Geology 435 - Laboratory #4. Due Tues Sept 30

Sedimentary Structures and Preliminary to the Interpretation of Sedimentary Environments

Please read the section from your lab text *Preliminary to Depositional Environments and the Evolution of Sedimentary Rocks* starting on p.69. Pay particular attention to Flow Regime, Sedimentary Structures, Structural Sequences, and Depositional Environments, p.73-77. Also note the catalogue of sedimentary structures in Appendix C&D. You need to finish this week's lab by 10/1 prior to the field trip. Observations of sedimentary structures "in the wild" is a critical objective of our field work!

Interpreting depositional environments in the rock record is largely dependant on the recognition of evidence for PROCESSES; physical, biological, and chemical, during deposition. This lab attempts to introduce various sedimentary structures and their origins and relate these to process (process-response models). We will continue to talk about physical processes of sedimentation in the lecture to help with a theoretical basis for the Sedimentology of sedimentary structures.

Complete the lab-type exercises in the Lab Text, ***Part Three: Interpreting Sedimentary Structures and Sequences*** on p. 86-88 in addition to the lab activities below. You may want to work on the samples in the section below FIRST (since the lab book activities can be completed outside the lab)

Use the instructions on this sheet (below) as a tour guide through the collection of sedimentary structures in the department collection. Answer the questions as best you can for those samples that are available (most ARE). Us your text as reference for the structures as indicated by the page numbers referred to in the lab.

BE NEAT!

PART I

I. Primary Structures (mostly, but not all, current induced)

A. Stratification and Cross Stratification

1. Examine the slab (specimen #1) showing internal stratification and cross stratification (arrow indicates younger beds). Note the cross-stratification at the base of the slab overlain by an interval of horizontal stratification, which is, in turn, overlain by an interval of cross-stratification.

a. What is the thickness of the cross-stratification in metric units___________? Are you looking at the cross-lamina or cross beds?

In which direction (A or B) was the current flowing?

Examine the horizontal stratification. What is the thickness of the strata in metric units ______? Are you looking at lamina or beds?

If we split the horizontally-stratified interval so that we could see a bedding plane we would probably observe parting lineation as shown in sample #35. [*Haven't found this one yet]* Parting lineation is a structure commonly found on bedding planes of horizontally-laminated sandstones; and can be divided into (1) parting-plane lineation where subparallel linear grooves and ridges of low relief (less that 1 mm) occur on lamination surfaces and (2) parting step lineation where subparallel step-like ridges where the parting surface cuts across several adjacent lamination. Current flow is parallel to the lineation. Note planar laminations in x-section and parting lineations in plan view. Under what flow regime was the cross-stratification generated?

Under what flow regime was the horizontal stratification generated?

Considering the flow regimes involved, how do you explain the interbedded horizontal lamination and cross-lamination?

2. Examine the cross-stratified slab (specimen #2).

3. Examine the specimen #3 with ripple-marks and internal cross-stratification.

4. Sample #14

-What is the cross-sectional geometry of the sample?

-What is the plan view geometry and bedforms that are preserved?
Describe the angle of inclination of the bedforms. Which direction was current flowing?

Which direction (A or B) is up?

In which direction (C or D) was the current flowing?

What was the progressive change in flow regime during deposition?

-Which direction (A or B) is up?

-In which direction (C or D) was the current flowing?

-Are the ripples symmetrical or asymmetrical?

-Is the current direction indicated by the symmetry of the ripple crests the same as the current direction suggested by the internal cross-stratification?

-What was the relative importance of traction (bed load) versus suspension deposition during formation of the cross-stratified units? (Contrasts with specimens #1 and #2).

5. Sample #19.
Which side up (numbered or not)?

What are the bedforms on the top of the sample?

What the devil are the things on the base of the sample??

6. Wave formed structures.
Have a look at samples #13. Describe the cross-sectional symmetry.

Describe the plan view geometry.

Are there other geometric features of this sample that help determine it's hydrodynamic origin?

Notice the faint surface markings on this slab. Describe or draw their geometry. What is the origin of these structures? What does the combination of these structures say about water depth during formation?

7. Have a look at the ripple bedforms on sample #16. Describe the geometry as above. What are the cracks on the upper surface?? Describe what you see. Ever see similar things on a dried-up muddy surface?

What do these structures in combination say about water depth?

8. More of the same?
Describe the cross-sectional geometry of sample #100.

Describe the plan view geometry and the variation on the slab. What do you think happened to create the features you see?

