

# 中央大學 台灣地質 野外

2013年  
1月20日  
至1月25日

授課老師：

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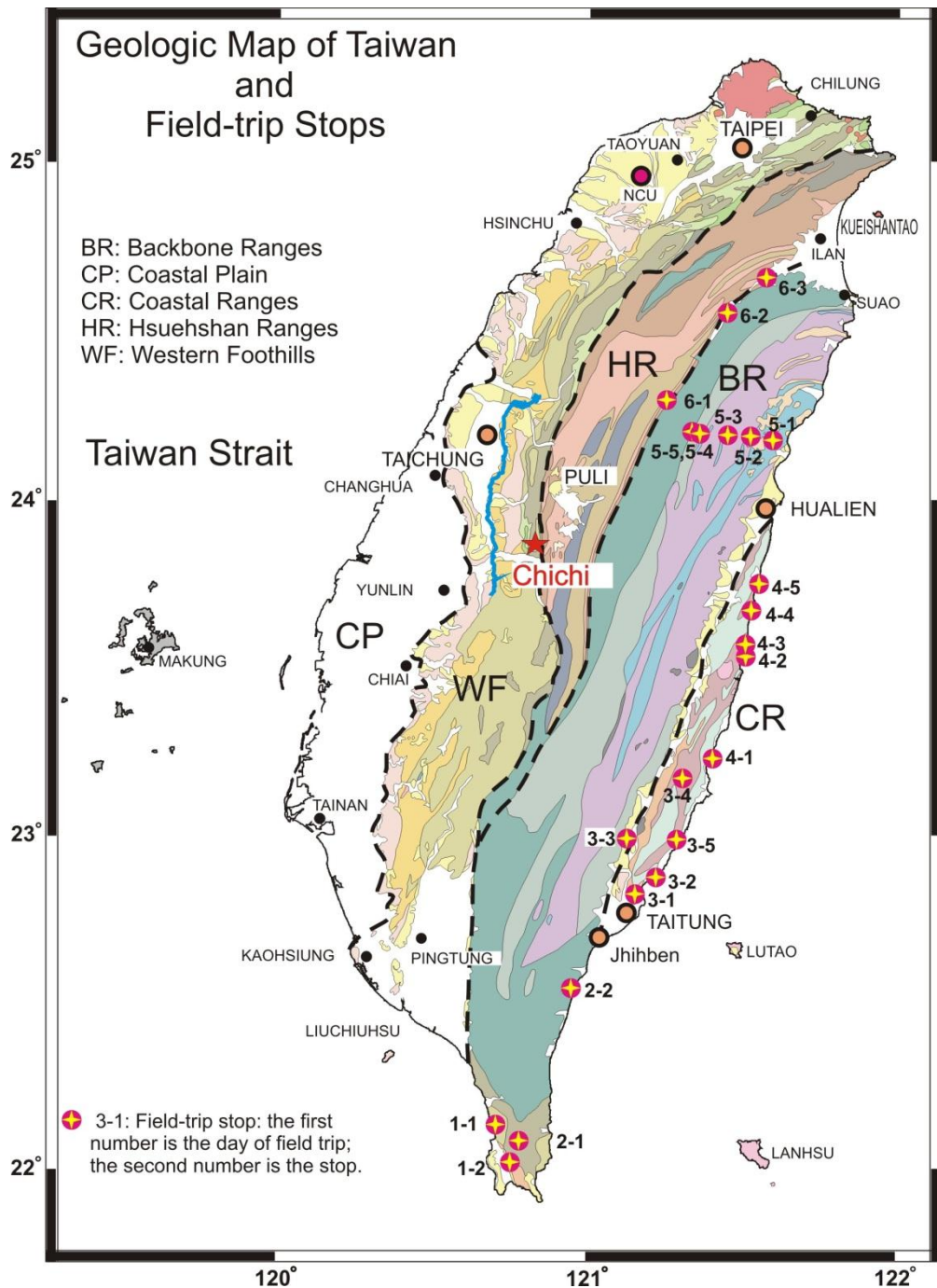
助教：  
莊介璋  
李延慶

Date (2013)	露頭點
20 January (Day 1)	<p>主題：恆春半島地質</p> <p>1-1：墾丁層尖山外來岩塊及遠眺恆春西台地</p> <p>1-2：墾丁出火：墾丁混同層</p> <p>住宿：墾丁</p>
21 January (Day 2)	<p>主題：中新世大陸邊緣深海沉積及變形構造</p> <p>2-1：石門：石門礫岩及四重溪層 (午餐)</p> <p>2-2：台東太麻里：中新世廬山層深海沉積及變形構造</p> <p>住宿：台東知本</p>
22 January (Day 3)	<p>主題：海岸山脈南段地質與花東縱谷活動構造</p> <p>3-1：台東利吉村：利吉混同層</p> <p>3-2：台東富岡：富岡砂岩(利吉層外來岩塊)</p> <p>3-3：台東高台：台東縱谷近代變形及河階與台地的形成 (午餐)</p> <p>3-4：富里鯨溪5號橋：都巒山層與蕃薯寮層交界</p> <p>3-5：台東東河：東河石灰岩</p> <p>住宿：台東成功</p>
23 January (Day 4)	<p>主題：海岸山脈北段地質</p> <p>4-1：台東烏石鼻：都巒山層</p> <p>4-2：花蓮豐濱秀姑巒溪長虹橋：都巒山層與港口石灰岩</p> <p>4-3：花蓮石梯坪：石梯坪凝灰岩 (午餐)</p> <p>4-4：跳浪隧道南口(21.5 km)：蕃薯寮層及八里灣層層界</p> <p>4-5：鹽寮檜樹橋(14.6 km)：水璉礫岩</p> <p>住宿：花蓮</p>
24 January (Day 5)	<p>主題：中央山脈變質岩(大南澳片岩、畢祿山層、廬山層，中橫公路太魯閣至梨山段)</p> <p>5-1：長春祠：長春層</p> <p>5-2：白沙橋(182.1 km)：溪畔片麻岩與大理岩接觸</p> <p>5-3：天祥(169 km)：天祥層片岩</p> <p>5-4：碧綠隧道西口(122 km)：大南澳片岩與始新統不整合接觸</p> <p>5-5：中橫(120.3 km)：始新統/中新統不整合面，N礫岩及上下板岩</p> <p>住宿：梨山</p>
25 January (Day 6)	<p>主題：雪山山脈及脊梁山脈地質(中橫公路宜蘭支線)</p> <p>6-1：武陵農場：眉溪砂岩</p> <p>6-2：四季繼光橋：南眺蘭陽溪於南山的河階及支流的河口沖積扇</p> <p>6-3：大同牛鬥橋：白冷層(西岸)與廬山層(東岸)的層界(?梨山斷層)</p>

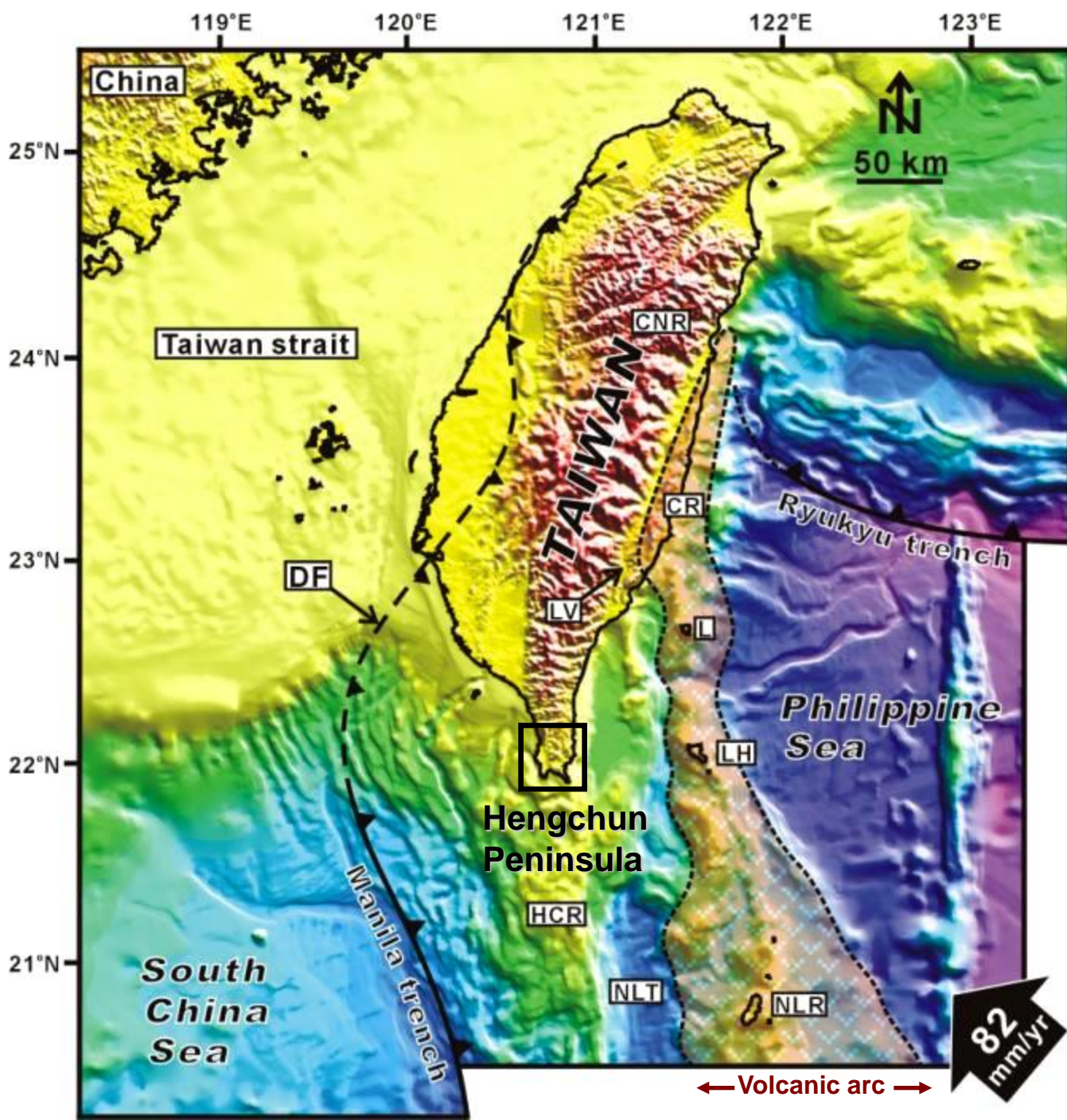
# 台灣地質野外 預計考察地點

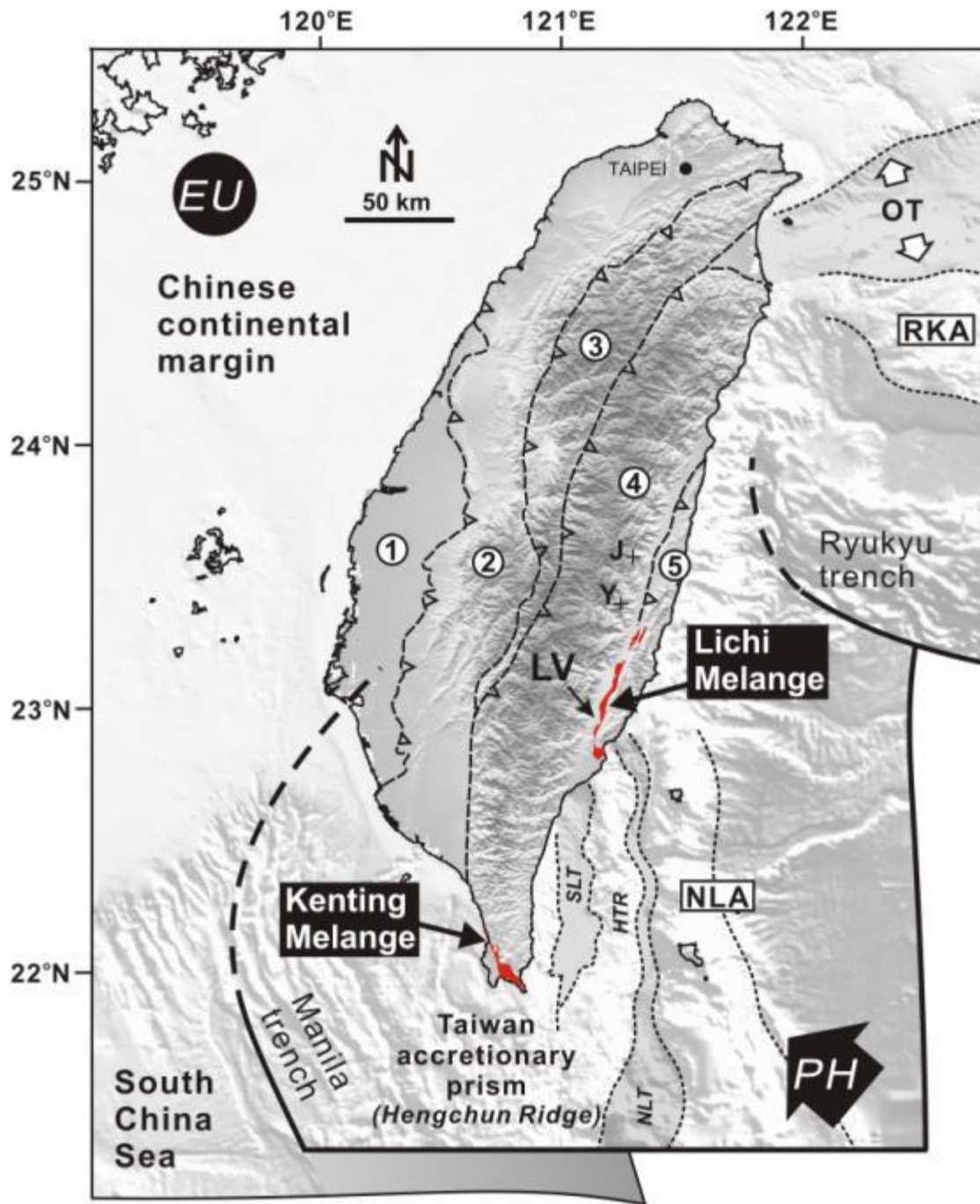
## 野外用具

野外用具	自備	系上提供	自由攜帶
童軍繩、登山繩、安全帽		V	
地形圖/地質圖/描圖紙/stereonet/		V	
羅盤儀		V	
地質鎚		V	
放大鏡		V	
捲尺 (5 m)		V	
稀鹽酸 (10% HCl)		V	
野外紀錄簿	V		
鉛筆、色筆、原子筆	V		
量角器、短直尺	V		
計算機	V		
顆粒度表	V		
GPS			V
捲尺 (30 m)			V
照相機			V
標本袋 + 油性筆			V



第一天：恆春半島地質





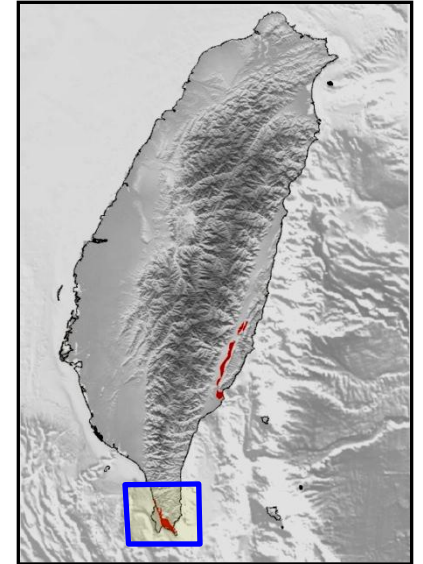
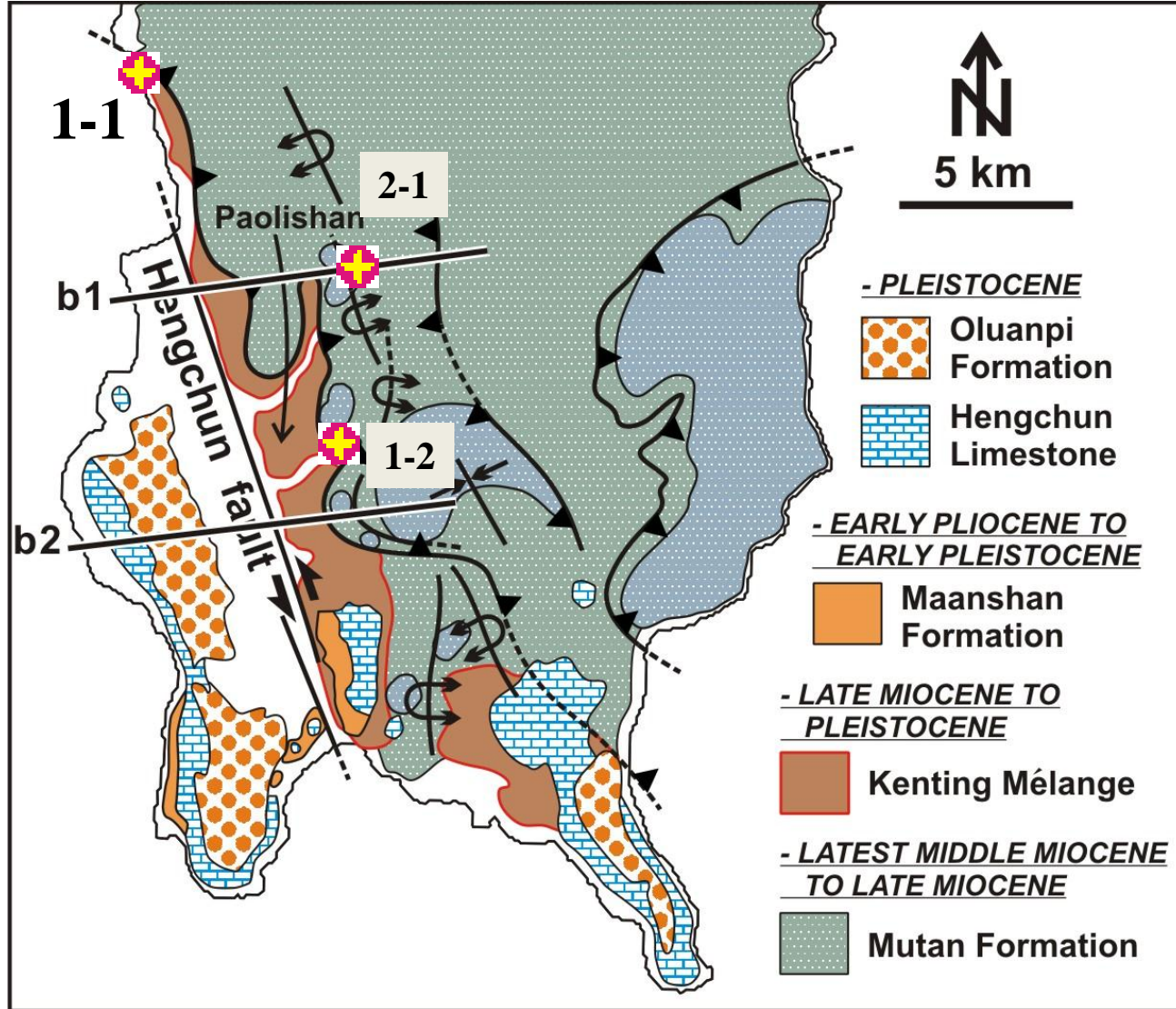
## 台灣主要地質分區圖

