FAKULTAS TEKNIK &
SEKOLAH PASCASARJANA
UNIVERSITAS GADJAH MADA

UTHM
Universiti Tun Hussein Onn Malaysia

GUIDE BOOK
JOINT LECTURE 2019

ENVIRONMENTAL AWARENESS AND ECOSYSTEM SUSTAINABILITY

This joint lecture is hosted by Faculty of Engineering UGM and the Graduate School of UGM in collaboration with Universiti Tun Hussein Onn Malaysia (UTHM)

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WELCOME TO YOGYAKARTA!

Yogyakarta (English: /ˌjɒgjəˈkartə/ or /ˌjoʊgjəˈkartə/; often also called Yogya, Jogja, Jogjakarta) is known as Neverending Asia for its endless attractions and appeal. As one of Indonesia's 32 provinces, this city is one of the foremost cultural centers of Indonesia. Yogyakarta at present is a place where tradition and modern dynamics are going on together continuously. In this city, there is a palace which has hundreds of loyal servants to run the tradition, but there is also University of Gadjah Mada that is one of the leading universities in South East Asia. Some of its residents live in a strong agrarian culture. In the other side, there are also students who live with pop life-style. Traditional markets and handicraft centers are numerous in the city where some of them located by the malls which are no less hectic.

Fig.1. Indonesia Map

History

Yogyakarta is a city of history. Yogyakarta itself dates back to the 18th century when the Muslim Mataram Kingdom was ruled by Paku Buwono II. At that time, Yogyakarta was the center of ancient Mataram Kingdom which was prosperous and high civilized. This kingdom built Borobudur Temple which was the biggest Buddhist temple in the world, 300 years before Angkor Wat in Cambodia. After Paku Buwono II passed away, there was a conflict between his son and his brother which was encouraged by the Dutch who were trying to colonize the region on a 'divide and rule' basis. The kingdom was eventually divided into two regions namely Surakarta Hadiningrat kingdom (under the rule of Sunan Pakubuwono III), and Ngayogyakarta Hadiningrat kingdom (under the rule of Sultan Hamengku Buwono I). The second kingdom was later called Yogyakarta, now better known as Yogya.

After the independence of the Republic of Indonesia was proclaimed, Yogyakarta Special Region and was given provincial status in 1950 in recognition of its important role in the fight for Independence. The area is now a self governing district answerable directly to Jakarta and not to the governor of Central Java. [http://en.wikipedia.org/wiki/Yogyakarta ; http://www.indonesia.travel/ ; http://www.yogyes.com/]

University Town in Indonesia

Whilst steeped in rich tradition and history, Yogyakarta, lovingly known as Jogja, continues to remain young. This is university town, where students from all over Indonesia from different ethnic backgrounds flock to pursue knowledge and wisdom. For this reason, Yogya is both very Javanese and at the same time a melting pot of different Indonesian cultures.

Fig.2. Universitas Gadjah Mada

Universitas Gadjah Mada is one of the oldest, biggest, and best universities in Indonesia, founded on December 19, 1949. UGM is the largest institution of higher learning in Indonesia. Located in Yogyakarta, Indonesia, the 360 acre university comprises of 18 faculties, 68 undergraduate study programs, 23 diploma study programs, 104 master and spesialist study program, and 43 Doctorate study programs.

UGM is implementing an educopolis area, a step taken by universities in creating conducive environment for the continuity of the learning process. These efforts are pursued in the context of developing multidisciplinary collaborations and responding to ecological issues in order to achieve the vision of the university. Some of the steps are reducing pollution and vehicle exhaust emissions, development of pedestrian, restriction of vehicles entering the campus, construction of new dormitories on the campus, development of parking pockets, planting the trees green and many more. [http://www.ugm.ac.id/]

VENUE

Fig.3. The Graduate School of Universitas Gadjah Mada

The Graduate School of Universitas Gadjah Mada (SPs UGM)
Jl. Teknika Utara, Pogung, Mlati, Sleman, Yogyakarta, 55281
Telp. (+62 274) 544975, 564239
Email : sps@ugm.ac.id

TIMETABLE

INTERNATIONAL MOBILITY PROGRAMME TO JOGJAKARTA, INDONESIA:
UTHM-UGM ACADEMIC & RESEARCH COLLABORATION TOUR

Yogyakarta, October 27 – November 1, 2019

DAY 1 [Sunday, Oktober 27, 2019]

Time	Activity	Remarks
07.00	Gather at the UC Lobby Hotel	Lecturer : 1. Didit Hadi Barianto, S.T., M.Si., D.Eng. 2. Dr. Eko Haryono, M.Si. Note : Make sure to wear sneaker/sport shoes , bring hat, jacket, mineral water and **student card.**
07.30 – 09.00	Trip to Borobudur Temple	
09.00 – 11.00	**Observing Borobudur Temple**	
11.00 – 11.45	Trip to Jejamuran Restaurant	
11.45 – 13.00	**Dhuhur Prayer and Lunch at Jejamuran**	
13.00 – 14.00	Trip to Museum Merapi	
14.00 – 15.30	**Observing Merapi Museum**	
15.30 – 16.00	Trip to Raminten (optional)	
16.00 – 17.00	**Shopping Souvenir and Batik at Raminten**	
17.00	Back to Jogja	

DAY 2 [Monday, October 28, 2019]

Venue : Room, 5th Floor, Graduate School, Universitas Gadjah Mada

Time	Activity	Remarks
07.15	UTHM's Students gather at the Lobby Hotel	
07.15 -07.30	Transfer UTHM's Students to SPs UGM	
07.30 – 07.50	Opening Speech by : 1. Prof. Ir. Nizam, M.Sc.,Ph.D., IPM., ASEAN.Eng. (Dean of Faculty of Engineering, UGM) 2.Prof. Ir. Siti Malkahmah M.Sc.,Ph.D. (Dean of Graduate School, UGM) 3.Assoc. Prof. Ts. Dr. Jumadi bin Abdul Sukor (Deputy Dean of Academic and International Affairs, Fac. Of Engineering, UTHM)	
08.00 – 10.00	**Lecture #1** **Introduction to environmental awareness and ecosystem sustainability**	Delivered by the UTHM Lecturer
10.00 – 10.30	Tea Break	
10.30 – 12.30	**Lecturer #2** **Environmental analysis**	Delivered by the UTHM Lecturer
12.30 – 13.00	Topical reflection	
13.00 – 14.00	Lunch and Dhuhur Prayer	Mushola is at the 4th Floor
14.00 – 16.00	**#Labwork 1** **Practical Session**	Lecturers : 1. Dr. Wawan Budianta, S.T.,M.Sc 2. Dr. Ir. Harjito, M.Si
16.00	Transfer UTHM's Students to UC Hotel	

