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The lithofacies at west of Lai Chi Chong pier

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Abstract

Eight lithofacies were divided by the rock texture, color and sedimentary structures, include Facies 1: Massive Black Cherty Mudstone, Facies 2: Interbedding Pale Tuffite and Dark Mudstone, Facies 3: Parallel Laminated Fine Sandstone and Mudstone, Facies 4: Parallel laminated Coarse Sandstone, Facies 5: Reddish Yellow Ungraded Sandstone, Facies 6: Graded Volcanic Sandstone, Facies 7: Yellowish Green Tuffite and Facies 8: Pebbly Volcanic Sandstone. The bioturbation of rock of west Lai Chi Chong pier is not obvious. It implicates an anoxic aquatic environment.

Introduction

Lai Chi Chong is located on the southeastern shore of Tolo channel and on the northern shore of the Sai Kung peninsula. The rock crops out along the beach west of Lai Chi Chong pier for about 500m (Figure 1).

The rocks found in the west of Lai Chi Chong pier are the pyroclastics rock with sedimentary structure. The rock was classified to Lai Chi Chong formation and belonged to Repulse Bay volcanic group (Strange et al., 1990, Lai et al., 1996, Campbell & Sewell, 1998). In 2000, the Lai Chi Chong formation has been moved to Lantau volcanic group by Sewell et al. The discovery of fossil plant including conifers, cycads and parts of tree trunks, implicate the age of Jurassic and early Cretaceous (Dale and Nash, 1984; Wai 1986; Atherton, 1989; Lee et al., 1997). Allen & Stephens (1971) according to the radiometric dating method to obtain the age of Lai Chi Chong formation is 146.2 million years ago.

Nau (1986) indicated the west shore of Lai Chi Chong pier could be divided into three units: an upper volcanic unit, a sedimentary unit and a lower volcanic unit, while the sedimentary unit was an intercalated unit in the volcanic succession. In 1991 Workman used the term “volcaniclastic” to identify the rock in west shore of Lai Chi Chong pier.

He pointed out that the exposed rocks and structures could explain in terms of intermittent sedimentation in shallow water with contemporaneous volcanic activity and attendant ground movements.

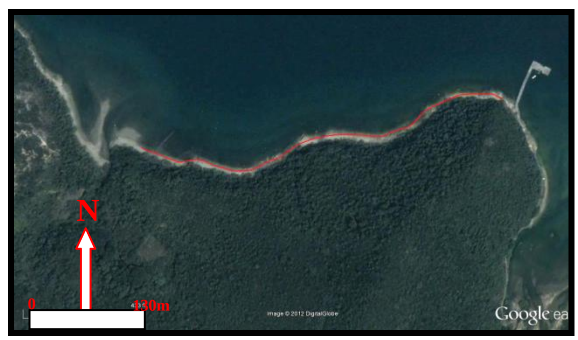

Figure 1: The red line in the map is the study area of Lai Chi Chong.

Bioturbation

Bioturbation is the displacement and mixing of sediment particles and solutes by fauna or flora. The phenomena seem burrowing, ingestion and defecation of sediment grains, construction and maintenance of galleries, infilling of abandoned dwellings, displace sediment grains and mixture the sediment matrix (Tucker, 2003). It is an evidence of past environment could provide sufficient oxygen for living thing to survive (Rhoads & Morse 1971). The bioturbation of rock of west Lai Chi Chong pier is not obvious. It implicates an anoxic aquatic environment, which is a mass of water so depleted in oxygen that virtually aerobic biologic activity has ceased.

Lithofacies analysis

The lithofacies analysis of the volcanic and sedimentary rock unit succession at Lai Chi Chong is based on field study. Lithologies, texture, color and sedimentary structures were recognized and recorded. Eight lithofacies were identified in Lai Chi Chong formation.

Facies 1: Massive Black Cherty Mudstone

The facies is massive, very thin bedded sequence of black shales, volcanic mudstone and cherty mudstone. The rock is dark grey or black becoming light grey even brow on weathering. The bed could be interpreted as the result of deposition in water at a location further away from the site of eruption as the grain size is fine (Tucker,2003; Reading, 1996).

