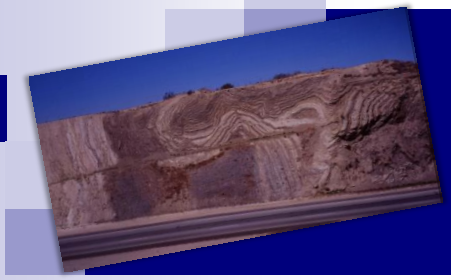
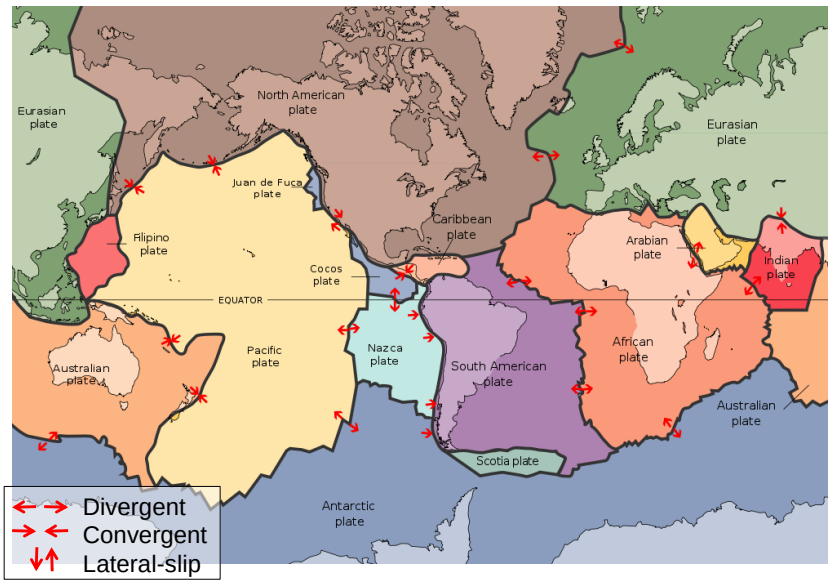


Wrench Tectonics: Lateral-Slip Boundaries

Earth Structure (2019)
(Processes in Structural Geology &Tectonics)