DAY 3 [Tuesday, October 29, 2019]

Venue : Room, 5th Floor, Graduate School, Universitas Gadjah Mada

Time	Activity	Remarks
07.30	UTHM's Students gather at the Lobby Hotel	
07.30 -07.45	Transfer UTHM's Students to SPs UGM	
08.00 – 10.00	**Lecture #3** **Environmental analysis**	Delivered by the UTHM Lecturer
10.00 – 10.30	Tea Break	
10.30 – 12.30	**Lecturer #3** **Wild Conservation**	Lecturer : Atus Syahbudin, Ph.D
12.30 – 13.00	Topical reflection	
13.00 – 14.00	Lunch and Dhuhur Prayer	Mushola is at the 4th Floor
14.00 – 16.00	**#Labwork2** **Practical Session**	Lecturer : 1. Dr. Wawan Budianta, S.T., M.Sc 2. Dr. Ir. Harjito, M.Si
16.00	Transfer UTHM"s Students to UC Hotel	

DAY 4 [Wednesday, October 30, 2019]

Venue : Room, 5th Floor, Graduate School, Universitas Gadjah Mada

Time	Activity	Remarks
07.30	UTHM's Students gather at the Lobby Hotel	
07.30 -07.45	Transfer UTHM's Students to SPs UGM	
08.00 – 10.00	**Lecture #5** **Environmental Issues**	Lecturer : Ir. Agus Prasetya, M.Eng., M.Sc., Ph.D
10.00 – 10.30	Tea Break	
10.30 – 12.30	**Lecturer #3** **Diversity Exploration**	Lecturer : Eka Tarwaca Susila P., S.P., M.P., Ph.D.
12.30 – 13.00	Topical reflection	
13.00 – 14.00	Lunch and Dhuhur Prayer	Mushola is at the 4th Floor
14.00 – 16.00	**Research Exploration**	Lecturer : UTHM
16.00	Transfer UTHM"s Students to UC Hotel	

DAY 5 [Thursday, October 31, 2019]

Time	Activity	Remarks
07.15	Gather at Lobby UC Hotel	Lecturer : 1. Didit Hadi Barianto, S.T., M.Si., D.Eng. 2. Dr. Eko Haryono, M.Si. Note : Make sure to wear sneaker/sport shoes and Sandal , bring hat, jacket, mineral water and additional clothes.
07.30 – 08. 15	Trip to Watuadeg (Pillow Lava)	
08.15 – 09.00	**Observing Pillow Lava**	
09.00 – 10.00	Trip to Wanagama	
10.00 – 11.00	**Observing Wanagama**	
11.00 – 12.00	Trip to Ngingrong Cave	
12. 00 – 13.30	**Observing Ngingrong Cave**	
	Lunch and Dhuhur Prayer	
13.30 – 14.30	Trip to Kalisuci	
14.30 – 18.00	**Observing Kalisuci and Karstubing**	
18.00	Trip back to Jogja	

DAY 6 [Friday, November 1, 2019]

Time	Activity	Remarks
07.00	Gather at the UC Lobby Hotel	Lecturer : tba Note : Make sure to wear sneaker/sport shoes , bring hat, jacket and mineral water
07.00 – 08.00	Trip to Yogyakarta City (Gather at Abu Bakar Ali Parking Space)	
08.00 – 11.00	**Tour Yogyakarta City Incl. Malioboro, Alun-alun, Code River**	
11.00 – 13.30	Lunch and Friday Prayer	
13.30 – 14.00	Riding Becak to Taman Sari	
14.00 – 15.00	**Observing Taman Sari**	
16.00 – 18.00	**Farewell and Closing Ceremony at Bale Raos Restaurant**	
18.00 -	Free time : Minitrip to Alun Alun Kidul	

OVERVIEW FIELD TRIP LOCATION

Field Trips #1

Volcanism and Paleoanthropology Evidences

BOROBUDUR TEMPLE

Fig.4. Borobudur Buddha Temple

The Borobudur Temple Compounds is one of the greatest Buddhist monuments in the world, and was built in the 8th and 9th centuries AD during the reign of the Syailendra Dynasty. The monument is located in the Kedu Valley, in the southern part of Central Java, at the centre of the island of Java, Indonesia. It is approximately 40 kilometres northwest of Yogyakarta, Borobudur is located in an elevated area surrounding by Tertiary volcanoes of Menoreh (south), and two twin Quaternary volcanoes, Sundoro-Sumbing (north) and Merbabu-Merapi (east), and two rivers, the Progo and the Elo. According to local myth, the area known as Kedu Plain is a Javanese "sacred" place and has been dubbed "the garden of Java" due to its high agricultural fertility.

The Borobudur Temple Compounds consists of three monuments; namely the Borobudur Temple and two smaller temples situatued to the east on a straight axis to Borobudur. The two temples are Mendut Temple, whose depiction of Buddha is represented by a formidable monolith accompanied by two Bodhisattvas, and Pawon Temple, a smaller temple whose inner space does not reveal which deity might have been the object of worship. Those three monuments represent phases in the attainment of Nirvana. The main temple is a stupa built in three tiers around a hill which was a natural Centre: a pyramidal base with five concentric square terraces, the trunk of a cone with three circular platforms and, at the top, a monumental stupa. The walls and balustrades are decorated with fine low reliefs, covering a total surface area of 2,520 m^2. Around the circular platforms are 72 openwork stupas, each containing a statue of the Buddha.

