

# **Paleotsunami workshop in Taiwan**

## **Reconstructing 1867 Keelung Earthquake and Tsunami**

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# Outline

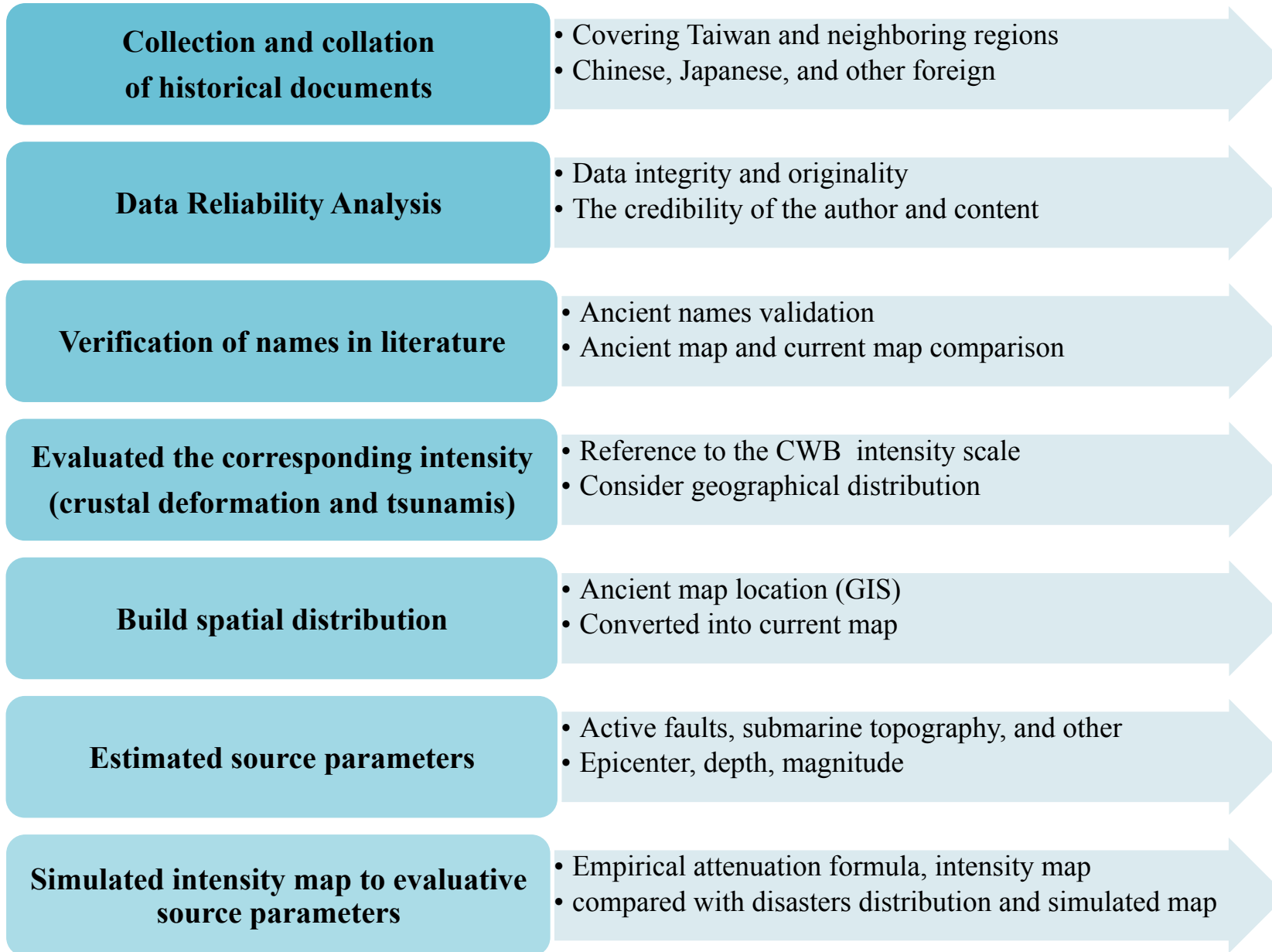
- **Introduction**
- **Collect and collate historical documents**
- **Data Reliability Analysis**
- **Verification of place names in literature**
- **Build spatial distribution of disaster**
- **Evaluated the corresponding intensity (Crustal deformation and tsunami)**
- **Estimated source parameters**
- **Simulated intensity map to evaluative source parameters**
- **Preliminary Result**

# **Introduction**

**December 18, 1867, a disaster earthquake occurred in northern sea of Taiwan, and triggered a tsunami, hundreds of persons were killed and many houses were destroyed. Because of the age, lack of detailed literature data, for this limited understanding of the 1867 Keelung earthquake and tsunami.**

**This earthquake may be closely relative with the northeastern extending of Shanchiao fault. Earthquake and tsunami inflicted severe damage on the north coast, and impact of the entire Taipei area. There are many important constructions in this region, such as nuclear power plant. It is worth further study and discussion.**

**This study from the collection and collation of historical document to proceed, with assessing the reliability of data and the corresponding site locations. The use of GIS to build disaster spatial distribution. Simulated intensity map to evaluative source parameters.**



Procedure of data processing

# Collect and collate historical documents

1. Official file  
lack of document

2. Local version  
of literature

3. Personal  
records and  
article

4. Temple history  
and stele

ID	Data Source	Classified	Remark
01	淡水廳志/卷十四/陳培桂(1871)	Original document	
02	淡水廳志/卷四/陳培桂(1871)	Original document	
03	淡水廳志/卷十二/陳培桂(1871)	Original document	
04	苗栗縣志/卷八/沈茂蔭(1892)	Original document	
05	象山縣志/卷三十	謝毓壽和蔡美彪(1987)	
06	1881年通商各關貿易報告/海關總稅務司署	謝毓壽和蔡美彪(1987)譯本	
07	North China Daily News/1867.12.19	謝毓壽和蔡美彪(1987)譯本	
08	The North China Herald and Market Report/1868.01.08	English original document	
09	伊能嘉矩，大日本地名辭書續編	徐泓(1983) translation	
10	Alvarez/Formosa	徐泓(1983) translation	
11	Macdonald(1895)	English original document	
12	Davidson(1903)	徐明同(1981)譯本	
13	TMO(1914)	English original document	
14	岡本要八郎(1913)	Japanese original document	
15	武者金吉(1951)日本地震史料	謝毓壽和蔡美彪(1987)譯本 許明光和李起彤(1996)引述李善邦譯本	二個譯本 有差異
16	包澄瀾等(1991)引用葉琳	許明光和李起彤(1996)引述	有爭議性
17	楊華庭(1987)中國海嘯歷史年表	許明光和李起彤(1996)引述	內容雷同
18	Soloviev and Go(1974)	許明光和李起彤(1996)引用李起彤譯本	待查證
19	宇佐美龍夫(1977)	許明光和李起彤(1996)引述	無資料
20	聯合報49年5月25日	許明光和李起彤(1996)引述	有爭議性
21	金包里慈護官沿革	Temple history	
22	淡水清水祖師廟石碑與沿革	Temple history and Stele	
23	文化部臺灣知識的骨幹/磺嘴吼煙	文化部官方網頁	
24	新北市政府觀光旅遊局/景點資訊/基隆山	新北市官方網頁	
25	自由時報/93年12月27日+訪問	interviews	
26	中國時報/931年2月29日+廟誌+訪問	Temple history and interviews	

Historical documents are difficult to describe with English, and my English is poor, if not clear at explaining. Please bear with me.

## 2. Local version of literature and document

一八六七年地震发生在十二月十八日，海水从基隆港倾泻而出，留下了一个干涸的泊位，但不几秒钟，带着两个浪头的海水又汹涌而回，淹没了舢板和人口。基隆、金包里及巴其那等城镇部分泡为废墟。淡水遭到严重破坏，好几百人死亡。

《1881年通商各关贸易报告》（英文） 第十七期 附件《台湾淡水部分》页11—15 Translation by 謝毓壽和蔡美彪(1987)

December 18, 1867, a earthquake occurred. Sea water rushed out from Keelung, leaving a dry berths, **for a few seconds**, with **two tide waves** while back, junk and people were submerged, Keelung, Ching-bao-li, and **巴其那** towns that its part soaked in water. Tamsui was severely damaged, several hundred people deaths.

- ★ 6、海關總稅務司署/1881年通商各關貿易報告/第十七期附件/臺灣淡水部分：一八六七年地震發生在十二月十八日，海水從基隆港傾瀉而出，留下一個乾涸的泊位，但不幾秒鐘，帶著兩個浪頭的海水又洶湧而回，淹沒了舢板和人口。基隆、金包里及巴其那等城鎮部分泡為廢墟。淡水遭到嚴重破壞，好幾百人死亡。(謝毓壽和蔡美彪, 1987)
- 7、字林西報/1867.12.19：(江蘇上海) 昨日，租界里許多人感到一次地震(謝毓壽和蔡美彪, 1987) (據該報後幾日來自寧波、九江的報導說此次地震為十七日) (?)
- ★ 8、The North China Herald and Market Report/January 8th, 1868 (English original document)



**Document No. 8: The North China Herald and Market Report/January 8, 1868 (北華捷報)**  
謝毓壽和蔡美彪主編 (1987)中國地震歷史資料彙編：字林西報/1868.01.04

## TAMSUI.

The quiet town of Tamsui became the scene of much excitement on the morning of the 18th, in consequence of a terrible earthquake experienced at 10.20 A.M. No rumbling voice was previously heard; and the only intimation we had was a slight vibration at first, which drove us out of the house, until it increased so much as to make us stagger like drunken men. While we stood reeling about, prepared to see the house fall in, our attention was suddenly attracted to the west hill (upon which stands part of the town of Tamsui) by a loud crashing noise and a dense cloud of dust, which too truly indicated that many houses had been shaken down. The people were in a wild state of commotion, and rushed about bewildered, like ants. The scene on the hill was awful; villagers, apparently paralysed, stood looking at the debris of their houses, too frightened even to try and extricate the unfortunates who were buried alive beneath the ruins. The Foreign Customs officers immediately went to the scene of disaster, to render what little assistance they could in getting out the sufferers;—but it was a hopeless task. The mud walls of the native houses appeared to have fallen inward and crumbled at once, and with the roof above debarred all chance of saving people alive. Hoes or spades could not be found, the people were too alarmed or indifferent to do any thing.

Two (we suppose opium smokers) on a bed, were got out, but dead. A woman who must have been cooking was got out alive, with her face fearfully burned; many more were severely wounded. The shock came from the N.E. towards the S.W. Houses fell in regular order, just as if artillery had been discharged at them. The loss of life at Tamsui is estimated at 80; but Pa-tsun, a small town distant a few miles, suffered more, and it is reported 150 persons were killed. It was a most peculiar disposition of providence that the shock did not occur at night. During the day and following night, shocks were felt at intervals of an hour or so, the last being about 6.30 A.M. By persons residing at the sulphur pits, it is reported little caution was felt. The steam issuing from the pit seemed to lessen. The noisome smell so common at this place appeared much stronger on the 18th and following days. Houses on elevated sites suffered least.

At Keelung, we learn the first shock was felt at 9.45 A.M., and lasted about thirty seconds. The earth cracked slightly in front of the Custom-house. A great portion of the town is down, burying numbers in the ruins. A cloud of vapour has been to rise from the sea between Palm and Keelung islands, which was succeeded by the water in the harbour rushing out seawards, leaving it dry as far as Ruin Rock for some seconds. Everything was carried away with the receding water. The sea then returned in the shape of two large waves, swamping sampans and drowning

the people therein, and junks were carried away high and dry opposite Keelung. The harbour was in a state of agitation during the whole day; on the 20th it was hardly quiet. Instead of the water being clear as usual, it became yellow and muddy. Enormous quantities of fish were washed ashore and secured by the Chinese. The people appeared to exhibit the greatest indifference with regard to the fate of the sufferers, and would not assist in extricating them without a guarantee of some reward. When the water left the harbour, a man got down from a junk, but before he could reach the shore was overwhelmed by the returning water. Numerous coal boats were upset or sunk. An old wreck of a junk, deeply embedded for years in the sand, was washed high up on shore. Luckily no foreign vessels were in port. Large stones were hurled from the hills at Keelung and near the sulphur pits. Natives report that a large opening has been made in the earth along the coast between this and Keelung. At 6.30 A.M., on the 20th a sudden shock drove us out of the house, and during the night two more were felt. The amount has been high; and the 18th was a splendidly clear day, as has been the case for weeks past. On the 10th it clouded up, and a little rain fell; the next day it was again clear. Chinese attribute these shocks to the unusual absence of rain. We are interested to know whether this was a local shock, or has been felt elsewhere. The great difference in the time given at Keelung and Tamsui may be explained by our having no accurate means of getting correct time. Often one person's watch is half an hour faster or slower than another.



