# Potential Meltwater Incision of the Blue Hills Felsenmeer Valley, Rusk County, Wisconsin, during the Late Wisconsin Glaciation

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## ABSTRACT

The Blue Hills Felsenmeer State Natural area is an unusual valley of angular quartzite boulders in a high-relief area of Rusk County, WI (Thompson and Syverson, 2006). The valley at the Blue Hills site (NW1/4 Sec. 31, T35N, R9W; Strickland 7.5' quadrangle) is 25 m deep and 300 m long. The valley has a small modern water-catchment area that heads at an elevation of 1456 ft (444 m) based on LiDAR data. Cahow (no date) proposed the valley was cut by Chippewa Lobe meltwater during the late Chippewa Phase of the late Wisconsin Glaciation. The purpose of this study is to determine if the Chippewa Lobe ice surface was sufficiently high during the late Chippewa Phase to supply meltwater to erode the valley.

In order to do this, we mapped the maximum extent of the Chippewa Moraine. We used domestic well logs, the Rusk County soil survey, aerial photographs (1:16,000 scale), and 7.5' topographic maps to construct a preliminary 1:24,000-scale glacial sediment/landform map. Ten field days were spent studying the proposed glacial sediment/landform contacts in the felsenmeer area. Work included excavating slumped road-cuts, describing exposed sediment outcrops, and digging bore holes to examine glacial sediment. Field observations verified the presence of chaotic hummocks, kettles, and ice-walled-lake plains in the Chippewa Moraine. The outermost extent of the Chippewa Moraine provides reasonable minimum estimate of ice extent during the late Chippewa Phase.

The method of Clark (1992) was used to determine minimum ice-surface elevations near the head of the felsenmeer valley. This method requires measuring hummock-crest elevations within 2 km of the former ice margin. This provides a minimum ice-surface elevation estimated by Clark (1992) to be within 30-100 ft (10-30 m) of the actual value.

We measured a hummock crest elevation between 1400-1410 ft (427-430 m). The hummock, located 1.5 km south of the felsenmeer valley head, puts glacier ice within 56 ft (17 m) of the valley head threshold. This is well within the 30-100 ft (10-30 m) range. It is therefore possible that glacier ice from the late Chippewa Phase of the late Wisconsin Glaciation could have provided meltwater to erode the valley. It is also possible that an earlier event (such as the early Chippewa Phase or a pre-Wisconsin event) could have supplied meltwater to erode the valley.

## INTRODUCTION

The Blue Hills Felsenmeer State Natural area is an unusual valley of angular quartzite boulders in the high-relief Blue Hills of Rusk County, WI (Figs. 1, 2, Thompson and Syverson, 2006). The valley at the felsenmeer site (NW1/4 Sec. 31, T35N, R9W; Strickland 7.5' quadrangle) is 25 m deep and 300 m long. The valley has a small modern water-catchment area that heads at a cataract (elevation 1480 ft) and a lower surface with an elevation of 1456-1458 ft (~444 m) (Figure 3). The lack of water collected in the small drainage basin suggests that meltwater was necessary to incise the valley.

The Blue Hills have been covered by glacial ice during the Ice Age (Johnson, 1986; Syverson and Colgan, 2004). Most recently the Blue Hills were covered completely by the Chippewa Lobe during the early Chippewa Phase of the late Wisconsinan Glaciation ~20,000 to 25,000 years ago. It is possible that the felsenmeer valley could have been eroded at this time or even earlier.

The purpose of this study is to evaluate the hypothesis of Cahow (n.d.) with regard to felsenmeer valley incision. Cahow (n.d.) proposed the felsenmeer valley was cut by Chippewa Lobe meltwater during the late Chippewa Phase of the late Wisconsin Glaciation (~15,000 to 20,000 years ago). It is unclear if the ice was sufficiently thick during the late Chippewa Phase to supply meltwater to erode the Blue Hills Felsenmeer valley. We have mapped the maximum extent of the Chippewa Moraine in the felsenmeer area to determine how high the glacier ice extended during the late Chippewa Phase. This permits us to evaluate if meltwater from the late Chippewa Phase could have eroded the felsenmeer valley.

