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[EA]Evolution of the Shallow Pleistocene Carbonates of New Providence Island, Bahamas – Using GPR and Outcrop Data*

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Abstract

Key Findings

• Mapping of western New Providence Island shows a complex carbonate facies suite of Pleistocene MIS 5e deposits from variable subtidal, through beach to eolianite facies.

• High precision 2D GPR data provides insight, including enhanced facies mapping to the surface and shallow subsurface sedimentary succession.

• Evidence of exposure within the MIS 5e highstand indicates a fall of sea level of 10+ meters subdivided the highstand into older and younger substages.

• Facies are variable between the two substages and suggest the younger substage deposits formed at a higher sea level than those of the older one.

Significance

The shallow Pleistocene carbonates that form New Providence Island, Bahamas, were deposited during a series of sea level highstands, with most of the island forming during the last interglacial highstand - Marine Isotope Stage (MIS) 5e. Outcrops in the western part of the island reveal a complex carbonate succession of MIS 5e deposits and an exposure horizon that indicates a sea level oscillation within the highstand.

Combined ground penetrating radar (GPR) and outcrop data delineate the distribution of the carbonate facies in map view and placing the facies distribution on a digital elevation model (DEM) produces a refined view of facies distribution.

Methods and Preliminary Results

The sedimentology and stratigraphy of the western portion of New Providence Island are analyzed using outcrops, high precision 2D GPR, and a DEM (Figure 1). Six main lithofacies recognized within outcrops of the MIS 5e deposits range from eolianite to beach and to variable subtidal. The facies are delineated on outcrop (Figure 2) and can be interpreted and correlated with the GPR data (Figure 3).

The 2D GPR data provides insight to the surface and shallow subsurface sedimentary succession within MIS 5e including enhanced facies mapping. Heights and geometries of different ridges are captured with the DEM as well as by the topography along the GPR lines (z-coordinate). The DEM shows a series of ridges, which were interpreted as beach facies by previous workers. Outcrop and GPR show some of the relatively lower ridges instead to be subtidal bars (Figure 1). This finding prompts a revision of the notion of down-stepping beach ridges with the onset of the glaciation at the end of MIS 5e to be instead a forced regression of shoal ridges.

An exposure horizon identified on outcrop as a well-formed calcrete within MIS 5e subtidal deposits can be traced across most of the GPR lines (Figure 4). This horizon records a 10+ m fall of sea-level and notably subdivides the highstand into older and younger substages, as was previously postulated by Jackson (2017) and others. Shallow-water facies relations vary between the two 5e substages: younger subtidal bars locally overlie older subtidal burrowed facies and dip directions can vary between younger and older stacked subtidal bars. Additional evidence supporting the sea level oscillation within 5e and suggesting a difference in position of sea level between the two highstands is the local juxtaposition of younger subtidal facies on top of older eolianites. Thus, facies relationships suggest the late substage deposits formed at a higher sea level than those of the early one.

