Priority Subjects with Limited Terms — **Establishment of Optimal Risk Management**

Assessment for the Effects of Natural Hazards on Nuclear Facilities

Background and Objective

The generation of nuclear power has declined substantially since the Great East Japan Earthquake of 2011, and this has resulted in the lack of stable electricity supply. We need to assess the magnitude and frequency of large-scale natural external phenomena including earthquakes, tsunamis, and volcanic eruptions. We need to understand their mechanism, so that we can implement mitigation measures to the facility and operation of nuclear power plants. This subject develops hazard assessment methods on natural external events as a part of the research program at NRRC aimed at safety improvement and development of PRA.

Main results

1 Application of seismic interferometry to an exploration of subsurface structure by using microtremors

Rayleigh-wave group velocities using synthesized Green's functions from seismic interferometry are applied to estimate deep subsurface geological structures. We carried out continuous measurements of microtremors at Ohshima peninsula (OSM) and Otomi peninsula (OTM) in the Wakasa bay region. Using more than 80 days' worth of data, dispersive waveforms in the cross correlations were identified as a Green's function from OTM (source) to OSM (receiver) based on seismic interferometry. By identifying deep subsurface structures at OSM and OTM based on an inversion of phase velocity from both methods, the depth of S wave velocity of approx. 3.5 km/s, considered as a top of seismogenic layer, was determined to be 3.8 - 4.0 km at OSM and 4.4 - 4.6 km at OTM (N14020).

2 Utilization of organic matter as the marker of tsunami deposit

Chemical (C/N) and isotopic ($d^{13}C$) analyses were used to determine the origin of organic matter in the 2011 Tohoku-oki tsunami deposits collected from 19 coastal areas. We found that these parameters can be useful markers to distinguish marine organic matter from freshwater; as we confirm that a marine signature is found in beach samples, while a freshwater signature is recognized in samples obtained from unaffected inland areas [1] (Fig. 2a). The method provides scientific criteria for the identification of tsunami deposit, and contributes to estimating the magnitude of pre-historic tsunamis and the distribution of their deposits (Fig. 2b).

3 Development of numerical analysis of volcanic ash dispersion coupled with the effect of meteorological condition

Numerical code for volcanic ash dispersion and ash-fall, Fall3D, is coupled with our weather forecasting and analysis system, NuWFAS. The method is capable of calculating temporal variation of particle concentration and accumulation of volcanic ash-fall, crucial to the hazard assessment of utility facilities. Dispersion of volcanic ash at the 2011 Kirishima volcano eruption is satisfactorily reproduced by our method (Fig. 3). Iterative improvements on the accuracy of defining boundary conditions, including meteorology and height of volcanic ash-cloud, are conducted to be applied to the hazard assessment of nuclear facilities (N14004).

[1] Ito et al., The Origin of Organic Matter in the 2011 Tohoku-oki Tsunami Deposit Determined by Chemical and Isotopic Signatures, AOGS 2014, Sapporo (2014).

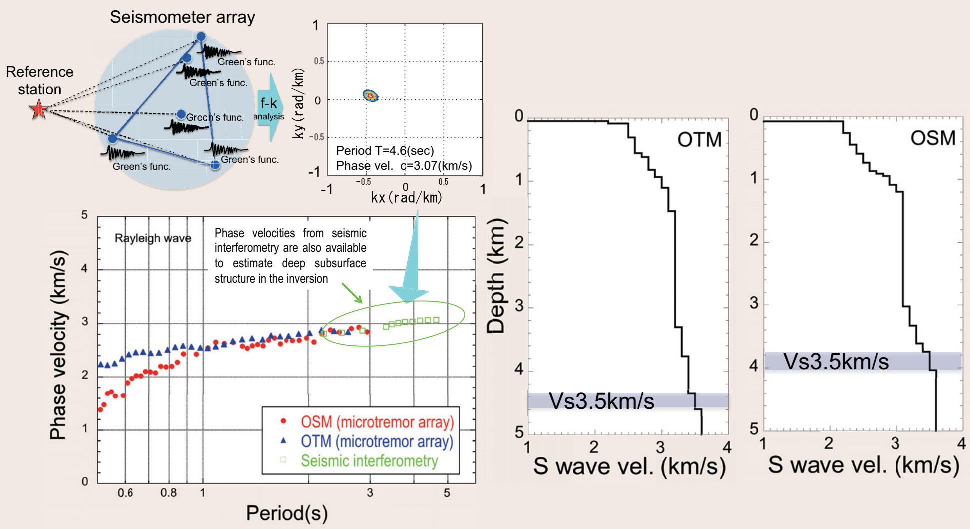

Fig. 1: Phase velocity inversion using synthesized Green's functions from seismic interferometry to estimate a deep subsurface geologic structure

