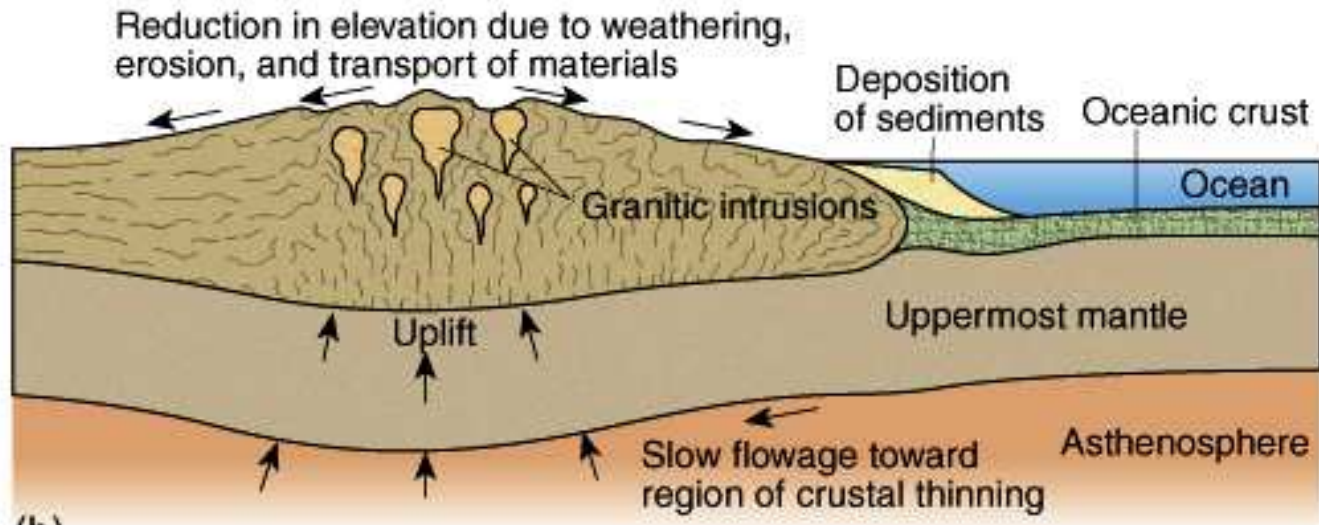
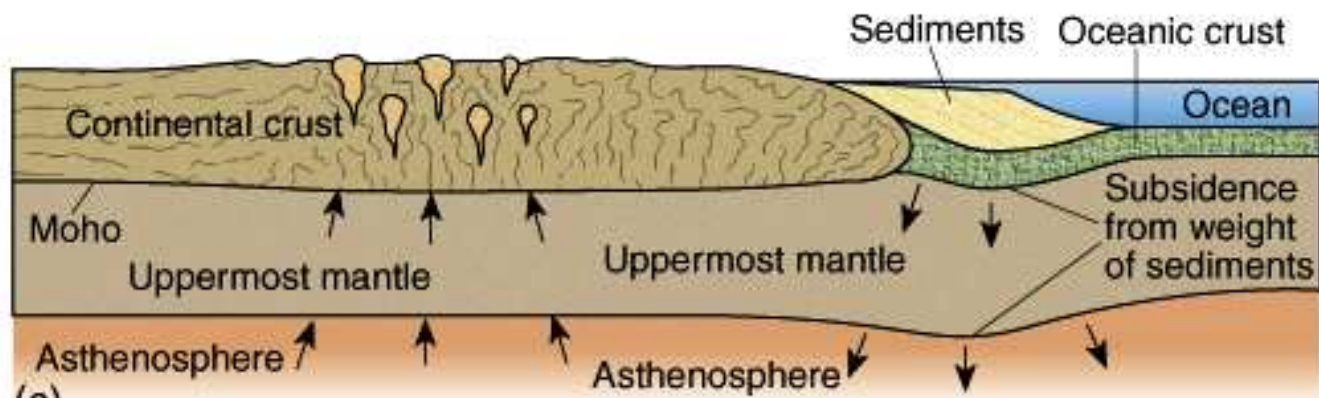


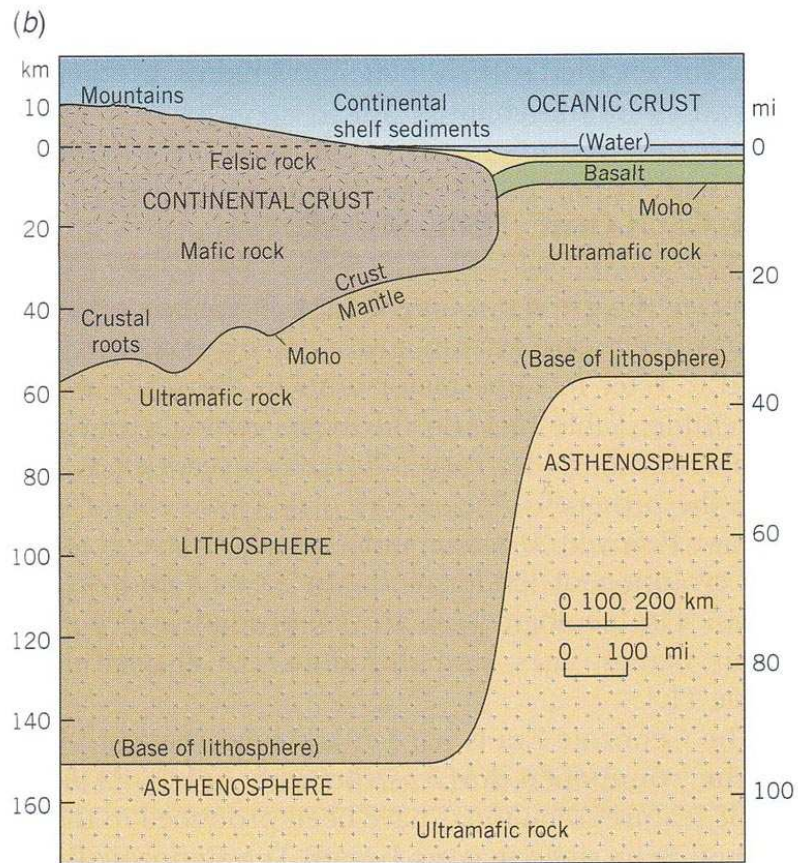
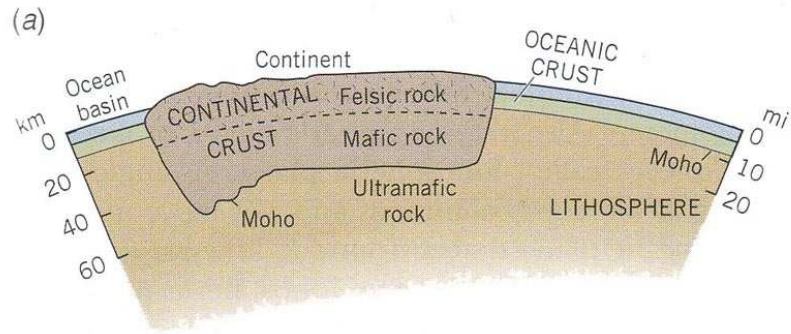
(a)



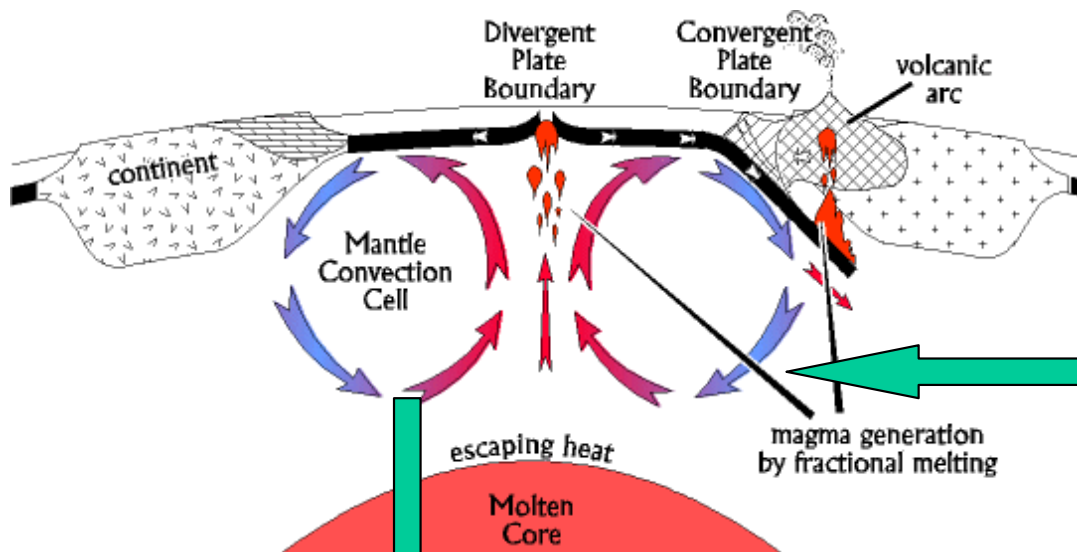
(b)



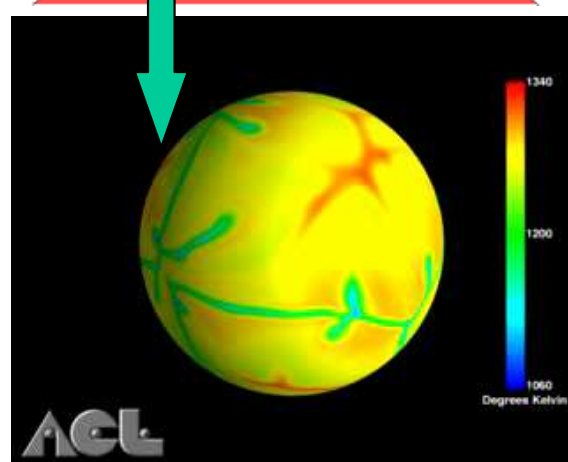
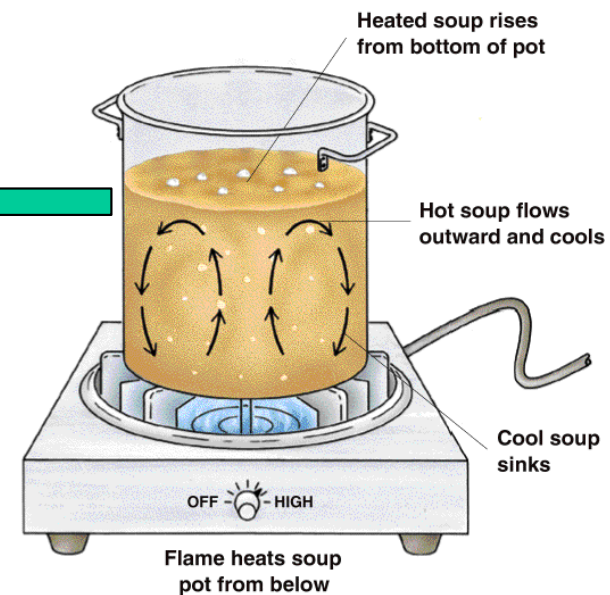
(c)



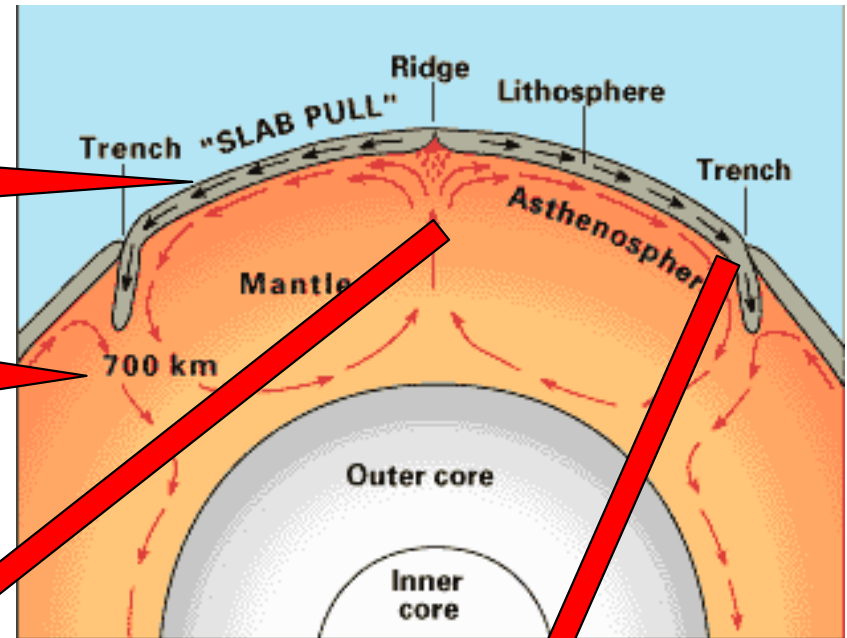
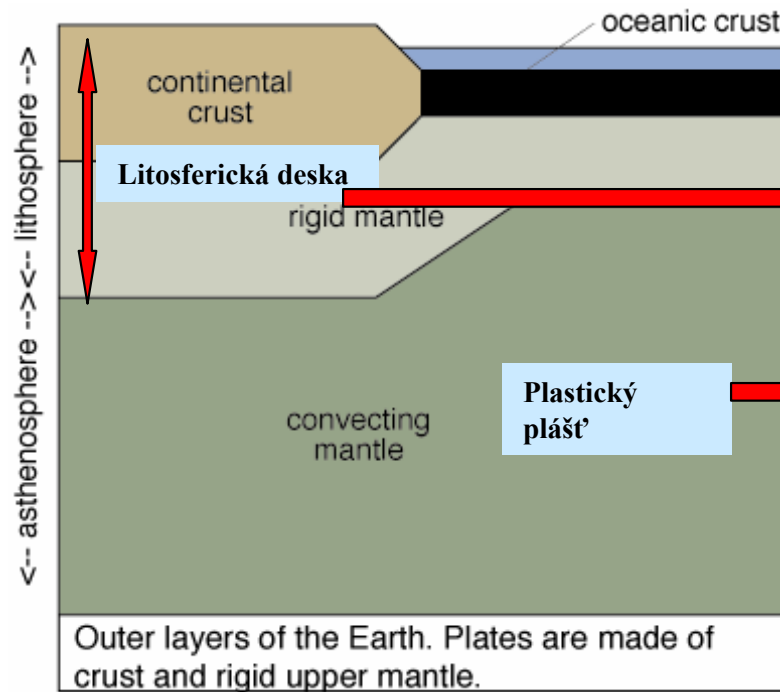
Geologie na konci 20. století přešla od fixistických statických interpretací k dynamickému pojetí vývoje Země. Dnes dominující paradigma geologie – tektonika litosferických desek - zdůrazňuje výrazné horizontální přesuny kontinentálních bloků. Za jejich hnací motor je považována tepelná konvekce v plášti Země, která je určována tepelnou výměnou mezi žhavotekutým jádrem Země a poměrně chladným povrchem.



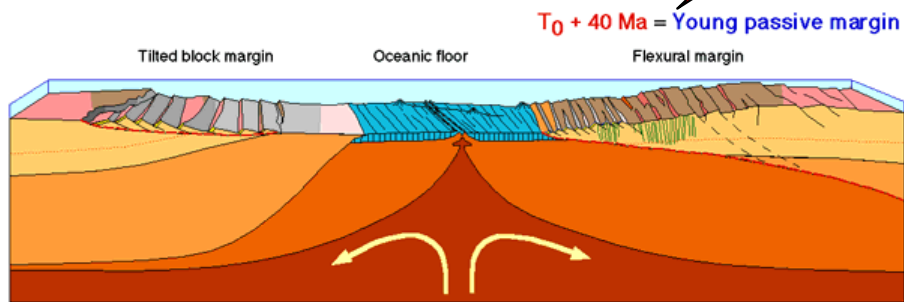
Thompson and Turk: Earth Science and the Environment, 2/e
Figure 5.11



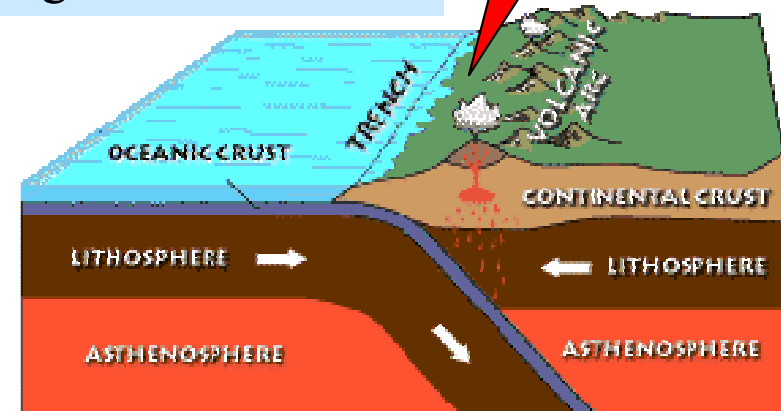
Teorie litosferických desek předpokládá, že konvekční tepelné proudy v plastické části zemského pláště vedou v místech vzestupných tepelných proudů ke vzniku divergentních rozhraní a v místech sestupných tepelných proudů ke vzniku konvergentních rozhraní litosferických desek



