Sedimentary Basins

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Course Outline

University : South Valley University

Faculty : Faculty of Science

Department: Geology

Program: Geophysics

Course Title: Sedimentary Basins &Seismic Stratigraphy

Course Code:412 G

Total Course Hours: 60 (4 hours x 15 weeks**)**

Course Description

This course will provide an introduction to the Sedimentary basin clasifications, This course is an attempt to summarize the more important aspects of the sedimentary basins evolution and analysis as well as sedimentary basins in Egypt

Introduction

Sedimentary rocks cover a large part of the earth;s surface. It represented 75% of the land areas and it represent only 5% of the lithosphere. So, the sedimentary rocks cover the earth only as thin and superficial veneer. Sediment were laid down in localized areas, termed sedimentary basins.

A sedimentary basin is an area of the earth's crust that is underlain by a thick sequence of sedimentary rocks.

- Hydrocarbons commonly occur in sedimentary basins and are absent from intervening areas of igneous and metamorphic rocks (North, 1971).
- This fundamental truth is one of the cornerstones of the sedimentary-organic theory for the origin of hydrocarbons

Sedimentary basins are depressed areas to accumulate the sediments, erosionally or structurlly origin, subaerial or subaqueous.

Generally, there are three types of basins:

1- Topographic basins

2- Structural basins

3- Sedimentary basins.

1- Topographic basins are lower areas of the earth,s surface surrounded by higher areas and there are two types of topographic basins:

- Subareal topographic basins
- Subaqueous topographic basins.

2- Structural basins: The sedimentary sequences affects by tectonic process.

3- Sedimentary basins generally cover tens of thousands of square kilometers. The origin and the types of sedimentary basins depends on tectonic subsidense.

- A- Post-depositional basins
- B- Syndepositional basins

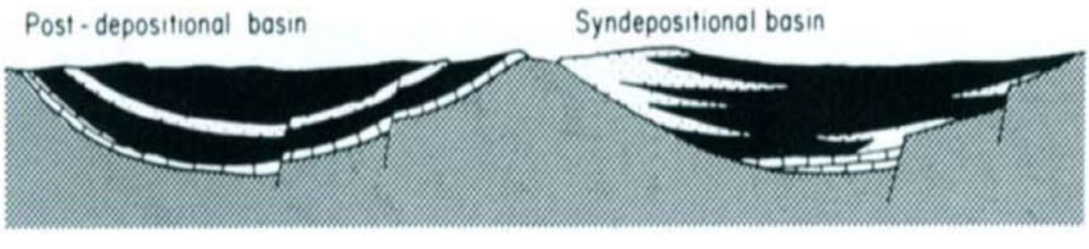


Fig.1 Section illustrating the differences between post-depositional basins and syn-depositional basins. The sedimentary facies of syn-depositional basins reflect the position of the basement margin and the movement of faults. In post-depositional basins stratigraphy is discordant (cross /opposite) with structure.

There are three types of sedimentary basins according to the shape (in plan view).

- **A- Senso Stricto**: subcircular in plan view and structurally closed
- **B- Embayment** are areas which are not completly closed structurally. But it open out a deeper area.
- **C- Troughs are linear** basins (elongated) and structurally closed

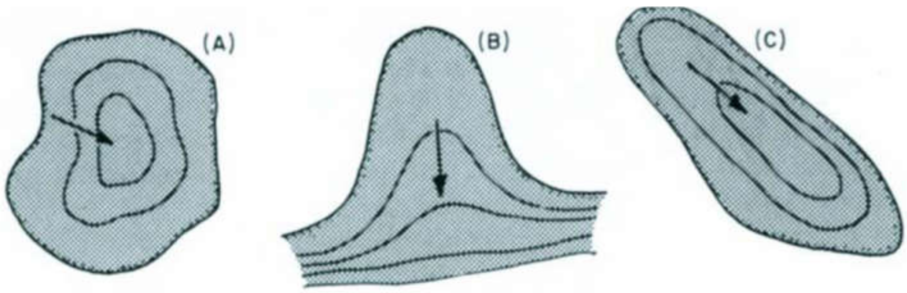


Fig.2. Three types of sedimentary basins according to the shape (in plan view).

Overview about the tectonic settings

The important features of plate tectonics which control the global location of deposits:

1-Plate divergence and spreading centres

2-Plate convergence (subduction)

3-Hot spots (mantle plumes)

4-Rifting

5-Collision

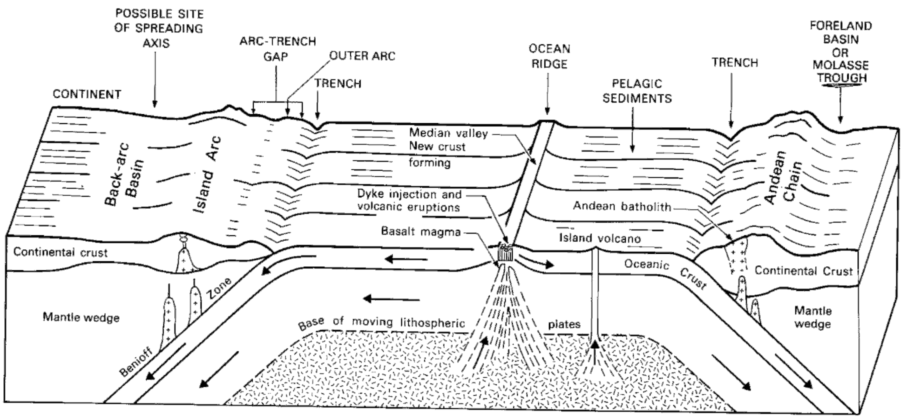


Fig. 22.1. Block diagram of the basic elements of oceanic crust formation and plate movements. On the right is the site of the Andean-type arc with a molasse trough on the continental side, its deposits overlapping on to Precambrian crust, and an arc-trench gap and trench on the oceanic side. On the left is the island arc-setting with its trench, troughs of deposition in the arc-trench gap, volcanic arc and (not shown) the back-arc wedges of clastic sedimentation. The back-arc basin represents the site of the Japan Sea-type setting which may or may not have its own spreading axis.

Fig.3. Overview about the important features of plate tectonics which control the global location of sediments**.**

After Mitchell and Reading (1986): the tectonic settings sedimentary basins classified into:

1- Interior basins, intracontinental rifts and aulacogens.

2- Oceanic basins and rises.

3- Passive continental margins.

4- Subduction-related settings.

5- Strick slip settings.

6- Collision-related settings.

Mechanisms of sedimentary basins formation

Basins can form in four main ways (Fischer,1975). Three of these processes are summarized in next Fig. One major group of basins, the rift basins, form as a direct result of crustal tension at the zones of sea floor spreading. A second major group of basins occurs as a result of crustal compression at convergent plate boundaries. A third type of basin can form in response not to lateral forces but to vertical crustal movements. A fourth mechanism of basin formation is simple crustal loading due to sedimentation

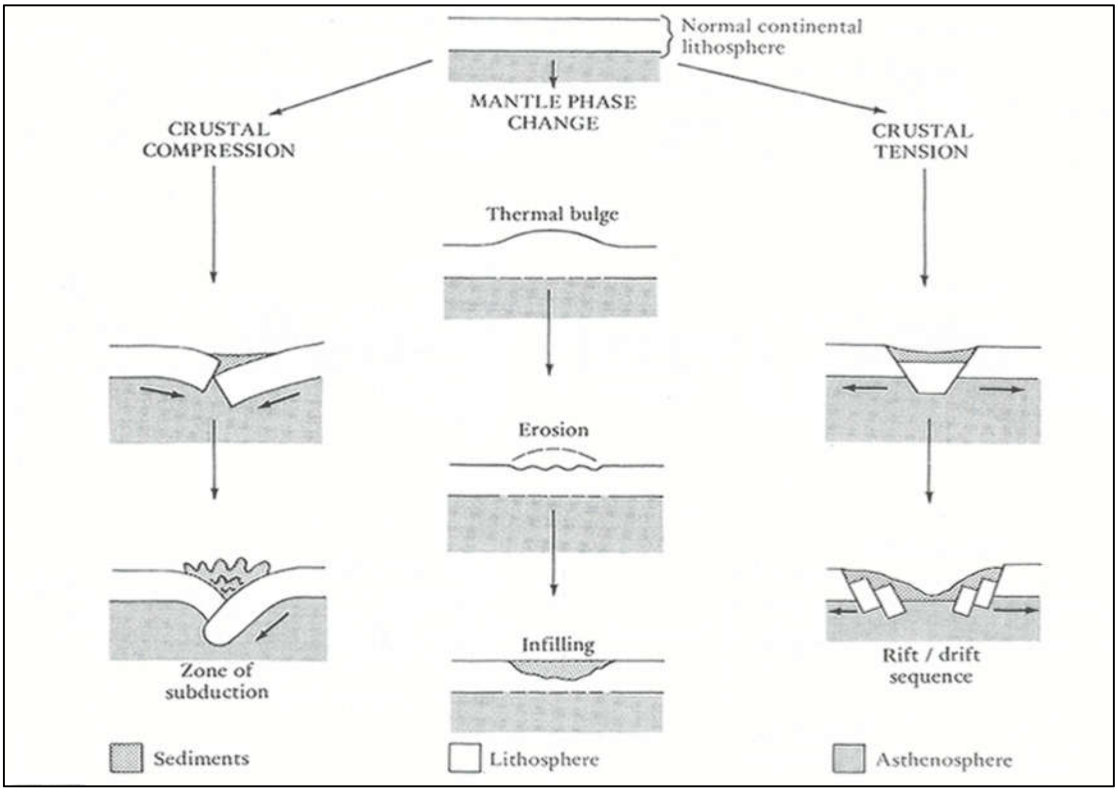
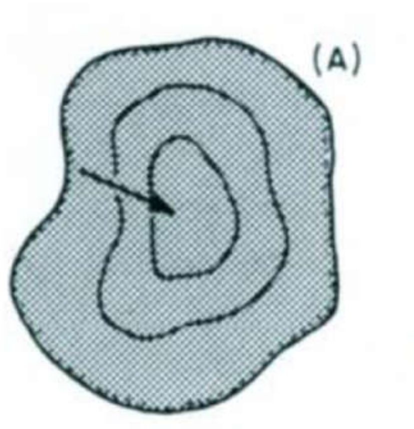


Fig.4. Cross-section showing the various types of basin formation (After Fischer,1975).

Senso stricto basins



- **Senso stricto** Basins are saucer-shaped area of sedimentary rocks, and it is sub-rounded (oval) in plan view.
- The dip of strata and thicken centripetally towards the center of the basin.
- In cross-section it draw as curvature of the earth, in the fact it is veneers of sediment on the earth surface.

Types of Senso stricto basins:

There are two types of these basins:

1- **Intracratonic basins** (More stable)

2- **Epicratonic basins** (Less stable than intracratonic basins)

1- Intracratonic basins:

* It lie within the continental crust.

* Intracratonic basins occur within continental interiors away from plate margins.

* They are oval or subcircular in plan and saucer-shaped in cross section.

* intracratonic basins are floored with continental crust, and in most instances, are also underlain by failed or fossil rifts.

*Their evolution involves a combination and succession of basin-forming processes, which include continental extension, thermal subsidence over a wide area, and later isostatic readjustments (isostatic adjustments.

***** Intracratonic basins are clastic type of the sedimentary basin, sometime the water of sea cover the lower area to formed marine sediments „Evaporites“ as carbonate.

* Intracratonic stratigrafic sequences: Within intracratonic basins and adjacent platforms, stratigraphic subdivision differs from international stratigraphic subdivisions. Intracratonic st. subdivisions follows the now well stablished concept of „Cratonic Sequences“ of Sloss 1963

<u>Examples of intracratonic basins</u>:

There are four major intracratonic basins from North America.

