Stop The Sand Mafia!

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Introduction

Sand is the second most exploited natural resource in the world after fresh water and is being called "the new gold," as illegal mining groups known as the "sand mafia" fight to collect this valuable resource. Sand is used to build many objects such as glass, roads and concrete and as demands continue to grow, it is said we could run out of sand by 2050. It is difficult to track these extraction activities since there is lack of oversight, due to sand being easily accessible compared to other resources such as oil or coal. A new research method using luminescence geochronology could identify specific locations where sand is being extracted to help stop illegal sand extraction and help the environment.

The basic conception of luminescence provenance analysis starts with various source areas that have different sediment proportions. This sediment is amalgamated by transport processes downstream. Based on the decay curves of each region, we can see how much sediment from each region is being sourced into a river.

After analyzing the luminescence signals from sand samples, a comparison can be made to see if the sand samples collected from specific locations have unique luminescence properties that are characteristic of their origins. This technique could determine whether sand of unknown origin was illegally sourced based on measured luminescence signals.

How does OSL sensitivity fingerprinting work?

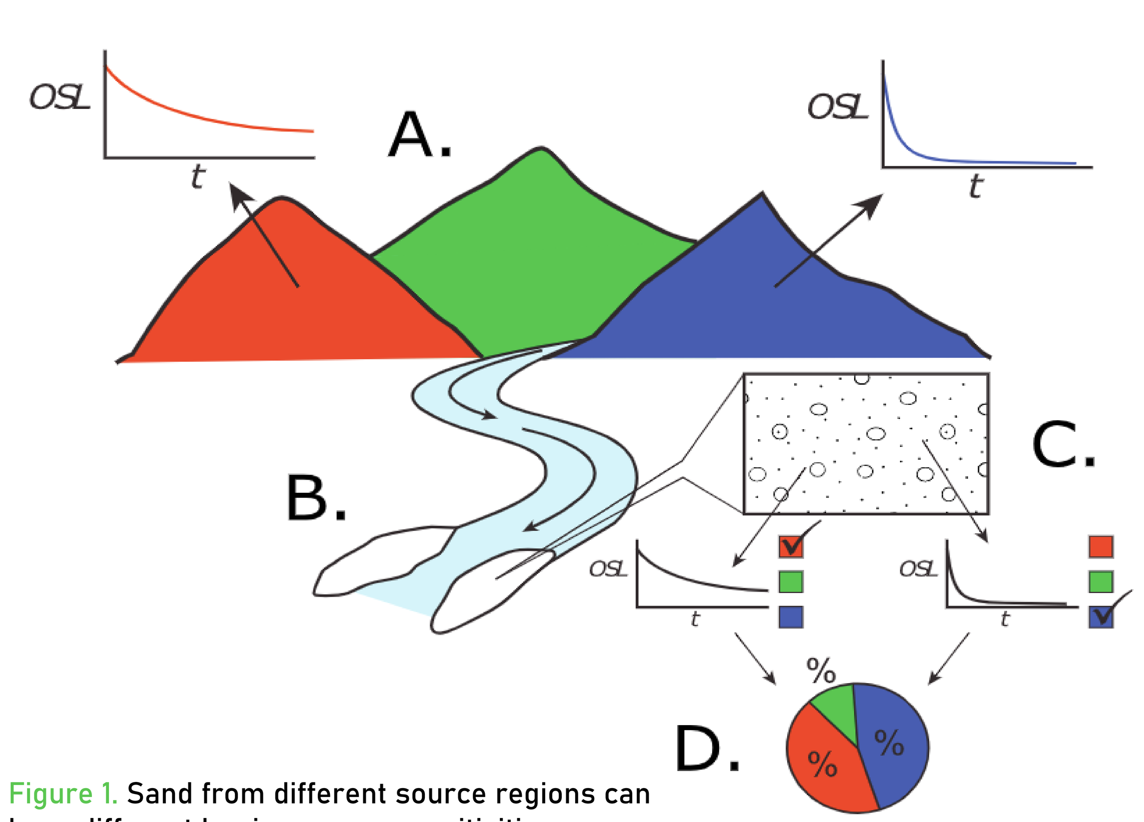

Figure 1. Sand from different source regions can have different luminescence sensitivities.

