



**4th Workshop of ODA-UNESCO Project for
Promotion of Energy Science Education for
Sustainable Development in Myanmar**

**Theme 5
Dr Ohn Thwin**

**Renewable energy for geothermal potentials of
Myanmar**

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Renewable Energy for geothermal potentials of Myanmar

Outline

- **Introduction**
- **Geothermal Energy**
- **Formation of Geothermal reservoir**
- **Geothermal Power Plant**
- **Generation of Electricity in Geothermal Generator**
- **Locations of Geothermal Energy Source**
- **Typical Geothermal Power Plants**
- **Benefits of Geothermal Power**
- **Geothermal Energy Potentials in Myanmar**
- **Regional Tectonic Setting of Myanmar**
- **Region and States of Myanmar**
- **Location Map of Hot Springs in Myanmar**
- **Geothermal Sources of Myanmar**
- **Conclusion**

Geothermal Energy

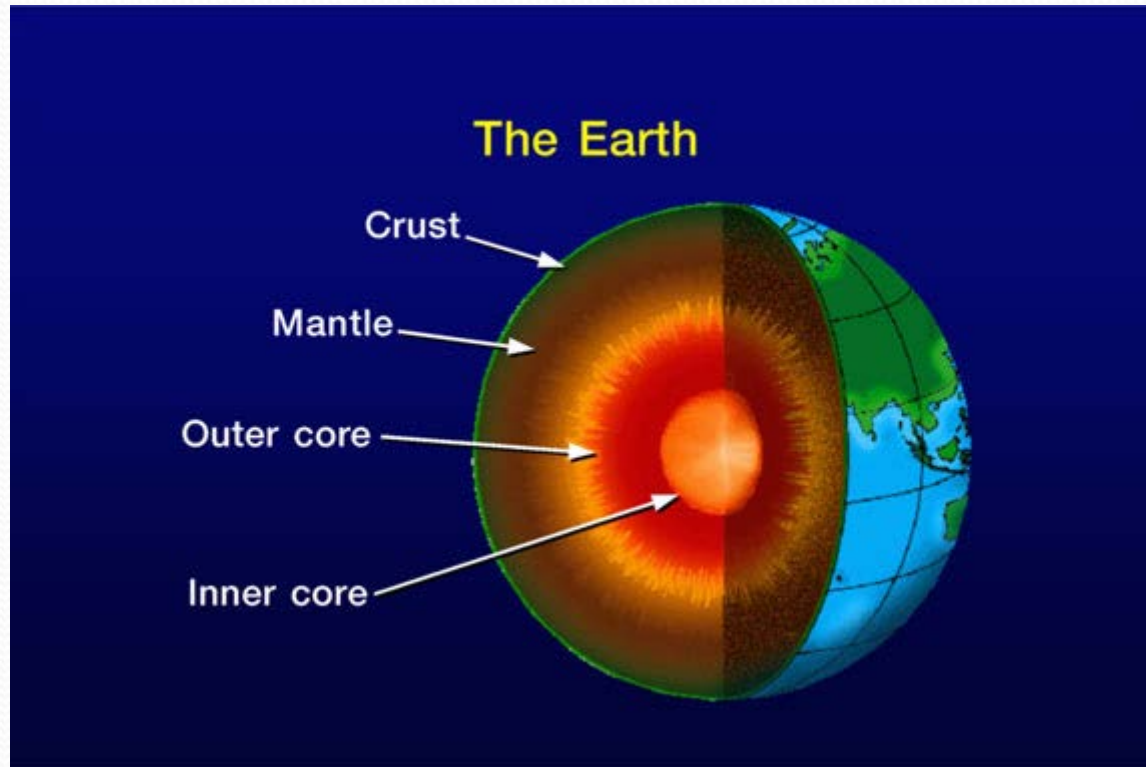
- Renewable and sustainable power source that comes from the heat generated by the earth.
- Thinned or fractured crust allows magma to rise to the surface as lava but heats large regions of underground rock.
- Rainwater can seep down faults and fractured rocks for miles.
- After being heated, it can return to the surface as steam or hot water.

Geo means  **Earth**

Thermal
means  **Heat**

Composition of the Earth

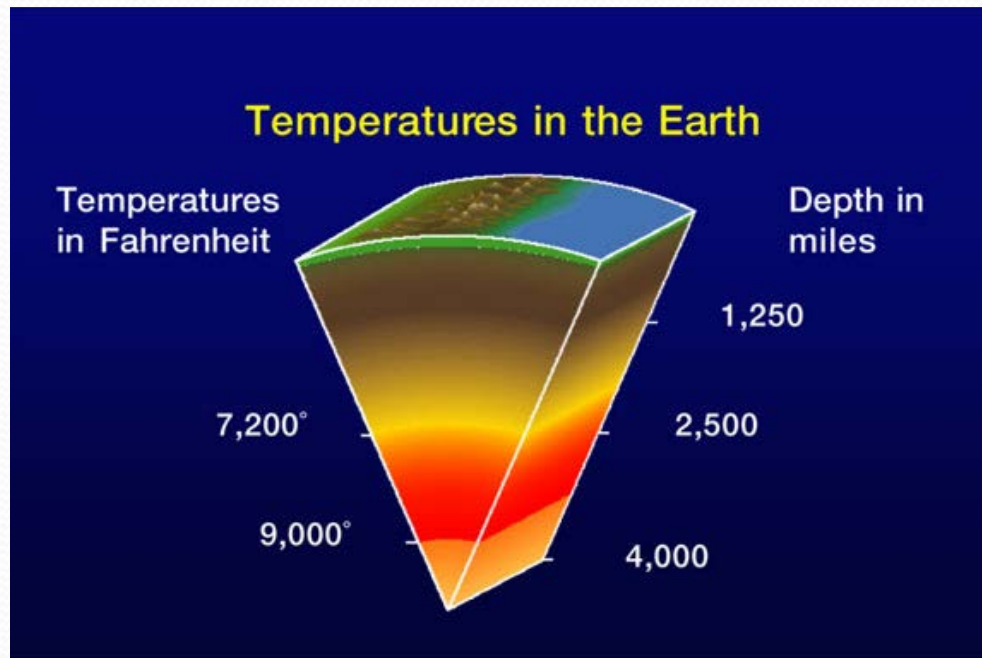
The Earth has four main layers, as is shown in the picture below.



