Stratigraphic Relationships

Consider the contrast between the paper-like vertical dimensions of individual rock masses and the enormity of their lateral extent, commonly involving tens, hundreds of miles, or in some instances a thousand miles. In exposures, the significant and obvious vertical lithologic changes define units of rock, which succeed one another at right angles to the bedding. Parallel to the bedding. The degree of lithologic change is infinitely less, and individual units seem to extend endlessly. This impression reinforced by the linear nature of most ?????.

American stratigraphers thought in the early decades of this century, was based on the concept that most bodies of strata extend, virtually unchanged:

1- Until their depositional limits are reached.

2- Until they are truncated by erosion.

Lithosomes: (by Wheeler and Mallory. 1956)

Masses of essentially uniform lithologic characters which have intertonguing relationships with adjacent masses of different lithology, without delimit their lithostratigraphic units subdivisions (Formation, Member, …….). such units are established on the basic of units are established on the basic of utility anf practical in mapping and are of primary importance as vertically succession subdivisions of the stratigraphic column.

Each body would then be seen as a roughly tabular mass with intricately shaped boundaries the presenting its surfaces of contract with erosion surfaces and with other rock masses of different constitution above, below, and to the sides.

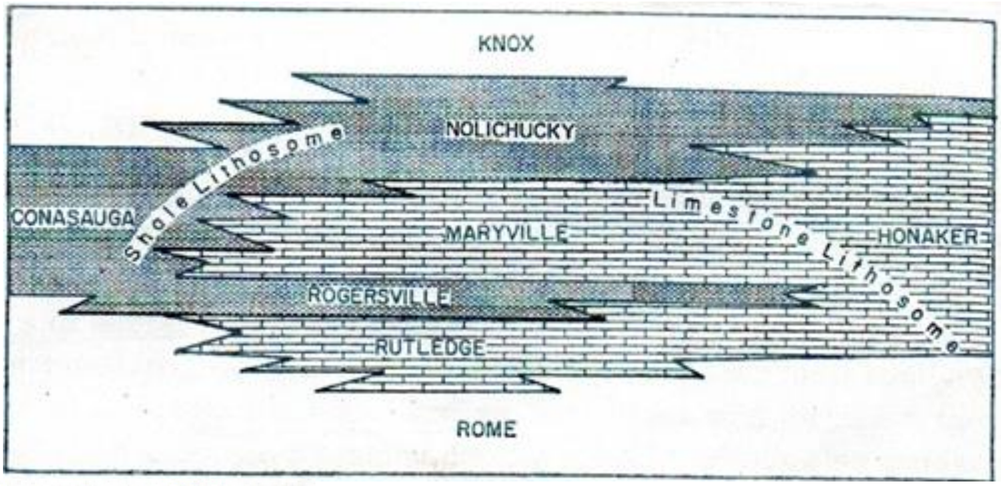
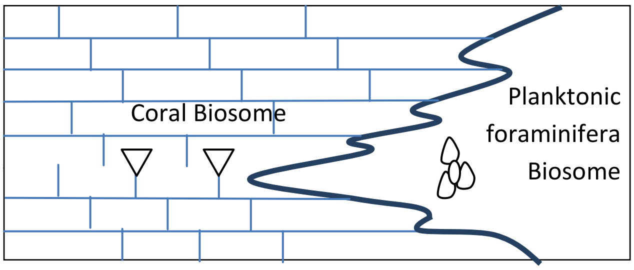


Fig. 9-1. Formations and lithosomes intertonguing shale and limestone lithosomes are subdivided into four vertical successive rock units at the center of the diagram, whereas only two mappable units are recognized at the right and only one such unit at the left. [After Wheeler and Mallory (1958).]

Biosomes: (by Wheeler, 1958)

Three dimensional Rock masses of uniform paleontologic content which have intertonguing relationships with adjacent masses of different paleontologic contents.

Shapes of Lithosomes:



Stratigraphy /Lecture (5)

The shape of lithosome is largely controlled by its relationship to adjacent lithosomes.

Geometric Classification of Shapes of Lithosomes

Krynine (1948) has used the width-to-thickness rations of lithosomes to establish a strictly geometric classification into:

(1)Blanket (great than 1000:1

(2)Tabular (1000:1 to 50:1)

(3)Prism (50:1 to 5:1)

(4)Shoestring (less than 5:1)

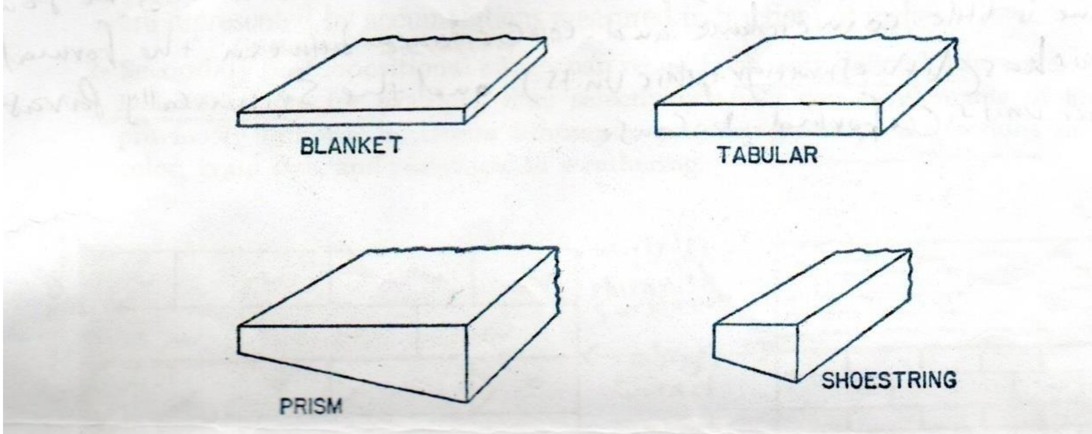


Fig ( ): shapes of lithosomes (adapted from Krynine (1948))

VERTICAL RELATIONSHIPS AMONG LITHOSOMES

The vertical relationships between successive sedimentary bodies are the most easily visualized, since they can be studied at a single point of observation, either in outcrop or in the subsurface, without involvement with the problems of lateral changes in character, Since the geologist is familiar with these relationships, through his routine subdivision of the local stratigraphie column into vertically successive groups, formations, and members, they do not demand an exhaustive examination here, and the following paragraphs are presented more in the nature of a synoptic review. Major types of vertical relationships among lithosomes.

