第六章　断层与断层作用（5）

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断层与断层作用

- 断层概论
- 断层作用
- 逆冲推覆构造
- 伸展构造
- 走向滑动断层



内容提要

- 走滑断层的主要特征
- 走滑断层的主要伴生构造
- 剪切作用与剪切破裂
- 关于转换断层问题
- 走滑断层的形成机制

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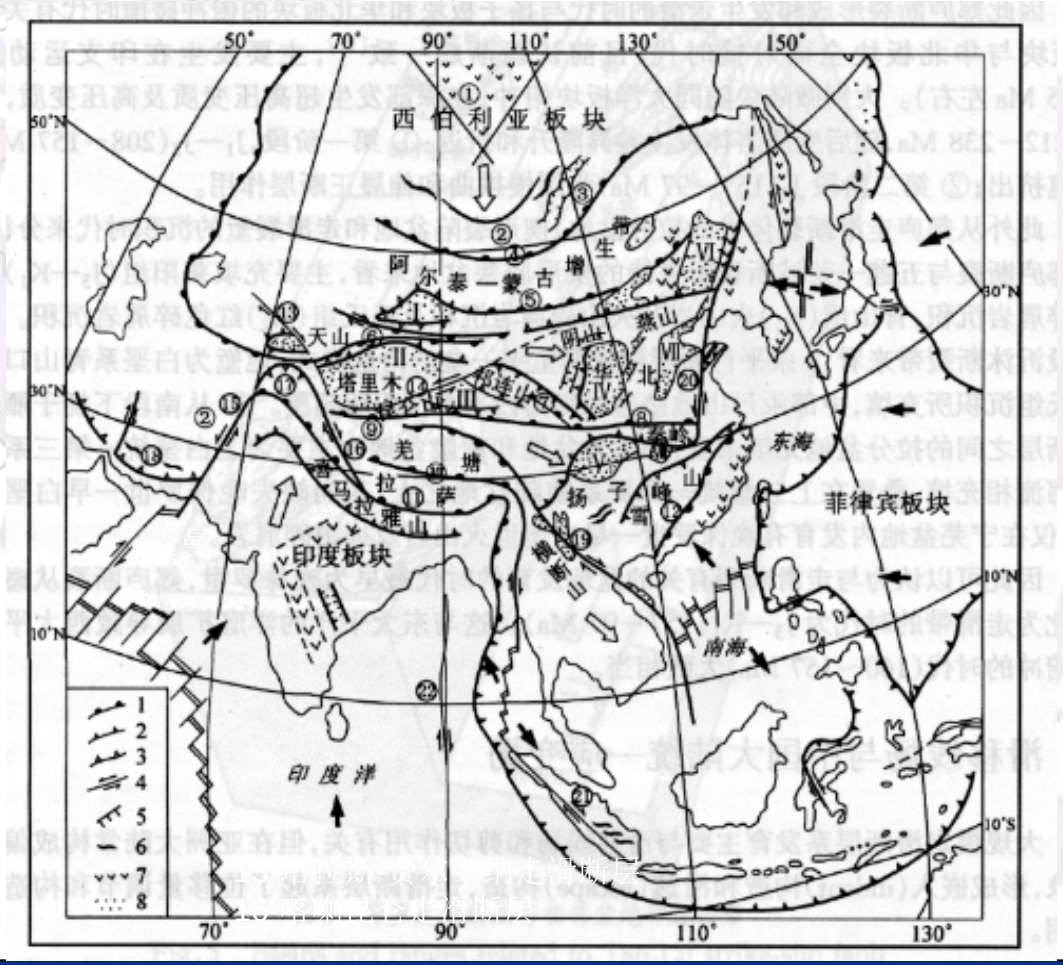
亚洲大地构造图


西伯利亚板块
阿尔泰—蒙古增生带
天山
塔里木
羌塘
拉萨
喜马拉雅山
印度板块
印度洋
东海
南海
菲律宾板块
50°
70°
90°
110°
130°
150°
50°N
30°N
10°N
10°S
1
2
3
4
5
6
7
8



阿尔金断裂

The Altyn Fault





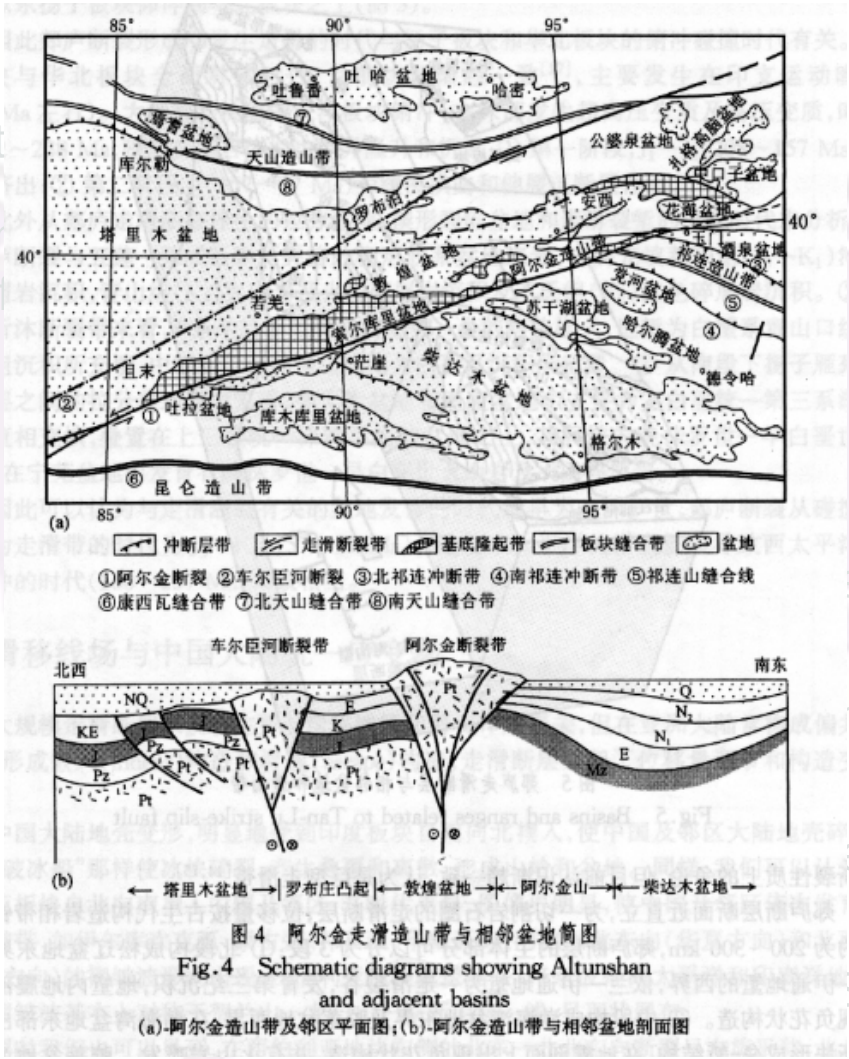


图 4 阿尔金走滑造山带与相邻盆地简图

Fig.4 Schematic diagrams showing Altunshan and adjacent basins

(a)-阿尔金造山带及邻区平面图;(b)-阿尔金造山带与相邻盆地剖面图

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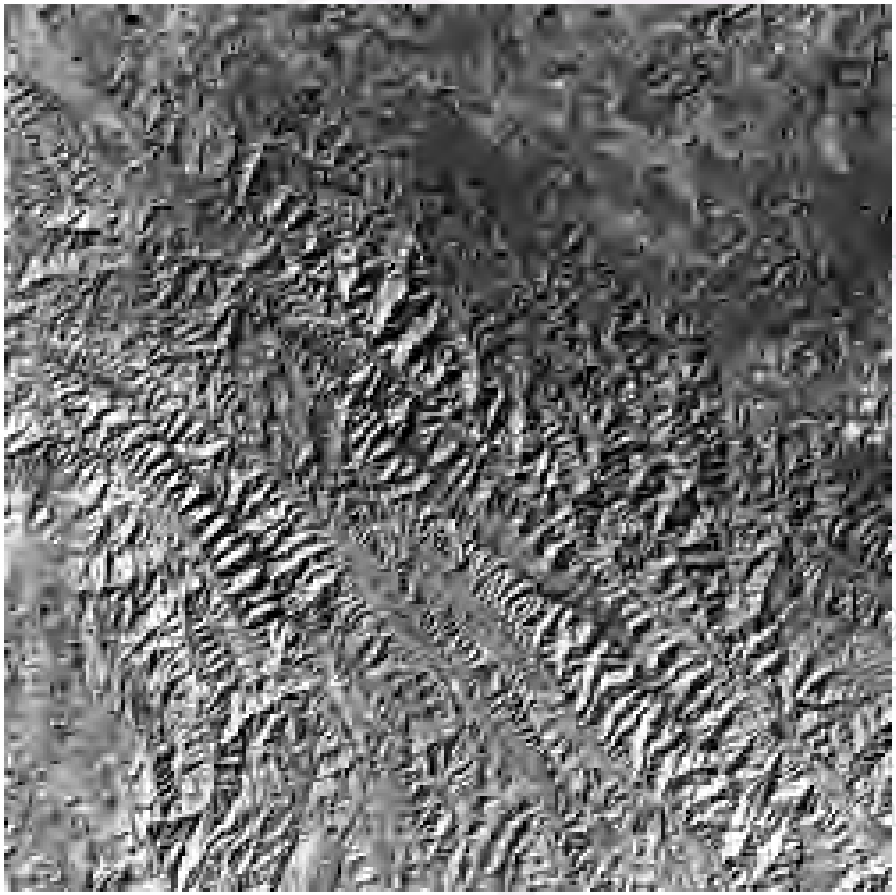