Heat flows outward from Earth's interior. The crust insulates us from Earth's interior heat. The mantle is semi-molten, the outer core is liquid and the inner core is solid.

Earth's Heat and Volcanic Regions

- Each layer has different compositions, functions and temperatures, as is illustrated in the figure below.
- It is almost 6500 kilometers (4,000miles) from the surface to the center of the earth and the deeper you go, the hotter it gets. The outer layer of the crust, is three to 35miles thick and insulates us from the hot interior.

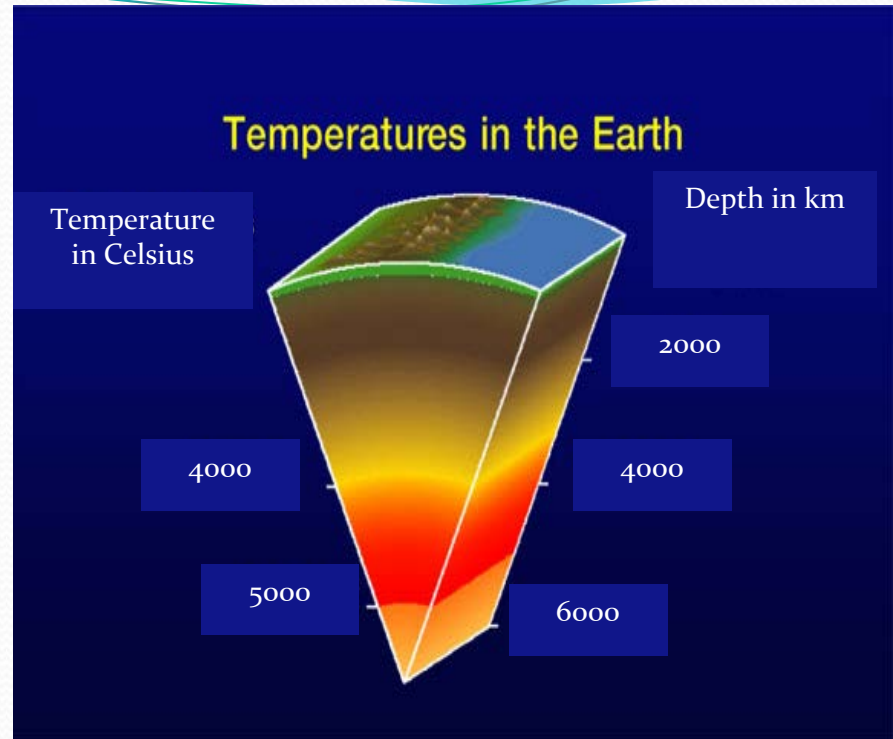


The deeper you go, the hotter it gets (in Fahrenheit and miles)

From the surface down through the crust the normal temperature gradient (the increase of temperature with the increase of depth) in the Earth's crust is 17-30° C per kilometer depth (50-87° F/mile).

Below the crust is the mantle, made of highly viscous, partially molten rock with temperatures between 650 and 1,250° C (1,200-2,280° F).

At Earth's core, which consists of a liquid outer core and a solid inner core, temperatures may reach 4,000-7,000° C (7,200 to 12,600° F).



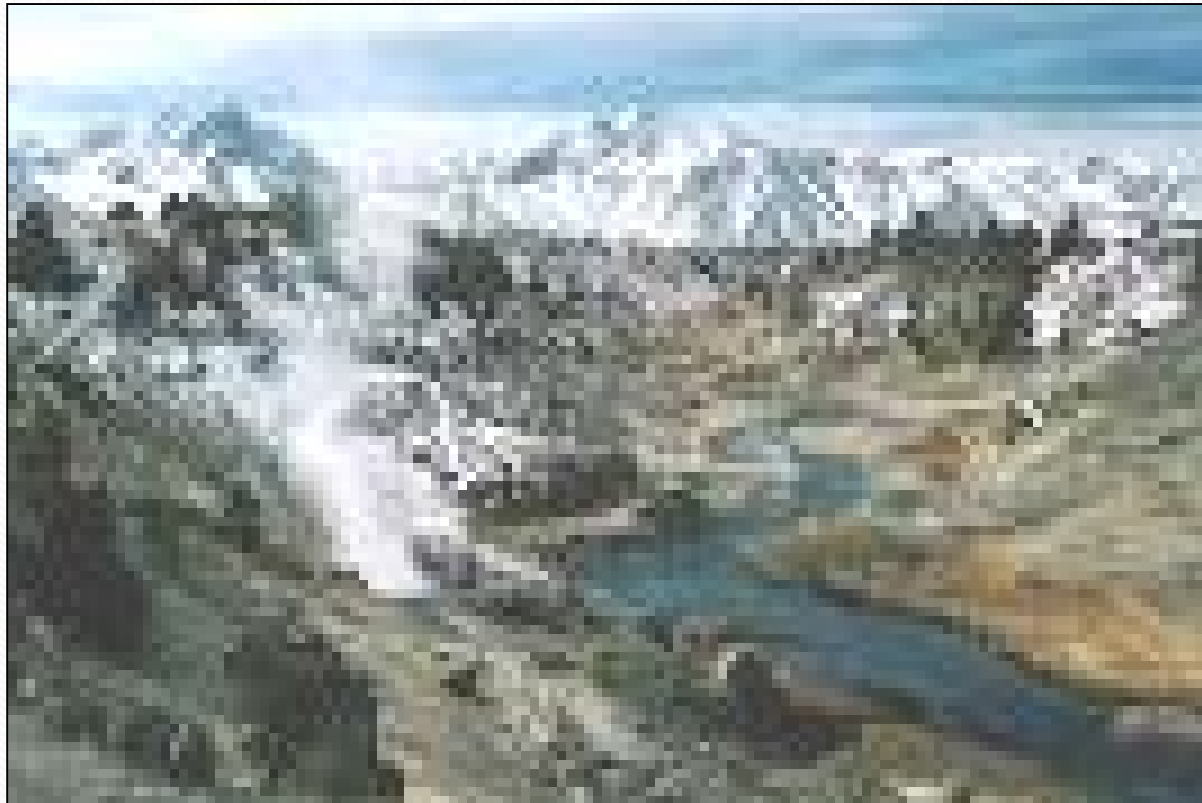
The deeper you go, the hotter it gets (in Celsius and kilometers).

