I. ABSTRACT

The Zion Beach-ridge Plain (ZBRP) defines the northernmost portion of the Illinois coast of SW Lake Michigan, where it hosts a variety of unique ecosystems within its “washboard style” ridge-and-swale topography (e.g., dunes). The ZBRP is a vast coastal plain formed by glacial depositional processes, where nearshore and shoreline environments are continuously restructured by wave and current forces. The ZBRP is formed by glacial till deposits, which are 200 to 300 m thick and underlain by sand and gravel, which are 5 to 10 m thick. In this study, we present a comprehensive analysis of the ZBRP’s heterogeneous coastal plain using geophysical tools, such as ground-penetrating radar (GPR), and sedimentological observations. We focus on the dynamic nature of the ZBRP and its influence on the coastal environment, which is crucial for understanding the coastal processes and ecological changes in the region.

II. BACKGROUND

The ZBRP is a valuable location for studying coastal processes and their impact on the coastal environment. The ZBRP is characterized by a series of coastal ridges and swales, which are formed by the deposition of glacial till and sand and gravel deposits. These deposits are influenced by wave and current forces, which continuously reshape the coastal environment. Understanding the dynamic nature of the ZBRP is crucial for predicting future changes in the coastal environment and for developing effective coastal management strategies.

III. METHODS

The Illinois State Geological Survey (ISGS) collected 10 km of GPR data in 2021 using a 250 MHz geophone. This coverage, mostly along shore-parallel road sections, spans from Chicago, IL to Zion, IL. The GPR data were processed in Gokyo203 software. Two-way travel time was measured to a depth of 30 m below sea level, a standard for nearshore GPR data. The ISGS also collected sedimentological data to complement the GPR data. The GPR data were analyzed using a suite of geophysical tools, such as frequency analysis and spectral analysis, to identify sedimentary features and their spatial relationships.

IV. RESULTS AND DISCUSSION

The GPR data provide a high-resolution image of subsurface architecture to depths of 6 meters, revealing depositional structures at the scale of meters. These structures are distinguished based on reflectivity patterns (Fig. 2). Major radar facies are often well defined and can be mapped across extensive stretches of the ridge plain (Fig. 4). Detailed sedimentary characteristics by Hester and Fraser (1971) along Waukegan Road (IL-83) provide lithologic constraints that generally correlate with these interpretations (Fig. 4). Coarse sand and gravel deposits described in one section correlate with a high-amplitude, topographically unusual zone separating RF1 and RF2. These deposits are 10 m thick and contain a horizon of coarse sand and gravel deposits that are 10 m thick. Sites with coarse sand and gravel deposits in the same section also contain a horizon of coarse sand and gravel deposits that are 10 m thick.

V. REFERENCES AND ACKNOWLEDGEMENTS

This research was supported by the Illinois State Geological Survey and the Illinois Prairie Research Institute. The authors would like to thank the Illinois State Geological Survey and the Illinois Prairie Research Institute for their support.

Anatomy of a Migrating, Late Holocene Strand Complex: A GPR-Based Architectural Study of the Zion Beach-ridge Plain, SW Lake Michigan

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FIGURE 1 (left) – Maps showing (A) the location of the Zion Beach-ridge Plain (ZBRP) within the context of the greater Illinois lake plain; the Mokena moraine along the western margin and the Illiana moraine along the eastern margin (B) and (C) 2012 LIDAR bathymetric LiDAR showing the elevation and geomorphology of the ZBRP. FIGURE 2 (left) – Map of subsurface deposits (top) and radar facies identified by color. FIGURE 2 (right) – Collage series of net erosion (a) and net deposition (b) models of the ZBRP shoreline, showing 2012-NAIP aerial photographs and 2012-DEM derived DEM (USACE) and historic shoreline reconstructions against modern LIDAR. FIGURE 3 (a)–(b) – Configuration of radar facies in the beach ridge plain (ZBRP) in the Illinois shoreline environment with 2012-NAIP aerial photographs and 2012-DEM derived DEM (USACE) and historic shoreline reconstructions against modern LIDAR.