Chinese-Korean-Japanese Cooperative Program

Seismic Hazard Assessment for the Next Generation Map

Seismic hazard assessment in low seismicity provinc

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Outline

- The state-and -art of Seismic hazard assessment in low seismicity province in China
- A new seismic hazard assessment method in low seismicity province
- One Example in Yunnan Province
- Conclusions

1. The state-of the art of Seismic hazard assessment in low seismicity province in China

➢ General methods

- ☐ Historical earthquake method—Paleoearhquake or historical earthquake
- ☐ Tectonic analogism method---high seismic hazard data

(Deterministic Seismic Hazard Analysis (DSHA), Probabilistic Seismic Hazard Analysis (PSHA))

➢ Ongoing methods

- ● Containing strong earthquake observation info- including earthquake source mechanism, history sequence or serial
- ● Continental dynamic—deformation and mechanism

2. A new seismic hazard assessment method in low seismicity province-based on deformation and energy accumulation and releasing

- **Continental Dynamic mechanism**
  - GPS deformation and velocity field, geotectonic environment and paleoearthquake
- **3Dimension geological info**
  - Site effection
- **Fault types, dynamic and segment**
  - Normal, reserve and strike fault, Tectonic dynamic and earthquake
- **Based on geophysics and geochemical**
  - comprehensive info-gravity, geo-resistance and geomagnetism, abnormal geochemical field- inert element and hydrargyrum(Hg)
- **Rock deformation**
  - Rock elastic-plastics deformation, energy cumulation

Formulation of Model

Regional total energy---
lithosphere or continental dynamic

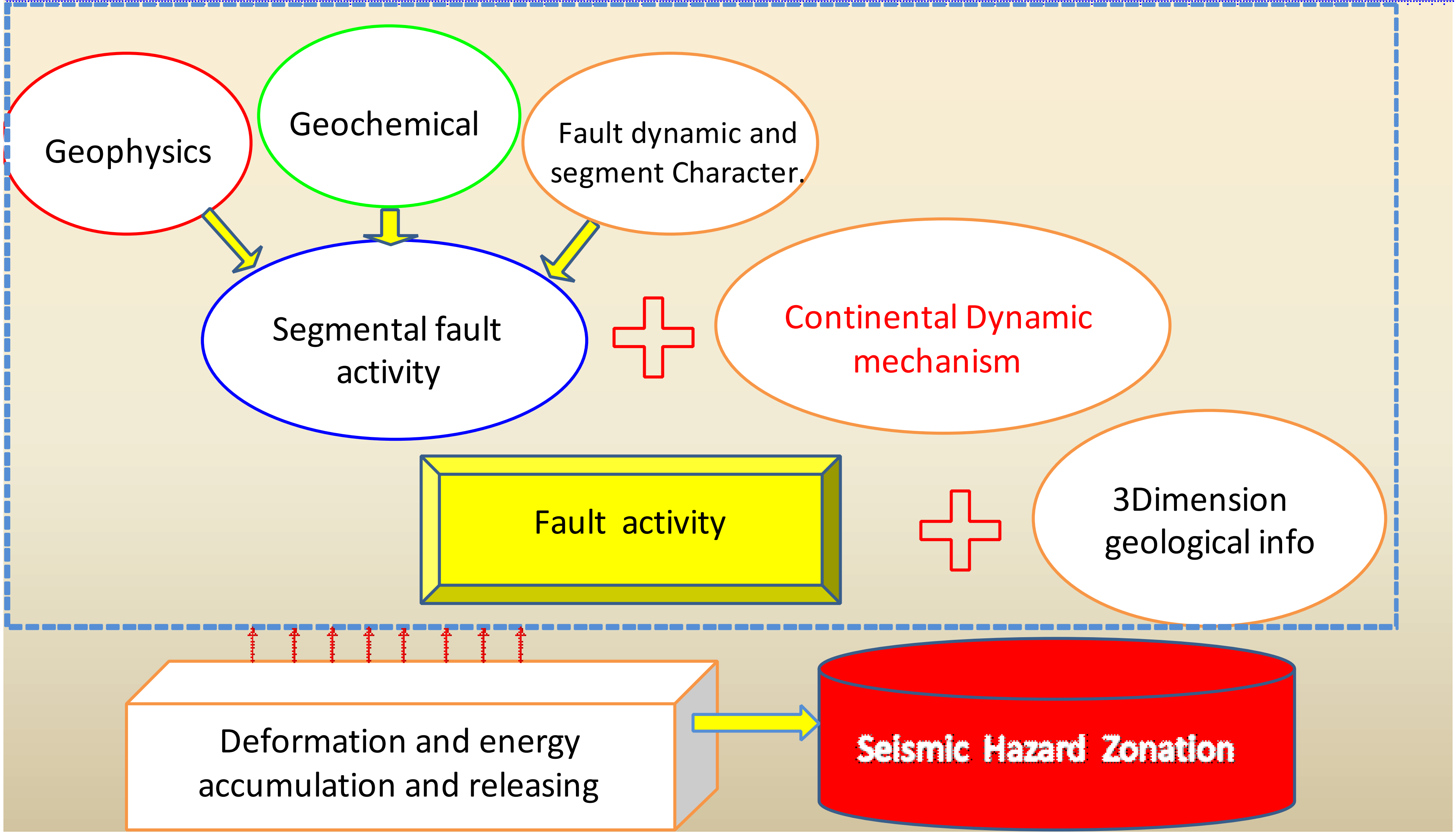
Heat energy---
regional tectonic and volcanism

$$E_{total} = \left(\sum_{i=1}^{n} D_i(t,s)S_i(t,s)\right) + \left(\sum_{i=1}^{n} Q_i(t,s)\right) + \sum_{i=1}^{n} cM_i(t,s)\, v_i(t,s)$$