Borobudur constituent rock type andesite from both Tertiary and Quaternary volcanoes with high porosity, pore content of about 32% -46%, and the pore holes with one another are not related. Strong compressive strength is relatively low when compared to similar rock compressive strength.

From the research Sampurno (1969), obtained a minimum compressive strength of 111 kg/cm^2 and a maximum compressive strength of 281 kg/cm^2. Heavy rock volume between 1.6 to 2 t/m^3. The source rock material taken from the river around the temple. This means that the distance between the quarry and the site is very close. Although the number reached 2 million pieces, but each piece of stone material light and proximity haul, this means that the transport process can be done easily without the need for specific technologies.

Speculation about the lake's existence was the subject of intense discussion among archaeologists in the 20th century. In 1931, a Dutch artist and scholar of Hindu and Buddhist architecture,W.O.J. Nieuwenkamp, developed a theory that the Kedu Plain was once a lake and Borobudur initially represented a lotus flower floating on the lake. It has been claimed that Borobudur was built on a bedrock hill, 265 m (869 ft) above sea level and 15 m (49 ft) above the floor of a dried-out paleolake.

Dumarçay together with Professor Thanikaimoni had taken soil samples in 1974 and again in 1977 from trial trenches that had been dug into the hill, as well as from the plain immediately to the south. These samples were later analysed by Professor Thanikaimoni, who examined their pollen and spore content in order to identify the type of vegetation that had grown in the area around the time of Borobudur's construction. They were unable to discover any pollen or spore samples that were characteristic of any vegetation known to grow in an aquatic environment such as a lake, pond or marsh. The area surrounding Borobudur appears to have been surrounded by agricultural land and palm trees at the time of the monument's construction, as is still the case today. Caesar Voûte and the geomorphologist Dr J.J. Nossin in 1985–86 field studies re-examined the Borobudur lake hypothesis and concluded the absence of a lake around Borobudur at the time of its construction and active use as a sanctuary. These findings *A New Perspective on Some Old Questions Pertaining to Borobudur* were published in the 2005 UNESCO publication titled "The Restoration of Borobudur".

References

- Sampurno, 1969, Penelitian tanah-dasar tjandi Borodudur, Proyek Pelita Restorasi Borobudur, Departemen Pendidikan dan Kebudayaan
- Unesco, 2005, The Restoration of Borobudur, Unesco - Paris.
- https://en.wikipedia.org/wiki/Borobudur#Etymology
- https://en.wikipedia.org/wiki/Mount_Merapi

SMALL HISTORY OF MERAPI VOLCANO, YOGYAKARTA – CENTRAL JAVA, INDONESIA

Fig.5. Merapi Volcano

Mount Merapi, Gunung Merapi (literally Fire Mountain in Indonesian and Javanese), is an active stratovolcano located on the border between Central Java and Yogyakarta, Indonesia. It is the most active volcano in Indonesia and has erupted regularly since 1548. It is located approximately 28 kilometres (17 mi) north of Yogyakarta city which has a population of 2.4 million, and thousands of people live on the flanks of the volcano, with villages as high as 1,700 metres (5,600 ft) above sea level.

In general, geological history of G. Merapi is divided into four periods namely Pre Merapi, Merapi Tua, Merapi Muda and Merapi Baru. The first period is Pre Merapi started since about 700,000 years ago which currently leaves a trail of G. Bibi (2025 m asl) on the eastern slopes of Mt. Merapi. Mount Bibi has basaltic andesite lava. The second period, the period of Merapi Tua leaves the hills Turgo and Plawangan that has been between 60,000 to 8,000 years. Currently these two hills dominate the morphology of the southern slopes of Mount Merapi. In the third period of the Merapi Muda beraktivitas between 8000 to 2000 years ago. In those days there was some melanic andesitic lava that make up the hills of Batulawang and Gajahmungkur which now appears on the northern slopes of Mount Merapi and leaving the crater of Pasar Bubar. The fourth period of Merapi's current activity is called Merapi Baru, which forms the peak cone of Merapi which is now called Mount Anyar in the former crater of Pasar Bubar started about 2000 years ago.

In volcanoes with thick enough magma, lava forms what is called "lava block", lava chunk with irregular surface. In certain positions, if the lava discharge rate is slow enough, lava can be directly piled on the surface then freezes into a lava dome or "dome". It can be seen that between the viscosity of the lava and the nature of the flow there is a very dilute flow with long range with small thickness, until the flow is very thick with short range, even just a dome with a large thickness. Very thick lava can freeze as soon as the surface forms a "lava plug".

Merapi lava flow occupies the transition position between lava fluid flow and lava stoppers formation. If the lava exits and occupies a sloping position, for example at the edge of the main crater, the lava will form "lava tongue" because the lava flow process is very slow which then quickly freezes. When lava exits on a flat surface, the Merapi lava dome will be in reverse shaped with relatively symmetrical sides.

Fig.6. The Existence of Lava Flow, Lahar and Pyroclastic Materials, Located in Kaliadem, Merapi

On 25 October 2010 the Indonesian government raised the alert for Mount Merapi to its highest level and warned villagers in threatened areas to move to safer ground. People living within the range of a 20 km (12 mi) zone were told to evacuate. About 500 volcanic earthquakes had been recorded on the mountain over the weekend of 23–24 October, and that the magma had risen to about 1 kilometre (3,300 ft) below the surface due to the seismic activity. On the afternoon of 25 October 2010 Mount Merapi erupted lava from its southern and southeastern slopes.

The mountain was still erupting on 30 November 2010, but due to lowered eruptive activity on 3 December 2010 the official alert status was reduced to level 3. The volcano is now 2930 metres high, 38 meters lower than before the 2010 eruptions. After a large eruption in 2010 the characteristic of Mount Merapi was changed. On 18 November 2013 Mount Merapi burst smoke up to 2,000 meters high, one of its first major phreatic eruptions after the 2010 eruption. Researchers said that this eruption occurred due to combined effect of hot volcanic gases and abundant rainfall.

REMAINING TREASURE – MERAPI MUSEUM

Fig.7. The Melted Clock Shows The Time of Merapi Erupted at 12.05 AM, Friday, November 5, 2010

This is a modest museum that was established by a small family (Mr. Kimin and Mrs. Wati). Museum Sisa Hartaku can be translated to My Remaining Treasure Museum. The museum is actually within their house. This house was affected by the Merapi eruption in 2010.

