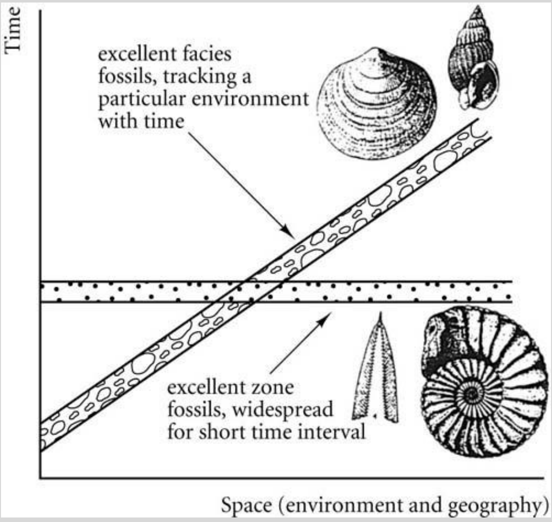
CORRELATION OF ROCKS

BOREHOLES FOR MINING

Correlation is the process of matching beds in geographically different areas, often for economic purposes such as coil or oil exploration. Most correlation work is done using borehole data. The closer the boreholes are drilled, the less probable any lateral variation or fault lines are between the boreholes and so the more accurate the data.

METHODS OF BIOSTRATIGRAPHIC CORRELATION

1. **First/Last appearance (extinction) of zone fossils** is useful for finding an age range for a series/sequence of rocks. However, there is difficulty in determining when a fossil first appeared in geohistory. Fossils ca be very rare when that organism first evolved. Likewise, near to extinction, a fossil group maybe very rare to find (scarcity of the organism).
2. **The range of a zone fossil and overlapping with other fossil groups;** some fossils will have a shorter time range than others. When the ages of two fossil groups overlap then the age of a particular bio zone can be determined accurately.
3. **A fossil assemblage occurs when a number of different organisms die rapidly and are preserved in the same bed.** A number of different fossils in the same bed shows that all those fossils of organisms were alive during the same period that the rock was being deposited.



Problems with biostratigraphic correlation

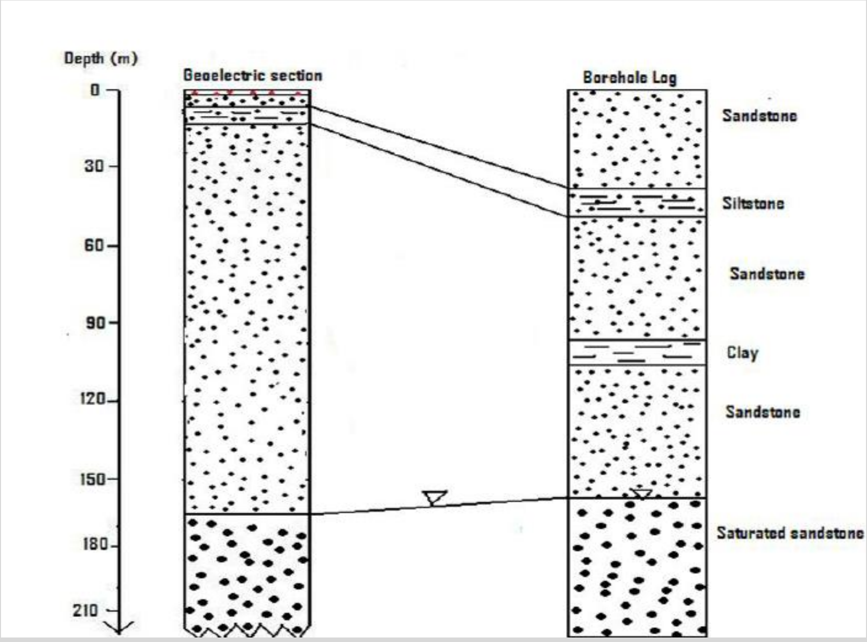
1. Many fossils, especially benthonic invertebrates, are restricted to particular environments and so are found in just a few rock types.
2. Some kinds of fossils are very long-ranged (lived over a long period of time). Especially if their evolutionary changes are small/slow and not apparent then it makes them useless for defining biozones.
3. Graptolites are delicate and can only be preserved well in quiet environments so only found in fine sediments like mudstones, limestones, shales and fine sands. They are destroyed in more turbulent waters.
4. Derived fossils confuse the true sequence of beds. They are fossils that have been removed and possibly transported from their original sediment to be deposited in a younger one. Radiometric dates of the derived fossil show a much older date than the rock it is found in.
5. Fossils are rare, they will not be present in all rocks as not all environments have optimal conditions for preservation. **Glacial, fluvial** and **desert** environments tend to be lacking in fossils.

METHODS OF LITHOSTRATIGRAPHIC

Lithostratigraphic correlation is based on recognising rock types, sequences of rock types and successions.

