Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)
©2015. Japan Geoscience Union. All Rights Reserved.

MIS25-01 Room:201B Time:May 24 09:00-09:15

The foraminifera assemblages in tsunami sediments on Ishigaki Island, southwestern Japan

TU, Yoko[1*] ; CHIEN, Chih-wei[2] ; ANDO, Masataka[3] ; KITAMURA, Akihisa[4] ; SHISHIKURA, Masanobu[5] ; NAKAMURA, Mamoru[6]

[1]Department of Natural History Sciences, Hokkaido University, Japan, [2]Department of Earth Sciences, National Central University, Taiwan, [3]Center of Integrated Research and Education of Natural Hazards, Shizuoka University, [4]Institute of Geosciences, Faculty of Science, Shizuoka University, [5]Institute of Earthquake and Volcano Geology, National Institute of Advanced Industrial Science and T, [6]Faculty of Science, University of the Ryukyus

Foraminifera, single celled protists, are widely applied to paleoenvironmental, paleooceanic, stratigraphic and sedimentological investigations due to their abundant populations. Moreover, they are sensitive to living environment and have high preservation potential within the sediments (Mamo et. al, 2009). Although foraminifera assemblage analysis is remarkable tools for geoscience researchers to understand the variation of paleoenvironment, however, the use of foraminifera assemblage has not been developed well in palotsunami research. Up to the present, not only investigation methods but also analytic procedures have not been established.

In 1771, a destructive tsunami struck Ishigaki Island, southwestern Japan, with the maximum run-up height of 30 meters to cause about 9000 fatalities (half populations of Ishigaki Island), and the mortality rates of 25 villages on the eastern and southern coasts reached 10- 90%. For the mechanism of this tsunami, Nakamura (2009) proposed the source should be a large subduction thrust earthquake that occurred near Ryukyu trench axis, while Goto et al. (2010) suggested a model of extensive submarine landslides triggered by an intra-plate earthquake. Furthermore, Ando et al. (2015) identified four tsunami evens from tsunami sediments for the last 2000-2500 years.

In this study, we tried to identify tsunami events based on foraminifera assemblage in soil deposits. In order to approach this aim, we analyzed forty-seven soil samples obtained from five excavation sites on both eastern and western coasts in this island. A total of 117 foraminifera species from 36 genus were recognized through our analysis. Subsequently, we classified all foraminifera tests into three clusters based on the result of Hatta and Ujiie (1992): shallow-water foraminifera ($<$15m), inter-mediate depth foraminifera (15m to 50m) and deep-water foraminifera ($>$50m). After this procedure, we took the ratio of individual numbers in deep-water + inter mediate-depth to total amount for each soil sample. This analysis yields that samples with high ratios ($>$0.2) were identified as tsunami deposits, conversely those with low ratios ($<$0.15) as beach sand or terrigenous sediments. This suggests that foraminifera assemblage analysis can provide significant tool to identify paleotsunami deposits from other sedimentary processes. Our analysis of foraminifera assemblages provides at least three tsunami events in 1771, AD 1000 to 1300, and BC 300 to 600 that struck Ishigaki Island.

Keywords: foraminifera assemblages, tsunami sediments, Ishigaki Island, 1771 tsunami, Ryukyu subduction zone

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)
©2015. Japan Geoscience Union. All Rights Reserved.

MIS25-02 Room:201B Time:May 24 09:15-09:30

Evaluating the magnitude of late Holocene mega-tsunamis on Ishigaki Island based on an analysis of molluscan assemblages

KITAMURA, Akihisa[1*] ; ITO, Mami[2] ; ANDO, Masataka[3] ; IKUTA, Ryoya[1] ; IKEDA, Masayuki[1] ; IMAI, Takafumi[2]

[1]Faculty of Science, Shizuoka University, [2]Graduate School of Science, Shizuoka University, [3]Center for Integrated Research and Education of Natural hazards, Shizuoka University