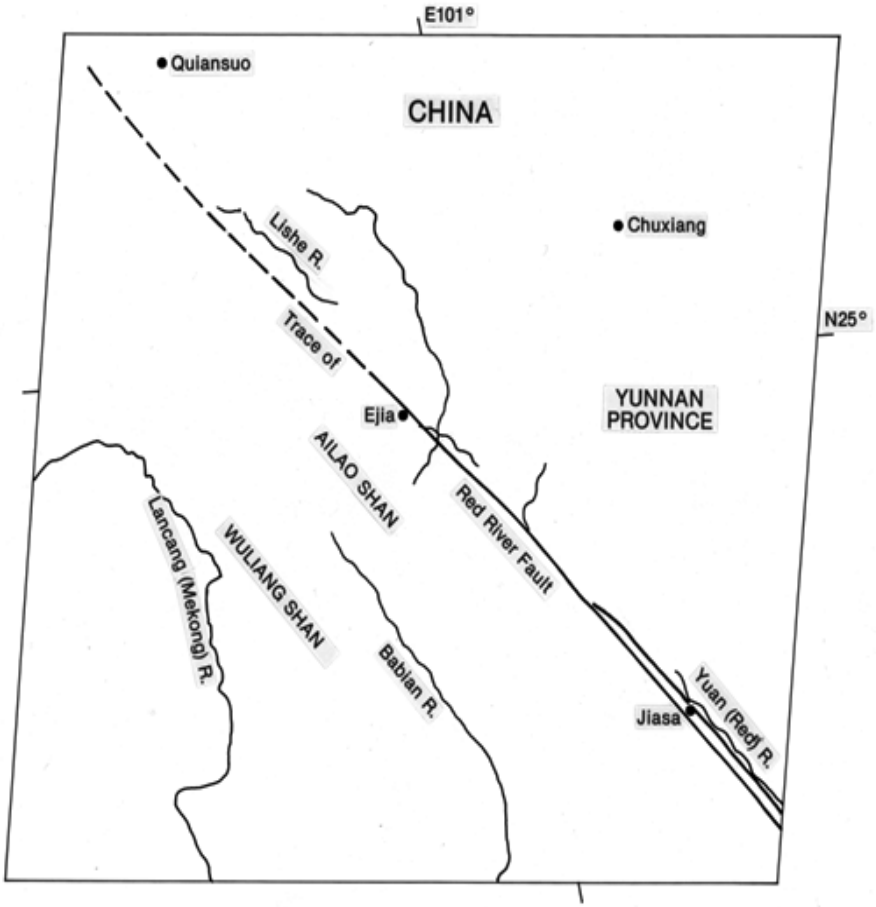

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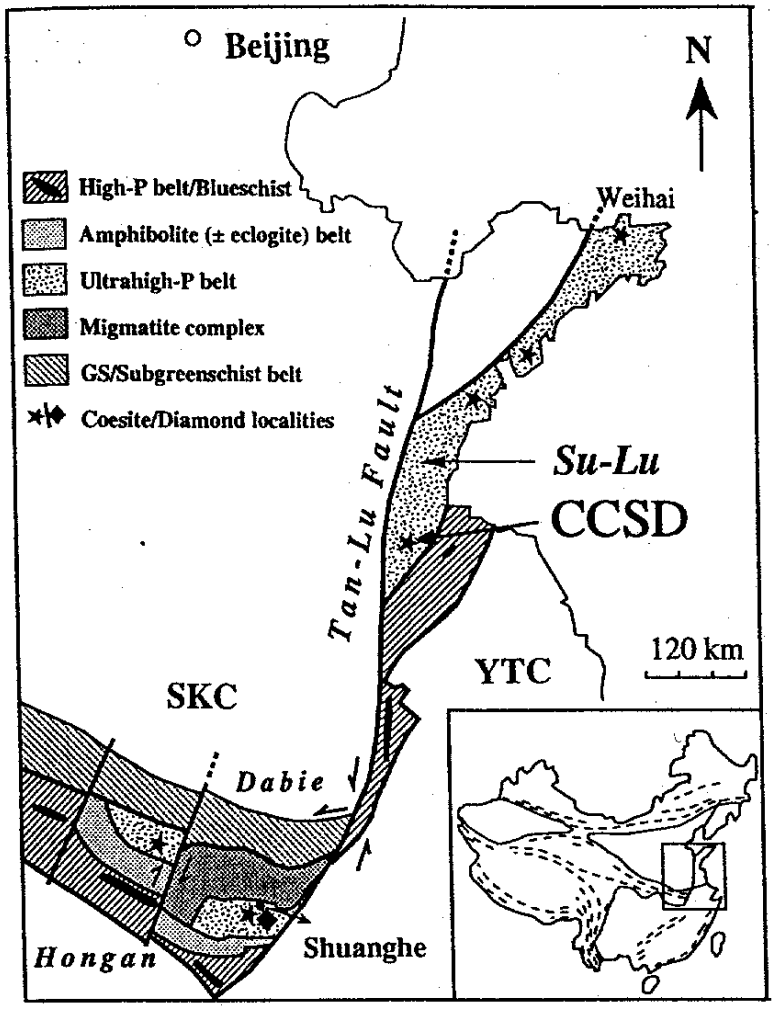
郯庐断裂


Beijing
N
High-P belt/Blueschist
Amphibolite (± eclogite) belt
Ultrahigh-P belt
Migmatite complex
GS/Subgreenschist belt
Coesite/Diamond localities
Weihai
Tan-Lu Fault
Su-Lu
CCSD
YTC
120 km
SKC
Dabie
Hongan
Shuanghe

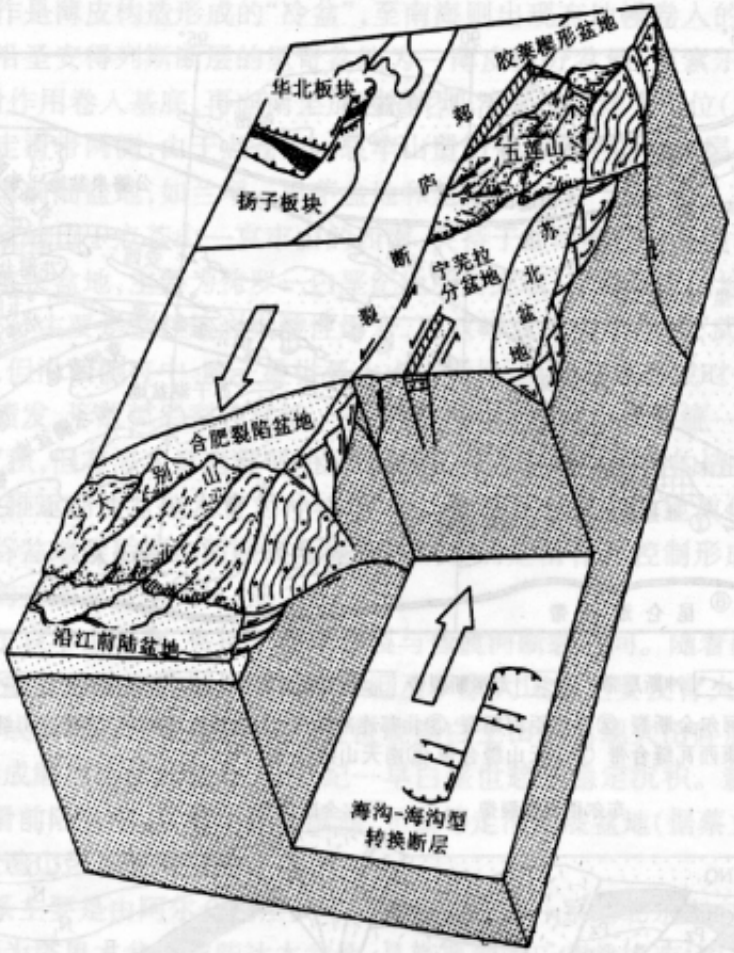


图 5　郯庐走滑断层与相邻盆地和造山带

Fig.5　Basins and ranges related to Tan-Lu strike-slip fault

West Coast Plate Boundaries

- San Andreas Transform Fault
- Juan de Fuca Spreading Ridge
- Olympic-Cascadia Subduction Zone



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Geology 101 Environmental Geology
Ray Joesten

Lecture 7 Slide 13

圣安德列斯断裂
San Andreas fault and related lakes



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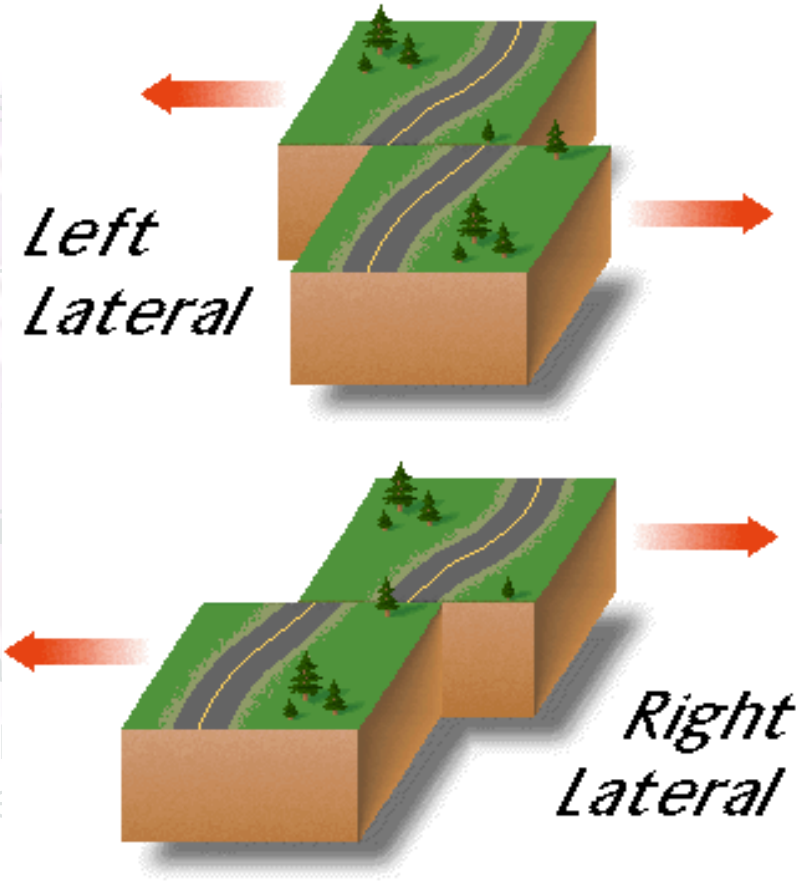
（一）走滑断层的主要特征

又称横断层（transcurrent)
或扭断层（wrench)

- 规模
- 产状陡立、线性显著
- 断层带窄
- 单列或共轭、左行与右行
- 位移在中间较大
- 伴生复杂的次级构造

走滑断层.avi

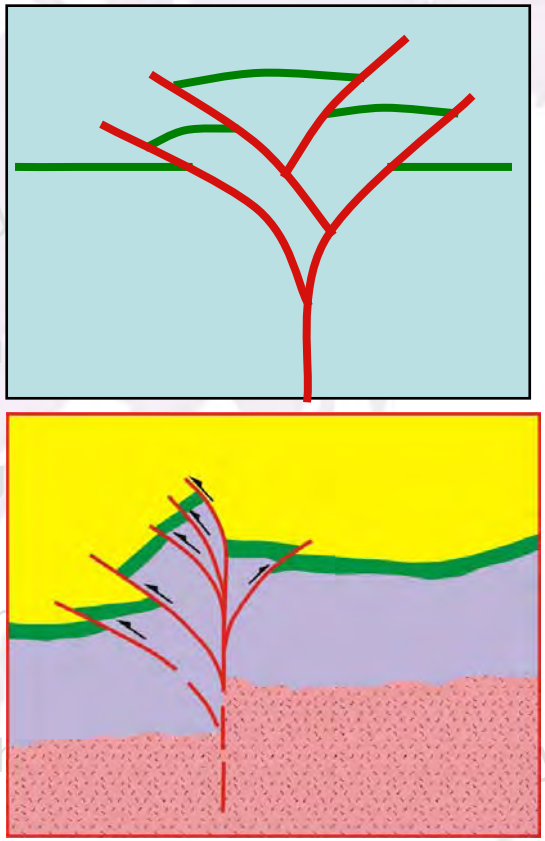


（二）走滑断裂伴生的构造型式

1、花状构造

正花状构造

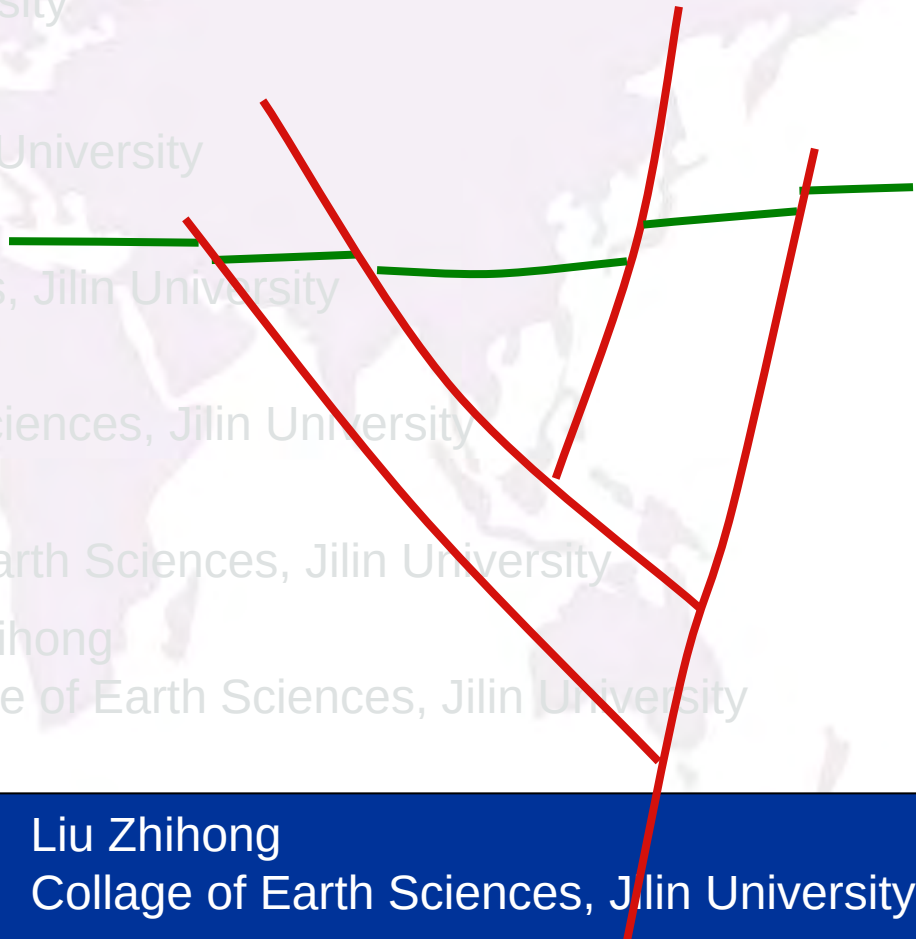
——棕榈树构造（palm tree structure），主干断层近直立插入盆地基底 / 呈现上凸的逆断层组 / 夹持部分形成隆起断块和背斜，它是压扭性断层作用（聚合型扭动）的产物。



