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RPPR Final Report
as of 30-Jun-2020

Agency Code:

Proposal Number: 73837EVRIP

Agreement Number: W911NF-19-1-0158

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Final Report for Period Beginning 05-Mar-2019 and Ending 04-Mar-2020

Title: Acquisition of Laser Diffraction Particle Sizing System for Research and Research Education on Earth, Environmental, and Atmospheric Boundary Layer Processes and Materials

Begin Performance Period: 05-Mar-2019

End Performance Period: 04-Mar-2020

Report Term: 0-Other

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Distribution Statement: 1-Approved for public release; distribution is unlimited.

STEM Degrees:

STEM Participants:

Major Goals: The acquisition of the Malvern-Panalytical Mastersizer 3000 laser diffraction particle sizing system by Drs. Gill and Langford will continue and enhance their established record of providing research-related education at the University of Texas- El Paso and elsewhere to undergraduate and graduate students, most of them from groups underrepresented in STEM, in applications of particle sizing to science and engineering. The new laser particle analyzer replaced a 13 year old, Malvern Mastersizer 2000 laser diffraction particle sizer that no longer is supported by the manufacturer.

Accomplishments: Record of Accomplishments -- Please note a pdf copy including figures is also attached

1. Installation and Maintenance of Equipment.

a. A purchase order for the system was submitted on June 7, 2019 to Malvern- Panalytical with requisition number 119174643 for a total cost of \$107,000.00. Receipt of the instrument system was delayed for approximately two months through software issues at Malvern-Panalytical Instruments that were better resolved before installation.

b. All components of the Malvern Mastersizer 3000 system with serial number MAL1219441 were received on August 2, 2019 (see Figure 1) and installed and certified by Malvern-Panalytical Instruments personnel in the Pls' laboratory in the Geological Sciences Building at the University of Texas at El Paso on August 7, 2019. The Malvern-Panalytical Instruments engineer who installed and certified the particle sizing system trained the Pls and their students on the use and maintenance of the system.

2. Teaching

The instrument system was used for three UTEP courses this academic year. GEOL 3326 & GEOL 3126, Sedimentology & Stratigraphy and Lab for Sedimentology & Stratigraphy, respectively, during Fall Semester 2019. The instrument was used to demonstrate to students the principles of sediment size, sorting and rounding. The data was used to teach students statistical particle size. In the first three weeks of the course, students collected samples from five different local environments, eolian dune, arroyo channel, river channel and floodplain. They then ran the samples through the Malvern Mastersizer. The resulting data was then used to teach the student how to

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obtain means and standard deviations graphically and through the method of moments. The results were used throughout the course to show students how environmental processes are reflected in sample processes.

In the Graduate Level Sandstone Petrology GEOL 5362 class the students asked to be taught how to use the machine. We began to run samples, however access to the laboratory and machine were curtailed by the coronavirus lockdown.

The Environmental Science Senior Project class ESCI 4301 is designed to teach students how to describe and analyze data. Students form groups and select projects and analyze the data. One group of three students selected the a project that used the data from the Malvern Mastersizer. They collected and analyzed 31 samples and conducted a detailed analysis of the results. Their conclusions were (correctly) that they needed more samples and a different sample distribution. A not unexpected result for initial exploration of an area.

Training Opportunities: Nothing to Report

Results Dissemination: Research Completed and Underway -- Note a pdf file including

a.. Using Statistical Analysis, Grain Size Distributions, Grain Shapes to Distinguish Populations of Gypsum Sand, White Sands National Monument used a variety of novel statistical techniques along with detailed grain-size data from the Malvern Mastersizer 3000 system to distinguish populations of gypsum crystallized in microbiotic horizons from those crystallized abiotically. This is the first research using laser diffraction data suggesting that gypsum crystal shape and size may be influenced by biotic activity. A talk with published abstract was presented at the Geological Society of America Annual Meeting.

b. A Test of the End Member Mixing Analysis, Lucero Arroyo, Dona Ana Mountains, New Mexico compares grain composition measured through petrographic microscopic techniques with measurements of grain size from the Malvern Mastersizer 3000 system. More in-depth sampling will be needed to produce conclusive results because the initial data is surprising. Arroyo sediment from different sources does not appear to mix but travels as distinct slugs of sediment. Initial results are not statistically conclusive, but if confirmed with data, this study can both show how grain size data can be used to estimate sediment sources as well as demonstrate how sediment mixing works in an arid environment. Research is ongoing and a manuscript is in preparation for Sedimentary Geology.