- Thinned or fractured crust allows magma to rise to the surface as lava. Most magma doesn't reach the surface but heats large regions of underground rock.



Igneous rocks intrusion from magma

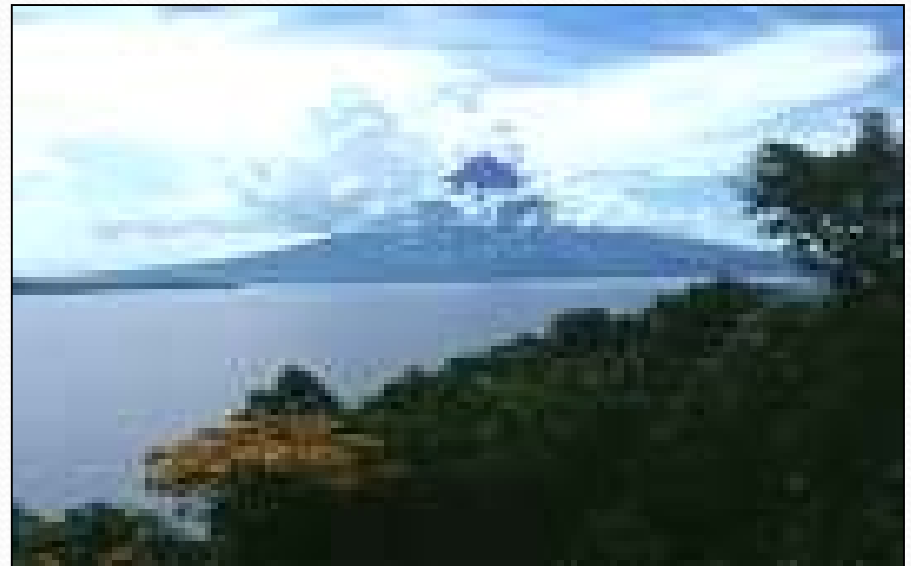
- Rainwater can seep down faults and fractured rocks for miles. After being heated, it can return to the surface as steam or hot water.





This steaming ground is in the Philippines.

Volcanoes are obvious indication of underground heat, this volcano, Mt. Mayon in the Albay province of the Philippines erupted in 1999.