Divergentní rozhraní



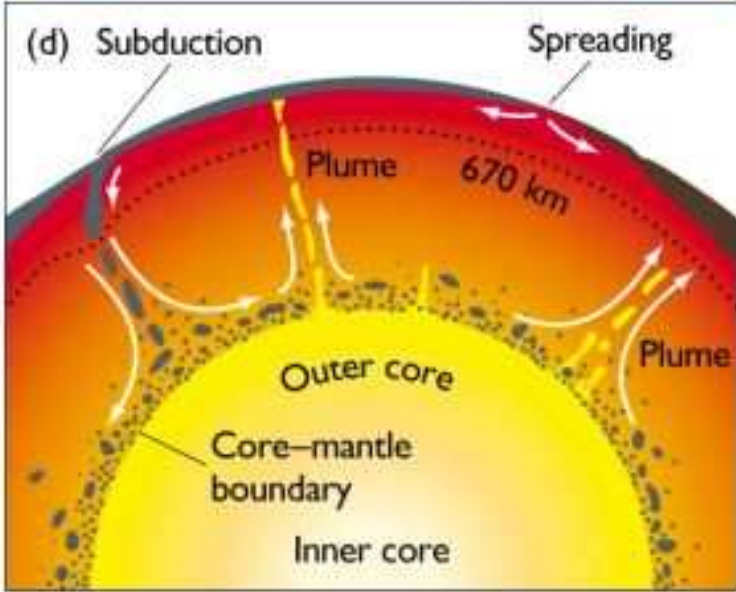
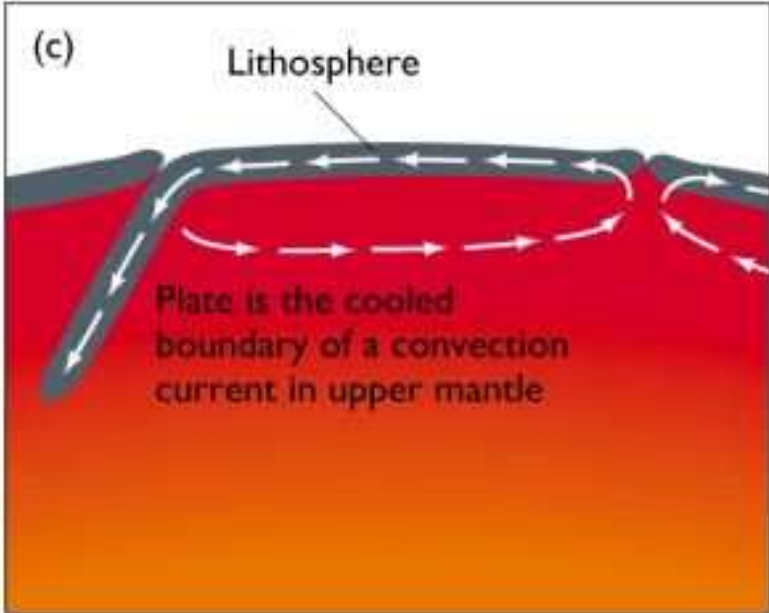
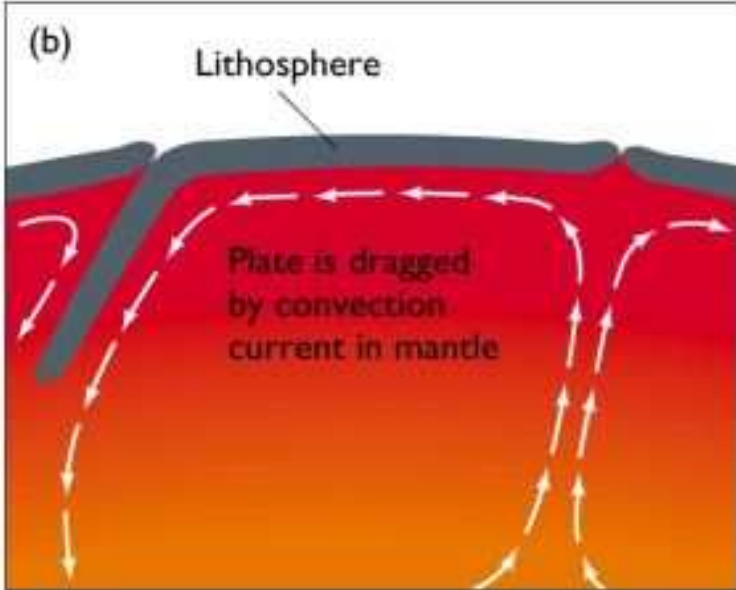
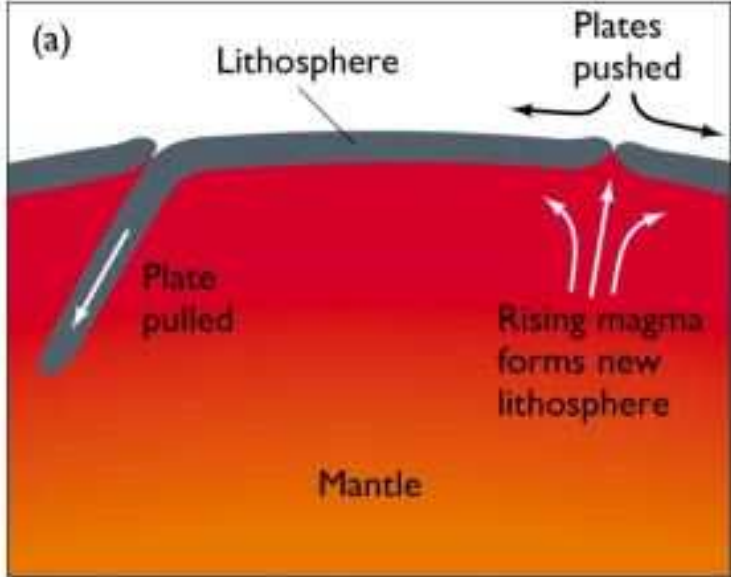
Konvergentní rozhraní



Driving mechanism of plate tectonics

- Trench pull
- Ridge push
- Thought to be cooling of the planet.
- Friction at base of the lithosphere transfers motion from the asthenosphere to the lithosphere.
- Convection may have overturned asthenosphere 1–6 times.

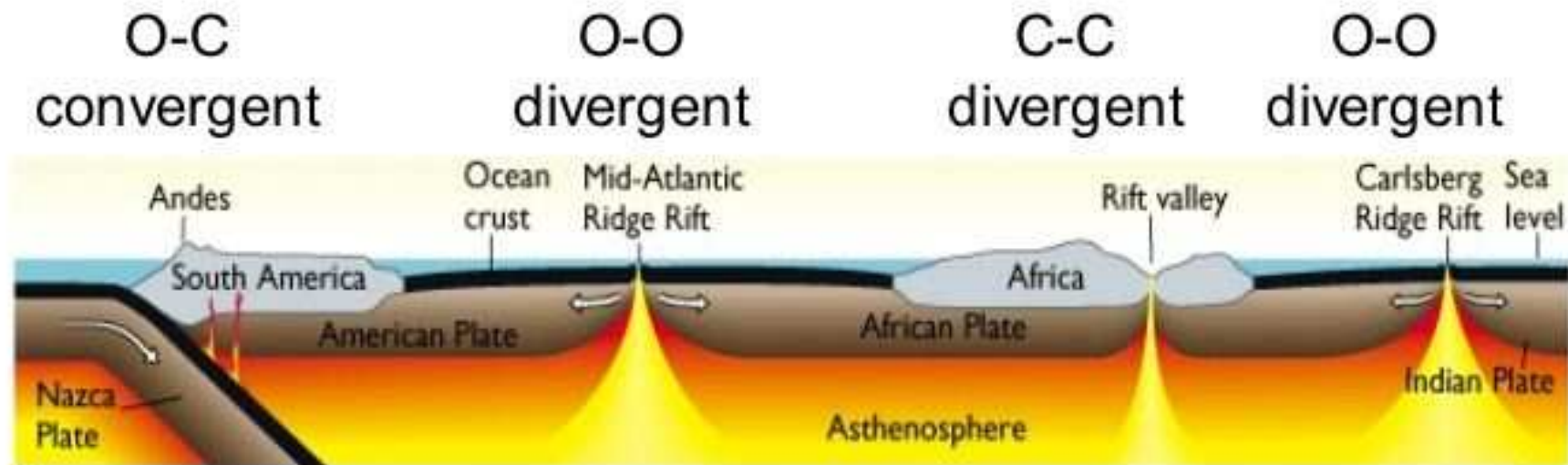
Mechanisms



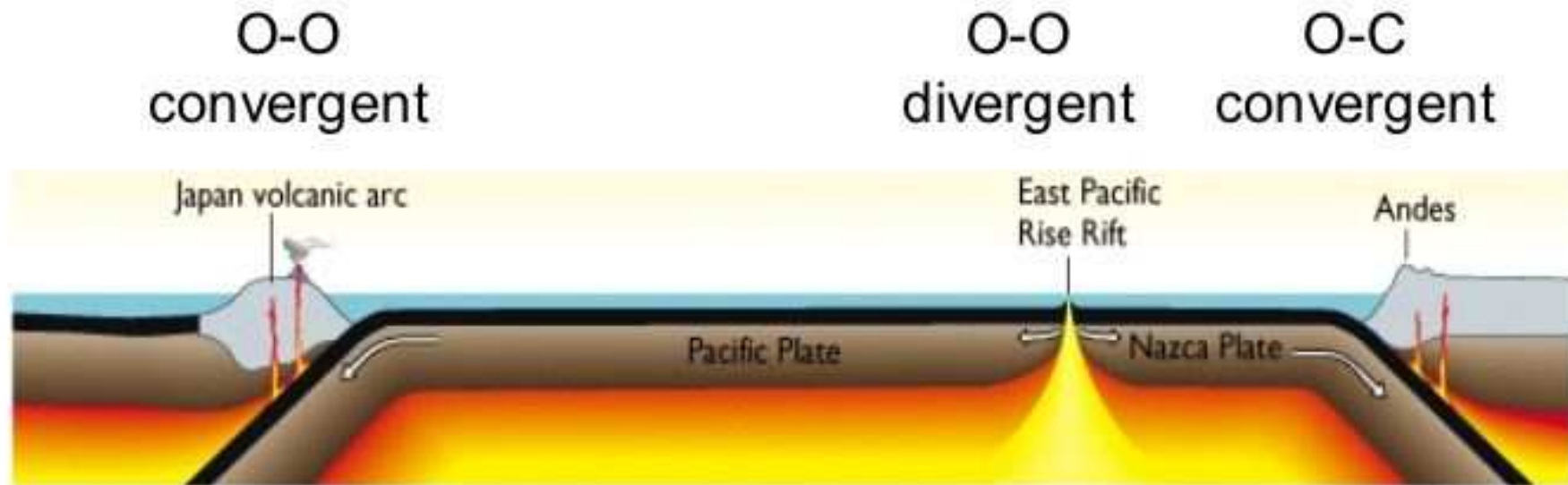
Types of plate boundaries

- ***divergent:*** mid-ocean ridges
- ***convergent:*** collision zones
volcanic arcs
- ***strike-slip:*** San Andreas fault
Alpine fault, N.Z.

Examples of Plate Boundaries



(a)

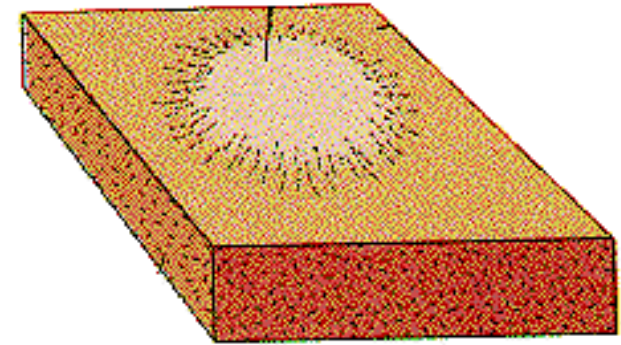


(b)

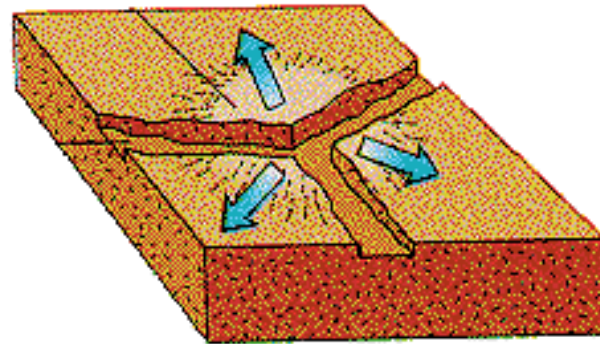
Fig. 20.8a,b

•Triple Junction

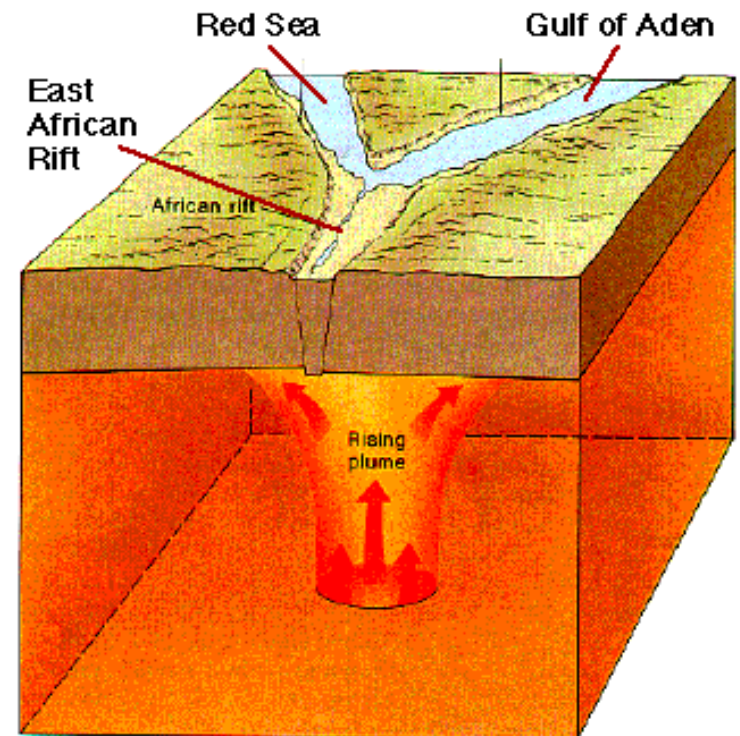
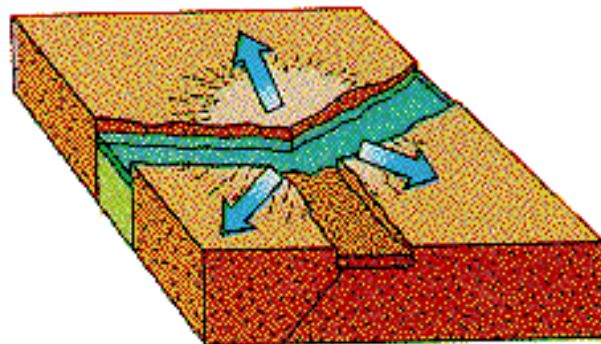
Bulge over rising mantle plume



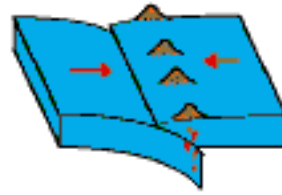
Development of 3 radial rifts



•Aulacogen



Convergent Plate Boundaries

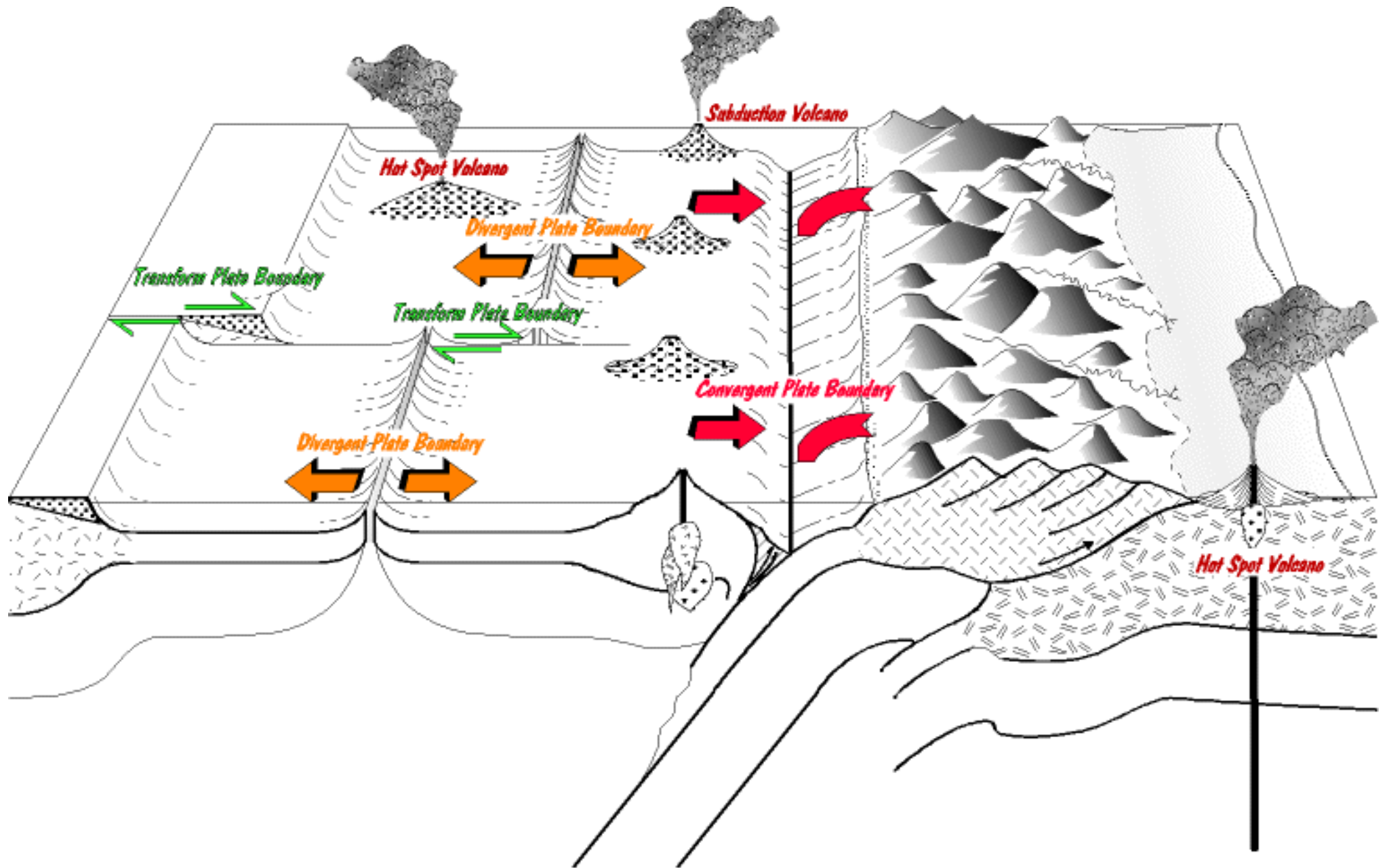


•oceanic-oceanic convergent plate boundary



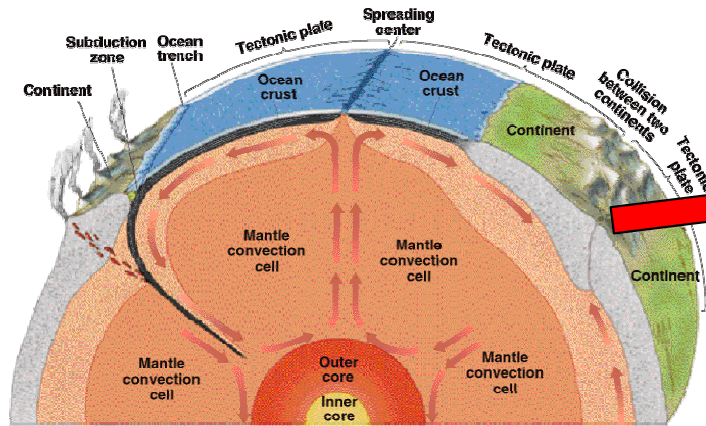
•continental-oceanic convergent plate boundary