Four ancient tsunami deposits have been identified on Ishigaki Island, Okinawa, Japan. Three tsunami deposits (T-I, T-II, and T-IV) are calcareous sand beds which have sharp erosional bases and normal graded structure, while one tsunami deposit (T-III) is buried tsunami boulders between tsunami deposits T-II and T-IV. The youngest tsunami deposit T-I, was caused by the AD 1771 Meiwa tsunami, which had a wave height of at least 10 m in the study area. The depositional ages of the three older tsunami deposits (T-II, T-III, and T-IV) are 790-610 cal. yrs BP, 1494-1258 cal. yrs BP and 2502-2287 to 1494-1258 cal. yrs BP, respectively. The elevations of the landward margins of sandy tsunami deposits T-I, T-II, and T-IV are up to 9, 6, and 8 m, respectively. This study examines the influence of the local topography, such as beach ridge and reef system, on the runup of these ancient tsunamis based on a comparison of molluscan assemblages in the tsunami deposits T-I, T-II, and T-IV and those found in recent beach deposits. The results show that the conditions in the reef system off the study area have remained largely unchanged since the occurrence of tsunami T-IV. Beach ridge during the occurrence of tsunami T-IV did not become well developed relative to those during the occurrence of tsunami T-I and T-II. These findings suggest that the magnitude of tsunami T-II were smaller than those of tsunamis T-I and T-IV, while the magnitude of tsunami T-IV did not reach that of tsunami T-I (AD 1771 Meiwa tsunami).

Keywords: large tsunami, Ishigaki Island, late Holocene, analysis of molluscan assemblages

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)
©2015. Japan Geoscience Union. All Rights Reserved.

MIS25-03 Room:201B Time:May 24 09:30-09:45

Paleo environment changes and tsunami deposits in Susami city, Wakayama prefecture during the Holocene

CHIBA, Takashi[1*] ; GOTO, Kazuhisa[2] ; FUJINO, Shigehiro[1] ; YOKOYAMA, Yusuke[3] ; MIYAIRI, Yosuke[4] ; SAWADA, Chikako[4] ; ISHIZAWA, Takashi[5] ; NISHIMURA, Yuichi[6] ; SUGAWARA, Daisuke[2] ; GOFF, James[7]

[1]Faculty of Life and Environmental Sciences, Univ. of Tsukuba, [2]IRIDeS Tohoku Univ., [3]ACES Univ. of Tokyo, [4]AORI, Univ. of Tokyo, [5]Department of Earth Science, Graduate School of Science, Tohoku Univ., [6]Graduate School of Science, Hokkaido Univ., [7]School of Biological, Earth and Environmental Sciences, Univ. of New South Wales

Kii peninsula was attacked by many tsunamis accompanied by the previous Nankai earthquakes. There is little geological evidence supporting past tsunamis in western coast of Kii peninsula (Komatsubara et al. 2007, Fujino et al. 2008), although there are some geological evidences recognized as tsunami deposits in eastern coast. On the other hand, it is suggested that some great earthquakes brought about co-seismic uplift larger than the usual great earthquake such as Showa Nankai earthquake in southern part of Kii peninsula generated (Shishikura et al. 2008). However, information of tectonic movements by past earthquakes is limited. Therefore, we need to obtain the geological evidence of the past tsunamis and tectonic movements due to Nankai earthquakes in western part of Kii peninsula to reveal the recurrence intervals and co-seismic or inter-seismic crustal movements. Against this background, we conducted drilling survey in lowland probably be not affected directly from sea waves at Susami city, Wakayama Prefecture, central Japan and obtained about 800cm long core sample, and also analyzed fossil diatoms.

The core is composed of organic rich mud from 150cm to 300cm, organic-organic poor mud from 300cm to 680cm and gravel deposit of basement rock fragments from 680cm to 760cm depth mainly. Basement rock sedimented in Miocene is recognized below 760cm depth. Also, at least 7 sand or gravel layers are included in organic-rich muddy sediment from 150cm to 300cm depth in the core. Meanwhile, K-Ah volcanic ash (erupted in 7200 cal. BP) layer is recognized at 560cm to 630cm depth. And also we obtained accelerator mass spectrometry (AMS) radiocarbon dates covering during 2000BC-6000BC.

