Site Observation on Fault Geometry and Coseismic Behavior of Nay Pyi Taw Segment, Sagaing Fault

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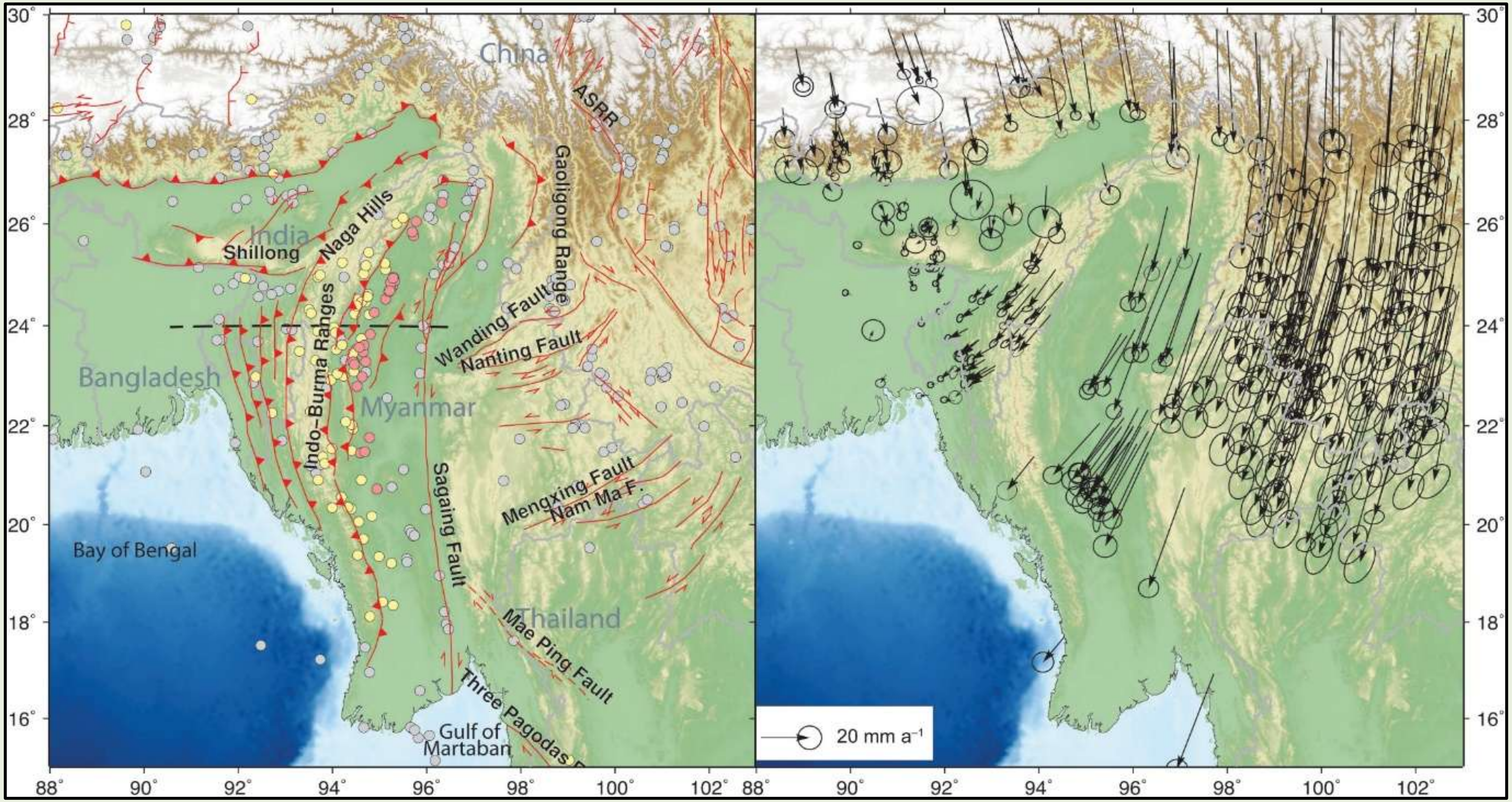
Outline of Presentation

- Introduction
- Preexisting Sagaing Fault and Fault Segmentation
- Strike-slip fault geometry
- Earthquake ruptures along the Sagaing fault
- Probabilistic seismic effects in Nay Pyi Taw revealed by the recurrence of the Swa, Pyu and Bago earthquakes
- Coseismic Structures of Mw 7.7

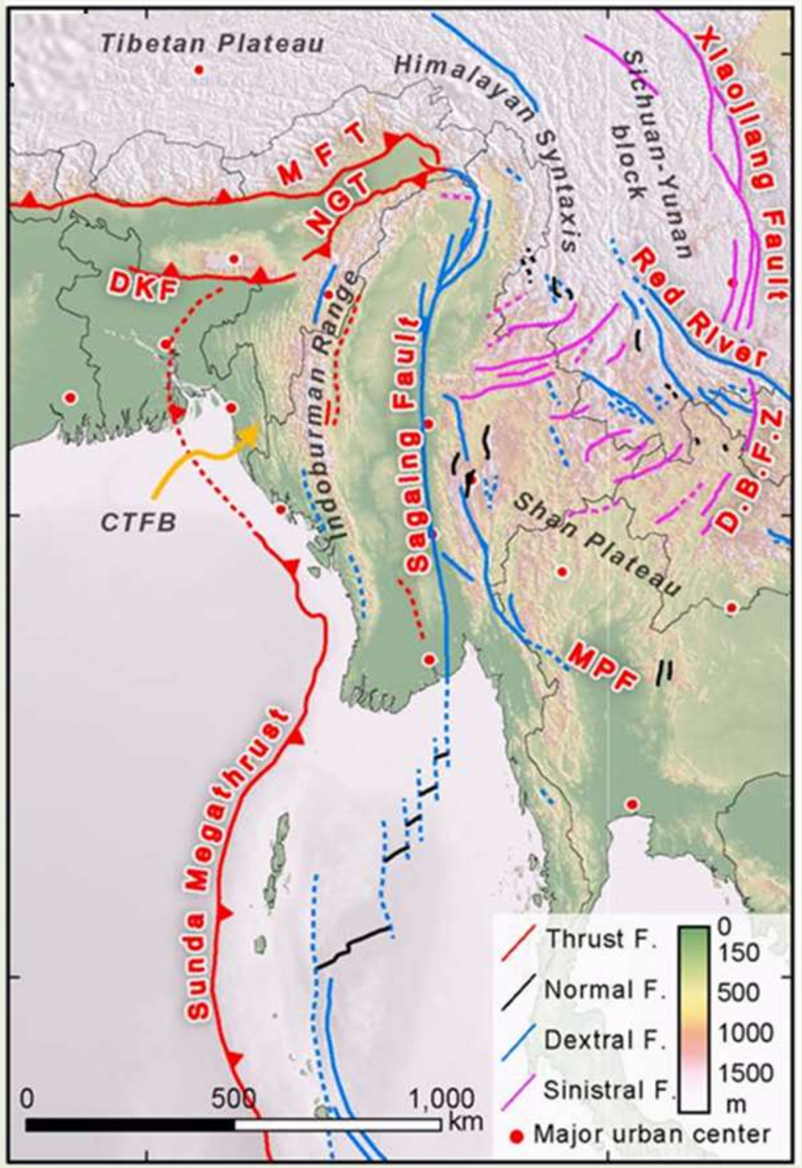
Introduction

- presentation focuses is approximately 150 km of the Sagaing Fault, which runs through the Nay Pyi Taw Union Territory.
- tectonic geomorphology is influenced by pre-existing Sagaing Fault geometry, which has been active since the Miocene (Geological Time)
- On 28 March 2025, a Mw 7.7 earthquake struck the Sagaing Region of Myanmar, with an epicenter close to Mandalay and ~ 200km apart from Nay Pyi Taw.
- This strong earthquake, with a nearly 500km long surface rupture was formed along the Sagaing Fault.
- rupture segment can be considered the middle segment of the Sagaing Fault, as it consists of the Sagaing-Meikhtila-Nay Pyi Taw and part of the Phyu Segment.
- Fresh strike-slip ruptures at the ground surface are coseismic structures revealed by reactivation of Sagaing Fault.



Seismotectonic map of Myanmar (Burma) and surroundings. Gahalaut *et al.* (2013), Maurin *et al.* (2010), and Gan *et al.* (2007). Coloured circles indicate $M_w > 5$ earthquakes from the EHB catalogue. Grey events are listed for depths <50 km, yellow for depths of 50–100 km and red for depths >100 km. (Sloan et al,2017)

Preexisting Sagaing Fault and Fault segmentation



Sagaing fault was first introduced by Win Swe (1970).

seismically active fault and N-S trending right-lateral strike-slip fault passing through the whole Myanmar region.

Onshore Sagaing Fault into five main Segments, based on fault geometry, geomorphic expression and historical seismicity.