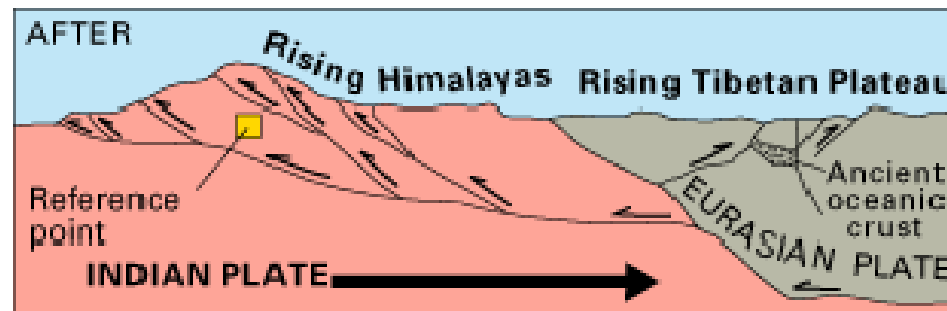
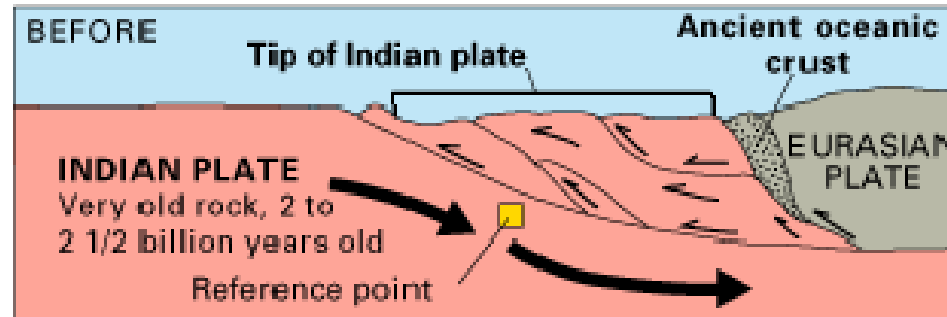
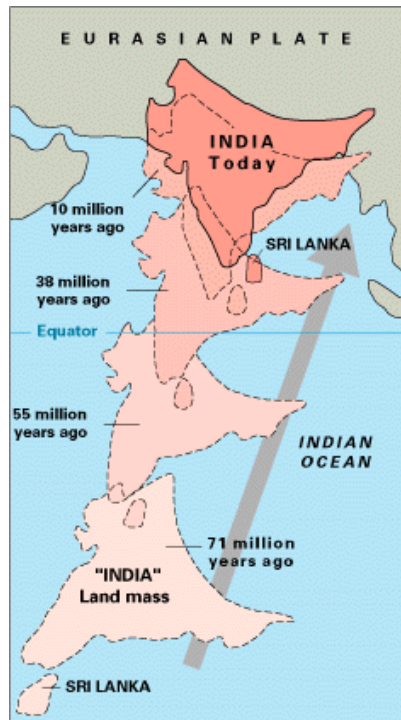
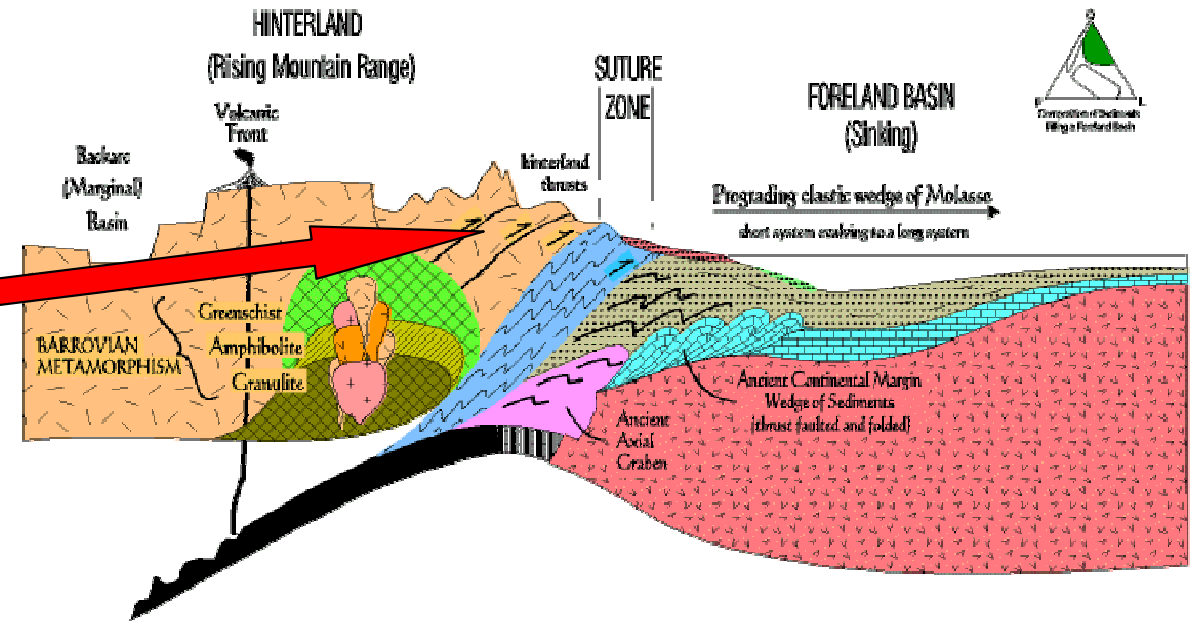


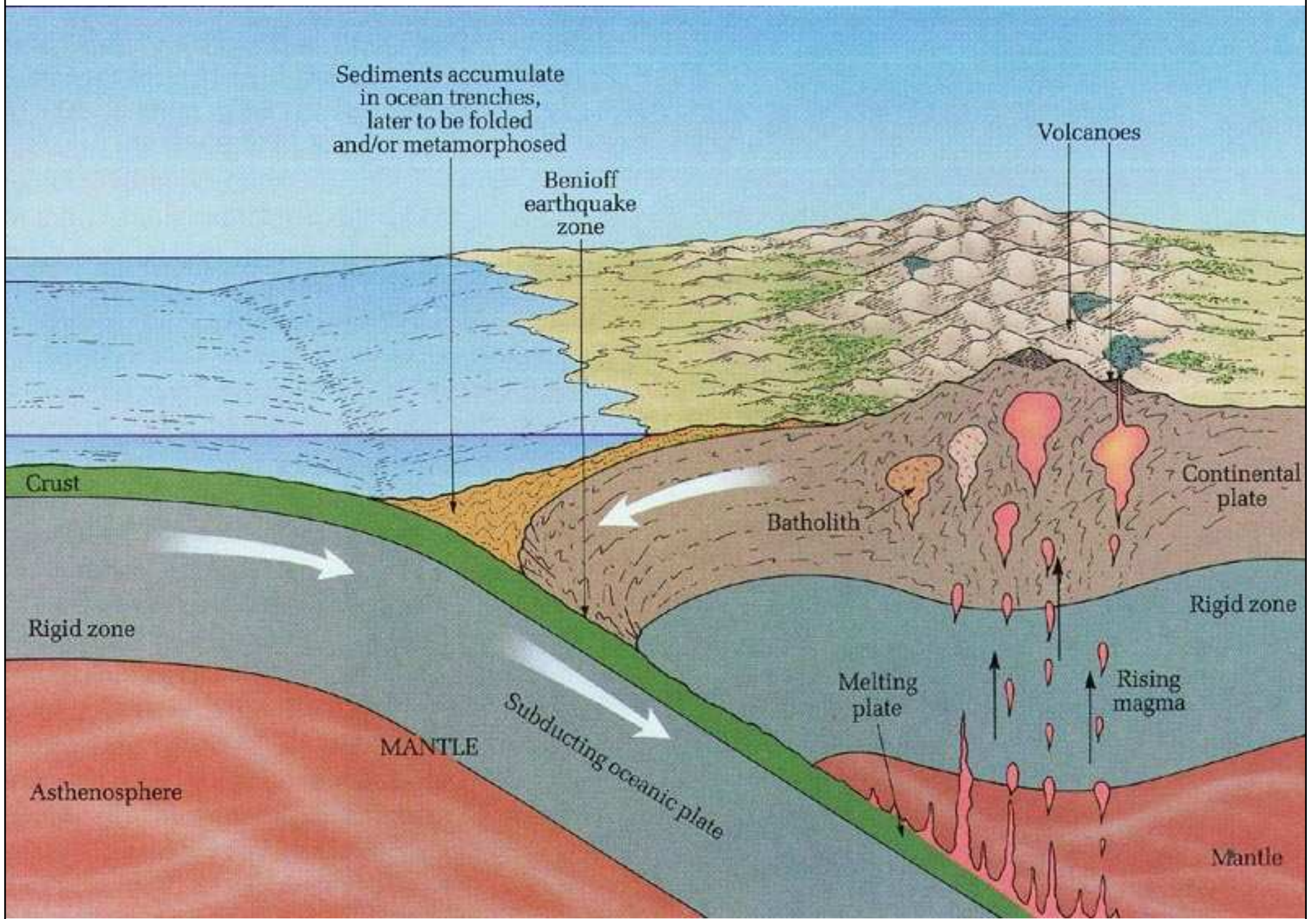
Konvergentní rozhraní představují místa vrásnění, vulkanické činnosti, vzniku pohoří a kolize kontinentů

Thompson and Turk: Earth Science and the Environment, 2/e
Figure 5.12



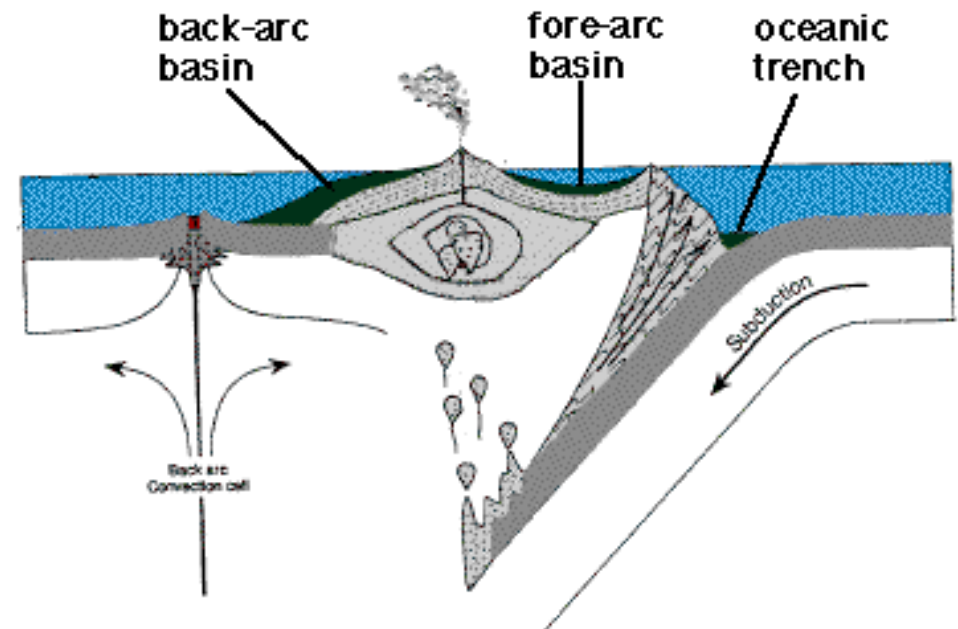
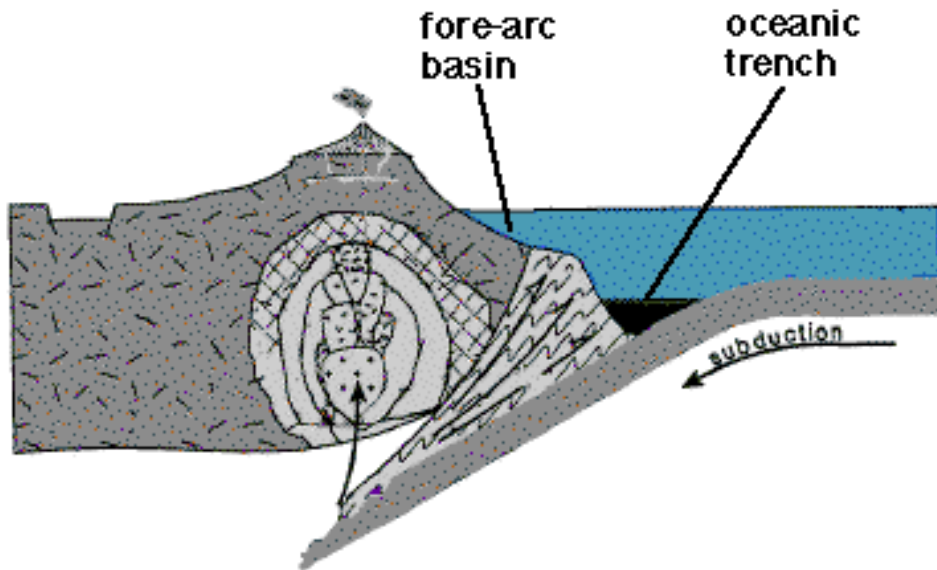
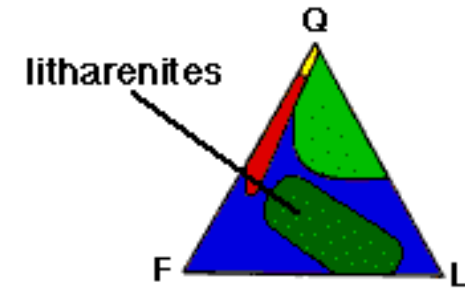
Saunders College Publishing

