[E] Poster | S (Solid Earth Sciences ) | S-CG Complex & General

# [S-CG52] Inter-segment Tectonics: Interdisciplinary Research on Responses to Plate Subduction

convener:Kimihiro Mochizuki(Earthquake Prediction Research Center, Earthquake Research Institute, University of Tokyo), Claudia Maria Adam(Kansas State University), Dan Bassett(GNS Science), Ryosuke Ando(Graduate School of Science, University of Tokyo)

Sun. May 25, 2025 5:15 PM - 7:15 PM Poster Hall (Exhibition Hall 7&8, Makuhari Messe)

During the 2011 Tohoku Earthquake off the Pacific coast, multiple earthquake fault segments along the Japan Trench triggered a massive M9 earthquake. Similar cases, where multiple segments of a subduction zone interact to cause a large earthquake, are known in many subduction zones worldwide. When observing the distribution of volcanic alignments and topography from offshore to onshore regions, in addition to earthquake fault segments in subduction zones, a notable correlation can be identified. This suggests that the responses to plate subduction, ranging across time scales from earthquake cycles to the formation of topography, may be understood in a unified manner as part of the subduction system. Achieving this unified understanding requires interdisciplinary approaches, covering areas such as seismology, volcanology, geomorphology, and geology. This session focuses on the correlation between earthquake fault segments, volcanic alignments, and topography from offshore to onshore regions along subduction zones. We welcome presentations on research that explores the factors responsible for the formation of these correlated segments and the interactions between segments.

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[SCG52-P01] **Monitoring of plate coupling along the Nankai Trough using seafloor observation networks: A case of the 2024 Hyuga-nada Earthquake**

*Keisuke Ariyoshi[1], Eiichiro Araki[1], Hiroyuki Matsumoto[1], Yuya Machida[1], Shuhei Tsuji[1], Takashi Yokobiki[1], Shuhei Nishida[1], Shuichiro Yada[1], Takeshi Iinuma[1], Kan Aoike[1], Yasuyuki Nakamura[1], Gou Fujie[1], Takane Hori[1], Nobu Eguchi[1], Shuichi Kodaira[1] (1.Japan Agency for Marine-Earth Science and Technology)

5:15 PM - 7:15 PM

[SCG52-P02] Geodetically estimated Nankai asperities below oceanic basins bordered with slow earthquakes

*Daisuke Sato[1], Takane Hori[1], Yukitoshi Fukahata[2] (1.Japan Agency for Marine-Earth Science and Technology, 2.Disaster Prevention Research Institute, Kyoto University)

5:15 PM - 7:15 PM

[SCG52-P03] Pore pressure estimation in Nankai Trough using full waveform inversion of ocean-bottom seismometer data

*Paul Caesar Mason Flores[1,2], Shuichi Kodaira[1], Kazuya Shiraishi[1], Gou Fujie[1], Ryuta Arai[1], Yasuyuki Nakamura[1] (1.Japan Agency for Marine-Earth Science and Technology, 2.Yokohama National University)

5:15 PM - 7:15 PM

[SCG52-P04] Three-dimensional resistivity structure beneath the Chugoku and Shikoku districts in Southwestern Japan using Network-Magnetotelluric method

*Yujie SHI[1], Makoto Uyeshima[1], Hideki Murakami[2], Ichiro Shiozaki[3], Satoru Yamaguchi[4], Yoshiya Usui[1] (1.Earthquake Research Institute, The University of Tokyo, 2.Kochi University, 3.Tottori University, 4.Osaka City University)

5:15 PM - 7:15 PM

[SCG52-P05] Comparison of Resistivity Heterogeneity in Subduction Zones to Clarify the Formation Mechanism of Island Arc Volcanoes

*Maki Hata[1], Grant Caldwell[2], Makoto Uyeshima[3], Alex Caldwell[2], Yasuo Ogawa[4], Ted Bertrand[2], Stewart Bennie [2], Wiebke Heise[2], Ryokei Yoshimura[1] （1.Disaster Prevention Research Institute, Kyoto University, 2.GNS Science, 3.ERI, the University of Tokyo, 4.Tokyo Institute of Technology）

5:15 PM - 7:15 PM

[SCG52-P06] **Monitoring the electrical features of the overlying plate in the Northern Hikurangi subduction zone, New Zealand, using ocean bottom electromagnetometers**