Facies 2: Interbedding Pale Tuffite and Dark Mudstone

This facies is regular, thin alternative bedding of pale parallel laminated tuffite and laminated cherty mudstone or sandstone. This interbedding sequence may reflect the repetition of environment suspension settlement and flow deposition (Reineck & Singh, 1980; Darlrymple et al., 1992) or the disturbance of one facies to another (Ericson et al., 1952).

Facies 3: Parallel Laminated Fine Sandstone and Mudstone

The facies consists of very fine grained, cross thickly lamination of alternative regular white and grey mudstone bedding. The thickness of bedding is around 5 mm and reflected the suspension current in water (Tucker, 2003). The black cherty mudstone inclusive the lenticular shape yellow sandstone. The ripples structure appear between bedding occasionally, it can be supported there was action of water.

Facies 4: Parallel laminated Coarse sandstone

The facies has cross thickly lamination of alternative regular white and grey mudstone bedding, the grey part of the facies becomes dominant near the bottom when bedding becomes thinner. Grain size insides grey bedding is uniform but varies from fine to very coarse sand in different beddings. Black mudstone pebbles can be observed occasionally. The lamination is preserved reflect an abiotic environment because no significant bioturbation. It could be interpreted as the suspension current settlement in water (Tucker, 2003).

Facies 5: Reddish Yellow Ungraded andstone

The facies consists of reddish yellow sandstone which contains ungraded grey or black mudstone coarse sand size grain (0.5mm-1mm). It lacks internal stratication and its disorder grain pattern may represent relatively faster flow deposition as the sediments show insufficient time for sorting (Reineck & Singh, 1980; Dott&Bourgeois, 1982).

Facies 6: Graded Volcanic Sandstone

The facies have pale grey sandstone with normal graded bedding of black angular mudstone grain; the grain size of mudstone grain is from 1mm-5mm. The coarser sand grains occur near the bottom of bed with finer sand grain toward the top. The graded structure is caused by segregation of gravity in the water. The deposition from a flow decelerates; the heaviest particles were deposited followed by finer particles (Tucker, 2003). Occasionally, the bedding has wavy boundaries implicate the rework of water current.

Facies 7: Yellowish Green Tuffite

The facies contain gravel size particle with yellowish green color. It has angular shape size from 0.2cm to 1cm cementation material. The facies is formed by the pyroclastic fall deposition (Tucker, 2003). Workman (1991) describe rocks contain substantial amounts of both detritus (fragments derived from pre-existing rocks by surface processes) and pyroclasts was defined the term “tuffite”.

Facies 8: Pebbly Volcanic Sandstone

The facies consists of coarse grain with poorly sorted black or dark grey sub-rounded mudstone pebbles of size from 0.5cm-3cm, in sandy volcanic ash deposits. Its appearance with poor sorting of ash particle and lack the internal stratification. It is usually created by pyroclastic fall or pyroclastic flow deposition (Tucker, 2003).

Conclusion

Based on the particle size and sedimentary structure (Table 1). The depositional environment of Facies 4 and Facies 5 are implicated above fair-weather wave base. And the Facies 1 , Facies 2 and Facies 3 are from below fair-weather wave base to below storm wave base. The facies 6, facies 7 and facies 8 are belong to the terrestrial deposit.

Lithofacies	Name	Plate	Characteristics	Formation Mechanism
1	Massive Black Cherty Mudstone		Massive, very thin bedded sequence of fine black shales, volcanic mudstone and cherty mudstone	Rapid deposition in water at a location further away from the site of eruption.
2	Interbedding Pale Tuffite and Dark Mudstone		Regular, thin alternative bedding of pale laminated tuffite and dark laminated cherty mudstone/ sandstone	Repetition of environment change between suspension settlement and flow deposition . Disturbance of one facies to another
3	Parallel Laminated Fine Sandstone and Mudstone		Very fine-grained (< 0.15mm), neat surface, cross thickly lamination of alternative regular white and grey mudstone bedding pattern, thickness of bedding < 5mm, black cherty mudstone layer appears between beddings occasionally	Suspension current in water
4	Parallel laminated Coarse Sandstone		Sandy surface, thickly parallel lamination of alternative white and grey sandstone bedding pattern, grey color becomes dominant near the bottom when bedding becomes thinner, uniform grain size within each grey bedding but vary from fine to very coarse sand in different beddings (0.1 - 2mm), black mudstone pebbles appear occasionally	Suspension current settlement in water
5	Reddish Yellow Ungraded Sandstone		Reddish yellow sandstone contains ungraded grey/black mudstone coarse-sand size grain (0.5 - 1mm)	Fast, flow deposition
6	Graded Volcanic Sandstone		Pale grey sandstone, with graded bedding of black angular mudstone grains (common size: 1mm - 5mm, max: 3cm)	Deposition in a decelerating flow
7	Yellowish Green Tuffite		Formed by cementation of angular volcanic clastic sediment vary from 0.2 - 1cm in particle sizes	Pyroclastic fall deposition
8	Pebbly Volcanic Sandstone		Coarse-grain with poorly sorted black/ dark grey sub-rounded mudstone pebbles of size 0.5 - 3cm, in sandy volcanic ash deposits	Pyroclastic fall or pyroclastic flow deposition