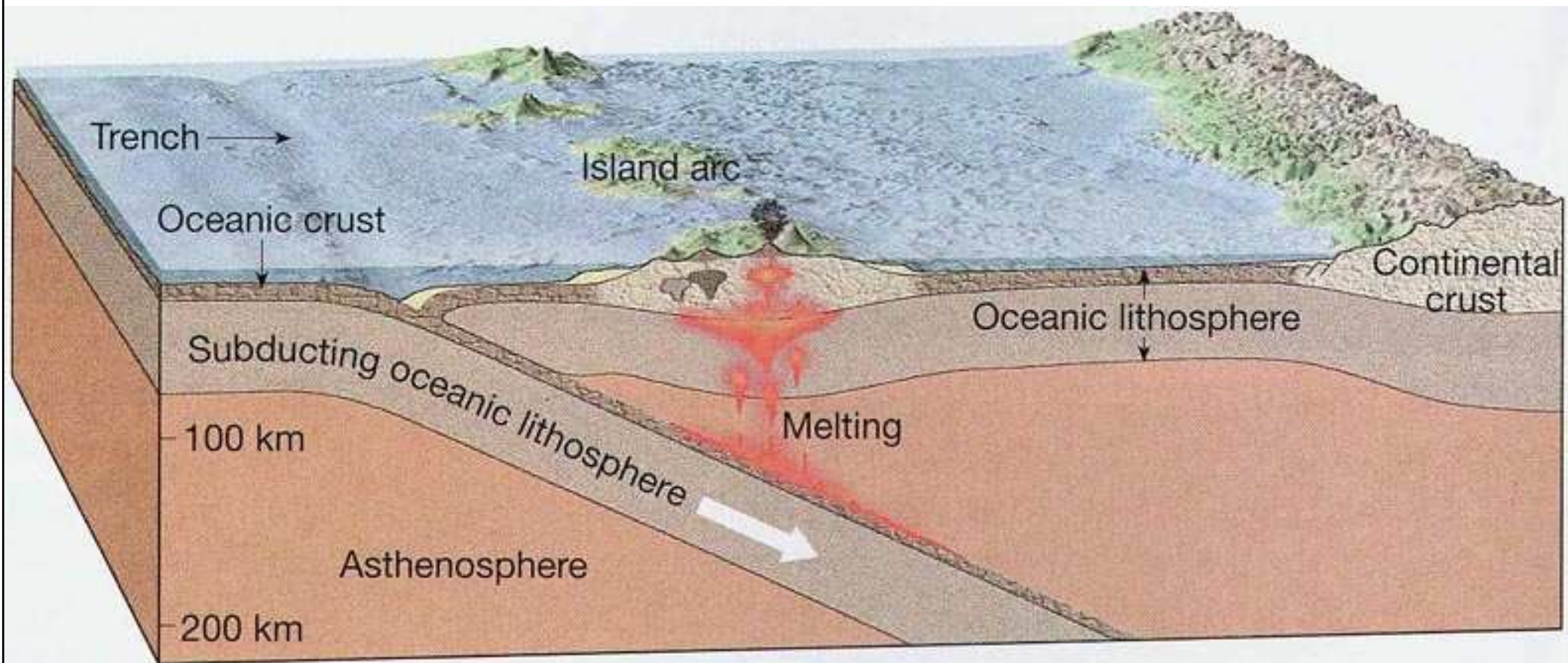






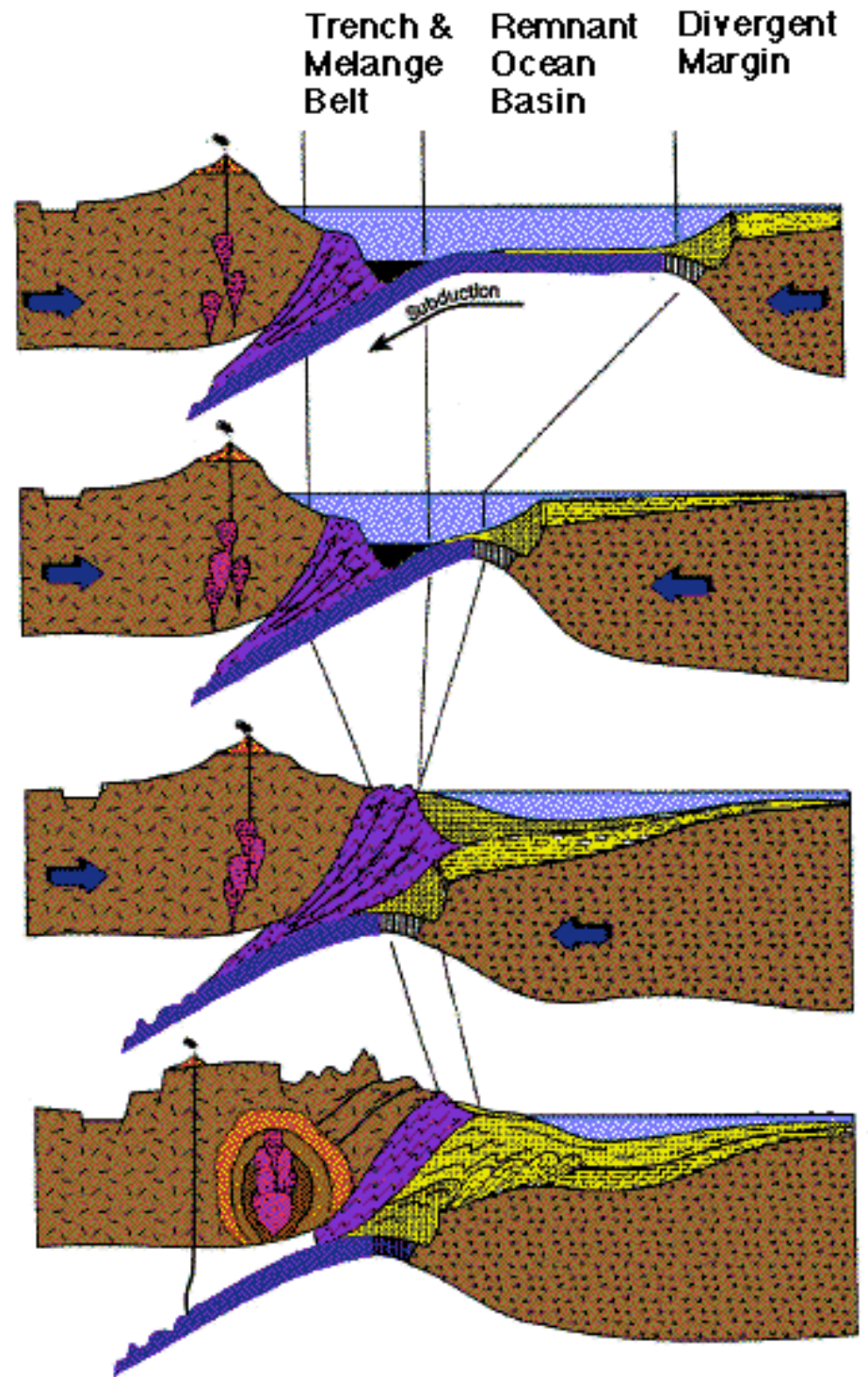
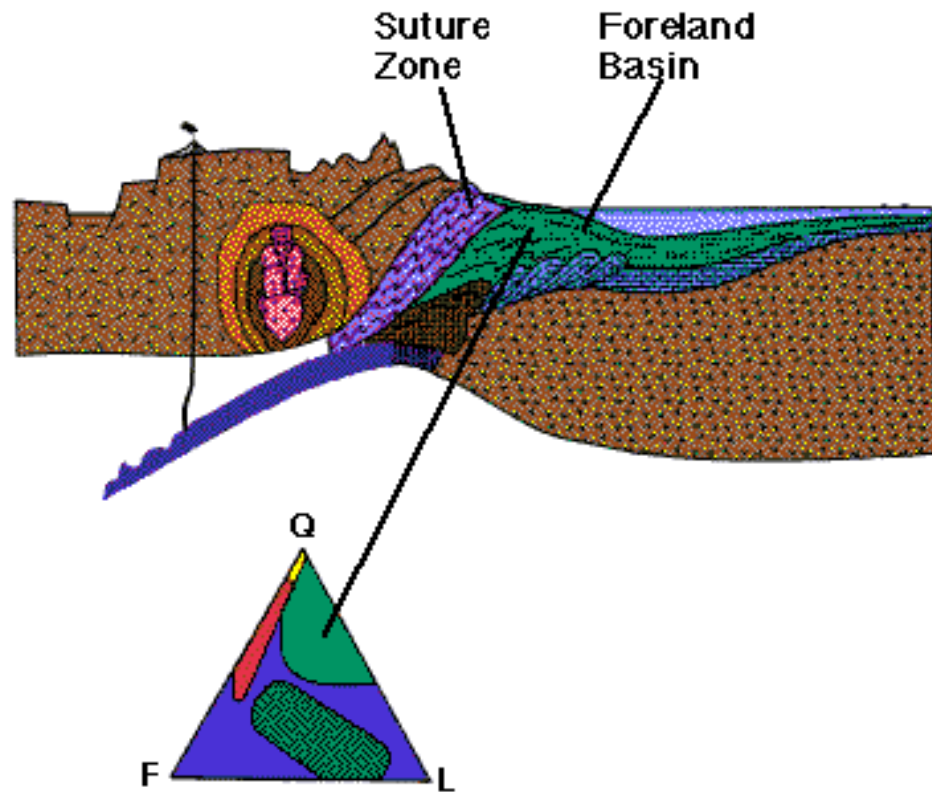
•Sedimentary Deposits



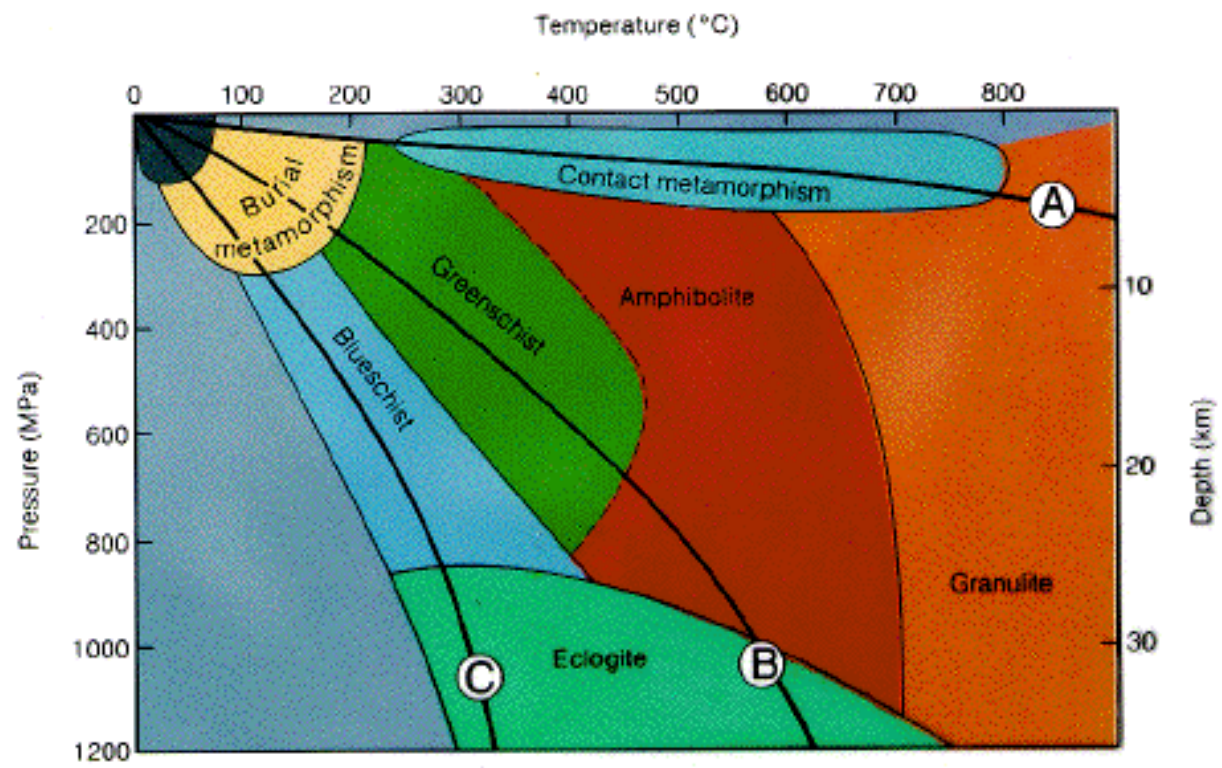


•Continent-Continent Collision

Regional metamorphism –granulite, amphibolite, greenschist, blueschist metamorphism, glaucophane



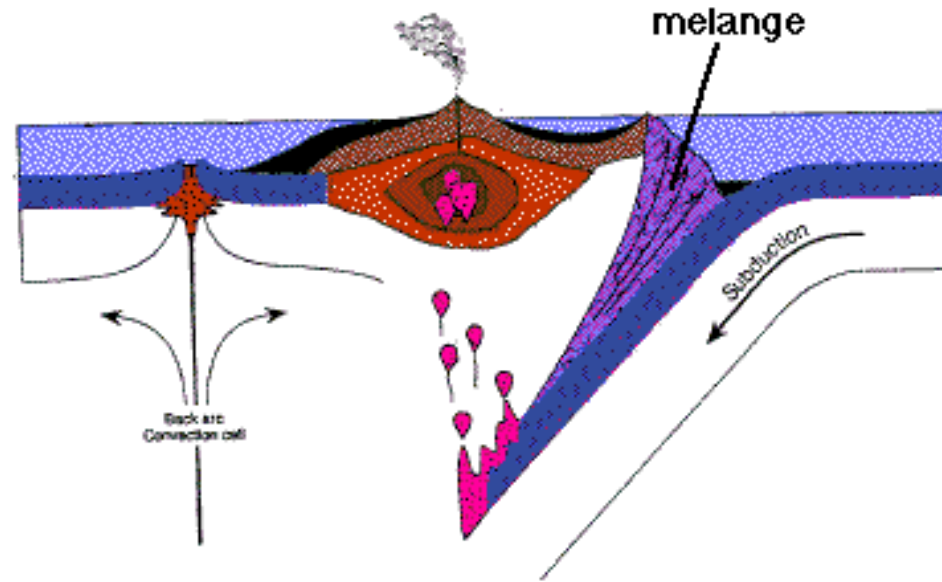
•Suture zone- foreland basin, thrust faults regional metamorphism



•Subduction Zone Complex

•melange

•ophiolite suite



Idealized Ophiolite Suite

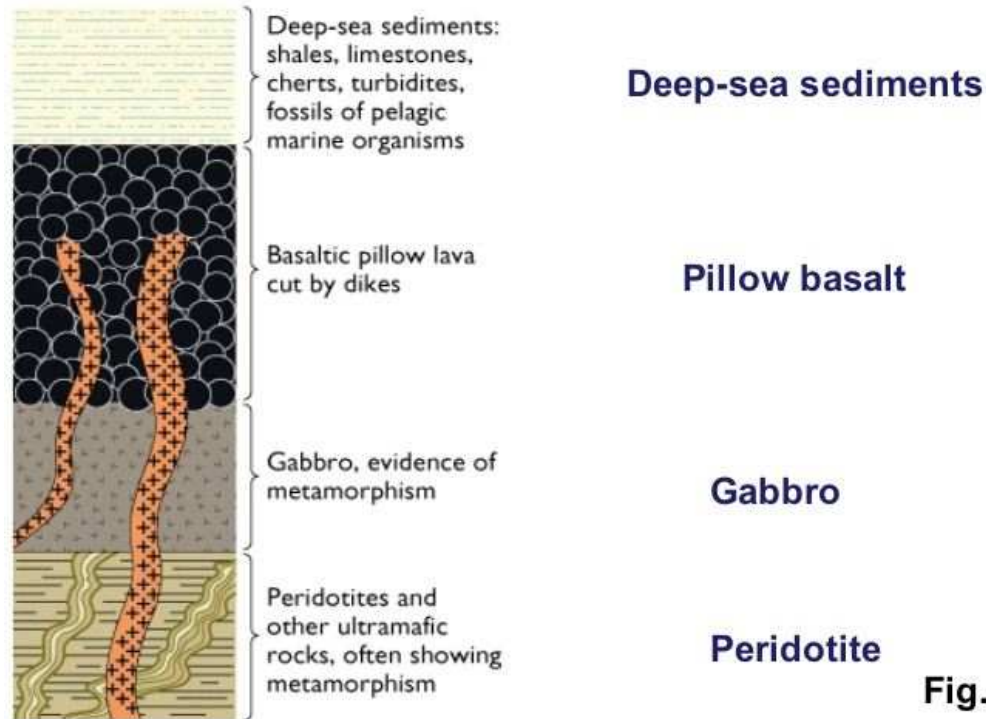


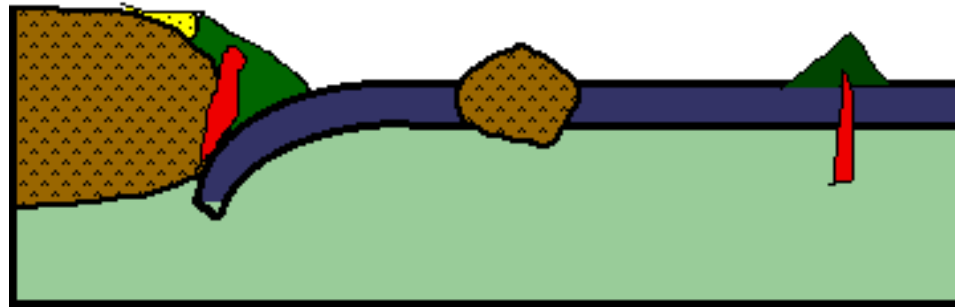
Fig. 20.14

•Accretionary Tectonics

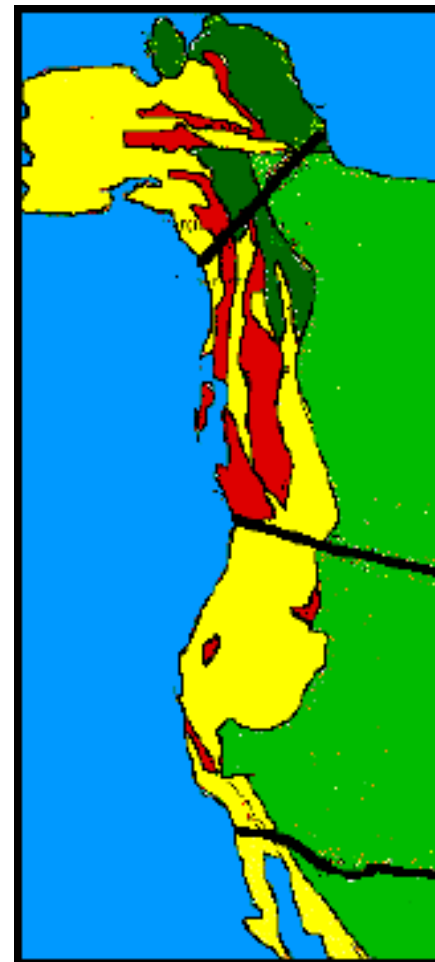
•Allochthonous Terrains

•allochthonous

•autochthonous



•red - blocks from continents other than N. America
dark green - blocks displaced from parts of N. America



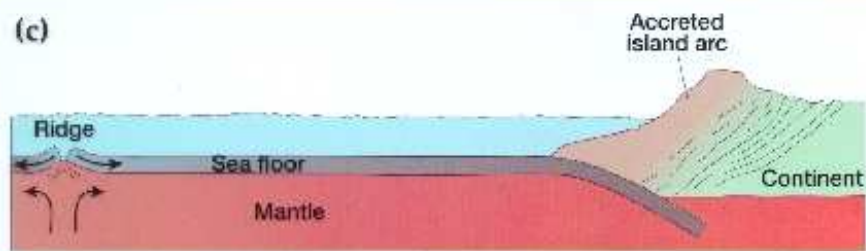
Formation of an accreted terrane

(b)