The family (initiated by their first child) created this museum to inform people about the last Merapi eruption. Various personal things that were owned by the family are displayed at the museum such as: motorcycles, clothing, cutlery, furniture, pets, television and much more. I got melancholy feeling looking at their clock attached to the wall. The hands of the clock are stuck forever at the moment of the eruption. It is a chilling reminder of what happened when the hot ash cloud reached the village.

Based from the melting point several materials (See Table.1.) we can predict the temperature of eruption in the area. Some of the furniture made by aluminum and lead were melted during the pyroclastic surge occured, mean the temperature of eruption reach more than 600^{o}C.

THE GEOLOGY OF SOUTHERN MOUNTAINS

Physiography of the Southern Mountains on the eastern part of Central Java Province consist of east – west striking uplifted blocks that is gently dipping southward. To the north, the Southern Mountains is bounded by Baturagung escarpment and to the west by Boko – Parangtritis escarpment. The southern block, located between Parangtritis to the west and Pacitan to the east, forms karst morphology which consists of conical hills of Gunung Sewu or Thousand Mountains (Figure III.1). To the north of the karst morphology, the relief is weak and flat (Wonosari plateau). The northern part of the Southern Mountains forms moderate to strong relief, occupied by volcanic breccias of Nglanggran Formation. This physiography is also illustrated on Shuttle Radar Topographic Mission (SRTM) Image (Figure)

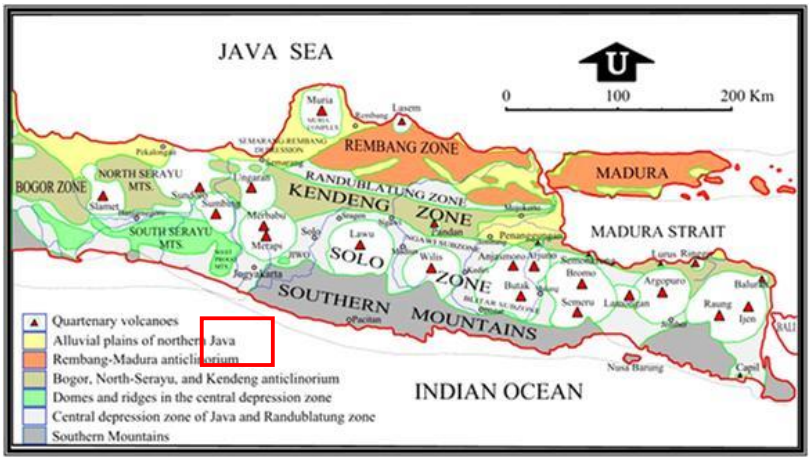

Figure III.1. Physiographic sketchmap of the Central Java area (adopted from Van Bemmelen, 1949) 1. Quaternary volcanoes, 2. Alluvial plain, 3. Rembang-Madura anticlinorium, 4. Bogor-North Serayu-Kendeng anticlinorium, 5. Domes and ridges, 6. Depression, 7. Southern Mountains

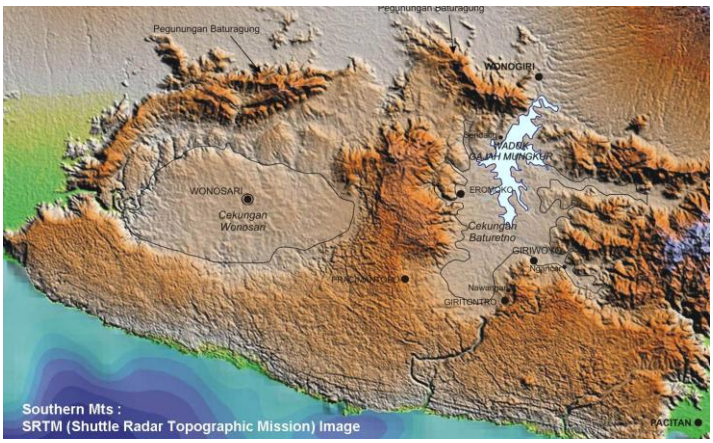

Fig.11. SRTM Image of the Southern Mountains

STRATIGRAPHY

The Stratigraphy of Southern Mountains consists of a series of mixed volcanic and flysh-like deposits with total thickness of about 4500 m (Bothe, 1929 in Rahardjo & Wiyono, 1993), which overlies unconformably the *pre-Tertiary* metamorphic rocks and Eocene sedimentary formation of the Jiwo Hills Complex, which was covered by limestone formation (Wungkal-Gamping Formation). The series of mixed volcanic and flysh like deposits can be separated into Oligocene-Lower Miocene Kebo-Butak Formation, Early-Middle Miocene Semilir Formation, Middle Miocene Nglanggran Formation, and Early-Middle Miocene Sambipitu Formation, and Middle Miocene Oyo Formation. These formations are covered by Middle Miocene - Pliocene limestones of Wonosari Formation, Late Miocene Kepek Formation and Quaternary clay formations (Figure III.3).

Pre-Tertiary metamorphic rocks

The pre-Tertiary metamorphic rocks crop out in Jiwo Hills, Bayat area, just north of Southern Mountains. The metamorphic rocks consist of foliated mica and chlorite schists, phyllite, marbles, metasediment and slates.

Eocene Wungkal-Gamping Formation

The Eocene sedimentary formation (Wungkal-Gamping Formation) consists of sandstones, sandy marls, and claystones with limestones lenses in the lower and upper parts. The lower limestones which crop out near Watuprahu and Padasan villages, rich in large foraminifera such as *Nummulites javanus, Nummulites bagelensis, Assilina spira, Discocylina sp.,* which indicate Eocene age. The upper limestones crop out around Gamping village, contain *Nummulites semiglobulus, Pellatispira madaraszi, and Discocylina sp.* which indicate Middle to Late Eocene (Rahardjo, 1980). Microdiorite, diorite and syenite in upper Late Eocene (?) intruded this formation.