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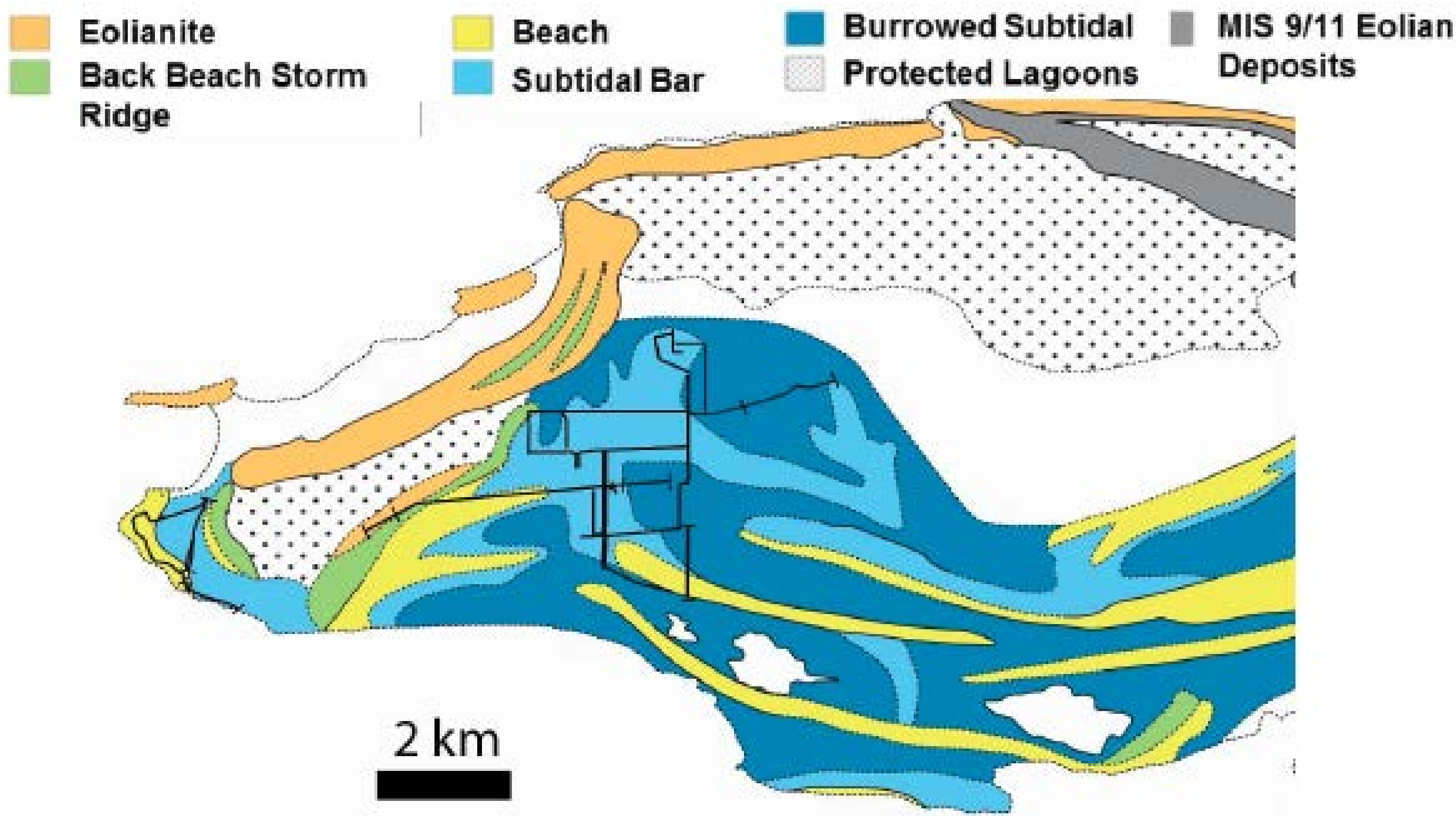

Figure 1. Facies map of western portion of New Providence Island (modified from Reid, 2010 by Alothman, 2017) showing distribution of MIS 5e deposits. Locations of GPR lines (28 km of 250 MHz GPR data) are shown by black lines.

