Walther's law of sedimentation – teaching it the Lego™ way

How does a relative rise in sea level affect a vertical sequence of sediments?

Walther's Law explains the relationship between a vertical sequence of sediments and the environments in which they were deposited.
Teaching about Walther's Law often relies on complex diagrams which many people struggle to understand.

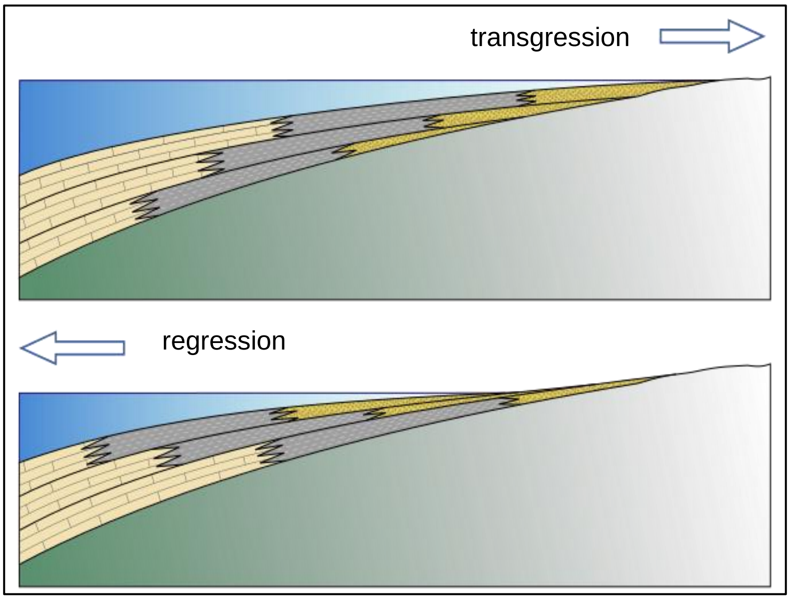

Diagram showing the effects of a relative rise in sea level on the sediments (transgression) and a relative fall (regression) – difficult to understand. (*Woudloper, Rowanwindwhistler, CC-SA 1.0*).

The method below simulates what happens when sea level rises, otherwise called a transgression, whereby the sea floods more and more of a sloping land surface. Relative sea level rise can be caused by land sinking, sea level rising, or a combination of these. This method using Lego™ is a hands-on highly visual approach.

Figure 1 shows a modern beach, where the sediments become gradually finer in grain size as you move outwards from the shoreline. If you have paddled on a beach like this one, you might be familiar with this commonly found sequence, as your feet become progressively muddier as you wade out!

Figure 1. Beach at Stubbington, Hampshire
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Step 1: Start by building a staircase of Lego™ blocks, representing a sloping land surface (Fig. 2). Then place single differently coloured blocks next to the lowest level of the white blocks. These represent adjacent sediments forming in the sea. Each one represents a finer grain size of sediment as distance from the shore increases. So the black block marked "C" stands for coarse material such as gravel or pebbles: the yellow "M" block represents medium-grained sediment such as sand: and the red "F" block shows fine-grained sediment such as silt or mud.

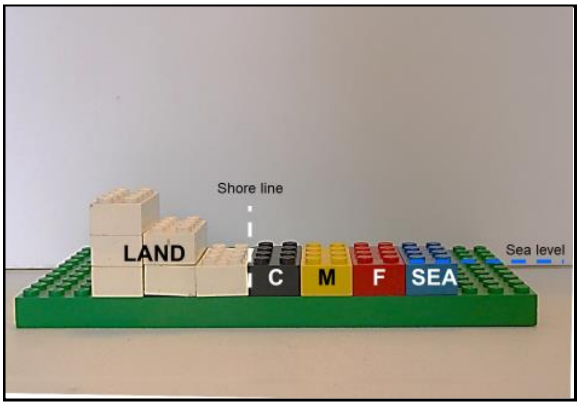

Figure 2. The white wedge represents the sloping land surface. When the sea level is relatively low, as shown, three different types of sediment are being deposited, becoming finer grained as distance from the shoreline increases. These are represented by black (**c**oarse = C), yellow (**m**edium = M) and red (**f**ine = F) blocks laterally adjacent to each other

Step 2: A relative rise in sea level takes place, resulting in the shoreline moving inland. This also results in a landward shift in the depositional environments (Fig 3). The different sediments are now seen to be stacked on top of each other.

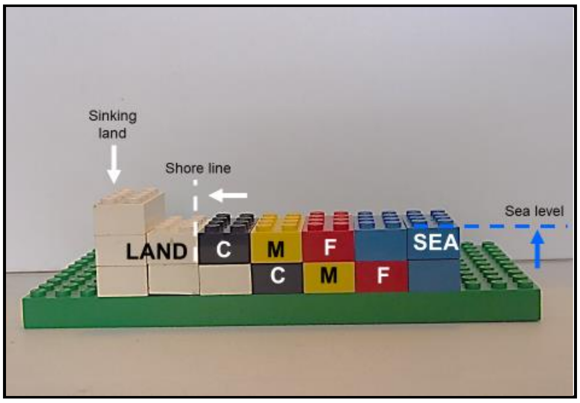

Figure 3. A relative rise in sea level (dashed blue line, blue arrow showing the direction of change) results in a landward shift of the shoreline (dashed white line, white arrow showing the direction of change). As a result there is a lateral movement of the depositional environments so the position of the different sediments has also moved landwards.