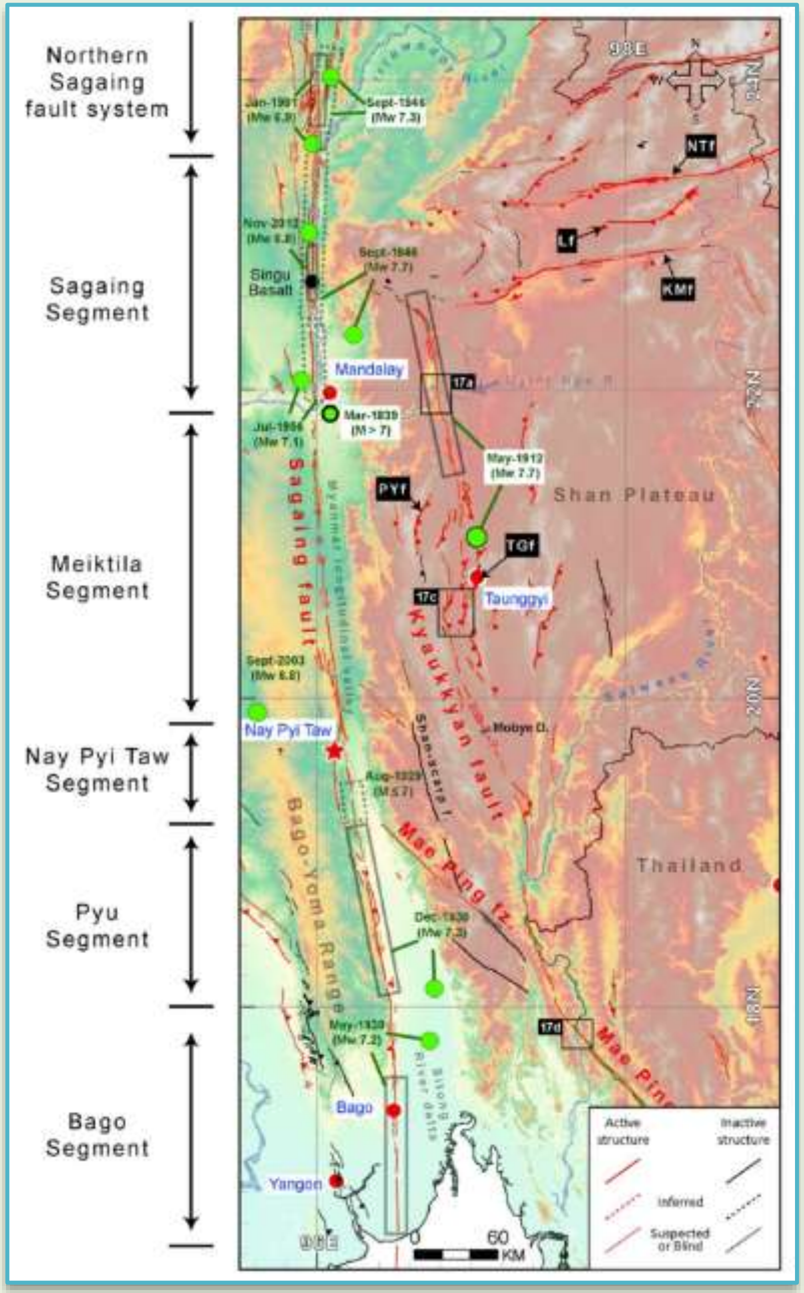
Segments of Sagaing Fault

Sagaing Fault segments based on the geometry of the rupture zones, geomorphic and structural features of the Sagaing Fault Zone

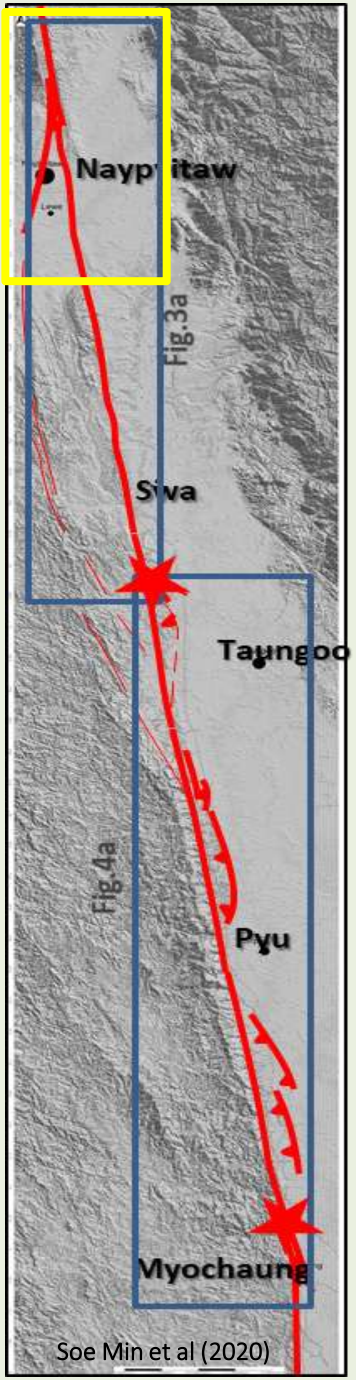
Wang et al. (2014) divided

Southern section: Bago, Pyu, **Nay Pyi Taw**, Meiktila, Sagaing.

Northern section:Northern Sagaing Fault System



(Figure) Fault segmentation along the Sagaing Fault (Wang et al. (2014)



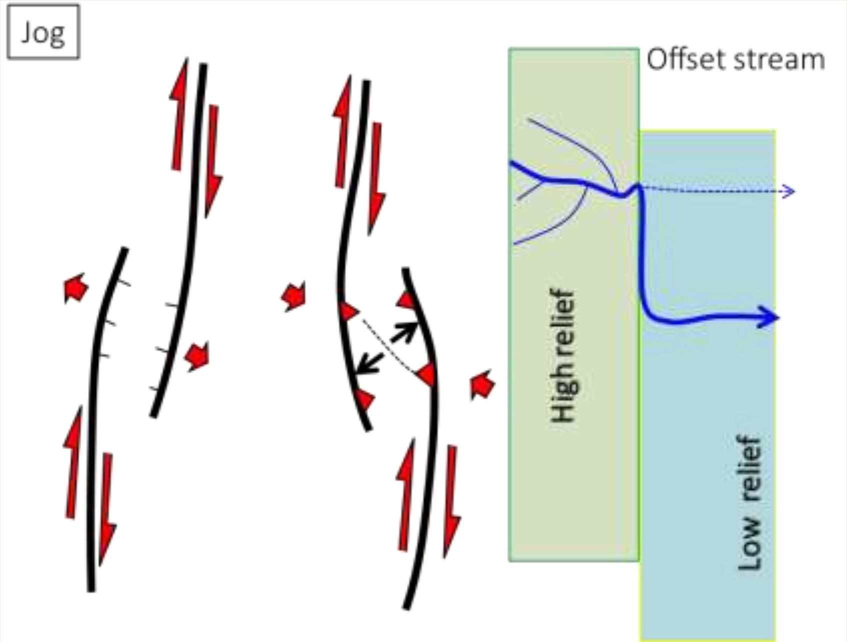
Fault geometry

Structural trend of the Sagaing Fault between Naypyitaw and Myo Chaung is roughly 350º azimuth direction.

Nay Pyi Taw is structurally more complex than other central sections of the Sagaing Fault

Distinct Linear and east-facing scarp are found along the Pyu Segment.

Fault Segmentation

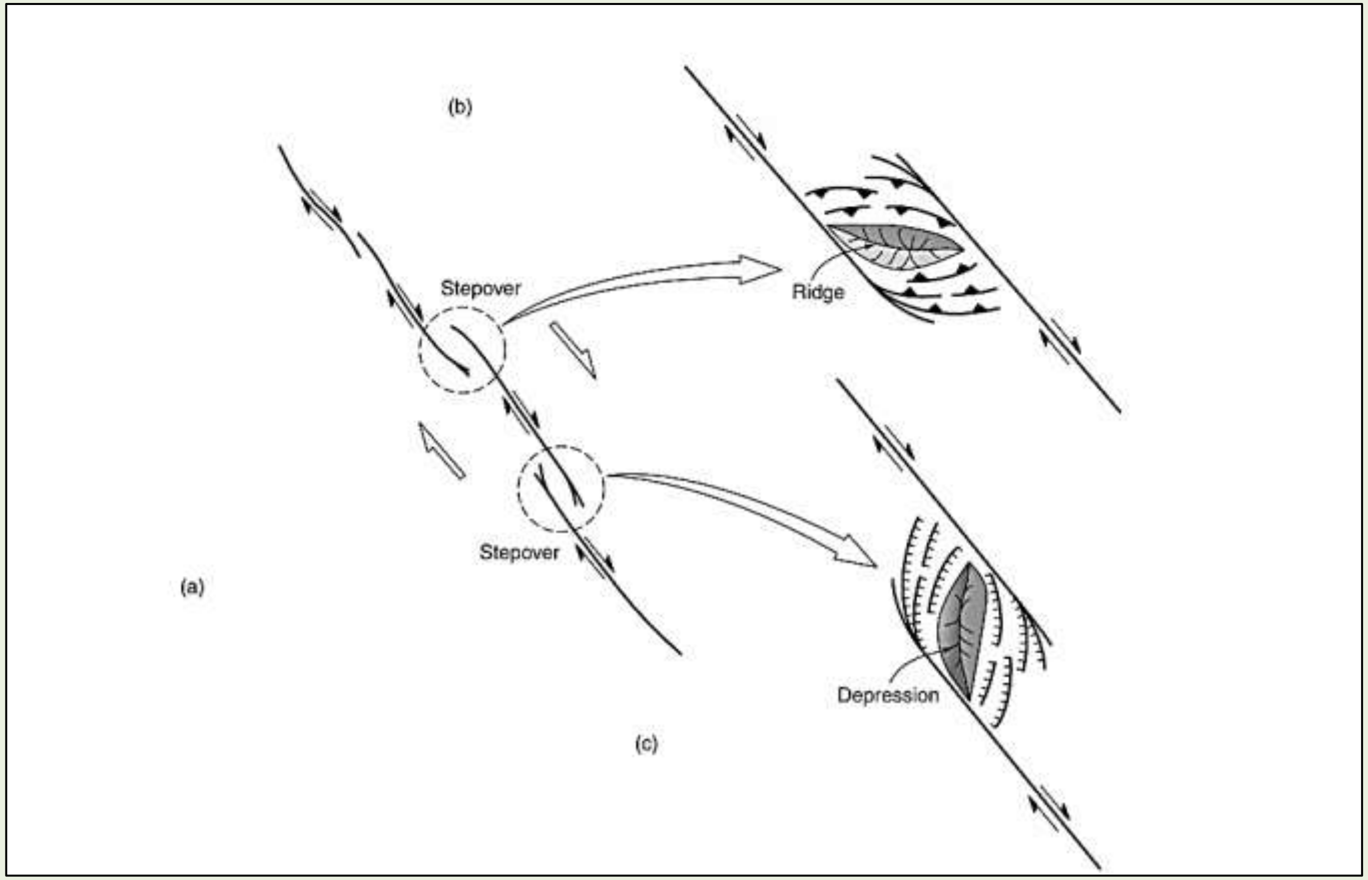


Key Aspects of Right lateral Strike-Slip Segmentation:

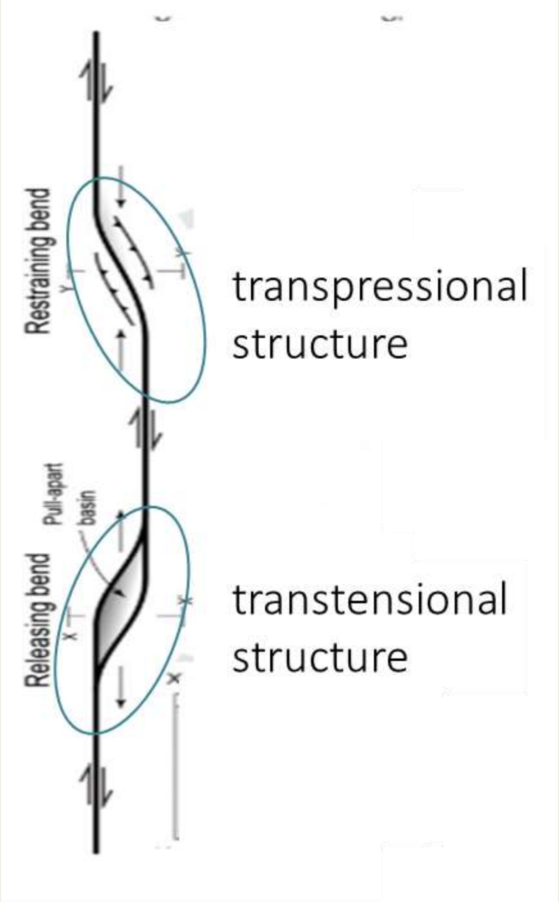
- Segments based on fault jogs, such as fault step-overs and abrupt changes in the amount of slip along the fault strike.
- Step-overs and Bends: Right-stepping dextral faults create transtensional pull-apart basins, while left-stepping dextral faults produce transpressional mountain ranges.
- Earthquake Rupture Control: Fault segments are typically separated by step-overs or non-coplanar offsets that act as barriers, limiting the total length of earthquake ruptures and resulting in smaller, distinct seismic events.