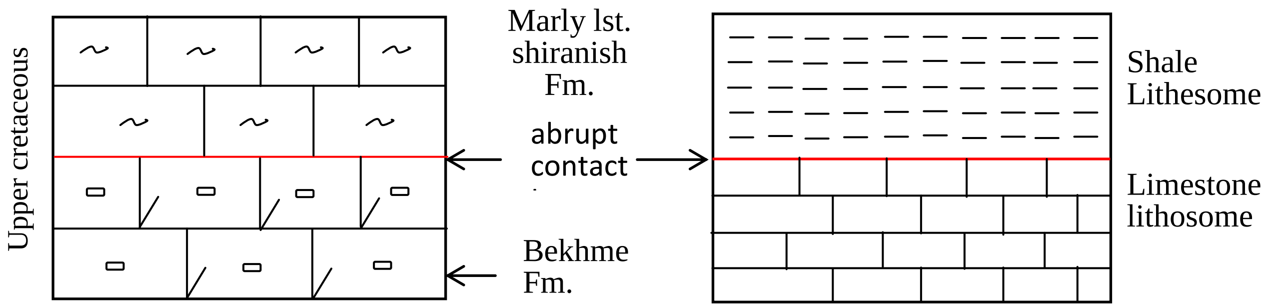
1- Conformable Relationships

Surfaces of contact between vertically successive lithosomes are considered conformable if there is no significant evidence of interruption of desposition between adjacent units. Conformable contracts may be abrupt, gradational, or intercalated. In each case, the change in lithologic character reflects 1- a shift in the conditions of deposition or 2- in the materials brought to the site of deposition.

(1) Abrupt, yet strictly conformable, sharp contacts between vertically successive lithosomes are relatively rare. Where such contacts can be observed, they do not persist over large areas but commonly pass laterally into unconformable relationships. Abrupt conformable contacts resulting from:

1- primary causes are most frequently encountered in areas of very slow deposition, in which changes taking place over spans of thousands of years are represented by accumulations measured in fractions of inches.

2- Secondary postdepositional effects can result in sharply defined lithosomes. Dolomitization, for example, may selectively affect certain elements of a previously uniform limestone lithosome, producing abrupt distinctions in color, grain size, and resistance to weathering.

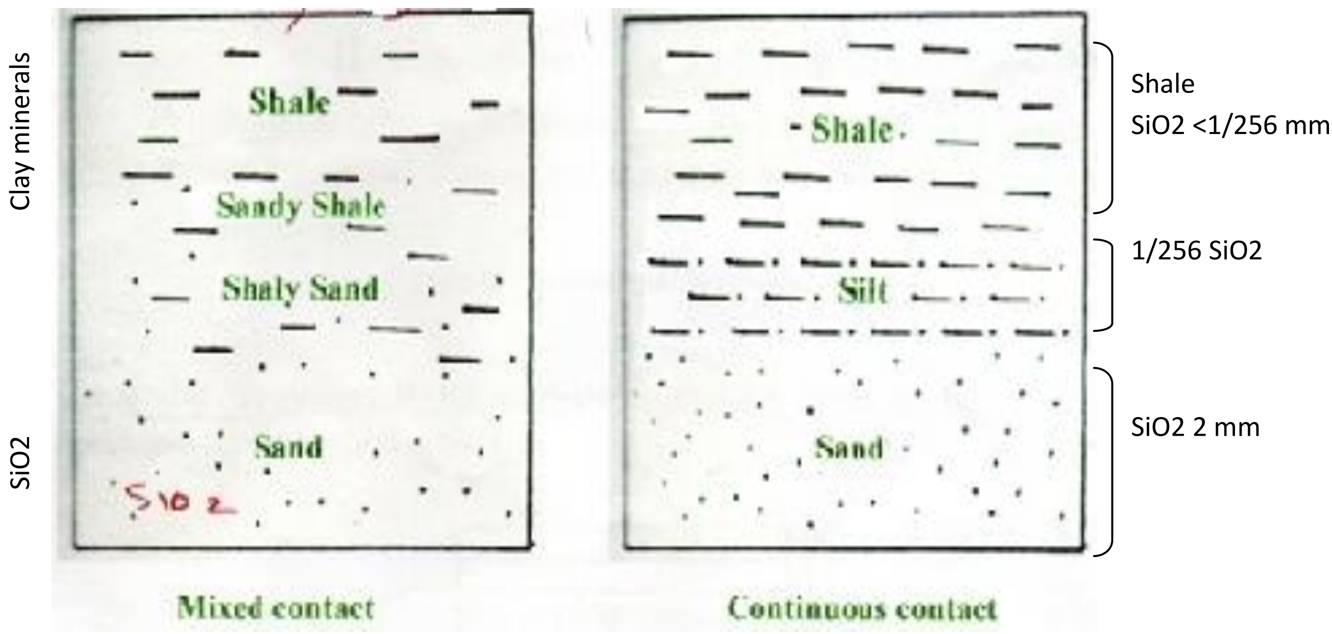


(2) Gradational contacts.

Normally, the changes in material and conditions that differentiate successive sedimentary bodies are gradual throughout a variable thickness of stratigraphic section. The resulting gradational contacts are two types, mixed and continuous:

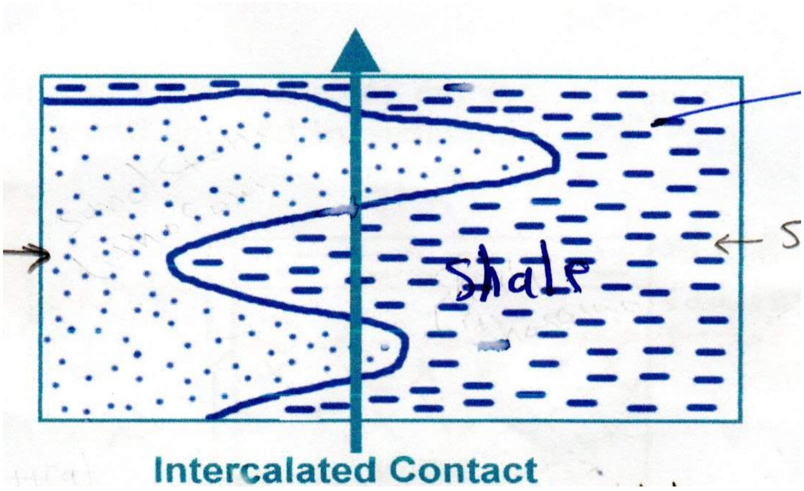
(a) mixed gradation occurs where two distinct sediment types grade from one to the other. A Sandstone, for example, may grade upward into shale by gradual admixture of clay, starting with a clay matrix in the voids between sand grain, the composition may change to sand grians enclosed in clay laminae, then to "floating" sand grains in a mass of clay, and finally to pure, sand-free, clay shale.

