

# 由混同層探討台灣的隱沒帶演化

## Evolution of Subductions Indicated by Mélanges in Taiwan

張中白

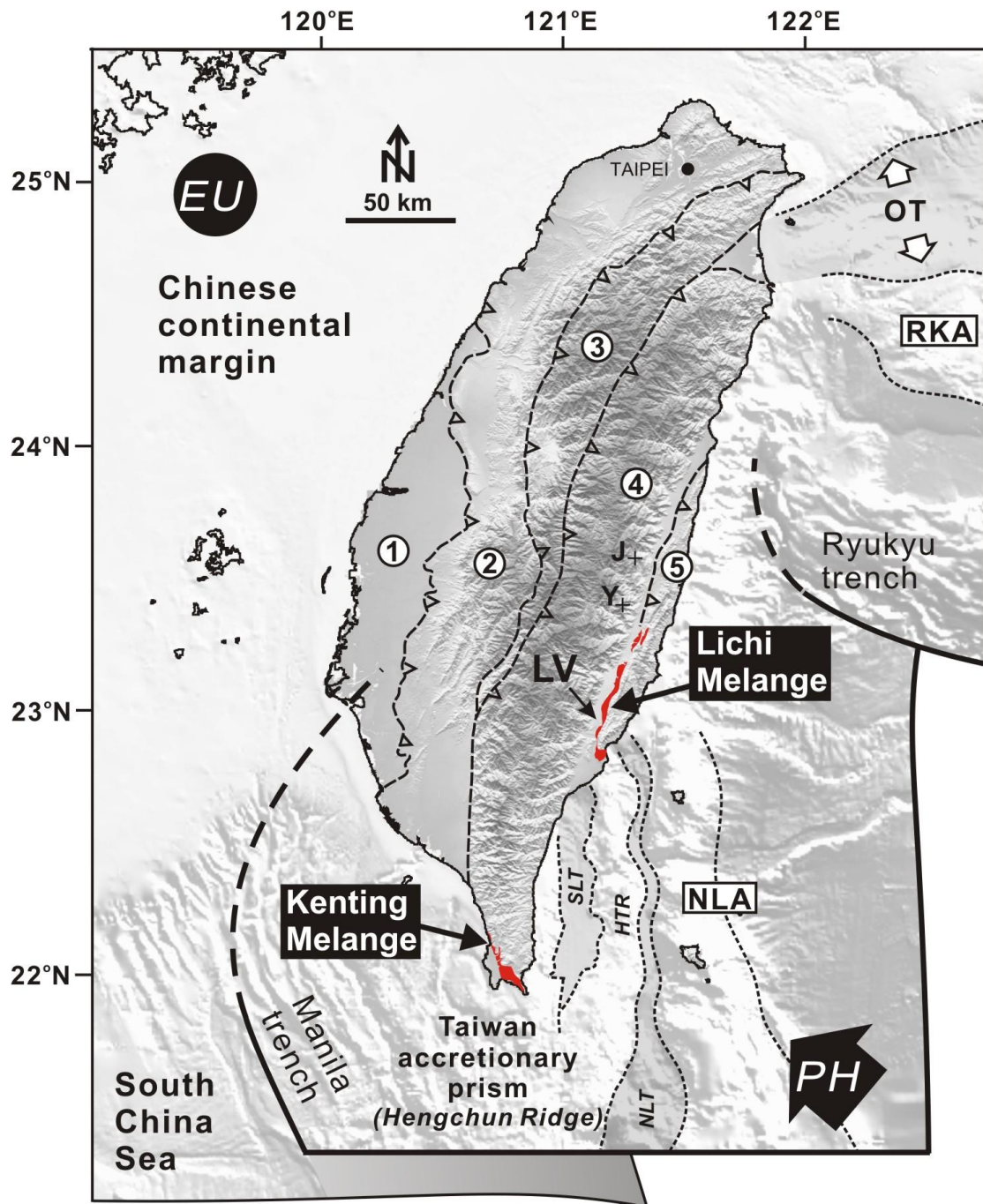
國立中央大學太空及遙測研究中心



地質遙測實驗室  
Geological Remote Sensing Laboratory



Center for Space and Remote Sensing Research



## 台灣主要地質分區圖

- 1: 西部海岸平原
- 2: 西部麓山帶
- 3: 雪山山脈
- 4: 中央山脈
- 5: 海岸山脈

- EU: 歐亞板塊
- HTR: 花東海脊
- LV: 台東縱谷
- NLT: 北呂宋海槽
- OT: 沖繩海槽
- PH: 菲律賓海板塊
- RKA: 琉球島弧
- SLT: 南縱海槽
- J: 瑞穗蛇綠岩塊
- Y: 玉里蛇綠岩塊

