

International Conference on Silk-roads Disaster Risk Reduction and Sustainable Development, Beijing International Convention Center, China, 11-12 May 2019



**Geohazards of Myanmar
(Events & Mitigation Activities)**

**Myint Naing
Exploration Geologist**

**Department of Geological Survey and Mineral Exploration
Ministry of Natural Resources and Environmental Conservation**

CONTENTS

1. Country Profile

2. Regional Geology

3. Geohazards of Myanmar

- ❖ EARTHQUAKE
- ❖ LANDSLIDE
- ❖ TSUNAMI
- ❖ Mud Volcano

4. Conclusion



LOCATION



Ethnic groups

Bamar-68%, Shan-9%, Kayin-3.50%, Rakhine-3.50%, Mon.-2%, Kachin-1.25%, Kayah -0.75 % and Chinese -2.50%, Indian-1.25%, Other -4.5%

Location

Lat. 9°58' - 28°31'N,
Long. 92°9' 100°10'E

Capital and Largest city

Rangoon (Yangon), 4,477,638
Naypyidaw (administrative capital)

Monetary Unit

kyat

Area

Land area - 657,741 sq. km
Total area - 677,000 sq. km

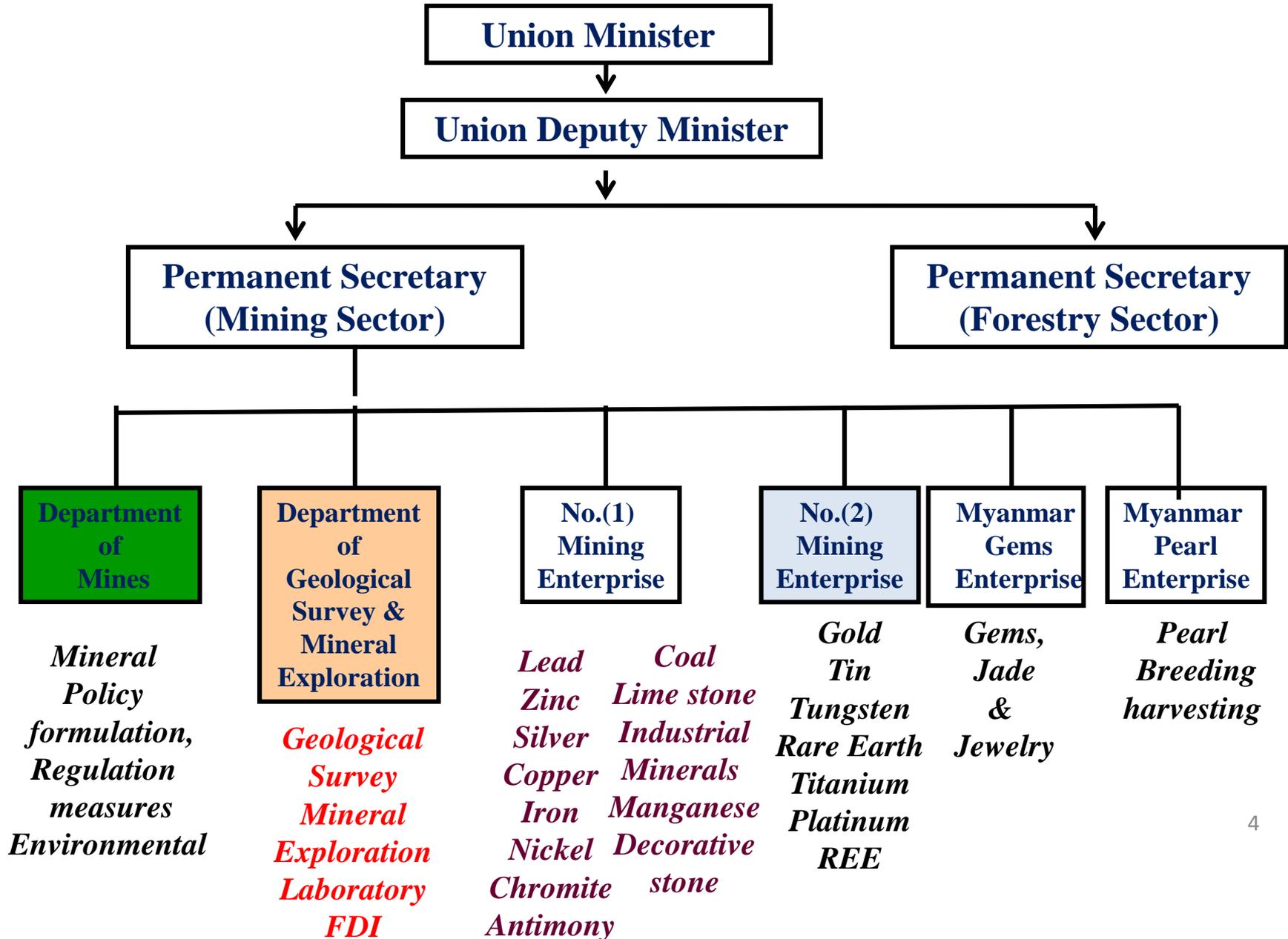
Climate

Tropical and Sub-tropical
Three seasons (Rainy, cold and summer)
The maximum temp:- from 31 to 42°C
The minimum temp:- from 0.3 to 13.4°C

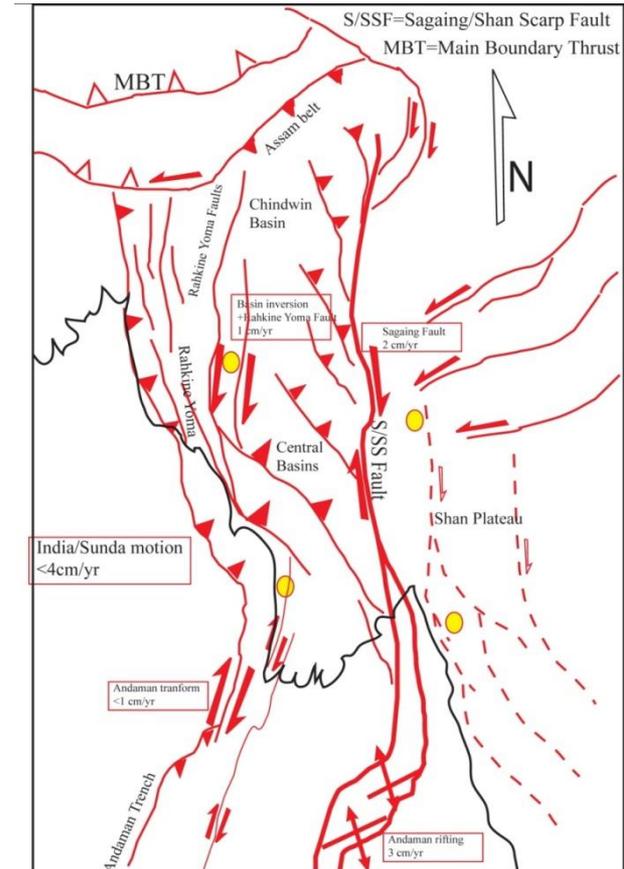
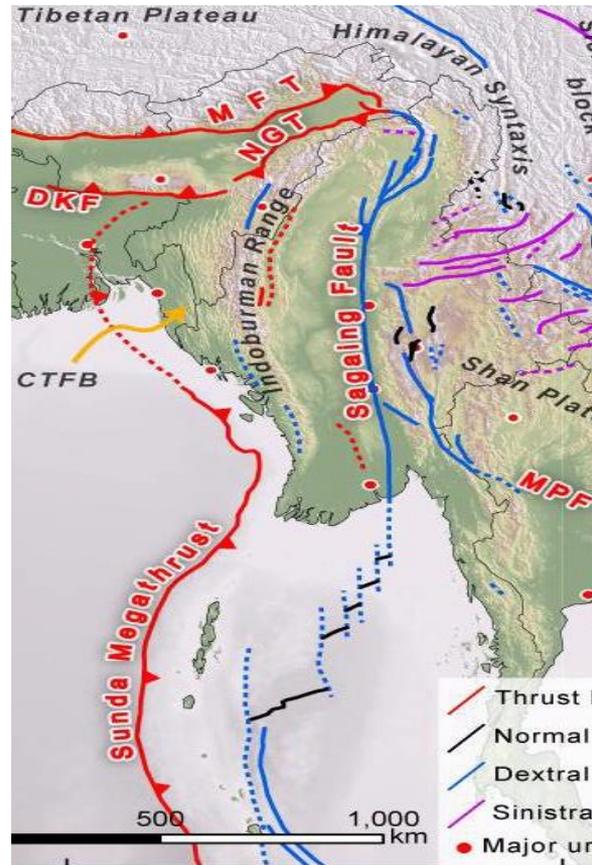
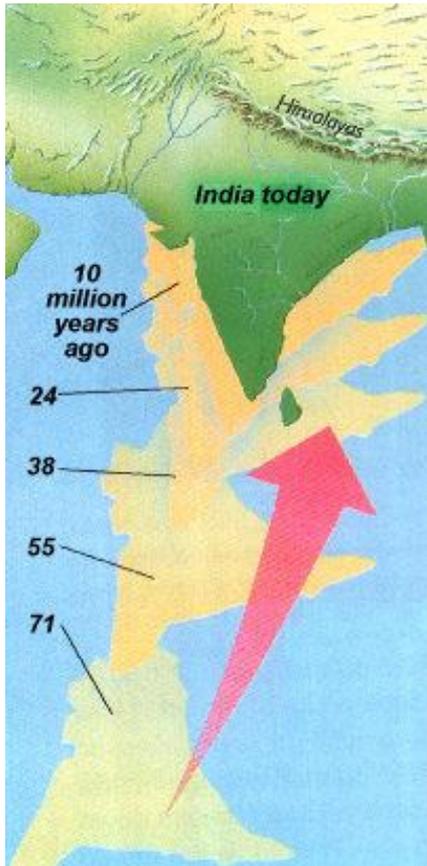
Population

- 54.246 millions (2019)
Growth - 0.89%
Urban - 20.259 millions (37.3%)
Rural - 33.987 millions (62.7%)
Density - 83 (per Sq Km)

