, [2]AIST

Introduction:

The actinides (An) may migrate through fracture in the components of geologic formation. Microorganisms exist in these fractures, and consequently, Ans released are adsorbed by microorganisms.However, whilst there are considerable data on the sorption and retention of Ans by inorganic components of fracture, the effects of microorganisms on the migration of Ans are not fully understood.

The structure of cell surface of microorganism differs between Gram-negative and Gram positive microorganisms. The adsorption of actinides may differ between Gram-negative and Gram positive microorganisms. In this study, we have studied the adsorption of U(VI) by *Shewanella putrefaciens* (Gram-negative) and *Bacillus subtilis* (Gram-positive).

Experimental:

The cells of the microorganisms were grown for 2 days in medium solution at 30^{o}C were washed three times with 0.1 mol/L NaCl solution. Harvested cells were contacted with aqueous solution containing 1.0x10^{-5} mol/L U(VI) and 0.01 mol/L NaCl. The pHs of the exposure solutions were adjusted to 3, 4, 5, and 6. The cell density was changed from 0.02 g/L to 0.5 g/L. The effect of the presence of Ca^{2+} ions, citrate ions, and glucose was examined. The chemical states of the adsorbed U(VI) on the cell of S. putrefaciens were determined by U_{LIII} EXAFS spectrum measured at BL-27B at photon factory of KEK, Tsukuba.

Results and discussion:

The concentration of U in the solution was the same between 2 and 4 h after exposure of the cells to U(VI), indication that the adsorption was attained to equilibrium within 2 h. At pH 3 the concentration of U after exposure of two kinds of microorganisms of 0.02 g/L to U containing solution was approximately 2x10^{-6} mol/L. The concentration of U decreased with increasing solution pH. The charge of the cell surface increased negatively with increasing solution pH, resulting in the ascent of adsorption of U with increasing pH. The EXAFS analysis indicated that U was associated with phosphoryl functional groups. These results indicated that U was adsorbed on the functional groups of the cell surface.

Presence of Ca^{2+} ions between 0.01 and 0.05 mol/L in the solution did not affect the adsorption of U by *S. putrefaciens*. Adsorption of U by *B. subtilis* decreased with increasing concentration of Ca^{2+} ions. Presence of citrate ions reduced the adsorption of U(VI) by *S putrefaciens* and *B. subtilis*. The presence of glucose did not affect the adsorption U(VI) on *S. putrefaciens*, but decreased the adsorption of U(VI) by *B. subtilis*. These results suggest that the presence of cations and organic acids affect the adsorption of An by microorganisms, and the adsorption of U(VI) are different between Gram-negative and Gram-positive microorganisms.

This study was supported by grants from the Nuclear and Industrial Safety Agency (NISA).

Keywords: Geological disposal, adsorption, microorganism, long-lived radionuclides, migration

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SCG068-14 Room:104 Time:May 22 17:45-18:00

BiogeochemicalBiogeochemical Investigations of Granitic Groundwater from the Grimsel Test Site, Switzerland

Uta Konno[1*], Mariko Kouduka[1], Yohey Suzuki[1], Ito Kazumasa[1], Yoshio Watanabe[1]

[1]AIST

As collaborative efforts between Nagra and AIST, we investigated biogeochemical properties of granitic groundwater from the Grimsel Test Site, Switzerland. We selected 5 boreholes depending on flow rate and hydrogeological unit, and total cell counting, metabolic activity measurements, DNA-based analysis for microbial populations and analyses for stable isotopic compositions of gases were performed in addition to basic geochemical analyses. For quality control, it is necessary to flush, at least, three borehole volumes before sampling. This is because stagnant water in a borehole could be colonized by distinct microbes from those in formation water. As microbes initially colonized in a borehole would also be of our interest, we sampled groundwater at the beginning and at the end of flushing. In this presentation, biogeochemical profiles and microbial populations found from the granitic groundwater will be shown to discuss their generic and site-specific features.

This study was supported by grants from the Nuclear and Industrial Safety Agency (NISA).

