

# Deciphering the Origin and Behavior of the Dune du Pilat, Southwest France

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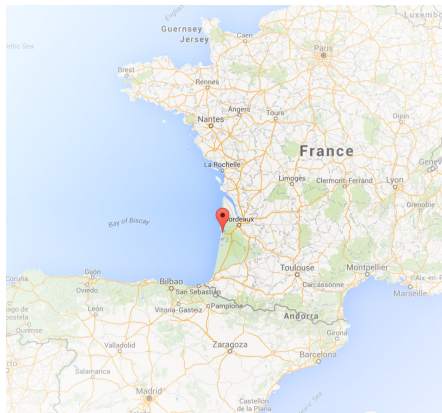
FRS 135 State of the Earth: Shifts and Cycles, Princeton University

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# The Dune du Pilat (1)

- The Dune du Pilat, is a large (108 m high) dune, near the village of La Teste-de-Buch, France.

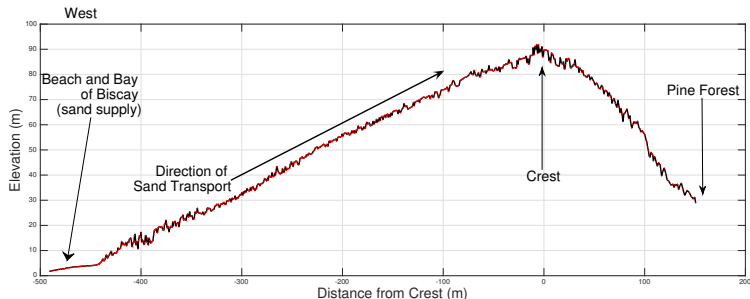


# The Dune du Pilat (2)



# The Dune du Pilat (3)

- The Dune du Pilat is a transverse foredune, located behind high tide line.



**Figure:** Average of 5 dune profiles

# The Perilous Dune du Pilat

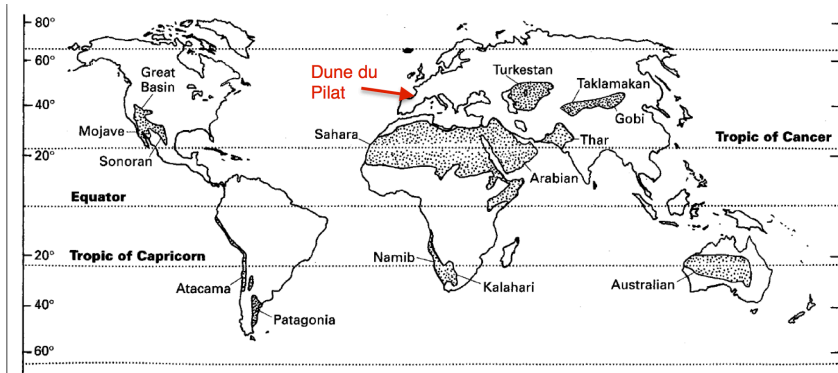
- Dune du Pilat moving 3-4 m inland per year.



- Dune could swallow villages and roads.

# Main Question

- Why is there a massive sand dune in France?



**Figure:** Worldwide distribution of deserts. Image: (Kocurek, 1996)

# How We Will Answer Main Question

- Two approaches:
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- "*Present is the key to the past*" & grain size and sphericity.

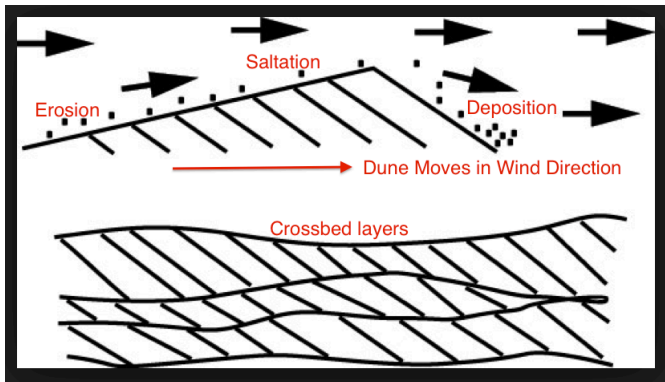


# How We Will Answer Main Question

- Two approaches:
  1. modern dune
  2. **paleodunes and paleosols (ancient soil layers)**
- "*Present is the key to the past*" & grain size and sphericity.
- Study **paleodunes, paleowinds**, and adjacent already dated **paleosols** to recreate evolution and past movement of the dune.