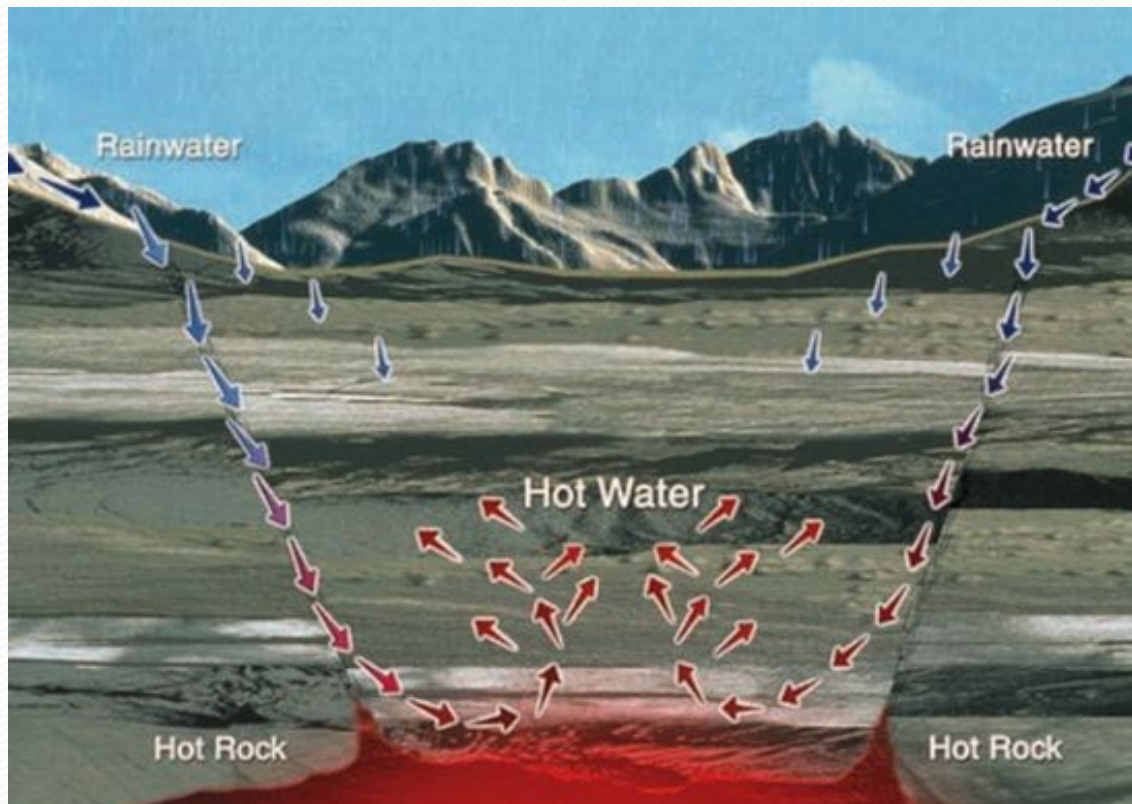


- When hot water and steam reach the surface, they can form fumaroles, hot springs, mud pots and other interesting phenomena.



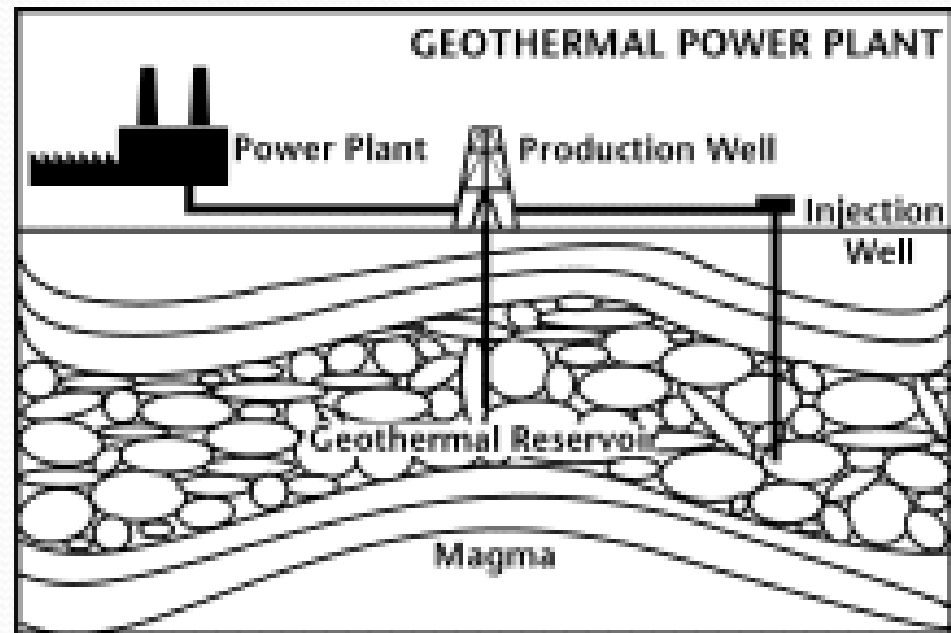
Formation of Geothermal Reservoir

When the rising hot water and steam is trapped in permeable and porous rocks under a layer of impermeable rock, it can form a geothermal reservoir. A geothermal reservoir is a powerful source of energy.

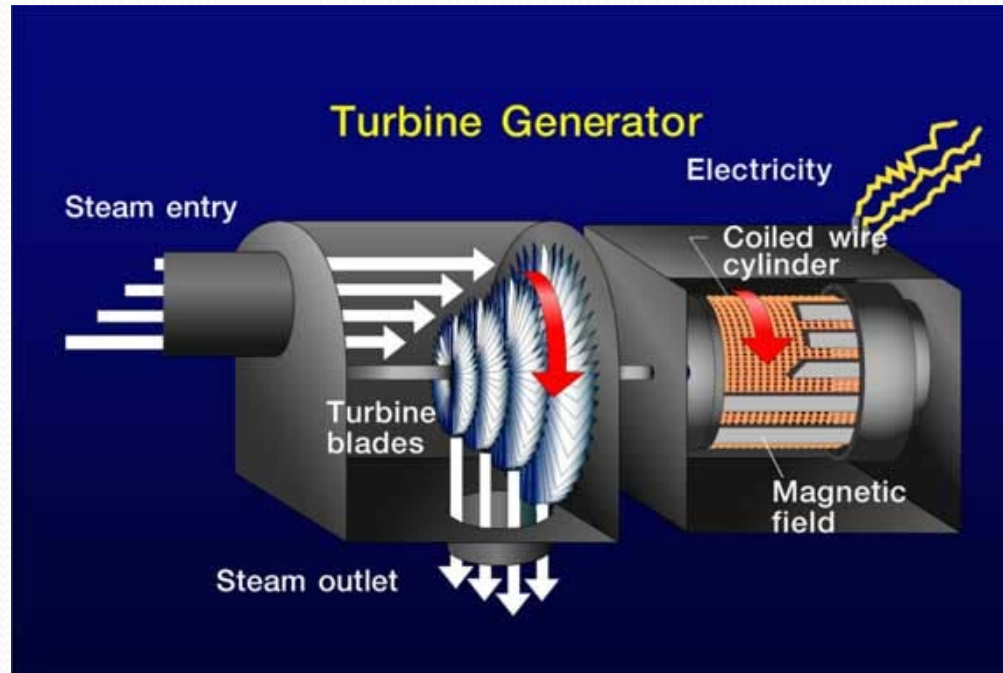


Geothermal Power Plant

- Geothermal energy is produced by drilling a well into the ground where thermal activity is occurring. Once a well has been identified and a well head attached, the steam is separated from the water, the water is diverted through a turbine engine which turns a generator.
- Usually the water is injected back into the ground to resupply the geothermal source.



