Sustainable and Meaningful Research Opportunities for Community College Students

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Abstract

Science classes generally teach students to question assumptions. In order to best prepare our community-college students for careers in the geosciences, we have created an ongoing student-led research project that provides opportunities to develop skills necessary for geological field work as well as experience with decision-making and collaborating. Students may participate for up to two semesters in the study; returning students are expected to mentor incoming students.

The project involves testing the logical assumption that sediments undergo changes along the length of a given stream. Trabuco Creek is a tributary of San Juan Creek in southern Orange County, CA. In past semesters, students have been mapping the bedrock and the creek, conducting both longitudinal and cross-sectional profiles, sampling sediment from the creek bed, and performing sieve analyses. This semester's work, defined by the team, is to continue mapping the bedrock and to analyze sediments for changes in roundness, sphericity and compositional distribution among different size fractions, as related to stream position and tributary input, in an effort to test standard assumptions.

Students will present both scientific and academic returns. Instructors will also report on lessons learned, including involvement of faculty, procuring of resources, strategies for assessment of students at various levels in the project, and addressing the challenges of course repeatability.

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Introduction

GEOL99 (special projects in geology) is a 2-unit course requiring instructor consent to enroll. This is an independent study course currently in its 3rd semester.

Format:

- Students and supervising faculty spend one day in the field area together for training.
- Students make subsequent field outings and conduct lab work on campus.
- Returning students train new students in field and lab techniques (Figure 1).
- Communication between students and faculty: listserv for day-to-day communication. Face-to-face meetings twice per month.

Students gain experience with:

- Field and laboratory techniques: using Brunton compasses, interpreting topographic maps, route finding, measuring and constructing longitudinal and cross-sectional profiles, collecting stream sediment, sieving, constructing digital plots
- Literature reviews
- Oral and written presentation of project: all students are required to give a public presentation at a local, regional, or national meeting
- Cognitive and affective skills development: selecting appropriate sites, justifying methods, working collaboratively, practicing safety in the field, interpreting results

Fig. 1: A veteran of the project trains new students in techniques used for cross sectional profiling.

