Algodones Dune Migration and Strigraphic Analysis Using Ground Penetrating Radar, Southern California

Joseph Beck, Logan Bergevin, August Guenthner, Matt Mangin, Hunter Wood | Faculty Mentors: Harry Jol and Martin Goettl
University of Wisconsin-Eau Claire | Department of Geography & Anthropology

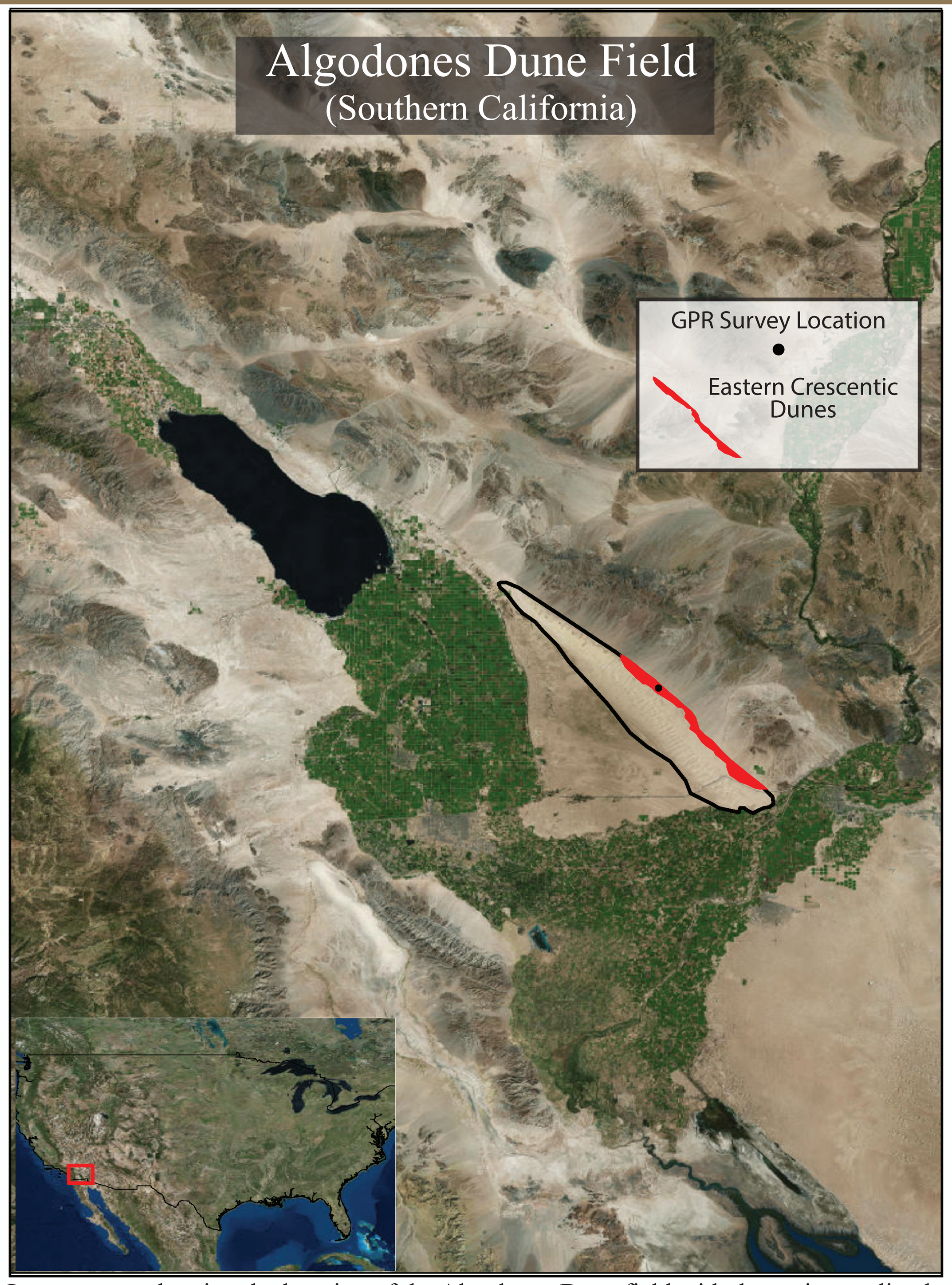
San Diego State University

University of Wisconsin Eau Claire

Introduction

The Algodones dune field, is located south-east of the Salton Sea in Southern California. The dune field is divided into two sections composed of a protected wilderness area (north) and a larger area of public land (south), which is managed by the Bureau of Land Management. The Algodones Dune field is a highly complex geomorphic and spatially diverse dune system (Dickerson et al, 2007). Dune sediments in the region are derived from aeolian (wind) processes and are remnant sediments from Ancient Lake