## 台灣混同層分布區域

# 1. 從台東縱谷談起

## 2. 台灣的混同層

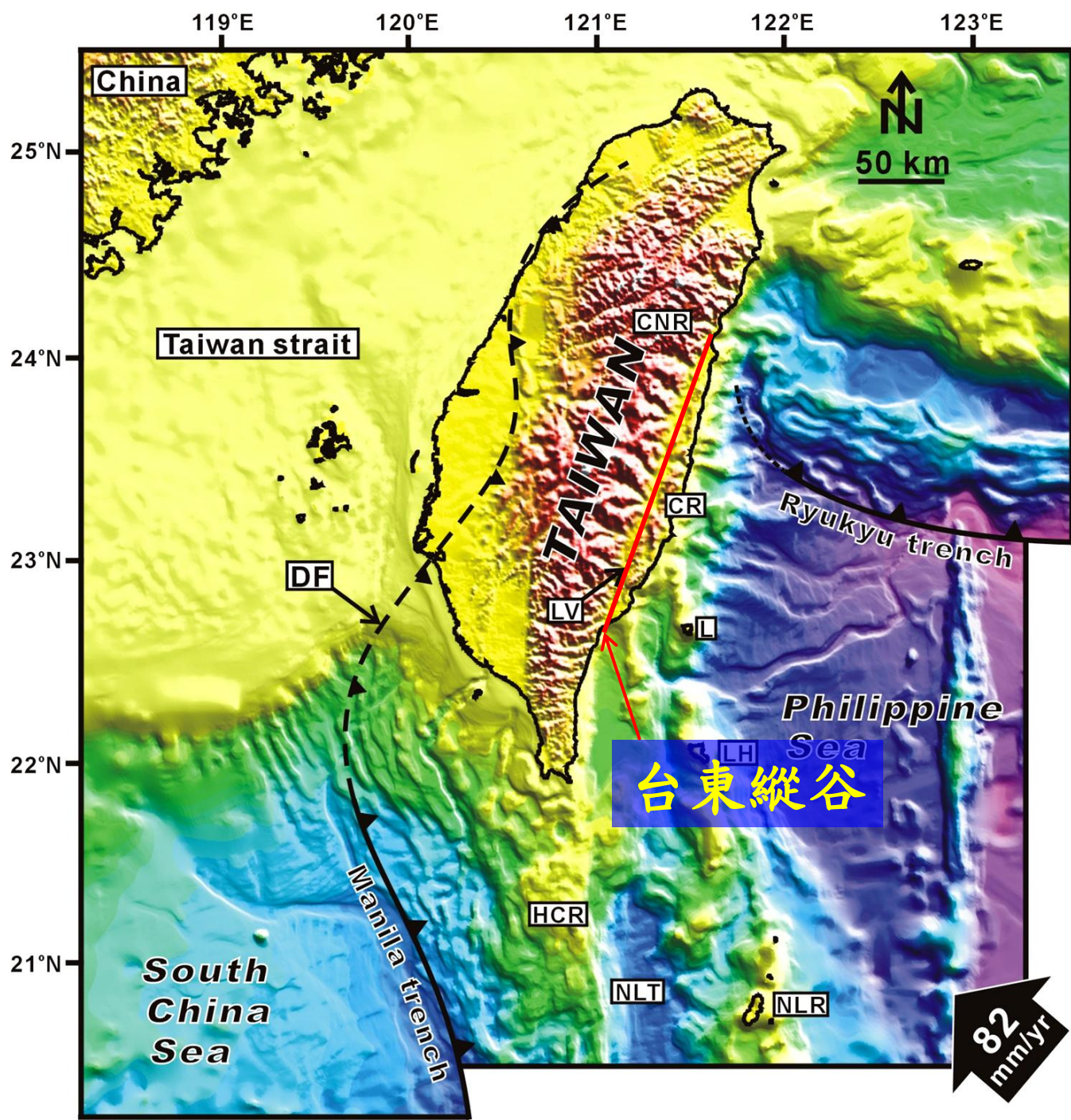
- 利吉混同層
- 墾丁混同層

## 3. 利吉與墾丁的異同與意涵

## 4. 馬尼拉海溝的演化過程

- 單純隱沒
- 海溝跳躍
- 弧前隱沒

## 5. 結論



# 中央山脈

變質基盤雜岩  
第三系大陸邊緣沉積物

# 海岸山脈

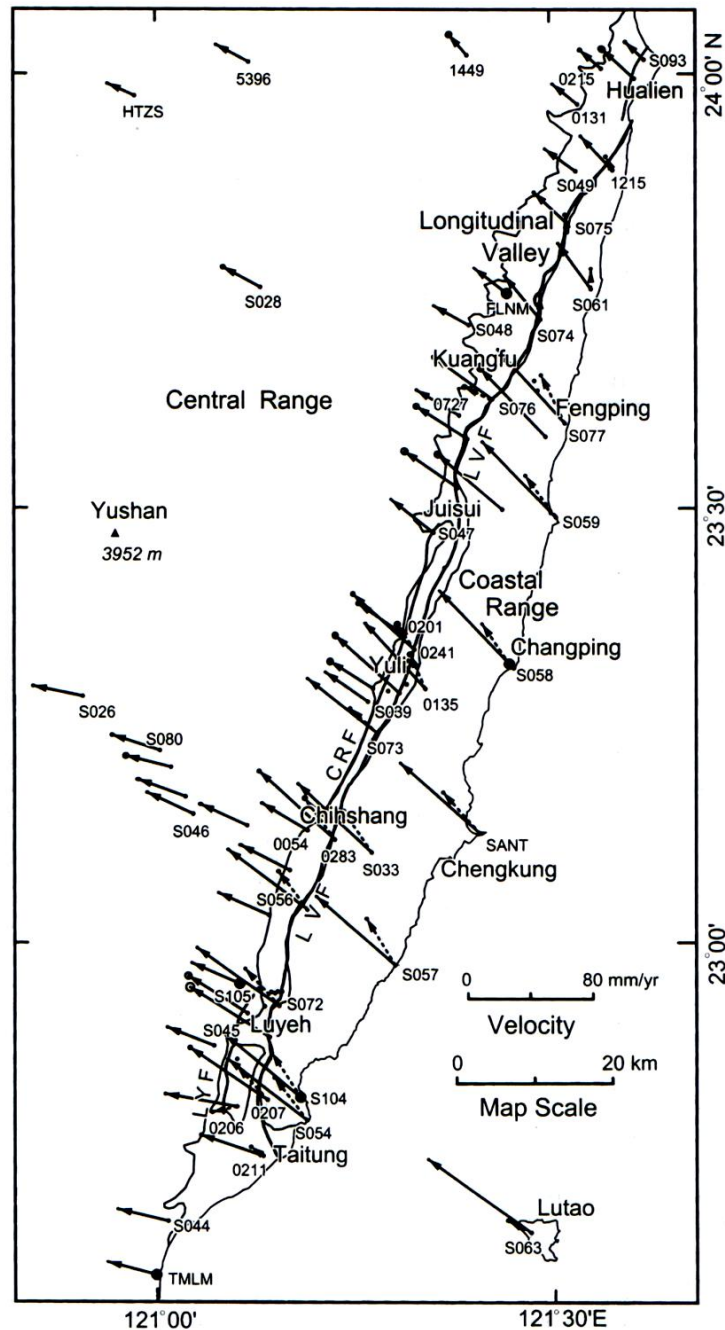
火山島弧 - 都巒山  
弧前盆地 - 泰源盆地  
混同層 - 利吉層

# 台東縱谷

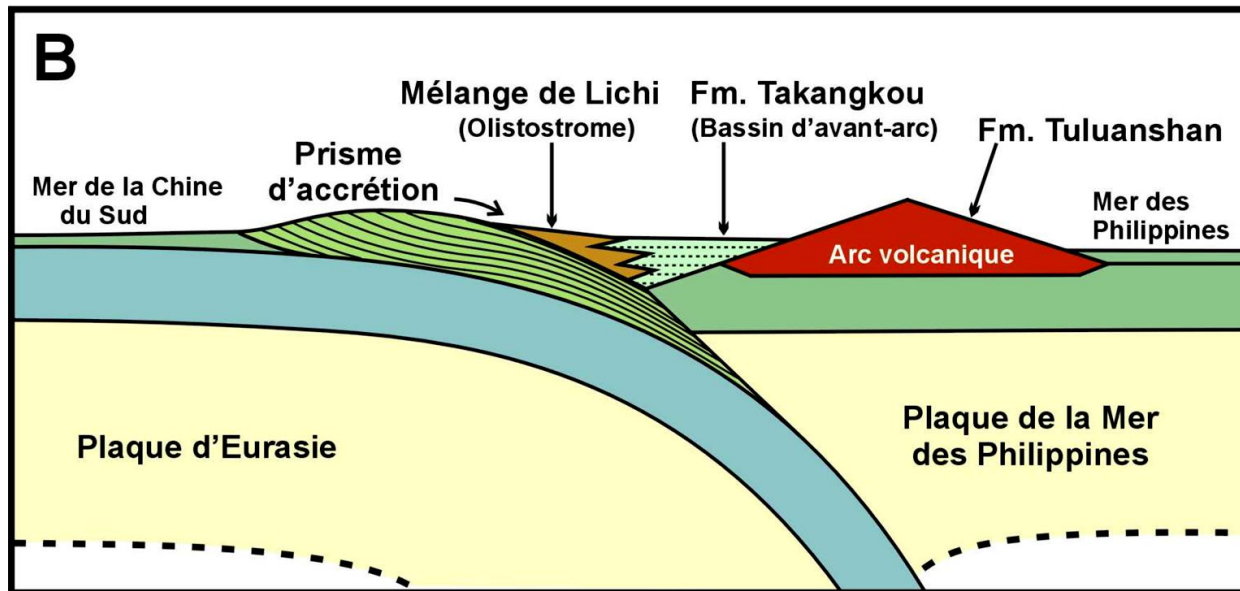
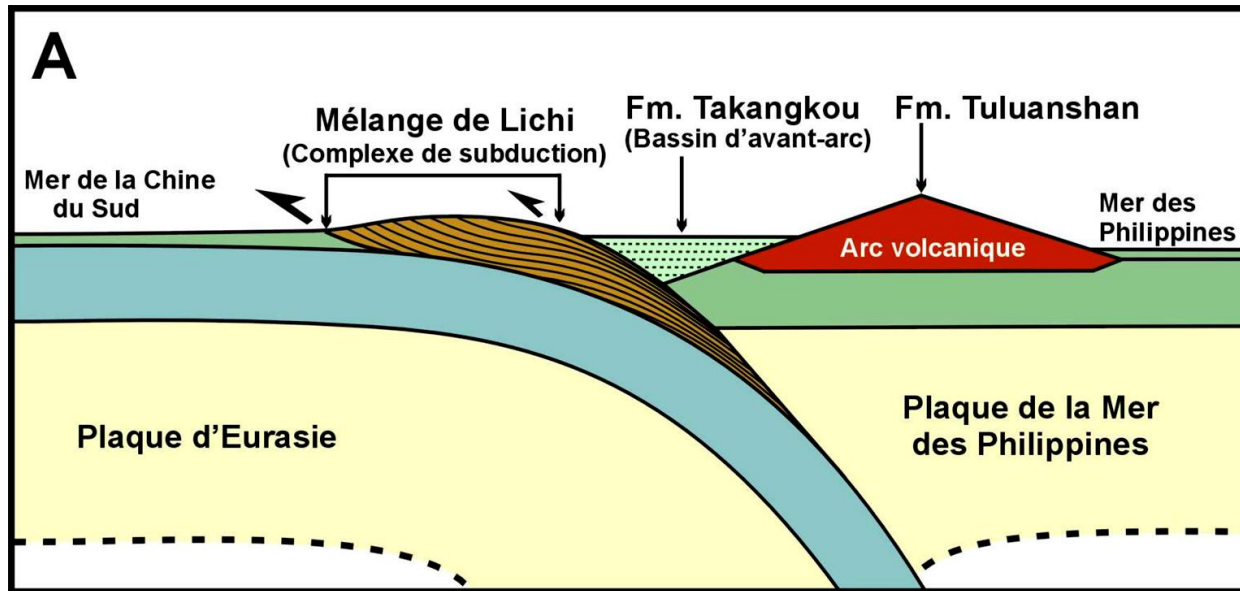