Generation of Electricity in Geothermal Generator



Like all steam turbine generators, the force of steam is used to spin the turbine blades which spin the generator, producing electricity. But with geothermal energy, no fuels are burned.



Turbine blades inside a geothermal turbine generator.



Turbine generator outdoors at an Imperial Valley geothermal power plant in California.

Locations of Geothermal Energy Source



Number of Active Volcanoes and Geothermal Resource Base

Country	No. of Active Volcanoes	Geothermal Resource Base (MW)
U.S.A	133	23,000
Japan	100	20,000
Indonesia	126	16,000
Philippines	53	6,000
Mexico	35	6,000
Iceland	33	5,800
Nicaragua	20	4,350
New Zealand	19	3,650

Typical Geothermal Power Plants



The first modern geothermal power plants were also built in Lardello, Italy. They were destroyed in World War II and rebuilt. Today after 90 years, the Lardello field is still producing.



The first geothermal power plants in the U.S. were built in 1962 at The Geysers dry steam field, in northern California. It is still the largest producing geothermal field in the world.

Japan's first Geothermal Plants

- **Locations-Tsuchiyu Onsen hot spring resort, Fukushima city**
- **Capacity – 500kW to 1MW**



People who live in these areas are receiving electricity from geothermal power plants.



Geothermal electricity in the World

The International Geothermal Association (IGA) has reported that 10,715 megawatts (MW) of geothermal power in 24 countries is online, which is expected to generate 67,246 GWh of electricity in 2010. IGA projects growth to 18,500 MW by 2015.

Installed geothermal electric capacity in some countries

Country	Capacity (MW)2007	Capacity (MW)2010	Percentage of national
USA	2687	3086	0.30%
Philippines	1969.7	1904	27%
Indonesia	992	1197	3.7%
Mexico	953	958	3%
Italy	810.5	843	1.5%
New Zealand	471.6	628	10%
Iceland	421.2	575	30%
Japan	535.2	536	0.1%
Iran	250	250	
El Salvador	204.2	204	25%
Kenya	128.8	167	11.2%
Costa Rica	162.5	166	14%
Nicaragua	87.4	88	10%
Russia	79	82	
Turkey	38	82	
Papua-New Guinea	56	56	
Guatemala	53	52	
Portugal	23	29	
China	27.8	24	
France	14.7	16	
Ethiopia	7.3	7.3	
Germany	8.4	6.6	
Austria	1.1	1.4	
Australia	0.2	1,1	
Thailand	0.3	0.3	
Total	9,981.9	10,959.7	



Benefits of Geothermal Power

- Provides clean and safe energy using little land
- Is renewable and sustainable
- Generates continuous, reliable “baseload” power
- Conserves fossil fuels and contributes to diversity in energy sources
- Avoids importing and benefits local economies
- Offers modular, incremental development and village power to remote sites

Geothermal Energy Potentials in Myanmar

- Myanmar is one of the countries with numerous geothermal resources that could be represented as an additional source of energy to fulfill its future energy requirements.
- Widespread occurrences of hot springs had known to exist not only in the younger volcanic regions but also in non-volcanic and metamorphosed areas where ground water heated at depths have ascended through faults, fractures and fissures.
- Hot springs are found in Kachin State, Shan State, Kayah State, the Southern Part of Rakhine State in Kyaukphyu, Central Myanmar Area, Shwebo-Monywa Area and especially in Mon State and Taninthayi Division. A total of 93 hot springs have so far been recorded and indentified.

Main Boundary Thrust

Sagaing fault
(Sliver Fault)