Cahuilla (Dickerson et al, 2007). On March 5th, a ground penetrating radar (GPR) grid was shot consisting of horizontal and vertical lines on the Eastern Crescentic dune region located in the northeastern portion of the Algodones dune field. Two GPR systems were used in collaboration with San Diego State University.

Photos of the Algodones Dune field in Southern California where the GPR survey was conducted.

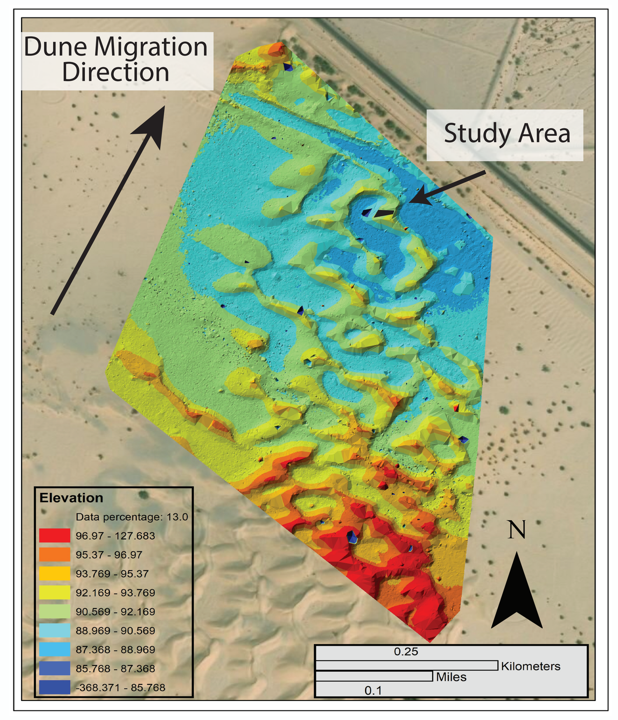


Locator map showing the location of the Algodones Dune field with the region outlined in black. The Eastern Crescentic Dunes where the GPR survey was conducted is highlighted in brown.

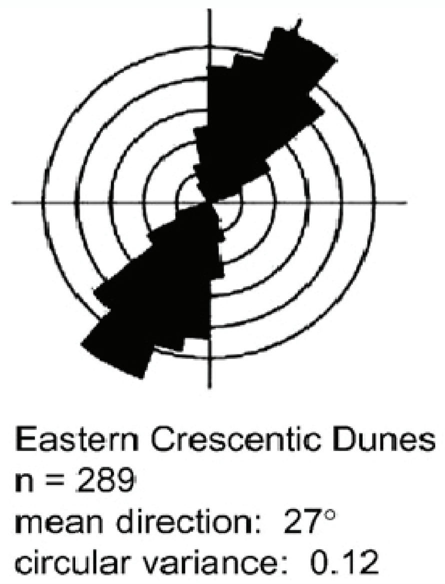
Project Goals

- Identify and analyze subsurface stratigraphy of the Algodones Dunes
- Deduce dune migration patterns related to eastern crescentic dune field
- Learn new geophysical analysis techniques such as GPR and topographic data