# 縱谷斷層 —

台灣陸上最重要的活動構造



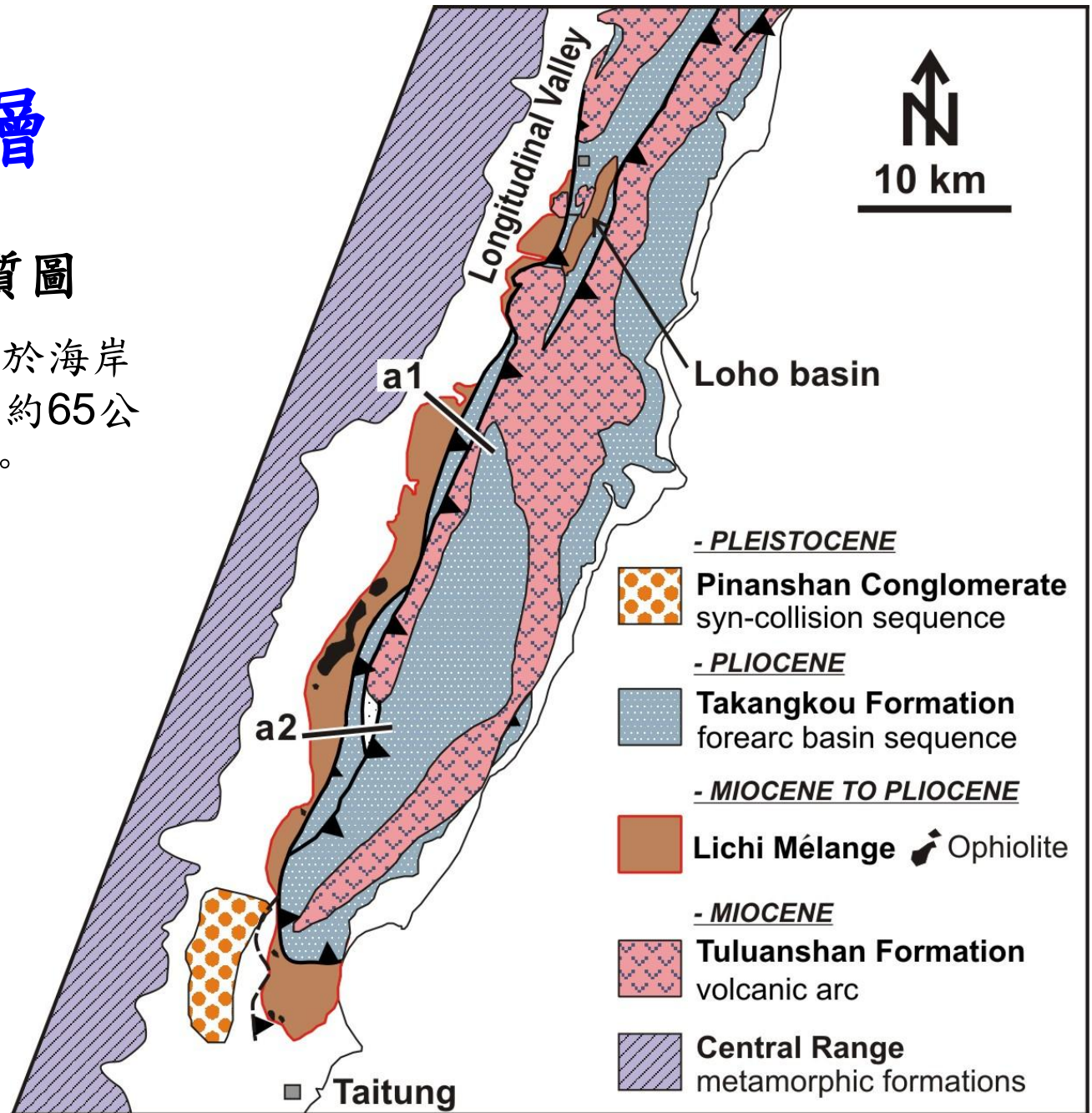
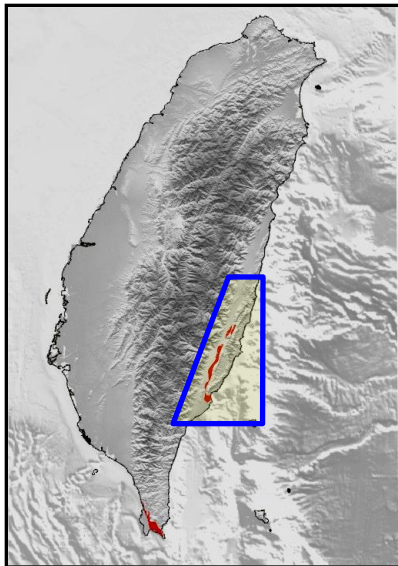
# 利吉混同層所扮演的關鍵角色



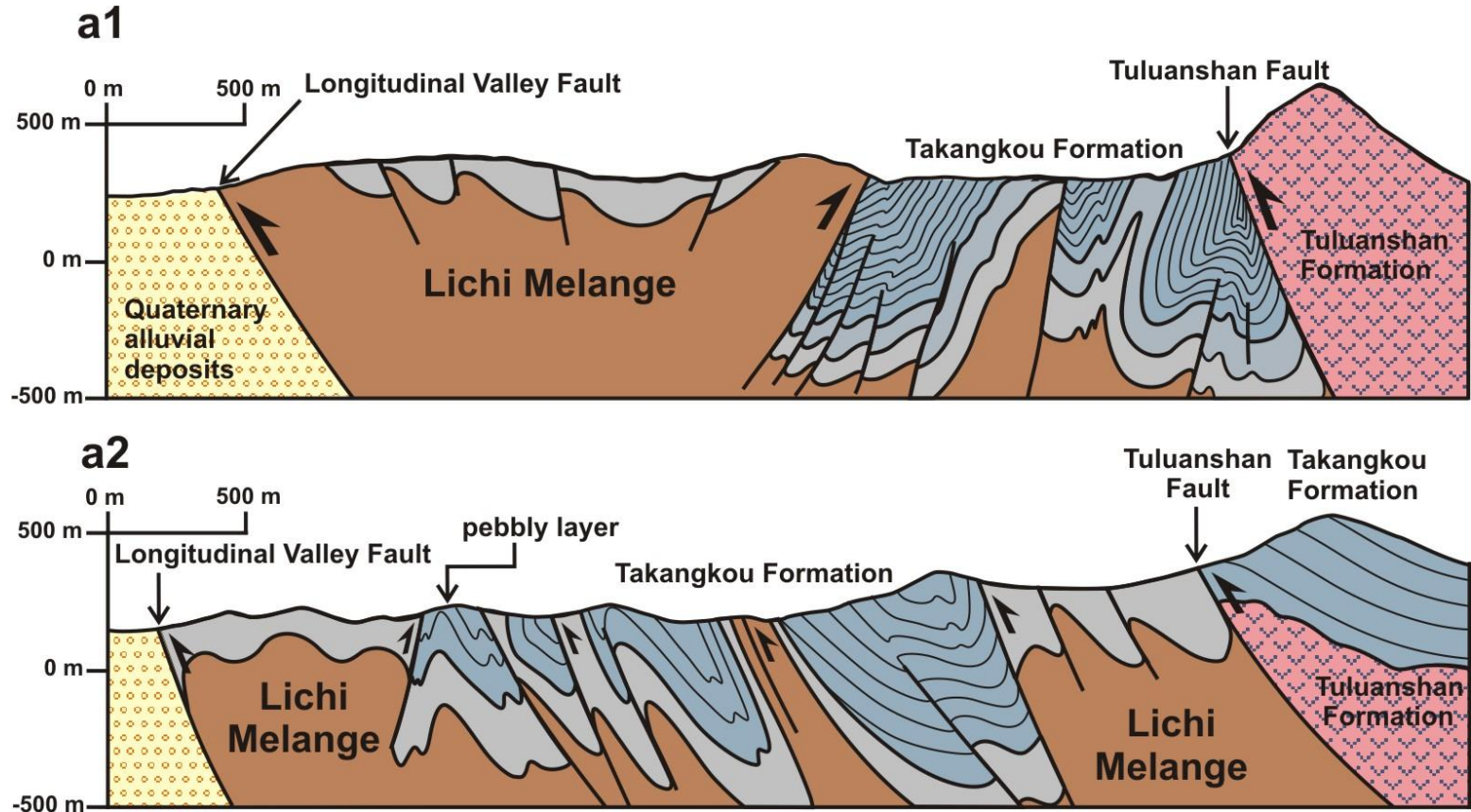
# 利吉混同層

## 海岸山脈南段地質圖

利吉混同層主要分布於海岸山脈西南緣，總長度約65公里，最寬不及5公里。



# 利吉混同層



## 利吉混同層地區地質剖面

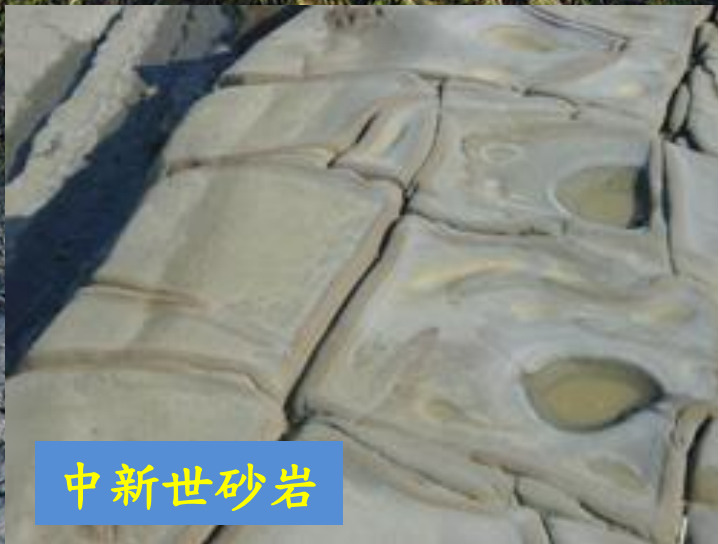
利吉混同層主要分布於海岸山脈弧前盆地較下部的位罝，由於擠壓而沿著斷層及褶皺出露於地表。