The diatom assemblages included in the mud deposits to 300cm from 760cm depth were dominated by marine and marine-brackish species such as Planothidium delicatulum and Cocconeis scutellu. These species decreased and freshwater diatom such as Eunotia and Pinnlaria increased gradually from lower to upper of the core. Especially, the organic rich mud above 300cm depth contained no marine species. The changes of diatom assemblages in the muddy sediments from 300cm to 760cm depth show the tendency of increase of freshwater diatoms and decrease of marine diatoms, suggesting effects of paleo-sea level changes so called Jomon transgression and its regression. These diatom assemblage changes also suggest that tidal flat was formed in this area during 3500BC-6000BC, and changed to salt marsh after that. On the other hand, the sand and gravel layers from 150cm to 300cm depth contained very small amounts of marine diatoms. It is suggests that these sand and gravel layers were transported by strong current from seaside such as tsunami during 2000BC-3500BC.

Keywords: Nankain trough, Kii peninsula, Tsunami deposit, Fossil diatom assemblage, Holocene

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)
©2015. Japan Geoscience Union. All Rights Reserved.

MIS25-04 Room:201B Time:May 24 09:45-10:00

Trench and coring survey of the tsunami deposits in the coastal area along the Wakasa Bay, Takahama, Fukui Prefecture.

YAMAMOTO, Hirofumi[1*] ; URABE, Atsushi[2] ; SASAKI, Naohiro[1] ; TAKASHIMIZU, Yasuhiro[2] ; KATAOKA, Kyoko S.[2]

[1]University of Fukui, [2]Niigata University

Some sand layers which might be formed by the tsunami event were found in the peaty deposits under the coastal lowland in Sonobe area, Takahama-cho, Fukui Prefecture. This time, we mainly investigate the shallow sand layers than 1m.

The coring and trench survey in this area shows that the sand layers are distributed more than 500m to the inland form the shore. The sand include grains of the well-rounded rock fragments and organic remains such as shell, foraminifera and spine of the sea urchin, which are a lot included in the coastal sand of this area. In addition, the sand layers eroded the peaty sediments at the base, and include the rip-up clast of them. The radiocarbon dates of the peaty sediments below and above the sand layer show that the layers deposited between the 14th and the 16th century.

These data shows that the sand layers might be formed by ancient tsunami event of 16th century recorded in the historical documents in this area.

Keywords: tsunami deposits, Wakasa Bay area, Takahama, coastal plain

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)
©2015. Japan Geoscience Union. All Rights Reserved.

MIS25-05 Room:201B Time:May 24 10:00-10:15

Event deposits discovered on the mouth area of Arakawa River, Niigata, Japan

TAKASHIMIZU, Yasuhiro[1*] ; ONO, Katsunori[1] ; URABE, Atsushi[1] ; TSURUMAKI, Shunsuke[1]

[1]Niigata University

A characteristic sandy layer probably resulting from past tsunami event was discovered on the mouth area of Arakawa River, Niigata, Japan. The event layer shows following features. The deposit is 1) distributed at least approximately 1 km from the coast; 2) shows a fining- and thinning- landward trend, 3) indicates increasingly poor sorting landward, and 4) includes mud clasts eroded from the muddy layer below the event deposits.

Keywords: Tsunami deposits

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)
©2015. Japan Geoscience Union. All Rights Reserved.