4/23/2019 09:51

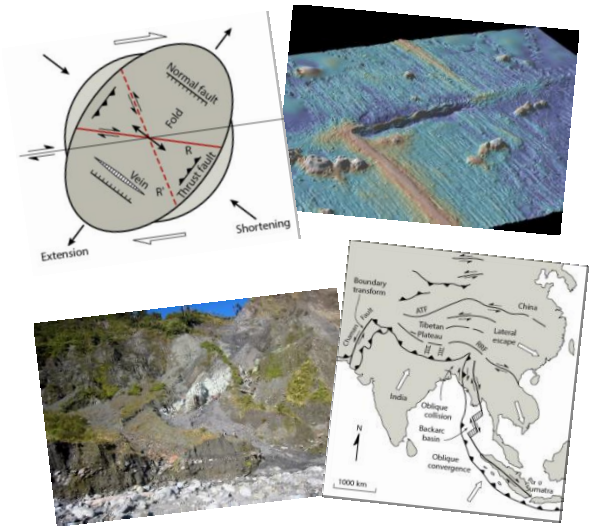
Today's Plates and Boundaries



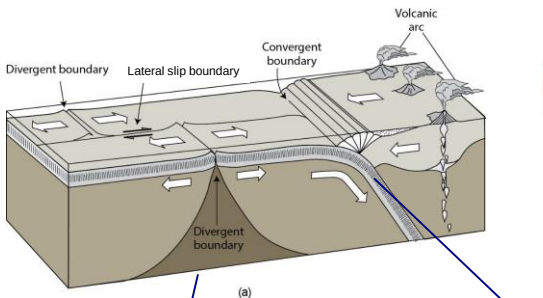
We Discuss …

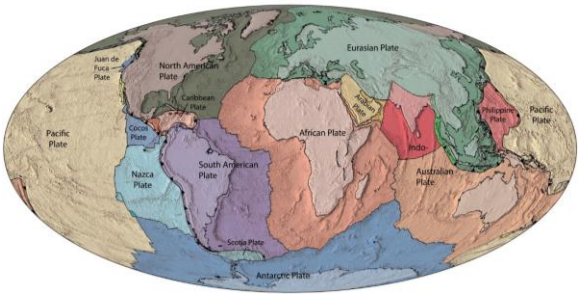
Wrench Tectonics

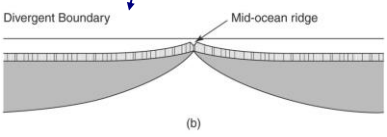
- Classes of Lateral-slip Faults
  - Transcurrent Faults
  - Transfer Faults
- Lateral-slip Systems
  - Transpression and Transtension
  - Restraining and Releasing Bends
  - Subsidiary Structures
- Oceanic Lateral-slip Zones
  - Oceanic Transfer (or Transform) Faults
  - Fracture Zones
- Continental Lateral-slip Zones
  - Continental Transfer Faults
  - Tectonic Extrusion
  - Terrane Slicing
- Transfer Fault Evolution

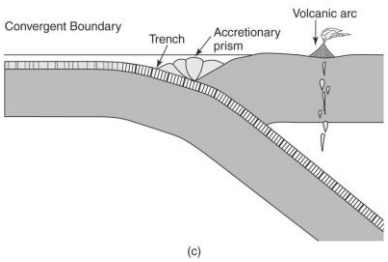


Types of Plate Boundaries





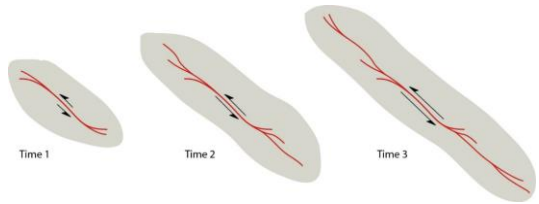




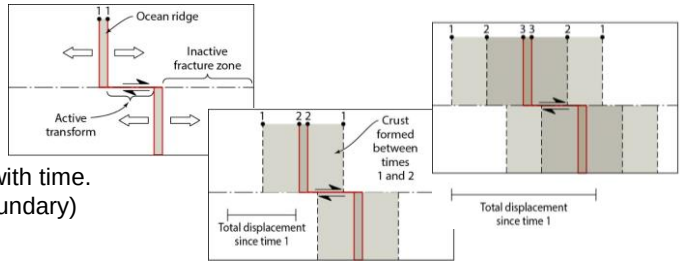
Types of Lateral-slip Faults

Faults on which displacement is (mostly) parallel to their surface intersection. The term is purely *geometric*, and has no genetic, tectonic or size connotation. They are subdivided into two *kinematic* classes: **transcurrent faults** and **transfer faults.**

Transcurrent fault
- dies out along its length;
- displacement across is less than length of fault;
- length of fault increases with time and continued movement;
- displacement is greatest at center of fault trace and decreases toward its ends.



Transfer fault
- once formed, displacement *can* be constant along length of fault;
- displacement across can be much greater than length of active fault;
- length can be constant, increase, or decrease with time.
- starts/terminates at another fault (e.g., plate boundary)



Lateral-slip Faults

Faults on which displacement is (mostly) parallel to their surface intersection. The term is purely *geometric*, and has no genetic, tectonic or size connotation. Lateral-slip faults are subdivided into two *kinematic* classes: transcurrent faults and transfer faults.

Transcurrent fault

Characteristics:

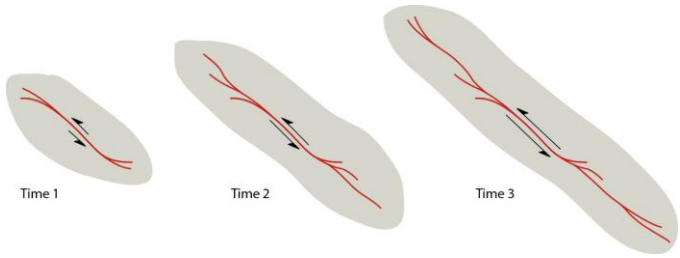
- it dies out along its length;
- the displacement across is less than length of the fault;
- the length of the fault increases with time and continued movement;
- displacement is greatest at center of fault trace and decreases toward its ends.

