

岷江叠溪古堰塞湖

THE DIEXI PALEO-DAMMED LAKE
AT UPSTREAM OF MINGJIANG RIVER
SICHUAN ,CHINA

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2016.12

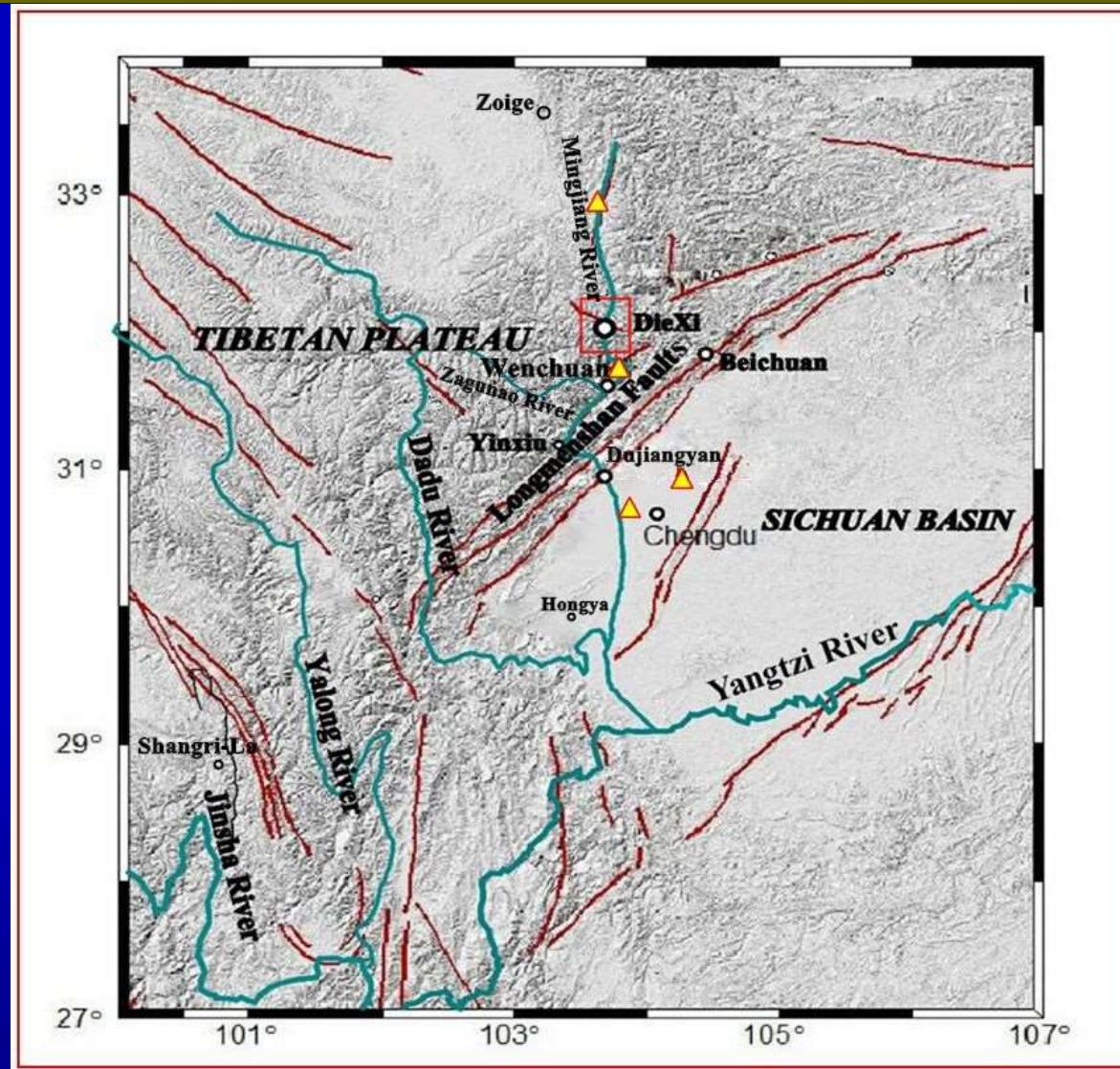
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Introduction

- About 17 years ago (In May 1999), a huge **Paleo-lake sediment**, covering 20 square kilometers, was found in the **Diexi town area** of the Minjiang River Sichuan province, where **the east edge of the Tibetan plateau and the Sichuan Basin** meet. This paleo-lake was formed about 30000 years ago . It existed for about 10000 years with over 240m of thick lacustrine sediments then bursted around 15000 years ago. Diexi is a historical town located along the upstream of Mingjiang river (180Km away from Dujiangyan City), where there was an 7.5 magnitude earthquake on August 25th, 1933. About 130Km away from Yinxui city is the **Wenchuan** earthquake center which happened on May 12th,2008.
- In this speech I will talk about the geological formation and importance of these discoveries. Then I will briefly discuss the fallowing topics:
 - (1) **Comparative Analysis on paleo climate ;**
 - (2) **Diexi paleo-lake and Chengdu plane ;**
 - (3) **Diexi paleo-lake and the development history of Mingjiang river;**
- Finally, with the presented data, I hope we can come to the conclusion that paleo-dammed lake sediment analysis offers a new approach to studying ancient geological changes and climatic evolution.



Fig.1 Regional tectonics map of the east edge of the Tibetan plateau and the Sichuan Basin.



Red rectangle - Die Xi paleo-dammed lake ;

Yellow triangle - Typical ruins of ancient town in Mingjiang river and Chengdu plane

叠溪地区1933年8月25日里氏7.5级地震堰塞湖

Diexi earthquake landslide dammed lake of Mingjiang River, an earthquake of magnitude 7.5(Richter Scale),at 15:50:30 of August 25th, 1933



叠溪古城 **Diexi town**

Photo.Thomas.Theresa 1920



地震后 **Diexi town**

Photo.Xueben zhuang 1933

叠溪古城城址现貌 **Diexi town**

Photo.2005.8.25



叠溪地区1933年8月25日里氏7.5级地震后景观

Pictures after the Diexi earthquake of magnitude 7.5(Richter Scale) of August 25th, 1933 (Photo. Xueben zhuang 1933, Reporter of Sen Newspaper Shanghai)



叠溪地震灾难的见证人

The witness of the Diexi earthquake disaster 1933 year

叠溪古镇“蚕陵重镇”石刻碑文

Stone Tablet of Diexi Town (Chanling town)

Uncle Xu (Photo. 2004)

许天觉大爷 (2004年)



1933年疊溪地震崩塌滑坡与 堰塞湖

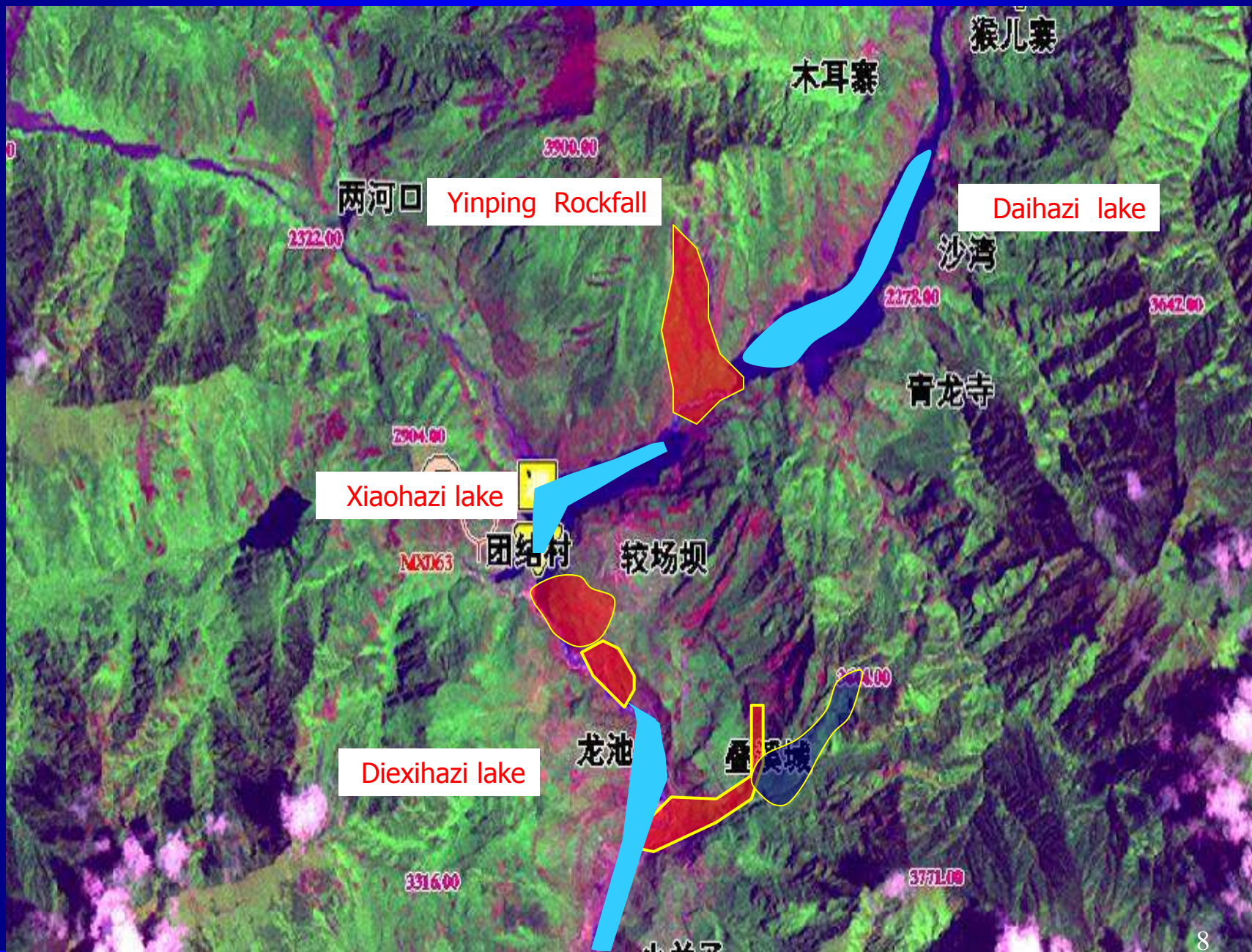
*DIEXI EARTHQUAKE ROCK FALL, LANDSLIADE AND THEIR
DAMMED-LAKE in 1933.8.25*



1. 大海子 (DAIHAIZI LAKE)

2. 小海子 (XIAOHAIZI LAKE)