Step 3: Another relative rise in sea level with the resulting landward migration of the shoreline results in further vertical stacking of sediments (Fig 4).

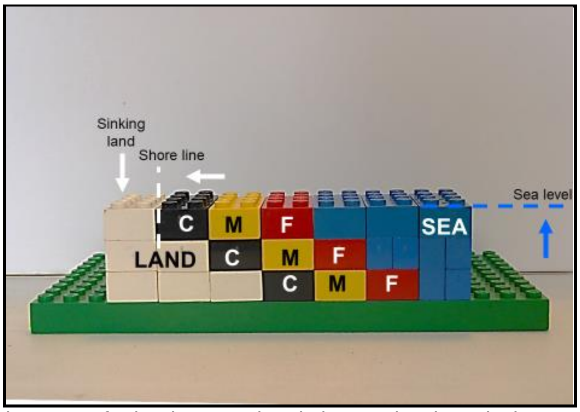

Figure 4. A further increase in relative sea level results in further landward shift of the shoreline and depositional environments.

Step 4: The drilling of a borehole through the sediment pile shows the vertical sequence of sediments that has built up. The grain size becomes finer upwards through the succession and this is the same pattern as seen in the original horizontal pattern of sediments in moving outwards from the coast (Figs 5 and 6).

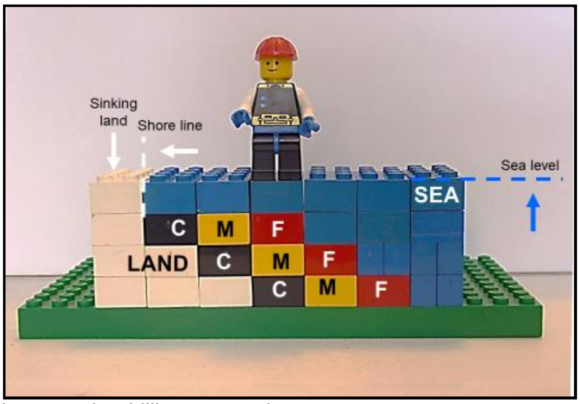

Figure 5. The drilling crew arrive.

Figure 6. The core recovered from the borehole shows a fining-upwards sequence as predicted by Walther's Law.

These patterns were first recognised by J. Walther in 1893 and are now called Walther's Law, which simply stated is: 'When a sedimentary environment moves laterally, the vertical sequence of sediments produced is the same as the original lateral sediment pattern.'

This is called a "fining-upward" sequence (Fig. 7). An understanding of Walther's Law enables us to reconstruct the original sedimentary environments of the depositional area.

Figure 7**.** The cliff section near Corton, Suffolk, showing a fining-upward sequence of sands, silts and clays in Corton Sands. *GeoScenic | Image Details - P007900 (bgs.ac.uk)*

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The back up

Title: Walther's law of sedimentation – teaching it the Lego^{TM} way

Subtitle: How does a relative rise in sea level affect a vertical sequence of sediments?

Topic: A demonstration of a key principle in sedimentology and stratigraphy

Age range of pupils: 16 years upwards

Time needed to complete activity: 15 minutes

Pupil learning outcomes: Pupils can:
- show how a relative rise in sea level can result in a lateral sediment pattern being reflected in the vertical sequence deposited;

- explain an example of how a fining-outward pattern can become a fining-upward sequence due to the lateral migration of sedimentary environments on a sloping coastline.

Context: An understanding of the effects of relative sea level change on stratigraphy is an important aspect of sedimentology and stratigraphy**.** Walther's Law underpins the field of sequence stratigraphy, the development of which has been a major factor in successful hydrocarbon exploration for the last forty years.

The term 'transgression', as used in geology to describe the effects of the sea progressively flooding a land surface, should not be confused with the term 'transgression' meaning an offence against a law or rule.

Following up the activity: Use photographs from the internet or investigate the rocks in a local quarry to look for grain size changes in the rocks upwards from the base of the section.

Underlying principles:
- Sedimentary environments can shift laterally as a result of sea level change, causing the sediments in any location to change: hence the laterally related environments become superimposed, forming vertical successions.
- The term **facies** is assigned to a sequence of sediments or sedimentary rocks referring to its distinct characteristics, produced by physical, biological and or chemical processes during formation. Here a coarse-grained facies is overlain by a medium facies and then, in turn by a fine-grained facies.
- An understanding of the facies principle leads to an interpretation of the origin of a sedimentary sequence.
- Walther's Law (1894), summarised simply above, may be described as "A conformable vertical sequence of facies was generated by a lateral sequence of environments" (*Selley, An Introduction to Sedimentology, 1976, p 309).*

Thinking skill development:
A pattern is established that each increase in relative sea level results in a landward migration of the shoreline accompanied by a landward migration of facies. This lateral shift results in a vertical juxtaposition of the facies. Bridging is involved when the principle is applied to sequences of sedimentary rocks in the field.

Resource list:
- Lego™, Duplo™ or equivalent building block resources

Useful links:
https://www.earthlearningidea.com/PDF/327_What_layers_are_preserved.pdf

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