# Spatial variation of creep rate of the Philippine fault on Leyte Island and its relation with the 6 July 2017 earthquake (Mw 6.5) revealed by SAR interferometry

*福島 洋[1]、橋本 学[2]
*Yo Fukushima[1], Manabu Hashimoto[2]

1. 東北大学災害科学国際研究所、2. 京都大学防災研究所
1. International Research Institute of Disaster Science, Tohoku University, 2. Disaster Prevention Research Institute, Kyoto University

Creep along the Philippine fault on Leyte Island has been inferred from studies using GPS measurements and field surveys. Recently, Fukushima et al. (2013, AGU) reported preliminary results on detection of the fault creep using SAR data acquired by ALOS/PALSAR. In this study, the previous results are updated after re-analyzing with a more robust method, and the relation to an Mw 6.5 earthquake that occurred along the fault is discussed.

We use ALOS/PALSAR SAR data obtained between October 2006 and January 2011 from paths 443 (ascending), 76 (descending), and 77 (descending), with which interferometric SAR analyses were performed. To enhance the coherence of the signals, multi-looking of the interferograms are applied so that the resulting pixel size corresponds to roughly 500 x 500 meters. Small-baseline InSAR time-series analyses, which models and removes artificial bilinear trends, are applied to the interferograms of each of the data sets to obtain the mean velocity field on almost the entire island of Leyte. The velocity fields in the two line-of-sight directions are finally decomposed into east-west and quasi-vertical components.

The resulting velocity field clearly shows discontinuity across the Philippine fault (Figures a,b). The corresponding creep rates along the fault are roughly consistent with the values with the field survey results. The estimated rates spatially vary in the range of roughly 10 to 30 mm/year, but the rates are relatively higher on the northernmost part (Region A) and on the middle part (Region D–F). For the southern part (Region G–H), although the uncertainty in our creep estimates is large (Figure c), no clear across-fault offset is identified in the horizontal velocity (Figure a). The subsidence signal observed east of the fault in Region B prevents us from applying the offset estimation method, but the horizontal velocity field (Figure a) does not show any offset across the fault in this region. From these observations, the fault in Regions B, G–H is suggested to be locked.

An Mw 6.5 earthquake occurred on the 6 July 2017 along the fault in northern Leyte. The largest historical event in and around Leyte since 1589 was Ms 6.4 in 1890 (Bautista and Oike, 2000), which is comparable to the 2017 event. Interferometric SAR analysis of the data obtained by ALOS-2/PALSAR-2 is performed to obtain the coseismic displacement maps in both ascending and descending directions. Then we perform a fault slip inversion using the method proposed by Fukahata and Wright (2008) and show that the slipped part well corresponds to the fault locked portion (Region B) identified by our fault creep rate estimates (Figure a), indicating release of the accumulated strain energy along the fault. The maximum amount of slip reaches 2.5 meters, and the fault is estimated to be dipping northeast with the dip angle of 74 degrees.

Assuming a constant fault slip rate of 20 mm/year, which is about the creep rate estimated adjacent to the section ruptured in 2017, 2.5 meters of slip deficit accumulates in 125 years. Although the precise location of the 1890 Ms 6.4 event cannot be known, it is possible that the 1890 event was the “last one” that ruptured the locked portion (Region B) before 2017.