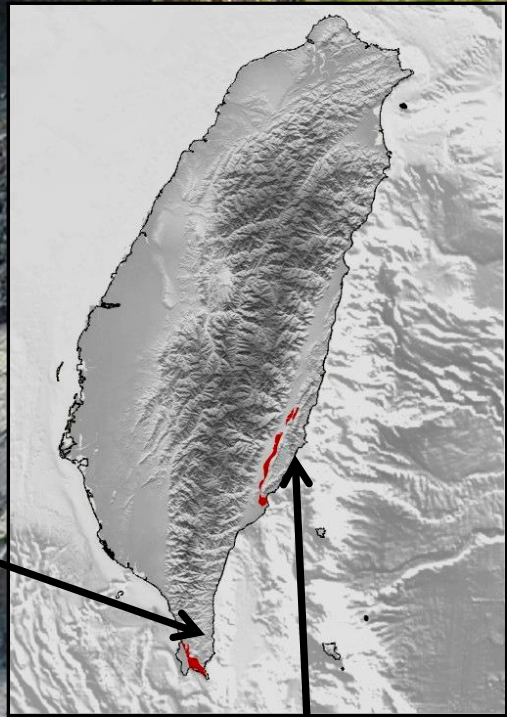
# 利吉混同層



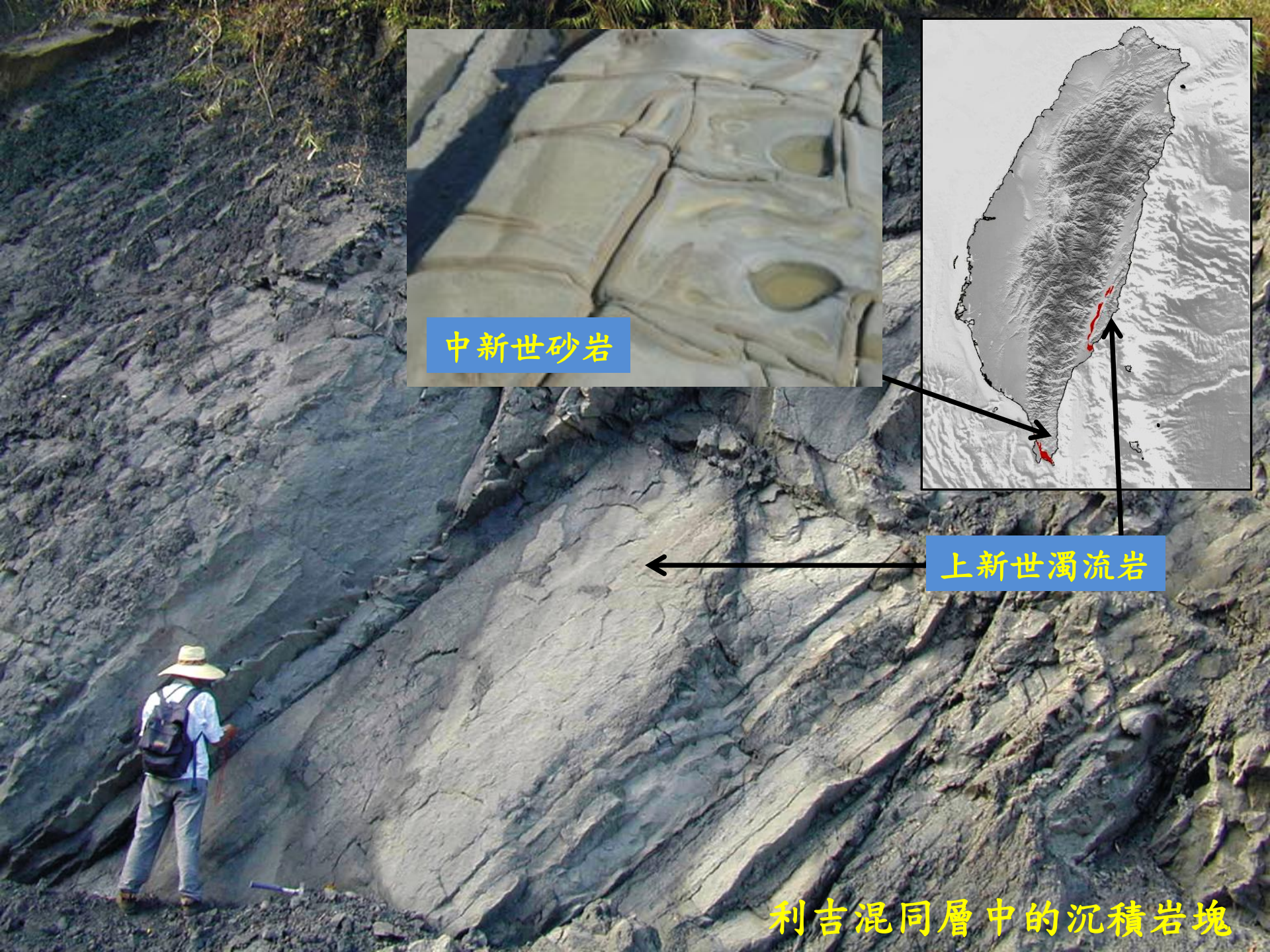
利吉混同層中的蛇綠岩塊



中新世砂岩



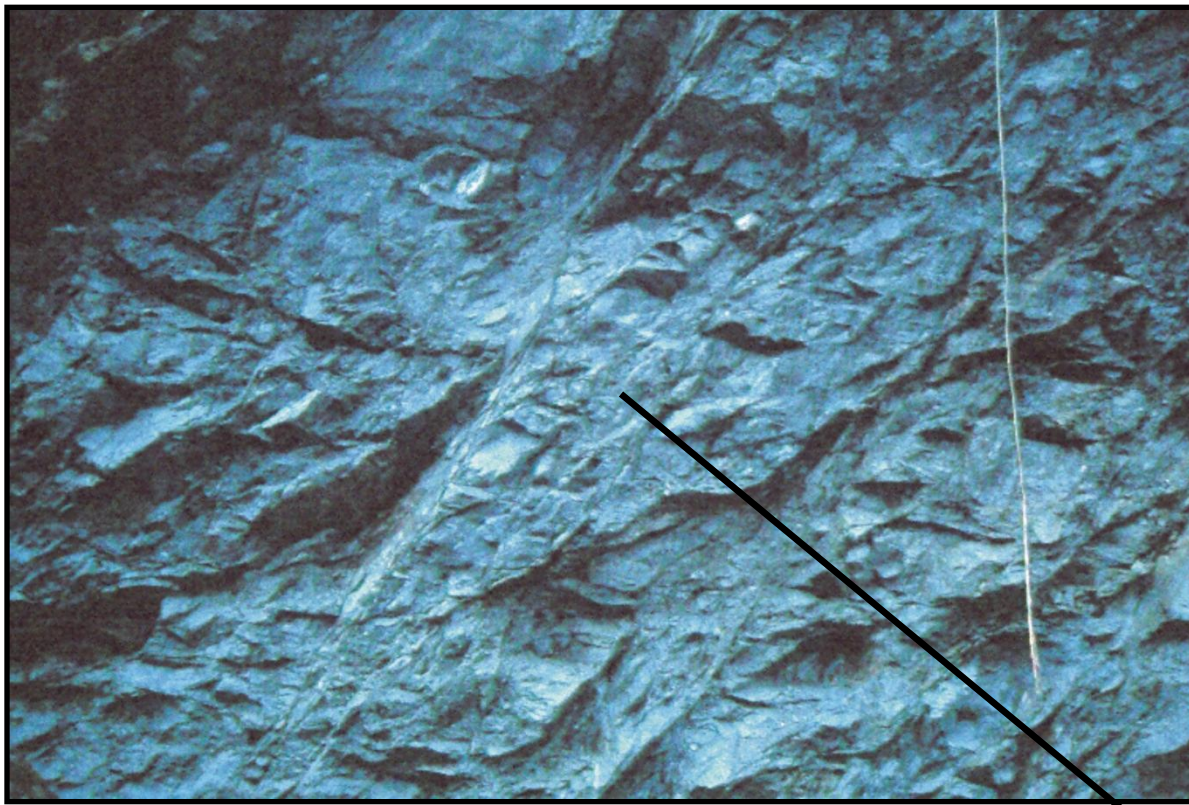
上新世濁流岩



利吉混同層中的沉積岩塊

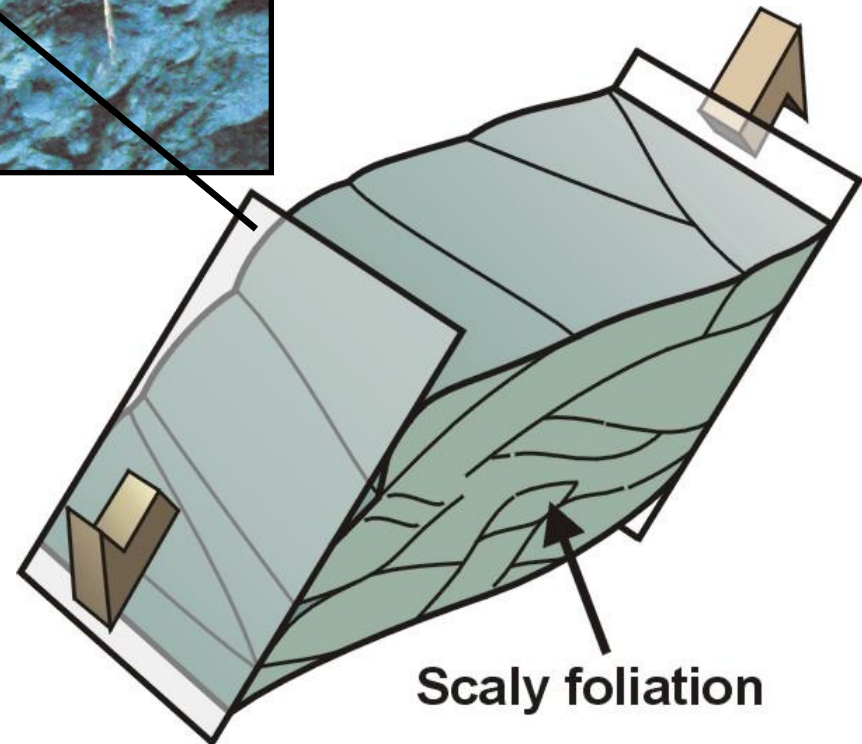


利吉混同層中的鱗片狀葉理 (scaly foliation)