### 3. Personal records and article

- 9、伊能嘉矩，大日本地名辭書續編(頁16)「台灣·台北·士林街」：「同治六年之地震，(肆店)過半遭崩壞，邇來頹衰，已失其舊觀。」(徐泓, 1983)
- 10、Alvarez, Formosa：1867年12月18日，北部地震更烈，災害亦更大，基隆城全被破壞，港水以已退落淨盡，船隻被擱于沙灘上；不久，水又復回，來勢猛烈，船被衝出，魚亦隨之而去。沙灘上一切被沖走。原本建築良好之屋宇，亦被衝壞，土地被沙淹沒，金包裹地中出聲。水向上冒，高達四十尺；一部分土地沈入海中。**基隆港內，有若干尺面積地方，其下落已較原來為深。**此係據若干歐洲商人證實報告。(徐泓, 1983)
- 11、Macdonald (1895)/From Far Formosa(P.53)：**(English original document)**
- 12、Davidson(1903) The island of Formosa, past and present：此地震在台灣全島都有感覺而北部地區最強烈，而基隆市街及其附近發生大災害。據在海關服務的外國人報告，在這一天基隆發生十五次有感地震，而引起災害者為第一次地震。第一次地震發生後十五秒內發生災害而基隆市街變成廢墟。由基隆港的海水流出，而留下海底暴露的事實，可判斷地震力。幸而當時沒有外國船舶在港內，而只有中國帆船。這些大小帆船一瞬間留在乾的海底，而另一瞬間被折回的巨大波浪淹沒或者以驚人的速度猛衝街上，**破壞海邊附近留下來的少數房屋。**很多魚向海岸衝上來，而人民迅速地拾集。在許多地方，大地裂開而再封閉，有一座山裂開而形成大山峽，而從山的側面流出熱水。**這些熱水來自火山坑，而富有硫磺質溫泉和噴泉。**此外還有發生許多有形的變化，包含**基隆拋錨地加深數英尺。**人命損失不知道，很可能沒有計算，預估死者可能達數百人。  
**(徐明同, 1981) a few houses near the sea damaged**  
**Hot water from the crater containing sulfur springs**  
**The deepening by a few feet of the anchorage at Keelung**

- 13、TMO(1914) The climate, typhoons, and earthquakes of the island of Formosa (Taiwan)  
**(English original document)**
- ★ 14、岡本要八郎(1913)/同治年間に於ける金包里附近の地變 **(Japanese original document)**
- 15、武者金吉(1951)「日本地震史料」：(1867年12月18日)臺灣基隆地方大地震，全市倒壞，海嘯，死者眾多，附近火山口**岩漿溢出/流出熱水(The crater lava overflows/ hot water outflow)** (謝毓壽和蔡美彪, 1987)/(許明光和李起彤, 1996)
- 16、To quote包澄瀾等(1991) quoting葉琳 description：此次海嘯持續了38小時，淹.)沒120公里長的海岸線，4-5萬人死亡/ Tsunami lasted 38 hours, flooding 120 km of coastline, 4-5 million deaths. ◦ **(許明光和李起彤, 1996)(Content is the same as description of Soloviev and Go(1974) for the 1781 tsunami in southern Taiwan.)**
- 17、引述楊華庭(1987)之「中國海嘯歷史年表」中記載地震發生於1867年12月18日，震央為東經121.7度北緯25.5度，震級7，產生規模為2之海嘯，海嘯之信度為4。災情記述為「震後碼頭上水，眾多船屋被毀，死數百」。 **(許明光和李起彤, 1996)(內容雷同)**
- 18、To quote李起彤 quoting Soloviev(1974)(Russian)，揚子江面先下降135公分，後上昇165公分/ Yangtze River water decreased first 135 cm, and 165 cm rise. **(許明光和李起彤, 1996)(Soloviev and Go, 1974)(If the earthquake and tsunami relation to the Shanchiao fault should be increased and then decreased.)**
- 19、宇佐美龍夫(1977)之「日本被害地震總覽」無任何描述。 **(許明光和李起彤, 1996)**

lodes of quartz. It is difficult to estimate the quantity procured annually, although it must be considerable.

Great physical changes are continually taking place on the island. What was once a large and beautiful lake is now the fertile Bang-kah plain. Storms and freshets brought down vegetable matter from the mountains, and the bottom of the lake was gradually elevated. Meanwhile the waters were grinding and pressing against the spur that joined the Tai-tun and Quan-yin mountains, forming the lower bank of the lake. At some time a violent earthquake-shock rent this spur, and the waters rushed madly down to the sea, leaving behind a rich alluvial plain, and cutting what is now the channel of the Tamsui River.

Earthquakes are very common and do enormous damage. In 1891 on one day four shocks were felt, and a month later two more. Years ago at Keelung rumbling sounds were heard and the waters of the harbor receded until fish of all sizes were left wriggling and floundering in the mud and pools. Women and children rushed out to secure such rare and enticing prizes, but shrieks from the shore warned them of the return of the water. Back it came, furious as a charge of battle, overleaping its appointed bounds, and sweeping away all the houses in the low-lying land along the shore. The story of that tidal wave is handed down as one of the great catastrophes in history. At Kiu-pau-li, not many years ago, a shock was felt. Rice-fields suddenly sank three feet, and the sulphurous water rose and still covers the place. Sugar-cane is now cultivated in large tracts where boatmen plied their oars in 1872, and the waters of the Tamsui River glide over places where stood villages in which I preached the gospel twenty-three years ago. Changes are taking place, too, all along the shore. One might suppose that the hard rocks on the east coast would be able to resist all forces and influences. But no; tides and waves of the great Pacific tunnel, undermine, and wear away the bases of the

Document No. 11: Mackay(1895)/From Far Formosa(P.53). Mackay arrived Taiwan in 1871. The descriptions of tsunami in Keelung are different with the other.

1867 December 18

10 a.m.

Extreme  
North  
Coast.

A violent earthquake occurred on the coast in the extreme north of the island, accompanied by a seismic tidal wave, which wrought great havoc on many buildings and caused a large loss of life. A foreign officer, who was stationed at the Keelung Custom House, at that time, reported this earthquake as follows:

\* At Keelung some fifteen shocks were felt during the day, but it was the first movements that did the damage. In fifteen seconds after the first perceptible shock the damage was done and the town of Keelung was in ruins. The force of the earthquake may be judged when it is noted that the water of Keelung harbour ran out, leaving the bottom of the bay exposed. Fortunately there were no foreign vessels present, but the Chinese junks which were there, large and small, were in one second left dry on the bottom and in another caught by the huge returning wave to be either swamped or dashed into the town with fearful speed, to work havoc among the few remaining houses left near the shore. Multitudes of fish were thrown upon the shore and promptly gathered by the populace. The earth opened in places and closed again. A large gorge was formed by the splitting of a mountain side through which now runs a stream of hot water from a volcanic pit abounding with sulphurous springs and geysers. Many other physical changes were noted, including the deepening by a few feet of the anchorage at Keelung. The loss of life was never known; it is extremely doubtful if there was any count made, but probably several hundreds perished."

Document No. 13: TMO(1914) The climate, typhoons, and earthquakes of the island of Formosa (Taiwan) (P.74)

同治六年丁酉二月二十日 同本要八郎

大和八郎は、同治六年丁酉二月二十日、同本要八郎の...

Table with 2 columns: Name, Amount. Includes entries like 大和八郎, 同本要八郎, etc.

同治六年丁酉二月二十日、同本要八郎の...

同治六年丁酉二月二十日、同本要八郎の...

大いせ、彼はあり、左右に西しく、約五...

同治六年丁酉二月二十日、同本要八郎の...

Document of No. 14: 岡本要八郎(1913)/同治年間に於ける金包里附近の地變

## **Ching-bao-li bao(金包里堡)** document of No.14 (Okamoto, 1913)

### **Original document using the ancient Japanese writing**

#### Date:

At 10:00 on December 18, 1867, the first occurrence of severe earthquake, followed by tsunami along the coast

#### Earthquake:

The earthquake sound was heard before quake occurred..

#### Tsunami:

About 5 minutes, seawater dramatic ups and downs, about 30 minutes, the sea backwards 400-500 meters, exposing the seabed. Seawater back as tsunamis, water rushed 磺港 and 水尾, wave height about 6 m. Ching-bao-li and Pa-tao-chi area immersed in water

#### Land subsidence

三界壇, 跳石, 磺溪頭 region, the subsidence about 7 meters, neighboring areas a little subsidence, multiple cracking occurs, 三界壇 and 磺溪頭 area are particularly many. Candlestick Rock fall about 3 meters.

## Ching-bao-li bao(金包里堡) document of No.14 (Okamoto, 1913)

### Landslide and ash reduction

火庚仔坪頂 and 三重橋 area occurred landslide, about 600-700 m. The smoke contained ash occurred at 火庚仔坪頂、死礮坪 and 三重橋 regions. There is small amount of ash reduction in sunny day, but does not happen often.

### Spring

Spring ejected about 12 m at 礮堀, most people have been scalded, one person died. Seaside of 水尾 and 礮港 each have a ejected spring, 9 m height, continuous 3 days.

### Disaster area

八斗仔, 金包里, 三界壇 region as the center, 大坪 and 阿里磅 regions disaster less. 基隆, 滬尾, 士林, 小基隆 region has some damage.

### Disaser

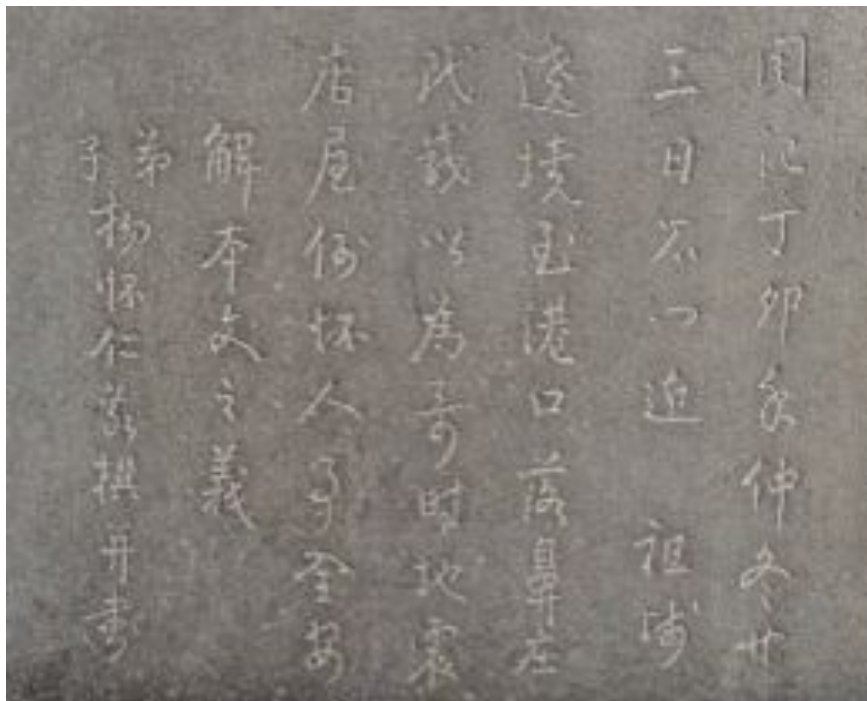
100 houses collapsed by earthquake, 200 houses flooded in shore. 金包里, 礮港, 水尾 half of the houses were destroyed. 400 death, and more than 100 were injured. about 70-80 person were swept away. Killed 30 buffalo, 300 pigs.