キーワード：InSAR、地殻変動、フィリピン断層、断層クリープ、地震発生
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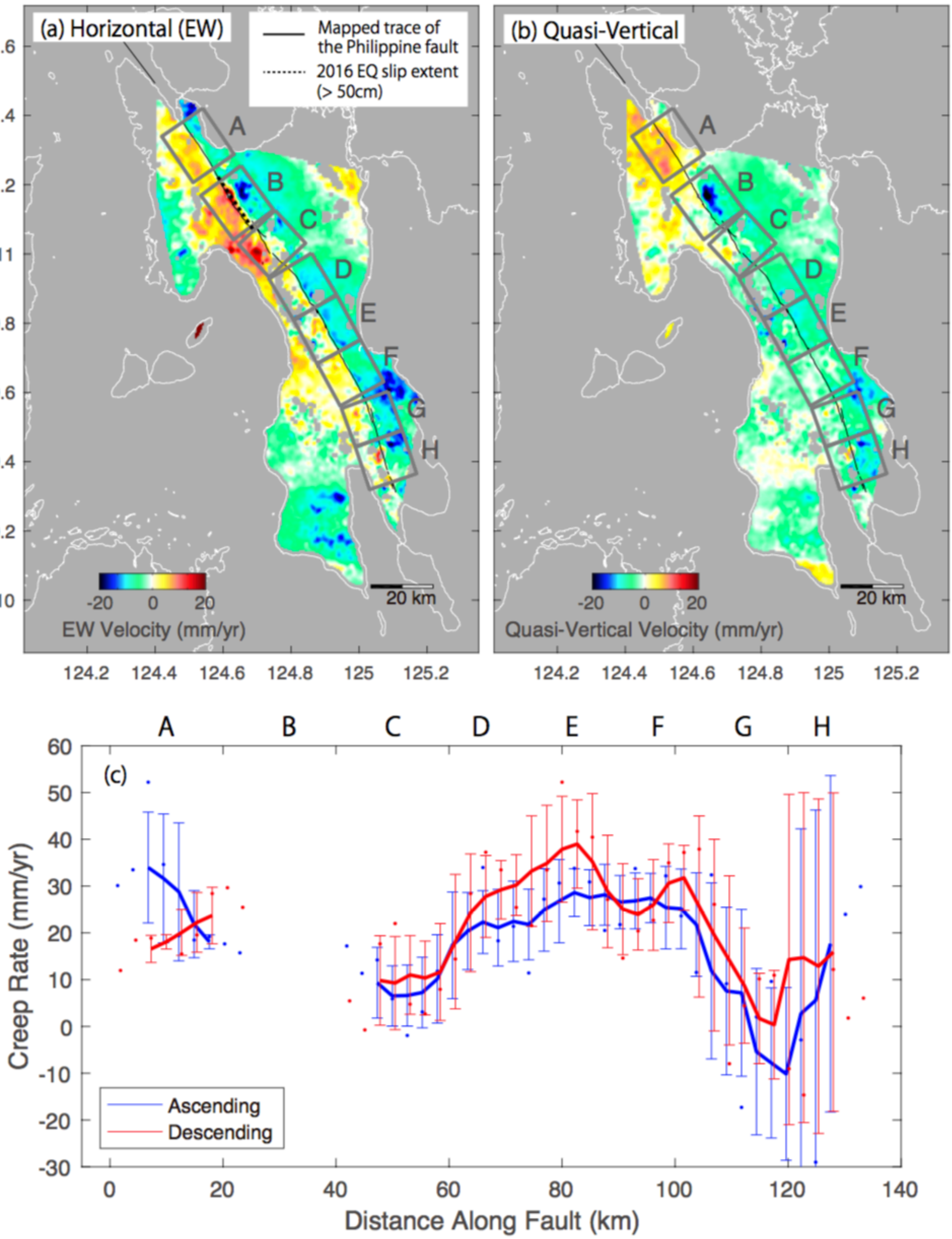
(a) Horizontal (EW)
Mapped trace of the Philippine fault
2016 EQ slip extent (> 50cm)
A
B
C
D
E
F
G
H
11.6
11.4
11.2
11
10.8
10.6
10.4
10.2
10
-20 0 20
EW Velocity (mm/yr)
20 km
124.2 124.4 124.6 124.8 125 125.2
(b) Quasi-Vertical
-20 0 20
Quasi-Vertical Velocity (mm/yr)
(c)
Creep Rate (mm/yr)
Distance Along Fault (km)
Ascending
Descending