# How Does the Dune Move Over Time?

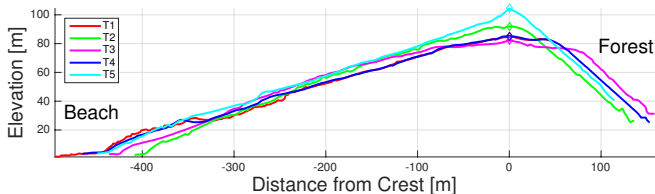
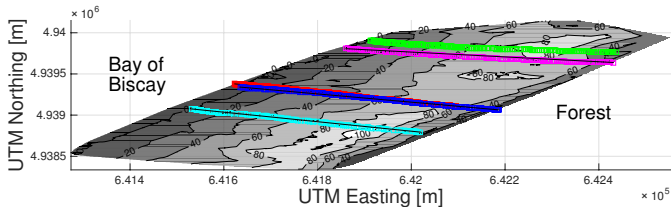
- Understanding **Aeolian Transport** on a Dune:



- Rate of grain transport depends on grain density, size, shape and windspeed. **Selective Transport.**

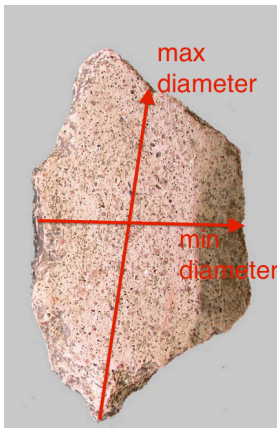
# Methodology of Modern Dune Study (1)

- Collected 61 grain samples along 5 transects of the Dune du Pilat. Elevation and distance determined using a GPS.



## Methodology of Modern Dune Study (2)

- Determine grain size using a **camsizer** at U Penn. Thousands of grains analyzed per sample.
- The data are: maximum and minimum **diameters** of the grains, and cross-sectional **area**.



# Grain Size and Sorting

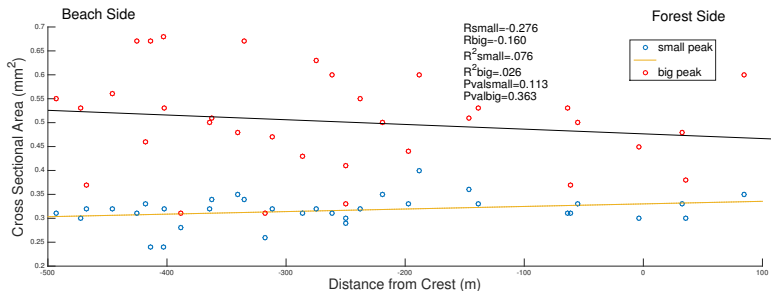
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- Why grain size?
- Grain cross sectional area does not increase with distance from beach to crest.
- Grain sorting seems to improve with increasing distance from beach towards crest. However, not statistically significant.
- Result opposes previous studies.



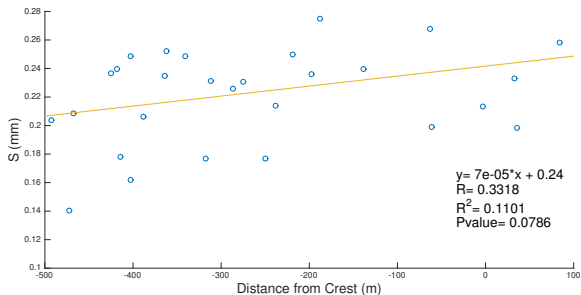
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- Why sphericity?



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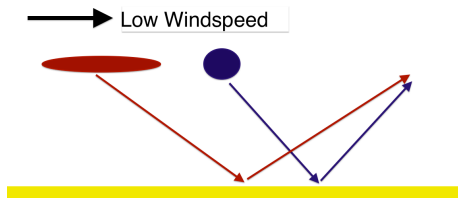
- Significant positive correlation between S (nonsphericity) and distance.