A- Illinois. B- Michigan. C- Williston. D- Hudson Bay Basin

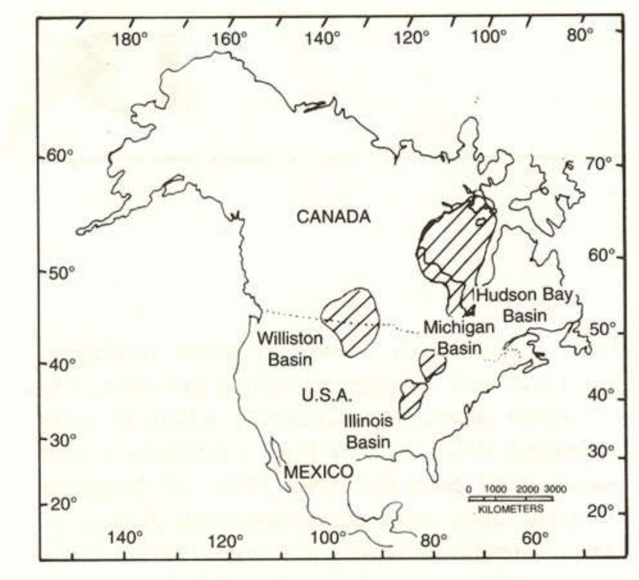


Fig.5. Major intracratonic basins from North America.

Mechanisms of Formation of Intracratonic Basins

Intracratonic basins formed by a sequence of processes. Theses processes are:

1- lithospheric stretching.

2- mechanical, fault-controlled subsidence.

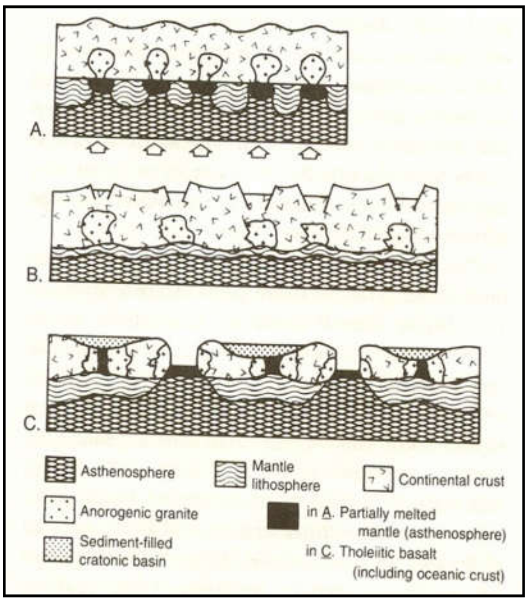
3- thermal subsidence and contraction.

4- merging of slower thermal subsidence with reactivated subsidence due to isostatically uncompensated excess mass (Sleep et al., 1980).

A- Partially melting

B- Rifting

C- Thermal subsidence

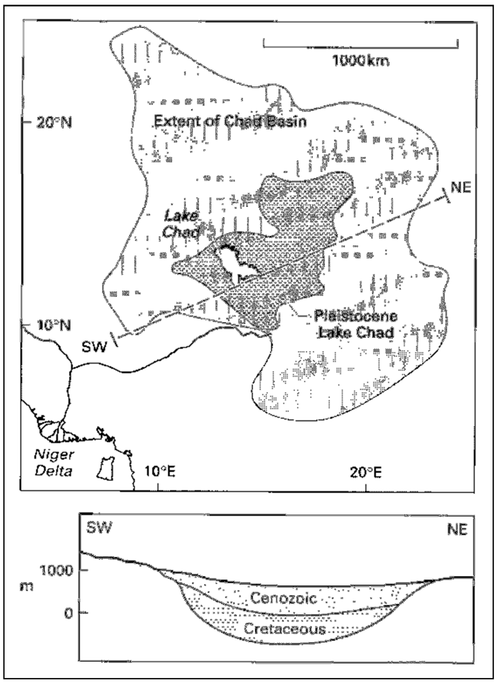


2- Epicratonic basins:

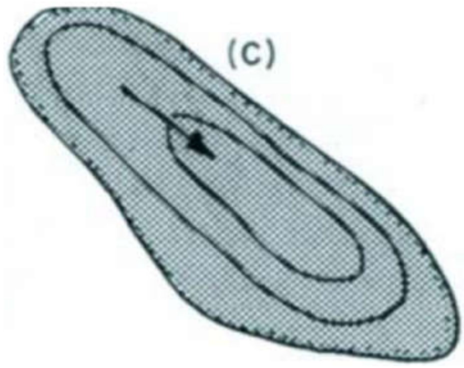
- It lies on the continental crust but is partially open to the ocean basin, which means, it lies on edge of the continental crust. (between the continental crust and marine areas „Oceans“).
- The axis of the epicratonic basin may be plunge to the floor of the ocean or interrupted by Sill-like feature at the rim of the continental margin.
- Epicratonic basins are less stable than intracratonic basins, due to their situation at the continental margins.
- At the floors of theses basins, there are subsidence leading to faulting on these floors and found some igneous activity.

- **Examples of epicratonic basins:**
- Niger delta basin and Mississipian Gulf Coast.
- These basins are infilled by terrigenous „clastic“, and the final phase of epicratonic basins are infilled during the Oligocene and Miocene

- by terrigenous „clastics“ and carbonate sedimentation in both marine and continental environments.



Trough Basins



- **Trough basin** , is elongated (linear) sedimentary basins and structurally closed.
- The most comon type of trough basins is Geosyncline. It is trough of highly tectonic sediment which forms mountain belts. Dimentions: several kilometers (depth) & hundres kilometers (long).
- To understand the basins general and the geosyncline basins, this need necessary to know the larger scal morphology and mechanics of the earth.
- Plate tectonic lead to a reappraisal of the concept of basins and basins analysis especial in case the tectonic linear troughs termed **Geosynclines.**

Geosyncline divided into several tectonomorphic zones:

1- Forland shelf

2- Miogeosyncline

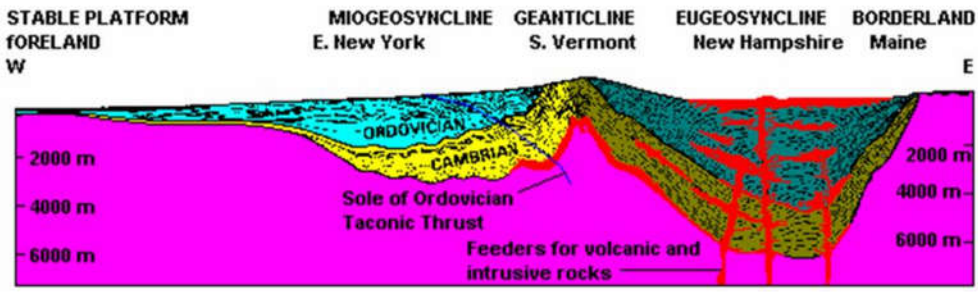
3- Miogeanticline ridge

4- Eugeosyncline

5- Eugeanticlinal ridge

6- Open ocean

Geosyncline



- Miogeosyncline: is less active and more stable trough.
- Eugeosyncline: is more active and unstable trough.
- Eugeosyncline is separated from the open ocean by the eugeanticline (island arc of rising volcanic).
- Miogeosyncline separated from the eugeosyncline by the miogeanticline.
- The sedimentation in the Miogeosyncline is more still than shelf and shallow marine (Foreland), this due to the subsidence.
- The sediments of moigeosyncline differ from the sediments in foreland in the thickness.
- Miogeosyncline similar to epicratonic basins.
- The continous tectonic activity lead to uplift of the eugeanticline (island arc), this becomes the major source of terrigenous (clastic) sediments.

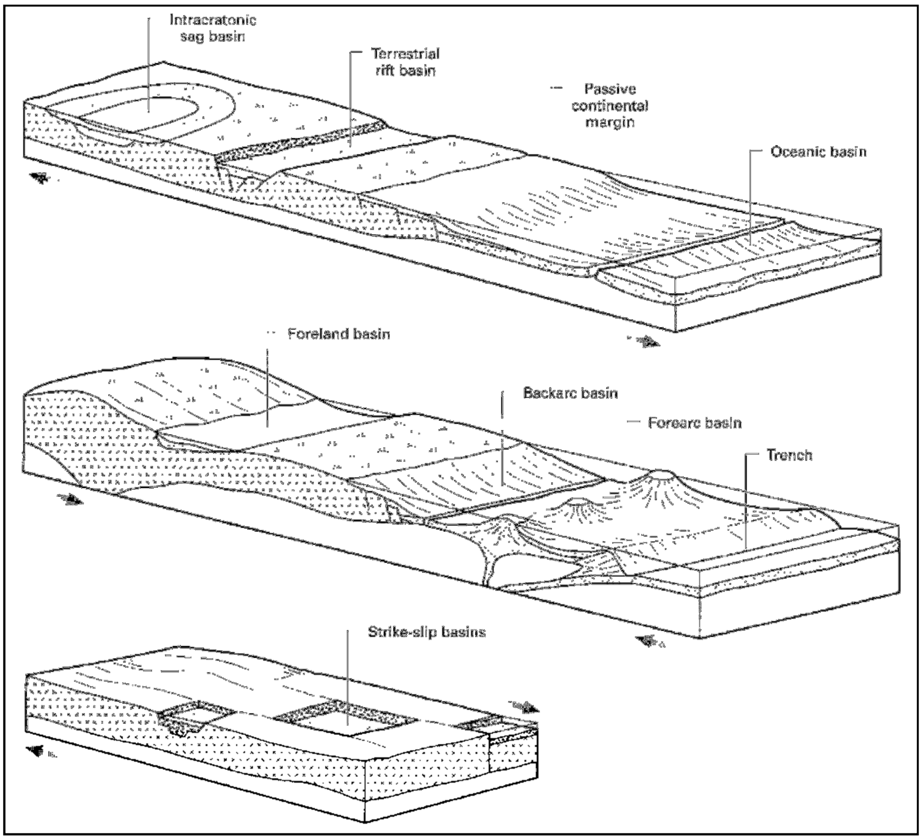
- These deposits are lead down within the eugeosyncline as turbidities to form the flysh facies.
- By continuous of tectonic activity, the deposits migrated from eugeosyncline to miogeosyncline, during this migration the deposits change from the flysh to the Molasse facies.
- Molasse facies are largely coarse terrigenous clastic with abundant with conglomerate.
- By continuous tectonic activity, the Molasses is laid down into non-marine fluvial and fanglomerate environments.

Classification of Sedimentary Basins

Sedimentary basins are the subsiding areas where sediments accumulate to form stratigraphic successions

The tectonic setting is the premier criterion to distinguish different types of sedimentary basins

- **Extensional basins** occur within or between plates and are associated with increased heat flow due to hot mantle plumes.
- **Collisional basins** occur where plates collide, either characterized by subduction of an oceanic plate or continental collision
- **Transtensional basins** occur where plates move in a strike-slip fashion relative to each other

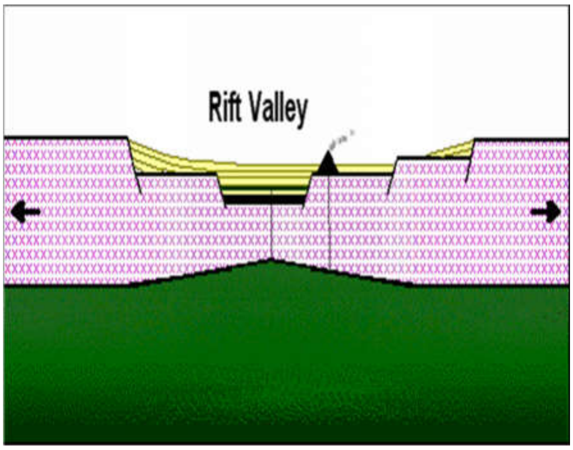


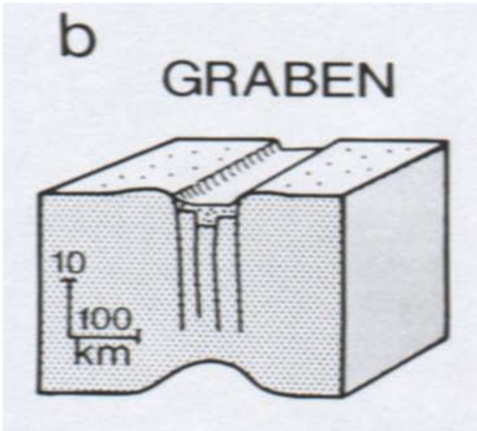
Extensional Basins

- Rift basins develop in continental crust and constitute the incipient extensional basin type; if the process continues it will ultimately lead to the development of an ocean basin flanked by passive margins, alternatively an intracratonic basin will form
- Rift basins consist of a graben or half-graben separated from surrounding horsts by normal faults; they can be filled with both continental and marine deposits
- Intracratonic basins develop when rifting ceases, which leads to lithospheric cooling due to reduced heat flow; they are commonly large but not very deep.

