Primary Sedimentary Structures- ErosionalS-1: Introduction

Sedimentary structures are the larger-scale features of sedimentary rocks; they are best seen in outcrop or in large hand specimens rather than through a microscope.

Sedimentary structures include features like bedding, ripple marks, fossil tracks and trails, mud cracks etc.

Geologists use these structures to interpret the processes that made the rock and the environment in which it formed. They use uniformitarianism to usually compare sedimentary structures formed in modern environments to lithified counterparts in ancient rocks.

Sedimentary structures, particularly those formed during sedimentation, have a variety of uses:

1. For interpreting the depositional environment in terms of processes, water depth, wind strength, etc.
2. For determining the way-up of a rock succession in an area of complex folding
3. For deducing the palaeocurrent pattern and palaeogeography.

S-2: Introduction

Many sedimentary structures originate by physical processes involving moving water or wind that operate at the time of deposition. Others are formed by physical processes such as gravity slumping or sediment loading that deform unconsolidated sediment after initial deposition (soft-sediment deformation). Still other structures are of biogenic origin, formed by the burrowing, boring, browsing, or sediment-binding activities of organisms. Some types of bedding, the laminated bedding of evaporites for example, are generated by primary chemical precipitation processes. A few other structures, such as concretions, form by chemical processes operating within sediment during burial and diagenesis; thus, they are regarded to be secondary in origin.

Sedimentary structures may be classified purely on the basis of their morphological or descriptive characteristics or on the basis of presumed mode of origin. None of the current methods are entirely satisfactory.

Descriptive classification provides very little or no information on the genesis of the structures; also, all the structures may not fit into a few descriptive categories. On the other hand, genetic classifications are subjective and can be misleading. Some structures can form by more than one process or by a mixture of processes and hence the same structures can be classified under different genetic categories.

S-3: Types of Sedimentary Structures

We recognize two principle types of sedimentary structures

- Primary sedimentary structures: occur in clastic sediments and produced by the same processes (currents, etc.) that caused deposition. Includes plane bedding and cross-bedding.
- Secondary sedimentary structures: are caused by post-depositional processes, including biogenic, chemical, and mechanical disruption of sediment.

We will focus on some of the primary sedimentary structures in this lecture

S-4: **Erosional sedimentary structures**

Most of the structures in this category have formed through erosion by aqueous and sediment-laden flows before deposition of the overlying bed, and by objects in transport striking the sediment surface.

Sole mark is a broad term that describes several different sedimentary structures that appear as impressions or grooves in sediment, including flute casts, tool marks, groove casts, and load casts. Typically, the cast of the marking (the raised bump) is preserved at the bottom of a sedimentary bed, hence the term “sole” mark, and the mold side (the impression) is filled with sediment. This makes sole marks good way-up indicators since the cast side is facing down.

S-5: Flute marks

Flute casts are common structures created by turbidity currents. The movement of these sediment avalanches underwater can scour the ocean floor, creating an elongated impression.

Flute marks can be described as spatulate or heel-shaped, consisting of a rounded or bulbous upstream end, which flares downstream and merges into the bedding plane. Flute casts are usually closely spaced and can be stacked on top of one another. They average 5–10cm across and 10–20cm in length, and occur in groups, all with a similar orientation and size.

Not only can they tell you which way is up, but they can also tell you which way the current was flowing. The tapered end of the flute cast points in the direction of flow.

S-6:

In this image we can see flute casts from the central Alps, Switzerland. The view is from the underside of the rock.

S-7: Groove marks

Groove marks are linear ridges on the undersides of sandstone beds that formed by the filling of a groove cut into the underlying mud. As we can see in the given illustration, initially a groove in formed in the underlying sediment, later deposited sediment fill into the groove giving rise to a grove cast on the underside or sole of the bed. Groove marks may occur singly or many may be present on one under surface, all parallel or deviating somewhat in orientation.

It is generally held that grooves are formed through a tool, a fossil, pebble or mud clast for example, which was carried along by the current, gouging the groove into the mud. In rare cases the tool has been found at the end of a groove.

Groove marks are common on the soles of turbidite beds but they can form elsewhere, on floodplains when a river breaks its banks for example, and on shallow-marine clastic shelves and carbonate ramps when there are storm currents.

Interpreting the paleocurrent from groove casts can be difficult because the marking is often symmetrical. Without the addition of other paleocurrent evidence, you may only be able to narrow down the paleocurrent to two directions that are 180° apart.

S-8: In this image the yellow arrow indicates the direction of transport. This arrow is double-ended as there is no indication if the water was flowing up or down the river before it was tilted and exposed. The view is from the underside of the rock.

S-9: Tool marks

Tool marks are produced when objects, such as a stick, sand grains, shells, mud chips etc., are dragged across the underlying mud surface by a current, rolling or intermittently impinging on that surface and leaving behind what looks like scratches in the soft sediment which become preserved as weak positive features on the base of overlying sandstone.

Various types have been distinguished, including prod, bounce, brush, skip and roll marks, depending on how the impact is thought to have taken place.

The elongated scratches can be used as an indicator of the paleocurrent.

S-10: Gutter casts

Gutter casts look similar to groove marks, being elongate ridges on the base of a sandstone or coarse limestone. They are U- or V-shaped in cross-section, 10–20cm across and nearly as deep. They are straight to sinuous and may persist for many meters.

These structures are common in shallow-marine sediments, where they are attributed to fluid scour, in many cases by storm currents. The sediments that fill the gutters are often sufficiently different from those in which the gutter is incised. After lithification and weathering, the sediment fills erode out as casts.

S-8: In this image we can see Gutter cast in fossiliferous limestone. View of underside of bed.

S-9: Channels

Channels are sediment-filled troughs that show a U- or V-shape in cross-section and that cut across previously formed beds or laminations.

Channels are generally filled with sediment that is texturally different, commonly coarser, than that of the beds they truncate. Channels are probably eroded principally by currents, but some may be the result of erosion by sediment gravity flows. Channel structures are generally on the scale of meters, in some cases kilometres, whereas scours are smaller-scale erosional features, occurring within or on the bases of beds.

The larger channels can sometimes be mapped out on a regional scale, giving useful palaeogeographical information.

Thank You.