## Grain Sphericity (2)

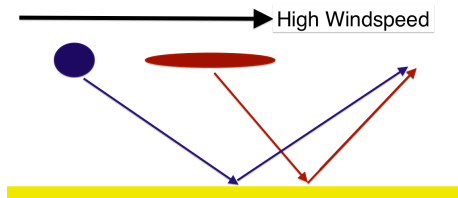
- How do we explain this?

## Grain Sphericity (2)

- How do we explain this?
- At low windspeeds nonspherical grains favored.

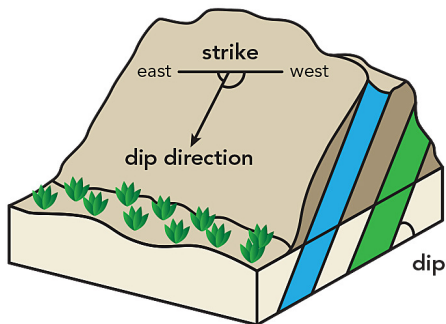


- At high windspeeds spherical grains favored.



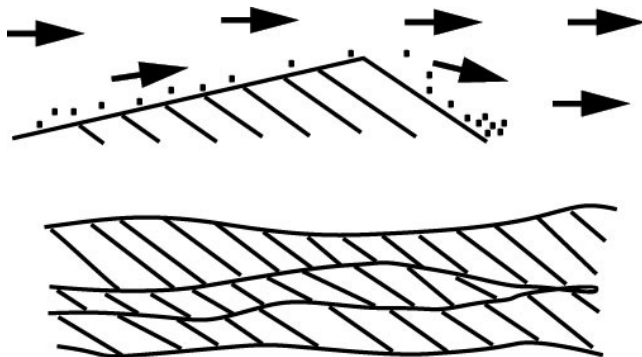
# Methodology of Ancient Dunes Study

- **Crossbed dip and strike** tell us about the direction of sediment transport, i.e. **paleowind directions**.



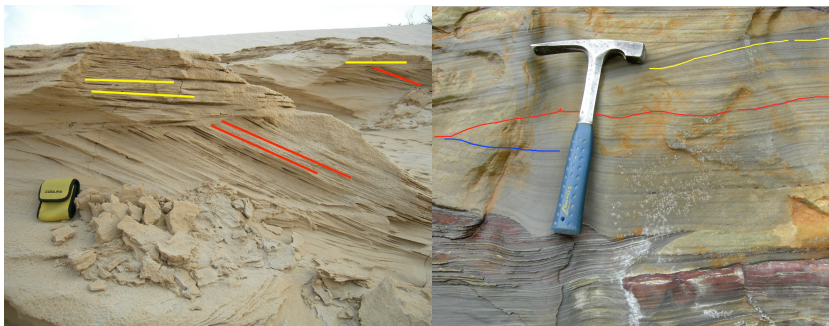
# Crossbeds of Paleodunes (1)

- If the dune has always been **transverse**, we would expect:



# Crossbeds of Paleodunes (2)

- If the dune had varying shapes in the past, we would expect:



# Crossbeds of Paleodunes (3)

- Crossbeds we observed on the Dune du Pilat.



# The Paleosols (1)

- Paleosol organic material dated to find adjacent paleodune age.





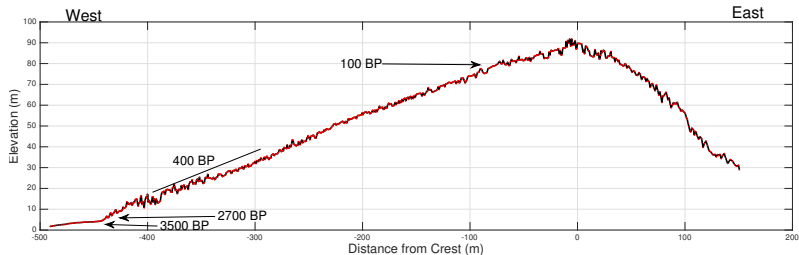
## The Paleosols (2)

Exposed layers of **paleosols** contained wood, fragments of pottery and microbial mats.



