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Landforms of fetch-limited saline lakes as evidence of storm-wind direction and strength

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Landforms of Fetch-Limited Saline Lakes as Evidence of Storm-Wind Direction and Strength*

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Coastal landforms of some lakes provide evidence of relative wave energy and direction of strong storm winds. Others are evidence of relative wave energy but not evidence of direction of strong storm winds. For example, relative wave energy can be due to long fetch rather than storm-wind strength. A detailed study of elevations of 1986/87 shoreline debris of Great Salt Lake suggests that shorezone landforms of similarly fetch-limited, shallow, closed-basin, relatively equi-dimensional, saline lakes can provide evidence of direction of storm winds.

In 1986/87, Great Salt Lake reached its historic highstand lake elevation creating research opportunities for studying the lake's coastal processes. Evidence of the 1986/87 shoreline included anthropogenic trash such as lumber, plastics, and automobile tires as well as beach sediments and shorezone landforms. Shoreline superelevation (the elevation of shoreline debris above still-water lake level) was surveyed at 1228 locations along the 64 km shoreline of Antelope Island, the largest island in Great Salt Lake. One third of the surveyed debris was more than a meter above still-water lake elevation. Shores facing west and northwest into strong storm winds generally had higher shoreline superelevation than eastern shores in the lee of the island. High shoreline superelevation was associated with erosional shorezone features including rocky shores, steep beach faces, curvilinear bays, pocket beaches framed by bedrock, sea cliffs, and wave-cut platforms. Low shoreline superelevation was associated with accreting shorezone features including mudflats, salt water wetlands, sandy beaches, linear beaches, multiple beach ridges, spits, bars, cuspate bars, and lagoons.

Differences in wave energy cause differences in shoreline superelevation. Research explored whether differences in energy of waves of Great Salt Lake were caused primarily by differences in wind strength or by differences in fetch. This research question was tested by examining shoreline superelevation at locations on opposite shores of Gunnison Bay, the large northwestern part of Great Salt Lake (Figure 1). For fetch-dominated lakes, shoreline superelevation would be similar on opposite sides of a lake because the wind-generating area is great enough that moderate to strong winds generate approximately the same wave heights. For fetch-limited lakes, the wind-generating area is small enough that relative wind strength determines wave height. Shoreline superelevation on opposite sides of a fetch-limited lake would not be symmetric. Patterns of shoreline superelevation of 1986/87 debris for Gunnison Bay are asymmetric (Figure 1). Shores facing into strong winds have debris at higher elevations than those on the upwind sides of the lake. The recognizable contribution of wind strength to superelevation is explained by Great Salt Lake's fetch-limited size that limits the wave-generating areas sufficiently that wave environments do not develop into fully-arisen seas.

The hypothetical water body ideal for determining wind directions from shorezone landforms would be: fetch-limited (less than 50 km open water); circular; preferably with three equidistant islands; and water sufficiently saline to not freeze. Contrasting landforms of that lake should indicate relative strength of storm winds if other factors do not complicate the relationship of coastal landforms and wind strength. Complicating factors include: sediment influx, tectonics, and ice. Shorezone features of lakes and paleolakes similar to Great Salt Lake are logical places to look for evidence of storm-wind strength and direction.