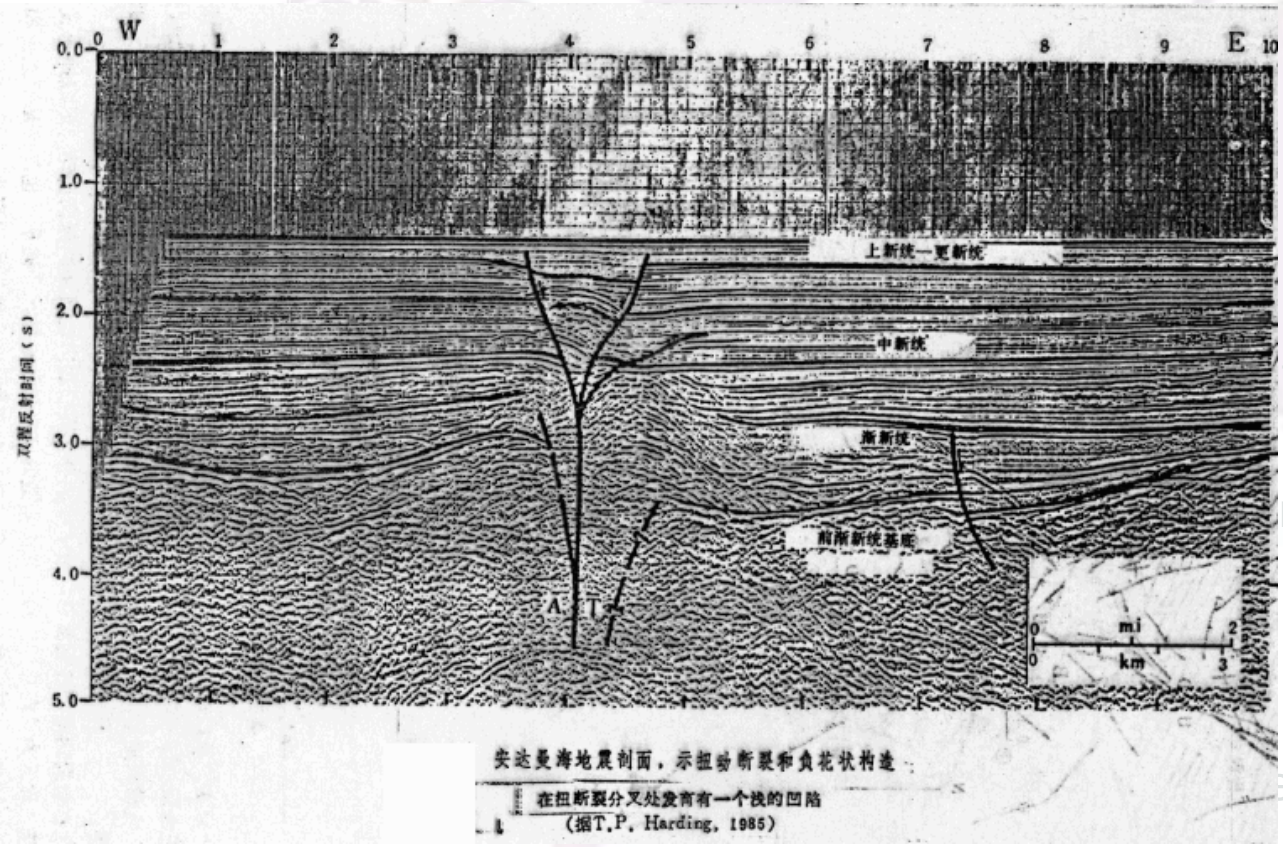
二、走滑断裂伴生的构造型式

负花状构造

——郁金香构造（tulip structure），主干断层同样近直立插入盆地基底 / 上凹的正断层组 / 夹持部分形成下凹断块和向斜。一般认为它代表张扭性断层作用（离散型扭动）的产物，但是Naylor（1986）的沙箱实验表明，纯扭断层作用（平行扭动）所产生的也是负花状构造。