(Gray et al., 2019)

Methods

Sediment samples were collected from various Texas river locations. Once brought to the lab, I isolated 100-150µm quartz grains that were mounted on aluminum discs.
All discs are treated using the same radiation dose under an OSL machine and different signals were analyzed.
Thermoluminescence (TL) is measured by heating the sample to 190°C and the other measurement done shows the ratio of "fast" blue OSL signal to the "total" signal.

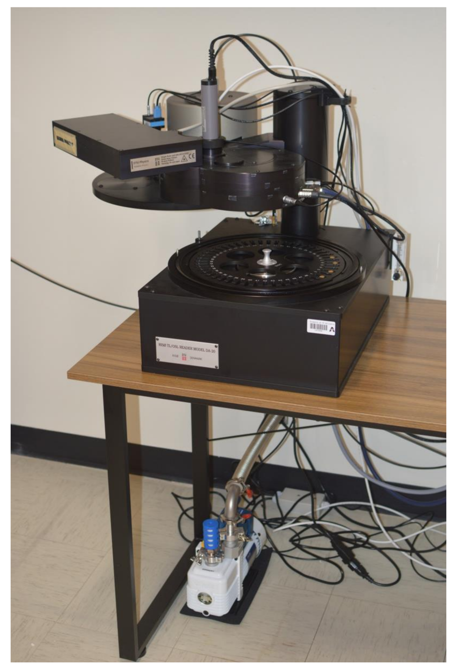

Figure 2. Optically Stimulated Luminescence (OSL) machine.

Ratio Figure

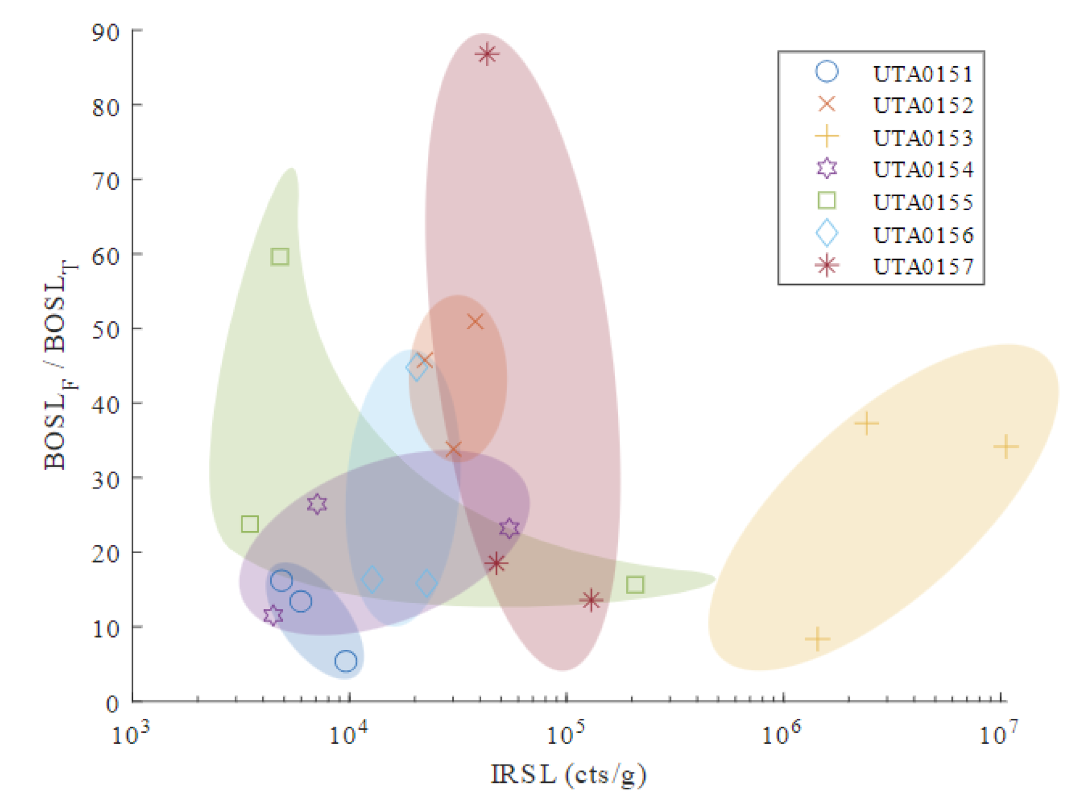

Figure 3. BOSL and IRSL luminescence sensitivities in polymineral aliquots of riverbed sands. (brighter quartz = higher values) plotted against the total infrared stimulated luminescence intensity, (brighter feldspar = higher values).