Continental graben strictures and rift. zones form narrow elongate basins bounded by large faults. Their cross sections may be symmetric or asymmetric (e.g., half grabens).

1- If the underlying mantle is relatively hot, the lithosphere may expand and show up doming prior to or during the incipient phase of rifting.
2- Substantial thinning of the crust by attenuation, which is often accompanied by the up- streaming of basaltic magma, thus forming transitional crust, causes rapid subsidence in the rift zone.
3- Subsequent thermal contraction due to cooling and high sedimentary loading enable continuing subsidence and therefore the deposition of thick sedimentary infillings.



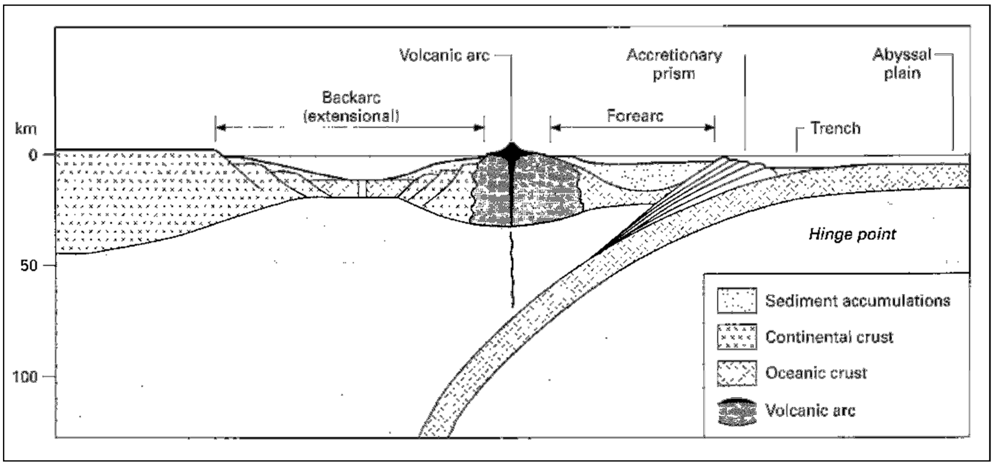


- Proto-oceanic troughs form the transitional stage to the development of large ocean basins, and are underlain by incipient oceanic crust.
  - Passive margins develop on continental margins along the edges of ocean basins; subsidence is caused by lithospheric cooling and sediment loading, and depending on the environmental setting clastic or carbonate facies may dominate
  - Ocean basins are dominated by pelagic deposition (biogenic material and clays) in the central parts and turbidites along the margins

Collision Basins

- Subduction is a common process at active margins where plates collide and at least one oceanic plate is involved; several types of sedimentary basins can be formed due to subduction, including trench basins, forearc basins, backarc basins, and retroarc foreland basins

- Trench basins can be very deep, and the sedimentary fill depends primarily on whether they are intra-oceanic or proximal to a continent
- Accretionary prisms are ocean sediments that are scraped off the subducting plate; they sometimes form island chains



- Forearc basins form between the accretionary prism and the volcanic arc and subside entirely due to sediment loading; like trench basins, their fill depends strongly on whether they are intra-oceanic or proximal to a continent.
- Backarc basins are extensional basins that may form on the overriding plate, behind the volcanic arc.
- Retroarc foreland basins form as a result of lithospheric loading behind a mountainous arc under a compressional regime; they are commonly filled with continental deposits.

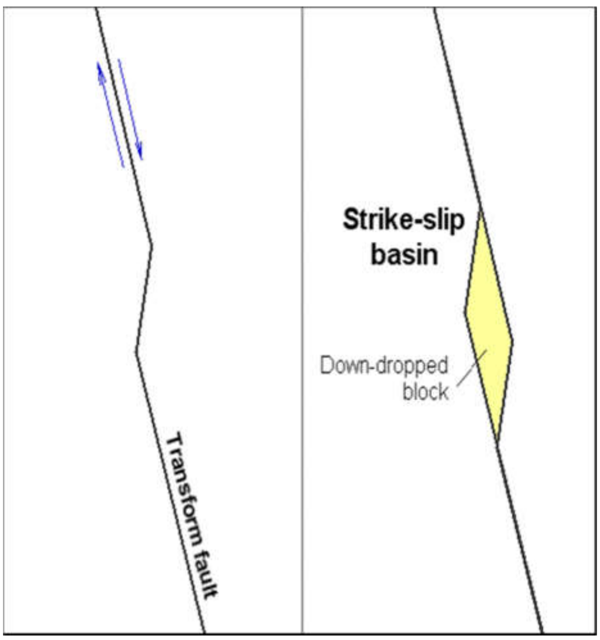
Continental collision leads to the creation of orogenic (mountain) belts; lithospheric loading causes the development of **peripheral foreland basins**, which typically exhibit a fill from deep marine through shallow marine to continental deposits

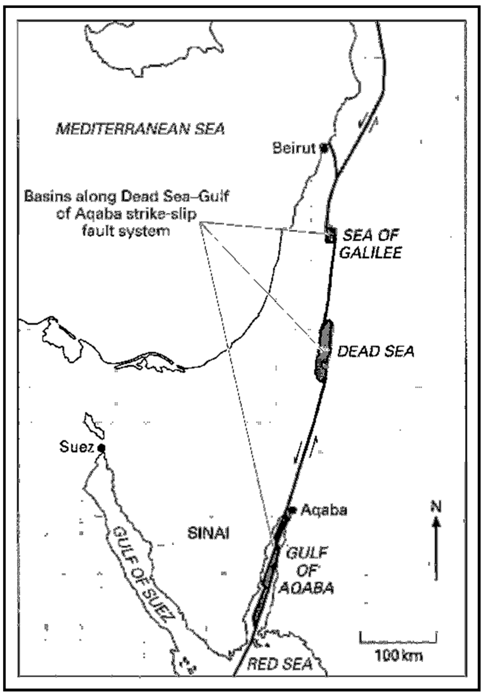
- **Foreland basins** can accumulate exceptionally thick (~10 km) stratigraphic successions

Mt. Everest (8844.43m): World's Highest Mountain

Transtension Basins

Strike-slip basins form in transtensional regimes and are usually relatively small but also deep; they are commonly filled with coarse facies (e.g., alluvial fans) adjacent to lacustrine or marine deposits





Rift-related basins

Active extension or stretching of continental lithospheric plates causes surface deformation, volcanism and high heat flow due to the effects of normal faulting and changes in crustal and mantle thickness, structure and state.

The elongate rift basins and marginal uplifts that result from theses processes are prominent tectonic features of the continental surface.

The major areas undergoing active extension and rifting in the world are shown in the following

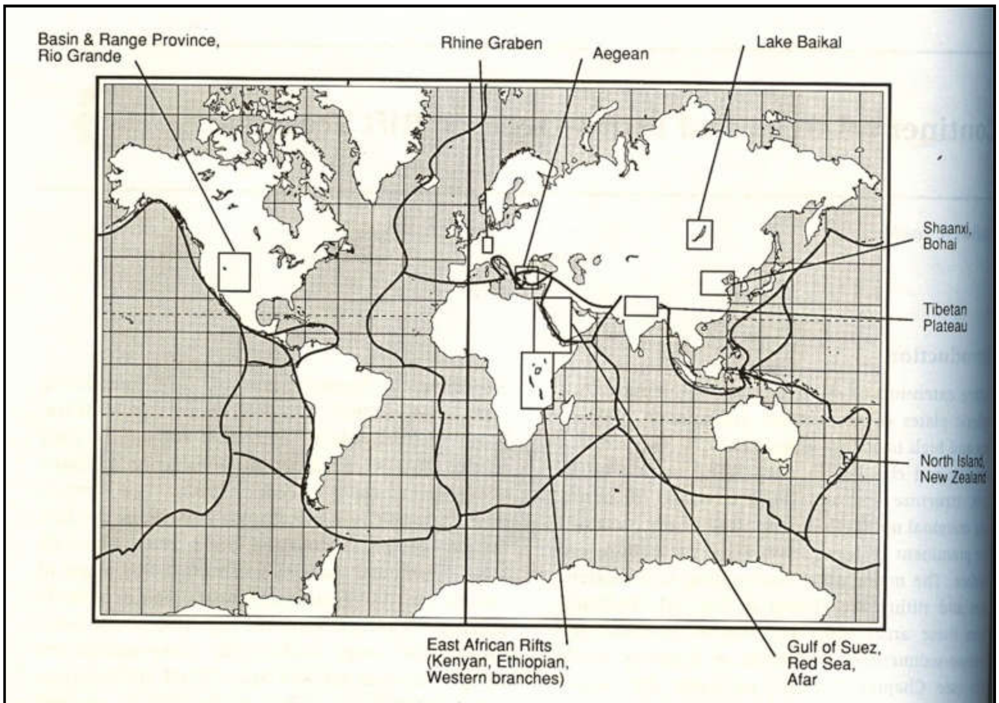


Figure. 3.1 World map (Mercator projection) with plate boundaries (solid lines), to show main areas of active continental extension. (Also see Fig. 2.2.)

1- Rift basins

- are long fault-bounded trough which occur in various tectonic setting and show corresponding diverisity (difference of sediment fill).

- Geological Origin: The down-dropped basin formed during rifting because of the stretching and thinning of the continental crust.
- They have economic importance as sources of hydrocarbons, evaporites and metals.

Mechanism of Rift-related basins :

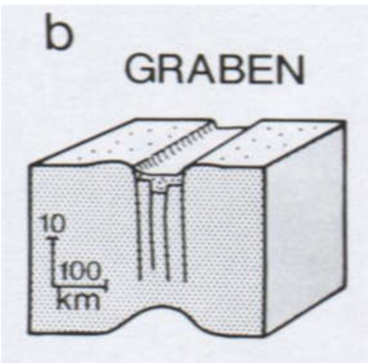
1- Rift initiated by updoming of the crust.

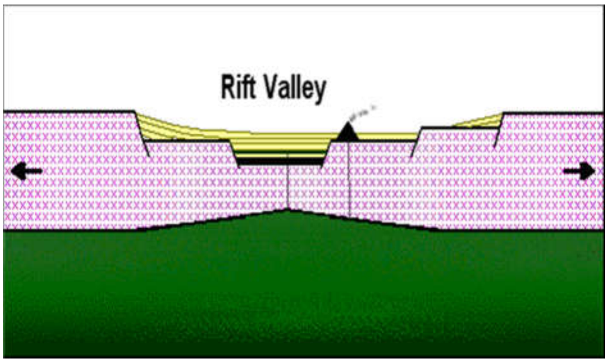
2- Updoming lead to forme the fructure system (triradiate rift system) as (triple rift junction).

3- In initially, the rift lie above sea level, so, they are infilled with terrgenous clastics sediments (fluvial and lacustrine sediments).

4- When, the rift subsides below the sea level (the frist subsidence), the rift floods by water of sea, so, the favours evaporites will formed. (at shallow depth).

5- the second subsidence of rift. (the rift-floor subsides below sea level but, into greater depth and by continous subsidence and separation, the rift become infilled with open marine sediments (clastic or carbonate).





