The Presence of Aeolian Loess in Northern Delaware and Southeastern Pennsylvania Soil Samples

December 8, 2015

Introduction to Loess

- Composed of terrestrial, clastic sediments.
- Formed by wind-blown dust accumulating.
- Composed of mostly silt-sized particles (20-50 um).
- Deposits are sub-aerial and must be predominantly from wind-blown particles.
- Deposits are thick, unstratified and often contain paleosols, leached layers and pedocomplexes

Loess Deposits

- Collapsible, highly erosion resistant
- Vertical slopes in outcrops

http://cas.umkc.edu/geosciences/env-sci/module8/pct2.GIF

Loess

- Loess is important texture from engineering standpoint.
  - Highly collapsible when wet from porosity and loose grain packing
- Paleontological studies of past glaciations and global atmospheric changes.
- Covers 10% of the land area.
- Found near glacial outwash and along east banks of rivers in the US.

http://gec.cr.usgs.gov/archive/eolian/images/14.gif

Genesis of Loess

- Periglacial conditions
- Another type of loess from mountainous areas
- Silt sized material abraded in several ways: glacial grinding, frost weathering, fluvial abrasion, or crushing.
- Quaternary Loess formed during last glacial maximum
- Loess forms in semi-arid to hyper-arid conditions
- Best environments for silt are glacial outwash plains, fluvio-glacial channels and wadi deposits.

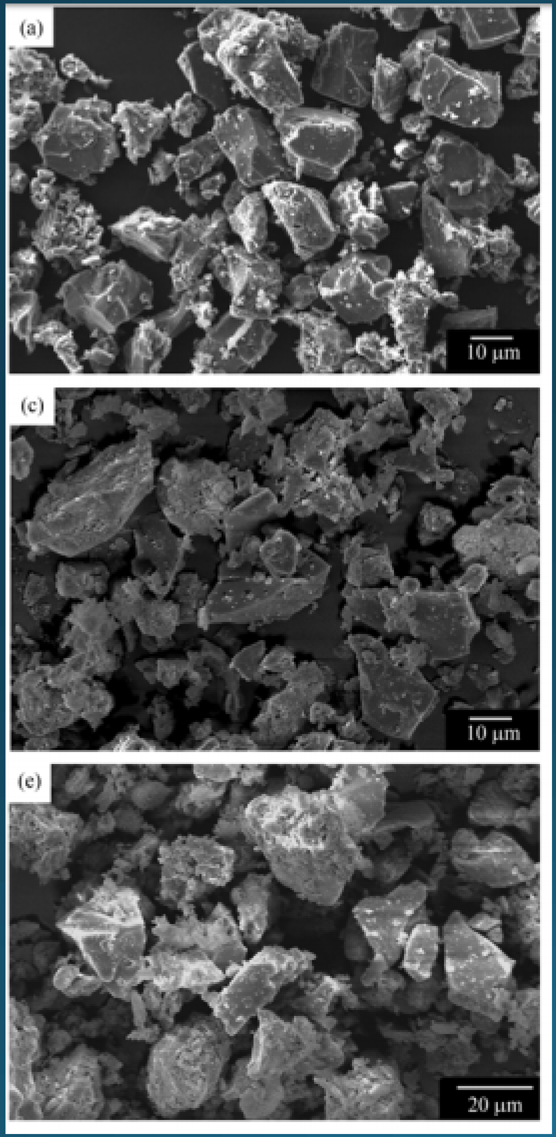
Loess formation theory

After silt particles are formed by one of the methods previously mentioned, it is picked up from the surface if there is a low level of humidity. When the velocity is above the critical shear velocity (20-40 cm/s) the particles will be moved by the wind. The particles are often assisted in lifting by impacts from saltating grains, which is why an arid to semi-arid environment is key to Aeolian transport (Iriondo 2007). Loess belts will be deposited when the silt reaches vegetation or grass and becomes trapped.

Mineral Content of Loess

- Large variation of minerals in loess, making loess difficult to identify.
- Dominant feature is quartz.
- Can also contain feldspars, carbonates, heavy minerals, clay minerals and volcanic material.
- Contains more than 50% silt particles and variable amounts of sand and clay.

Loess particle morphology



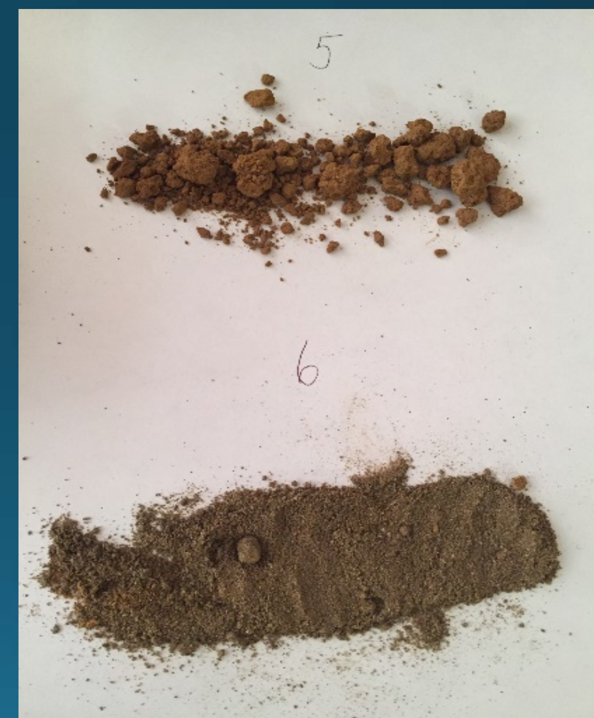
- Very different from wind abrade sand particles in shape.
- Loess studies in Long island was flattened, and angular to sub rounded in outline.
- Clay generally adheres to the surface.
- European loess generally sharp and unweathered with calcium carbonate encrustations.
- Individual particles can show a blade-like shape.

Samples

- The samples were collected by Mr. Russell Losco
- All were the Glenelg soil series