Formation of an accreted terrane

(c)



Approaching Arc or Microcontinent

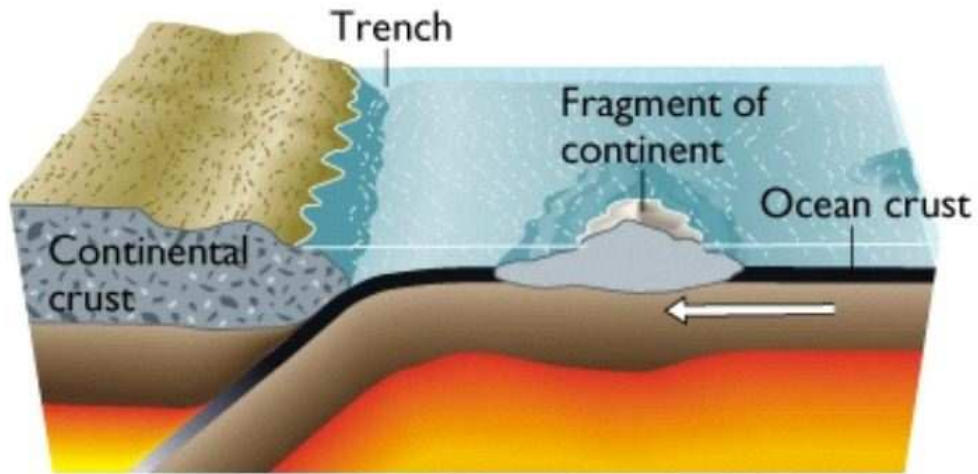


Fig. 20.21a

Collision

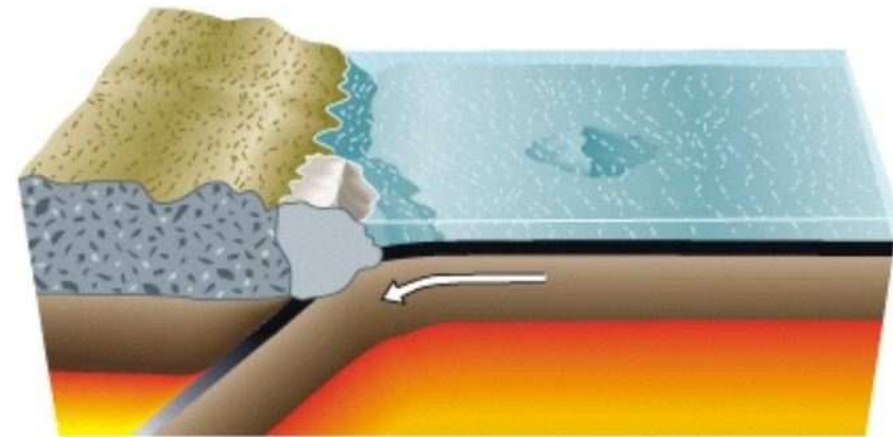


Fig. 20.21b

Accreted Microplate Terrane

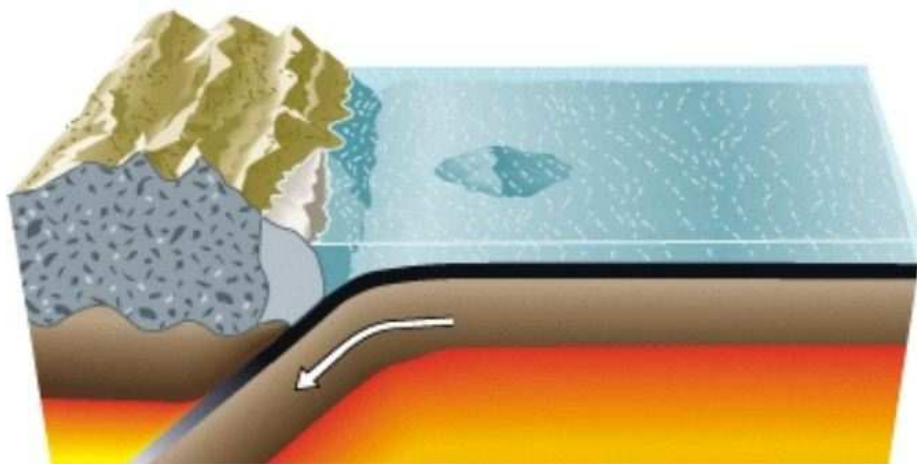


Fig. 20.21c



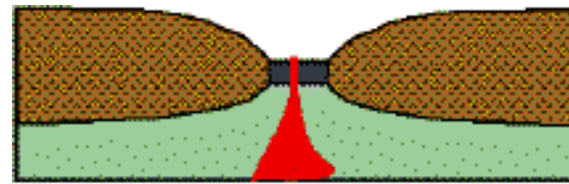
Microplate terranes Added to Western North America Over the Past 200 Million Years

After Hutchinson, 1992-1993

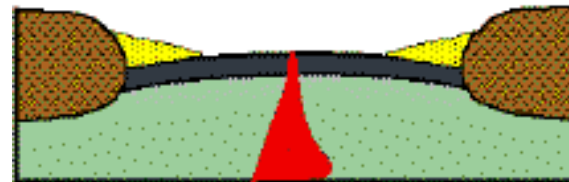
Fig. 20.22

•Wilson Cycle

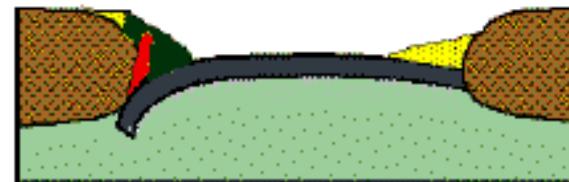
•Supercontinent Cycle (500 million years)



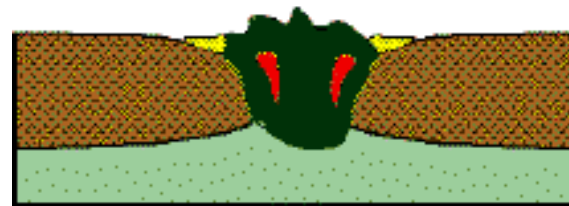
1) Initial Rifting



2) Rafting of Continents

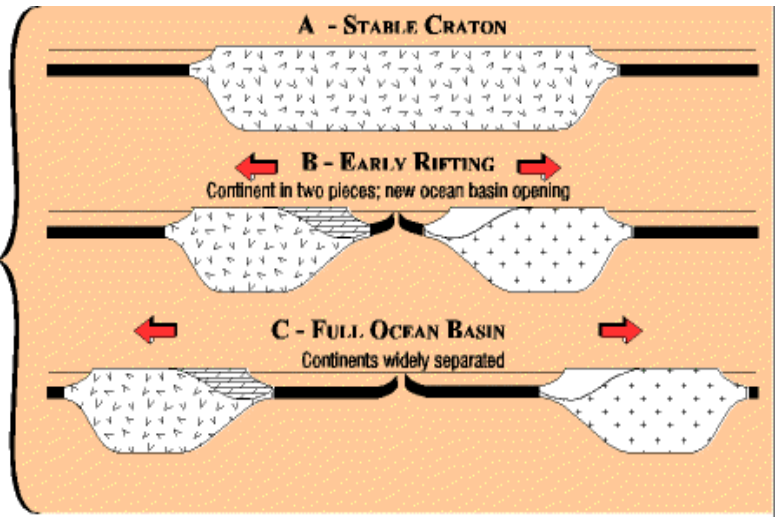


3) Subduction of oceanic crust at continental margins

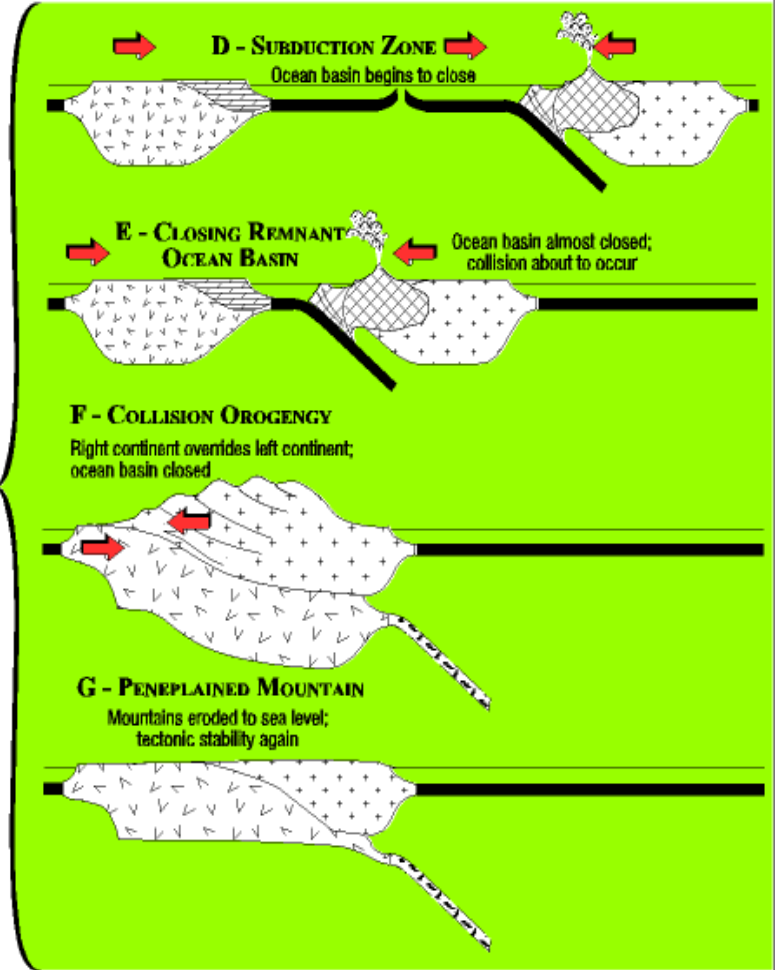


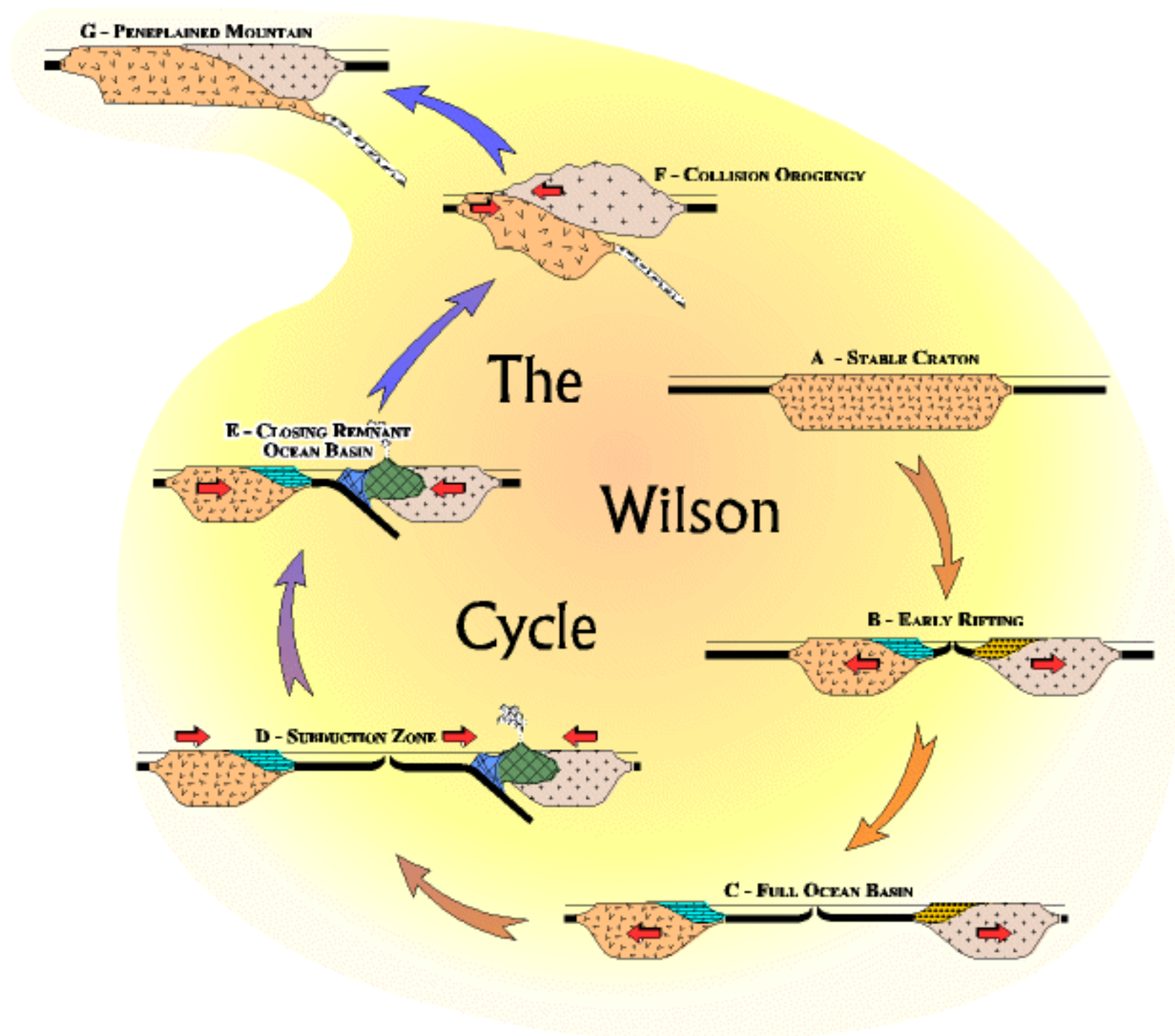
4) Continental collision

Opening Phase



Closing Phase



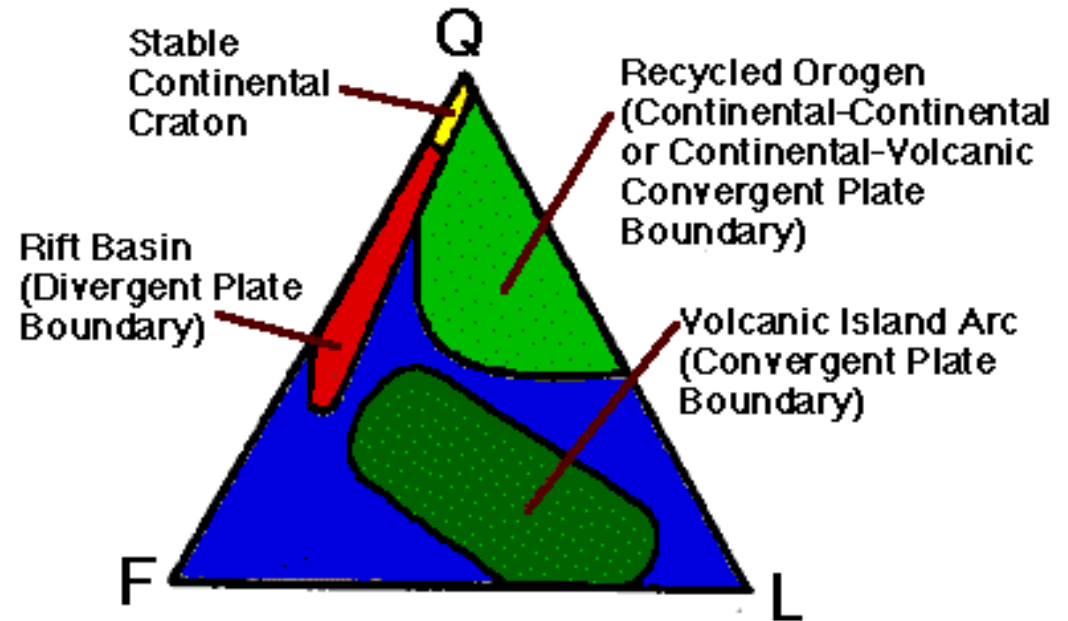
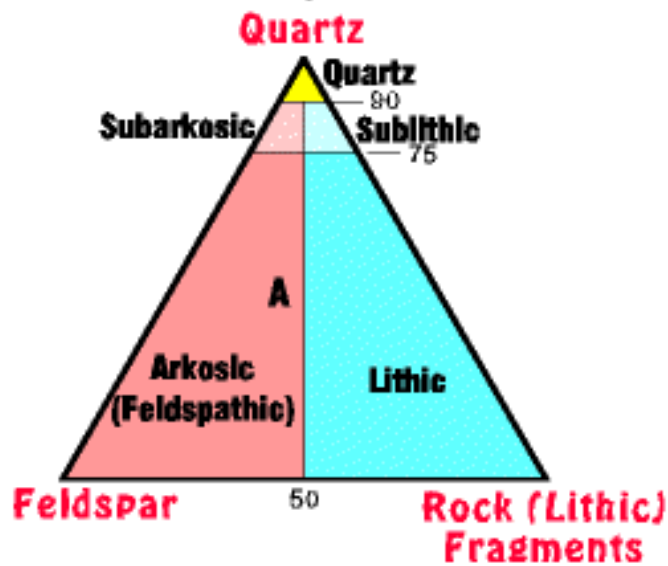