Organization Chart of the Ministry

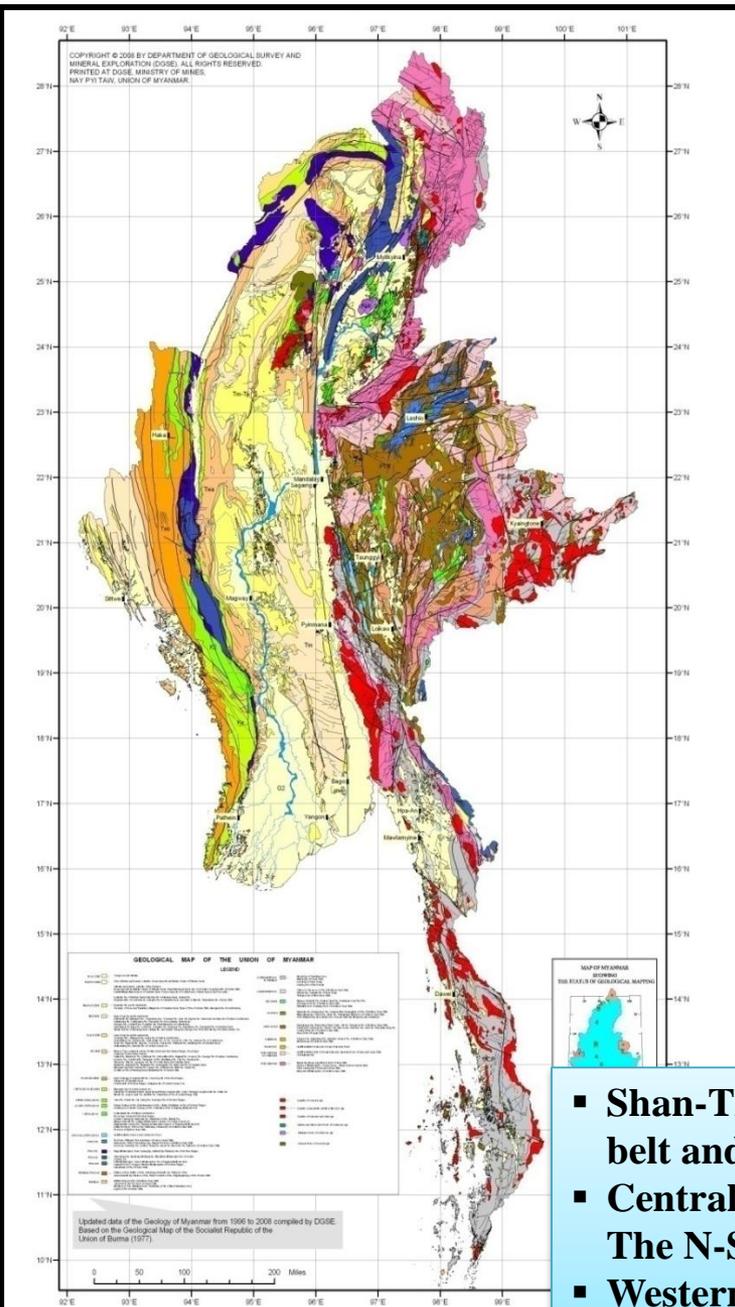


The regional tectonic setting of Myanmar as a result of Indian-Asian collision



- The northward-moving Indian Plate underneath the Burma Platelet at an average rate of 3.5 cm/yr.
- The northward movement of the Burma Platelet from a spreading centre in the Andaman Sea at an average rate of 2.5–3.0 cm/yr.

Geological Map of Myanmar (2008)



LEGEND

- Holocene Rocks
- Pleistocene Rocks
- Miocene-Pliocene Rocks
- Miocene Rocks
- Oligocene Rocks
- Eocene Rocks , Molasse Type
- Eocene Rocks, Flysch Type
- Cretaceous Rocks
- Jurassic-Cretaceous Rocks
- Jurassic Rocks
- Triassic Rocks
- Permian-Triassic Rocks
- Upper Paleozoic Rocks
- Paleozoic Rocks
- undifferentiated Mainly Upper and partly Lower Paleozoic
- Paleozoic Rocks
- Cambrian Rocks
- Precambrian Rocks
- Low grade metamorphic Rocks (of greenschist facies)
- Metamorphic Rocks (undifferentiated)
- Mesozoic & Cenozoic Granites
- Paleozoic Granites
- Gabbro and related intrusives
- Ultrabasic and basic intrusive
- Volcanic Rocks (mainly Cenozoic)

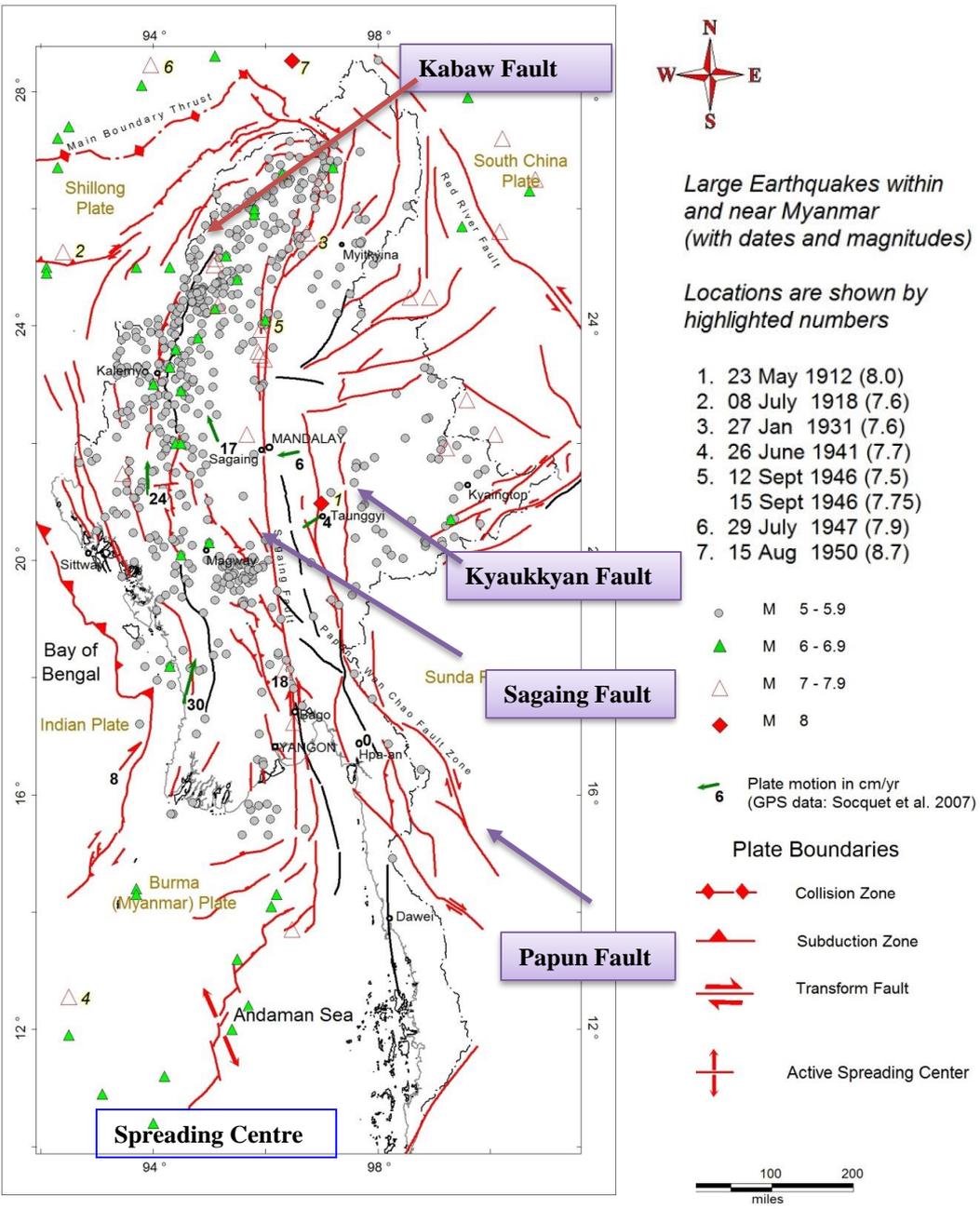
JICA
Digital Geological
Mapping Project
2005 - 2008

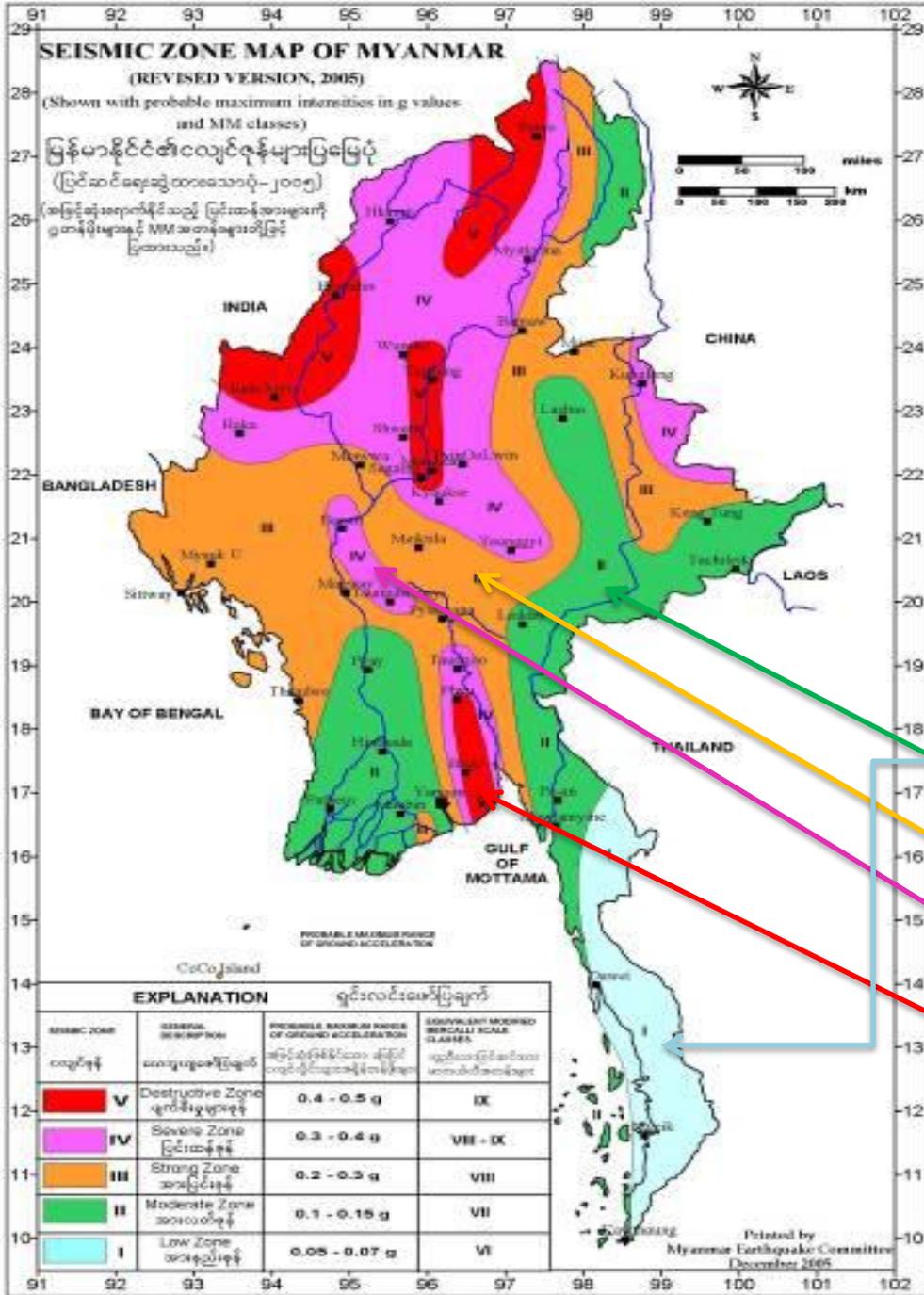
- **Shan-Thai Block includes Precambrian to cretaceous rocks with Slate belt and Mogok Metamorphic belt to the west.**
- **Central Tertiary sedimentary basins with oil-gas and coal occurrences. The N-S trending Central Magmatic Belt at the centre.**
- **Western Ranges- fold-thrust belt with Chin flysch.**

