Climate Significance of Magnetic Material in Windblown Dust Deposits, Palouse Loess WA

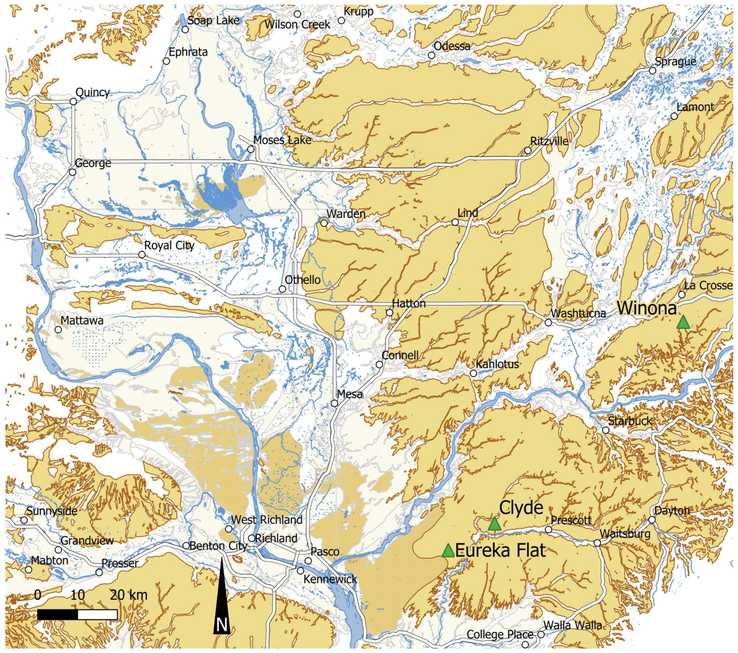
Ricks, Kristy and Selkin, Peter

Introduction

> Loess is a deposit of windblown silt formed from glacier movement, weathering, and flooding associated with glacial episodes which erode and transport sediment.

> The composition of magnetic material in loess can be used to determine past climates. Magnetic susceptibility, which measures the concentration and type of magnetic material, is typically used as a climate indicator in loess.

> Palouse loess accumulated over a 2-million-year interval between the Pleistocene and Holocene. Magnetic susceptibility in the Palouse is related to the silt content, but we are unsure of what the connection is.



Above Map of sites in Eastern Washington. Eureka Flat (source), Clyde (loess deposits). (DNR 2016)

Methods

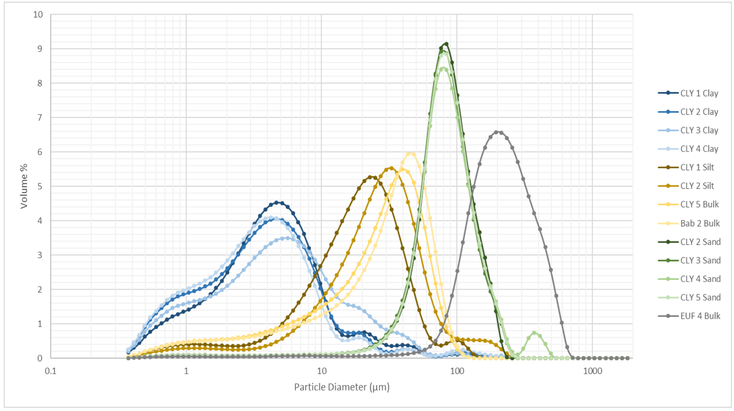
> Each sample was collected at well-documented loess outcrops near Clyde, WA also sampled by King (2000)

> Size-fractionated samples were separated into sand, silt, and clay by disaggregating in water and $Na_6[(PO_3)_6]$, sieving to separate sand fractions, and settling to separate silt and clay.