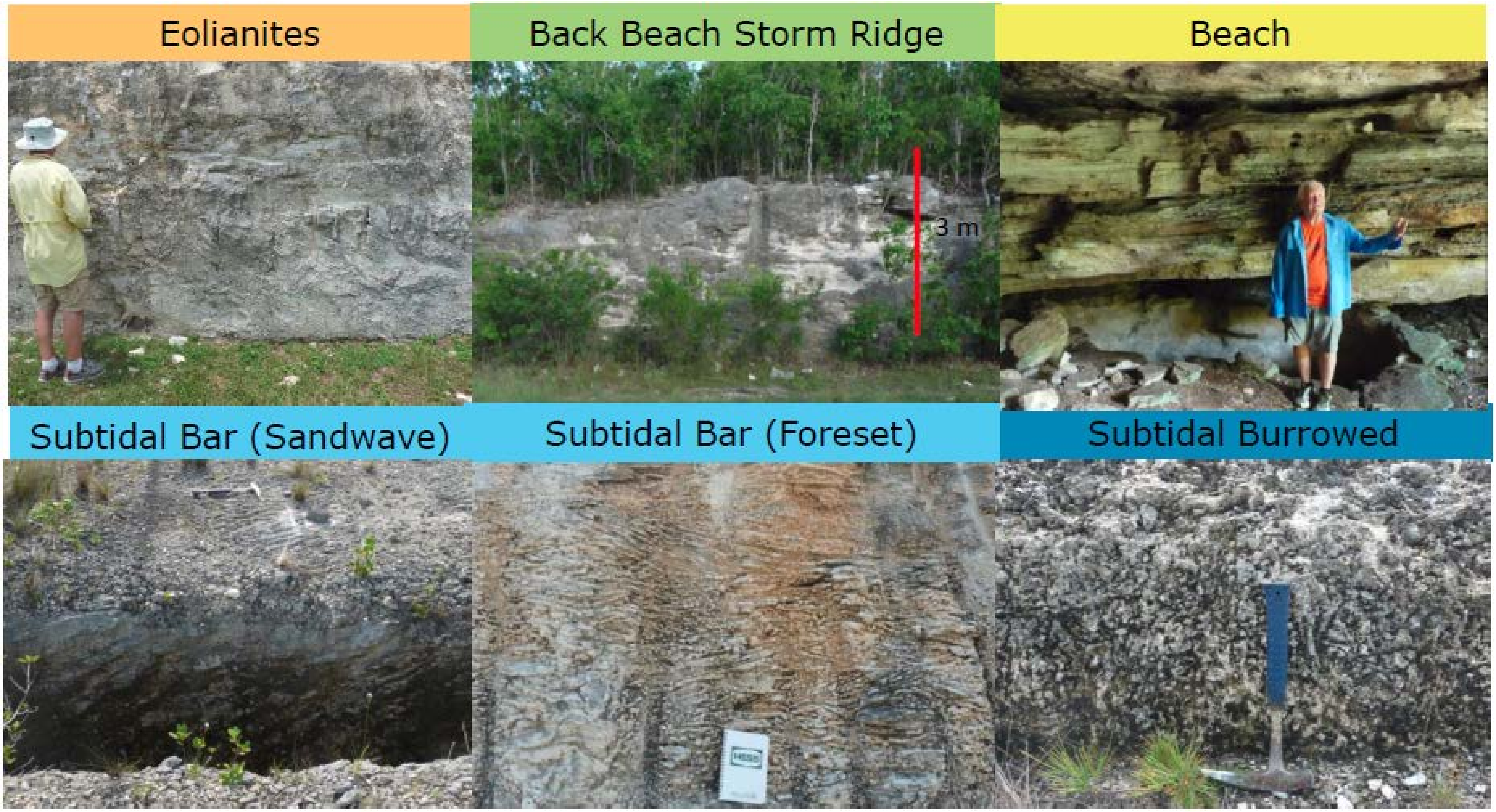

Figure 2. MIS 5e facies identified on outcrop.

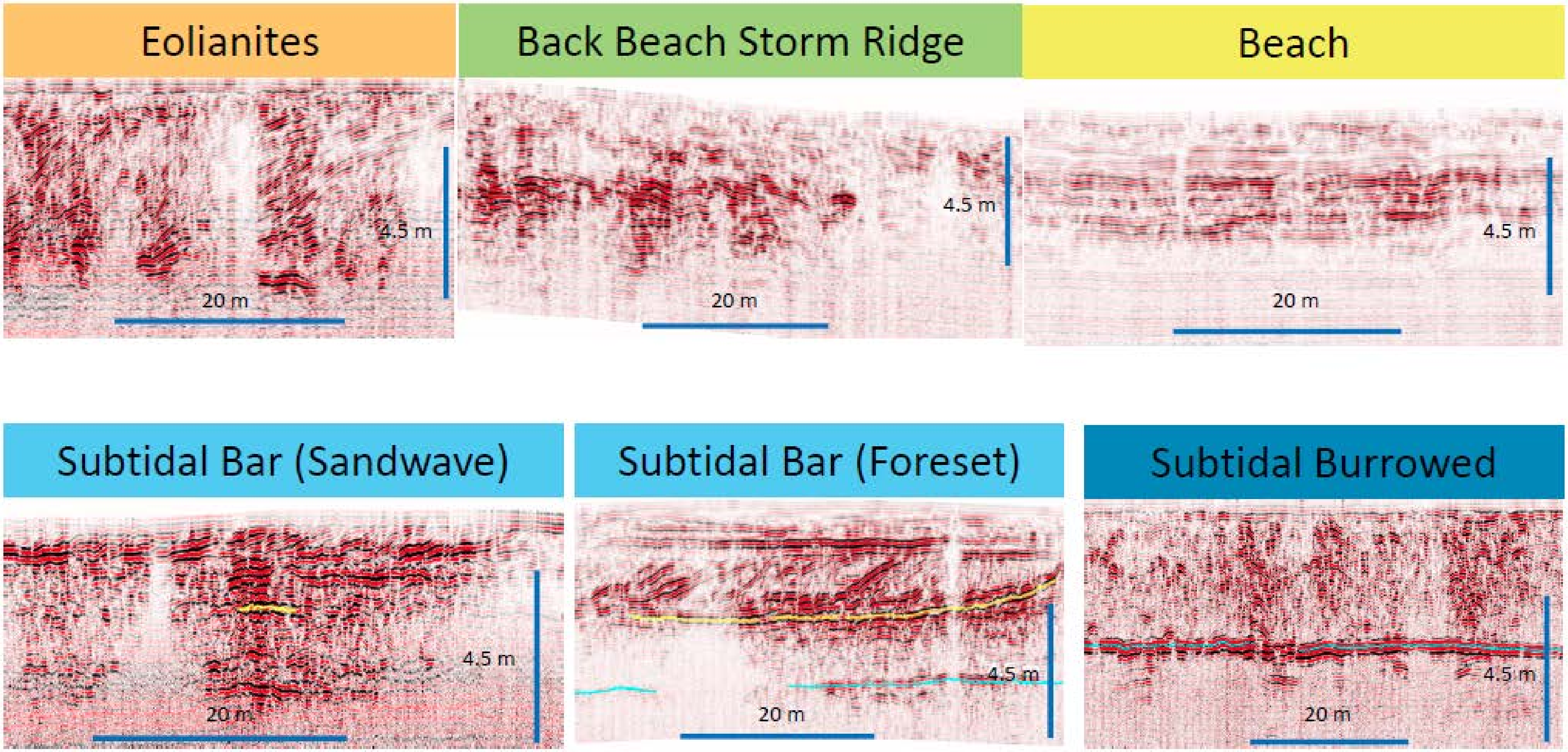

Figure 3. MIS 5e facies interpreted on GPR data.