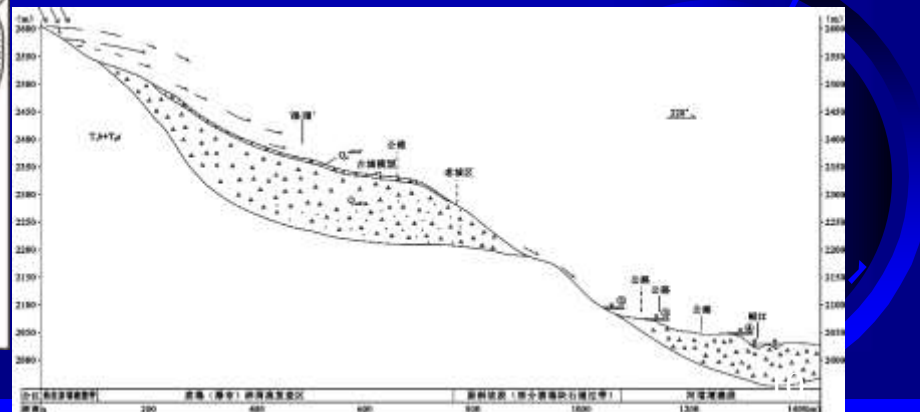
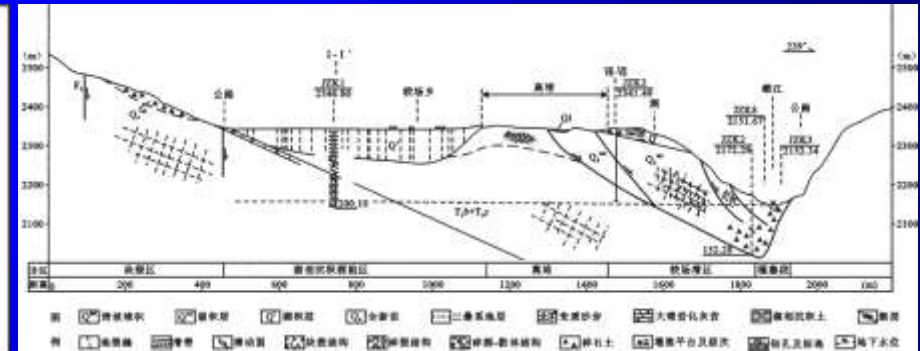
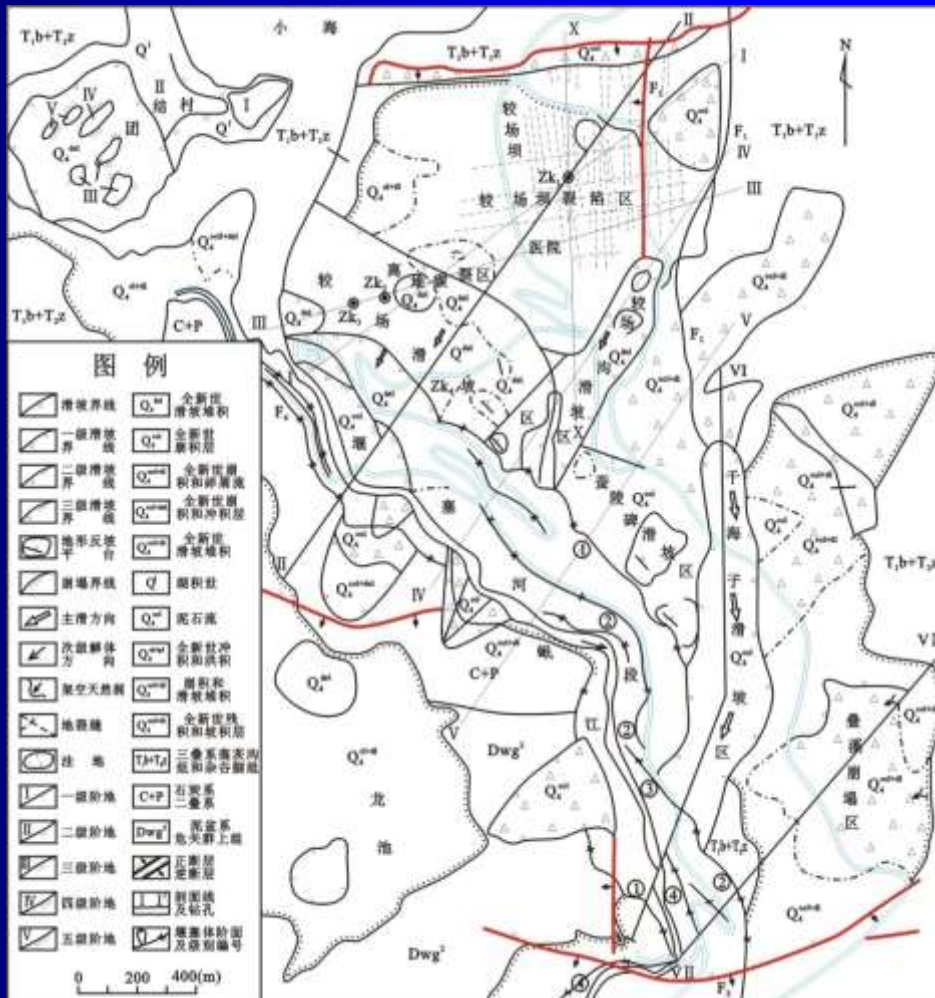




1933年叠溪地震松平沟中的系列堰塞湖
*A series dam-lakes during Diexi earthquake 1933 in
 Songping stream area*

叠溪滑坡工程地质平剖面图

Engineering geological map (left) and sections (right) of Diexi landslides and rock fall during the earthquake 1933 (II, Jiaochang landslide; VI, Ganhaizi landslide; VII, Diexi town rock fall)



叠溪古堰塞湖

Discovery of Diexi paleo-dammed lake

- *The paleo-lake sediments are a set of light dark yellow to grey- black silty sand or silty-clay layers. They can be observed over a length of 30 km along the valley slopes of the Minjiang River from Xiaoguanzi village to Taiping village .*
- *The top of the sediments lies about 2340 m above sea level and about 200 m above the present water level of the recent dammed lakes caused by the 1933 earthquake .According to the records of four borehole ,the sediments are more than 240 m thick.*
- *They occur in distinct layers with colors from dark to light. The thickness of each individual horizontal layer is about 2.0 cm . Sand wave (delta facies) deposits, roll-up and flame structures, convolute structures, and cross-beddings can be observed in the sediment profiles shown in , respectively.*
- *An ancient landslide and debris flows deposits are observed on the side of the paleo-lake .*



大海子-太平乡岸坡上残留的古堰塞湖沉积物

*Paleo-dammed lake lacustrine sediments on the bank slope of Daihazi lake
(center part)-Taiping village (near the upper part of the pleo- lake , 30km from Diexi)*

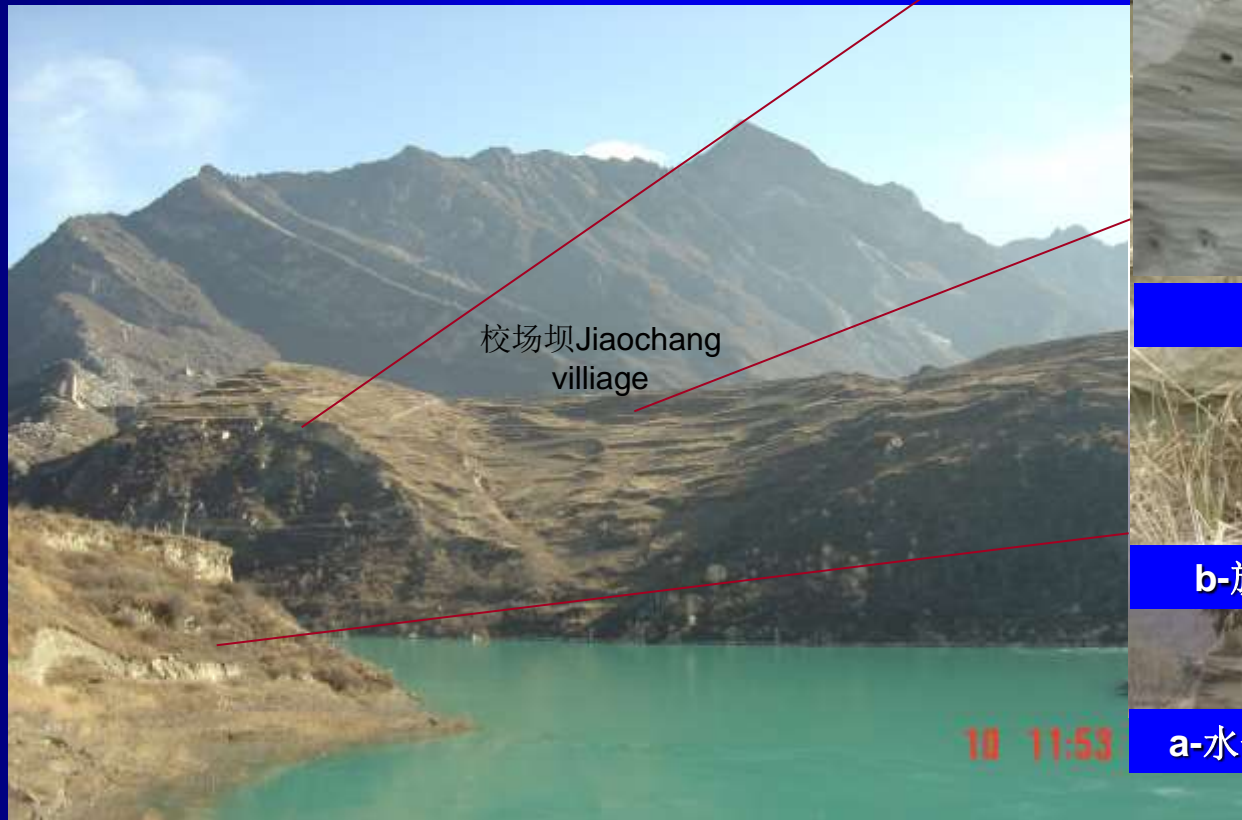


Traces of paleo-lake sediments along the bank of the Mingjian river

- a. silty sand or silty-clay layers ;*
- b. fluvial deposits with an intercalated lake deposit*