- 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

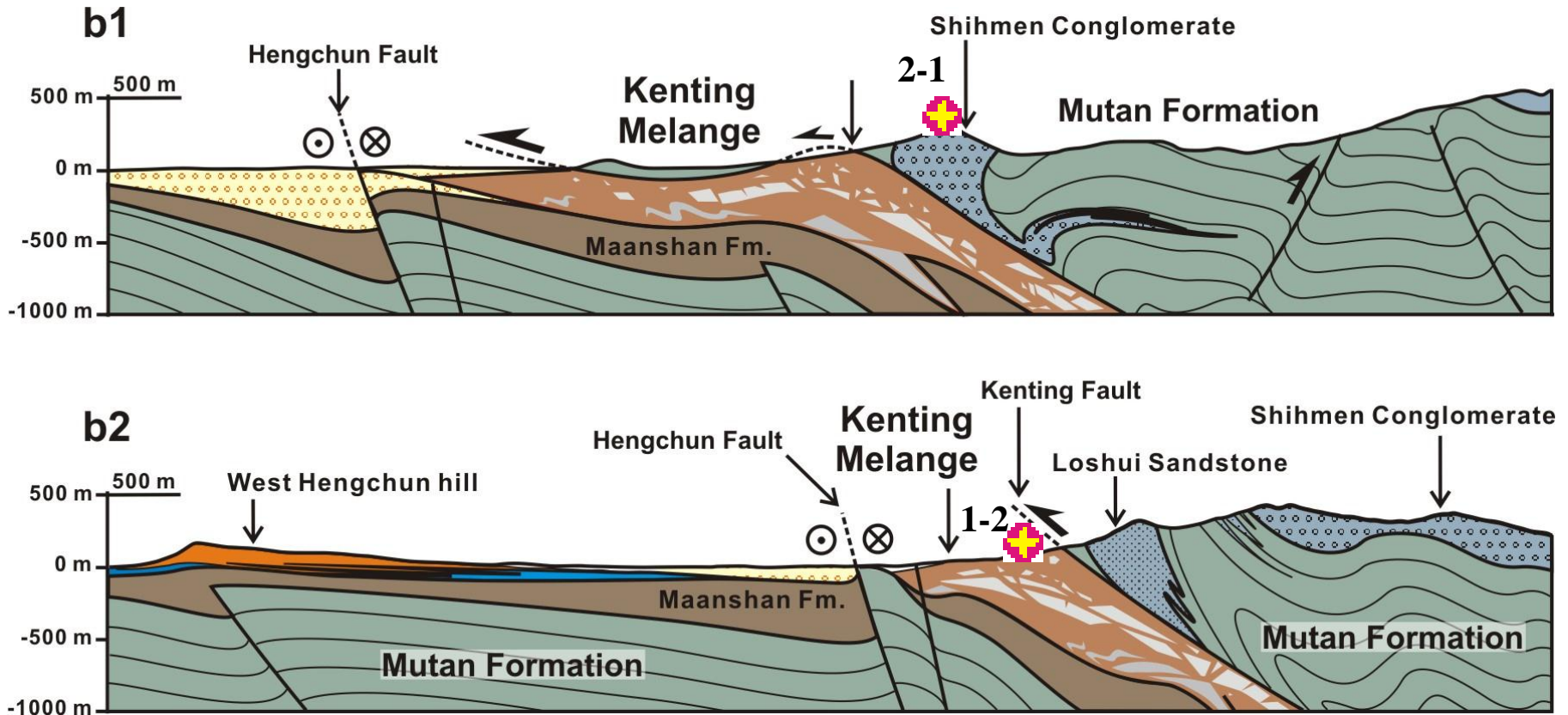
台灣混同層分布區域

# 恆春半島地質圖



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。

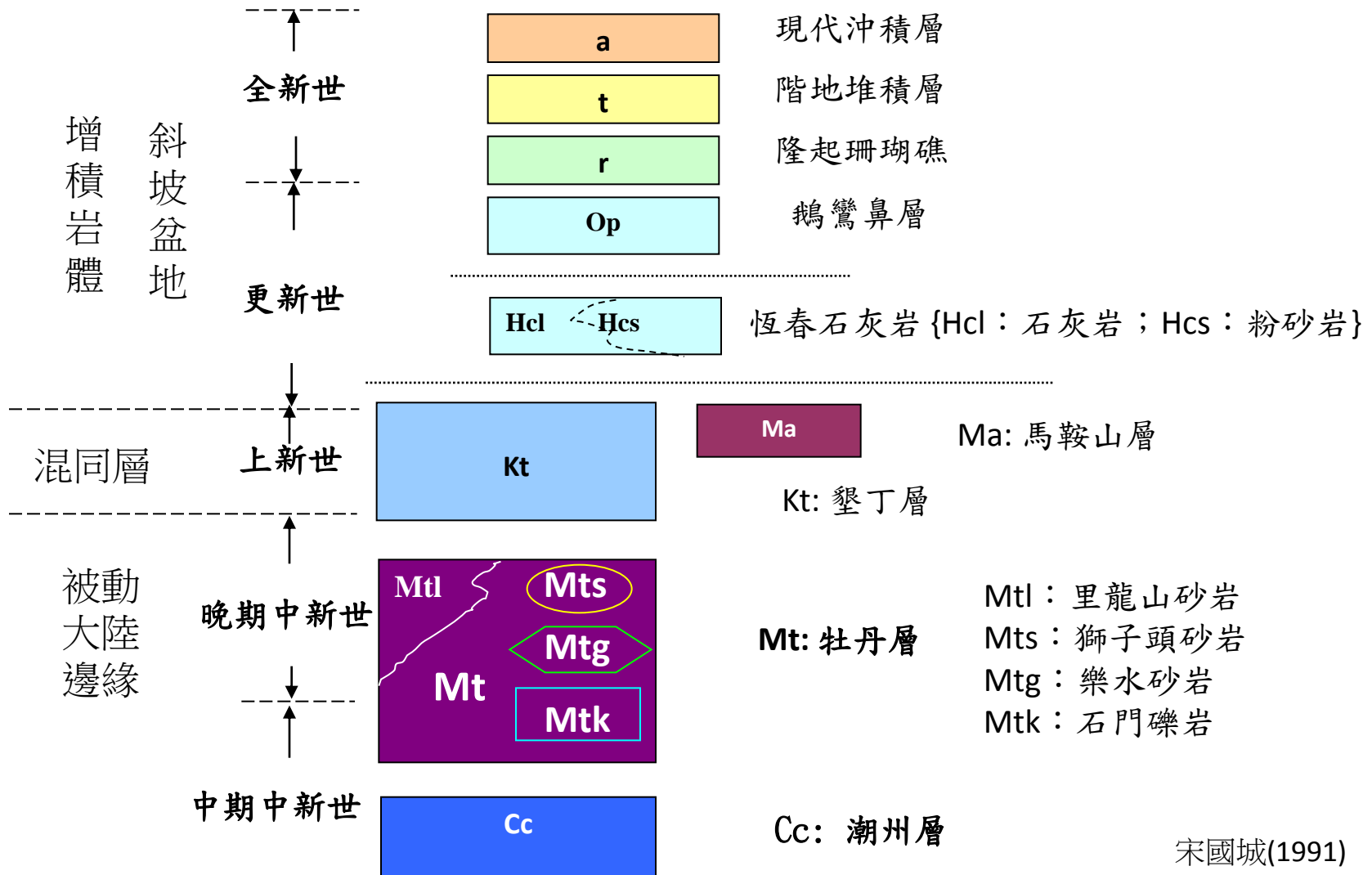
# 墾丁混同層地質剖面圖



## 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

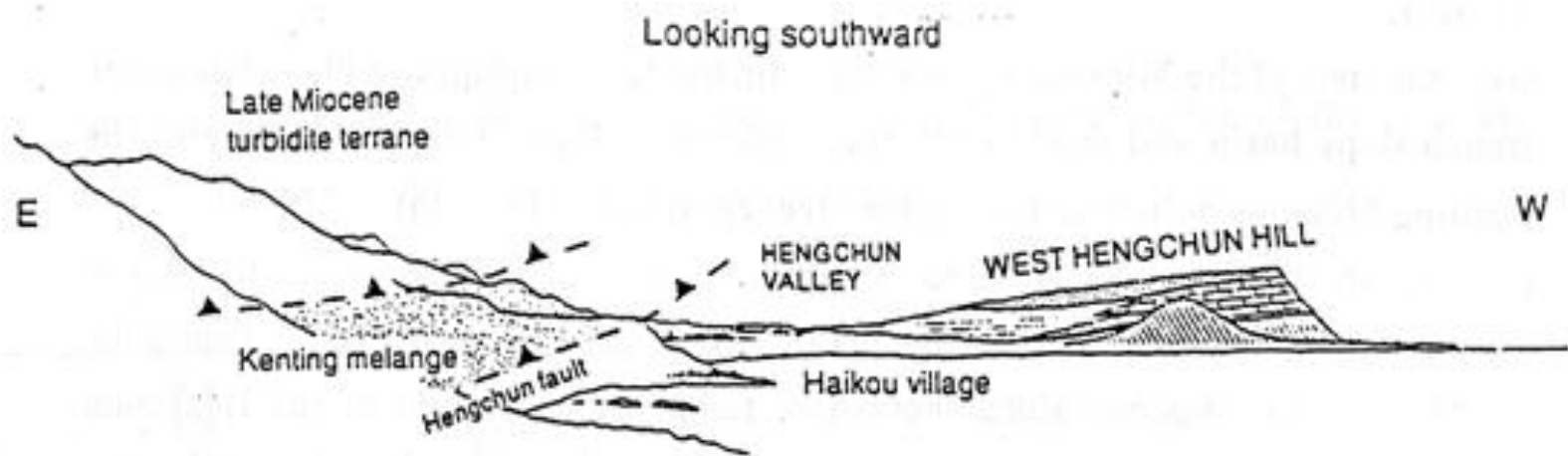
# 恆春半島地層



宋國城(1991)

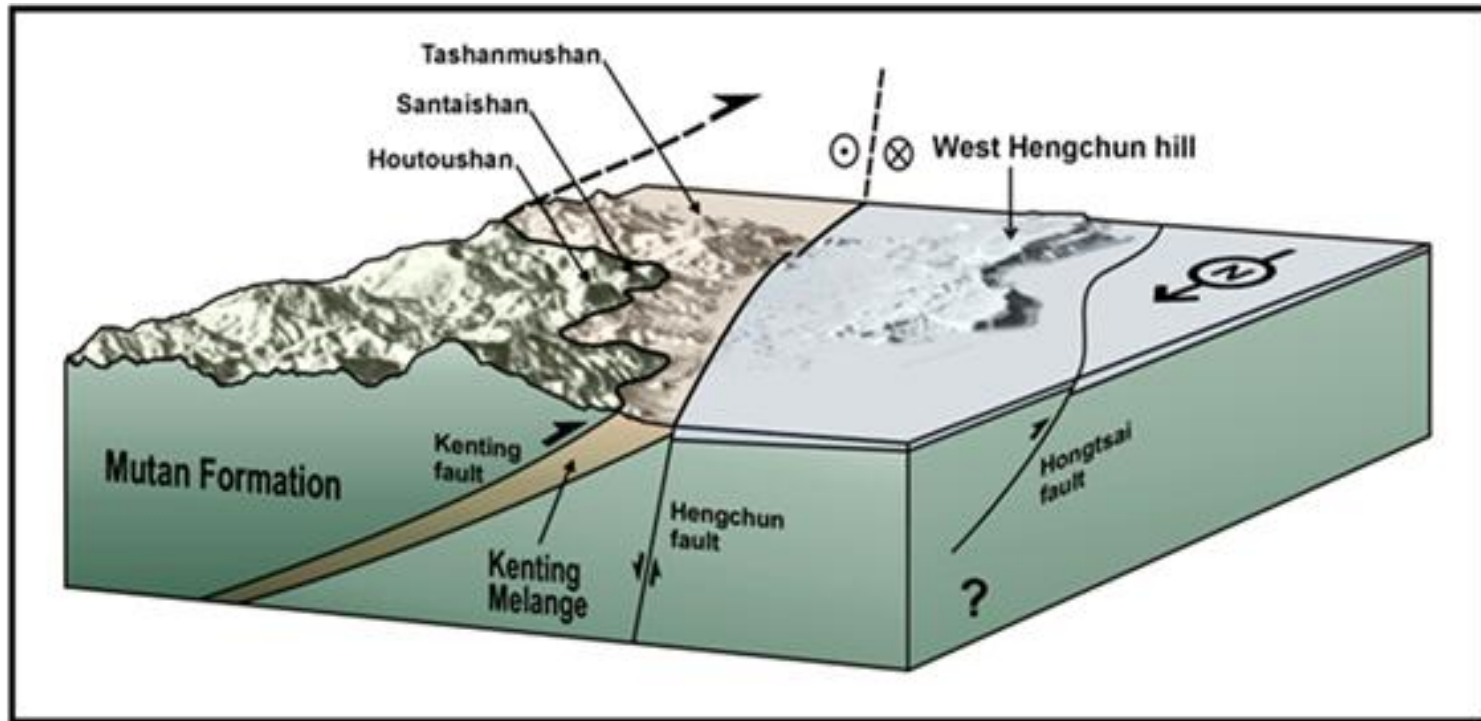
## Stop 1-1: 墾丁層尖山外來岩塊及遠眺恆春西台地

At this stop, the shape and geometry of the Western Hengchun Hill can be observed. Three distinct geological units are distributed in the Hengchun Peninsula: the Middle-Late Miocene Mutan Formation turbidite in the east, the Plio-Pleistocene shallow marine sequences in the west, and the Kenting Melange along the Hengchun Valley. The high uplift rate in this area suggests fast rising of the block west of the Hengchun fault. Also, two reddish-green igneous blocks are exposed at Chienshan. The Chienshan blocks are strongly sheared and altered and consist mainly unsorted, unstratified angular fragments of basalt, diabase, gabbro, and anorthosite (Page and Lan, 1983).



Sketch of general geology of the Hengchun Peninsula viewed from Chienshan and relationship of formations and faults in the Hengchun Peninsula

## Stop 1-1: 墾丁層尖山外來岩塊及遠眺恆春西台地



The geometrical distribution of the shear features in the Kenting Mélange suggests that this zone dips to the east with an angle of about  $30^\circ$  or less. In order to avoid confusion, Chang et al. (2003) proposed to name the shear zone as the “Kenting Fault”. To the east, in the hanging wall of the Kenting Fault, the Mutan Formation has been thrust westward along the Kenting Mélange and formed the principal mountain range of the Hengchun peninsula. To the west, in contrast with the sinuous upper boundary of the mélangé zone, the western boundary of the Kenting Mélange is a linear structure, which is cut by the steeply east-dipping Hengchun Fault.

