Walther's law of sedimentation – teaching it the Lego™ way Part 2: How does a relative fall 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. The method below simulates what happens when sea level falls, otherwise called a regression. Relative sea level fall can be caused by land rising, sea level fall, or a combination of these. This method using Lego™ style building blocks is a hands-on and highly visual approach.

To begin, place a green block, representing the land surface, next to a series of single differently coloured blocks representing adjacent sediments in the marine environment.
Each block represents a finer grain size of sediment as distance from the shore increases (Fig.1).

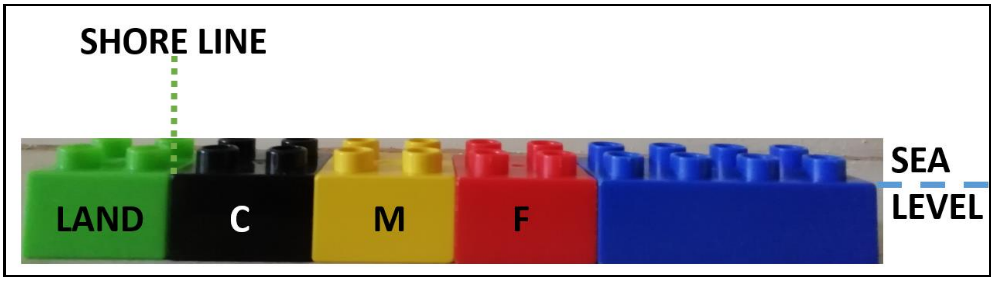

Figure 1. The green block represents the land and the green dotted line shows the shoreline. Three different types of sediment are being deposited, becoming finer grained as distance from the shoreline increases. They are represented by black (**C**oarse), yellow (**M**edium) and red (**F**ine) blocks laterally adjacent to each other. The blue blocks represent the sea water.

A relative fall in sea level will result in a seaward shift in the shore line (orange arrows illustrate the direction and magnitude of crustal subsidence, (Fig 2). This also results in a seaward shift in the depositional environment .The sediments can now be seen to be stacked on top of each other.

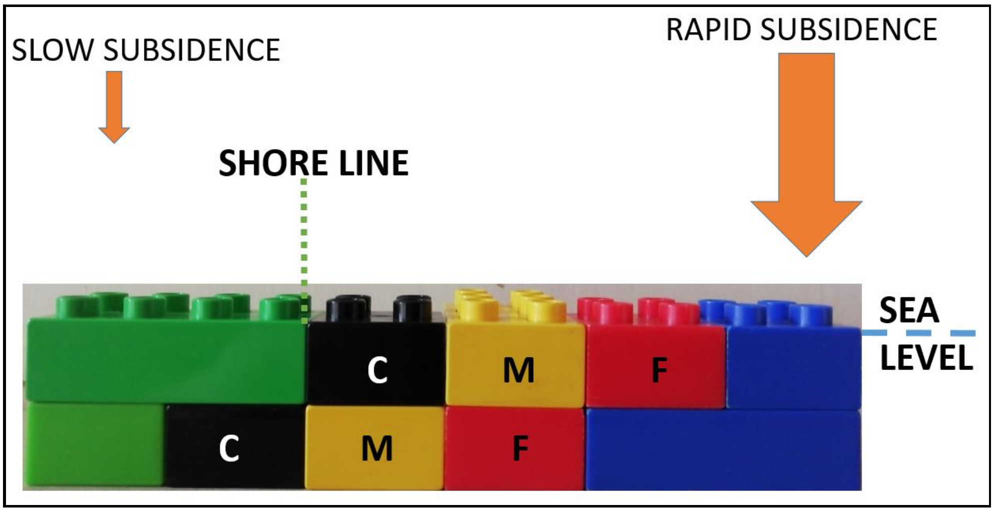

Figure 2. A relative fall in sea level causes a seaward shift of the shoreline. As a result there is a lateral movement of the depositional environments, so the position of the different sediments has also moved seawards.

Another relative sea level fall with the resulting seaward migration of the shoreline results in further vertical stacking of different sediments (Fig 3)
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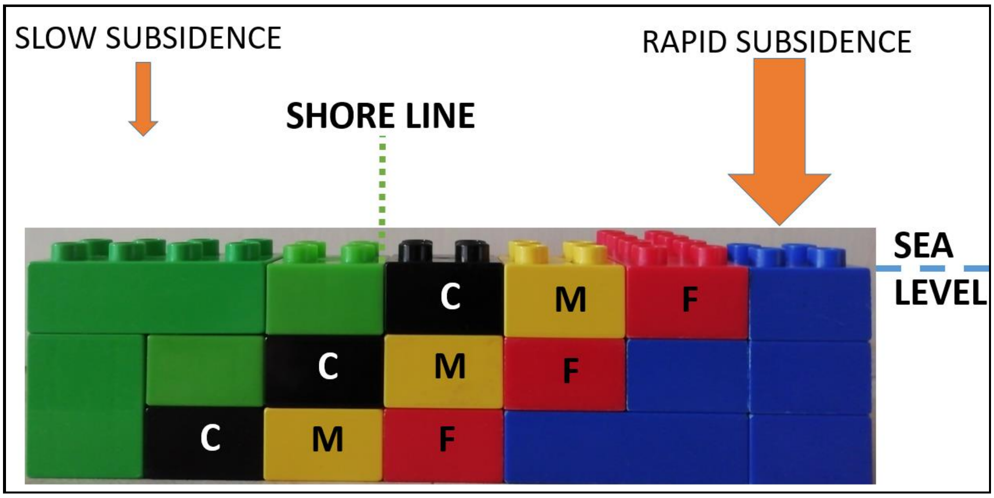

Figure 3. A further decrease in relative sea level results in further seaward shift of the shoreline and also of the depositional environments.