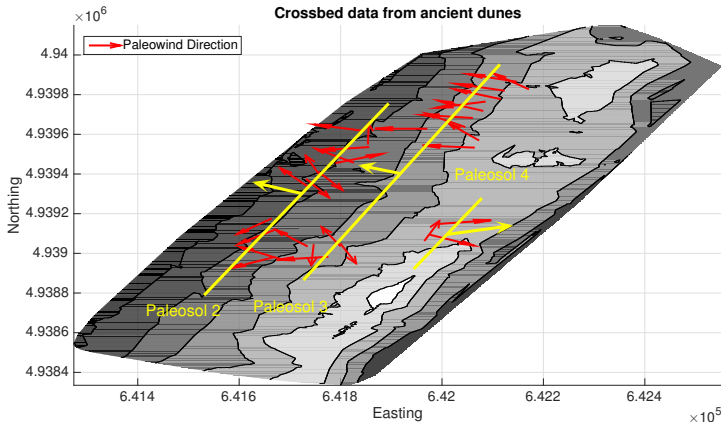
# Paleosol Ages

- Paleosol layers were dated (Froidefond & Prud'homme, 1991) using radiocarbon dating, palynologic analysis and historical dating.



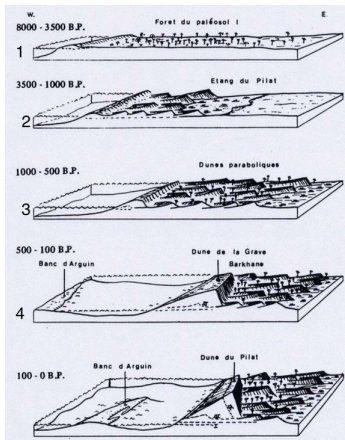
# Paleowinds and Transformation

- The direction of the paleowind at each crossbed's location is depicted as a red arrows.  
Average wind directions for crossbeds near each paleosol in yellow.



# What happened?

- Two possible explanations for the change in dune shape:
  1. Climate change influenced wind direction
  2. Huge storm resulted in abundant sand supply.



- Image: (Barnroff-Nielsen & Willetts, 1991)

# Acknowledgements and Questions

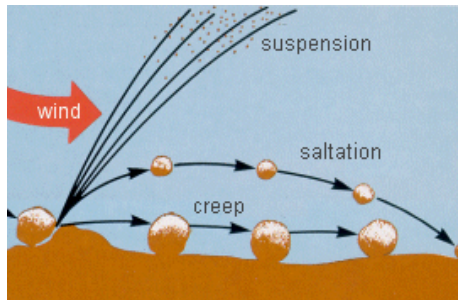
- We would like to thank Dylan Lee of the University of Pennsylvania for permitting us to use the camsizer machine.
- We also wish to thank our instructors professors Adam Maloof, Frederik Simons and Amanda Wilkins, teaching assistants Chris Harig and Askhay Mehra (all Princeton University) for their help with our presentation and assistance during research, as well as all fellow FRS 135 classmates, especially James Tralie and Artemis Eyster, for helping us create a topographical image of the dune with their relentless walking.
- Questions

# The End

# Appendix

# Grain Transport

- A grain's affinity to transport depends on the **size, density and shape** of the grain. Causes **Selective transport**



- $q$  the rate of **grain transport**, is determined by:  
$$q = au_*^b(\rho/g)$$

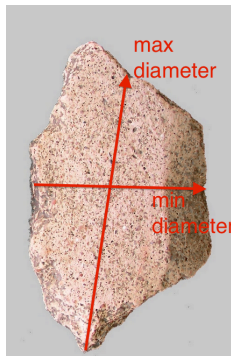


# Grain Sphericity (1)

- Grain shape measured in terms of how much the grain approaches a sphere, known as **sphericity**.

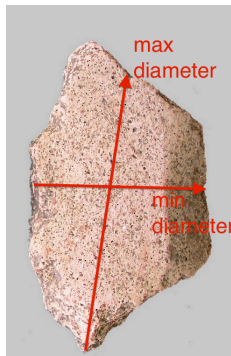
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- Previous studies.