Types of Rift basins:

There are two types of the rift basins:

1- Intracontinental rift basins

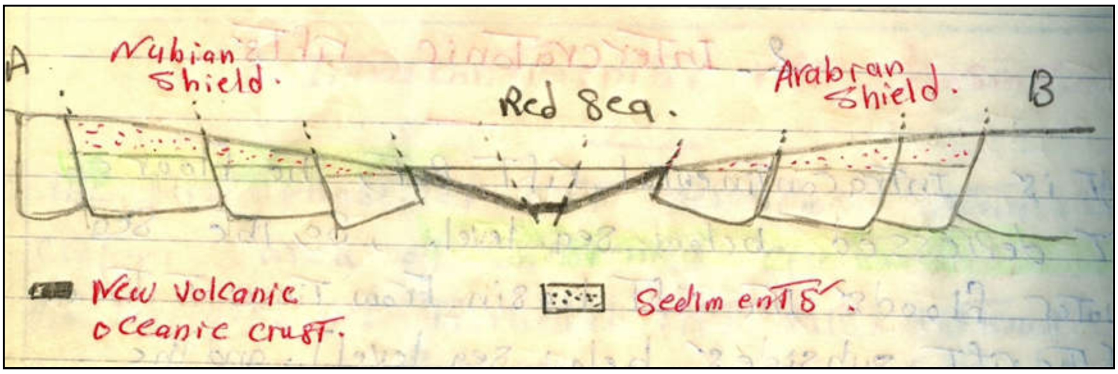
2- Intracratonic rift basins.

1- intracontinental rift basins

- It is the the first phase of rift development within the cratonic area of the continental crust. Where the fractures of triradial rift valley systems commonly diverge from the culmination of the dome.
- The rift become infilled with continental fluvio-lacustrine deposits, often, associated with volcanics (igneous activity).
- The best examples of this type are:(Baikal in Siberia, Rhine Valley in Germany, and East Africa).

2- intracratonic rift basins

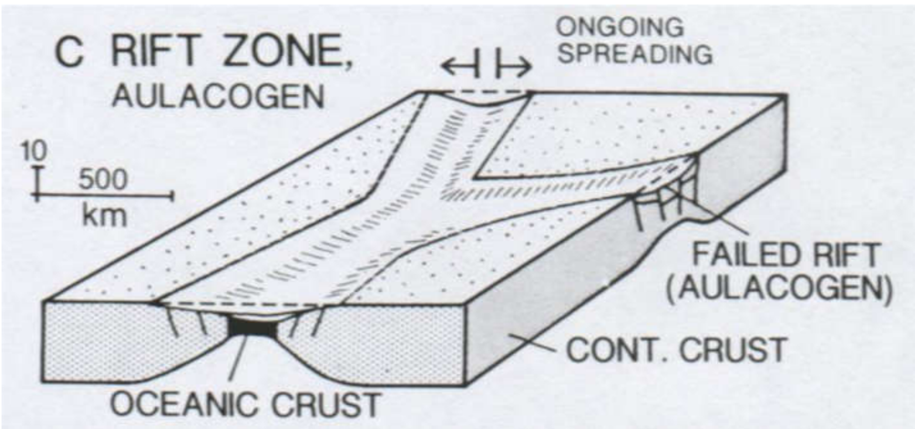
- It is intracontinental rift, but, the floor of it depressed below sea level, so, the sea water floods the rift basin from time to time (the rift subsidence below sea level).
- The continental clastic facies (Fluvial & Lacustrine) are overlain by evaporites.
- Example: The suez graben (pre-rift basement rocks are overlain by 4 km of miocene sediments „clastic sediments“ which formed by updoming. This clastic sediments are overlain by the evaporites group (dolomites and algal limestone, gypsium-anhydrite, marls, rock salts).
- The suez gulf opens out southwards into the Red-Sea. This is intercratonic rift basin. It formed by the crustal rifting of Arabo-Nubian Pre-Cambrian craton.By continous the subsidence and separation, the Red-Sea will convert Ocean. It is termed the incipient ocean.



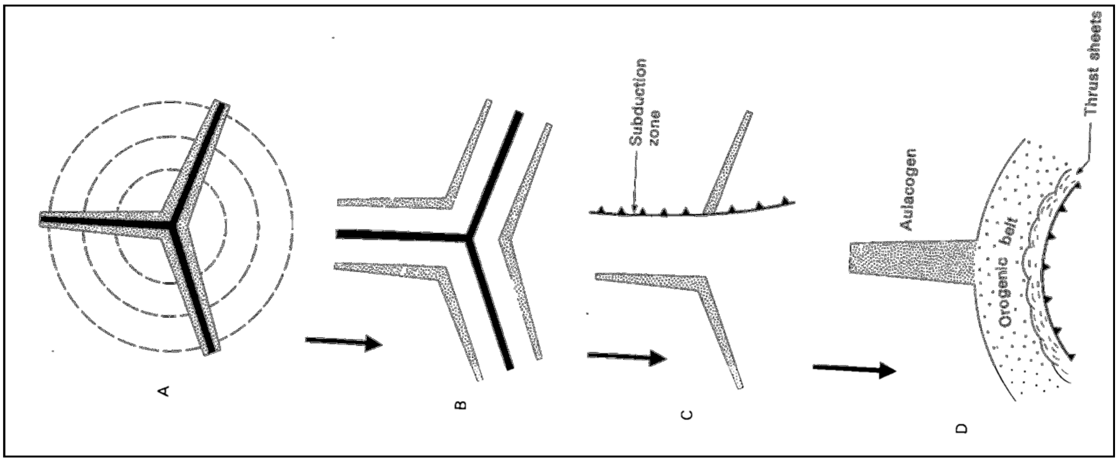
Cross-section in the red sea show, the coastal sedimentary basin and the volcanic activity which forms new oceanic crust.

2. Aulacogens basins:

- Doming of continental areas (due to stretching) lead to three rift vallyes meeting at a 120° triple Junction.
- Two rift vallyes combine to form a divergent plate leading to (through graben) ocean spreading, but the third arm closed by subduction causing deformation of sediments and volcanics.
- Continental margin collides with subduction zone forming orogenic belt and the faild arm called aulacogen.



- If divergent plate motion comes to an end before the moving blocks are separated by accretion of new oceanic crust, the rift zone is referred to as "failed". A certain type of such failed rifts is an aulacogen.
- Aulacogens represent the failed arm of a triple junction of a rift zone, where two arms continue their development to form an oceanic basin. Aulacogen floors consist of oceanic or transitional crust and allow the deposition of thick sedimentary sequences over relatively long time periods. Basins similar to aulacogens may also be initiated during the closure of an ocean and during orogenies.
- Recently-formed aulacogens occur at both ends of the Red Sea and Gulf of Suez is one of theses. It contains a 4 km thick succession of Neogene salt, limestone and clastic sediments. Also contains oilfield (Ras Morgan).



- Older aulacogens are present on both sides of Atlantic. Spreading occured at the triple junction 120-80 Ma ago. Benue Trough closed with subduction. It contains lead-zinc-fluorite-baryte mineralization in the fractures of Lower Cretaceous Limestone.Similar lead mineralization is present in the Amazon Rift Zone.

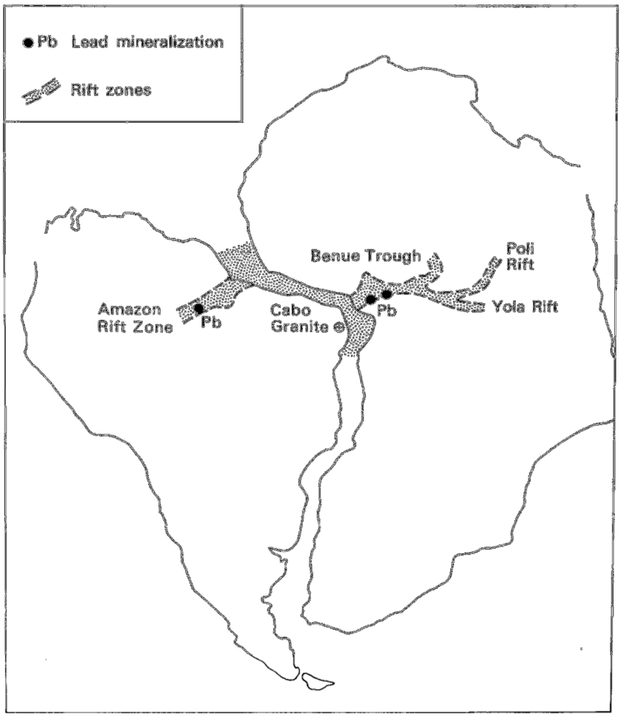


Fig. 22.4. Sketch map showing the locations of the Benue Trough, the Amazon Rift Zone and the lead mineralization within these aulacogens. (After Burke & Dewey 1973 and Mitchell & Garson 1976).

SUMMARY

AULACOGENE BASINS

• Narrow continental rifts which do not evolve into spreading ridge oceanic basins.

• Dominated by initial alluvial fan, fluvial, lake facies; up to 4 km thick.

• May extend enough

– crustal subsidence & extension

– marine transgression; no oceanic crust

– coastal plain rivers, coal swamp shoreline, shelf & slope environment

• Provenance

– continental, mixed

– plutonic, metasedimentary, metavolcanic, contemporaneous volcanic

– ± marine carbonates.

Subduction-related basins

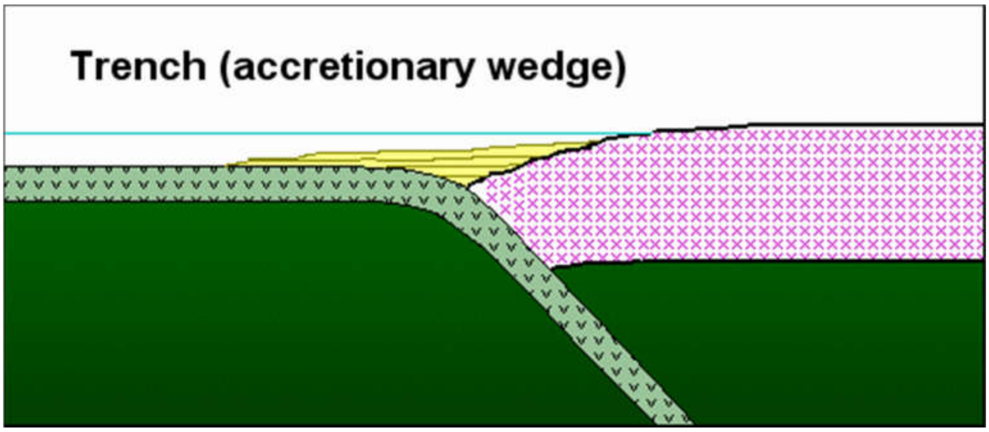
Collisional basins occur where plates collide, either characterized by subduction of an oceanic plate or continental collision.

Basins related to the development of subduction complexes along island arcs or active continental margins include deep-sea trenches ,Forearc basins, back arc basins and smaller slope basins and intra-arc basins.

1- Trench (accretionary wedge)

• Geological Origin: Downward flexure of the subducting and non-subducting plates (sites of accretionary wedges)

• Example: Western edge of Vancouver Island, Canada



- Deep-sea trench floors *are composed of* descending oceanic crust. Therefore, some of them represent the deepest elongate basins present on the globe.
- Deep-sea trenches commonly do not subside as do many other basin types. In fact, they tend to maintain their depth which is controlled mainly by the subduction mechanism, as well as by the volume and geometry of the accretionary sediment wedge on their landward side.
    - Trenches are generally parallel to a volcanic island arc, and trenches about 200 km from a volcanic arc. A trench marks the position at which the flexed, subducting slab begins to descend beneath another lithospheric slab.

- The deepest ocean depth to be sounded is in the Challenger Deep of the Mariana Trench at a depth of 10,911 m (35,798 ft) below sea level.
- Geographic distribution: There are about 50,000 km of convergent plate margins, mostly around the Pacific Ocean – the reason for the reference “Pacific-type” margin - but they are also in the eastern Indian Ocean, with relatively short convergent margin segments in the Atlantic Ocean and in the Mediterranean Sea.

Example:

The Peru-Chile Trench, also known as the Atacama Trench, is an oceanic trench in the eastern Pacific Ocean, about 160 kilometers (100 mi) off the coast of Peru and Chile. It reaches a maximum depth of 8,065 meters (26,460 ft) below sea level and is approximately 5,900 kilometers (3,666 mi) long; its mean width is 64 kilometers (40 mi) and it covers an expanse of some 590,000 square kilometers (228,000 mi²).