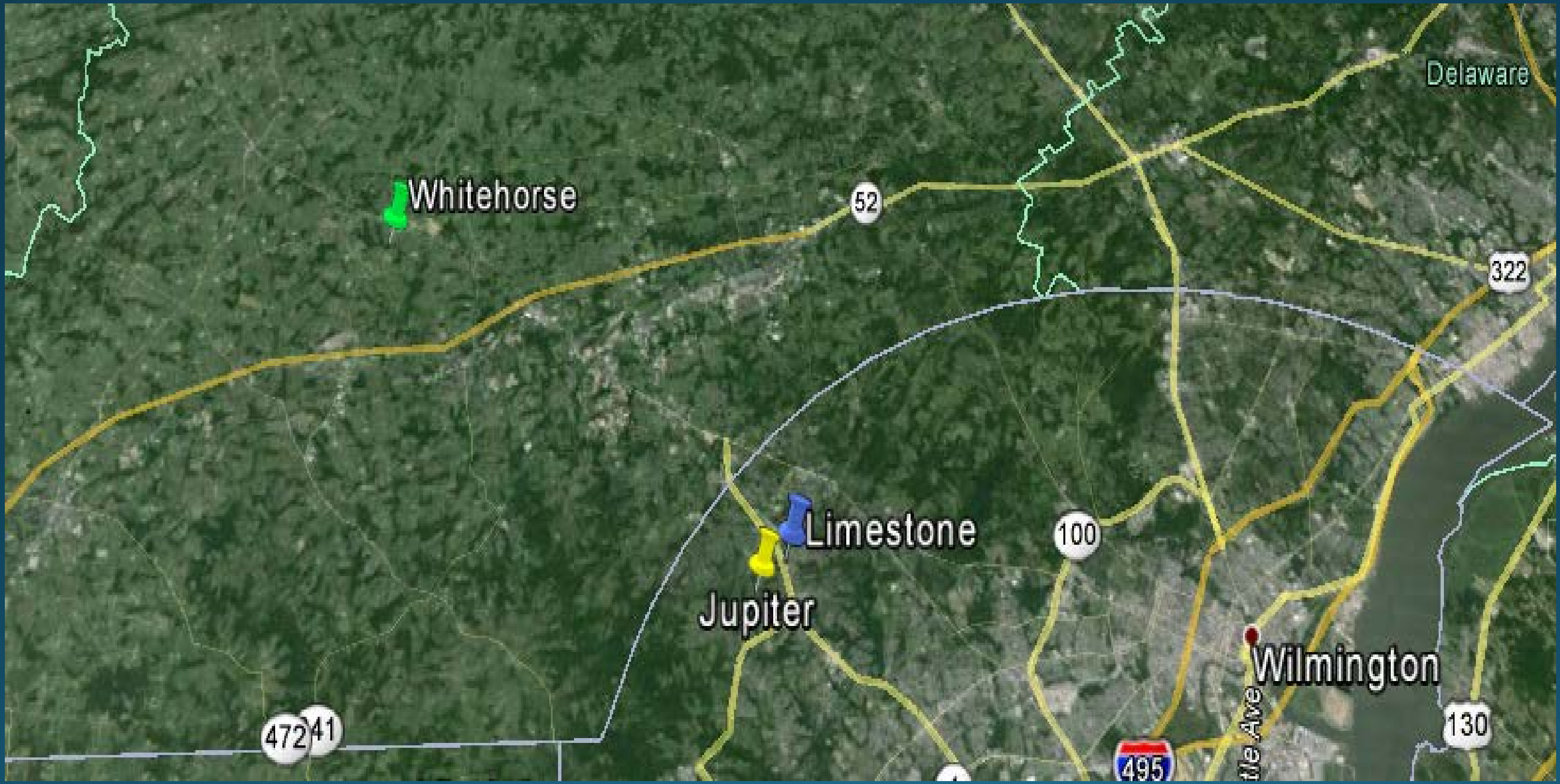
Whitehorse

Limestone



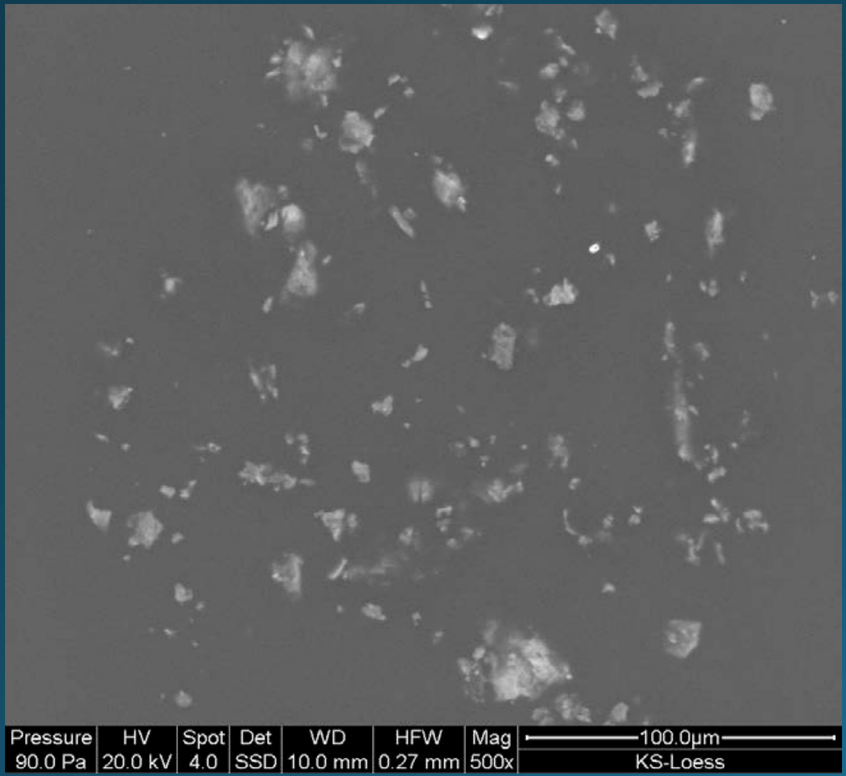
Jupiter

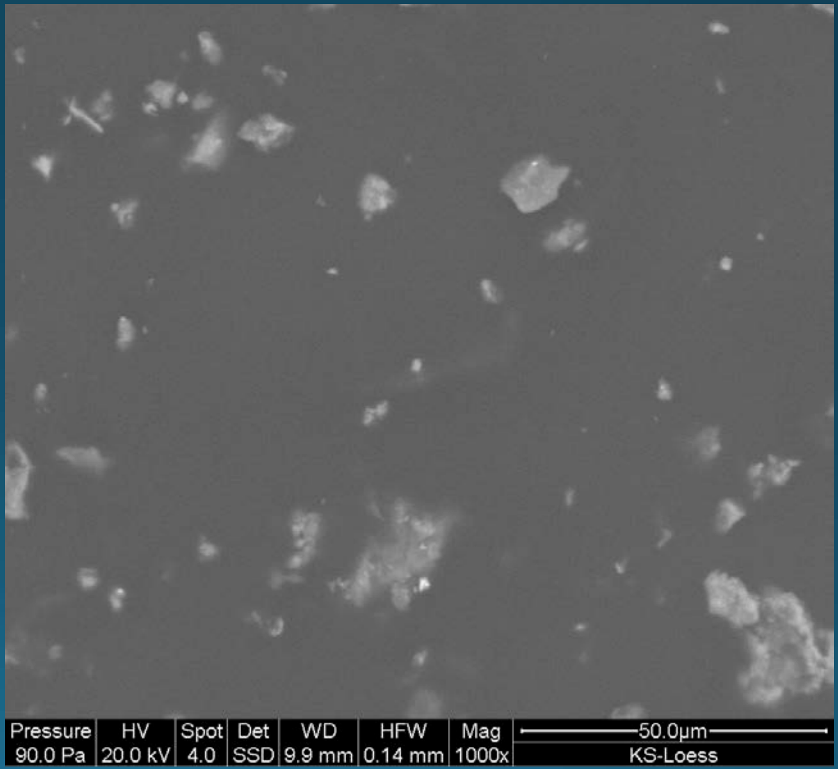
Map of soil samples



Methods

- First Set
  - Samples prepared by sprinkling soil onto epoxy coated slides

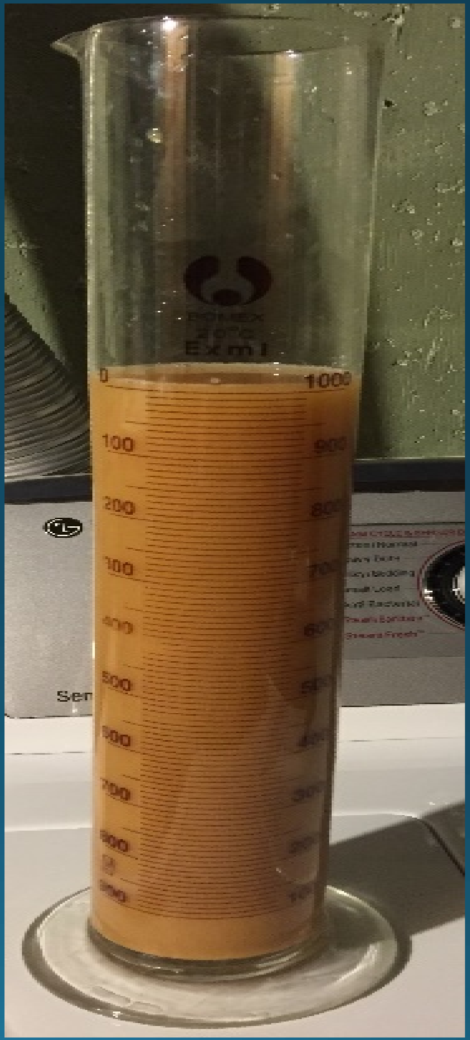




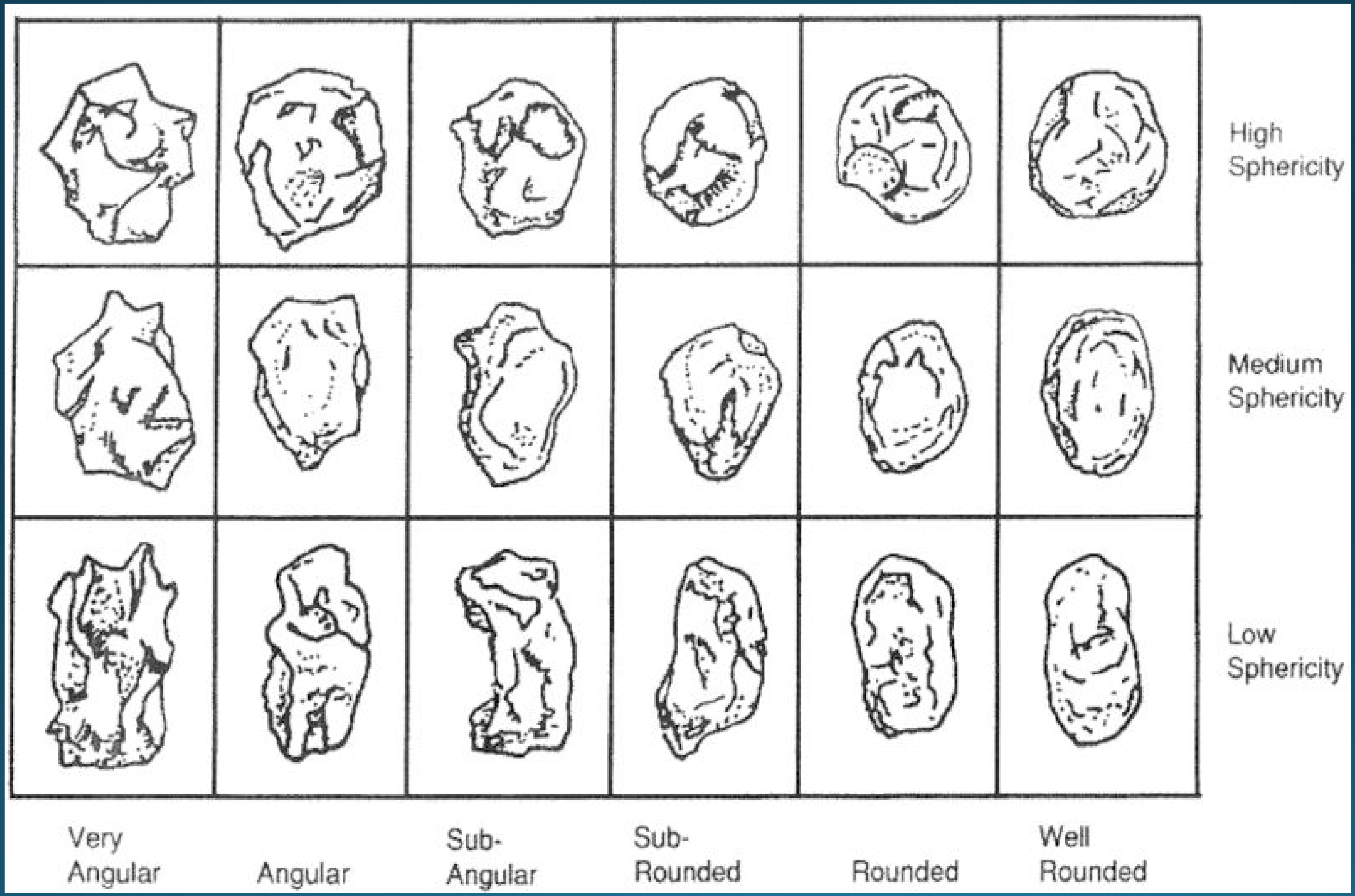