Deformation energy
–regional tectonic , considering the segmental characteristics , rock types

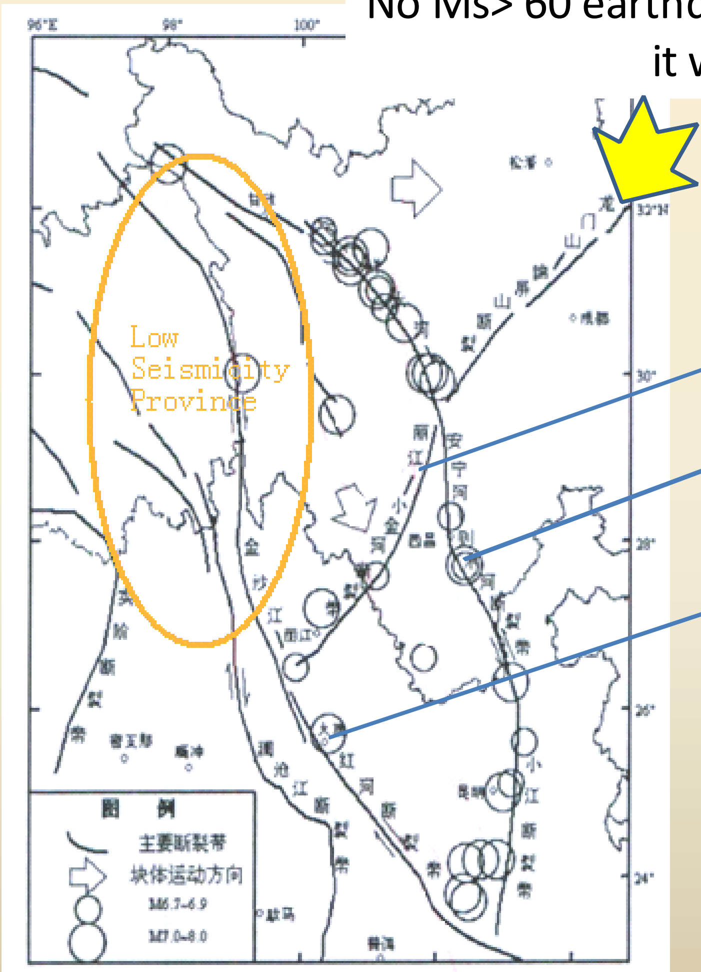
Kinetic energy–
tectonic activity, including evolvement

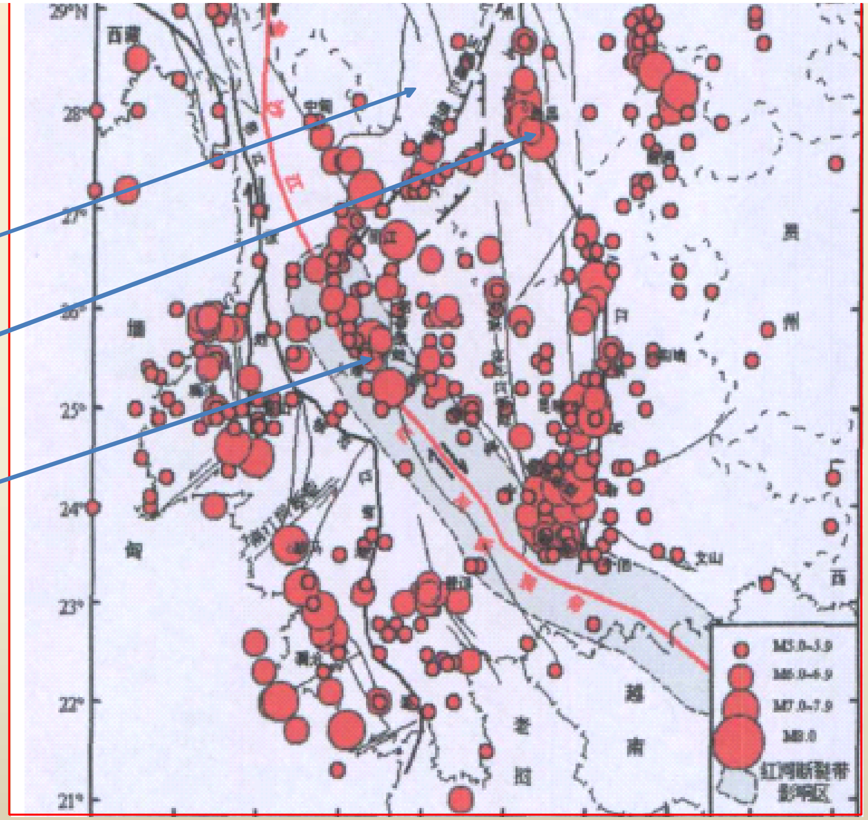
Technique Diagram



3. One example

No Ms> 60 earthquake invaded in Longmenshan fault for 2264 years, so, it was considered a low seismicity province