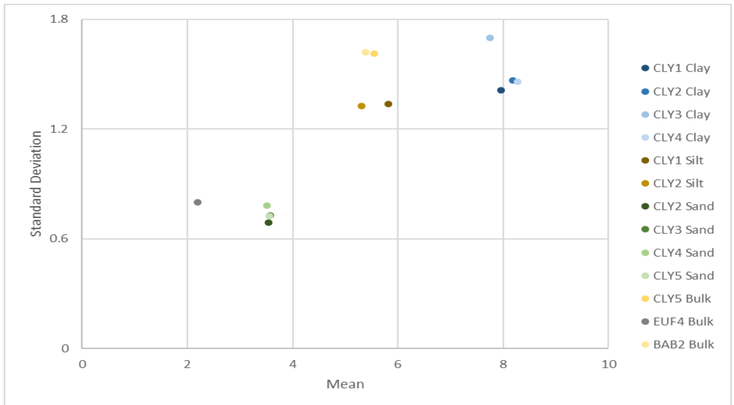
> Using the Bartington MS2B, magnetic susceptibility was measured at high (4700 Hz) and low (470 Hz) frequencies.

> Using the Beckman Coulter LS 13 320 PSA to measure particle size distribution of bulk samples

Results



Above Mean and standard deviation of the particle sizes (Wentworth φ scale).



Above Particle size distributions collected from the samples.

AVERAGE of mass normalized susceptibility		Particle Size		
Bulk Sample Number	Meas Type	Sand	Clay	Silt
CLY1			6.8588×10^{-7}	-1.1826×10^{-6}
CLY2	LF	3.2488×10^{-6}	1.2539×10^{-7}	4.6071×10^{-7}
CLY3	LF	7.2756×10^{-7}	1.0015×10^{-6}	
CLY4	LF	8.2635×10^{-7}	4.6555×10^{-7}	
CLY5	LF	8.9583×10^{-7}		

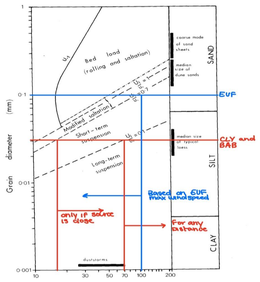
Above Pivot Table of sample magnetic susceptibilities.

Discussion

> Positive magnetic susceptibilities indicate that most Clyde loess deposits contain ferromagnetic material such as magnetite.

> CLY1 Silt turned out negative, meaning that the materials are diamagnetic; this is to be expected when soils are rich with materials such as quartz and feldspars. This suggests the variations of magnetic minerals in the silt rather than the silt content itself are the reason for the magnetic susceptibilities observed by King (2000).

> The bulk sediment samples from the Clyde outcrop have similar particle size distributions to each other.



Above Transport of particles depending on wind velocity in meters per second. (Tsoar and Pye 1987)

Conclusion

> Relative wind speeds based on particle sizes from the bulk sediments were between 15m/s (33.5mph, or near gale winds) and 70m/s (223mph, or EF4 tornado winds, according to the Enhanced Fujita Scale).

> We still don't understand the connection between magnetic susceptibility and silt content, but the further studies of silt separates could possibly provide a more detailed analysis between magnetic susceptibility and silt content.

References

[DNR] Washington Department of Natural Resources. 2016. Geology GIS Data and Databases, 1:100 000. [accessed 2022 May 31]. https://www.dnr.wa.gov/programs-and-services/geology/publications-and-data/gis-data-and-databases.

King M. 2000. Late Quaternary loess-paleosol sequences in the Palouse, Northwest USA: pedosedimentary and paleoclimatic significance [Centre for Quaternary Research]. [Department of Geography]: University of London.

Pye K. 1995. The nature, origin and accumulation of loess. Quaternary Science Reviews. 14(7–8):653–667. doi:10.1016/0277-3791(95)00047-X.

Tsoar H, Pye K. 1987. Dust transport and the question of desert loess formation. Sedimentology. 34(1):139–153. doi:10.1111/j.1365-3091.1987.tb00566.x.

Acknowledgements

> Eric DeSart

> Julie Masura

Scan me to read my report!