Methodology



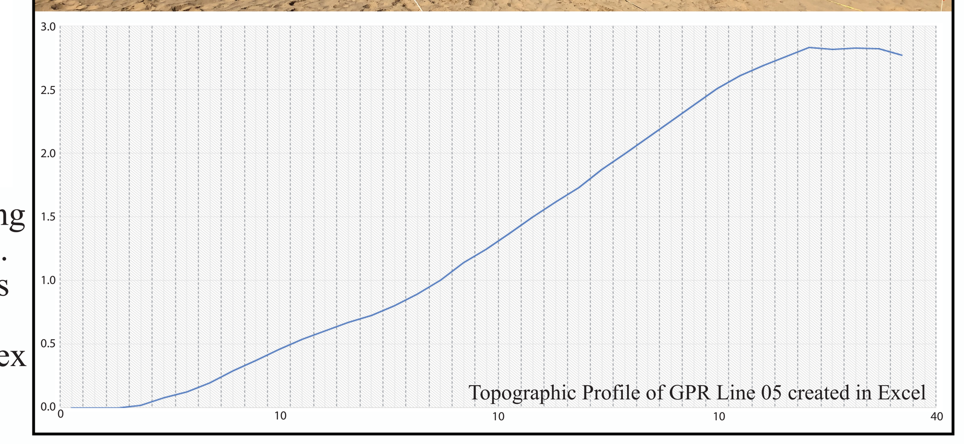
Digital surface model of the study area shows dune slip off slopes to the north-east. General dune migration of the Algodones Dune field is south-east.

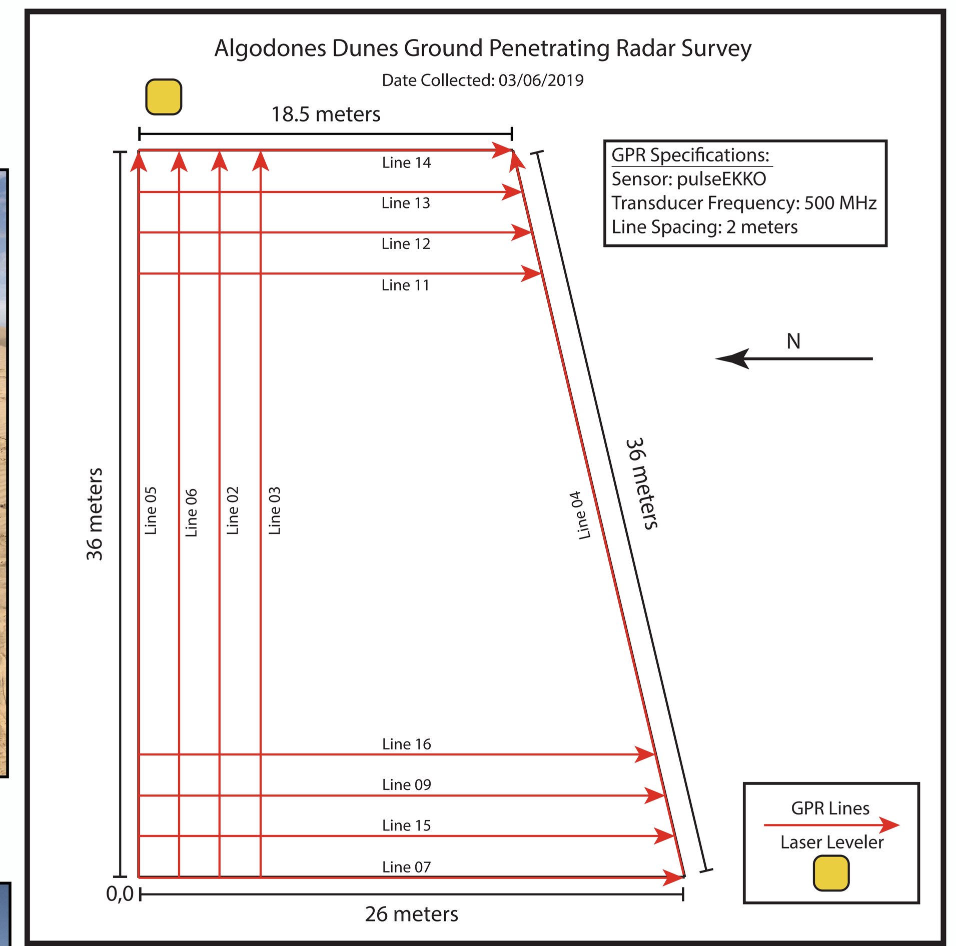


Eastern Crescentic Dune indicate prevailing wind direction of 27 degrees (north-east). Overall, dune migration of the Algodones Dune field is to the southeast. Differing dune migration direction indicate a complex dune system.
(Derickson et al, 2008)