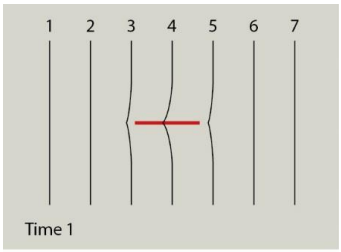
Transfer fault

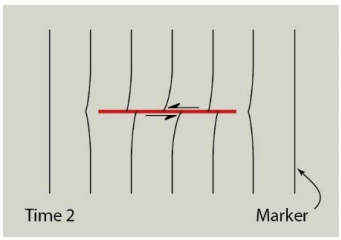
Characteristics:

- once formed, displacement across *can* be constant along length of the fault;
- displacement across can be much greater than length of the active fault;
- its length can be constant, increase, or decrease with time.
- it starts/terminates at another fault (e.g., plate boundary)

Transcurrent Fault Evolution

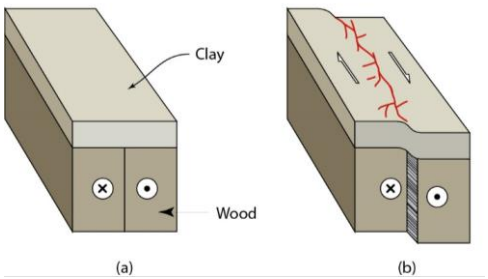


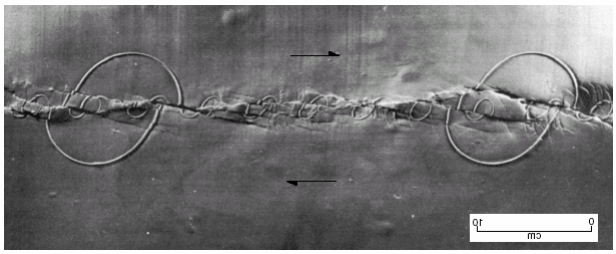


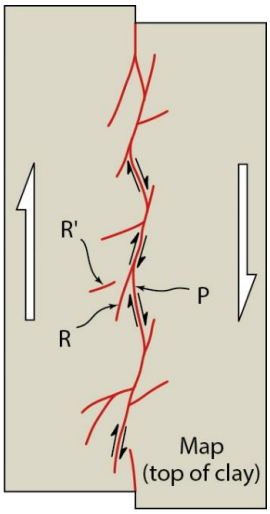


- Transcurrent faults lengthen (L) with increasing displacement (D).
- Rule of thumb: max displacement = 0.03 . Length (or, L = 30 . D)
- Displacement decreases to 0 at tips