Honors and Awards: Nothing to Report

Protocol Activity Status:

Technology Transfer: Nothing to Report

Final Progress Report for Army Research Office Award # W911NF1910158, “*Acquisition of Laser Diffraction Particle Sizing System for Research and Research Education on Earth, Environmental, and Atmospheric Boundary Layer Processes and Materials*,” prepared by Richard P. Langford and Thomas E. Gill, Principal Investigators, Department of Geological Sciences, University of Texas at El Paso, El Paso, TX 79968-0555, email langford@utep.edu and tegill@utep.edu, respectively.

This grant funded the purchase of a Malvern-Panalytical Mastersizer 3000 laser diffraction particle sizing system.

The system will be used to continue and enhance the PIs’ established record of providing research-related education at the University of Texas- El Paso and elsewhere to undergraduate and graduate students, most of them from groups underrepresented in STEM, in applications of particle sizing to science and engineering. Laser diffractometers work by passing laser beams through clouds of particles and measuring the diffraction of the beams. The Malvern 3000 unit uses two different colors for greater accuracy. Small particles will diffract the light more than coarse particles, similarly to how water drops in the atmosphere create rainbows. In the Malvern, 66 detectors measure how much dispersed light fall on them, and thus a distribution of particle sizes is estimated. The PI’s typically use 10,000 to 20,000 measurements and aggregate the measurements for greater accuracy in measuring coarse particles. In order to work correctly, the particles must be well dispersed in a cloud, so that coarse and fine particles are both passing through the light. The cloud must also have a concentration that gives the laser a high possibility of encountering a particle and a low probability of encountering several, which would add to the diffraction and provide size estimates that are too low. The new particle sizer provides new wet and dry dispersion units that improve the ability to get accurate measurements as well as a new optical device that allows observation of particles to ensure good dispersion. New sample dispersion units and the Hydrosight particle shape analyzer allow for analysis of samples that previously could not be accurately measured.

Participants: This was an equipment grant with no participant support.

Technical Reports (including Articles): As this was an equipment grant, no technical reports were required by the Army. However, so far, the equipment has produced one conference talk with published abstract and one paper that used the equipment is in preparation and should be completed this summer.

1. Langford, Richard P., 2019. Using Statistical Analysis, Grain Size Distributions, Grain Shapes to Distinguish Populations of Gypsum Sand, White Sands National Monument *Geological Society of America Abstracts with Programs*. Vol. 51, No. 5, ISSN 0016-7592, doi: 10.1130/abs/2019AM-340089

2. Langford, R.P., Guijarra, Carolina C., and others, 2020 (in preparation). A Test of the End Member Mixing Analysis, Lucero Arroyo, Dona Ana Mountains, New Mexico. To be submitted to *Sedimentary Geology*.

Scientific Progress and Accomplishments:

Record of Accomplishments

1. Installation and Maintenance of Equipment.

- a. A purchase order for the system was submitted on June 7, 2019 to Malvern-Panalytical with requisition number 119174643 for a total cost of \$107,000.00. Receipt of the instrument system was delayed for approximately two months through software issues at Malvern-Panalytical Instruments that were better resolved before installation.
- b. All components of the Malvern Mastersizer 3000 system with serial number MAL1219441 were received on August 2, 2019 (see Figure 1) and installed and certified by Malvern-Panalytical Instruments personnel in the PIs' laboratory in the Geological Sciences Building at the University of Texas at El Paso on August 7, 2019. The Malvern-Panalytical Instruments engineer who installed and certified the particle sizing system trained the PIs and their students on the use and maintenance of the system.



Figure 1. Particle sizing system components received from Malvern-Panalytical Instruments in the PIs' laboratory on August 2, 2019.