Seismotectonic map

➤ Earthquakes in Myanmar have resulted from *two main causes* :

- 1) The continued subduction (with collision only in the north) of the northward-moving Indian Plate underneath the Burma Platelet (which is a part of the Eurasian Plate) at an average rate of 3.5 cm/yr; *and*
- 2) The northward movement of the Burma Platelet from a spreading centre in the Andaman Sea at an average rate of 2.5 – 3.0 cm/yr (Bertrand et al., 1998; Curray, 2005)
 - ❖ The well-known and seismologically very active Sagaing Fault

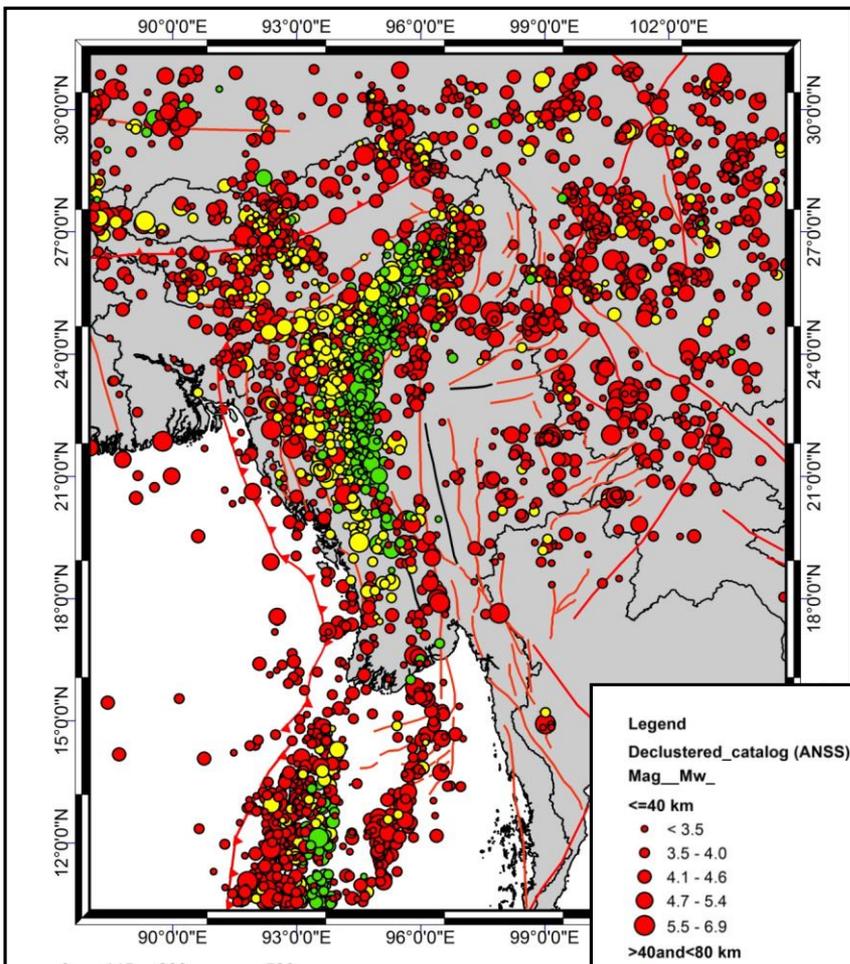




The seismic zone map of Myanmar (2005) was prepared by a team led by Dr Maung Thein during 2003 to 2005

➤ Five seismic zones are demarcated and named (from low to high)

- Zone I (Low Zone),
- Zone II (Moderate Zone),
- Zone III (Strong Zone)
- Zone IV (Severe Zone), and
- Zone V (Destructive Zone)



Earthquakes in myanmar

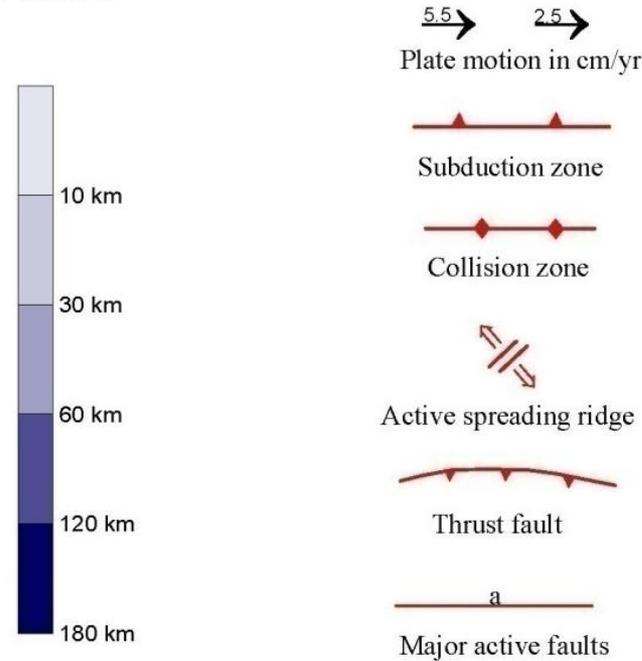
Type	Richter Magnitude	Frequency	Time Range	Data Source
Great	> 8	1	1839-2008	Historical record and NEIC
Major	7-7.9	15	1839-2008	Historical record and NEIC
Strong	6-6.9	25	1950-2008	ANSS Catalogue
Moderate	5-5.9	549	1950-2008	ANSS Catalogue

Seismicity of Myanmar

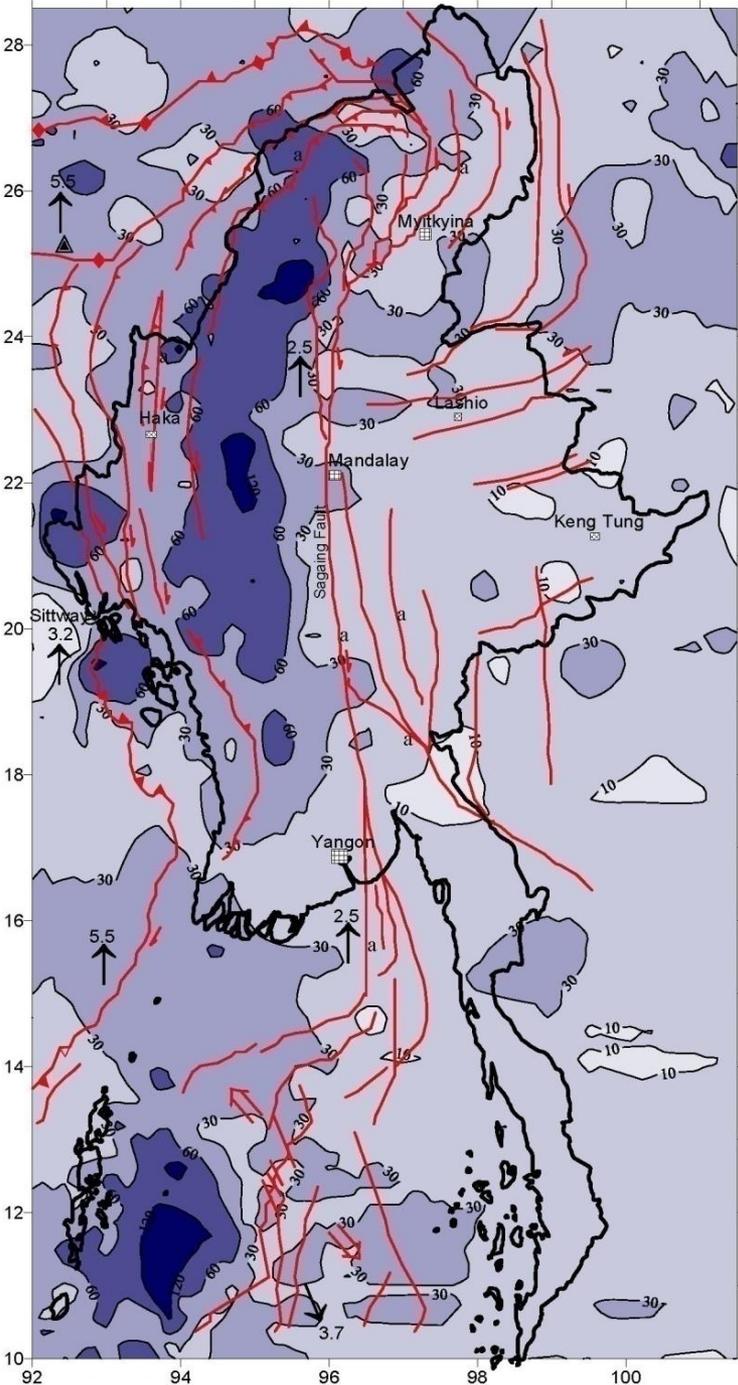
Declustered ISC catalog
 (with complement of IRIS
 catalog)