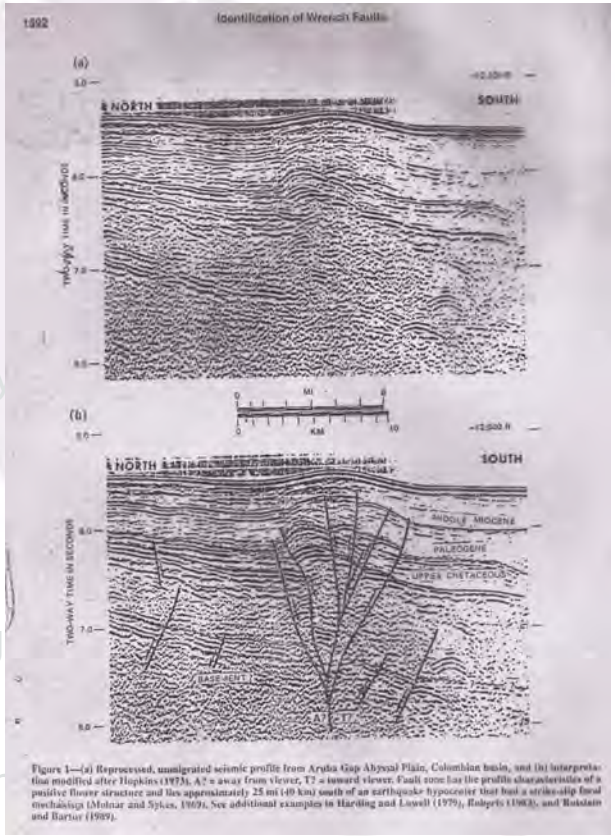
花状构造实例



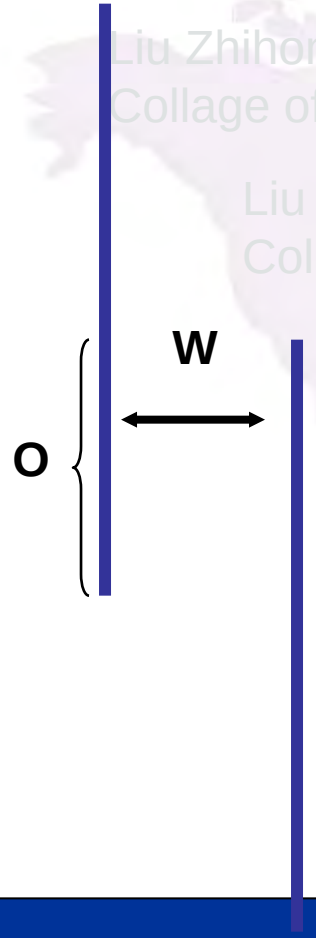
安达曼海地震剖面，示扭动断裂和负花状构造

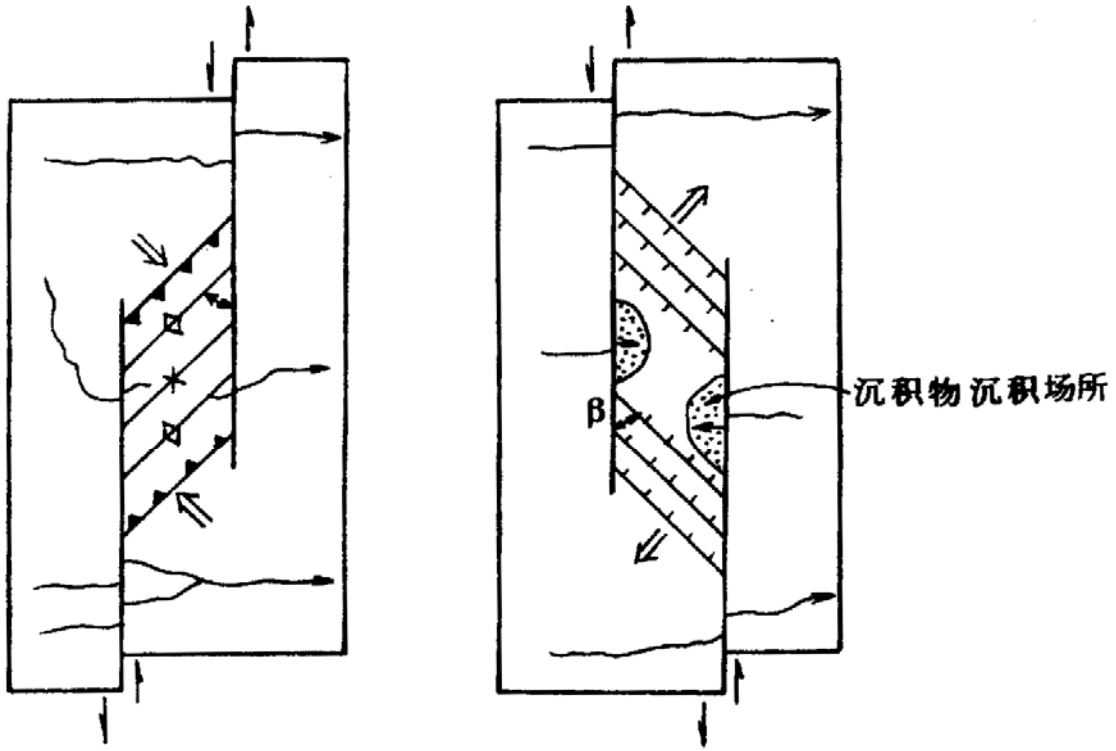
在扭断裂分叉处发育有一个浅的凹陷

（据T.P. Harding, 1985）



2、走滑断层的重叠与间隔

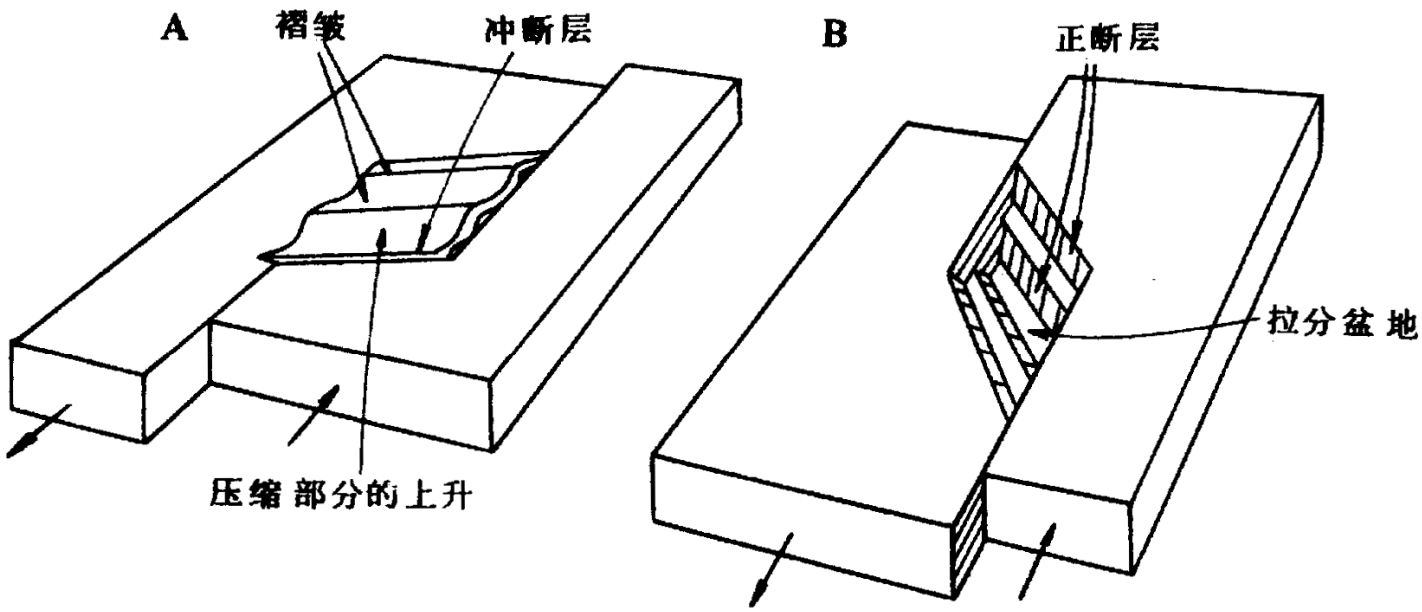




雁行状走滑断层系重叠区次级构造类型

（据 J. G. Ramsay，1987）

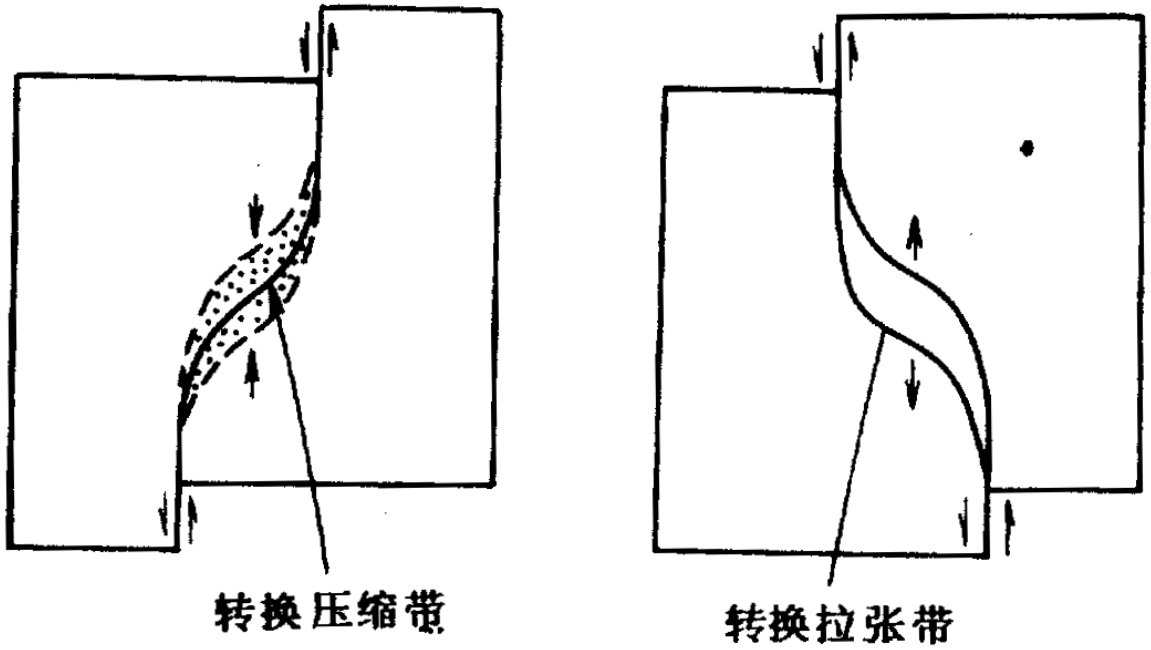
3、主断层面弯曲与走滑双重构造



走滑断层面弯曲形成的构造（据 J. G. Ramsay，1987）

A—转换挤压带的上升区；B—转换拉张带的拉分盆地和菱形地堑

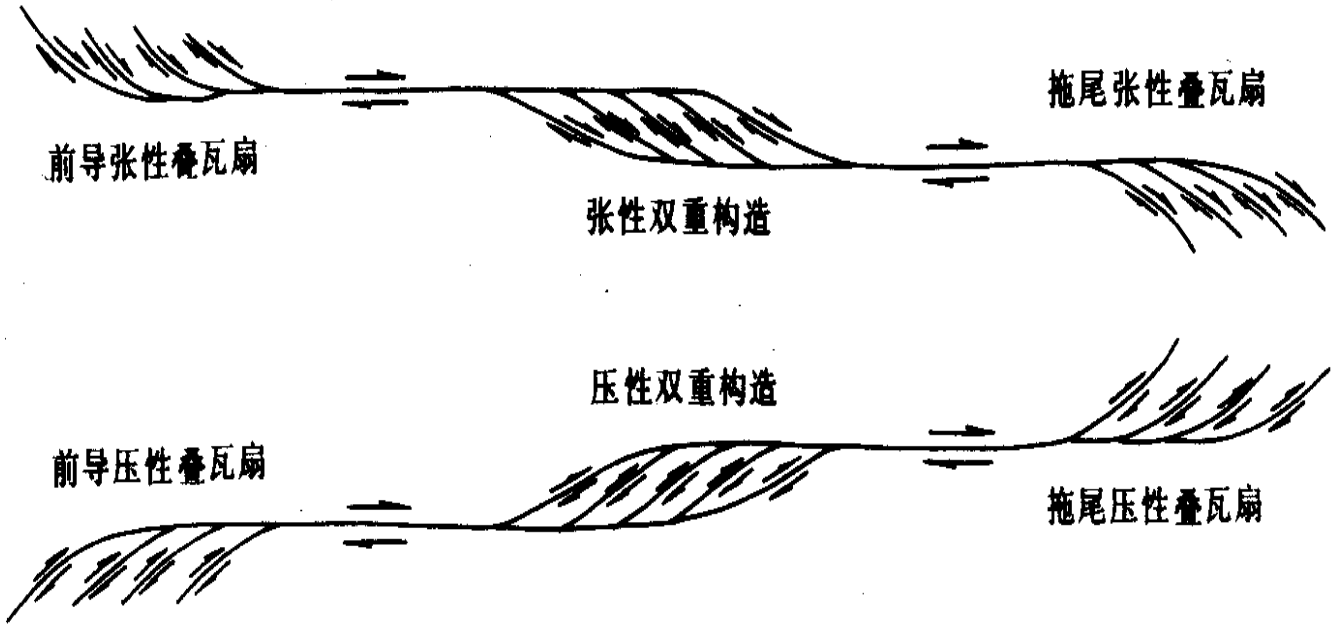
3、主断层面弯曲与走滑双重构造



走滑断层弯曲处的转换挤压和转换拉张

（据 J. G. Ramsay，1987）

3、主断层面弯曲与走滑双重构造



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4、拉分盆地

拉分盆地（**pull-apart)**一词最早是由**Burchfield & Stewart(1966)** 在研究加州死谷形成机制首先提出的。

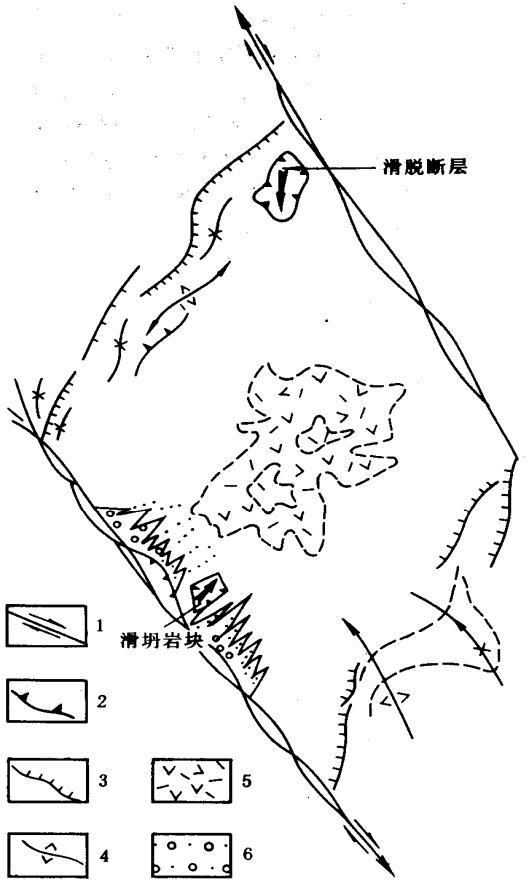

图 14-9　拉分盆地理想化模式图
（据 J. C. Crowell，1974，简化并修改）
1. 走滑断层；2. 逆冲断层；3. 正断层；
4. 褶皱轴；5. 火山岩系；6. 碎屑岩系

拉分盆地类型



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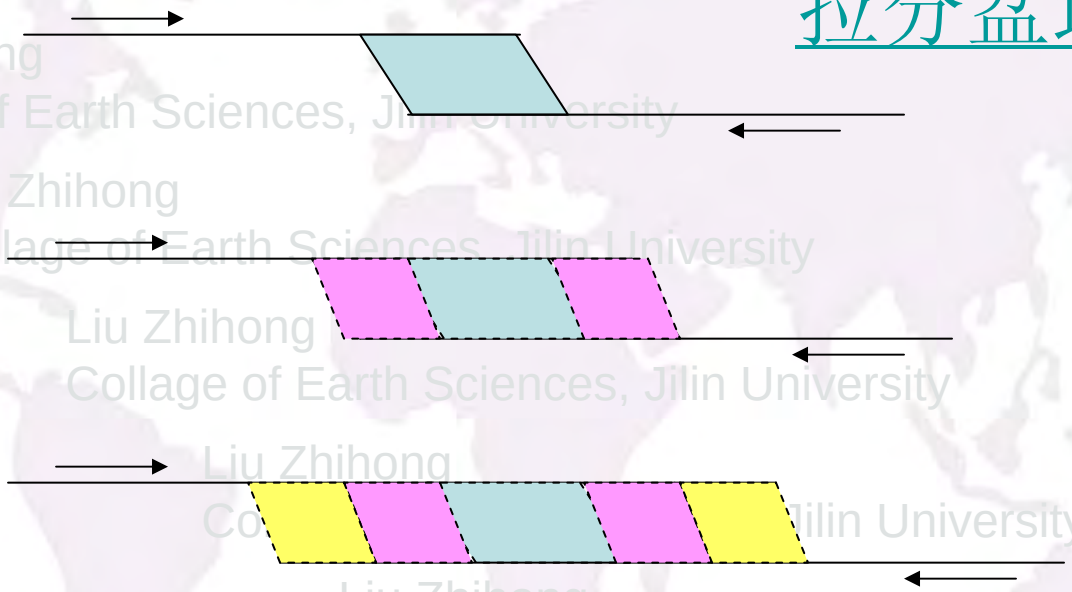
拉分盆地的演化



拉分盆地.avi

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拉分盆地的地质特点

- 发育快、沉降快、相变快、厚度大
  - 陆缘：陆相→海相；或海相→湖相→河流相
  - 陆内拉分盆地：全为陆相
- 大型拉分盆地，长期生长，地壳相对薄，有火山活动和侵入岩侵入，热流较高
- 快速沉积埋藏提供良好生油层，走滑形成的雁列褶皱形成良好的储油构造
- 常发生地震

拉分盆地的地质特点

- 有利于油气、盐类矿床形成
  - 厚的多有机物海、湖相沉积，快速沉降埋藏，高热流—生油层
  - 碎屑沉积—储油层；雁列褶皱—储油圈闭
- 地震：伸展扭动背景中，容易诱发地震
  - 土耳其安那托利亚断层；1920年甘肃海原地震；

