Evidence of Eolian Erosion of the Bedrock Landscapes of Western Wisconsin during the Late Pleistocene

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Abstract

We report on a variety of geomorphic evidence suggesting that strong winds facilitated a widespread and long-lasting event which eroded and redistributed sediments in the Chippewa River valley of western Wisconsin. Although some key dates have yet to come in, we believe that this event coincided generally with the retreat of the MIS 2 ice from the region. As the Chippewa lobe of the Laurentide ice sheet reached its maximum extent at the northern margins of the Chippewa valley, it developed large valley trains of outwash. This outwash, as well as residuum from the sandstone ridges that dominate the region, provided the sand necessary to facilitate eolian sand erosion and transport across the region. We suggest that the proximity of the ice margin led to strong temperature and pressure gradients, and thus, strong storms that facilitated this event.

In many areas, parabolic dunes and long, low, linear "stringers" (ridges) of sand, silty-sand, and even loess are evidence of a period of remobilization of preexisting sediment on west-northwest winds. Well-formed sand wedges and ice-wedge casts on low uplands filled with clean sand suggest that much of this erosion and sand transport occurred in conjunction with a period of extensive permafrost. Ventifacts abound on the landscape, and are especially common in "wind-tunnel" areas between and beside isolated bedrock ridges, around which winds may have been funneled. On the windward, i.e., west and northwest, sides of these bedrock ridges, bare bedrock is common, residuum is universally thin, and loess is often absent. Ridges that occur downwind of areas with abundant sand supply are often blanketed with eolian sand on their western and northwestern flanks, driven partially up the windward slopes as sand ramps and climbing dunes. Thick loess commonly occurs on the east and southeast sides of the largest sandstone ridges, suggesting that winds from the west-northwest were often unidirectional and strong enough to form prominent wind shadows. Together, these features point to a permafrost/thawing permafrost landscape that was largely impacted, and in many places eroded, by saltating sand. In this poster, we provide examples, many of them photographs but some also as digital terrain maps, of the features described above.

Study Area

Our study area is the Chippewa River valley of western Wisconsin. The Chippewa River heads in northern Wisconsin, north of the MIS 2 glacial border. South of the border, in the Lower Chippewa valley, the river crosses a landscape of sandstone hills that retain remnants of an old, weathered outwash deposit (River Falls Formation). The lowlands of the valley proper are generally sandy, with many areas of MIS 2 aged outwash. Dunes and other low-relief landforms formed in eolian sand are common across the valley; their orientations suggest formation on westerly and northwesterly winds (Schaetzl et al. 2018). Loess is mainly found in the valley on the eastern sides of large ridges. Its presence there is assumed to either to (1) protection from strong, erosive winds, or (2) redeposition of loess that was pesent originally in the valley, but which was later remobilized and deposited in the these windshadow lee areas.

Study Purpose

To document the widespread geomorphic evidence of wind erosion and eolian processes in the Chippewa Valley

Wind erosion I. Ventifacts

Landscapes in the Chippewa Valley are rife with ventifacts (Fig. 1); many occur in the River Falls Formation outwash. In some fields, they form a type of lag concentrate, one layer thick. The ventifacts point unequivocally to a period of widspread eolian erosion in the Chippewa Valley.

Figure 1. Ventifacts in farmed fields in the Chippewa Valley. Most of the ventifacts shown here are formed in quartzite. Many fields show clear evidence of erosion in the form of surface boulder lag concentrates.

Wind erosion II. Ice wedge casts

Ice wedge casts and similar pseudomorphs are unmistakable indicators of permafrost. On the upland landscapes where the River Falls Formation is present, these features are not uncommon (Holmes and Syverson 1997). Photos of representative ice wedge casts (Fig. 2) suggest that Late Pleistocene winds here swept across a frozen landscape with minimal vegetation, likely helping to facilitate eolian erosion.