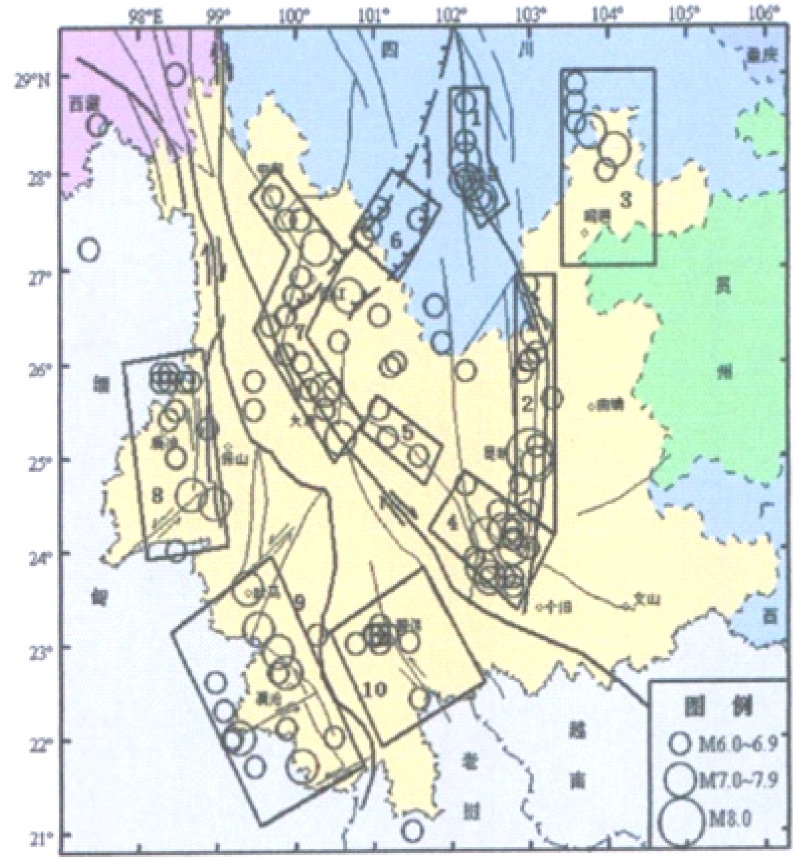




MS≥ 5.0 in Yunnan province since 624

MS≥ 6.7 in Sichuan-Yunnan rhombic plate since 1700

Seismic provinces

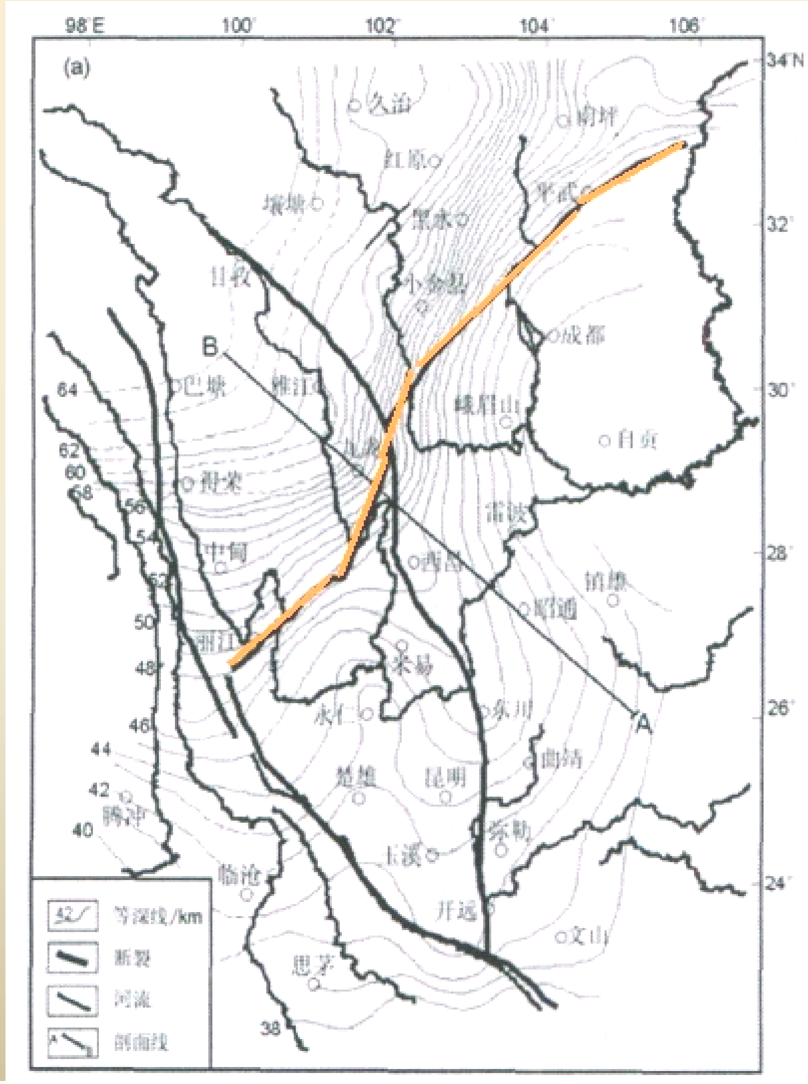


云南地震带（区）与6级以上地震分布图

1. 安宁河-则木河带；2. 小江带；3. 马边-大关带；4. 通海-石屏带；5. 南华-楚雄带；6. 木里-盐源区；7. 中甸-大理带；8. 腾冲-龙陵区；9. 澜沧-耿马带；10. 思茅-普洱区