- c. On 02/06/2020, the investigators purchased extra laser chamber windows using funds from another source. This purchase will extend the life of the Malvern Mastersizer 3000 system for another year or more without additional expense by UTEP, guaranteeing continued operation of the machine for several years.

2. Teaching and Research Using The Instrumentation

a. Teaching

The instrument system was used for three UTEP courses this academic year. GEOL 3326 & GEOL 3126, Sedimentology & Stratigraphy and Lab for Sedimentology & Stratigraphy, respectively, during Fall Semester 2019. The instrument was used to demonstrate to students the principles of sediment size, sorting and rounding. The data was used to teach students statistical particle size. In the first three weeks of the course, students collected samples from five different local environments, eolian dune, arroyo channel, river channel and floodplain. They then ran the samples through the Malvern Mastersizer. The resulting data was then used to teach the student how to obtain means and standard deviations graphically and through the method of moments. The results were used throughout the course to show students how environmental processes are reflected in sample processes.

In the Graduate Level Sandstone Petrology GEOL 5362 class the students asked to be taught how to use the machine. We began to run samples, however access to the laboratory and machine were curtailed by the coronavirus lockdown.

The Environmental Science Senior Project class ESCI 4301 is designed to teach students how to describe and analyze data. Students form groups and select projects and analyze the data. One group of three students selected the a project that used the data from the Malvern Mastersizer. They collected and analyzed 31 samples and conducted a detailed analysis of the results. Their conclusions were (correctly) that they needed more samples and a different sample distribution. A not unexpected result for initial exploration of an area.

b. Research Completed and Underway

1. *Using Statistical Analysis, Grain Size Distributions, Grain Shapes to Distinguish Populations of Gypsum Sand, White Sands National Monument* used a variety of novel statistical techniques along with detailed grain-size data from the Malvern Mastersizer 3000 system to distinguish populations of gypsum crystallized in microbiotic horizons from those crystallized abiotically. This is the first research using laser diffraction data suggesting that gypsum crystal shape and size may be influenced by biotic activity. A talk with published abstract was presented at the Geological Society of America Annual Meeting. See Figures 2 and 3 below.