Dauki fault

SE Asia

Chittagong–Tripura
Fold Belt

Andaman spreading
centers

Sunda megathrust

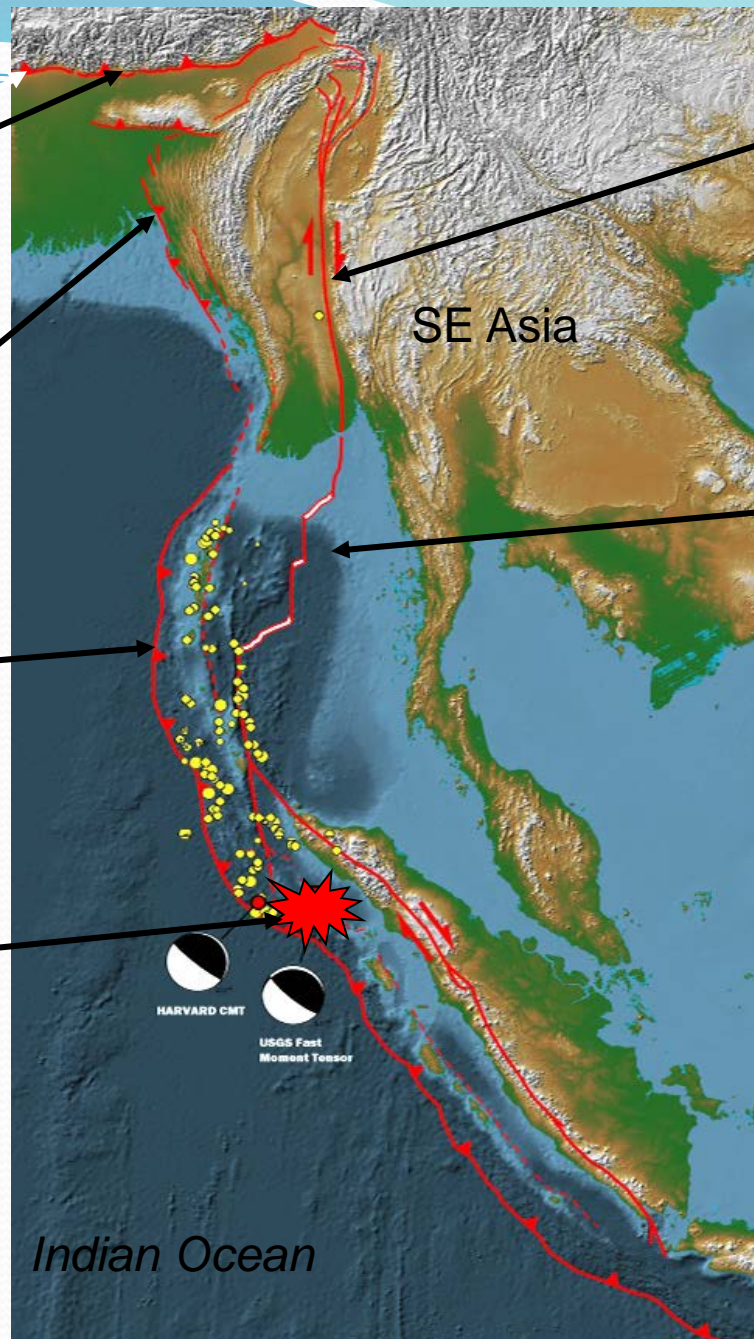
2004 Dec 26 Giant
Earthquake



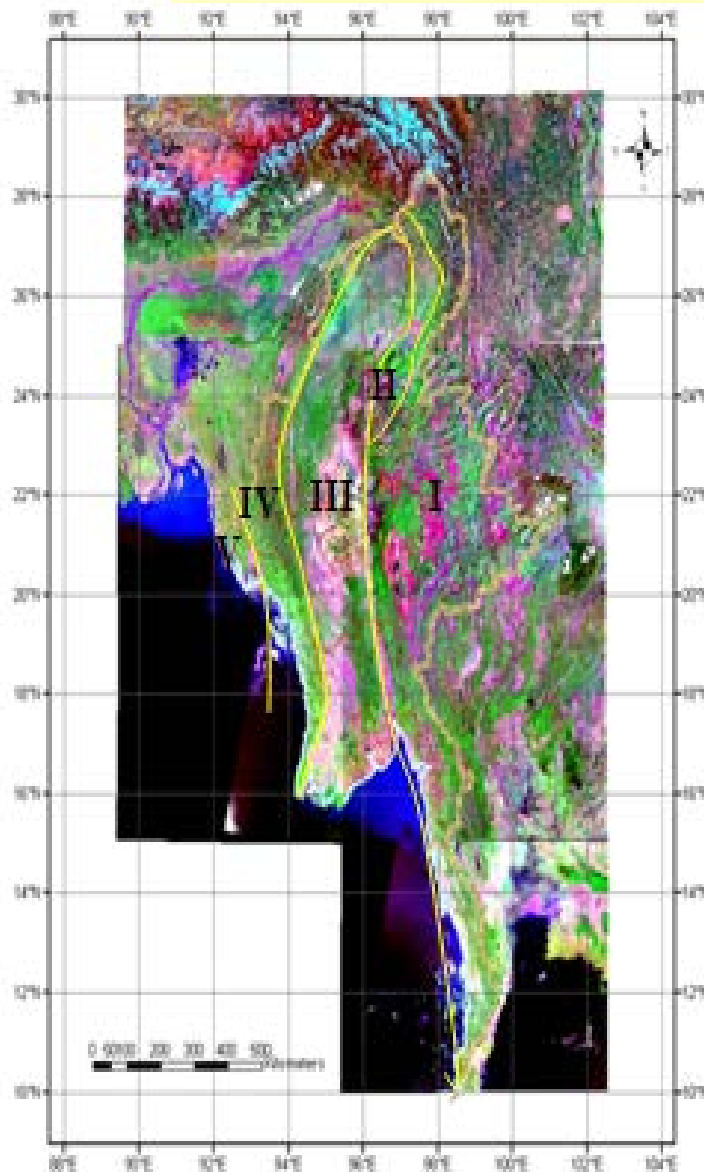
Modified from Robin
Lacassin, IPG Paris, and
Wang Yu, 2007