Two selections from the first set of samples of Kansas Loess, blurry from sinking into the epoxy. These samples were not used for analysis.

Methods

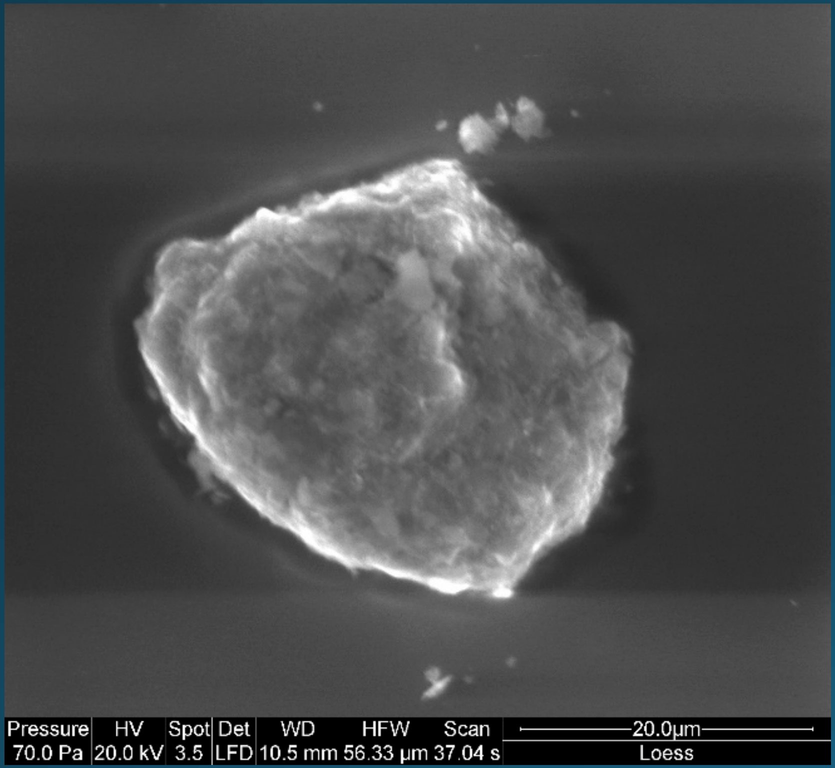
- Second set
  - Samples mixed with Calgon to break up particles.
  - Sorted through 3 sieves.
  - Clay was removed using Stokes Law.