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Natural analogue study on long-term reaction of bentonite and highly alkaline groundwater

Masaya Oi[1*], Naotatsu Shikazono[1], Minoru Yamakawa[2], Naoki fujii[2]

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Geological disposal of high level nuclear waste has been planned and developed in many countries worldwide. In Japan, it is to be vitrified and an overpack enclosing metallic containers that contain the vitrified waste is to be placed in a deep geological repository with the multibarrier system consisting of an engineered barrier and a natural barrier by geological formations. One of the possible buffer materials for the engineered barrier is bentonite, which should possess the property of long-term stability, although the functions required for it depend on the method of disposal of the waste. When used with cement materials as reinforcing agents, however, the functions required for the bentonite-based barrier material may deteriorate due to such phenomena as dissolution and change of properties by highly alkaline groundwater formed by reactions of the cement materials with groundwater. Since it takes hundreds of thousands of years for the radioactivity of high level nuclear waste to decrease to the natural background level, it is impossible to clarify the reaction mechanism of bentonite and highly alkaline groundwater in the laboratory for such a long time. An appropriate method to examine such a long-term system is natural analogue study which is an investigation of a natural system that has some similarities with a radioactive waste repository and its surrounding environment.

The Mangatarem district, in the Philippines, was chosen as a study area in this natural analogue study due to the following reasons:

?Ophiolite suite is widely distributed and may be utilized for elucidation of the reaction mechanism of basic rocks with groundwater. Ophiolite is layered rock consisting of several rocks such as peridotite, gabbro and basalt.

?There are natural bentonite ore deposits (Saile Mine) in the district, where observation of the deposit outcrop is possible.

?Evidence is found that there existed highly alkaline groundwater at Saile Mine in the past (Mn-staining), which enables us to examine the reaction of bentonite with such a highly alkaline groundwater.

?There are world-prominent eruption spots of highly alkaline groundwater in the district (Manleluag National Park).

?There are regions where bentonite is currently interacting with highly alkaline groundwater (Bigbiga).

Through the investigation of the Mangatarem district with the above mentioned features, we tried to elucidate the following two points: 1) the origin of the highly alkaline groundwater and 2) the long-term interaction of bentonite with highly alkaline groundwater

At present, we are mainly trying to elucidate the long-term interaction of bentonite with highly alkaline groundwater. Analyses were made for rock samples collected from trenches of the bentonite mine and an outcrop of the quarry in 2009 and 2010. The major element contents of these samples were determined by XRF, and the contents of rare earth elements and trace elements (mainly heavy metals) were measured by ICP-MS. The constituent minerals of the samples were identified by XRD. Analytical results reveal some differences between the trench and outcrop samples. Assuming that the source rock of bentonite and zeolite is common for the rock samples of the two sampling points, those differences are probably attributable to the difference in the reaction of the source rock with the highly alkaline groundwater that had come up along faults. The trench samples collected from deeper parts in the ground have been influenced by the highly alkaline groundwater more substantially than the outcrop samples.

Keywords: high level nuclear waste, natural analogue study, bentonite, highly alkaline groundwater, basic rocks, rare earth element

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Study on investigation techniques of uplift rate using sediment of incised meander scars

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We focused on the incised meander scars to be distributed along the river and carried out a study of the estimate technique of the uplift rate using the sediment on the scars. More than 800 incised meander scars in Japanese Islands were extracted by interpretation of 1:25000 topographical maps. The scars are distributed over various altitudes. As a case study, we studied about uplift rate using the incised meander scars in an area along Totsukawa River where typical scars were distributed over various altitudes. The sediment was got by machine digging with high preservation quality of the unconsolidated materials. Sedimentation age was estimated by volcanic ashes analysis. The age of the sediment on the incised meander scars of relative height approximately 90 m from the present riverbed is approximately 300-400 thousand years ago. From these results, given the dynamic equilibrium of the riverbed height, the uplift rate is estimated at a few ten centimeters for one thousand years. It is an assignment to increase case studies to show validity of the estimation technique of the uplift rate using the sediment on the scars. In addition, the comparison with the result of different techniques is an assignment.

Keywords: uplift, denudation, incised meander scars, detached meander core