We propose a method to estimate phase velocities by the f-k spectral analysis using the synthesized Green's functions with a common observation station. It is suggested that the deep subsurface structure of the shallow sea region between two peninsulas is continuous structure from OSM to OTM and that Love- and Rayleigh-wave group velocities using synthesized Green's functions from seismic interferometry can be used to validate identified deep subsurface structures.

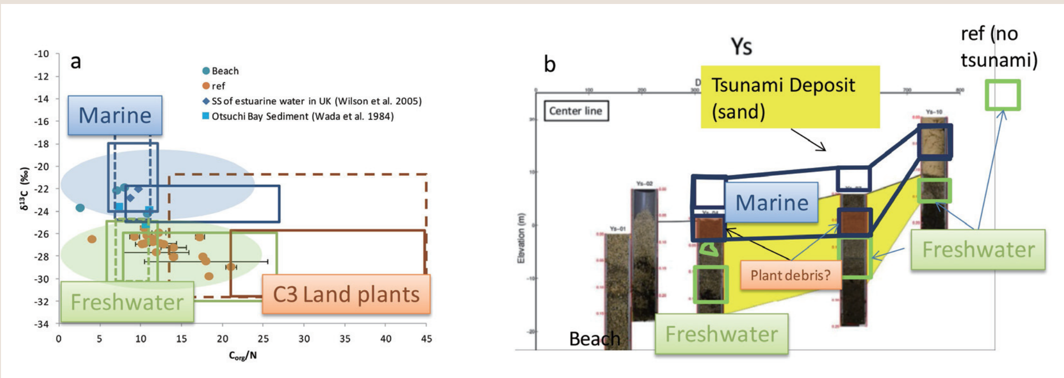

Fig. 2: Comparison of carbon isotope and C/N ratios between beach or estuary deposits, humic soil and tsunami deposits, and estimation of depositional environment of the sediments in the coastal region by organic marker

Chemical (C/N) and isotopic (d[13]C) parameters are found to be useful markers to distinguish marine organic matter from a freshwater environment. We confirm that a marine signature is found in beach samples, while a freshwater signature is recognized in samples obtained from unaffected inland areas (Fig. 2a). Tsunami deposit is distinguished from river sediment by identifying its marine signature (Fig. 2b).

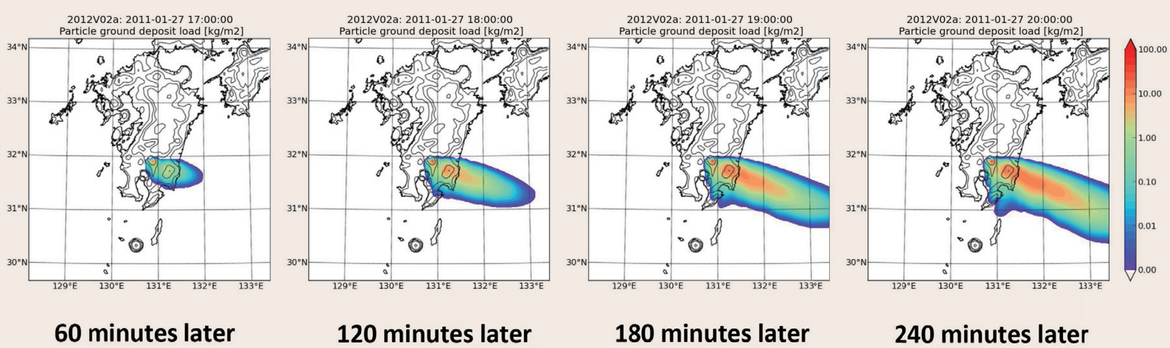

Fig. 3: Dispersion of volcanic ash-fall (Kirishima volcano 2011 eruption)

The calculated hourly dispersion of volcanic ash is displayed. The distribution expands southward due to the northerly wind on the day of eruption, which agrees well with observation. The method is capable of calculating the temporal variation of ash-fall accumulation and particle concentration at the given location. The method is therefore useful for the assessment of wide-ranging effects on utility facilities including mass load, intrusion and blockage of emergency generators and loss of external power.