Thermoluminescence Figure

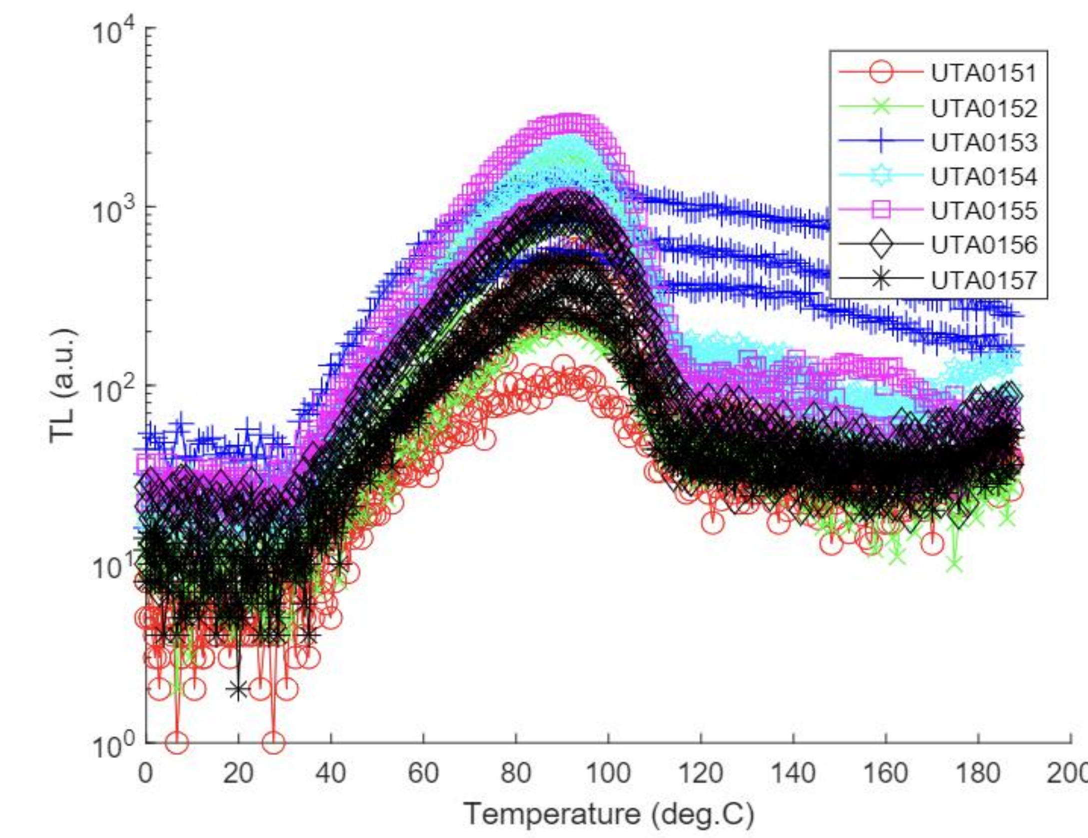

Figure 4. Thermoluminescence signals re-emitted as light upon heating the quartz minerals.