Strike-slip fault geometry

- Strike-slip faults are rarely straight, instead consisting of discontinuous segments with bends, steps, and en echelon strands that break the fault into distinct, interacting sections.
- The fault dip is vertical, which revealed the pure strike-slip motion, and if the fault dip is 65 to 70 degree may cause the strike-slip motion together with oblique slip.
- These segments create complex zones of deformation, such as pull-apart basins, normal extensional features (transtension) or uplifted ridges (transpression), based on the step-over direction

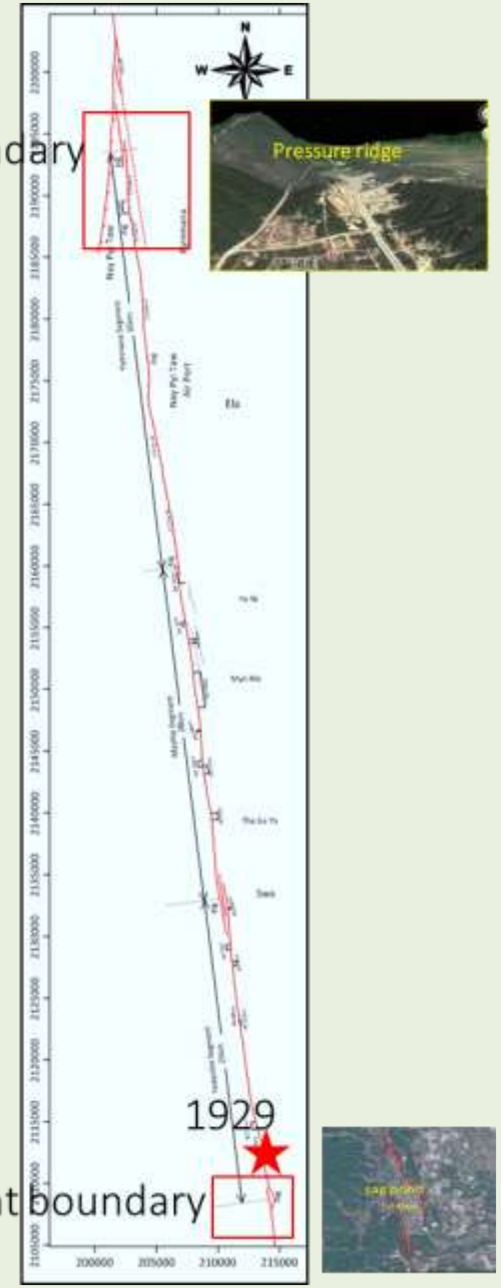


A stepover along a strike-slip fault. (a) Sketch map showing how regional dextral shear can be distributed along fault segments that are not coplanar. Slip is relayed from one segment to another at a stepover. (b) At a restraining stepover, compression and thrusting occur. (c) At a releasing stepover, extension and subsidence occur.



Transtension and transpression at releasing and restraining bends on a dextral strike-slip fault.

Fault Segmentation



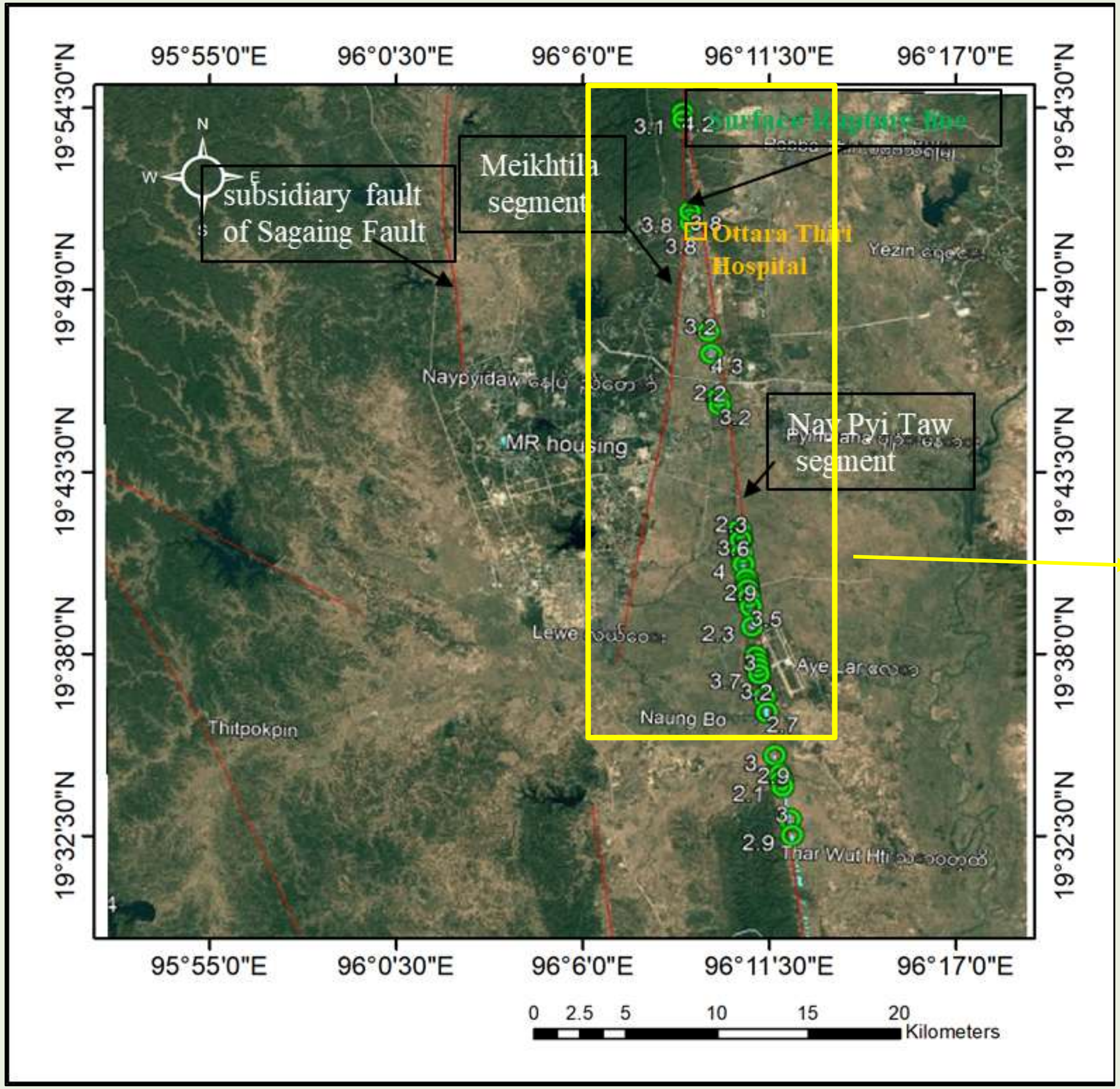
Soe Min et al (2020)

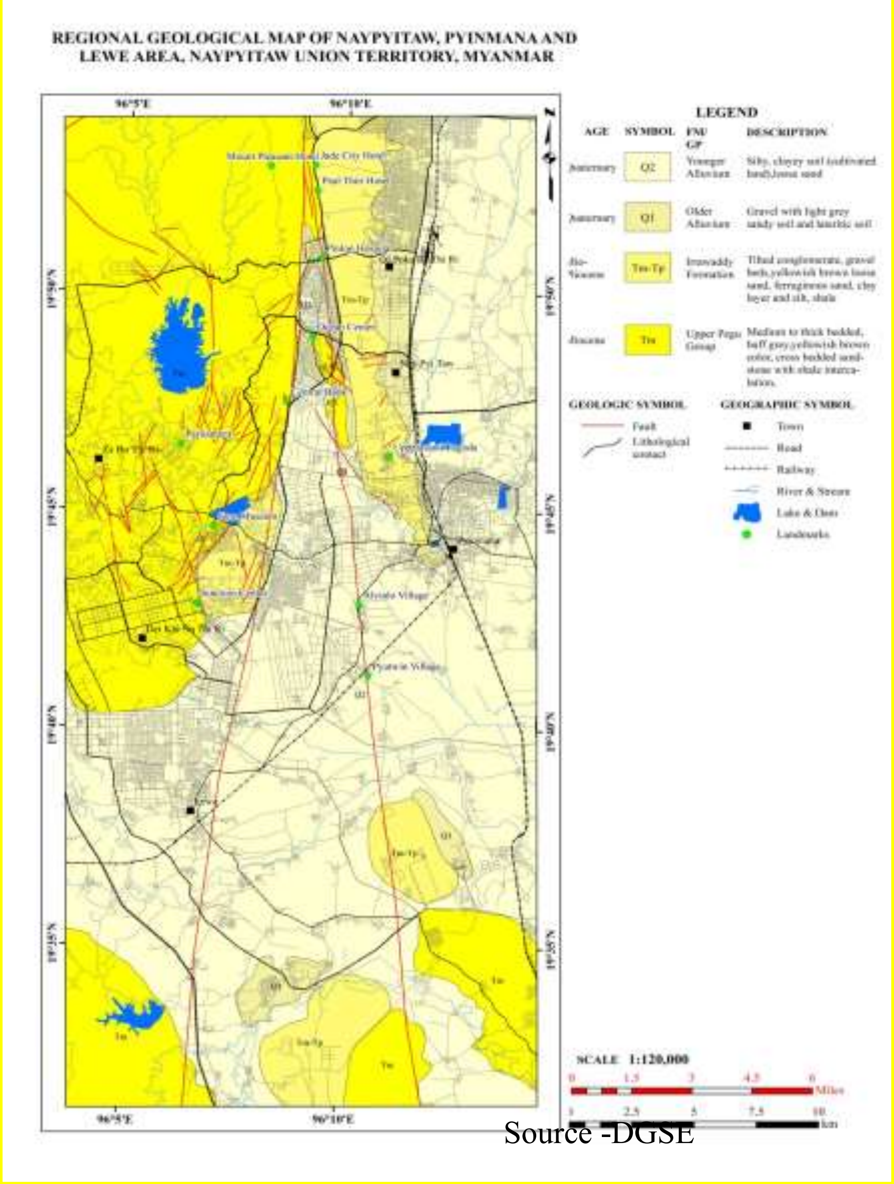
Nay Pyi Taw Segment

Segments boundary between Meiktila and Swa Segment is 100m high pressure ridge. Nay Pyi Taw and Pyu Segment are also separated by 0.45km wide sag pond.

