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Perennial ice patch studies – preliminary results from a case study in Jotunheimen, southern Norway

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The long-term aim of this study is to uncover the climate archive in high altitude ice patches in Norway. The presented case study is from an ice patch named Juvfonna in Jotunheimen, central southern Norway (0.2 km2, 61.676oN, 8.354oE). The ice patch is situated at 1850-2000 m a.s.l., approx. 800 metres from a deep permafrost borehole at Juvvasshøe (Isaksen et al. 2007). In Norway there has been an increasing focus on these ice patches since the extreme melting in autumn 2006. A Bronze Age leather shoe was found that had melted out of an ice field in Jotunheimen. The shoe was dated to be 3300-3400 years old (BC 1420-1260), and is by far the oldest shoe found in Norway (Finstad and Vedelser, 2006). Several complete arrows and a spade made of wood were also found at perennial ice fields. In front of Juvfonna more than 300 wooden artefacts have been found. These finds are mostly small wooden sticks (so called 'scaring sticks') used for reindeer hunting. Radiocarbon dating of these finds range from AD 500 to 1000.

Ground Penetrating Radar (GPR) soundings at Juvfonna in September 2009 revealed a maximum ice thickness of 17-19 metres. The near-surface reflection horizons are nearly parallel to the present surface. At depth, curved reflection horizons are observed. In May 2010, an ice tunnel was made in the Juvfonna ice patch. The length of the tunnel is 30 metres. In the tunnel the curved layers of the deepest ice layers can be directly observed forming a distinct angular unconformity with the surface ice layers. The curved layering of the deepest ice layers is probably caused by deformation. Lichenometry indicates that the front of the ice patch extended 300 metres from its present position during the 'Little Ice Age' maximum position. A small cold-based glacier with an estimated thickness of 40-50 metres probably caused the deformation during the 'Little Ice Age' or earlier.

Based on interpretation of the radar profiles, the deepest deformed ice layers is asymmetric relative to the present extent. These layers are exposed at the southern end of the ice field; the northern part consists entirely of ice layers parallel to the present surface. Within the ice tunnel in Juvfonna there are several organic layers of uncertain origin. From the appearance of some of these layers it is probably wind transported organic remains from the surroundings and reindeer excrements frozen into the cold ice. At 10-metres depth, the ice temperature is approximately -2 oC based on measurements in one borehole. Radiocarbon dating of these layers show ages ranging from 1095 $\pm$ 30 yr BP to 2960 $\pm$ 30 yr BP.

This gives concluding evidence that some high-altitude ice patches in Jotunheimen have survived since the Bronze Age. This Bronze Age ice is now exposed at or near the surface of perennial ice patches. These finds are consistent with proxy data in the area (Matthews and Dresser, 2008).

References

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