序号	地震带（区）名称	所处省份	主要断裂带	$M \geq 6$级地震次数	最大地震震级	地震记载起始时间
1	安宁河-则木河带	四川	安宁河带、则木河带	8	$7\frac{1}{2}$	624年
2	小江带	云南	小江带	13	8	1500年
3	马边-大关带	四川 云南	马边-盐津断裂带	8	7.1	1216年
4	通海-石屏带	云南	曲江带、石屏建水带	16	7.8	1420年
5	南华-楚雄带	云南	南华-楚雄带	3	$6\frac{3}{4}$	1511年
6	木里-盐源区	四川 云南	木里弧形带、盐源弧形带	5	6.7	1467年
7	中甸-大理带	云南	乔后-龙蟠带、红河带	18	7.0	886年
8	腾冲-龙陵区	云南	腾冲带、龙陵-瑞丽带、大盈江带等	21	7.4	1478年
9	澜沧-耿马带	云南	旱母坝-邦多带、澜沧-勐遮带	16	7.6	1935年
10	思茅-普洱区	云南	无量山带	11	6.8	1884年

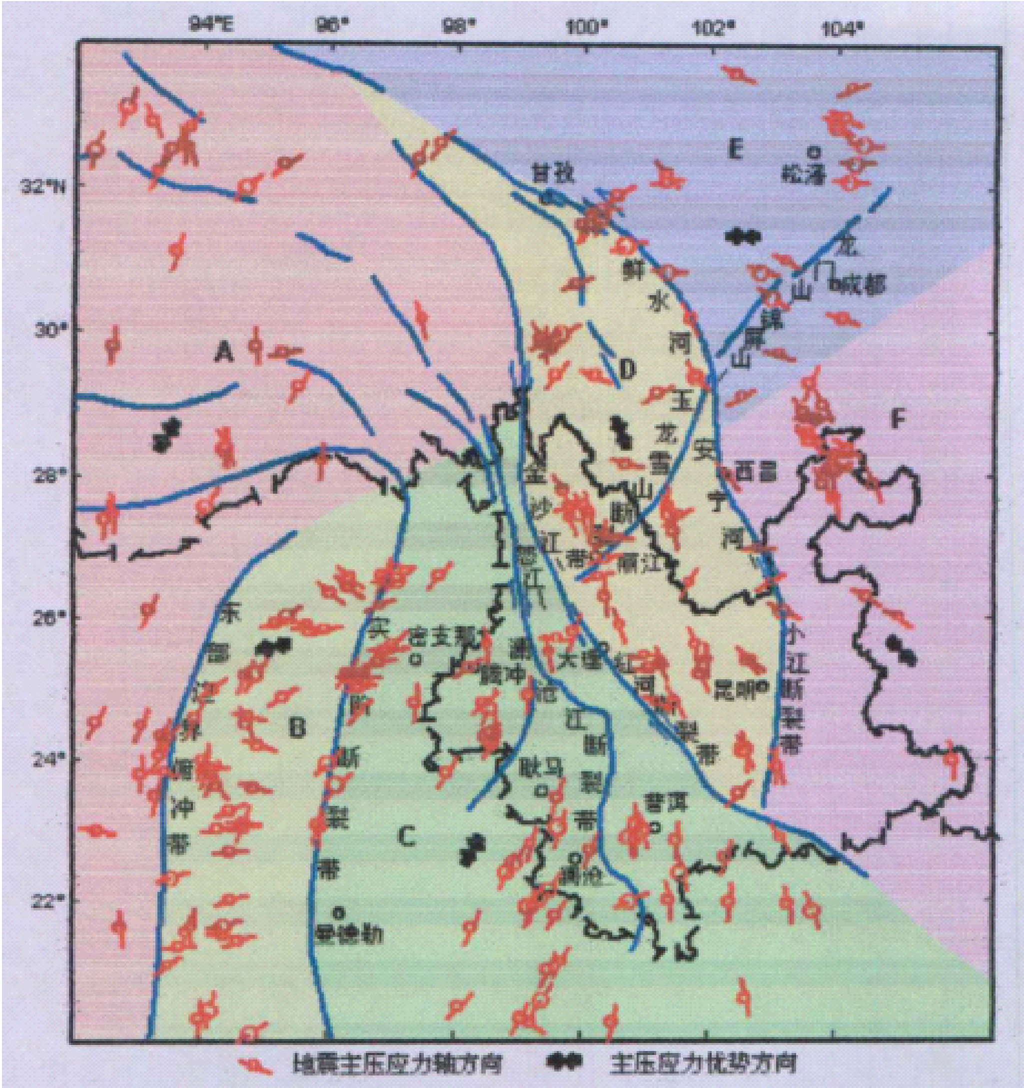
Continental dynamic

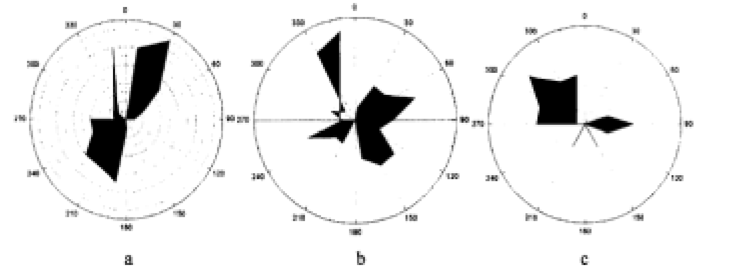


The Depth of Moho surface

Lithosphere thickness

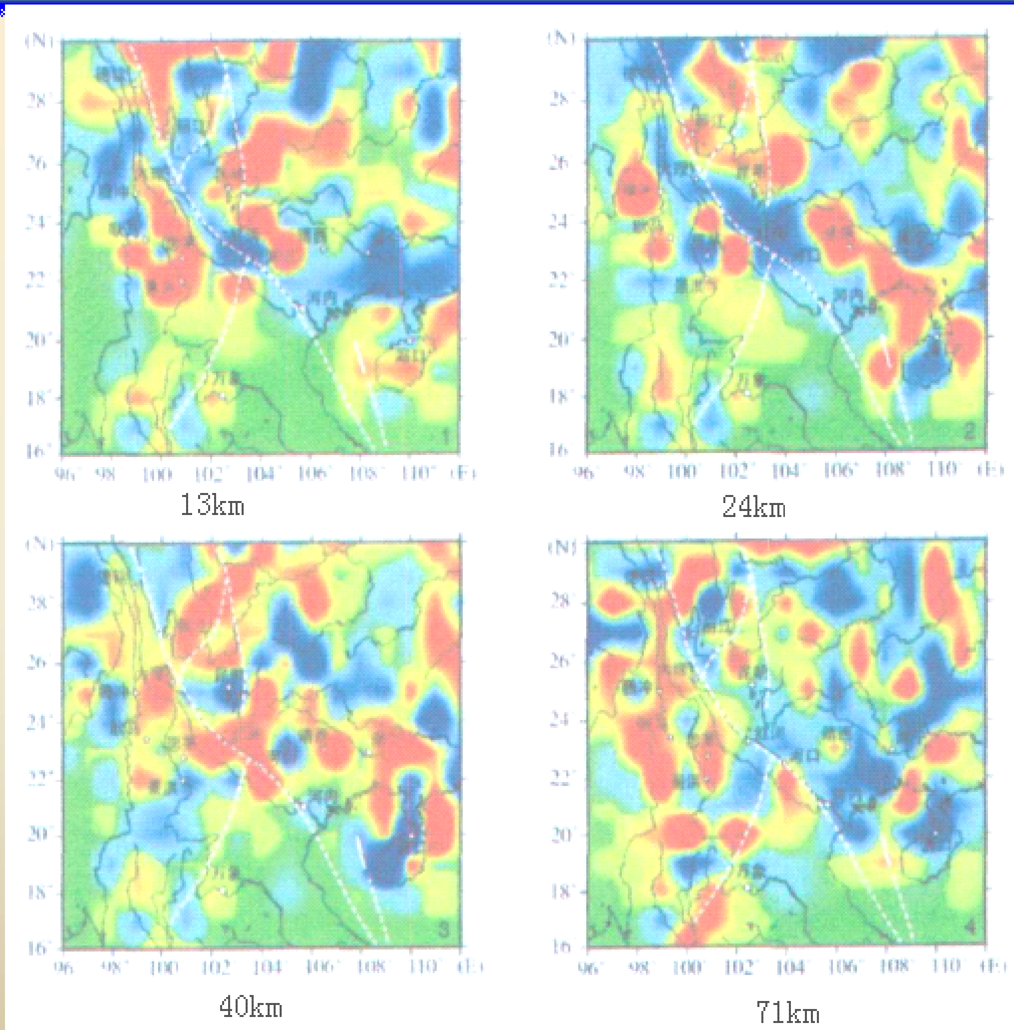
seismic source mechanism –P axial