*Kiyoshi Baba[1], Makoto Uyeshima[1], Feng Jiang[1,2], Grant Caldwell[3], Yuki Obana[4], Kimihiro Mochizuki[1] （1.Earthquake Research Institute, The University of Tokyo, 2.South China Sea Institute of Oceanology, CAS, 3.GNS Science, 4.International Research Center for Space and Planetary Environmental Science, Kyushu University）

5:15 PM - 7:15 PM

[SCG52-P07] **Classification of the April 3$^{rd}$, 2024 $M_w$ 7.4 Hualien, Taiwan, Aftershock Sequence Using Waveform Cross-Correlation**

*Hsuan-Ching Hung[1], Kuo-Fong Ma[2] （1.Natl. Taiwan Univ., Taipei, Taiwan, 2.Inst. Earth Sci., Acad. Sinica, Taipei, Taiwan）

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[SCG52-P08] Sesimic Velocity Structure Beneath Sulawesi Island, Indonesia

*Ahmad Mustafid Miftahul Huda[1,2,3,4], Hsin-Hua Huang[2,3], Yih-Min Wu[2,3], Dimas Salomo J. Sianipar[5,6], Emi Ulfiana[6,7,8] （1.Taiwan International Graduate Program (TIGP) – Earth System Science Program (ESS), Academia Sinica and National Taiwan University (NTU), Academia Sinica, Taipei 11529, Taiwan, 2.Department of Geoscience, National Taiwan University, 3.Institute of Earth Science (IES), Academia Sinica, 4.Sekolah Tinggi Teknologi Migas Balikpapan (STT MIGAS), Indonesia, 5.State College of Meteorology, Climatology, and Geophysics (STMKG), Indonesia, 6.Indonesian Agency for Meteorological, Climatological and Geophysics (BMKG), 7.Taiwan International Graduate Program (TIGP) – Earth System Science Program (ESS), Academia Sinica and National Central University (NCU), Academia Sinica, Taipei 11529, Taiwan, 8.Department of Earth Sciences, National Central University）

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# Monitoring of plate coupling along the Nankai Trough using seafloor observation networks: A case of the 2024 Hyuga-nada Earthquake

*Keisuke Ariyoshi[1], Eiichiro Araki[1], Hiroyuki Matsumoto[1], Yuya Machida[1], Shuhei Tsuji[1], Takashi Yokobiki[1], Shuhei Nishida[1], Shuichiro Yada[1], Takeshi Iinuma[1], Kan Aoike[1], Yasuyuki Nakamura[1], Gou Fujie[1], Takane Hori[1], Nobu Eguchi[1], Shuichi Kodaira[1]

1. Japan Agency for Marine-Earth Science and Technology

The Nankai Trough, which is thought to be a region where a large subduction earthquake will occur in the near future, is thought to be made up of four segments: the Tokai, Tonankai, Nankai and Hyuga-nada segments. According to records of historical earthquakes, in some cases, such as the 1707 Hōei earthquake, all segments are destroyed at once, while in others, such as the 1854 Ansei earthquake, the Tonankai segment is destroyed first, followed by the Nankai segment about 30 hours later, or, as in the case of the 1944 Showa Tonankai earthquake and the 1946 Showa Nankai earthquake, there is a time difference of about two years. For this reason, real-time monitoring of the stress field at the segment boundary is expected to provide very important information for objectively evaluating the possibility of a multiple event with time delay triggered by partial rupturing.
Recently, the Nankai Trough Earthquake Extra Information was issued on the occasion of the Hyuga-nada Earthquake on August 8, 2024 (Mw 7.1, thrust-type at low angle along dip direction) which satisfies interplate earthquake and JMA magnitude greater than 7 as partial rupturing. From January in 2024, the Japan Agency for Marine-Earth Science and Technology (JAMSTEC) has operated Long-Term Borehole Monitoring System (LTBMS) beneath the seafloor off Kii channels. This is a new version from the LTBMS off Kumano-nada installed above the source region of the 1944 Tonankai earthquake. These LTBMS are connected to the Dense Oceanfloor Network system for Earthquakes and Tsunamis (DONET), which enables to monitor the seafloor crustal deformation in real time. Just after the occurrence of the Hyuga-nada Earthquake, JAMSTEC investigated the possibility of the significant seafloor crustal deformation and seismic activity by monitoring the data of pore pressure in LTBMS and broadband seismogram in DONET.
As a result, no significant volumetric strain changes attributable to seafloor crustal deformation were observed in the Kii channel, which shows that the Hyuga-nada Earthquake did not have a significant effect on the Nankai segment. On the other hand, in the Kumano-nada, we confirmed that contraction began on the downdip region from around the end of July, and that it turned to dilation from around August 5, ending around the middle of the month. Although the change in pore pressure was caused by shallow SSE in the Kumano-nada, it occurred before the Hyuga-nada Earthquake, and the rate of change did not change before or after the Hyuga-nada Earthquake. These results suggest that there was no direct relationship between the SSE and the Hyuga-nada Earthquake.
In conclusion, we believe that a proper understanding of the process of inter-segment tectonics and being able to monitor it in real time is essential for grasping the risk of occurrence of megathrust earthquakes in advance, including the Nankai Trough Earthquake Extra Information.