Earthquake Focal Depth Contour Map

LEGEND

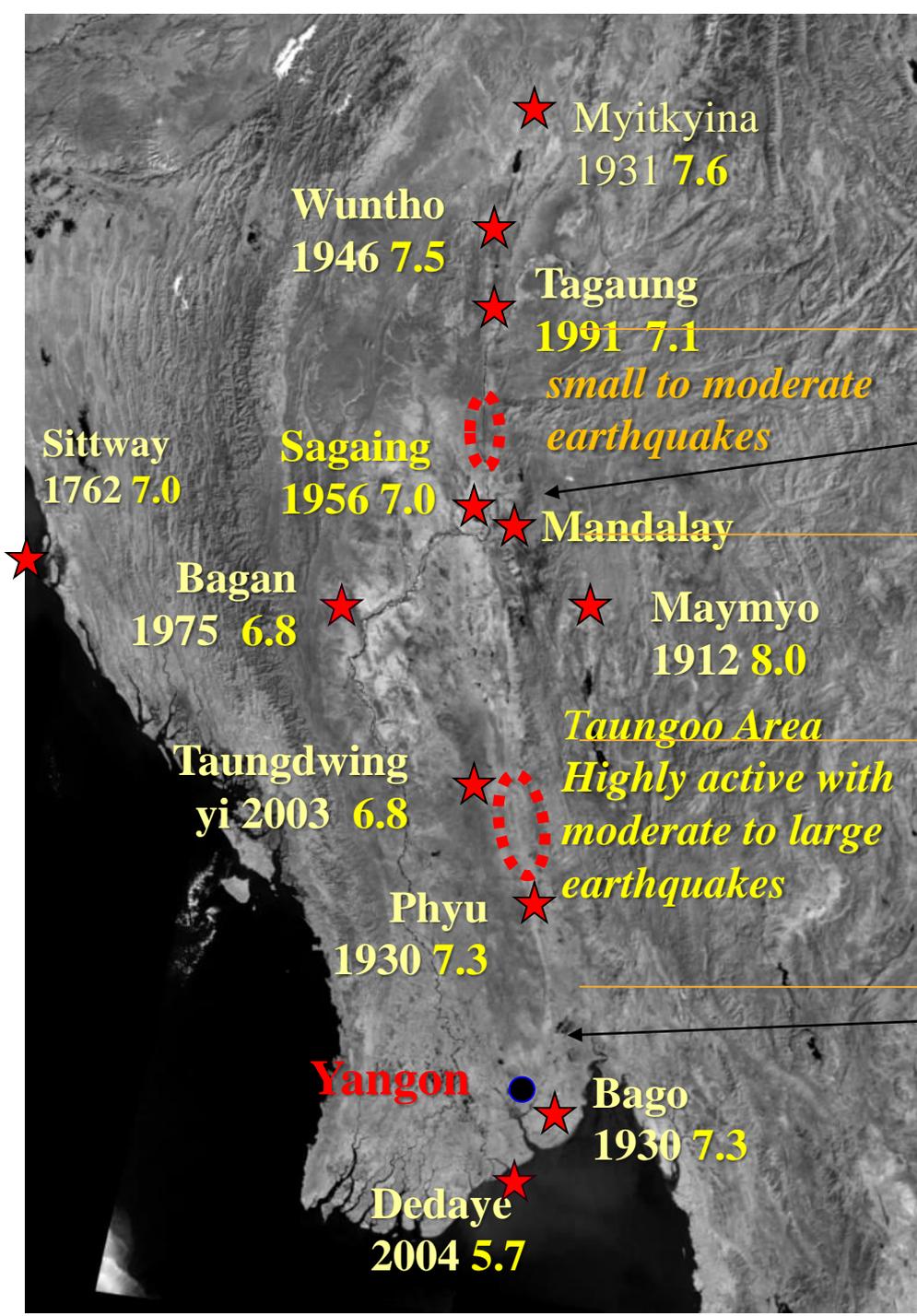


**(Maung Thein and
Tint Lwin Swe, 2006)**



- ❖ Earthquake focal depth contour of Myanmar Region in period of 1964-2004
- ❖ Intermediate earthquakes occur only in the Western Fold Belt while the other parts of Myanmar experience shallow crustal earthquakes
- ❖ The locations of major faults are superimposed on the focal depth zones

Significant Earthquakes



Historic earthquakes in AVA Era

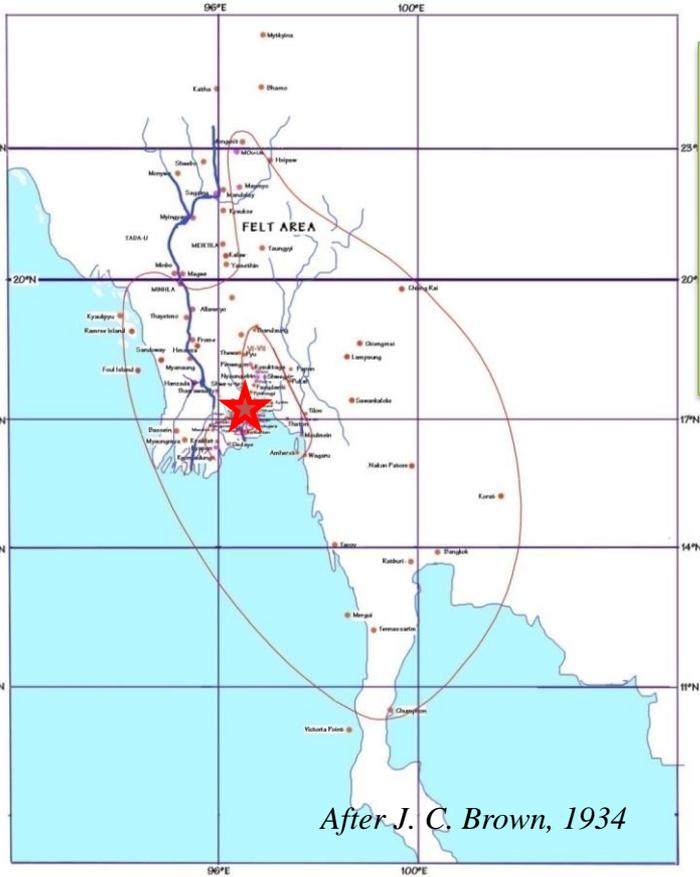
1429, 1467, 1501, 1602, 1696, 1762, 1771, 1776, 1830, **1839**

Historic Earthquakes in Bago

868, 875, 1564, 1567, 1582, 1588, 1590, 1757, 1768, 1830, 1888, 1913, 1917, 1920, 1930

1930 Bago Earthquake, MW 7.3

Taungdwingyi Earthquake



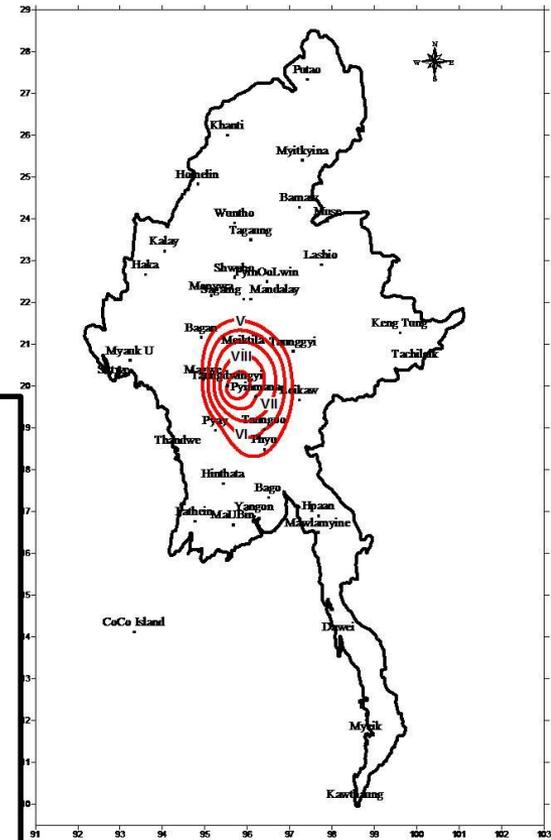
Historical Earthquakes in Bago (AD)

868, 875, 1564, 1567, 1582, 1588, 1590, 1757, 1768, 1830, 1888, 1913, 1917, 1920, 1930

Taungdwingyi Earthquake

(22 September, 2003)

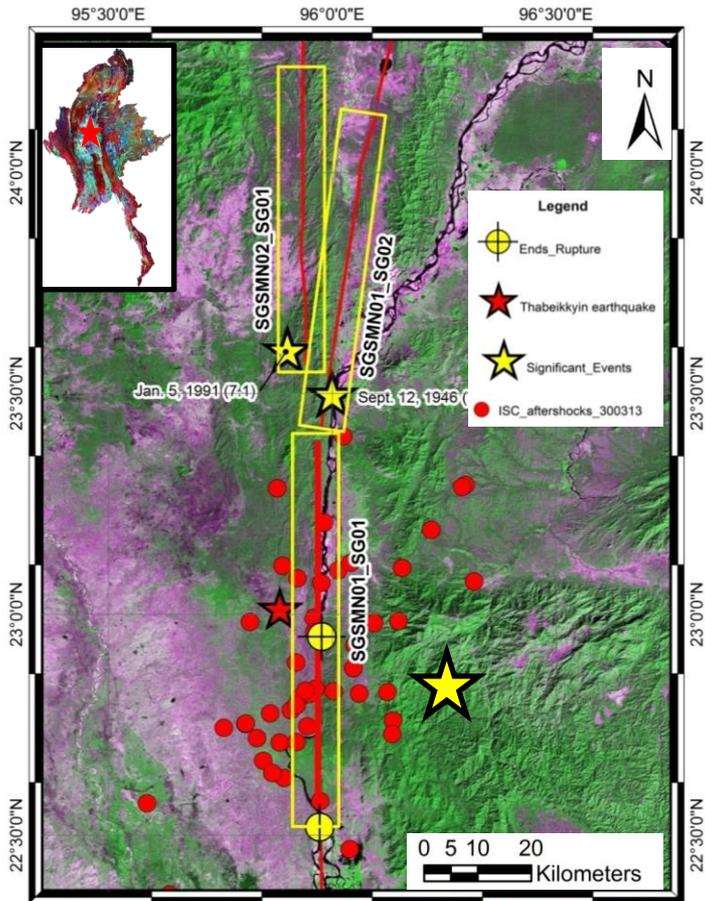
- ❖ 00:46:54 MST
- ❖ 6.8 on magnitude Scale
- ❖ Depth – 10km
- ❖ 7 death, 42 Injure, 180 houses damaged, 182 Pagodas collapsed



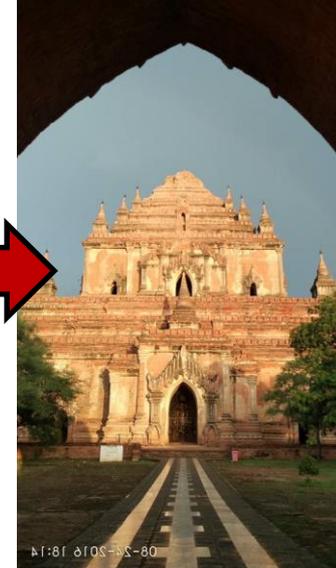
Top portion of the pagoda fallen down by 1917 Bago Earthquake