Kebo-Butak Formation

This Kebo-Butak formation consists predominantly of conglomerate, sandstones and clay, which were deposited by turbidity current and gravity flow in Late Oligocene time (N2-N4). According Bothe (1929), this formation can be separated into two beds (members), i.e. : Kebo beds at its lower part and Butak beds at its upper part.

A. Kebo Beds

Kebo beds consist of alternation of medium grained sandstones, claystone and mudstones. The coarser grained portion exhibits graded appearance, while the silty portions are characterized by parallel laminations. Intercalations of massive pebbly conglomeratic sandstone containing claystone and shale fragments are found especially in the middle and upper part of these beds. The thickness of individual pebbly conglomeratic sandstones ranges from 2 up to 12 m. Three layers of basaltic sill (lava flows ?) are found in the middle part of this beds. The Kebo Beds are terminated by contorted bedding sandstone, which is exposed in the vicinity of Cermo river junction, north of Cermo village. The total thickness of the Kebo Beds is 575m.

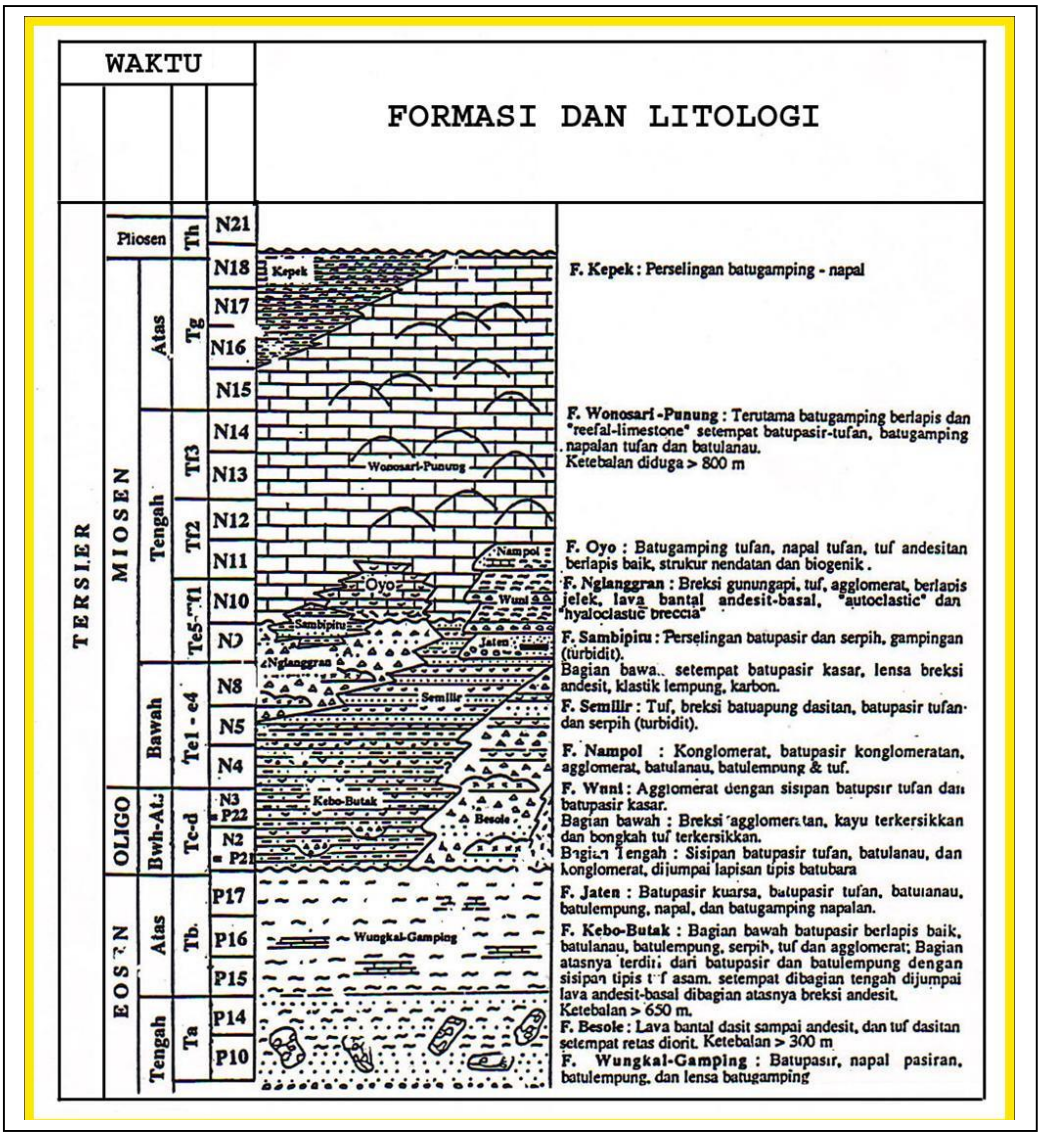

Figure III.3. Stratigraphic Column of The Southern Mountains (UGM, 1994)

B. Butak Beds

The Butak Beds consists of cyclic normal graded bedding from pebbly conglomeratic sandstone to claystone. The coarser bed dominates the sequence, so that overall outcrop of this unit appears to be massive. The pebbly fragments of the Butak Beds are composed of chloritized tuffaceous claystone and subrounded andesitic pebbles. Scattered chloritized claystone grains are also found in this sandstone. Thickness of individual pebbly conglomeratic sandstone sequence range from 2 to 4 m and the total thickness of the Butak Beds is 360 m.

Semilir Formation

The Semilir Formation consist of alternated tuffaceous sandstone and claystone with occasional layers of pumiceous pebbly-sandstone in its lower part and thick pebbly-sandstone with intercalation of massive pumice-breccia in its upper part that were deposited in the deep marine environment, probably below CCD. The fragments contain mostly acidic pumiceous tuffs. According van Gorsel et al. (1987), the age of this formation was interpreted based on the fossil content (*Globigerinoides primordius*) in the clayey layer found in the vicinity of Piyungan, i.e., Early Miocene (N4). The thickness of this formation is more than 460 m (Surono et al., 1992). The Semilir Formation is terminated by an abrupt contact with andesite cobble and boulder breccia of the Nglanggran Formation.