Table 1: Summary table of lithofacies of Lai Chi Chong

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The lithofacies of Kiu Tsui Chau pier and Kiu Tau, Sai Kung

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Introduction

Kiu Tsui Chau is located in the Inner Port Shelter (Sai Kung Hoi), to the southeast of the town of Sai Kung. The selected study area is belonging to the Mang Kung Uk formation (Sewell, et al 2000) and Sewell, et al (2000) according to the rock specimen of Bayside beach

(Pik Sha Wan) reveals the age of Mang Kung Uk formation is about 142.9±0.2 Ma.

The selected study area was separated to three areas to investigate the lithofacies of rocks. Area 1 is the western coast area of Kiu Tsiu Chau near the pier. Area 2 is the Kiu Tau Island. Area 3 is the southwest of Kiu Tau Island.

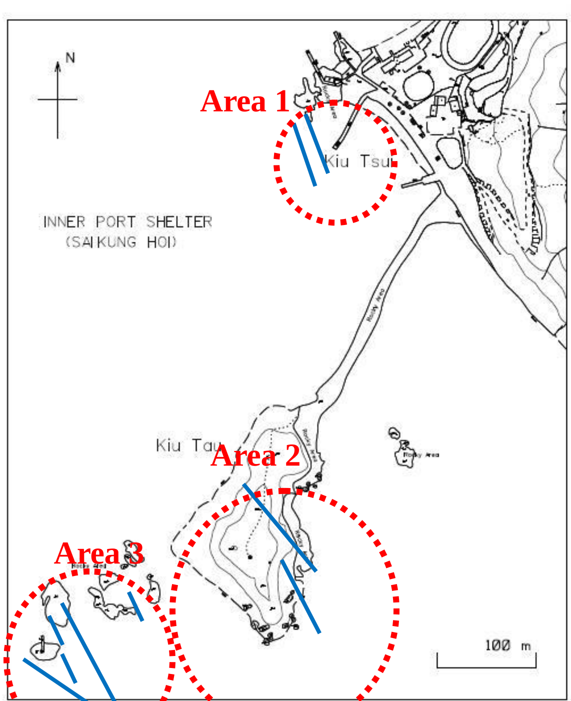


Figure 1: Selected study area and location of fault.

Selected study area

Area 1 is the western coast area of Kiu Tsiu Chau near the pier. The rock was suffered weathering with reveal the yellowish to reddish brown, and the fresh rock is grey. Size of angular lithic fragments is from 5mm to 150mm. The size of chert fragment can up to 150mm. No obvious bedding had been found in area 1. Two fault strike direction recorded in this area are SE 148° and SE 154°. Part of the rock fragment in area 1 retains laminated structure (plate 1).

Area 2 is the Kiu Tau Island. The cobble and gravel size fragment can be found in the rocks, the weathered rocks are white to yellowish brown and some are pale reddish brown. Otherwise, some rocks are pale grey. Quartz and feldspar are common in the rock, size from 1mm to 5 mm. The angular lithic fragments are from 5mm -250mm. Some chert fragment is up to 200mm (plate 1). Three fault were recorded in area 2, the strike direction are northwest to southeast.

