

Analysis of Substructure of Dune du Pilat via Ground Penetrating Radar Techniques

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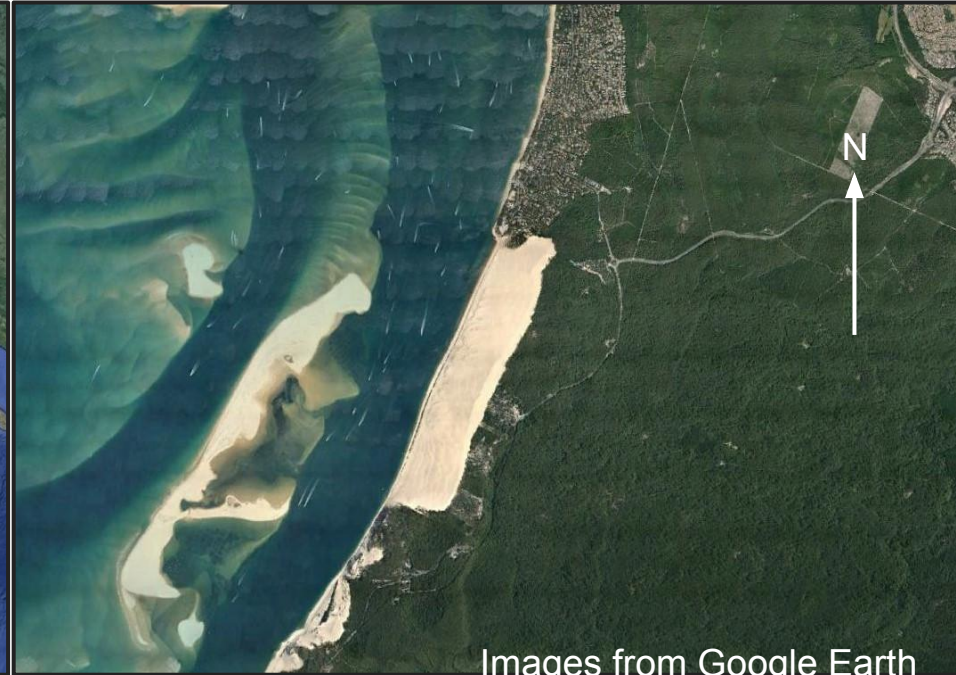
Dune du Pilat

- Located in La Teste-de-Buch in Arcachon, France.
- GPS location: 44.5900° N, 1.2117° W
- Dune height: 100 m, length: 2700 m, width: 500 m
- Dune alignment: at 20° to N

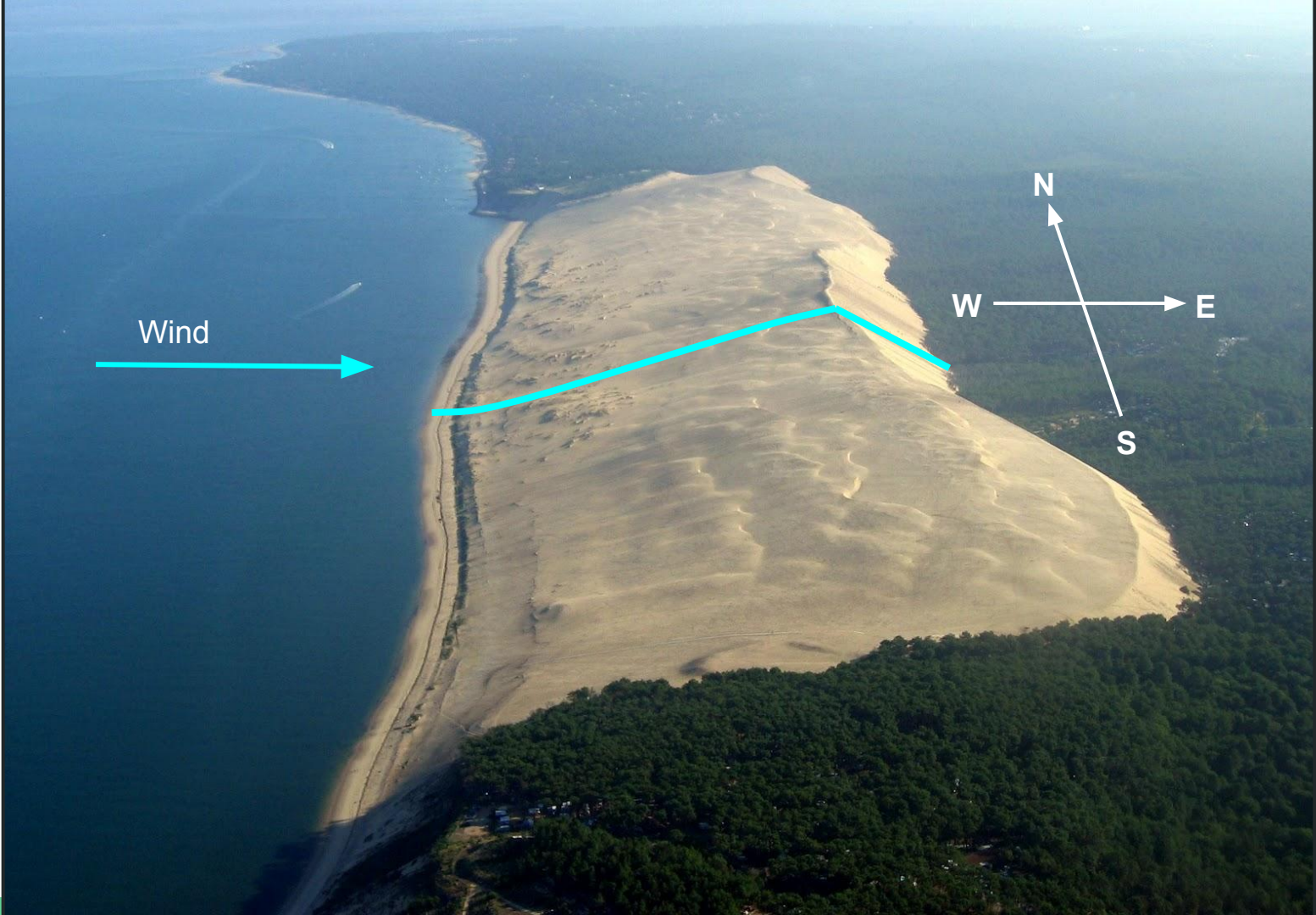


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Images from Google Earth



Wind

N

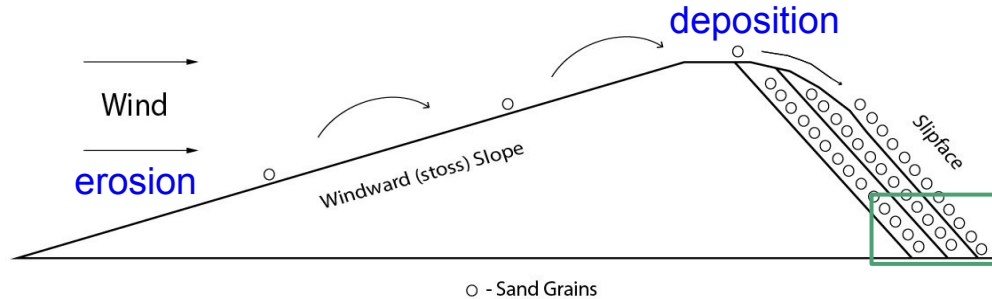
W

E

S

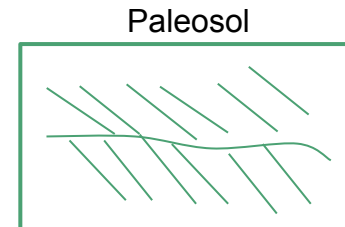
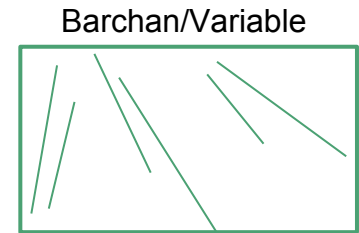
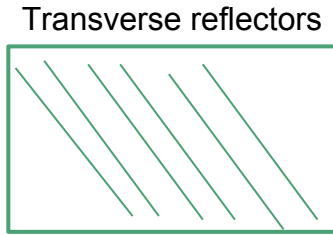
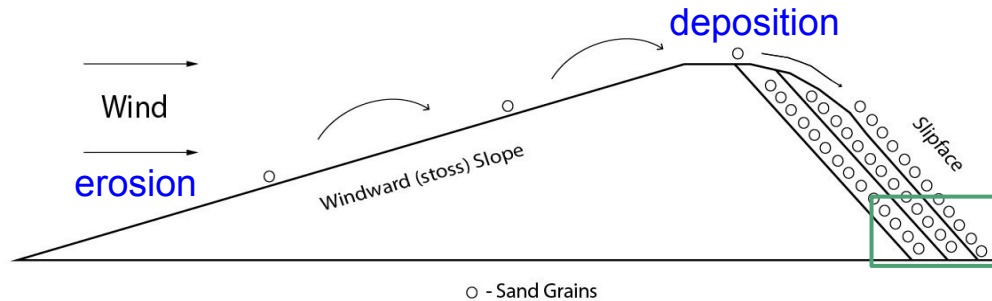
Aeolian Subterranean Structures

- Dunes change in response to wind direction and velocity
- Typically only preserve cross bedding
- Transverse, Barchan, or Paleosols?