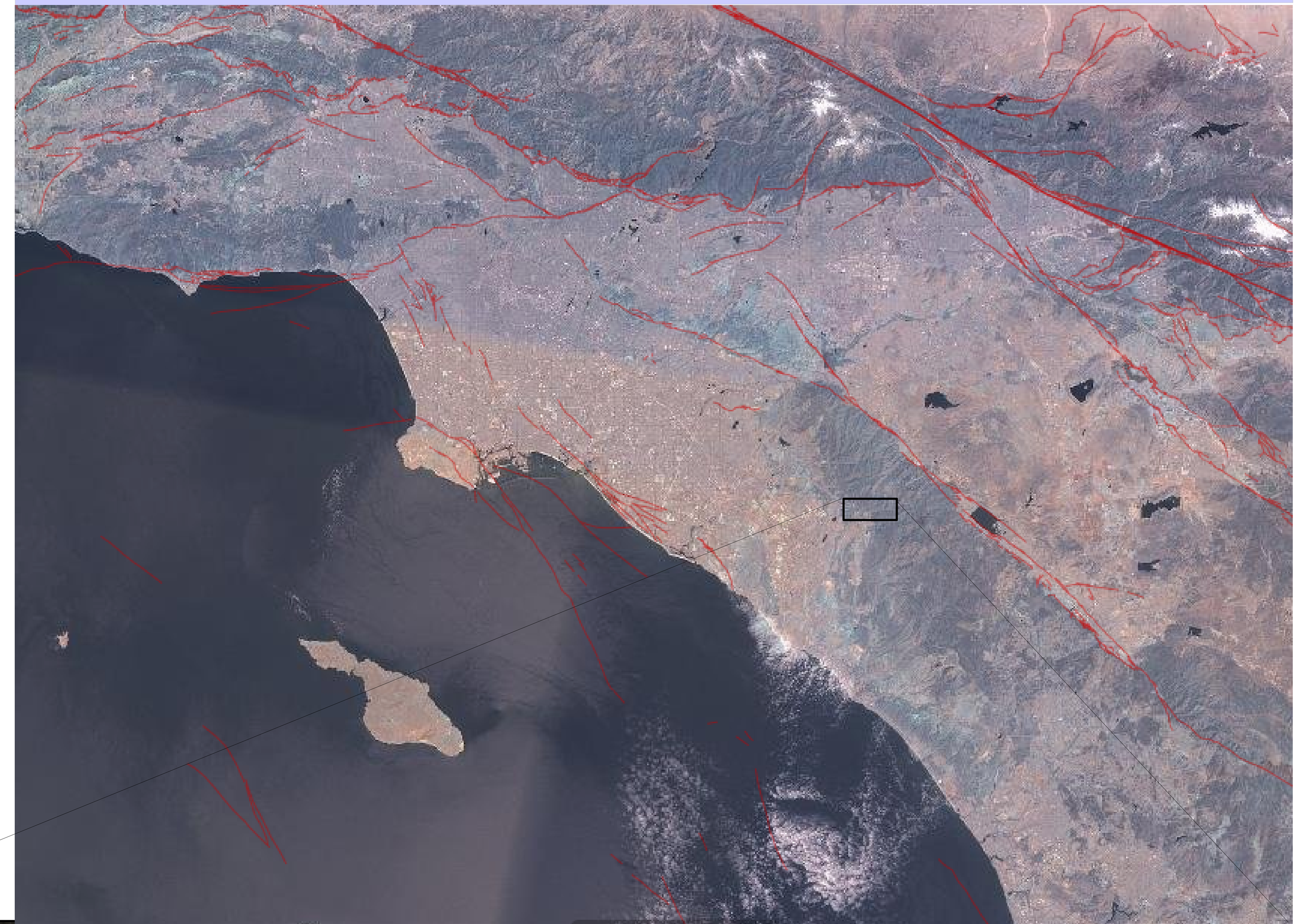
Field Area

- Location and local topography: Trabuco Creek (Figure 2a and 2b) is in the Santa Ana Mountains, Orange County, CA. It is a tributary of San Juan Creek; it runs about 35 km from headwaters (Trabuco Peak, 33°42' N 117°28' W, elev. 4600' and Los Pinos Peak, 33°39' N 117°28' W, elev. 4500') to mouth (Doheny State Beach).
- Study area: proximal third of Trabuco Creek located in Trabuco Canyon (Figure 2b). Many smaller streams enter Trabuco Creek in this area. There is minimal human development.
- Stream profiles (figure 2b):
  - Profile 1-6 range from 2500'-1800' over 2.8 km.
  - After a large gap, profile 7-10 extend 3.5 km downstream.
  - Profiles 8-10 located in an urbanized area.
  - Total 10.3 km from profile 1-10.
- Distal portion of Trabuco Creek (not included in the study) runs through urbanized areas of Rancho Santa Margarita, Las Flores, Mission, Viejo, San Juan Capistrano, Dana Point, and Capistrano Beach.

Methods

- Field work:
  - Sites with minimum vegetation selected for stream profiling
  - Equivalent banks identified using Brunton compass; cross-sectional profile constructed
  - Sediment samples collected using soup can
- Lab work:
  - Sieve analysis performed using eight-layered sieve pans
  - Each sieve size (split) was weighed, bagged, and labeled
  - Microscopy undertaken to determine average sediment size and roundness of grains for each split; students used binocular scopes with 2X and 4X magnifications. Several students looked at each split, data reported here are averages of these analyses