Area 3 is the southwest of Kiu Tau Island. This area would be submerged beneath the water when the higher tide period. Colour of the rocks is similar to the Area 2. Size of quartz and feldspar are from 1mm to 5 mm. The average size of angular lithic fragments are small than other two areas, the range from 5mm -15mm. Chert is rarely in the area, and size from 5mm to 25mm. Fault orientation in area 3 is from northwest to southeast.

Petrographical analysis

Six specimens were collected from three areas to prepare the thin section and observed under polarizing microscope to identify the mineral composition, fragment composition and texture of the rocks (plate 2).

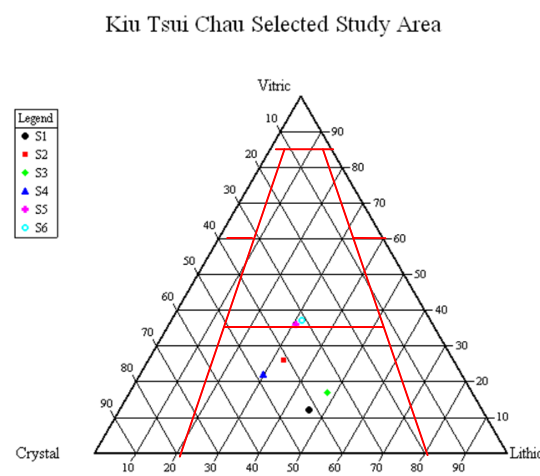


Figure 2: The fragment composition of selected area of Kiu Tsui Chau.

Two specimens are from area 1; three specimens are from area 2 and one specimen from area 3(Table 1). The fragment composition is shown as the figure 2 and table 1. According to the classification and nomenclature of Sun (1987), the collected rock specimen in the three selected areas are belong the crystal tuff (area 1), crystal lapilli tuff (area 2), and complex tuff (area 2 and 3).

Area	Specimen no.	Specimen description	Specimen photo	Fragment composition(%) of collected specimens			Rock name of collected specimen	Lithofacies	On site Size range of angular lithic fragment
Area 1	S1	Light gray to gray; quartz is white with size up to 2mm.		Lithic	Crystal	Vitric	Crystal tuff	Lithic and crystal tuff with volcanic agglomerate and breccias.	5mm to 150mm
				46	42	12			
	S2	Light gray to gray		Lithic	Crystal	Vitric	Crystal tuff		
				33	41	26			
Area 2	S3	Brownish green, feldspar with pink to orange with size up to 2mm; quartz is white with size up to 2mm		Lithic	Crystal	Vitric	Crystal lapilli-tuff	Complex and crystal lapilli tuff with volcanic agglomerate and breccias.	5mm -250mm
				48	35	17			
	S4	Pale green; rich in lithic fragment, their range from 1-6mm; quartz is white with size up to 2mm.		Lithic	Crystal	Vitric	Crystal lapilli-tuff		
				30	48	22			
	S5	Greenish gray to gray; pink feldspar mostly 1mm in size, quartz is white with size smaller than 1mm; some dark mineral with size 1mm and.		Lithic	Crystal	Vitric	Complex lapilli-tuff		
				31	33	36			
Area 3	S6	Light gray to gray; quartz is white with size up to 1mm, a green spot with size 3x6mm.		Lithic	Crystal	Vitric	Complex lapilli-tuff	Complex lapilli-tuff with volcanic breccia	5mm -70mm
				32	31	37			

Table 1: The Fragmental composition and lithofacies of selected study area in Kiu Tsui Chau

Area	On site Fragment photo	Description	On site Fragment photo	Description
Area 1		Lithic fragment retain the laminated structure.		
Area 2		Lithic fragment contain the rhyolitic structure (150×100mm).		The rounded volcanic bomb contains vesicular structure.
		The chert lithic fragment (130×30mm).		The rounded chert fragment (200mm).
		The angular lithic fragment (5-40mm) and vitric fragment (black colour).		
Area 3		Lithic fragment (5-13mm) and crystal fragment (1-2mm).		Lithic fragment (5-20mm) and vitric fragment (black colour).
		Rounded chert fragment (25mm).		Lithic fragment (50×30mm).
		Rounded sandstone fragment (70×40mm).		

