The origin of laminae in shales

Michael J. Oard

Fine-grained sedimentary rocks, generally called mudrocks or mudstones, make up about 50% of all sedimentary rocks,[1] although estimates vary. These represent various proportions of silt- and clay-sized particles, and are mostly composed of silicate minerals. Mudstones come in great variety, but generally can be broken down into massive mudstone, siltstone, and claystone with a variety of textures. Siltstone is defined as a rock with greater than about ⅔ silt-sized particles.[2] A claystone is a mudrock that contains over ⅔ clay-sized particles.[2] When the mudstone is laminated it is called shale. Shale is ubiquitous in the rock record (figure 1). There are a variety of shale laminations which are thought to reflect a range of depositional settings. Shales can be quite thick, sometimes up to hundreds of metres, and are usually widespread.[3] Shales are commonly believed to have been deposited in distal locations from their source in quiescent, often anoxic conditions.[4] Of course, under uniformitarian assumptions, any significant mudstone deposit would have taken a long period of time.

The production of the laminae

Uniformitarian scientists have struggled to explain laminations in shale and have suggested multiple mechanisms for their formation.[5] A new mechanism for forming the shale laminae has recently been proposed, one that is based on flume experiments.[6] From mixtures of clay and silt of various sizes, the flume experiments were able to reproduce the laminae in currents of 25 cm/sec. Higher currents produced silt layers only. Slower currents allowed the clay to flocculate up to a few hundred microns in diameter, the size of sand, and remain intact even within the current. The layers then segregated out simultaneously into coarse silt and floccule lags in moving waves or ripples. Fine silt was observed to be incorporated within the clay floccules. The flume produced multiple styles of laminae identical to those observed in natural shales.

In order to explain the origin of laminae, the researchers suggested that the clay floccules at first absorbed all the silt, and as the floccules moved and encountered obstacles, such as smaller floccules, they abruptly slowed down. The inertial forces due to the denser, larger silt grains caused the coarse silt to be dislodged from the floccules. The floccules continued moving in the current while the coarse silt was deposited. The coarse silt built up and started to move as a silt ripple and migrated over the bed. Simultaneously, clay floccules with fine silt inclusions grew to equilibrium size and then formed migrating floccule ripples. Thus, moving ripples leave behind a thin lag of alternating coarse silt and clay deposited simultaneously. Whether this complicated mechanism is the real reason for the formation of laminae remains to be seen. Upon compaction, most of the evidence of the ripples becomes destroyed.[5] The experiment demonstrated shales can form in water that moves fast enough to transport sand. The experiment proved that laminations were not necessarily deposited in calm water.

Implications

The flume experiments cannot of course reproduce the exact natural deposition of all shale rocks which would be of much larger scale both horizontally and vertically. But, the experiments do demonstrate that coarse silt and clay separate out simultaneously in a current fast enough to transport sand. Calm conditions and slow deposition are unnecessary. The separating layers in a current are similar to what creation scientist Guy Berthault discovered in his flume experiments. He observed that a moving current laid down repeated fine layers when the sediment contained particles of different shape, size, and mass.[7]

Creation scientists still need to account for thick, widespread layers

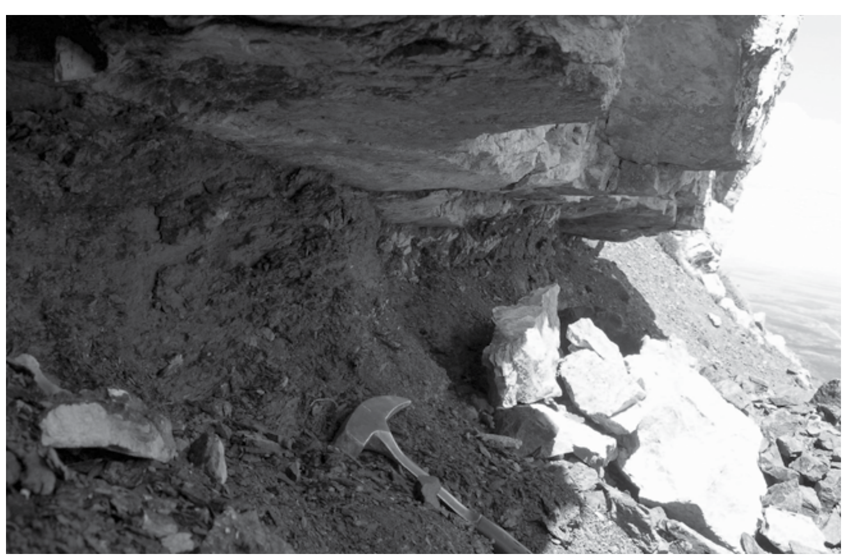

Figure 1. Thin-bedded black shale just below the contact with the Lewis Overthrust, north of Marias Pass, Montana

of shale in the rock record, but secular researchers have come *part way* in showing laminae can form rapidly in a moving current. It is possible that moving water loaded with silt and clay can deposit multiple laminae quickly.

Numerous surface and internal waves in currents during the Flood may help.[8–10] Internal waves are gravity waves below the surface that propagate on a boundary between two density-stratified layers or propagate when a water current flows over an underwater barrier. These internal waves are common in the oceans today[9] and cause erosion, transport, and redeposition of sediment. With the catastrophism of the Flood, one would expect innumerable internal waves. These discoveries bring us one step closer to explaining how fine-grained sedimentary rocks were deposited during the year-long global Flood.

References

1. Boggs, Jr., S., *Principles of Sedimentology and Stratigraphy*, 5th edn, Prentice Hall, New York, p. 118, 2012.
2. Pettijohn, F.J., *Sedimentary Rocks*, 3rd edn, Harper and Row, New York, p. 290, 1975. Clay is less than 1/256 mm and silt is between 1/16 mm and 1/256 mm.
3. Boggs, ref. 1, p. 122.
4. Potter, P.E., Maynard, J.B., and Depetris, P.J., *Mud and Mudstones: Introduction and overview*, Springer-Verlag, New York, 2005.
5. Yawar, Z. and Schieber, J., On the origin of silt laminae in laminated shales, *Sedimentary Geology* **360**:30, 2017.
6. Yawar and Schieber, ref. 5, pp. 22–34.
7. Berthault, G., Analysis of main principles of stratigraphy on the basis of experimental data, *Lithology and Mineral Resources* **37**(5):509–515, 2002.
8. Macquaker, J.H.S., Bentley, S.J., and Bohacs, K.M., Wave-enhanced sediment-gravity flows and mud dispersal across the continental shelves: reappraising sediment transport processes operating in ancient mudstone succession, *Geology* **38**:947–950, 2010.
9. Pomar, L., Morsilli, M., Hallock, P., and Bádenas, B., Internal waves, an under-explored source of turbulence events in the sedimentary record, *Earth-Science Reviews* **111**:56–81, 2012.
10. Oard, M.J., Internal oceanic waves and sedimentation, *J. Creation* **27**(1):16–18, 2013.