Keywords: Long-Term Borehole Monitoring System, DONET, Nankai Trough Earthquake Extra Information

# Geodetically estimated Nankai asperities below oceanic basins bordered with slow earthquakes

*Daisuke Sato[1], Takane Hori[1], Yukitoshi Fukahata[2]

1. Japan Agency for Marine-Earth Science and Technology, 2. Disaster Prevention Research Institute, Kyoto University

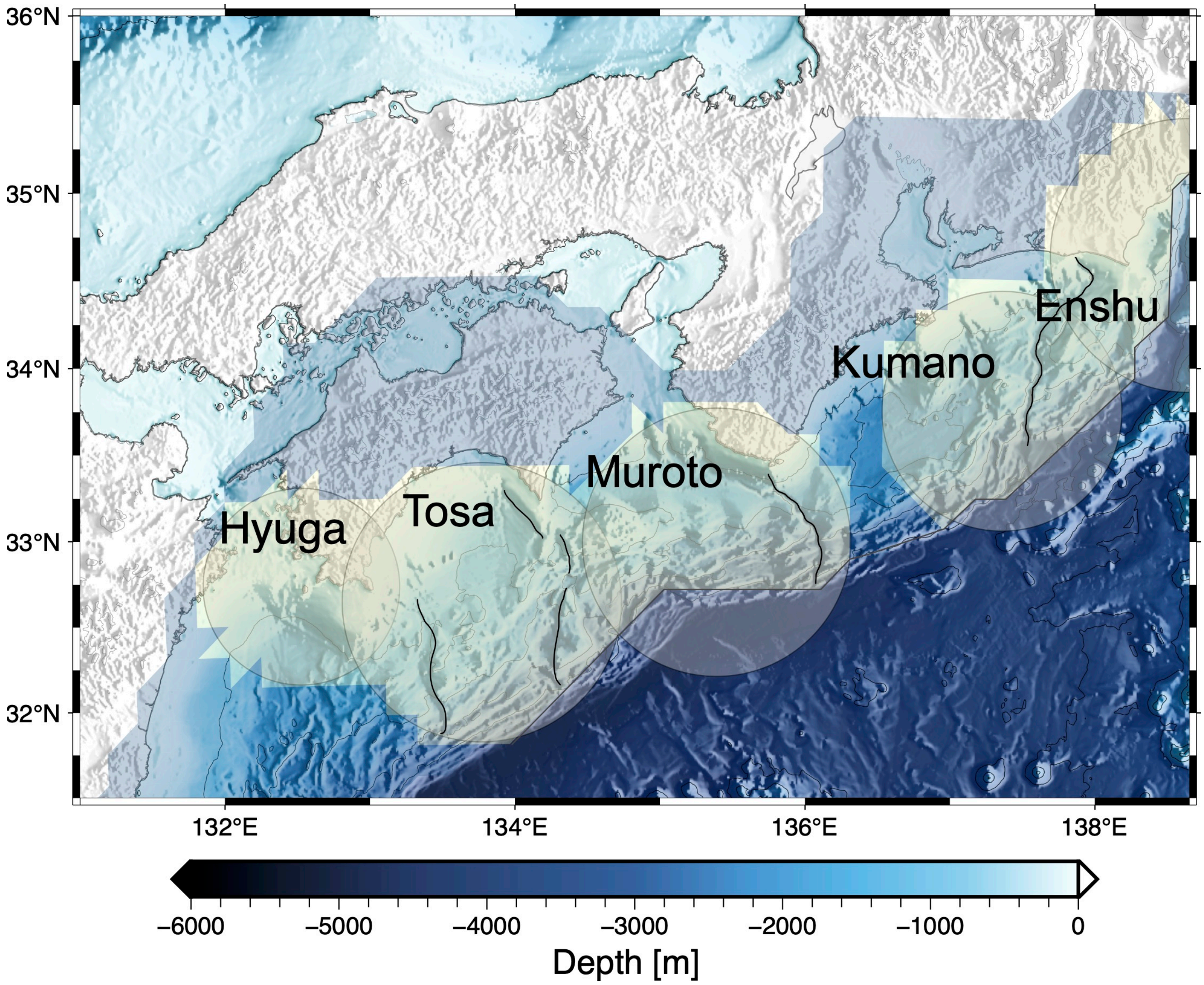
A locked zone of a plate boundary fault refers to the interseismically stationary area that eventually incurs frictional failure: an earthquake. The locked zone can be detected from interseismic slip deficit recorded by geodetic data (Savage, 1983). Therefore, the slip deficit normalized by the plate convergence rate, termed plate coupling (Kanamori, 1971), is a proxy of seismic potential (Scholz & Campos, 2012). However, the plate coupling must not be mistaken as the plate locking (Wang and Dixon, 2004). The problem is that the locked zone segment, or an asperity, creates a stress shadow around it, slowing the surrounding creeping zone to fill the stress shadow (Heman et al., 2018; Lindsey et al., 2021). A coupled zone is, in short, an overestimate of a locked zone. Thus, we have developed a method to estimate the locked zone segments, called asperities in fault mechancis, in its original sense of friction (Sato, Hori, & Fukahata, under review; arXiv:2409.14266), where locking (pre-yield) means a stationary phase of zero slip rate while unlocking (post-yield) is interseismically synonymous with a quasi-static phase of zero stressing rate. This presentation reports our preliminary results on the spatial distribution of the locked zone in the Nankai subduction zone and its correlation with seafloor topography and seismic activities.