Plate 1: The type of the lithic fragment of selected area in Kiu Tsui Chau

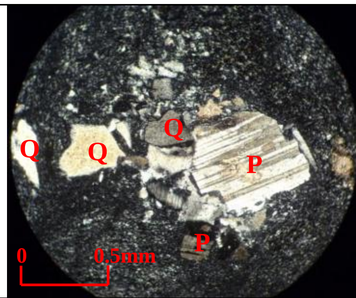
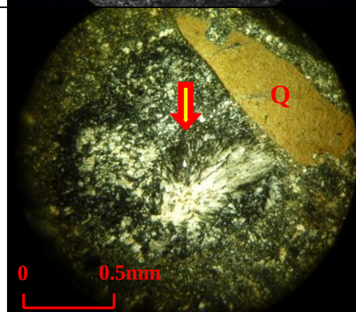
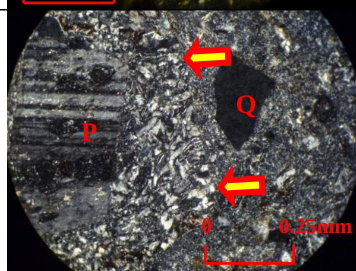
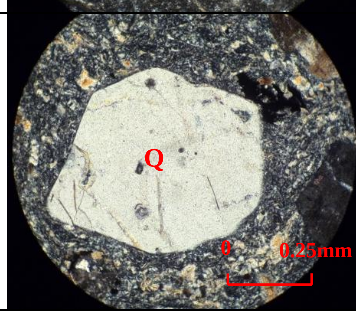
Area	Specimen no.	Petrographic photo	Description
Area 1	S2		A Lithic fragment contained the quartz and plagioclase. The quartzes are angular and plagioclases have polysynthetic twinning. (Q: quartz, P: plagioclase)
Area 2	S3		The radiating spherulite (arrow) consists of very fine intergrowth needles of quartz and alkali feldspar (MacKenzie, et al, 1997). The quartzes are angular. (Q: quartz)
Area 2	S5		The curved fragments are vitric fragment (arrow) and crystal fragment are plagioclase and quartz. (Q: quartz, P: plagioclase)
Area 2	S5		The eutaxitic texture (MacKenzie, et al, 1997) of vitric fragment.
Area 3	S6		The edge of quartz crystal fragment was smoothed. (Q: quartz)

Plate 2: Mineral and fragment picture under polarizing microscope.

Lithofacies

Based on the petrographic analysis and on site observation, the lithofacies of selected area are established (Table 1). Lithofacies of Area 1 is Lithic and crystal tuff with volcanic agglomerate and breccias. Lithofacies of Area 2 is Complex and crystal lapilli tuff with volcanic agglomerate and breccias. Lithofacies of Area 3 is Complex lapilli-tuff with volcanic breccias. The distribution of size lithic fragment is shown as figure 3. The size lithic fragment is increment from area 1 and area 3 to the area 2. In area 2, some lithic fragment size is larger than 200mm (plate1). The composition of the lithic fragment included the chert, volcanic rock.

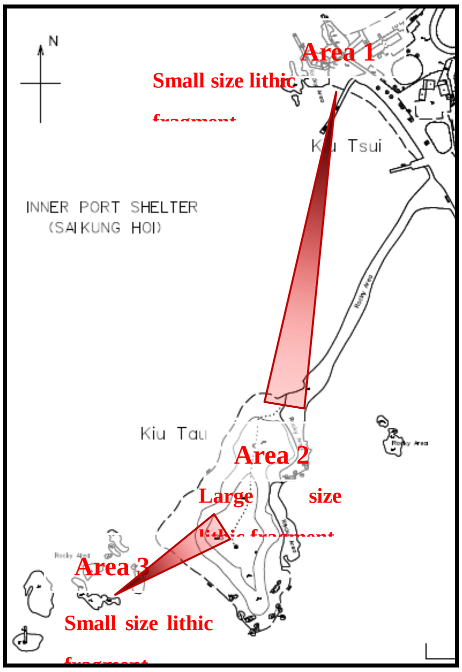


Figure 3: Size variation of lithic fragment

Conclusion

Three lithofacies were developed in the selected area of Kiu Tsui Chau. Large angular lithic fragment exist in area 2 is possible inference the distance of area 2 closed to the eruption center of the volcano and area 1 and area 3 are far from the eruption center. Otherwise, these three areas have not obvious stratified structure and it is massive. Therefore, inference the rocks are deposited on land.