古堰塞湖沉积物岩相结构特征

Petrography and strcture charact of Diexi paleo-dammed lake lacustrine sediments



c-侧向加积结构 Sand wave



b-旋卷构造 Convolution stravture



a-水平层理 Bedding & laminated plane

古堰塞湖沉积物岩相结构特征

Petrography and strcture charact of Diexi paleo-dammed lake lacustrine sediments



a-水平层理 *Bedding & laminated*



b 沙波纹层 *Sand wave*



c-扰动层 *Convolution strcture*



d-交错层 *Cross bedding*

叠溪古湖相沉积物上的河流阶地（小海子）

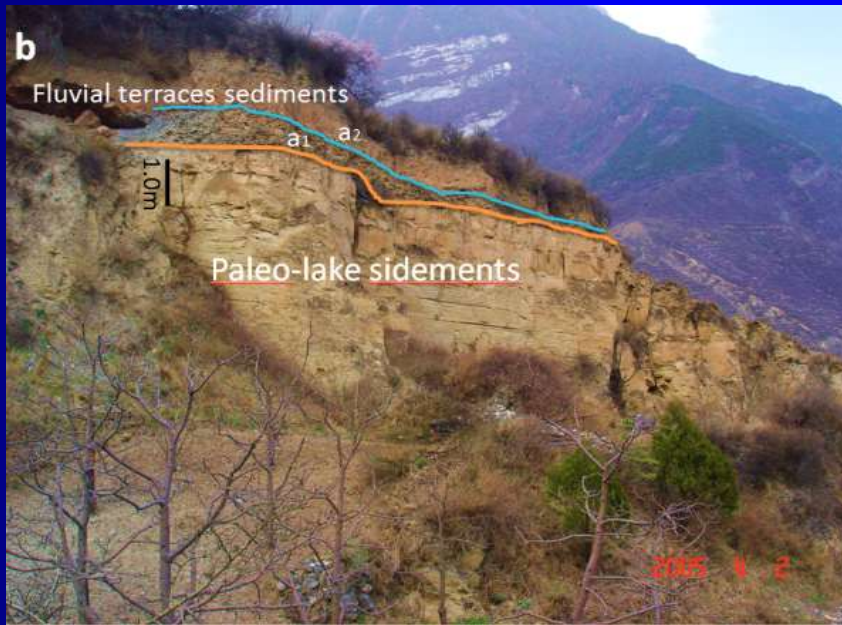
Fluvia terraces on Diexi pleo-dammed lake lacustrine sediments (Xiaohaizi area)



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叠溪古堰塞湖沉积物上覆的河流相“阶地”

Fluvia terraces on Diexi pleo-dammed lake lacustrine sedments (Xiaohaizi area)



河流相“阶地”堆积物与二元结构

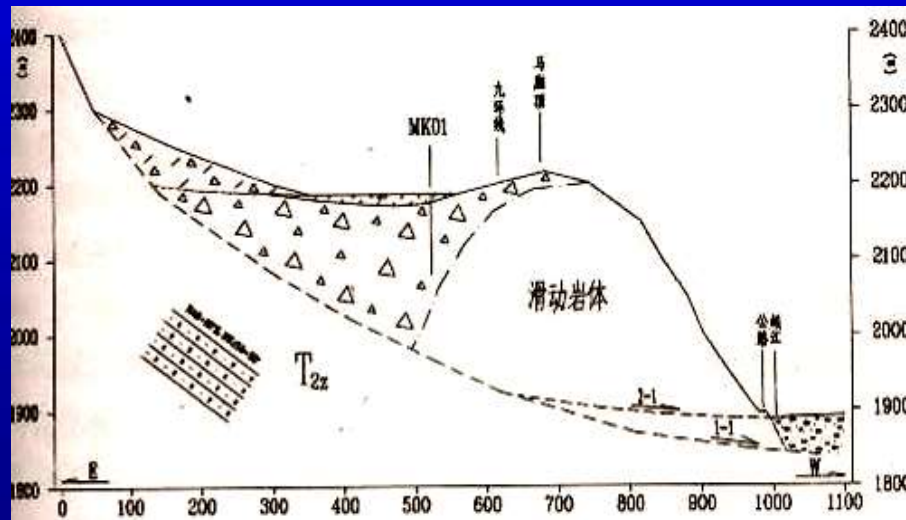
Fluvial terrace and river deposit on the paleo-dammed sediment

(a_1) Sandy matrix with imbricated of pebbles (decken structure)

(a_2) flooding facies with fine sandy clays

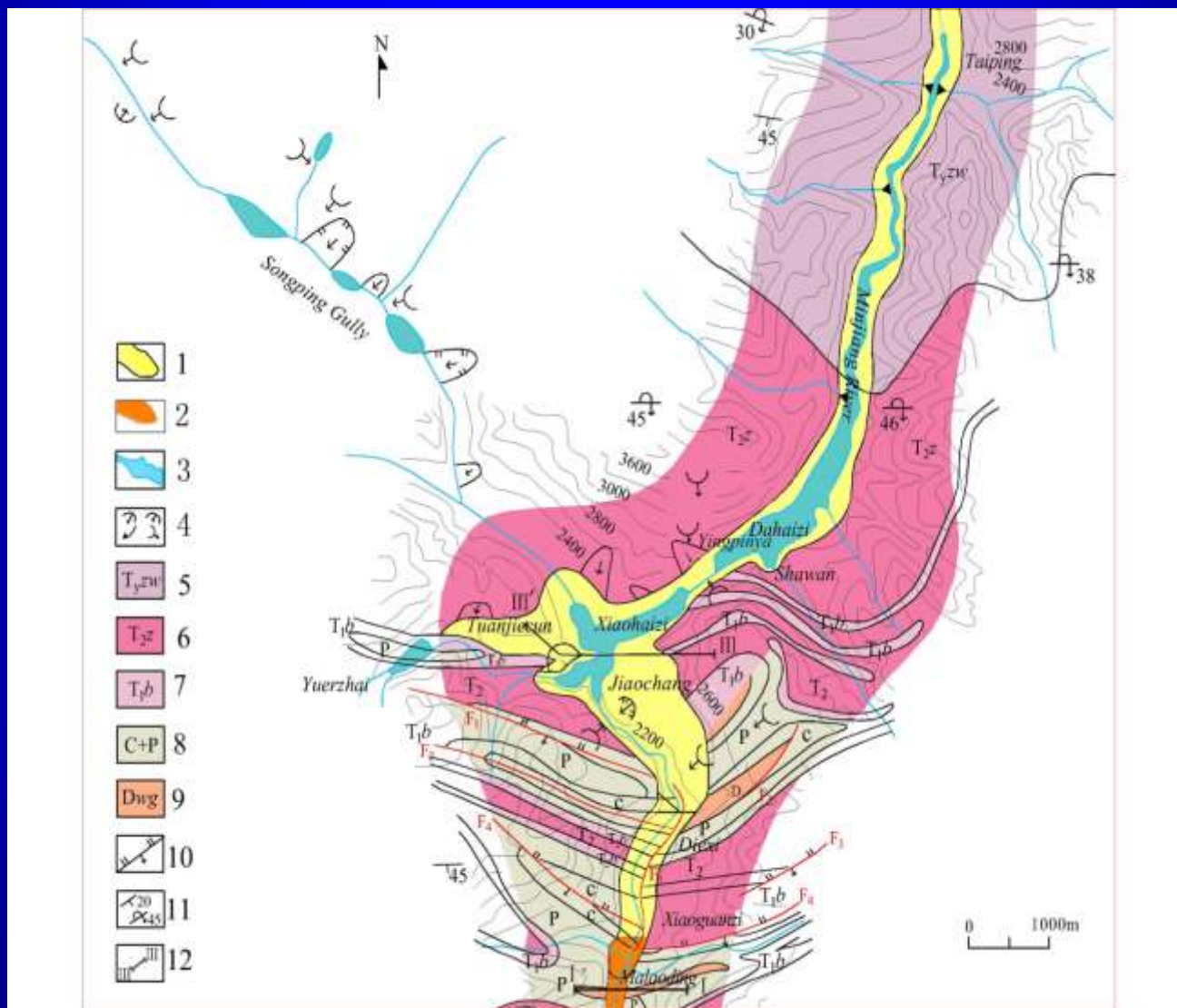
古堰塞湖堰塞坝（马老顶滑坡）景观

Dam of Diexi Paleo-lake – Malaoding landslide



古堰塞湖沉积物分布范围图

Geological tectonic map of the Diexi area after the 1933 earthquake



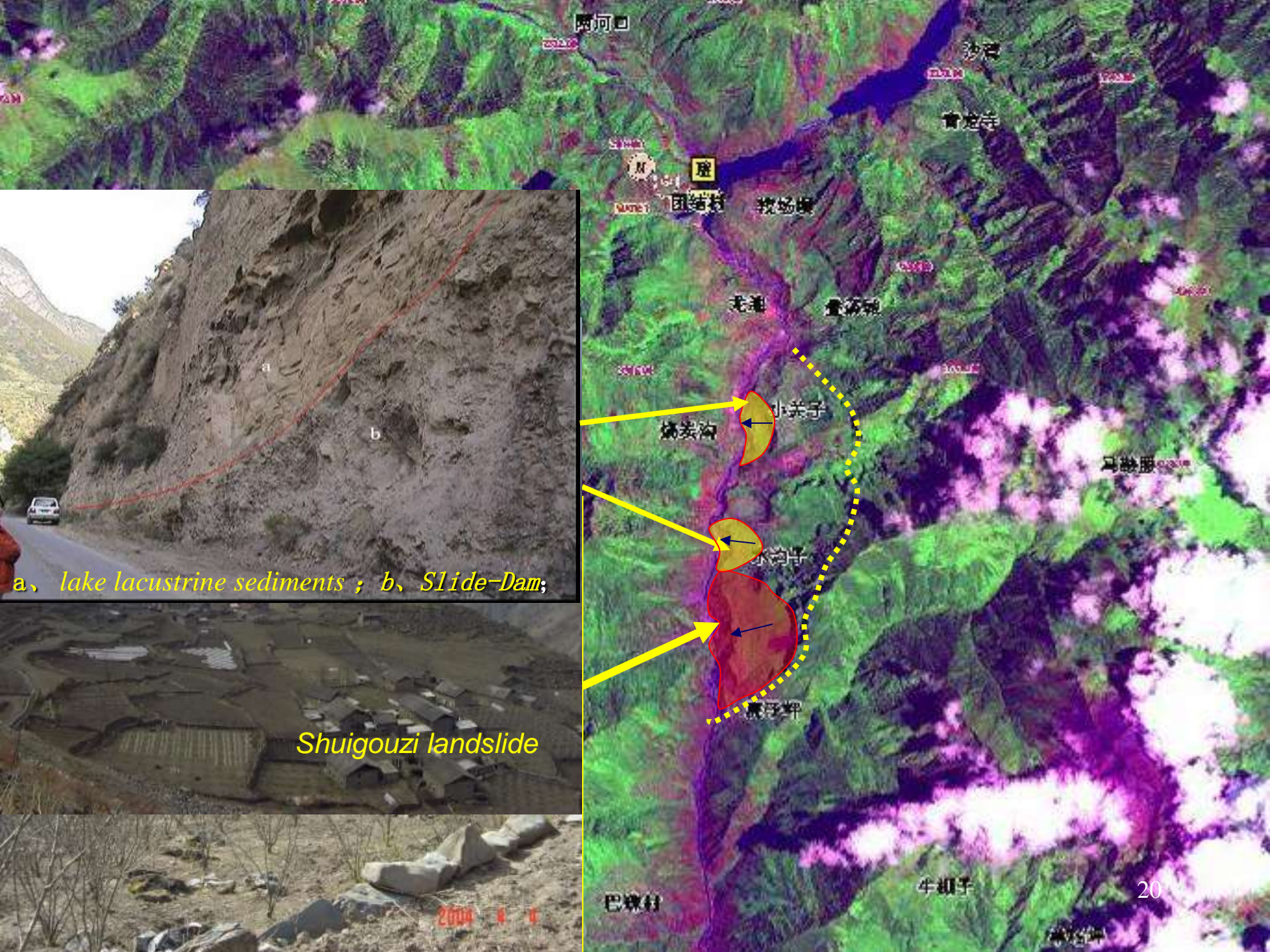
Blue area—1933 earthquake dammed lakes;

Yellow area-- Diexi paleo-dammed lake (30000 B.P.)