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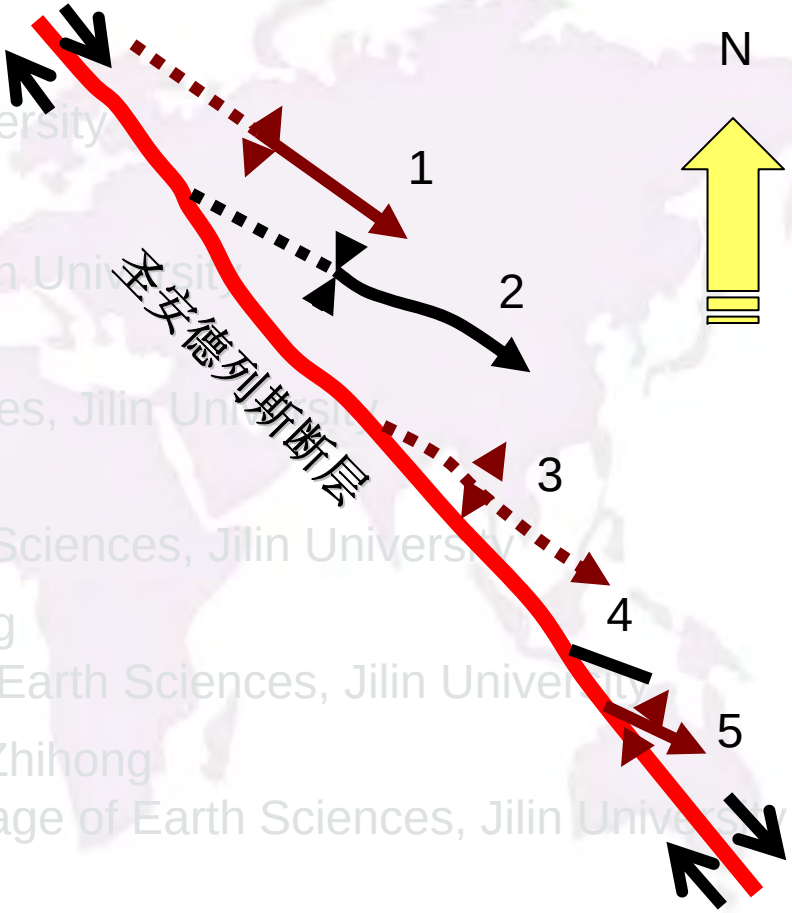
5、走滑断层伴生的褶皱

- 雁列式褶皱
  - 褶轴小角度交于断层
  - 远离断层逐渐消失
  - 产于断层一侧或二侧，或带内



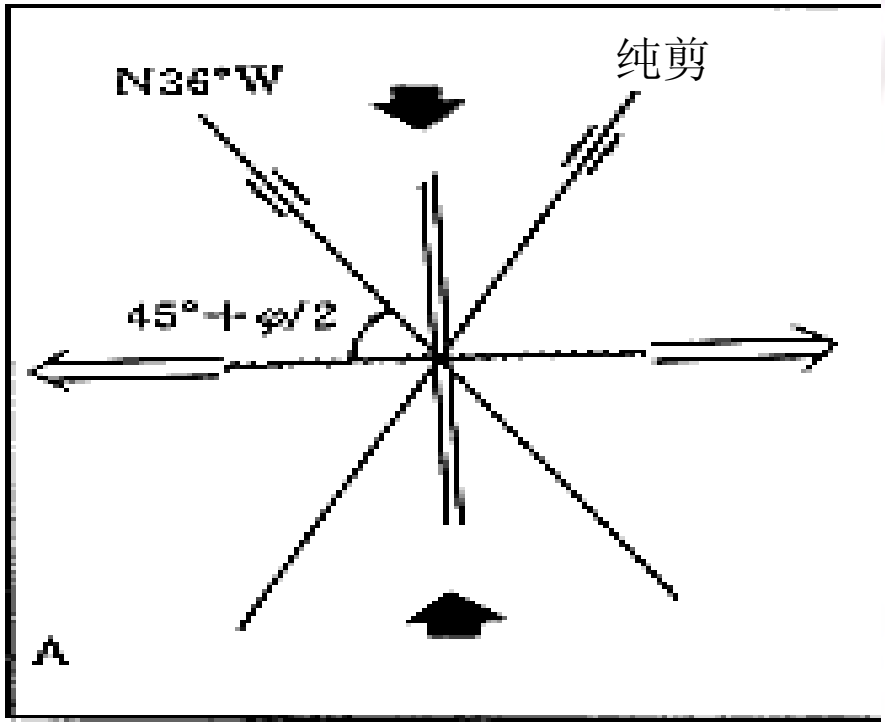
牵引褶皱



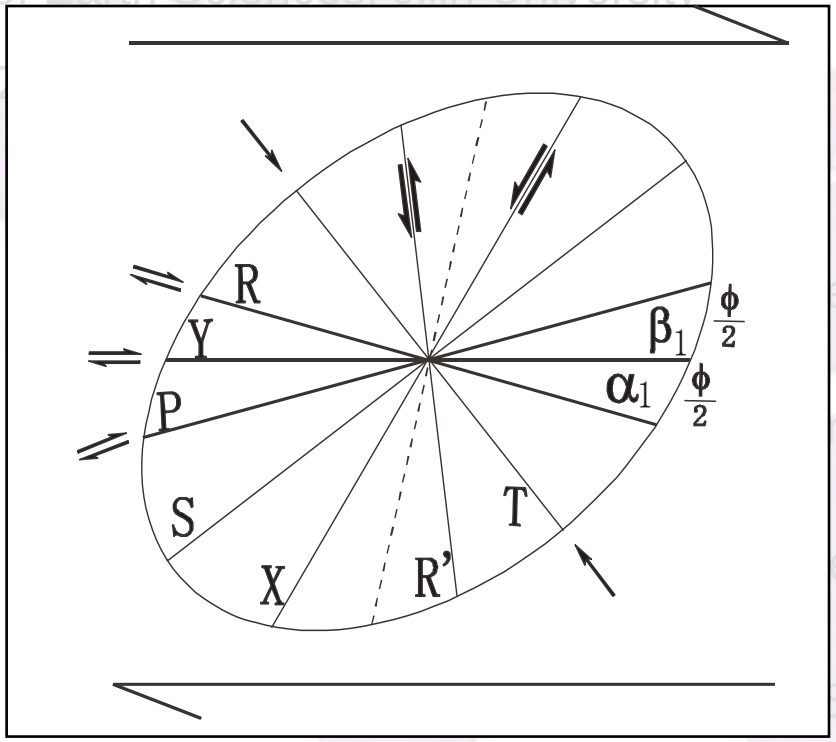
新西兰阿尔卑斯走滑断层及其东南盘的牵引弯曲

（三）剪切作用与剪切破裂
Shearing and shear fractures

纯剪应变中变形前与应变椭球主轴平行的直线在变形后仍保持其平行性。



（三）剪切作用与剪切破裂
Shearing and shear fractures



1. R剪切面：与走滑主剪切面Y夹角很小的锐角 $\phi/2$；
2. R'剪切面：与主滑主剪切面Y呈较大的锐角90°-$\phi/2$；
3. P剪切面：与Y面夹小锐角 $\phi/2$
4. X剪切面：与Y面夹较大的锐角90°-$\phi/2$
5. T面：与Y面夹角等于45°
6. S面：与Y面夹角45°

单剪应变中平行于剪切面方向上的平面在变形前后保持其平行性，单剪变形是一种等体积变形。

The two geologists stand astride the main strand of the Superstition Hills fault where is courses straight across the desert floor.

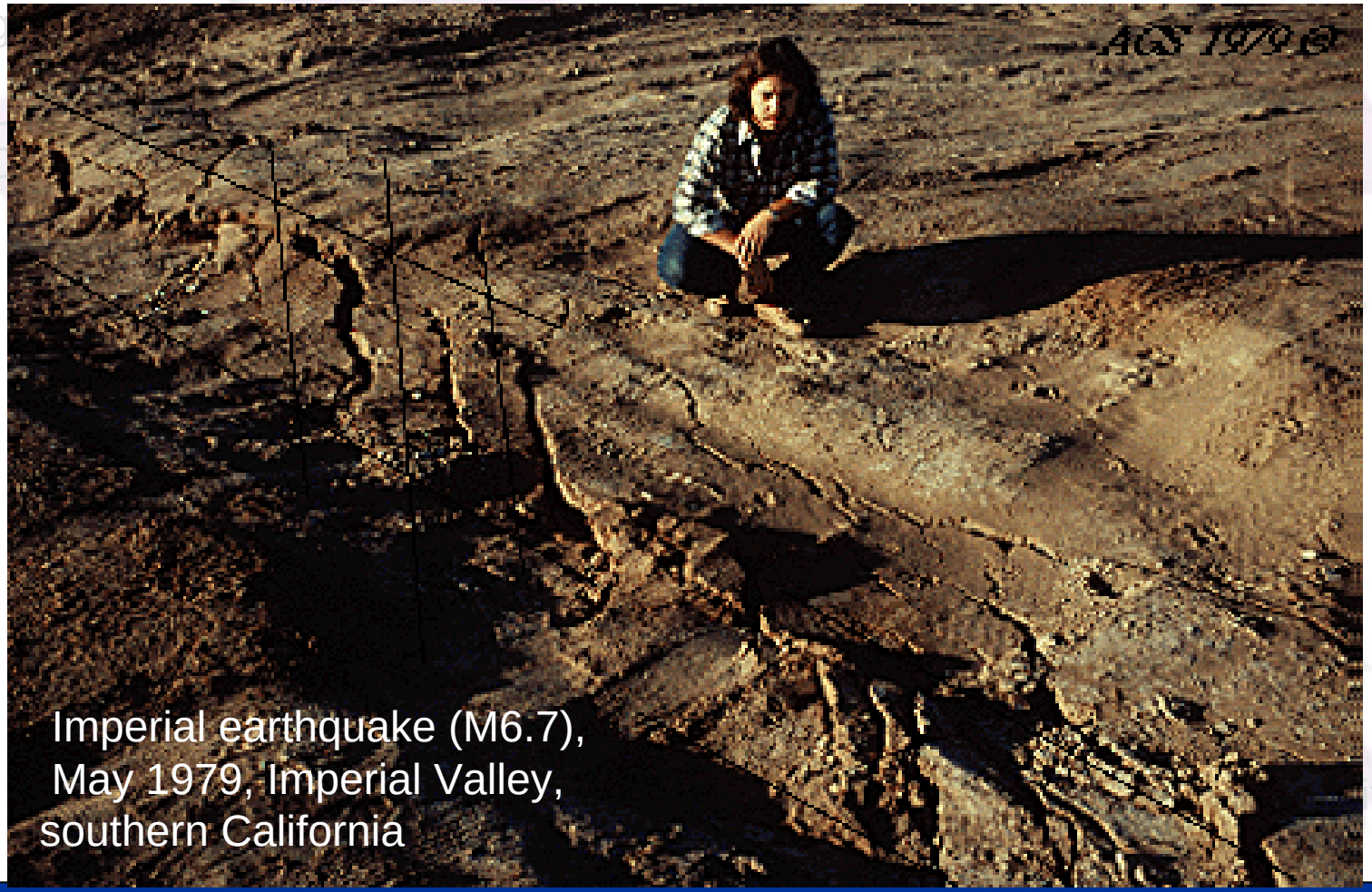
The fault steps to the right, and between the two fault strands is an elongate ditch