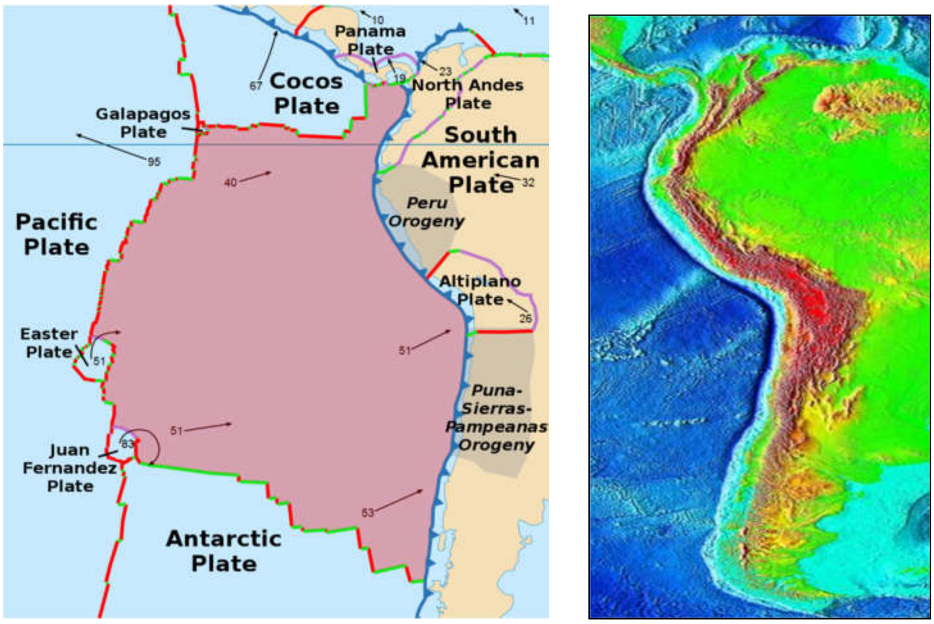
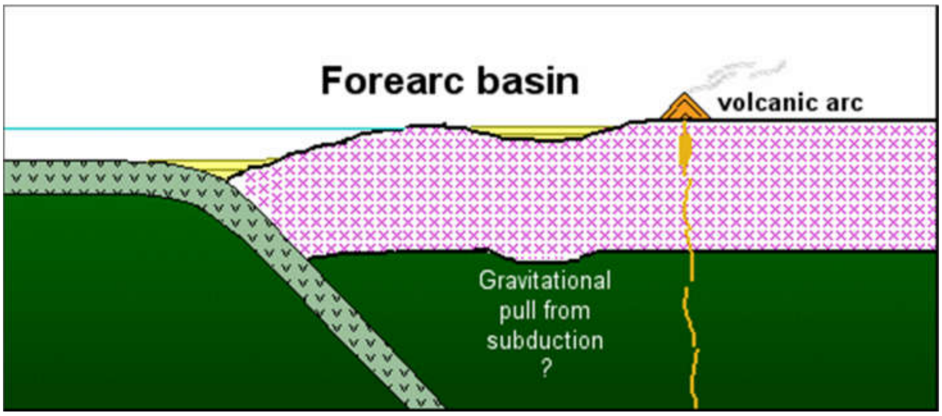


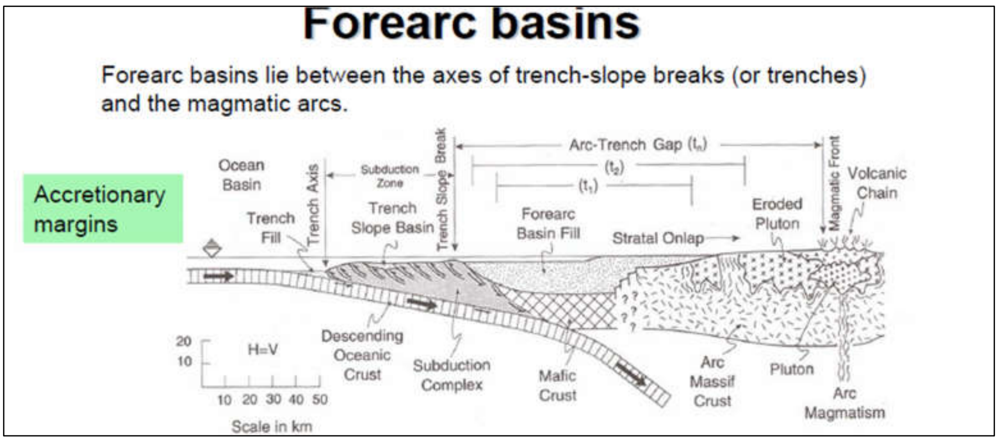
Fig. The trench is a result of the eastern edge of the Nazca Plate being subducted under the South American Plate.

Forearc basin

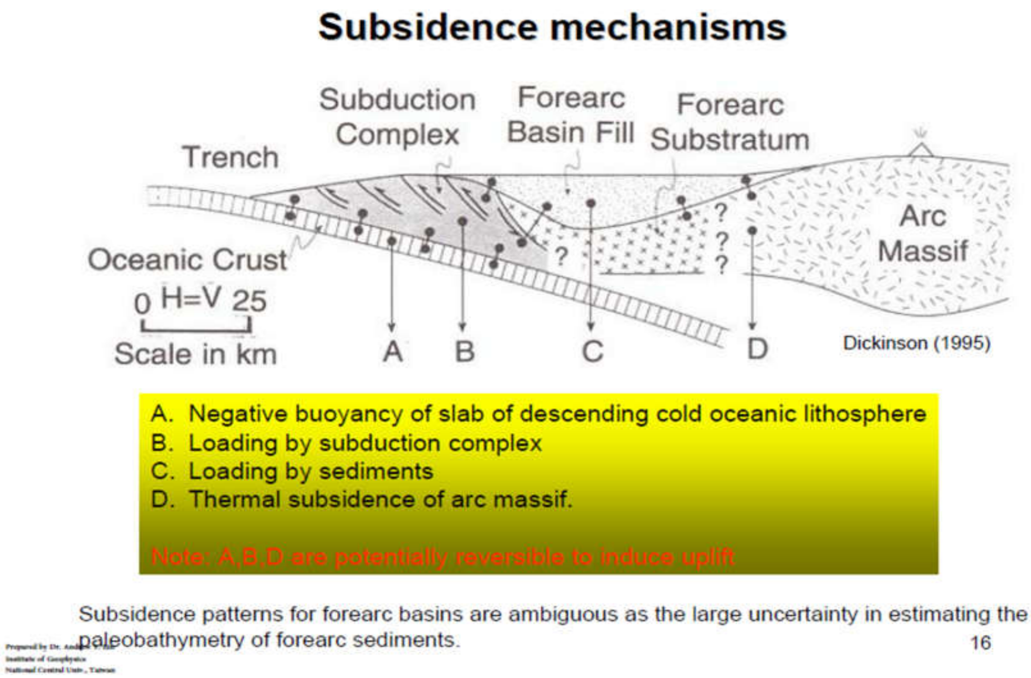
- Geological Origin: The area between the accretionary wedge and the magmatic arc, largely caused by the negative buoyancy of the subducting plate pulling down on the overlying continental crust
- Example: Georgia Strait



- A Forearc is typically filled with sediments from the adjacent landmass and the island arc in addition to trapped oceanic crustal material.
- The oceanic crustal fragments may be abducted as ophiolites onto the continent during terrane accretion.
- The late Cretaceous - early Paleocene development of the Central Valley of California is an example of Forearc development.

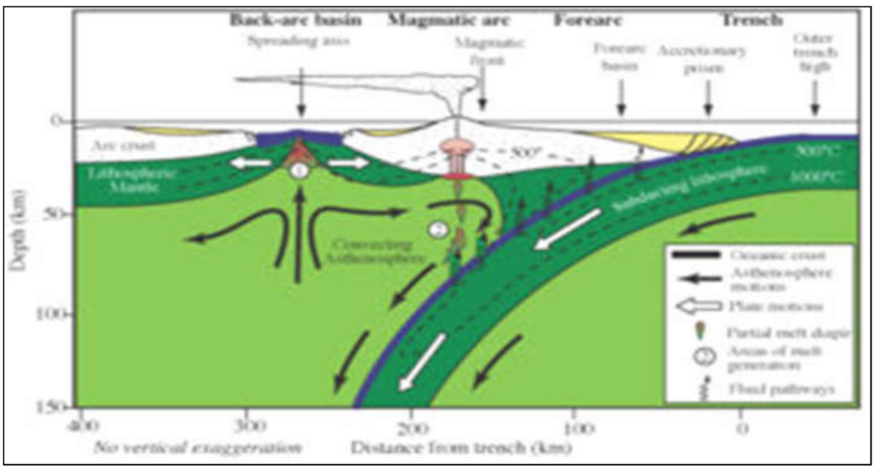


Mechanisms of Forearc basins

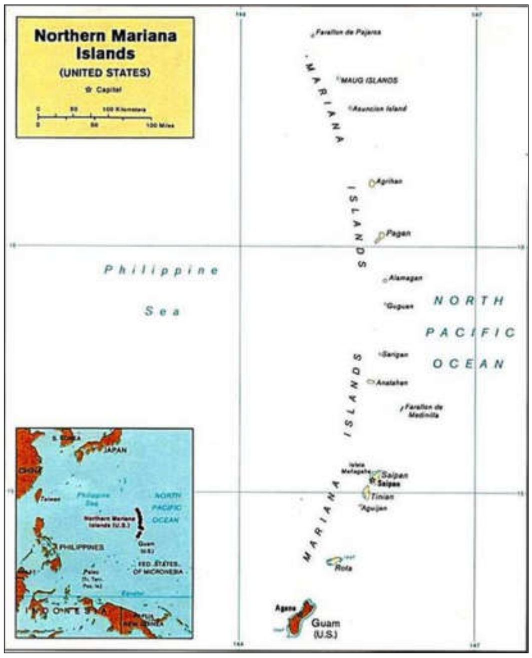


Backarc or inter-arc basins

- form by ocean spreading either landward of an island arc, or between two island arcs which originate from the splitting apart of an older arc system.
- The evolution of these basins resembles that of normal ocean basins between divergent plate motions. Their sedimentary fill frequently reflects magmatic activity in the arc region.
- **E.g. Marianas**

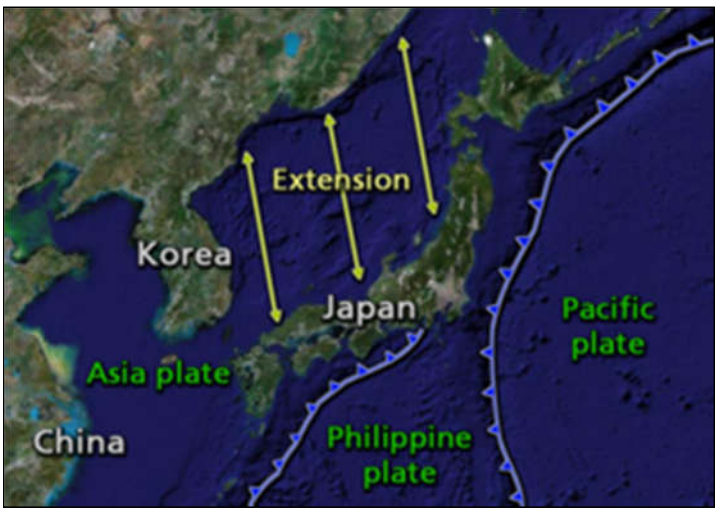


- Back-arc basins are typically very long (several hundreds to thousands of kilometers) and relatively narrow (a few hundred kilometers).
- The restricted width of back-arc basins is probably due to the fact that magmatic activity depends on water and induced mantle convection and these are both concentrated near the subduction zone.
- Spreading rates vary from very slow spreading (Mariana Trough), a few centimeters per year, to very fast (Lau Basin), 15 cm/year.
- Northern Mariana islands are an archipelago made up by the summits of 15 volcanic mountains in the north-western Pacific Ocean



Backarc or interarc basins

The island of Japan was separated from mainland Asia by back-arc spreading



SUMMARY

ISLAND ARC-SUBDUCTION ASSOCIATED BASINS

• **E.g. Marianas**

• **Origin**

– oceanic plate is subducted under another oceanic plate

– trench, accretionary prism, volcanic island arc

– volcanic arc on oceanic lithosphere

– back arc basin(s) originate by rifting of arc block, development of small spreading ridge

• widening basin; oceanic crust

– arc block migrates trench ward as subducting plate "rolls back".