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Message from Editor

This newsletter is published every three months. Please contribute your articles. Thanks

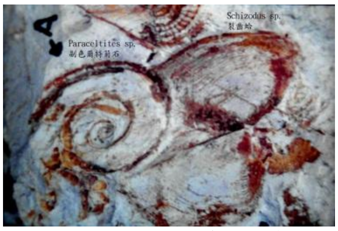
Pictures of Fossil from Mr. Nau

Fossil plant and fossil animals are found in sedimentary rocks in Ma Shi Chau which provide direct evidence of live in the past and can be used for estimating the age of the rock in which they occurred.

The writer had collected some fossil plant and fossil animals from Ma Shi Chau long time ago. Among them, fossil plant[1] and coral[2] had been published. The other fossils were presented to the Hong Kong Museum, but the writerkeeps the photos and would like to present here for reference.

The fossil animals presenting here are as follows:

Phylum Mollusca Class Cephalopoda Order Ammonoidea



Paraceltites sp. (副色爾特菊石)

AltudocerasjianshienseXu 阿爾圖菊石

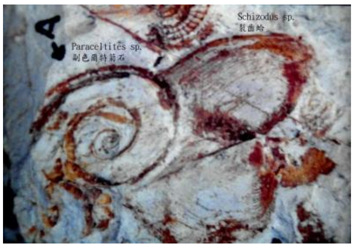
Phylum Brachiopoda

Not identified

Phylum Mollusca Class Bivalvia

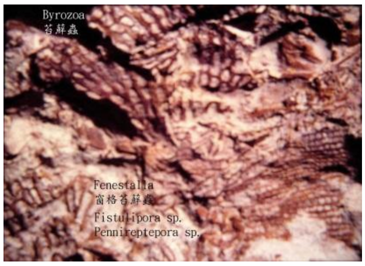
Limipecten sp.

Euchadrioide sp.



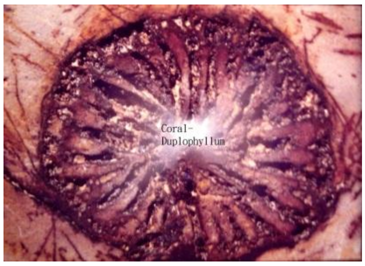
Schizodus sp. 裂齒蛤

Phylum Bryozoa



Fistulipora sp.Pennireptepora sp.Fenestalla sp.

Phylum Mollusca Class Anthozoa



Duplophyllum

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Field trip to Madagascar
By George Tsang

Introduction

In June, 2012, I and my partners were invited by a mining company to appraise and investigate a gold mine and a zircon mine in Madagascar. I was responsible for the geological part.

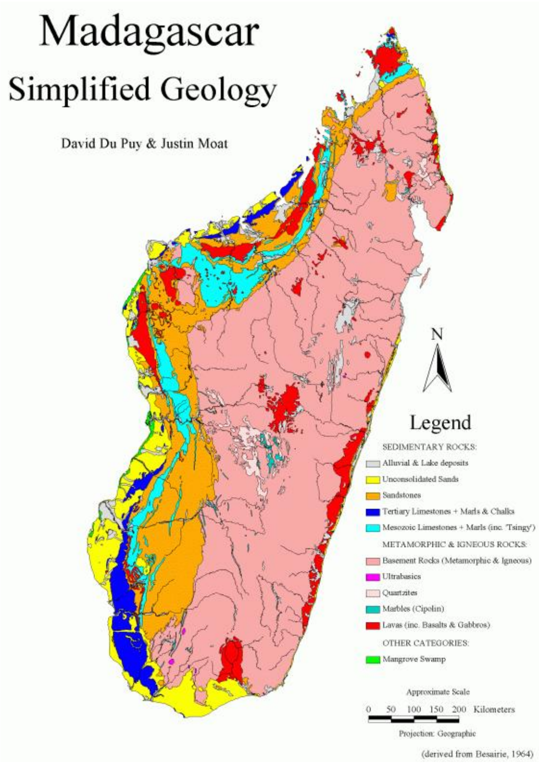


Fig1- Geological map of Madagascar

Almost all geological work in Madagascar were done by French in their colonial period between 1895- 1960.