Indian Ocean

REGIONAL TECTONIC SETTING OF MYANMAR



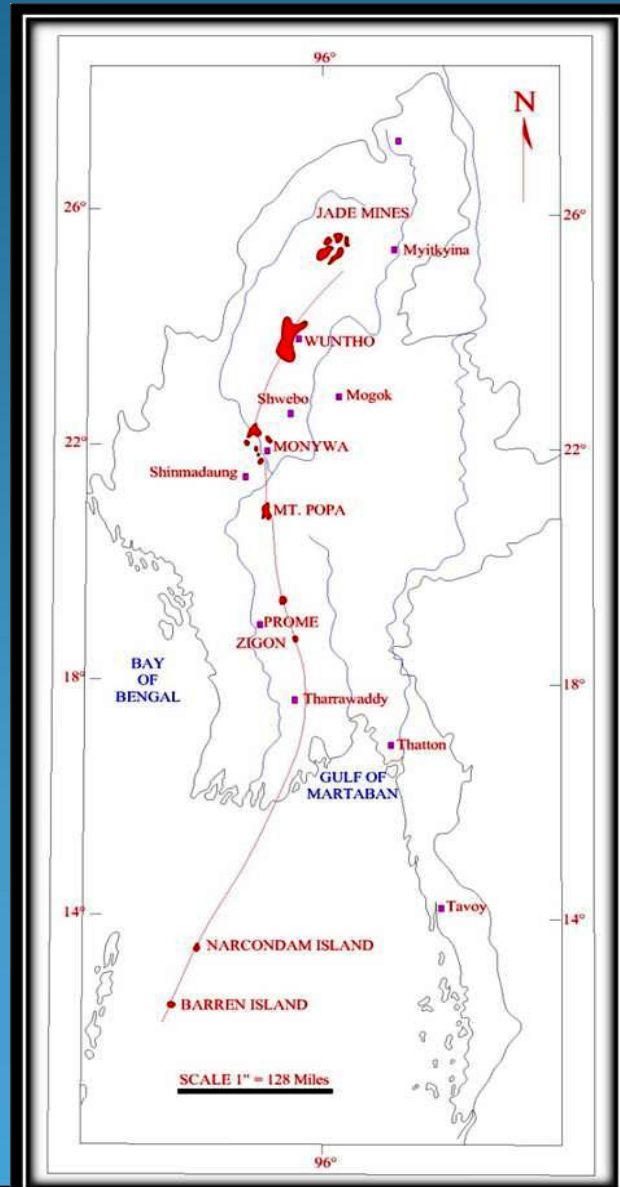
4. MORPHO- TECTONIC BELTS OF MYANMAR



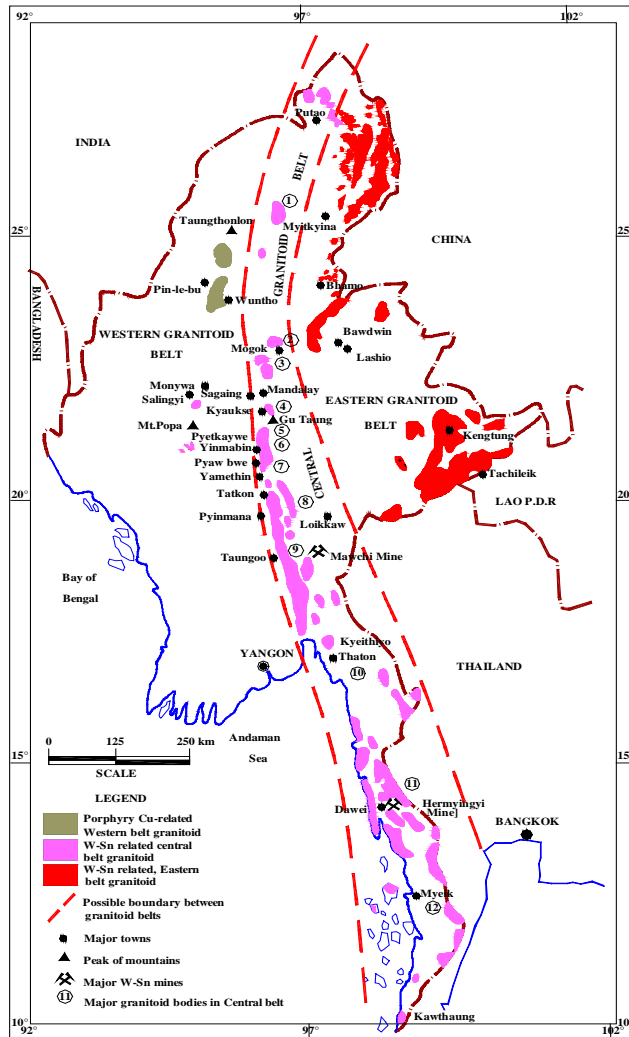
From East to West.

- I. The Eastern Highlands
- II. Upper Irrawady Province
(Tagaung- Myitgyinar Belt)
- III. The Central lowlands
- IV. The Western Ranges
- V. The Arakan Coastal Belt

Central Volcanic Arc of Myanmar



Major Granitoid Belts of Myanmar, (after Khin Zaw, 1990).

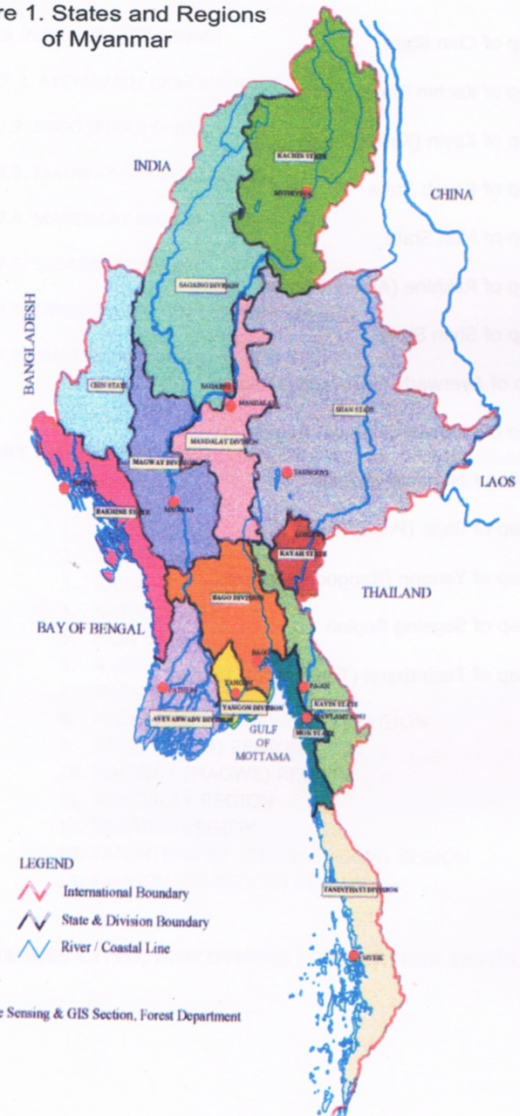


1. The western Granitoid Belt - Central Volcanic Arc
2. The Central Granitoid Belt - Shan Scarp – Tanintharyi Region
3. The Eastern Granitoid Belt - Eastern High Lands