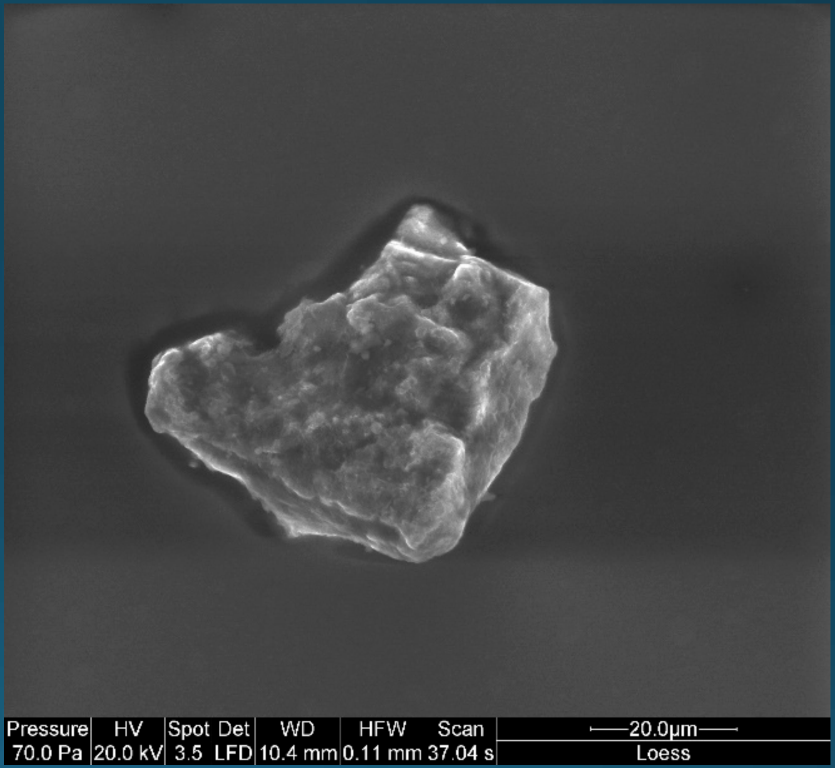


Particle analysis



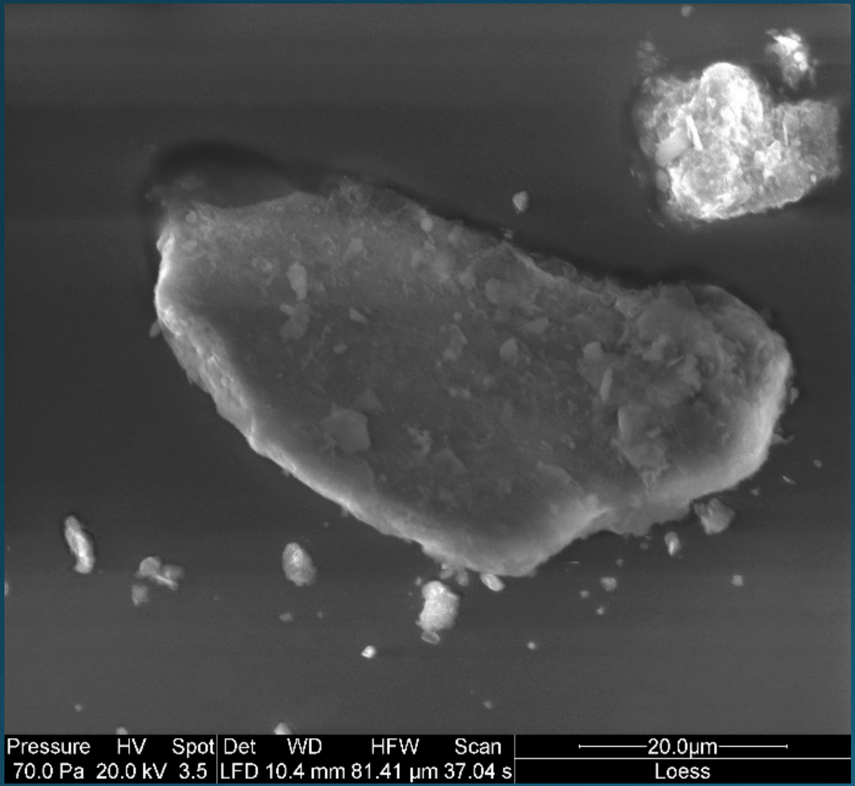
Kansas Loess

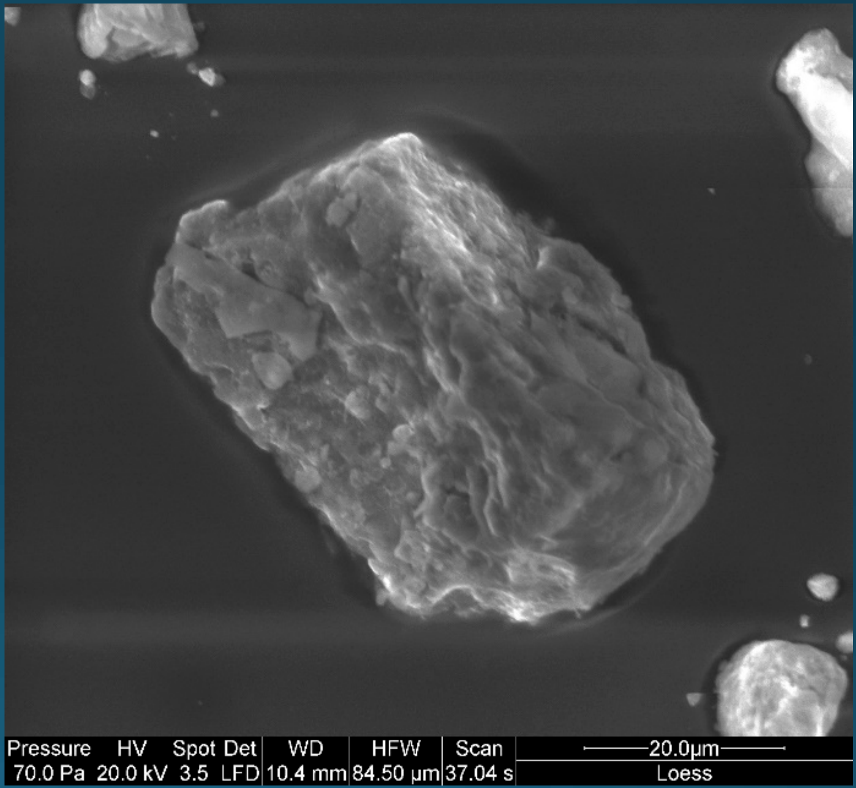




Kansas Loess A & B showing flattened particles, slightly bladed, with jagged, angular edges. The surface is coated with clay particles.

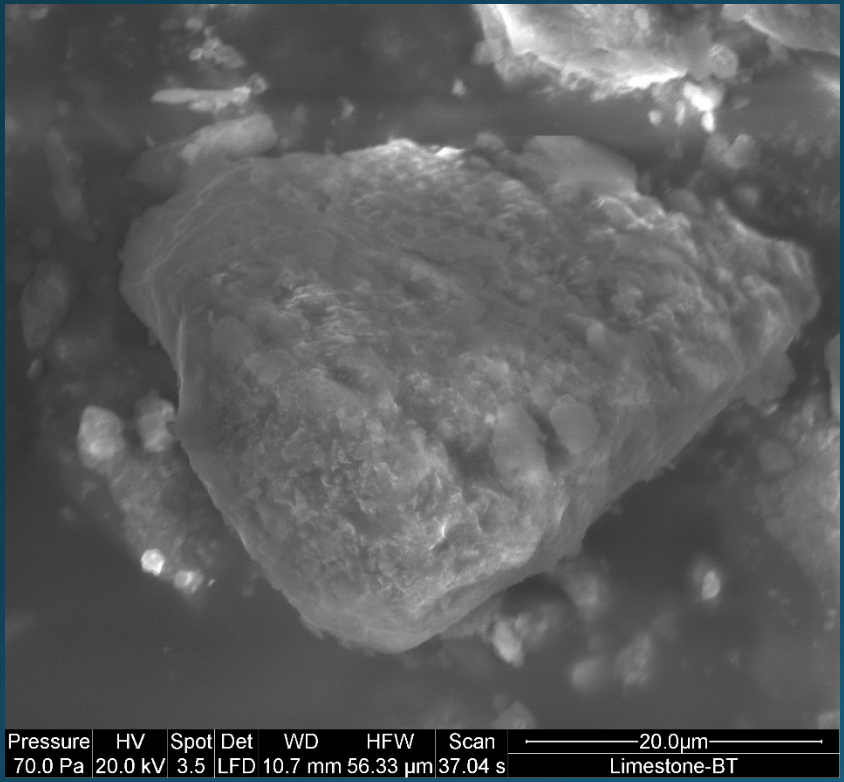
Kansas Loess

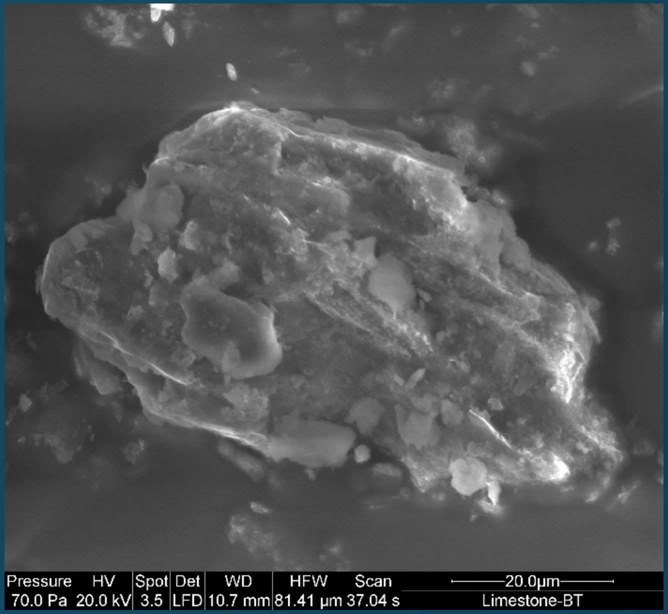


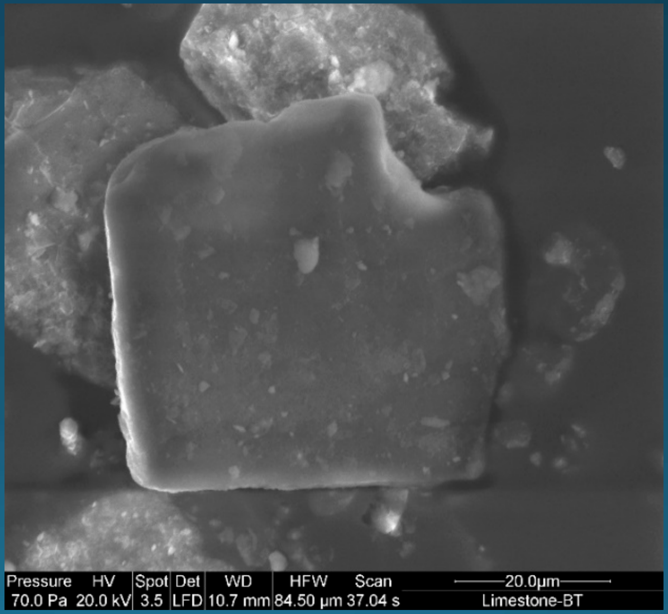


Kansas Loess pictures C and D which exhibit the bladed features of a typical loess with clay concretions on the outside.