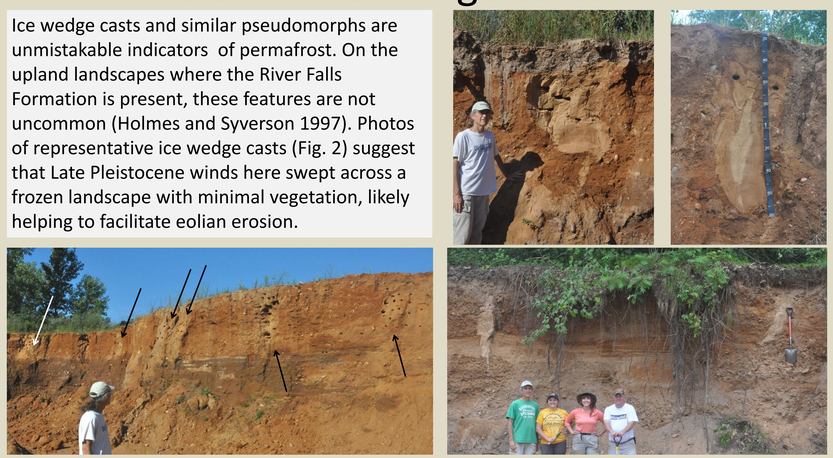

Figure 2. Typical ice wedge casts (lower left, arrows) in River Falls Formation sediments of the Chippewa Valley.

Wind erosion III. Loess-free windward slopes

Despite being near two prodigious loess sources, the Mississippi and Chippewa River valley trains, much of the Chippewa Valley proper is loess-free (Fig. 3). Loess in the Lower Chippewa Valley proper is typically found only on east-facing slopes of sandstone hills, or in protected areas in the lee (SE sides) of these hills (Fig. 3). On the western, windward, slopes, loess is typically absent and evidence of erosion is unmistakable, i.e., thin soils occur above bedrock. Occasionally, sand ramps are present on the lower parts of these windward slopes. Conversely, sites downwind from sandstone knobs have thick loess mantles and are home to productive agriculture (Fig. 4). Together, these features suggest strong westerly winds that both eroded exposed parts of the landscape, and also transported eolian sediment.

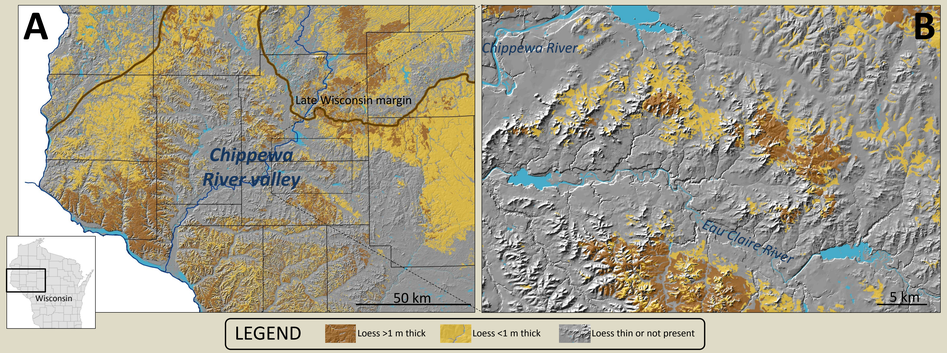

Figure 3. Loess distribution in western Wisconsin, including the Chippewa valley, as based on NRCS county-wide soil maps. A: Regional view. B: Localized view, showing in detail the thick loess areas to the east and southeast of some of the larger sandstone ridges immediately east of the valley. Some of the loess in the immediate lee of these ridges exceeds 5 - 7 m in thickness.

Figure 4. Examples of productive agriculture on the downwind (eastern) sides of isolated sandstone hills in the Chippewa valley. Areas on the windward sides of these hills are typically a mix of forest and minimally productive agriculture.

References

Holmes, M.A. and K.M. Syverson. 1997. Permafrost history of Eau Claire and Chippewa Counties, Wisconsin, as indicated by ice-wedge casts. The Compass 73:91-96.

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