MIS25-06 Room:201B Time:May 24 10:15-10:30

Geologic evidence of tsunamis in Kujukuri

PILARCZYK, Jessica[1*] ; SAWAI, Yuki[2] ; HORTON, Benjamin[1] ; NAMEGAYA, Yuichi[2] ; SHINOZAKI, Tetsuya[2] ; TANIGAWA, Koichiro[2] ; FUJIWARA, Osamu[2] ; SHISHIKURA, Masanobu[2] ; MATSUMOTO, Dan[2] ; DURA, Tina[1]

[1]Rutgers University, [2]National Institute of Advanced Industrial Science and Technology (AIST)

Along the northern part of the Japan Trench, the subduction of the Pacific plate under the North American plate has frequently generated tsunamigenic-earthquakes up to ˜M 8.0. In contrast, the middle and southern parts of the Japan Trench were considered relatively inactive until the 2011 Tohoku-oki (M 9.0) event generated one of the largest tsunamis in recorded history. Geologic evidence from the Sendai plain revealed an event in A.D. 869 that could have forecast the severity of the Tohoku-oki tsunami in 2011. Seismic models indicate that the Tohoku-oki earthquake may have transferred stress southwards down the fault to the potentially locked southern segment of the Japan Trench (Simons et al., 2011 Nature). This scenario could produce an earthquake in the near future that would be comparable in magnitude to the Tohoku-oki event. Reconstructing the history of individual great earthquakes and accompanying tsunamis from the coastal zone adjacent to the southern trench provides an assessment of the seismic hazard for several metropolitan areas.

We have found two anomalous marine sand layers preserved in low-energy freshwater environments where they would not normally occur (i.e., present day rice paddies). The medium to coarse sand layers range in thickness from 3-10 cm, are intercalated with muddy peat, and the two upper layers can be traced 3.8 km inland and ˜5 km along the present Kujukuri coastline near Sanmu City. The sand layers have features consistent with tsunami deposits found elsewhere, such as a distinct erosional base, marine geochemical signature, offshore foraminifera, rip-up clasts, normal grading, and a mud drape. Preliminary radiocarbon dating of seeds, charcoal and insect cuticles constrain the age of the upper sand to A.D. 1613 ? 1651. Possible candidates for the upper sand are the Genroku tsunami of A.D. 1703 and the Empo tsunami of A.D. 1677. The age of the bottom sand is A.D. 971 ? 1047, an age that coincides with an 11th century gap in the historical record.

Keywords: Japan Trench, Tsunami deposit, Kujukuri

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)
©2015. Japan Geoscience Union. All Rights Reserved.

MIS25-07 Room:201B Time:May 24 10:30-10:45

Was the 2011 Tohoku tsunami once-a-millennium disaster in the Sendai Plain?

SAWAI, Yuki[1*] ; NAMEGAYA, Yuichi[1] ; TAMURA, Toru[1] ; NAKASHIMA, Rei[1] ; TANIGAWA, Koichiro[1]

[1]National Institute of Advanced Industrial Science and Technology (AIST)

Geological evidences show that recurrence intervals of outsize tsunamis along the Japan Trench may be shorter than previously thought. In the Sendai Plain, A sand layer was found in peat above a historical volcanic ash (AD 915), and is dominated by brackish-marine diatoms. Radiocarbon dating obtained from plant macrofossils permits correlation of the sand layer for the 1454 Kyotoku tsunami. The distribution of the layer shows that the run-up distance of the 1454 tsunami was at least 1 km, longer than any tsunamis that occurred during the last 200 years except for the 2011 Tohoku tsunami. Numerical simulation for tsunami inundation suggests that such an inundation distance is accounted for a rupture similar to that of the Jogan earthquake. The 1454 Kyotoku tsunami is thus considered as an unusually large tsunami comparable with the AD 869 Jogan and 2014 Tohoku tsunamis, indicating that such tsunami inundated on the Sendai Plain more often than previously thought.

Keywords: Japan Trench, Tsunami deposit, Recurrence interval

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)
©2015. Japan Geoscience Union. All Rights Reserved.