古堰塞湖沉积物分布范围

Distributive province of Diexi paleo-dammed lake (after Google earth)



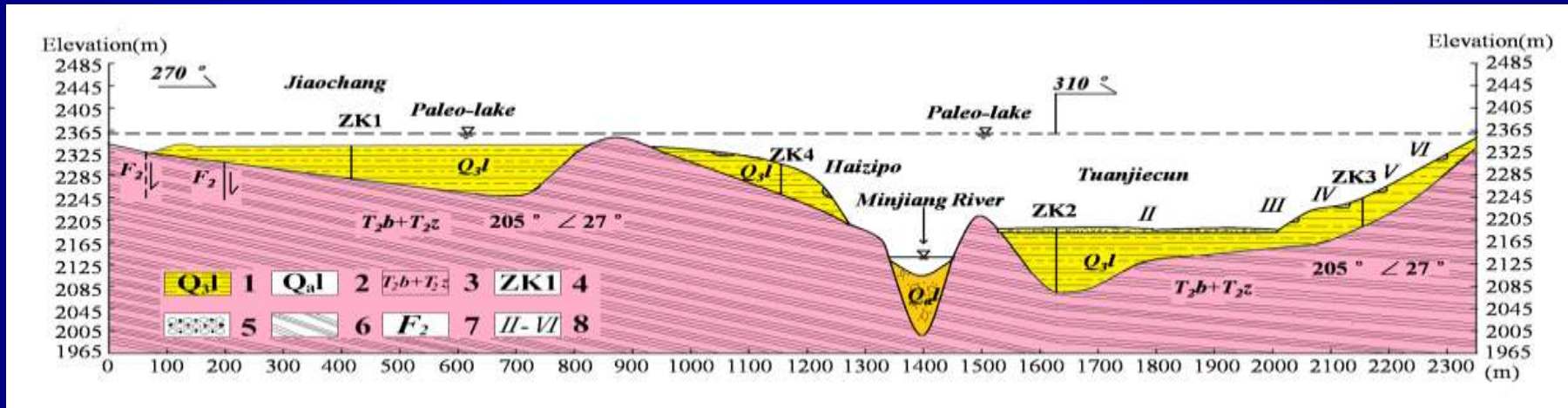


a、 lake lacustrine sediments ; b、 Slide-Dam;

Shuigouzi landslide

叠溪古堰塞湖（小海子区）勘探地质剖面图

Typical geological tectonic profile of Diexi paleo-dammed lake sediments in Diexi Xiaohazhi area (Section III-III)



①The sediments about 240-meter-thick

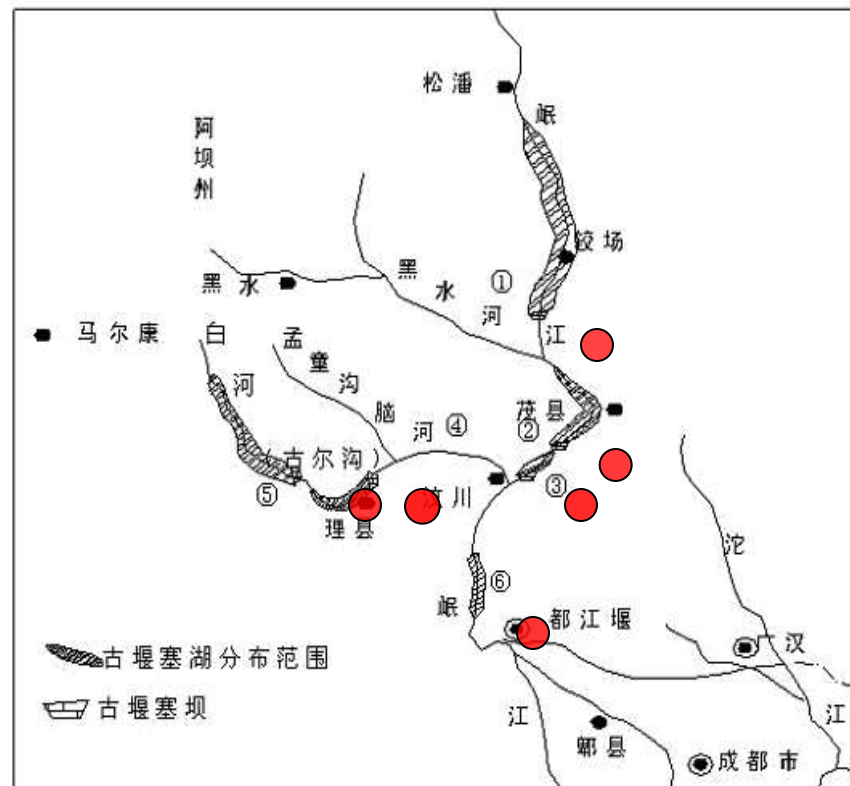
②The level of the bottom of sediments is 2094 m which lower then the base of river ;

岷江上游古堰塞湖群

Paleo-dammed lakes in upstream of Mingjiang River

- ① 叠溪古堰塞湖 (Diexi)
- ② 茂县古堰塞湖 (Maoxian)
- ③ 文镇古堰塞湖
- (Maoxian Wenzheng)
- ④ 杂谷脑河古尔沟古堰塞湖
- (Guergou in Zagunao river)
- ⑤ 杂谷脑河理县
- (Lixian in Zagulao river)
- ⑥ 映秀-绵虬古堰塞湖
- (Yingxue-Miangchi)

岷江上游古堰塞湖分布图



- ① 叠溪古堰塞湖 ② 茂县古堰塞湖 ③ 文镇古堰塞湖
④ 理县古堰塞湖 ⑤ 古尔沟古堰塞湖 ⑥ 映秀-绵虬古堰塞湖

岷江上游古堰塞湖群 (② ③ ⑥ / ④ ⑤)

