THE M_W 6.8 THABEIKKYIN EARTHQUAKE IN CENTRAL MYANMAR: A WIDELY FELT STRONG EVENT WITH UNILATERAL RUPTURE THROUGH THE SINGU BASALT ON THE SAGAING FAULT

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1. INTRODUCTION

Despite active seismicity in Myanmar, none of the previous damaging earthquakes were studied by field surveys integrated with modern geophysical analysis [1,2]. Here we report the first multidisciplinary results for the 2012 Mw 6.8 Thabeikkyin earthquake on the Sagaing fault in central Myanmar. Our field survey documented a ~45 km long surface rupture with a ~102 cm maximum dextral offset on the main fault. A macroseismic assessment was made from damage patterns and felt intensities obtained via post-earthquake field surveys (community-based felt intensity data), which was integrated with the geophysical analyses of high-rate GPS and teleseismic data.

2. METHODOLOGY

This study is primarily focused on the macroseismic mapping of the Mw 6.8 Thabeikkyin earthquake in the European Macroseismic Intensity (EMS-98) scale [3] and distance-dependent ground-motion analysis of felt reports gathered by field surveys, interviews, press reports, and online sources, which were integrated with modern geophysical analyses of high-rate (50 Hz) GPS data across the Sagaing fault and seismic data from nearby stations.

3. RESULTS

Based on the macroseismic dataset, we estimated felt intensity at 99 sites. We observed that the felt intensity of the Thabeikkyin earthquake was more widespread in the Sunda plate than in the Burma plate. Grade 4-5 damage of mixed masonry and brick noggin structures were observed along the coseismic rupture corresponding to EMS 7-8. Damage and felt effects spread much further south of the epicenter along the Sagaing fault than to the north, likely related to the southward rupture directivity of the main shock, extending from the epicenter southward along the fault. The epicenter relocation, nearby GPS observations and fault plane solution all suggest that the ruptured Sagaing fault dips 50-65° to the east. The finite fault model, derived from static GPS offsets and waveform inversion of high-rate GPS and seismic data, shows that the largest asperity, with 1.8 m maximum slip, coincides with the Singu basalt. The model also shows a unilateral southward rupture with relatively fast rupture speed.

4. CONCLUSIONS

Our macroseismic dataset suggests that ground-motion attenuation of the mainshock best fits the California region, western North America. Both the field survey data and the finite fault model confirm that the rupture length of the earthquake is ~50 km along strike, bounded between Thein Taung hill in the north and Singu town in the south. The intensity distribution and finite fault model both support southward rupture directivity; along with strong site amplification, this may explain the significant shaking and damage at far as ~200 km to the south of the earthquake. The largest asperity in the finite fault model is collocated with the Singu basalt, suggesting the Sagaing fault is strongly coupled by the injection of Pliocene basaltic lava near Singu, the first such observation along a continental strike-slip fault.

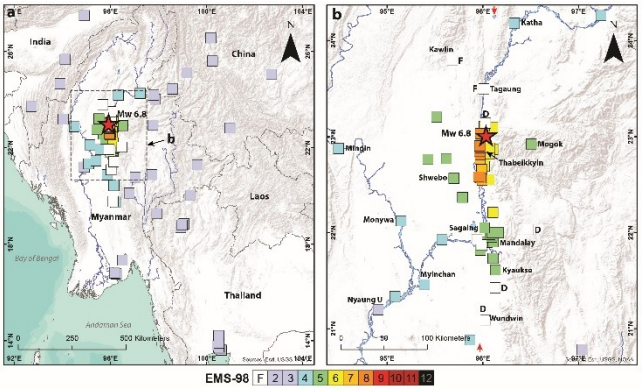

Fig.1 Macroseismic maps of (a) the Mw 6.8 Thabeikkyin earthquake, and (b) its epicentral area. F-Felt / D-Damage (no more additional information for intensity assignment).

