

Paleobasin Mapping using Lunette Morphology*

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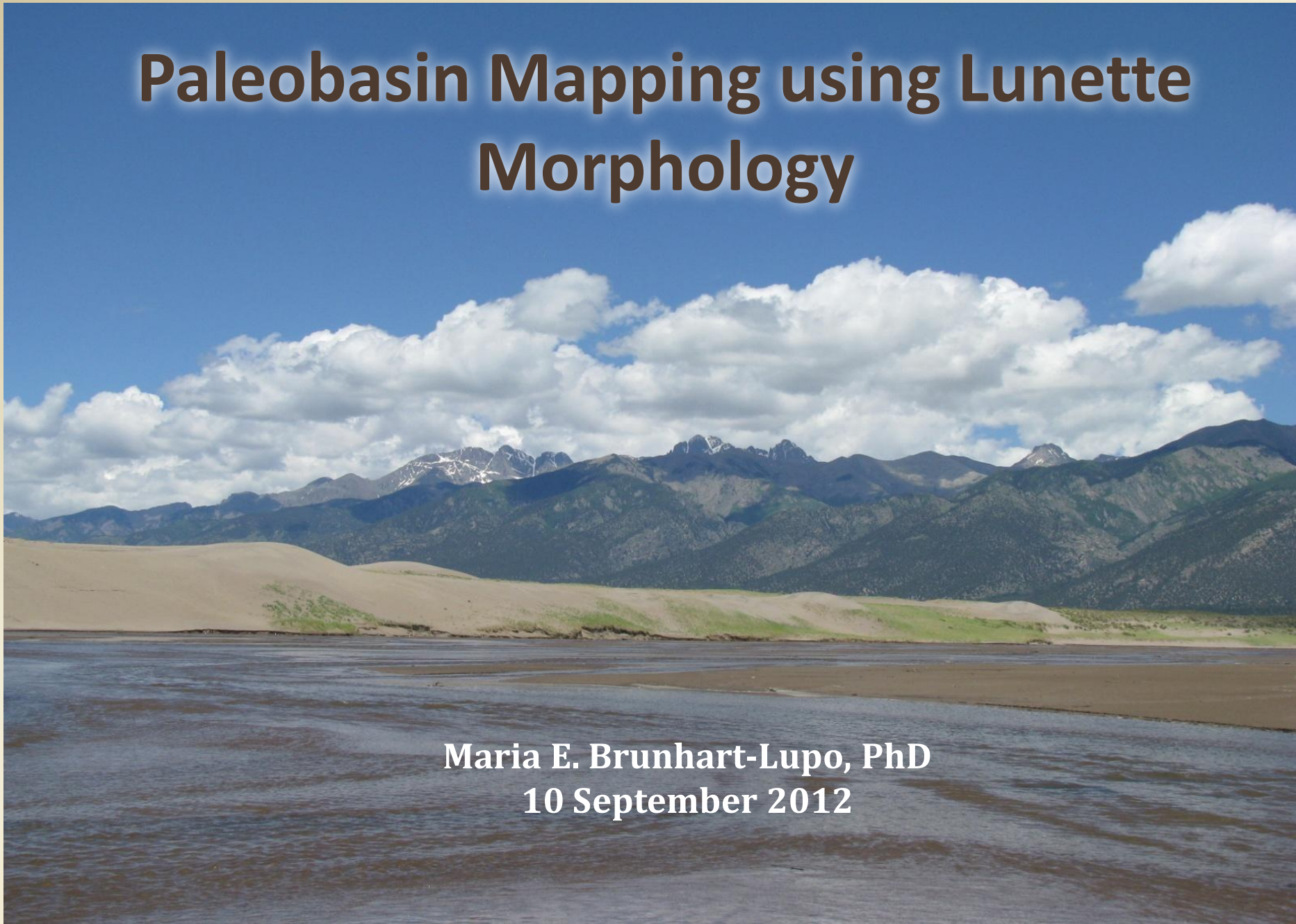
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Abstract