## 4. Temple history and stele

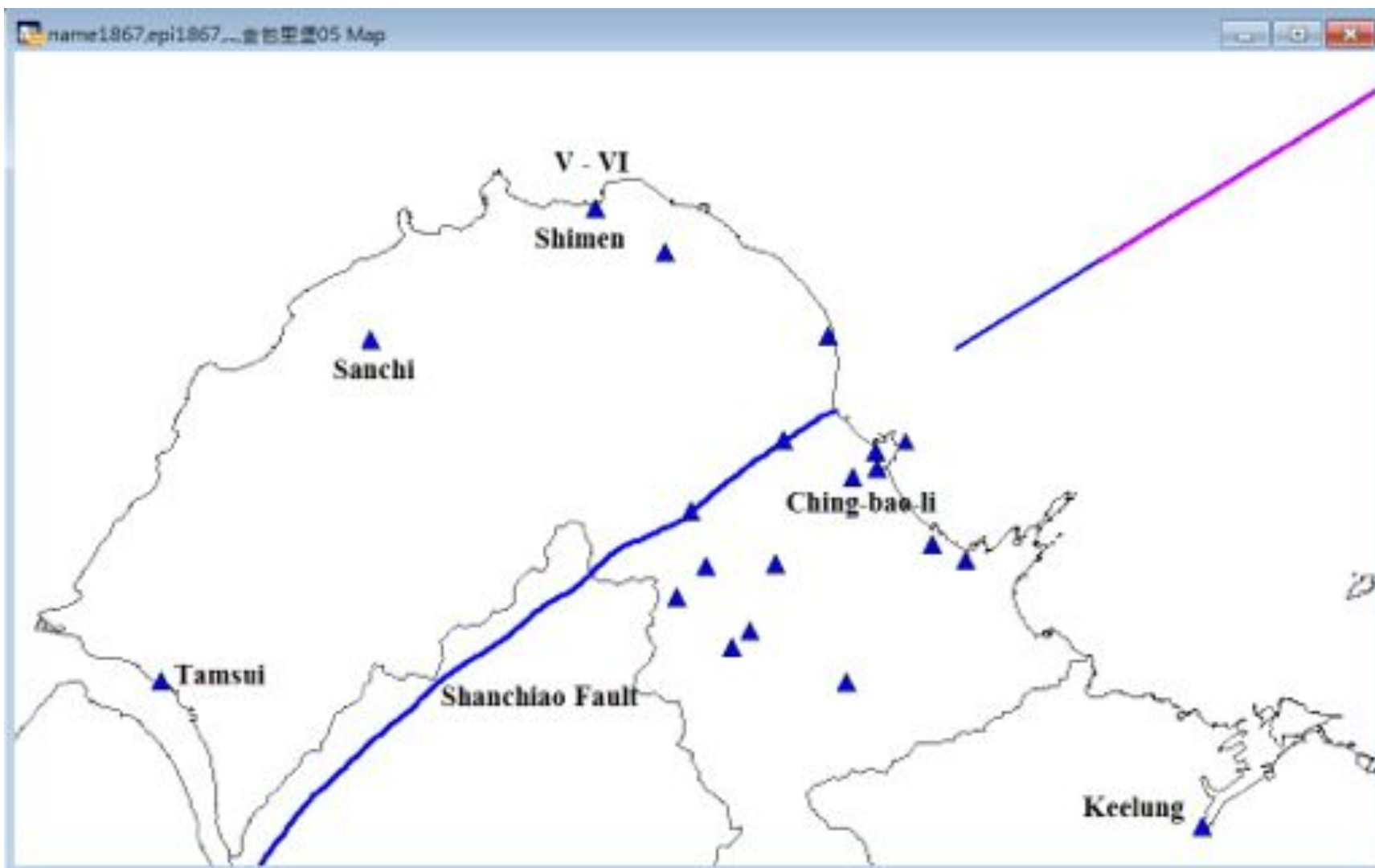
- 20、聯合報49年5月25日記者訪問省氣象所預報科長湯捷喜：「...根據日本高橋龍太郎博士的研究文獻，本省於光緒12年及民國六年前後，曾發生二次海嘯，前者海嘯之最高波浪高達7.5公尺，在基隆方面造成嚴重災害。.....又據日人岡田四亥氏記載，光緒12年(公元1867)12月18日在基隆方面發生的海嘯，因大地震而發生。當時海水一時向外流出而現出海底，然後不久大波浪復由外洋流入港內，再衝入基隆市區，其速度甚快，而在淡水，雞籠頭，金包里沿海沖毀房屋無數，溺死數百人.....」。(**許明光和李起彤, 1996**)(**時間不對, 岡四四亥(1948)未見此資料**)(**The 1960 Chile earthquake**)
- 21、金包里慈護宮沿革：同治六年十一月淡北大地震，廟宇倒塌，至同治十二年重建告竣始見規模。(temple history)
- ★ 22、淡水清水祖師廟石碑與沿革(temple history + stele)
- 23、台灣大百科全書/文化部臺灣知識的骨幹/磺嘴吼煙：...遠在清同治6年12月23日發生大地震，一聲巨響火山爆發於此，其噴火口至今猶存，歷久不絕，磺煙怒吼...
- 24、新北市政府觀光旅遊局/驚豔水金九旅遊網/景點資訊/基隆山：
- 25、自由時報，93年12月27日+interviews：基隆市政府民政局宗教禮儀課課長林振興表示，小時候曾聽祖父敘述這段歷史，連市區田寮河水也被吸出大海乾涸/Listen to his grandfather once described this history, urban river water is sucked out and dried. (**2013年5月31日經林振興(殯葬所)所長親自證實, 不止是田寮河, 是基隆四大河全部被吸乾**)
- ★ 26、中國時報，93年12月29日+慶安宮沿革+interveiwis：After 2004 South Asia tsunami Folk legend, the tsunami in Keelung in 1867, Matsu apparitions(顯靈), the water is stopped front of the temple. Reference to the history of temple, and interviews seniors, are without this event. Chairman of the temple(童永) said that Matsu is God of sea, but never heard about Matsu apparitions in hundred years ago earthquake, there is not historical record.(**2013年5月31日訪問慶安宮誌(2001)與基隆媽慶安宮誌(2012)作者, 未將此事件放入慶安宮誌中**)(temple history + interviews)

## 淡水清水祖師廟 (document of No. 22)

Shimen, north coast of Taiwan, plague occurred in 1867. Residents ask God to patrol and remove disasters(出巡消災). The god sedan arriving at the port, a sudden drop nose. All of residents rushed to the harbor. At that time a large earthquake occurred, the house collapsed, but no casualties. Thank God for prediction earthquake, a stele was set up at temple entrance, a wall murals produced to commemorated this event. 「祖德施石門昔日賑災禪佛力」 「聞記丁卯年仲冬廿三日石門迎 祖師繞境，至港口落鼻，庄民咸以為奇，時地震店屋倒壞人事安全 解本文之義弟子楊懷仁敬撰并書」









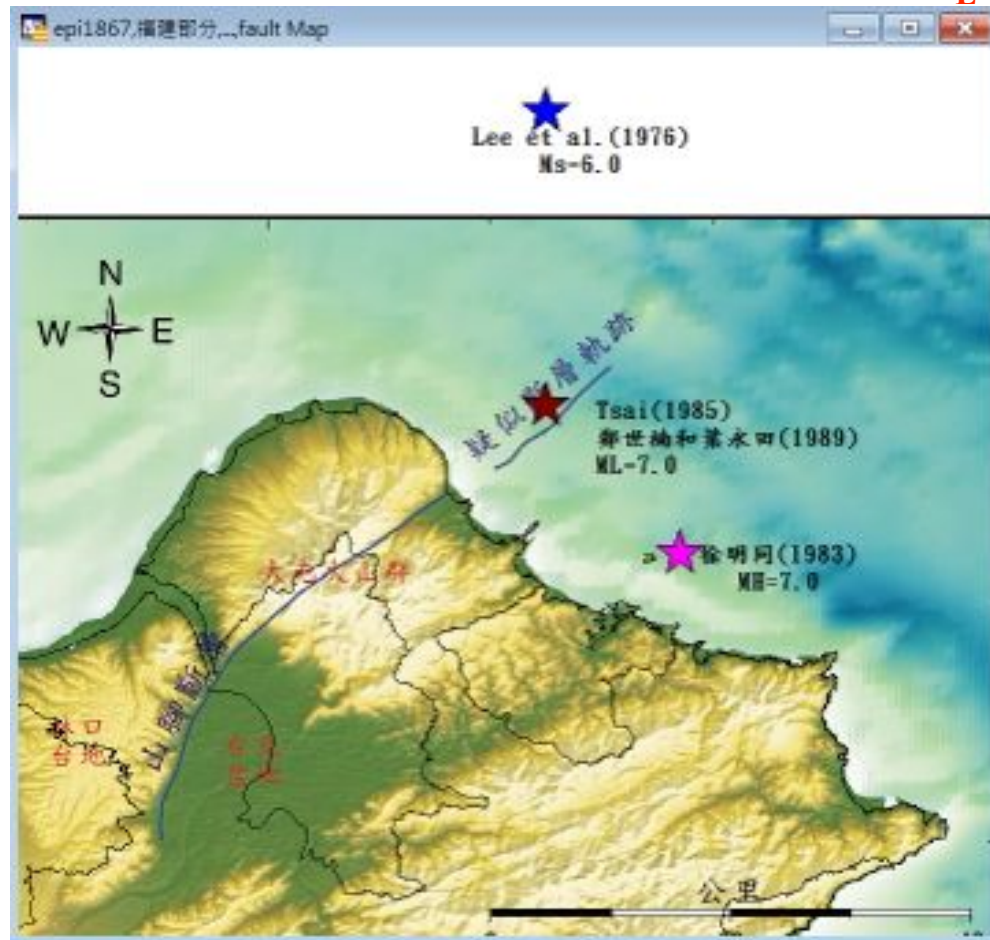
North China Daily News 字林西報 Clock is stopped, candlesticks tilt, water stocks → IV

Lee et al.(1976)整理中國地震目錄中登載：**25.5°N,121.7°E,  $M_S=6.0$** 。

Hsu(1983)依據徐泓(1983)資料，推論震災地區為台北基隆地區，震央位於基隆外海：**25.2°N,121.8°E，地震規模為7.0**。

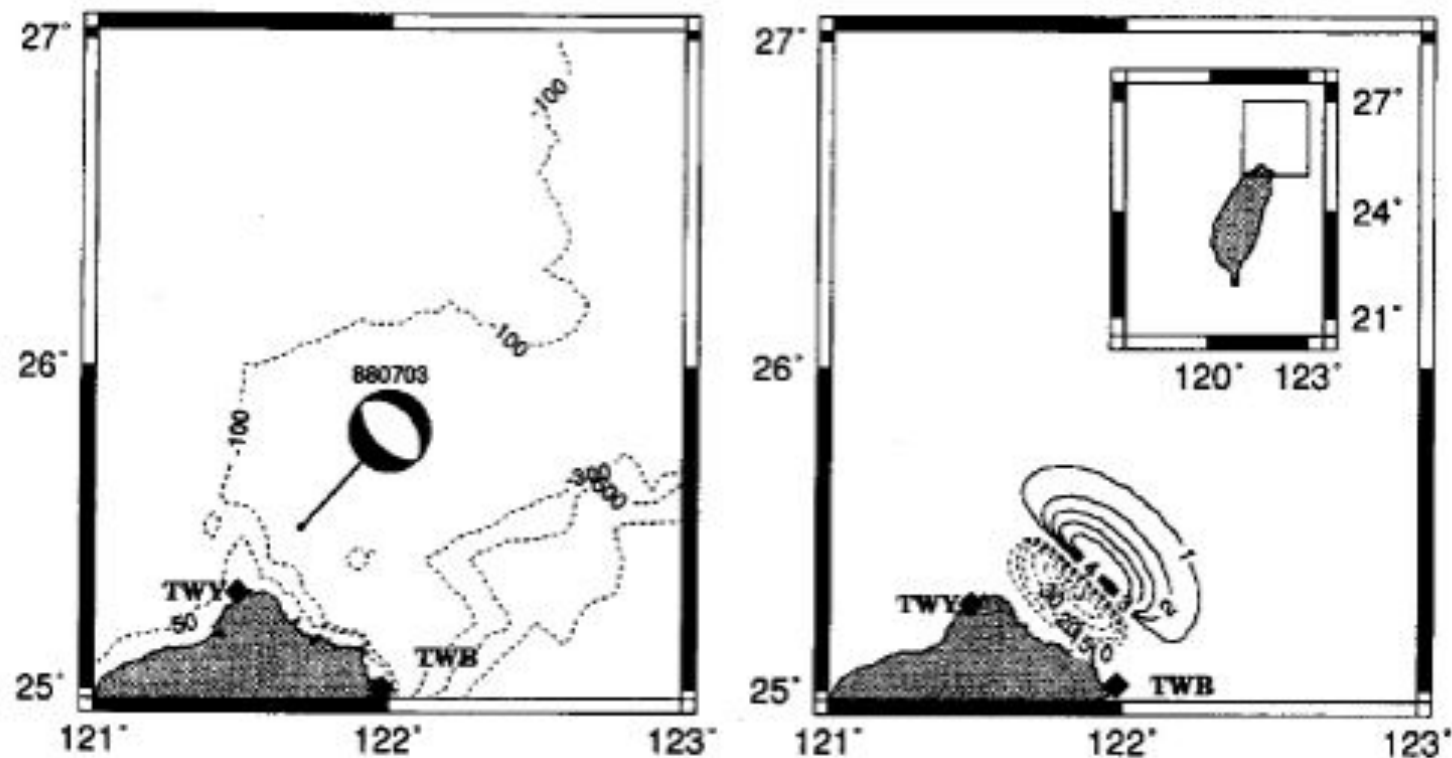
Tsai(1986) Considering tsunami was generated, the epicenter should be offshore, widespread landslides, epicenter is not too far from the coast.**25.3°N,121.7°E,  $M=7.0$**

Cheng and Yeh(1989)地震目錄中登錄為：**25.3°N,121.7°E,  $M_L=7.0$**



**Lee and Wang(1988)** the 1867 Keelung earthquake is normal fault.

**Ma and Lee(1997)** simulation the 1867 tsunami (fault plane solution : the 1988 Yangmingshan earthquake, normal fault),  $M_w=6.9-7.2$ . Tsunami may comprehensive earthquake, landslides, volcanic eruptions and coastal shape.

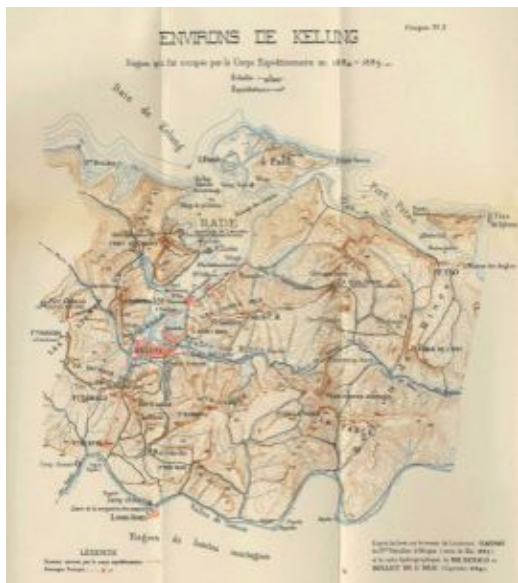


# Verification of place names in historical documents

淡水廳全圖(陳培桂, 1871)



日人基隆築港(1900)前繪製的基隆港灣地圖



The maps were drawn when the French army attacked Taiwan during 1884-1885.