(b) continuous gradation involves the progressive size change in a single sedimentary parameter, without mixing of end members. Examples are found in sand-to-shale size gradations in which there is a progressive reduction in grain size from sand 2-1/16 mm to silt 1/16-1/156 mm to clay <1/256mm.



(3) Intercalated Contacts.

The majority of intercalated lithosomes contacts are problems of formation and member definition rather than questions of lithosome differentiation. When-as, for example, in a Sand body that becomes interbedded with shale before giving way to an overlying shale body-a three-dimensional picture is assembled, the interbeds are seen to be tongues extending from the main bodies of shale and sandstone, each of which exhibits abrupt or gradational contacts with lithosomal tongues above and below. Such complex three dimensional patterens are more easily understood after discussion of the lateral relationships among lithosomes. When shale unit on lapped sandston unit, caused the pinch out of sand unite in shale by effect of transgression of sea.



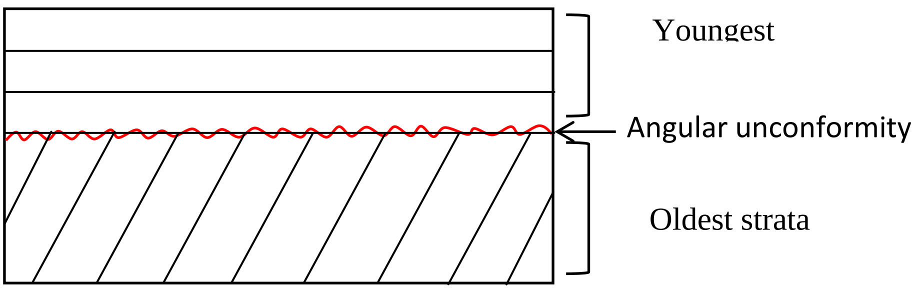
Vertical Conformable Relationship Between lithosomes

II – Unconformable Relationships

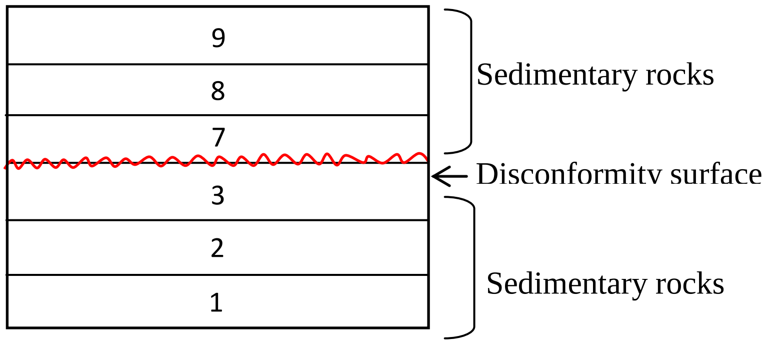
Relationships between lithosome separated by a surface of nondeposition (interruption) or erosion are unconformable, and the separating surface is an unconformity.

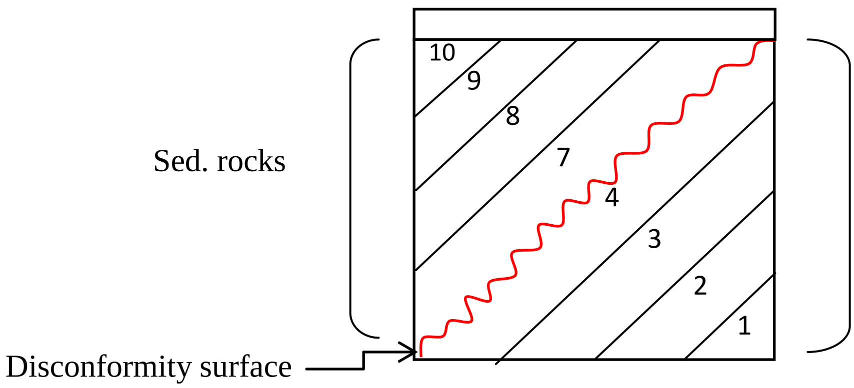
(Type of unconformable relationships)

1) angular unconformity: a surface separating tilted or folded strata from overlying undisturbed strata

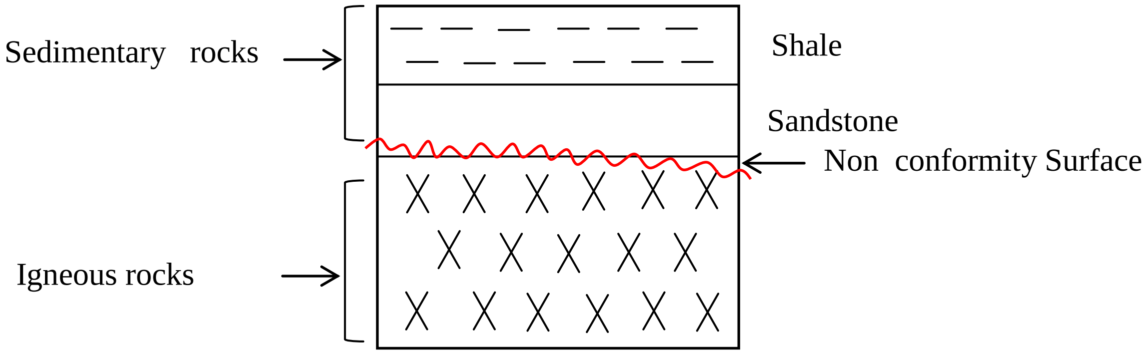


2) disconformity (Paraconformity) (Graben 1905): a surface of unconformity separating essentially parallel strata.





3) Nonconformity: an erosion surface cut into plutonic igneous or massive metamorphic rocks and covered by sediments.



Diastem : refer to the slight discontinuities in marine sediments that indicate minor interruptions in deposition of brief duration.