Data processing within Ekko_Project (a software used to analyze GPR lines) allows for signal velocity, line dimensions, and slice resolution to be adjusted. Signal velocity is an important input which is determined by the soil type and allows for a depth range to be calibrated

Pulse_EKKO 1000 GPR system used to collect data on the Algodones Dune field



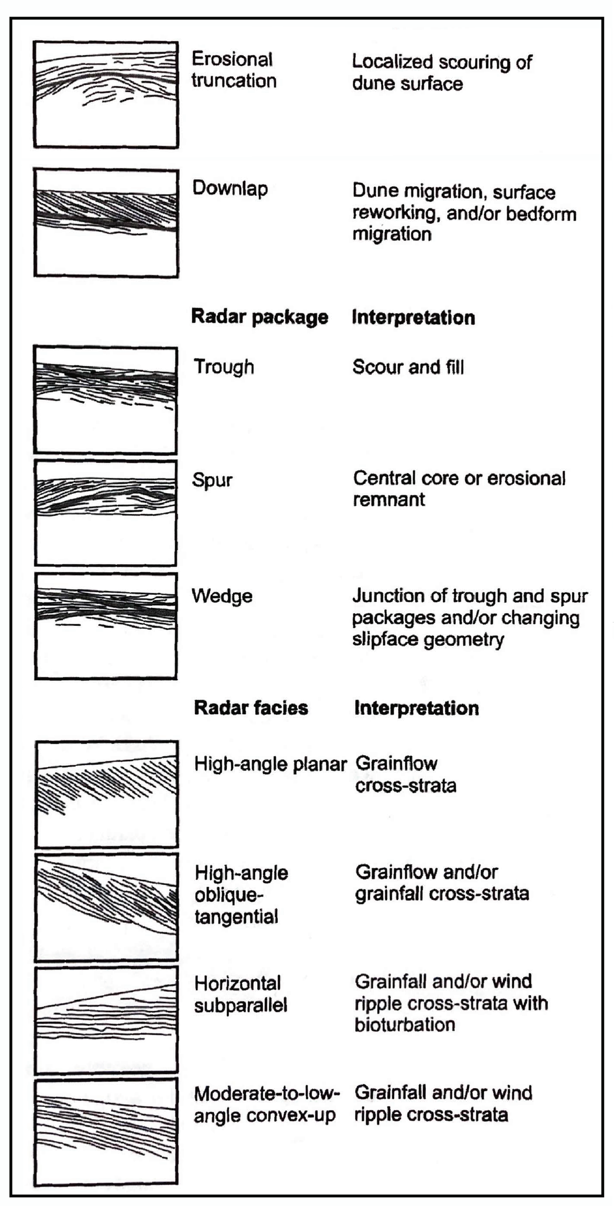


Schematic of data collection including X and Y lines and GPR specifications

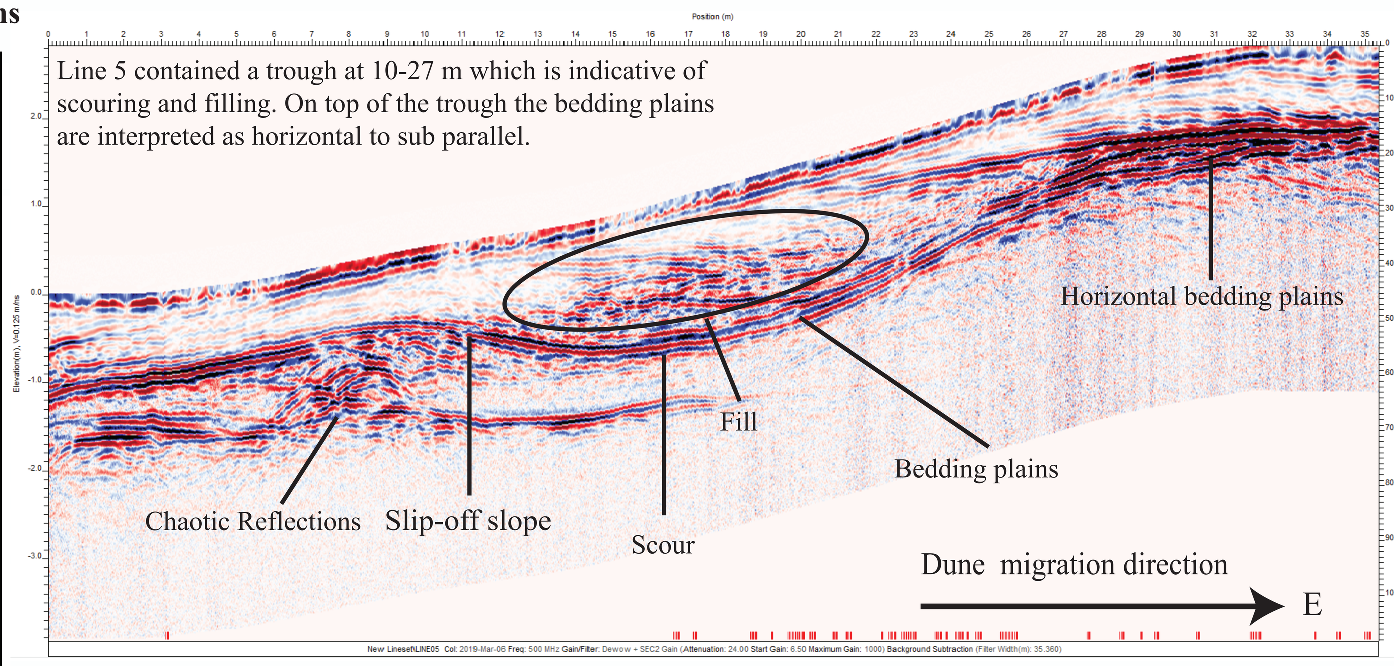
The technology used in this study was ground penetrating radar (GPR). GPR is a geophysical tool that allows for the subsurface to be imaged. Pulses of electromagnetic energy are sent into the ground, the electromagnetic waves of energy are then reflected back to the sensor (Jol and Bristow, 2003). Areas of different dielectric properties cause the radar pulse to reflect back to the sensor (Davis and Annan, 1989). The sensor then records these reflections in units of time (ns) where the velocity of the electromagnetic waves can then be calculated. To find the depth of the different stratigraphic layer's velocity is calculated through hyperbola matching or by manually inputting velocity based on the soil properties, which then allows for a depth of features in the subsurface to be measured (Jol and Bristow, 2003). Ekko_Project software enables stratigraphic facie analysis through lineview. SliceView software extension in Ekko_Project provides both planar and horizontal view analysis.

