THE 2025 M7.7 MANDALAY, MYANMAR EARTHQUAKE AND THE SEISMICITY CHARACTERISTICS OF THE SAGAING FAULT

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1. INTRODUCTION

On March 28, 2025 the magnitude 7.7 earthquake occurred on the right lateral strike-slip Sagaing Fault with the focal depth of 10 km, and the epicenter at about 20 km NNW of Sagaing and WNW of Mandalay. According to the various sources, the earthquake caused above 5300 casualties, 7108 injuries; 538 missing and 120,000 building damages including various infrastructures, government buildings, hospitals, schools and different sorts of religious buildings. The affected regions include Mandalay, Sagaing, Naypyitaw, and Bago which are situated along the surface fault rupture of the earthquake and Inle - Nyaung Shwe area, Shan State. The damages correspond to the primary impacts as ground motion and surface rupture, and secondary impacts such as liquefaction, fire, landslides, etc.

2. Fault rupture and aftershocks behavior

The Mandalay, Myanmar earthquake ruptured bilaterally toward north till Singu, the southern termination of the 2012 M6.8 Thabeikkyin event rupture and to the south, the northern portion of the M7.3, 1930 Phyu earthquake rupture. The rupture propagated at ~4.8 km/s making as the supershear earthquake (Melgar et al., 2025)[1]. The rupture length is about 500 km with the surface rupture displacement of about 6 m (USGS). We carried out the surface rupture displacement measurements on the different sections of the Mandalay earthquake rupture, and the maximum displacement is about 4.5 m, at around the epicentral area. However, it should be noted that due to several concerns, the field survey could not cover the whole fault rupture.

The aftershock with largest magnitude 6.7 struck about 12 minutes after the main event, at about 21 km to the south. Above 75 aftershocks (> 2.5) were recorded by the end of July, 2025 (USGS catalog), while TMD recorded above 1100 events by the same time. With regards to the distribution patterns, the aftershock events (USGS) were concentrated along the northern section of the earthquake rupture, particularly in the epicentral area, till northern termination of the rupture, while the aftershocks were generally sparse in the central and southern section sections (Figure 1). However, the spatial distribution pattern of the aftershocks recorded by TMD occur to the east of the Sagaing Fault and seems to be sparse in the central section. The magnitude of the aftershocks happened in the southern section is mostly lower than 3.0, and the events with the magnitude ≥ 5.0 mostly occurred in the northern section of the earthquake rupture, in the epicentral area.

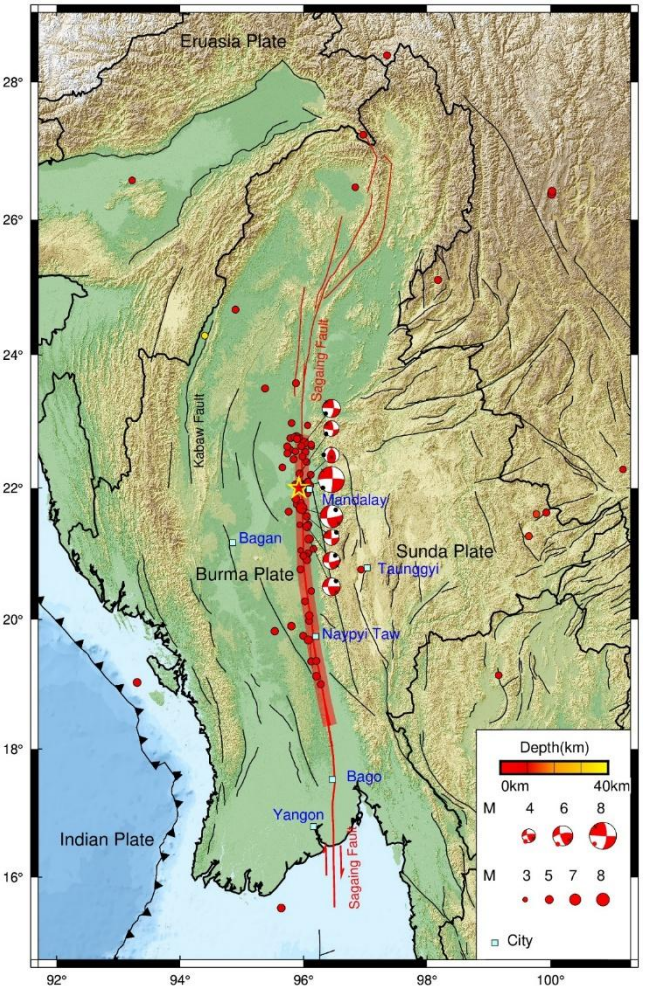


Figure 1. Epicenters of the 2025 M7.7 Mandalay, Myanmar earthquake, and the aftershocks of USGS earthquake catalog; and the total surface rupture of the main event.

3. Seismicity characteristics of the Sagaing Fault

The Sagaing Fault is the major active fault that can contribute the strongest seismic hazard to the major cities such as Mandalay, Naypyitaw and even Yangon. The event before the Mandalay, Myanmar earthquake is the 2012 M6.8 Thabeikkin earthquake originated by the Sagaing segment.

The earliest known event along the Sagaing Fault is 1839 Inwa (Ava) earthquake. The Inwa earthquake ruptured the whole segments of Meiktila and Sagaing (Soe Thura Tun and Ian Watkinson, 2016)[2], and in the case of Sagaing segment, 1946 (7.7); 1956 (7.1) and 2012 (6.8) events happened. Wang Yu (2015)[3] estimated the magnitude and rupture length of the 1839 event based on the felt records as 8.0 and 270 km. However, the 2025 Mandalay, Myanmar earthquake ruptured the segments of Sagaing, Meiktila, Naypyitaw (1929 M7) and Pyu (1930 M7.3).