Note: to distinguish between major breaks in the sedimentary record (unconformities) and minor interruptions of brief duration (diasterms)

The difference between unconformities and diastema

Unconformities	Diastema
Major breaks in the sedimentary (scaled large magnitude)	Minor interruptions of brief duration (scaled in small magnitude)
In land and marine	In marine
Resulting from subaerial exposure and the action of nonmarine degadational agencies and non deposition and marine erosional unconformities and high mobility depositional basins.	Resulting from wave and current energies are capable of stripping minor thickness of sediment minor interruption in marine deposition.

Regional Versus Local Unconformities

Geometric classification is the recognition that some unconformities are strictly limited in geographic extent, which are typically developed around the margins of sedimentary basins while continuous deposition took place in adjacent areas, are called local unconformities.

Certain unconformities, can be traced for hundreds of miles through the thick deposits of sedimentary basins, as well as around their margins and across uplifted trends. These, the regional unconformities.

Marine Unconformity: established without benefit above sea level by Marine wave and turbidity current energies are capable of stripping thicknesses of sediments. It may be called (unequeus unconformity)

Subaerial unconformity: the surface of erosional unconformity resulting from subaerial exposure and the action of non marine degradational agencies.

Note: the majority of recognized unconformities represents a greater or lesser degree of erosion and striping of older rocks or by a pause in deposition in areas that have reached an equilibrium state. In which neither deposition nor erosion takes place when the area is said to have achieved depositional base level.

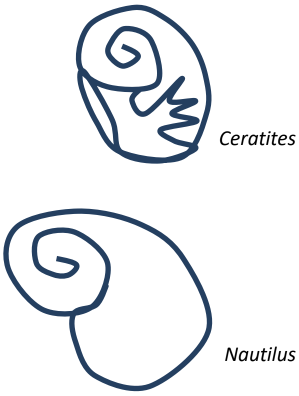
Subaerial uniformity may be caused from subaerial exposure and the action of non marine degradational agencies(action).

Recognition of Unconformities.

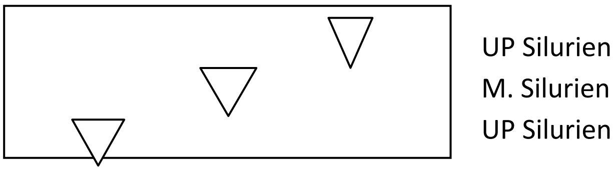
There are many criteria available for the recognition of unconformable surfaces, both in outcrop and in the subsurface. There criteria fall into three classes: sedimentary, paleontologic, and structural.

1- Sedimentary Criteria: More than twenty sedimentary criteria have been proposed. The more important ones include the presence of a basal gonglomerate. Residual (weathered) chert, buried soil profiles, and zone of glauconite; phosphatized pebbles, or manganiferous zones.
   The first three criteria are generally accepted as evidences of subaerial disconformities. The latter three, especially in combination, are taken to represent submarine disconformities or diastems, indicative of solution or nondeposition.

2- Paleontologic Criteria: most significant criteria, 1. Abrupt changes in faunal assembla ges 2.Gapsin evolutionary development, and 3.The occurrence of bone and tooth conglomerates represent. generally accepted criteria.

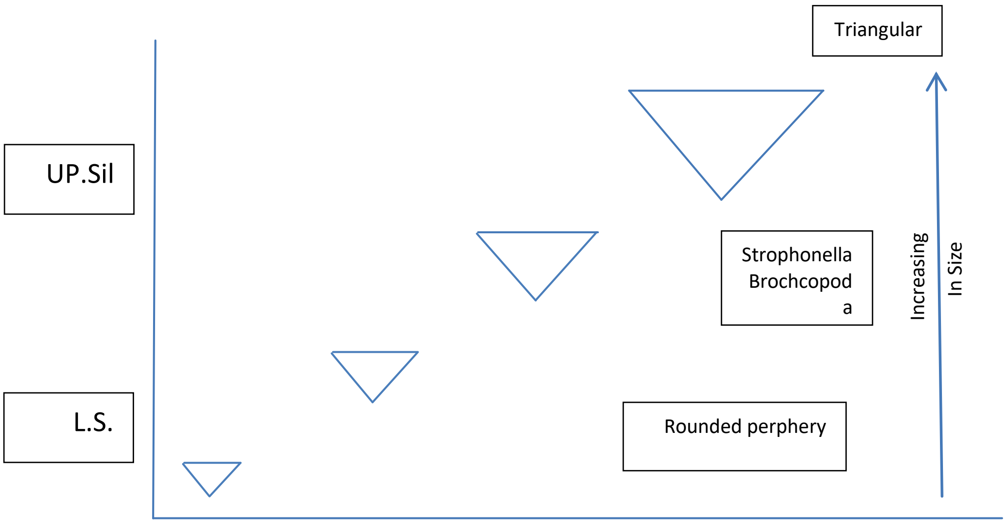


For example: abrupt phylogenetic change from one fossil assemblage to another in vertical succession of the rocks. If the beds below a stratigraphic surface contain lower Silurian fossils and the beds above contain upper Silurian forms, indicating of middle Silurian forms.



Abrupt change of Biosomes from marine to continental is significant. A gap in the orderly evolution of a single organism through a vertical series of beds is indicative of a hiatus.

bone and tooth conglomerates, commonly associated with phosphatized pellets, and which show some evidence of reworking. Indicate at least a submarine diastem, if not subaerial exposure.



The marine basin reference point is to the left of the cross section. Units A-E reflect regression and resulting offlap relationships; units F-I represent transgression and overlap relationships. At point 1 of the accompanying figure, the regressive strata are truncated and the overlapping transgressive beds rest upon them with angular unconformity.