Texas River Systems Figure

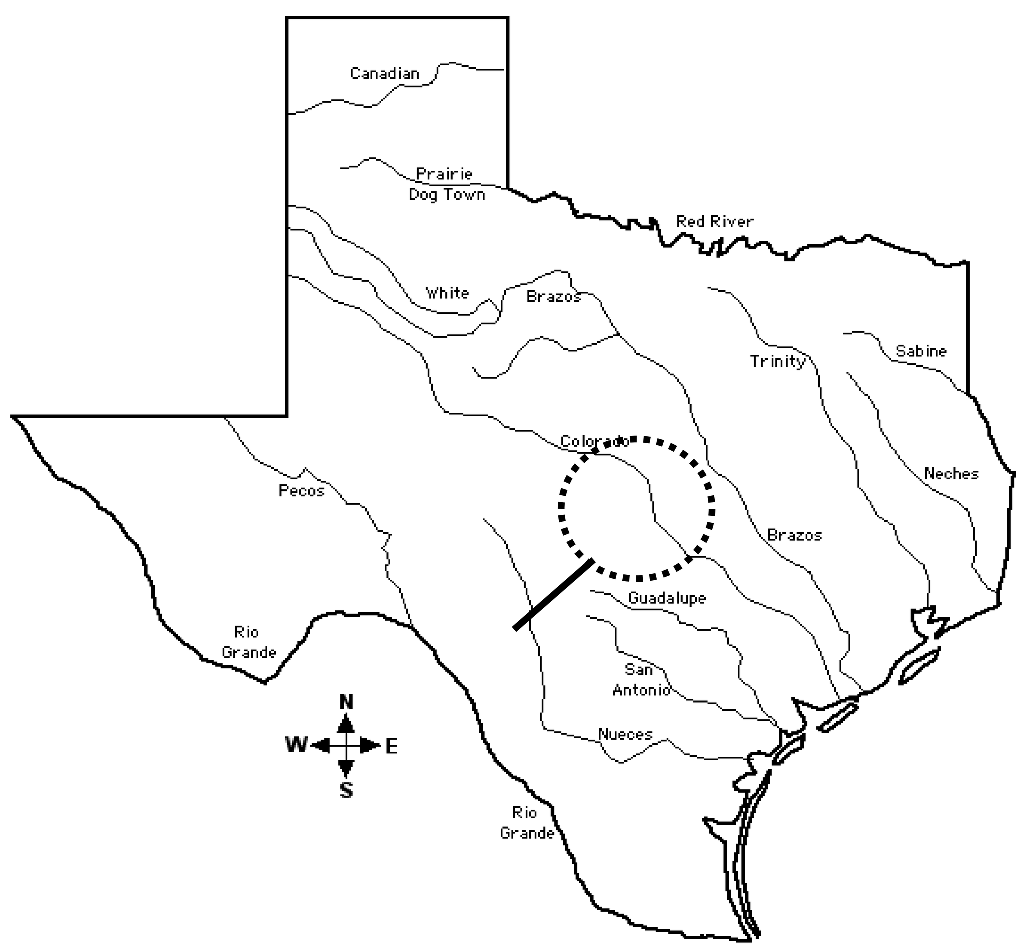

Figure 5. Major river systems in Texas with Llano Uplift region highlighted with magnifying glass.

(EnchantedLearning.com.,n.d.)