This Segment extends 88 km,

Swa earthquake of August 1929 (7.3) severely damaged the railroad and bridges about 40 km south of the new city.



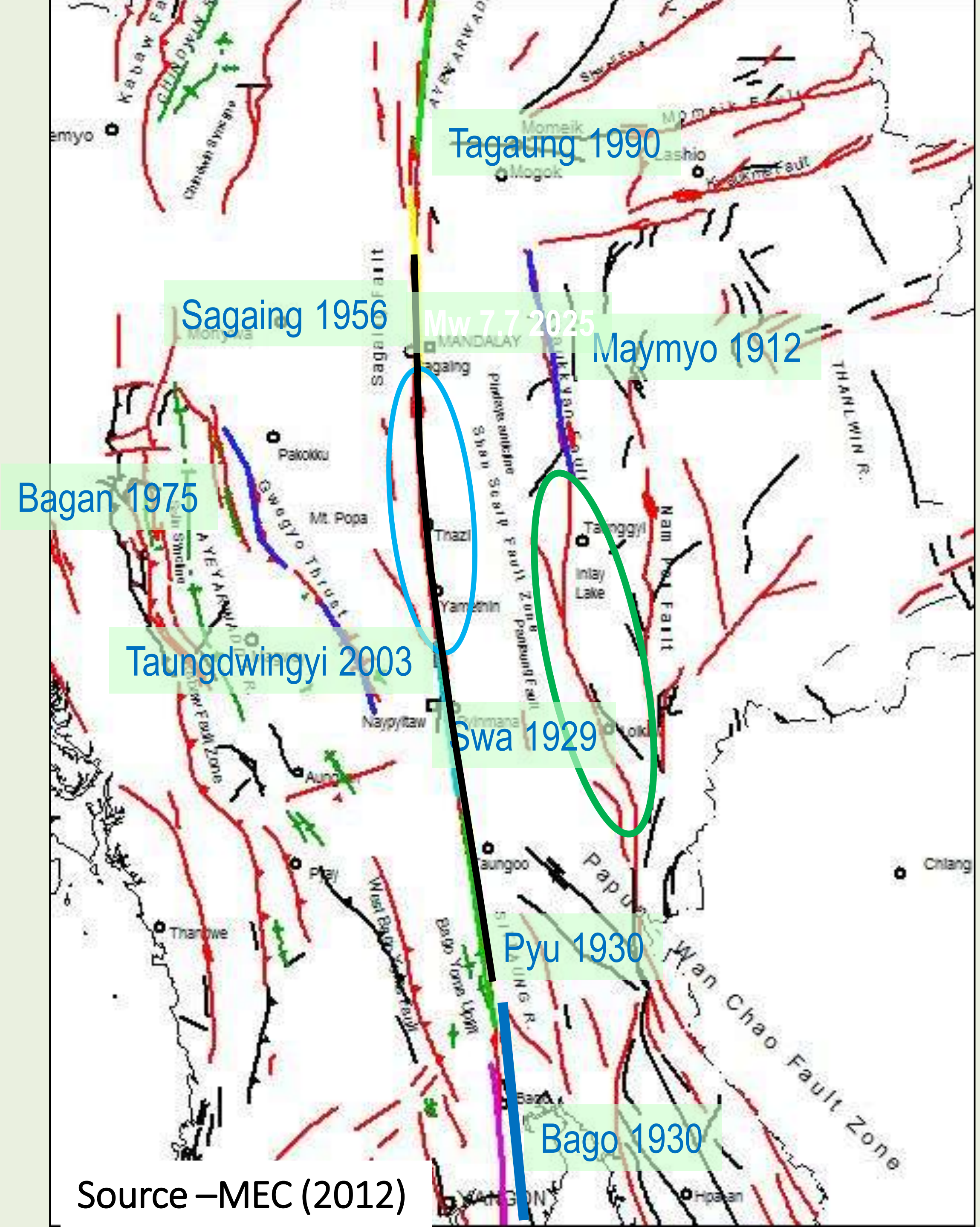


Structural and Geological Features of Nay Pyi Taw Area

Earthquake ruptures along the Sagaing fault

Ruptured segments during the last century

The fault length from the end of Mw 7.7 suface rupture for southern segment is nearly 100km .
According to fault rupture length on magnitude,
these amount of length may generate magnitude 7.4 -7.5 earthquake.
But for the recurrence of the Bago earthquake magnitude is 7.3 , the surface rupture length



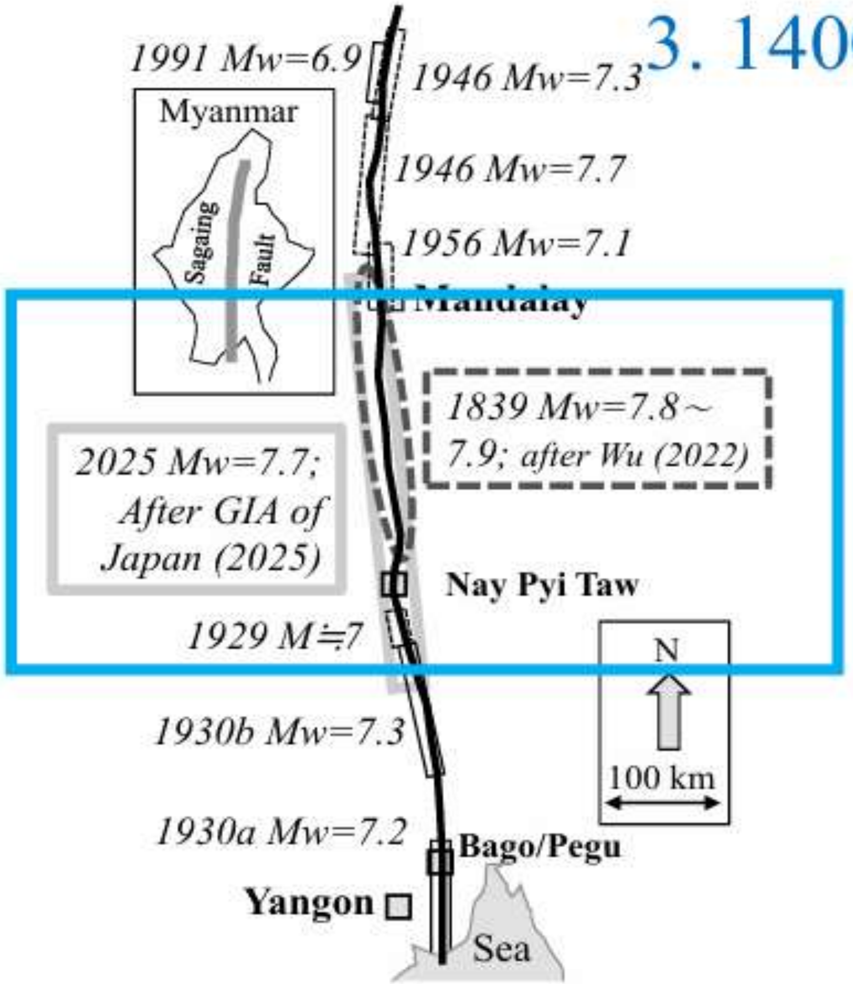
Source –MEC (2012)

Earthquake ruptures along the Sagaing fault

- The Rupture propagated from the Mw 7.7 epicentre,71.2km to North (near Singu) and 430km to South (near Hpado).
- The part of the Sagaing Fault (the Southern Segmentation) length could be 150km that is start from the end of Mw 7.7 surface rupture.

The offset along the Rupture (Northern end of the slip is 2.3m, and southern end of the slip is 3m)

3. 1400-km-long Sagaing Fault in N-S direction



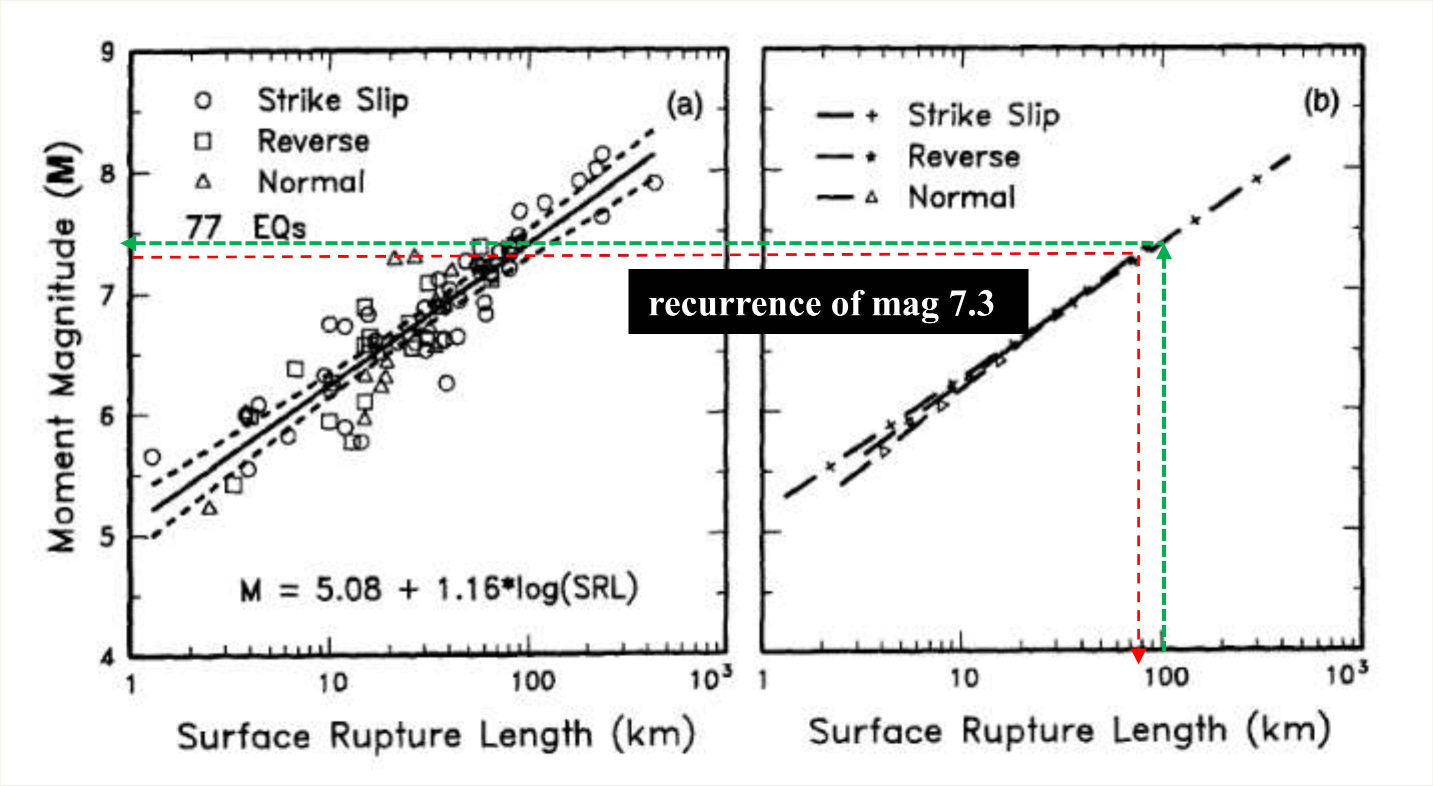
Map of the Central and Southern Parts of the Sagaing Fault; drawn after Wang et al. (2014)
Sagaing F Map.ppt