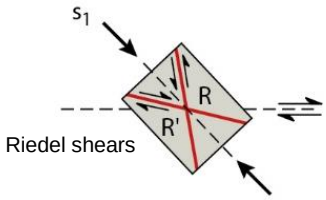
Transcurrent Fault Evolution



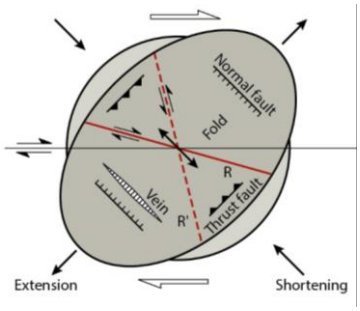


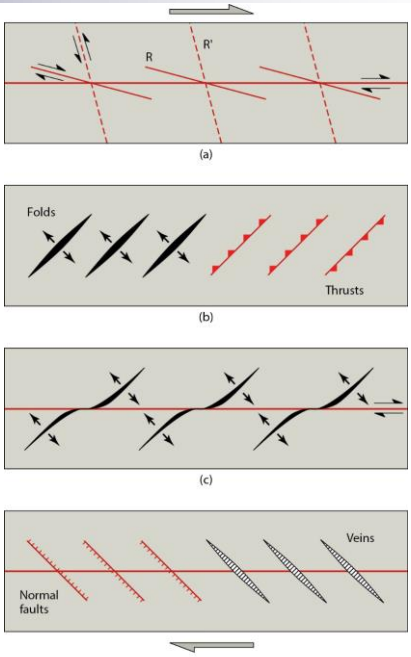


Wrench Systems: Subsidiary Faults and Structures

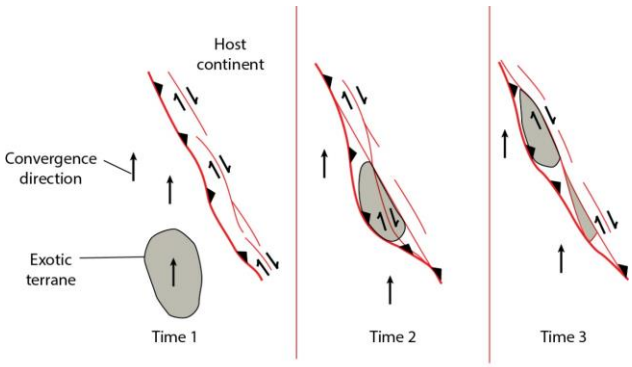


Riedel shears

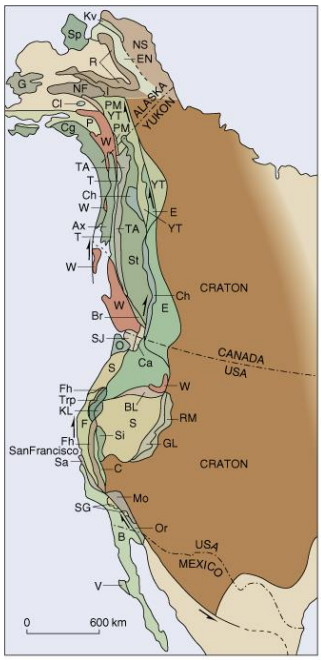




Transcurrent Faults and Oblique Plate Convergence



Terrane accretion and terrane slicing



Lateral-slip Faults

Faults on which displacement is (mostly) parallel to fault strike, in present-day surface coordinates. The term is purely *geometric*, and has no genetic, tectonic, or size connotation. Lateral-slip faults are subdivided into two *kinematic* classes: transcurrent faults and transfer faults.

Transcurrent fault

Characteristics:

- it dies out along its length;
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Transfer fault

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- once formed, displacement across *can* be constant along length of the fault;
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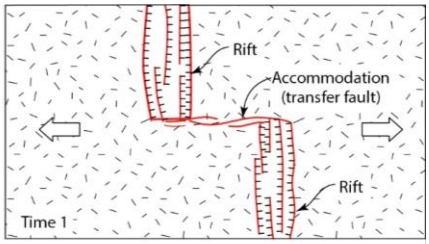
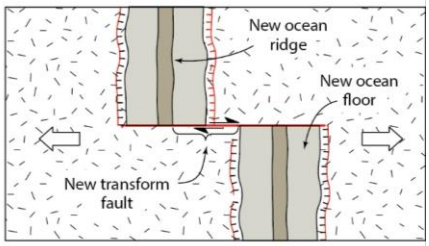
- it starts/terminates at another fault (e.g., plate boundary)

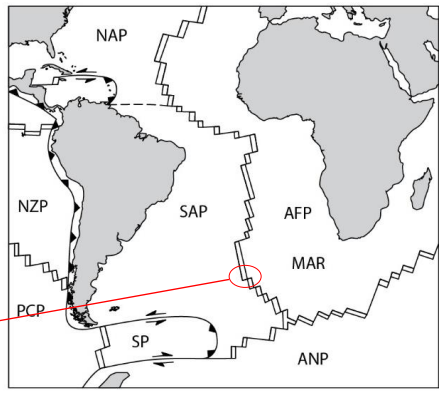
Oceanic Transfer Faults (= Transforms)



(a)

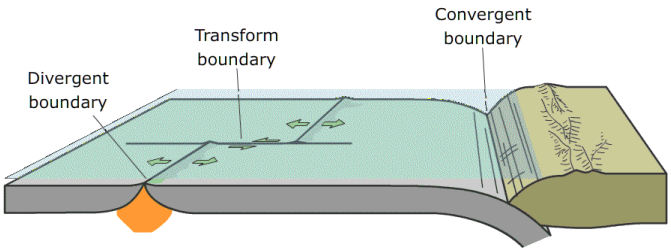


(b)



(c)

Oceanic Transfer Faults (= Transforms)