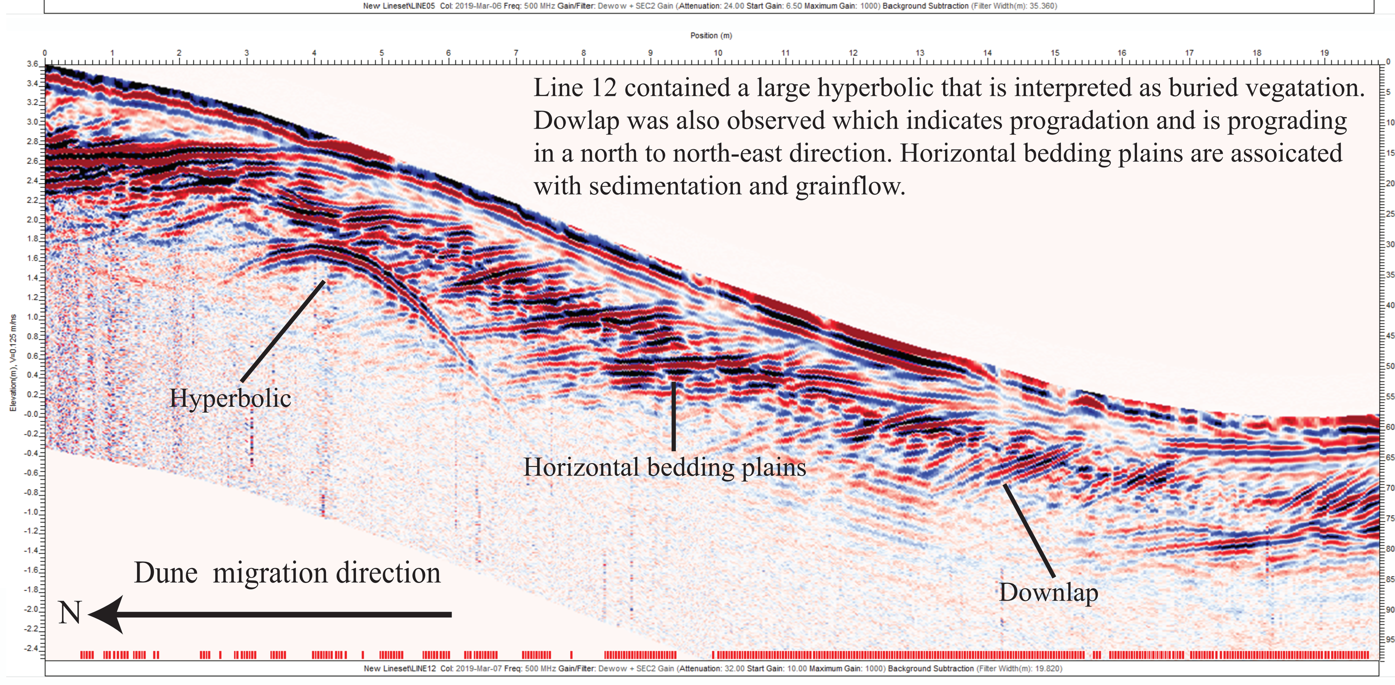
Results

Radar Facies for Stratigraphic Interpretations

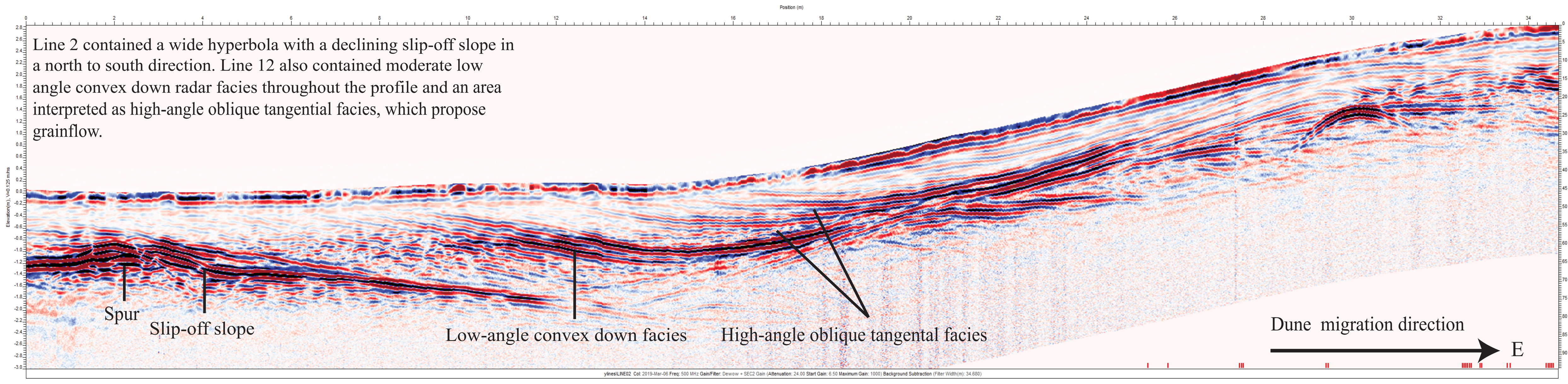


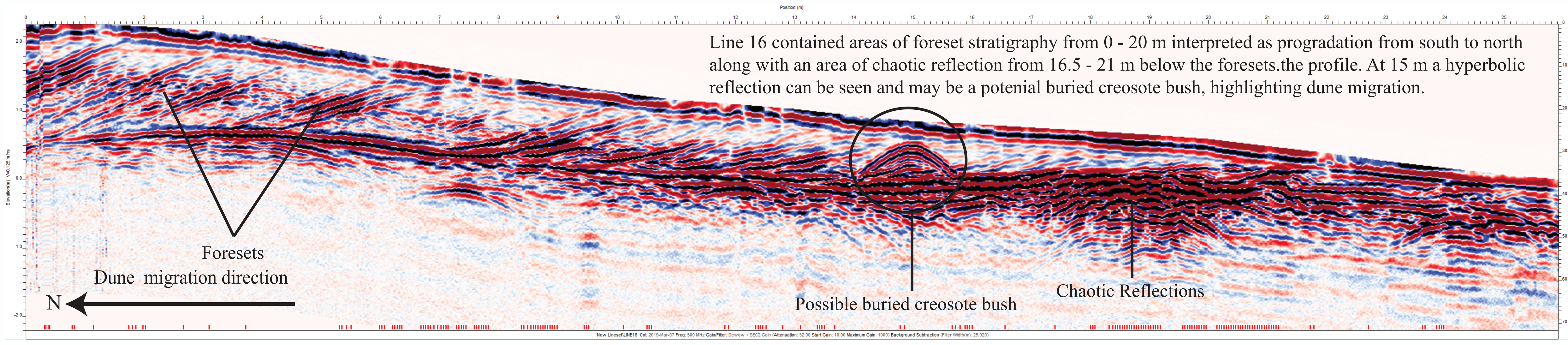
Interpretation and radar surfaces and radar facies (Baker, 2007)





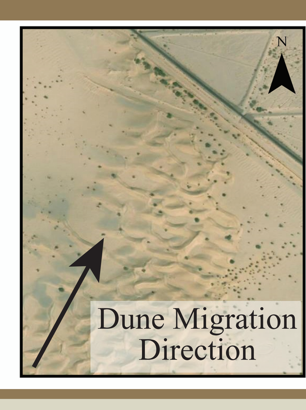
Stratigraphic interpretation of GPR lines indicated processes associated with dune movement such as forsets, scour, high-angle oblique tangential facies, low - angle convex down facies, bedding plains and spurs. Topographic correction of the lines allowed for lines to simulate real-world elevation and presented an accurate analysis of dune migration patterns. Findings indicate that dune migration is occurring to the north-east as lines were collected in a west-east orientation (Y lines) and a north-south direction (X lines).





Conclusions

GPR is a geophysical tool whose ability to identify subsurface stratigraphy is useful for understanding dune migration and formation. Analysis of the dune line stratigraphy indicated progradation radar facies such as downlap in Line 12, foresets in Line 16 and chaotic reflections highlight sediment disturbances. Line 5 revealed a scour and fill facies pattern, proposing both erosion and deposition around an ancient dune slipoff slope. Line 2 radar facies contained multiple ancient dune complexes with low-angle convex down facies and high-angle oblique tangential facies that show grainfall and flow. Dune migration patterns from both X any Y lines show movement in a north to north-east direction. These findings indicate that the eastern crescentic dune field near Glamis is migrating in a pattern that differs from