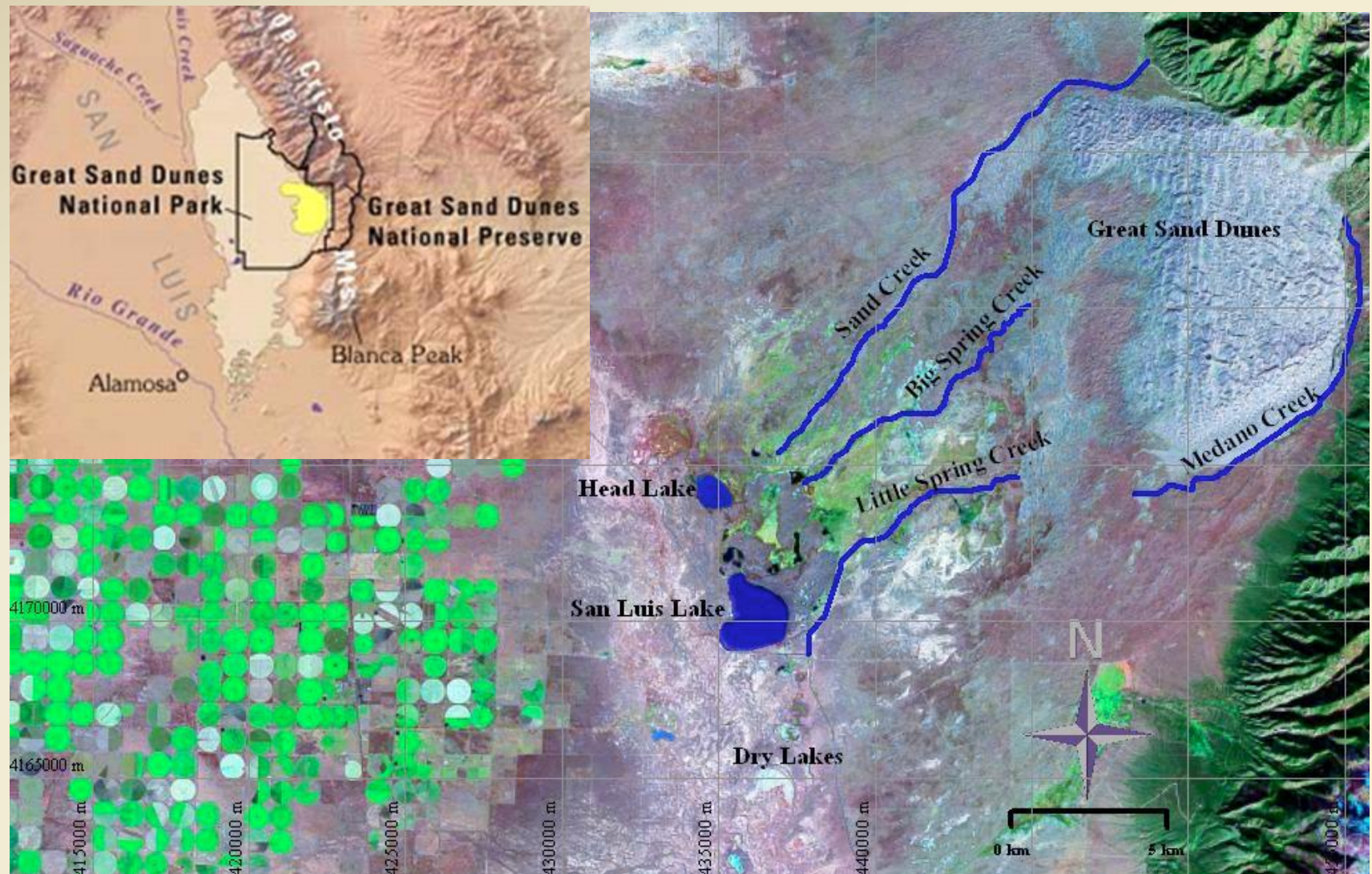
Lunette deposit morphologies are related directly to the amount of water that they are exposed to over time. In a recent study at the Great Sand Dunes National Park and Preserve, Colorado, three distinctive morphological expressions were recognized in lunettes; the single discrete lunette; the merged lunette; and the modified lunette (fluvially modified within the GRSA) in order of increasing complexity of morphology. In the current depositional regime, the largest and most morphologically complex lunette deposit is located in the depocenter of the current sub-basin within the San Luis Basin system. Surrounding that deposit is a 'ring' of merged lunettes, followed by the single, discrete lunette furthest from the depocenter. The lunettes do not extend to the edge of the basin itself, but instead are present within the central region only. The pattern indicates the current depocenter margins and dating indicates that this has been the case for at least the past 10,000 years. Using the premise that the most heavily modified lunette is at the center of the basin, and the lunettes become less complex from the center towards the margins of the basin, paleobasinal depocenters can be mapped by use of lunette morphology, giving a surficial methodology for establishing the movement of the deepest location of the depocenter over time. This is an important method for use in areas that are protected and preserved as it is non-invasive and requires only minimal sampling to establish the relative ages of the deposits.

Paleobasin Mapping using Lunette Morphology

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10 September 2012



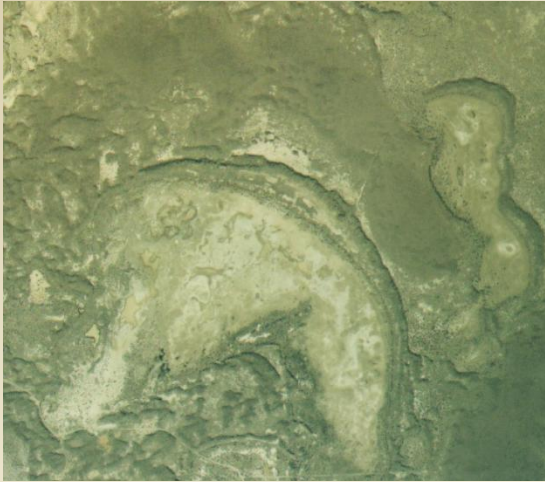
FIELD LOCATION



WHAT IS A LUNETTE?