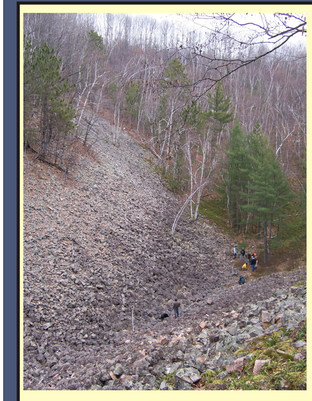


**Figure 1 (Left). Photo of the Blue Hills Felsenmeer valley looking east.**
The valley is composed of approximately 0.7 m in diameter angular quartzite

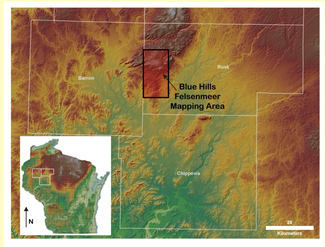



**Figure 2 (Right). Location of the Blue Hills Felsenmeer mapping area.**
Modified from Hinke and Wittkop (2007).

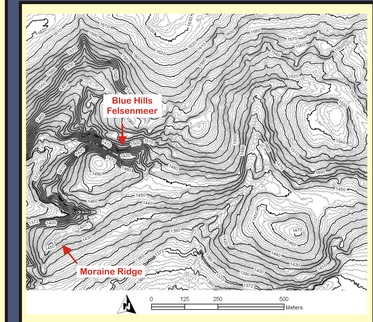
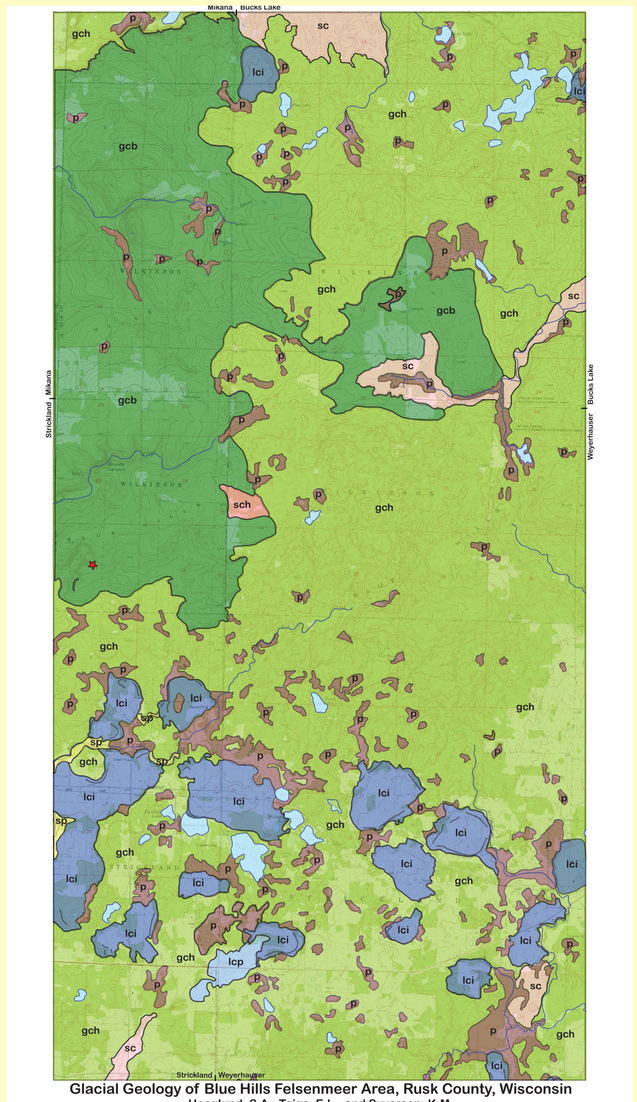



**Figure 3. Topographic map of the Blue Hills Felsenmeer (BHF) area (C.I. = 2 ft).**
From Hinke and Wittkop (2007) using LiDAR data.

**Figure 4. Glacial geologic map of the Blue Hills Felsenmeer area.**
Legend has been modified from Syverson (in press). Baseline topographic information is from the Strickland, Weyerhauser, Mikana, and Bucks Lake 7.5' USGS quadrangles.