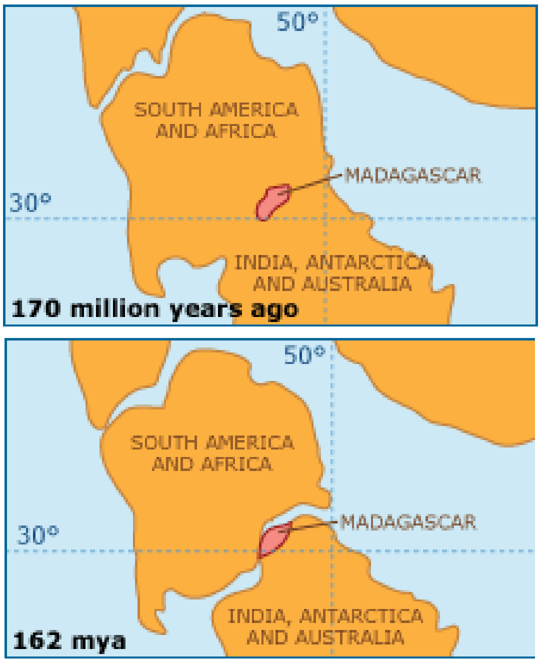
I intended to buy a book concerning the geology or geography of the country in vain after spending the whole afternoon with the help of a car. The only source of the geology data was from the "Bureau de Recherche" where I could find only the antique books written in French without cover.

Madagascar is the fourth largest island of the world, the largest island of Africa and in India Sea. The length is 1,160 Km in north-south direction, the widest part is 386 Km in the middle, latitude between 1000 meters to 2,600 meters.

It is also known as Country of Cows, they use cows for transportation, farming and food. I found out they use twin cows (Fig 2) for transportation and logistic which is different from China where we use one. I think the reason is that everywhere is grass, food for cows is not a problem, so they hire two free workers.

Fig 2- Cow car

The derivation of recent geomorphology of Madagascar is as follows (Fig-3): (Ref-2)



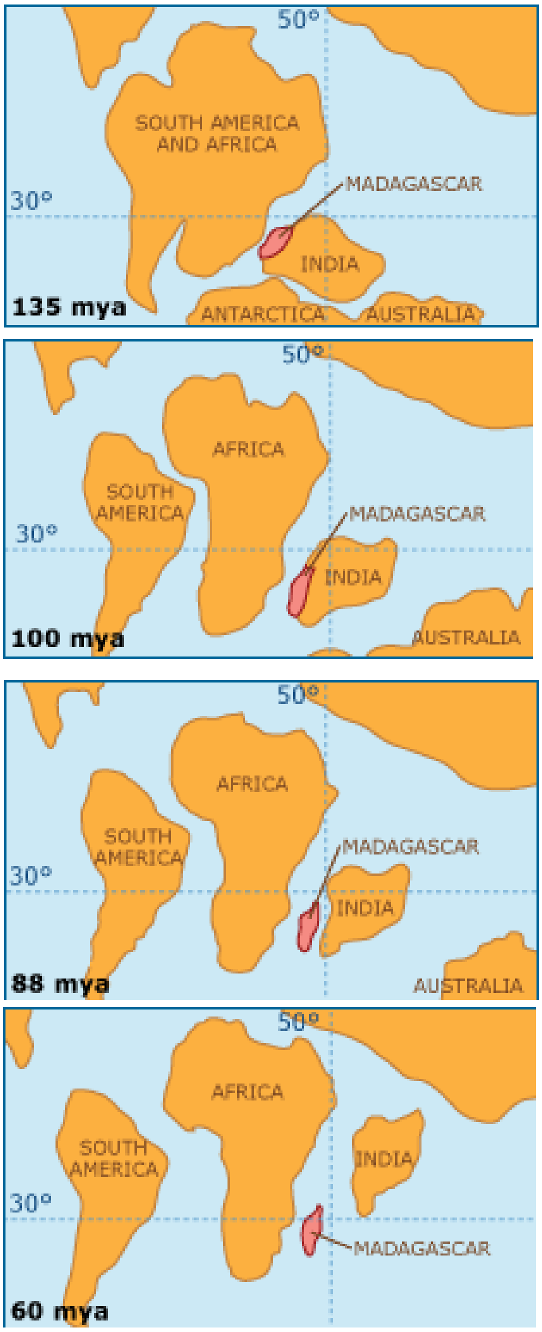


Fig 3- Continental drift & plate tectonic

Madagascar was in the middle of the large continent gondwanaland in 170 million years ago. It then separated slowly from the continents and has been remaining in its present position for 88 million years.

