c9 Bedding-plane features

< surface of the solid Earth, horizontality, sedimentary structures >

It has often happened to geologists, as to other explorers of new regions, that footprints in the sand have guided them to the inhabitants of unknown lands.
—J. William Dawson, 1863.[1]

A stratum can be built of one bed or it can be built of a succession of beds separated by bedding planes that are parallel to the horizontality of the stratum or are crossbeds inclined at the angle of repose for their materials with respect to the horizontality of the stratum. The top of each bed was once the emergent or (water) submergent ground surface that, irrespective of base level,[2] was for a while neither being eroded nor aggraded. Each bed records a geologically brief depositional event.

Bedding-surfaces can be flat or rippled and be with post-depositional features such mud cracks, erosion striations, lag gravels, tracks and trails of animals, evident bioturbation, paleosoils, and other evidences of the passage of time.

Bedding features that allow a bed's top, or bottom, to be determined have "way-up" value when folded strata are studied.

Ripple marks

Ripple marks (bedforms) are of two types: current and oscillation.[3]

Current ripple marks (cannot be used for way-up determinations) form where wind or water currents (in any depth of water), saltate loose clasts at the surface of sediments. In cross section, current ripples are noticeably asymmetrical with a steep leeward (down current) facing slopes. Their long axis trends at right angles to the current direction that they record.

Oscillation ripple marks (less common than current ripple marks but are useful for way-up determinations and are indicative of shallow water) form in water where waves of oscillation "touch base," which is when the water depth is less than half the wavelength of the waves. Oscillation ripples have cusp shaped crests with slopes that flatten symmetrically either side into relatively wide troughs. Their long axis trends parallel to the wave front of the overhead waves that generated them.

Cross-bedding

Clastic sediment can be transported by wind or water currents by traction as a bed load that slides, rolls, and hops. Cross-bedding is an internal feature of gravels, sands, and silts, that were transported as a bed load that rolled, hopped (saltated), and slid (lee avalanched) into the place of their deposition. Large-scale cross-bedding (measured in meters) is characteristic of dune sands. By comparison, measuring usually less than a meter in height is the cross-bedding of water deposited gravels and sands, in built bars and channel fills, and in stratified drift (glacial outwash plain sand and gravel). Smaller again, measuring at most a few centimeters in height, is the internal cross-bedding of current rippled sand or silt.[4] Large-scale foreset beds of marine deltas are of silt to clay sized clastic sediments that settled out of river water which spilled out across the top of the ocean water (which, because of its salinity is typically 2.5 percent denser than freshwater).

Graded bedding

Clastic sediment can be transported by turbulence in wind or water as a suspended load; or by buoyancy (in water) as a floating load. Graded bedding is an internal feature of turbidites—water laid clastic sediments in a submarine or sub-lacustrine environment deposited from bottom-hugging sediment loaded *density currents* (also called *hyperpycnal* or *turbidity currents*).[5] The sediment arrives in the place of deposition in suspension. Out of the "cloud" of muddy water left behind after the passage, or the arrest, of a turbidity current, the larger particles settle first and are followed by the smaller (in accordance to Stoke's Law). Each graded bed is built of clasts that can range in size from gravel at the bottom to clay size at the top [6] or, in more detail, as a sequence described by Arnold H. Bouma in 1962,[7] that (from the bottom up) is: *a.* massive to graded sandstone, *b.* sandy parallel laminations, *c.* rippled or convoluted bed, *d.* laminations of silt and mud, and *e*. mudstone. However, complete and partial Bouma sequences often can be reinterpreted as bottom-current reworked sediments,[8] as *contourites* (isolated fine-grained laminated bottom-current deposits)[9] and as *debrites* (sandy debris flows).[10]

Fill that comes to rest in scour depressions (see below) that a current of water has eroded into the upper part of an underlying bed, preserves those features on the bottom of its bed as *sole casts*.

Modified bedding-plane surfaces

Each bedding plane that is the top of a bed is also the surface of the solid Earth until it is buried. As such, it can be postdepositionally eroded or disturbed.

Trace fossils Tracks, trails, and scooped-out feeding depressions that record the activity of epifauna are called *trace fossils*. Some have value for way-up determinations.

Scour marks Erosion by water currents or of land by wind can scooped out depressions called *flute*, *sole*, and *scour marks* (have value for way-up determinations).

Lag residues Selective erosion of lighter components leaves a residue of heavies called confusingly a *lag deposit* (some have value for way-up determinations).

Load casts Post-deposition buoyancy adjustment in water saturated sediments can result in intrusion and differential evident settlings called *load casts* (have value for way-up determinations).

Impact and spatter marks Preserved rain and hail-formed depressions (have value for way-up determinations).

Mud cracks Polygonal desiccation cracks preserved in mudstones indicate shallow water deposition if they occur at many levels in a single stratum (as the water in which the mud accumulated must completely evaporate for them to form). Tidal mud flats, playas, and floodplains are environments that accumulate muds with mudcracks. Those preserved by infill have value for way-up determinations. ❑

Footnote c10.1 Ants, of which there are more than 12,000 species, inhabit cold and warm places and range wider than do earthworms. Presently, as a result of the Ice Age, northern prairies are without native earthworms and the main movers and aerators of soil there are ants that migrated in.

Ants are beneficial as their nest burrows allow air to get into the soil. Also, some ants eat harmful insects, some help in the spreading of seeds, and the discarded remains of their dead, and inedible parts of their food, enrich the soil in and around ant mounds. In forested areas, leaf-cutting ants, carry pieces of leaves and flowers into to their nest on which to grow a fungus on which they feed.

Earthworms (where they exist) consume plant litter and leave enriching excreta (castings). By their burrowing, worms turn and help make good top soil.[1]

Footnote c10.2 The excreta of infaunal annelids, gastropods, and crustaceans make up much of the pellet-lime mud facies of lagoons and tidal flats. The fecal pellets (100-500 mm diameter) are undigested skeletal components of ingested detritus full of the tiny aragonite needles that are secreted within the filaments of calcareous green alga such as big-coin green seaweed *Halimeda* and the shaving-brush seweed *Penicillus* that inhabit substrates as reef and the sand of lagoonal flats and after several months of growth die and break into many smaller pieces that drift and settle.[2]