Filling the seismic gap since the 1839 Ava earthquake of Mw = 7.8-7.9

Year	Reference
1839	400-km rupture; damage report Yule (1858)
1929	Wang (2013)
1930 a	Maung Thein et al. (2009)
1930 b	Hla Hla Aung (2017)
1946	Hla Hla Aung (2017)
1956	Hla Hla Aung (2017)
1991	USGS https://earthquake.usgs.gov/earthquakes/eventpage/usp0004k8g/region-info
2025	Rupture area drawn after GIA of Japan

Wang, Yu; Sieh, Kerry; Tun, Soe Thura; Lai, Kuang-Yin; Myint, Than (2014). "Active tectonics and earthquake potential of the Myanmar region". Journal of Geophysical Research: Solid Earth. 119 (4): 3767–3822.
Wu, S.-H.: Re-estimating the magnitude of 1839 Ava earthquake through geomorphic mapping and macroseismic records, central Myanmar, Master thesis, Department of Geosciences, National Taiwan University, 2022 (in Chinese).
GIA 国土地理院 https://www.gsi.go.jp/cais/topic20250328_Myanmar.html
Henry Yule (1858) Paper 13804

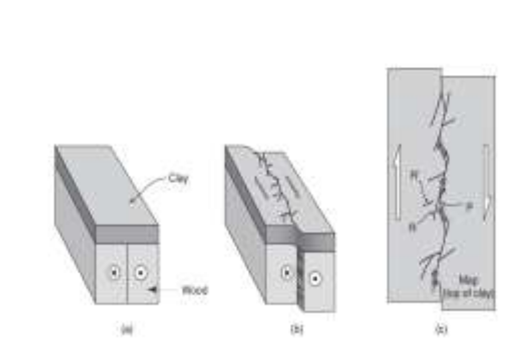
Surface rupture length on magnitude for Southern Segment of Sagaing Fault

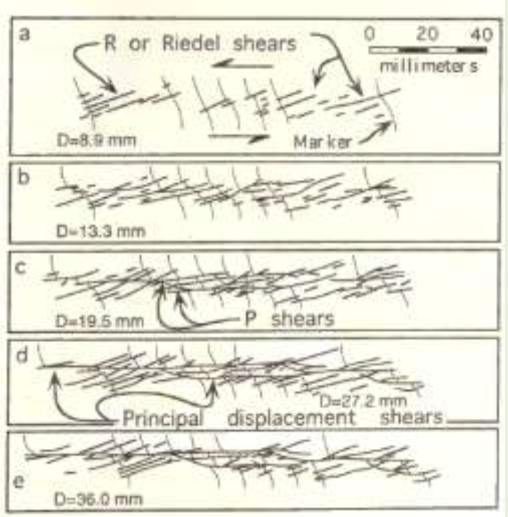


Explanation for Fault length of Southern Segment of Sagaing Fault

- Surface rupture of Mw 7.7 earthquake has a 460km (USGS) long Sagaing Fault Middle Segment such as Sagaing segment, Meikhtila Segment , Naypyidaw segment and part of Pyu segment.
- The end of fault rupture trace is reached at southern part of Penwegon (near Phado).
- Therefore, fault trace of Southern segment can be considered at Phado to South ,average fault length is 100km.
- Approximate earthquake magnitude from recurrence of 1930 Bago earthquake can be 7.3Mw .

Coseismic Structures

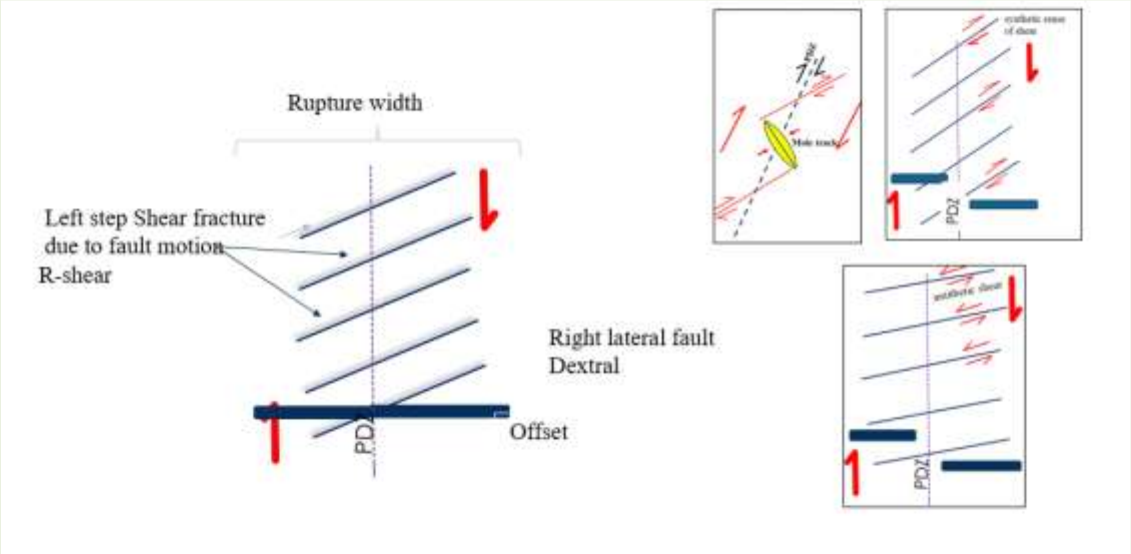




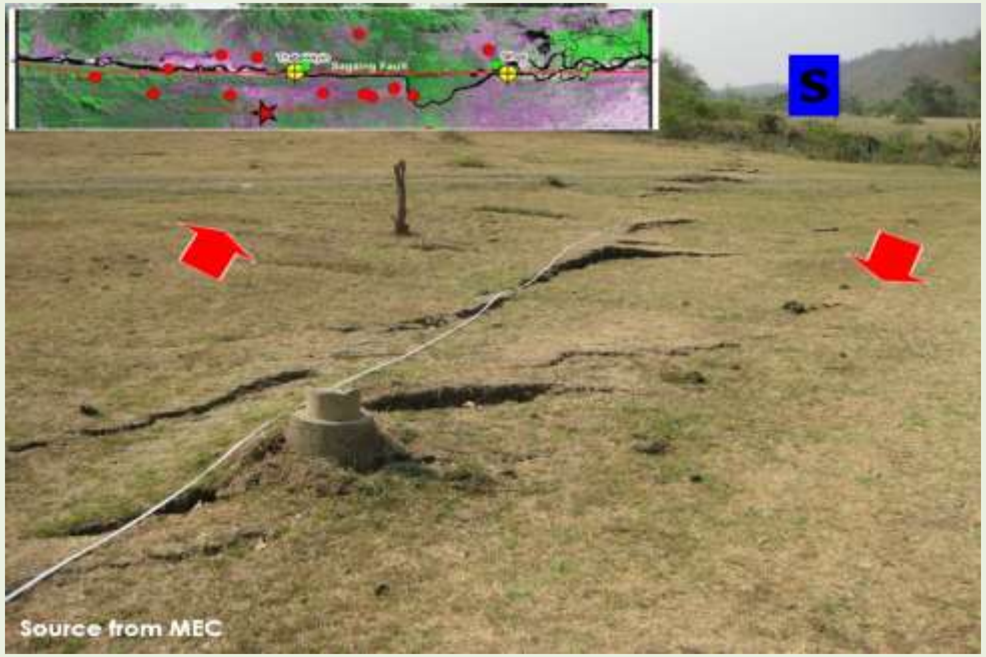
- In indurated sedimentary rock or in crystalline rocks, the surficial traces of a strike-slip rupture almost invariably follow preexisting faults.
- The geometry of the rupture trace is controlled principally by the geometry of the pre- existing faults.
- In both natural and laboratory settings, right- lateral faults generate fractures that are left-stepping— that is, in walking along the fault zone, one steps left from the end of one fracture to get to the next.
- Along left-lateral fault ruptures, the fractures are predomi- nantly right-stepping.
- Surface-rupturing features dominated by horizontal shear, commonly including en echelon shears (Riedel shear), P shear, tension fractures, and mole tracks.