## Stop 1-1: 墾丁層尖山外來岩塊及遠眺恆春西台地



Stop 1-2: 墾丁出火：墾丁混同層





童軍繩，登山繩，安全帽





## Ophiolites suite

(蛇綠岩系)：  
上部地函、  
海洋地殼、  
深海沉積物

Deep-sea sediments: Red clay (紅色深海泥), chert (燧石)

Pillow lava: 枕狀玄武岩

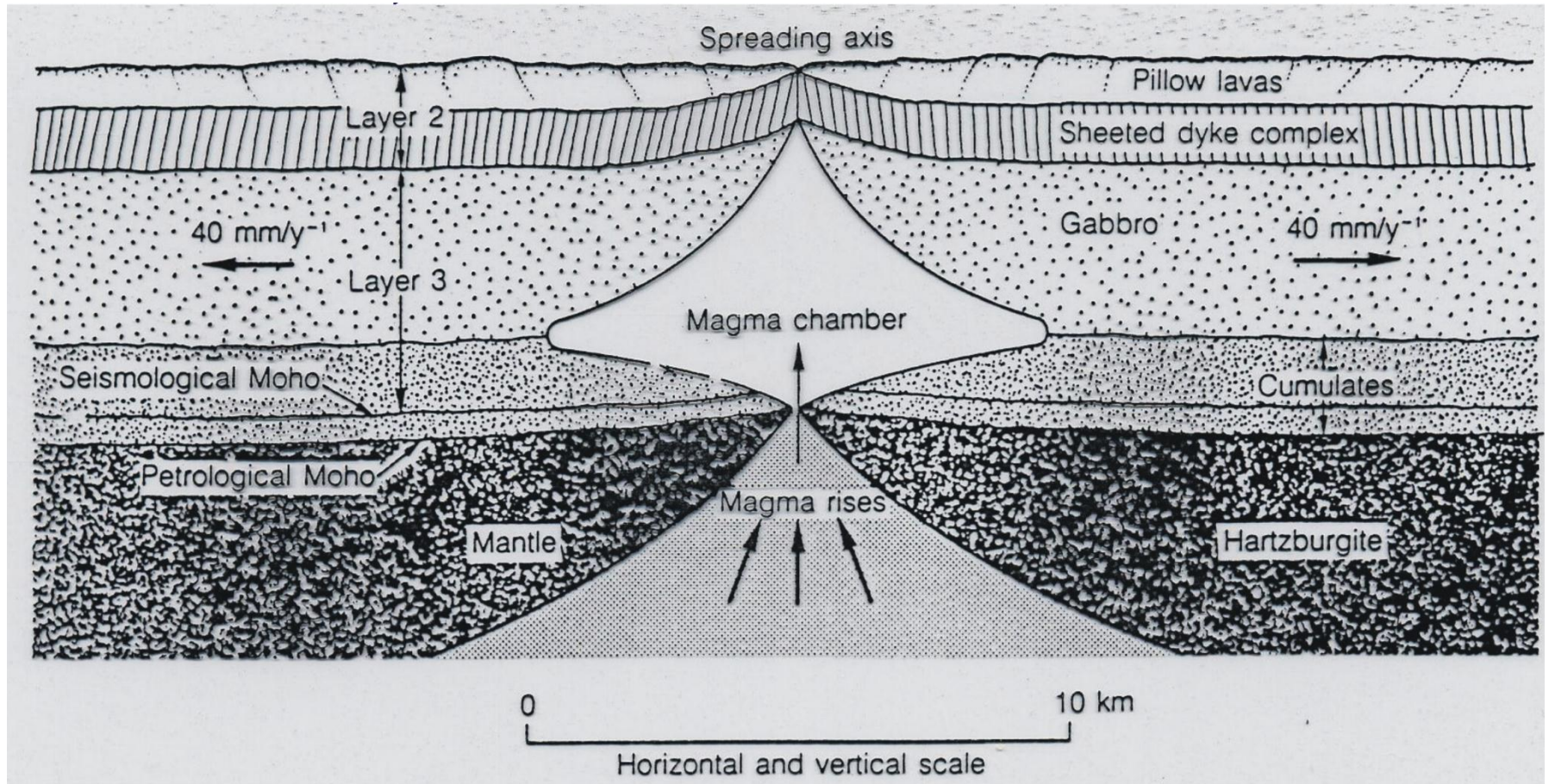
Sheeted dyke complex (diabase): 輝綠岩岩脈群

Gabbro: 輝長岩

Cumulates: 累積岩

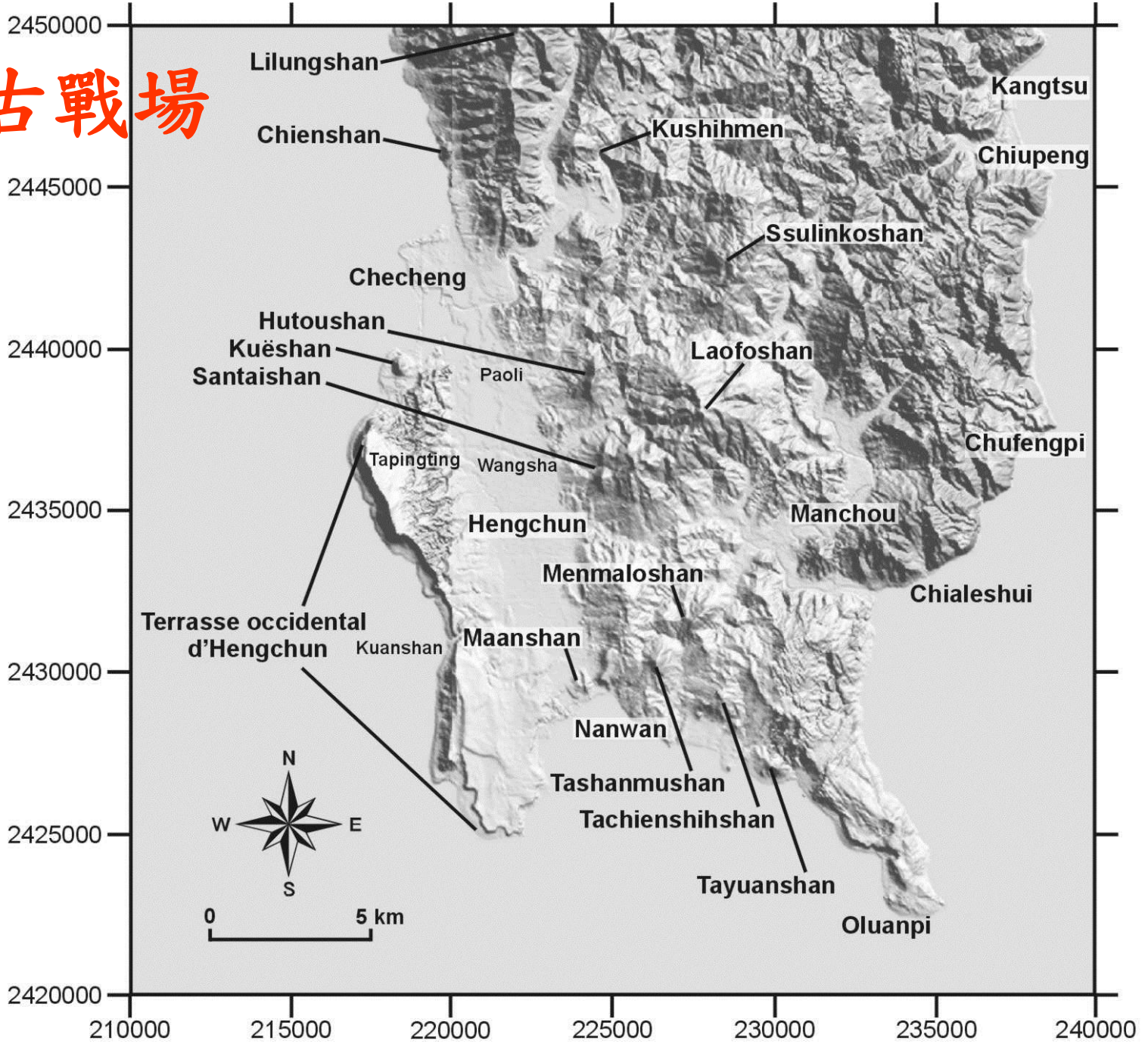
Peridotite: 橄欖岩

Serpentinite: 蛇紋岩 (橄欖岩受熱水換質後形成)





# 石門古戰場





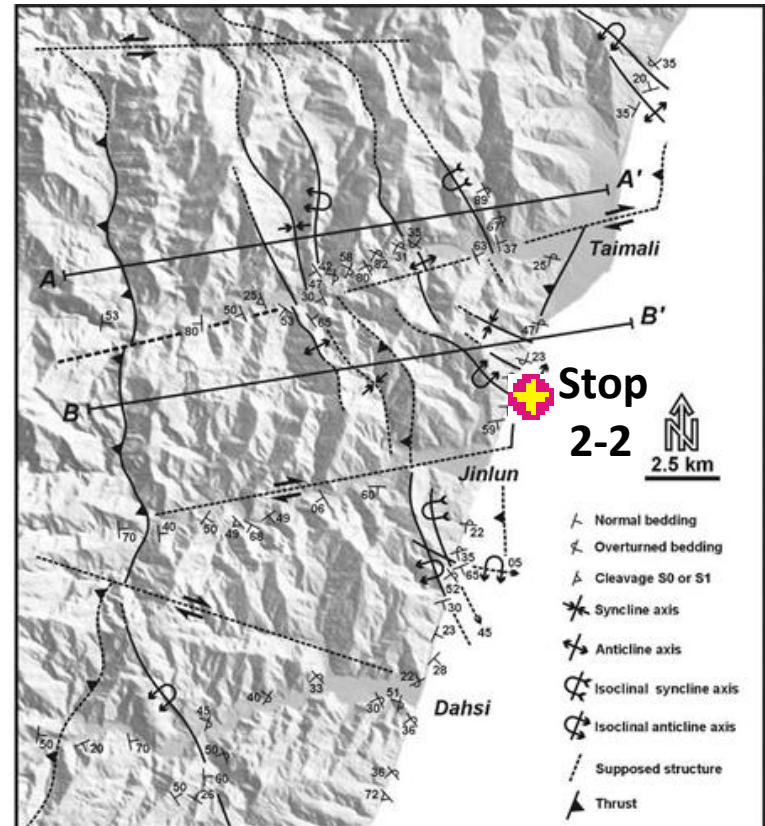
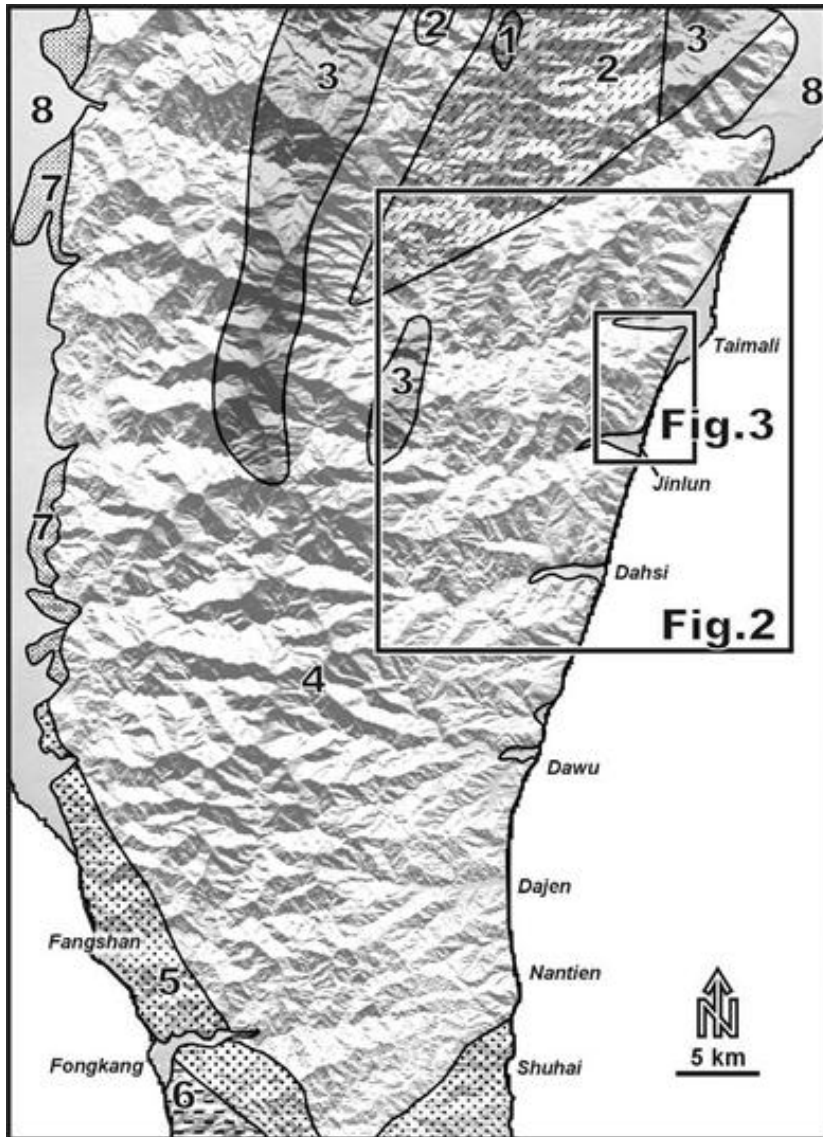
尺，量角器，stereonet，  
描圖紙





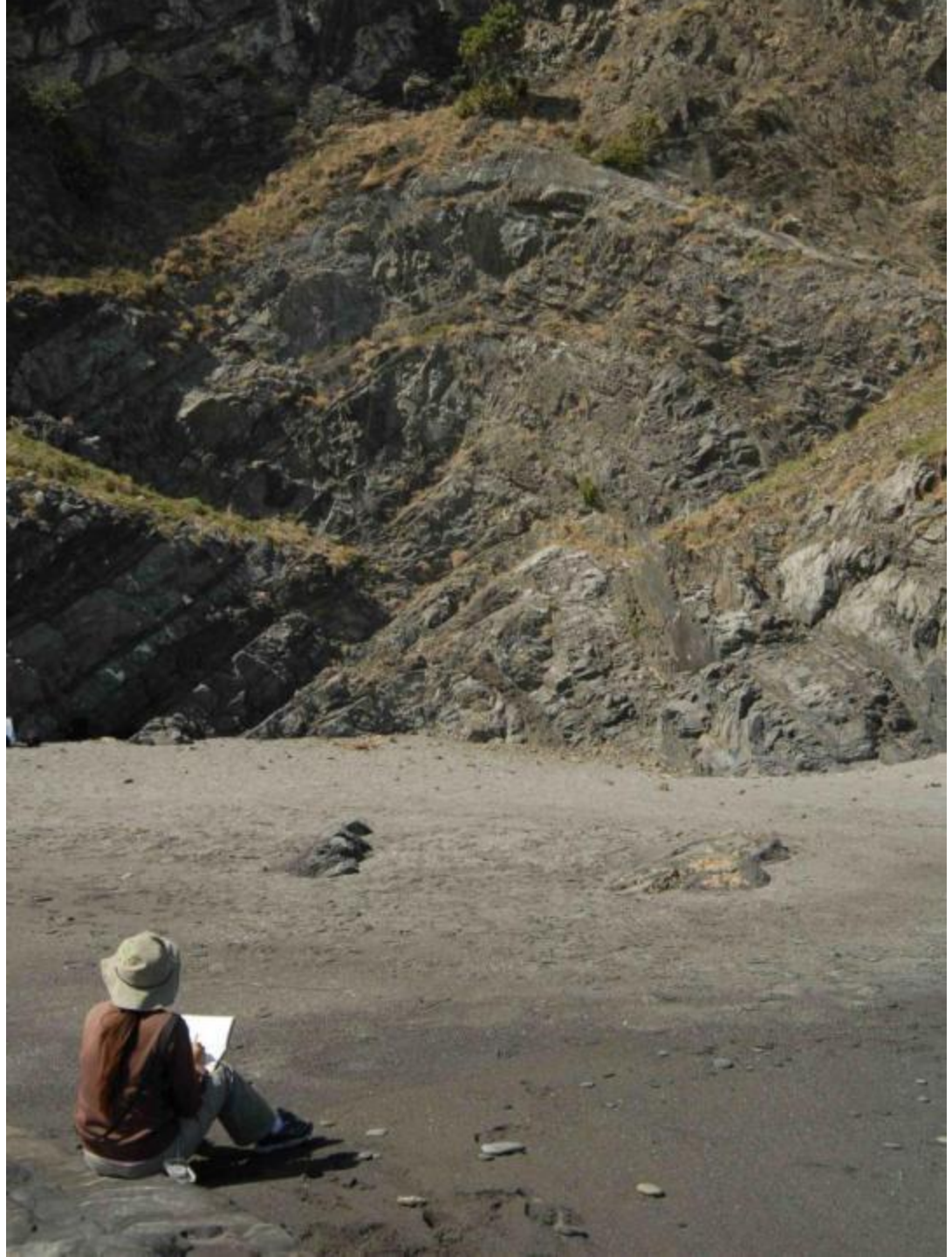
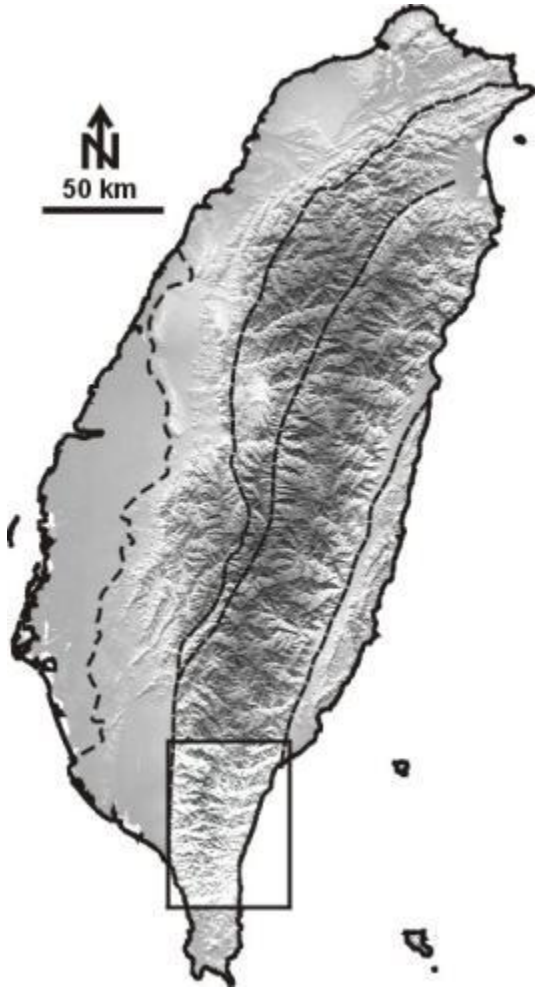
# 第二天：中央山脈南部構造地質

Topographic and geological map of the southernmost Central Range (geological data after the Central Geological Survey). Topography clearly shows the well-aligned en-echelon structure pattern in the eastern flank of the Central Range.