Limestone Bt

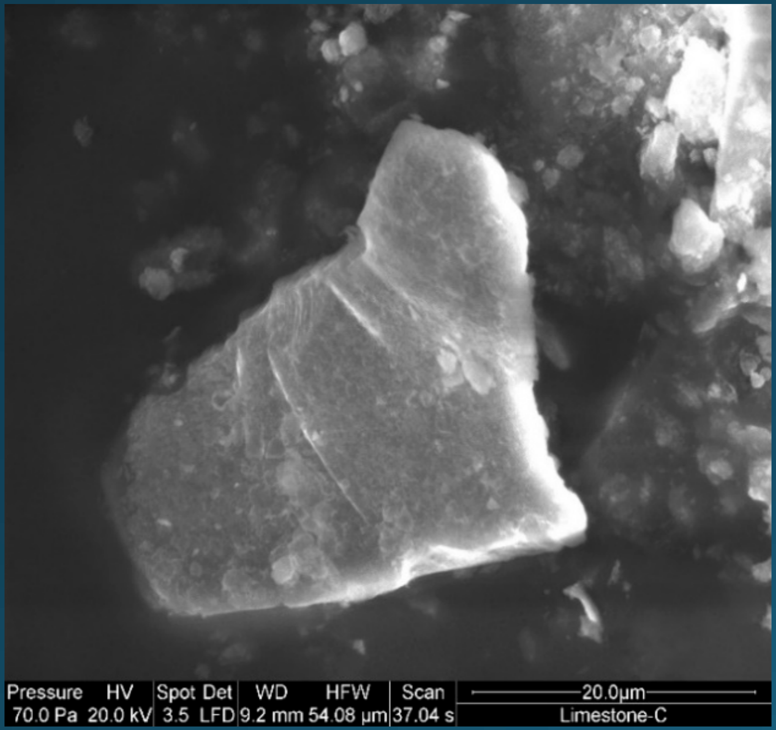


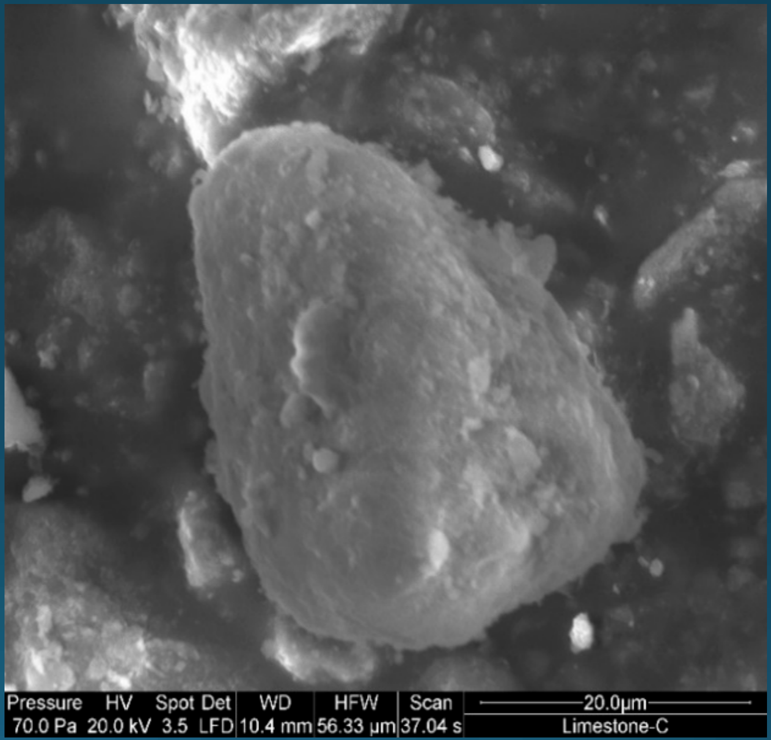




Limestone Bt particles, with large amounts of concretions. Both particles are angular with low and medium sphericity. This sample does not fit in with the description of standard loess particles.

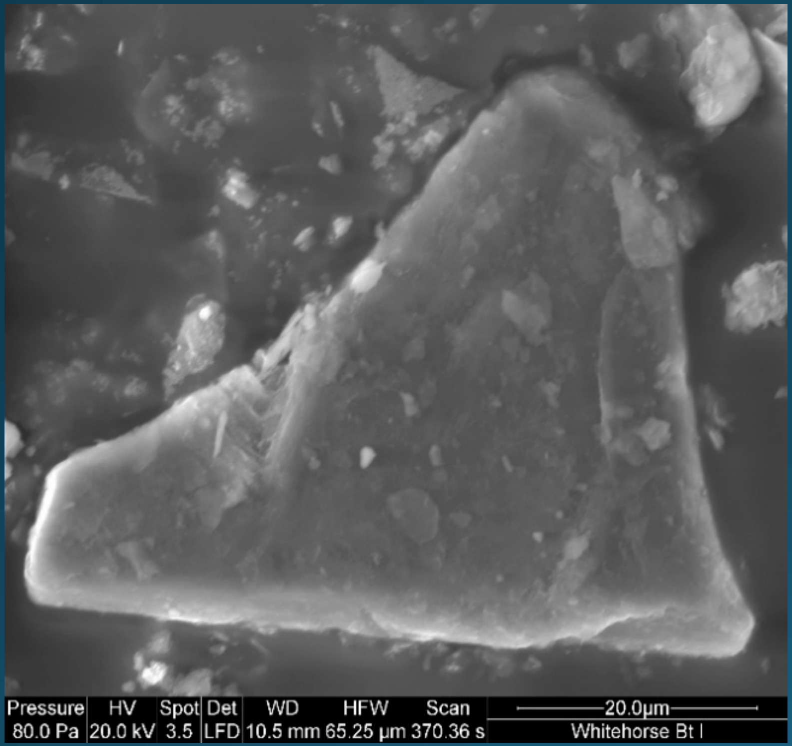
Limestone C

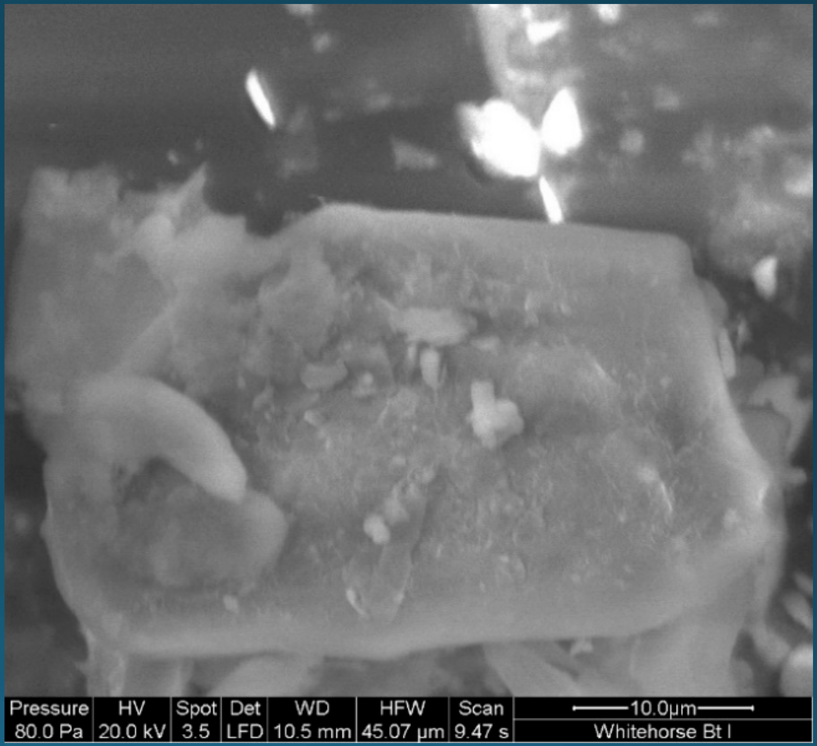




Limestone C particles. We do not expect to find loess in this horizon with is generally sub-angular with low to high sphericities.