H Fossen

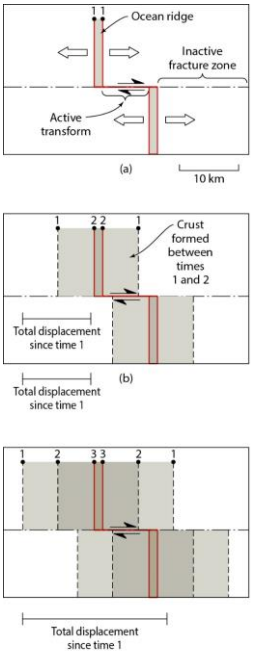
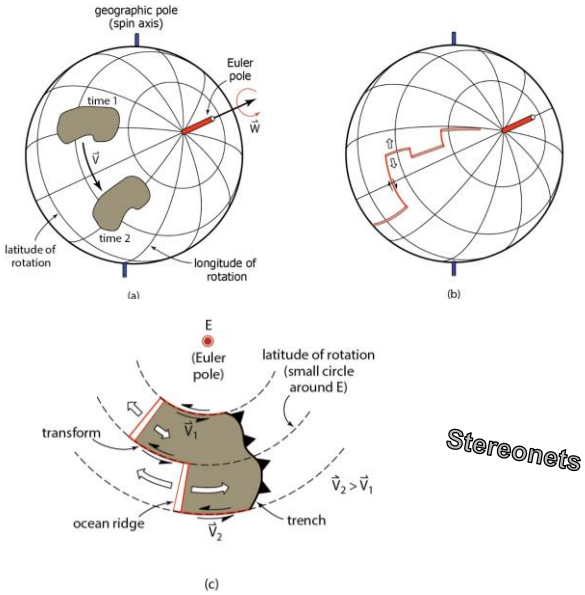


Plate Kinematics on a Sphere: Oceanic Transfer Faults (Transforms)



Stereonets

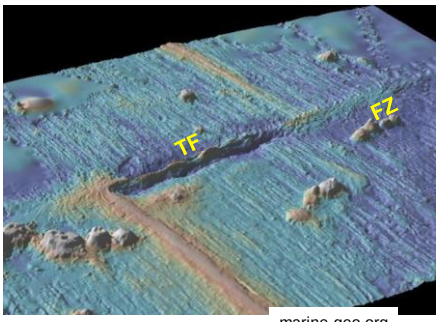
Displacement and Rotation:

a) Displacement follows small circles
b) Oceanic transfer faults (or oceanic transforms) parallel **small-circle segments around rotation axis**
c) Same angular velocity (w) between plates; different linear velocity (v), as function of distance from rotation axis (or Euler pole)

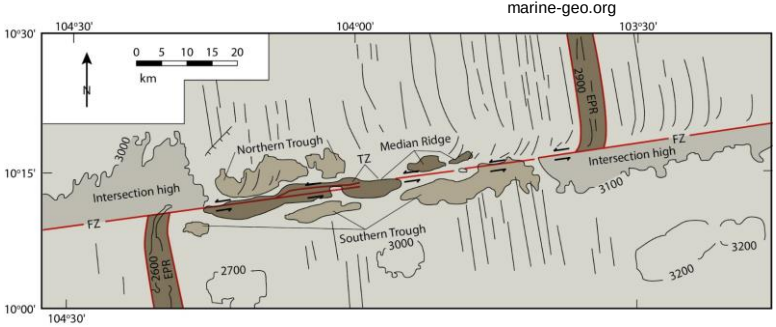
Transforms and Fracture Zones

Transform Fault: Active displacement.
Fracture Zone: Fossil fault, *no* active displacement.

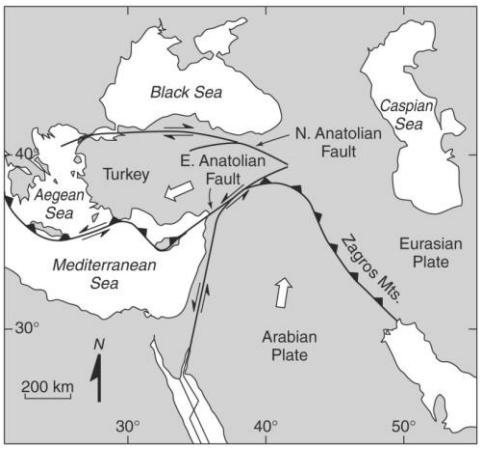
Clipperton fracture zone (FZ) and transform zone (TZ) of East Pacific Rise. Note intersection highs at ridge tips, and trough and ridges along transform zone.