臺灣堡圖1/20,000  
(臨時臺灣土地調查局, 1904)



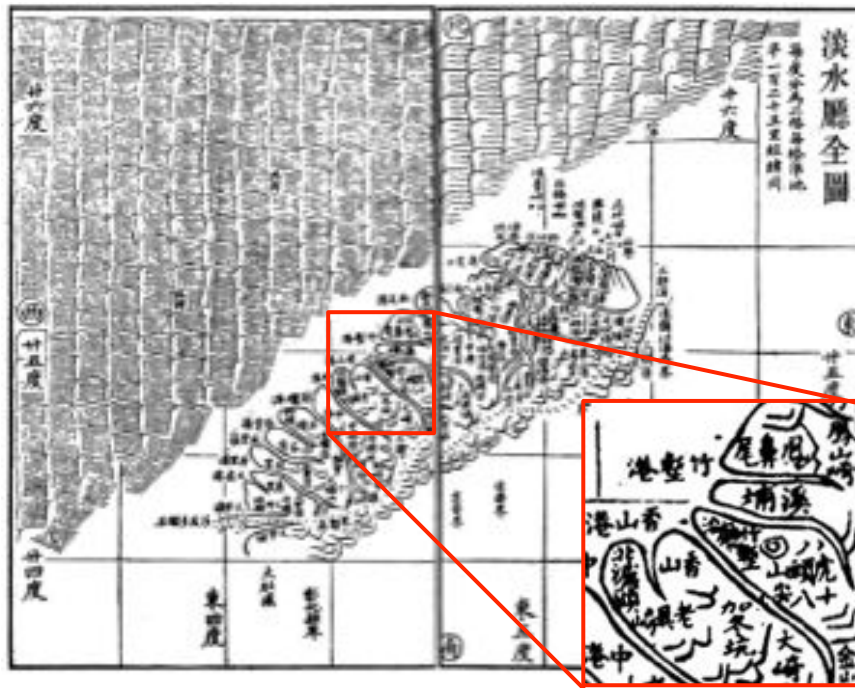
## Tamsui 現今淡水

福建淡水厅（今台湾新竹）、鸡笼头（今台湾基隆市）、金包里（今台湾台北金山乡）  
謝毓壽和蔡美彪(1987)

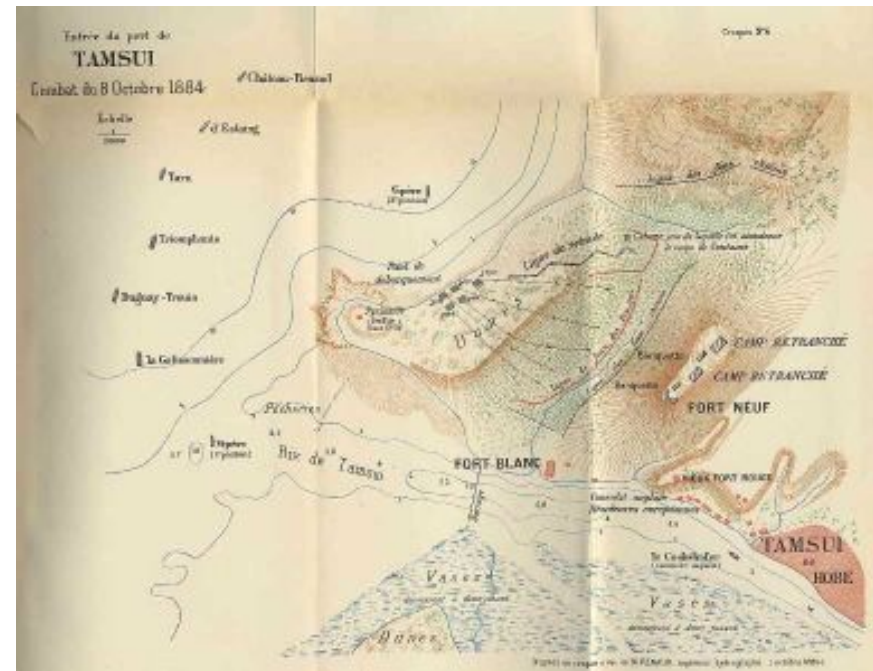
淡水这个安静的市镇，十八日上午十时二十分经受了一次可怕的地震。震情十分恐

The quiet town of Tamsui became the scene of much excitement on the morning of the 18th, in consequence of a terrible earthquake experienced at 10:20 A.M.

The North China Herald and Market Report/January 8th, 1868 (北華捷報)



淡水廳全圖(陳培桂, 1871)



1884-1885年法軍攻臺時繪製之地圖

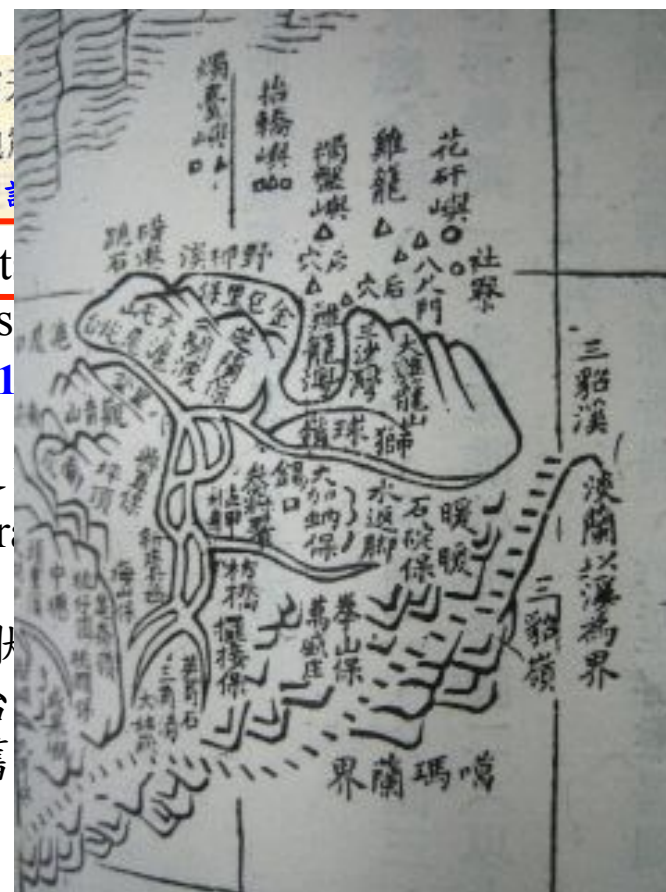
## Pa tsien na(帕千那)、巴其那 現今士林

一八六七年地震发生在十二月十八日，海水从基隆港倾泻而出，留下了一个干涸的泊位，但不几秒钟，带着两个浪头的海水又汹涌而回，淹没了舢板和人口。基隆、金包里及巴其那等城镇部分泡为废墟。淡水遭到严重破坏，好几百人死亡。

《1881年通商各关贸易报告》(英文) 第十七期 附件《台湾淡水部分》页11—15

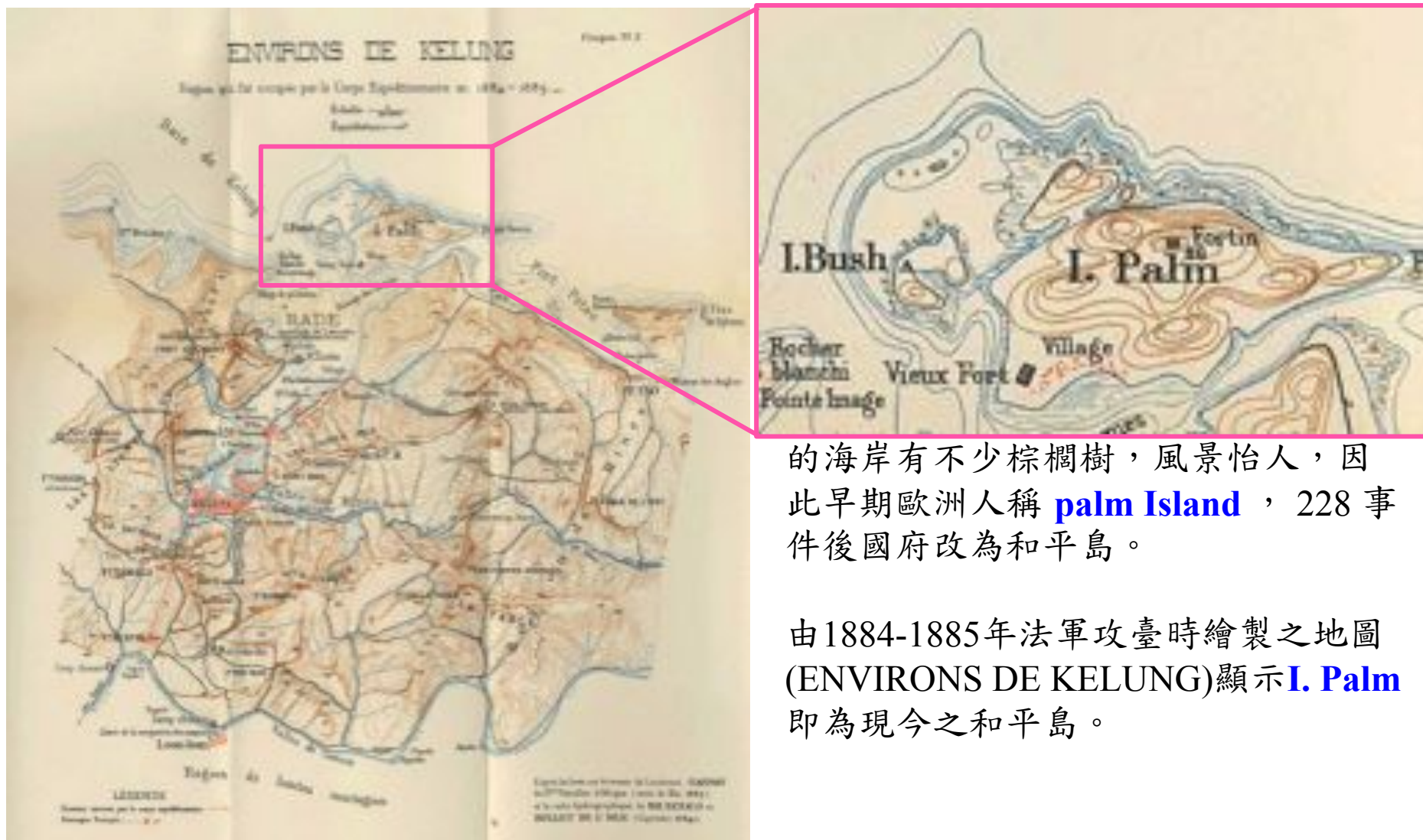
編號8資料/謝毓壽與蔡美彪(1987)

林明取(2006)認為巴其那即現今苗田



## Palm island(棕櫚島) 現今和平島

A cloud of vapour was seen to rise from the sea between Palm and Keelung islands(棕櫚島和基隆島之間的海面上有煙霧)，研判Palm Island(棕櫚島)應在基隆島附近



的海岸有不少棕櫚樹，風景怡人，因此早期歐洲人稱 **palm Island**，228 事件後國府改為和平島。

由1884-1885年法軍攻臺時繪製之地圖 (ENVIRONS DE KELUNG)顯示 **I. Palm** 即為現今之和平島。



# Ruin Rock

A cloud of vapour was seen to rise from the sea between Palm and Keelung islands, which was succeeded by the water of the harbour rushing out seawards, leaving it dry as far as Ruin Rock for some seconds. Everything was carried away with the receding water. **The North China Herald and Market Report/January 8th, 1868 (北華捷報)**

上有一些裂縫。市鎮內大部分房屋震塌。有许多人被压在废墟下面。棕榈岛和基隆岛之间的海面上有烟雾。海港内的水涌向海外，致使远至閻王岩的地方有几秒钟成为无水地带，所有的东西都被退去的海水卷走了，然后海水又形成两个大浪涌回，将舢板

謝毓壽和蔡美彪(1987)

林明聖(2006)認為閻王岩就是現今野柳

**The outcome of discussions (with local archivist) :  
Ruin Rock possible position:**



## 雞籠山(奎臨) 現今基隆山

淡水廳志/卷四/煤場:「雞籠山以肖形名，同治六年地震崩缺。」(徐泓, 1983)

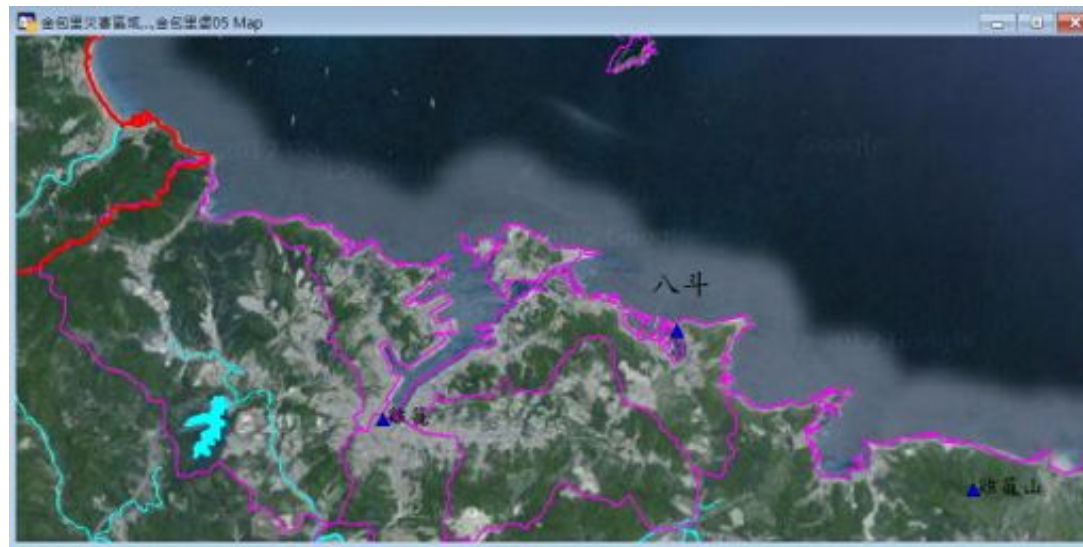
淡水廳志/卷四/煤場:雞籠山以肖形名，同治六年，地震崩缺，改名奎臨。

林明聖(2006)認為雞籠山就是基隆

根據新北市政府觀光旅遊局/基隆山(編號25資料):從海上與瑞芳方向看似雞籠，故舊稱為「雞籠山」。清光緒元年(1875年)以「基地昌隆」寓音將「雞籠」改稱為「基隆」。光緒六年(1880年)雞籠山亦跟著改稱為基隆山。從金瓜石方向側望，狀似一位仰臥孕婦、髮落東海，故也有「大肚美人山」之名。清同治6年(1867年)臺灣北部大地震，雞籠山崩、海嘯摧毀船舶房舍，彷彿天上奎星降臨，故當時文人亦稱呼基隆山為奎臨山，簡稱奎山。