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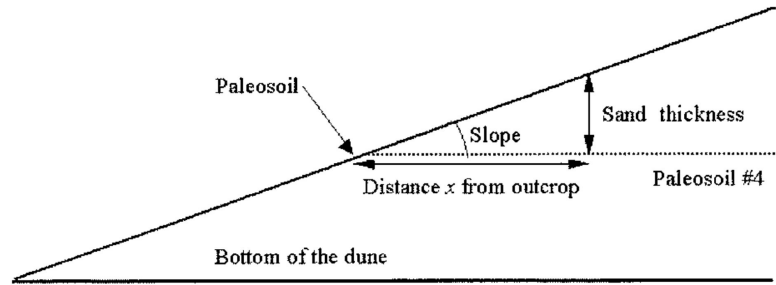
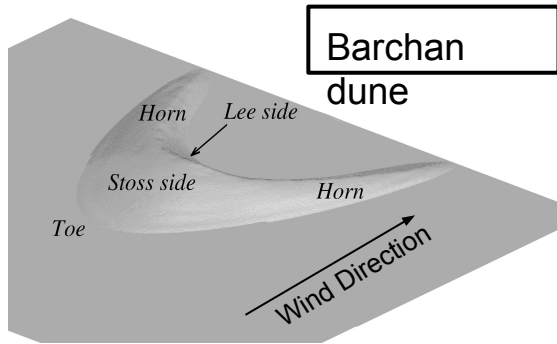


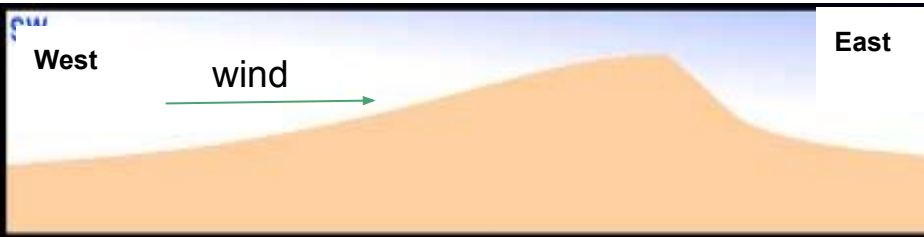
Fig. 17. Sketch of the geometry of paleosol #4 buried in the Pyla dune.

http://me.queensu.ca/People/Piomelli/images/barchan_geo.png

Grandjean, G., Paillou, P., Dubois-Fernandez, P., August-Bernex, T., Baghdadi, N., & Achache, J., 2001. Subsurface structures detection by combining I-band polarimetric sar and gpr data: example of the pyla dune (france), *Geoscience and Remote Sensing, IEEE Transactions on*, 39(6), 1245–1258.

Chinese Wall

- Dune substructure formed by reversing wind on dunes with large sand reserve.
- History of dune migration?



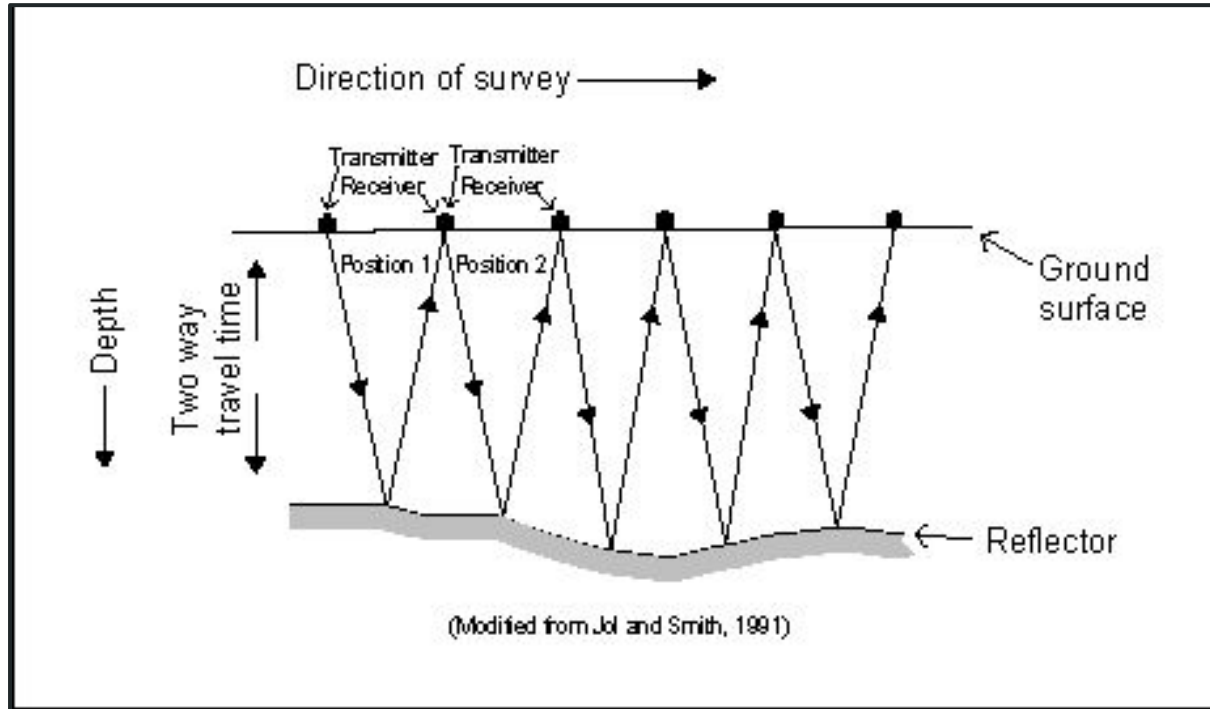
- Dune du Pilat formation has a complicated past that cannot be reduced to a simple W-E model.
- Dune has been moving at 5 m/yr (Froidefrond & Legigan, 1985). Is this true?
- Paleosol outcrops are observed to extend horizontally (Grandjean et al., 2001).
- Observation of clear, consistent dipping reflectors, variable dipping reflectors, or paleosols?

Hypothesis:

- Looking at substructure of Dune du Pilat can reveal the past and constrain possibilities for the future.