2012 Thabeikkyin Earthquake



6.8 Mw Bagan Earthquake, Myanmar (24.Aug.2016)



23 Aug 2016

24 Aug 2016

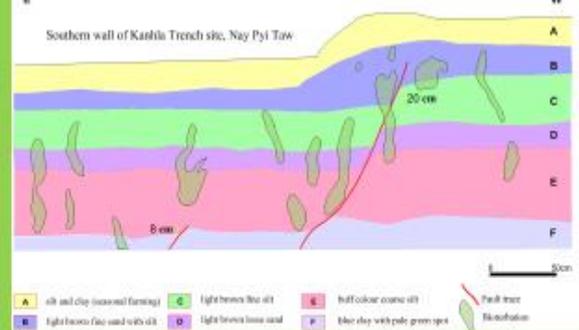
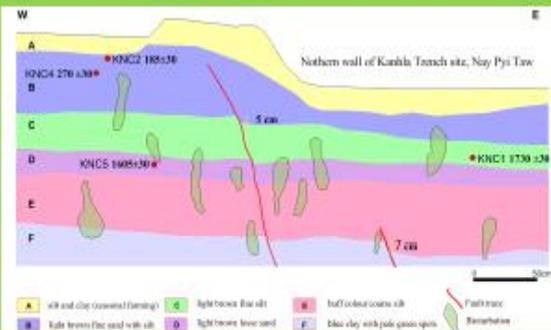
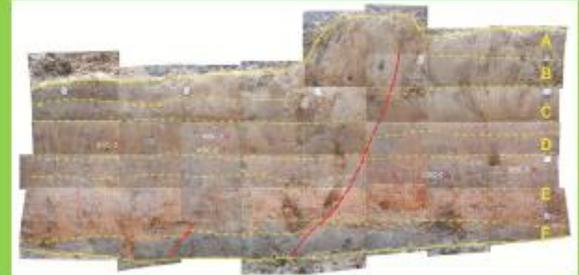
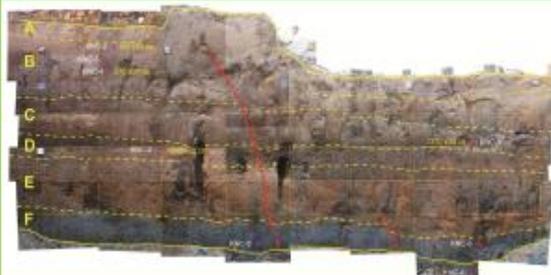
- ❑ Mw – 6.8, (about 10 km focal depth)
- ❑ Nov. 11, 2012 (7:50 am, Local time)
- ❑ 26 casualties, 231 injuries
- ❑ various sort of buildings (>500) damaged
- ❑ Source – right- lateral Sagaing Fault

Sept 12, 1946, 15:17:15 (7.3)
 Sept 12, 1946, 15:20:20 (7.5)
 Gutenberg & Richter, 1954

Paleoseismic study across the Sagaing Fault near Nay Pyi Taw



Trench site 1 (Kanhla Trench)

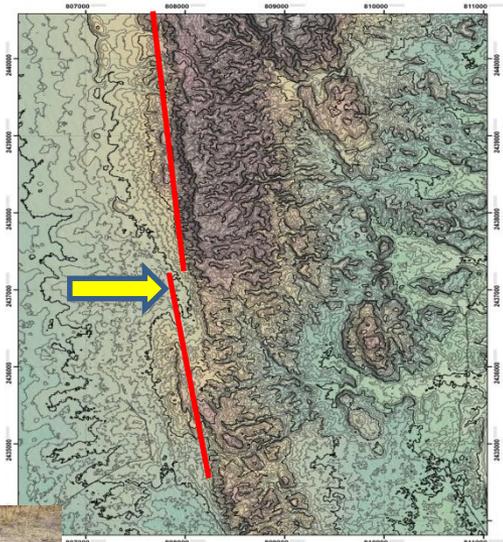
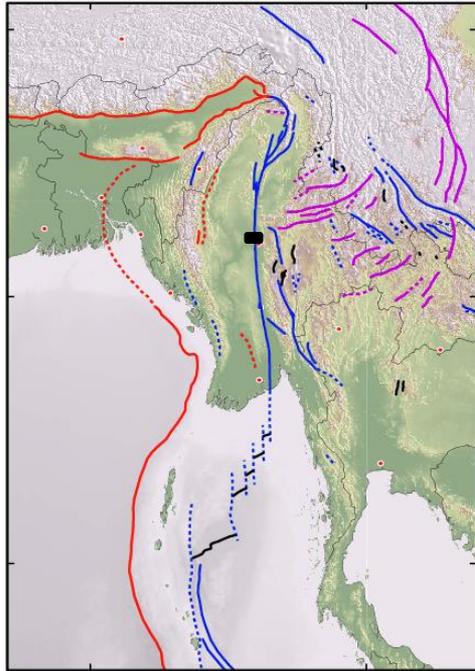


- > 5 cm vertical offset of sediment "B" layer
- > 185 ± 30 BP

- > 20 cm vertical offset of sediment "B" layer



Earthquake Geology Field Train along the Sagaing fault (March, 2016)



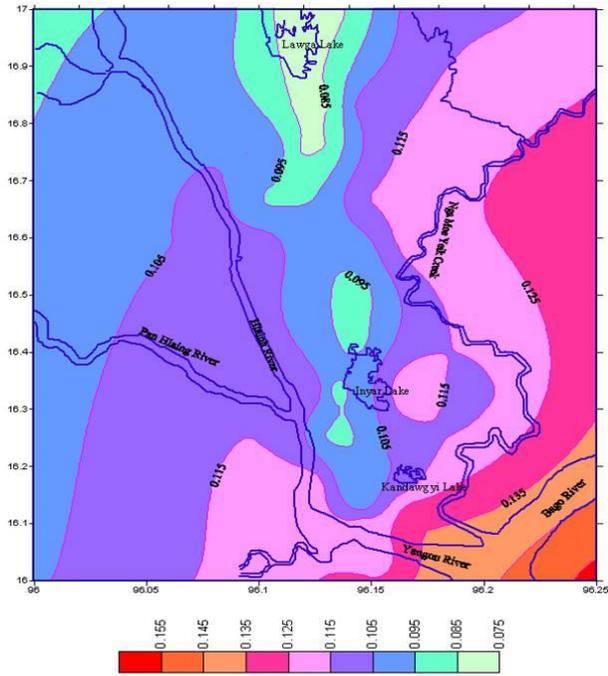
Supported by Earth Observatory of Singapore and Sloan Foundation

- ❖ Paleoseismology
- ❖ Geological mapping of active fault
- ❖ GPS survey
- ❖ Ground LiDAR topography survey

- North of the Yae Khar Lake, between Yae Khar Village and Yuan Da Yah Village
- Small valley within the fault zone that Wang Yu interpreted as a right step over along the fault



Yangon seismic zone map



EARTHQUAKE ZONING MAP OF YANGON AREA (TINT LWIN SWE, 2004)

Characteristic earthquake of 7.3 Mw and mean ground motion at firm rock using attenuation relationship of NWA Model (Boore et al, 1997).

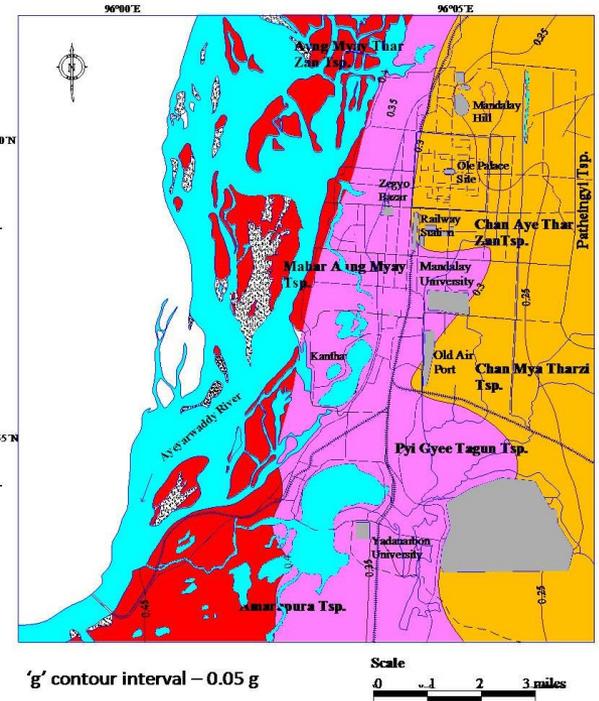
Mandalay seismic zone map

EXPLANATIONS

Seismic Zone	General Description	Probable Range of Ground Acceleration	Equivalent Modified Mercalli Scale Classes
■	Destructive zone	0.4 - 0.5 g	IX
■	Severe Zone	0.3 - 0.4 g	VII - IX
■	Strong Zone	0.2 - 0.3 g	VIII

LEGEND

- Stream
- reservoir, lake, pond
- Landmark
- Railway & car road
- "g" value contour line
- Fault



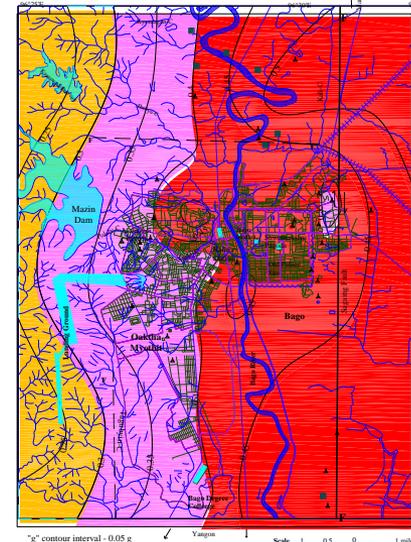
Seismic zone map of Bago-Oakthar Myothit

Seismic zone map of Taunggyi and Ayethayar

SEISMIC ZONE	GENERAL DESCRIPTION	PROBABLE MAXIMUM GROUND ACCELERATION	EQUIVALENT MODIFIED MERCALLI SCALE CLASSES
■	Destructive Zone	0.4 - 0.55 g	IX
■	Severe Zone	0.3 - 0.4 g	VIII - IX
■	Strong Zone	0.2 - 0.3 g	VIII