Overlap & Offlap: the reflects of transgression and regression affect both vertical and lateral relationships of sedimentary bodies. The accompanying diagrammatic cross section (fig.g-5) illustrates typical relationships

Fig. 9-5. Offlap and overlap relationships. Units A to E illustrate regression and offlap; units F to I represent transgression and overlap; unit H onlaps unit G, but both overstep units A to E

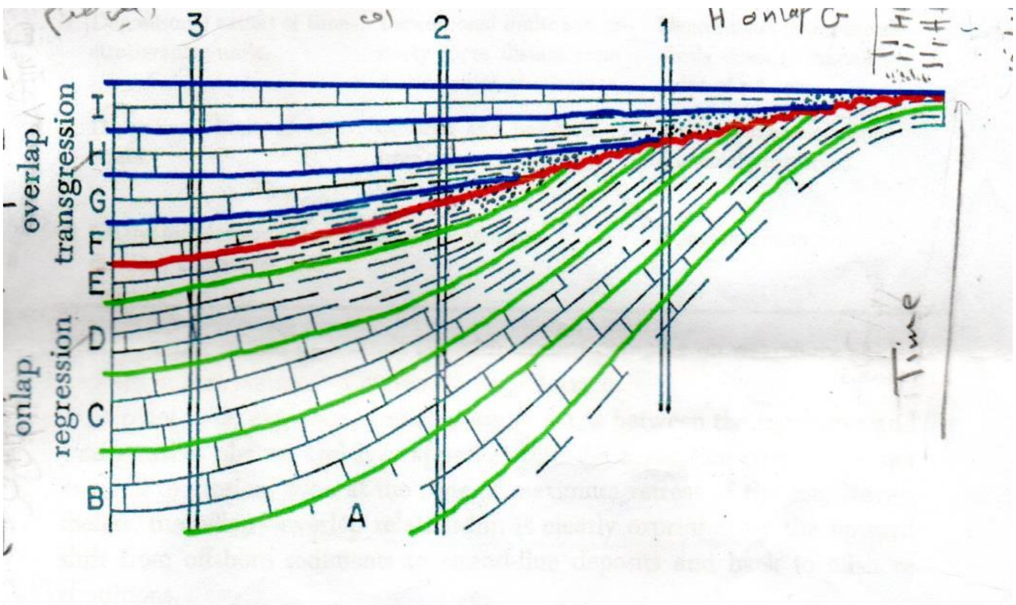


TABLE 9-1. CRITERIA OF OVERLAP AND OFFLAP

	OVERLAP	OFFLAP
Lithosomes typical of near shore environments progressively displaced in relation to marine point of reference	Displacement away from marine point of reference.	Displacement tower marine point of reference
Vertical relationship among lithosomes.	Offshore lithosomes overlie near-shore (fine-grained above coarse).	Near-shore lithosomes overlie offshore (coarse-grained above fine)
Relationships of lithosomes to time-stratigraphic markers.	Lithosomes become younger away from marine point of reference.	Lithosomes becomes younger toward marine point of reference
Depositional extent of time stratigraphic units	Depositional limits successively more distant from marine point of reference	Depositional limits successively closer to marine point of reference
Depositional limits of strats	Covered and protected from erosion by younger units	Exposed to erosion; not commonly preserved.
Lateral termination of individual lithosomes and beds.	Pinchout common	Truncation common.

Overlap: offshore lithosomes overlie near-shore (fine-grained above coarse), Lithosomes become younger away from marine point of reference and depositional limits successively more distant from marine point of reference.

Offlap: Near-shore lithosomes overlie offshore (coarse-grained above fine), Lithosomes become younger toward marine point of reference and depositional limits successively closer to marine point of reference.

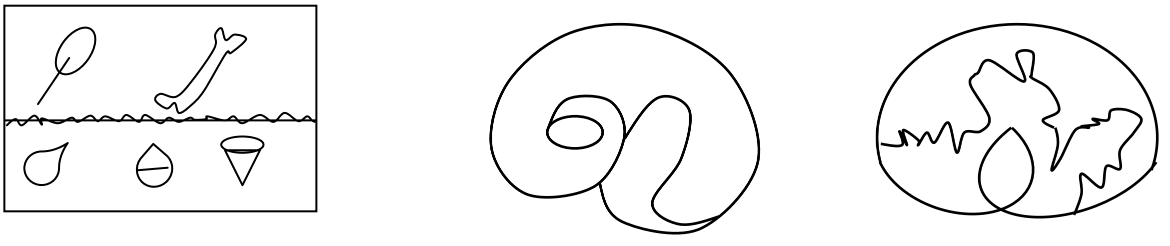
Overlap has been applied (as units A-D of figure 9-5 are coverd by units G-I) and to the progressive pinching out of strata in a transgressing succession (as in units F-I of the cross section). This overlap may refer to the progressive strata above an unconformity.

Onlap: the relationships within an overlapping succession, in which each unit of strata reaches a depositional pinch-out and is transgressed by the next overlying unit; each in turn terminates farther from the point of reference. Unit G (Figure 9-5) onlaps unit F and is onlapped by unit H.

Overstep: the relationships between an overlapping succession and the truncated starta below the surface of unconformity. Unit G (figure 9-5) oversteps unit D.

Recognition of Unconformities.

1- **Sedimentary Criteria**: more than twenty sedimentary criteria have been proposed. The more important ones include the presence of a basal Gonglomerate. Residual (weathered) chert. Buried soil profiles, and zones of glauconite, pnosphatized pebbles, or manganiferous zones.



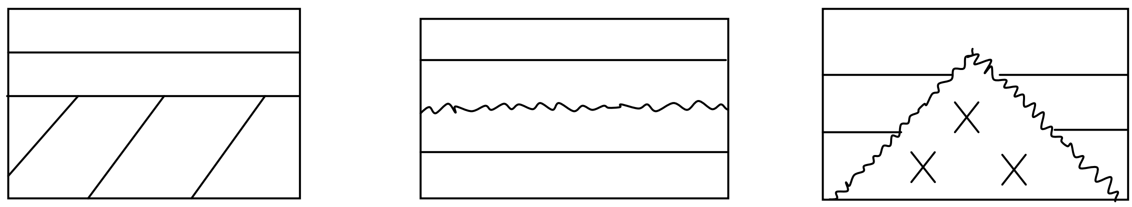
The first three criteria are generally accepted as evidences of subaerial disconformities. The latter three, especially in combination, are taken to represent submarine disconformities or diatems, indicative of solution or nondeposition.

2- **Paleontologic Criteria**: most significant criteria, abrupt changes in faunal assemblages, gaps in evolutionary development, and the occurrence of bone and tooth conglomerates represent generally accepted criteria.

For example: abrupt phylogenetic change from one fossil assemblage (brachiopod) to another in vertical succession of the rocks. If the beds below a stratigraphic surface contain lower Silurian fossils and the beds above contain upper Silurian forms, laiking fossils of middle Silurian age.