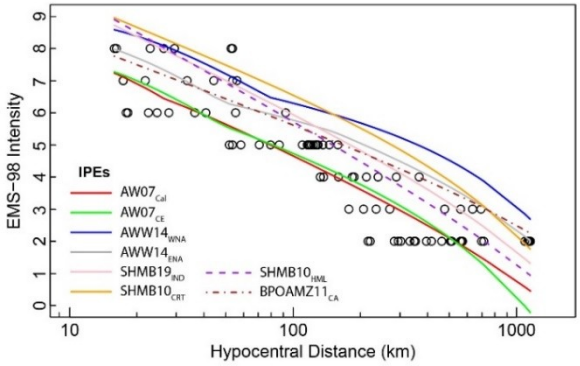

Fig.2 Intensity-versus-distance decay plot diagram with intensity prediction equations (IPEs) for different tectonic settings [4,5,6,7].

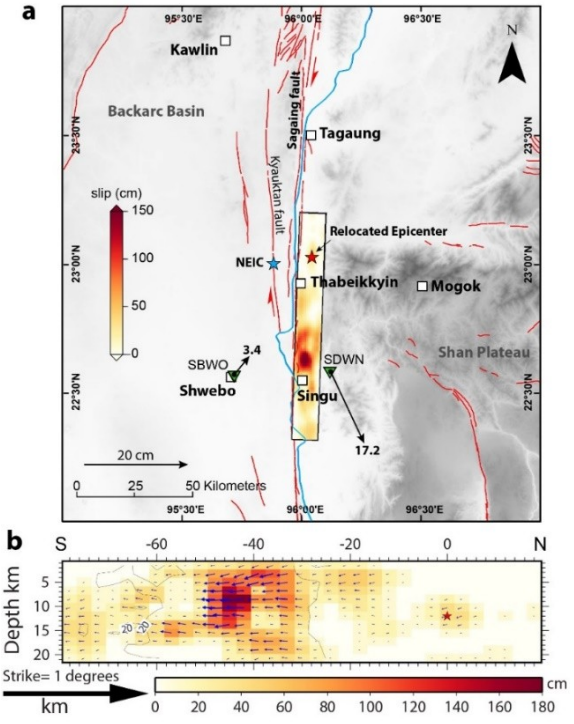

Fig.3 Finite fault solution result of the Mw 6.8 Thabeikkyin earthquake: (a) map view and (b) S-N longitudinal profile.

5. REFERENCE

[1] Wang, Y., Sieh, K., Tun, S.T., Lai K-Y., Myint, T., 2014. Active tectonics and earthquake potential of the Myanmar region. *Journal of Geophysical Research: Solid Earth* 119 (4), 3767-3822.

[2] Fadil, W., Wei, S., Bradley, K., Wang, Y., He, Y., Sandvol, E., Huang, B.-S., Hubbard, J., Thant, M., Htwe, Y.M.M., 2023. Active faults revealed and new constraints on their seismogenic depth from a high-resolution regional focal mechanism catalog in Myanmar (2016–2021). *Bull. Seismol. Soc. Am. XX*, 1–23. doi: 10.1785/0120220195.

[3] Grünthal, G. (Ed), 1998. *The European macroseismic scale EMS-98*, Conseil de I'Europe, Cahiers du Centre Europee'n de Geodynamique et de Seismoligie Luxembourg 15, 101.

[4] Atkinson G.M, Wald D.J, 2007. "Did you feel it?" intensity data: a surprisingly good measure of earthquake ground motion. *Seismological Research Letters* 78 (3), 362-368.

[5] Atkinson, G.M., Worden, C.B., Wald, D.J., 2014. Intensity prediction equations for North America. *Bulletin of the Seismological Society of America* 104 (6), 3084-3093. doi: 10.1785/0120140178.

[6] Bindi, D., Parolai, S., Oth, A., Abdrakhmatov, K., Muraliev, A., Zschau, J., 2011. Intensity prediction equations for Central Asia. *Geophysical Journal International* 187, 327–337. doi: 10.1111/j.1365-246X.2011.05142.x.

[7] Szeliga, W., Hough, S.E., Martin, S.S., Bilham, R., 2010. Intensity, magnitude, location, and attenuation in India for felt earthquakes since 1762. *Bulletin of the Seismological Society of America* 100, 570–584. doi.org/10.1785/0120080329.

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