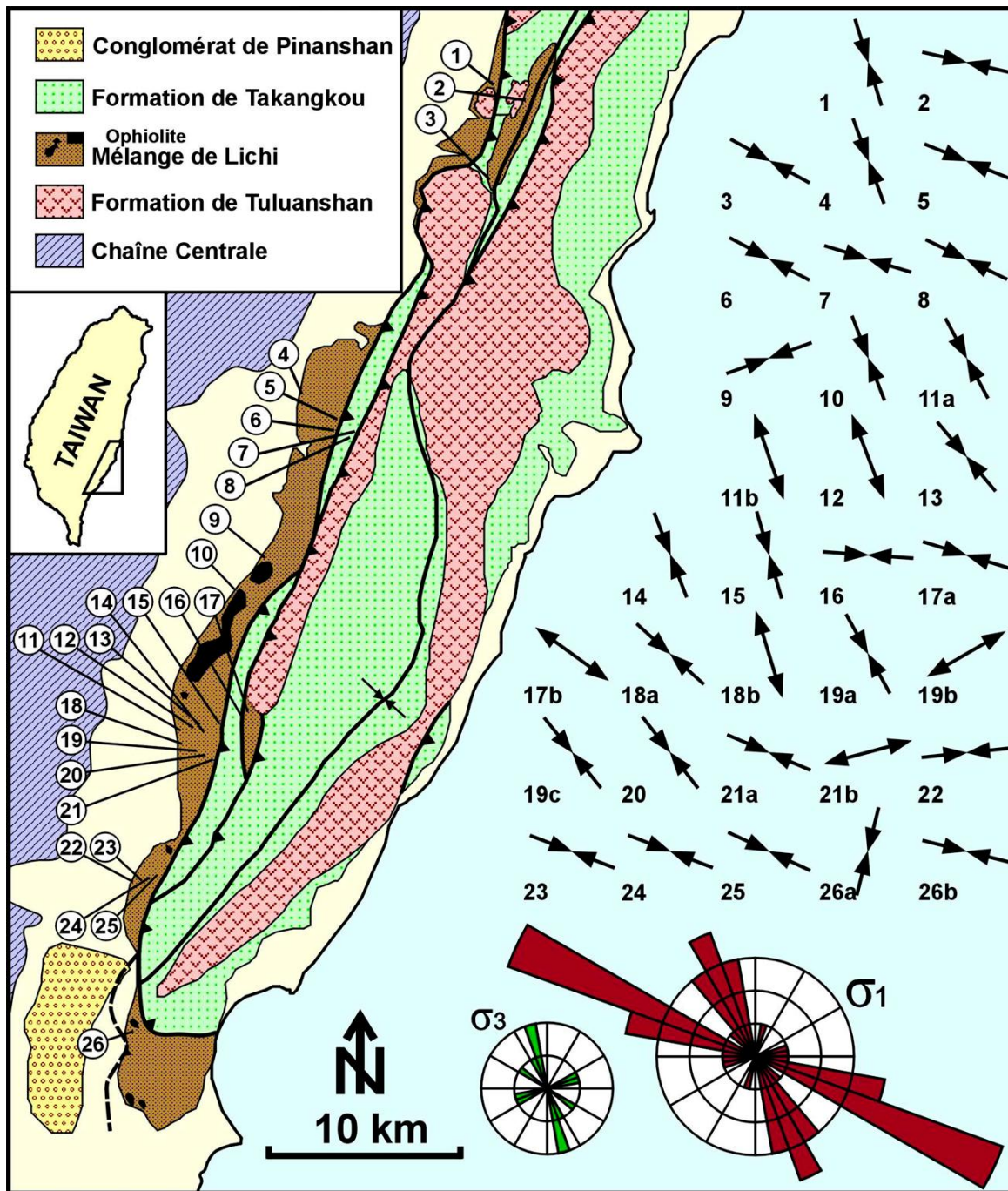


混同層中的基質泥岩由於受到強烈的剪切作用，發育良好的鱗片狀葉理

利用透鏡體的形貌及表面的擦痕，可以判斷造成區域變形的應力方向及形式。



Scaly foliation



利吉混同層中的  
應力紀錄



50 cm

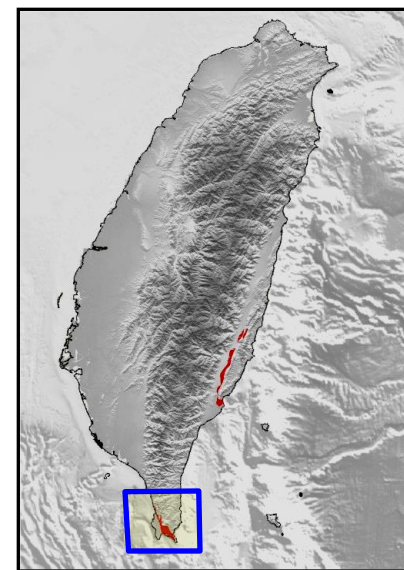
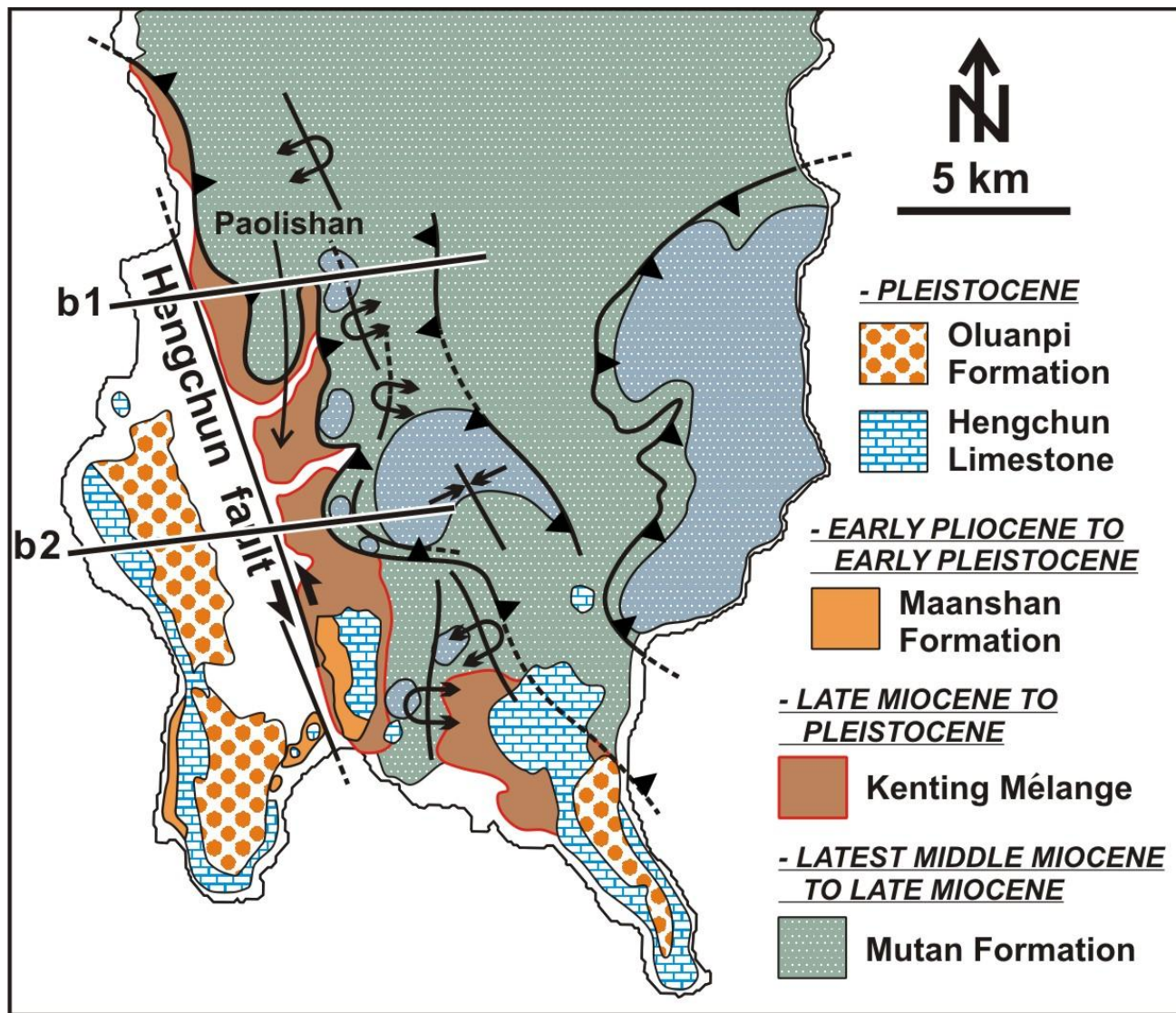
利吉混同層中的礫岩層