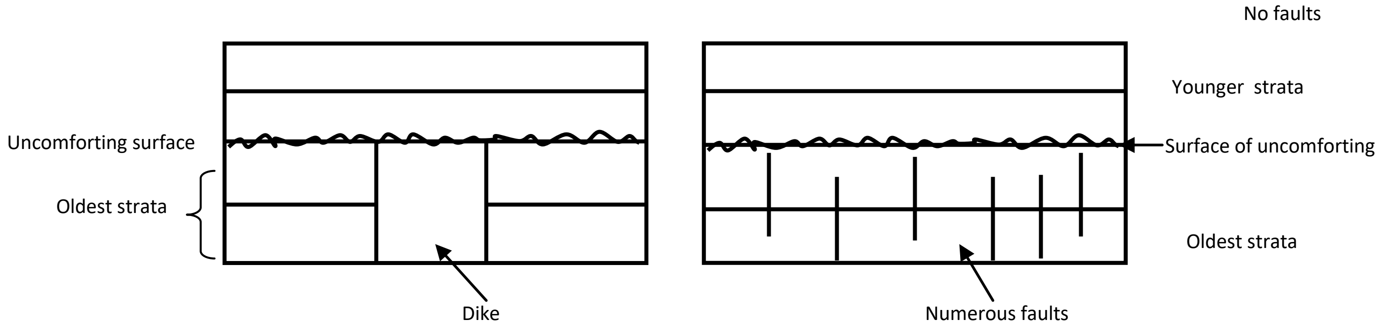
Abrupt change of biosome from marine to continental is significant. A gap in the orderly evolution of a single organism through a vertical series of beds is indicative of a hiatus 3- Bone and tooth conglomerates, commonly assocated with phosphatized pellets, and which show some evidence of reworking, indicate at least a submarine diastem, if not subaerial exposure.

3- Structural Criteria, four structural criteria are recognized. Discordance of dip above and below a contact is a definitive criterion of an angular unconformity. An undulatory surface of contact which cuts across bedding planes of the underlying formation marks a disconformity caused by emergence and erosion.

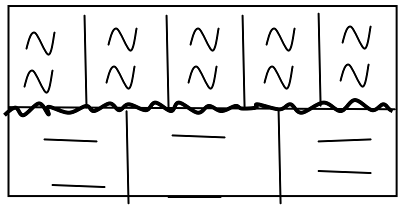


Angulor unconformity Disconfirming Nonconforming

Truncation of dikes at a surface of contact, with no evidence of thermal alteration of the overlying beds, marks subaerial unconformities caused by erosion. Similarly relative complexity of faults above and below a surface of contact may indicate an erosional disconformity. If the lower formation is more complexly faulted, with abrupt cessation of fault planes at the contact, an unconformity is established.

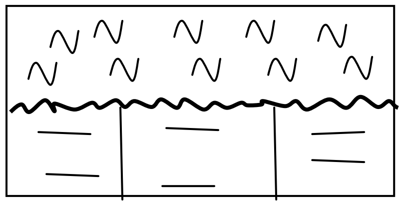


complexly faulted, with abrupt cessation of fault planes at the contact, an unconformity is established.



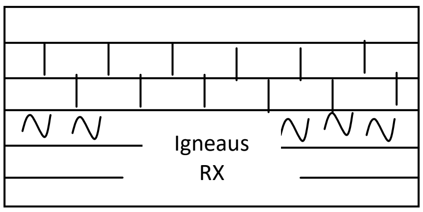
faults

Few faults



No faults

Many faults



Recent
sedimentary roks

Nonconformity

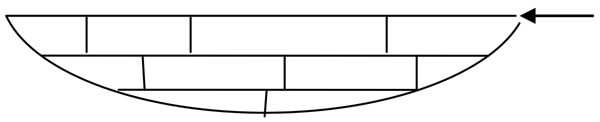
No altration

4-Stratigraphic map Criteria: require the intergration of many observation, preferably by means of stratigraphic maps of various types.

LATERAL RELATIONSHIPS AMONG LITHOSOMES

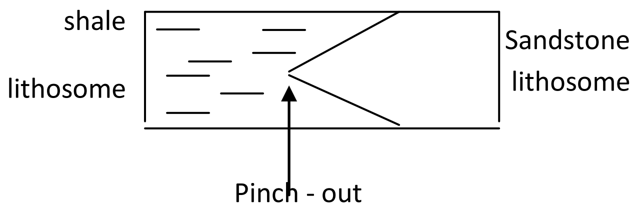
All sedimentary bodies, have laterally bounding peripheries. As a result of erosion and the edge of the lithosome no longer represents its original depositional limits.

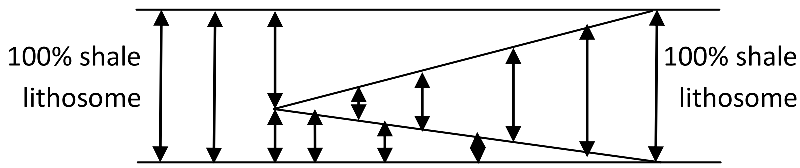
Lateral termination of a lithosome may involve pinch-out, intertonguing. Or lateral gradation.



1- Pinch-out

When the termination of a lithosome, a sandstone for example, that thins progressively to extinction. Pinch-out may be accompanied by an increase in the thickness of an adjacent body (a shale, for instance) which may lie above, below, or both above and below; or, Pinch-out may involve thining or convergence of the stratigraphic section forming feather edge of the body. Many stratigraphic – trap oil and gas fields have been discovered along the pinch-out zones of porous and permeable lithosomes.

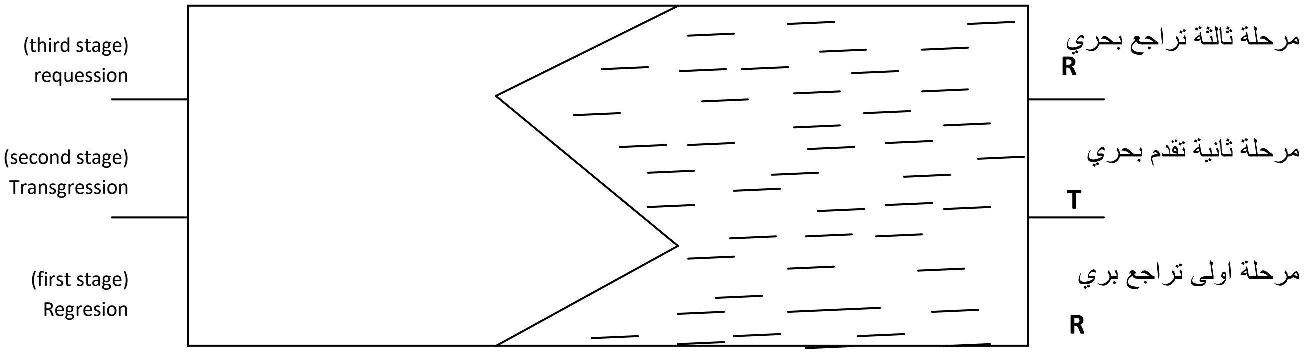




Sandstone lithesome thining to extinction accompanying thicking in shale lithesome becoming 100% shale lithosome

2- Intertonguing

Some bodies of sediment disappear and are lost in laterally adjacent masses owing to splitting into many thin units, each of which reaches an independent pich-out termination. The resulting intertonguing zone has many vertically successive intercalations of thin representatives of two lithosomes, the numbers of tongues increases with the distance from the main mass of either sedimentary body, reaching a maximum as tongues split and split again falling as individual tongues pinch out as a resulting from successive transquessions and regressions of sea levels.