Our inversion analysis of onshore Global Navigation Satellite System (GNSS) and offshore GNSS-acoustic data by Yokota et al. (2016) has detected five primary asperities (Figure attached). Interestingly, the estimated five asperities are consistent with offshore basins, including those discussed by M. Ando (1975). The asperities correlate with five basins: from the west, Hyuga, Tosa, Muroto, Kumano, and Enshu, the envisioned rupture segments of the Nankai megathrust earthquake (e.g., Hirose et al., 2022). It is intriguing that the “asperity” in fault mechanics, not directly related to the fault surface roughness unlike the original meaning in frictional physics, correlates with seafloor topography, the actual surface roughness, but of the earth.

The estimated asperities constitute the belts of locked zones with a locking gap separating western and eastern segments. The location of the locking gap, the east of the Cape Shionomisaki, is highly consistent with the slip patterns of the 1944 Tonankai and the 1946 Nankai earthquakes estimated by Kikuchi et al. (2003) and Murotani et al. (2015). The rupture initiation point of the 1944 Tonankai earthquake is in the locking gap, and the inverted rupture zone intrudes into the estimated eastern locked segment. The rupture initiation point of the 1946 Nankai earthquake is exactly at the edge of the estimated western locked segment, which includes the slip zone of the 1946 Nankai earthquake. It is physically natural that the earthquake nucleates at the stress concentration zone (Kodaira et al., 2006; Chen & Lapusta, 2009), and we were able to extract the associated interseismic behaviors from the surface deformation. Although rupture initiation points are unclear on or before 1854, the Cape Shionomisaki has been a segmentation boundary of the eastern and western segments, which have hosted megathrust earthquakes separately (Ishibashi, 2004). These facts consistently imply that the locking gap observed from the current geodetic data has been preserved for a geological time scale.

Documented deep low-frequency tremors are all outside the locked zone estimate. The estimated locked zones coincide with the previous focal zones of the same basins (Obara & Kato, 2016) in all basins but the Hyuga. Except for the Hyuga asperity, our results suggest that the seismogenic zones of slow earthquakes are unlocked in long-wavelength and long-time scales. The Hyuga locked zone includes the slip zones of the 1968 Hyuga-nada earthquake (Yagi et al., 1999) and the Bungo-Channel long-term SSEs (Obara & Kato, 2016). Moreover, this zone is supposed to have experienced the fault slip during the 1707 Hoei earthquake (Furumura et al., 2011). These behaviors of the Hyuga (Bungo-Channel) locked zone are highly complex, but here is one simple, consistent interpretation of these behaviors. Namely, the Hyuga locked zone is exceptionally the nucleation zone that often fails to slip faster, as in the Bungo-Channel slow-slip events, but sometimes succeeds, as supposedly in 1707.