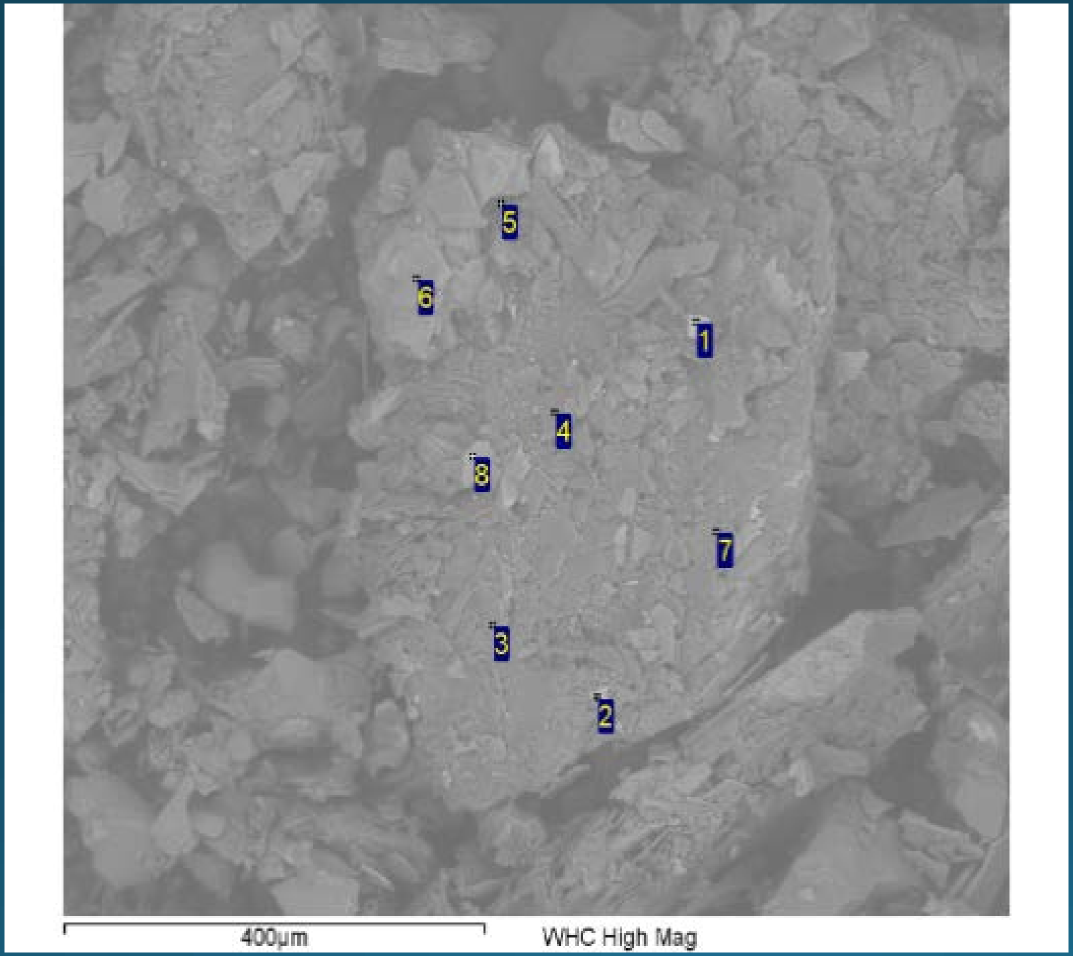
Whitehorse Bt





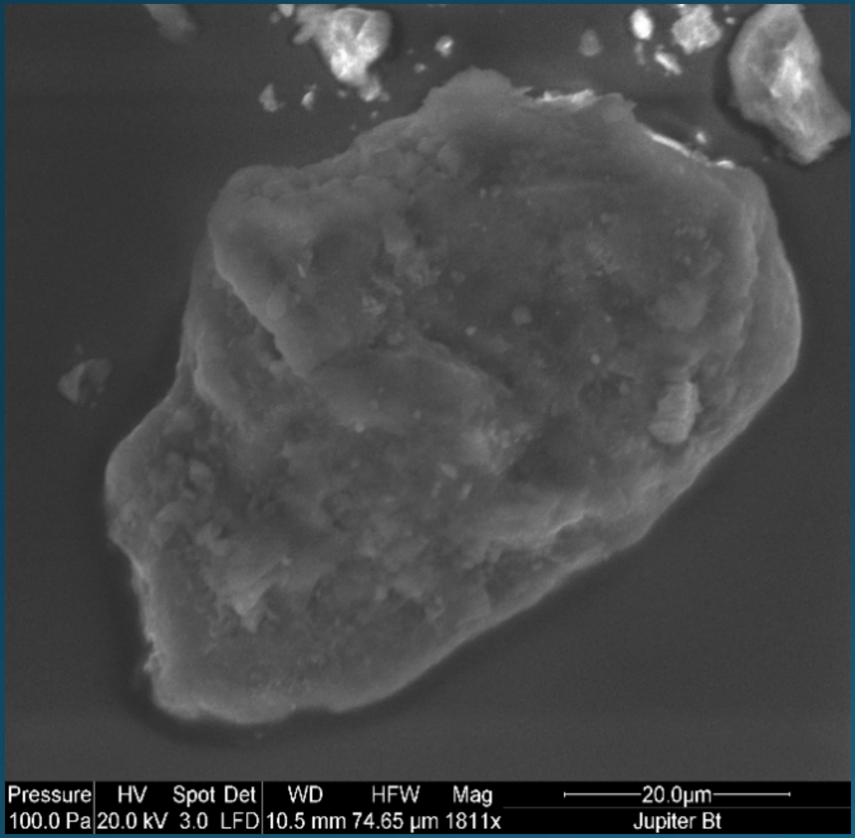
Whitehorse Bt particles, both sub-angular with low sphericity.
Sample 2 shows a bladed shape.

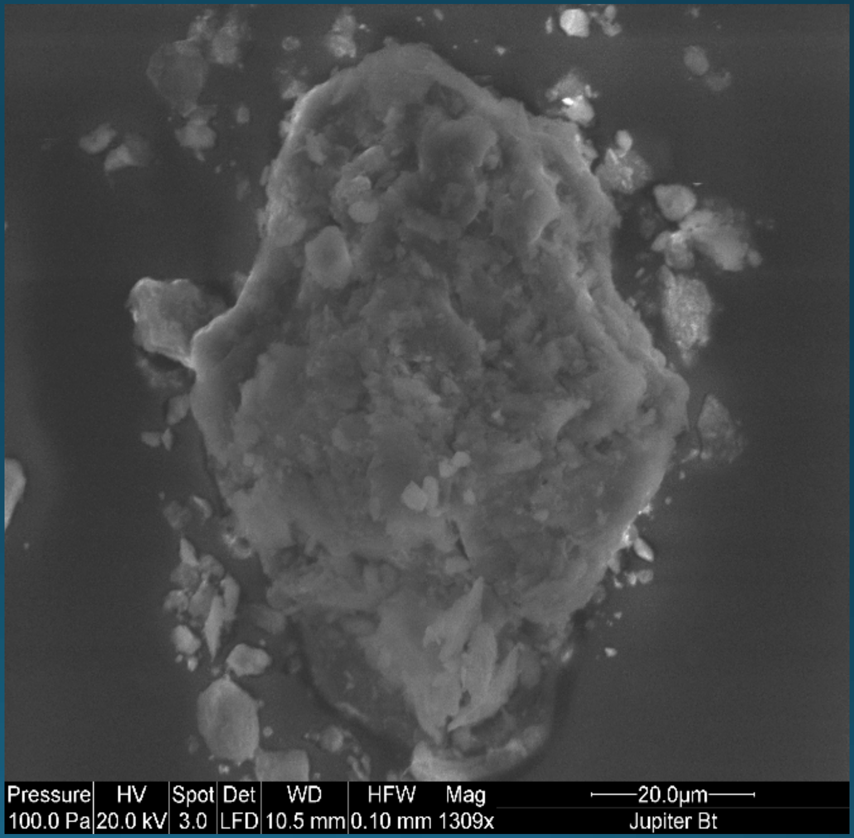
Whitehorse C



Whitehorse C horizon, showing a fairly weathered particle covered in concretions.

