

Frac sand suitability of the St. Peter Formation, Winneshiek County, IA

Elaine Jordan, Dr. Emily Finzel

University of Iowa Department of Earth and Environmental Sciences, Iowa Initiative for Sustainable Communities

Background

- St. Peter Formation
 - Deposited in the Ordovician (approximately 450 million years old)
 - Originated as sands in the shallow waters of the Paleozoic sea
 - Extends north-south from Minnesota to Missouri
 - Extends east-west from Illinois to Nebraska and South Dakota
 - Fine to medium grain size
 - Well-rounded
 - Commonly mined
 - Thickness of approximately 100 feet in Winneshiek County, IA

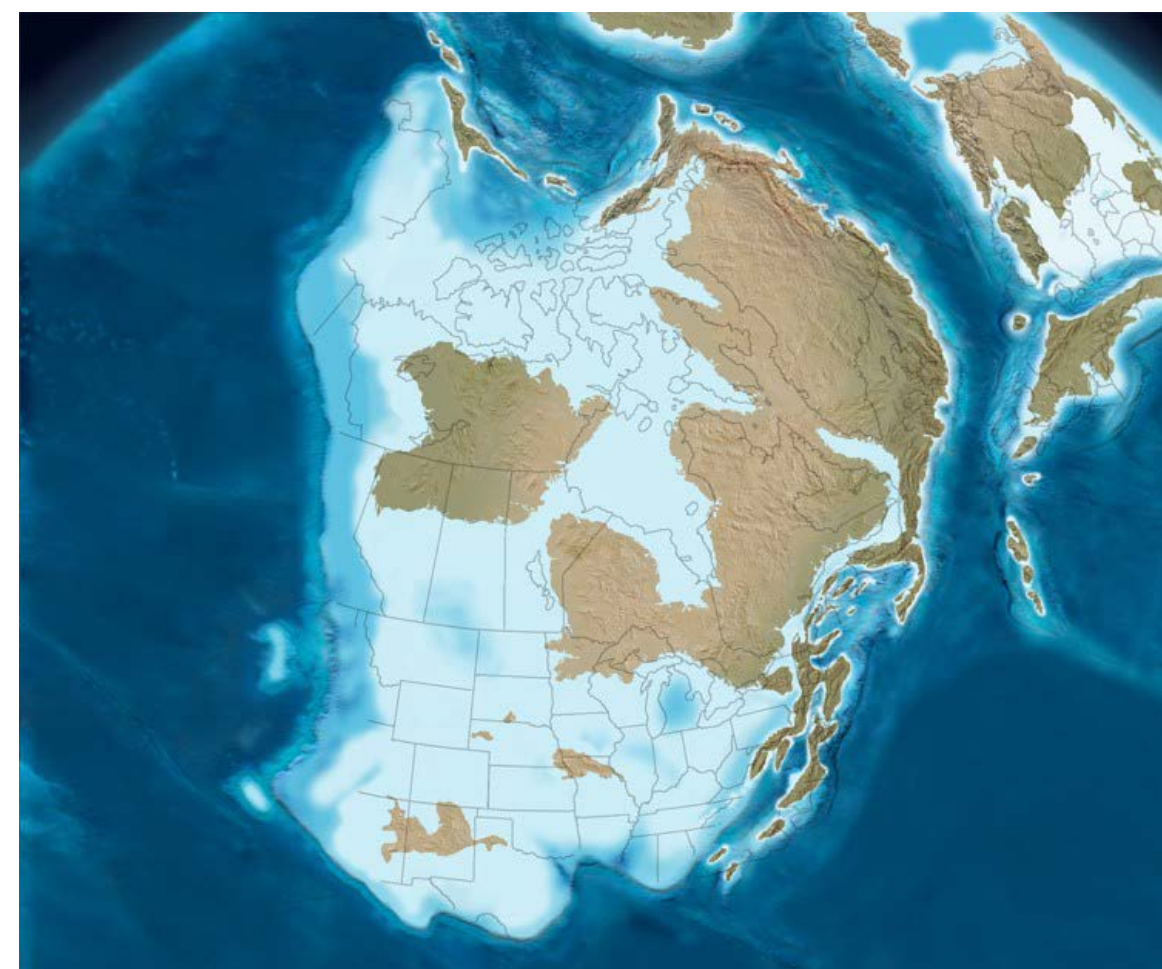
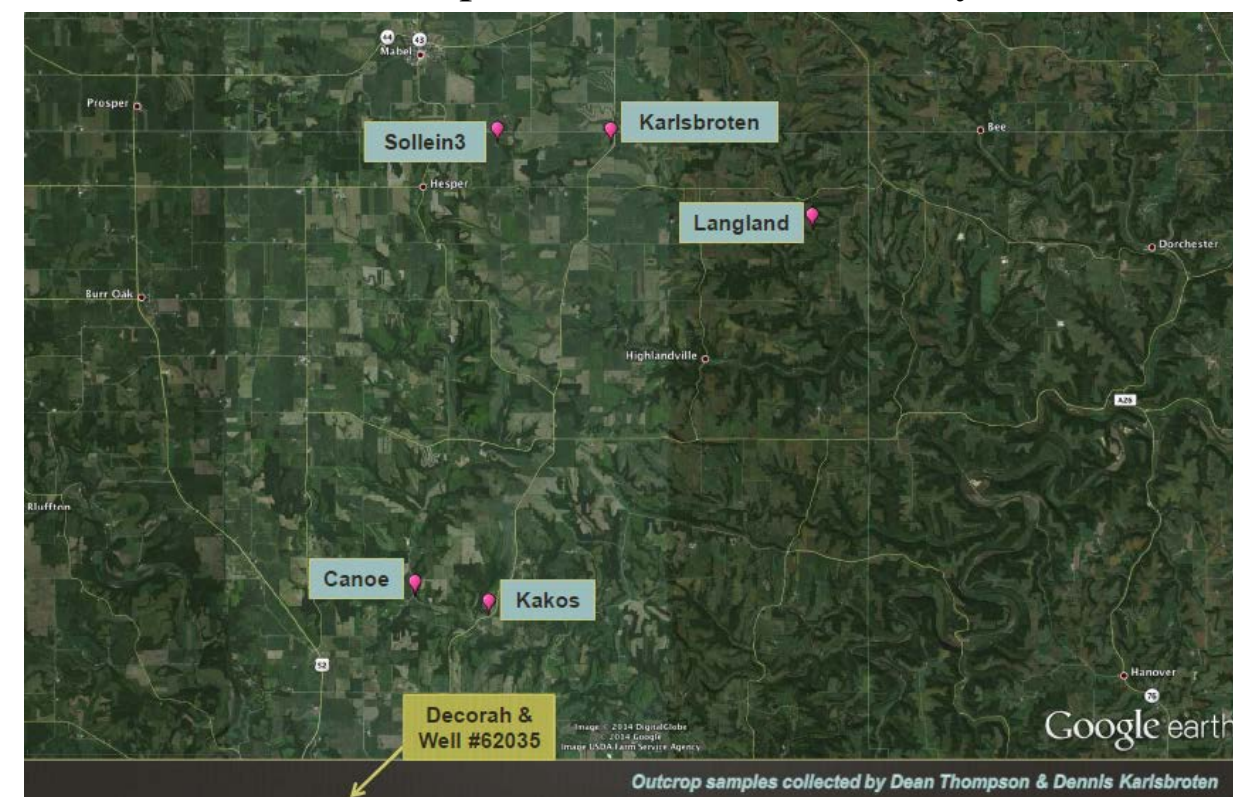