Keywords: Asperities, Seafloor topography, Nankai subduction zone, Geodetic data inversion



# Pore pressure estimation in Nankai Trough using full waveform inversion of ocean-bottom seismometer data

*Paul Caesar Mason Flores[1,2], Shuichi Kodaira[1], Kazuya Shiraishi[1], Gou Fujie[1], Ryuta Arai[1], Yasuyuki Nakamura[1]

1. Japan Agency for Marine-Earth Science and Technology, 2. Yokohama National University

Pore pressure is an important factor that controls the strength and sliding stability of faults. Elevated pore pressure has been invoked to explain the occurrence of slow earthquakes and shallow earthquake rupture during megathrust events. In the Nankai Trough offshore Muroto, elevated pore pressures have already been reported by previous studies based on taper angle, P- and S-wave velocities, and drilling. However, the extent of the high pore pressure zone is not yet clearly defined. This study utilized a high-resolution seismic velocity model derived by full waveform inversion (FWI) of wide-angle ocean-bottom seismograph (OBS) data to determine the pore pressure ratio ($\lambda^*$) in the underthrusted sediments of Nankai Trough. The $\lambda^*$ was calculated using empirical relationships between P-wave velocity, porosity, and effective mean stress. We observed an extensive zone of high $\lambda^*$ (0.5 –0.8) from the frontal thrust up to ˜65 km landward and up to a depth of ˜10 km. Within this high $\lambda^*$ zone in the outer wedge, a patchy distribution of overpressured aquifers ($\lambda^* > 0.6$) can also be observed which is consistent with previous drilling studies. Comparison with seismic reflection images also show that the high $\lambda^*$ zone in the inner wedge coincides well with a region of strong reflections. This region is interpreted to be comprised of trench fill sediments that were underplated due to seamount subduction. The high $\lambda^*$ (>0.6) in the underplated sediments is interpreted to be caused by tectonic compression from younger subducted seamounts.

Keywords: seamount subduction, sediment underplating, pore pressure, full wave inversion

# Three-dimensional resistivity structure beneath the Chugoku and Shikoku districts in Southwestern Japan using Network-Magnetotelluric method

*Yujie SHI[1], Makoto Uyeshima[1], Hideki Murakami[2], Ichiro Shiozaki[3], Satoru Yamaguchi[4], Yoshiya Usui[1]

1. Earthquake Research Institute, The University of Tokyo, 2. Kochi University, 3. Tottori University, 4. Osaka City University

Two oceanic plates are subducting in the Japan Islands. In the Chugoku and Shikoku districts in Southwestern Japan, Philippine Sea plate is subducting from the south-east to the north-west. This subduction causes various types of tectonic activities in the districts. Among them, the Low-Frequency Earthquakes (LFEs) in the forearc side and the intense crustal activities such as existence of linear seismically active zone with high- temperature hot springs in the back-arc side are interesting targets of investigation in geophysics. Subsurface fluid is thought to be one of the key factors causing these activities.
Electrical resistivity (hereafter expressed just as resistivity) is a physical parameter, which is especially sensitive to existence of interstitial fluids. In the Chugoku and Shikoku districts, previous studies have revealed two-dimensional (2-D) resistivity structures. However, bathymetry distribution in these districts is very complex and purely three-dimensional (3-D). Considering highly conductive sea water, 2-D interpretation may lead some fake structure. In order to mitigate this problem, this study focuses on the 3-D interpretation.
This study uses Network-Magnetotelluric (Network-MT) data acquired from 1994 to 1996, a period during which long baseline metallic telephone cables were available. In the Network-MT method, we use metallic telephone line network to measure potential differences between long distant points. Owing to the long electrode spacings, Network-MT data are relatively free from the static shift and the method enables us to cover a target area with less efforts compared with the conventional MT method.
The regional resistivity structure was obtained through a series of steps. First, the data with low artificial noise were carefully selected. Then, we were processed using the robust BIRRP code to estimate the Network-MT response function between each voltage difference and the horizontal components of the magnetic field in the frequency domain. Finally, the FEMTIC inversion code was applied to these response functions to obtain a 3-D resistivity structure.
The final 3-D resistivity model revealed three main features in these districts. First, the subducting Philippine Sea Plate is identified as a high-resistivity body. Second, a low-resistivity body is detected in the back-arc region, providing evidence of fluid upwelling in the mantle wedge and potentially contributing to intense crustal activities. Finally, a low-resistivity body in the fore-arc is associated with activities of LFEs, but more detailed discussion on relationship between location and intensity of the low-resistivity body and LFE activities will be necessary.