清代淡水廳志雞籠八景奎山聚雨

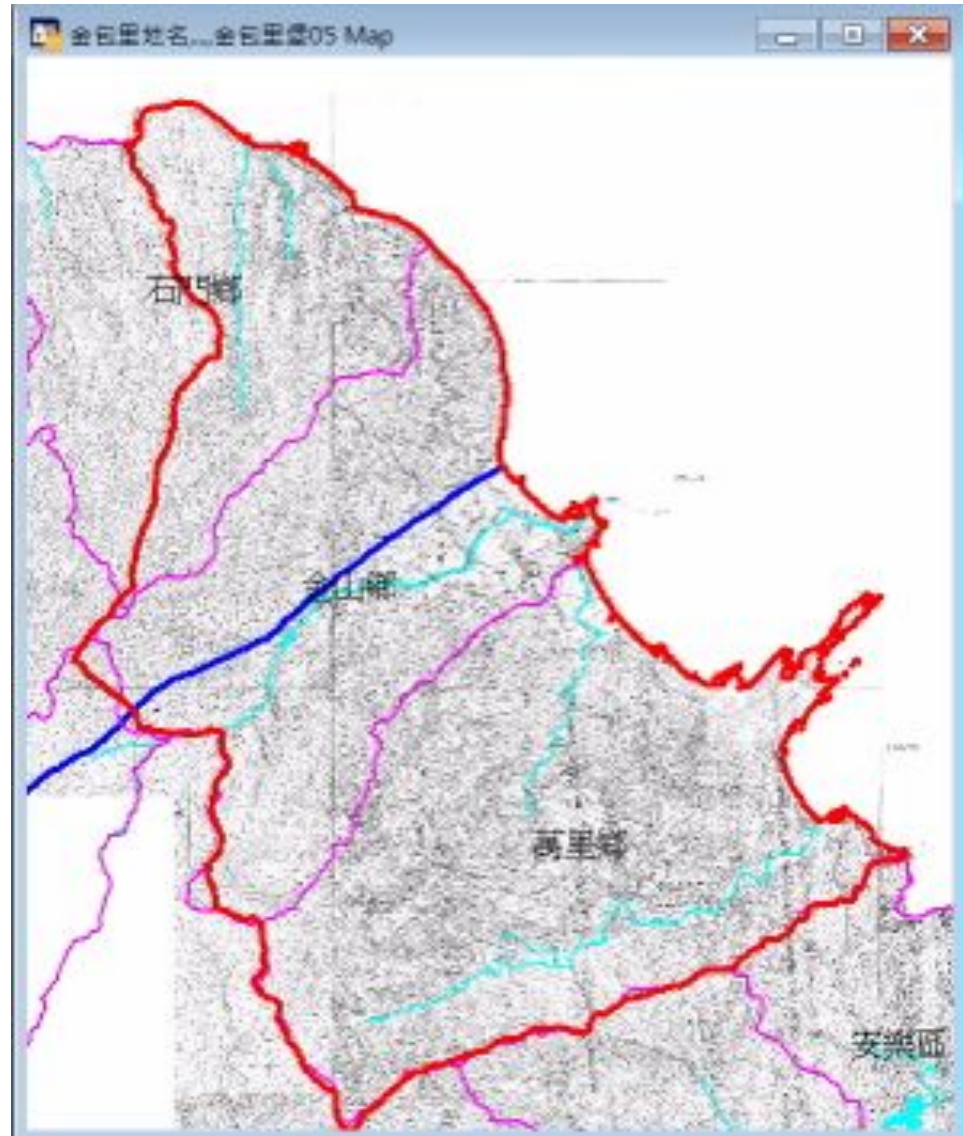
日據時代詩報基隆市志雞山驟雨



## Ching-bao-li prefecture(金包里堡) 岡本要八郎(1913)

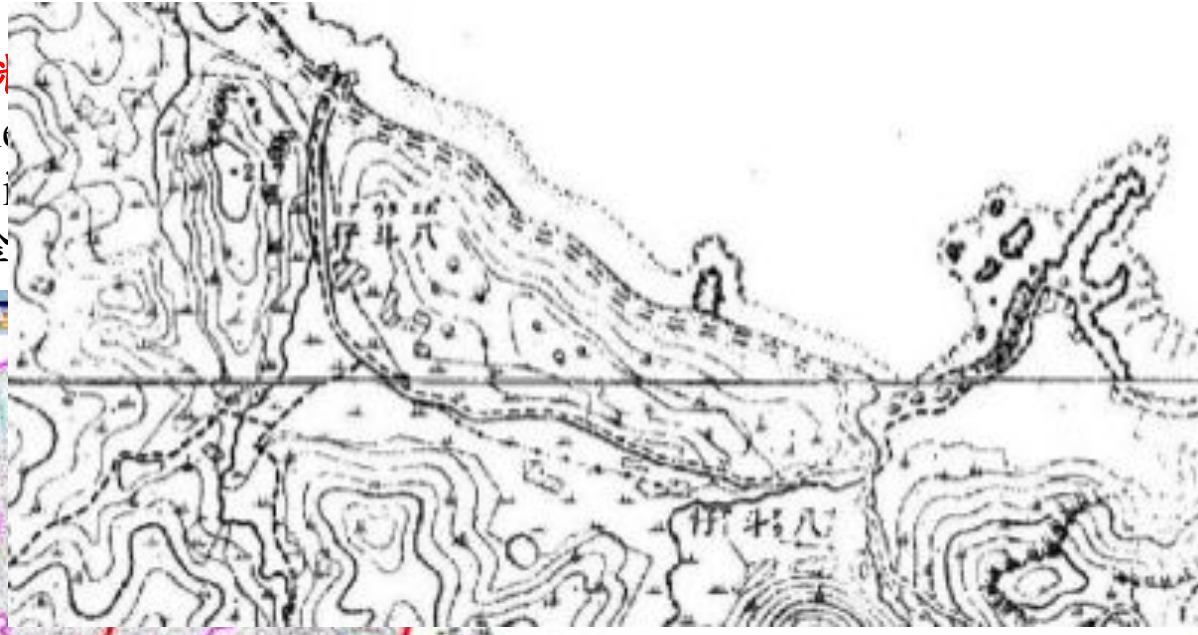
### Document No.14 (Okamoto, 1913)

根據淡水廳全圖(陳培桂, 1871)、臺灣堡圖(臨時臺灣土地調查局, 1904)描繪出金包里堡的範圍，包括新北市石門區石門溪以東(尖鹿里、乾華里、茂林里、草里里)、金山區、萬里區等區域。



# 八斗仔 Nuclear Power plant

編號14資料  
water rush  
immersed in  
八斗仔, 金



仔 area

disaster less.



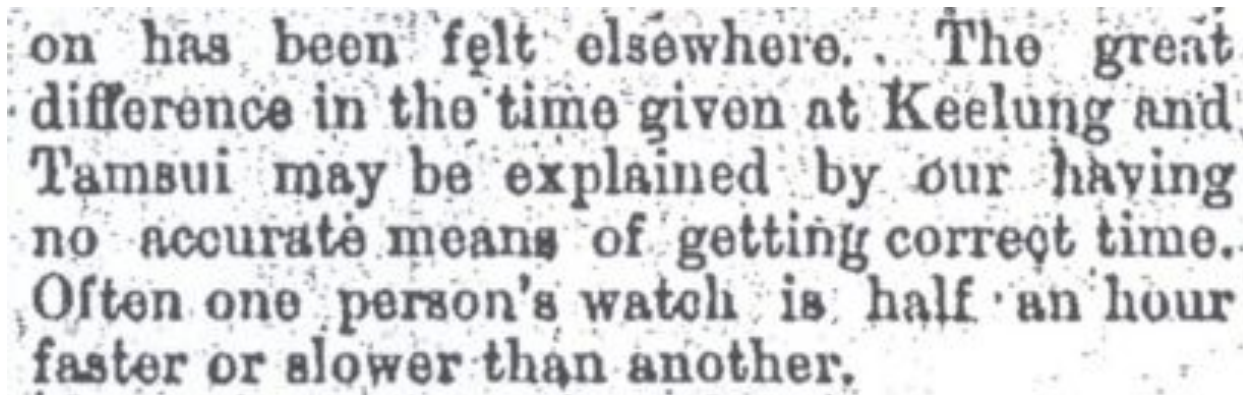
# Earthquake occurrence time

Almost all of the data for the date of earthquake have consistent results :

**December 18, 1867 (November 23, the 6<sup>th</sup> year of Tongzhi)**

For the occurrence time of quake, there are 3 documents with further description.

1. Document of No. 8 (The North China Herald and Market Report/January 8, 1868): **Tamsui 10:20 AM., Keelung 09:45 AM.**



on has been felt elsewhere. . The great difference in the time given at Keelung and Tamsui may be explained by our having no accurate means of getting correct time. Often one person's watch is half an hour faster or slower than another.

2. Document of No. 13 (TMO, 1914): **North coast of Taiwan 10:00 AM.**
3. Document of No. 14 (岡本要八郎, 1913): **Kim-bao-li 10:00 AM.**

**Based on the above information, estimate the occurrence time of quake is about 10:00 AM.**

# Tide

Reference the tide table of 2013(CWB, 2013)  
Keelung (Lunar calendar November 23) neap tide

January 4, 2013 (Lunar calendar November 23)

潮時	潮高(中等潮位)	潮高(最低潮位)	高低潮
01:42	2	100	H
07:25	-44	55	L
14:54	22	120	H
21:13	-40	59	L

45.5 cm  
65.5 cm → **10:00 (-21.4/77.6)**  
63.5 cm

December 25, 2013(Lunar calendar November 23)

潮時	潮高(中等潮位)	潮高(最低潮位)	高低潮
02:29	-1	97	H
08:13	-37	61	L
15:38	23	121	H
22:07	-35	63	L

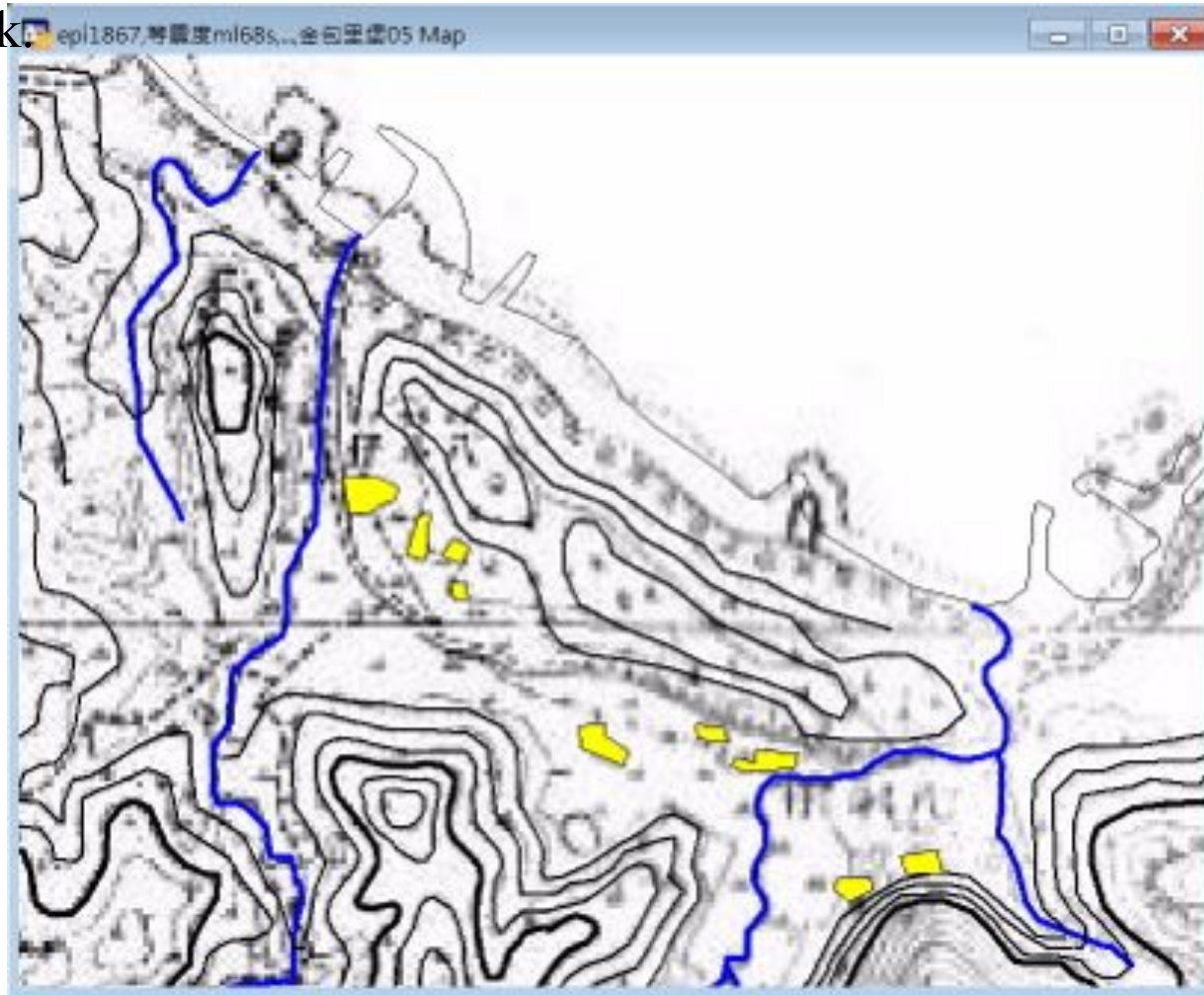
36.0 cm  
60.0 cm → **10:00 (-22.6/75.4)**  
58.0 cm

**Ebb to Rising tide**

中等潮位：以當地當年中等潮位為基準  
最低潮位：以當年最低潮位為基準

We assume that there are no major changes in topography in between 1867-1904.