Nglanggran Formation

This formation mainly consists of thick volcanic breccias, agglomerates and several basaltic andesite intrusions and pillow lavas. In the upper part of this formation, lithology changes gradually into sandstones (mainly lithic and feldsphatic-greywackes). This formation was deposited rapidly as a debris flow in a marine environment during the Middle Miocene. The thickness of this formation is up to 530 m (Surono et al., 1992).

Sambipitu Formation

The Sambipitu Formation is a thick complex of marine sandstones and claystones. The sandstones mainly consist of lithic and feldsphatic greywackes, and upward this sandstones become calcareous, where fragments of coral and large foraminifera can be found. This formation was deposited in a deep marine (bathyal) environment influenced by turbidity currents, during Early to Middle Miocene (NN2-NN5). On its upper part, this formation has gradually contact with Oyo Formation. The thickness of this formation is approximately 230 m (Surono et al., 1992).

Oyo Formation

The Oyo Formation is a mixed marine-volcanic facies of very well bedded tuffaceous marl, clays, andesitic tuffs, and conglomeratic limestones. This formation contains lager foraminifera : *Cycloclypeus annulatus* and *Trybliolepidina rutteni*, indicating an Upper Burdigalian age (Tf) (Marks, 1964 in Rahardjo & Wiyono, 1993). Bioturbation such as animal / worm tracks and trails have also been found in this formation. The thickness of this formation is more than 140 m (Surono et al., 1992). Depositional environment of the Oyo Formation was interpreted as a shallow marine , or probably as a basinal carbonate below a reefal platform influenced by volcanic activity. The latest interpretation is based on observation of vertical and lateral distribution lithofacies along Oyo River section in Bunder forest (personal opinion Toha, 2011).

In the south-eastern part of the boundary between Central Java and East Java (i.e. Pacitan area) the formation of Nglanggran, Sambipitu and Oyo are inter-fingering with Jaten, Wuni and Nampol Formations.

Neogene carbonate formations

The Oyo Formation is overlain by the Neogene carbonate formations that are Wonosari and Kepek Formations. In the eastern part the Wonosari Limestone is known as Punung Formation.

Wonosari /Punung Formation

The Wonosari Formation crops out mainly at the southern part of the Southern Mountains of Central Java. Morphologically characterized by conical hills due to karstification which belongs to the Thousand Mountains. These conical hills are located on between 175 – 312 m elevation to the north and bounded to the south by steep slope coast with approximately 80 m elevation above sea level. At least four E-W striking terraces can be observed on this area (Brahmantyo et al., 1998). Each conical hill has up to 50 m in height and its distribution is controlled by some intersected NE-SW, NS, NW-SE, and ESE-WNW trending lineaments (Pudjijanto, 2001).

This formation consists of bedded to poorly bedded limestones, rich in coral fragments and algae. In some area, such as at Pulutan well, west of Wonosari, Gunung Senen (Kepek village), Planjan, and east of Kemadang village, intercalation of silty tuffaceous sandstone unit can be found. Larger foraminifera such as *Lepidocyclina, Cycloclypeus, Spiroclypeus,* and *Miogypsina* can be found here, beside smaller foraminifera, molluscs and worm tracks. These limestones are 5° dipping southward in average with more than 800 m thick (Surono et al., 1992). This formation was deposited in a shallow marine environment during the Middle Miocene to Pliocene time.

In the south of Wonosari area, however extensive recrystalization has occurred on the limestone, several types of carbonate facies can still be identified, that are: floatstone, rudstone, and packstone facies. Wackstone, mudstone, and boundstone can also be found in restricted areas.

Floatstone facies is the main component of the Wonosari limestone, and consists of red algae onchoids and larger foraminifera fragments and grain supported matrix. The matrix consists mainly of associated reef debris (sand or mud size), benthic and planktonic smaller foraminifera, and some times ooids and pellets (UGM, 1986). Beside the larger foraminifera such as *Cycloclypeus, Lepidocyclina, Miogypsina,* and *Spiroclypeus*, small amount of smaller benthonic and planktonic foraminiferas, coral fragments, and mollucs are also found in this facies. This facies should be deposited in a moderate to high energy environment.

Rudstone facies is somewhat similar to the floatstone facies but its fabric is grain supported. It consists of grain-packstone fragments and up to 10% bioclastic packstone matrix. This facies crops out mainly in the northern area, striking WNW-ESE parallel to the present coast line, and mostly up to 12° dipping southward. This facies was deposited in a high energy environment, i.e. fore-reef as shown by the present of red algae onchoids dominantly, facing open sea to the south.

Packstone facies consists mainly of bioclastic packstone with small amount of grainstone. The fossil content is dominated by *Lepidocyclina*, *Mollusca* fragment, coral fragment, and small amount of planktonic foraminifera. This facies crops out mainly at the northern area. Environment of deposition of this facies should be relatively calm water with local high agitation during the deposition.

Wackestone facies consists mostly of bioclastic wackestone. It was found as an intercalation between above main facies and closely associated with the packstone facies. Environment of deposition of this facies was medium energy condition.

Mudstone facies occurs within packstone facies or intercalated in the wackestone facies. This facies should be deposited in the very low energy environment.

Boundstone facies crops out in very limited area in association with rudstone facies. Due to very intensive crystallization this facies is difficult to identify, however it can be seen that this facies consists of bindstone and framestone with very small amount of bafflestone.

During the deposition of the Wonosari, sea level might have been rising and falling for several times. At the lower sea-level stand, subaerial exposure has been endured by some of the limestone bodies. Following the exposure, meteoric diagenetic processes might have taken place on the exposed rock body, resulted in the alteration of the mostly crystalline nature of the limestone into a more brittle to somewhat powdery chalk, or better called chalky limestones. Prolonged exposure enable plant grew on the weathered rock, which in turn enhance the possibility of soil formation. The rising of sea level put the carbonate depositional cycle into starting point again. The soil was eventually covered by younger limestone to become a paleosoil horizon.

Along field trip route, at least four paleosoil out-crops can be found in the Wonosari Limestones.