LEGEND

- Railway
- Peak and elevation
- Landmark
- Car road
- Dam and Reservoir
- Contour with Elevation



EXPLANATIONS

Seismic Zone	General Description	Probable Range of Ground Acceleration	Equivalent Modified Mercalli Scale Classes
■	Destructive zone	0.4 - 0.5 g	IX
■	Severe Zone	0.3 - 0.4 g	VII - IX
■	Strong Zone	0.2 - 0.3 g	VIII

LEGEND

- Stream
- reservoir, lake, pond
- Landmark
- Railway & car road
- "g" value contour line
- Fault

PGA in "g" value (in upper 30m)

Earthquake

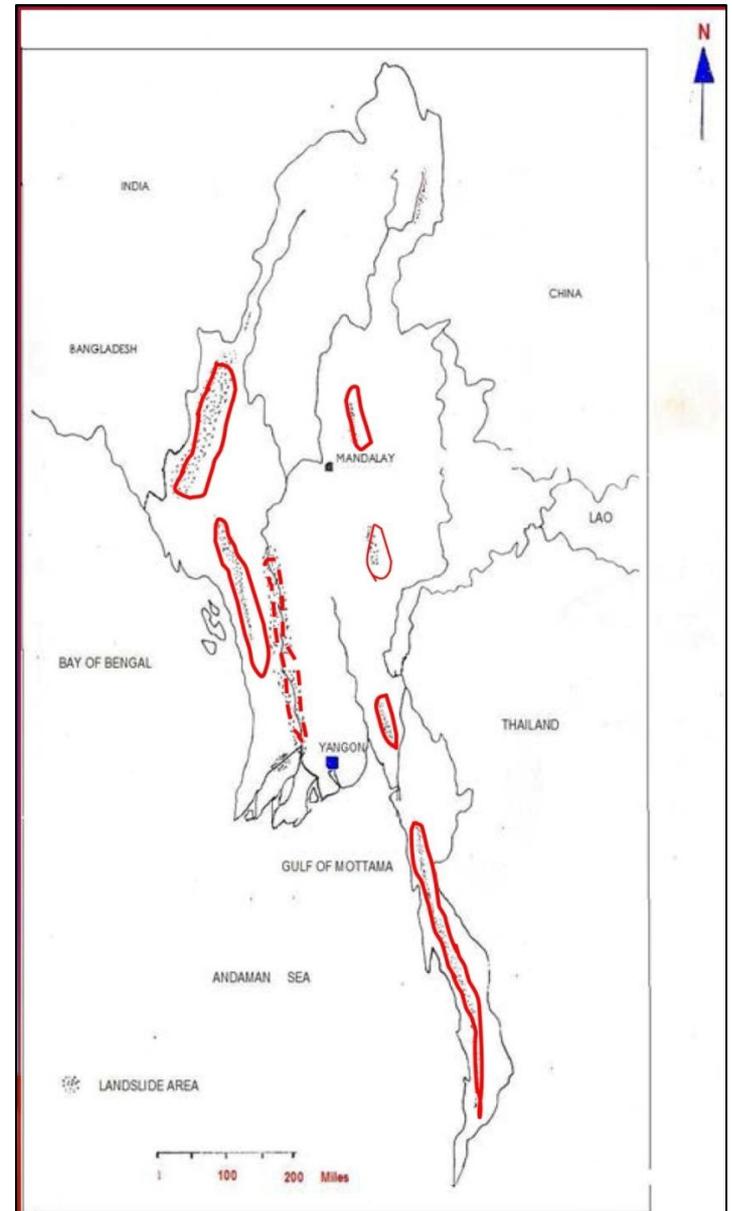
- 16 major eq. (magnitude >7) in last 170 years
- Urban centres Mandalay, Bago, Yangon, Taunggyi are along fault lines
- Department of Meteorology & Hydrology is the nodal agency for seismic monitoring
- Earthquake preparedness is very important

Future tasks and activities

- ❖ Continuation, extension, and expansion of the active fault studies along the Sagaing, Kyaukkyan and Kabaw faults.
- ❖ Preparation of the PSHA map of Myanmar.
- ❖ Regular precise GPS measurements along the Sagaing Fault, especially between Bago and Mandalay.
- ❖ Training of some seismologists and earthquake engineers.
- ❖ Upgrading of the existing seismological stations, and then installation of some more modern-type seismological stations in some suitable locations, such as Hpa-an, Pathein, Bago, Pyinmana, Magway, Kalemyo, and Muse.

LANDSLIDE EVENTS IN MYANMAR

- The landslides of various scales occur in mountainous regions especially in the Western Ranges and some localities in the Eastern Highland of Myanmar.
- These provinces are inherently unstable nature of areas of the country.
- The steep slopes, unstable geologic conditions and heavy monsoon rains combine to make the mountainous areas one of the most hazard-prone areas in Myanmar.
- Even in central lowland between the two mountainous provinces, landslide features occur along the banks of lower Ayeyarwady river and its distributaries.
- Due to the sparse population, landslides in this region damage infrastructure rather than human settlements.



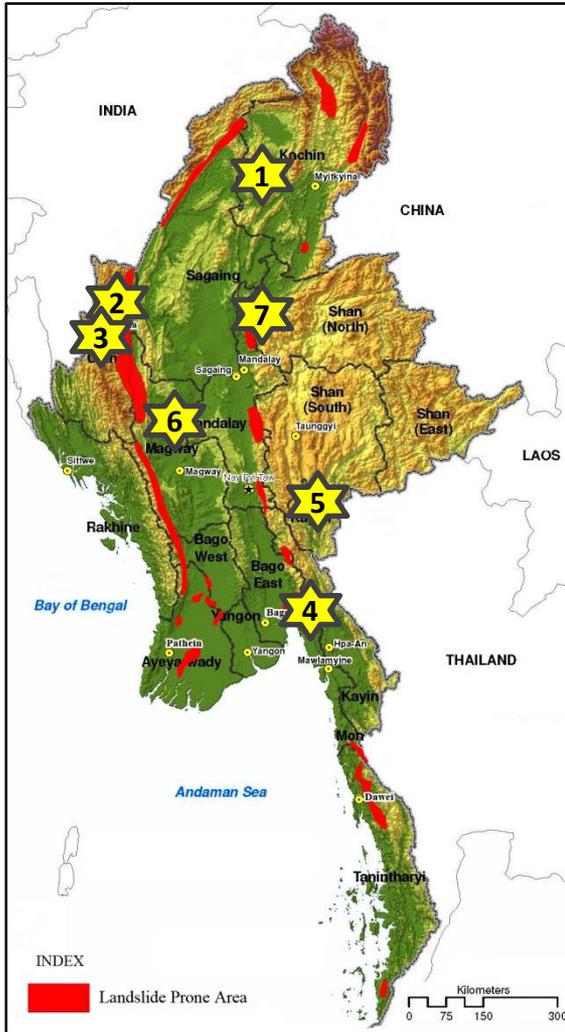
Landslide Hazard Zone Map of Myanmar

- The main factors that influence landslides in Myanmar are mainly classified as follow:
 - a) The gradient of the slope
 - b) Hydrologic characteristic of the slope
 - c) The presence of trouble some earth materials
 - d) The process of erosion
 - e) Man-made causes
 - f) Geological conditions
 - g) The occurrence of a triggering event

Lists of Some Historical Landslide in Myanmar

Year	Location	Name and Type	Triggering Process	Impact
1912	North of Taunggyi	Maymyo landslide	Earthquake	Serious landslide and ground cracks
1946	Tagaung	landslide	Earthquake	380 acres of crop damaged
1991	Tagaung	landslide	Earthquake	Some buildings destroyed
1999	Tanintheryi Ranges	landslide	Torrential rain	Buried some villages
2001	Nansang	Subsidence	Heavy rain	Two circular graven about 50 feet diameter appeared
2003	Taungdwingyi	landslide	Earthquake	Some slope and rain road along the western abutment of Pegu Yoma failure

Recent Landslide in Myanmar (2012-2017)



Landslide Prone Areas in Myanmar



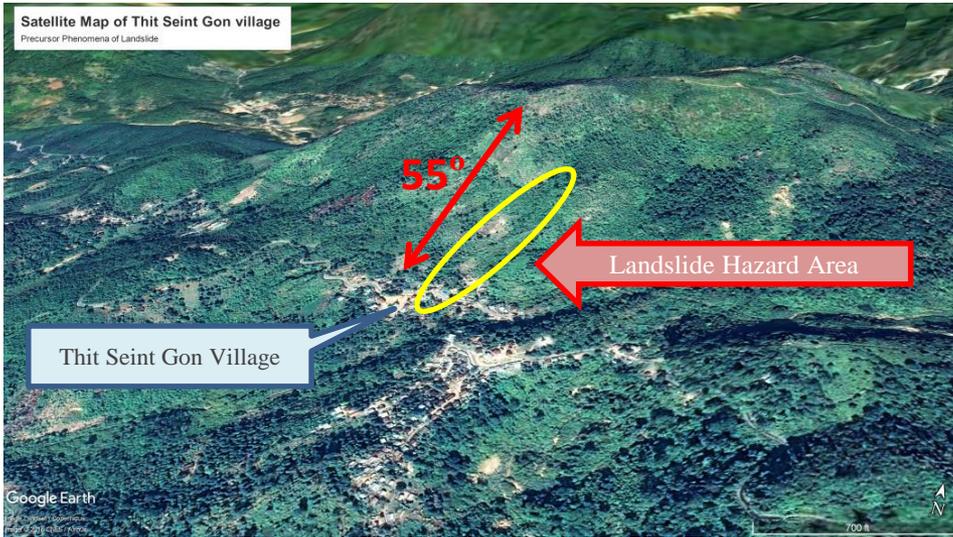
7. Thit Seint Gon Landslide

Many crack signs appeared and the car road was uplifted owing to creep the soil after the continuous heavy rains.