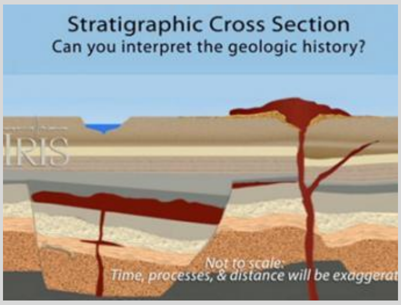
Marker horizon: A bed that is so easily distinguishable it is used to determine the position in a sequence relative to other strata.

Marker horizons are unusual features/beds such as an oxidised red bed in a sequence of rocks (e.g. oxidation of lava flow during weathering and erosion creates a red surface on a bed which may be surrounded by darker strata).

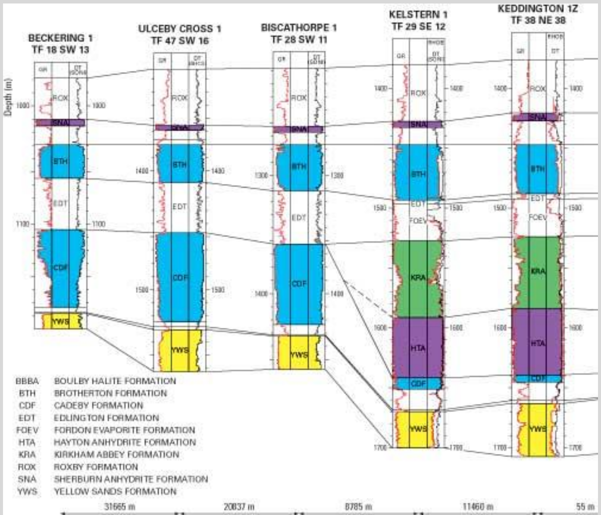


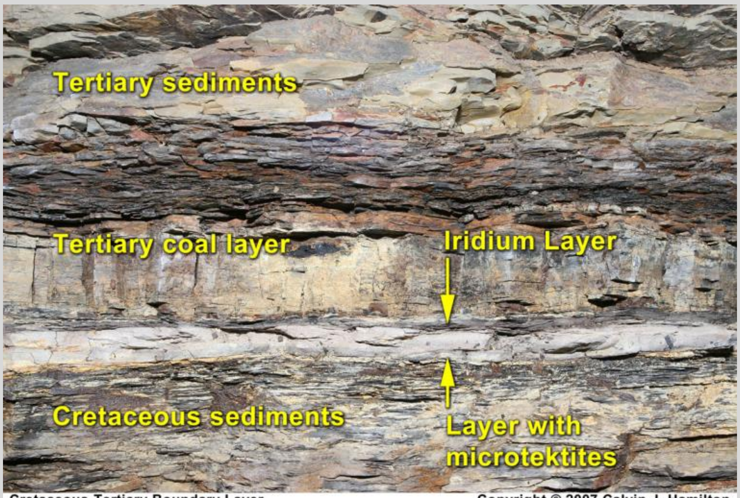
1. **A sequence of beds can be used to correlate**. However, without biostratigraphic correlation, and so fossil evidence, lithostratigraphic correlation like this is difficult. We always put greater trust into biostratigraphy.

2. **Boreholes can be correlated using thicknesses of strata** as a barcode. Different strata are matched by sharing the same thickness. Whether strata are thick or thin, if there are a series of thicknesses matching then it is easy to correlate. This is particularly useful **in coal fields** to determine if it is economic to mine a nearby area based on coal seam thickness. This has an immense economic impact.



3. **The composition of beds** can be used as a distinctive characteristic if there is e.g. a rare mineral like **iridium present**. Iridium is used for the **Cretaceous-Tertiary** boundary rocks.