Madagascar can be divided into two zones, the Precambrian basement complex in the east and sedimentary cover formation in the west. (Ref-1)

The central is plateau which is chiefly granite, west is low plateau, east is highland and south is arid.

The natural resources of Madagascar include graphite, gold, iron, bauxite, chromite, coal and salt etc. It also produces all kinds of precious stones especially tourmaline, aquamarine, ruby, emerald, sapphire, amazonite, labradorite etc.

Fig 4- The villagers are panning the precious stones in the river

People (Fig 4) are panning the precious stones in nearby river of the source. I found out many stores in the mining village with “Gems” indication in front of their houses. However, I was told they were buyers, not sellers when I intended to buy some stones from them.

The famous Isalo National Park (Fig 5 & 6) is a heaven for geologists to study the tectonic development. It is similar to our stone forest in Guangxi province. Some precious stones are found along a nearby river.

Fig 5- A wide view of the park

Fig 6- An enlarge view

The roads of the country are terrible, no proper way from capital to the mines. I spent 3 days to arrive the destination. I have to walk a whole day up and another day down if I wish to go to a Ta /Nb mine.

Fig 7- A typical tunnel

Fig 8- Collecting sample

My objective of this trip was to appraise a gold mine which is being mined by the villagers. The area was seriously damaged by the people. They dug tunnels to chase the gold veins from surface (Fig 7 & 8). Some gold particles are embedded in quartz (Fig 9). Some nature gold are found.

Fig 9- Crushing the quartz into powder

I stayed in a presidential house hotel (Fig 10) which was supposed to accommodate one of the African Presidents who would come to attend the conference. Unfortunately, the host president was overthrown before the Presidents come.

I enjoyed the luxury facility alone with 5 suites and a garden. However, it is pity that internet is not installed in the house. I had to go to hotel lobby to connect the Wi- Fi. Besides, all decorations and construction materials were from China including the triangular power socket.

Fig 10- Presidential hotel

On a contrary, I stayed in a tent in the mining village as below (Fig 11).

Fig 11- Our hotel in the mountain

After visiting the gold mine, I investigated a zircon mine (Fig 13) which is so rich that I could find a lot of zircon lumps from ground surface. Be careful ! It contains radiation. The zircon is the only element left after weathering near the surface but it is embedded in gneiss in the deep portion. The granite intruded the gneiss which shows mylonitization (Fig 12).

Fig 12- Granite intruded gneiss

I found minerals existing as single element mine in the country which is the characteristic of the mines, such as tourmaline mine which contains mostly only tourmaline, the zircon mine contains only zircon, the labrador mine contains only labrador.

Fig 13- Test tunnel for zircon

Fig 14- Examining boring core

From the core drilling (Fig-14), I can see zircon is found even in the depth of 280 meters in pegmatite which is associated with gneiss.

Madagascar is part of the East African Orogen which is characterized by a high grade gneissic basement that was structurally and thermally revoked during the Neoproterozoic collision of the Dharwar craton of India with the Congo/ Tanzania/ Bangweulu craton of Africa (Ref- 3).

The typical evidences of metamorphosed rocks are shown by gneiss rocks, amphibolites, mica in the deep portion of the boring core (Fig 15).

Fig 15- Amphibolite and gneiss rock in the boring core

Fig 16- Nipple mountain

On my way back to Hong Kong, I had to undergo the same process which took me three days to arrive the capital- Antananarivo. I passed the “Nipple mountain” (Fig 16), “Bread trees” (Fig 18) and met a group of happy children (Fig 17) in a village.

Fig 17- Happy children in the mining town

Fig 18- Good bye- Bread trees

Fig 19- Au revior, Madagascar, bonne nuit

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