Geologic Map of Texas Figure

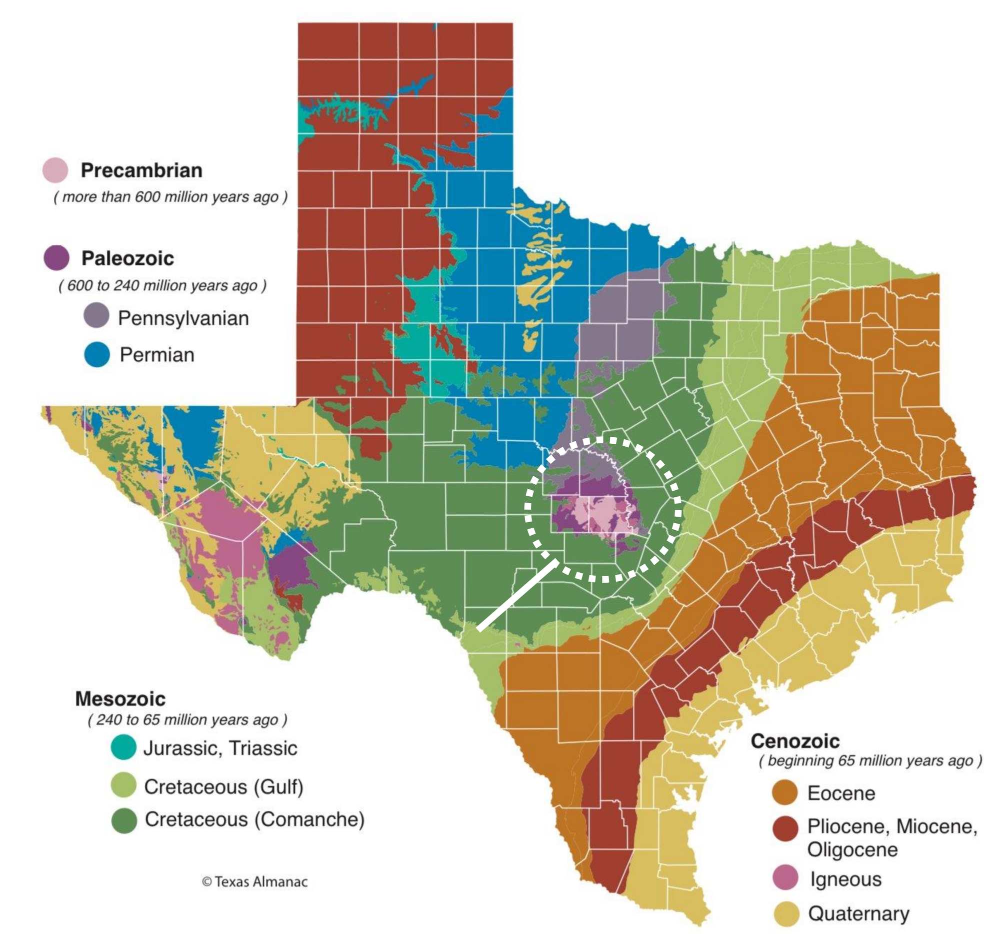

Figure 6. Geologic Map of Texas with Llano Uplift highlighted with magnifying glass.

(Texas eco-regions,n.d.)

Future Work: Texas Barrier Islands

Figure 7. Texas barrier islands.

Figure 8. Galveston island.

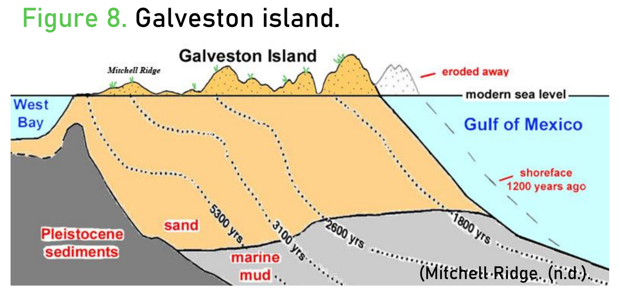

Figure 9. Galveston island depositional history.

Luminescence fingerprinting analysis could also be used for illicit sand mining at barrier island locations along with figuring out the geological history of these islands. By figuring out the ages and using sensitivity signals of minerals, we can determine if interglacial periods influenced source river changes.

Conclusions & Future Work

Samples from the Upper Colorado river are possibly "first-cycle" sources in that most of the sand is eroded primarily from crystalline basement rock in the Llano Uplift just a few thousand years ago. The other closely grouped samples are possibly "multi-cycled" sand in that the sand is either eroding from sedimentary rock regions, or from older shallow marine systems with high remobilization.

More detailed sampling of the Red, Brazos, and Colorado rivers will help in further understanding OSL sensitivity fingerprinting analysis of this region and could be correlated to other materials to prevent illicit sand mining. This fingerprinting method could potentially be used in analyzing modern barrier island systems to unravel the geologic history of sedimentation from different sand sources during glacial-interglacial transition periods.

Observation 1

Samples UTA0151 (Wilcox Silica Sand) and UTA0152 (County Line Gully) have tightly clustered readings that is unique to the region. Sample UTA0153 (Upper Colorado river) is the most different showing a higher Infrared Stimulated Luminescence (IRSL) sensitivity signal and is the most unique compared to the other river sediment samples.

Observation 2

Sample UTA0153 (Upper Colorado river) does not experience the typical quartz temperature drop off pattern found in the Thermoluminescence (TL) experiment and resembles a K-feldspar TL behavior.

Observation 3

Sample UTA0153 (Upper Colorado river) comes from the Llano Uplift region indicated by the magnifying glass on Figures 5 and 6. The Llano Uplift contains Precambrian igneous and metamorphic rocks which is different from the other Texas regions that are composed of sedimentary basement rock. This lithology changes causes the sensitivity signals to be different.

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