

## 長期滞在型共同研究（課題番号：28L-02）

課題名： Transient Deformation in Taiwan Island by Geodetic Measurement, SAR Interferometry and Borehole Strainmeters

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滞在期間：平成 28 年 8 月 12 日 ～ 平成 28 年 11 月 26 日

滞在場所： 京都大学防災研究所

共同研究参加者数： 5 名（所外 3 名，所内 2 名）

- ・大学院生の参加状況： 2 名（博士 2 名）（内数）
- ・大学院生の参加形態 [ 共同研究の実施，データベースの管理他 ]

研究及び教育への波及効果について

In this joint research, a couple of graduate students participated. A student from DPRI, Kyoto University, actually made a research of tectonics of Taiwan. This research was fully benefited from Prof. Hu who kindly permitted him to use their data and encouraged him. This student developed rapidly with Prof. Hu's help.

研究報告

(1) 目的・趣旨(Objectives, Aim)

The main goal of this joint research is to study the active deformation across an ongoing collisional orogenic belt in Taiwan by InSAR with continuous GPS network and precise leveling to characterize the interseismic crustal deformation. The major objective is to use the results of observations with InSAR, GPS, leveling and borehole strainmeters, to characterize temporal transient deformations induced by hydrological change, triggered slip, creeping and the mud-core anticline-related folding. In Taipei metropolitan area, short-term fluctuation of surface deformation is revealed by high resolution X-band SAR interferometry and precise leveling. In southwestern Taiwan, recent geodetic observations (InSAR and leveling) in the Tainan area have revealed very temporal changes in the active deformation pattern of the area from the period 1996-1999 to 2005-2011. These observations definitely deserve a more systematic investigation at the scale of southwestern Taiwan. In addition, high uplift rate related to fault-related folding is observed in SW Taiwan. The combination of InSAR measurements with continuous GPS and leveling data allow us to characterize the deformation through time, leading to develop new hypothesis and models on the physical processes of these transient deformations.

(2) 研究経過の概要(Outline of Development of Collaboration)

After the coordination in the early FY 2016, Hu visited DPRI to collaborate with Hashimoto, Kano and their group. Hu delivered a lecture entitled with “Reassessment of seismic hazards in SW Taiwan: Insights from multiple fault slip triggered by 2016 Mw 6.4 Meinong earthquake” in the special seminar of RCEP, DPRI, on 26 September 2016 as an introduction of tectonics and seismic hazards including the effect of the Meinong earthquake of February, 2016. Hu attended the 15<sup>th</sup> Japan-Taiwan International Workshop on Hydrological and Geochemical Research for Earthquake Prediction in Tsukuba on 7 September 2016 with Kano, and presented his research. After Hu returned to Uji, Hu and Hashimoto started discussion of coseismic and postseismic deformation following the Meinong earthquake detected by ALOS-2. Hashimoto processed ALOS-2 images to detect deformations associated with the Meinong earthquake. Hashimoto also presented a preliminary

result of processing of ALOS-2 images over the Longitudinal Valley, eastern Taiwan. Hu presented the results of GPS observation in Taiwan and crustal structure models. Hashimoto presented the results of discussion in the 2016 Taiwan-Japan Workshop on Crustal Dynamics (TJWCD3) which was held in the National Cheng Kung University in Tainan on 14-16 November 2016. Atsushi Takahashi, a graduate student in the Kyoto University, who developed a clustering algorithm for the analysis of displacement field, asked Hu to help him for the study of tectonics of Taiwan. Takahashi applied his method to the observed displacements of Taiwanese GPS network on which Hu gave him invaluable suggestions. Takahashi also presented the results of his analysis in TJWCD3, and attracted attention from Taiwanese researchers. Hu also presented his research on the Meinong earthquake in this workshop. Hashimoto and Takahashi visited Hu's office in Taipei for the discussion on further collaboration. Hashimoto delivered a lecture entitled with "The Largest Possible Nankai Trough Earthquake: Model, Long-term Forecast and Short-term Predictability" on 18 November 2016 in the Friday seminar of Department of Geosciences, National Taiwan University.

Hu stayed in DPRI till 26 November 2016 except several trips to Taiwan and other countries due to his official jobs or invitation from other agencies. However, Hashimoto and Takahashi had many opportunities to discuss crustal deformation and tectonics of Taiwan with Hu. After Hu returned to Taiwan, Hashimoto and Takahashi met him in AGU (San Francisco) or EGU (Wien). We are discussing further collaboration.

Kano visited Hu's office in Taipei for the discussion on collaboration for monitoring by strainmeter and groundwater. Hu arranged an informal workshop for discussion on strain and groundwater data in Taiwan. Kano exchanged knowledges on groundwater and strain change related to earthquakes with Hu and his collaborators including an officer of Central Weather Bureau. The Hu provided data of groundwater data and Kano started analyses on groundwater level related to occurrence of earthquakes in Taiwan. Hu helps Kano to access historical documents related to earthquake owned by National Taiwan University Library.

### (3)研究成果の概要(Outline of Results of Collaboration)

Hu and Hashimoto discussed deformation associated with the Meinong earthquake and notice the importance of faulting in shallow part of crust, especially in relation to Lungchuan fault. This result was presented in TJWCD3. Takahashi delineated block structure of Taiwan using GPS displacement field derived from the Taiwanese continuous GPS network. He spotted several faults with large relative motions that have not been considered to be active by Taiwanese researchers. Hu showed Hashimoto and Takahashi their archive of Taiwanese GPS data. Hu also showed kano their archive of Taiwanese strainmeter and groundwater data. Hu kindly allowed us to use this archive, which will boost up the collaboration.

### (4)研究成果の公表(Dissemination of the Results of Collaboration)

Part of products of research were presented in the 2016 Taiwan-Japan Workshop on Crustal Dynamics (TJWCD3) as listed below:

Jyr-Ching Hu, Reassessment of high strain rate and seismic hazards in SW Taiwan: Insight from 2016 Mw6.4 Meinong earthquake and numerical modeling.

Manabu Hashimoto, Observation of surface deformation with ALOS-2/PALSAR-2 in southern Taiwan before, during and after the Meinong earthquake.

Atsushi Takahashi, Identification of crustal block structures in Taiwan Islands investigated by cluster analysis of super dense GNSS data.

We are planning to present products of research in future meetings/conferences of related associations.