Fig. 2a: Trabuco Canyon location map



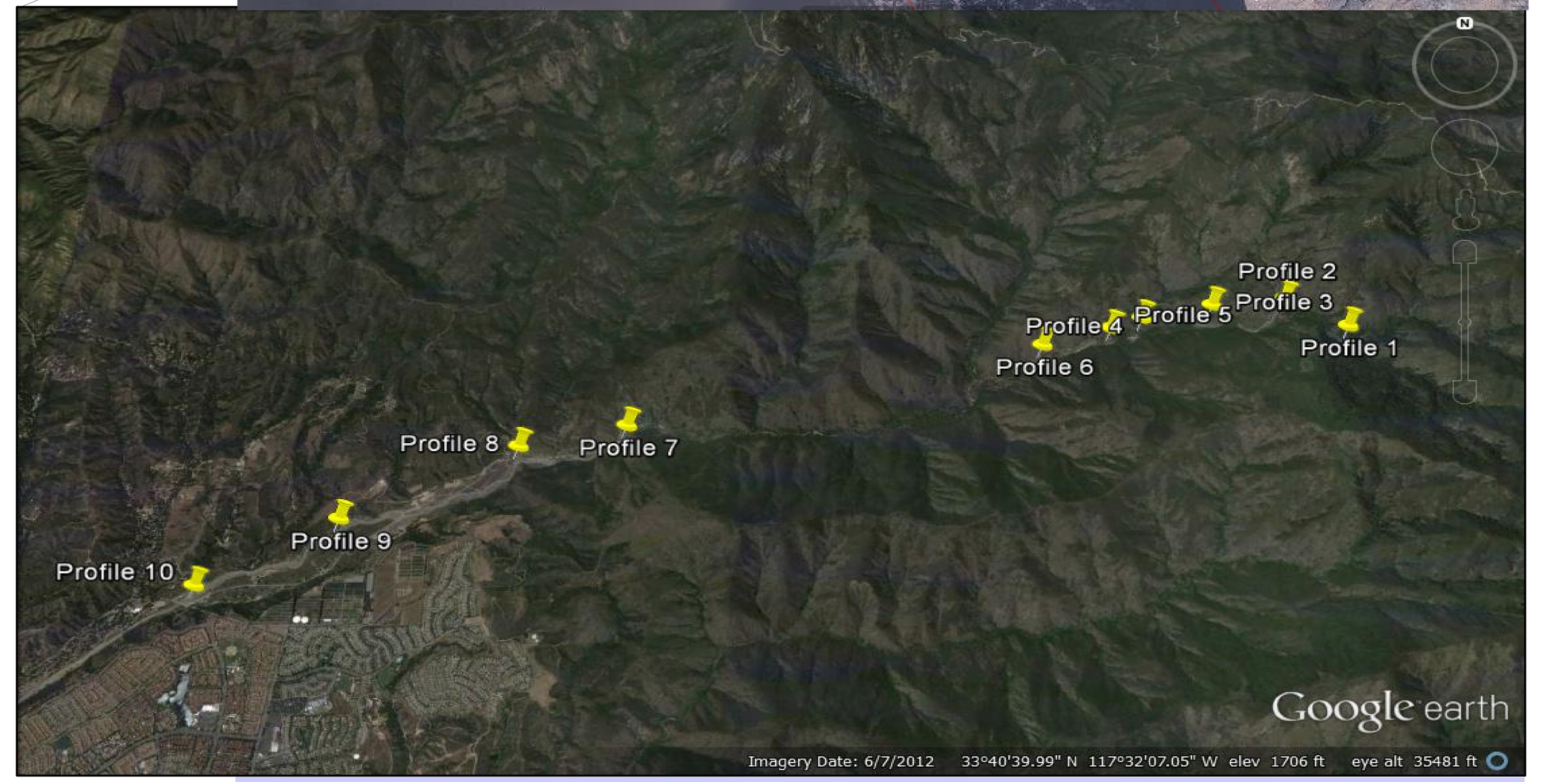


Fig. 2b: Trabuco Canyon and stream profile locations; this area is about 10 km across

Results

In Figure 4, normalized weight fractions of the samples are plotted to show the percentage of coarse, medium, and fine sand for each midstream profile. The diagram shows that in general, sand is coarser in the highest elevation of the stream, and gets finer further down. Though this is true for most of the data, there is an anomaly that occurs at Profile 7, where the trend seems to reset. Between profiles 6-7 there is a 3.5 km gap where samples were not able to be taken. The data show that somewhere in the gap, the percentage of larger-sized particles increases, which is inconsistent with our expectations. It is interesting that there was very little fine sand in our samples.

Fig. 4: Ternary diagram (after Graham and Midgley, 2000) showing percentages (coarse, medium, and fine sand, clockwise from top) of midstream profiles.