Figure 1: Reconstruction of the Paleozoic sea nature.nps.gov

- Location of the samples in Winneshiek County, IA



- Frac sand characteristics
 - Type/amount of overburden
 - Composition (99% silica)
 - Solubility (<2-3%)
 - Crush resistant
 - Grain roundedness: sphericity values >0.6
 - Grain size: medium to coarse sand (250-1000 μm)
- Frac sand grade
 - Names (20/40, 30/50, 40/70) correspond to sieve size cutoffs
 - 20/40: between sieve sizes 20-40, grain sizes 420-840 μm
 - 30/50: between sieve sizes 30-50, grain sizes 300-600 μm
 - 40/70: between sieve sizes 40-70, grain sizes 212-420 μm
 - Most sought over frac sand grades: 20/40 & 30/50

Camsizer Analysis

- Measures grain size and shape
- Sample is poured into funnel
- Tray gently shakes, which allows sand to consistently fall into the Camsizer
- Within the Camsizer, the cameras take 60 images per minute of the grains against the light
- This data computes into grain size and shape measurements
- Average sample size: ~670,000 grains

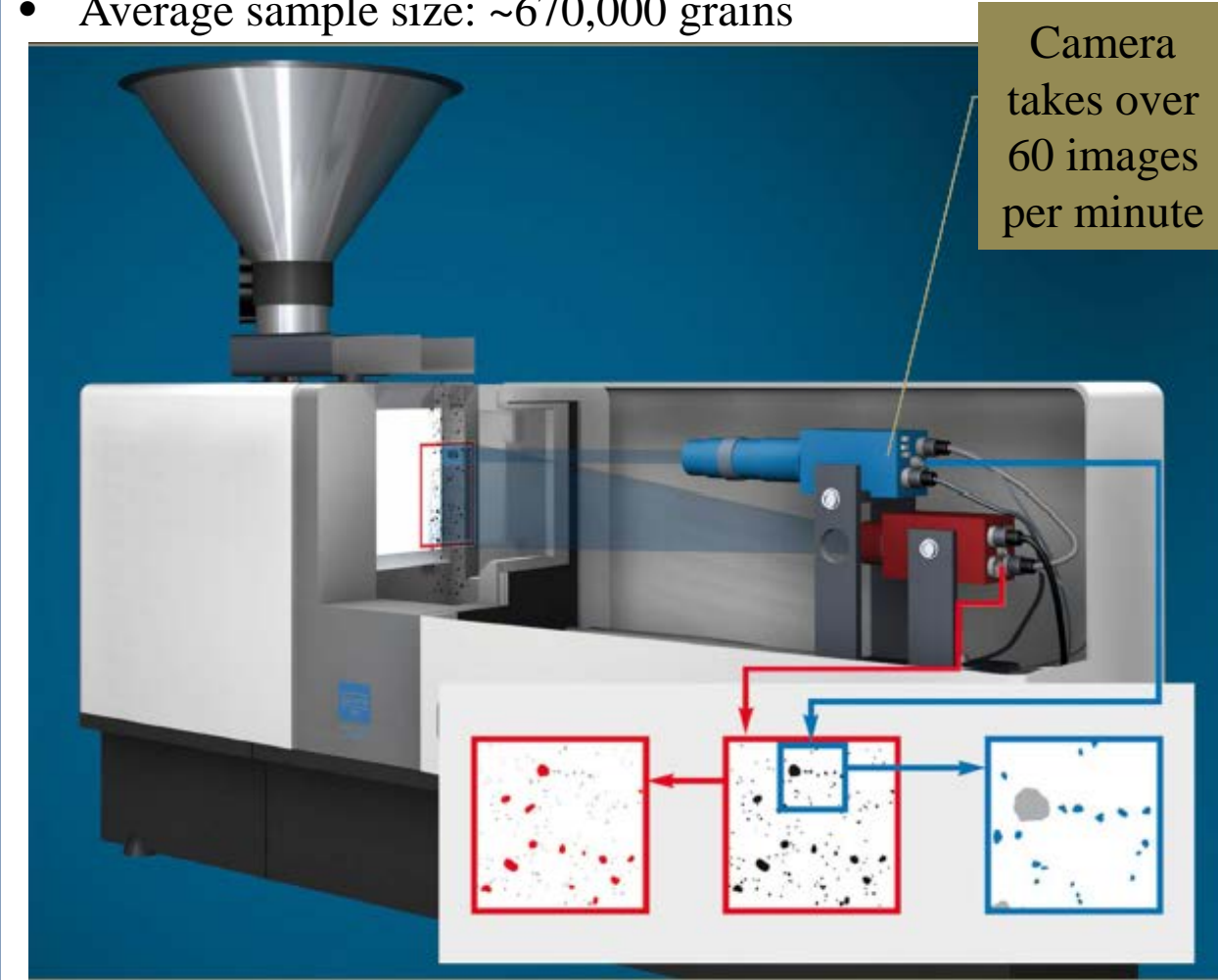


Figure 2: Interworking of a Camsizer

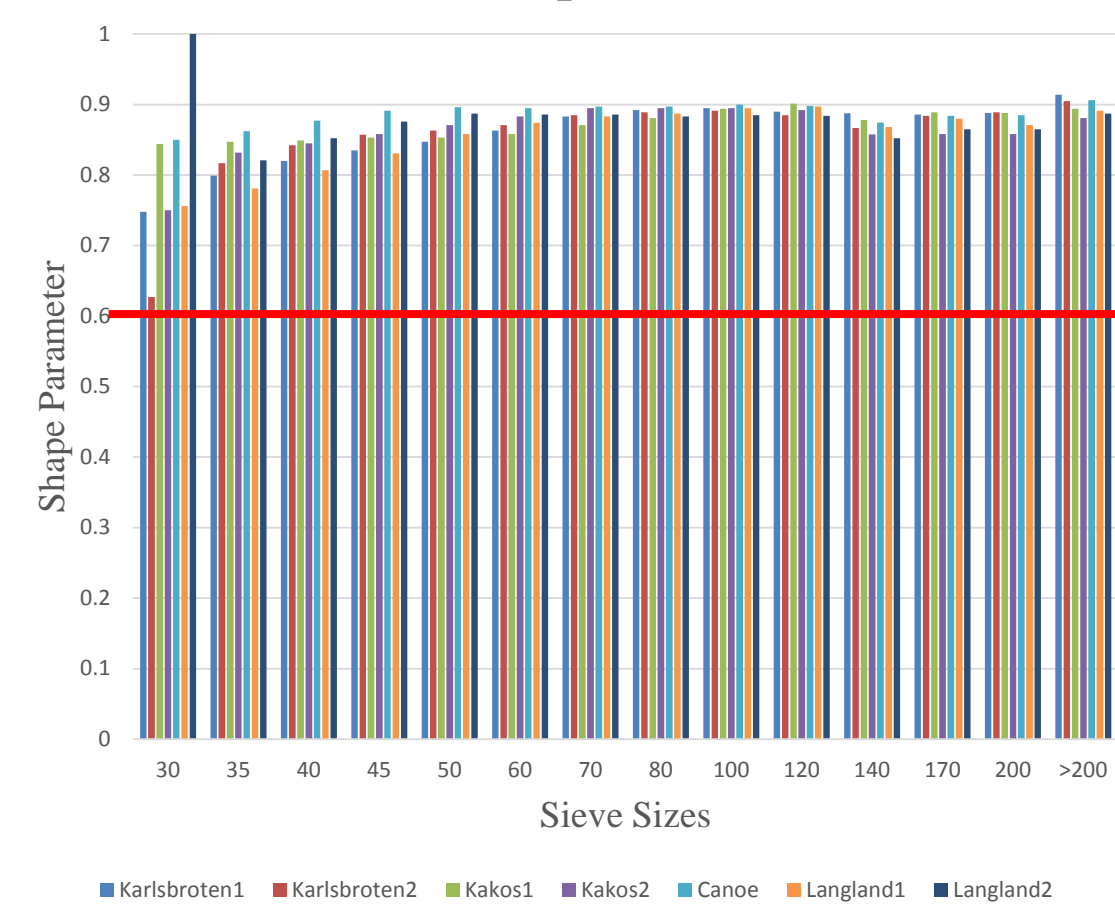
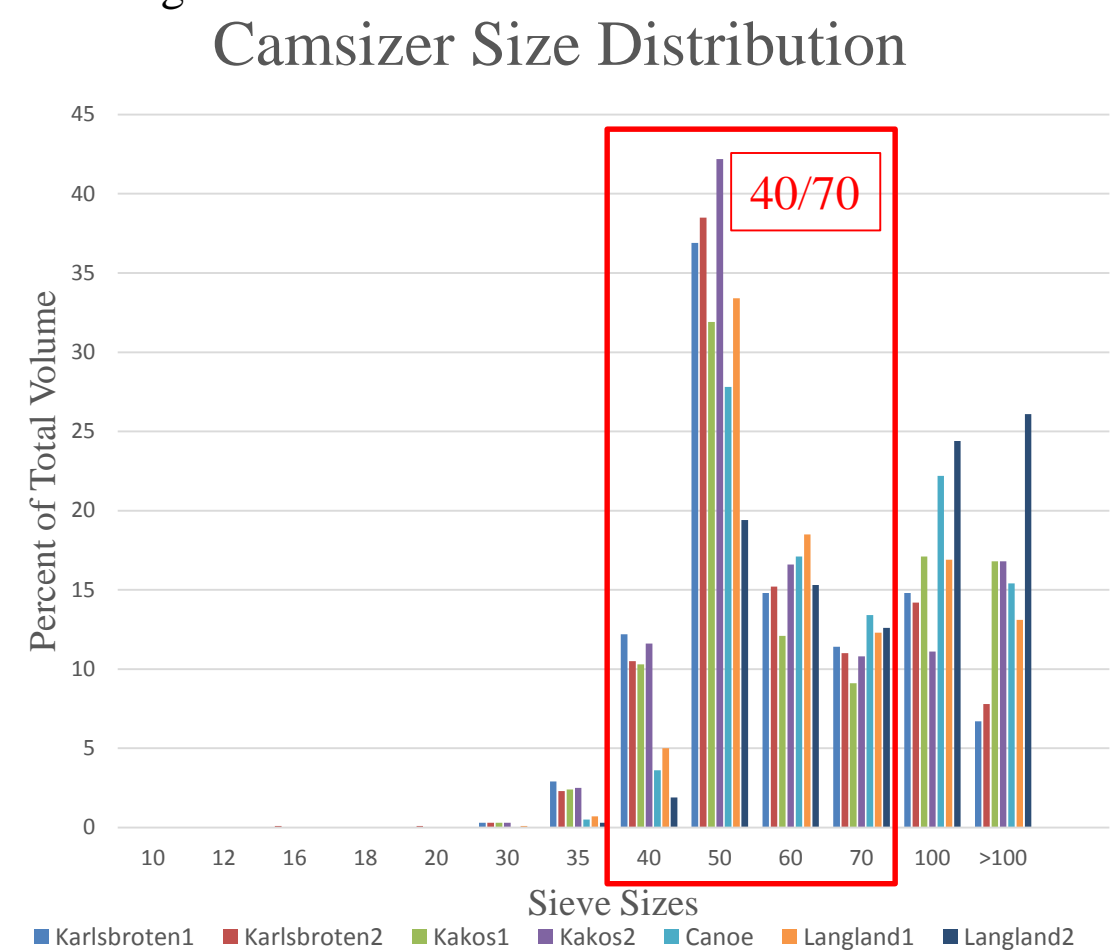


Figure 3: Camsizer shape distribution

- All values are >0.6 for the sphericity: rounded to well-rounded grains



Sieve Analysis

- Measures grain size
- Sample is poured into the six coarser stack of sieves with an collection pan on bottom
- Ran in Ro-Tap for 20 minutes
- Sample left in collection pan is then poured into the six finer sieves and ran again for 20 minutes
- Amount of sand in each sieve size is weighed to give percent of total volume by weight
- Average sample size: ~530 grams



Figure 4: Stack of sieves in the Ro-Tap



Figure 5: Coarsest (left) and finest (right) of the sieve sizes.