5 cm

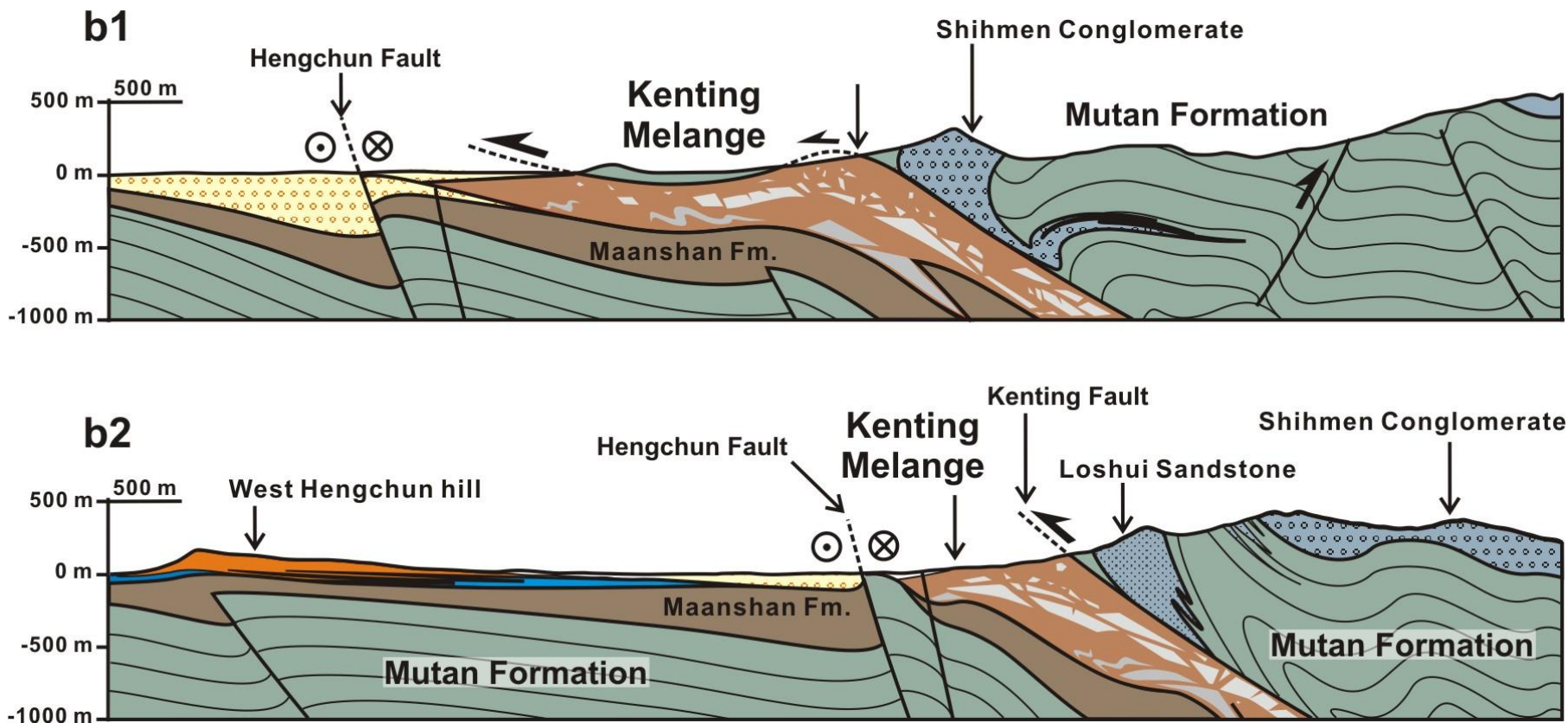
利吉混同層中的礫岩層

# 墾丁混同層



墾丁混同層主要分布在恆春半島主體山脈的西緣，長度不及15公里，寬度越北越窄，越南越寬，最寬約5公里左右。

# 墾丁混同層



## 墾丁混同層地區地質剖面

由構造的觀點來看，墾丁混同層像是一個巨大的低角度向西逆衝的斷層帶，此斷層帶截切恆春半島的主體山脈 - 中新世的牡丹層

# 墾丁混同層



牡丹層

墾丁混同層



# 墾丁混同層



# 利吉與墾丁混同層的詳細比對表

		Lichi Mélange	Kenting Mélange
similarities	<b>Matrix</b>	Intensely sheared mudstones without distinctive stratification. Some layers with coherent stratification have been locally reported	
	<b>Texture</b>	Scaly foliation, dense pattern of small faults with slickenside lineations (mainly thrust and strike-slip in type, also normal)	
	<b>Exotic blocks</b>	Ophiolitic blocks (including basic to ultrabasic rocks) and sedimentary blocks (including sandstone, sandstone/shale interbeds, shales and limestones), metric to kilometric in size	
	<b>Boundary structure</b>	Bounded by west-verging thrusts at both eastern and western boundaries of mélange zone	
	<b>Footwall</b>	Quaternary fluvial deposit (both Lichi and Kenting) and coral reef (Kenting only) in the west	
	<b>Tectonic regime</b>	Mainly NW-SE compression indicated by fault slip data and other structures inside the mélange	
differences	<b>Clay mineral</b>	illite (48.8%), chlorite (8.4%), kaolinite (13.9%), smectite (1.9%) and mixed-layer clay minerals (27.0%)	Illite (57.8%), chlorite (10.3%), duckite (11.5%), montmorillonite (2.0%) and mixed-layer clay minerals (18.6%)
	<b>Age of matrix</b>	Rather well constrained, 3.5~3.7 Ma	Large dispersion of ages, approximate range 1 to 10 Ma
	<b>Exotic blocks</b>	Include both Miocene and Pliocene sedimentary rocks and Miocene volcanic rocks (with volcanic breccias, tuffs, and volcanoclastic turbidites) issued from the Luzon Arc	Include Miocene turbiditic blocks, but does not include Pliocene sedimentary rocks and Miocene volcanic rocks
	<b>Pebbly layer</b>	Locally reported (especially in the rivers of the central segment)	Not found (but many conglomerate blocks exposed)
	<b>Limestone included</b>	Pliocene Kangkou Limestone (around the summit of the volcanic arc east to the mélange)	Pleistocene Hengchun Limestone (apron coral reef and lagoon phase limestone exposed in west of the mélange)
	<b>Hanging wall strata</b>	Miocene volcanic basement overlaid by Pliocene turbidites to the east	Miocene turbidite formation to the east
	<b>Geographic location</b>	Along the southwestern flank of the Coastal Range, east of the Central Range and Longitudinal Valley	In a narrow area of low hills that bound the main range of Hengchun Peninsula (southern extension of Central Range) to the west
	<b>Geological location</b>	Between the Taiwan accretionary prism/Central Range and the Luzon volcanic arc	Between the foreland of the Taiwan belt and the western flank of the southern Taiwan accretionary prism
	<b>Origin of ophiolite</b>	Basement of forearc basin (probably the Philippine Sea oceanic crust)	South China Sea oceanic crust
	<b>Tectonic origin</b>	Forearc mélange: originates from the thrust strata at the front of a forearc basin west of, and attached to, the Luzon Arc	Formed at the front of an accretionary prism above the subduction zone, representing the relic of a submarine trench.