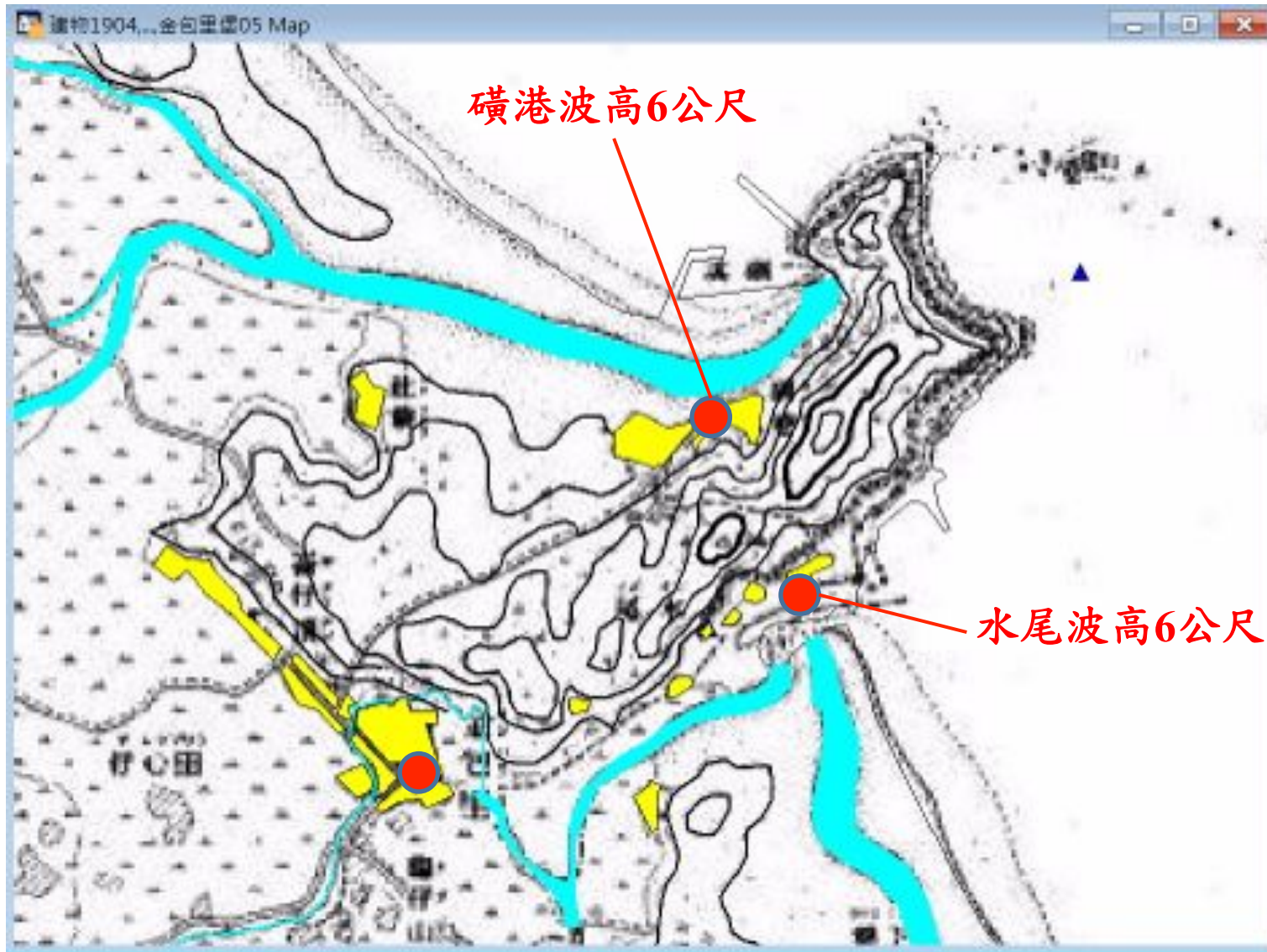
The 1904 map using as a basis for estimating the elevation of sea water traced back



50 feet = 15.2 m  
200 feet = 60.8 m

— 50 feet  
— 200 feet

**Along the river, the sea water traced back to Pa-tao-chi area with elevation about 15.2 m.**



**Along the river, the sea water traced back to Ching-bao-li, elevation < 15.2 m.**



## Keelung

Earthquake occurred at 09:45 AM, and lasted about 30 seconds. The earth cracked slightly in front of the Custom-house. A great portion of this town is down, burying numbers in the ruins.

A cloud of vapour was seen to rise from the sea between Palm and Keelung island, which was succeeded by the water of the harbour rushing out seawards, leaving it dry as far as Ruin Rock for some seconds.

The sea then returned in the shape of two large waves.

It overtopped the dikes and washed out all the houses on the low-lying land along the coast.

The deepening by a few feet of the anchorage at Keelung

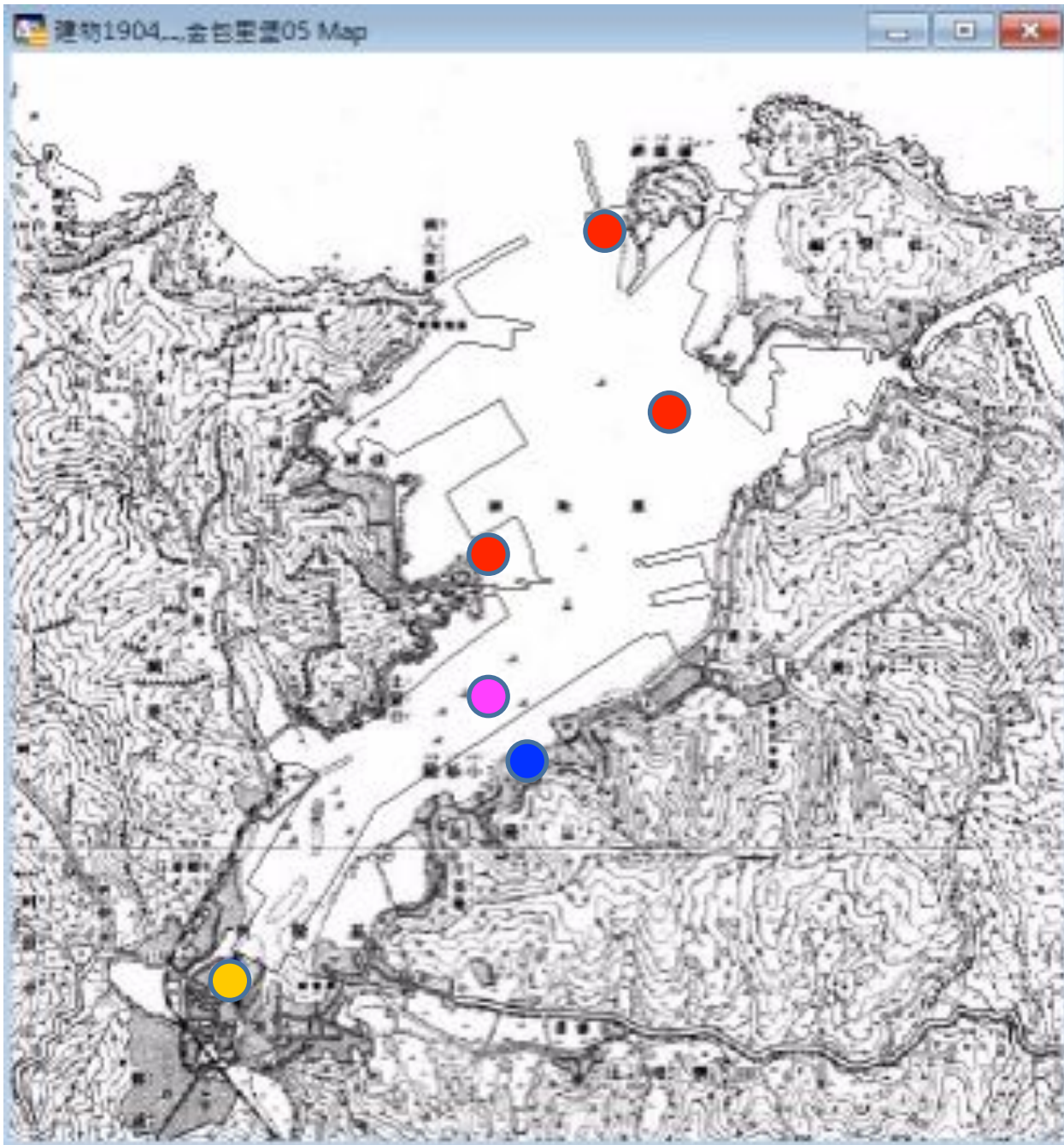


1913年度末  
基隆港平面圖



築港前  
基隆港平面圖

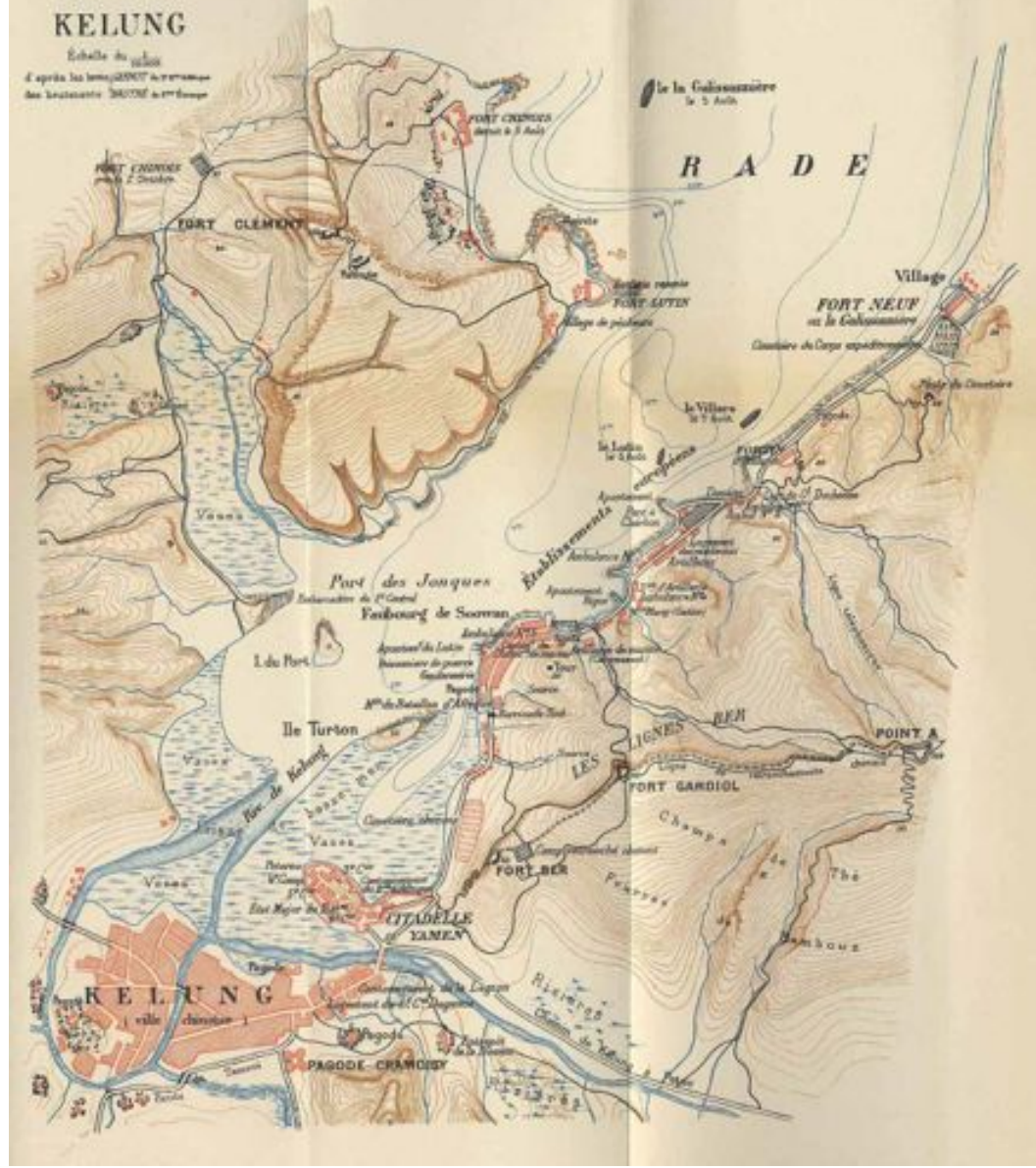
There was a large shoal  
in front of Keelung,  
large ship can not be  
reached.  
Need to rely on sampan  
or small boat