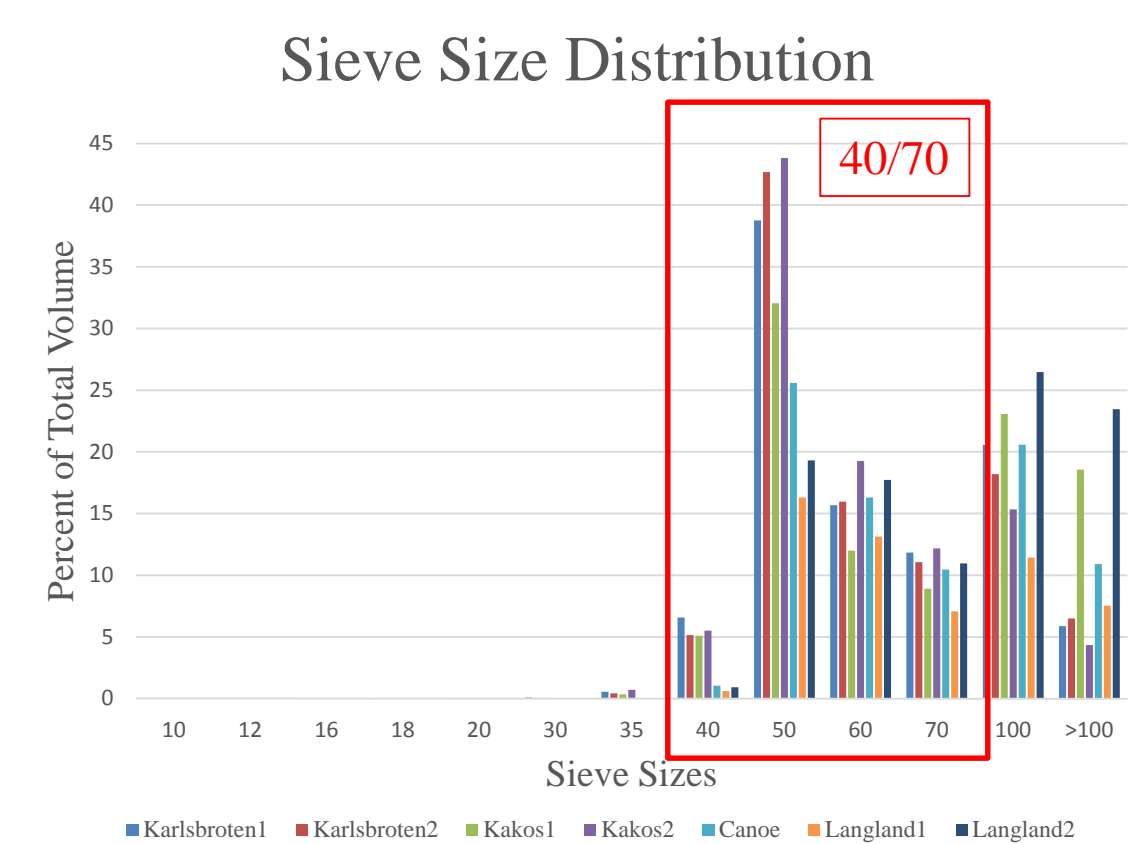


Figure 6: Grain size distribution by percent of total volume. 40/70 frac sand grade parameters outlined in red.

Petrographic Analysis

- Measures grain size
- Samples are made into thin-sections



Figure 7: Example of one sample made into a thin-section. The blue is the epoxy glue.

- Thin-sections are examined with a microscope connect to a computer that displays the image from under the microscope
- Grain sizes measured using the program Petrog
- Each end of the major and minor axes selected for each grain
- Number of grain sizes measured for each sample: 200 grains