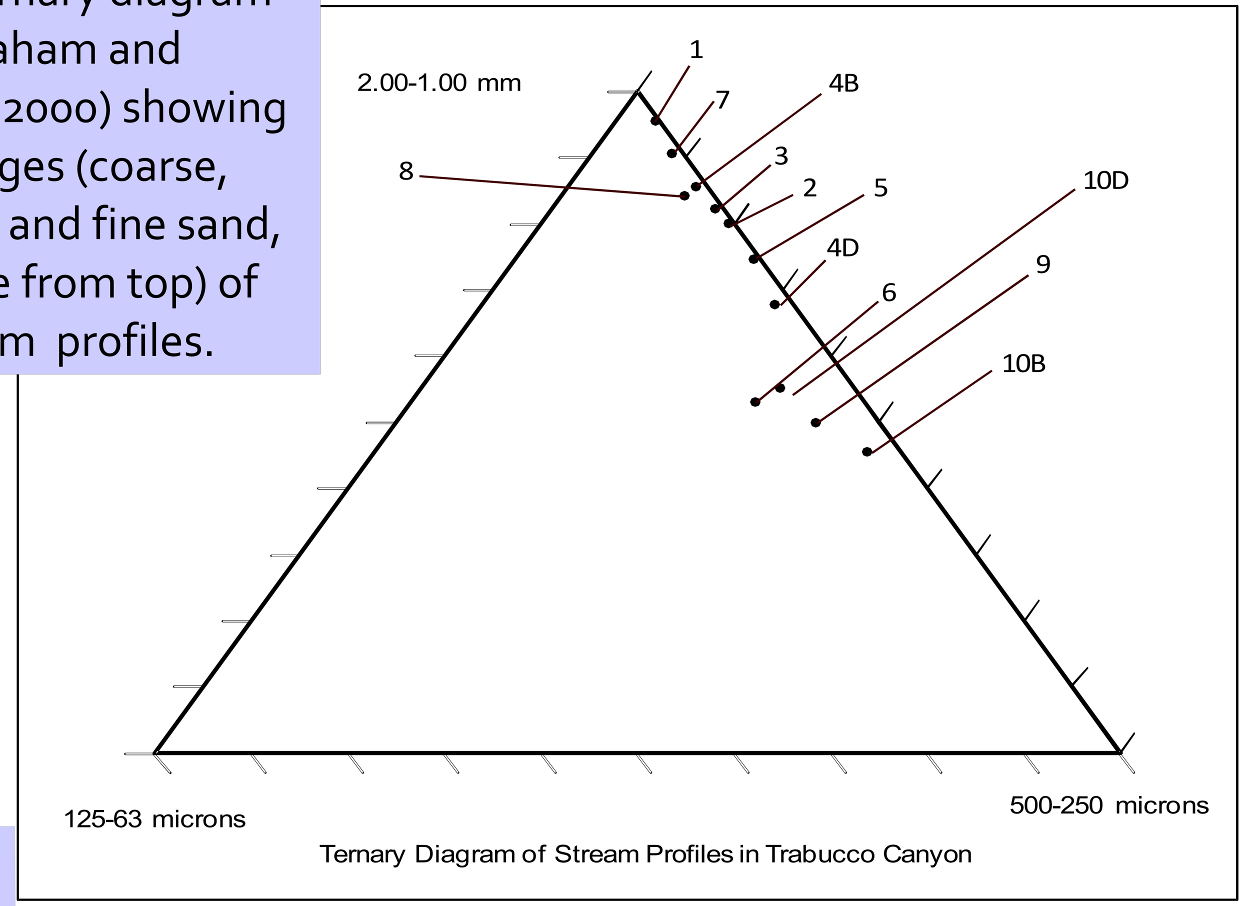


Fig. 5a-f: Average roundness and size of sand from each split