Ground Penetrating Radar

How GPR works



Ground Penetrating Radar



Computer panel

Cord connecting computer to GPR

Odometer

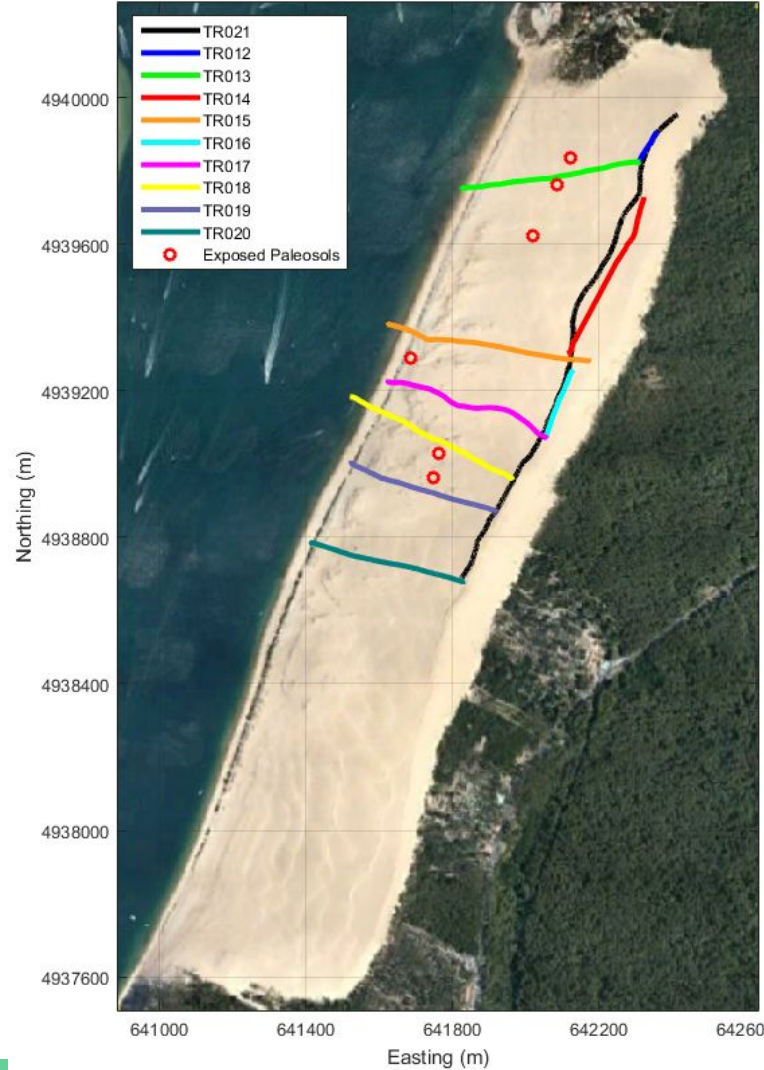
Cord connecting GPR to dynamo

GPR device

Bucket holding GPR

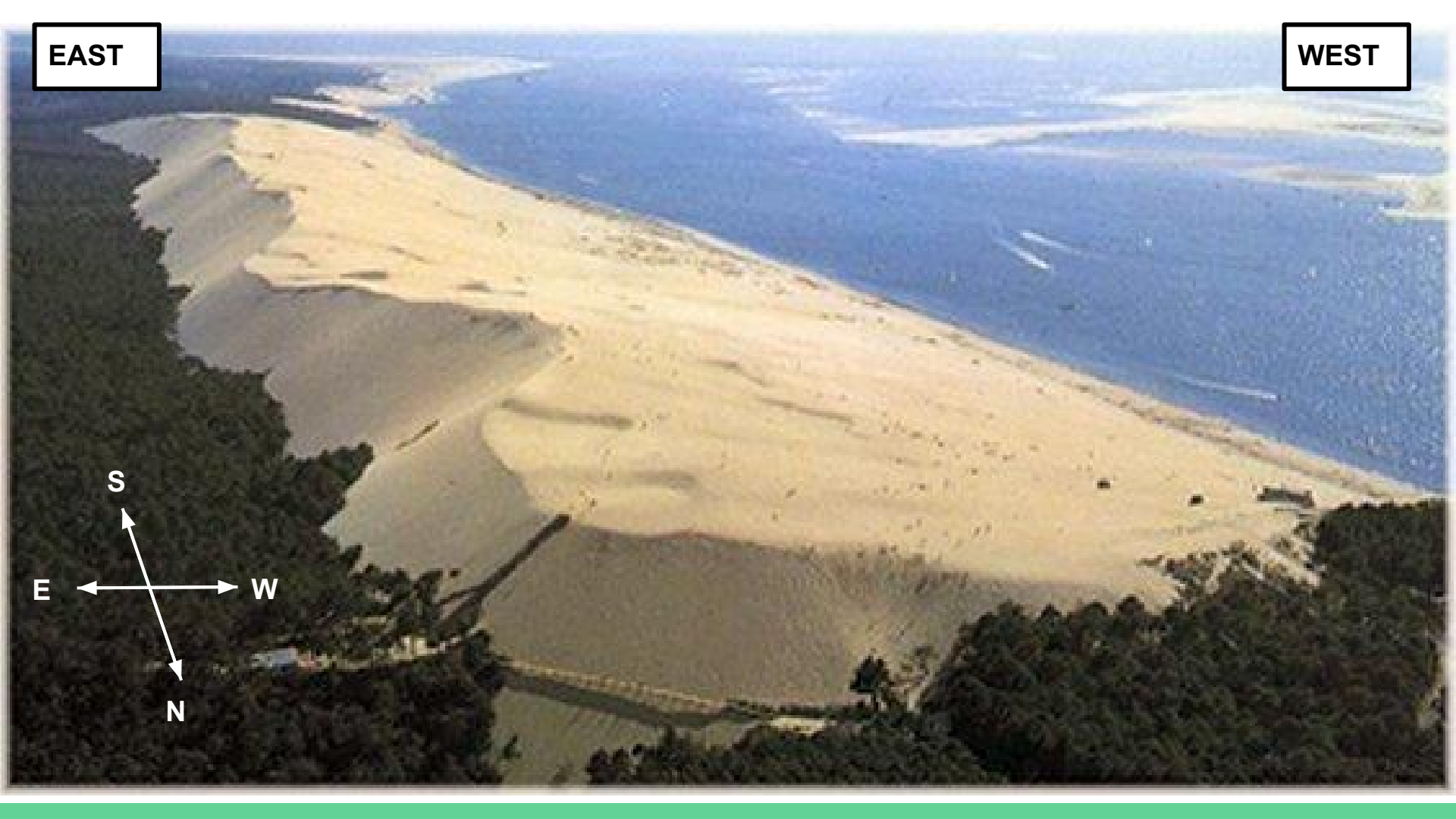
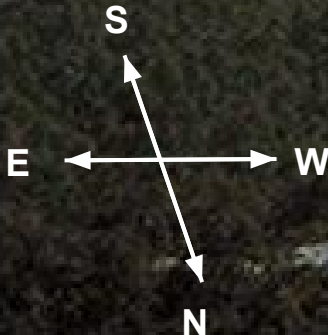
Data Collection

- GPR was run on transects spanning the dune.
- “Heading” person
- Trimble GPS data



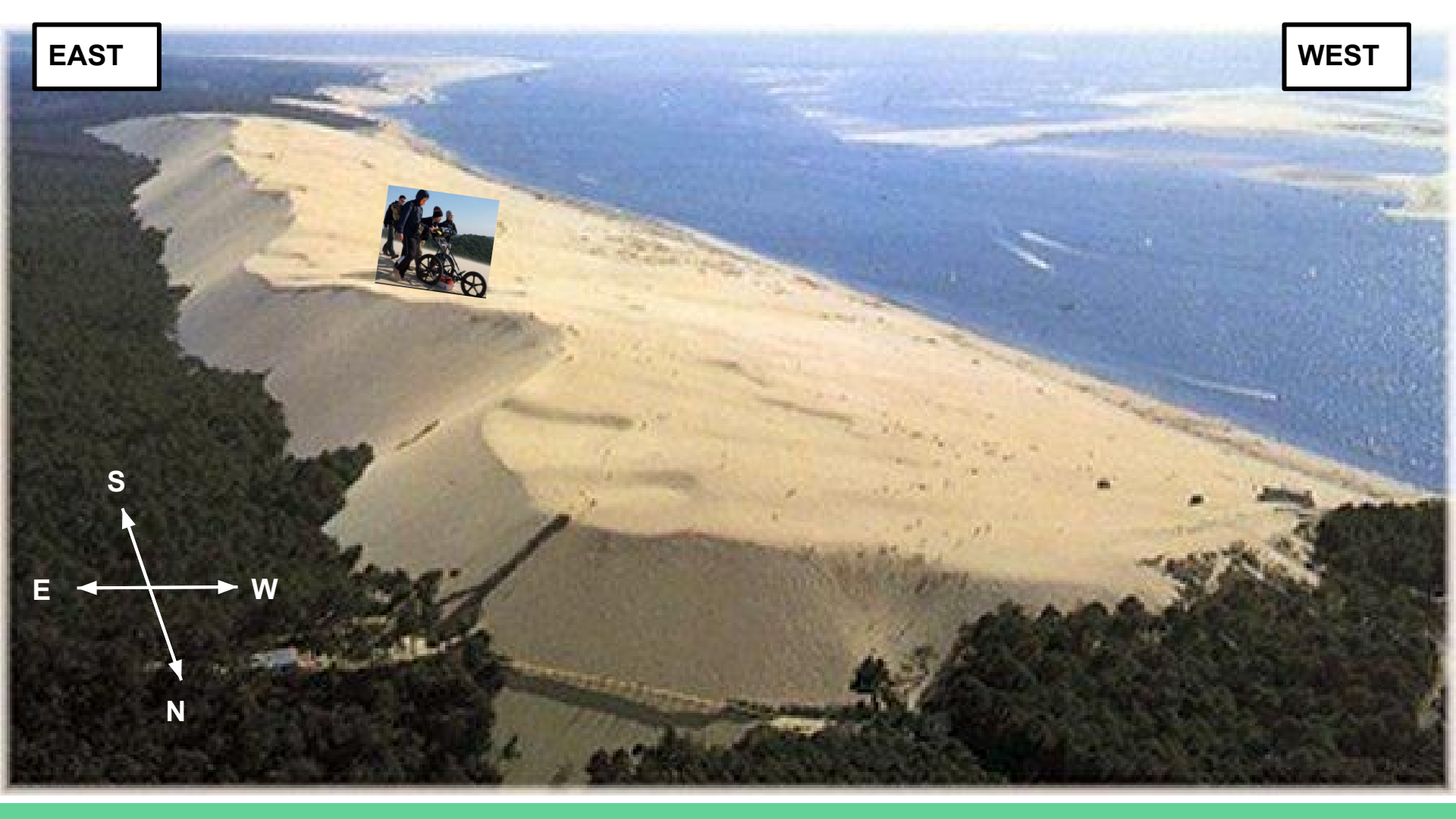
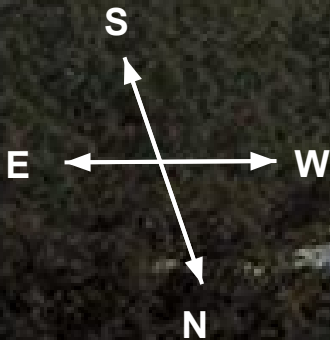
EAST

WEST



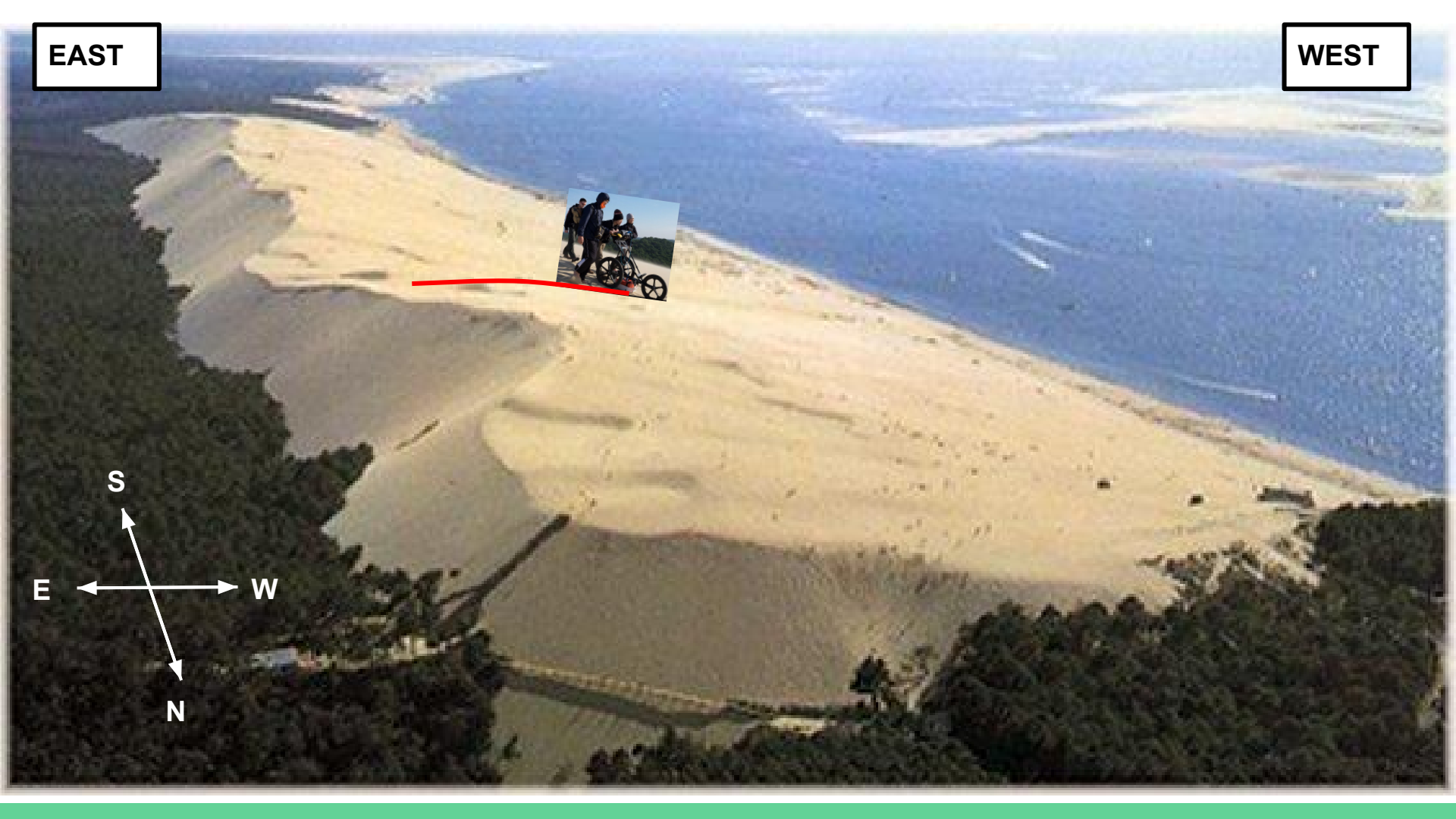
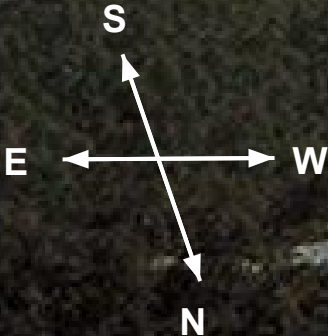
EAST