—stepover basin



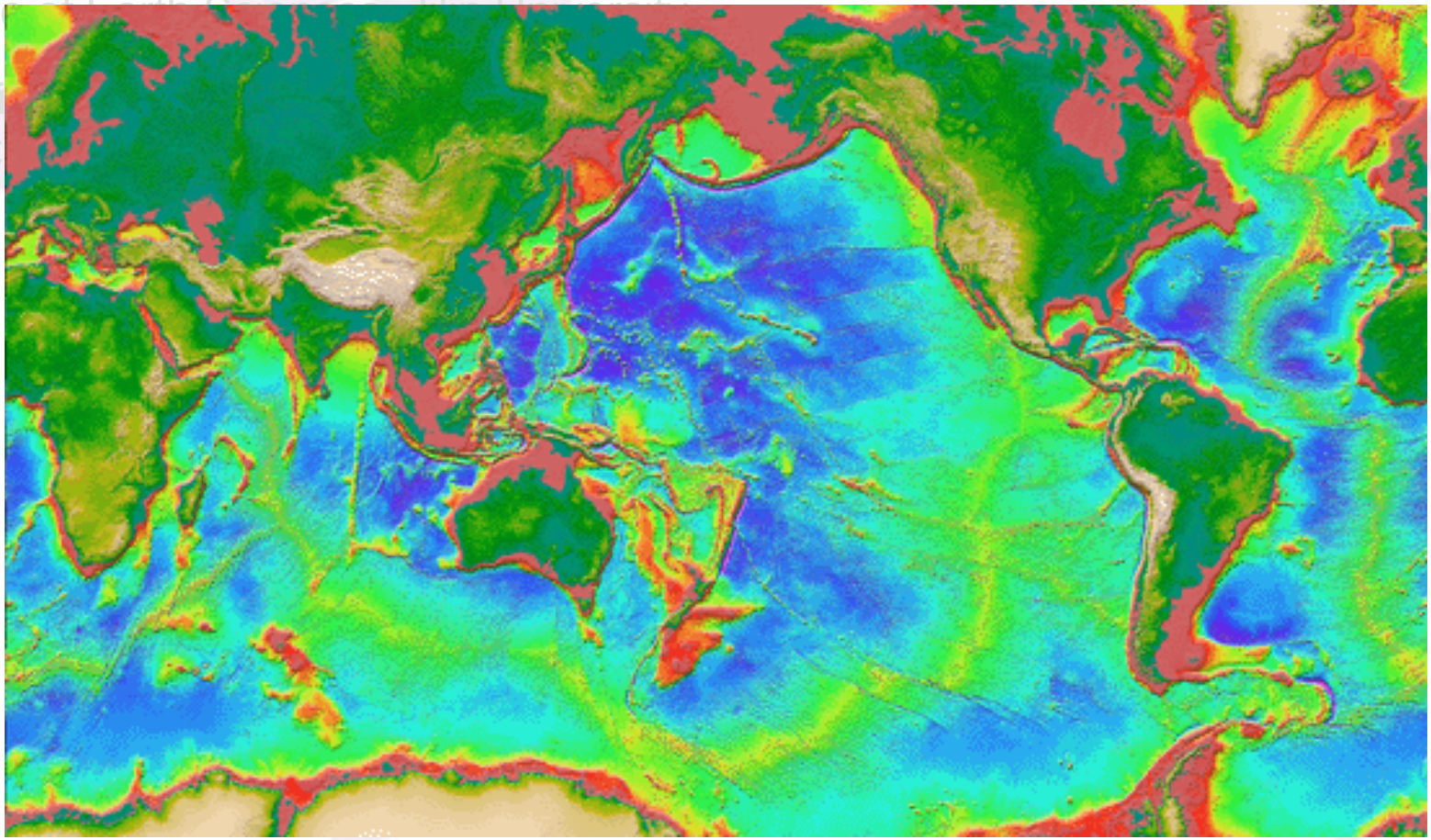
Imperial earthquake (M6.7), May 1979, Imperial Valley, southern California

en echelon R fractures



Imperial earthquake (M6.7), May 1979, Imperial Valley, southern California

（四）关于转换断层问题



关于转换断层问题

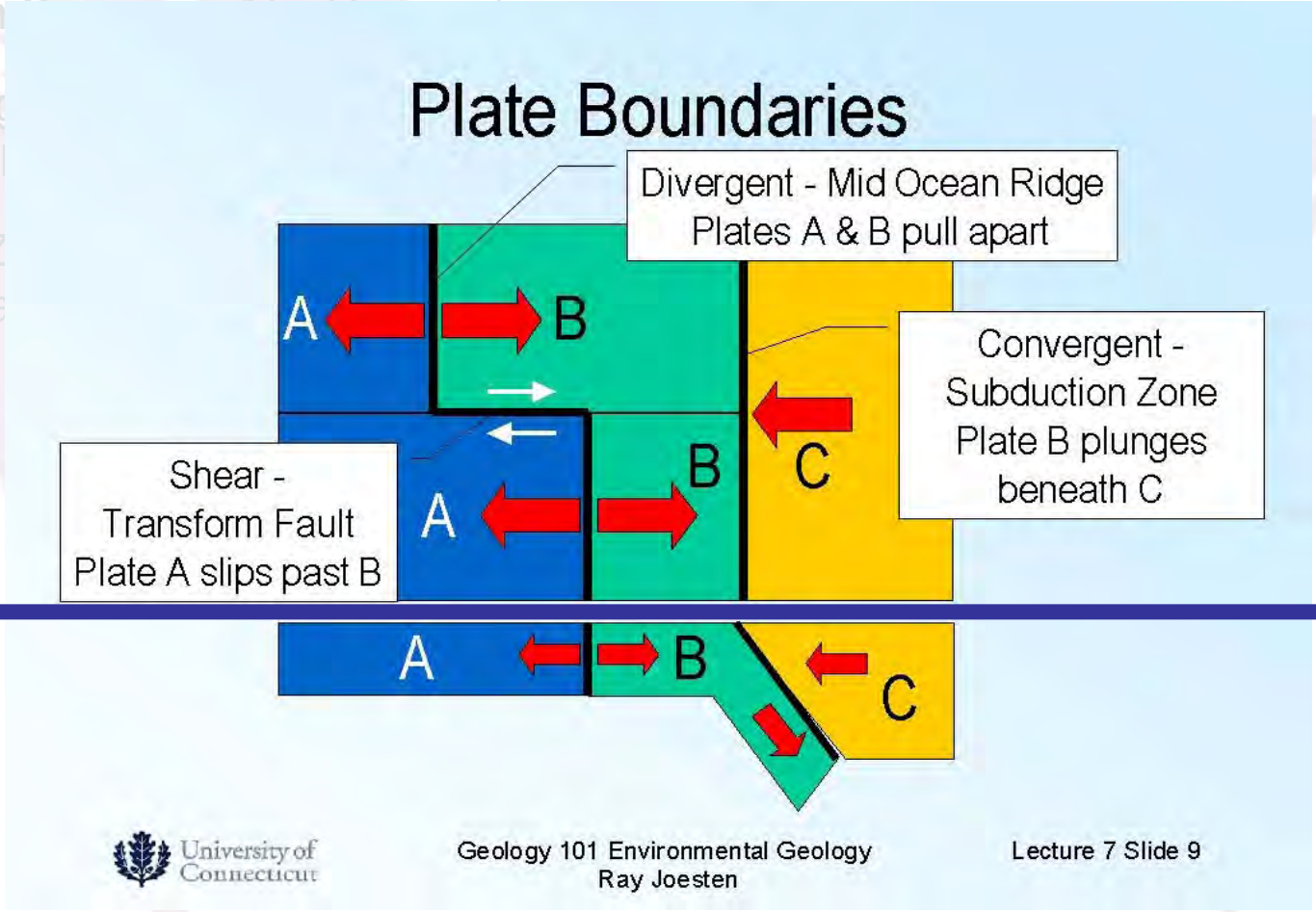
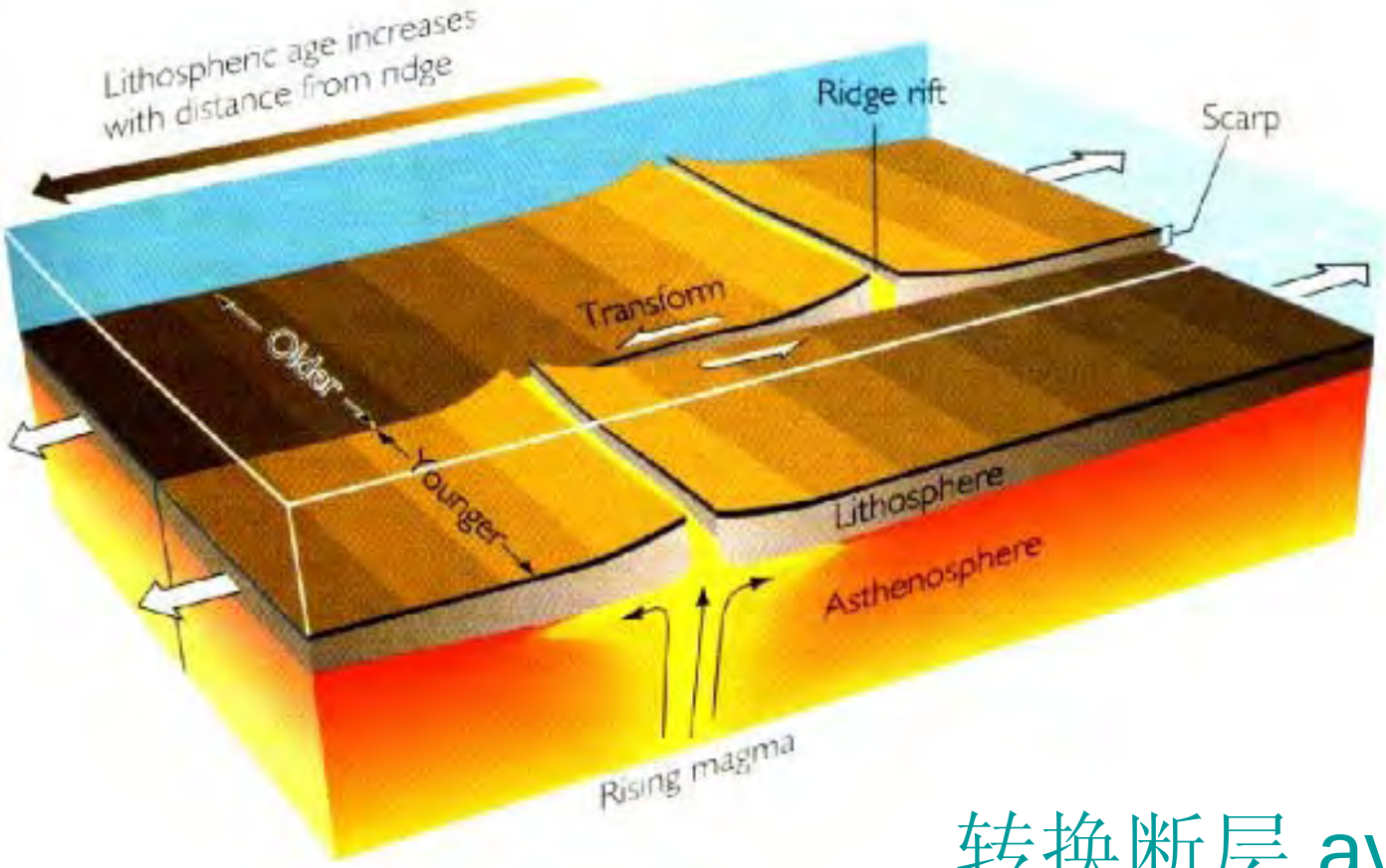
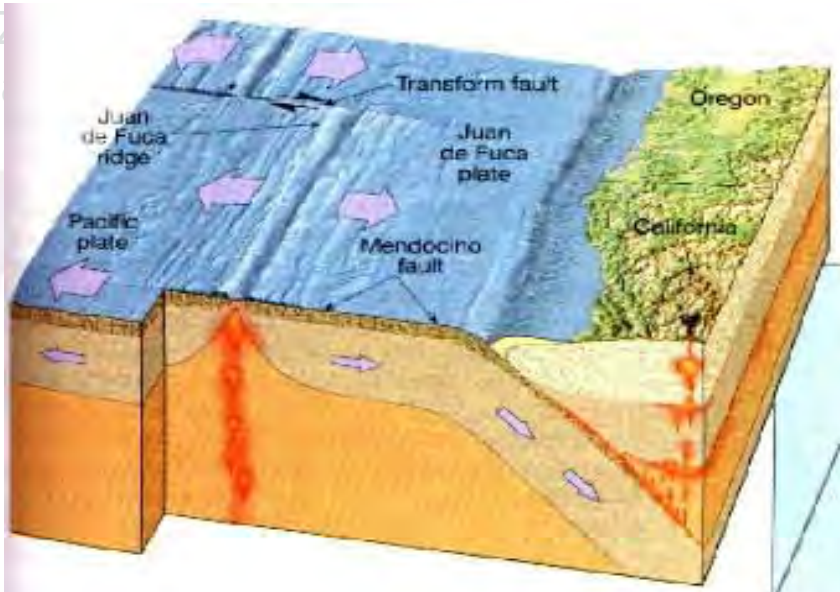
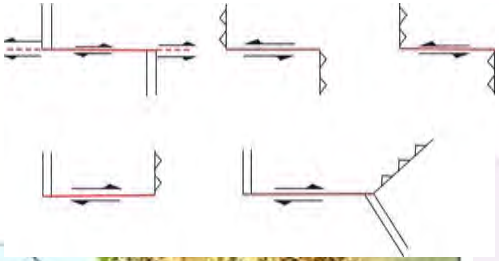