Keywords: Three-dimensional electrical resistivity structure, Southwestern Japan, Network-MT, Magnetotelluric method

# Comparison of Resistivity Heterogeneity in Subduction Zones to Clarify the Formation Mechanism of Island Arc Volcanoes

*Maki Hata[1], Grant Caldwell[2], Makoto Uyeshima[3], Alex Caldwell[2], Yasuo Ogawa[4], Ted Bertrand[2], Stewart Bennie [2], Wiebke Heise[2], Ryokei Yoshimura[1]

1. Disaster Prevention Research Institute, Kyoto University, 2. GNS Science, 3. ERI, the University of Tokyo, 4. Tokyo Institute of Technology

In subduction zones, the movement and distribution of fluids brought into the Earth's interior by the subducting oceanic plate (slab) are crucial in driving igneous/volcanic activity and seismic events. As these fluids reach specific temperature-pressure conditions during the subducting process, they are released from the oceanic plate through a dehydration reaction. The released fluids in the mantle lead to partial melting of the mantle, resulting in the formation of magma sources for island arc volcanoes. This process establishes volcanic chains/regions (on island arcs) that align with the depth contour lines of the subducting plate. On the other hand, some island arcs, such as the island of Kyushu in Japan and the North Island of New Zealand (NZ), exhibit non-volcanic regions devoid of active Quaternary volcanoes for approximately 100 kilometers. It is not entirely understood why volcanic and non-volcanic regions form or why volcanic chains are discontinuous in a single-island arc despite being under the same tectonic conditions. Thus, a key objective of our research is to obtain and compare subsurface heterogeneity information in different island arcs using the electromagnetic method to aid in understanding the mechanism behind the formation of island-arc volcanoes.
Besides, due to the subduction of the oceanic plates, various types of earthquakes have repeatedly occurred in and around the island of Kyushu and the North Island of NZ, respectively, such as large thrust earthquakes in respective offshore and historic earthquakes along the tectonic lines in the land area. We have imaged three-dimensional (3-D) electrical resistivity structures by inverting magnetotelluric (MT) data, which were acquired on the whole of Kyushu by various surveys, to reveal the fluid/magma distribution beneath Kyushu [e.g., Hata et al., 2015; 2017; 2020]. The 3-D resistivity models indicate magma and fluid systems relating to slab-derived fluid as significant electrical resistivity features/anomalies. In addition, we conducted long-period MT surveys in a 300 km x 150 km square area, including the southernmost part of the Taupo volcanic zone (TVZ) and a non-volcanic region on the North Island of NZ in the Hikurangi subduction zone, during the period from July 2023 to January 2024. The primary purpose of the surveys is to extract subsurface heterogeneity information, which covers the depths of the crust and mantle in the transition area between the TVZ and the non-volcanic region, as a 3-D electrical resistivity model. In this presentation, we especially introduce a detailed discussion of the subsurface heterogeneity beneath the transition area between the volcanic and non-volcanic regions of the two island arcs, inferred from the 3-D resistivity distribution.

Keywords: Magma and fluid systems, Island arc volcanoes, Subduction zones, Transition areas between the volcanic and non-volcanic regions, Electrical resistivity structure models, Magnetotelluric method

# Monitoring the electrical features of the overlying plate in the Northern Hikurangi subduction zone, New Zealand, using ocean bottom electromagnetometers

*Kiyoshi Baba[1], Makoto Uyeshima[1], Feng Jiang[1,2], Grant Caldwell[3], Yuki Obana[4], Kimihiro Mochizuki[1]

1. Earthquake Research Institute, The University of Tokyo, 2. South China Sea Institute of Oceanology, CAS, 3. GNS Science, 4. International Research Center for Space and Planetary Environmental Science, Kyushu University