WEST



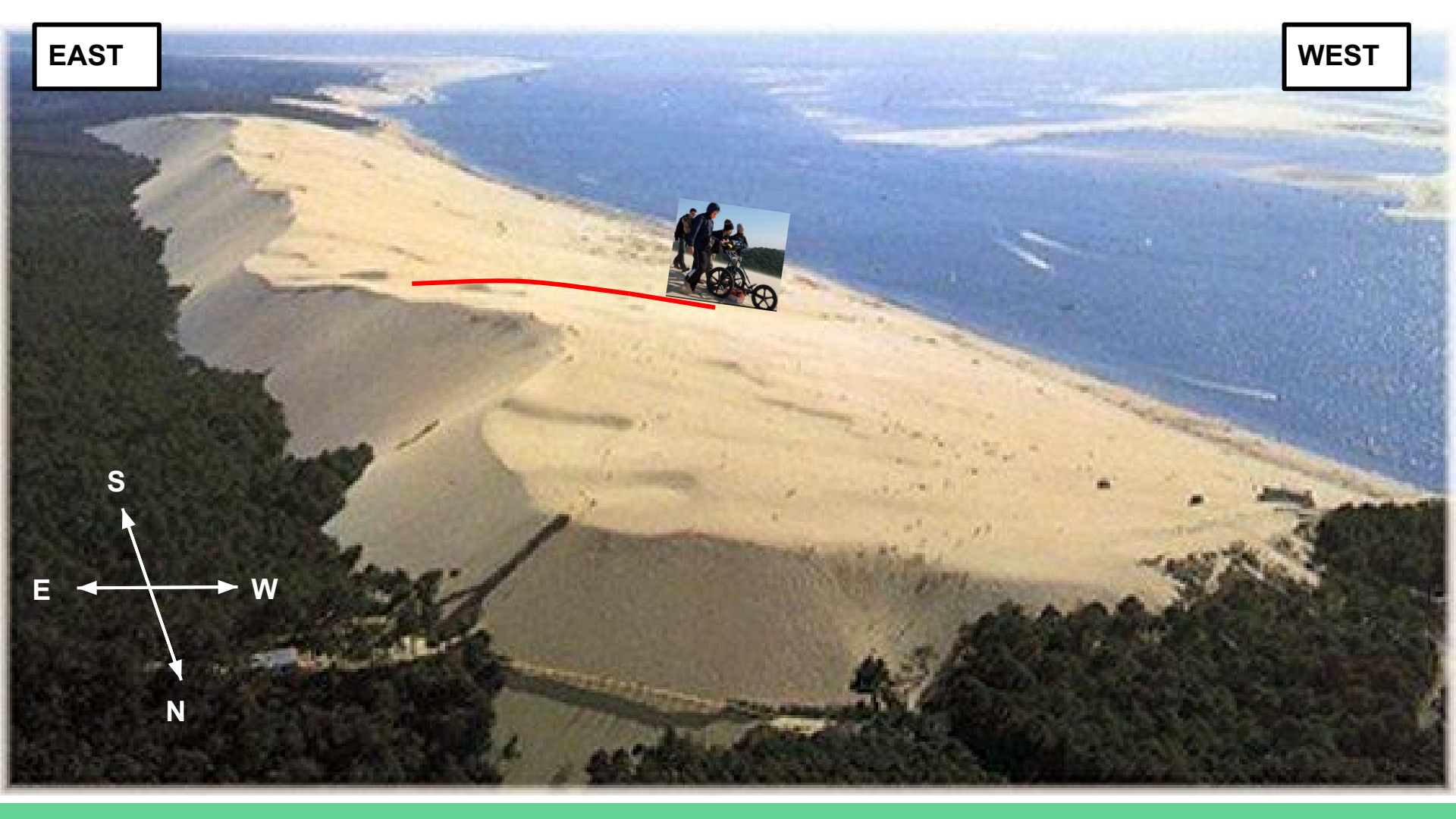
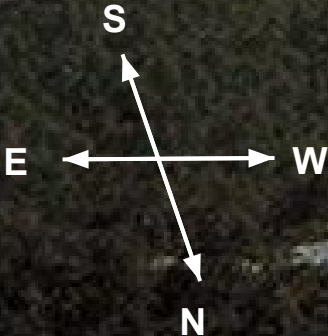
EAST

WEST



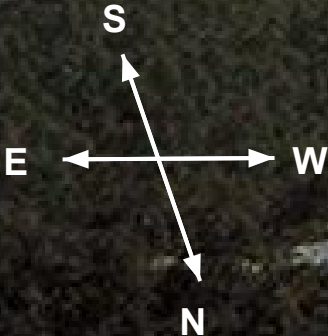
EAST

WEST



EAST

WEST

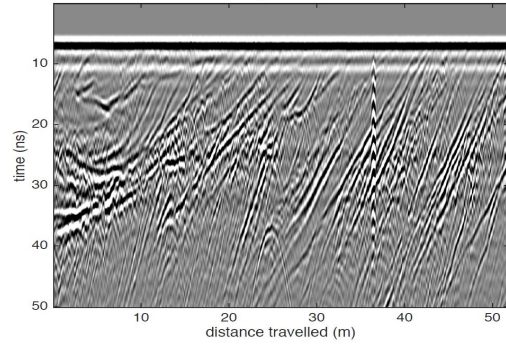


EAST

WEST



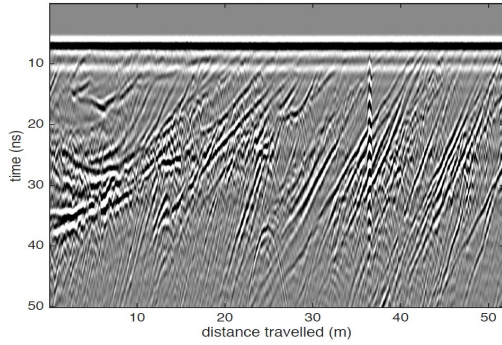
TR012: Day 2 test transect



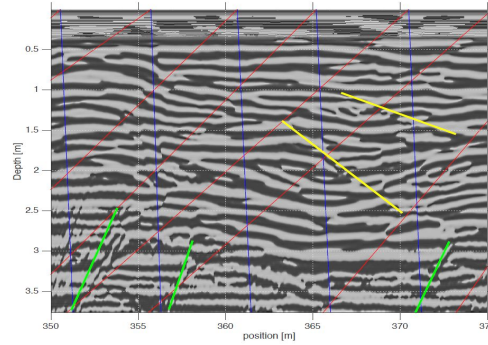
Raw GPR data

GPR analysis

TR012: Day 2 test transect



Raw GPR data

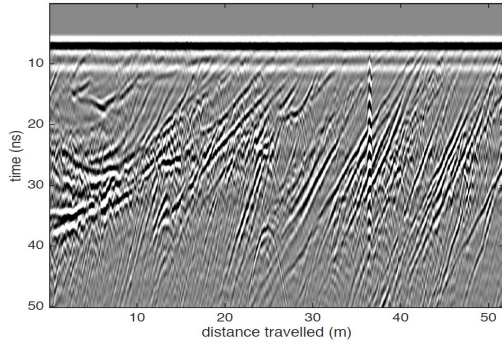


Contrast & Gain
Adjustments, Scale
Conversion

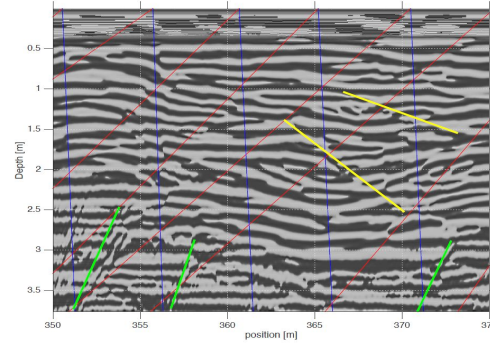
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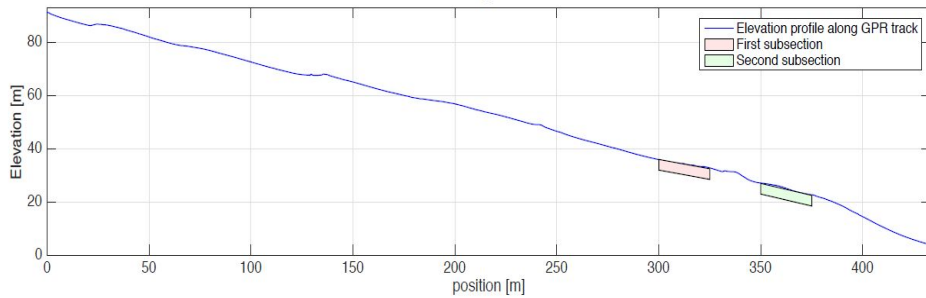


Raw GPR data



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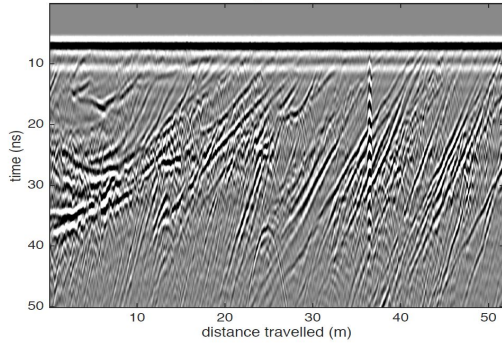
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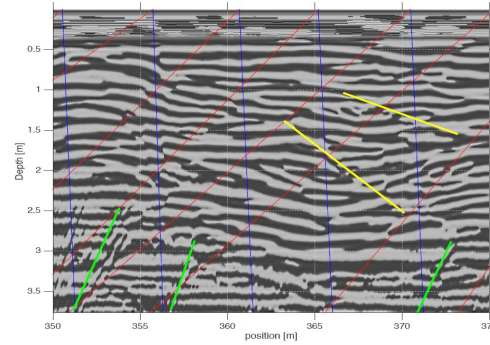
GPS based elevation model