Figure 8: Microscope setup with Petrog displayed on computer

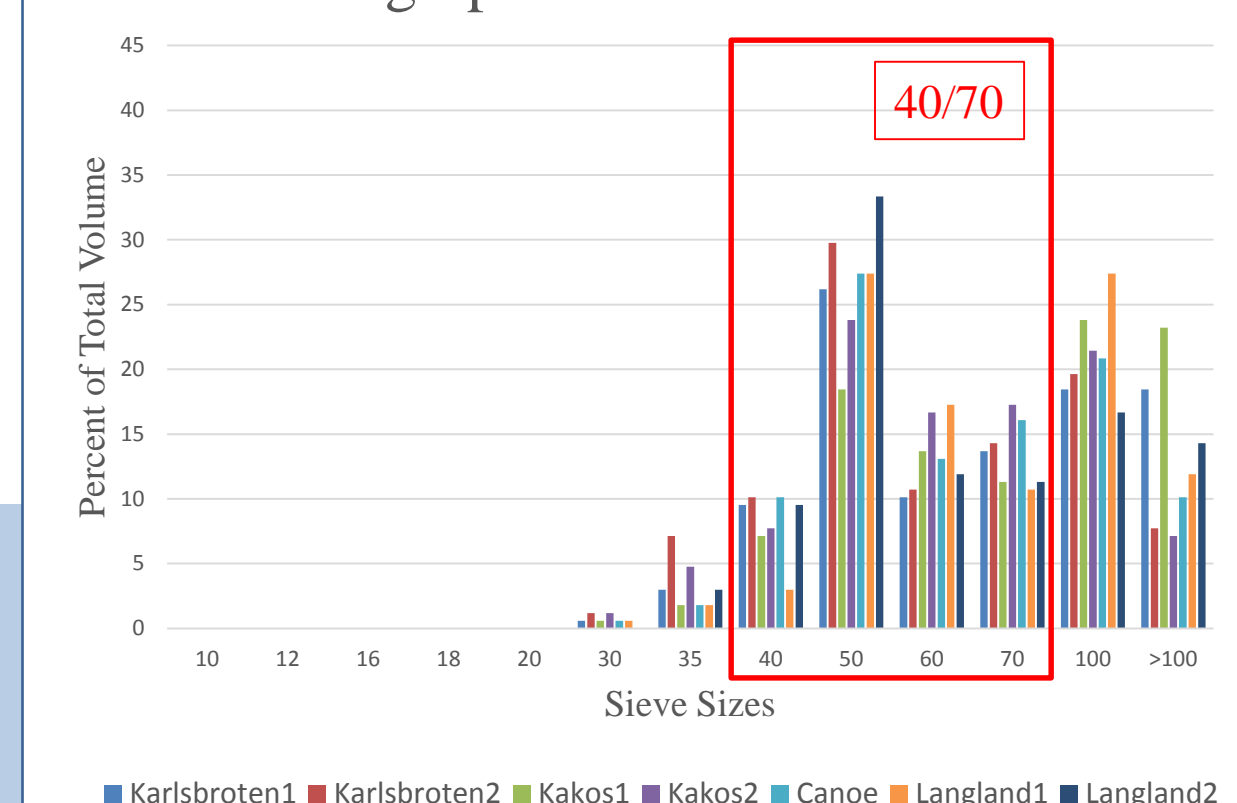


Figure 9: Grain size distribution by percent of total volume. 40/70 frac sand grade parameters outlined in red.