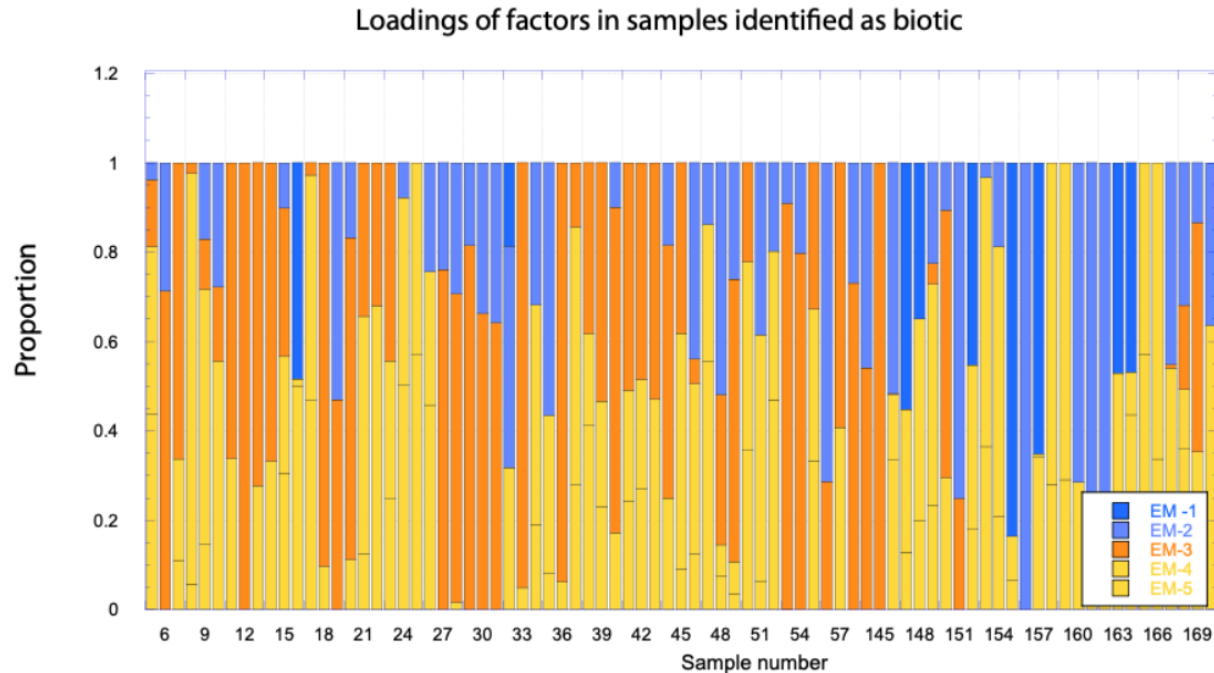


Figure 2. This figure shows the factor loadings of five grain size populations of gypsum at White Sands, New Mexico. The two blue populations are found almost entirely in biotic crusts. The yellow populations are wind-sorted, and the orange population represents enlarged grains which have grown through crystal cementation in the subsurface.

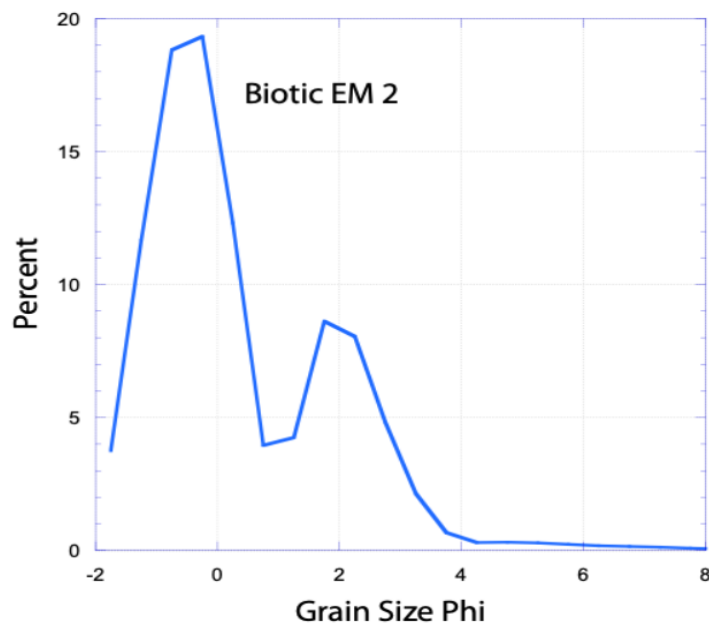


Figure 3. A histogram of the average distribution of grain sizes in one of the biotic horizons at White Sands, New Mexico as measured by the Malvern Mastersizer.

2. *A Test of the End Member Mixing Analysis, Lucero Arroyo, Dona Ana Mountains, New Mexico* compares grain composition measured through petrographic microscopic

techniques with measurements of grain size from the Malvern Mastersizer 3000 system. More in-depth sampling will be needed to produce conclusive results because the initial data is surprising. Arroyo sediment from different sources does not appear to mix but travels as distinct slugs of sediment (see Figure 4). Initial results are not statistically conclusive, but if confirmed with data, this study can both show how grain size data can be used to estimate sediment sources as well as demonstrate how sediment mixing works in an arid environment. Research is ongoing and a manuscript is in preparation for *Sedimentary Geology*.