Rock assemblages and plate tectonics

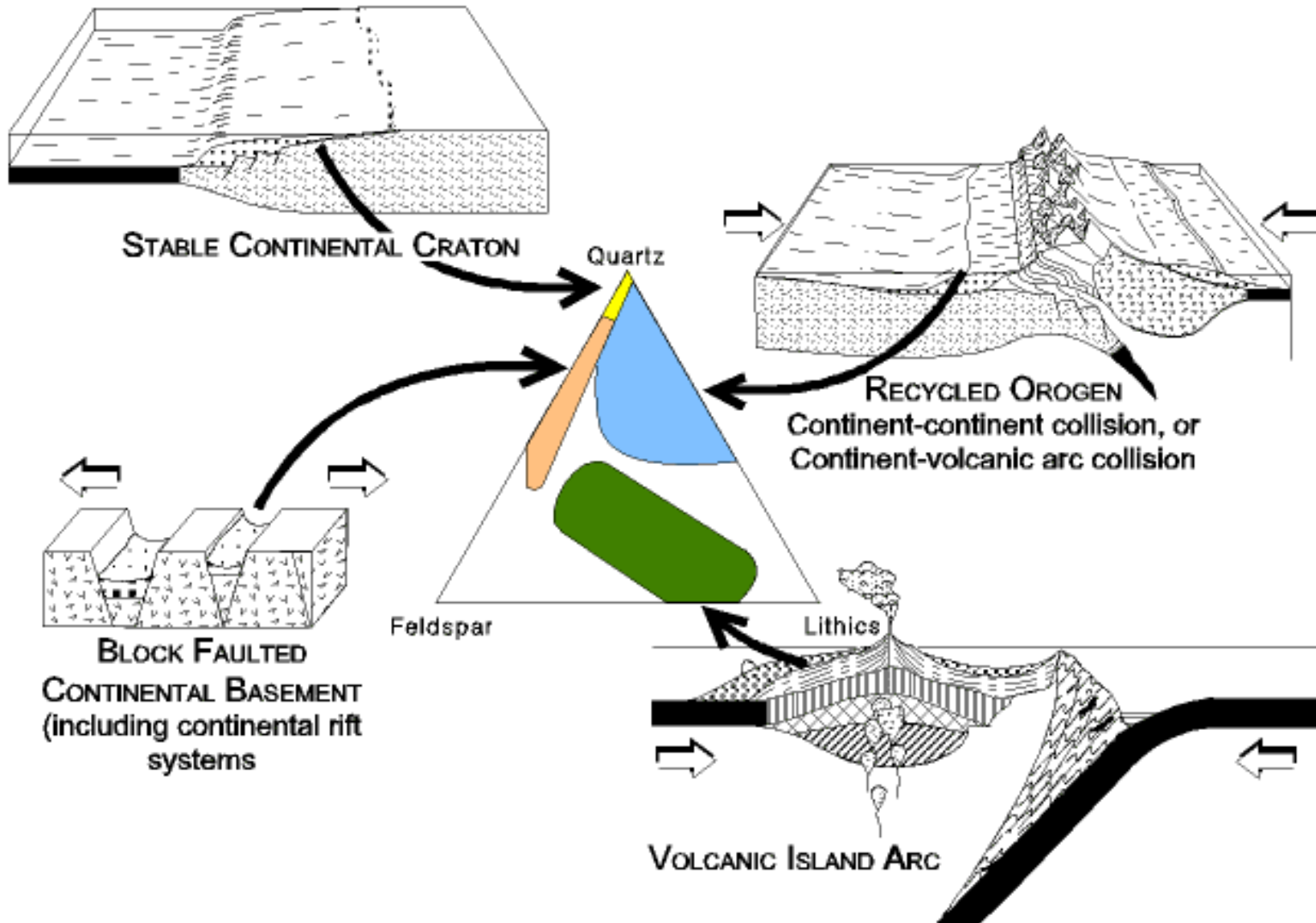
- **Each plate tectonic environment produces a distinctive group of rocks.**
- **By studying the rock record of an area, we can understand the tectonic history of the region.**

•Tectonic QFL Distribution

QFL Composition Diagram



The QFL Distribution Of Sedimentary Rocks In Various Tectonic Regimes



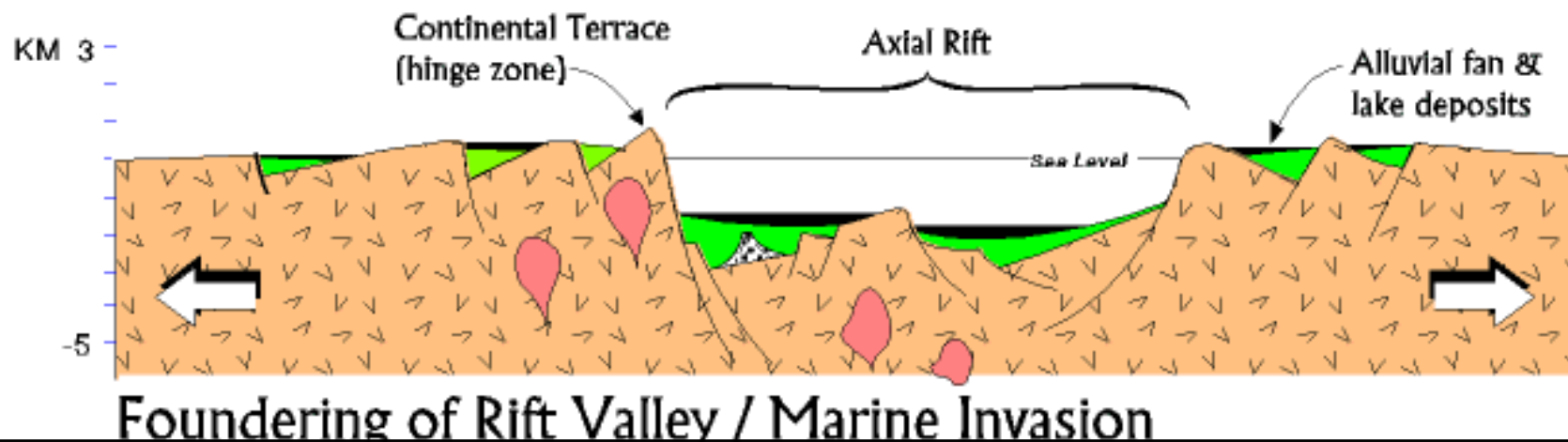
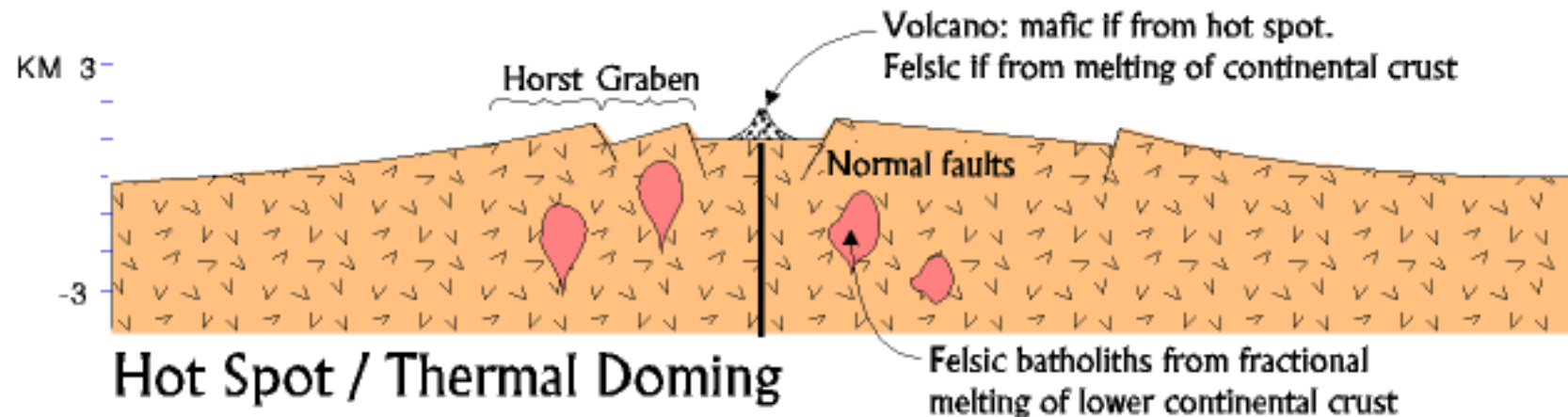


FIRST TWO STAGES IN THE RIFTING PROCESS

STAGE B IN WILSON CYCLE

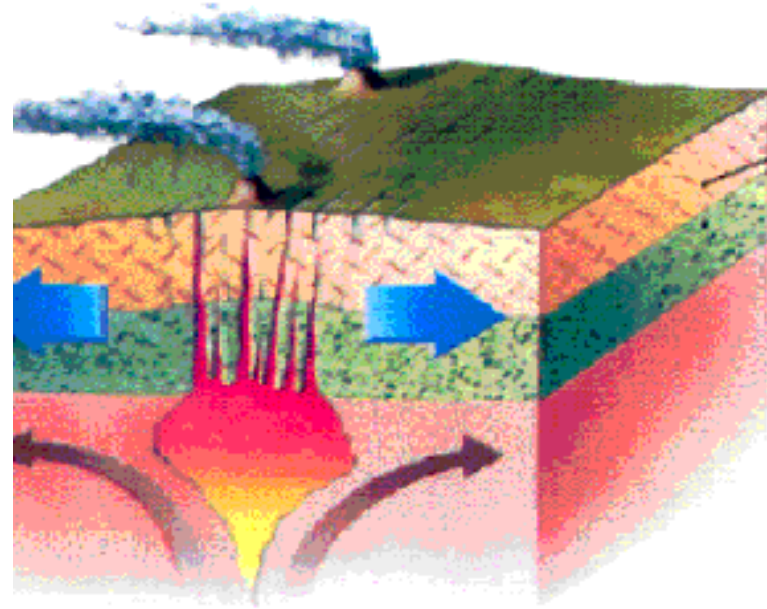
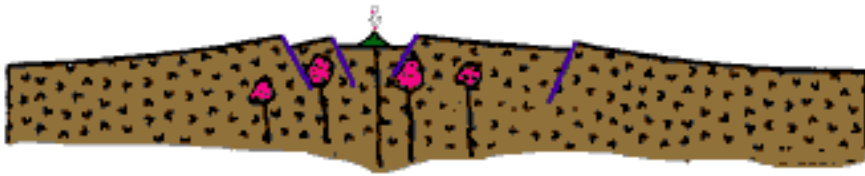
- Wilson Home Page
- Stage B
- Igneous Home Page

- Volcanos may be fissure type or conduit type
- Bimodal association: felsic (alkaline) + mafic (tholeiitic)

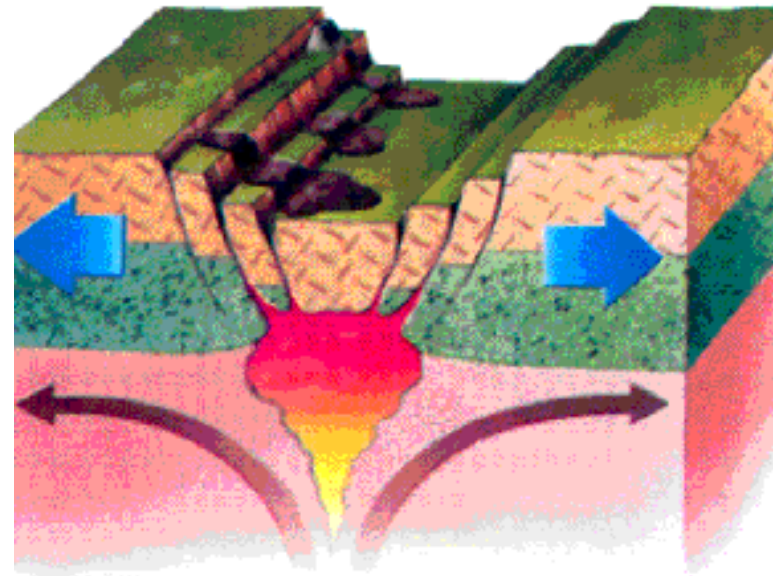
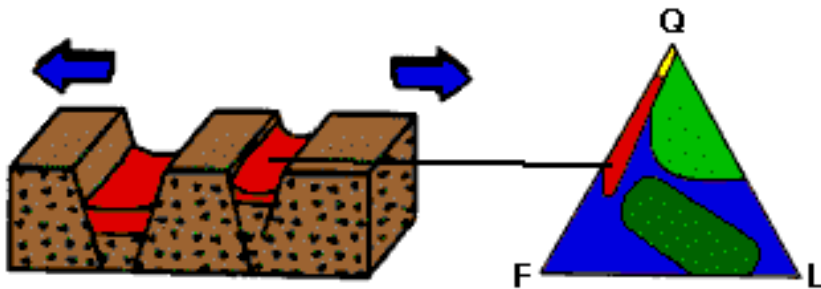


•Continental Rifting (figure 6.15, p 143)

•Upwarping

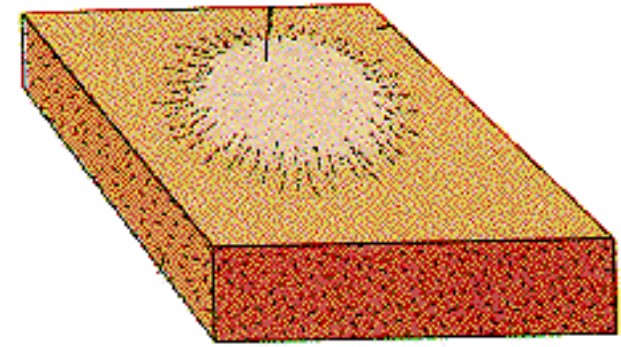


•Rift Valley

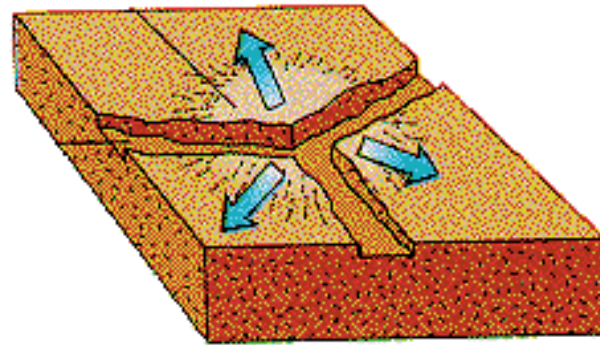


•Triple Junction

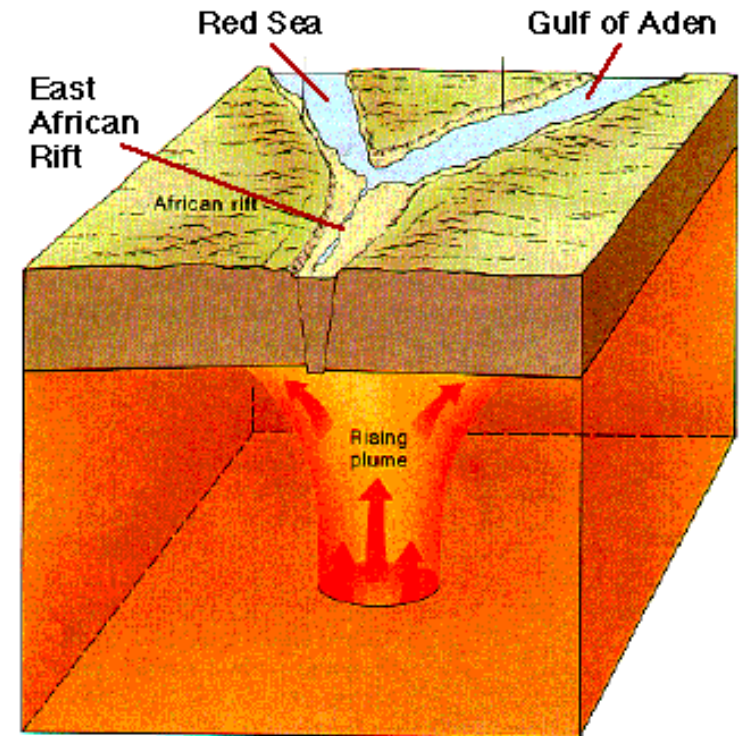
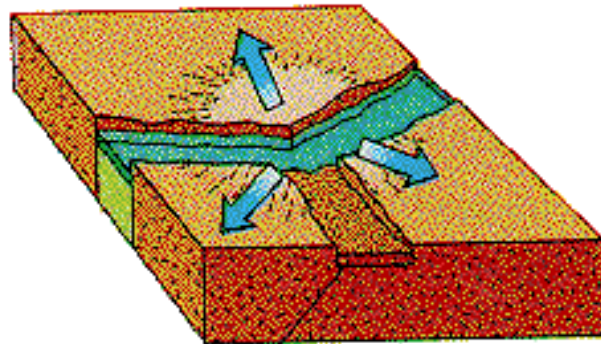
Bulge over rising mantle plume