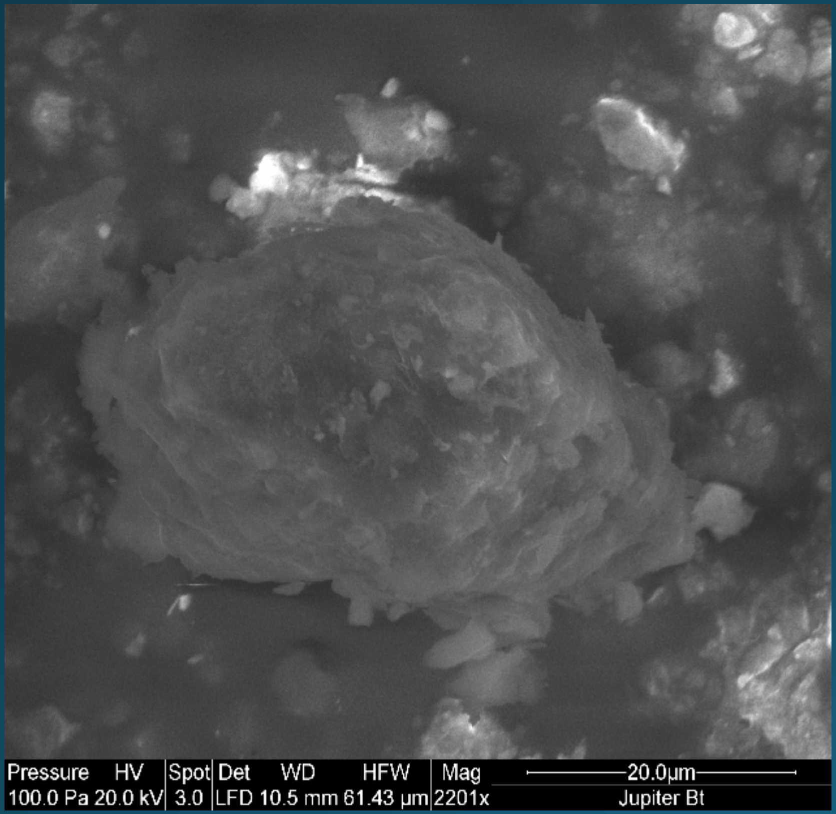
Jupiter Bt

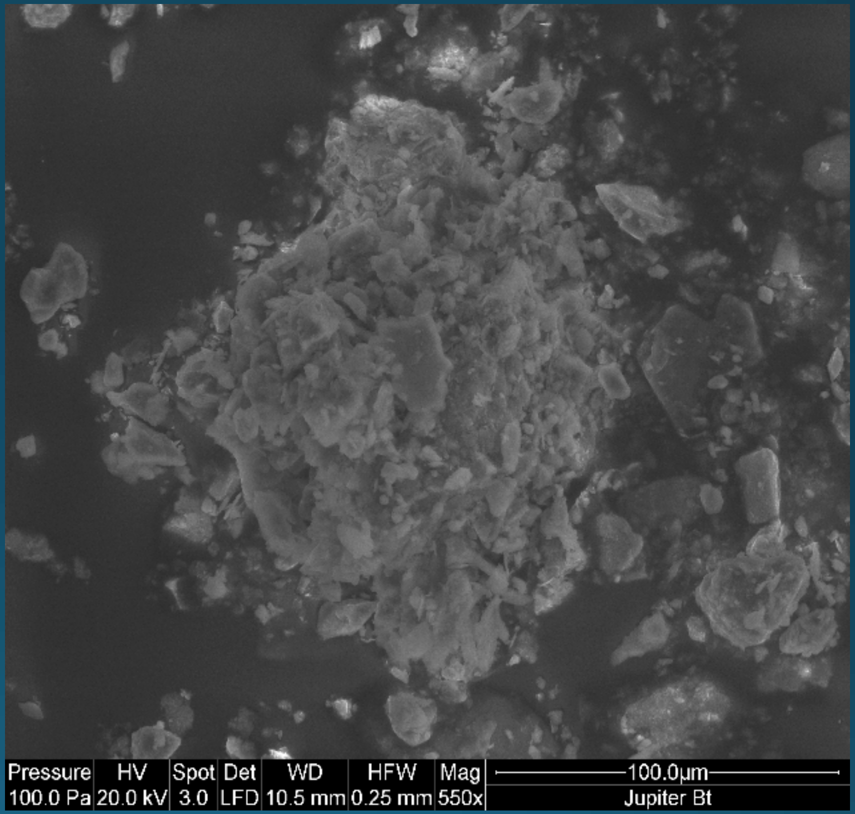




These samples are all sub-angular with medium sphericity. None of them are bladed.