Cretaceous-Tertiary Boundary Layer Copyright © 2007 Calvin J. Hamilton

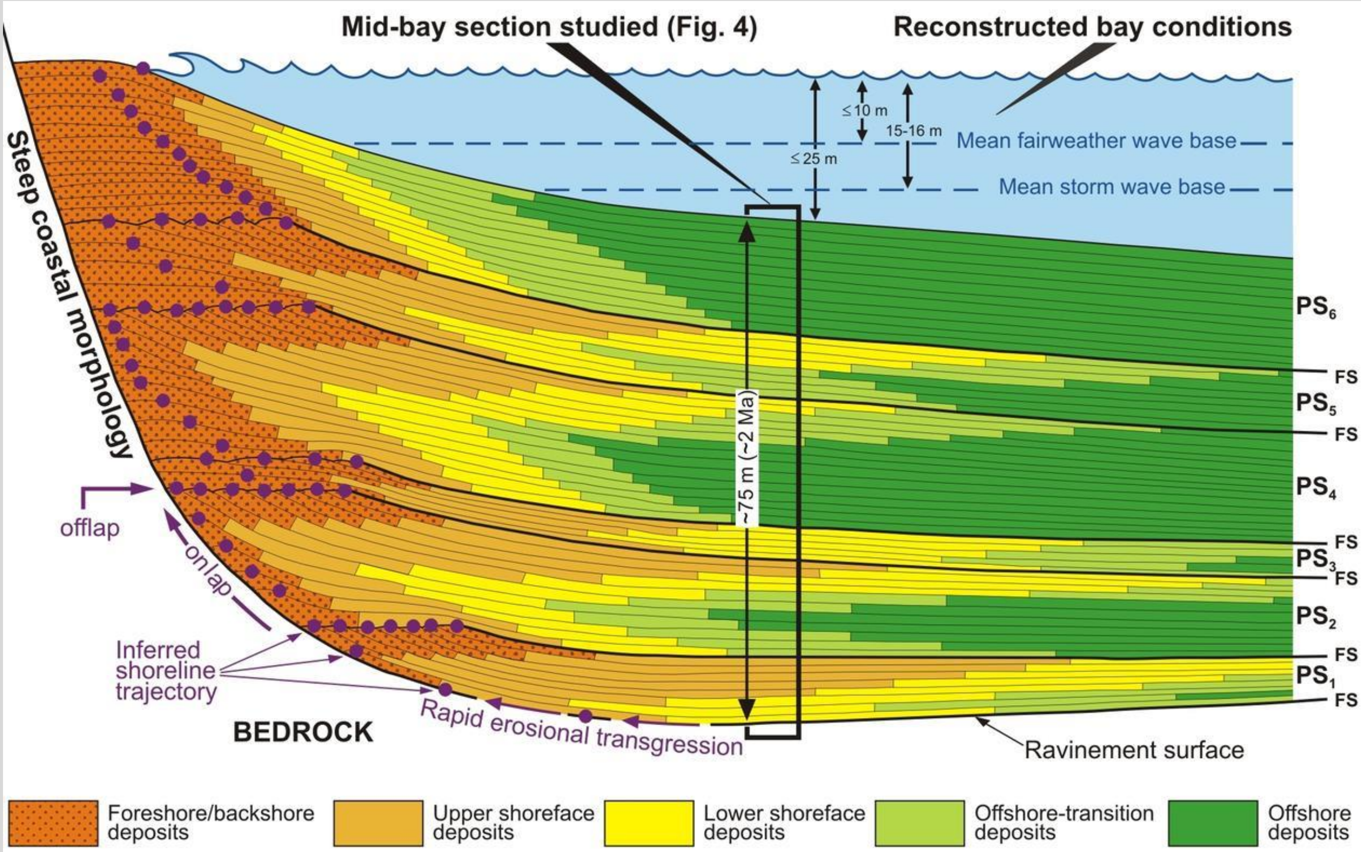
Problems with lithostratigraphic correlation

1. **Lateral variation** – where sediments change type horizontally.

Sedimentary rocks may change thickness laterally for instance in turbidite sequences which get thinner out to sea.

In a fluvial environment, point bar sands are deposited at the same time as flood plain clay. In shallow seas, sands are deposited close to the beach and limestones further offshore and clays far offshore, all simultaneously.

Finally, deltaic environments show beds of sands, clays silts and limestones all being laid down simultaneously as topsets, fore sets and bottom sets.



2. **Diachronous beds** – are where the same type of sediment is laid down in different areas at the same time. This forms Diachronous beds that cut across time. A good example is the prograding of a delta out to see as the sea retreats. A sequence of sandstone fore sets are laid down leaving a continuous layer of sandstone building out to sea. This process takes a long time with sandstones of different ages although they appear as one homogenous series.

CHRONOSTRATIGRAPHIC CORRELATION

These are matching features / events that can be applied on a global scale. Sometimes worldwide sea level changes can cause huge unconformities over large areas which can then be correlated.

Using tuff from volcanic eruptions
Tuff is a volcanic, pyroclastic deposit formed from ash (<2mm particles).
When a violent eruption occurs, ash is blasted tens of kilometres up into the atmosphere and can be transported and deposited over vast areas of land. This deposition occurs very rapidly and so represents one finite event in time. We use the term geologically instantaneous to describe the deposition of ash to form tuff. Tuff is ideal for radiometric dating and so rock correlation as it contains the correct radioactive isotopes of ^{40}K-^{40}Ar, it is laid down rapidly, can be relatively dated too and chemical analysis can be applied to it to find the exact composition matches.

Using varves from glacial lakes
Glacial varves are fine grained banded deposits from glacial lakes containing coarser pale material (silt) deposited in the summer and finer darker (clay) material deposited in the winter.
In the summer, glacial meltwater has a higher energy and there is more of it so it carries coarser particles (silt and rock flour) into the glacial lakes, depositing paler coarser particles. In the winter, glaciers do not produce meltwater and the lake itself may freeze. The low energy conditions mean that the finer, darker particles of clay sized material can be deposited in the glacial lake. Annually there is a repeated pattern of light and dark banded deposits so each pair represents one year deposition. The pattern of thick and thin bands will be the same for all glacial varves in the same area.

Oxygen isotope ratios can be measured using shells of marine microfossils. The ratios show the ocean water temperature; Pollen grains are preserved in lake sediments too. Some plants like pine could tolerate colder environments more than plants like oak and this affects their abundance in lake sediment samples.