PRF #57156 UNI-8
"3-D imaging of experimental stratigraphy using computed tomography"
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The overall scientific goals of this grant are to develop a novel methodology for recovering high-resolution, three-dimensional stratigraphic data from physical experiments, and examining spatial scaling characteristics of geo-bodies under different boundary conditions. Our methodology uses computed tomography (CT) scans to produce sub-millimeter-scale, three-dimensional stratigraphy. During year one of this grant several important steps were taken towards accomplishing these goals. The first major step was renovation and restructuring of the existing experimental laboratory space in the Department of Geology at Western Washington University. Initially built in the 1960's PI Foreman, undergraduates, and graduate students modified existing installations and built new experimental equipment. Two new acrylic flumes were built to the specifications of the CT scanners housed at Mount Baker Imaging, the medical facility we will be using for our scans. The flumes are 50 cm by 165 cm by 45 cm and will allow the production of 25 cm of deltaic stratigraphy to be generated as well as an efficiently draining system prior to scanning. The first major shipment of sediment was obtained as well as construction of the head tanks, a sediment feeder, and rock cribs. Students performed calibrations of these units with the various sediment types. An undergraduate and graduate student performed six initial experimental runs testing the equipment and flume setup. Initial runs focused on the fluvial component of deltaic strata, and formed the basis of an undergraduate's senior thesis. The undergraduate student developed the imaging protocol and analysis for the active experimental geomorphic surface. The study captured data on the mechanisms of formation and geometries of braid bars under different discharge conditions (Figure 1). Two graduate students have also been involved in this PRF project, one funded by PRF and the other by in-house funds. One graduate student is evaluating bed thickness patterns in purely autogenic deltaic strata based on previous experiments that did not incorporate CT imaging. This work will form baseline information on bed thickness patterns and distributions with which we can compare our new experimental datasets. The second graduate student has made major steps in the surface scanning and topography protocols for the CT experiments. We are applying structure-from-motion techniques to obtain millimeter-scale topographic information throughout the experimental runs.

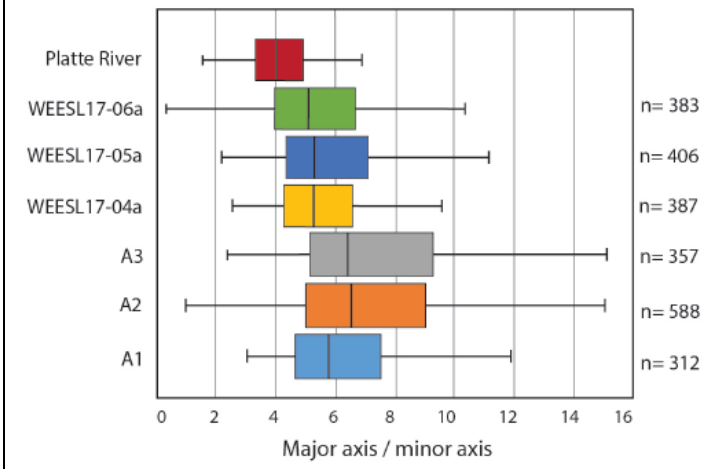

Figure 1. Braid bar geometries for braided river (Platte River), experimental braided rivers (WEESL17-06a, WEESL17-05a, WEESL17-04a), and experimental braided density currents (A3, A2, A1).

There are several scientific and educational impacts from the project thus far. The first is that we have established a workflow, tested and calibrated our experimental setup, and produced initial datasets that can reproduce data in other labs. This puts the research on firm footing as we continue into phase two of CT scanning the experiments. Once complete we will have a large and highly quantitative dataset of three-dimensional stratigraphy to compare with scaling relationships established in natural systems that relate 1-D well/stratigraphic section, 2-D outcrop, and 3-D reservoir measurements. The career of PI Foreman has advanced in that he has been able to devote additional

time to experimental studies, broadening his expertise beyond field-based stratigraphic studies and geochemistry. The career of the undergraduate involved has been broadened by the development of a senior thesis, which provided extensive writing training, application of statistical techniques, and use of new computer software. After graduating with her B.S. she applied for graduate studies at Western Washington University, and is interested in continuing elsewhere for a Ph.D. after she completes her M.S. The two M.S. students involved in this project have similarly benefited, learning new mathematical approaches to stratigraphy, new computer software, and experimental construction/troubleshooting. Over the following year they will be performing CT scans, analyzing that data, and producing theses and manuscripts based on the research. They both are interested in pursuing careers in the petroleum industry and are applying for a variety of internships. Moving forward Foreman PI will be interviewing undergraduates to participate in year two of this research. The science education impact has been expansion and enhancement of pedagogic equipment in several courses at Western Washington University as auxiliaries to this project. Greater research use of existing laboratory facilities induced a need to expand teaching space and instruments. This included new and improved teaching flumes for the Geomorphology course taught in the department (impacting ~50 students per academic year), and a new Augmented Reality Sandbox for teaching topographic maps in the Introductory Geology course (impacting ~300 student per academic year). Overall the PRF grant has had a sizeable impact on the education and research opportunities of undergraduate students at Western Washington University.