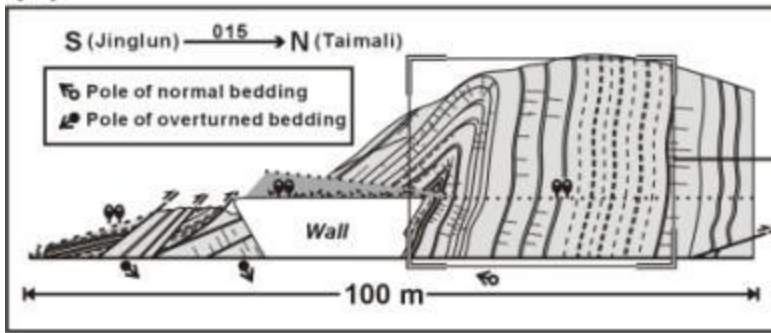


- 8 Alluvium - RECENT
- 7 Terrace Deposits - PLEISTOCENE
- 6 Mutan Formation - LATE MIOCENE to PLIOCENE
- 5 Chaochu Formation - MIDDLE MIOCENE
- 4 Lushan Formation - MIOCENE
- 3 Pilushan Formation - EOCENE
- 2 Schists - LATE PALEOZOIC and MESOZOIC
- 1 Metamorphosed limestone - LATE PALEOZOIC and MESOZOIC

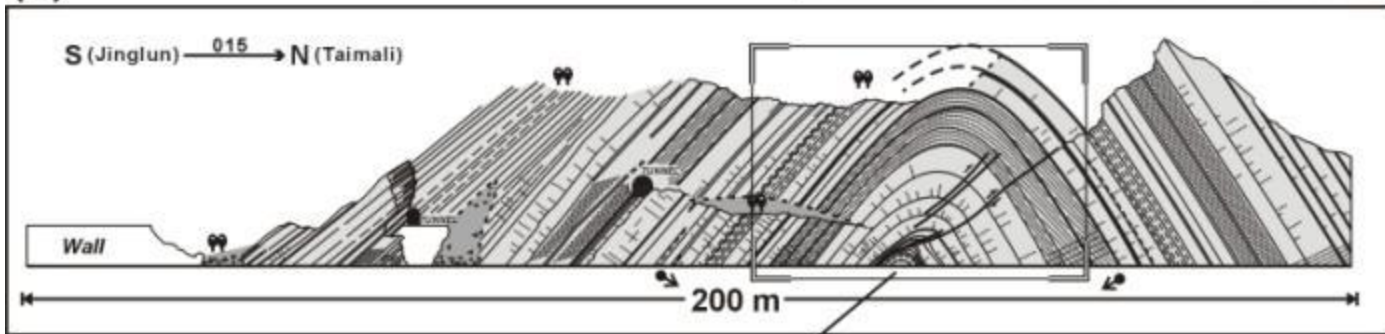
Stop 2-2：台東太麻里：  
中新世廬山層深海沉積  
及變形構造



(a)



(b)



East-west striking Antiforms in the Lushan Formation of the Taimali beach











# 第三、四天：海岸山脈、花東縱谷地質與活動構造

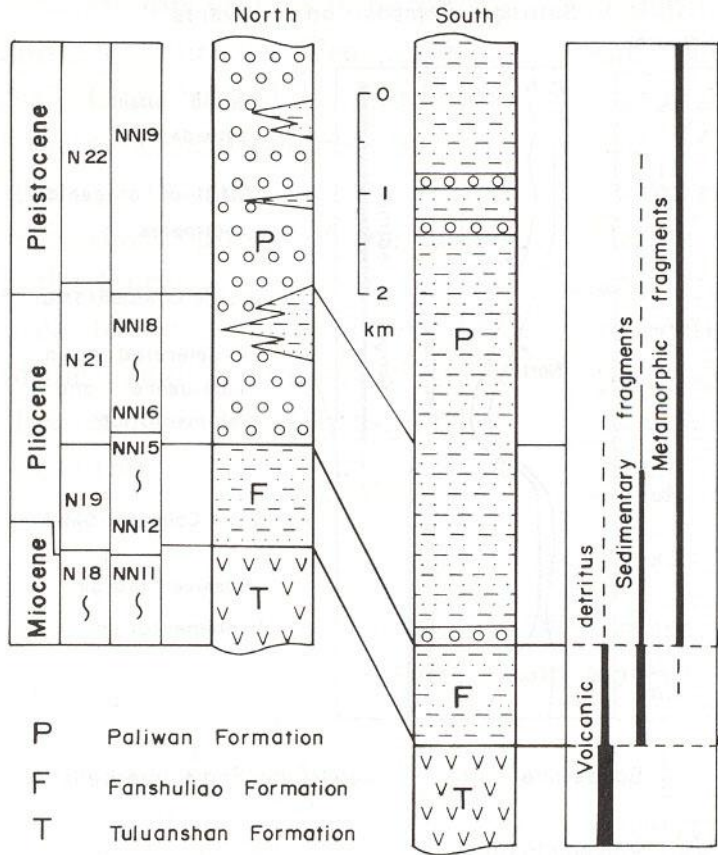
Biochronology

Rock

Columns

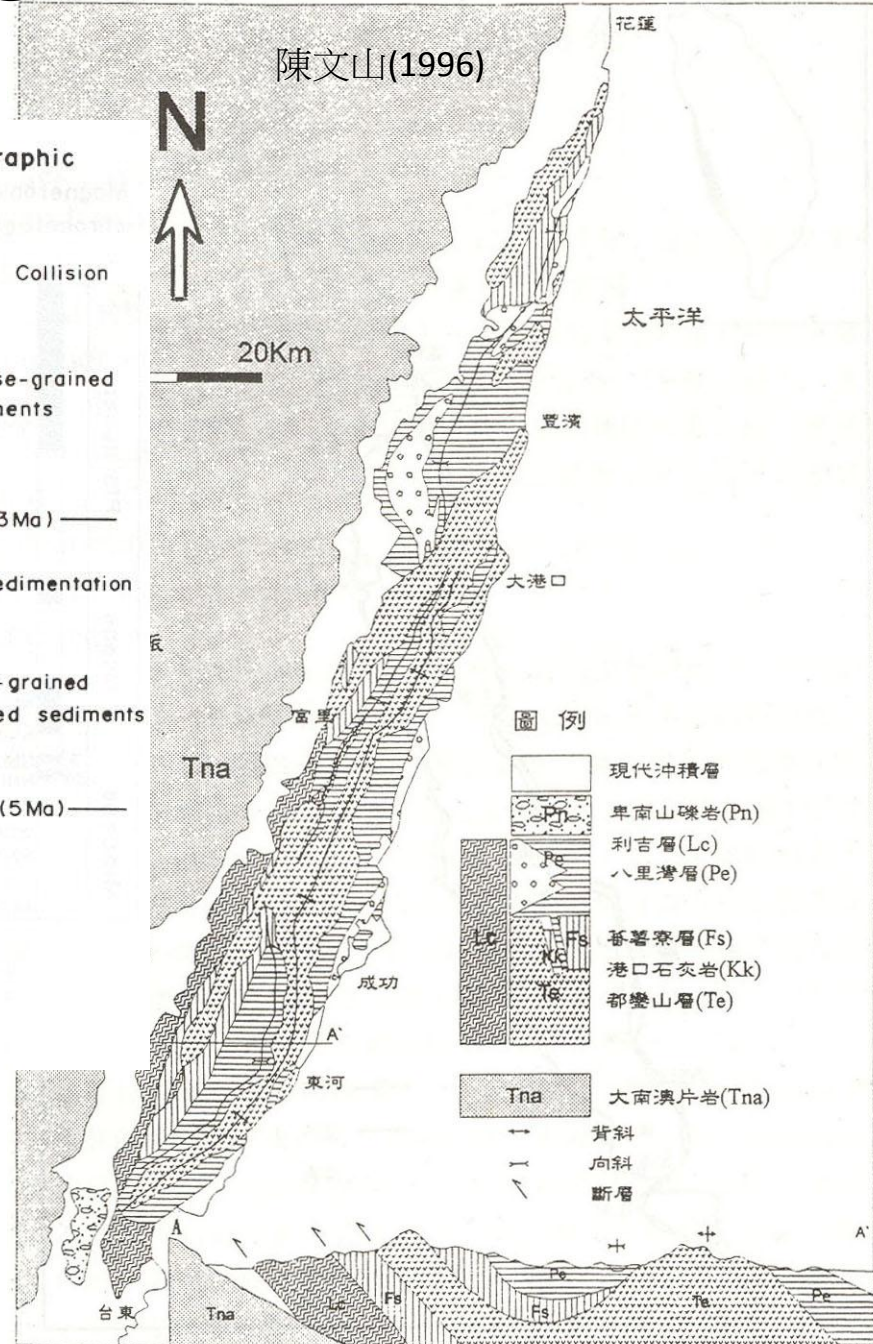
Sediment Composition

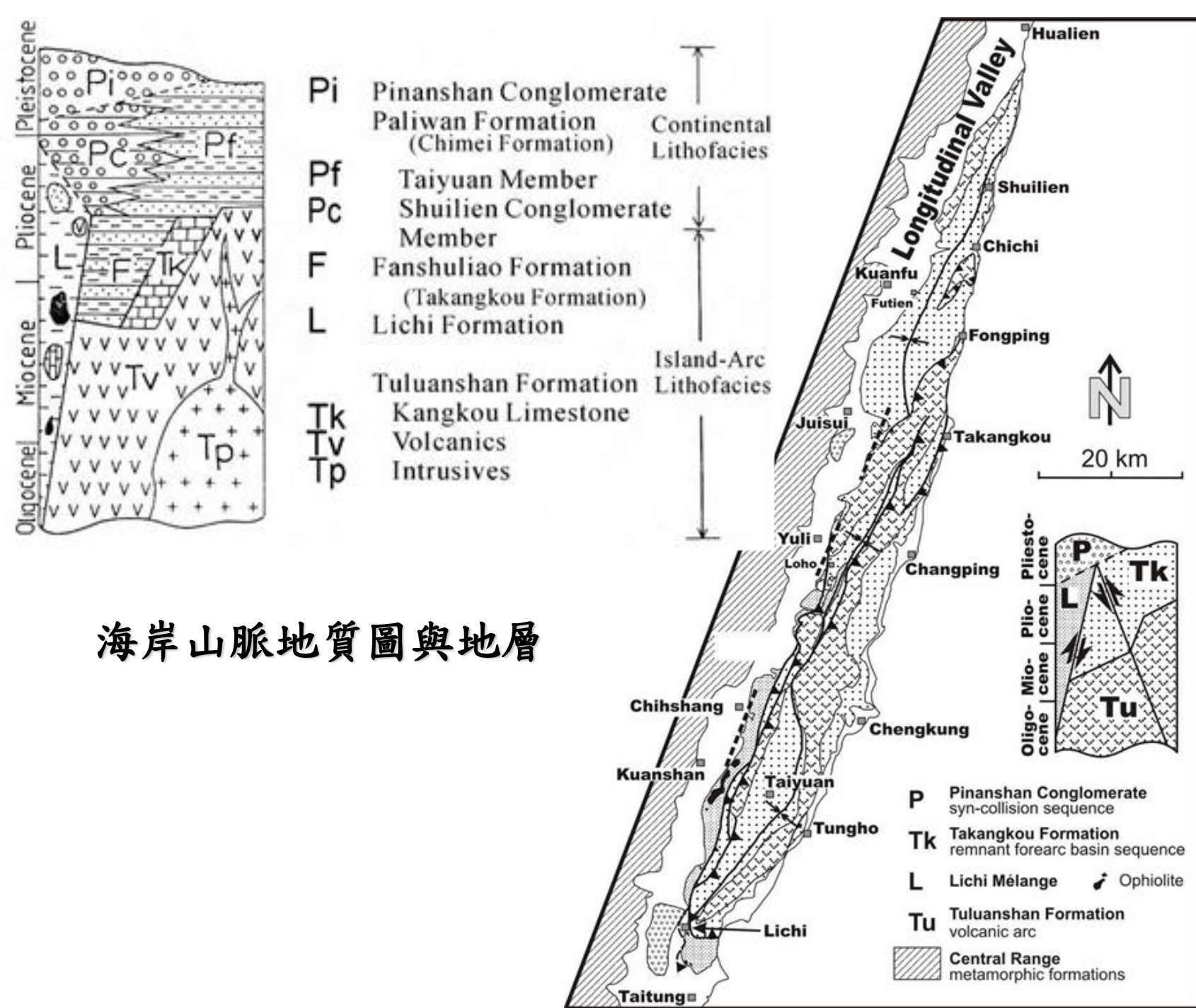
Tectonostratigraphic Events



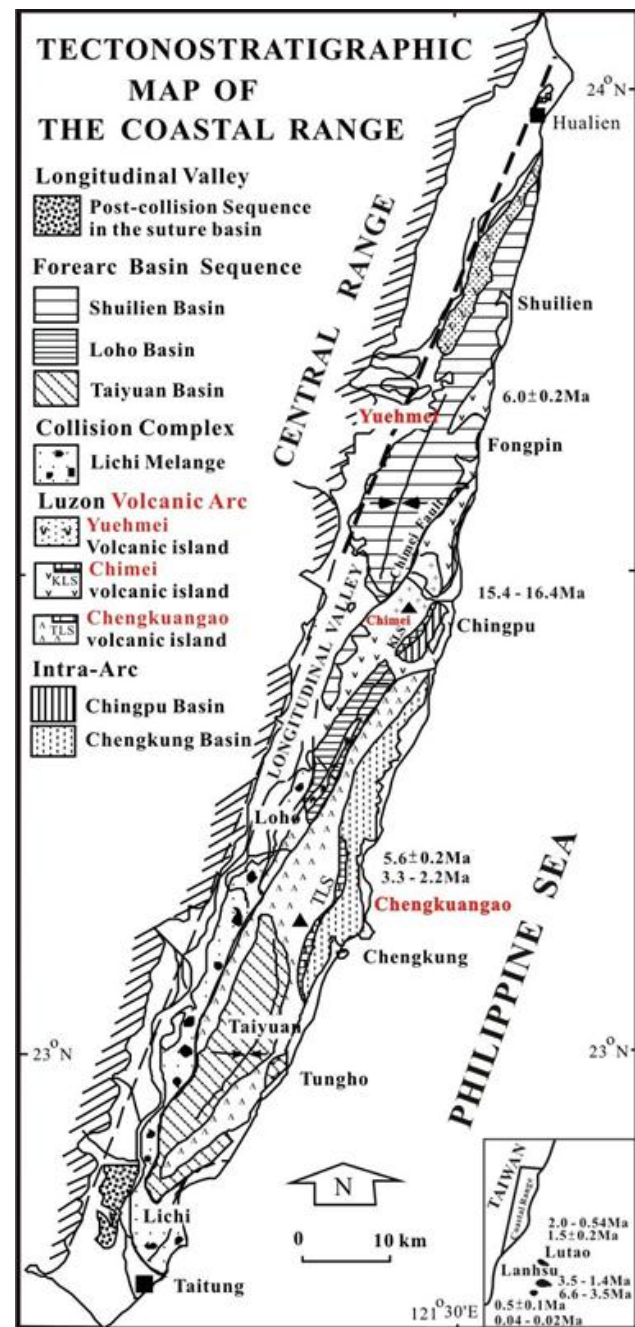
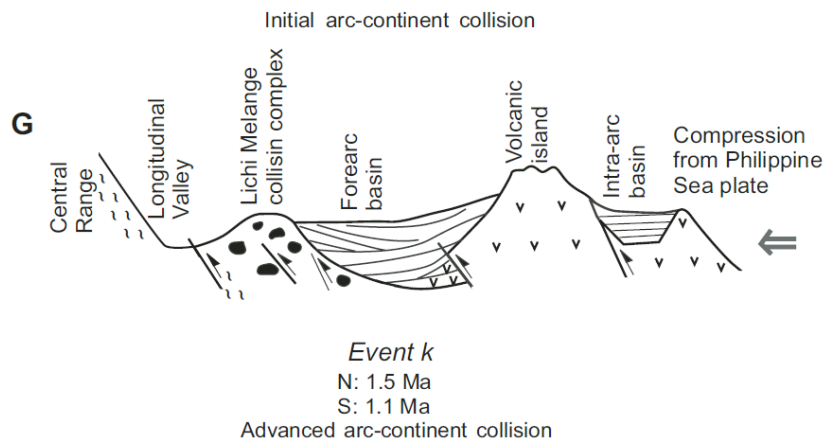
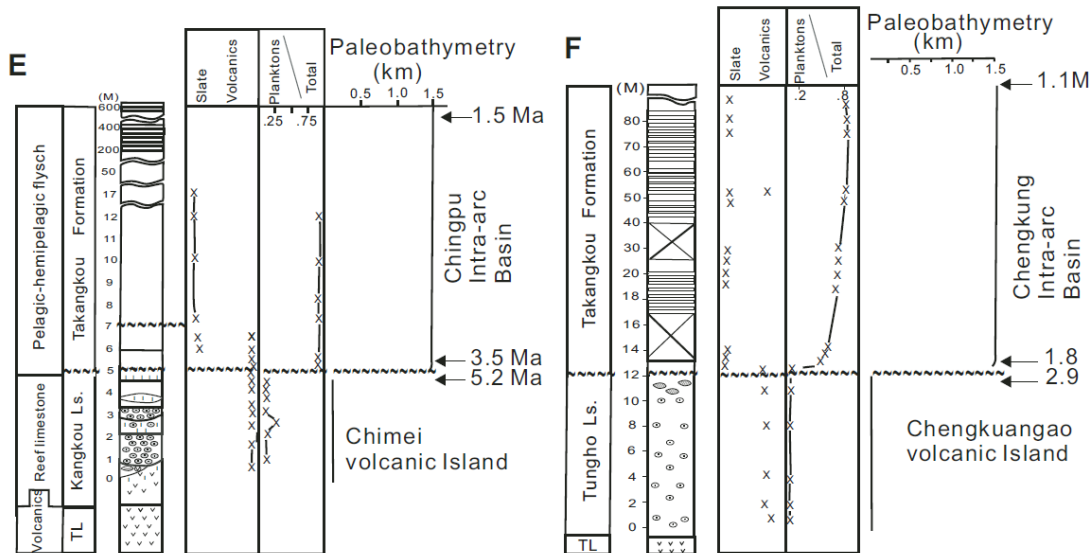
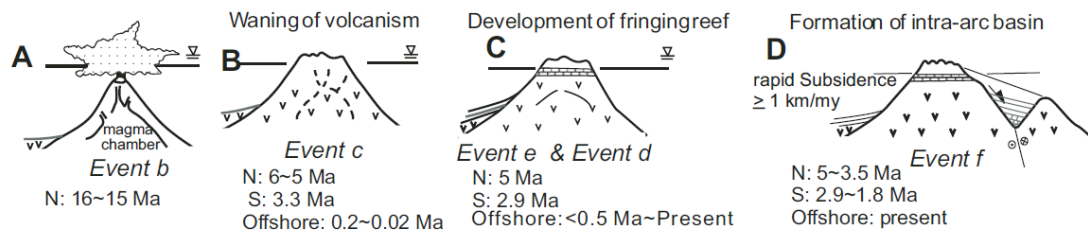
Teng (1990)