GPR analysis

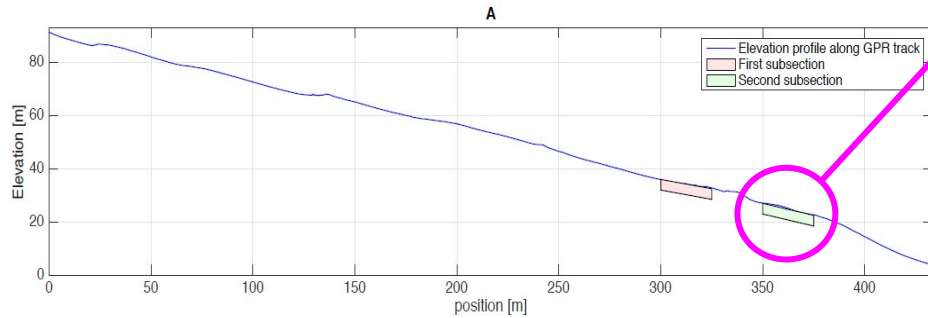
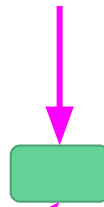
TR012: Day 2 test transect



Raw GPR data



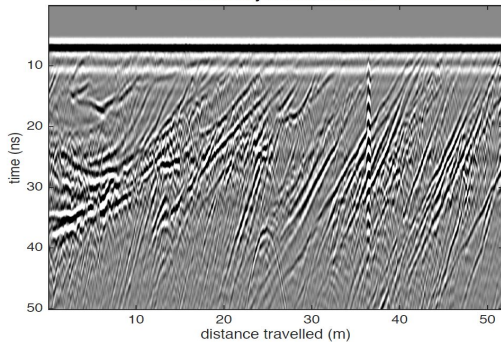
Contrast & Gain
Adjustments, Scale
Conversion



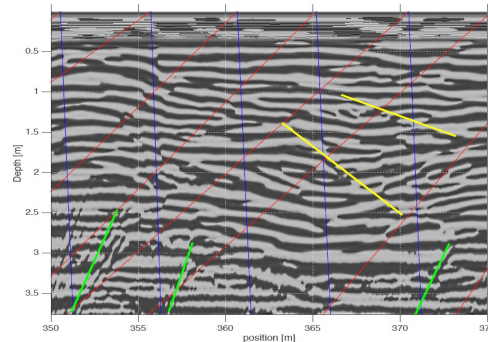
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GPR analysis

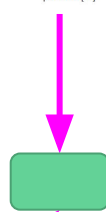
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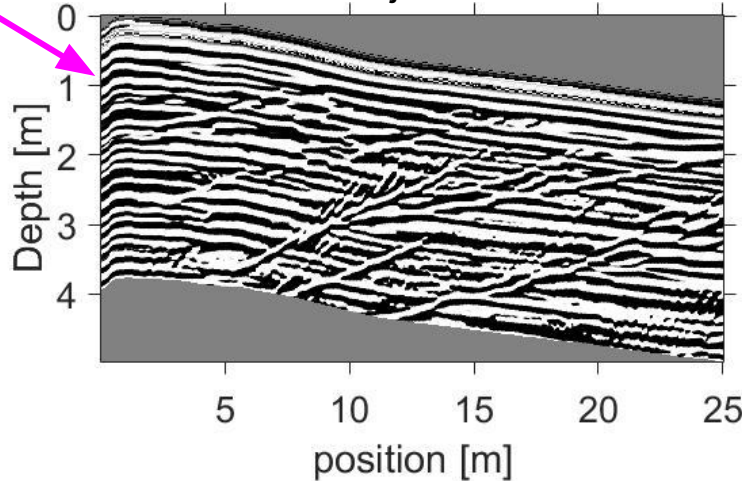
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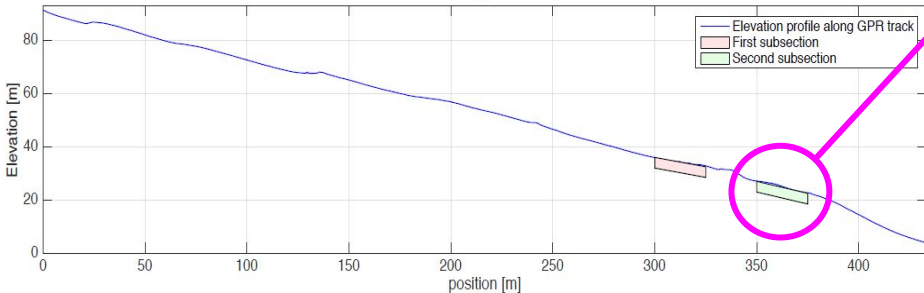
Contrast & Gain
Adjustments, Scale
Conversion



Elevation Adjusted Terrain Profile



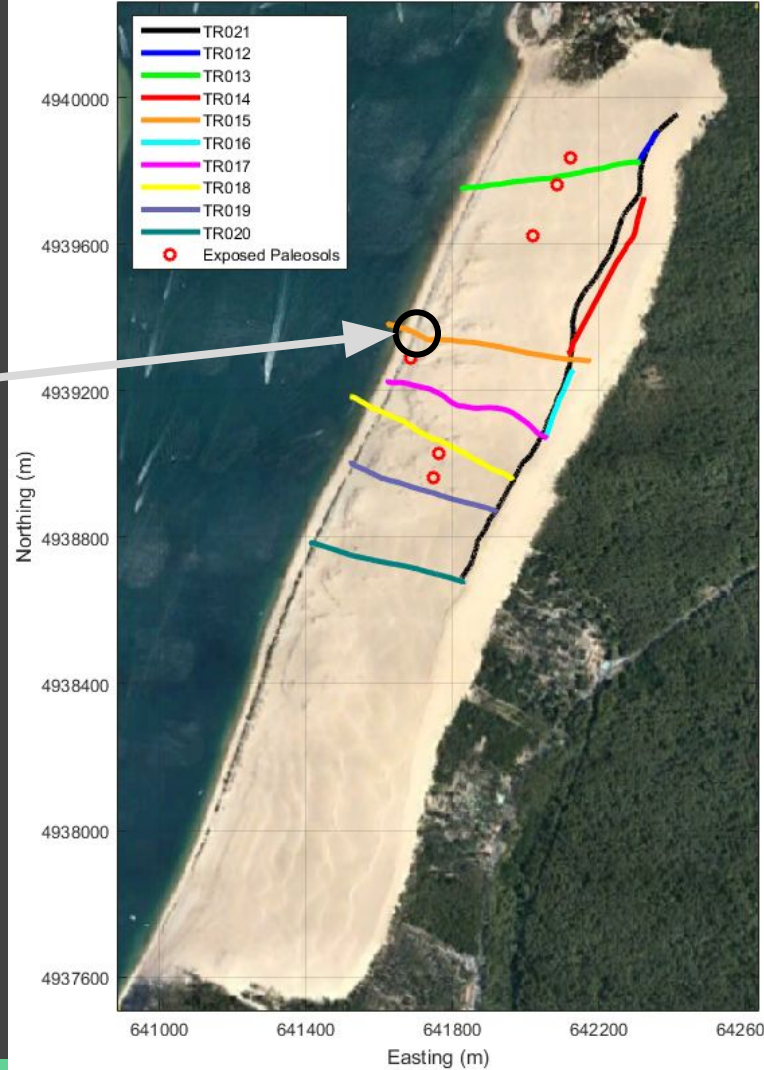
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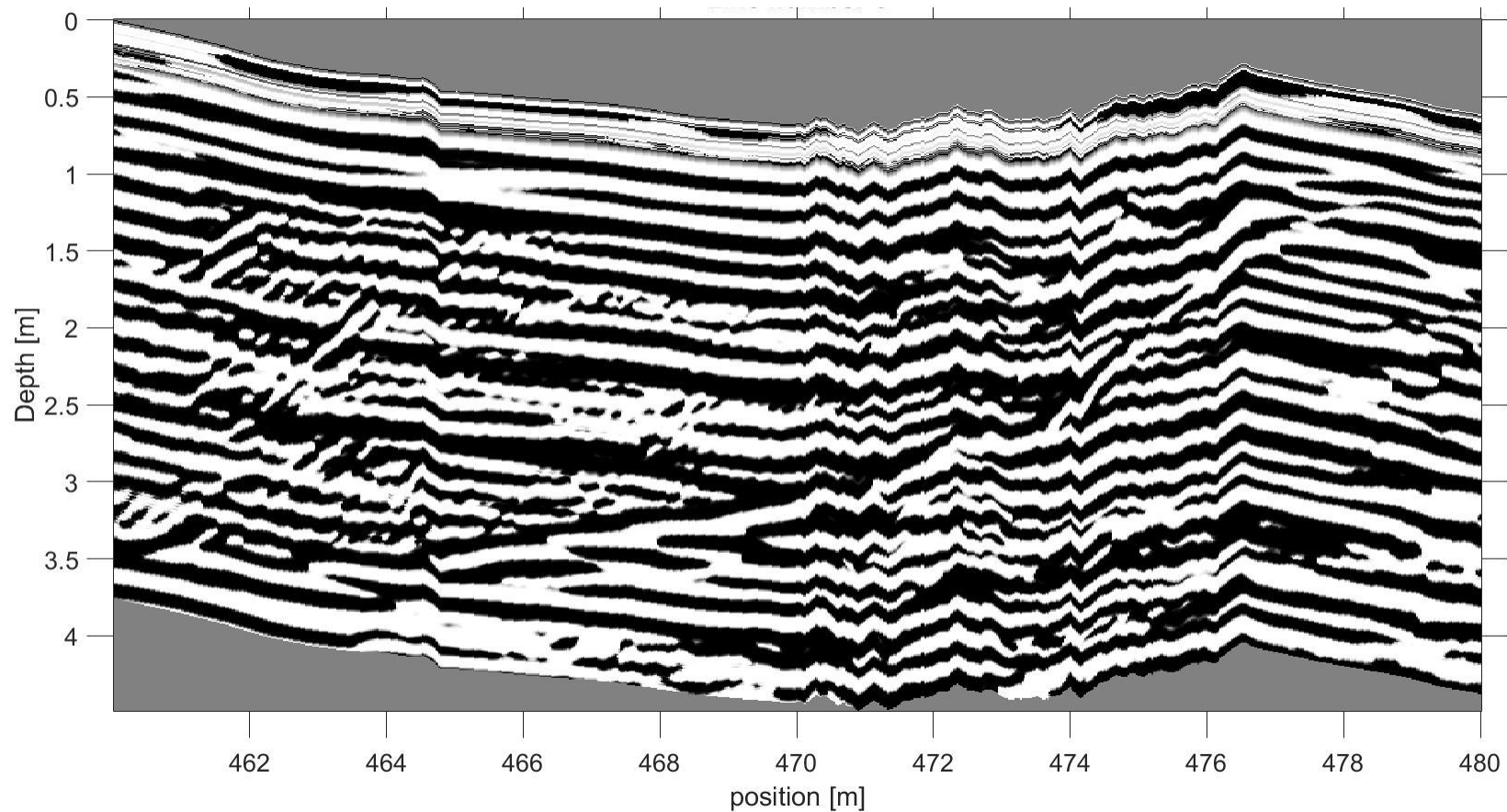
GPS based elevation model