- ✗ Lunettes are horseshoe shaped deposits found in association with playas
- ✗ These deposits have a mix of aeolian and lacustrine deposits, occasional layers of evaporites
- ✗ Often curve roughly $2/3$ around the playa, with the $1/3$ windward face having no deposit

LUNETTES



NPS aerial archive



FORMATION OF LUNETTES

- ✗ Formation begins with a low ridge of sand along the lee edge of a playa
- ✗ During dry periods, fines from the dry playa blow onto the ridge, providing a small amount of cohesive material
- ✗ Uppermost layers of the lunette are not stable, but underlying layers can be incredibly hard to erode
- ✗ Sand is also accumulated onto the feature during this time

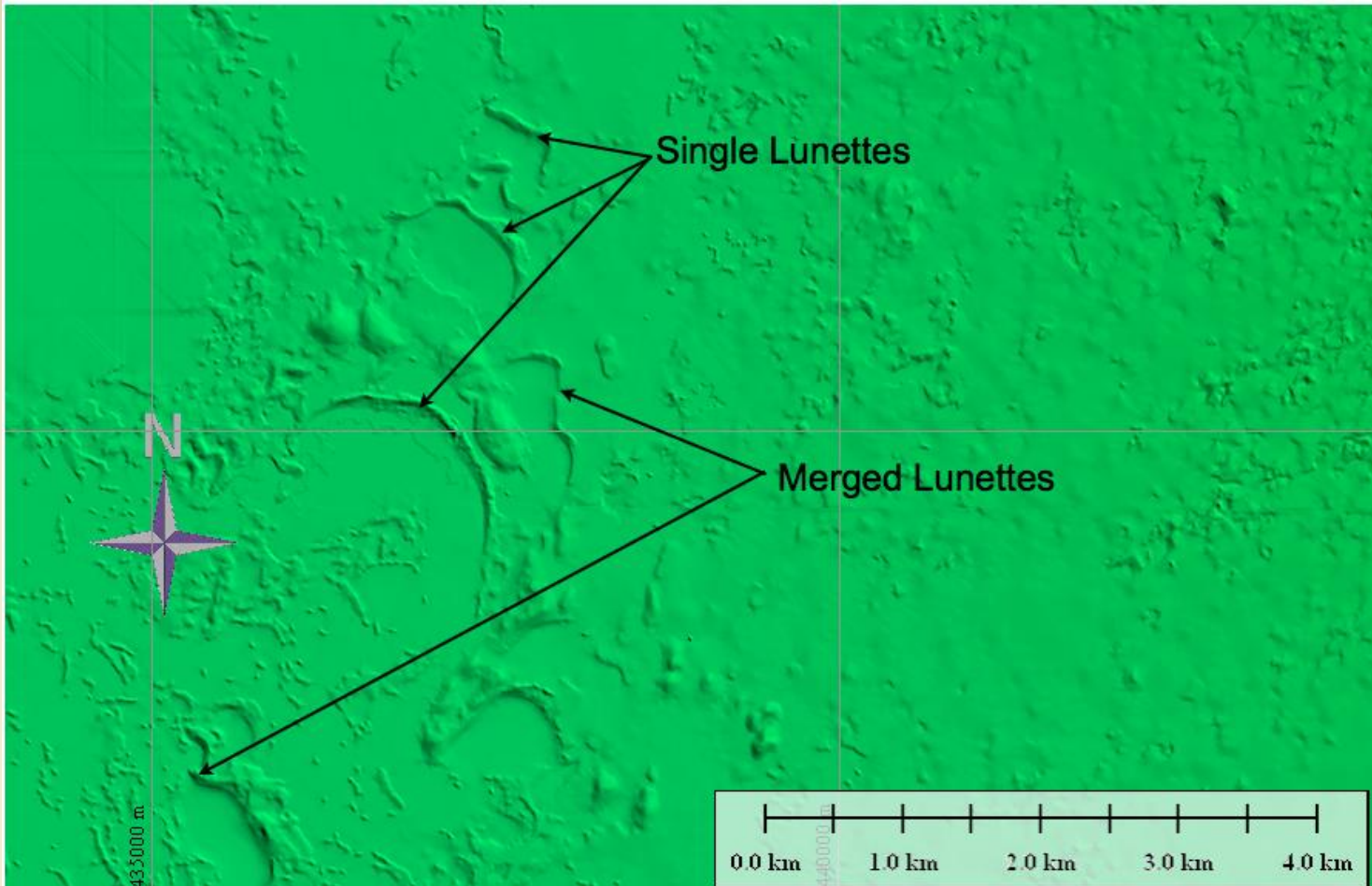
FORMATION OF LUNETTES CONT'D

- ✗ During wet periods, the lunette still receives aeolian sand, but the source of fines is cut off
- ✗ Instead, fine materials are deposited directly onto the edge of the lunette via lacustrine sedimentation
- ✗ Lunette is more or less stabilized during wet phases, though some of the feature may be lost into the playa