Development of 3 radial rifts

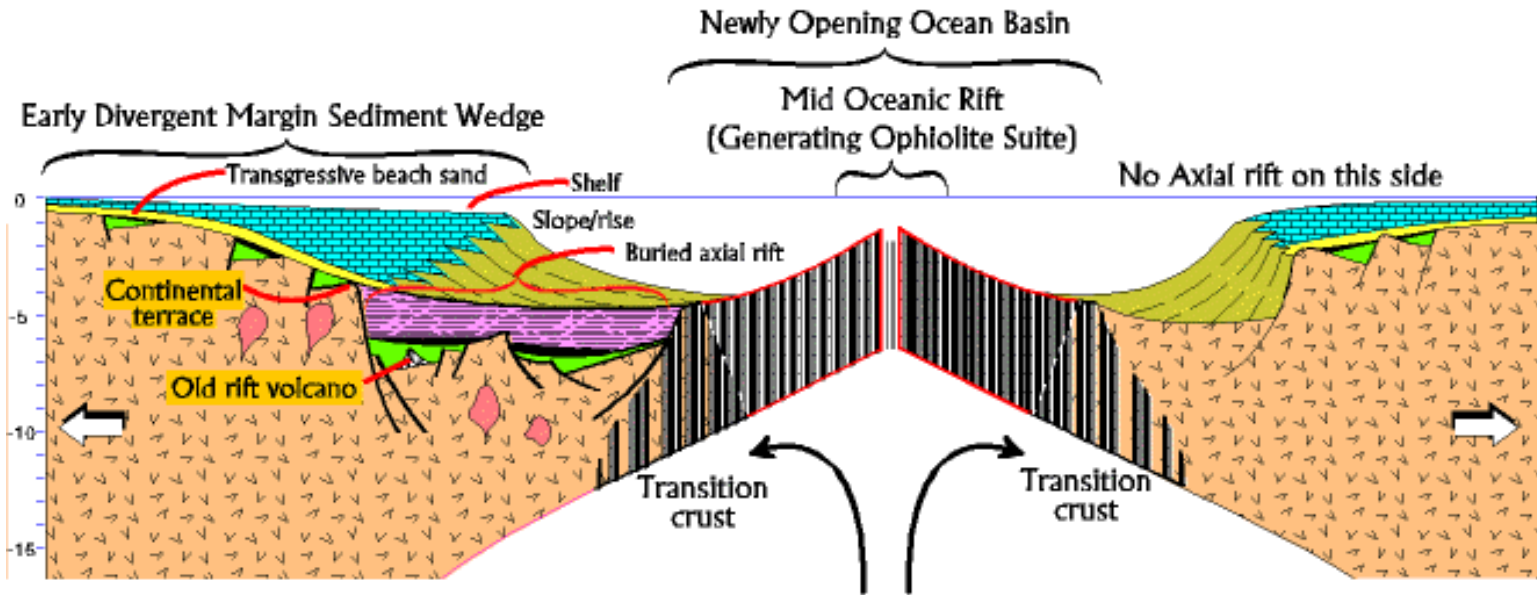


•Aulacogen



THIRD STAGE IN THE RIFTING PROCESS

STAGE C IN WILSON CYCLE

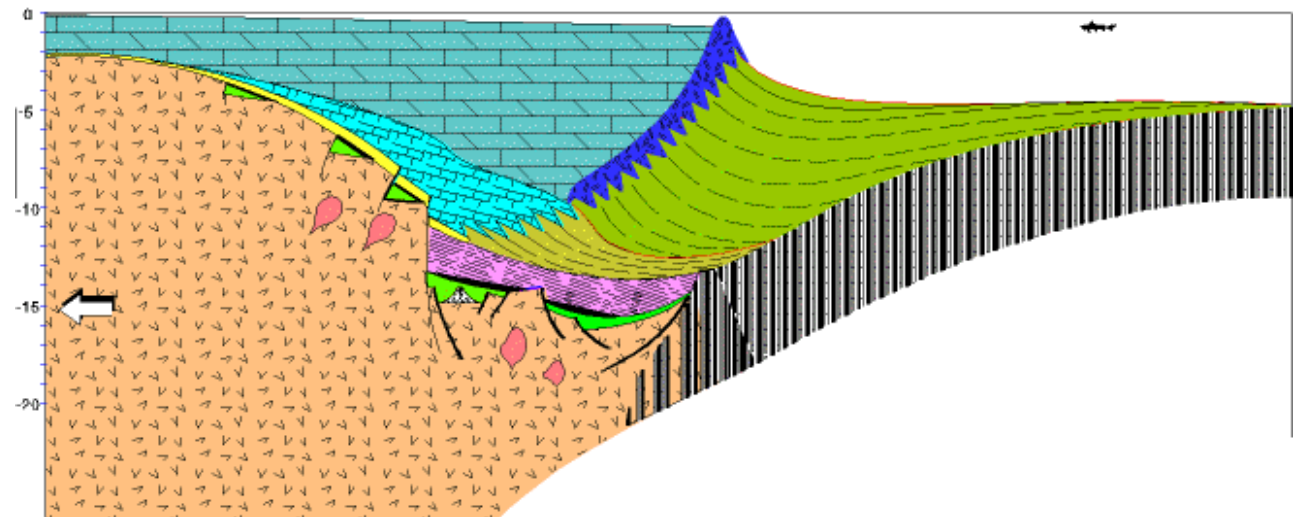


Early Divergent Margin

- First Two Stages
- Wilson Home Page

FOURTH STAGE IN THE RIFTING PROCESS

STAGE D IN WILSON CYCLE



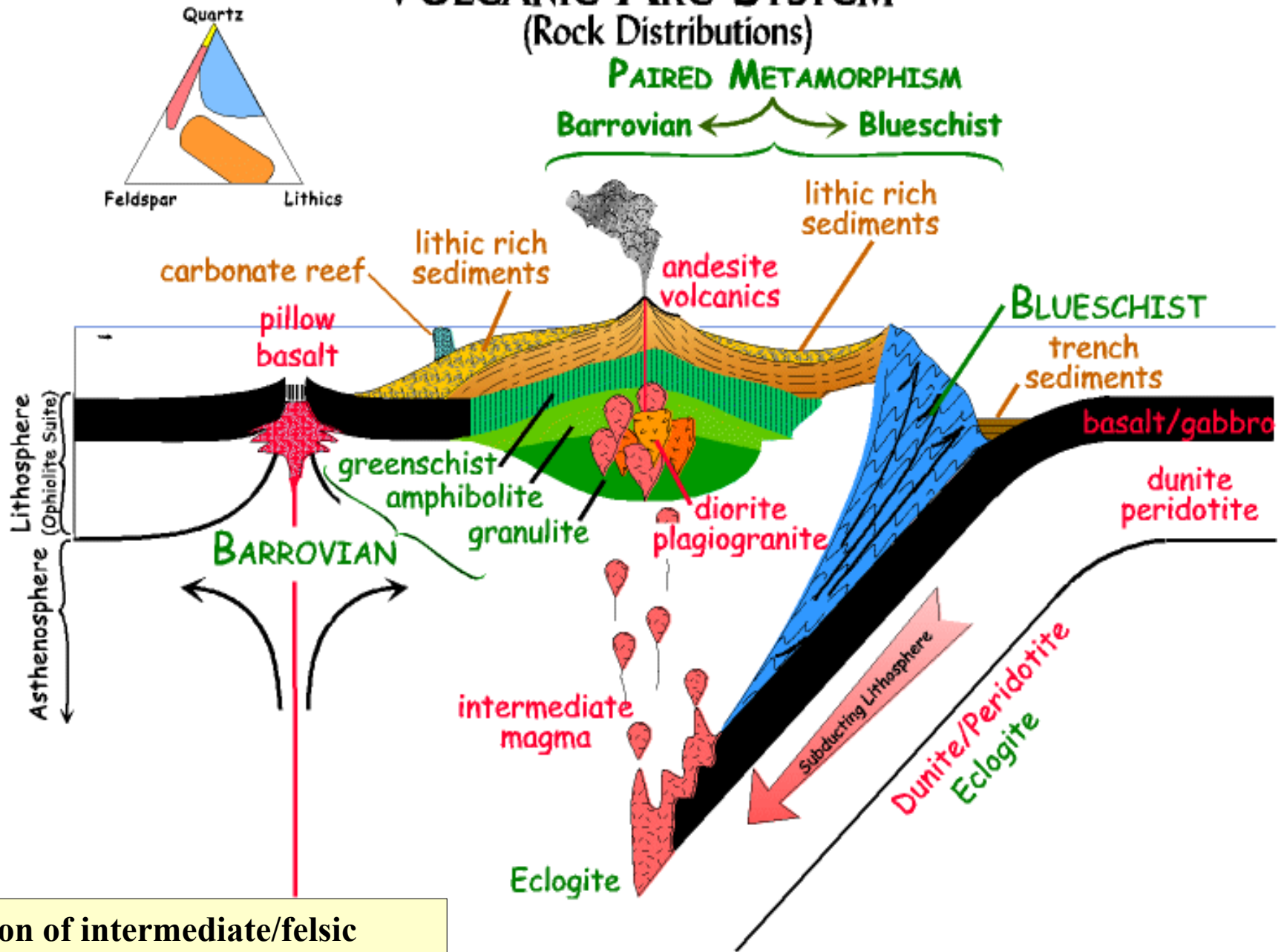
Full Divergent Margin

Generation of mafic oceanic crust

VOLCANIC ARC SYSTEM (Rock Distributions)

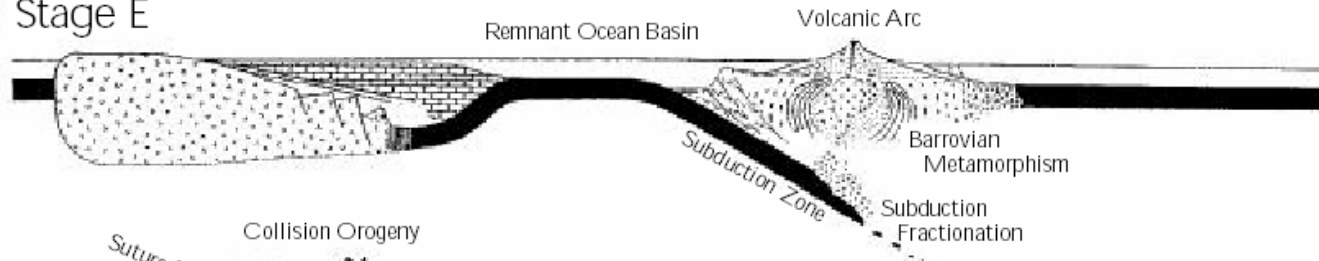
PAIRED METAMORPHISM

Barrovian ← → Blueschist

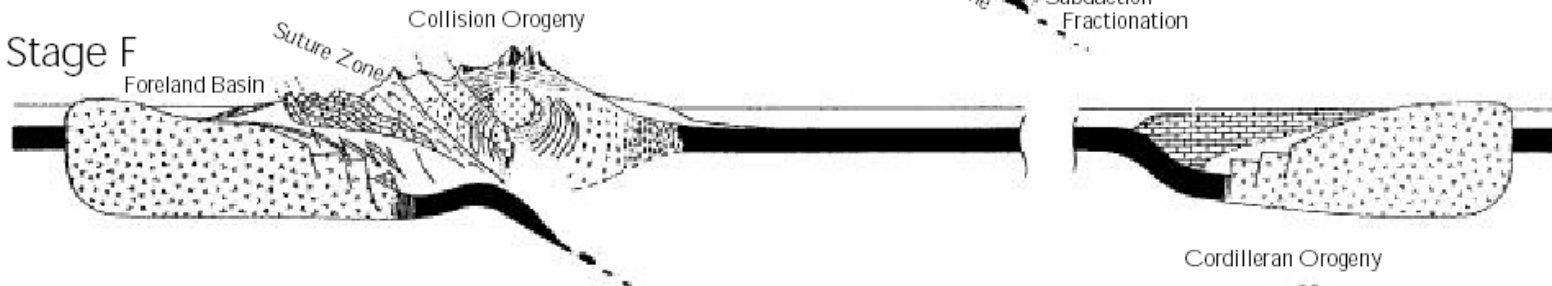


II - Generation of intermediate/felsic igneous rocks by fractional melting in a subduction - zone stage E-G