Overall Results

Comparison of the three analyses

- Camsizer vs. Sieve Analyses

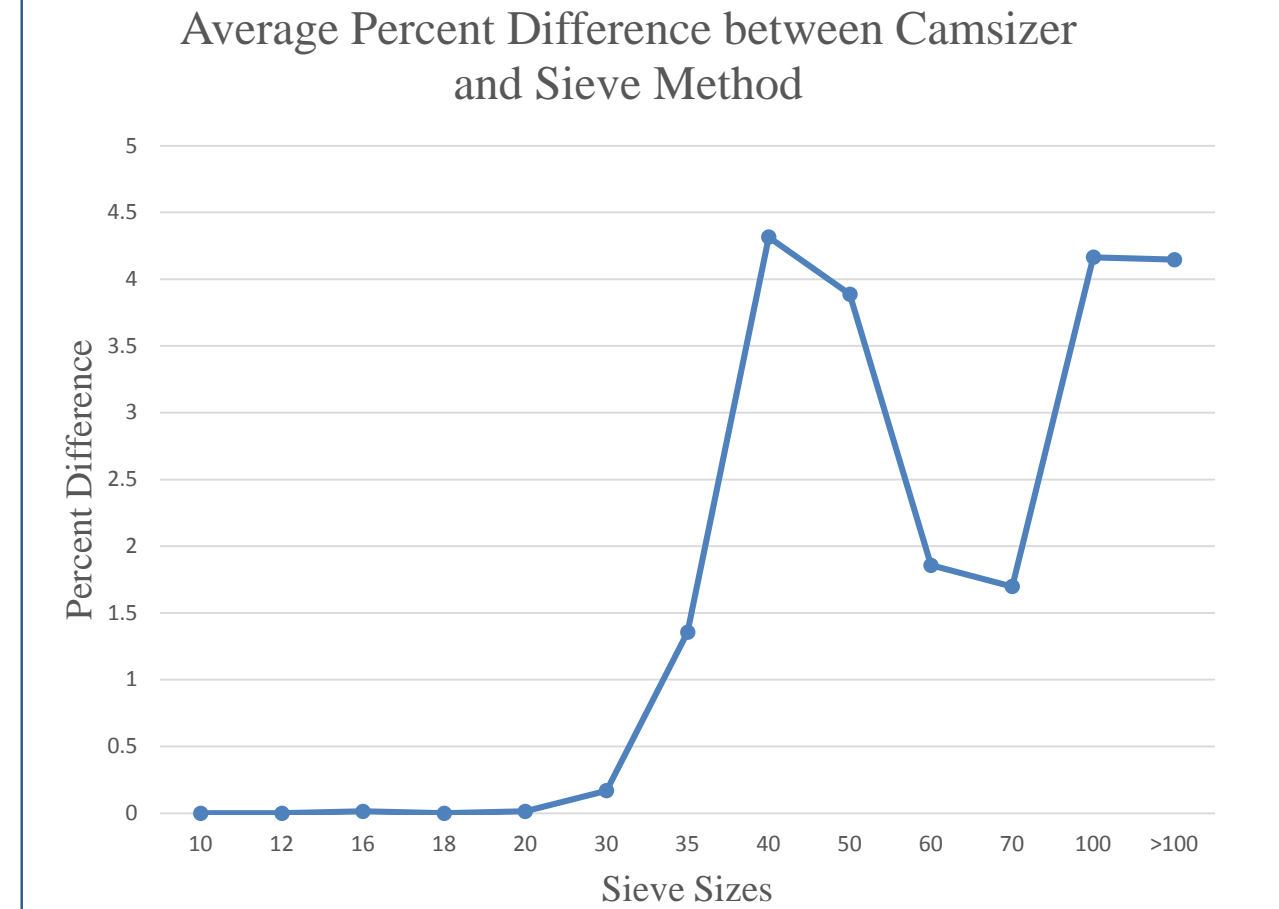


Figure 9: Average percent difference between the Camsizer and sieve method for measuring grain size.