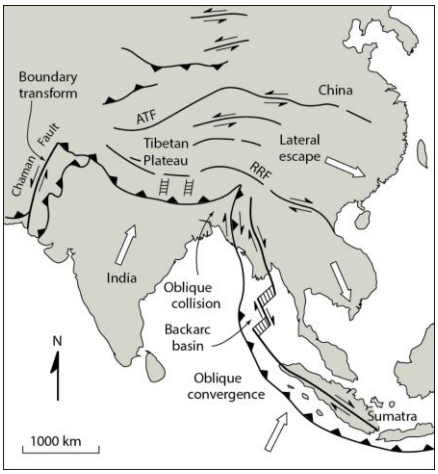
marine-geo.org

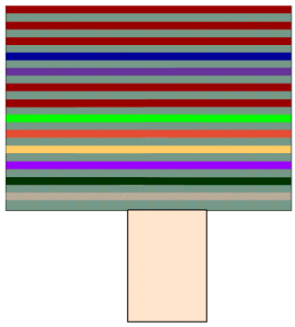


Continental Transfer Faults: N&S Anatolian Faults (Turkey)



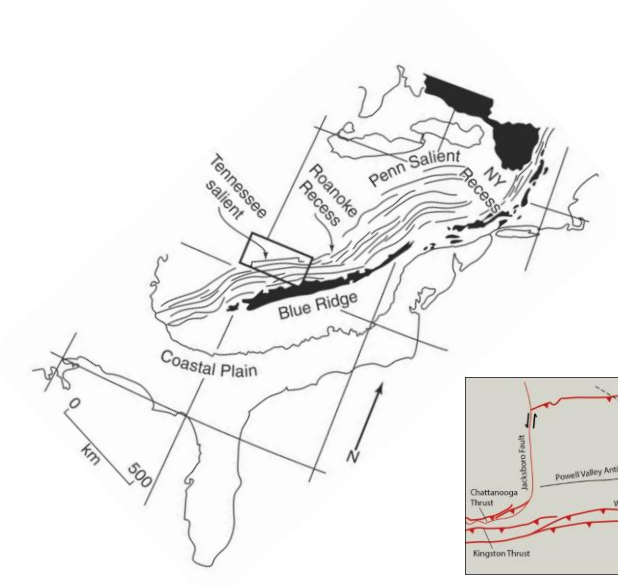
Continental Transfer Faults: Extrusion Tectonics



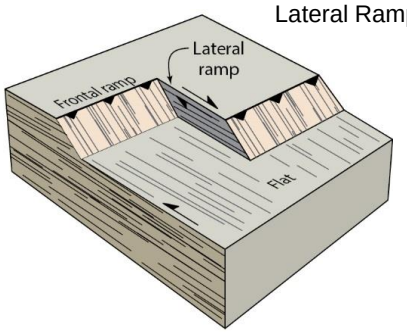


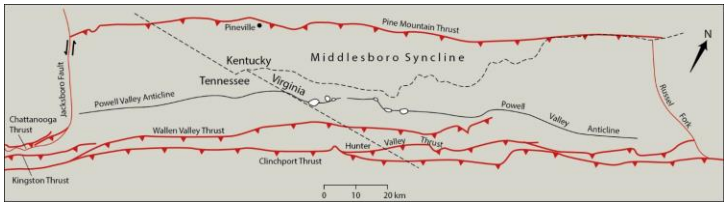
(a) Red River (RRF) and Altyn Tagh (ATF) continental transfer faults and Himalayan convergence zone.
(b) Tectonic extrusion (or lateral escape) of tectonic blocks in SE Asia.

Continental Transfer Faults in Contractional Settings

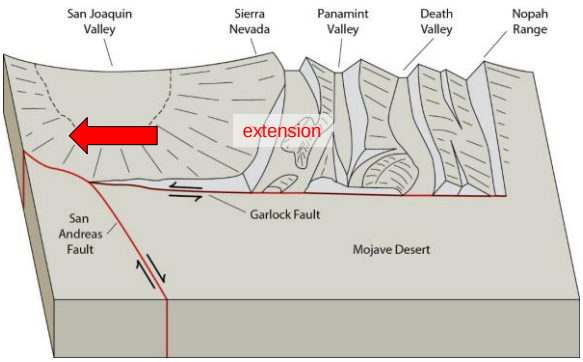


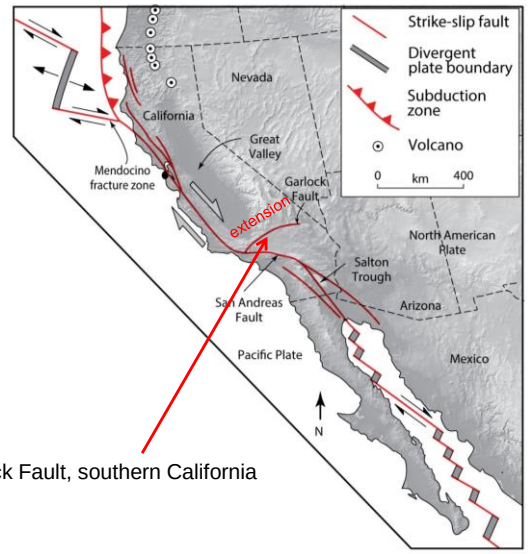
Lateral Ramp (or Tear Fault)