MIS25-08 Room:201B Time:May 24 11:00-11:15

Quartz optically-stimulated luminescence dating of AD 869 Jogan tsunami deposit

TAMURA, Toru[1*] ; SAWAI, Yuki[1] ; ITO, Kazumi[1]

[1]Geological Survey of Japan, AIST

Optically-stimulated luminescence (OSL) dating, as applicable to the sediment grain directly, has a potential to provide an effective way to establish the chronology of tsunami deposits. AD 869 Jogan tsunami is one of the oldest tsunamis recorded in a historical document in Japan. Deposit of the Jogan tsunami thus offers an opportunity to check the reliability of OSL dating to a deposit older than 1,000 years, which may be prehistoric elsewhere. We applied the quartz OSL dating to a sand layer formed by the Jogan tsunami found in a geoslice sample obtained from the Sendai plain, Japan, to compare resultant OSL ages with the depositional age. The sediment succession consists of beach-dune sand, lower peat, the Jogan tsunami deposit, upper peat, pre-2011 paddy soil, and the 2011 tsunami deposit, in ascending order. A standard Single Aliquot Regenerative (SAR) protocol was applied to large aliquots of 180-250 μm fraction of two samples from the beach-dune sand, and four samples from differing levels of the Jogan tsunami deposit to obtain equivalent dose ($D_{e,bulk}$). OSL decay curves are dominated by the medium component, and thus for two samples from the Jogan deposit the fast OSL component was isolated to be used for determining the equivalent dose ($D_{e,fast}$). All samples show unimodal distribution of De,bulk with relatively low overdispersion 11-22 %, suggesting that sediment grains were well bleached before burial. Using $D_{e,bulk}$, OSL ages of the tsunami deposit was underestimated by 30-40 %, and even the beach-dune sand was dated younger than AD 869. $D_{e,fast}$ in contrast resulted in a robust age estimate with a slight underestimation. Pulsed annealing test shows that the bulk OSL signal is thermally unstable. The medium component OSL, isolated from the bulk signal, is clearly truncated in the natural OSL decay curve compared to regenerated ones, which is considered as the main source of the underestimation. Such unfavourable influence of the medium OSL component has been commonly reported in tectonically active regions, which are also prone to tsunami, and thus should be considered with caution in dating tsunami deposits.

Keywords: tsunami, luminescence dating, Jogan earthquake, tsunami deposit, Sendai Plain, chronology

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)
©2015. Japan Geoscience Union. All Rights Reserved.

MIS25-09 Room:201B Time:May 24 11:15-11:30

Highly precise radiocarbon dating of tsunami deposits

MIYAIRI, Yosuke[1*] ; YOKOYAMA, Yusuke[1] ; SAWADA, Chikako[1] ; ISHIZAWA, Takashi[2] ; NISHIMURA, Yuichi[3] ; SUGAWARA, Daisuke[4] ; KAWAMATA, Takahisa[5] ; GOTO, Kazuhisa[4]

[1]Atmosphere and Ocean Research Institute,The University of Tokyo, [2]Department of EARTH SCIENCE, Graduate School of Science, Tohoku University, [3]Graduate School of Science, Hokkaido University, [4]International Research Institute of Disaster Science, Tohoku University, [5]Board of Education, Iwanuma City

Highly precise dating of tsunami deposit will be a useful tool for elucidation the frequencies of occurrence of the paleotsunami. Radiocarbon dating is used as dating tool of tsunami deposit. However, conventional radiocarbon dating does not have the enough precision to distinguish historical tsunami deposits.We have developed a highly precise radiocarbon dating method using a high-density sampling method.We will present about a high precision radiocarbon dating method of tsunami deposit using data from Iwanuma investigation site.

Keywords: radiocarbon dating, tsunami deposit, peat, wiggle matching, 14C, AMS

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)
©2015. Japan Geoscience Union. All Rights Reserved.

MIS25-10 Room:201B Time:May 24 11:30-11:45

Spatial variation of sediment observed by reflecting surface and columnar core at Hirota bay

YOKOYAMA, Yuka[1*] ; SAKAMOTO, Izumi[1] ; YAGI, Masatoshi[1] ; INOUE, Tomohito[1] ; IIJIMA, Satsuki[1] ; NEMOTO, Kenji[1] ; FUJIMAKI, Mikio[2]

[1]School of marine science and technology, Tokai University, [2]COR

The study of onshore features for tsunami impact is well researched, but offshore is only a few researches. In this presentation, we will show about characteristic of tsunami deposit left by 2011Tohoku earthquake and spatial change of sediment in Hirota bay using by Sub Bottom Profiler (SBP) and Vibration Core Sampler (VCS).