GEOMORPHOLOGICAL IDENTIFICATION

- ✕ Three lunette types recognized, mapped, and described
- ✕ Fluvially modified lunette at San Luis Lake
- ✕ Single, discrete and merged lunette systems at the Dry Lakes
- ✕ Each lunette type displays a unique topographic profile

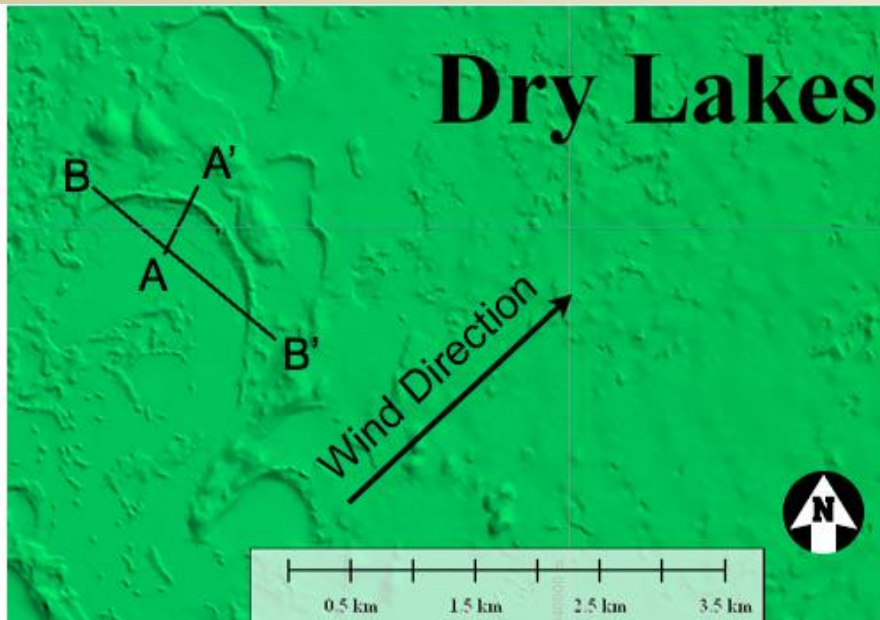
SINGLE AND MERGED LUNETTE MAP: DRY LAKES AREA DEM



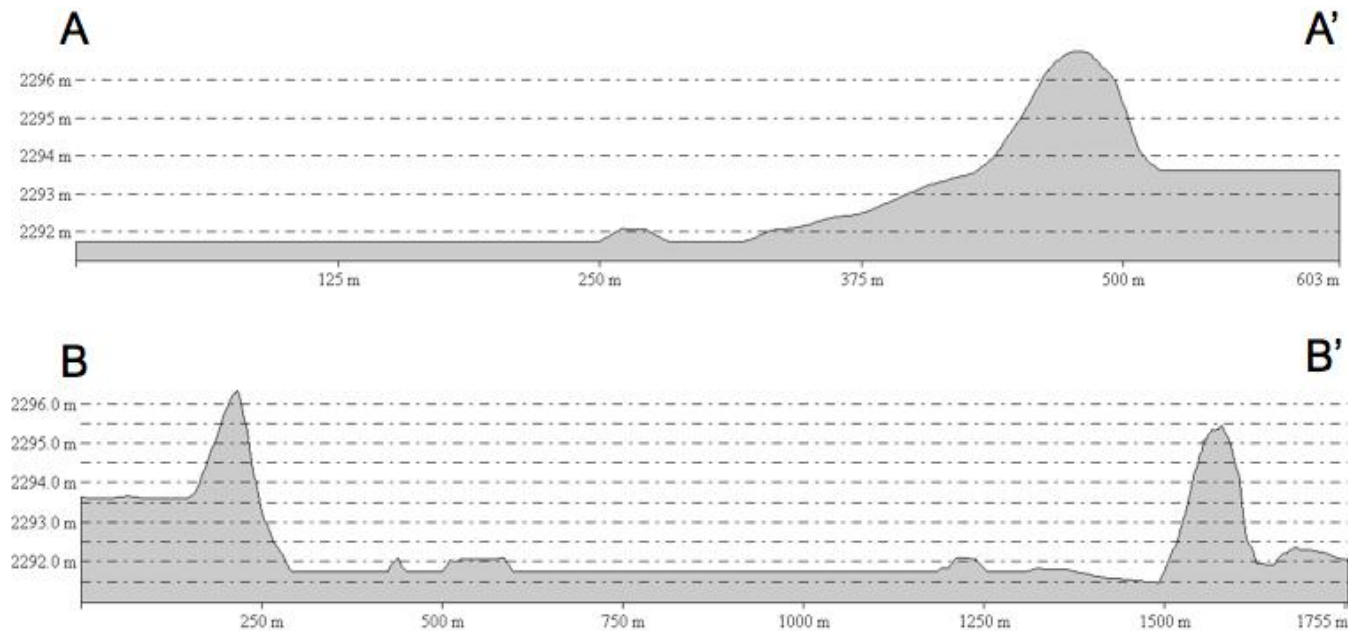
SINGLE DISCRETE LUNETTES

- ✗ Dimensions are generally narrow; width: 3 to 4 m, median height: 3 m
- ✗ Similar to lunettes recognized elsewhere: distinctive horseshoe shape, $\sim 2/3$ around lee side of associated playa
- ✗ Do not connect to any other morphologic features