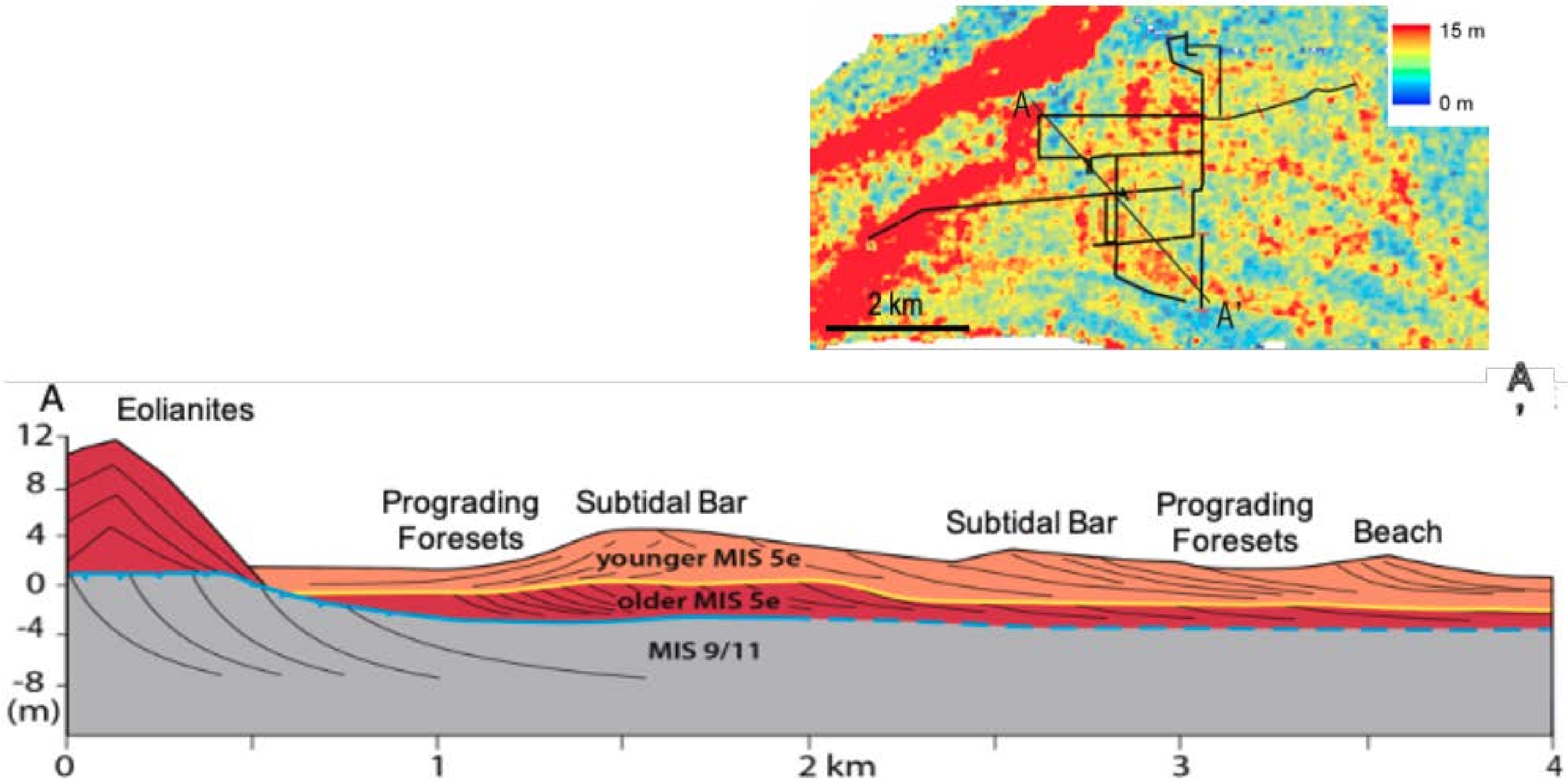

Figure 4. Cross section through study area showing stratigraphy and facies distribution. Line of section and locations of the GPR lines are shown on the DEM inset.