تراجع بحري Regression

3- Lateral Gradation contact:

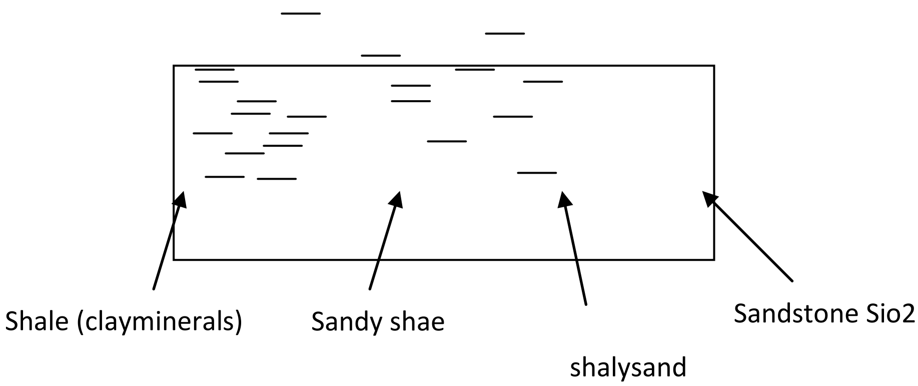
Lithosomes are terminated by gradual replacement of their lithologic characteristics by those of another type.

I – the leteral rate of change is very low.

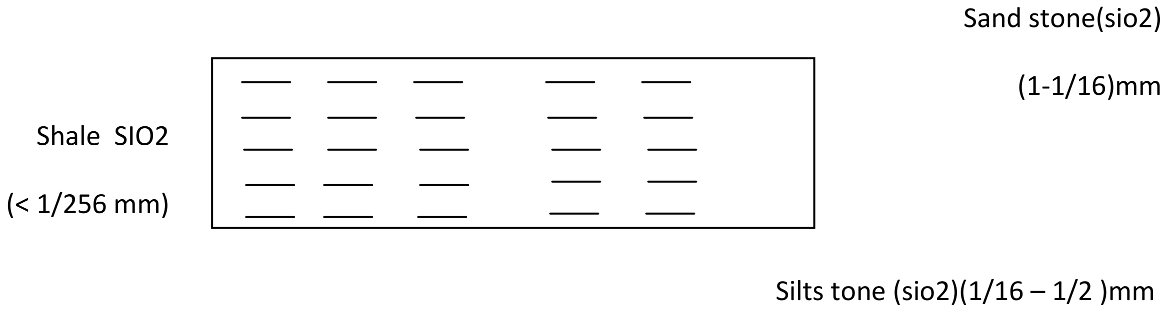
II- distances of hundred of feet, or even must be trauered in order to observe the some magnitude of change exhibited within a few beds invertial.

Lateral gradation may be either mixed or continuous, similar in nature to the vertical gradational relationship.

(1) Mixed lateral gradation of sandstone to shale is typical for oil and gas trapping where the zone of gradation is relatively narrow. Similar relationships are common between carbonate rocks and shale and between carbonates and sandstone.



(2) Continuous gradation is exemplified by many sand-tp-shale patterns and is also common amomg carbonates, as in the gradual change of a coarse biogenic limestone to a micrite lithosome.