Paleo-dammed lakes in upstream of Mingjiang River



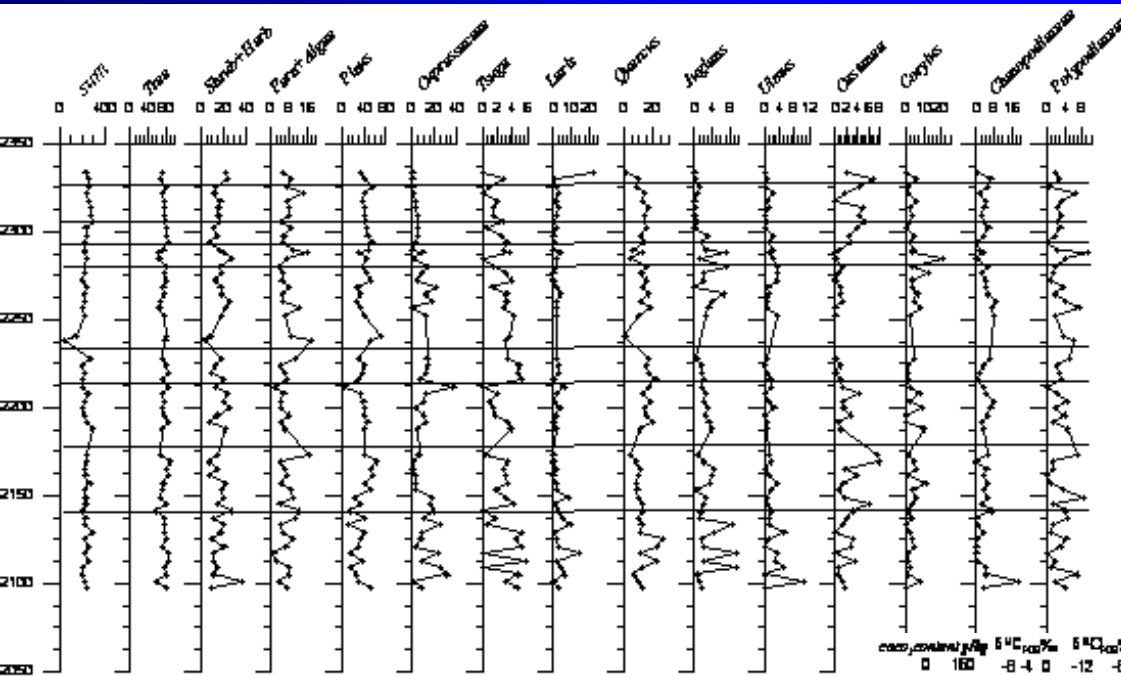
叠溪古堰塞湖沉积物古环境信息

Paleo-environmental information from Diexi paleo-lake sediment

AMS¹⁴C Dating of paleo-lake sediments and terraces deposit

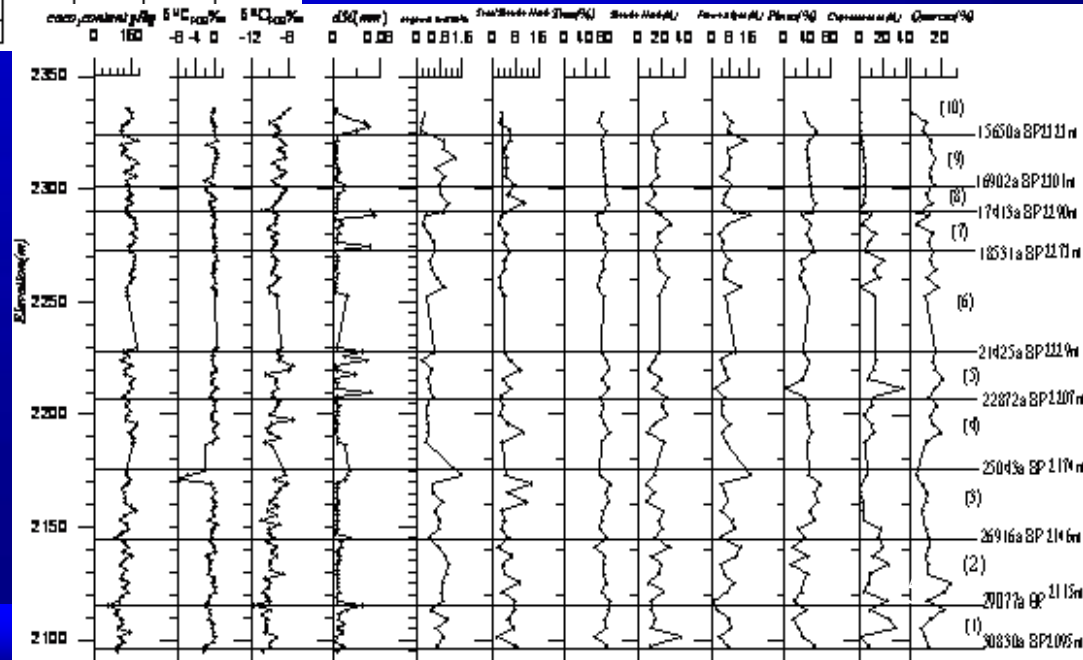
Position	Elevation	Ag B.P.
ZK1-2 Diexi paleo-lake sediments ZK1 (Fig.4)	(2305m)	16902 ***
ZK2-5 Diexi Paleo -lake-sediments ZK2 (Fig 4)	(2094m)	30830 ***
ZK1-3Diexi paleo-lake-sediments ZK1(Fig.4)	(2291m)	16865 \pm 50 ***
ZK1-5Diexi paleo-lake sediments ZK1 (Fig 4)	(2306m)	16781 \pm 116*** #
ZK1-6 Diexi paleo-lake sediments ZK1 (Fig.4)	(2291m)	16865 \pm 50*** #
ZK4-1 Diexi paleo-lake sediments ZK4(Fig.4)	(2253m)	20180 \pm 95*** #
ZK4-2 Diexi paleo-lake sediments ZK4(Fig.4)	(2269m)	17709 \pm 91*** #
ZK3-1 Diexi paleo-lake sediments ZK3(Fig.4)	(2200m)	21287 \pm 139*** #
MN2 Malaoding ancient landslides (Fig.5a)	(1948m)	30170 ***
SW2 Sawang disturbed layer sediment (Fig2, Fig.9b)	(2282m)	21368 ***
NO13 Lixiang paleo-sediments[Wang L.S 2002,2007]		28500 \pm 380
		\sim 33790 \pm 365 ***
QT-1 Maoxiang T2 terraces deposit of Mingjiang River	(1569m)	5780 ***
Xiaohazi III terraces deposit (Fig6)	(2185m)	3428 \pm 82 *B.P.
Xiaohazi IV terraces deposit (Fig6)	(2213m)	4880 \pm 72~4741 \pm 72 *B.P.
Xiaohazi V terraces deposit (Fig6)	(2254m)	8496 \pm 93~8255 \pm 93*B.P.

古气候信息 *Paleo climate information*



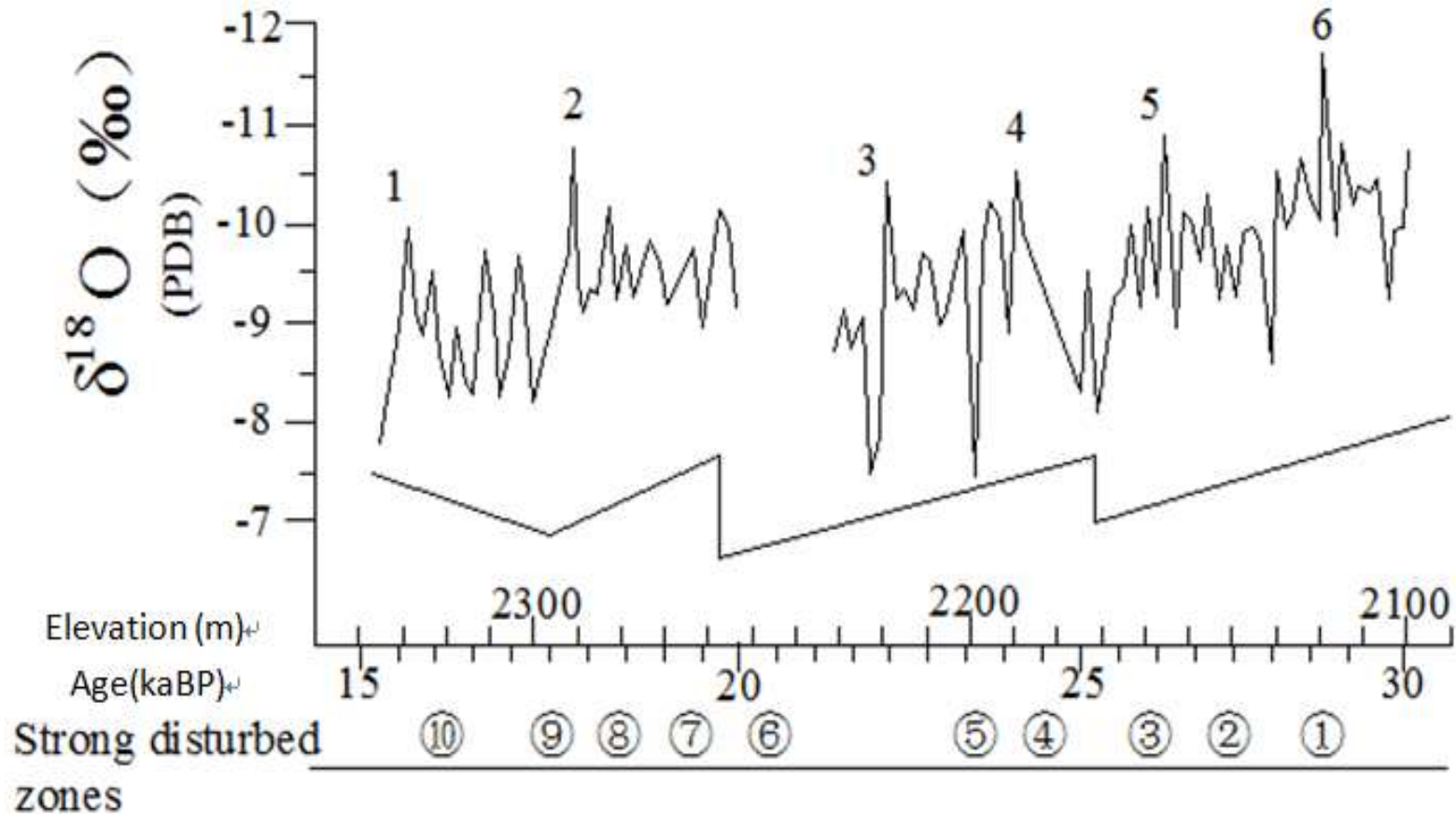
Pollen analysis of the sediments

Multi-proxy data including stable carbon oxygen isotopes ($\delta^{18}\text{O}$ and $\delta^{13}\text{C}$), organic content, CaCO_3 content



古气候信息 *Paleo climate information*

The oxygen isotope $\delta^{18}\text{O}$ time series of Diexi paeo-lake sediments (DXY)



古堰塞湖沉积物中的扰动现象

Disturbed structure in the Diexi paleo-dammed lake lacustrine sediments



c-古滑坡崩塌体 Ancient landslide during the formation period of the pleo-lake

a-b-“火焰构造”和扰动层，
Flame structure and disturb structure ;

古堰塞湖沉积物中古地震信息

Paleo earthquake information in sediments - Strong disturbed zone in sediment
(a) Lixian section; (b) Wenzhen section; (c) Drill cores (Zk2)

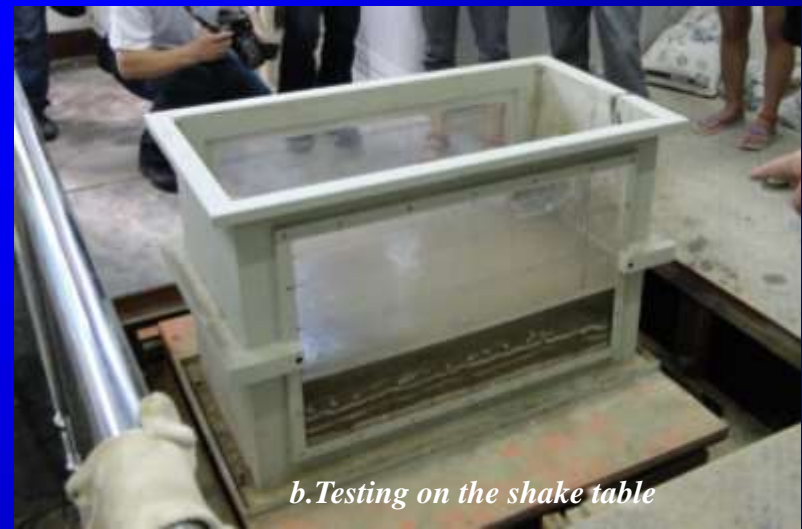


扰动现象形成机制地质力学模拟试验（地震台）

Model test for the formation mechanism of disturbed zones in paleo-sediments



a. Test material in the water tank;



b. Testing on the shake table



c. A series of disturbed zones after testing ;