Results

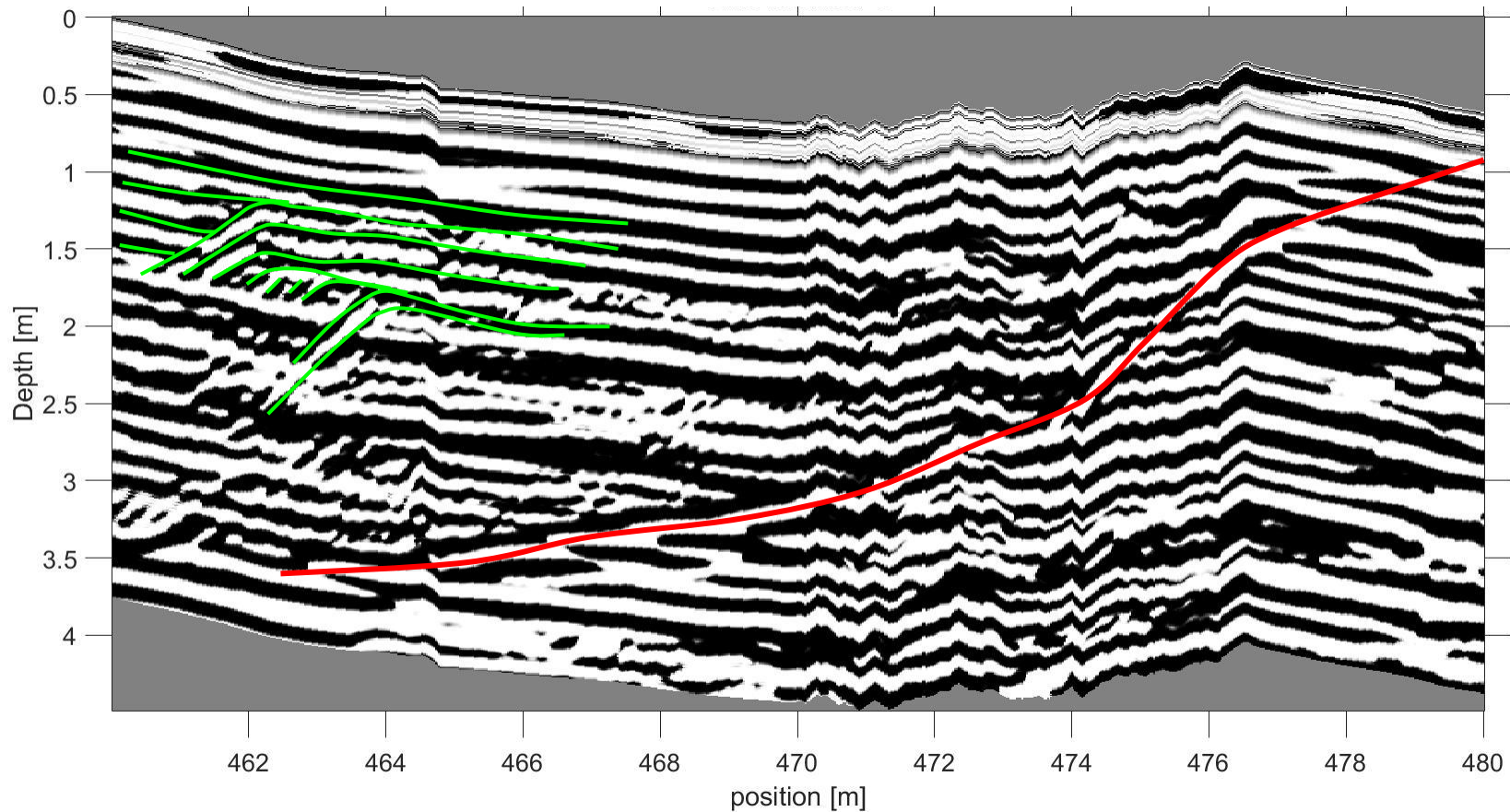
First, let's look at Transect 15, right here



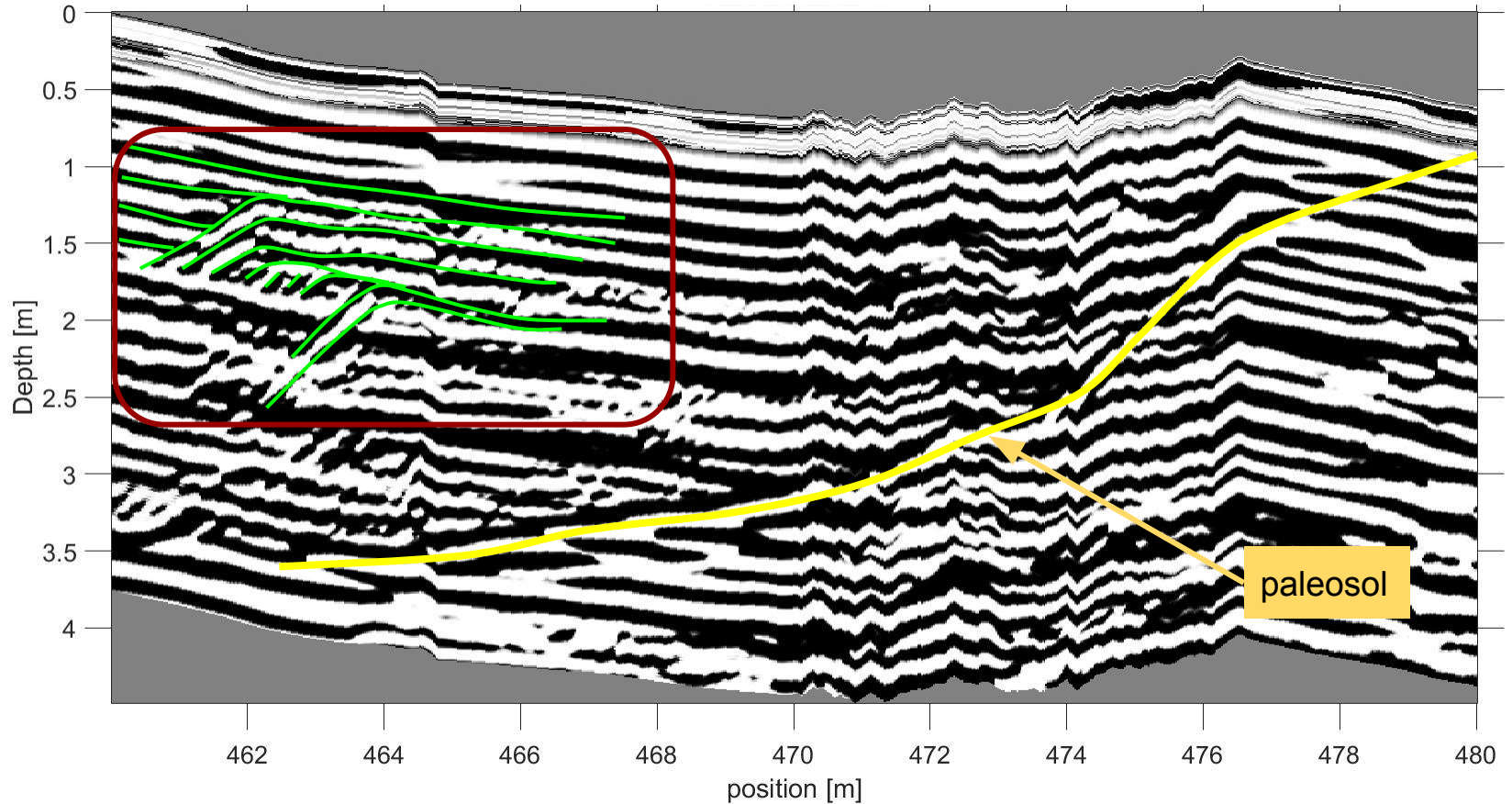
Transect 15, coordinates:



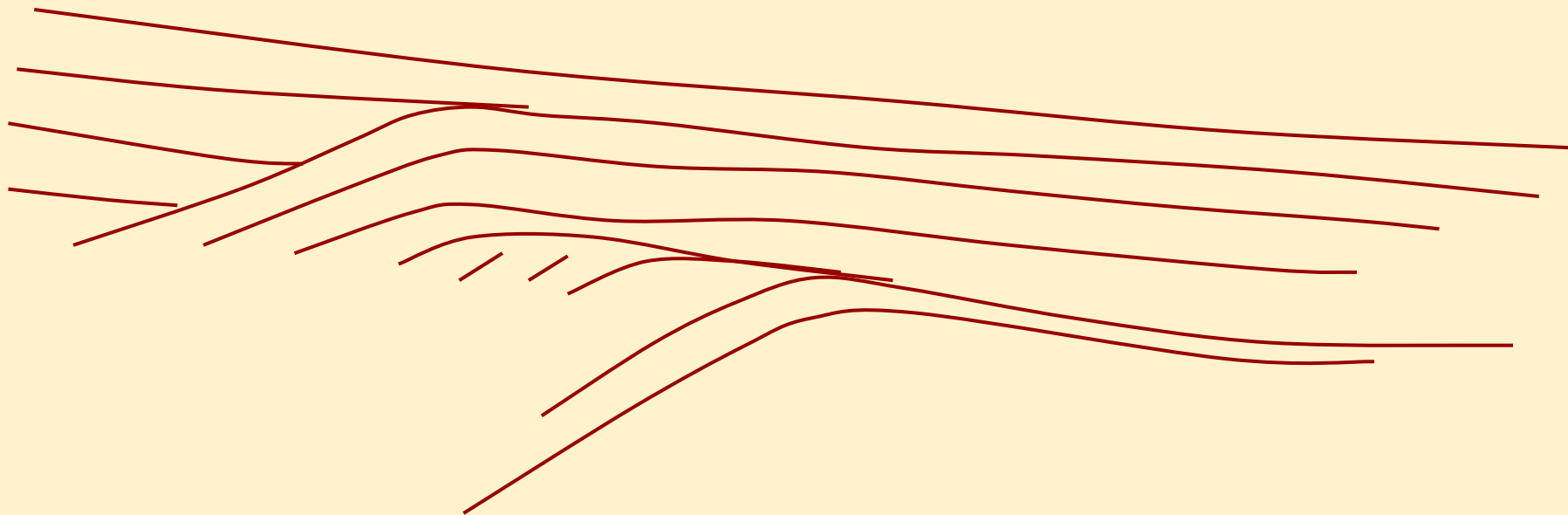
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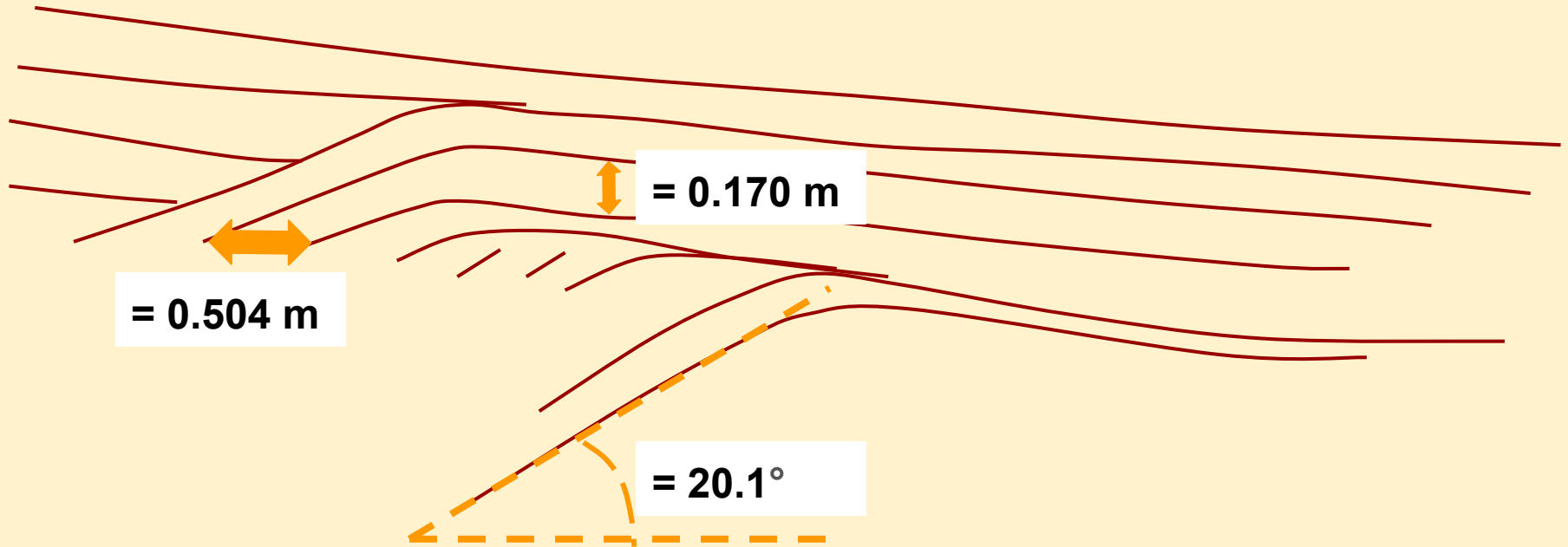
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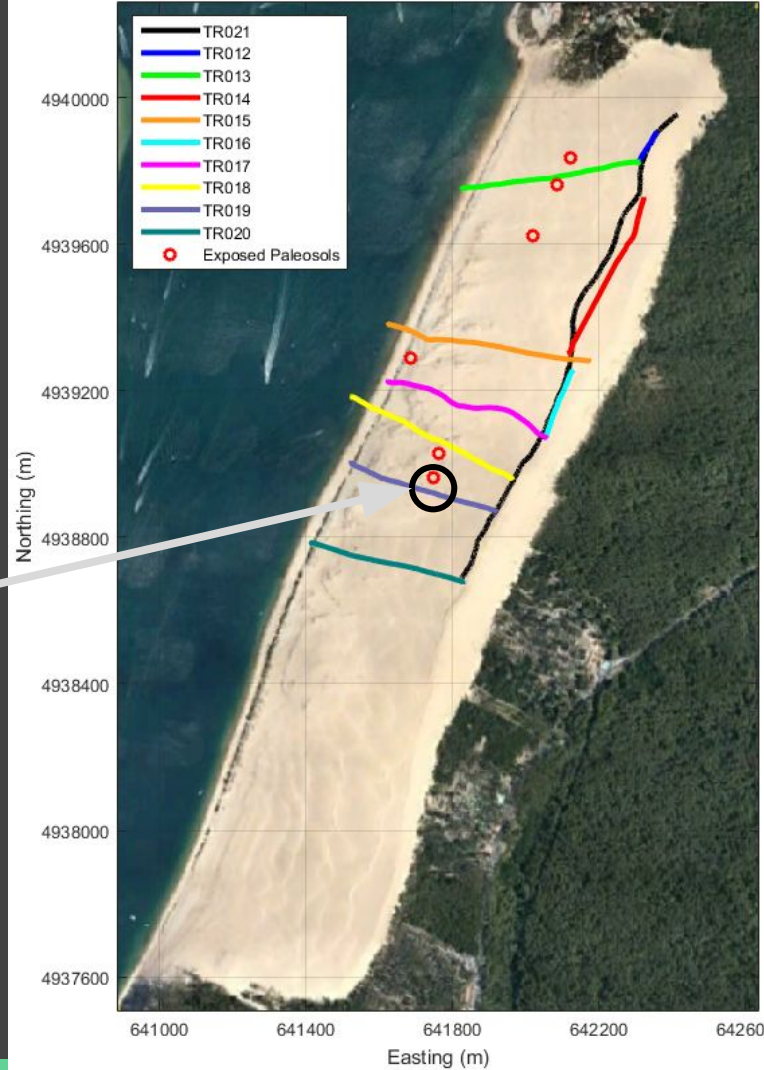
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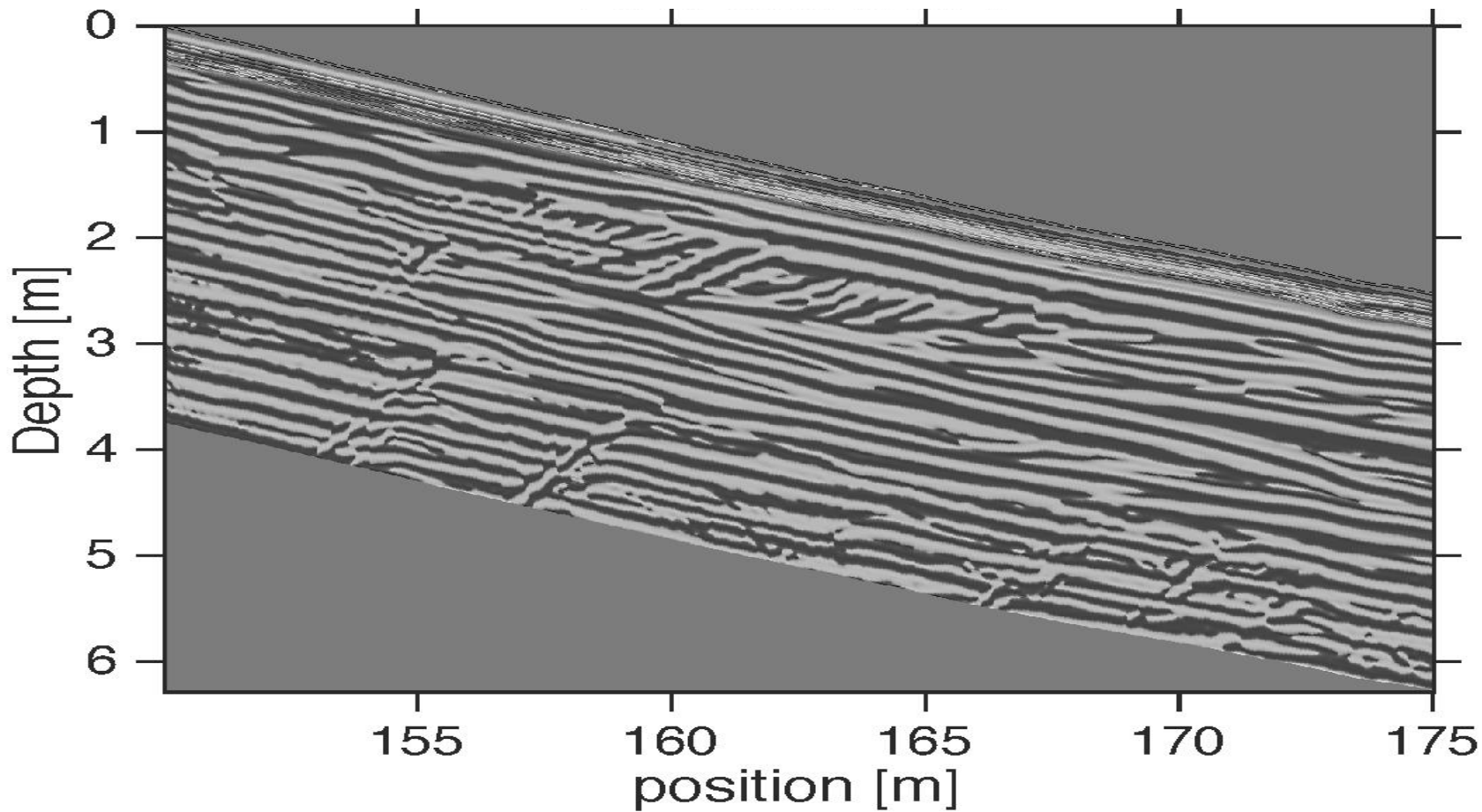
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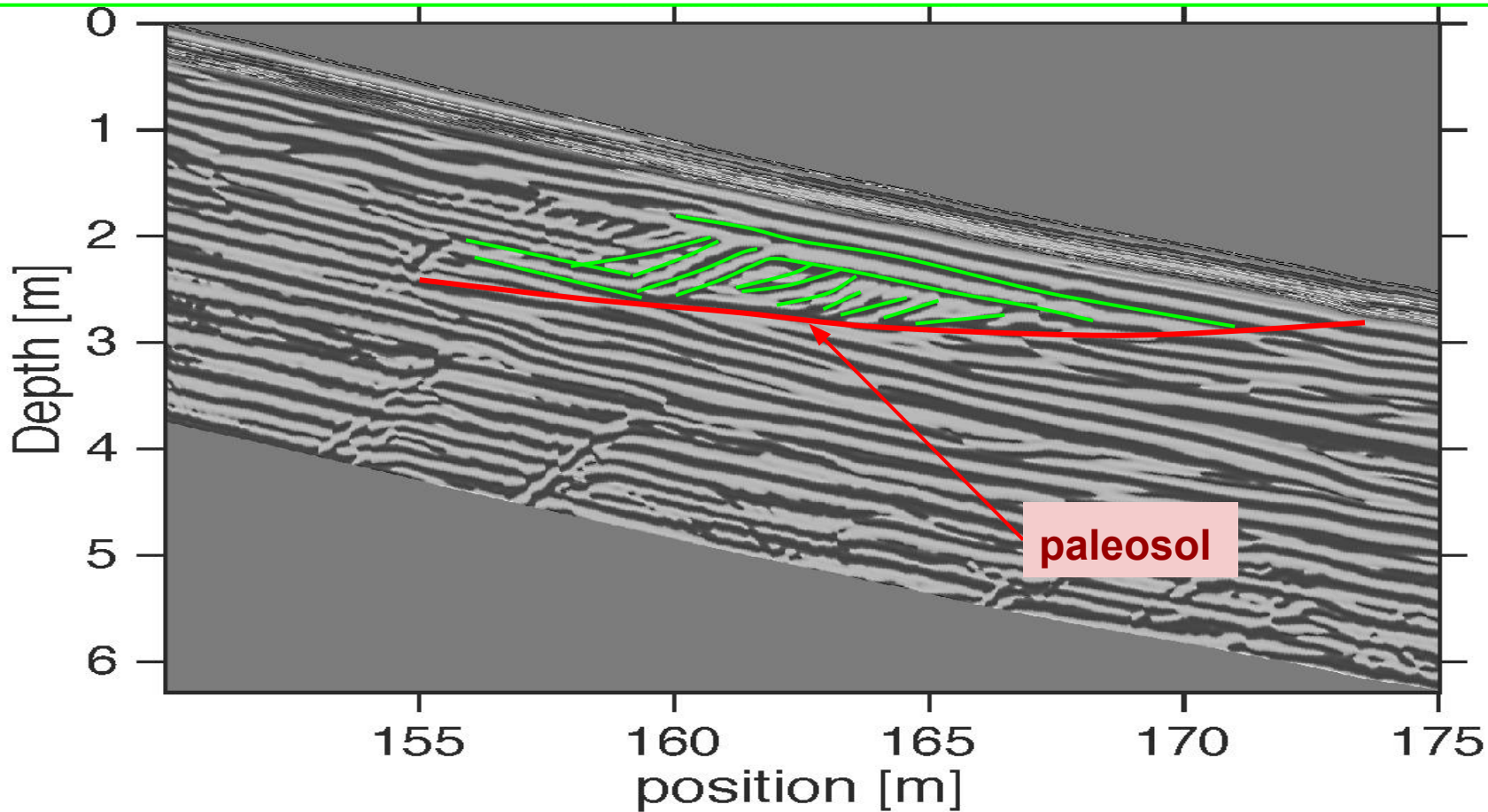
Now, let's
look at
Transect 19,
right here