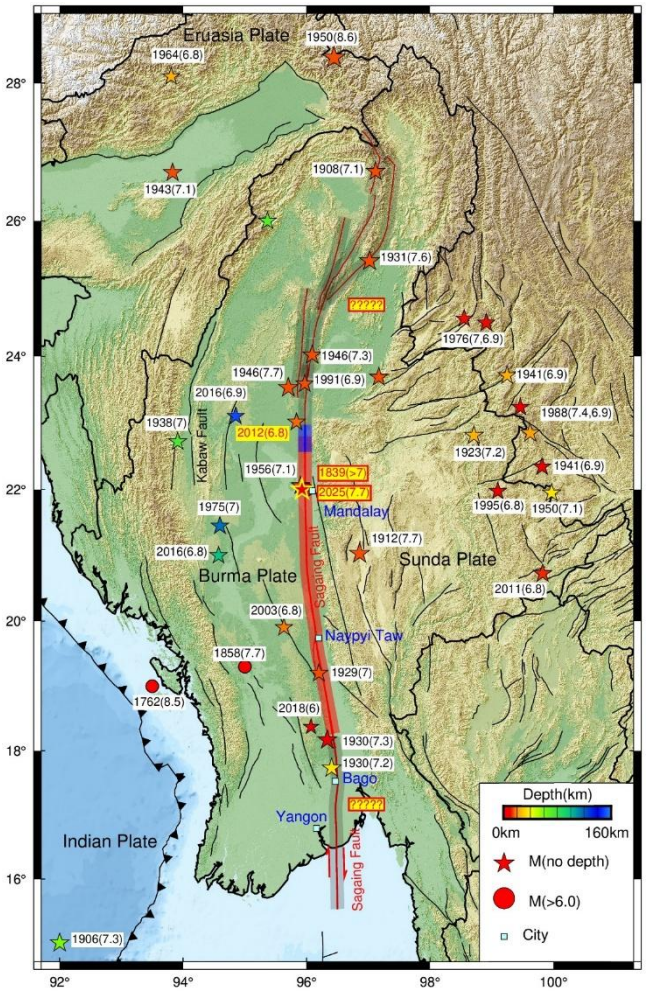
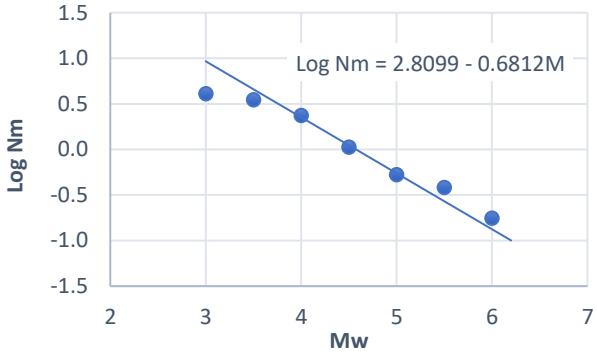


Figure 2. The significant events with the magnitude ≥ 6.0 happened along the Sagaing Fault and around the country Myanmar.

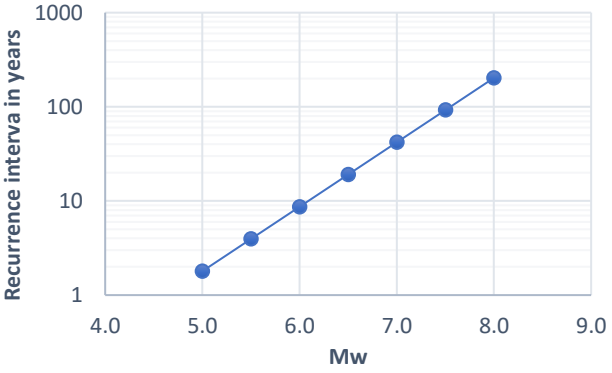
When the earthquake occurrences along the Sagaing fault are observed, two significant earthquakes sequences can be recognized as 1929 – 1931 sequence (M7.0 Aug. 8, 1929; M7.3 May 5, 1930; M7.2 Dec. 3, 1930; M7.6 Jan. 27, 1931) with the interval of some months (1-9 months) and the two 1946 events (M7.7 and M7.3 Sept. 12, 1946) above 3 minutes interval – local time 21:47:23 and 21:50:27 (ISC earthquake catalog), resulted possibly by the stress transfer to the adjacent or distant fault segments triggering the subsequent earthquakes.

By using the earthquake catalogs (1900 – 2009) of USGS, ISC with the complementary of IRSS, the Gutenberg – Richter recurrence relations was developed in each segment of the Sagaing fault and also as a whole (Figure 3). For the seismic hazard assessment, the b-values and recurrence interval of a certain magnitude event are required to estimate, and maximum magnitude of the earthquake potentials were also calculated. For the middle section (the segments of Sagaing, Meiktila, and Naypyitaw), the maximum magnitude was estimated as 7.9 (7.6 as the average), and the recurrence interval for the event with magnitude ≥ 7.5 is above 150 years (Myo Thant et al., 2014)[4].

For the Mandalay, Myanmar earthquake, many scientists estimated the high possibility of the occurrence of this kind of event, even though not exactly the same estimation happened.



(a)



(b)

Figure 3. (a) Gutenberg-Richter Relation for the Sagaing Fault, and (b) the earthquake recurrence interval derived from the seismicity of the Sagaing fault (1900 – 2009).

Based on the seismicity characteristics, geological and geodetic information, and stress transfer nature, the possibilities of earthquake hazard become higher for the rest parts of the Sagaing fault, particularly for the southern segment, 1930 Bago earthquake segment, since some of the towns such as Bago, Taungoo, Khayan, and also Yangon are located on and nearby the fault.

3. REFERENCE

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