Two preponderant directions—NNE-NE and NW-NNW—means two tectonic stress field

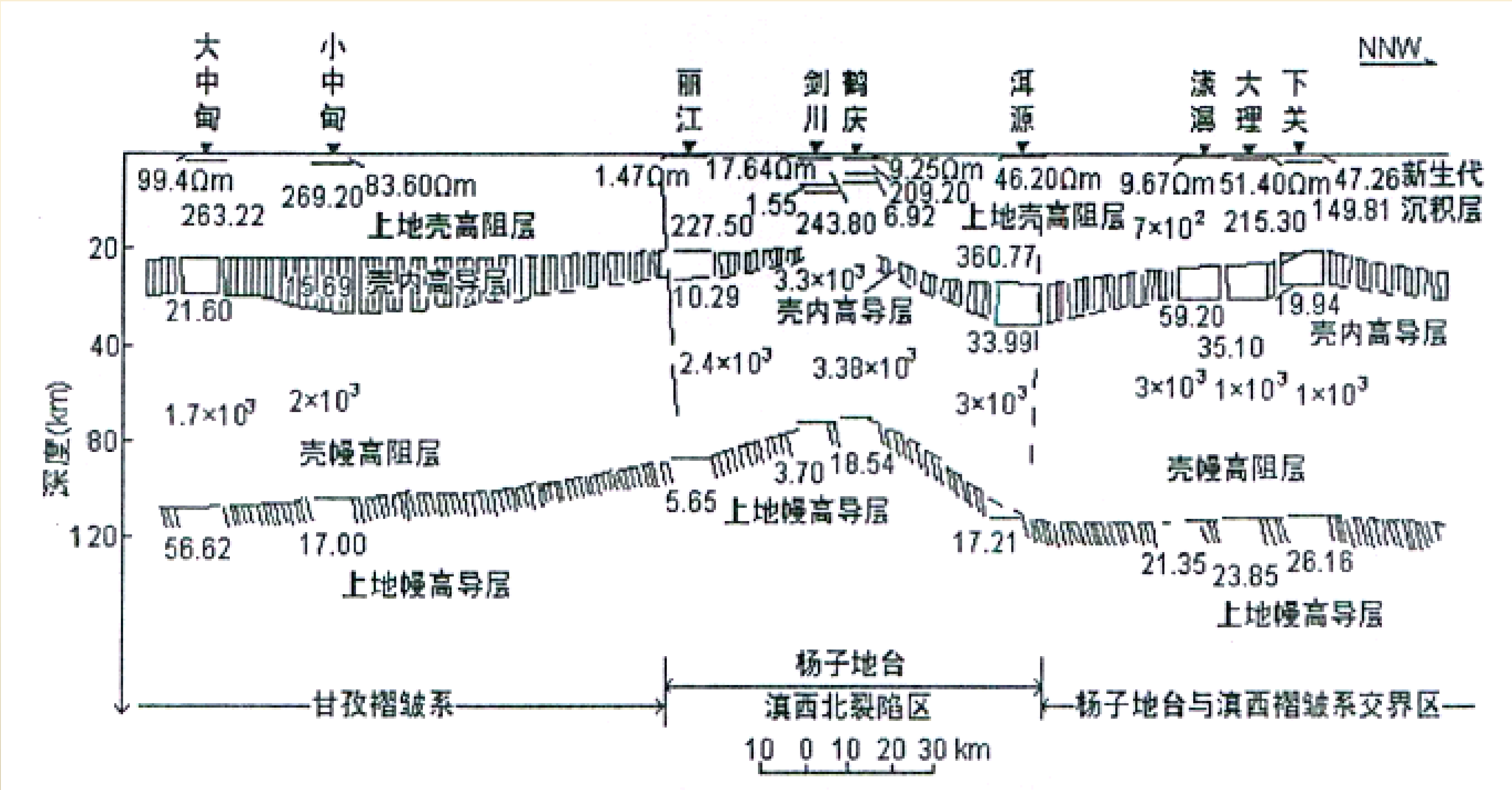
Geophysics



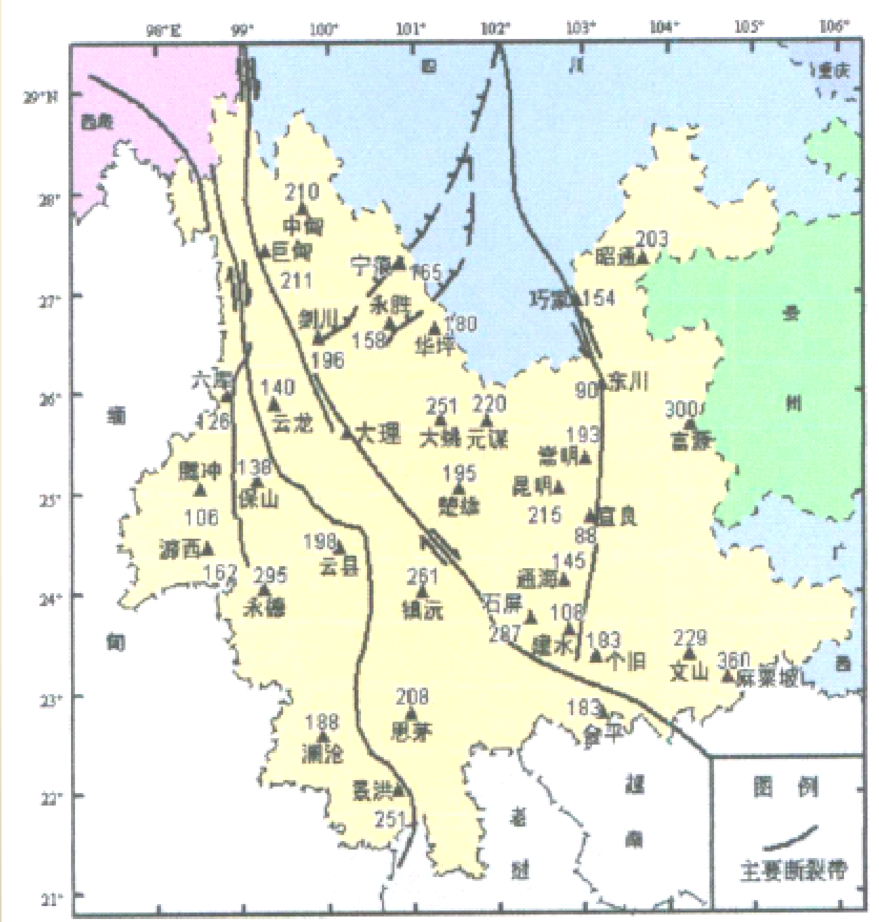
大范围为相对低速区(RED),NNW展布的长条状地壳底部明显的低速区。地震多发生于高速与低速过渡带.

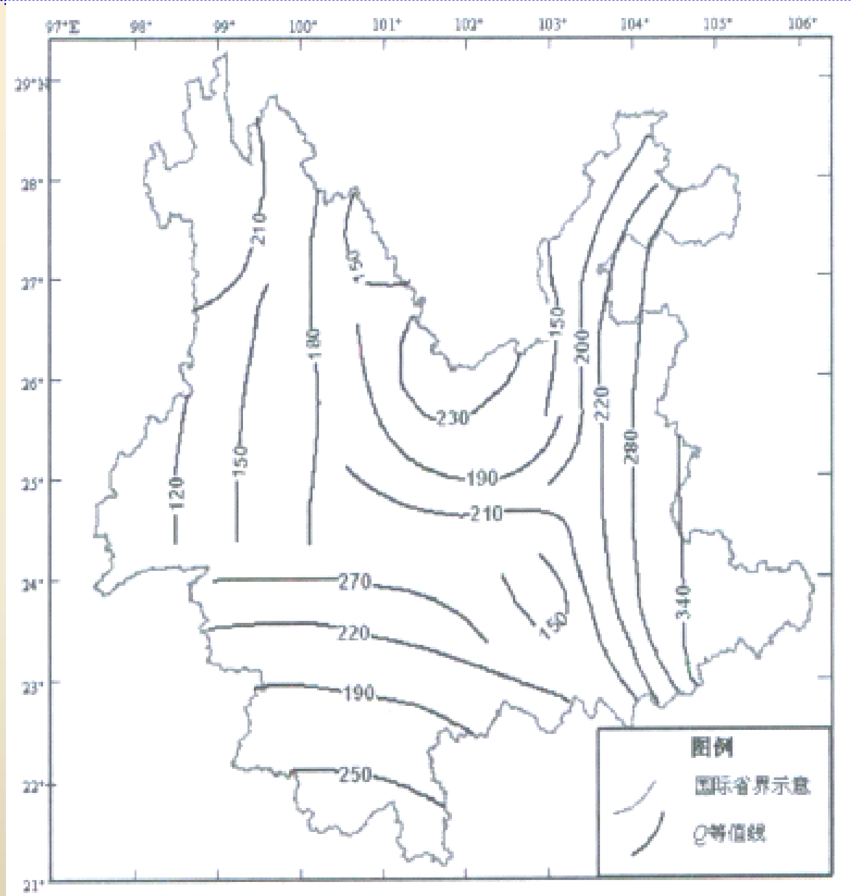
Velocity structure of lithosphere and upper mantle

