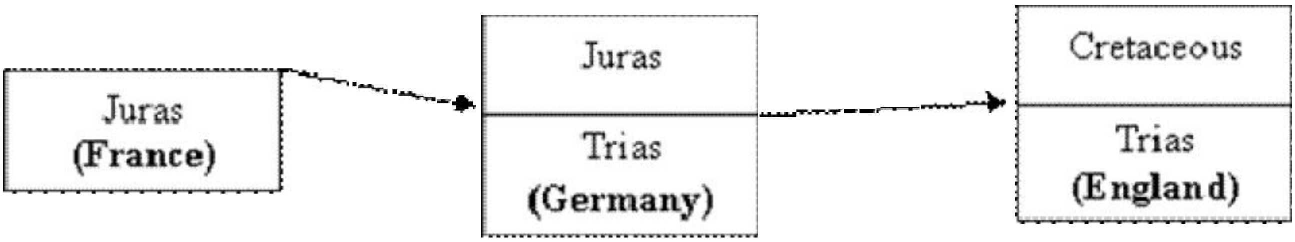
Correlation of Strata

- The need to classify and organize rock layers according to relative age led to the geologic discipline of stratigraphy.
- Rocks at different locations on Earth give different "snapshots" of the geologic time column. At a particular location, the rocks never fully represent the entire geologic rock column due to extensive erosion or periods of non-deposition or erosion.
- The thickness of a particular rock layer (representing a particular time period) will vary from one location to another or even disappear altogether.
- The process that stratigraphers use to understand these relationships between strata at different localities is known as "correlation".
- For example, rocks named Juras (for the Juras Mountains) in France and Switzerland were traced northward and found to overlie a group of rocks in Germany named Trias. The Trias rocks in turn, were found to underlie rocks named Cretaceous in England (the chalky "White Cliffs of Dover").



Based on these relationships, is the Juras older or younger than the Cretaceous? What are the two possible scenarios?

The location where a particular rock layer was discovered is called a "type locality". Most of the "type localities" of the geologic time column are located in Europe because this is where the science of stratigraphic correlation started.

Lateral Variations in Formations

Historically, geologists initially believed that the layer-cake sequence of sedimentary rocks existed worldwide (i.e., that the layers extended indefinitely without change).

By the late 1700's people began to realize that formations had a limited extent both vertically (up and down) and laterally (horizontally across Earth's surface).

People also began to realize that lithologic variations (changes in texture, color, fossils, etc) can occur laterally within formations themselves.

Today we interpret such variations in the context of modern depositional environments. For example:
Different lithologies grade laterally into one another in a manner called intertonging. An example is the way that the Old Red Sandstone of Wales (a terrestrial deposit) grades laterally into marine sediments of Devonshire to the south (both are Devonian).

ENVIRONMENT OF DEPOSITION	EXPECTED LITHOLOGY
Near shore marine- The energy is high due to rough waters at the water-land interface.	Coarse sediments, and fossils of robust organisms that can withstand high energy environments.
Deep ocean- The energy is low due to the general calmness of water away from land.	Fine sediments, and fossils of more fragile organisms.
Note that the two different lithologies can be deposited simultaneously (representing the same moment in geological time) so long as they are deposited at different locations.	

Intertonging reflects the changes in depositional environments that occur over space and time (lateral and temporal variations). Often these changes in environment are linked to shoreline migrations resulting from sea-level changes over time.

Depositional Environments and Sedimentary Facies

Depositonal environments are characterized initially by the sediments that accumulate within them, and ultimately by the sedimentary rock types that form. For example, a reef environment is characterized by carbonate reef-building organisms. Ultimately, the sediments become lithified to form fossiliferous limestone.

FACIES	LITHOLOGIES
Floodplain	Mudstone and shale with interbedded sandstone.
Ocean basin	Laminated pelagic clays, cherts, and possible limestone.
Delta	Well-sorted, well-rounded, and possibly cross-bedded sandstone.

A ***sedimentary facies*** is a three-dimensional body of sedimentary (or rock) with features like lithology, colour, body geometry, contact of the beds, grain size, texture, sedimentary structures, fossil content representative of a particular depositional environment. Analysis of sedimentary facies helps geologists to reconstruct past geologic environments and paleogeography.

Lithofacies are defined on the basis of sedimentary characteristics, while biofacies rely on paleontological differences. With detailed work, subfacies can be recognized and microfacies is microscopic studies are used to distinguish between rocks which in the field appear similar.

Facies can be described in terms of—

a) the sediment itself (Ex. Cross-bedded sandstone facies)
b) the depositional process (Ex. Turbidite facies)
c) the depositional environment (Ex. Tidal-flat facies)

Only (a) is objective and unequivocal while (b) and (c) are both interpretative.

Facies may be also grouped into facies association keeping in mind the paleogeography.