• Volcanism

– island arc tholeiitic volcanics

• basalts, basaltic andesites

– back arc basin tholeiitic crust

Basin types, environnent, facies, provenance

– Trench basin

• turbidites, pelagic sediments

• metasedimentary sed. from accretionary prism

• arc derived volcanic sediment

– Fore-arc basin

• on accretionary prism

• volcanic seds., carbonates

• turbidites

– Back arc basin

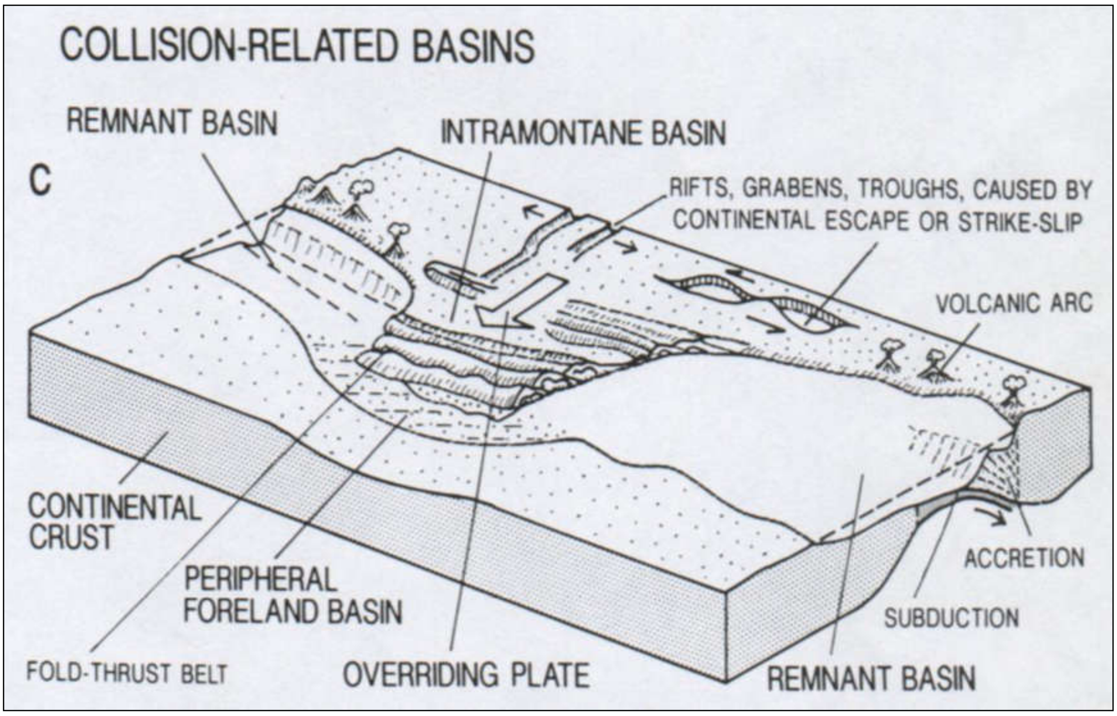
• arc derived volcaniclastics turbidite

• pelagic sediments, especially where basin is large

– no continental derived sediment

– only rare silicic volcanism.

Collision-related Basins



CONTINENTAL COLLISION BELTS & BASINS

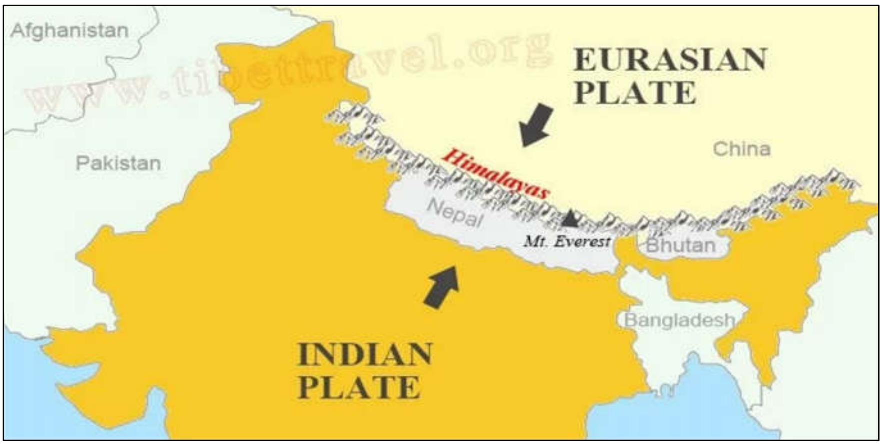
- **E.g. Himalayan mountain chain, European Alps**
- **Origin**

- long term subduction of oceanic plate under continental margin, will bring "passenger" continent into collision with arc host continent.
- oceanic basin closes during collision subduction continent under thrust over-riding continent uplift, mountain range, double continental crust thickness

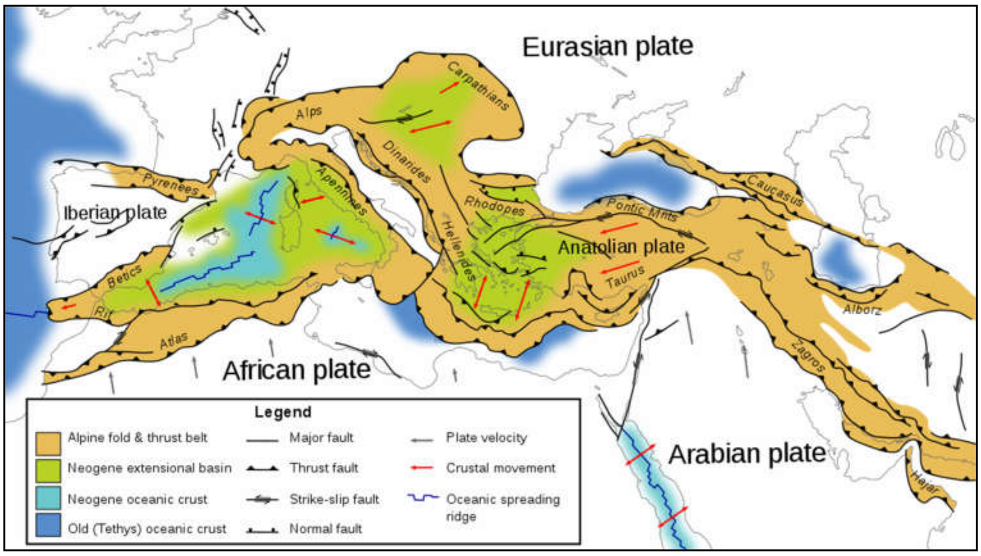
- **Volcanism**

- subduction related volcanism stop at collision, when subduction stop
- Granitoid plutonism may occur due to extremely thickened crust

magmas won't rise because of compressional stress field.



Himalayan mountain chain. Mt. Everest (8844.43m): World's Highest Mountain.

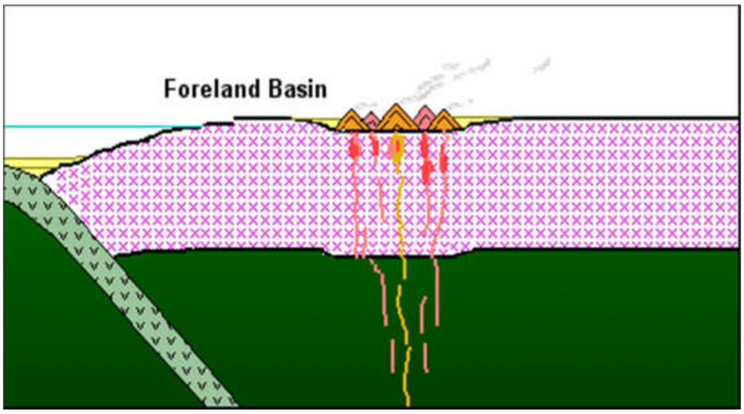


The Alps arose as a result of the collision the African and Eurasian tectonic plate.

Collision-related Basins

1- Foreland basin

Foreland basins and peripheral basins in front of a fold-thrust belt, are formed by depressing and flexing the continental crust ("A subduction", after ampferer, Alpine-type) under the load of the over-thrust mountain belt.

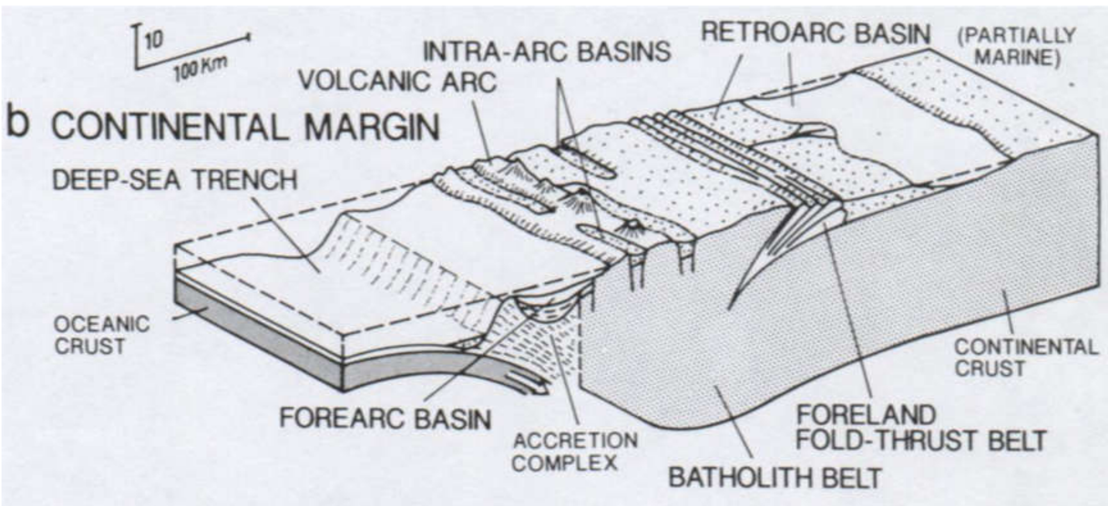


foreland basin

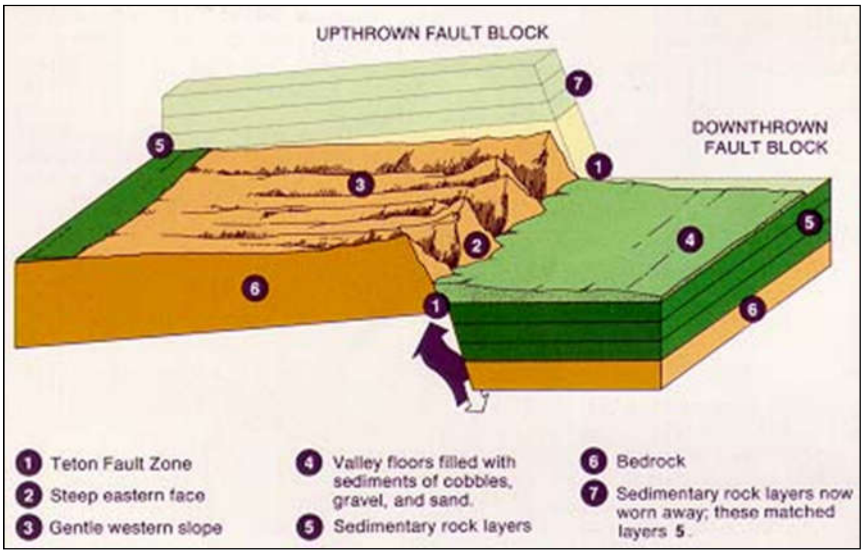
- at front of fold & thrust belt
- subject to isostatic subsidence
- huge sediment flux off mountain belt
- alluvial fan, braided river, meandering river, lake environments & facies
- metasedimentary, met. (include high grade plutonic, reflecting deep crustal erosion).