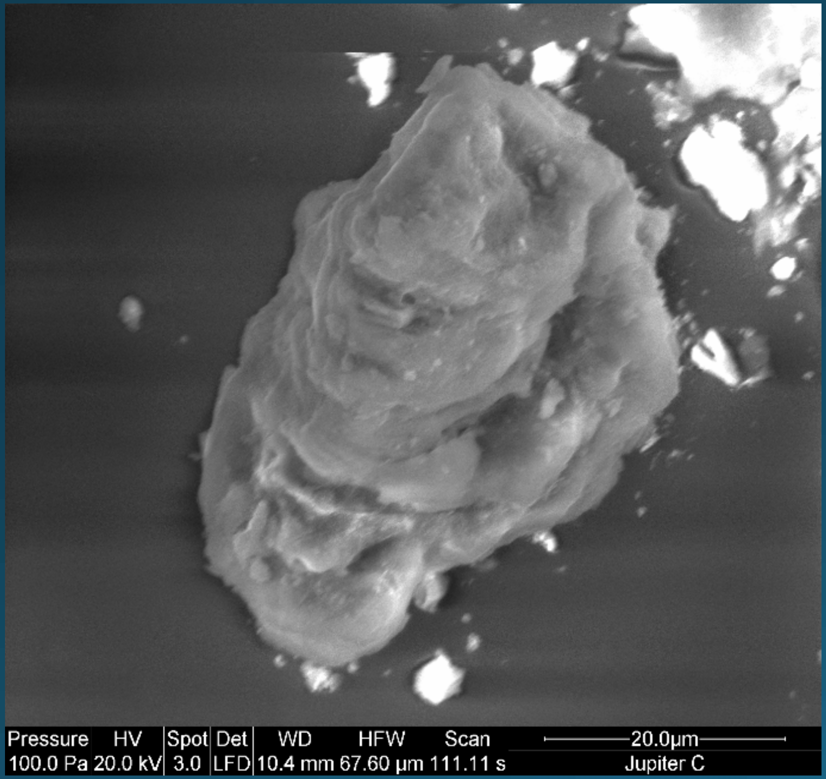
Jupiter Bt

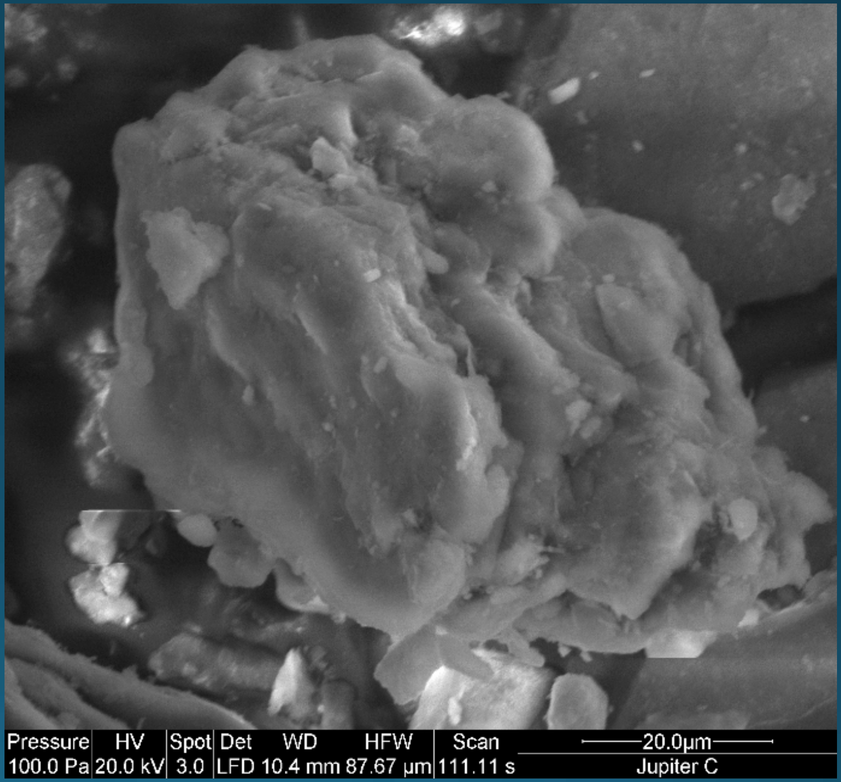




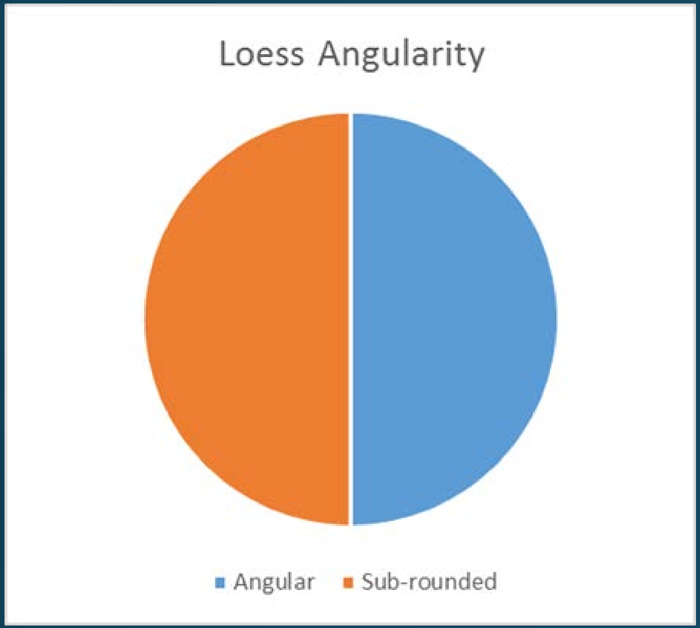
The sample on the right is a conglomerate. It is hard to make a determination of the shape and weathering of this one. The particle on the left is similar to the other Jupiter Bt samples.

Jupiter C

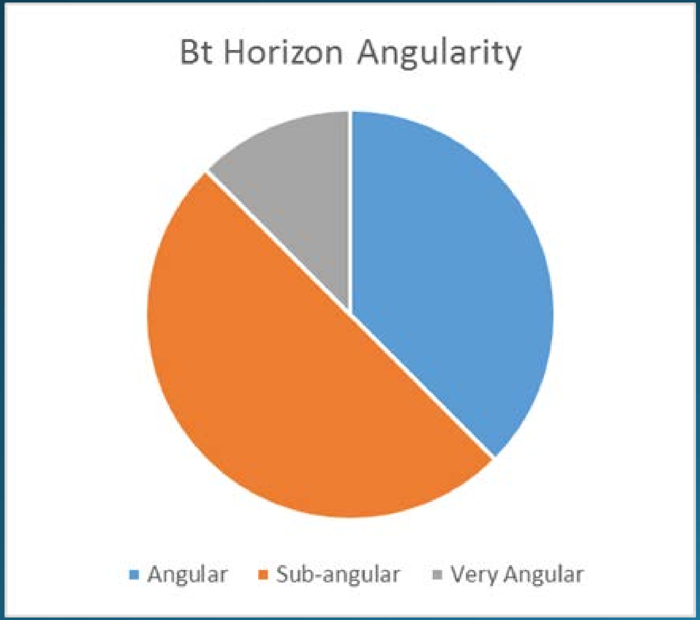


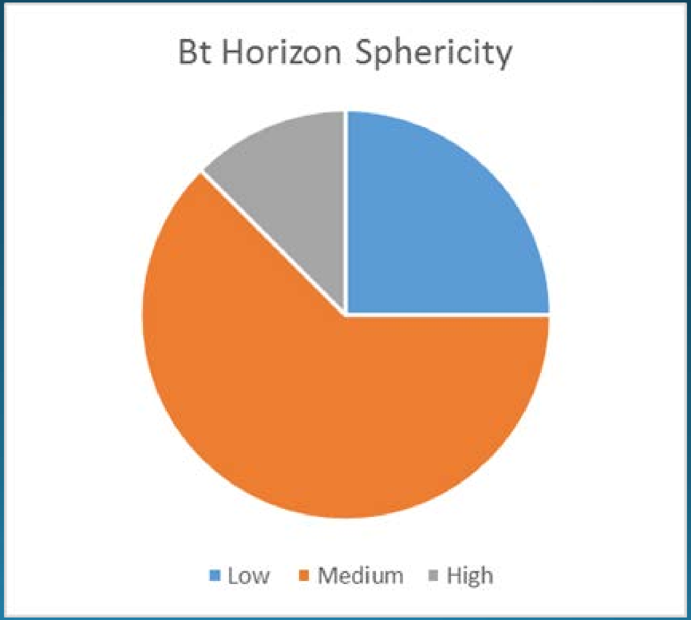


All four pictures showed a platy morphology and are angular with a low sphericity.


Loess Angularity
Angular
Sub-rounded


Loess Sphericity
Low
Medium


Bt Horizon Angularity
Angular
Sub-angular
Very Angular


Bt Horizon Sphericity
Low
Medium
High

Results

- Kansas loess had classic loess morphology under the SEM
- Angular to sub rounded with low sphericity.
- Loess was generally jagged and unweathered.

- Limestone Bt and Whitehorse Bt had particles with morphology similar to loess.
- Both had angular particles, unweathered, covered in clay particles.

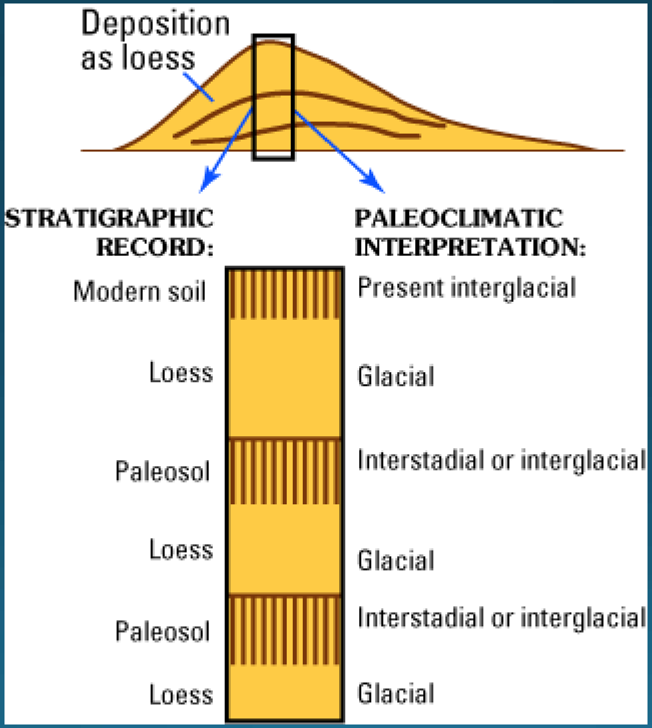
- Jupiter samples were most dissimilar to the loess.

Conclusions

- Limestone and Whitehorse Bt samples had particles similar to loess silt.
- Unlikely Jupiter Bt contains loess based on the particles viewed in SEM.

- Could build upon study using morphometrics.

- Likely that Limestone and Whitehorse locations, soil boundaries between B and C mark ancient land surface.



http://gec.cr.usgs.gov/archive/eolian/images/11a.gif

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