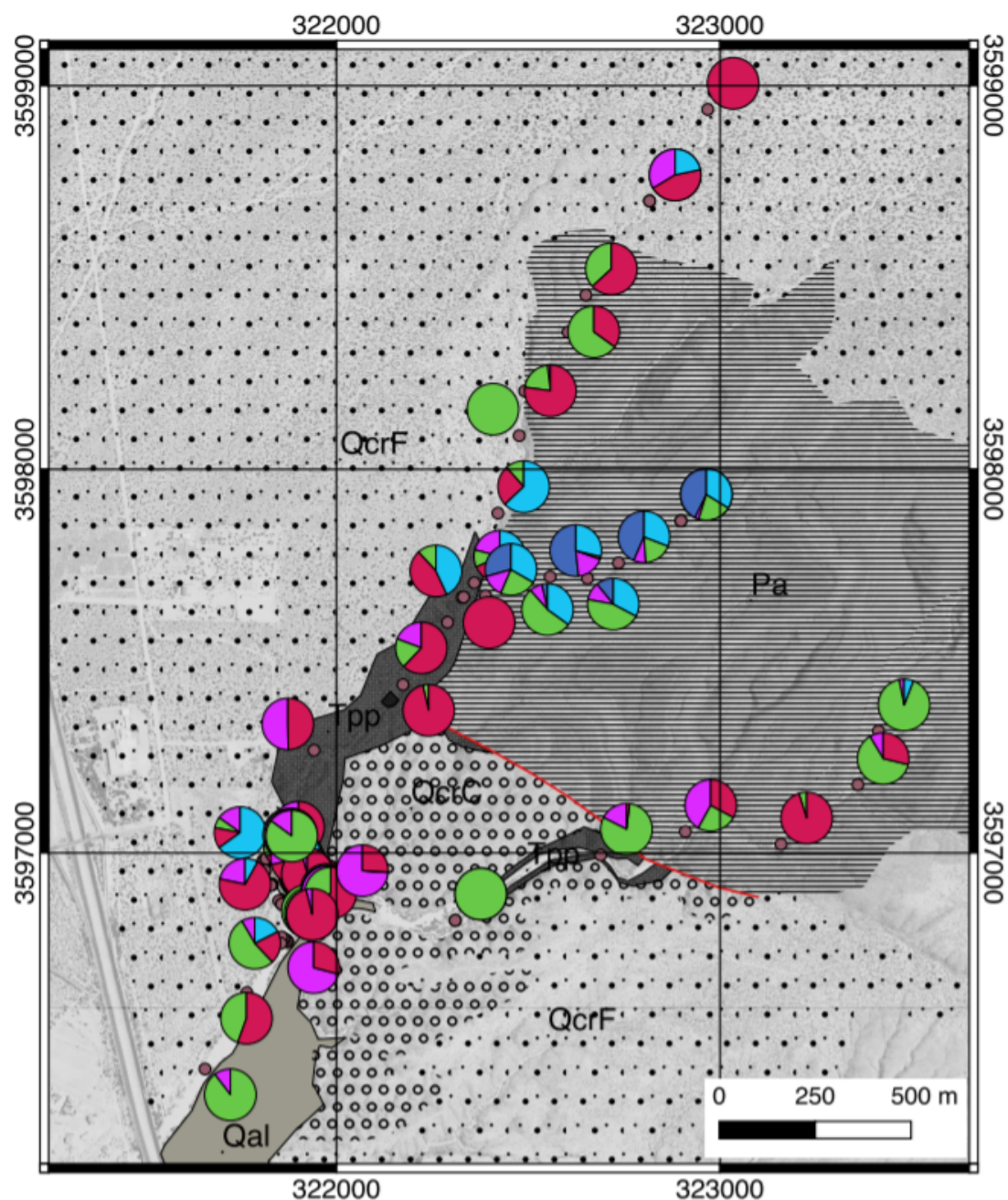


Figure 4. Map showing the percentages of different end-member sand populations in the Lucero Arroyo, as estimated from grain sizes produced by the Malvern

Mastersizer 3000. The sands in the channel are dominantly composed of one end member, yet adjacent to others that are composed of other end members.

3. Other research is planned but not currently underway as of the final report submission date, including analysis of sediment cores from the Arctic North Slope of Alaska to document environmental processes and changes, and analysis of sediment samples from the Lordsburg Basin, New Mexico to determine the grain size characteristics of dust samples and dust storm source areas in a hotspot of aeolian processes. However, these projects are led by students, and restrictions in place by the University, City of El Paso and State of Texas in light of the COVID-19 pandemic have prohibited undergraduate students and limited graduate students from accessing university laboratories since mid-March 2020. A planned research proposal, to be submitted to NSF this summer is an investigation of the dust emission source areas at White Sands national monument, creating a map of source morphology and measuring the Sulfur isotope signatures of the different areas.

Honors during the reporting period

None

Tech Transfer

None

STEM Student/Supported Personnel Metrics for the Reporting Period: This was an equipment grant. No support for personnel or students was included.