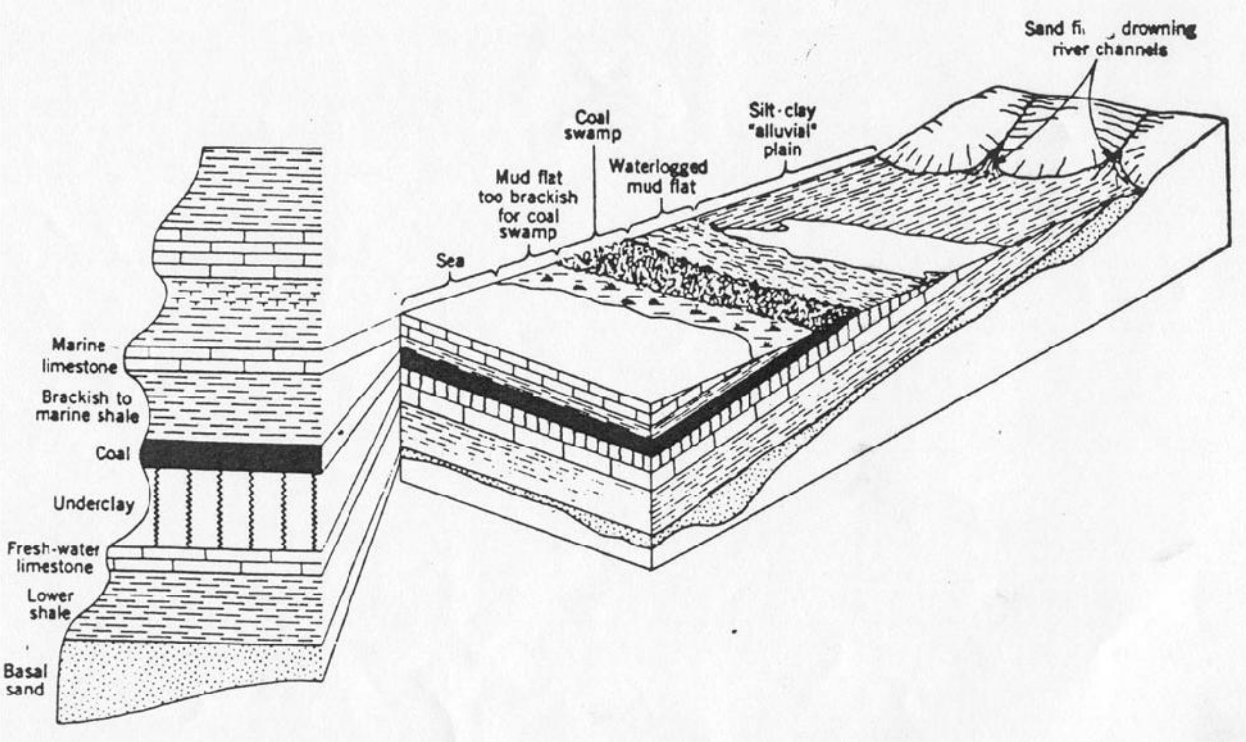
Walther's Law of Correlation of Facies (Relationship between vertical and lateral variations):

The Law of the Correlation (or Succession) of Facies of the German geologist Johannes Walther (1860–1937) is used widely in the interpretation of sedimentary sections. Though recognized earlier in Europe, Middleton, (1973) recognized and proselytized Walther's work as a pioneer stratigrapher-sedimentologist in the USA. Johannes Walther studied the relationship of facies to depositional setting. He recognized that as depositional environments change their lateral position and fill accommodation (i.e the space available for potential sediment accumulation), so the sedimentary facies of adjacent depositional settings succeed one another as a vertical sequence.

The law states that "The various deposits of the same facies areas and similarly the sum of the rocks of different facies areas are formed beside each other in space, though in cross-section we see them lying on top of each other. Only those lithofacies which are a product of sedimentary environments found adjacent to one another in the modern can be occurring superimposed in continuous, uninterrupted stratigraphic succession."

Even though Walther's Law states that "Facies adjacent to one another in a continuous vertical sequence also accumulated adjacent to one another laterally" one should recognize however:

- Walther's Law can only apply to a section without unconformities.
- Walther's Law can only apply to a section without subdividing diachronous boundaries, including transgressive turfaces (TS) and the maximum flooding surfaces (MFS).



Transgressions vs. Regressions

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The sea-level has fluctuated throughout geologic history, and these changes have a profound effect on the geologic rock record.

A transgression is an advance of the sea over land.

A regression is a retreat of the sea from land area.

A transgressive facies pattern is characterized by:

1. The movement of marine facies landward over terrestrial facies.
2. A fining-upward sequence (the new marine environment is lower energy than the prior terrestrial environment).
3. A basal, erosional unconformity (erosion was more profound before the seas advanced).

A regressive facies pattern is characterized by:

1. The movement of terrestrial facies seaward and over marine facies.
2. A coarsening-upward sequence.
3. An erosional unconformity at the top.

Walther's Law- Over time, the lateral changes in sedimentary facies due to transgressions and regressions will also produce vertical changes in sedimentary facies:

1. A transgressive facies sequence fines in the direction of the transgression, and also fines upward.
2. A regressive facies sequence coarsens in the direction of the regression, and also coarsens upward.

#What causes transgressions and regressions?

1. Worldwide rises and falls in sea level (eustatic changes), perhaps related to climatic change.
2. Tectonic uplift, isostatic rebound, or crustal subsidence.
3. Rapid sedimentation.

It is often difficult or impossible to determine the exact cause of a transgression or regression seen in the geologic record. The cause may be worldwide or local. The fact that there is a transgression or regression indicates an "apparent" sea-level change.