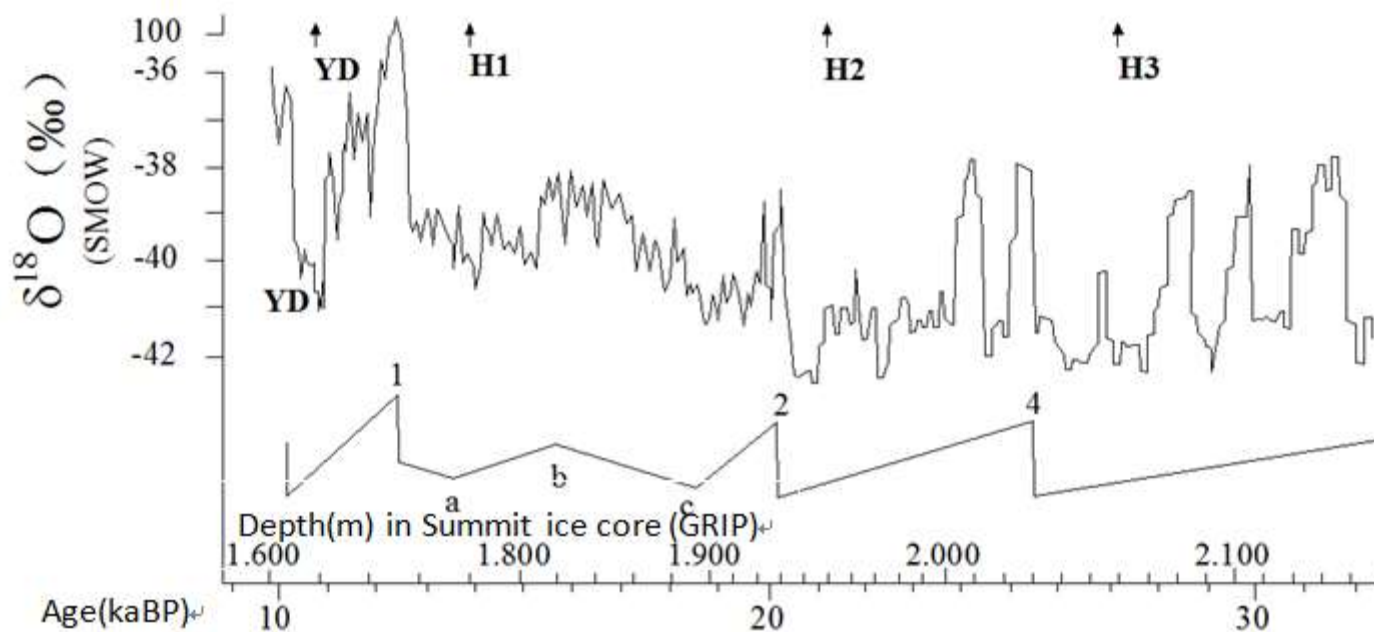
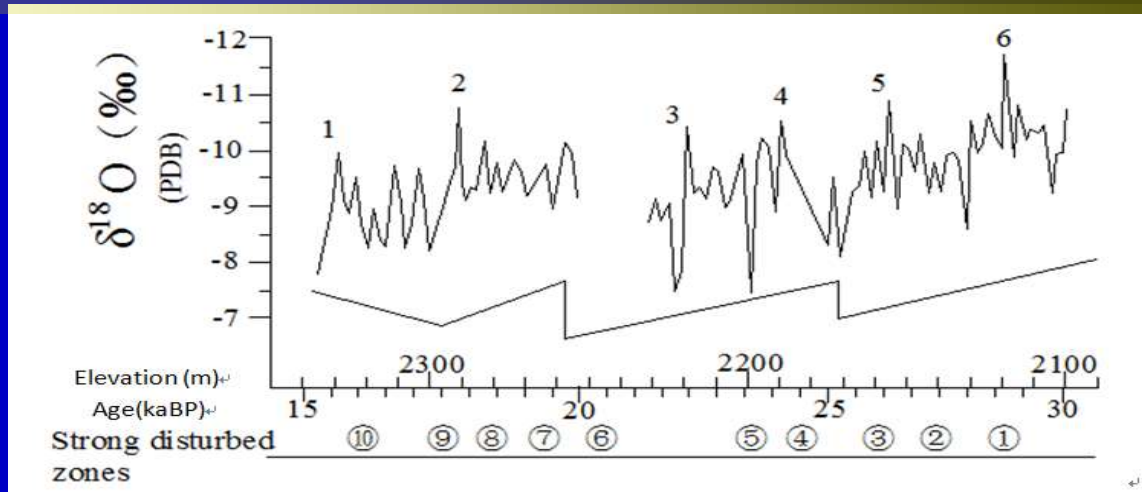


d. The disturbed zone can be compared to 3.4

4. 讨论 *Discussion*

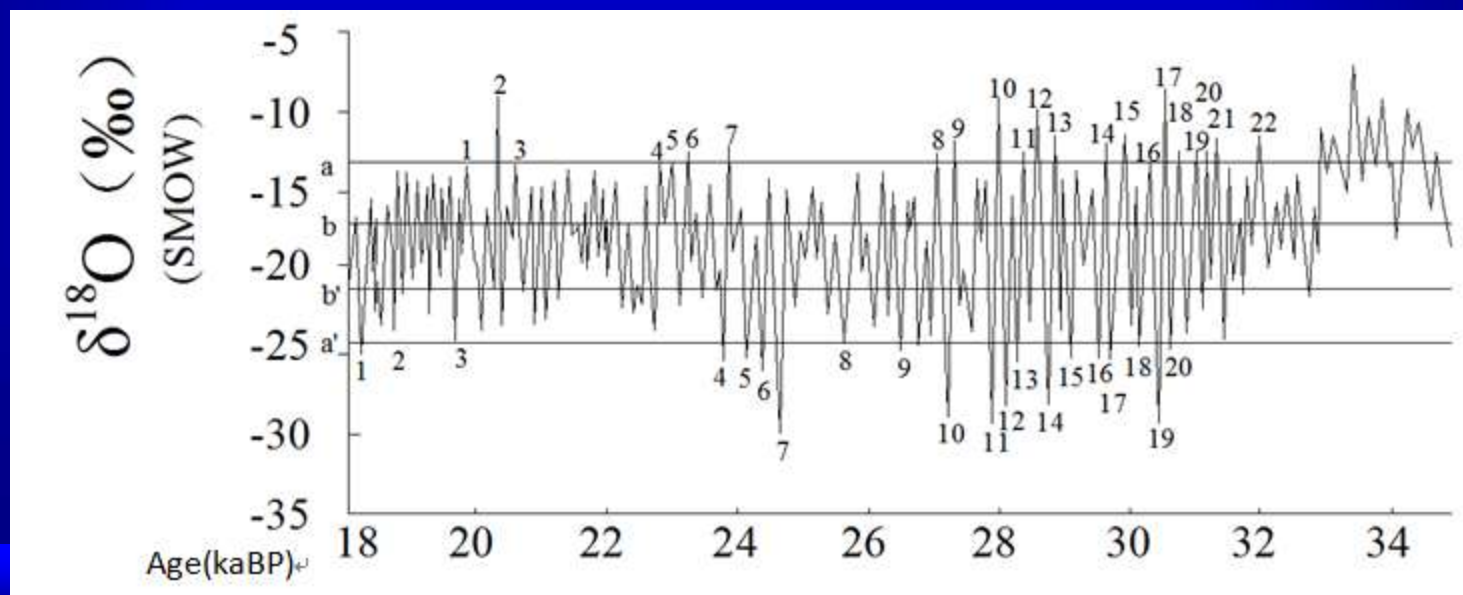
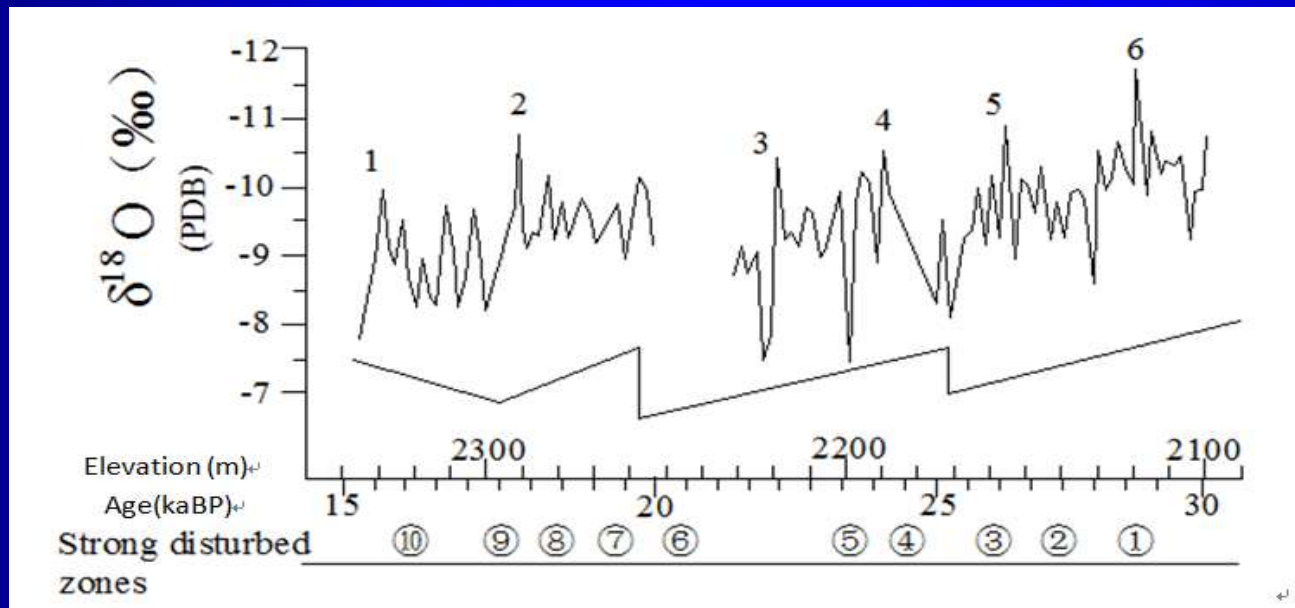
4.1. 古气候信息对比分析 *Comparative Analysis on pleo climate*

4.1.1. The oxygen isotope $\delta^{18}\text{O}$ time series of Diexi (DXY) compared to GISP2 (Ice core Greenland, Bond 1993)



4.1.2.对比青藏高原的古里雅冰芯 $\delta^{18}\text{O}$ 曲线 (姚檀栋, *G.L.Thomson, 1997*)