Geo-resistance



Q value of end-body





Q值偏低且横向不均匀(transverse asymmetry)。构造活动、高热以及低速区域的Q值低,1900年以来，云南6级以上地震多发生在低Q值区。但龙陵一澜沧一耿马带例外，Q值高，大震频繁与新生破裂带发育有关

Fault characteristics

□ Activity characteristics

1)50一38MaB.P. relative inactive ;

2)38 一25MaB left-lateral strike moving ; the maximum displacement is about 0.8～1.6km

3)25 一5MaB.P. quietude;

4)5MaB. Right-lateral strike, active

□ Segmental characteristics

1) the south-eastern part is more active in recent 100 years

2) smaller earthquakes occurred in north-western part in recent decades only a MS=7.0 took place in 1925, but there were more 8 earthquakes (MS>7.0) in the south-eastern parts in recent 100 years

3) slipping rate

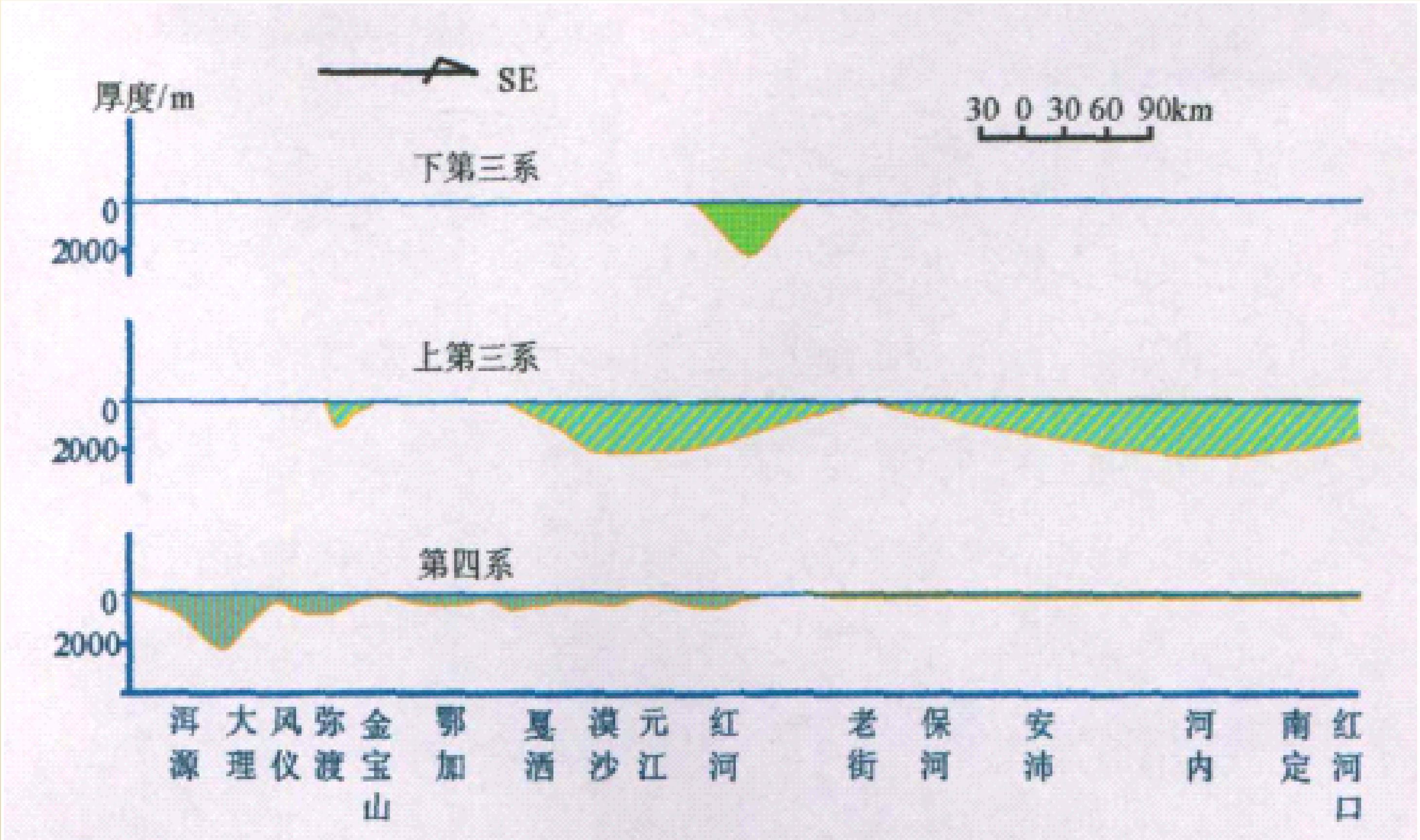
North-western : 3.5mm/a(horizontal)， 1.6mm/a(vertical)， Active in Q4