The Hikurangi subduction zone off the North Island of New Zealand offers significant opportunities for observing various types of fault slips along the plate interface. There is a prominent fault segment boundary in the central part of the Hikurangi subduction zone, which shows a sharp contrast in interplate locking strength, coinciding with the direction of plate convergence. In the north of the segment boundary, slow slip events occur with a relatively constant interval of approximately two years. The seismicity associated with these events has been determined at a depth of approximately 10 km below the seafloor of the overlying plate, which is relatively shallow compared to other subduction systems in which the occurrence of slow slip events has been recognized. These features benefit the monitoring of the events and studying their mechanism by seafloor geophysical observations because the closeness to the event source would provide more accurate observations and the repeatable nature would facilitate hypothesis testing. Therefore, for more than a decade, an international collaborative project between marine geophysical groups in Japan and New Zealand has been conducting continuous observations using ocean bottom seismometers and ocean bottom pressure gauges in this area. We initiated electromagnetic (EM) observations using ocean bottom electromagnetometers (OBEMs), joining this project.

A leading hypothesis for the cause of slow slip events is the migration of fluids in the crust. EM exploration is an alternative method for imaging the distribution of fluid in the crust, independently of other geophysical surveys such as seismological observations. Because fluids are much more conductive than the crust forming rocks, the high conductivity zone imaged in the crust can be interpreted to the zone with high porosity filled with fluid. Chesley et al. (2021) demonstrated a two-dimensional electrical conductivity structure model across the northern Hikurangi Trough obtained by joint analysis of magnetotelluric (MT) and controlled-source EM (CSEM) data. They argued that a high conductivity anomaly over a bulged plate boundary, which is coincident with the location of burst-type repeating earthquakes and seismicity associated with a recent slow slip event, can be interpreted as a fluid-rich damage zone formed by modulating the fluid overpressure associated with the subducting seamount. However, the electrical conductivity structure model is only a snapshot and therefore it cannot give information of temporal variation of fluid overpressure.

In this study, we aimed to determine the temporal variation of electrical conductivity by a long-term continuous EM observation. A sensitivity study by forward modeling showed that the MT responses significantly change in the periods between 10 and 1000 s if the conductivity value (~0.5 S/m) of the fluid rich zone imaged by Chesley et al. (2021) changes 1.8 times more conductive or 1.8 times more resistive, which corresponding to 40% and 20% in porosity, respectively. We focused on this conductive anomaly. Our strategy is to monitor the MT responses over the conductive anomaly for several years, which covers slow slip events in the future by iterating a one-year deployment of OBEMs. To achieve one-year observation, we improved the existing OBEMs so as to mount more batteries and to introduce a sampling mode in which the electric filed measurements can continue with high sampling rate (8Hz) but the

magnetic field measurement, which consumes power, is conducted intermittently (every 10 minutes). In October 2023, we deployed three OBEMs along the survey line of Chesley et al. (2021) where one site was just over the conductivity anomaly and the other two sites located approximately 5 km northwest and 17 km southeast of the first site. These OBEMs were successfully recovered in October 2024 and deployed at the same sites again. In addition, we built a land magnetic station in Waitārere, the west coast of the Northern Island, in September 2024. The magnetometer is driven by a commercial power supply, and the data can be retrieved in real time via internet. The land magnetic data can be used to complement the low sampling rate of the magnetic field measurement by the OBEM.
We check the repeatability and temporal variation of the MT responses by comparing them with the responses reported by Chesley et al. (2021). A brief summary of the preliminary analysis of the OBEM data retrieved in 2024 will be demonstrated in the presentation.
In December 2024, a large slow slip event occurred in the study area. We anticipate that the OBEMs on the seafloor recorded signals associated with the event.

Keywords: Hikurangi subduction zone, Marine electromagnetic survey, Electrical conductivity, Monitoring, Slow slip events

# Classification of the April 3rd, 2024 $M_w$ 7.4 Hualien, Taiwan, Aftershock Sequence Using Waveform Cross-Correlation

*Hsuan-Ching Hung[1], Kuo-Fong Ma[2]