(Robert S Yeats and Kerry Sieh 1997)

Coseismic Surface Ruptures of Sagaing Fault



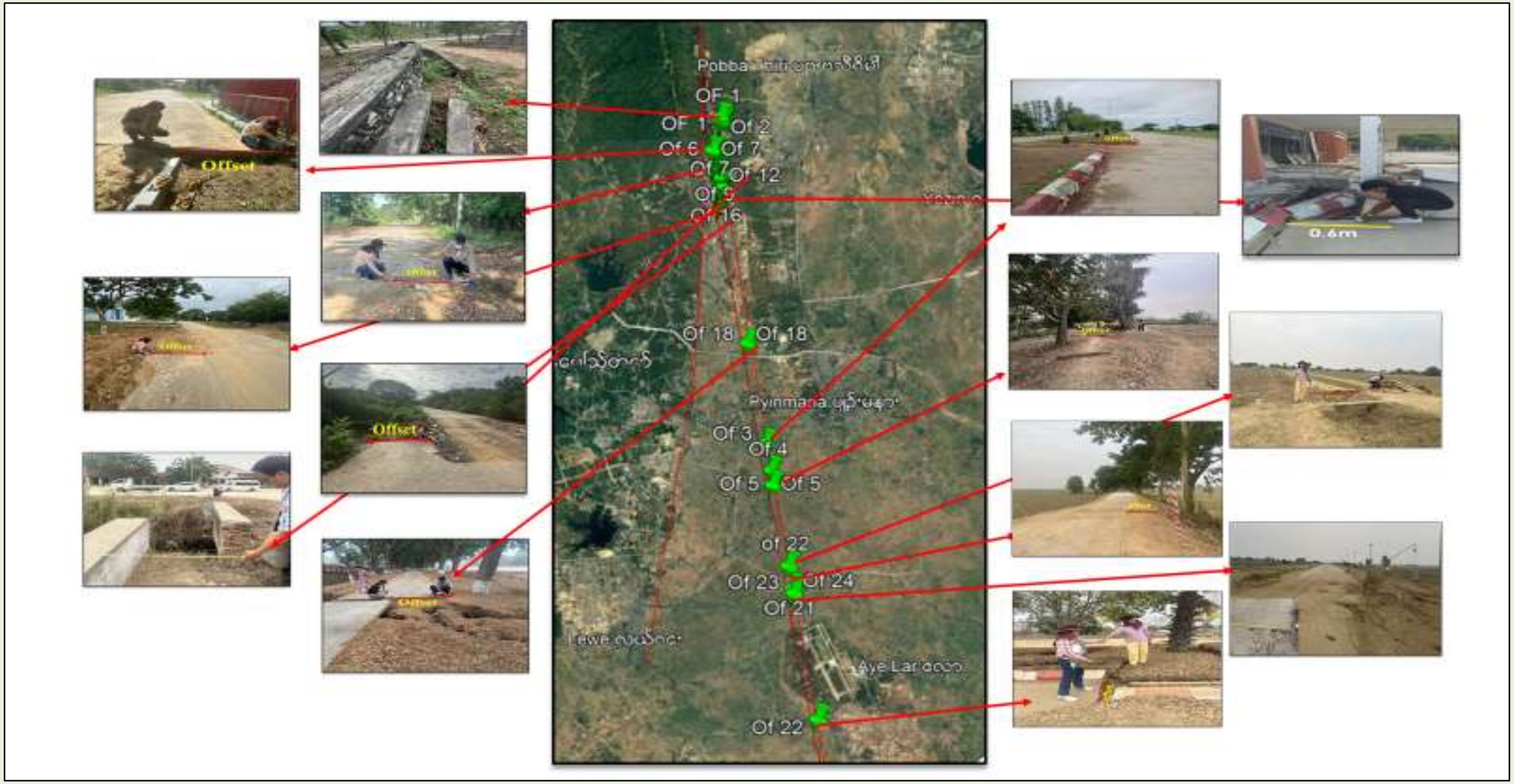
PDZ- principal displacement zone



Thabeikkyin earthquake (2012)

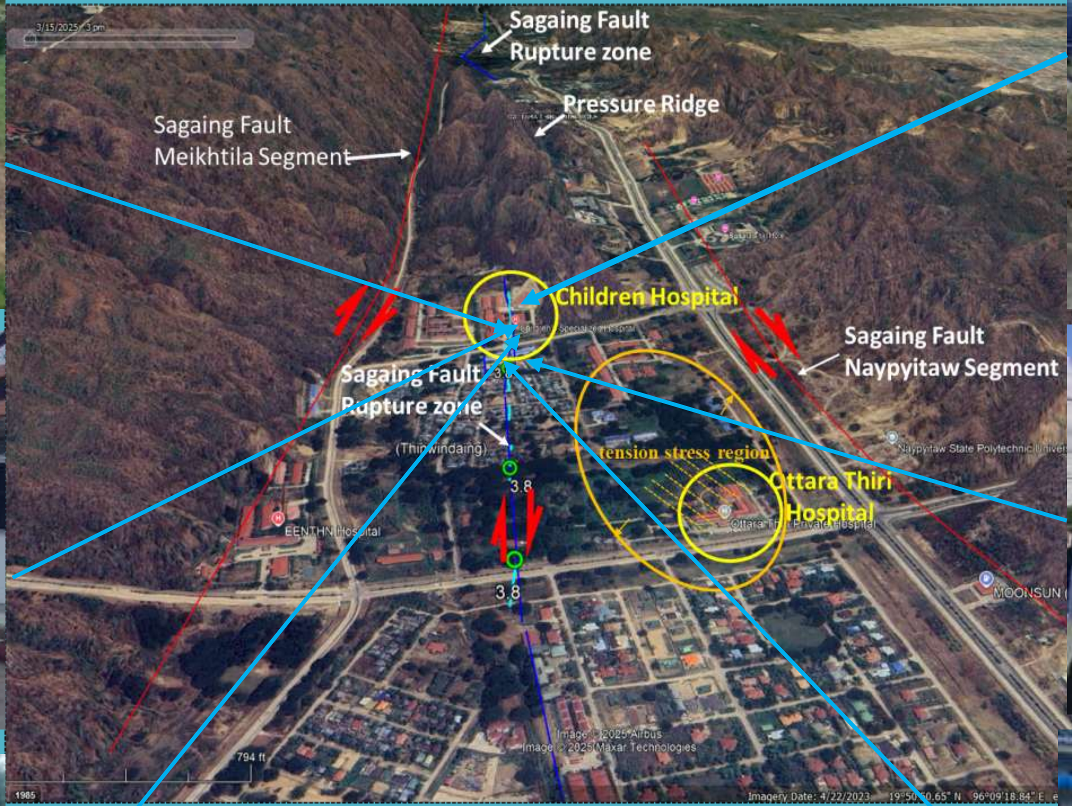
Mandalay Earthquake (2025)

Coseismic Structures of Mw 7.7 in Nay Pyi Taw Region



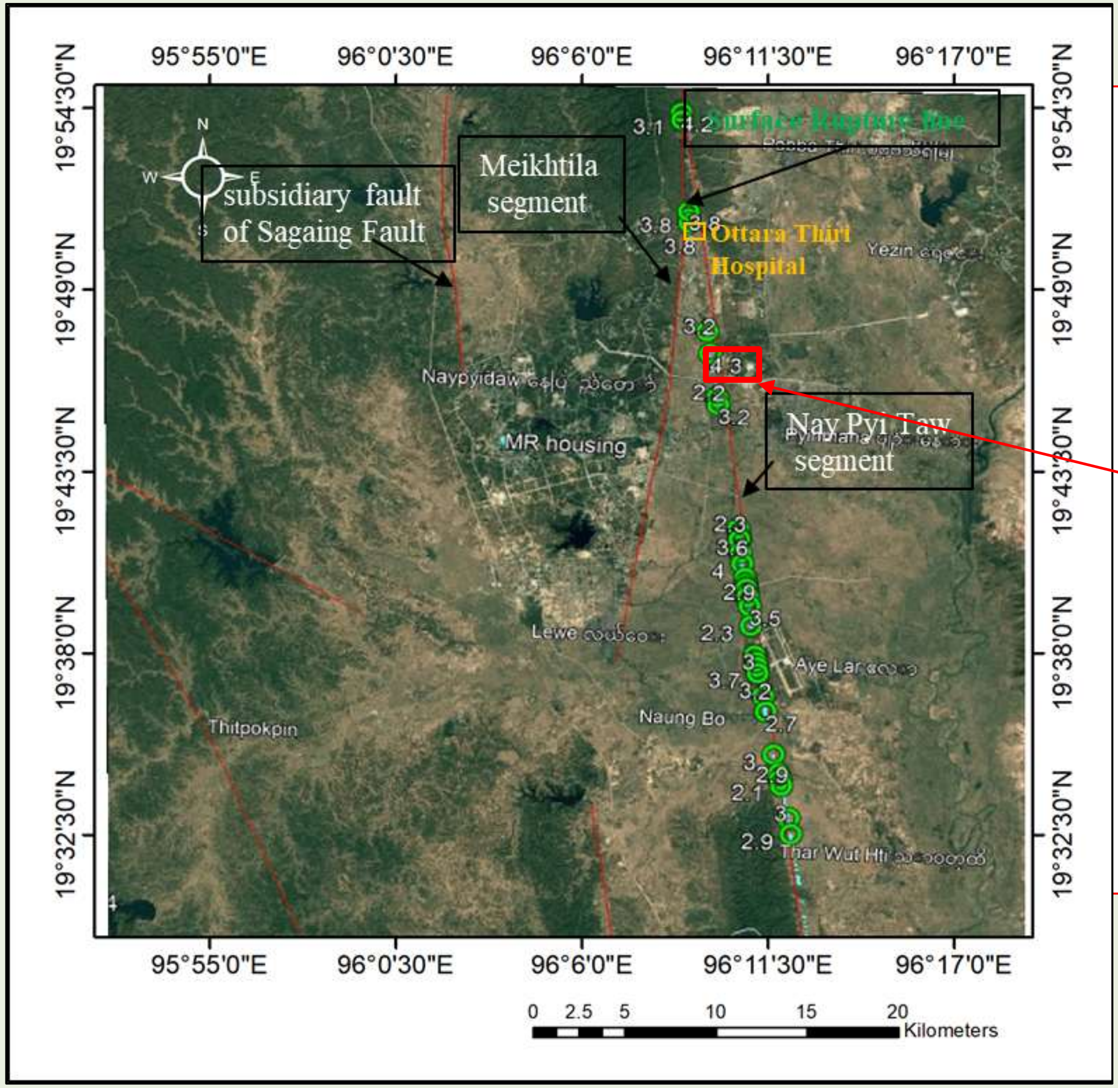
Some Offset features along the surface ruptures