Kepek Formation

The Kepek Formation characterized by a relatively flat morphology known as Wonosari Plateau. This formation crops out to the north of conical hills of the Thousand Mountains. The Kepek Formation consists of bedded marls and limestones, rich in small foraminiferas. In some areas the Kepek Formation laterally passed into the limestone facies of the Wonosari Formation. Thickness of this formation is up to 200 meters. The Kepek Formation was deposited in a shallow marine environment, or probably a short of open lagoonal on carbonate platform during the Late Miocene.

On the Wonosari plateau, the Wonosari and Kepek Formations are overlain unconformably by Quaternary clay unit where *Hippopotamus* teeth were found.

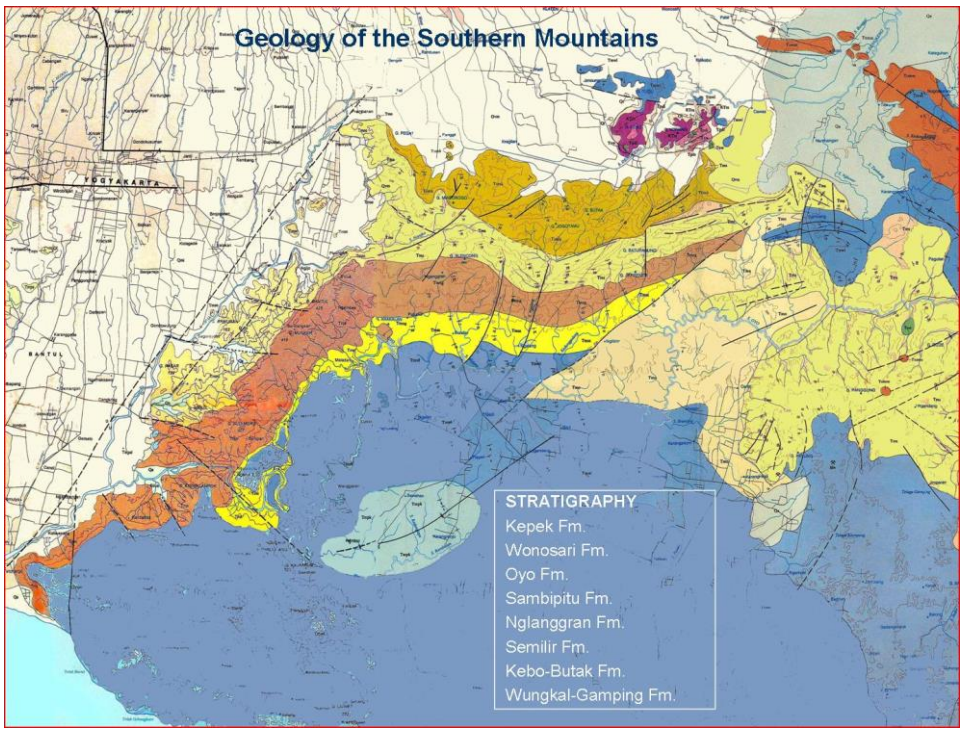

Fig.12. Geology of The Southern Mountains

WATUADEG (PILLOW LAVA)

Pillow lavas are lavas that contain characteristic pillow-shaped structures that are attributed to the extrusion of the lava under water, or *subaqueous extrusion*. Pillow lavas in volcanic rock are characterized by thick sequences of discontinuous pillow-shaped masses, commonly up to one metre in diameter. They form the upper part of Layer 2 of normal oceanic crust.

They occur wherever lava is extruded under water, such as along marine hotspot volcano chains and the constructive plate boundaries of mid-ocean ridges. As new oceanic crust is formed, thick sequences of pillow lavas are erupted at the spreading center fed by dykes from the underlying magma chamber. Pillow lavas and the related sheeted dyke complexes form part of a classic ophiolite sequence (when a segment of oceanic crust is thrust over the continental crust, thus exposing the oceanic segment above sea level).

Pillow lava flows of Watuadeg containing 50 wt.% SiO are exposed at Opak River, west of Watuadeg Village, Sleman - Yogyakarta. The length of flow structures is between 2 – 10 m, with diameter of 0.5 – 1.0 m and it has a glassy skin at the surface body. Flow directions vary from N70E in the northern side, through N 120E in the middle to N 150E in the southern side. About 150 m away from the river to the west, there is a small hill about 15 m high, that has a similar composition with the pillow lavas. Both lava flows and the small hill are composed of pyroxene basalt, dark grey in color, hypocrystalline vitrophyre to porphyritic texture, with fine-grained phenocrysts of pyroxene (10 %) and plagioclase (25 %) set in glassy groundmass. These data indicate that the small hill was the eruption source of the basaltic pillow lavas. The lavas are overlain by pumice-rich volcaniclastic rocks, composed of tuff, lapillistones and pumice breccias, that are known as the Semilir Formation. Near the contact with lavas, the volcaniclastic rocks contain some fragments of pyroxene basalt, similar composition with the pillow lavas. This fact, together with analyses of petrology, volcanology, and radiometric dating show that the basaltic pillow lavas are unconformably overlain by the Semilir Formation.

Fig.13. Pillow Lava

OYO RIVER

Walking toward the Oyo river bridge the section returns to more or less uniformly-bedded alternations of marly and sandy beds. The "sands" are becoming more and more calcareous, some beds are mostly composed mainly of larger foraminifera (*Lepidocyclina, Miogypsina, Amphistigina*, etc.). The marls still contain a deep marine fauna with common planktonic foraminifera, here including *Orbulina suturalis*, a zone N9 (basal Middle Miocene) assemblage; further downstream, along the Oyo river on the other side of the bridge, zone N10 faunas with *Globorotalia peripheroacuta* were found (see also Kadar, 1986).

