Outline

• Mountains belts and basins
• Tectonic plates
• Oceans
• Deep structure
• Seismicity
Mediterranean plates & subduction directions

Legend:
- Alpine fold & thrust belt
- Neogene extensional basin
- Neogene oceanic crust
- Old (Tethys) oceanic crust
- Major fault
- Thrust fault
- Strike-slip fault
- Normal fault
- Plate velocity
- Crustal movement
- Oceanic spreading ridge
Cenozoic orogens & basins

- Tyrrhenian
- Aegean
- Alboran
- Betic Cordillera
- Rif
- Maghrebides
- Liguro-Provencal
- Alps
- Carpathians
- Pannonian Basin
- Dinarides
- Hellenides
- Ionian
- Pre-Cenozoic

Royden, 1988, AAPG Memoir
Tectonic plates & their boundaries today
Tectonic plates & subduction polarities
Mantle structure

subducting lithosphere (slabs)

ALPS

flowing asthenosphere

F. Horvath
Mesozoic & Cenozoic plates and microplates

Handy et al. 2010
“....the great ocean that once stretched across Eurasia” whose “folded and crumpled deposits stand forth to heaven in Tibet, Himalaya and the Alps”

(E. Suess 1893)
Past & present ocean basins and sutures

Alpine Tethys
2 sutures
• Valais
• Piemont-Liguria

Neotethys
northern branch
4 sutures:
• Meliata-Maliac
• E & W Vardar
• Sava

Neotethys
southern branch
• Ionian Basin

W. Med. Basins
• Liguro-Provencal
• Alboran
• Tyrrenhian

Handy et al. 2010
Past tectonic approaches to the “ocean problem”

Abbate 1970, Sedimentary Geology
The Alps as the product of changing plate motion

Africa (here includes Adria) moved sinistrally with respect to Europe from 175 to 130-118 Ma, then moved northwards while rotating counterclockwise.

In many models, Adria considered part of Africa from 175 Ma – Present.
Past oceans – paleogeography

Dercourt et al. 1986

Early Cretaceous, 130 Ma

Alpine Tethys
- Valais
- Piemont
- Liguria

Future Alps-Carpathians

Future Apennines

Future Dinarides

Neotethys (north)
- Meliata-Maliac
- W. Vardar

Neotethys (south)
- Ionian Sea

Iberia

Early Cretaceous, 130 Ma
Past ocean basins

**Neotethys**
- Meliata-Maliac
- Vardar

**Alpine Tethys**
- Piemont-Liguria
- Valais

- Late Triassic
- Mid-Jurassic
- Late Jurassic
- Late Cretaceous
Past oceans & continental margins buried as slabs

Alpine Tethys

Neotethys

P-wave teleseismic tomography

Spakman & Wortel 2004

Piromallo & Morelli 2003
Area of subducted lithosphere from plate motion reconstruction

Handy et al. 2010
Sites of subducted Tethyan lithosphere

Handy et al., in prep.

Note - minor S or E displacement of European lithosphere with respect to the mantle transitional zone
Seismicity

Cloetingh et al. 2007
Part of Robert Mallet’s map of global seismicity

1810-1881

1857
Present plate motions

Nocquet & Calais 2004
Literature

Used in this lecture


Literature


**Historical literature**