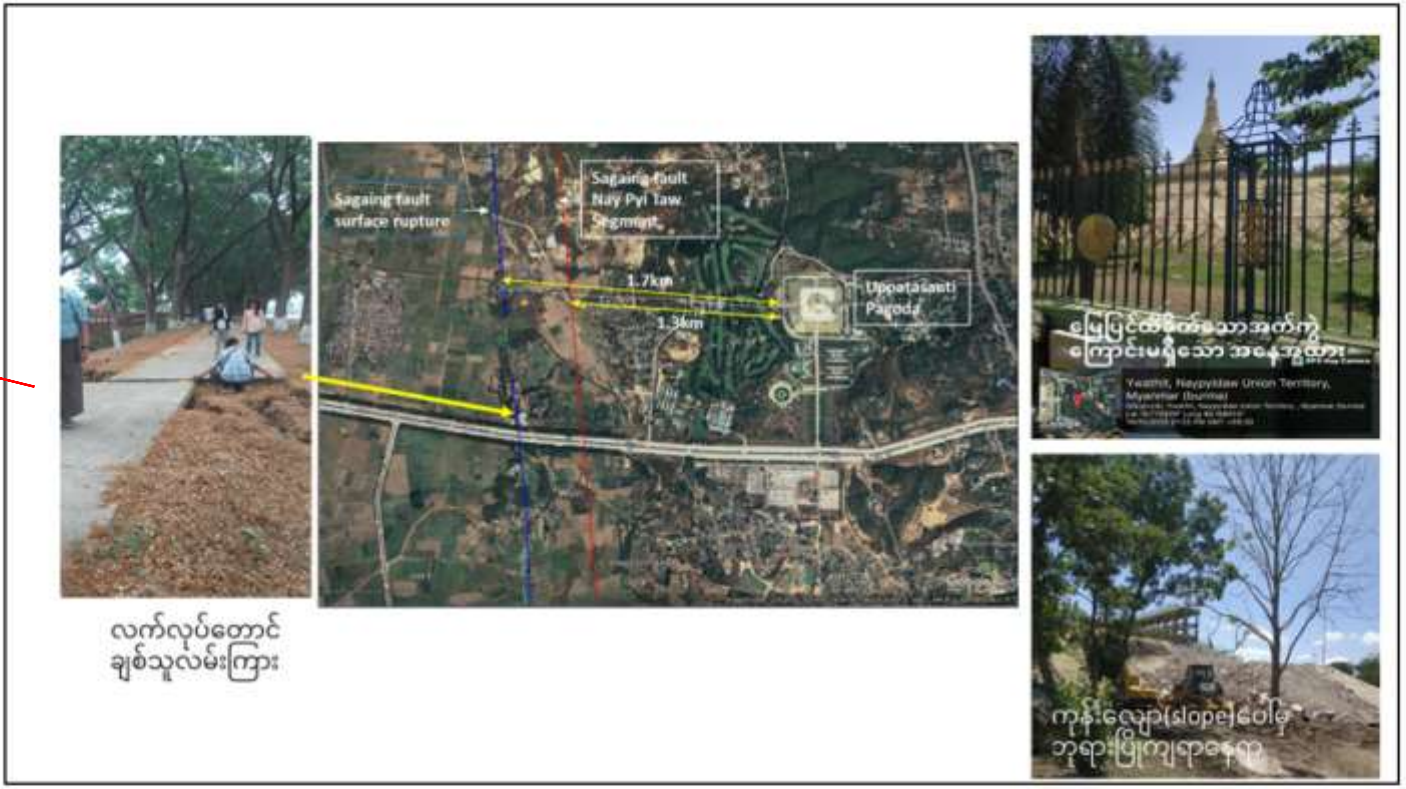
3/15/2025 3 pm
Sagaing Fault
Rupture zone
Pressure Ridge
Sagaing Fault
Meikhtila Segment
Children Hospital
Children's Specialized Hospital
Sagaing Fault
Naypyitaw Segment
Sagaing Fault
Rupture zone
(Thinwindaing)
3.8
3.8
3.8
tension stress region
Ottara Thiri
Hospital
Ottara Thiri Private Hospital
EENTHN Hospital
Naypyitaw State Polytechnic University
MOONSUN (M2K)
Image © 2025 Airbus
Image © 2025 Maxar Technologies
794 ft
1985
Imagery Date: 4/22/2023 19°50'50.65" N 96°09'18.84" E elev 471 ft eye alt 4273 ft
Google Earth

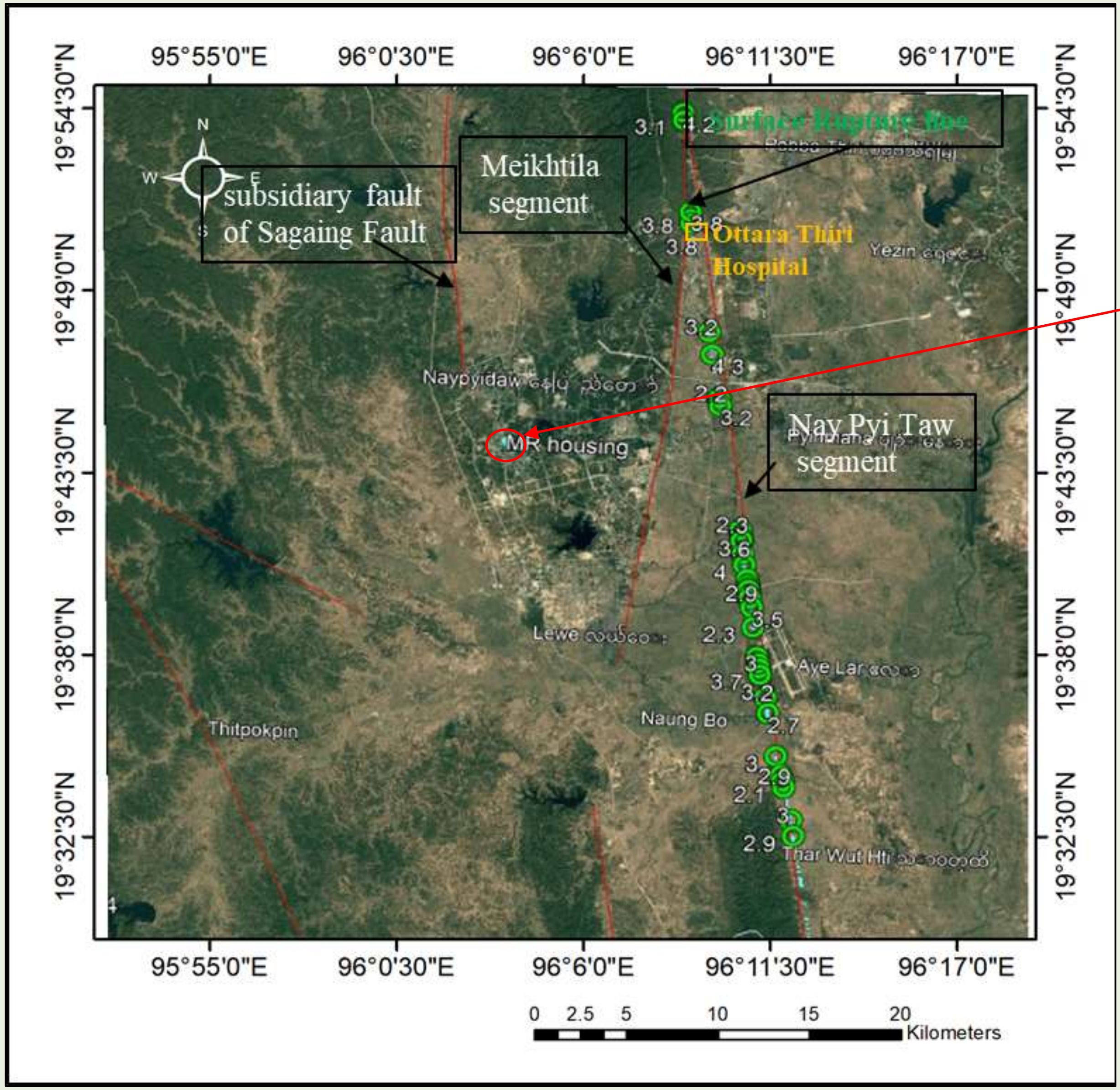


ဥတ္တရသီရိ ကလေးဆေးရုံ ထိခိုက်မှုအနေအထားအချို့

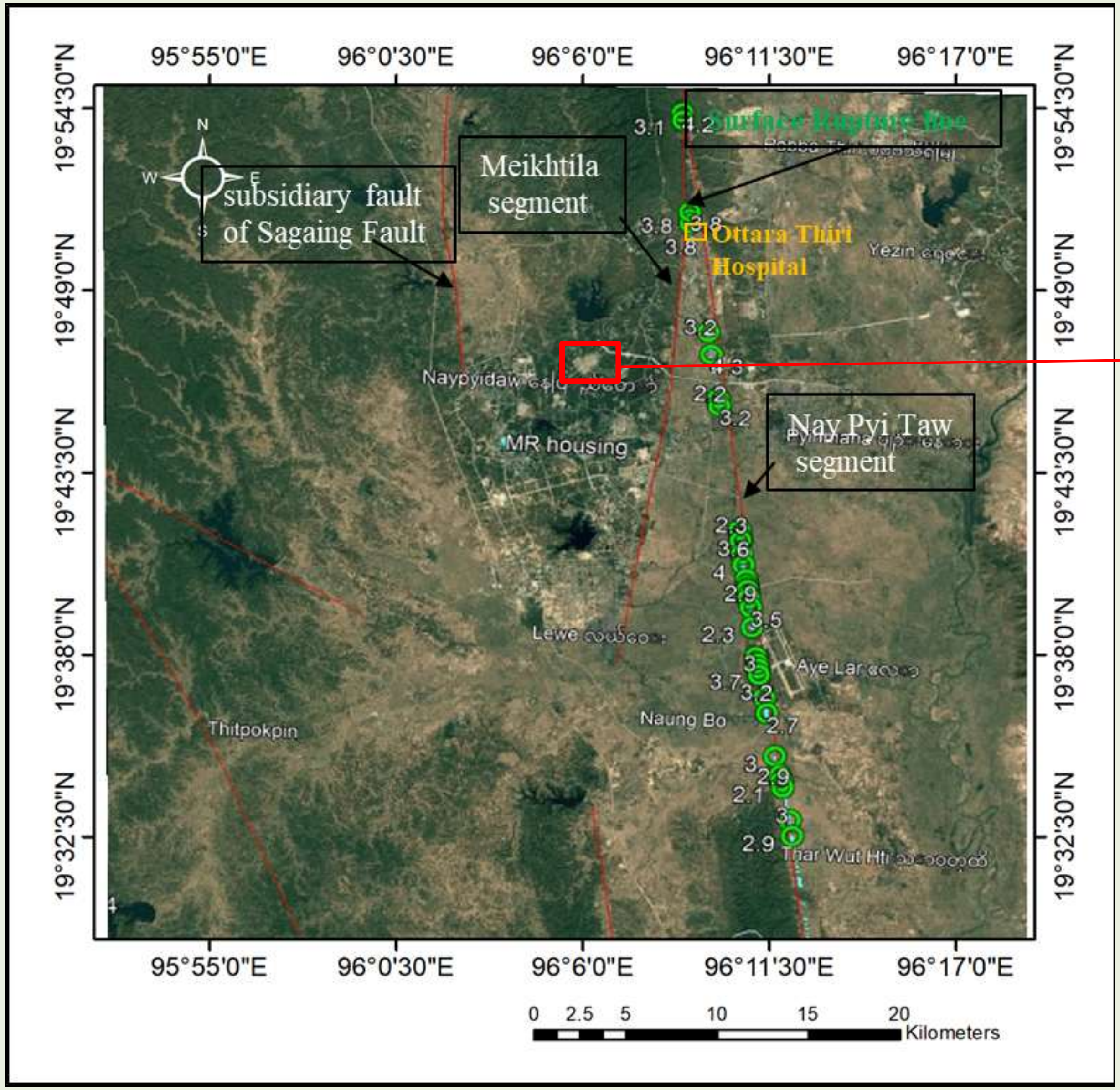
Ground Settlement Along Shear Fracture during earthquake shaking
Sagaing Fault Rupture zone
Pressure Ridge
Children Hospital
Sagaing Fault Naypyitaw Segment
tension stress region
Ottara Thiri Hospital
shear cracks
shear fracture (Ground deformation)
left lateral horizontal offset in E-W direction (~1ft)
3.8
3.8
3.8
Image © 2025 Airbus
Image © 2025 Maxar Technologies
794 ft
Imagery Date: 4/22/2023