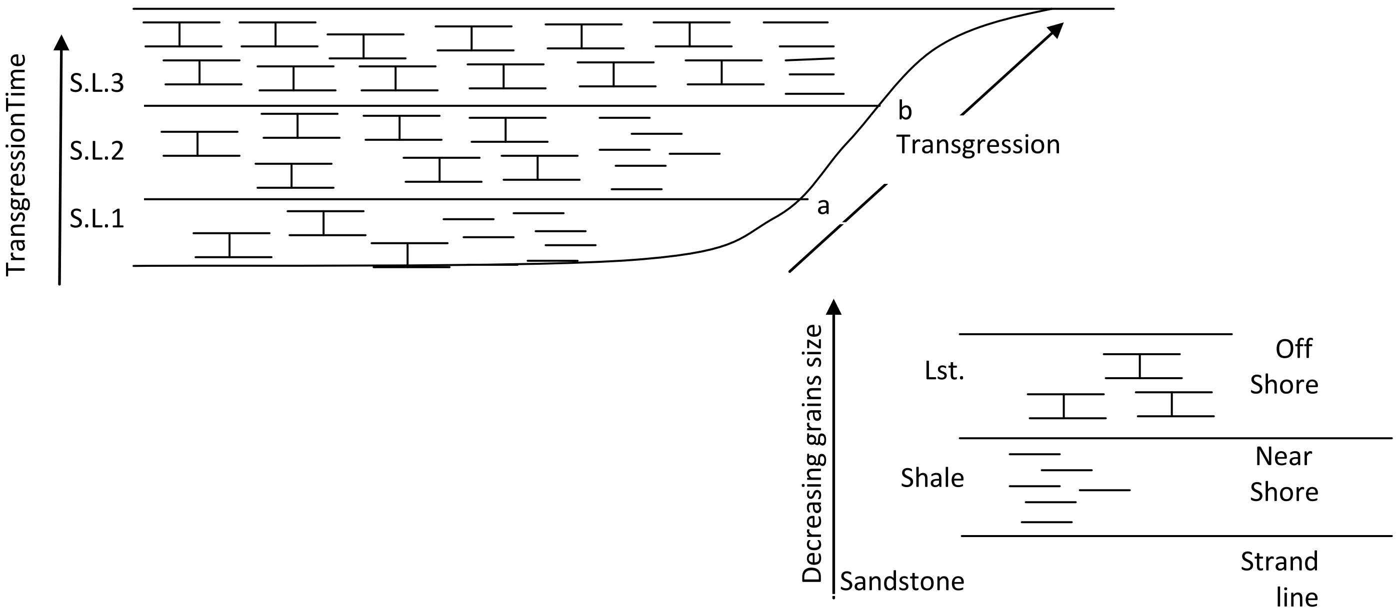


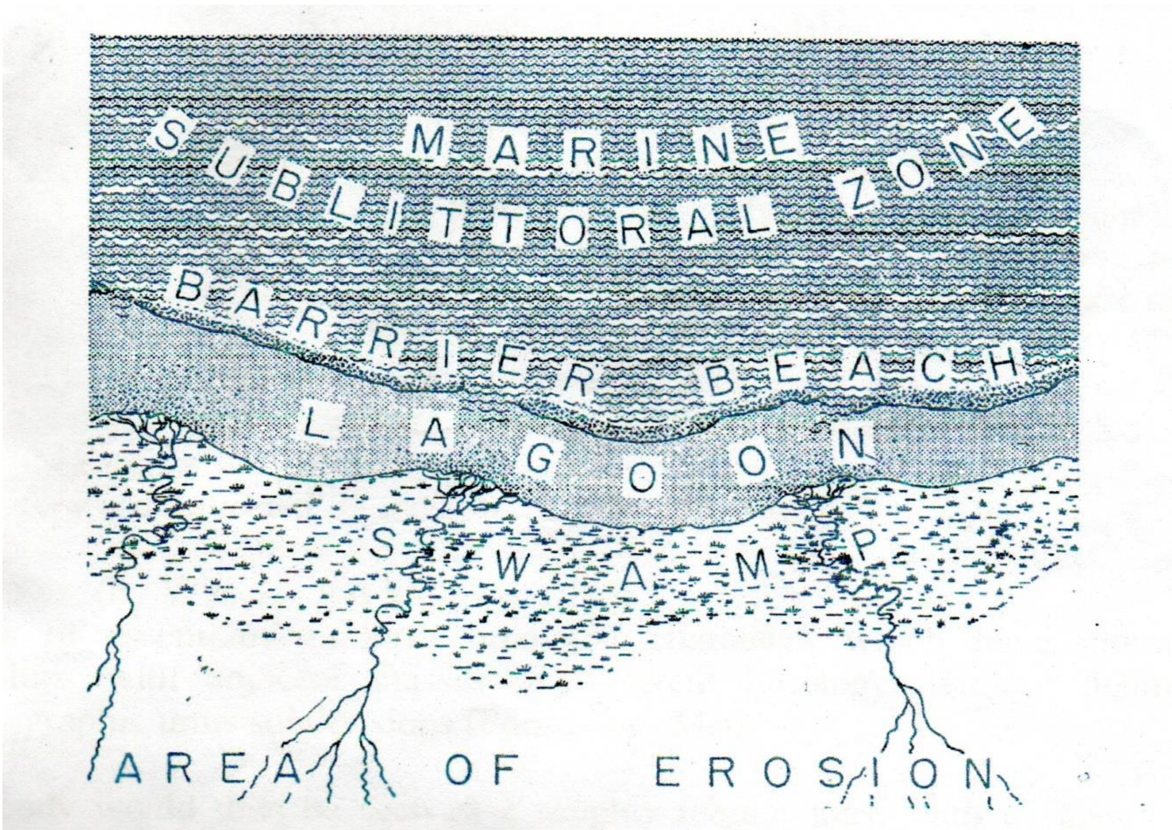
COMBINED LATERAL AND VERTICAL RELATIONSSHIPS

Both relationships vertical and lateral reflect the operation of both vertical and horizontal vectors. Which resulted brought By the geographic shifting of the agencies responsible for the deposition of various sedimentary masses during a particular span of geologic time reflected the instability of sedimentary enviroments that caused by the transqression and regression of sea level during the gcologic times.The shift in sedimentational pattern is reflected in the sizes, shapes, and interrelationships of the resulting three-dimensional lithososome.

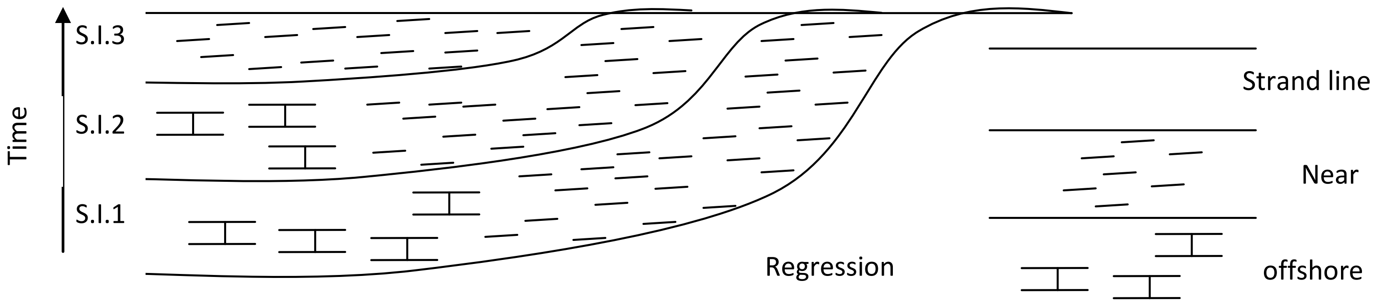
Transgression and Regression.

Transgression: using the center of the marine basin as the point of reference, any change that shift the boundary between marine (deposition) and nonmarine (erosion) outward from the basin center, or any change that brings offshore (typically deeper-water) environments to areas formerly occupied by near-shore (typically shallow-water) environments is also transgression, the converse constituting regression.





Regression. Using the center of the marine basin as the point of reference, any change that shifts the boundary between marine (deposition) and nonmarine (erosion) toward the basin center, or any change that brings near-shore (typically shallow-water) environments to areas formerly occupied by offshore (typically deeper-water) conditions.



Overlap and offlap

The effects of transgression and regression affect both the vertical and lateral relationships of sedimentary bodies. The accompanying diagrammatic cross section (Figure 9-5) illustrates typical relationships. Units a take time stratigraphic units identified by well established biostratigraphic zones. Sandstone, shale, and limestone lithosomes, representing strandline, near shore and offshore environments, are indicated by standard symbols.