Plate Boundaries
Divergent - Mid Ocean Ridge
Plates A & B pull apart
Convergent -
Subduction Zone
Plate B plunges
beneath C
Shear -
Transform Fault
Plate A slips past B
A
B
C
A
B
C
A
B
C
University of Connecticut
Geology 101 Environmental Geology
Ray Joesten
Lecture 7 Slide 9


Lithospheric age increases with distance from ridge
Ridge rift
Scarp
Transform
Older
Younger
Lithosphere
Asthenosphere
Rising magma

转换断层.avi

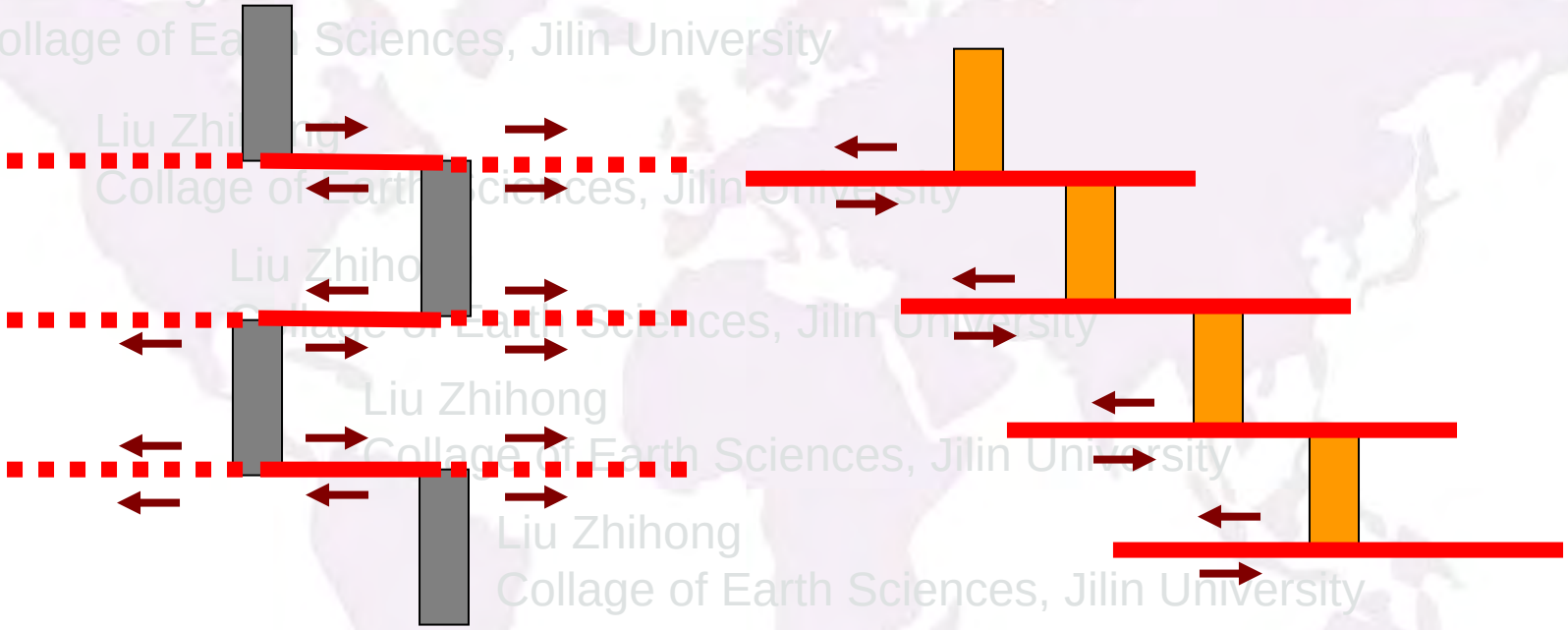






转换断层：是走滑断层的一种特殊类型。是分隔大型岩石圈板块边界，它连接其它板块边界（俯冲带、离散脊或三结点），构成能使刚性板块相互运动并保持地球表面积不变的重要构造要素。

转换断层与狭义走滑断层的区别



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转换断层与狭义走滑断层的区别

走 滑 断 层	转 换 断 层
1.以位移逐渐减小或转化为其它性质的分支断层而终止	**1.**在特殊的伸展性或收缩性构造处突然终止
2.位移有变化且向其终止处变小	**2.**沿断层位移相等
3.位移小于断层长度的**20%**	**3.**位移量无限制
4.相邻平移断层有相似的位移方式	**4.**相邻平行断层可以有相反位移方式
5.形成大陆板块内部应变型式的一部分	**5.**形成于板块接触处，并见于洋–洋，洋–陆和陆–陆板块边界

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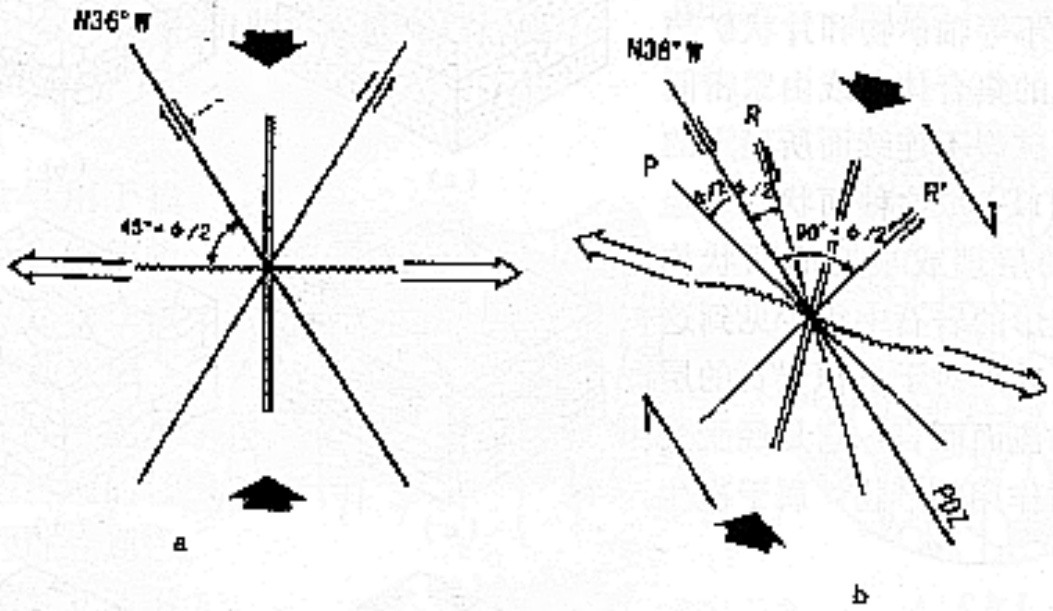
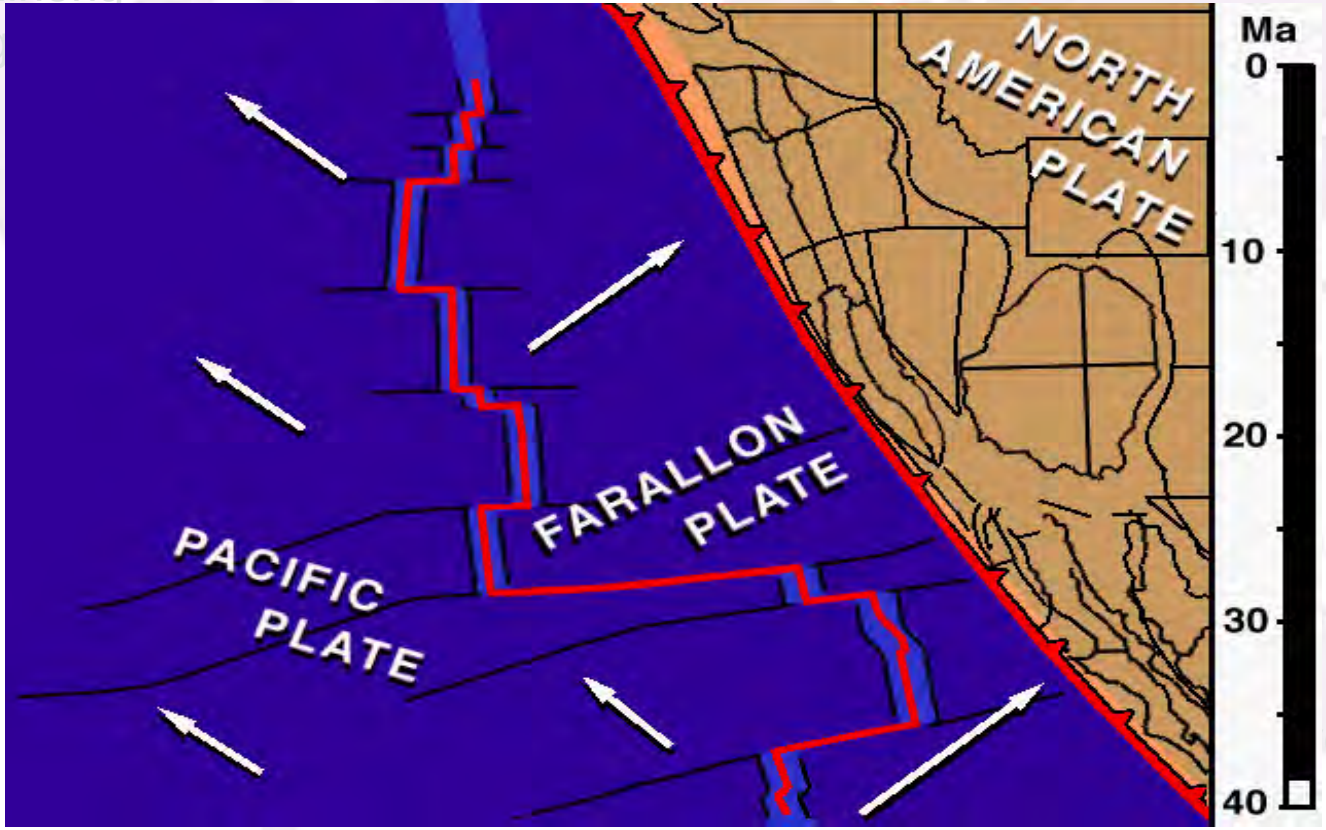


图10-18　走向 N36°W 的垂直断层走滑构造模式平面几何关系图

（据 Sylvester，1989）

（A）纯剪切的 Coulomb—Anderson 模式；（B）右行简单剪切的 Reidel 模式，双平行线表示拉线（T）断裂方向，波浪线表示褶皱轴方向，P：P 裂隙，R 和 R 分别是同向与反向剪切裂隙，PDZ，主位移带，Φ：内摩擦角，黑短尖头：压缩轴，白色尖头：拉伸轴

（五）走滑断层的形成
—板块相对运动



走滑断层的形成
—地壳水平剪切作用



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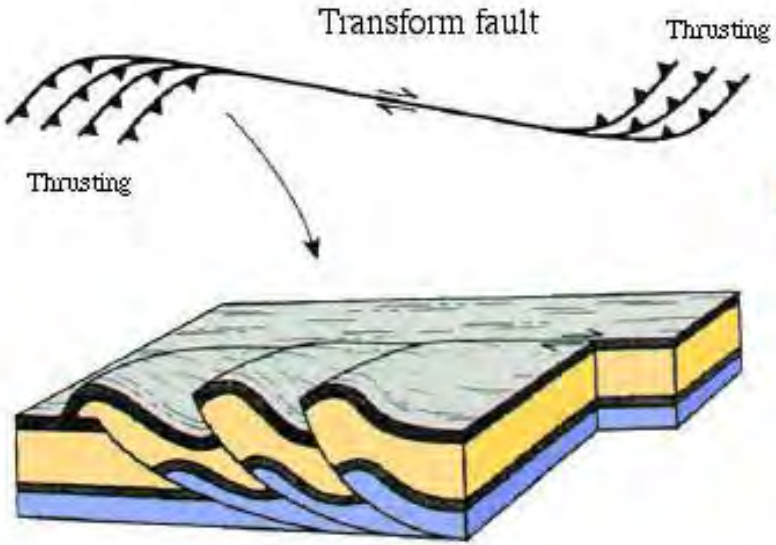
Thrust surface in 3D and lateral termination of thrust faults.