- Camsizer vs. Petrographic Analyses

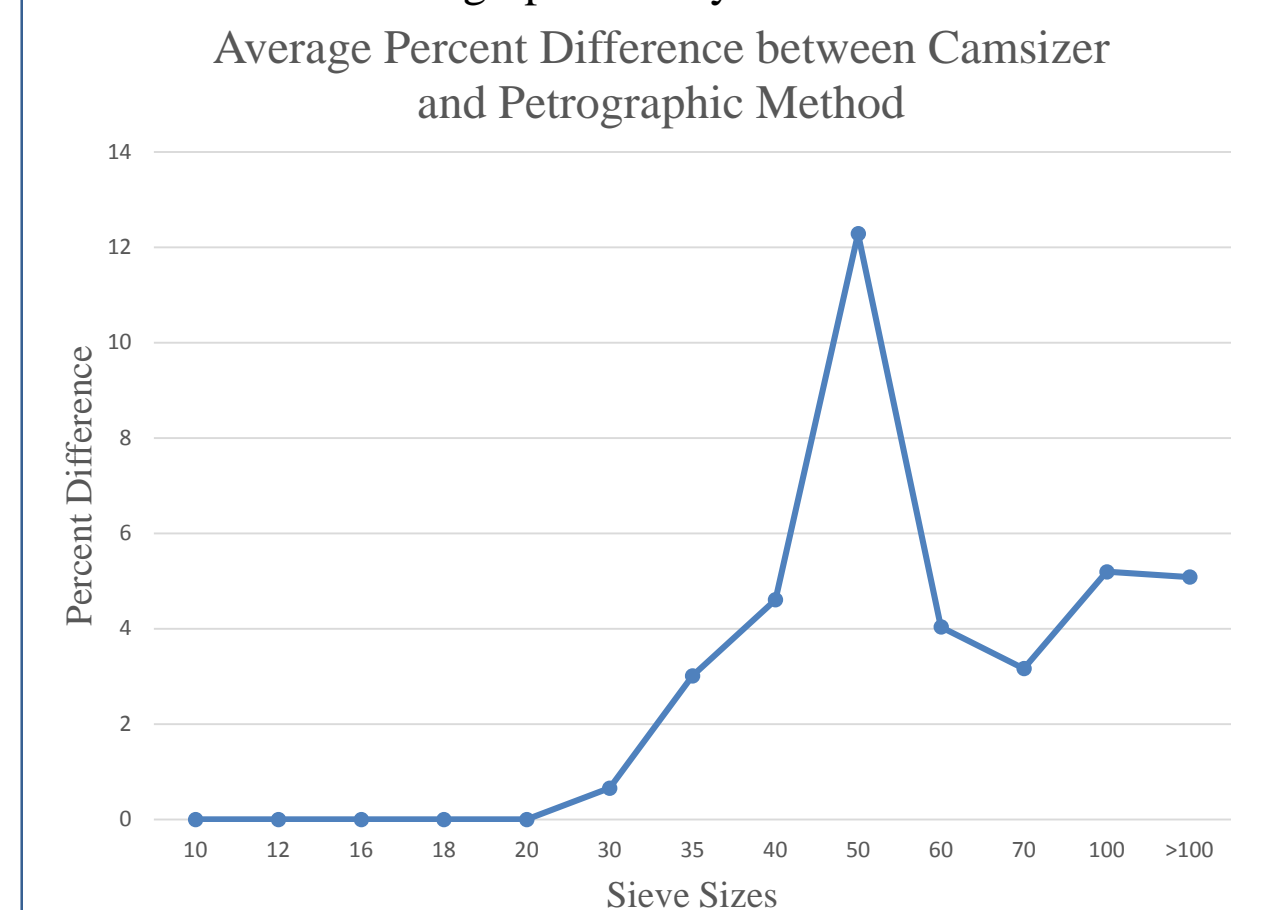


Figure 10: Average percent difference between the Camsizer and petrographic method for measuring grain size.

- Sieve vs. Petrographic Analyses