- Ruin Rock可能位置
- 海關可能位置
- 大船停泊處可能位置
- 慶安宮位置

Croquis N° 4  
**KELUNG**

Echelle de 1:50,000  
d'après les renseignements  
des Lieutenants MAURICE et RICHARD



## Evaluated the corresponding intensity (crustal deformation and tsunamis)

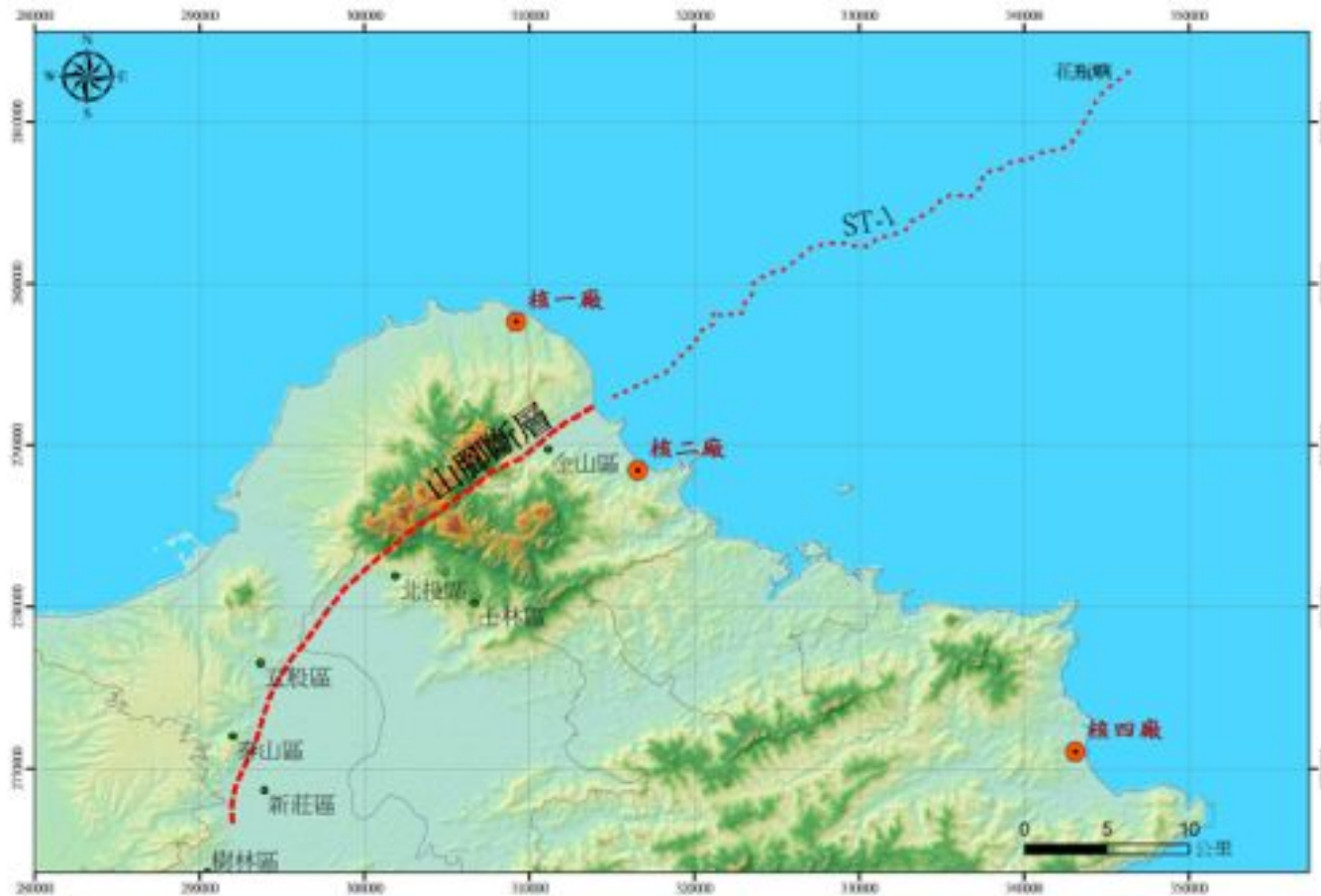
### CWB intensity scale

震度分級	地動加速度 範圍	人的感受	屋內情形	屋外情形
0 無感	0.8gal以下	人無感覺。		
1 微震	0.8~2.5gal	人靜止時可感覺微小搖晃。		
2 輕震	2.5~8.0gal	大多數的人可感到搖晃， 睡眠中的人有部分會醒來。	電燈等懸掛物有小搖晃。 房屋震動，碗盤門窗發出 聲音，懸掛物搖擺。	靜止的汽車輕輕搖晃，類 似卡車經過，但歷時很短。
3 弱震	8~25gal	幾乎所有的人都感覺搖晃， 有的人會有恐懼感。	房屋搖動甚烈，底座不穩	靜止的汽車明顯搖動，電 線略有搖晃。
4 中震	25~80gal	有相當程度的恐懼感，部分 的人會尋求躲避的地方，睡 眠中的人幾乎都會驚醒。	物品傾倒，較重傢俱移動， 可能有輕微災害。	汽車駕駛人略微有感，電 線明顯搖晃，步行中的人 也感到搖晃。
5 強震	80~250gal	大多數人會感到驚嚇恐慌。	部分牆壁產生裂痕，重傢 俱可能翻倒。	汽車駕駛人明顯感覺地震 ，有些牌坊煙囪傾倒。
6 烈震	250~400gal	搖晃劇烈以致站立困難。	部分建築物受損，重傢俱 翻倒，門窗扭曲變形。	汽車駕駛人開車困難，出 現噴沙噴泥現象。
7 劇震	400gal以上	搖晃劇烈以致無法依意 志行動。	部分建築物受損嚴重或倒 塌，幾乎所有傢俱都大幅 移位或掉落地面。	山崩地裂，鐵軌彎曲， 地下管線破壞。

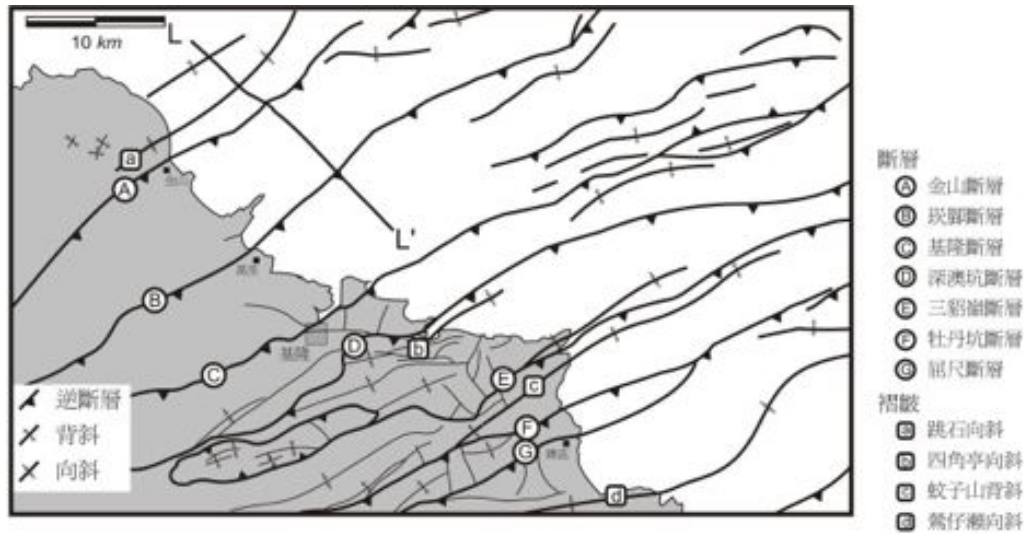
## 1867年基隆地震災害與震度對照表

Location	Intensity	Remak
淡水	V	小山丘上(淡水鎮中)的許多房屋被震塌了，死亡30人
士林	V-VI	過半遭崩壞，150人死亡
磺港	VI	房屋全倒過半，海嘯浪高6公尺；土壤液化，溫泉噴出9公尺，持續三日
水尾	VI	房屋全倒過半，海嘯浪高6公尺，土壤液化，溫泉噴出9公尺，持續三日More
金包里街	VI	房屋全倒過半，金包里街地區浸在水中
八斗仔	VI	災害嚴重,浸在水中
三界壇	VI	到處發生陷沒、龜裂
跳石	VI	土地陷沒
磺溪頭	VI	到處發生陷沒、龜裂
三重橋	VI	山崩，火山灰的煙
硫黃山	VI	山崩
庚子坪頂	VI	山崩，火山灰的煙
死磺坪	VI	火山灰的煙
大坪	V	災害比較少
阿里磅	V	災害比較少
磺嘴	VI	土壤液化，溫泉湧出變成池塘，噴出12公尺高
三芝	V	多多少少災害發生
石門	VI	大部分房屋震塌
基隆	VI	大部分房屋震塌，許多人被壓在廢墟下面，土壤液化，海嘯侵襲
基隆山	V	山崩
苗栗	III	地大震
浙江象山	I	地震
江蘇上海(?)	II	許多人感到一次地震

## Estimated source parameters

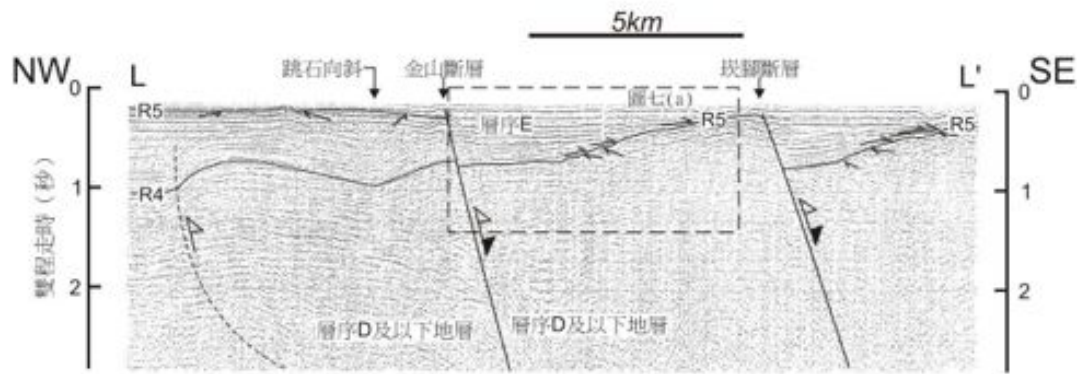


By the Geodetic Survey results show that the Shanchiao fault on both sides of the horizontal displacement did not significantly change, but the hanging wall subsidence obvious trend .



(a)

Strike: N60E  
 dip: more than 62  
 Rake: -90



(b)

(蕭力元等, 1998)



## Simulated intensity map to evaluative source parameters

Wells and Coppersmith (1994) fault length vs. magnitude

Normal fault

$$M_W = 4.86 + 1.32 \text{ Log}(\text{SRL}) \pm 0.34 \quad (5.2 < M_W < 7.3)$$

$$M_W = 4.34 + 1.54 \text{ Log}(\text{RLD}) \pm 0.31 \quad (5.2 < M_W < 7.3)$$

$$\text{Log}(\text{RW}) = -1.140 + 0.350 M_W \pm 0.12 \quad (5.2 < M_W < 7.3)$$

Cheng et al.(2011)  $M_L$ - $M_W$  relationship

$$M_L = 5.115 \ln(M_W) - 3.131 \pm 0.379 \quad (M_L \geq 5.5)$$

Length	Surface rupture(SRL)			Subsurface rupture(RLD)		
	RW	$M_W$	$M_L$	RW	$M_W$	$M_L$
30 km	17.4	6.8	6.7	14.8	6.6	6.5
40 km	20.4	7.0	6.8	17.4	6.8	6.7
50 km	22.1	7.1	6.9	20.4	7.0	6.8