## 黏土礦物組成

利吉混同層

illite, chlorite, kaolinite and little smectite

墾丁混同層

illite, chlorite, dickite, montmorillonite

## 基質泥岩年代

利吉混同層

rather well constrained, 3.5~3.7 Ma

墾丁混同層

large dispersion of ages, approximate range 1 to 10 Ma

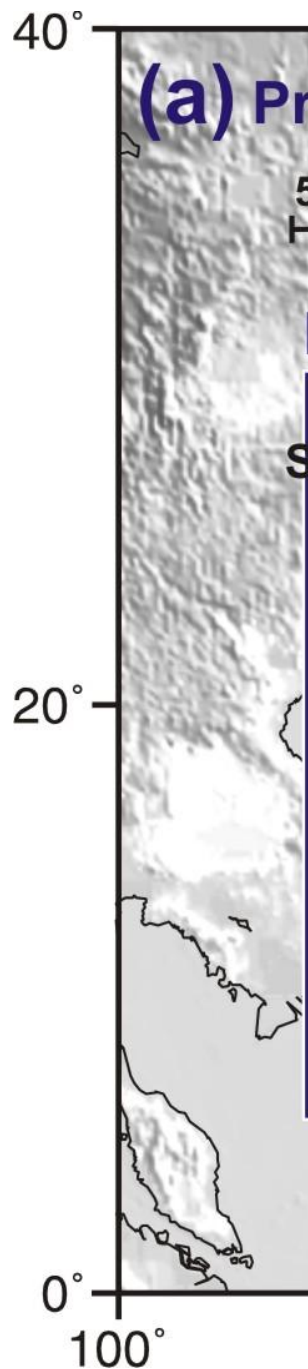
## 蛇綠岩系來源

利吉混同層

basement of forearc basin

墾丁混同層

South China Sea oceanic crust



(a) Pr

# (b) Paleogeography

500 km

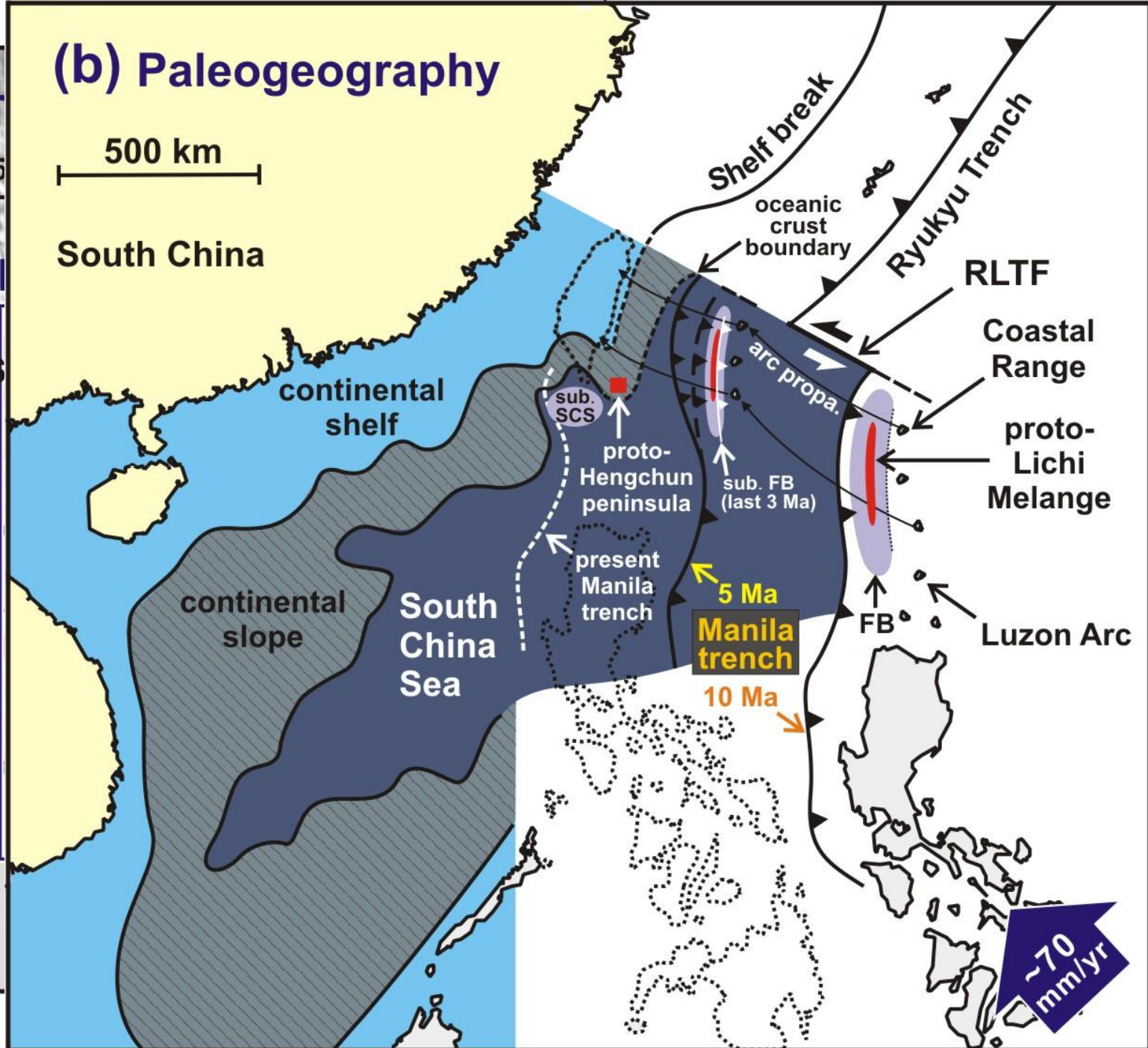
South China

continental shelf  
continental slope  
South China Sea  
proto-Hengchun peninsula  
present Manila trench  
sub. SCS

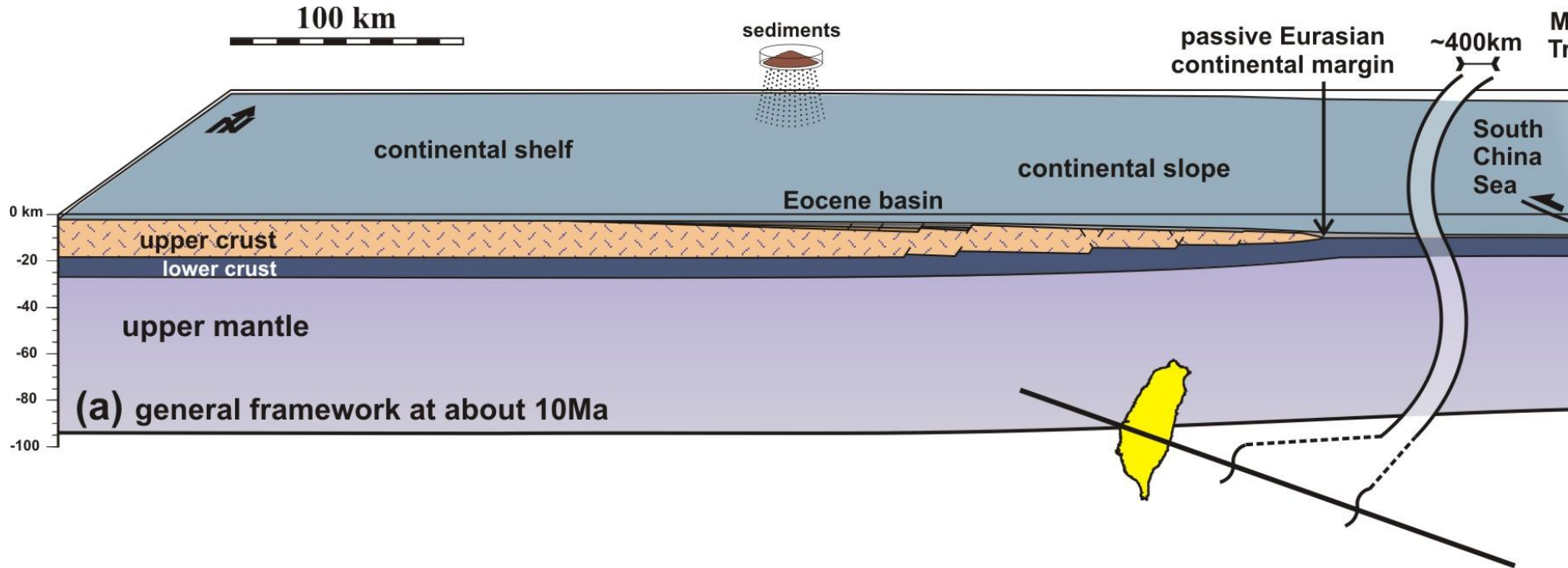
Shelf break  
oceanic crust boundary  
Ryukyu Trench  
RLTF

arc propa.  
sub. FB (last 3 Ma)  
5 Ma Manila trench  
10 Ma  
FB  
Luzon Arc  
Coastal Range  
proto-Lichi Melange