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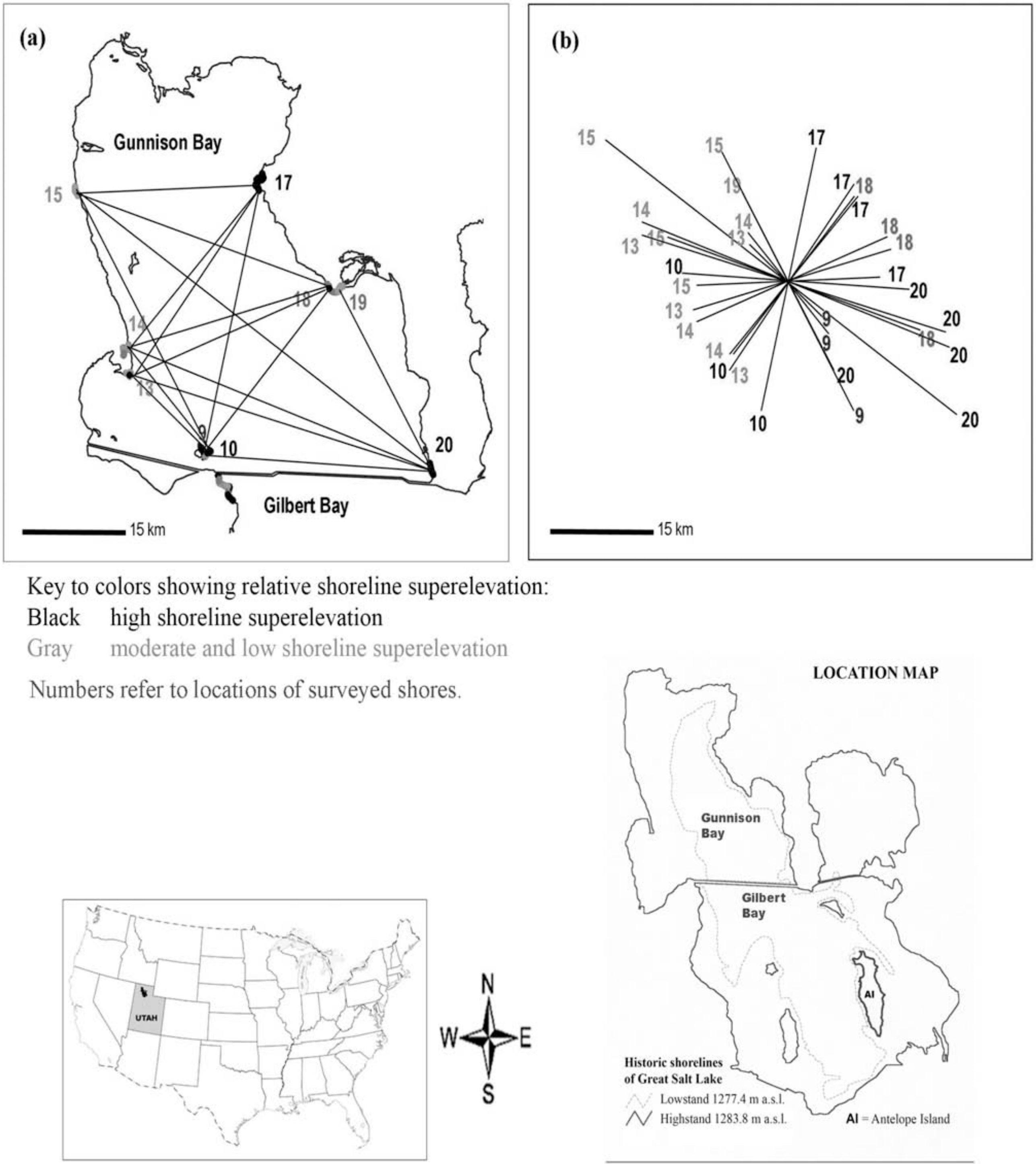

Figure 1–Shoreline superelevation, Gunnison Bay, Great Salt Lake, Utah. Shoreline superelevation patterns for Gunnison Bay indicate that differences in energy and storm waves of Great Salt Lake are primarily due to differences in wind strength rather than to differences in fetch length. (a) Pairs of surveyed shores with 1986/87 shoreline debris. Numbers refer to locations of surveyed shores. Length of line is fetch, distance across open water. Paired locations are on opposing sides of Gunnison Bay; (b) Compass rose of paired surveyed shores showing fetch length, fetch direction, and relative superelevation of shore debris. Shores facing into storm winds have high superelevation. Shores in the lee of land have relatively low shoreline superelevation.