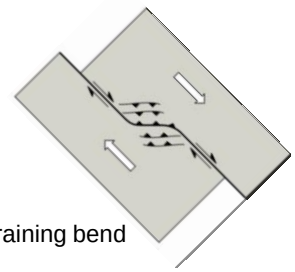
Continental Transfer Faults in Extensional Settings





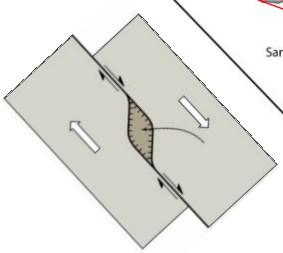
Garlock Fault, southern California

Wrench Systems: Fault Bends



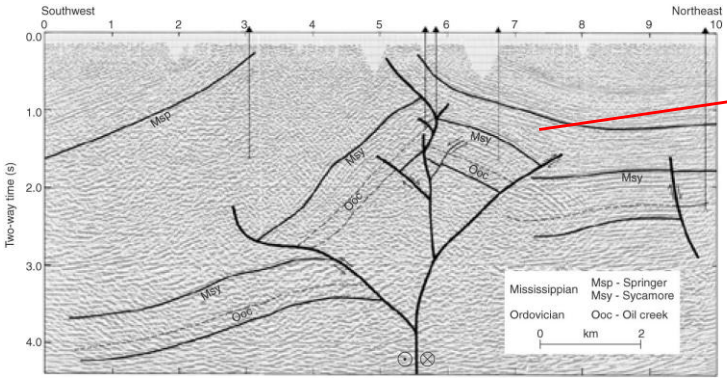
Restraining bend

Contraction along SAF near Palmdale, CA

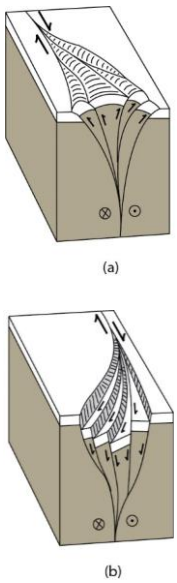


Releasing bend

Wrench Systems: Transpression and Transtension



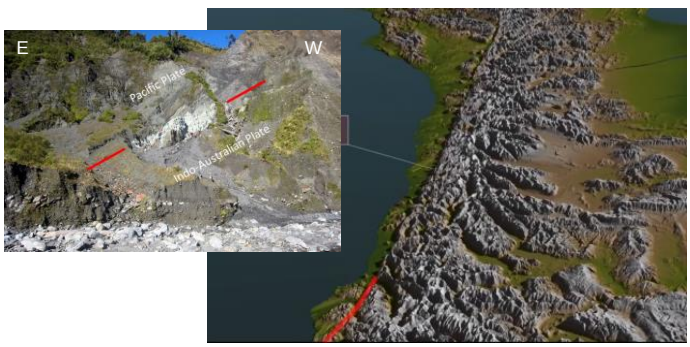
Seismic-reflection profile across a strike-slip fault in Ardmore Basin (Oklahoma), showing positive flower structure.

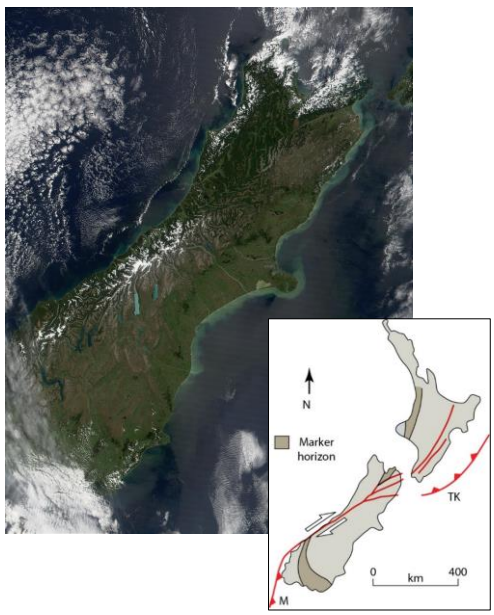


(a) Transpression: positive flower structure.
(b) Transtension: negative flower structure.