## 海岸山脈地質





海岸山脈地質圖與地層





Stop 3-1：利吉村：  
利吉混同層



<http://ashan.gl.ntu.edu.tw/>





## Stop 3-2 : 台東富岡 : 富岡砂岩(利吉層外來岩塊)

A huge classical sandy turbidite block is exposed along the coast north of the Fukang fishing port . The sandstone block is overturned. Its composition is similar to that of Loshui Formation exposed on the east coast of Hengchun Peninsula. Late Miocene (NN11) nannofossils have been reported from this sandstone block (Chi, 1981). This age is similar to Hengchun Peninsula turbidites, but older than the Plio-Pleistocene forearc turbidites and the muddy matrix of the Lichi Melange (3.5-3.7 Ma) in the Coastal Range. Again, fission track analysis on zircon grains separated from the sandstone block here shows an age pattern similar to those of the Hengchun Peninsula, but differs from the forearc turbidites in the Coastal Range.



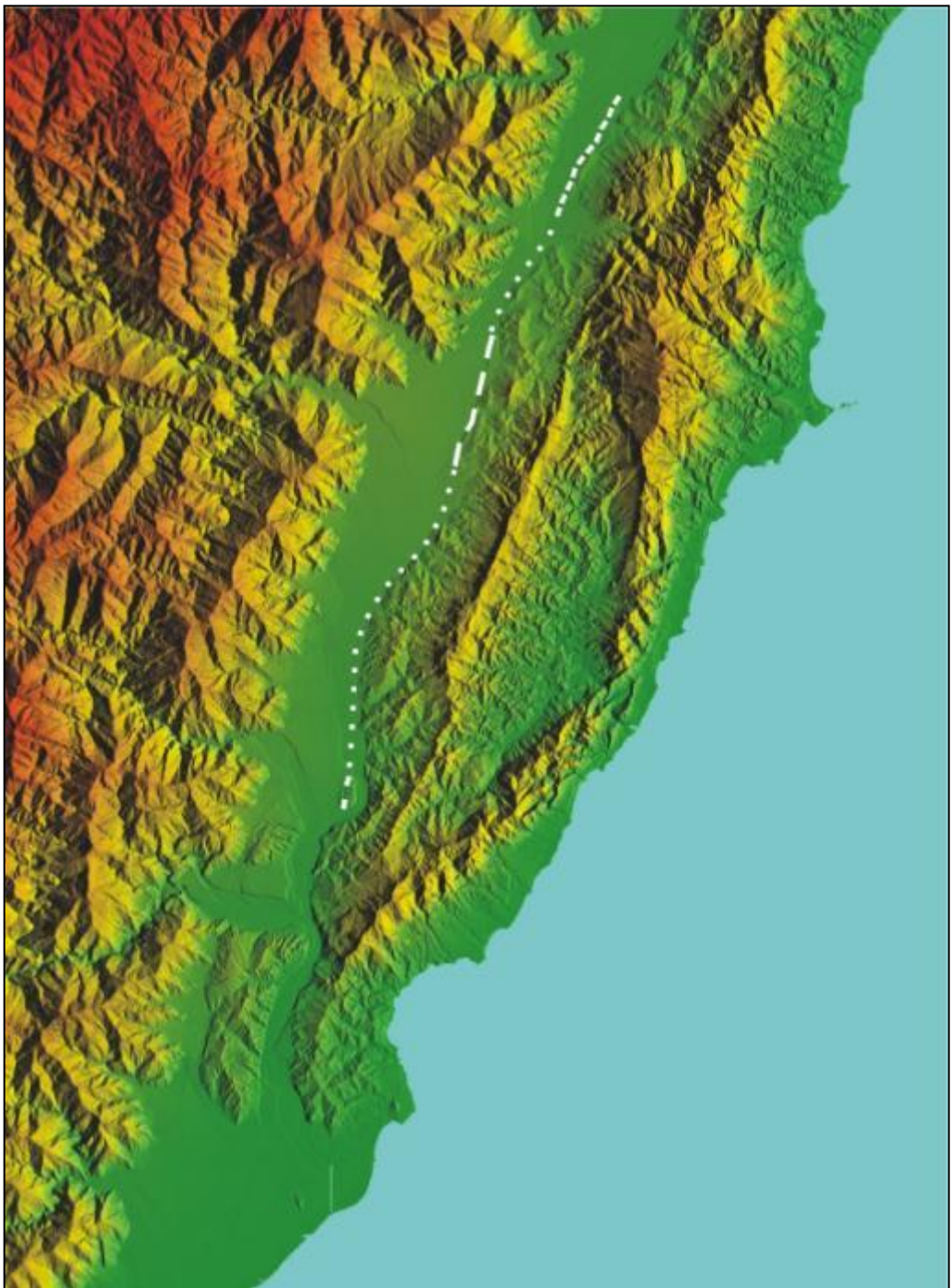
# 利吉與墾丁混同層的詳細比對表

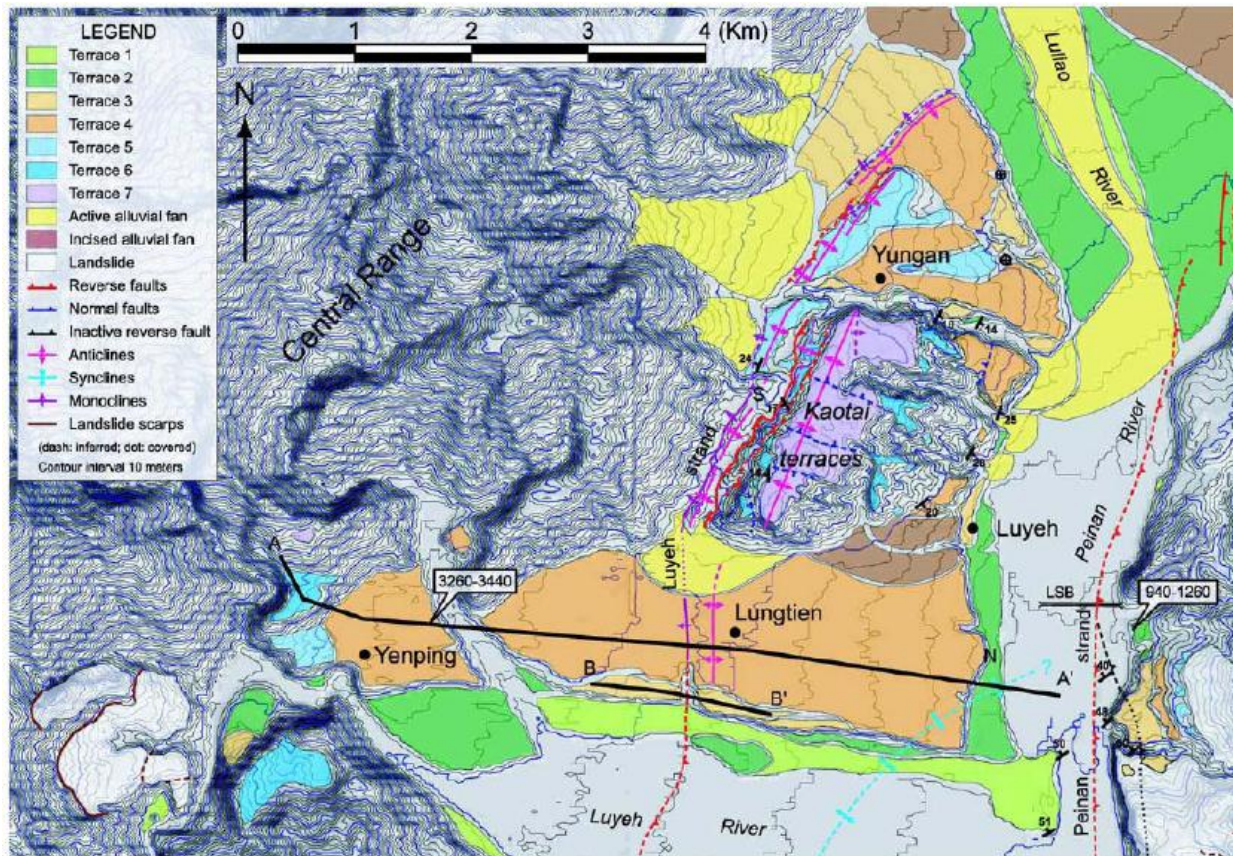
		Lichi Mélange	Kenting Mélange
similarities	<b>Matrix</b>	Intensely sheared mudstones without distinctive stratification. Some layers with coherent stratification have been locally reported	
	<b>Texture</b>	Scaly foliation, dense pattern of small faults with slickenside lineations (mainly thrust and strike-slip 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 mélangé 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 mélangé	
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 mélangé)	Pleistocene Hengchun Limestone (apron coral reef and lagoon phase limestone exposed in west of the mélangé)
	<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 mélangé: 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.

### Stop 3-3：台東高台：台東縱谷近代變形及河階與台地的形成

Lungtien and Gautai are located at high large terraces within the Longitudinal Valley in the Luyeh area (Fig. 5-25). Large terrestrial fluvial deposits, which extend from north of Luyeh to the entire Peinanshan area, appear to be products of the Peinan River and the Luyeh River from Pleistocene to present-day. Along the Luyeh river banks, at least 3-5 terraces can be observed at the different heights, indicating a rapid uplift and river incision in the area. The village of Lungtien is situated on the highest and largest, and presumably the oldest terrace of the Luyeh River. An N-S trending geomorphic scarp occurs at the Lungtien terrace.

In the trip, we will observe this scarp of Luyeh fault. The scarp of about 8-12 m high shows the east side going up. GPS data during the last 2-3 years indicate horizontal shortening occurred across the scarp (Chen et al., 2005). Together with the leveling data, it indicates that this scarp represents an active reverse fault scarp. In addition, we can also observe fractures with compressive features in the retaining walls at the foot of the scarp. This reverse fault scarp likely represents the surface trace of the Luyeh fault, which has been previously mentioned, although description is very limited. A few topographic profiles with detailed measurements across the scarp showed a growing anticlinal fold, which is presumably related to the reverse fault, in the hanging wall. We interpret this as that the Luyeh fault is probably locked at the shallow surface level. The Luyeh fault extends farther south and it likely affects significantly the deformation of the Peinanshan massif. The Peinanshan massif is composed of Plio-Pleistocene shallow marine to fluvial deposits (Chi et al., 1983). This massif is deformed by two faults on its both sides, the Luyeh fault to the west and the Lichi fault to the east (Fig. 5-26). At the top of Gautai, we can observe folded strata of the Peinanshan syncline. In addition, several levels of the terraces of the Luyeh River show clearly this growing syncline: older the terrace is (i.e., higher), more tilted.





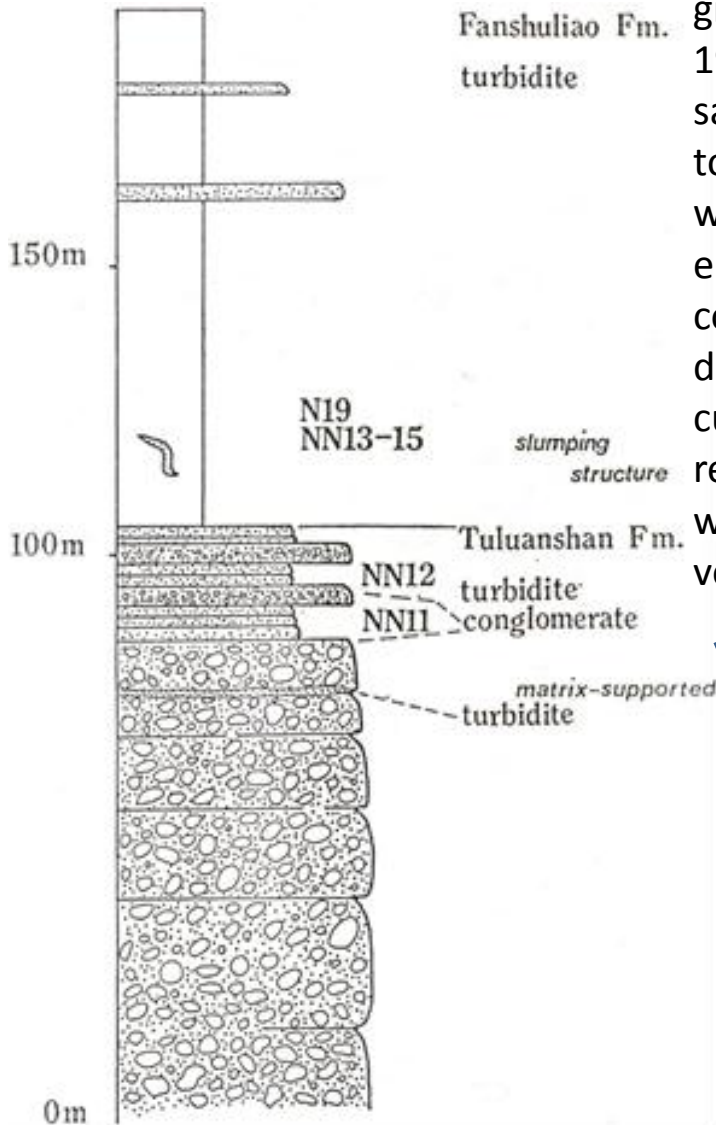
Detailed map of geomorphic features and active structures of the Gautai terraces area. Note that the names of terraces indicate only the relative ages of the terraces and do not imply correlation of the terraces; that is, terrace 4 north of the Luyeh River may not be the same age as terrace 4 elsewhere. The Luyeh strand, a major strand of the Longitudinal Valley fault, runs along the western edge of the Gautai terraces and has produced a monoclinical scarp on the Lungtien terrace to the south. To the north, the Luyeh strand dies out just south of the Luliao River. The other strand of the Longitudinal Valley fault, the Peinan strand, runs within the Peinan River valley and through the Luanshan Bridge (LSB) about 200 m from the eastern end of the bridge. Ages of terraces are calibrated ages (2s), in cal BP.