The drilling of a borehole through the sediment pile will now reveal a coarsening-upward sequence as described by Walther's law (fig 4). The combination of the transgression model (Murphy 2021 https://www.earthlearningidea.com/PDF/389_Walthers_law.pdf) and regression model illustrates the idealised sedimentary sequence produced by a transgression/regression cycle (Fig 5).

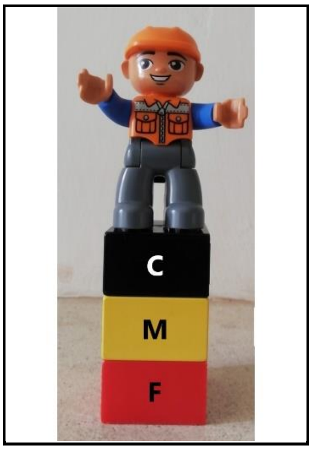

Figure 4. The core recovered from the borehole shows a coarsening-upwards sequence.

Figure 5. A combined transgression – regression sequence. (black – coarse; yellow – medium; red - fine)

The back up

Title: Walther's law of sedimentation – teaching it the Lego^{TM} way Part 2

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

Topic: A hands-on demonstration of a key principle in sedimentology and stratigraphy, to show how a relative fall in sea level can result in the development of a 'coarsening-upwards' sequence.

Age range of pupils: 16 upwards

Time needed to complete activity: 15 minutes

Pupil learning outcomes: Pupils can:
- show how a relative fall in sea level can result in a lateral sediment pattern being reflected in the vertical sequence deposited;
- explain an example of how a coarsening-outward pattern can become a coarsening-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 in post-16 geoscience teaching**.** 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.

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 relative 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 fine-grained facies is overlain by a medium-grained facies and then, in turn by a coarse-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 follows: "A conformable vertical sequence of facies was generated by a lateral sequence of environments" (*Selley, R. An Introduction to Sedimentology, 1976, p 309*)

Thinking skill development: A pattern is established that each fall in relative sea level results in a seaward migration of the shoreline and a seaward 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^{TM}, Duplo^{TM} or equivalent building block resources

Useful links:
https://www.earthlearningidea.com/PDF/327_What_layers_are_preserved.pdf
https://www.earthlearningidea.com/PDF/389_Walthers_law.pdf

Source:
Written by Dr. Phil Murphy, University of Leeds and Professor Chris King, Keele University.

Murphy P and King C 2022. Using Lego^{TM}, Duplo^{TM} and other building block toys to teach Walther's Law. Part 2 – a Regression. *Teaching Earth Sciences* **47**(1&2) pp 28-29.

Murphy P 2021. Using Lego ^{TM}, Duplo^{TM} and other building block toys to teach Walther's Law. *Teaching Earth Sciences* **46**(1) pp51-52.

Photograph, Figure 6 on page 4 by Peter Kennett

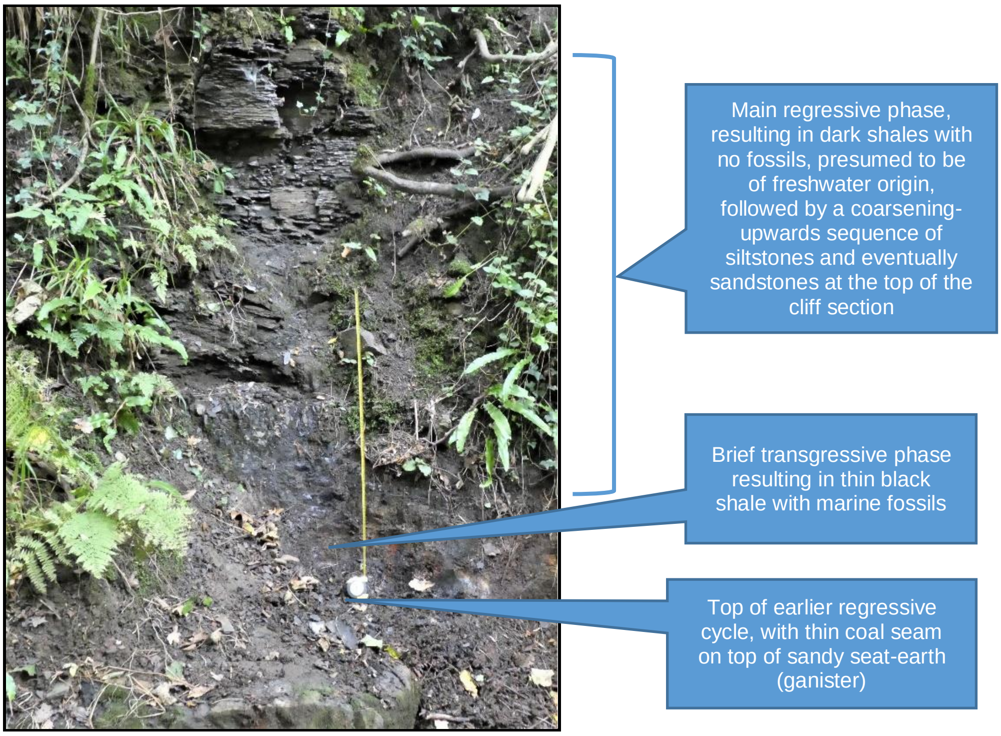

Figure 6. An example of a transgressive/regressive sequence from the Carboniferous Coal Measures, Sheffield, England (tape shows 1m)