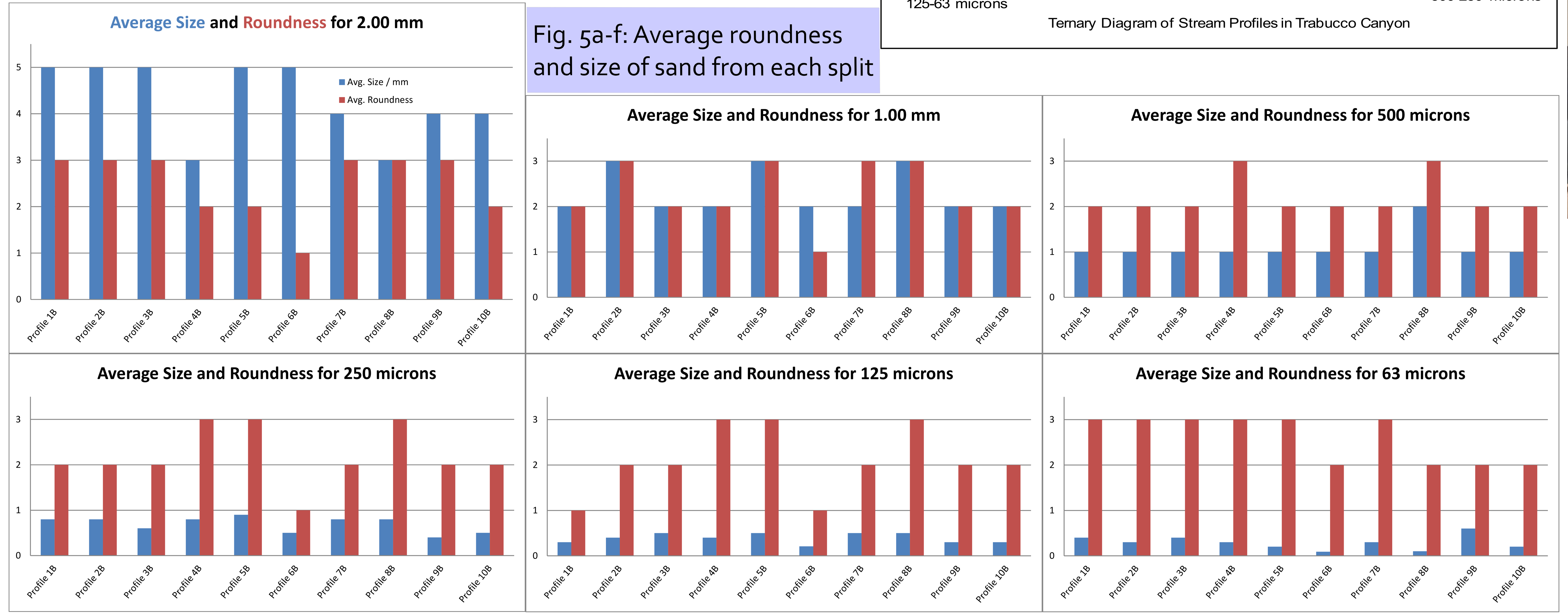
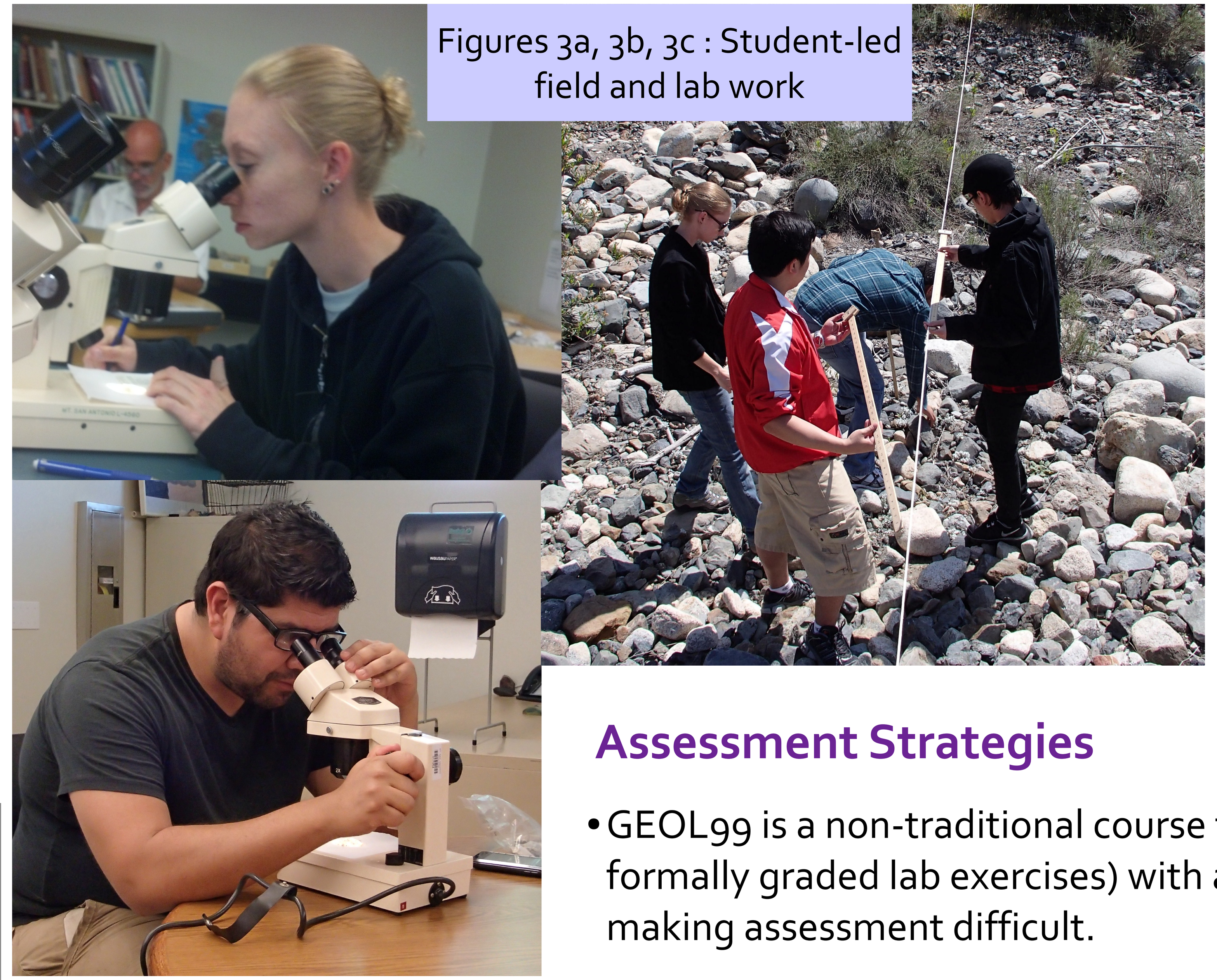