Dry Lakes

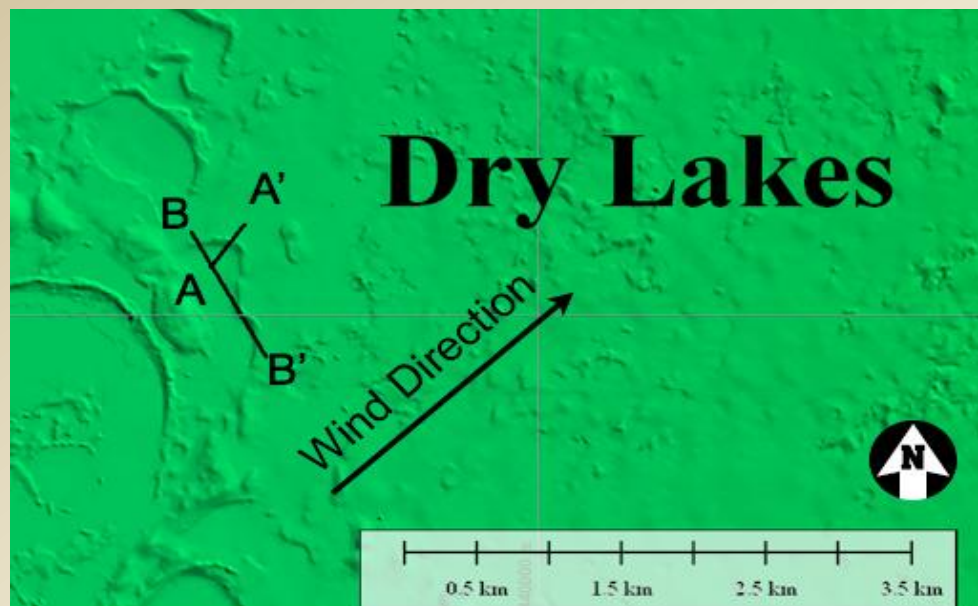


Single Lunette

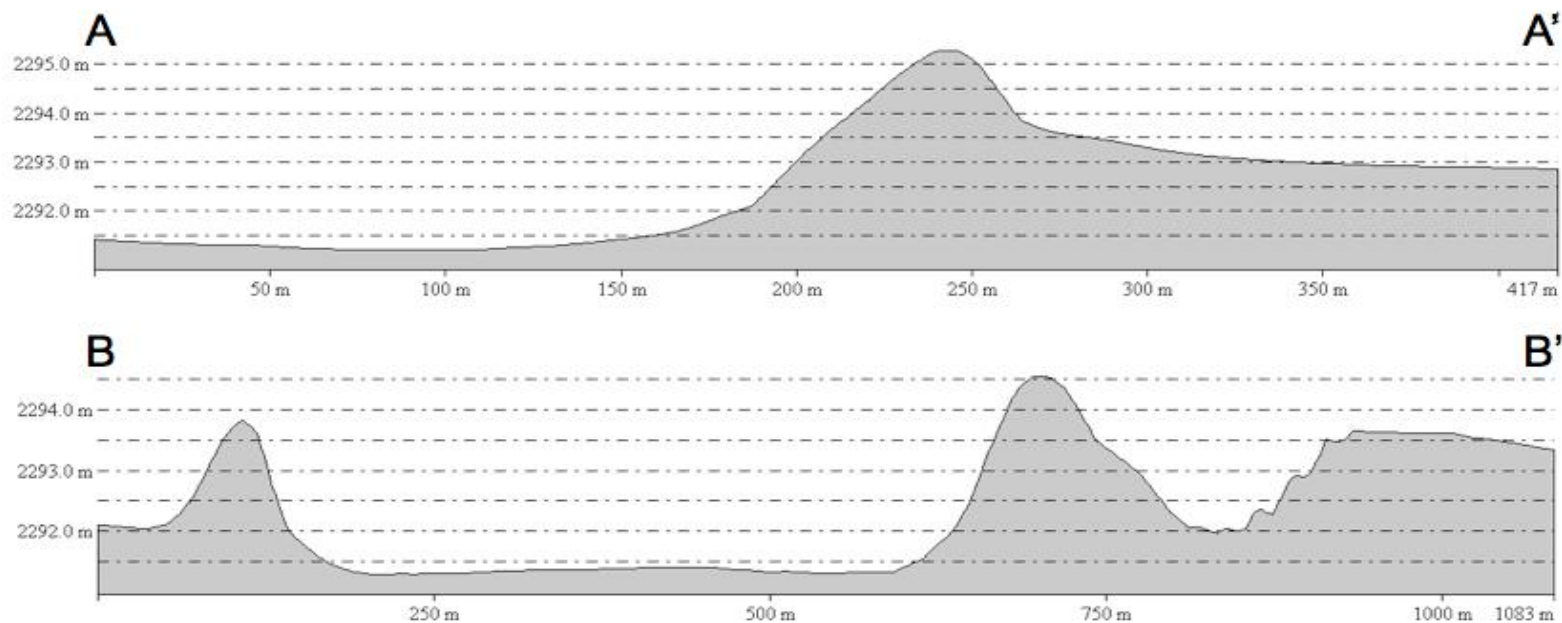


MERGED LUNETTES

- ✗ Merged lunettes consist of two single, discrete lunettes forming in close proximity and developing into single lunette front
- ✗ Dimensions and formation of original lunettes are identical to the profile of a single, discrete lunette; no topography between lunette and playa
- ✗ In merged lunette system, playa is furthest from lunette at edges



Merged Lunette



FLUVIALLY MODIFIED LUNETTE