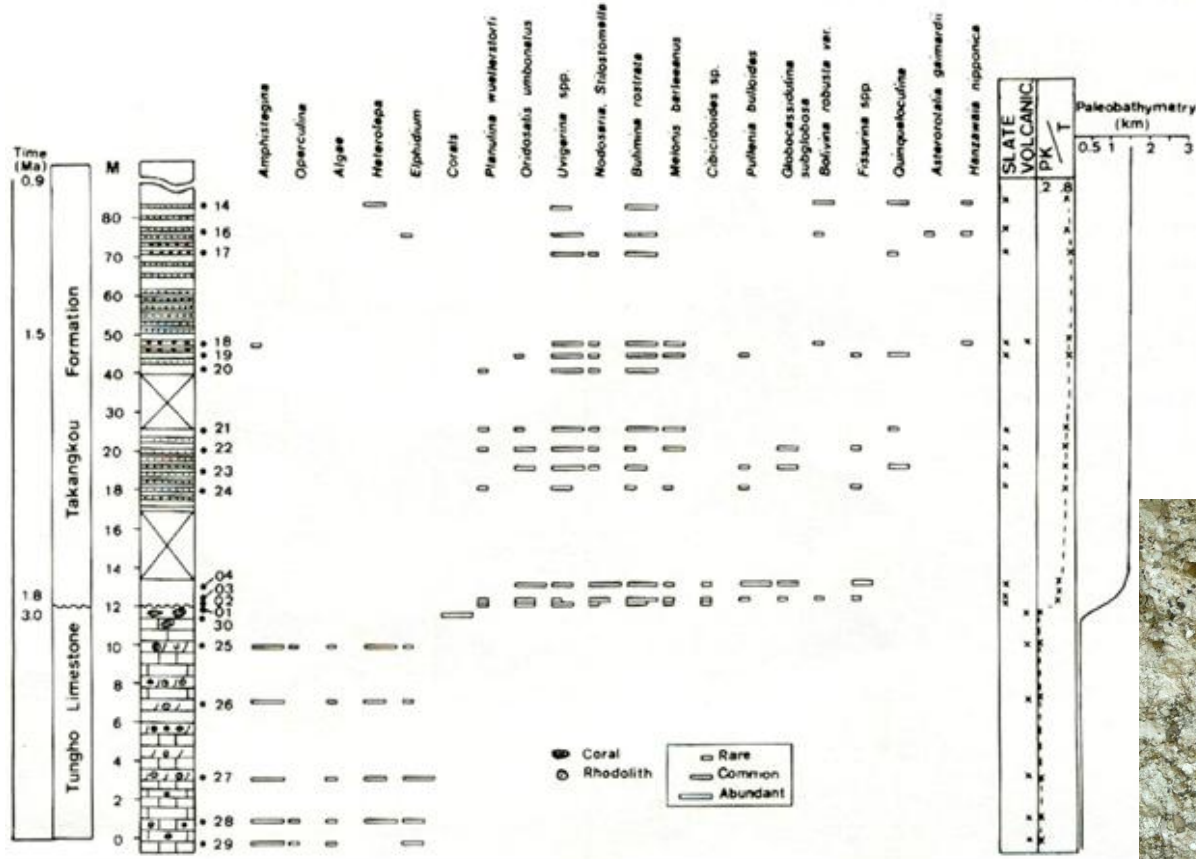


## Stop 3-4：富里驚溪5號橋：都巒山層與蕃薯寮層交界

At stop 3-4, it exposes the uppermost part of the Tuluanshan Formation with epiclastics and the lowest section of the fine-grained turbidites of the Fanshuliao Formation (Chen and Wang, 1988; Chen, 1997b). According to Chen (1997b), the epiclastic sandstone and conglomerate of the Tuluanshan Formation are up to 200 m thick at the locale. Conglomerates are matrix-supported with rounded andesite and limestone clasts up to 10 cm long. The epiclastic sandstones are thinly-bedded, non-welded and composed of detrital fossils and fragmented phenocrysts, displaying Bouma sequence typical of the products of turbidity currents. These deposits, which comprise high proportions of resedimented clasts that were originally accumulated in shallow waters, are interpreted as accumulated in a submarine and distal volcano-apron environment (Chen, 1997b).



# Stop 3-5 : 台東東河：東河石灰岩



Stop 3-5: Stratigraphy and major fauna in the Tungho Limestone and the overlying turbidite layers of the Chengkung intra-arc basin (Huang et al., 1995).

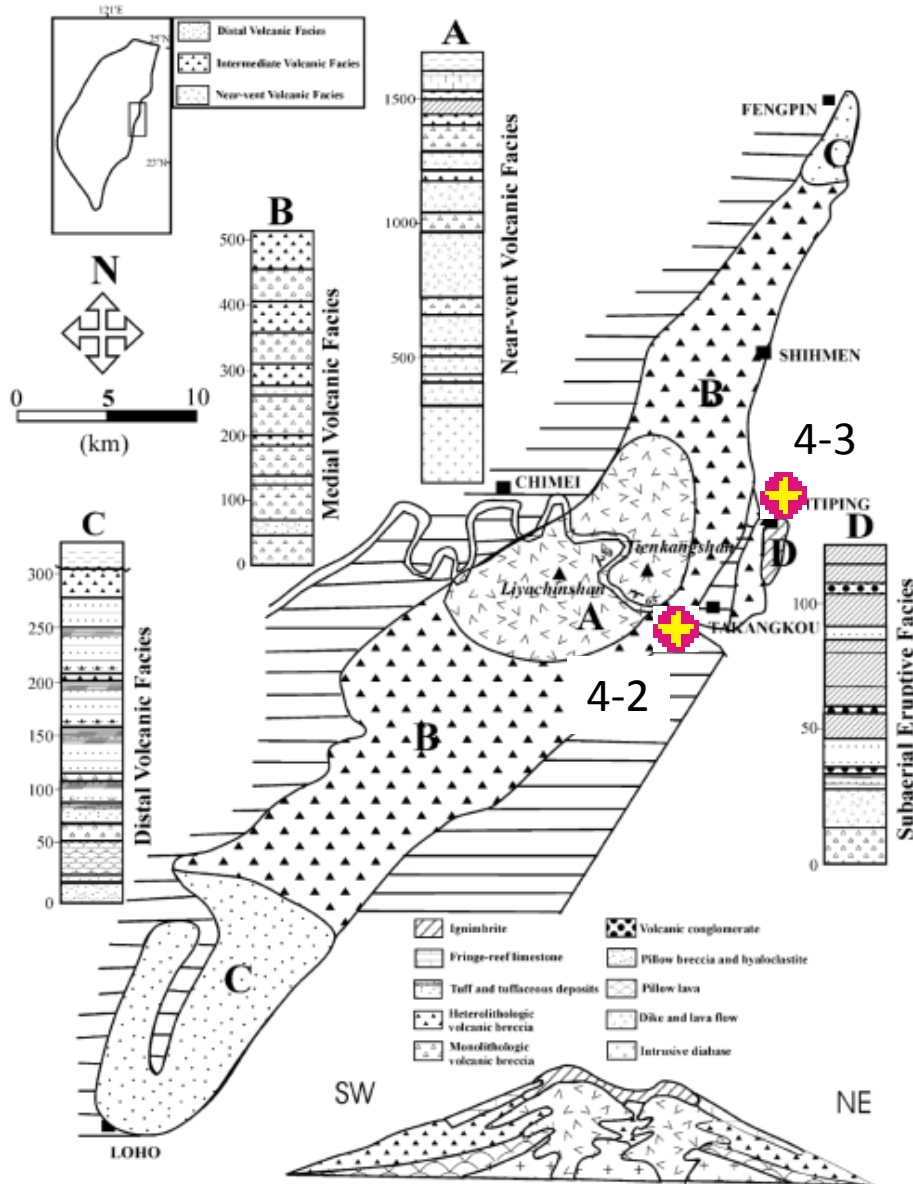
## Stop 4-1：台東烏石鼻：都巒山層



## Stop 4-2：花蓮豐濱秀姑巒溪長虹橋：都巒山層與港口石灰岩



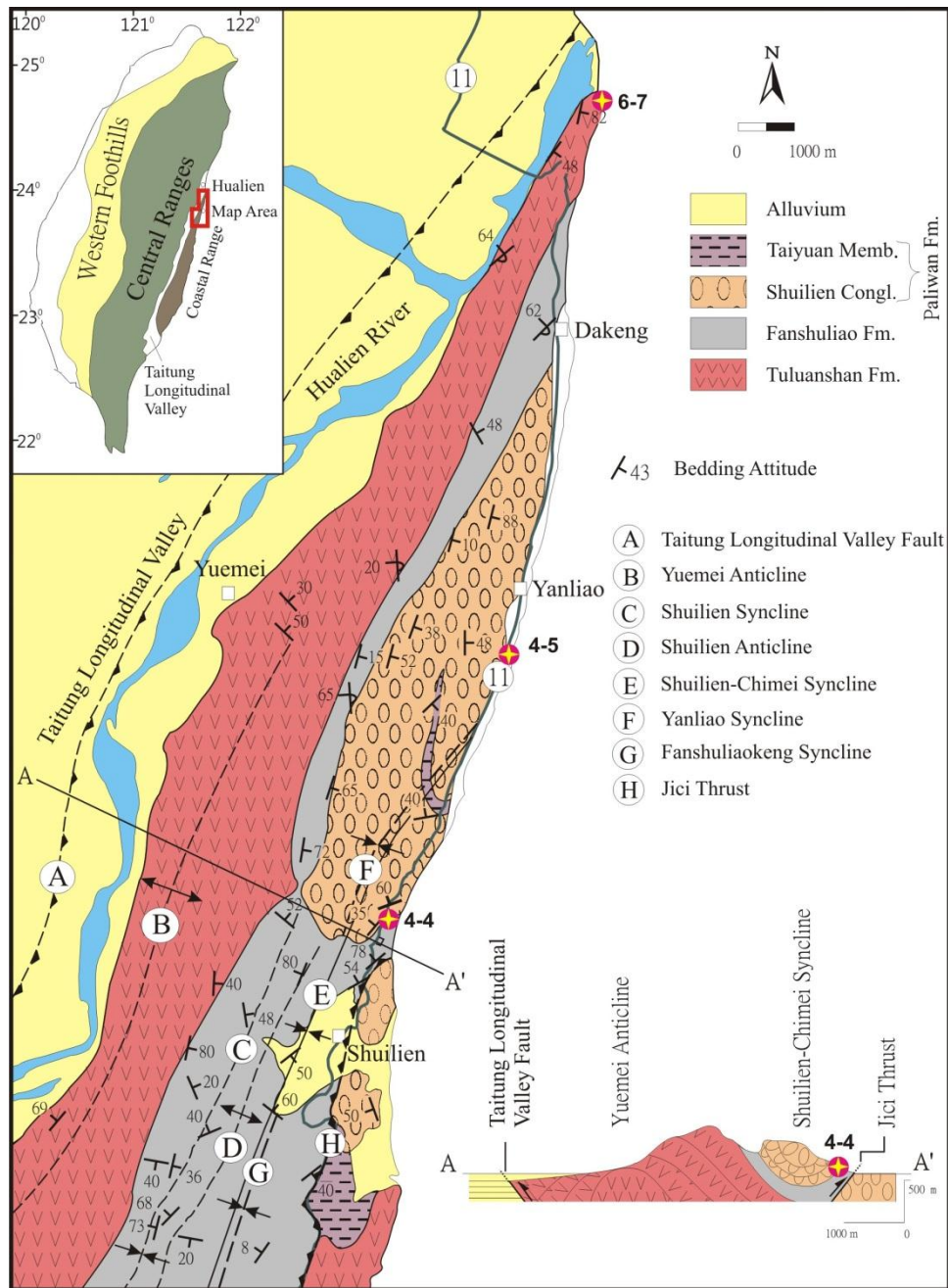
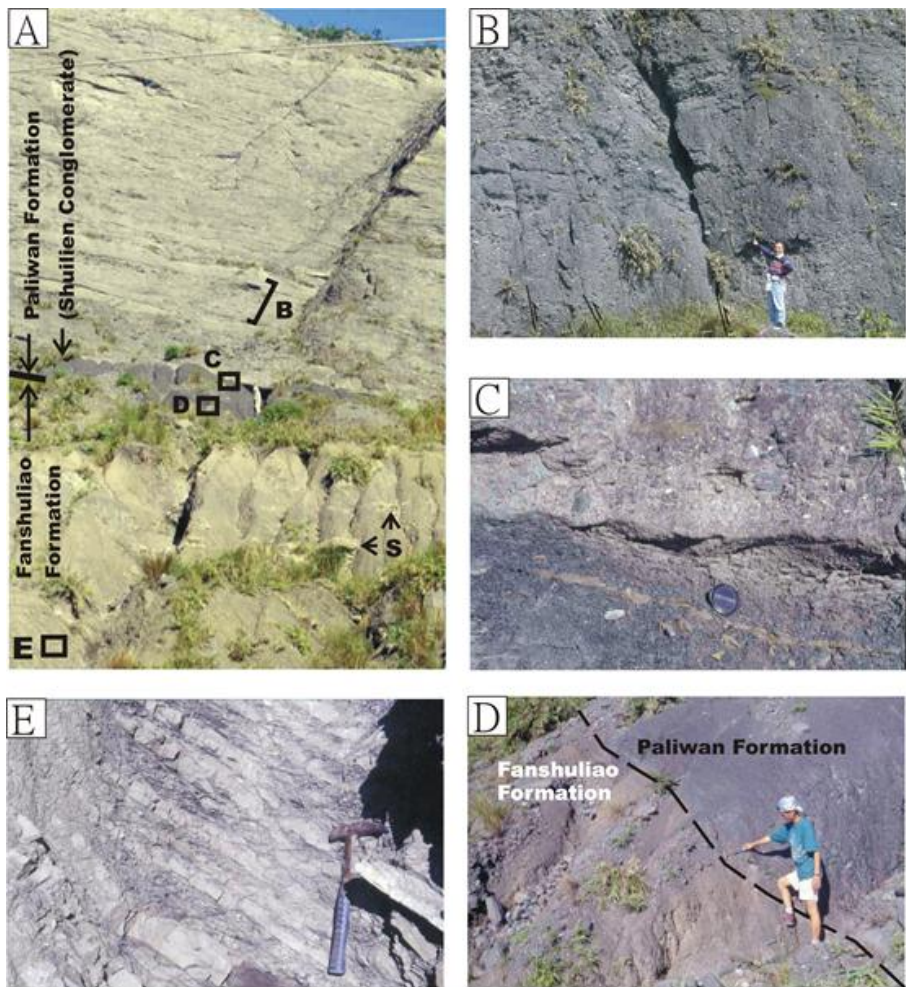
## Stop 4-3：花蓮石梯坪：石梯坪凝灰岩



Shitiping is an uplifted marine terrace composed of pyroclastic flows, ignimbrite and volcanic breccias. It is capped with Holocene coral limestone. Ignimbrites are glassy pyroclastic rocks formed by pyroclastic flows during a single eruption and compose predominantly of vesiculated glasses. The ignimbrite show both normal and reverse grading with occasionally large exotic blocks with impact structures. Rapid sedimentation is indicated by the fine-depleted ignimbrite whereas the angular blocks and contorted features (Fig. 5-38) suggest plastic deformation during sedimentation. The above features seem to suggest that the Shitiping white tuff were the products of subaerial eruption and were accumulated in a subaerial setting during late Miocene (Song and Lo, 1988).