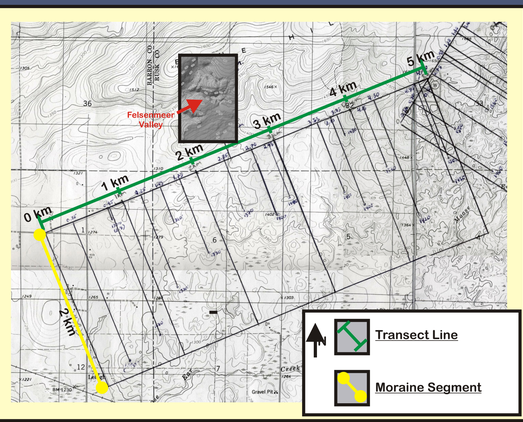




**Figure 5. Reconstructing the late Chippewa Phase ice-surface profile using the method of Clark (1992).**
Maximum hummock-crest elevations within 2 km of the transect line are referenced to distance along transect line. The plot of hummock-crest elevation versus distance (Fig. 7) represents a minimum ice-surface elevation. Base map is Strickland 7.5' USGS topographic map (CI = 10 ft).

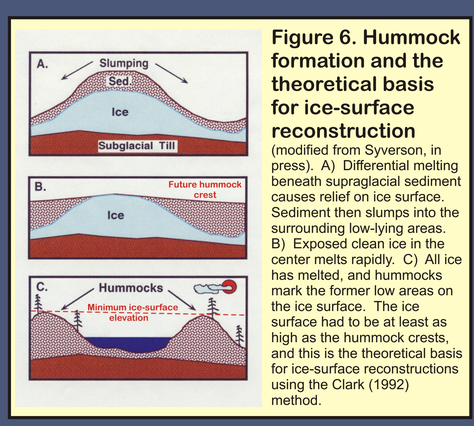



**Figure 6. Hummock formation and the theoretical basis for ice-surface reconstruction**
(modified from Syverson, in press). A) Differential melting beneath supraglacial sediment causes relief on ice surface. Sediment then slumps into the surrounding low-lying areas. B) Exposed clean ice in the center melts rapidly. C) All ice has melted, and hummocks mark the former low areas on the ice surface. The ice surface had to be at least as high as the hummock crests, and this is the theoretical basis for ice-surface reconstructions using the Clark (1992) method.

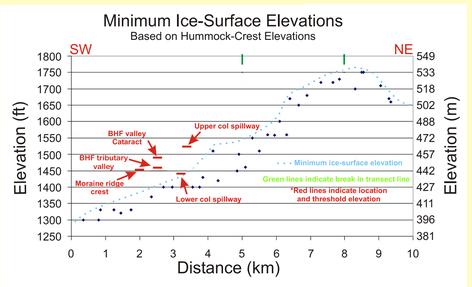



**Figure 7. Reconstructed minimum ice-surface profile using hummock-crest elevations and the method of Clark (1992, see Fig. 5 for explanation and the transect line).**
According to Clark (1992), actual ice surface elevations would have been 30 to 100 ft (10 to 30 m) above this minimum profile. Threshold elevations for the felsenmeer valley and upper and lower col spillways, as well as the moraine-crest elevation from Figure 3), plot within 100 ft of the reconstructed ice surface. Late Chippewa Phase ice was sufficiently high to supply meltwater to, and potentially erode, the Blue Hills Felsenmeer valley.

- Hinke and Wittkop (2007) found a sharp-crested, 10-m-high ridge southwest of the Blue Hills Felsenmeer valley (Figs. 3, 9). This appears to be a moraine and its crest elevation (1420-1454 ft, 433-443 m) agrees well with the minimum ice-surface elevations determined using the method of Clark (1992, see Fig. 7). This also shows that ice from the late Chippewa Phase was sufficiently high to supply meltwater to erode the felsenmeer valley.
- A high col channel at 1524-1526' (~ 465 m) appears to be a glacial meltwater spillway (Figs. 7, 9). If this is an actual meltwater spillway, then it provides further evidence of thick glacial ice.