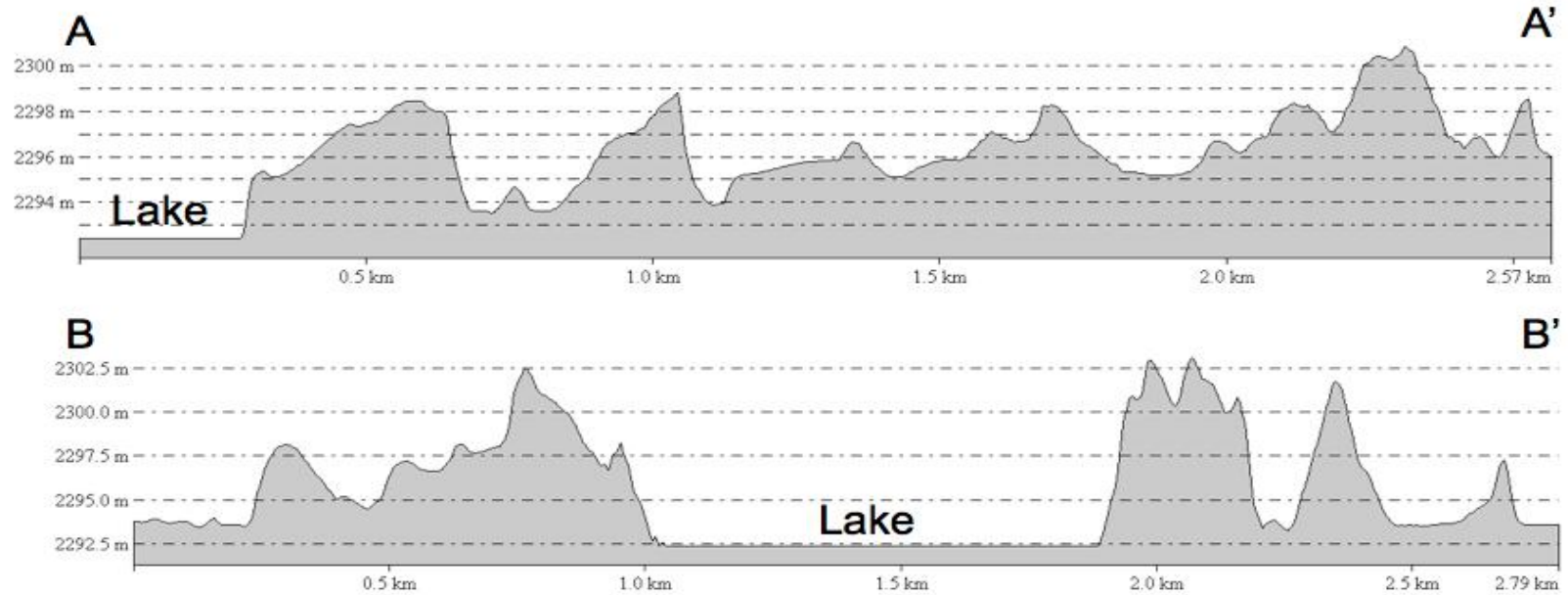
- ✗ The largest lunette in the field area
- ✗ This lunette deviates greatly from the common shape of lunettes documented elsewhere
- ✗ Fluvially modified system displays large amount of relief between the main lunette front and playa – three identified lunette ridges

FLUVIALLY MODIFIED LUNETTE

- ✗ Deposits have distinct internal architecture with complex mixture of different deposit types from different sub-environments
- ✗ Resembles that of single, discrete type, but does not have a singular, uniform, solid front