2-Retroarc or intramontane basins

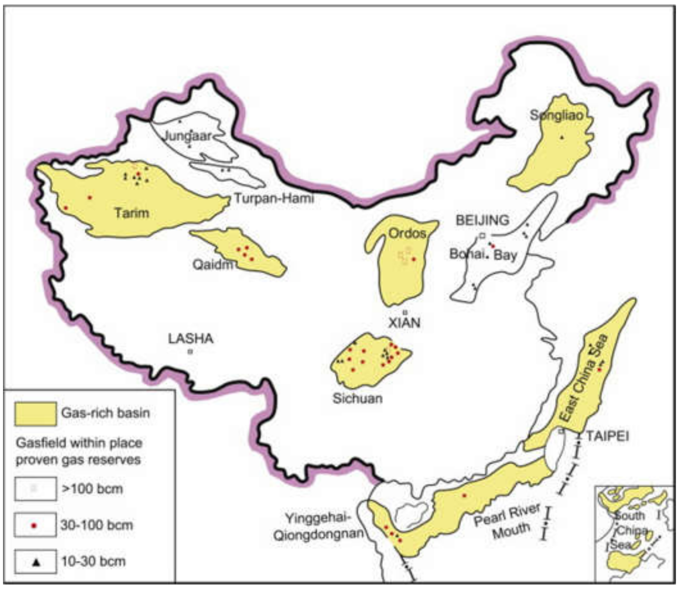
Retroarc or intramontane basins occur in the hinterland of an arc orogen ('B-subduction" zone).They may affect relatively large areas on continental crust. Limited subsidence appears to be caused mainly by tectonic loading in a Backarc fold-thrust belt.



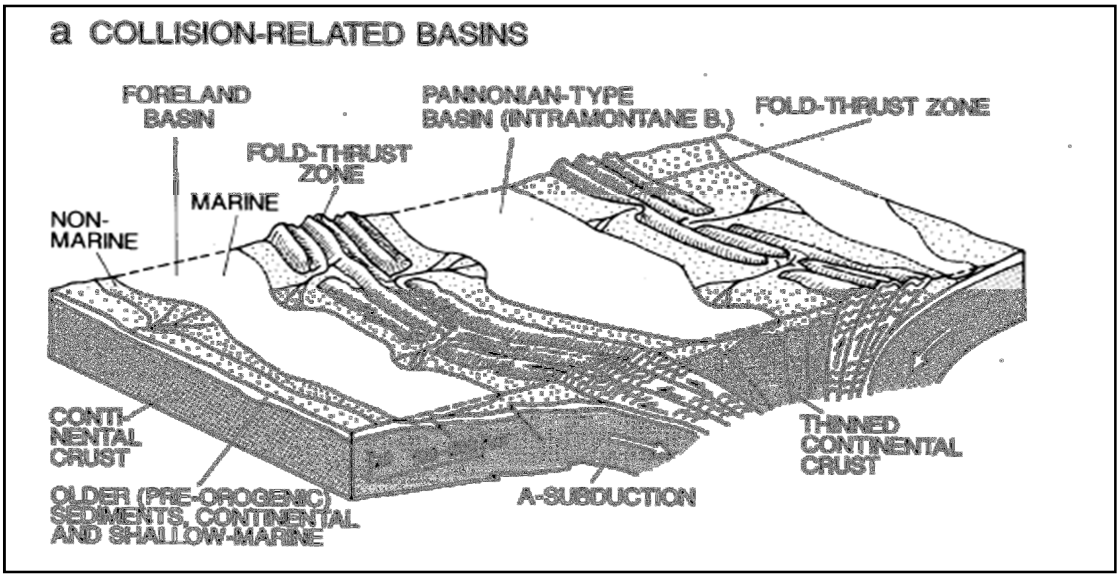
During crustal collision, some foreland (and retroarc) basins can get broken up into separate smaller blocks, whereby strike-slip motions may also play a role. Some of the blocks are affected by uplift, others by subsidence, forming basinal depressions. The mechanics of such tilted block basins.



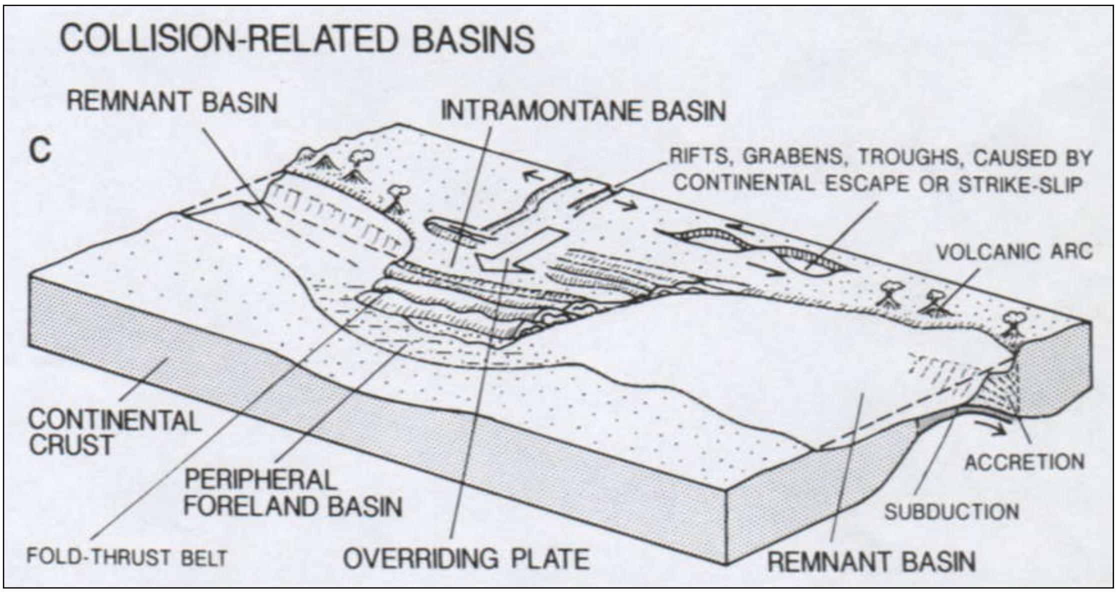
Example :Chinese-type basins *result* from block faulting in the hinterland of a continent-continent collision.



3-Pannonian-type basins originate from post-orogenic divergence between two fold-thrust zone. They are usually associated with an A- subduction zone and are floored by thinning continental or transitional crust.



As a result of the collision of two continental crusts, the overriding plate may be affected by 'continental escape', leading to extensional graben structures or rifts perpendicular to the strike of the fold-thrust belt

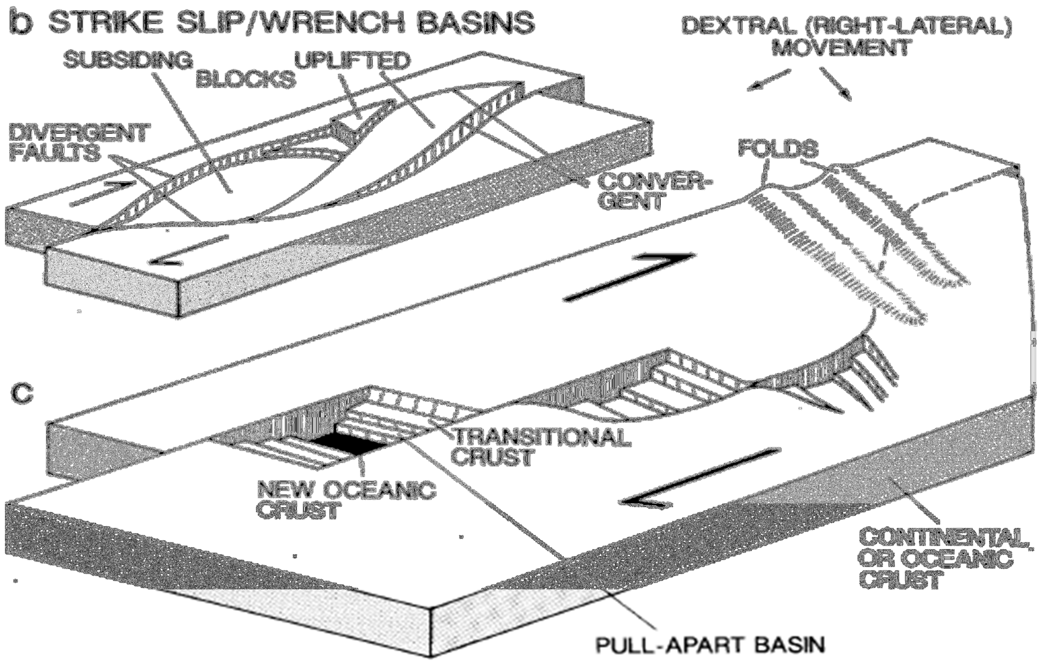


Strike-slip and wrench basins

Transform motions may be associated either with a tensional component (transtensional) or with a compressional component (transpressional)

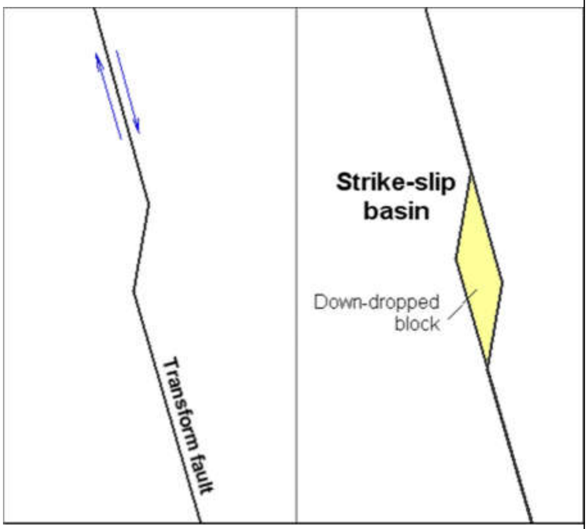
Transtensional fault systems locally cause crustal thinning and therefore create narrow ‹elongate pull-apart basins. If they evolve on continental crust, continuing transform motion may lead to crustal separation perpendicular to the transform faults and initiate accretion of new oceanic crust in limited spreading centers. Until this development occurs, the rate of subsidence is usually high.

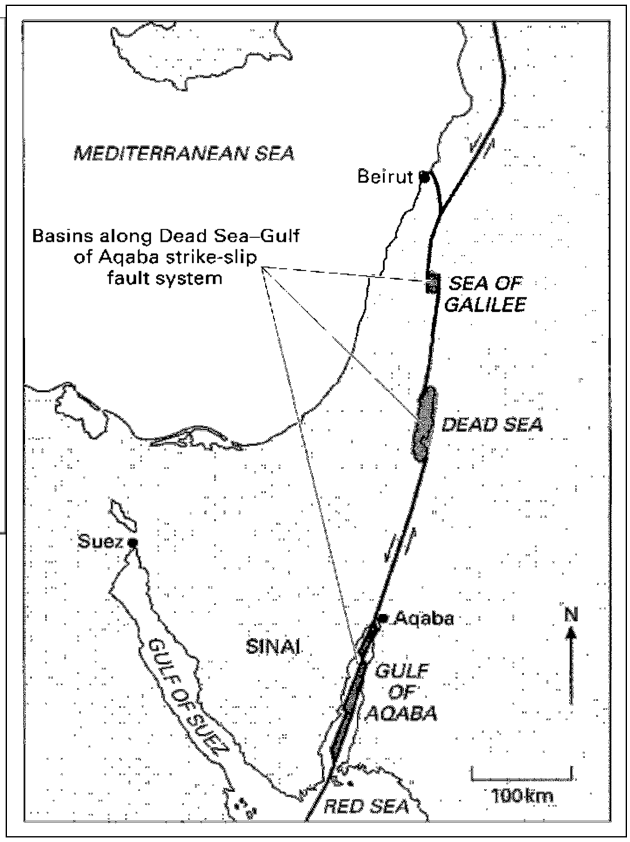
Transpressional systems generate wrench basins of limited size and endurance. Their compressional component can be inferred from wrench faults and fold belts of limited extent.