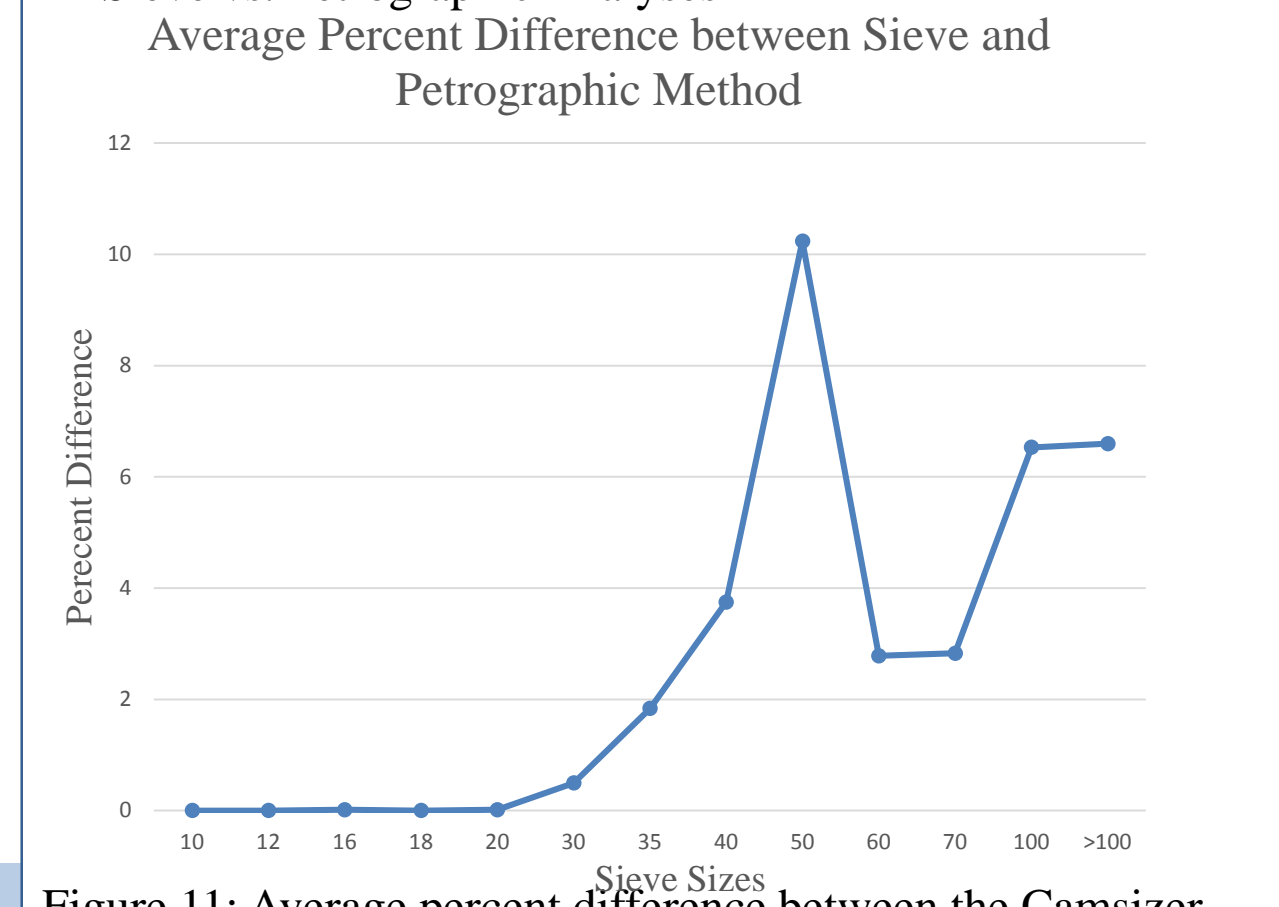


Figure 11: Average percent difference between the Camsizer and petrographic method for measuring grain size.

- Sands are suitable for the 40/70 frac sand grade