Jean et al.(2006)堅硬地盤衰減經驗式：

$$Y(g)=0.00284e^{1.73306M}[R+0.09994\exp(0.77185M)]^{-2.06392}$$

M為芮氏地震規模，R為震源距

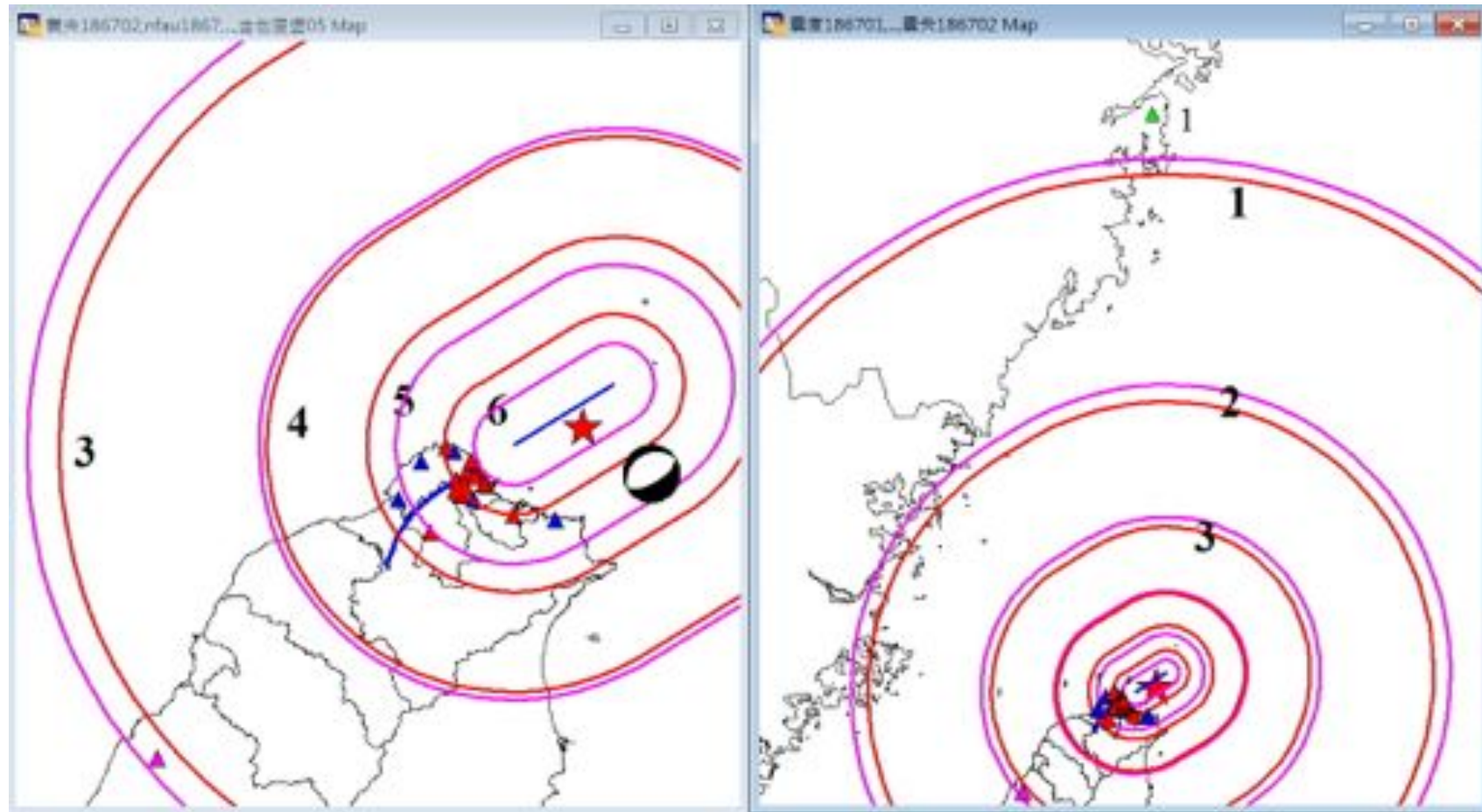
中央氣象局使用的衰減經驗式(Shin, 1998)進行比對：

$$PGA = 12.44 \times \exp(1.31 \times M_L) \times r^{-1.837}$$

上式中r為震源距。

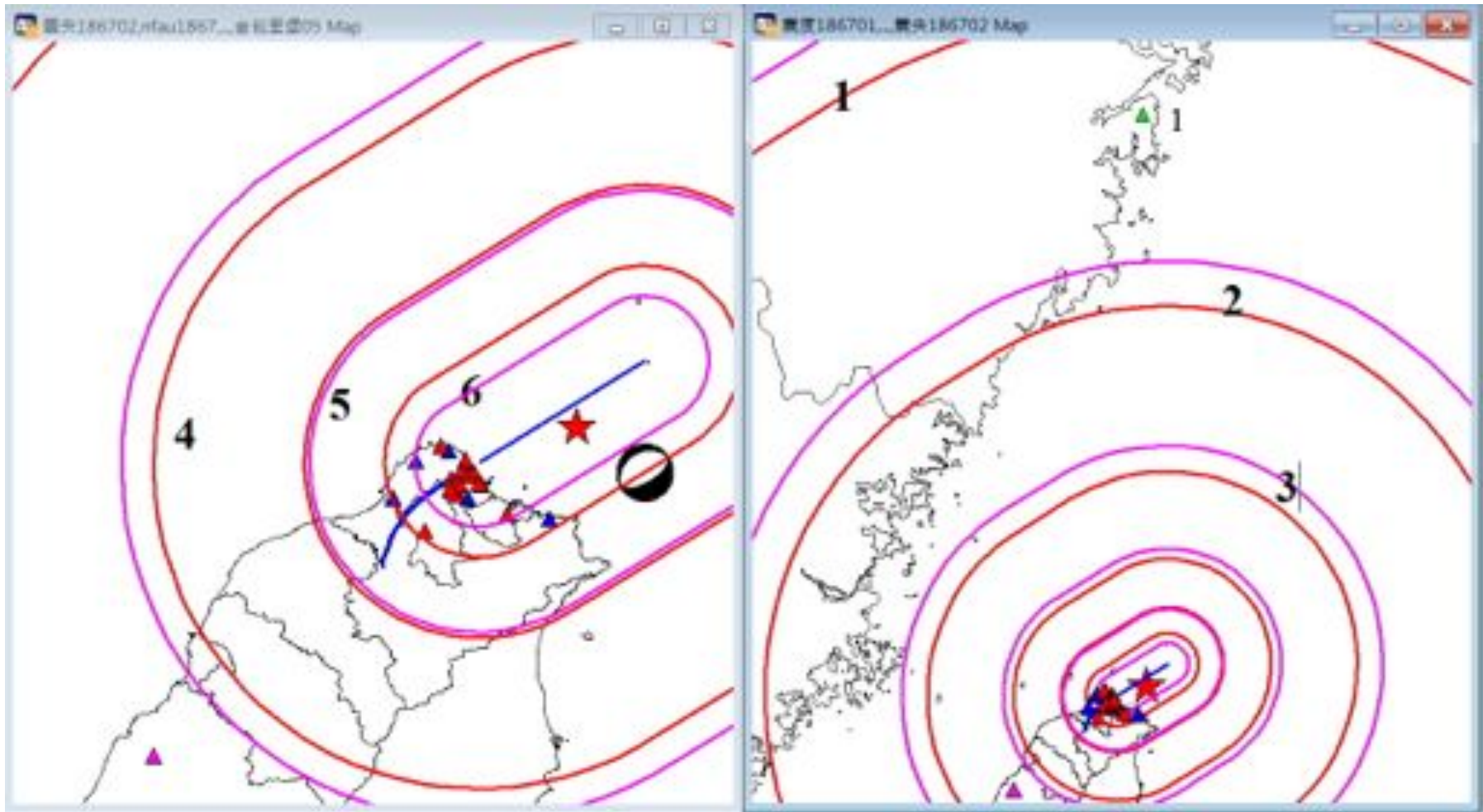
Mag	7 (0.4g)	6 (0.25g)	5 (0.08g)	4 (0.025g)	3 (0.008g)	2 (0.0025g)	1 (0.0008g)	Remark
6.7(Jean)	17.0	21.8	40.0	74.4	136.5	253.9	466.2	0km
6.7(辛)	7.6	14.1	37.5	79.1	150.4	277.6	495.2	0km
6.8(Jean)	18.2	23.4	42.9	79.7	146.4	272.3	499.9	0km
6.8(辛)	8.4	15.5	40.9	86.2	163.7	302.1	538.7	0km
6.9(Jean)	19.5	25.0	46.0	85.5	157.0	292.0	536.1	0km
6.9(辛)	9.3	17.0	44.6	93.9	178.2	328.7	586.0	0km

Mag	7 (0.4g)	6 (0.25g)	5 (0.08g)	4 (0.025g)	3 (0.008g)	2 (0.0025g)	1 (0.0008g)	Remark
<b>6.5(Jean)</b>	<b>13.9</b>	<b>18.3</b>	<b>38.4</b>	<b>64.5</b>	<b>118.6</b>	<b>220.7</b>	<b>405.4</b>	<b>5km</b>
<b>6.5(辛)</b>	<b>3.8</b>	<b>10.6</b>	<b>31.1</b>	<b>66.5</b>	<b>126.9</b>	<b>234.4</b>	<b>418.4</b>	<b>5km</b>
<b>6.7(Jean)</b>	<b>16.2</b>	<b>21.2</b>	<b>39.7</b>	<b>74.2</b>	<b>136.4</b>	<b>253.8</b>	<b>466.2</b>	<b>5km</b>
<b>6.7(辛)</b>	<b>5.8</b>	<b>13.2</b>	<b>37.1</b>	<b>79.0</b>	<b>150.3</b>	<b>277.6</b>	<b>495.1</b>	<b>5km</b>
<b>6.8(Jean)</b>	<b>17.5</b>	<b>22.8</b>	<b>42.6</b>	<b>79.6</b>	<b>146.3</b>	<b>272.2</b>	<b>500.0</b>	<b>5km</b>
<b>6.8(辛)</b>	<b>6.8</b>	<b>14.6</b>	<b>40.6</b>	<b>86.1</b>	<b>163.7</b>	<b>302.0</b>	<b>538.6</b>	<b>5km</b>

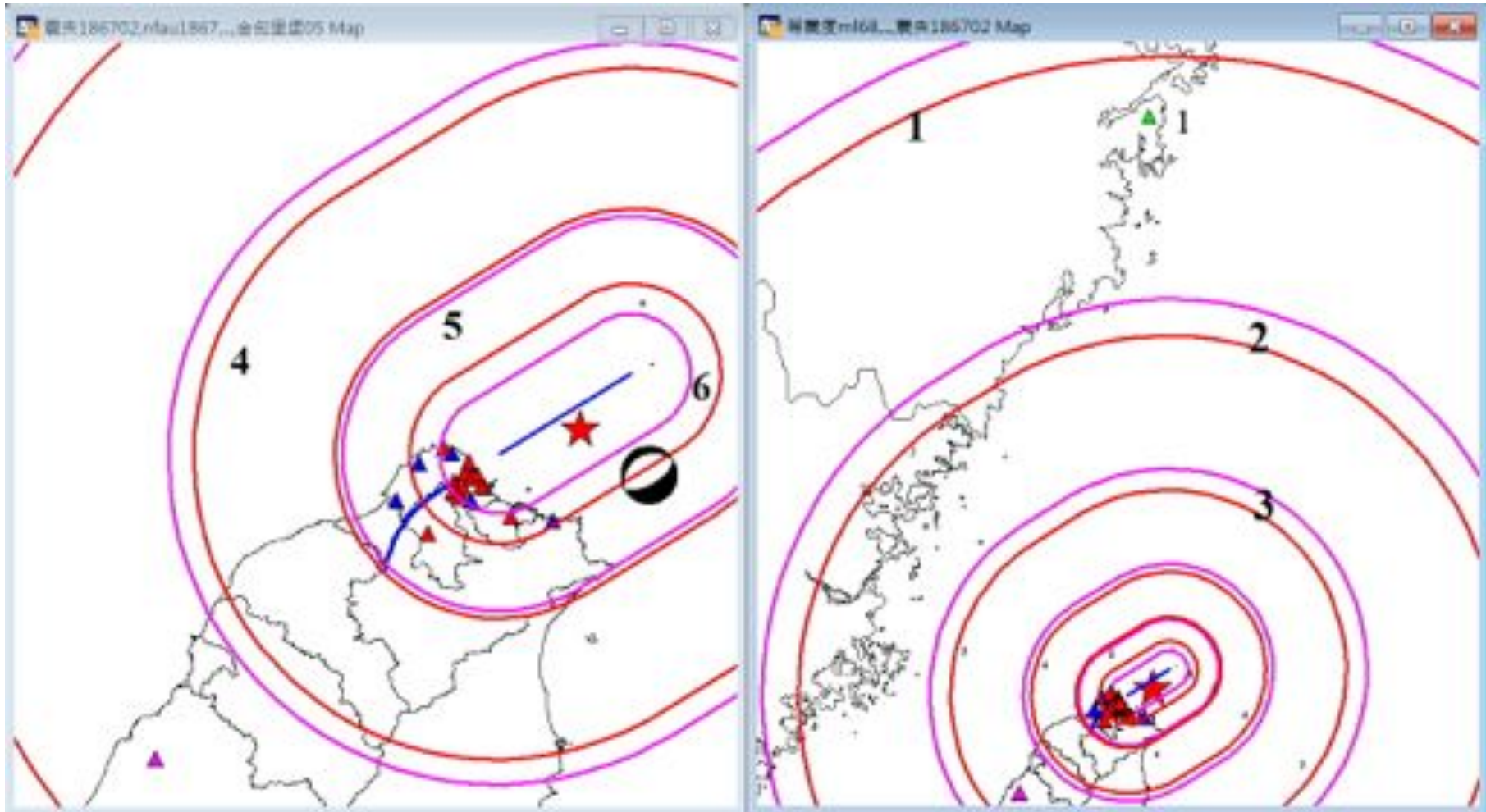


— Jean et al.(2006)

— Shin (1998) Fault length:30 km(subsurface rupture) ,  $M_W=6.6$ ,  $M_L=6.5$   
 25.34N, 121.91E, Depth=15 km (60, 62, -90)



- Jean et al.(2006) Fault length:50 km(surface rupture) ,  $M_W=7.1$ ,  $M_L=6.9$
- Shin, 1998 25.34N, 121.91E, Depth=10 km (60, 62, -90)



- Jean et al.(2006) Fault length:40 km(surface rupture) ,  $M_W=7.0$ ,  $M_L=6.8$
- Shin, 1998 25.34N, 121.91E, Depth=10 km (60, 62, -90)

## Preliminary results

- The 1867 Keelung earthquake is closely relative with the northeastern extending of Shanchiao fault.
- Earthquake triggered a tsunami, water rushed 磺港 and 水尾, wave height about 6 m.
- Along river, the sea water traced back to 金山 and 八斗仔 area with elevation about 15 m.
- The epicenter of the Keelung earthquake is : 25.34N, 121.91E, Depth=10 km, magnitude  $M_W=7.0$ ,  $M_L=6.8$ , fault length about 40 km, possible fault-plane : (60, 62, -90)