9. Check out sample #200. What do you think these things are? Include the term "mold" or "cast" in your answer!

B. Erosional Structures

1. Sole Markings (excluding load structures which ar also sole markings) Sole Mark refers to various protrusions or marks found on the underside or soles of sandstone (and in some cases limestone) beds. These protrusions are largely sandstone fillings (or casts) or scours, grooves, or other depressions formed on the surface of the underlying mud by currents, organisms, or other agents. After consolidation and exposure, the underlying shale weathers away leaving the sandstone protrusions (or casts) as a raised positive feature on the sole of the overlying sandstone. Common sole markings include flute casts, groove casts, bounce casts, etc.

2. Flute Casts Flute casts result from bottom current vortices which scoop out the substrate. The scooped-out void spaces are later filled with sediment to form flute casts. Flute casts are elongated parallel to current and the steep end is up current.
3. Groove Cast (sample # 10; 3 pieces) Groove casts are rounded or sharp-crested linear ridges produced by filling of grooves previously formed on he substrate. The orientation of flow can be determined but the actual direction (azimuth) of flow cannot. The flow direction is parallel to the ridge.

Which side is up A or B?

Are all the structures on this sample groove casts?

II. Biogenic Structures The degree of bioturbation accomplished by animals is a function of (1) the number of bottom dwelling (crawling and burrowing) individuals around; and (2) the length of time these individuals have available for working a particular volume of sediment. Because the length of time available depends upon the rate of sedimentation, bioturbation actually reflects burrower-crawler density and sedimentation rate. Seilacher (1964) has recognized five main groups of trace fossils: (1) feeding trails, (2) crawling burrows, (3) resting tracks, (4) dwelling burrows, and (5) feeding burrows.

1. Specimen #14 (Antrim Shale, Dev., Michigan)
a. Note the burrows on the split bedding surface. The dark (below) and lighter (above) shale of this sample was clearly deposited in a generally quiet water setting. The organisms were cruising around (Crusiana ichnofacies) the gray layer but don’t penetrate into the dark. Why?

2. Examine the cast (Specimen #8) of the dwelling burrow network produced by the burrowing shrimp Callianassa. This specimen is from the Florida Tertiary and is similar to burrow networks produced by Callianassa today.

3. See specimens #7a & 7c, good examples of Cruziana ichnofacies.

a. Which side (numbered, not numbered) is up?

4. Stromatolites Stromatolites are crenulated laminated structures that occur as bulbous heads, stacks, or mats, and commonly occur in carbonate rocks. These structures

range in range from 2,000 mybp to present. Modern Stromatolites from as a result of deposition of carbonate sediment on a sticky blue-green algal mat that traps and binds the grains. After deposition of a sediment layer, the algal filaments grow up around the sediment grains, and produce a new surface for trapping and binding the next sediment layer. Modern Stromatolites range from sallow subtidal (25 foot depth) to the supratidal zone.

Observe specimens #24 and #22a. Which side is up (arrow point up or down)?

Is there anything unusual (relative to the description of Stromatolites presented here) about samples 22a?

5. Have a look at sample #300. This is an outrageous example of the trace fossil Zoophycus. Look and marvel. We will see a lot of these in Kentucky.

III. DEFORMATIONAL STRUCTURES

1. Load structures are most commonly called "load casts" even though they are downward protrusions of sand that form as the result of uneven loading and down sinking of overlying sand into less dense hydroplastic mud below, and not by the filling of a depression. In many cases, loading modifies structures (such as flutes and grooves) that were present on the mud surface before deposition of the sand. In other cases, the internal structures of the sand indicate that it was originally present as ripples on the mud surface and, because of greater loading under ripple crests, sank into the underlying mud. Load structures ("load pockets", "load-casted flutes", "load-casted ripples") are generally observed in the field on the base of sandstone bed (on the "sole").

An extreme form of load structure is seen in "pseudo-nodules", which consist of distorted fragments of sand or silt with a lower convex surface that have become completely enclosed in mud. Kuenen (1958, Trans. Geol. Soc. Glasgow) produced a locally thickened layer of sand over a clay layer and subjecting the deposits to shock. The shock liquified the clay and caused the sand layer to founder into the clay. "Ball and pillow" is a similar structure which differs by involving less mud.

a. See specimens #20a, b, & c. Note irregular shape and distribution of load structures. Which side (numbered, not numbered) is up?

IV. Chemical structures

1. Samples #400 and 450 both have lots of visible features. Describe the primary structures and the secondary structures. The colored banding in both samples is called Liesegang banding and results from oxidizing fluid circulation altering ferroan components in the rock. These are common and not particularly useful structures (in terms of interpretive value). They are kind'a pretty and I have seen them sold as art.

2. Sample #600a and 600b are concretions. They form by secondary (usually in the subsurface) mineralization. Pretty, huh?