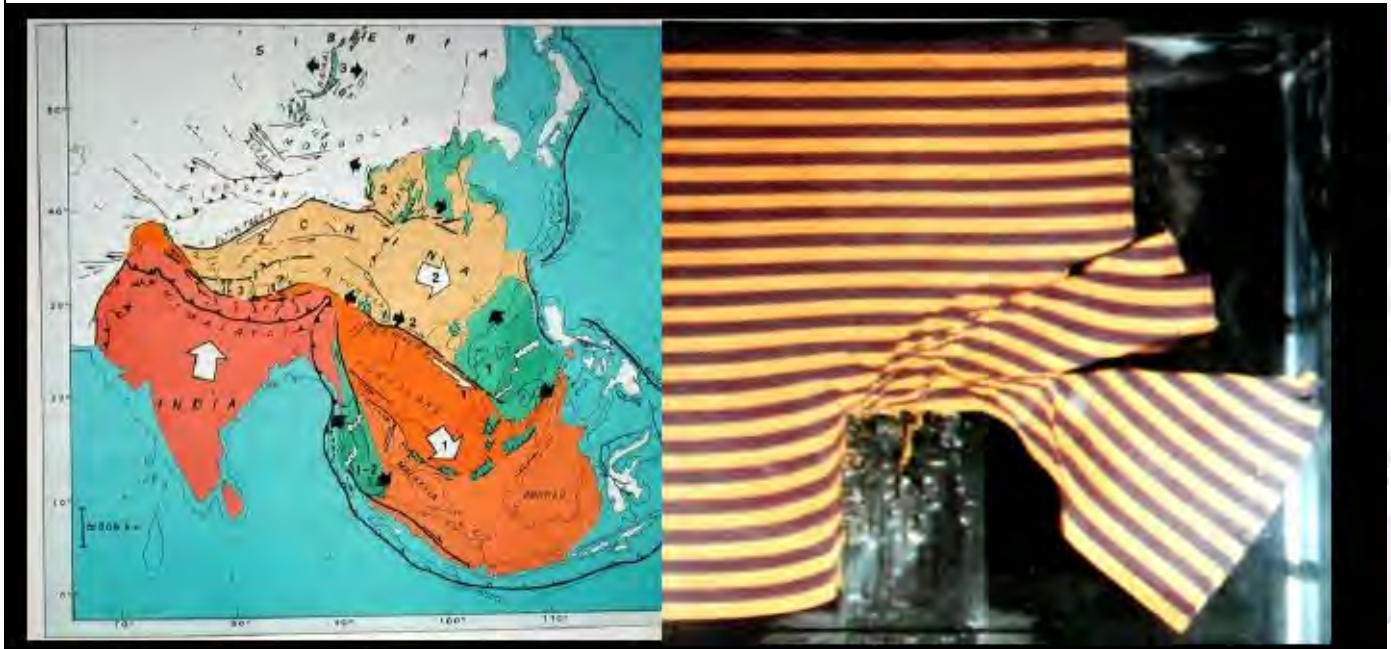
A transfrom fault, transfers the deformation from one region to another.



Different types of fault ramps (hanging wall removed).

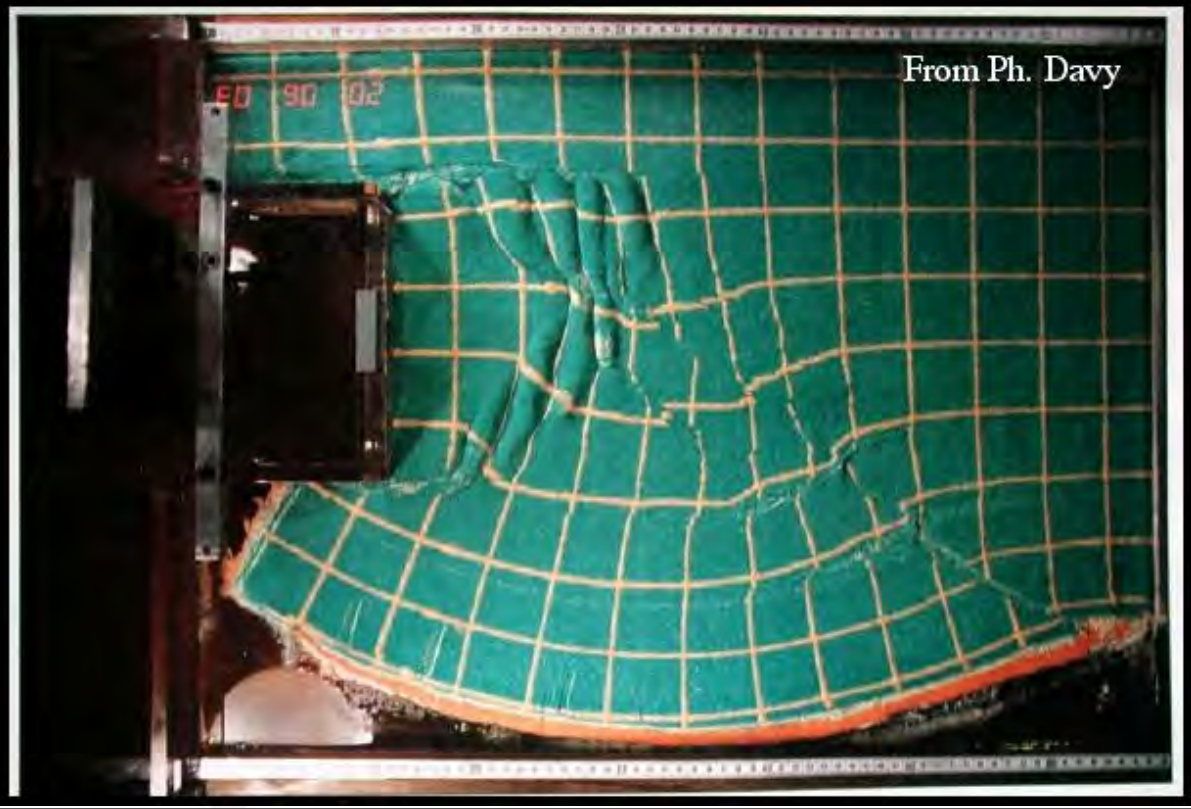


大陆楔入与挤出逃逸构造：是Tapponnier 等人为解释印度与欧亚大陆碰撞引起的欧亚大陆变形提出的一种假设模式。



Tapponnier et al., 1982

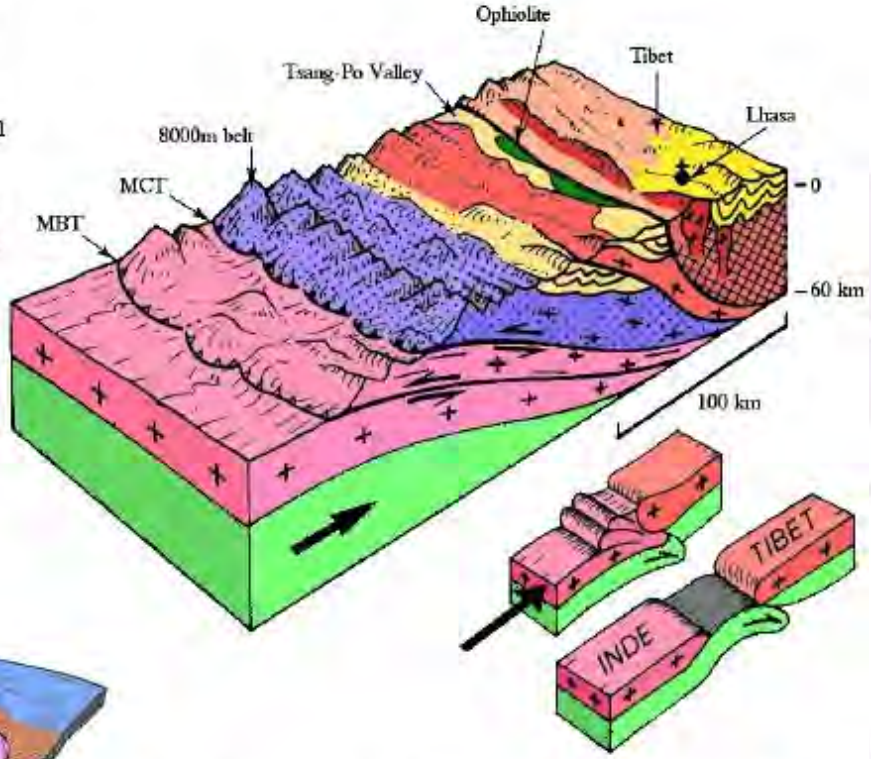
In this experiment, a 4 layers model is used to investigate the Euroasiatic lithosphere deformation: a brittle layer (sand for the upper crust) overlying two ductile layers (low viscosity silicone for the lower crust, a more viscous silicone for the upper mantle). Honey is the analogue for the asthenosphere. This model shows the development of lithospheric scale folding as well as the development of large-scale strike slip faults. Both structures are observed...

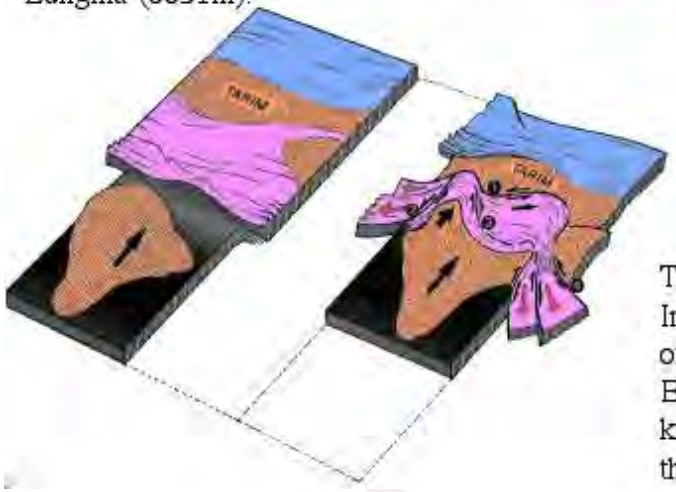


Collisional Mountain belts

The himalayas result from the closure of the Thetys ocean and the collision between India (detached from Gondwana 80Ma ago) and the Eurasian plate. The collision started 50Ma ago between India and Tibet (a microplate), and is still ongoing.

During the collision, India was underthrusted beneath Tibet. Devonian sedimentary rocks from the Indian platform were uplifted and now form the higher peak on Earth: The Mount Jolmo-Lungma (8851m).





The Main Central Thrust brings the highly metamorphosed Indian platform (in blue) onto a less metamorphic domain of schistose low-grade rocks. The MCT and the Main Boundary Thrust have accommodated a few hundred kilometers of convergence between India and Tibet since the beginning of the collision.

本讲重点

- 走滑断层的主要特征
- 走滑断层的主要伴生构造
- 剪切作用与剪切破裂
- 走滑断层与转换断层的区别

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思考、讨论题

- 正花状构造、负花状构造
- 拉分盆地的特征
- 走滑断层的特征。
- 绘图说明走滑断层所伴生的破裂构造。
- 绘图说明走滑断层与转换断层的区别。

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