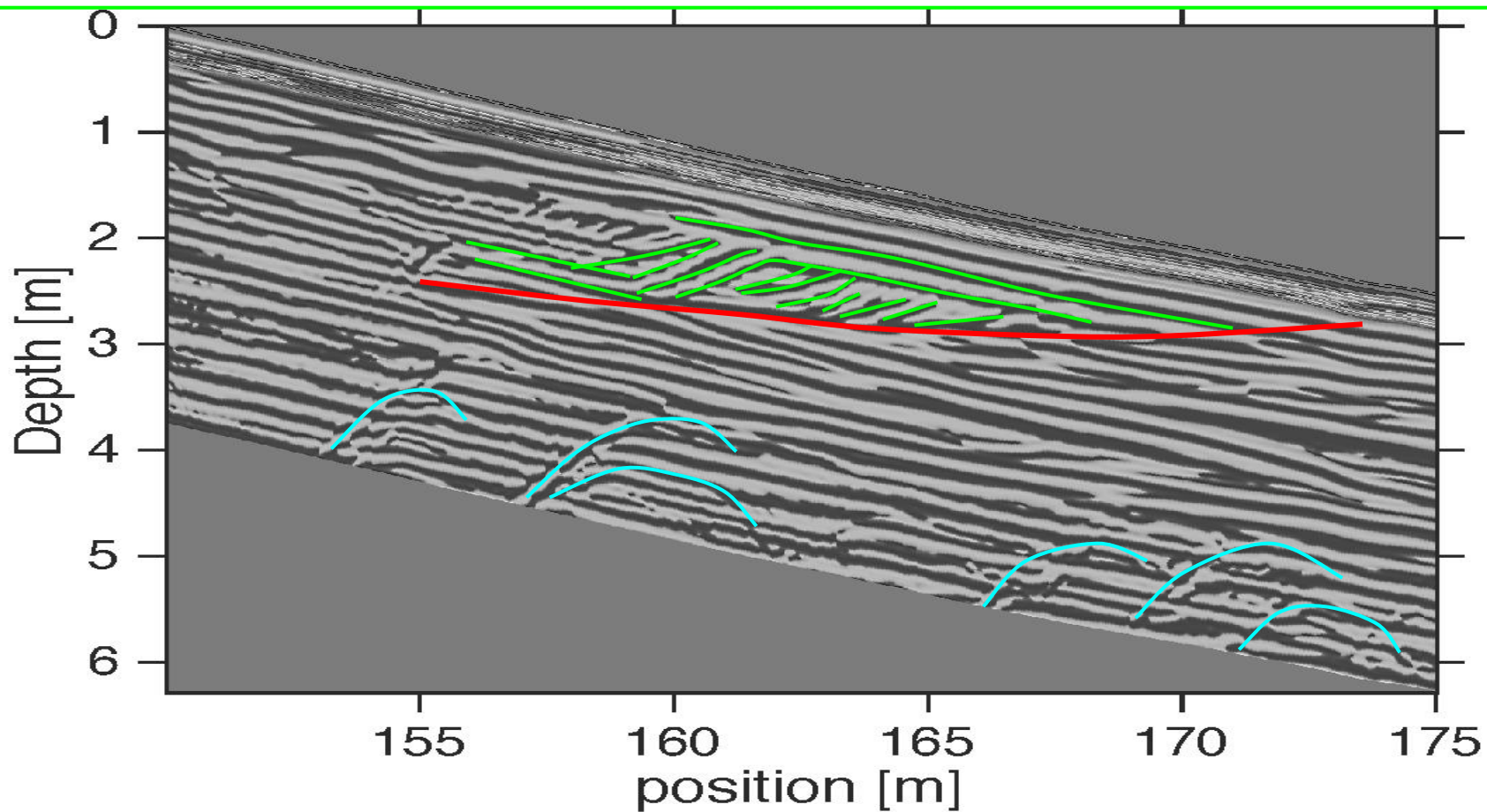
Transect 19



Transect 19



Transect 19



Conclusion

- Looking at the dune structures, we can tell that the Dune has been moving Eastward at least at some stage in the past.
- Based on the massive deposition on the stoss side - the Dune volume has been increasing because of more sand being added from Banc d'Argion in the West.
- Paleosol outcrop substructure appears distinctly on GPR profile, which completely flattened out sand, but then dunes were formed again over paleosols
- We observe complicated morphologies that cannot be explained by a simple W-E dune migration model.

Acknowledgements

Thank you to Princeton University and the Geosciences Department for giving us the opportunity to conduct this wonderful research.

Thank you to Adam and Frederik for sharing your amazing knowledge on MATLAB, dunes, sand, water, rocks, dinosaurs, and just about anything else. Thank you to Amanda for providing a valuable perspective on our presentation.

Thank you to Chris for helping us setup the GPR as well as understand and write MATLAB code to process the GPR and GPS data. Thank you to Akshay for shooting images of our work and showing us how to use the Trimble.

Finally, thank you to members of FRS 135 for helping push the GPR device up and down Dune du Pilat. It was hard work, and we couldn't have done it without the help from Amber, Bruce, Lillian, Sophie, Greta.

References

Froidefond, J. & Legigan, P., 1985. La grande dune du pilat et la progression des dunes sur la littoral aquitaine, *Bulletin Institut Geologique du Bassin d'Aquitaine*, **38**, 69–79.

Grandjean, G., Paillou, P., Dubois-Fernandez, P., August-Bernex, T., Baghdadi, N., & Achache, J., 2001. Subsurface structures detection by combining l-band polarimetric sar and gpr data: example of the pyla dune (france), *Geoscience and Remote Sensing, IEEE Transactions on*, **39**(6), 1245–1258.

Windstorm at Dune du Pilat in 2009, Metro France.

Questions?