Sr.No	Name	Location	Year	Triggering Process
1	Hpakant Waste Dump Landslide	Hpakant, Kachin	2015,2016, 2017	Torrential Rain & Human Activities
2	Zalai & Laizo	Falam, Chin	2013	Heavy Rain
3	Vicinity of Hakha	Hakha, Chin	2013/2015	Heavy Rain
4	Vicinity of Kyaikhtiyoe Pagoda	Kyaikhto, Mon	2016	Heavy Rain
5	Mawchi Mine Landslide	Hapsaung, Kayah	2015	Heavy Rain
6	Popa Landslide	Kyaukpadaung, Mandalay	2017	Heavy Rain
7	Thit Seint Gone	Mogok, Mandalay	2017	Heavy Rain

Source from DGSE & Internet

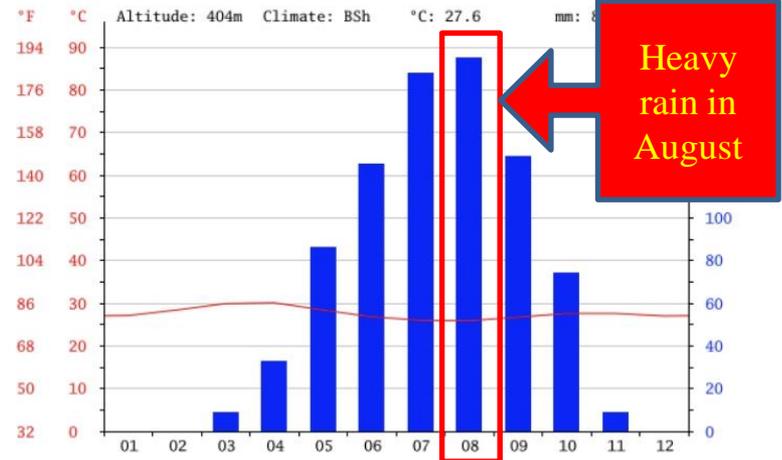
Culprits of Landslide



1. The mountain is 1320 m (above sea level) in height and **the gradient of Slope >50°**
2. **Lack of Vegetation**

3. **The Torrential rainfall** [The annual rainfall is 2000mm to 4000mm (Humid Climate)].

CLIMOGRAPH MOGOK (2017)



Culprits of Landslide



4. Earth material on the slope is mainly composed of weathered leuco-granite (Sandy soil).



5. Poor Drainage System (Increasing Pore Water Pressure)



6. Local fault and direction of crack signs. (Generally = 70°)



7. Human Activities (Old pit of Gemstone Mining activities)



Landslide at Western Range



Landslide at Western Range (Falam Area)



Landslide at Pegu Yoma (2011)

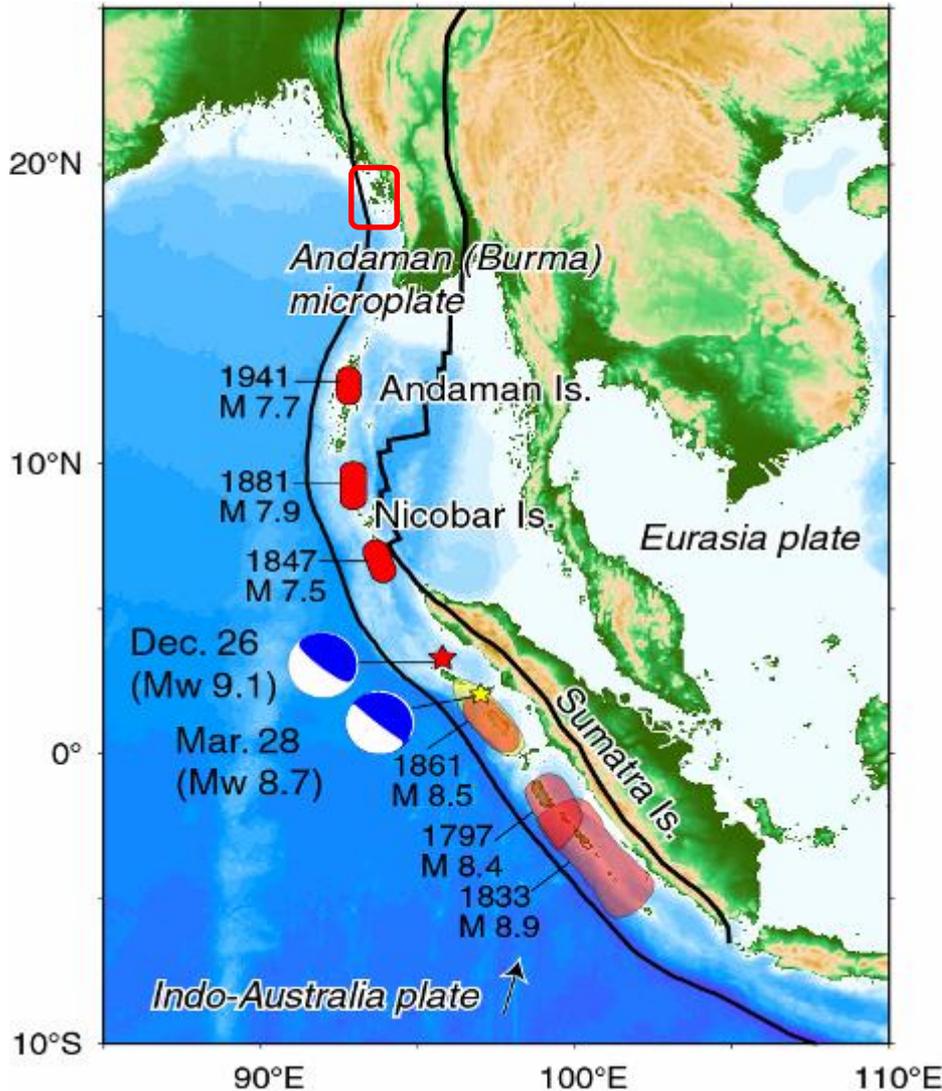


Landslide along Ayeyarwady and Hlaing River

Tsunami in Myanmar

- Myanmar coastline : 2200 kilometers long.
- Three main segments-Rakhine Coast in the northwest, the Ayeyarwady (formerly Irrawaddy) Delta in the middle, and the Tanintharyi Coast in the south.
- Myanmar coastal areas are vulnerable to Tsunami
- In 2004 Tsunami, Ayeyarwady was affected
- Out of 61 deaths, 31 took place in delta

The past earthquake and tsunami events in and around the Sunda Trench



1750	Cheduba Island Myanmar
1762 April 12	Bay of Bengal
1797 Feb 10	Sumatra
1833 Jan 29	Sumatra
1861 Feb 16	Sumatra (Mw 8.5)
1881 Dec 31	Bay of Bengal (Mw 7.9)
1883 Aug 27	Sunda Strait
1941 June 26	Andaman Island (Mw 8.1)
2004 Dec 26	Sumatra (Mw 9.1)

*Chhibber 1934, Heck 1947,
Berninghausen 1966, La Dean 1984*



Location Map of Tsunami Disaster in Myanmar

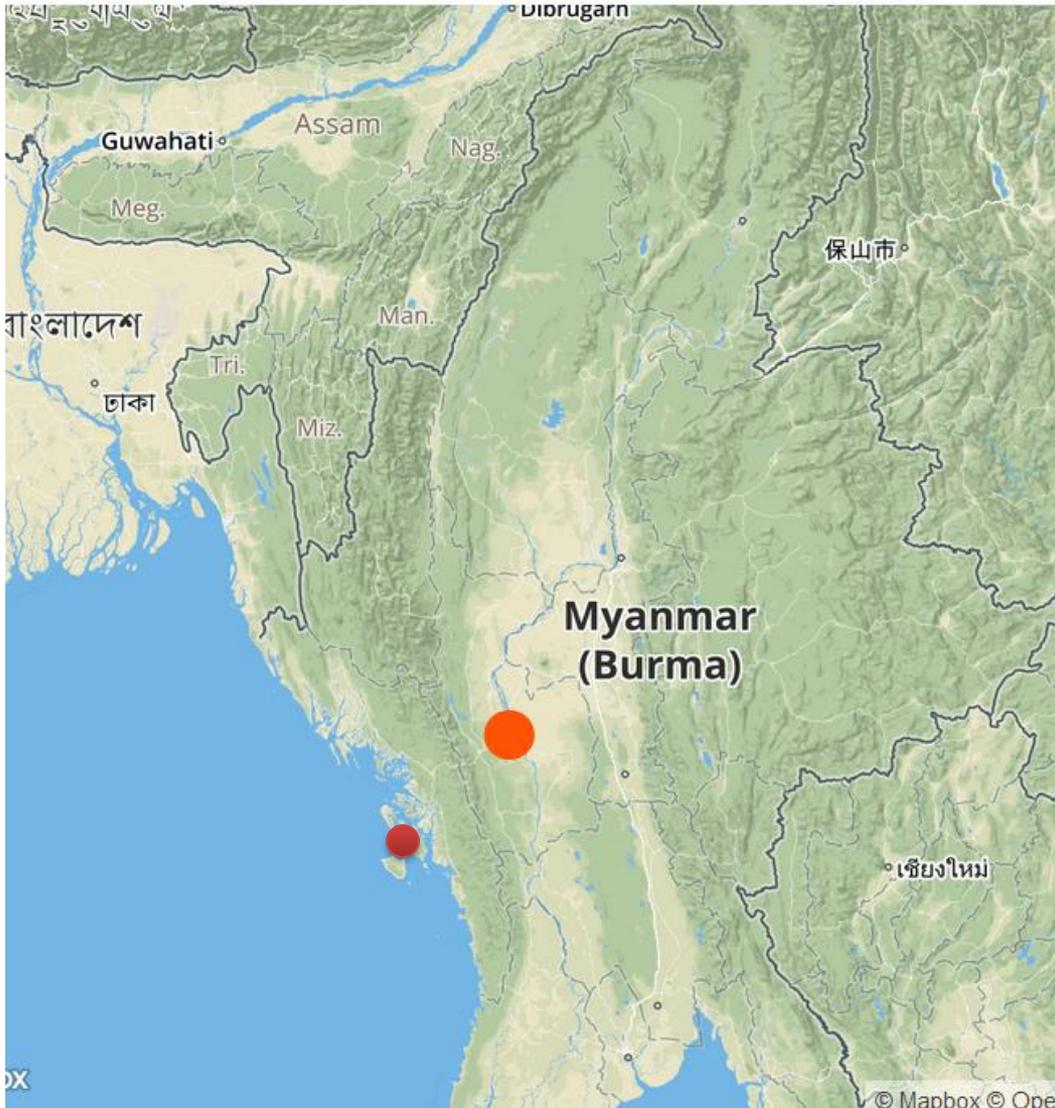
ata Sources:

EM-DAT, The OFDA/CRED International Disaster Database, Université catholique de Louvain, Brussels, Belgium: <http://www.emdat.be>.

Pacific Rim Coordination Center Disaster Data: <http://data.pacificrimnetwork.org/>.

