REPORT

Sedimentology of the Culm Basin: the Bude Formation of North Cornwall

Ellis Elliott was awarded the Society's Beryl Whittaker Bursary in 2013 for her undergraduate project studying Carboniferous sedimentology in Cornwall.

For many years there has been speculation as to how the sediments of the Bude Formation in Southwest England were deposited. The impressive exposures of these rocks along the coastal sections around Bude reveal a series of intensely folded sequences of interbedded, clastic, sedimentary rocks. Fossils are very sparse, but sedimentary structures occur in abundance, and reflect a unique set of processes that led to their deposition. The study area extended for about 3.5 km, containing a number of bay and beaches where marine erosion has exposed these sequences in well-polished sections through the Culm Measures.

The Bude Formation appears to represent a monotonous, interbedded sequence of sandstone, mudstone and shale. However, detailed logging of these coastal sections reveals subtle changes in both lithology and bed thickness along the coastline. Changes in bed thickness appear to represent fine-grained turbidite systems, or more specifically Bouma sequences, that form by deposition of sediment in low-density currents (Shanmugam, 2012). These sequences commonly have beds that are thicker and more massive low down, with beds that decrease in thickness and show thin laminations towards the tops of the units. However, the Bude Formation is unusual, as its sediments at the bases of the Bouma sequences are formed of medium-sized sand grains (around 0.5 mm in diameter), as opposed to typically coarser sand grains (1-2 mm). It is also notable that the northern exposures of the Bude Formation consist of a shale-rich, interbedded sequence, whereas the southern exposures are dominated by interbedded sandstone-shale units (Guy, 1995).

Culm sequences exposed at Wrangle Point on the north side of Crooklets Beach, Bude, are distinctive because they show a progressive upwards facies change with shale beds becoming thicker while the interbedded sandstones become thinner. The angular anticline was subjected to later fault movement during extension that followed the main phase of compression in the Variscan orogeny.

It appears that the sediment lithologies within the Bude Formation were influenced by transportation and external factors before reaching their destination in the Culm Basin. Facies changes along the coastline are a reflection of the sedimentary environments that surrounded the Culm Basin in the Westphalian stage of the late Carboniferous (Reading, 1966). More specifically the transition from sandstone-rich facies in the south to mudstone-rich facies in the north indicates a depositional change from wide, active river channels in the north to low-energy floodplains further south. This also accounts for the changes in bed thickness, as some sandstone beds that make up individual Bouma sequences are comparatively thicker in the north, due to high sediment input from these active channels.

There has been some controversy over the sediment source of these Culm deposits, and it has been suggested that the Pennine Basin may have contributed sediment to the Culm Basin (Hallsworth & Chisholm, 2008). Sediments in the Pennine Basin were transported from south-eastern, eastern and western sources. It is likely that these distant sedimentary sources led to prolonged transportation, and subsequently formed the mature, fine-grained interbedded sequences in the Culm Basin.

The sedimentary sequences in Cornwall were intensely deformed during the Variscan orogeny, in the late Carboniferous, when compressive stress originated from south of the Culm Basin and migrated north to produce thrust faults and strike-slip movement within the Bude Formation.

Besides being an attractive tourist location, the coastline that exposes the Bude Formation is a rewarding venue for the geologist, as it reveals a wealth of sedimentary features and structural elements that challenges geological debate at all levels.

References

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