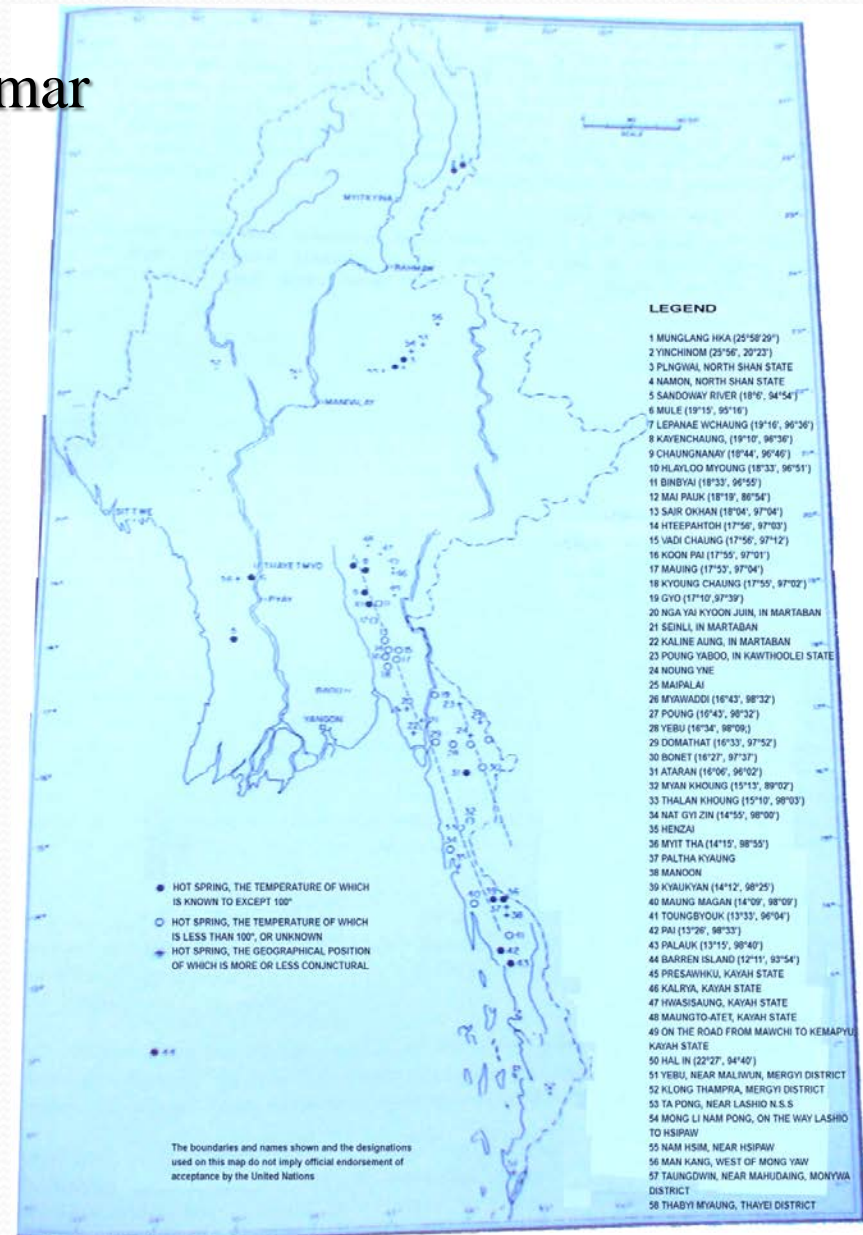
Regions and States of Myanmar



Figure 1. States and Regions of Myanmar



Location Map of Hot Springs in Myanmar



Some Hot spring examples of Myanmar

Myanmar people joining to the seeing and happy in the hot spring of Hanlin(ancient city of Pyu) in the Sagaing Region.



Lashio Hotspring in Shan State (North) Myanmar



Inlay Khaung Daing hot spring in the Shan State (South).



Inlay Lake Khaungdaing hot spring at Tourism place



Kyaing Taung hot spring in Shan State (East) Myanmar



Nay Pyi Taw (Capital city of Myanmar) hot spring



Bayintnyi Cave Hot spring in Kayin State(Male Swimming Pool)



Bayintnyi Cave Hot spring in Kayin State(Female Swimming Pool)



Hotspring of Maliwun area, Kawthaung Tanintharyi Region



Geothermal Resources of Myanmar

Sr.no.	State/ Division	No. of Hot Spring	Average Surface Temperature Degree C	PH Number
1.	Kachin State	2	-	-
2.	Kayah State	5	-	-
3.	Kayin State	15	48.61(37.78-61.67)	-
4.	Sagaing Division	10	32.41(29.44-48.89)	7.8
5.	Tanintharyi Division	19	51.46(37.78-51.67)	
6.	Magway Division	5	40.78(32.22-48.89)	7.6
7.	Mandalay Division	3	36.65(30.56-40.00)	6.5
8.	Mon State	19	51.08(37.78-65.80)	7.7
9.	Rakhine State	1	-	-
10.	Shan State	17	43.50(27.80-61.70)	6.9

Conclusions

- Rate of growth in power capacity can be much higher given adequate commercial incentives by governments and international agencies.
- Between **years** 2010 and 2050, geothermal power capacity in the world would increase from 11,000 MW to perhaps as high as 58,000 MW.
- Geothermal energy is a clean energy and renewable energy one. The uses of geothermal energy is rapidly increasing especially in developed nations.
- There are a lot of geothermal potentials areas in Myanmar.
- To get clean and safe geothermal energy, the quick start and establish energy resources coming out from our own world.



*THANK YOU
VERY MUCH!*