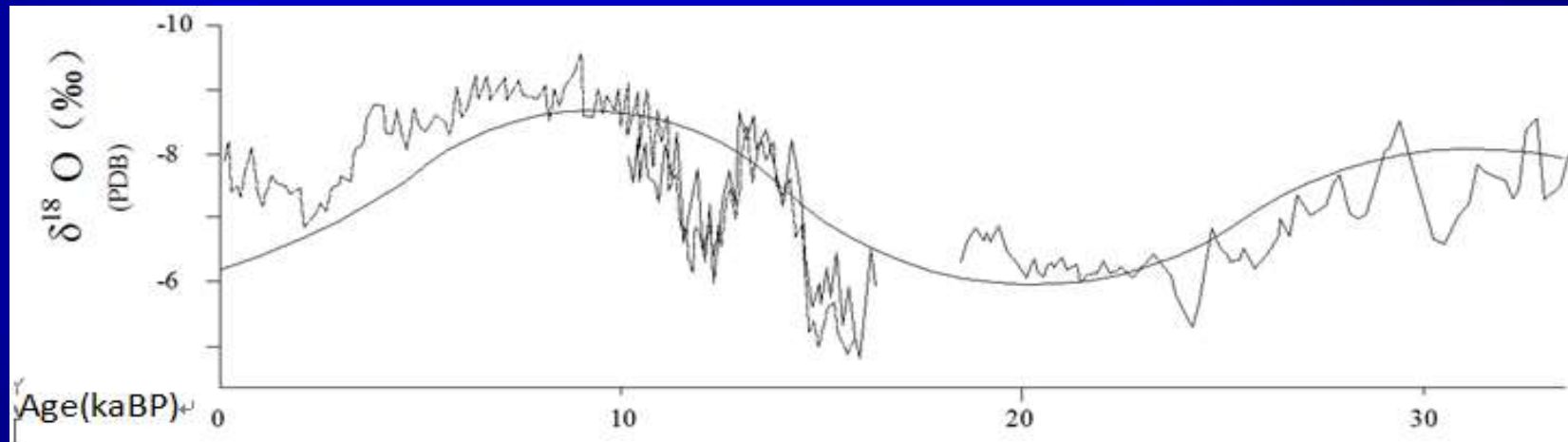
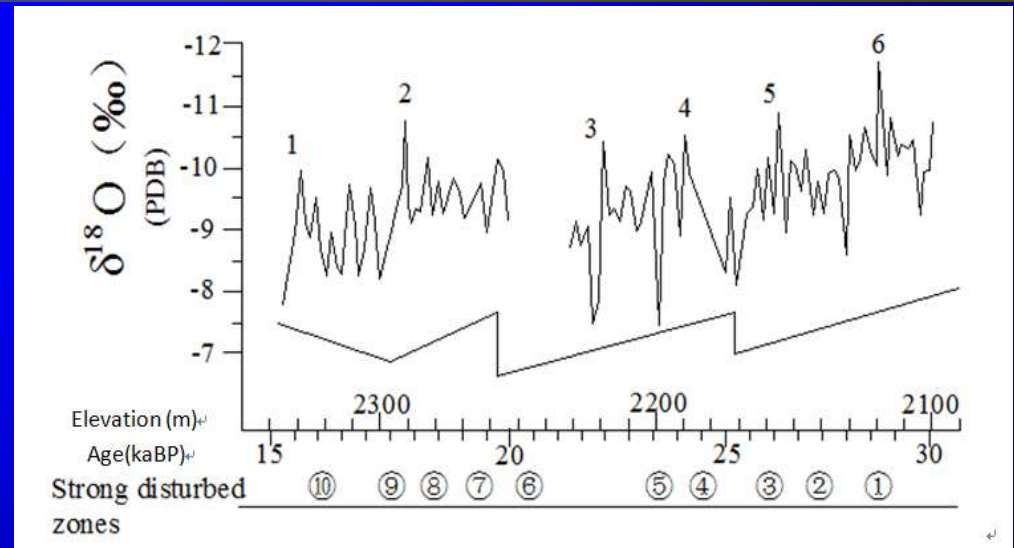
Compared to the $\delta^{18}\text{O}$ time series of the Guliya Ice cores in the Tibet Plateau



4.1.3. 对比我国岩溶石笋的氧同位素资料（袁道先等, 1999）

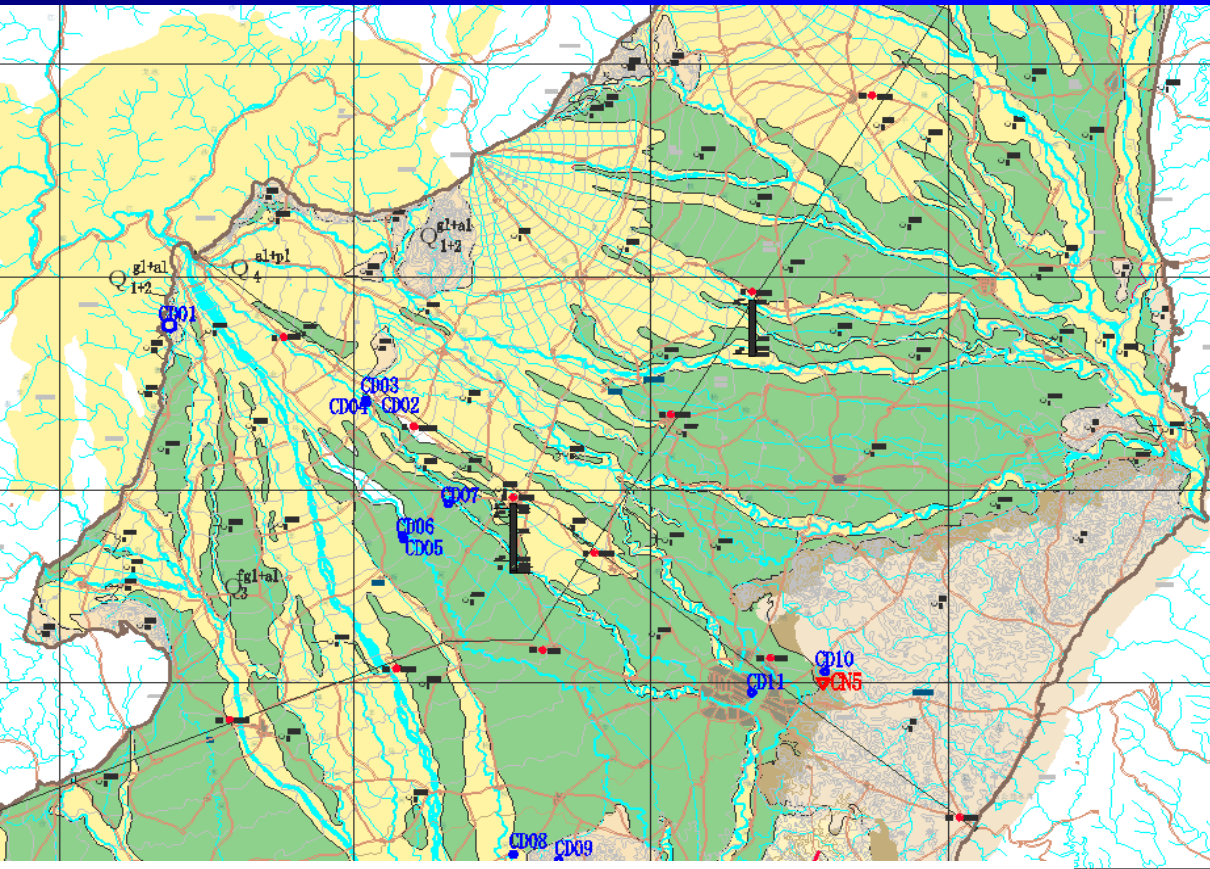
Compared to *the $\delta^{18}\text{O}$ time series of Karst deposits (Dongge & Hulu Caves) in southern China (Yuan Daoxiang .1999)*

Conclusions: The $\delta^{18}\text{O}$ time series of Diexi (DXY) is compared to them, and series typical climate change cycles can be found in DXY

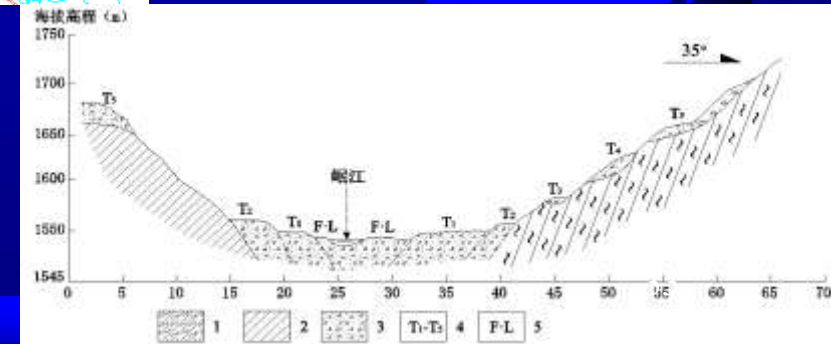
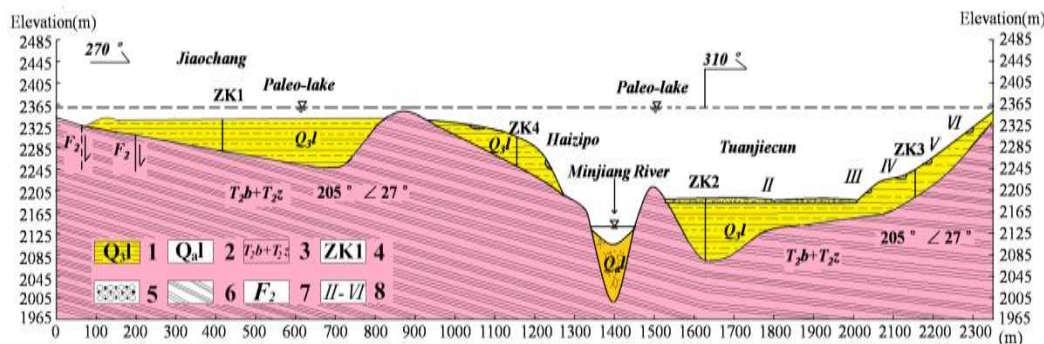


- ① N25° Solar light Milankovitch-cycles (20000 a.) ② Long term cooling cycles (Bond cycles) (5000~2000 a.)
 ③ Dansgaard-Oeschger (D-O) events (Sunspot cycle) (200-300a.) ④ Heinrich events (Ice rafting events)
 ⑤ Warm peak points (1-6)

4.2 古堰塞湖与成都平原 *Diexi paleo-dammed lake and the Chengdu plane*



A Series fluvial terraces on top of the lacustrine deposits , It is indicated that the disappear of paleo-lake occurred at least in six stages (from 15000 to 3000aBP). Each stage was related to a part breakage of the barrage dam ,and a consequent lowering of the water level some ten meters. Which made a series strong flood and debris flow scour – fill the river and Chengdu Plane



4.2.1. 古堰塞湖与成都平原—金沙遗址（3000年前）洪水沉积

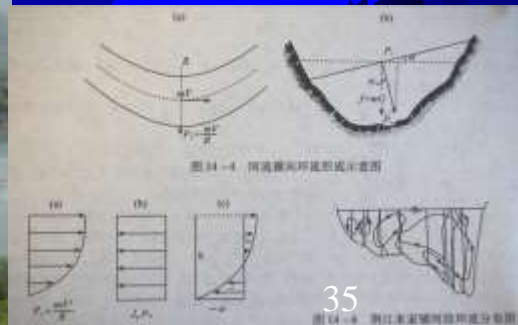
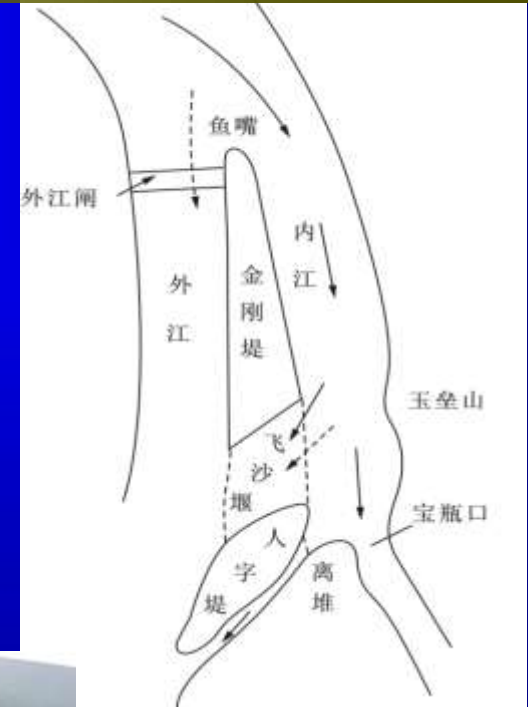
Jinsha ruin (3000aBP) , flood deposit (photo. 2004)