We took the columnar core at water depth from 8 to 30 m. The columnar cores were able to sectionalize into mainly two units by lithofacies, Unit-1(sand layer) and Unit-2(muddy layer) from the top. And, we sectionalize U2 into six more subunits, called U2-I to U2-Ⅵ from the top.

Therefore, layer of U2 is U2-I: sandy silt with shell piece, U2-Ⅱ: silt with bioturbtaion, U2-Ⅲ: sandy silt with wood chip, U2-Ⅳ: sandy silt with sand at the base, U2-Ⅴ: silty sand with granule and very coarse sand at the base and U2-Ⅵ: silt layer. Sagayama et al. (2014) assume that U2-I have a possibility of paleo event unit by diatom analysis.

SBP data were able to sectionalize to some reflection surfaces (R1-R7). R1 and R6 distribute widely, but other reflection surfaces clear away toward offshore.

We estimate distribute of each unit using by comparison of lithofacies and reflection surface. Reflection surface accord with sedimentary units. Then, U1 distribute widely and number of U2 combination were decrease toward offshore from coastal area.

These data shows paleo event sediment mechanism and it also show spatial changes of sub bottom environment.

Keywords: Tsunami deposit, Sanriku coast

Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)
©2015. Japan Geoscience Union. All Rights Reserved.

MIS25-11 Room:201B Time:May 24 11:45-12:00

Hydraulic experiment and numerical modeling on tsunami deposit aiming tsunami source estimation

TAKAHASHI, Tomoyuki[1*]

[1]Faculty of Safety Science, Kansai University

Tsunamis generate large amounts of bed load and suspended load because of strong tractive force and turbulence in shallow seas. The sediment transport due to tsunamis have caused various damages such as collapsing coastal structures, shoaling navigation channels in ports and blocking water intakes in power plants. A risk assessment of the sediment transport is important for tsunami disaster mitigation, and a numerical model to analyze the phenomena has been required. Many hydraulic experiments and field investigations on the sediment transport and the bathymetry change caused by tsunamis have been carried out, and the measured data have contributed to constructing the numerical model. However, because such damages occur in the water, almost all of the researches on the tsunami sediment transport have assumed an inundated condition. They focused on the sediment transport and the bathymetry change when tsunamis arrive in the shallow seas. On the other hand, the sediment transport can make tsunami deposit on land, lakes and marshes. Some analysis of the tsunami deposit have obtained invaluable knowledge of historical and paleo-tsunamis. Therefore, the hydraulic experiments on the tsunami sediment transport on land are also carried out and the numerical model is attempted to extend to tsunami run-ups recently.

The present numerical model can cover tsunami source, propagation and sediment transport in the sea. The model can predict bathymetry changes due to tsunamis in coastal areas if fault models of earthquakes are given. A small fishing port, for example, has complicated coastal structures like breakwaters, and generates numerical instability easily. However, the practical and detailed simulation on tsunami sediment transport using a two meters grid was conducted stably. Therefore, if the numerical model is upgraded to simulate the sediment transport and the tsunami deposit by tsunami run-up, the model is expected to enable to analyze tsunami sources using the tsunami deposit distribution on land, lakes and marshes.

Based on the background described above, the hydraulic experiments and the numerical modeling on sediment transport under the inundated condition are explained firstly. Besides, the hydraulic experiments on land aiming to extend the numerical model to tsunami run-up are introduced. From simulation on the tsunami sediment transport in actual sea areas, present state and issues of the numerical model are organized. Finally, a method to estimate tsunami sources using tsunami deposit distribution is investigated.

Keywords: tsunami run-up, sediment transport, bed load, suspended load, topography change, inverse analysis