## RESULTS

- Chaotic hummocks, kettles and ice-walled lake plains that are present in the Chippewa Moraine formed during the late Chippewa Phase (Figs. 4, 8).
- Hummock-crest elevations between 1400-1410 ft (427-430 m, Fig. 7) place glacier ice within 58 ft (18 m) of the felsenmeer valley threshold (well within the 30-100 ft (10-30 m) range suggested by Clark (1992) for the actual ice-surface elevation).

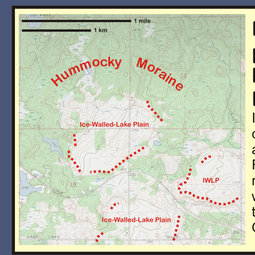
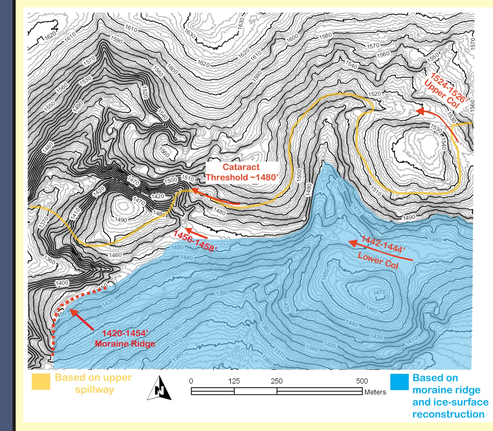



**Figure 8. Ice-walled-lake plains within the hummocky Chippewa Moraine**
Ice-walled-lake plains within the chaotic, hummocky, Chippewa Moraine are present in the Blue Hills Felsenmeer area. Dashed lines represent rim ridges along the ice-walled-lake plain margins. Taken from the Weyerhauser 7.5' USGS Quadrangle.

**Figure 9. Interpretation of former ice-margin positions in the Blue Hills Felsenmeer area.**
The yellow ice-margin positoin is based on the elevation of the upper col spillway (~1526 ft). If ice was supplying meltwater to that spillway, then the ice would have been sufficiently high to spill water over the cataract channel at the head of the Blue Hills Felsenmeer valley (~1480 ft). The shaded area shows the extent of the late Chippewa Phase Chippewa Lobe based on ice-surface reconstructions and the moraine ridge. Even here ice would be high enough for meltwater to flow across the 1456-ft threshold into the felsenmeer valley. Base map (C.I.=2 ft) modified from Hinke and Wittkop (2007).




## METHODS

- Examined well-log data, aerial photographs, the soil survey for Rusk County (Voigtlander, 2006), and topographic maps to construct a preliminary 1:24,000-scale glacial sediment map. Portions of the Mikana, Bucks Lake, Strickland and Weyerhauser 7.5' USGS Quadrangles were mapped.
- Mapped glacial landforms in the Blue Hills Felsenmeer area of western Rusk County for ten days and modified sediment contacts.
  - Drove all roads and described sediment in road cuts.
  - Used a bucket auger to determine sediment types in areas where outcrops and road cuts were not present.
- Analyzed findings from fieldwork to delineated maximum extent of the Chippewa Moraine.
- Used ArcMap 9.2 to create high-quality glacial sediment map of the Blue Hills Felsenmeer area (Fig. 4).
- Estimated minimum paleo-ice-surface elevations using the method of Clark (1992) (see Fig 5).
  - Used hummock-crest elevations in the moraine (Fig. 6).
  - Measured highest hummock-crest elevations from 7.5' topographic maps (C.I. = 10 ft) located within 2 km of the former ice-margin position.
  - Plotted hummock crest elevation vs. distance along the former ice-margin position (Fig. 7).

## CONCLUSIONS

- Glacial ice from the late Chippewa Phase of the late Wisconsin Glaciation could have provided meltwater to erode the valley ~15,000 to 20,000 years ago, as suggested by Cahow (n.d.). This is based on ice-surface reconstructions, col meltwater spillway elevations, and a previously unrecognized moraine ridge.
- Because other glacial events prior to the late Chippewa Phase were more extensive (i.e. early Chippewa Phase or a glaciation pre-dating the Wisconsin Glaciation (Johnson, 1986; Syverson and Colgan, 2004)), it is possible that meltwater from an earlier event could have eroded the valley.

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