the central Algodones Dune field which is currently migrating in a south-east direction. This study will be used to help plan for future infrastructure and was one of the first geophysical surveys done on the Algodones Dune fields Eastern Crescentic region.



Acknowledgements

We would like to thank the Student Blugold Commitment funds through the University of Wisconsin-Eau Claire Student-Faculty International Fellows Program for Research, Service, and Creative Activity as well as the Student Blugold Commitment Differential Tuition funds through the University of Wisconsin-Eau Claire Student/Faculty Research Collaboration program. Without this funding trips like these would not be possible. We would also like to thank our collaborators from SDSU, Dr. Allen Gontz and Chelsea Blanton for their time and resources. Thank you to Yvonne Plomedahl for her hard work as our department secretary and Harry Jol, our faculty mentor. Also, thank you LTS Printing services for printing our research poster.

References

Baker, G.S., and Jol, H.M., 2007, Stratigraphic analyses using GPR: Boulder, CO, Geological Society of America.

Derickson, D., et al, 2008, Origin of a Complex and Spatially Diverse Dune-Field Pattern, Algodones, Southeastern California, Geomorphology, vol. 99, no. 1-4, 2008, pp. 186–204., doi:10.1016/j.geomorph.2007.10.016.

Jol, H.M.,and Bristow, C.S., 2003, GPR in sediments: Advice on data collection, basic processing and interpretation, a good practice guide, in Bristow., C.S and Jol, H.M., eds., Ground Penetrating Radar in Sediments: Geological Society, London, Special Publications, v. 211, p. 1–7, doi: 10.1144/G SL.SP.2001.211.01.26.