Where is the sand? Using multibeam sonar to map sediment type in Marble Canyon.

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We're mapping Colorado riverbed sediments using multibeam sonar.

- Multibeam echosounder systems have been used to map riverbed bathymetry with large coverage (10s of miles per trip) & high (centimetric) resolution.
- It is also possible to infer sediment type based on the strength & statistical properties of the echoes.
- We are developing methods to classify sediments using multibeam data, so we have a more complete understanding of the distributions of sediments, & how that varies in time.
- This poster presents preliminary sediment classification results & details our research directions.

The statistics of the echoes can be used to infer sediment type.

- Bed sediments sampled using video has revealed an enormous heterogeneity, from fine sand to boulders with abrupt transitions.
- It is hard to predict the extent of sand coverage based on shoreline geomorphology & channel geometry.
- Video measurements are limited in space & hard to locate exactly. We're utilizing the high resolution & large coverage of the multibeam system to map sediments as well as bathymetry.
- This is challenging because the strength of the echo depends only in part on the sediment size.

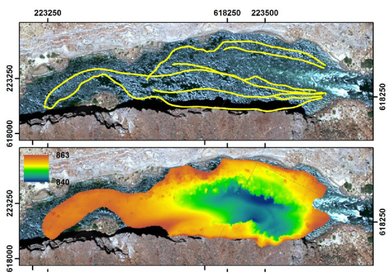
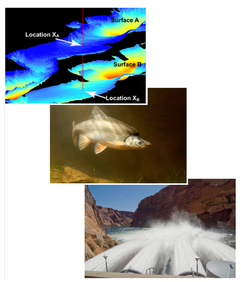


Figure: If we succeed in our sediment classification, we will have a sediment type for everywhere we have a depth, & an unprecedented insight into channel dynamics.

We need to know sediment type for improved sediment budgeting, mapping habitats, & channel response to high flows.

- Where is the sand? How much sand is there? How mobile is the gravel under high flows? How much sand is moving as bedload? What sand sizes move as bedload?
- Repeat mapping of grain size will allow us to reveal the mechanisms behind small areas of large scour & fill which account for a large majority of the sediment budget.



We're developing an empirical approach using 10 years of underwater video data.

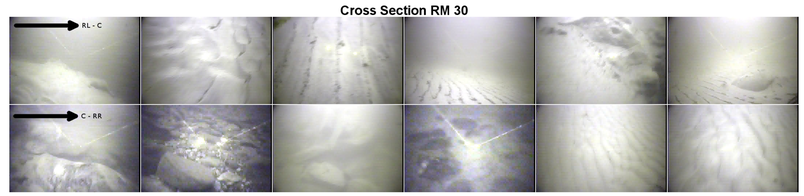


Figure: A typical cross section from river left to river right showing variation in bed grain size. This is under the tagline at RM30 in May 2012 which is considered a 'uniform sandy' reach.

We analyze the distribution & frequency content of echoes over small areas.

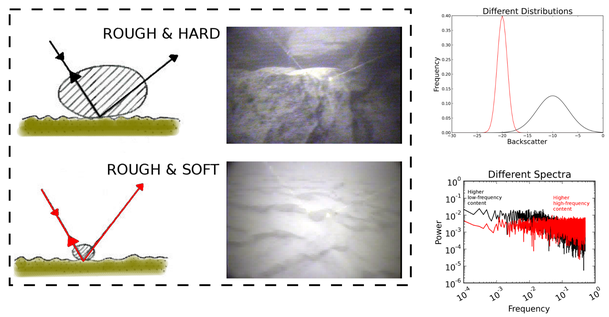


Figure: We've developed a data driven approach using the statistical characteristics of echoes over patches of known sediment type.

Sand, Gravel & Mixtures plot in different parts of this parameter space:

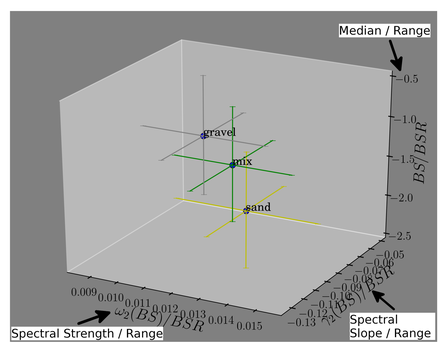
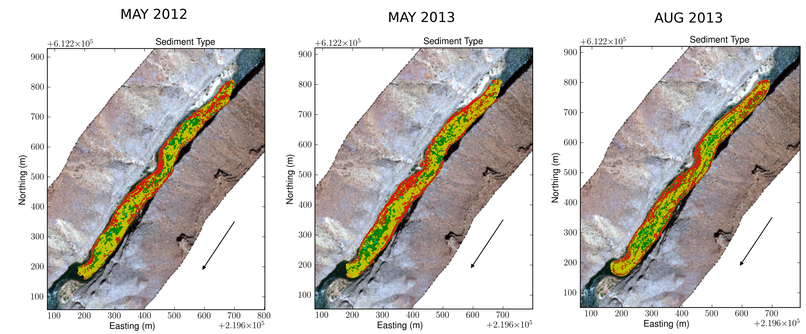


Figure: Sand, gravel & mixtures (sand/gravel) separate in a 3-parameter space. We use this information to classify each 25 cm^2 patch of riverbed according to sediment type.

Example sediment classifications:



MAY 2012		MAY 2013		AUG 2013	
0.25%	unclassified	0.56%	unclassified	0.28%	unclassified
47.0%	sand	48.1%	sand	46.3%	sand
23.6%	sand/gravel mix	22.5%	sand/gravel mix	25.1%	sand/gravel mix
2.8%	gravel	2.8%	gravel	2.0%	gravel
26.4%	rock	26%	rock	26.3%	rock

Figure: This is the pool above the RM30 gauge in May 2012, May 2013 & August 2013. Yellow=sand, green=mixtures, blue=gravel. The proportions of sand & gravel persist but the spatial distribution varies. Preliminary data, do not cite

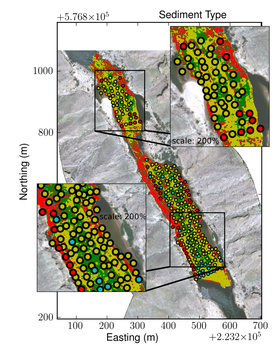


Figure: This is the same classification above the RM61 gauge in August 2013. The colored circles are grain size estimates from an underwater video camera. Preliminary data, do not cite.

Summary & ongoing work.

- We've made progress towards classifying bed sediments using only the echoes from the multibeam system.
- We're applying this to upper & lower Marble Canyon, mapped in 2009, 2012, & 2013.
- Refinements & validation are ongoing, as is an assessment of errors.
- Questions for the future include: How well does this apply to previous multibeam systems (such as those used to map the channel prior to 2011?)
- How well does this classification apply to 225 miles of gauged river?

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