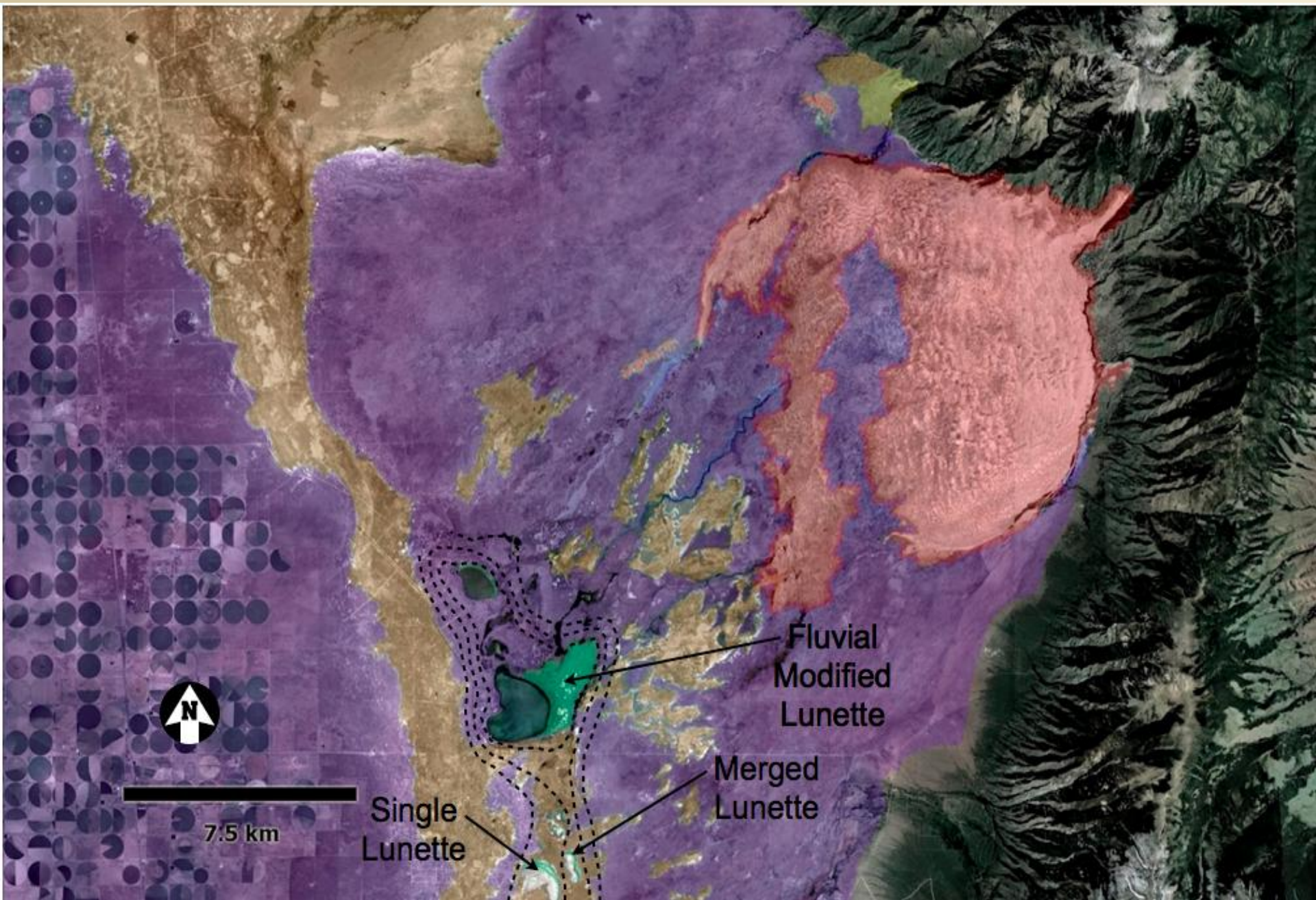


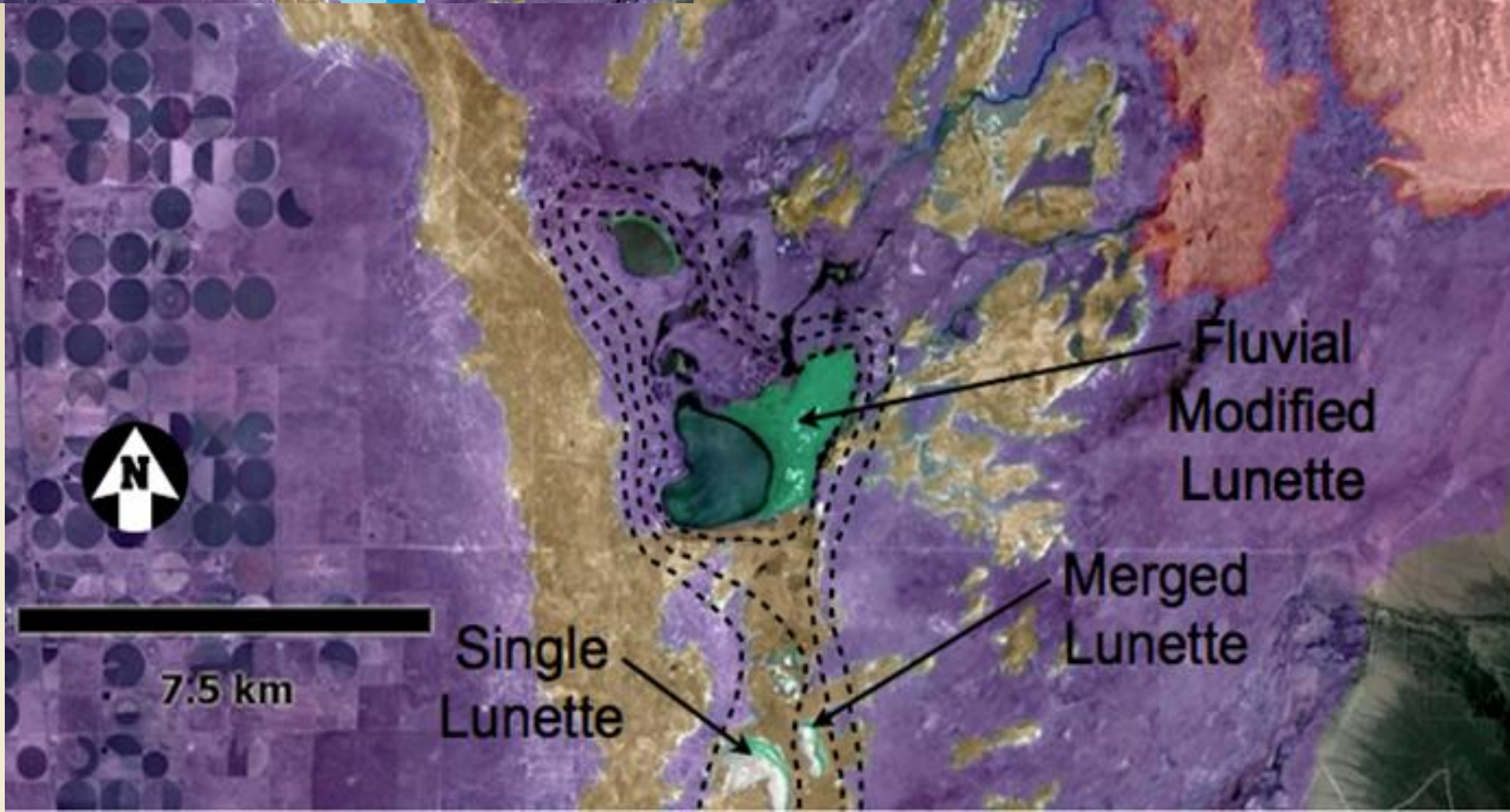
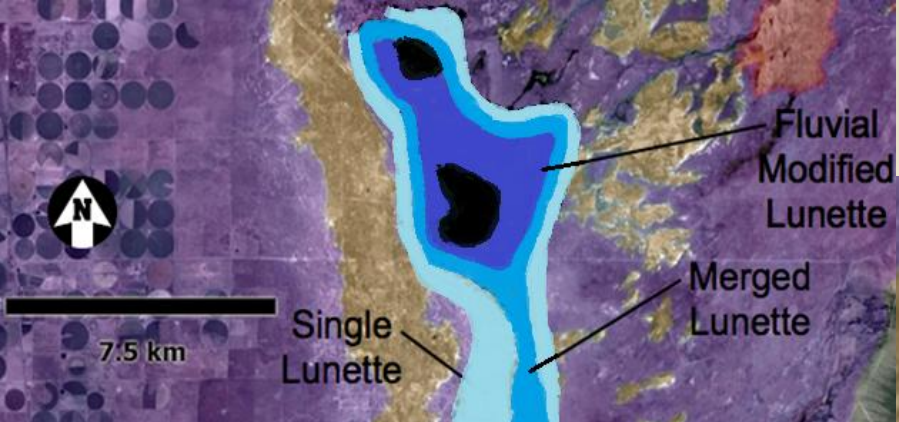
Fluvial Modified Lunette



PALEOBASIN MAPPING VIA LUNETTE MORPHOLOGY

- ✗ Morphology linked to amount of water, exposure to fluvial forces and duration of water presence
- ✗ Lowest point of the basin contains the fluvially modified lunette
- ✗ Further out are merged lunettes
- ✗ At the edge of the lunette field are single, discrete lunettes





PALEOBASIN MARGIN MAPPING

- ✘ Using the lunette morphology, can establish zones around the depocenter of a basin – most heavily modified to least
- ✘ At present the GRSA model is holding true for examples in Australia
- ✘ Allows for a rapid, surficial assessment for the basinal margins over the course of the lunette formations

ONGOING WORK

- ✖ Model is now being applied in regions with differing characteristics than the GRSA:
 - + Closely spaced seismic events
 - + Semi-arid regions with a higher percentage of humidity and/or rainfall
 - + Noted climatic shift
 - + Anthropogenic influence

THANK YOU

Thank you for attending this presentation, and
for your questions.