# Stop 4-4：跳浪隧道南口(21.5 km)： 蕃薯寮層及八里灣層層界



海岸山脈北段地質圖 (Teng et al., 2002)

Stop 4-5：檜樹橋(14.6 km)：水璉礫岩



# 第五天：中央山脈變質岩(大南澳片岩、畢祿山層、廬山層，中橫公路太魯閣至梨山段)

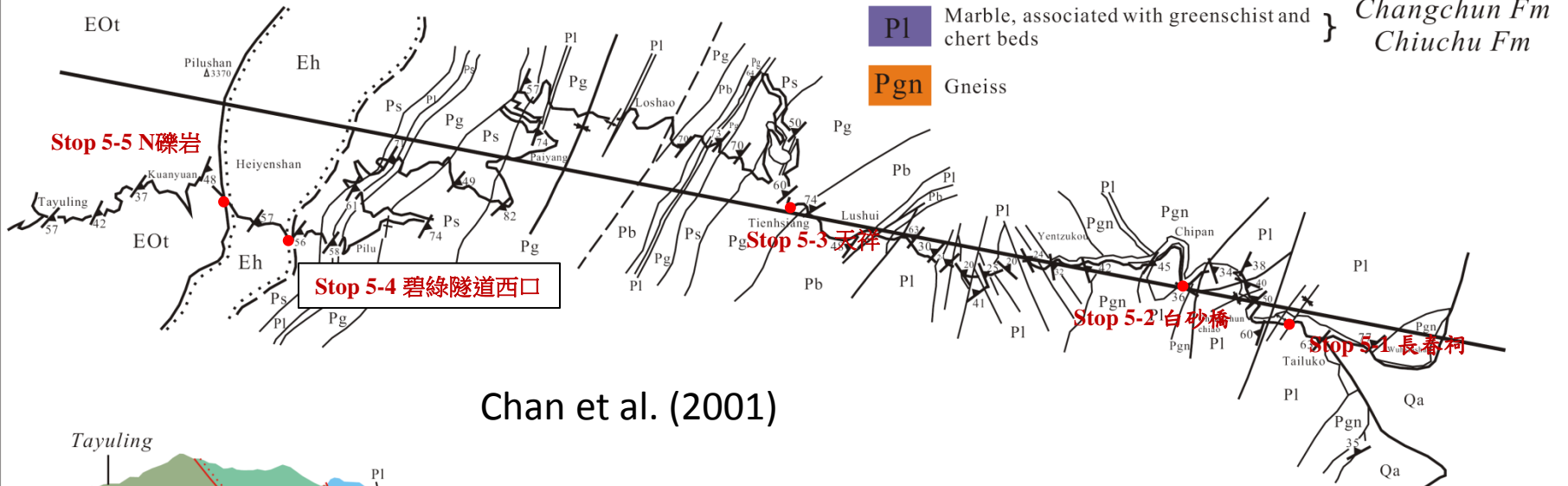
## 中橫東段路線地質圖

Backbone Range  
(Eocene-Miocene)

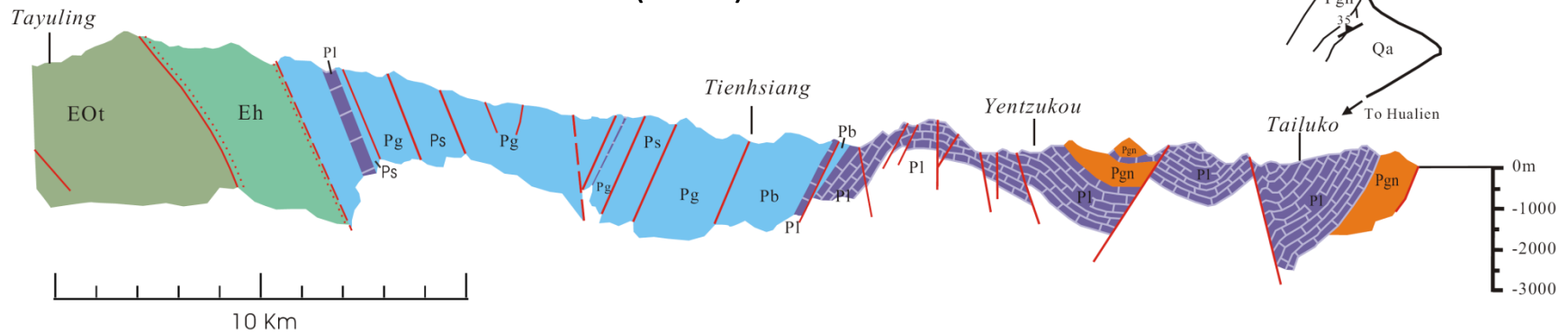
- EOt Tayuling Formation
- Eh Heiyenshan Formation

Tananao Metamorphic Complex  
(Paleozoic to Mesozoic)

- Pg Greenschist, associated with black schist, chert beds, and thin marble beds
  - Ps Psammitic schist or schistose sandstone, associated with black schist and chert bed
  - Pb Black schist, associated with quartz schist or chert beds, psammitic schist, and greenschist
  - Pl Marble, associated with greenschist and chert beds
  - Pgn Gneiss
- } *Tienhsiang Formation*
- } *Changchun Fm*  
*Chiuchu Fm*



Chan et al. (2001)



大南澳片岩地層對比表  
(李春生,1984)

Yen (1960)		Wang Lee (1979) 及王(1982)	李 (1984)
大 南 澳 群	玉里層	玉里層	玉里層
	太魯閣層 東澳相 大清水相	長春層 九曲層	長春層 天祥片岩 太魯閣層 東澳層?
	開南岡層	開南岡層	開南岡層
	三錐層 荖西相 公相	天祥層	三錐層 公層

大南澳片岩 (王執明, 1982)

玉里層: 石英雲母片岩、雲母片岩、綠色片岩、蛇紋岩

長春層: 綠色片岩、大理岩、石英岩(變質燧石)、角閃岩

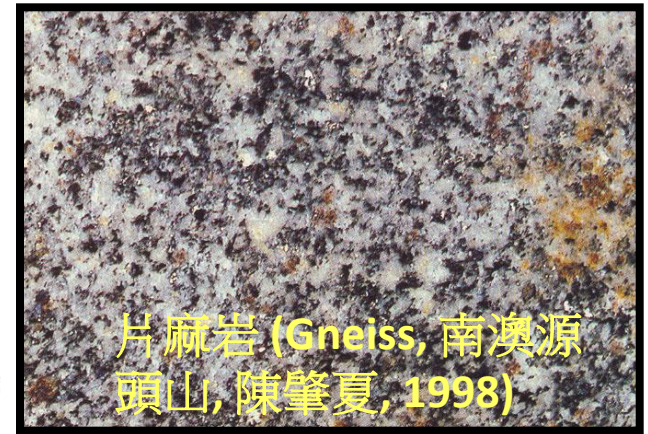
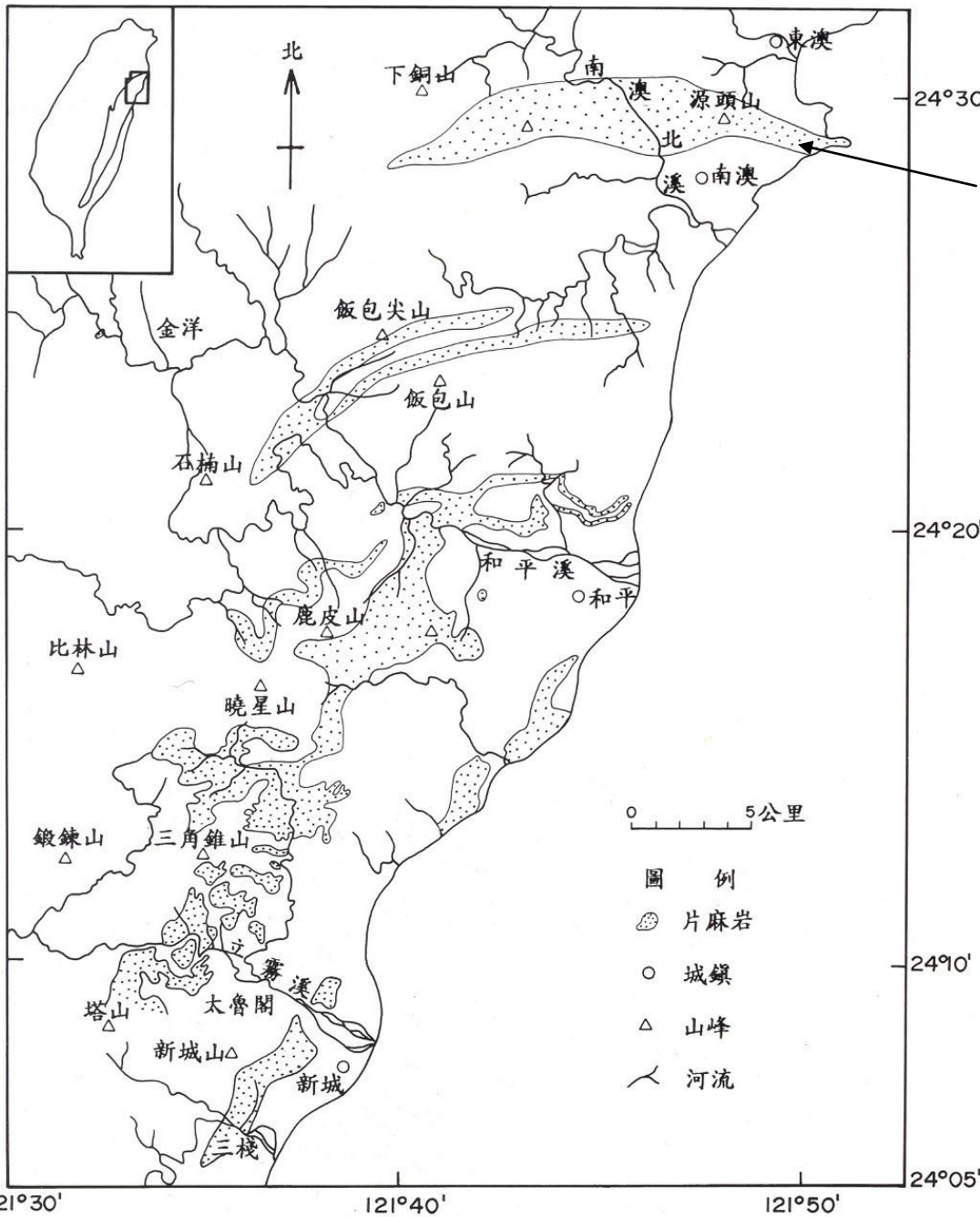
ΛΛΛΛ 硬綠泥石岩 (chloritoid rock, 由古生代土壤 (高鋁紅土) 變質而成 ΛΛΛΛ

九曲層: 大理岩

開南岡層: 混成岩、片麻岩

天祥層: 石英雲母片岩、千枚岩、變質砂岩

# 脊樑山脈片麻岩的分布 (王執明, 藍晶瑩, 1995)



## Stop 5-1：長春祠(1)：長春層



**Stop 5-1：長春祠(2)：變質基性岩(metabasite)**



Stop 5-1：長春祠(3)：大理岩、綠色片岩(及變質燧石?)薄互層

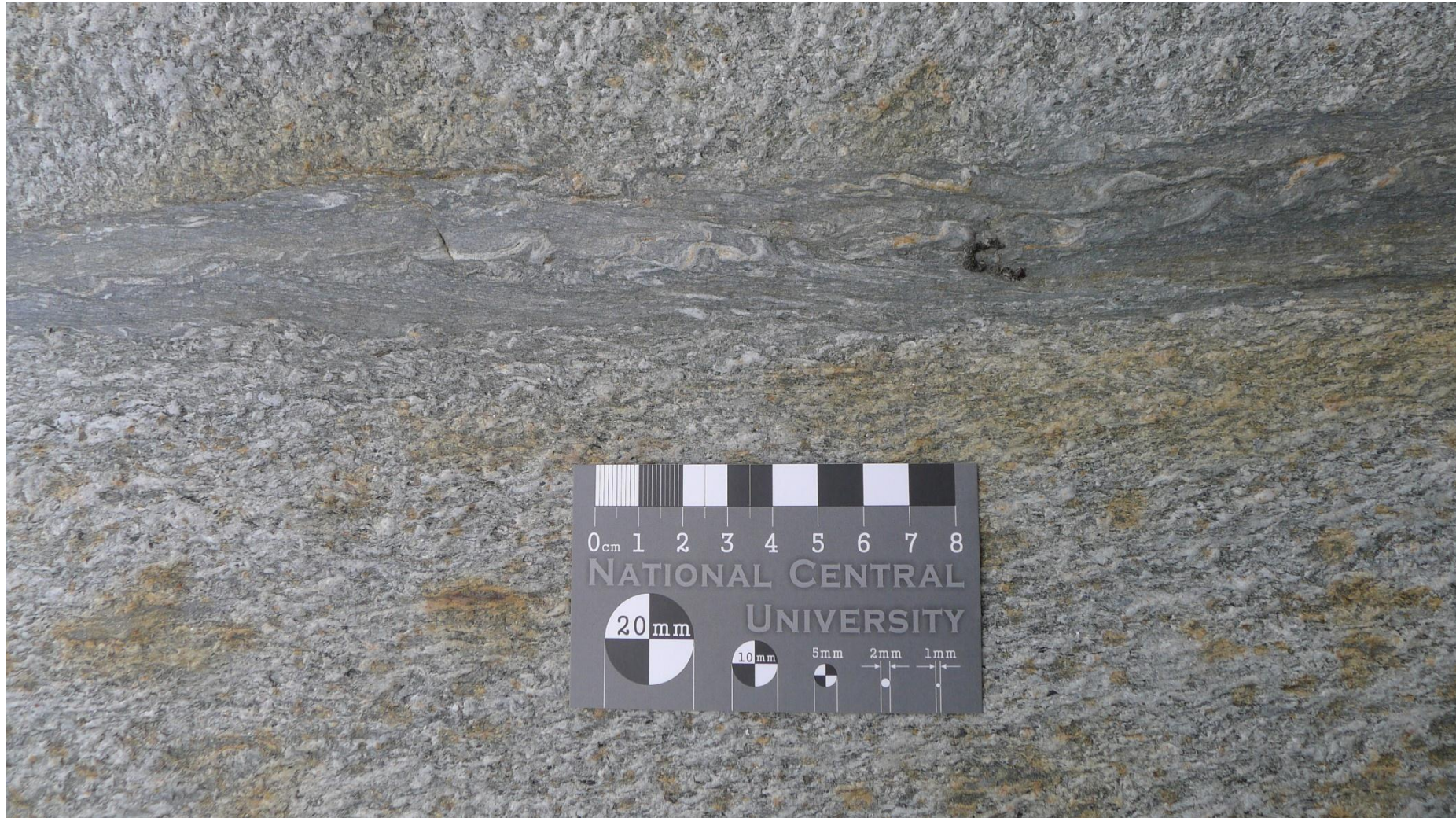


## Stop 5-2 : 白沙橋(182.1 km) : 溪畔片麻岩與大理岩接觸



A contact zone between granite and marble is observed near Baisha Bridge. Rocks near the granitic intrusions may contain amphibolite facies minerals. The P-T conditions as revealed by the Chipan granitic gneiss and Kainangang foliated gneiss indicate three episodes of metamorphism – the first stage at 2 kb and ca. 500°C, the second at 5-7 kb and 650-700°C, and the third stage at 4 kb and 450°C. Jahn et al. (1986) and Lan et al. (1996).

# Stop 5-2 : 白沙橋(182.1 km) 溪畔片麻岩之剪切帶



## Stop 5-3 : 天祥(169 km) : 天祥層片岩(1)



Stop 5-3 : 天祥(169 km) : 天祥層片岩(2)

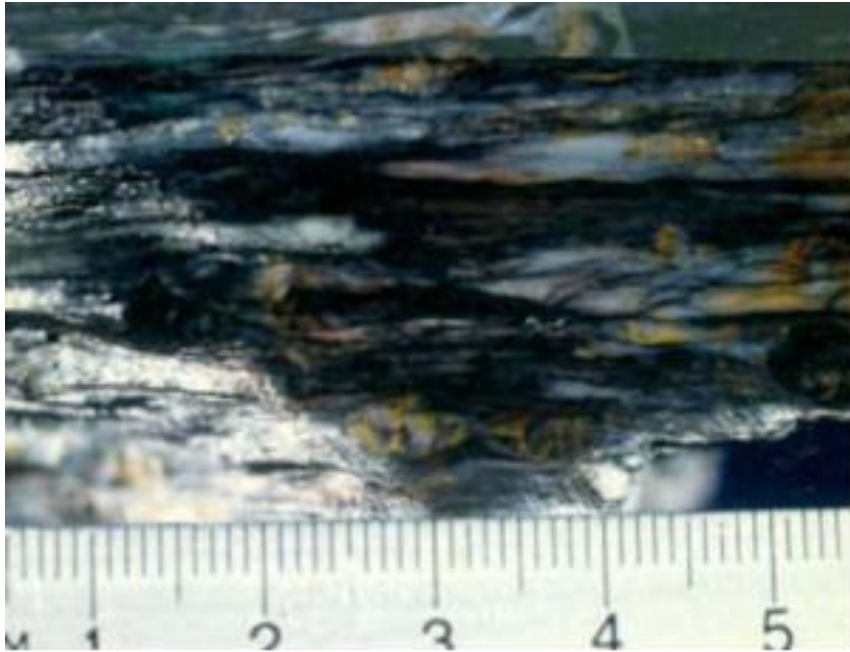


## Stop 5-4 : 中橫碧綠隧道西口(122 km):大南澳片岩與始新統不整合接觸

This stop begins at the western exit of the Pulu tunnel. We will first observe the strongly sheared quartzite and siliceous schist unit of the Tananao metamorphic complex and then walk northwest along the highway to the contact between the Paleozoic/Mesozoic basement and the Eocene Pilushan Formation of the slate belt. In this area, rocks of the Paleozoic/Mesozoic basement and the Backbone Range slate belt are strongly sheared. Well-developed shear structures such as stretched pebbles, S-C fabrics, noncoaxial pressure shadows, shear band, and stretching lineations can be observed at this outcrop. The chlorite-mica stacks aspect ratio is over 30 in the contact zone, this might indicate that the contact is a shear zone. Note that the sense of shear indicated by asymmetric fabrics is consistent with west-vergent thrusting, despite the observation that the rocks are exposed well to the east of the divide—that is, within the retrowedge where the instantaneous strain may be dominated by backthrusting. This paradox may be explained by the fact that the fabrics record a long-term history that largely occurred within the prowedge prior to eastward advection through the doubly vergent wedge system.



**Stop 5-4：中橫碧綠隧道西出口(122 km):大南澳片岩與始新統不整合面**



Stretched quartz pebbles in Eocene slates near the contact.