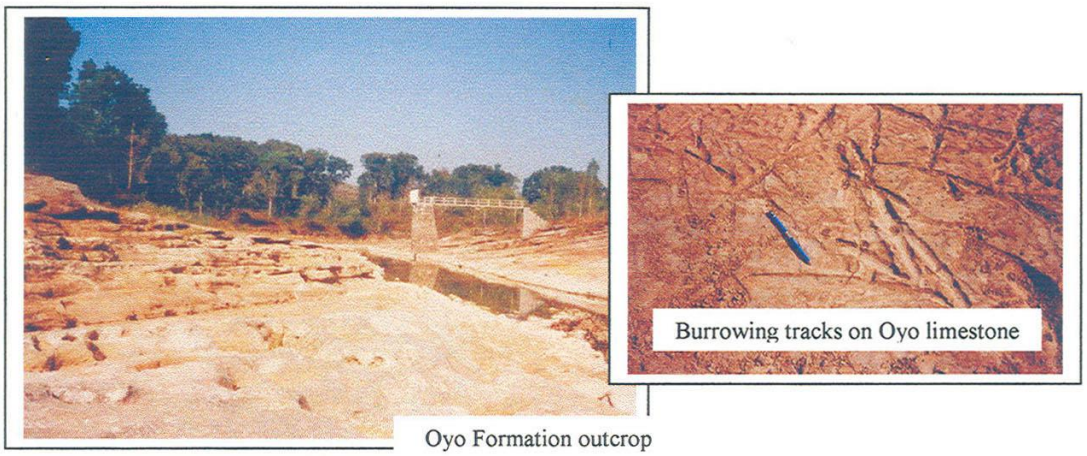

Fig.14. Photo of Stop Site; Gradatonal Contact of Sambitu to Oyo Formation

The outcrops shows bedded tufaceous marls, clayes, andesitic tuff, and conglomeratic limestone of Oyo Formation on Widoro River bed. On the south clift of the east sinkhole we can see vertical and horizontal carbonate facies changes with onlap, toplap, and sedging strata contact.

On the northern base of west sinkhole, the participants can see stalagtites on the roof of the underground river.

Fig.15. Photo of Stop Site. Carbonates Fasies Changes with Onlap, Toplap and Sedging Strata Contact

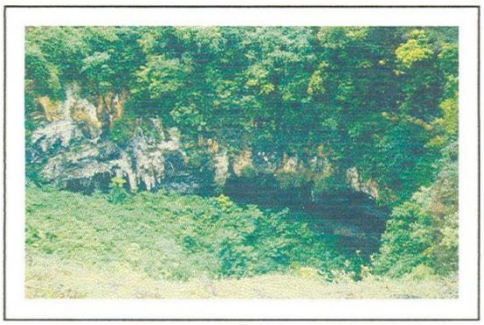

Fig.16. Another Collapse Doline in The Western Part of Previous Stop Site

KALISUCI KARSTUBING

Gunungkidul Regency has been known as a barren and dry area since topographically almost all of its regions consist of range of hills that underlain by limestone, or something known as karst. During the dry season, the green view of plants will dramatically change into brown because they are withering. However, behind its barrens, Gunungkidul possesses millions of potential tourism objects that are rarely found in other places. One among them is the beautiful cave that lies beneath the earth with the stream flows in it.

The winding river flow could clearly be seen from the cliff; the blue water looked contrast with the brown land, the karst, and also the withering plants, so that they formed an awesome and harmonious natural picture. After everybody got on the tube, the river adventure started. The tube moved as the river flew. When the water was still, our hands should row the tube to make it move, but when we were in a rapid, the tube would move fast and twirl following the stream flow. In some spots consisting of rocks and extreme rapid that was hard to go through.

The real adventure began when the stream entered the recesses of Kalisuci and Gelatik cave. The sunlight disappeared and the situation turned into something dark. The only light was from the headlamp. The stalactites seen on the cave's roof kept dropping water from their tip. Some of them were crystal. Three bats were hanging on the ceiling, some fish were swimming under our feet, and a big spider was on the stalagmite. The beauty of the cave and the coolness of the river in the silence made us reluctant to leave. Having an intimate experience with the coldness of the river flow beneath the earth with an extra wonderful and exotic view was a really unforgettable adventure

Fig.17. Kalisuci Karstubing

Field Trips #3
Cultural

History of Malioboro

Malioboro is maybe the most well-known street in Indonesia. In Sanskrit, the word 'Malioboro' means bouquet or wreath. It may be related to the past when Karaton had a big event then Malioboro would be full of flower. The word Malioboro also probably came from the word 'Marlborough', the name of English Duke who lived there in 1811-1816.[1] The establishment of Malioboro Street coincided with the establishment of Kraton Yogyakarta (Sultan's Palace).

In its earliest incarnation as a part of the Javanese town concept, Malioboro Street was laid out in an imaginary axis running north-south and correlated with the Sultan's Palace to Mount Merapi in the north and the South Sea as a symbol of the supernatural. In the colonial era (1790-1945), the urban pattern of Yogyakarta city seemed to be interrupted by the Dutch as a strategy to maintain their domination by building Vredeburg Fort (1790) at the south end of Malioboro Street near to the existing traditional market, followed by the Dutch Club (1822), the Dutch Governor's Residence (1830), Java Bank and the Post Office [2]. The rapid economic development during this period caused by trading between the Dutch and Chinese also led the Sultan to allot lands in a sub-segment of Malioboro street to the Chinese Community, which became known as the Chinese District. The development of Yogyakarta during this period was dominated by the activities of the Dutch in building facilities to bolster their economy and power, such as the construction of the main station (1887) in Malioboro Street, which physically succeeded in dividing the street into two parts. Meanwhile, Malioboro Street had an important role in the independence era (post-1945), as the Indonesian people fought to defend their independence in battles that took place north-south along the street [3].

Nowadays the street is at the centre of Yogyakarta's largest tourist district, with historical Dutch colonial-era architecture mixed in with the Chinese and contemporary commercial districts. Sidewalks on both sides of the street are crowded with small stalls selling a variety of goods. In the evening several open-air restaurants, called lesehan, operate along the street. The street was for many years two-way, but by the 1980s had become one way only, from the railway line (where it starts) to the south — to Beringharjo markets, where it ends, not far from Fort Vredeburg, a restored Dutch fortress. The largest, oldest Dutch era hotel, Hotel Garuda, is located at the street's northern end, on the eastern side, adjacent to the railway line. It also houses the complex of the former Dutch era Prime Minister, the kepatihan, on the eastern side, which has now become the Provincial Government offices (https://www.jvidusun.co.id/history-of-malioboro).

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