~70 mm/yr



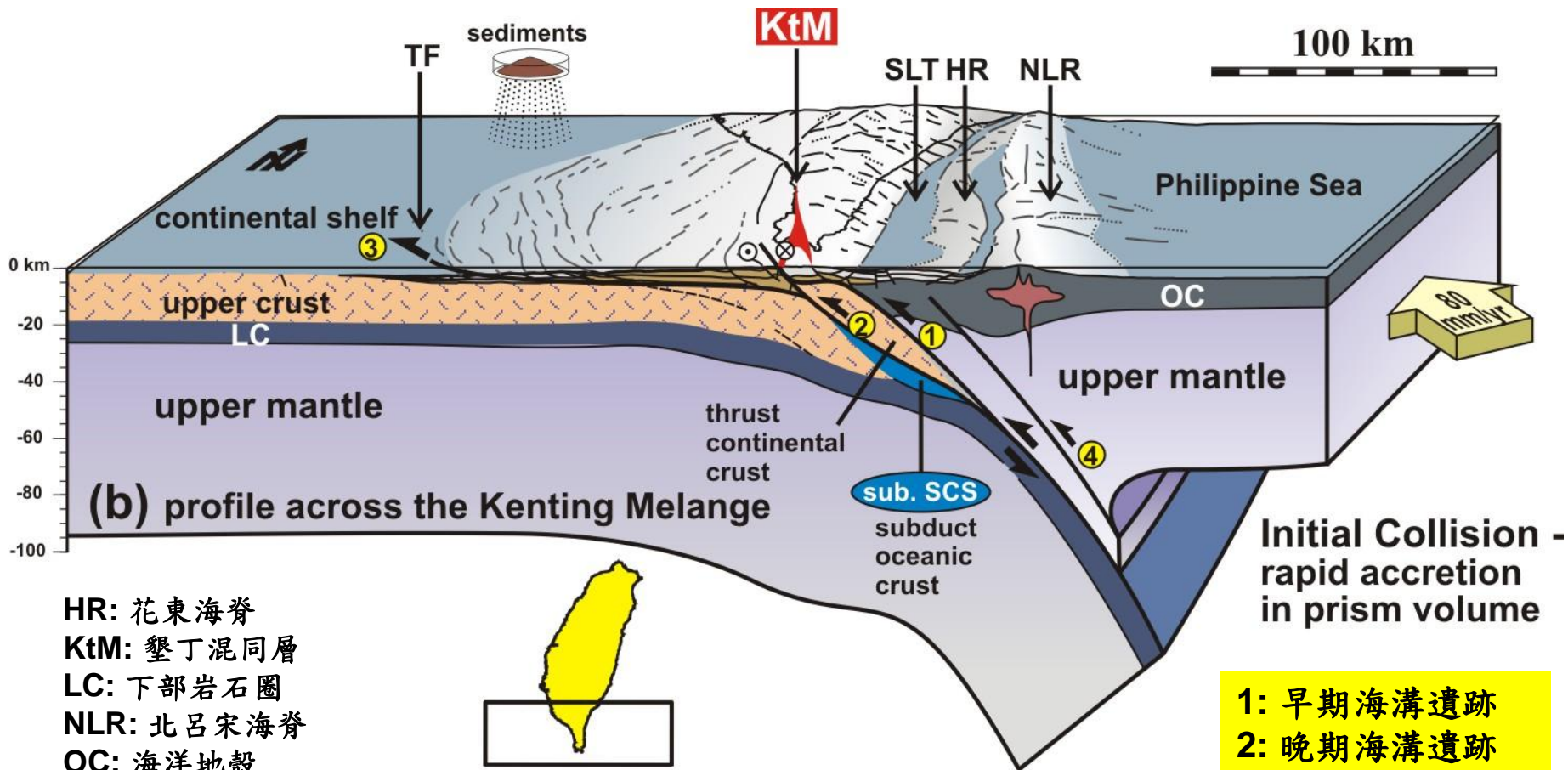
# 從隱沒到碰撞：馬尼拉弧溝系統的演化過程



1- 單純隱沒階段 (pure subduction stage)

2- 海溝跳躍階段 (trench jump stage)

3- 弧前隱沒階段 (forearc subduction stage)



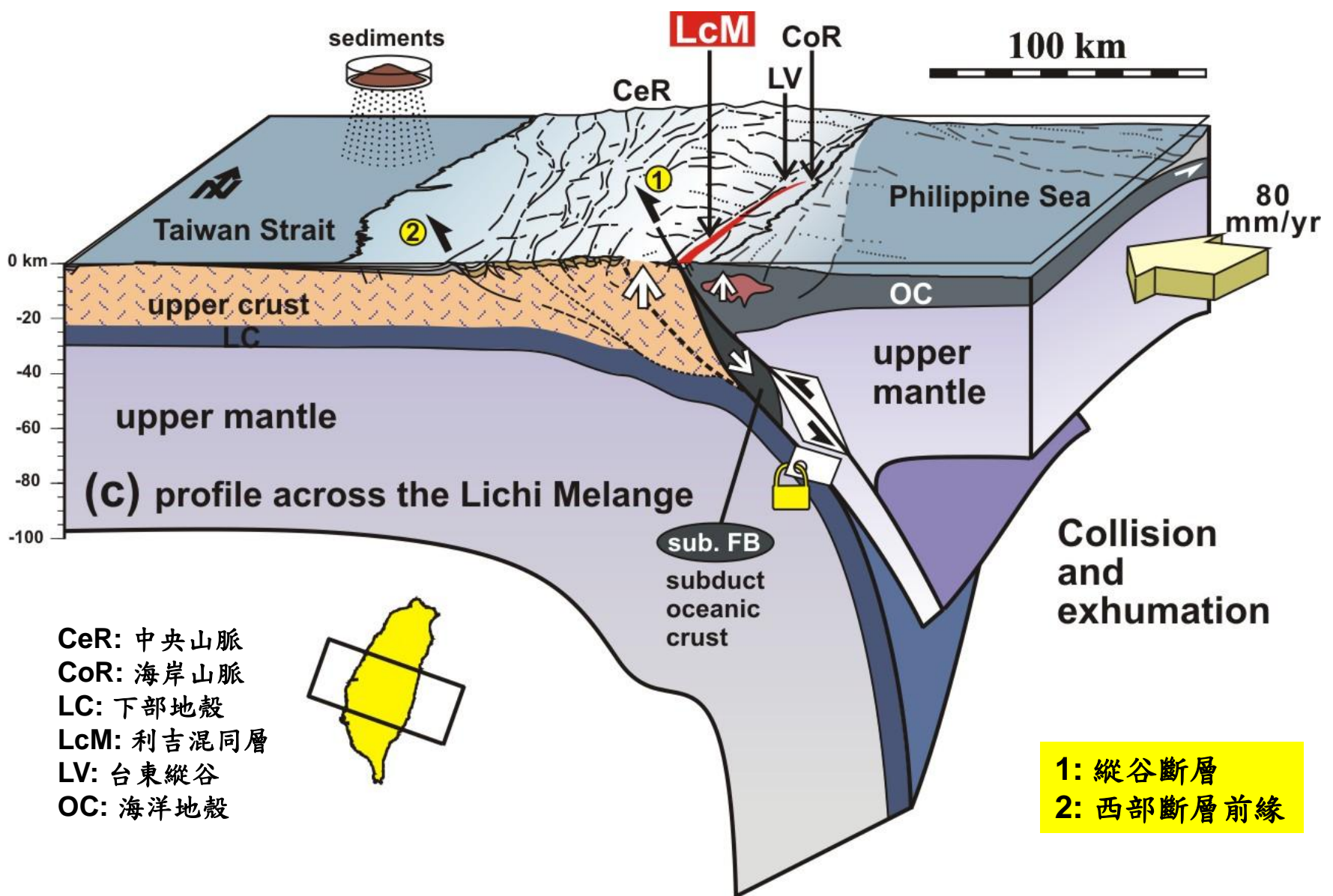
HR: 花東海脊  
 KtM: 墾丁混同層  
 LC: 下部岩石圈  
 NLR: 北呂宋海脊  
 OC: 海洋地殼  
 SLT: 南縱海槽  
 TF: 西部斷層前緣

1: 早期海溝遺跡  
 2: 晚期海溝遺跡  
 3: 現今斷層前緣  
 4: 新生岩石圈斷層

1- 單純隱沒階段 (pure subduction stage)

2- 海溝跳躍階段 (trench jump stage)

3- 弧前隱沒階段 (forearc subduction stage)



1- 單純隱沒階段 (pure subduction stage)

2- 海溝跳躍階段 (trench jump stage)

3- 弧前隱沒階段 (forearc subduction stage)

# 結論

## 不同的地質起源

### - 墾丁混同層

位於台灣增積岩體西緣的墾丁混同層，標示著馬尼拉海溝向西躍進所留下的遺蹟之一，此處曾是南中國海洋地殼隱沒發生的位置。

### - 利吉混同層

位於台灣增積岩體東側的利吉混同層則位在一個新發育的斷層系統上，此處原為島弧與增積岩體之間的弧前盆地，因擠壓而於大約3.5 Ma開始活動，並引發弧前基盤的隱沒作用。

## 相同的構造特性

由構造的觀點，兩者皆為巨大的斷層帶 (mega-fault zone)

## 利用混同層地質資訊，重建弧溝系統演化過程

- 1- 單純隱沒階段 (pure subduction stage)
- 2- 海溝跳躍階段 (trench jump stage)
- 3- 弧前隱沒階段 (forearc subduction stage)

好好準備期中考！  
寒假野外見！