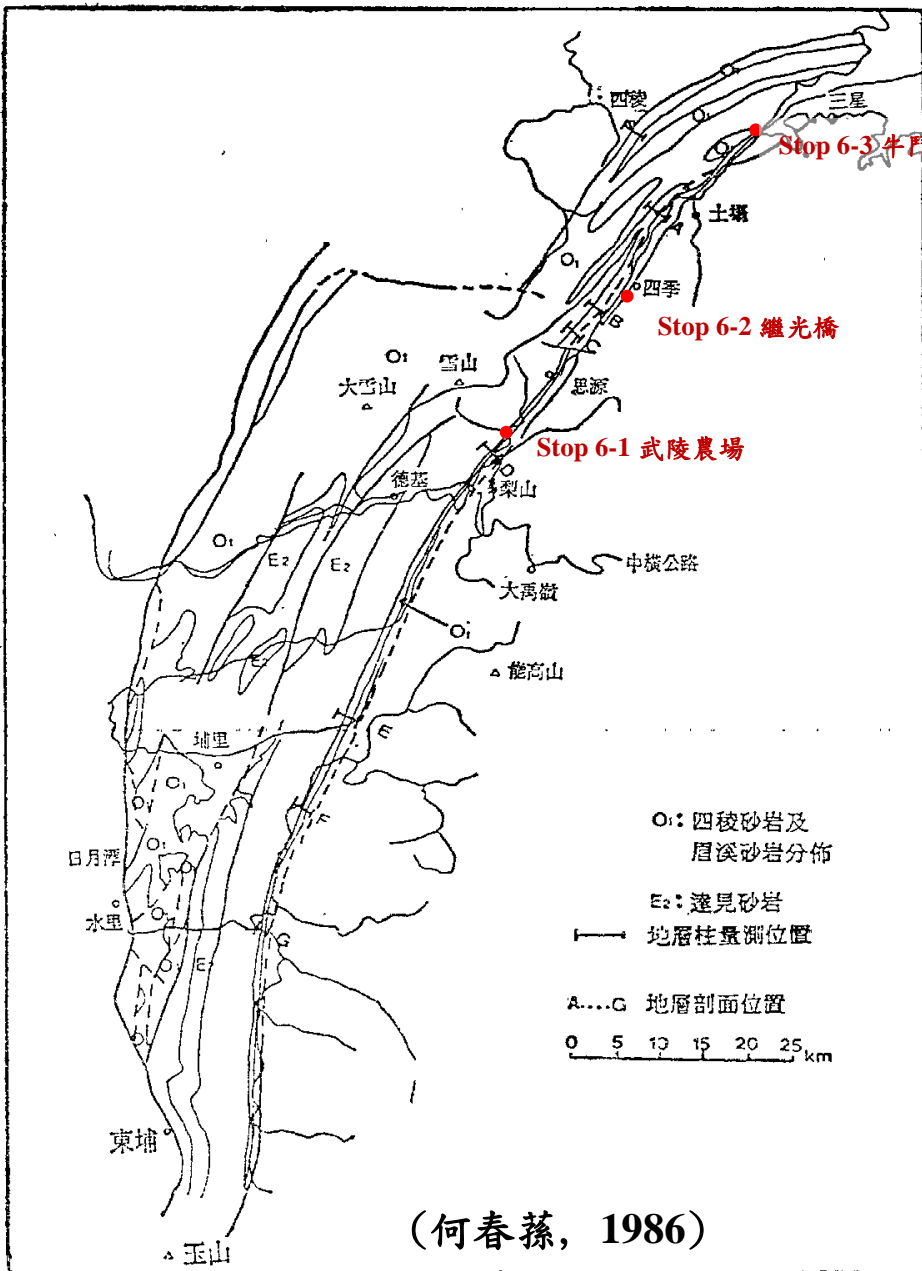
S-C band in the Eocene slate at the west entrance of the Pilu tunnel.

**Stop 5-5 : 中橫(120.3 km) : 始新統/中新統不整合面，N礫岩及上下板岩**



Conglomeratic layers lying in between the Eocene and Miocene (probably older) slates exposed at 120.3 km near Kuanyuan along the Central Cross-Island Highway. This is the so-called **N-Conglomerate**. The quartz grains are slightly deformed.

# 第六天：雪山山脈及脊梁山脈地質(中橫公路宜蘭支線)

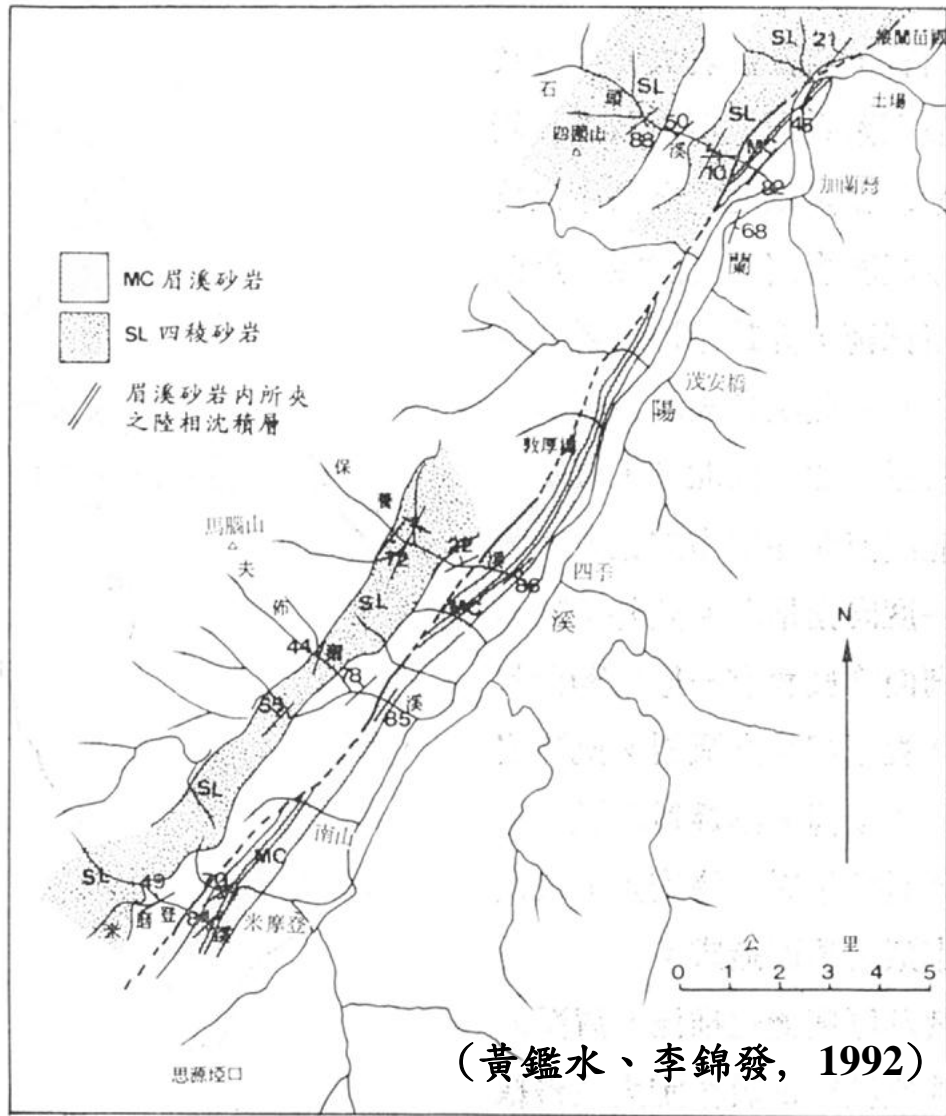
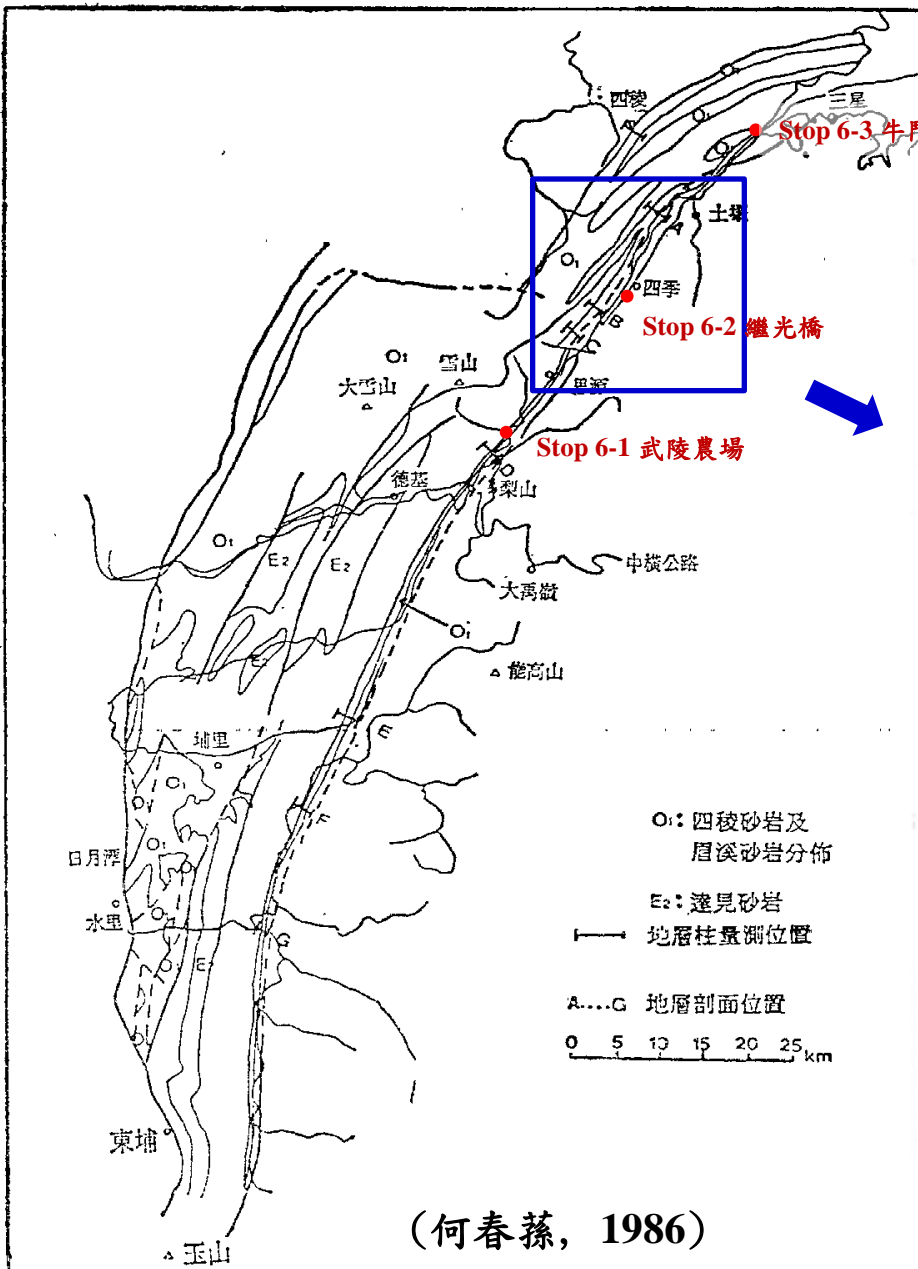


地層對比表(陳肇夏, 1992)

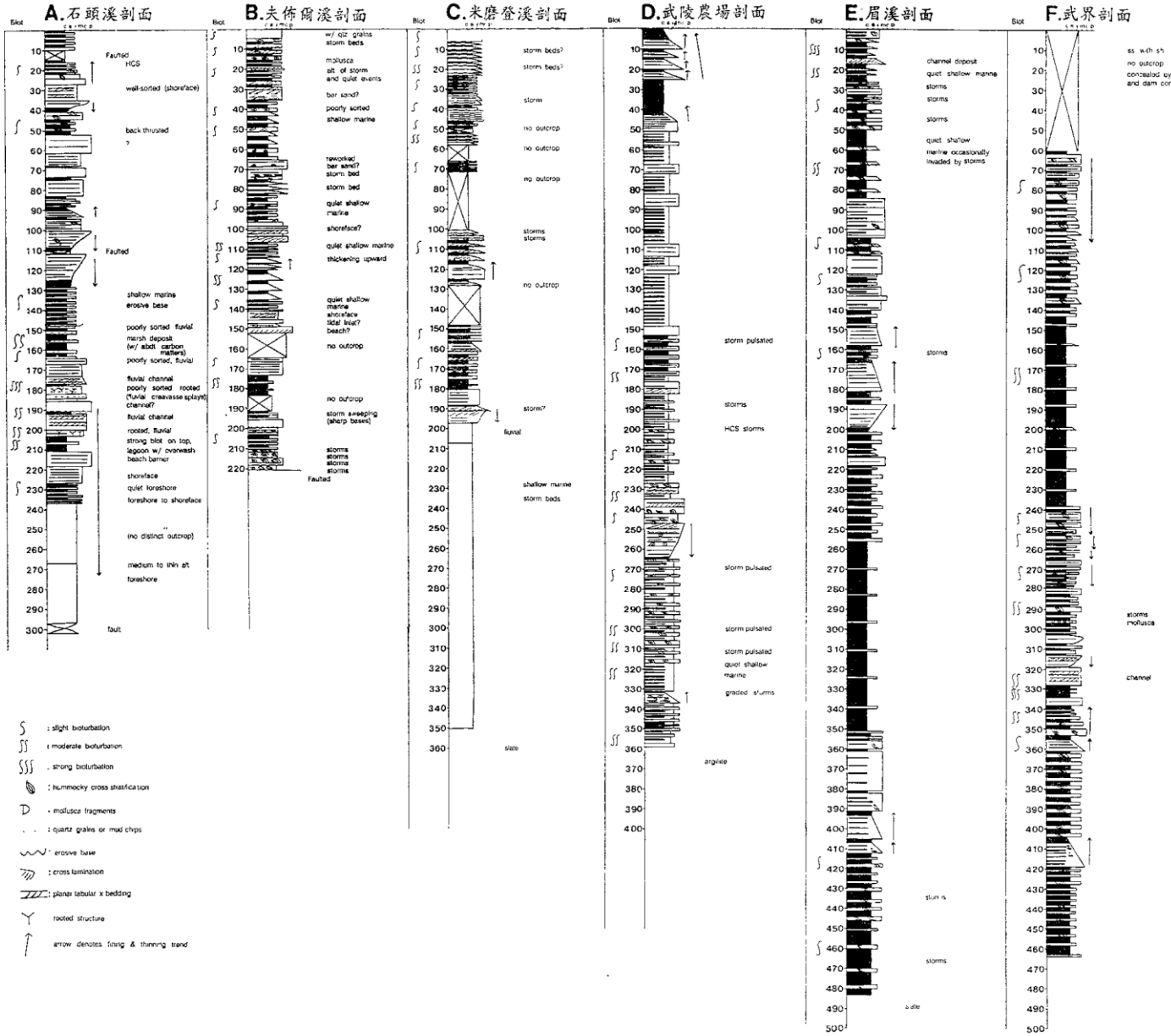
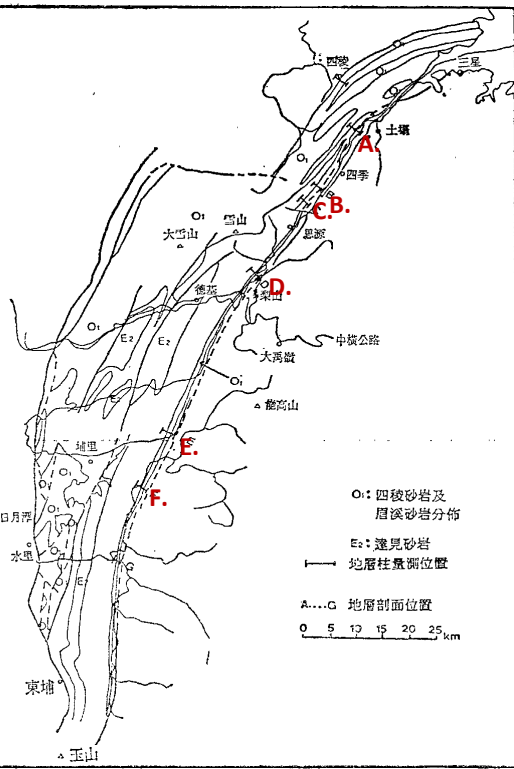
代	西部麓山帶	雪山山脈			南部中央山脈	
		北部	中南部西翼	中南部東翼		
	觀音山砂岩 打鹿頁岩 北寮層	湊合南港層		盧山層	盧山層	
	石底層 大寮層 木山層	石底層 大寮層 澳底層	石底層			
	青潭層 五指山層	大桶山層 粗窟砂岩 乾溝層	水長流層	(水長流層?)	(水長流層?)	
		四稜砂岩 西村層 中嶺層	白冷層	眉溪砂岩	新高層	孟浪山層
				佳陽層		小關山砂岩
				達見砂岩		關山層
				十八重溪層		
獻	主要參考黃廷章(1978)、邱華燈(1975)			陳肇夏(1977) 李春生(1979)	陳肇夏與莊德永(1989)	

# 眉溪砂岩

主要分佈於雪山山脈之東緣，呈南北狹長帶狀分佈，長約150公里。岩性上主要由層理良好的灰白色細粒至粗粒堅硬砂岩和間夾薄層頁岩組成，層理通常具相當之水平延展性，常具明顯的圓丘狀交錯層理(HCS)。



# 眉溪砂岩地層柱狀圖



## Stop 6-1 武陵農場入口：眉溪砂岩(1)



## Stop 6-1 武陵農場入口：眉溪砂岩(2)



## Stop 6-2 南山：為繼光橋往南眺望蘭陽溪上的河階及沖積扇



### Stop 6-3 牛鬥橋：蘭陽溪東岸的廬山層

牛鬥橋上，可同時遠眺蘭陽溪東岸的傾斜約 $10^{\circ}$ 左右以泥質岩為主的岩層(中新世廬山層)，及西岸傾斜約 $40^{\circ}$ 的砂岩層(始新世白冷層)，兩岸的岩層於岩性、位態及年代上皆有所差異，被認定為斷層接觸(?梨山斷層)。