Transpressive Transfer Faults

Alpine Fault (New Zealand)
- Continental transpressional transform
- Large (rapid) uplift and exhumation of hangingwall (Pacific plate)

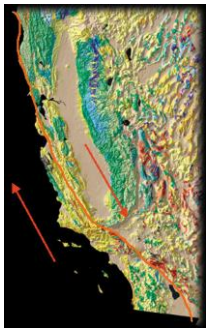


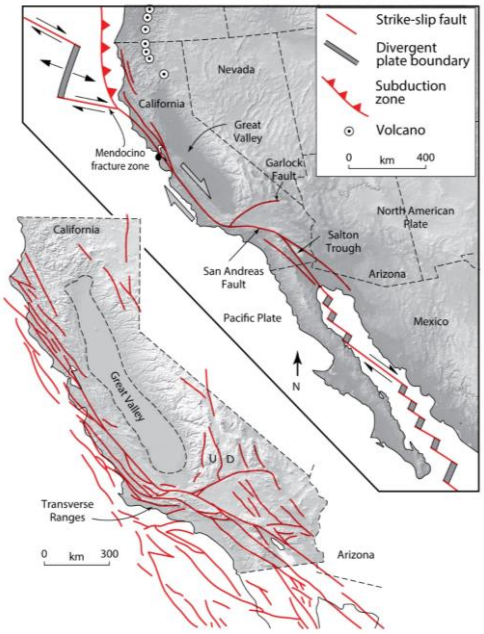


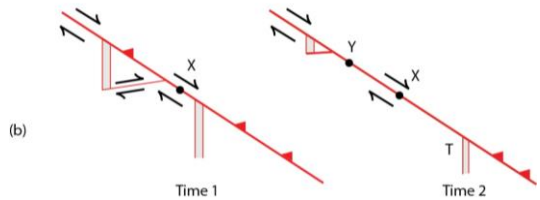
Continental Transfer Faults: SAF

San Andreas Fault (CA) is unusual continental transform.

Displacement rate unchanged while fault length changes, so total displacement varies along evolving SAF.

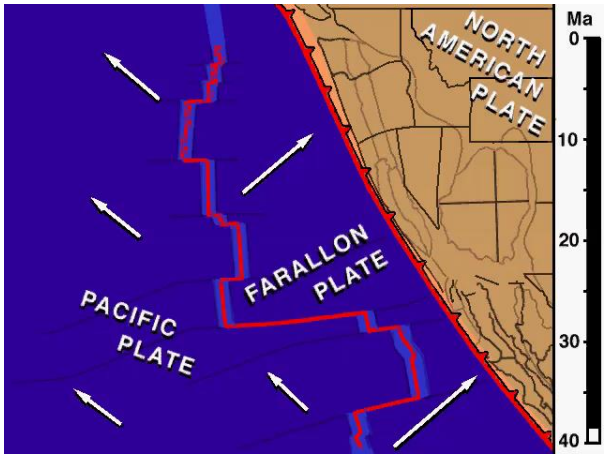






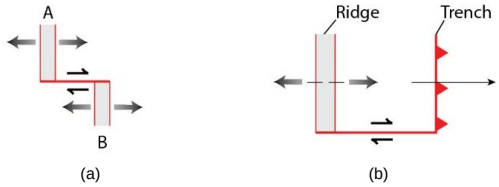
$D_x > D_y$

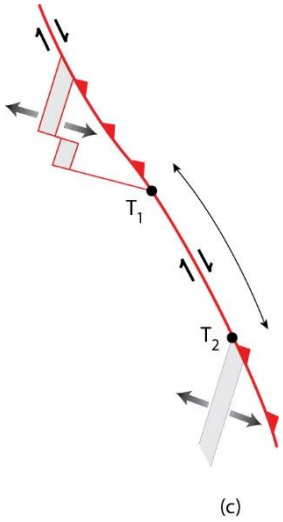
San Andreas Fault (38-0 Ma)



T. Atwater (UCSB)

Transfer Faults: Length and Displacement





Transfer fault length with time:

a) Same (characteristic behavior)
b) Can decrease
c) Can increase

Displacement rate always same (mm/yr), but total displacement can vary along lengthening transforms (e.g., SAF)

Today's Plates and Boundaries