95°55'0"E
96°0'30"E
96°6'0"E
96°11'30"E
96°17'0"E
19°54'30"N
19°49'0"N
19°43'30"N
19°38'0"N
19°32'30"N
subsidiary fault of Sagaing Fault
Meikhtila segment
Ottara Thiri Hospital
Nay Pyi Taw segment
Naypyidaw
MR housing
Lewe
Aye Lar
Naung Bo
Thitpokpin
Thar Wut Hti
Yezin
0 2.5 5 10 15 20 Kilometers


Sagaing fault surface rupture
Sagaing fault Nay Pyi Taw Segment
1.7km
1.3km
Uppatasanti Pagoda
လက်လုပ်တောင်
ချစ်သူလမ်းကြား

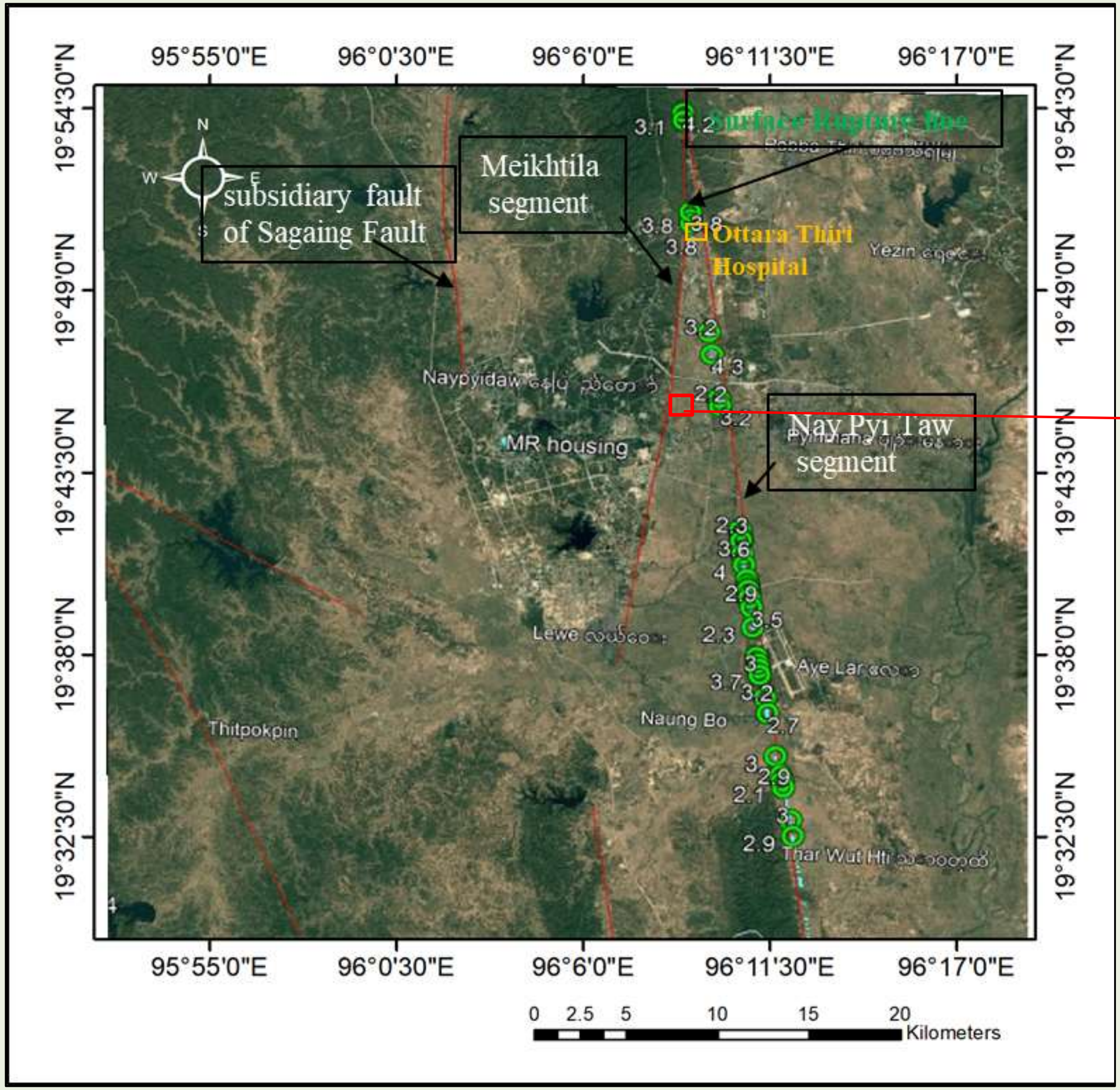


ခရေအိမ်ရာ ထိခိုက်ပျက်စီးမှု အချို့ပျက်စီးမှု အနေအထားပြပုံ

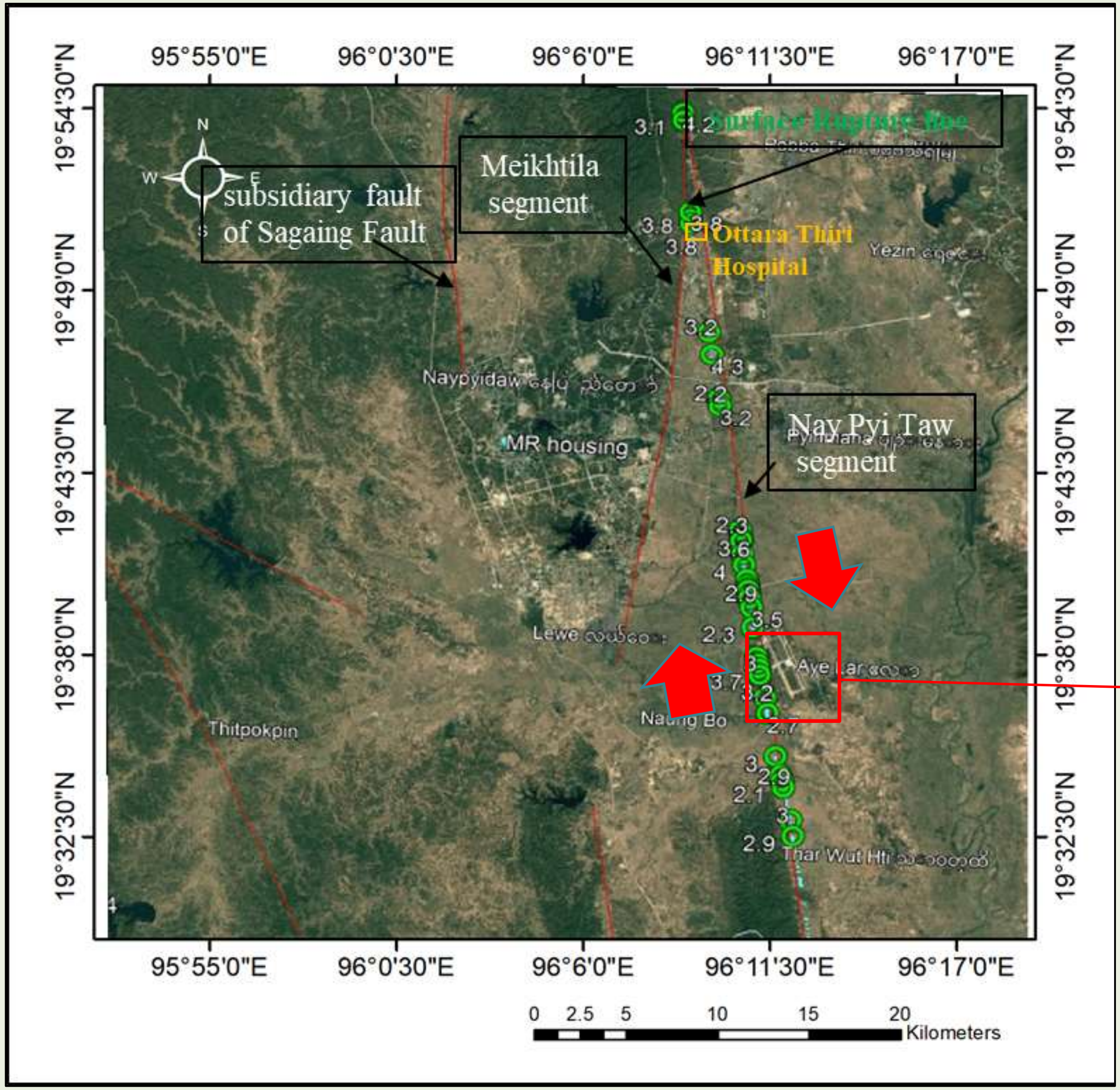


Damages at the Northwest part

Damages at the Northeast part



Liquefaction at Nyaungpingyisu village



Nay Pyi Taw Air Port, controlling tower

- The Nay Pyi Taw region was affected by the 1929 Swa earthquake surface rupture.
- Intense deformation due to the 2025 Mw7.7 Mandalay earthquake.
- Damages due to both along surface fault rupture and strong ground motion of seismic waves.
- Surface rupture represented the reactivation of a preexisting fault.
- That can be considered the future recurrence of fault location and can be prepared to face it.

Thank You For Your Kind Attention