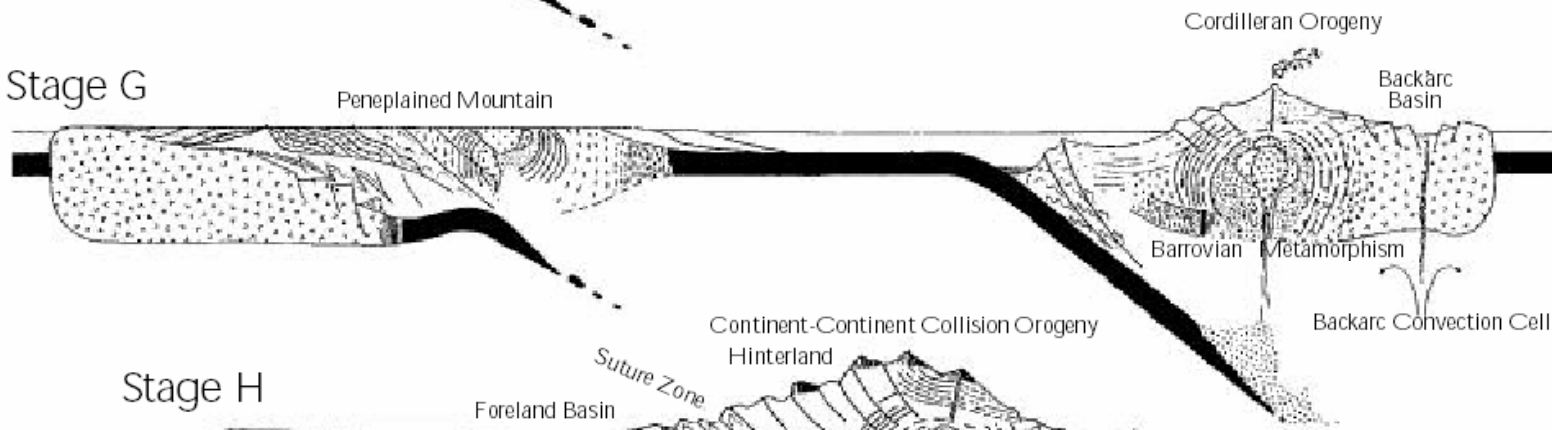
Stage E



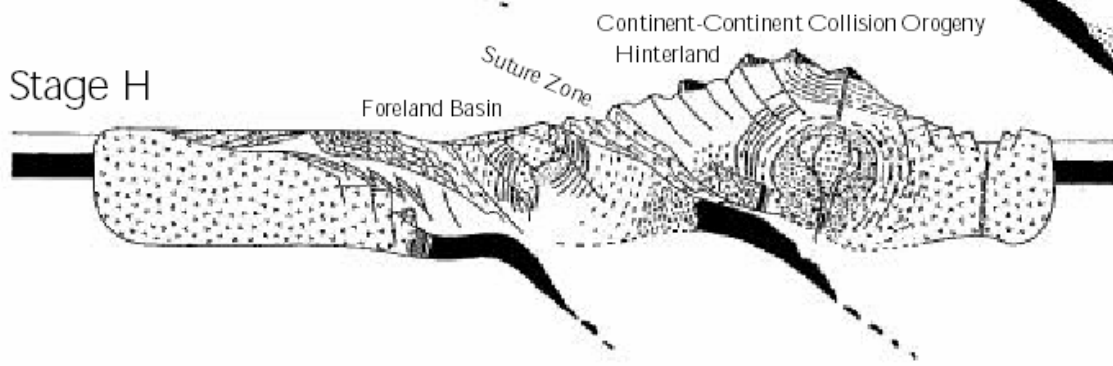
Stage F



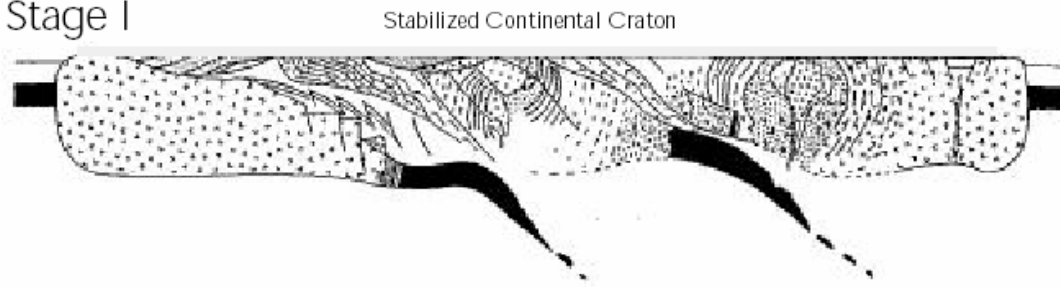
Stage G



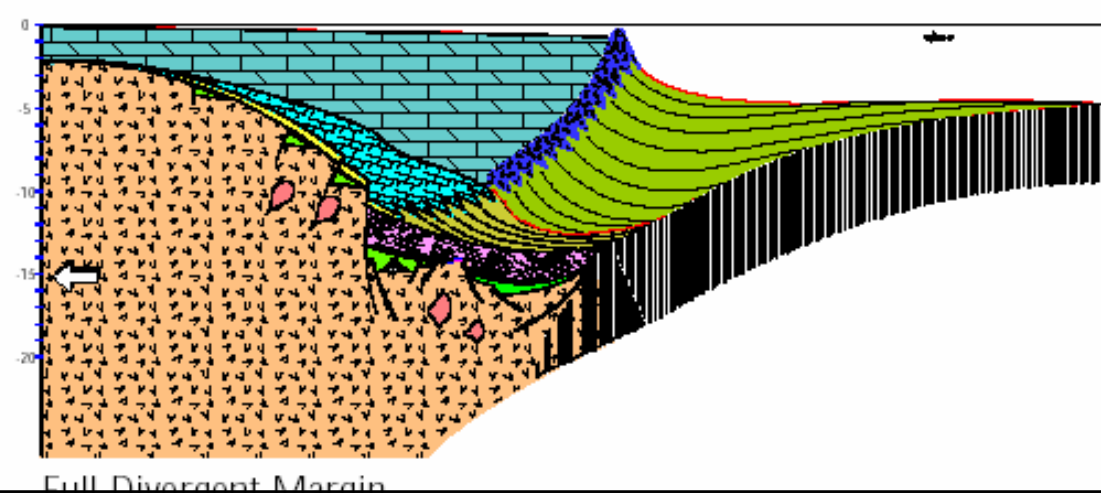
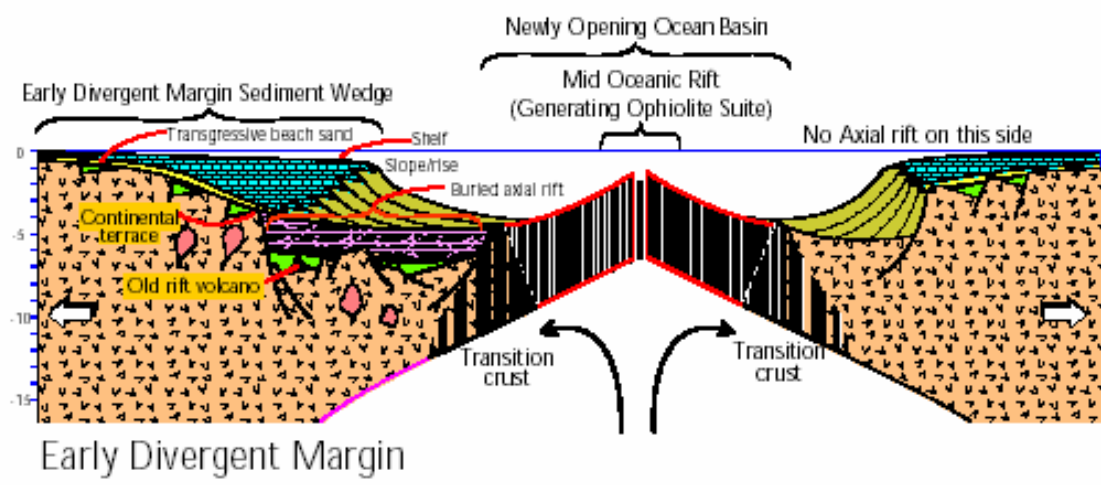
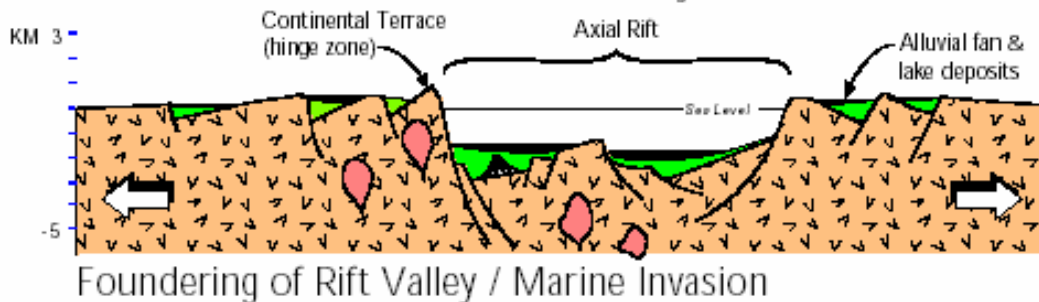
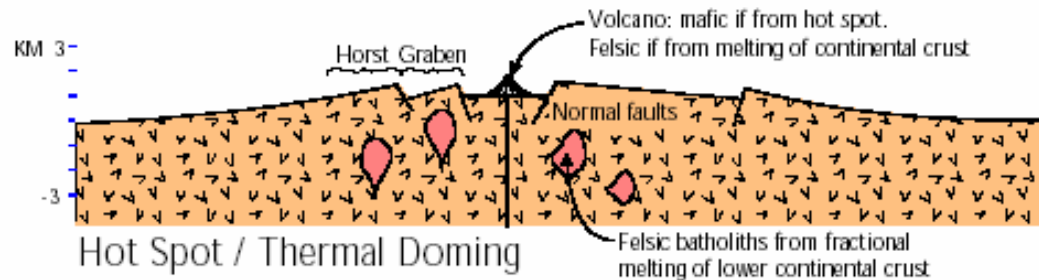
Stage H



Stage I







INTRODUCTION TO QFLQFL stands for Quartz, Feldspar, Lithics

Sedimentary rocks are classified on the basis of the *texture* (grain size) of the rock, and *composition*.

The [basic classification](#) only concerned texture, using the [Wentworth size scale](#). But any full rock name must specify both texture and composition. Thus, an *arkose sandstone* is a rock of sand sized particles, with a high percentage of those particles being feldspar.

It might seem that an unlimited variety of particles could end up in a sedimentary rock. After all, there are over 6000 known minerals. In addition, any incompletely weathered piece of igneous, sedimentary, or metamorphic rock can also be found in a sedimentary rock.

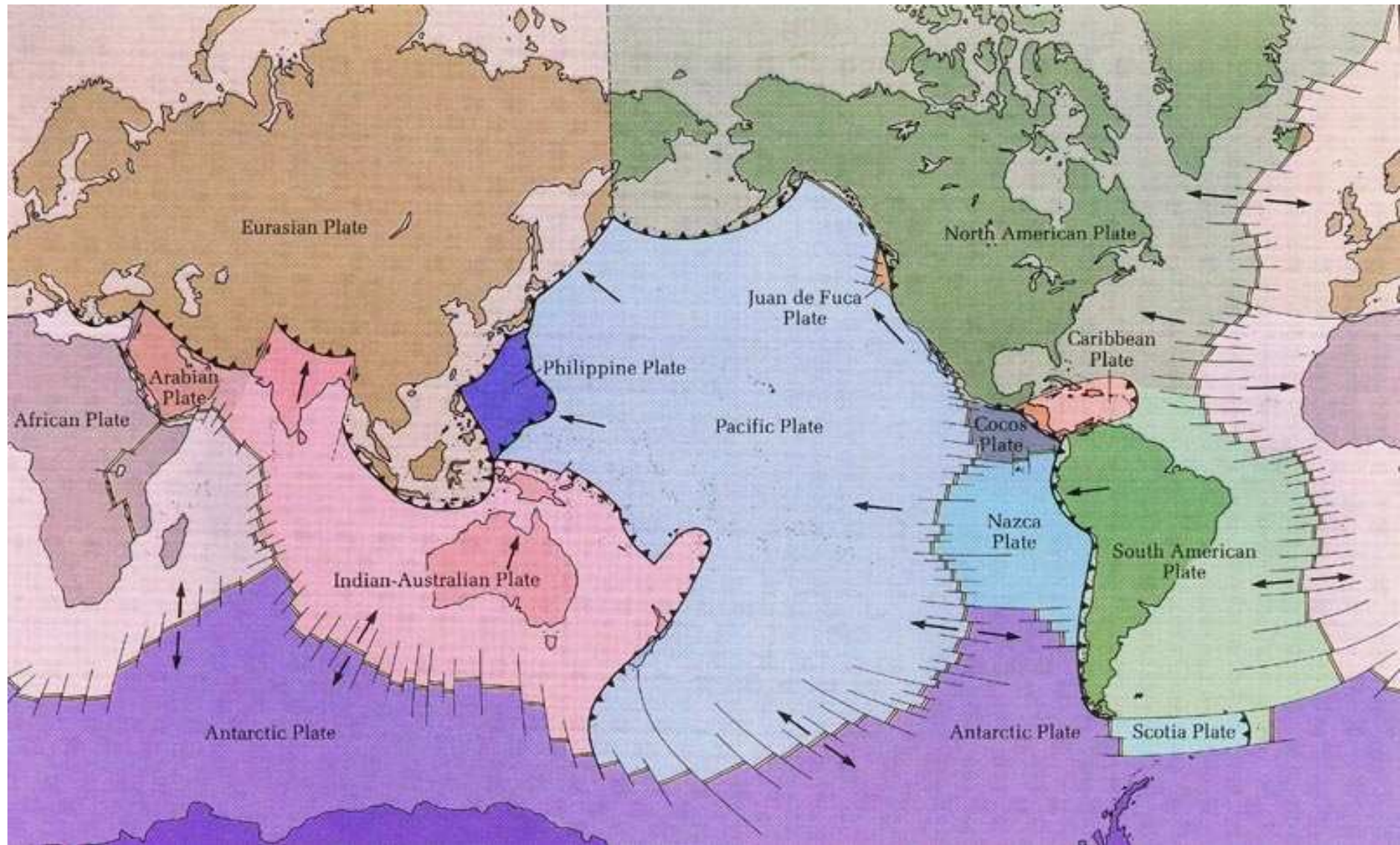
A composition classification could become very complicated if all of these different particles were considered. But in most cases rock composition can be defined by four compositional components:

>>> **Quartz**

>>> **Feldspar**

>>> **Lithic fragments** (including rock fragments and mineral grains other than quartz)

>>> **Matrix** (a catchall for the silt and clay grains that cannot be easily seen by eye).



QFL Diagram: The QFL diagram is to the right. Observe the following:

>>>> Quartz is at the top, feldspar on the lower left, and lithics on the lower right. It is always done this way.

>>>> The ternary diagram is divided into 5 fields, here color coded. The boundaries among the fields, left and right, are at the 50% boundary, and up and down at the 75% and 90% boundaries.

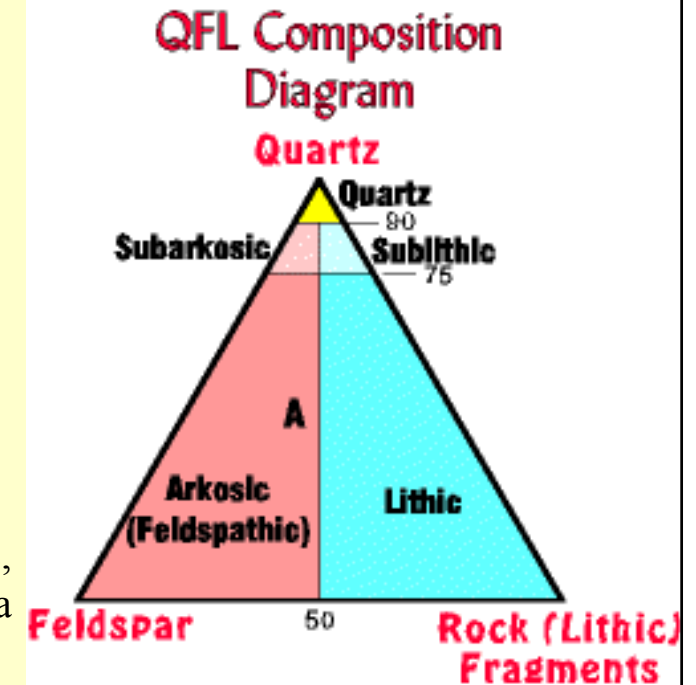
>>>> As you travel toward any apex the quantity of Q, F, or L increases accordingly, with 100% being, of course, right at the apex.

>>>> Notice that as we travel vertically the amount of quartz in the rock increases, and at the 90% boundary and above the rock has so much quartz the rock becomes a "quartz something", such as a quartz sandstone or quartz conglomerate.

>>>> The lower two fields contain rocks that are **felspar** (red) or **lithic** (blue) rich. That is, these rocks have more than 25% feldspar or lithics, that is, 25-100% feldspar or lithics.

Rocks with this composition have such names as *feldspathic (arkosic) sandstone* (both terms are used interchangeably) and *lithic sandstone*.

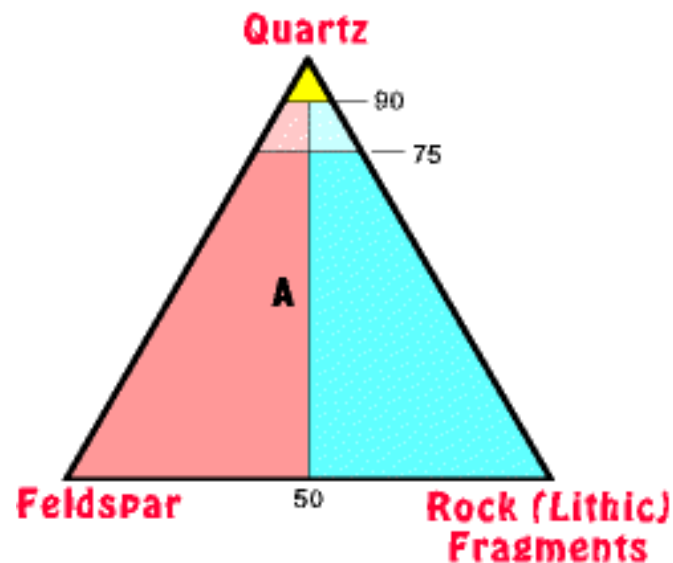
>>>> **Remember that all feldspar and lithic fragments are going to weather and disappear (to shale or dissolved minerals), leaving only quartz.** On the QFL diagram, however, we can only plot the abundance of sand (or larger) particles of various compositions. So, on this diagram, as feldspar and lithics weather the composition of the remaining sandstone migrates toward the quartz apex. No matter where you start on the diagram the **sediment is going to evolve in almost a straight line right to the top.**



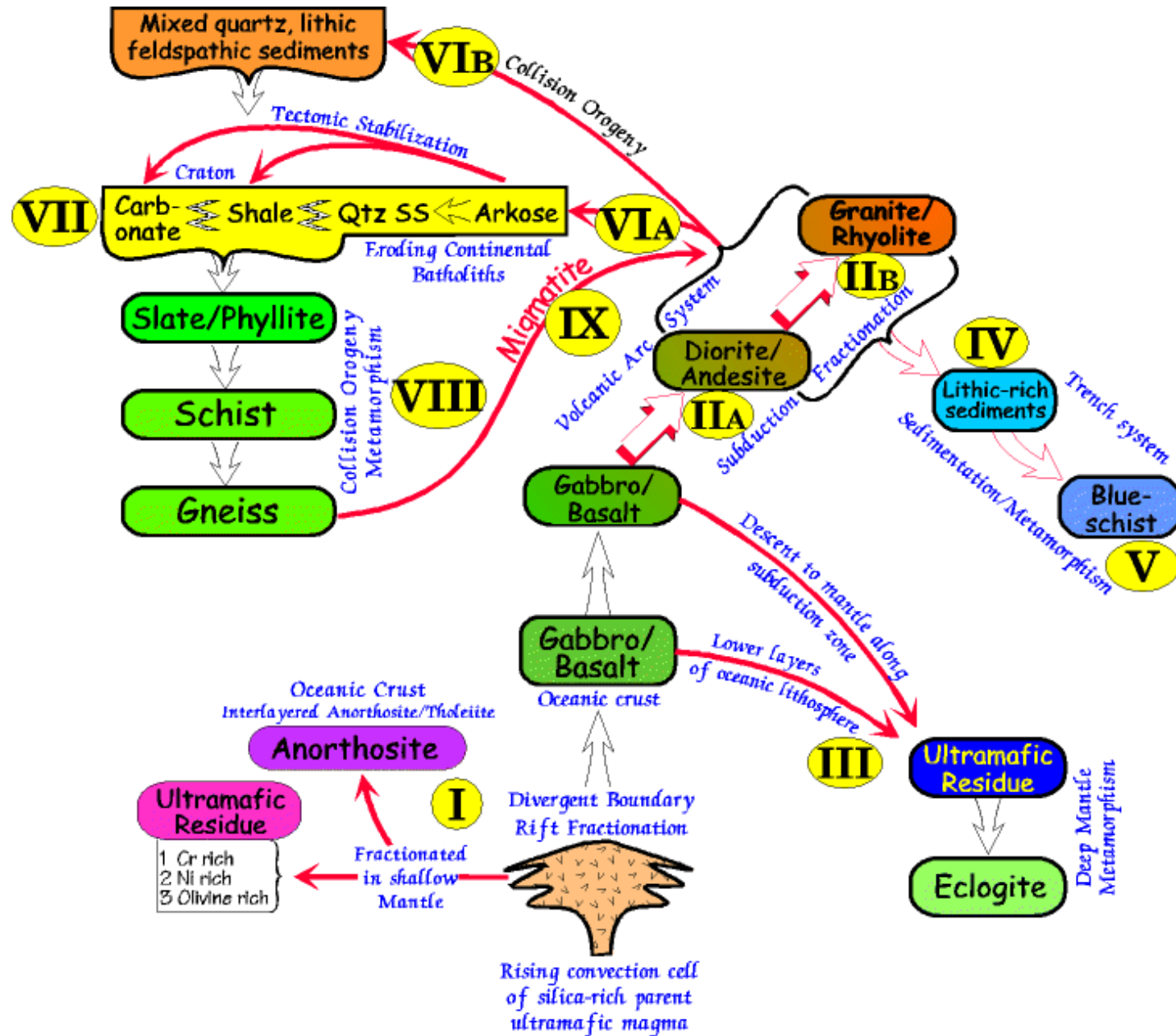
One of the things we are very interested in is how close the sediment has gotten along its path of evolution. This is the concept of **sediment maturity**. Thus, above the arkosic and lithic fields, but below the quartz field are two more fields, *subarkosic* and *sublithic*. Rocks in these fields have between 10-25 % feldspar or lithics and are thus farther along in their evolution toward pure quartz than feldspathic or lithic rocks.

>>>> In other classification systems, the boundaries among the fields sometimes differ from this one, and there may be more fields than 5 laid out. It all depends on what the geologist wants to do with them. But for this site we will always have these five fields, in these five places.

>>>> Observe that a composition plotted somewhere in the middle of the QFL indicates a mixed composition. For example, the composition of "A" to the right is about 50% quartz, 35% feldspar, and 25% lithics (ternary with percent numbers). We could just call it an arkose since it falls in the feldspar field, but it would be more accurate to indicate that a lot of lithics are present too. Such a name, following the [rules for naming rocks](#), is *lithic, feldspathic, quartz*.



A Tectonic Rock Cycle. The diagram below takes the outline tectonic rock cycle and explores it into its details and rationale. The Roman numerals in yellow circles are clickable and will take you to more detailed descriptions of the processes operating at that stage. Clicking the igneous rock names will take you to samples. Clicking the tectonic regime names (in blue script) will take you to a stage in the [Wilson cycle](#) where the processes are taking place.



•Igneous Activity

•andesite

•island arc

•volcanic arc

•batholithic core

•Metamorphism

•regional metamorphism

•- granulite

- amphibolite

- greenschist

•blueschist metamorphism

•- glaucophane