1. Natl. Taiwan Univ., Taipei, Taiwan, 2. Inst. Earth Sci., Acad. Sinica, Taipei, Taiwan

A destructive $M_w$ 7.4 earthquake struck Hualien, Taiwan, on April 3, 2024, followed by hundreds of felt aftershocks. Understanding the fault geometry of this sequence is crucial for comprehending its seismogenic structure and enhancing future preparedness. In addition to the common Centroid Moment Tensor (CMT) solution for the aftershocks, we utilized the cross-correlation of seismic waveforms to classify the characteristics of the aftershocks sequence.
We firstly analyze M >4 aftershocks that occurred within one week after the mainshock (April 3–10, 2024) from Central Weather Administration (CWA) of Taiwan. Waveform data were collected from all 41 stations of the Broadband Array in Taiwan for Seismology (BATS). We define an earthquake pair as two events separated by a distance of less than 3 km. This threshold is chosen not only to ensure proximity of the sources but also to maintain similar Green’s functions, allowing for more reliable cross-correlation analysis. We considered the time window spanning 1 second before to 5 seconds after the estimated P-wave arrival, applying a 1–8 Hz bandpass filter. For event classification, we compute cross-correlation coefficients for each earthquake pair using waveforms recorded across all channels of the BATS stations. This analysis aims to categorize aftershocks based on their waveform similarities, providing insight into their characteristics, and helping to map the major seismogenic structures through their spatial distribution.
By examing aftershocks patterns and the seismogenic structures in which they occurred, we seek to gain a deeper understanding of the faulting processes involved in the 2024 Hualien earthquake sequence. Additionally, this study explores the possible complexity of the offshore seismogenic structure associated with Ryukyu subduction zone.

Keywords: 2024 Hualien earthquake, Aftershock classification, Cross-correlation, Fault geometry, Faulting complexity, Offshore seismogenic structure

# Sesimic Velocity Structure Beneath Sulawesi Island, Indonesia

*Ahmad Mustafid Miftahul Huda[1,2,3,4], Hsin-Hua Huang[2,3], Yih-Min Wu[2,3], Dimas Salomo J. Sianipar[5,6], Emi Ulfiana[6,7,8]

1. Taiwan International Graduate Program (TIGP) –Earth System Science Program (ESS), Academia Sinica and National Taiwan University (NTU), Academia Sinica, Taipei 11529, Taiwan, 2. Department of Geoscience, National Taiwan University, 3. Institute of Earth Science (IES), Academia Sinica, 4. Sekolah Tinggi Teknologi Migas Balikpapan (STT MIGAS), Indonesia, 5. State College of Meteorology, Climatology, and Geophysics (STMKG), Indonesia, 6. Indonesian Agency for Meteorological, Climatological and Geophysics (BMKG), 7. Taiwan International Graduate Program (TIGP) –Earth System Science Program (ESS), Academia Sinica and National Central University (NCU), Academia Sinica, Taipei 11529, Taiwan, 8. Department of Earth Sciences, National Central University

Indonesia's Meteorology, Climatology, and Geophysical Agency (BMKG) has significantly expanded its seismic monitoring network, tripling the number of stations. This improvement allows for higher-resolution studies of Sulawesi’s tectonic structure, which is shaped by the interactions of the Philippine Sea Plate, the Eurasian Plate, and the Indo-Australian Plate. Sulawesi’s complex tectonic environment has led to major earthquakes, including the devastating 2018 event that triggered a tsunami and widespread liquefaction, emphasizing the need for better seismic models. Previous studies have attempted to determine the velocity structure of Sulawesi, but most of them used fewer stations than the current BMKG-enhanced seismic network and focused on either P-wave (Vp) or S-wave (Vs) velocity models separately, limiting their effectiveness for earthquake relocation and structural imaging. This study aims to refine the velocity structure of Sulawesi by utilizing the increased density of seismic stations and earthquake data. A new 1-D velocity model was developed using data from 1,788 earthquake events, incorporating 17,365 P-wave readings and 6,787 S-wave readings. Statistical analysis of earthquake locations indicates that this updated velocity model can be reliably applied to routine seismic monitoring. We then used this refined 1-D model as the initial model for a 3-D travel-time tomography inversion, incorporating data from 10,177 earthquake events and a total of 166,974 P- and S-wave readings. The resulting 3-D tomography model provides a detailed representation of the Vp, Vs, and Vp/Vs structures beneath Sulawesi. Several significant features were identified, including a negative velocity anomaly beneath the northern arm of the Sulawesi volcanic arc, indicating a potential magmatic source. Additionally, we observe fast velocity anomalies near the North Sulawesi Trench, depicting the southward subduction of the Celebes Sea Plate and the northward subduction of the Sula slab. The model also reveals notable crustal thickness variations in western Sulawesi, part of the Sunda Continent, and a sharp slow-velocity anomaly beneath the island arc. The improved velocity model enhances our understanding of Sulawesi’s tectonic structures and lays a foundation for future seismic hazard assessments in the region.

Keywords: earthquake relocation, North Sulawesi Trench, Sula slab, travel time tomography