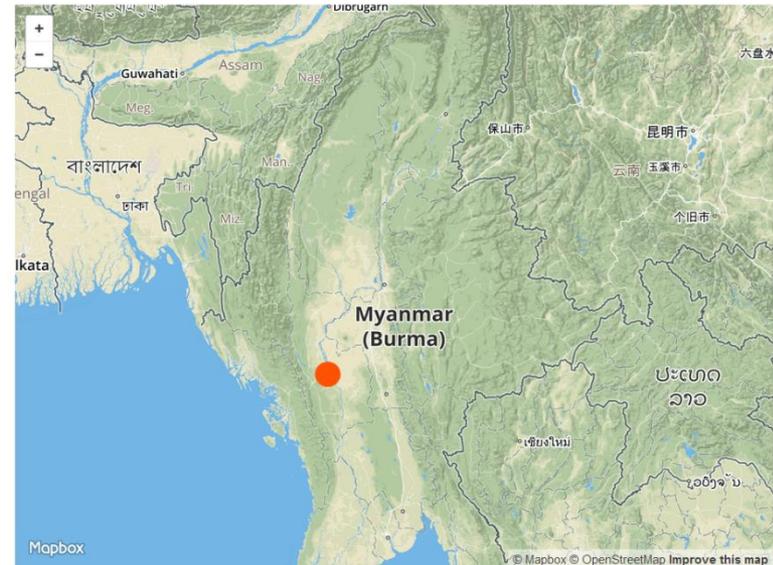
Global Unique Disaster Identification Number: <http://www.glidnumber.net/glide/public/search/search.jsp>.

Mud Volcano In Myanmar



In Myanmar, active mud volcanoes are as follow;

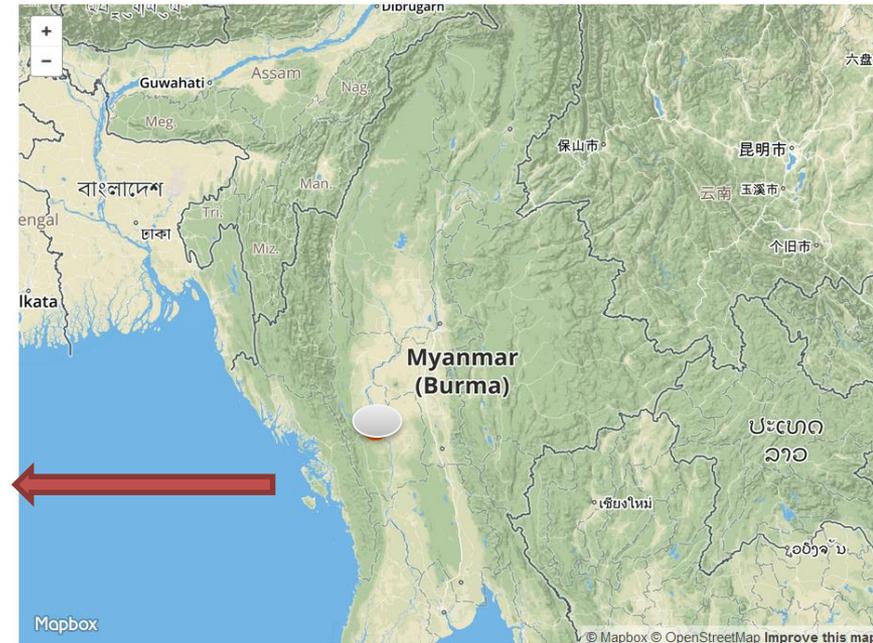
- ❖ Minbu mud volcano
(Western Ranges)
- ❖ Ranbye – Kyaukpyu Island
(Rakhine Coastal Belt)
- ❖ Manaung Island
(Rakhine Coastal Belt)



- Minbu mud volcano is situated on the western Range, near the oil-field of Yenangyaung (Upper Burma)
- are small hillocks of grey mud or clay
- The hills begin as holes, from which mud oozes and forms continually growing cones
- Inflammable gases are also exuded with the mud
- there is no heating involved, the mud is cool to touch



Mud Volcano Eruption Damages Farmland in Kyaukphyu

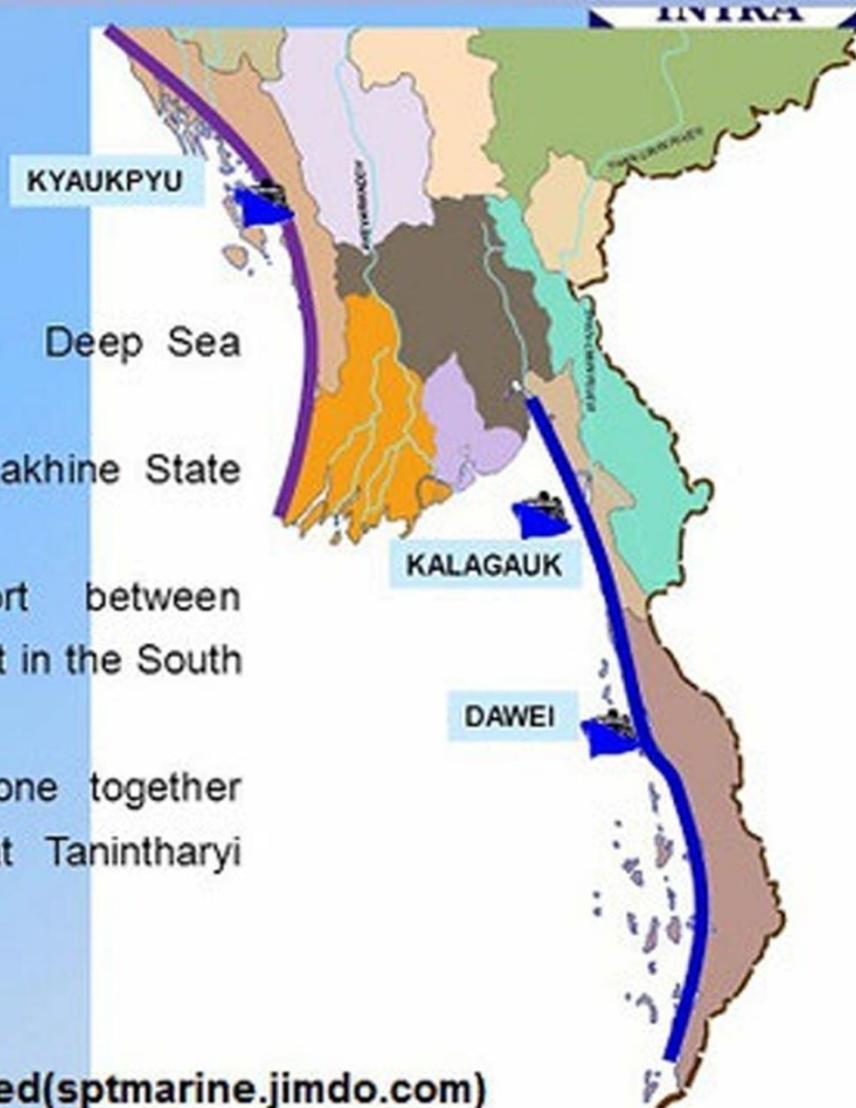


- Kyaukphyu and Manaung mud volcano is situated in the Rakhine Coastal Belt, near Kyaukphyu Special Economic Zone
- are small hillocks of grey mud or clay
- gases are also exuded with the mud
- mud volcano eruption in Kyaukphyu Township, Arakan State at 2014 August 31
- damaged more than 200 acres of farmland in Kyaukphyu Township

DEEP SEA PORT PROJECTS IN MYANMAR

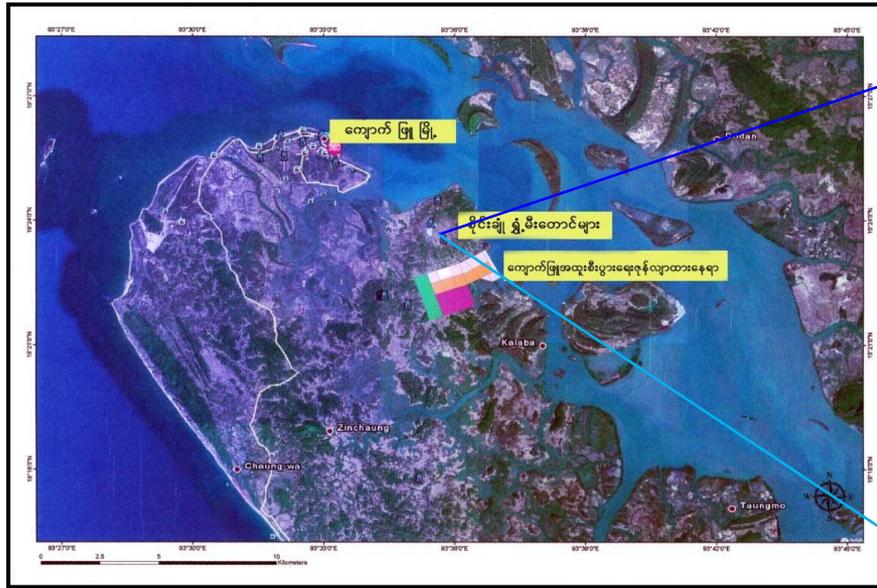
There are potential areas to develop Deep Sea Ports at the following areas -

- Kyaukpyu Deep Sea Port at Rakhine State in the West Coast.
- Kalagauk Deep Sea Port between Mawlamyine and Ye Region at in the South Coast.
- Dawei Special Economic Zone together with Deep Sea Port at Tanintharyi Region in the South Coast.



More Port Extensions are Expected(sptmarine.jimdo.com)

Mud Volcano near the Kyaukphyu Deep Sea Port Project



- ✓ volcano erupts to the south of Saichon village, Kyaukphyu Township
- ✓ mud volcano erupted less than two miles from Saichon village in Kyaukphyu Township on October 4, destroying farmland.
- ✓ molten mud lava flew about 70 feet high
- ✓ mud volcano in 1987 destroyed about 40 acres of farmland
- ✓ last volcano eruption in 1987, flames and lava came out
- ✓ current volcano eruption isn't strong and the damage is far smaller
- ✓ An earthquake hit the township and two mud volcanoes erupted on August 24
- ✓ There are around 14 volcanoes near Saichon village

Conclusion

- **Recently, Myanmar is facing more Disaster Risk and affecting more Geohazard.**
- **Every year since 2000, Myanmar has affected by flood and landslide in the raining season.**
- **Myanmar Earthquake Committee, Universities of Myanmar are also study and trying to get more complete geohazard map of Myanmar.**
- **Ministry of social welfare, Relief and Resettlement is already have DRR and DRM.**
- **This Ministry trying disaster and hazard map for the flood.**
- **D.G.S.E also carry out for the geohazard.**
- **Conclusively, I hope that I will be get many knowledge, know-how and technology for geohazard from SiDDER Conference.**



THANK YOU FOR YOUR KIND ATTENTION!