Figure 5 (a-f) shows our average measurement of sand size (in blue) and roundness (red) for each split. The sizes were measured under the microscope by comparing with a ruler at the same magnification (in the same field of view); average particle sizes are generally larger than the sieve size through which the sediment passed (see Discussion). The degree of rounding is translated to numbers; 1 represents Angular, 2 represents Subangular, 3 represents Subrounded, and 4 represents Rounded. Curiously, the degree of rounding does not follow the reasonable expectation that particles become more rounded with distance.



Figures 3a, 3b, 3c : Student-led field and lab work

Lessons Learned

- Structured, face-to-face meetings between students and faculty at regular intervals during the project are essential, as is regular e-mail communication. We have found that establishing action items at each meeting that must be completed by the next meeting has been an effective way of moving the research along.
- Having returning students train the new students has significant benefits for all (Adamec & Asher, 2013).
- Student content knowledge is a limiting factor (students have only taken freshman-level geoscience courses) and raises the philosophical question about which courses students should have taken prior to GEOL99. Is it more productive to offer this experience early in a student's academic career as a recruiting tool or later on as a retention tool? What is the synergistic value of each strategy?
- Scheduling conflicts and lack of access to facilities (example: classroom with sieve stations has limited open hours) is a barrier to collaborative work and research progress.
- Lack of confidence/fear while acquiring new skills (examples: Excel, constructing ternary diagrams, using a Brunton) is another impediment to progress; acquisition of skills is improved when students are teaching students.

Discussion

The results obtained thus far show that the ideal relationships discussed in introductory geology classes are not reproduced in natural settings since natural settings are more complicated. Size does not decrease uniformly (simply) with distance from the head-waters, and rounding does not seem to give an indication of distance. However, these deviations can easily be related to the more complex situation observed in the field area; namely, that there are tributaries feeding new material into the mixture of sediment, and that fine particles may be created during run-off events via abrasion of the larger particles in the streambed. The fact that sieve splits hold sand sizes larger than the sieve above is perhaps explained by the shapes of sand grains (i.e., they are not spherical but more cigar-shaped). This aspect of their character was noticed but not quantified in the present study.

Future work will involve refining precision of roundness and size measurements by repeating the microscope work to get better statistics; correlating sediment composition with position in the stream profile and with particle size fractions; mapping of regional geology for changes in bedrock; correlation of bedrock geology to merging of tributaries.

Assessment Strategies

- GEOL99 is a non-traditional course format (i.e., no exams, no problem sets, no formally graded lab exercises) with a traditional (A/B/C/D/F) grading scheme, making assessment difficult.
- Currently, grades are assigned based on peer evaluations, individual reflective writing (perceived contributions, personal strengths and weaknesses, and ideas for future work) and contributions to the project as observed by supervising faculty.
- As enrollment and project scope expands, we are considering moving to a formal evaluation rubric and more rigorous evaluation of field notebooks and raw data. However, as GEOL99 is not part of faculty teaching load at Mt. SAC, this would be extremely challenging from a time perspective.

Course Repeatability

We are struggling with repeatability; specifically,

- How many semesters should a student be allowed to participate?
- How should a student's role in the project evolve if s/he repeats the course?
- How do a small number of faculty supervise a group of students who are all working on different facets of the project?
- Recent Title V limitations on repeatability (GEOL 99ABC sequence?)

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