Example:

* Basins along Dead Sea- Gulf of Aqaba strike- slip fault system.





* The Dead Sea is located in the Dead Sea Rift, which is part of a long fissure in the Earth's surface called the Great Rift Valley.

* The 6,000 km (3,700 mile) long Great Rift Valley extends from the Taurus Mountains of Turkey to the Zambezi Valley in southern Africa. The Great Rift Valley formed in Miocene times as a result of the Arabian Plate moving northward and then eastward away from the African Plate.

* The lake that occupied the Dead Sea Rift, named "Lak Sodom", deposited beds of salt, eventually coming to be 3 km (2 miles) thick.

Dead sea:

- The Dead Sea is the Earth's lowest point, at 418 m (1,371 feet) below sea level and the deepest hypersaline lake in the world, at 330 m (1,083 feet) deep.
- It is the second saltiest body of water on Earth, with a salinity of about 30 percent. Only Lake Asal (Djibouti) has a higher salinity.
- This is about 8.6 times greater than average ocean salinity.
- It measures 67 km (42 miles) long, 18 km (11 miles) wide at its widest point, and is located on the border between Plastine, and Jordan and lies in the Jordan Rift Valley. The main tributary is the Jordan .

Summary

-Basins along Dead Sea- Gulf of Aqaba strike- slip fault system

-California borderland basins associated with San Andreas strike-slip fault system , Various locations on the San Andreas Fault or the Anatolian Fault.

• **Origin**

– strike-slip along non-linear faults
– opening "holes" or basins at fault jogs or bends
– A pull-apart block (eg. between two transform faults) that subsides significantly

• **Volcanism**
– usually none, unless "accidental" intraplate

• **Basin types, environments, facies, provenance**
– "pull-apart" or strike-slip basins
– alluvial fans, rivers, lakes
– alluvial, lacustrine, coal, ?evaporite seds.
– provenance: whatever is being eroded from exposed crust

Sedimentary Basins of Egypt

Based on their individual tectonic and depositional history a variation on the theme may occur. **Sedimentary basins of Egypt** are either

1- intracratonic basins.

2- pericratonic or rifts basins.

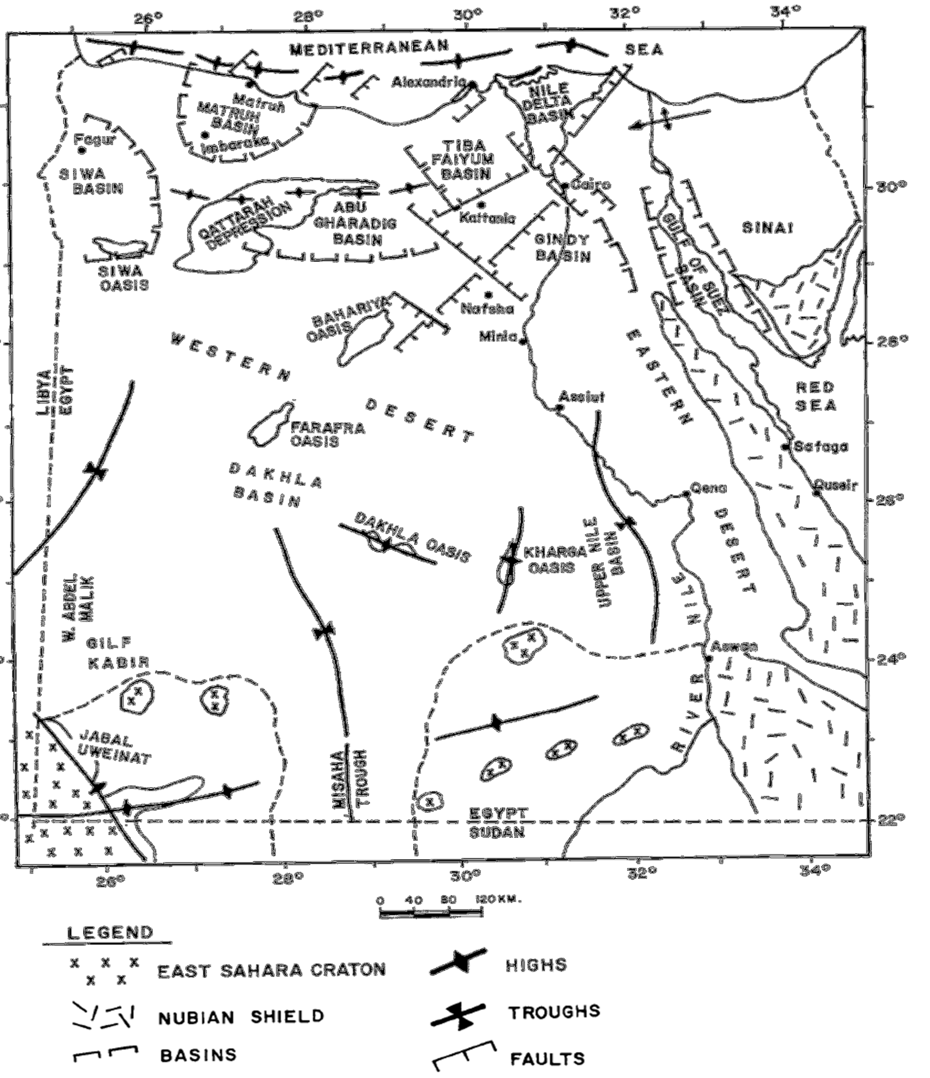


Fig. Configurations Sedimentary basins of Egypt

1- Intracratonic basins in Egypt

The Dakhla and Upper Nile basins are broad intracratonic depocentres which were developed in southern and central Egypt during the Palaeozoic and Mesozoic.

They have evolved as a result of structural differentiation and subsidence of the rigid cratonic plate.

Morgan (1990) suggested that subsidence in Dakhla and the adjacent Kufra basin in Libya was initiated in response to cooling and thermal relaxation of the crust at the closing stages of the Pan-African tectono-thermal event.

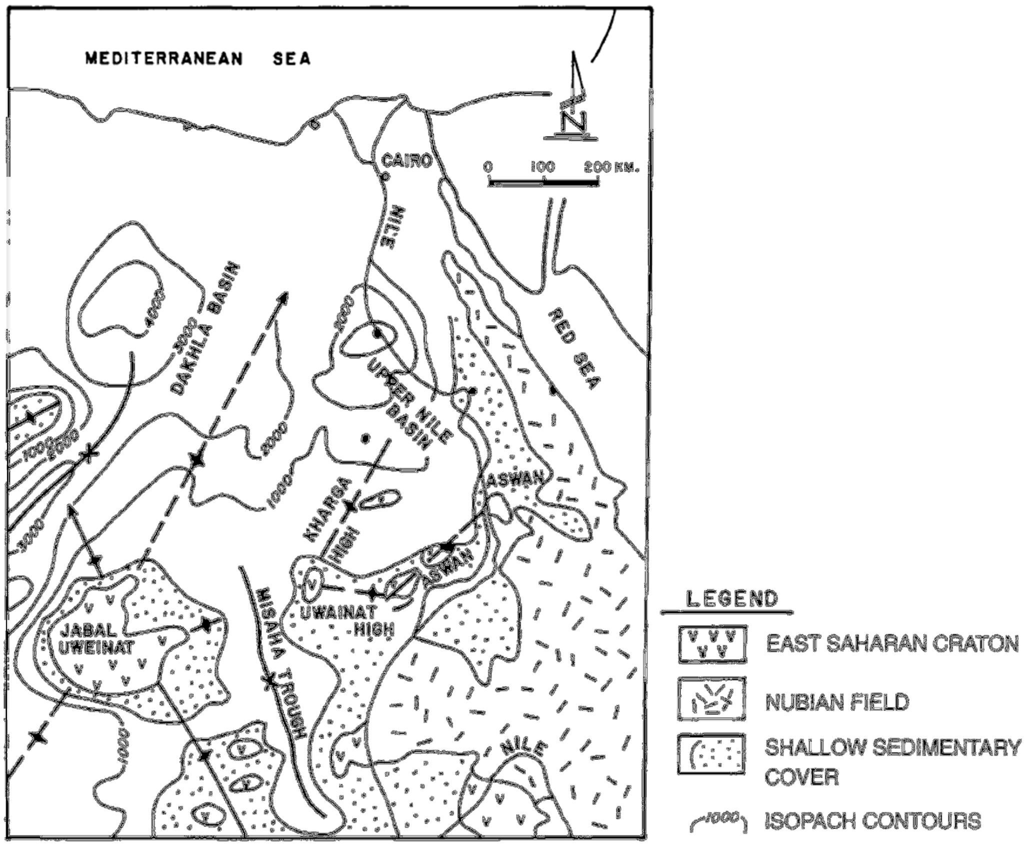


Fig. 2. Tectonic map showing intracratonic basins of Egypt and Northern Sudan (After Klitzsch, 1984).

2- <u>Pericratonic basins in Egypt</u>

The pericratonic basins of Egypt were developed on the northern continental margin of the Afro-Nubian craton following the opening of the Tethys ocean during the Middle Jurassic time.

These basins are bound to the north by a subsurface structural high trending parallel to the coastline in the Mediterranean offshore (Fig. 1). They are also, separated from the intracratonic basins the south by the subsurface Rayan-Nafsha and Farafra highs.

The pericratonic sedimentary basins were generally affected by the same prevailing regional structural and tectonic conditions as the intracratonic basins. However, being located on the margin of the craton, they were more susceptible to tectonic influences induced by collision with the Eurasian plate than their southern counterparts on the stable craton.

These basins include Siwa, Matruh, Abu Gharadig, Faiyum, lower Nile or Gindy, and the Nile Delta.

Siwa basin is one of the main Palaeozoic depocentres in the Western Desert of Egypt. The basin is bound to the east by Mamura-Farafra ridge, and extends westwards into Gaghboub basin across the border into Libya, where the basin attains greater depth. The Palaeozoic section is about 1700 m thick, but reaches a thickness of 2283 m in Gaghboub's Cori well G1-83. A hiatus (gaps) at the top of the Palaeozoic marks the Hercynian orogeny.

The Matruh basin is located northwest of the Western Desert and northeast of Siwa basin, it is bound to the south by the Qattarah ridge. The basin axis slopes to the northwest in the direction of the E-W trending Mediterranean offshore ridge

Abu Gharadig basin One of the major sedimentary basins in Egypt that exhibits a great hydrocarbon potential Currently, it produces 40,000 barrels of oil and 0.4 bcf of gas per-day from Cretaceous reservoirs. The basin is located in the central part of the Western Desert.

-The basin was opened during the Early Cretaceous as a result of right-lateral movement of E-W to ENE trending normal faults, leading to the development of pull-apart grabens (Abdel Aal and Moustafa, 1988).

- This basin is also considered to be an extension of the E-W trending arm of the Sirt basin rift system (Guiraud and Maurin, 1992). It has evolved as a result of the development of wrench faulting and structural inversion related to the Late Cretaceous Syrian Arc fold systems.

El Faiyum basin was developed during the Jurassic as a northerly sloping basement. Like most pericratonic basins it was developed during the opening of the Tethys.

Following the Late Cretaceous Syrian Arc tectonics, Faiyum basin was divided and the newly

developed **Lower Nile (Gindy) basin** and was separated from its northern counterpart Tiba basin. As the Lower Nile basin was established as the major Palaeogene depocentre in Egypt, **the Nile Delta** is recognized as the main Neogene depocentre in the Pericratonic area of Egypt.

The Gulf of Suez rift basin

- The Gulf of Suez basin is a tensional tectonic rift that forms the northern extension of the Red Sea graben.
- The basin is 60 to 80 km wide and consists of two major tilted blocks found on each side of the rift (Thiebaud and Robson, 1979.
- The rift, however, is considered to be a post-Eocene feature that became a fully developed basin during the Miocene as it received more than 3700 m of sediments .
- The Gulf of Suez basin contains several sedimentary units that are regarded as good source rock for oil.

Referecnces

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2- Applied sedimentology, R. C. Selley, 2000. (Chapter 10).

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