middle(creep slip) : 3.1mm/a, Active in Q3

south-eastern: :2.9mm/a, active in Q3

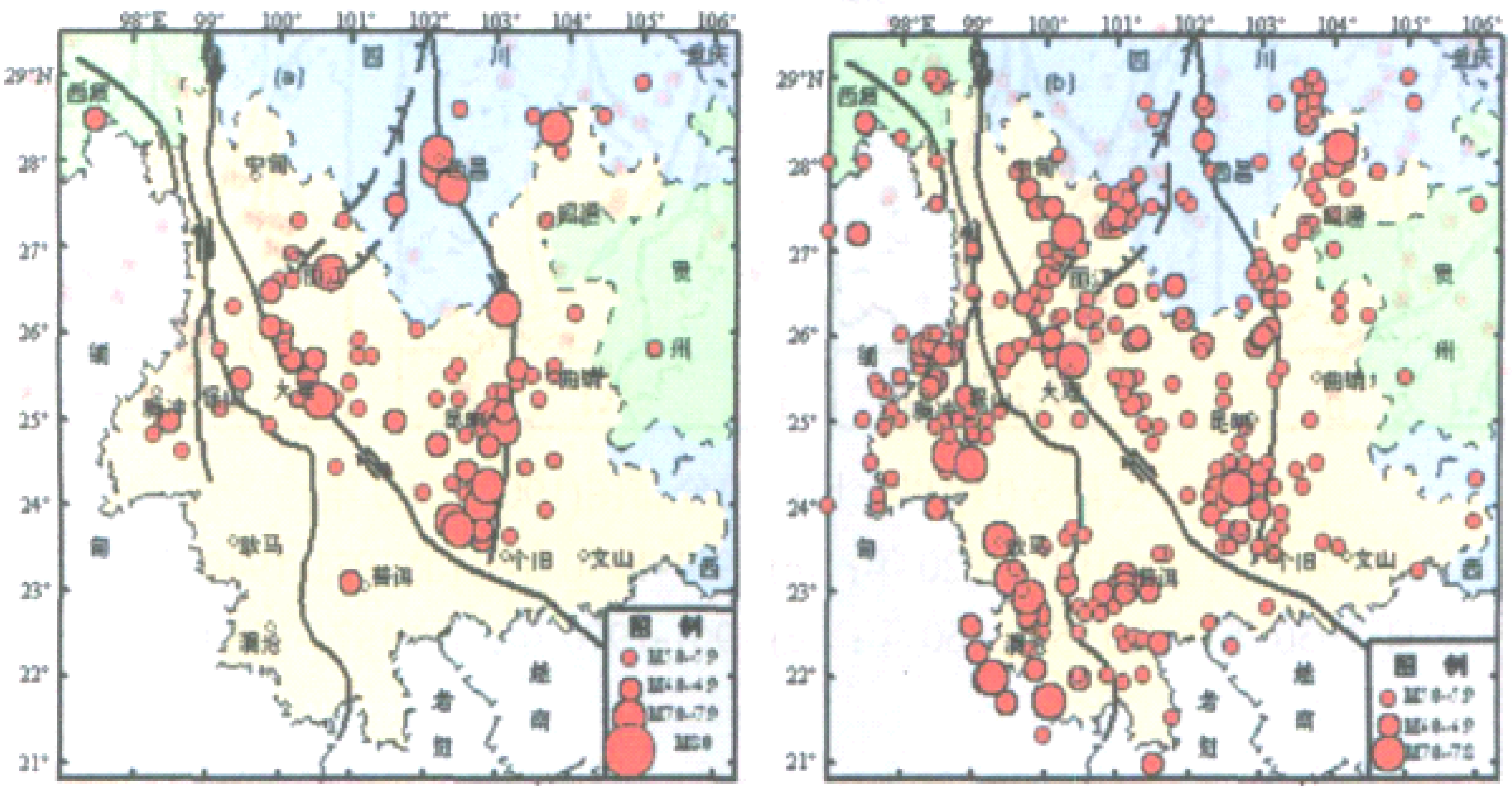
4) sedimentary thickness: sedimentary center moves towards the north-western part

Sedimentary in Tertiary and Quaternary period—move toward north-west



Sedimentary thickness of Tertiary(inactive and Quaternary (active)

Paleo-seismology



Ms > 5.0 earthquake map

From 624 to 1900 (left) From 1901 to 2008 (right)

The forecasting result of Seismic hazard assessment

- This fault has a obvious segmental characteristics, although the entire fault has a similar tectonic background , but many differences including slipping rate, activity period and stress direction and levels, etc.

- There will be a PGA= 0.1g earthquake in next 50 years in this low seismicity province based on the above comprehensive info including regional deformation developing and energy accumulation and releasing, etc.

4. Conclusions

- Comprehensive info is the most important foundation for seismic hazard assessment in low seismicity province

- Building fault system database --Including regional tectonic geology, continental dynamic, active and inactive faults and history earthquake database

The End

Successful Cooperation and Enjoying the everyday in Harbin

Thanks all of you!