4.2.2.古堰塞湖与成都平原—都江堰工程（2000年前李冰父子）

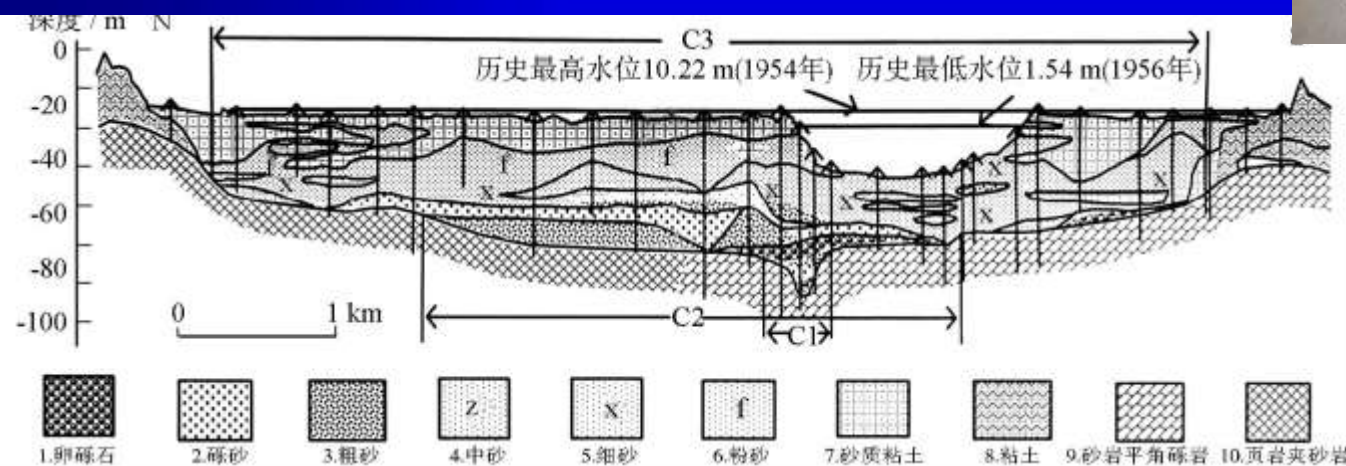
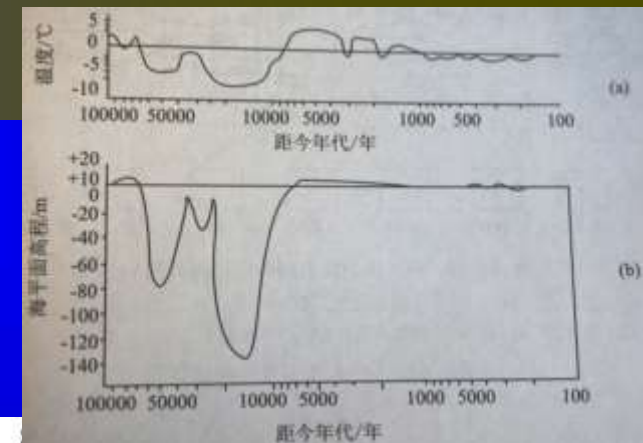
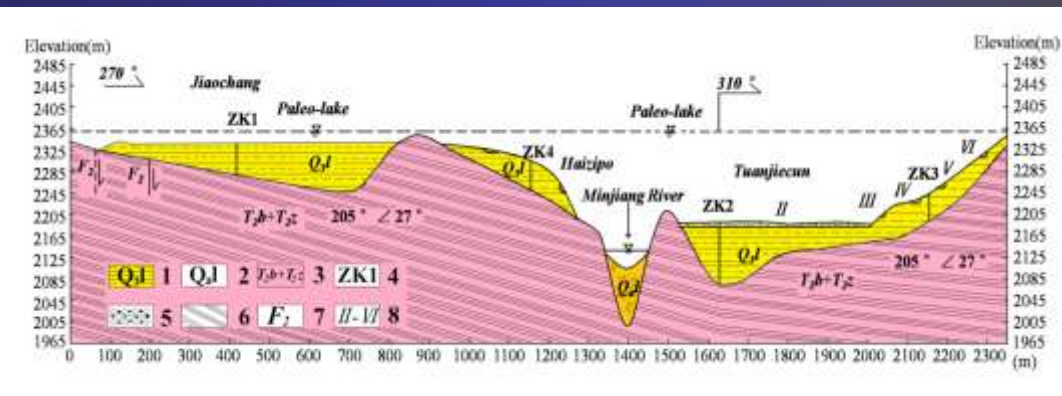
*Diexi paleo-dammed lake and the Chengdu plane—Dujiangyan Barrage (Dam) ,
A water conservancy project (building in 2000 aBP. Libing &son) .*

*Mingjian river in Chengdu plane was a braid river ; This project control the river
by the circulation (Analysis principle on Engineering- geological P.467)*



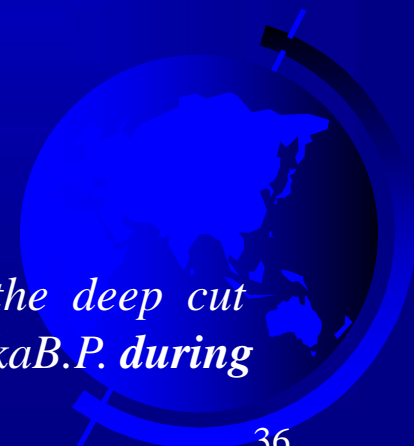
4.3古堰塞湖与岷江演化

Diexi paleo-dammed lake and the evolution progress of Mingjiang river. The deep cut valley of Mingjiang river is formed in 30000aPB, during the last deglaciation (Q3).



*Yellow Sea
sea level fluctuation history
Wang Jintai, 1980*

River geological section in Nanjing area of Yangtze River, where the deep cut valley is lower the sea level about 80m, and its formed in 20-15kaB.P. during the last deglaciation(Q3). (after Cao guangjie 2006)



4.4 暴雨古滑坡-长江三峡 *Three gorge of Yangtze river*

Rain storm horizon –push landslides, during the last deglaciation (Q3).

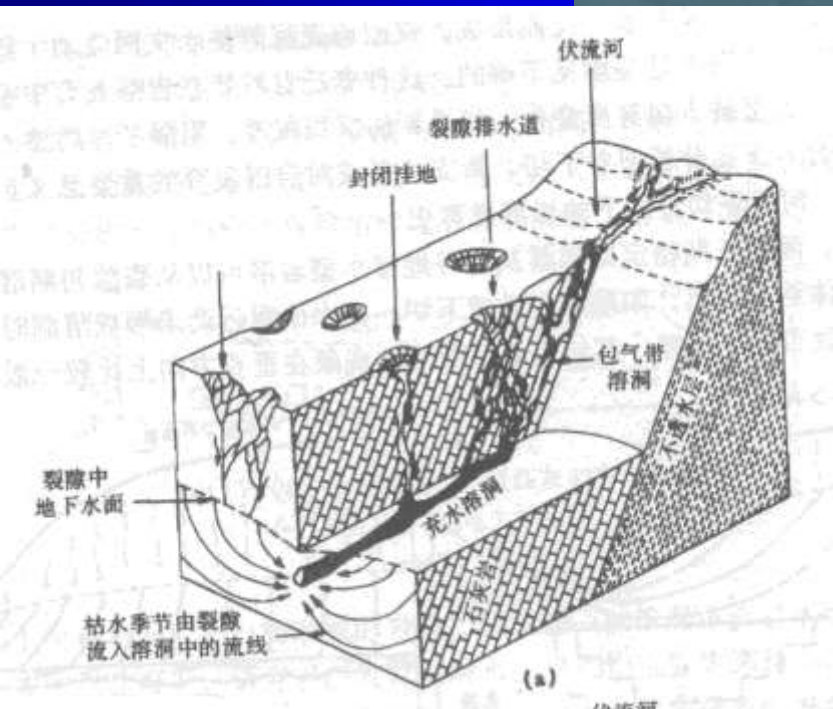


草街子滑坡全貌

A panoramic view of caojiezi landslide



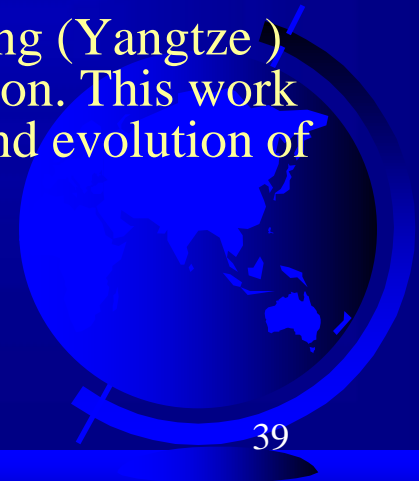
Sink holes (cave) in the karst of marble



结语 Conclusion

本项研究提出了通过对古堰塞湖沉积物为样本研究古地质环境和气候环境演变的新途径。研究的初步成果，展现了这些资料在研究地区地质环境变动强烈地震和古气候演化规律以及两者之间的相关性的意义和价值。

- A new approach studying paleo geological environment and climate evolution through Paleo dam-lake sediments is presented. The preliminary results indicated that there is strong correlation between regional geological environment and paleo climate evolution.
- The formation of Diexi paleo dam-lake was not random or accidental, but rather an important event closely related to sea level and climate changes during the time period. This was similar to the events that took place along the rivers in the transition area between Tibet plateau and Sichuan basin.
- This work is important in studying and evaluating Changjiang (Yangtze) River valley geological development and bank slope evolution. This work may also play an important role in studying the formation and evolution of Mingjiang river and West Sichuan plain.



Diexi Paleo Dam-lake Research Group



ACKNOWLEDGEMENT

Many thanks to prof. Yue Zhong-qi , Liu Baoju , Hong shizhong and the members of Diexi Paleo Dam-lake Research group for their complete devotion to the project in the past few years. Thank you!



THANKS!

大会圆满成功！预祝节日快乐！

Congratulations on this meeting
successful performance and extend
holiday greetings !