A drainage event of ancient Lake Siljan at Åkerö in Leksand, Dalarna – a scenario test

Introduction

The Siljan area, situated in the central part of the Dalarna province, south-central Sweden (Fig. 1), is of remarkable geologic interest, not least indicated by the presently ongoing process of making it part of the Swedish network of UNESCO Geo Parks (http://www.europeangeoparks.org/). Besides being the site of a major meteorite impact during the Devonian (Holmgren-Alwmark et al., 2017, and references therein) – maybe the most important aspect in the Geo Park motivation – the area displays a spectacular array of Quaternary sediments and landforms, and a complex deglaciation history. West and south of the central granite cupola, the latter marking the impact epicentre, are in the NW Lake Orsasjön, and to the south Lake Siljan. At deglaciation the Ancylus Lake inundated the area, forming a highest shoreline in the southeast around Leksand at c. 205 m above present sea level (a.s.l.)., while the highest shore line in the northeast formed at c. 220 m a.s.l. due to the differential isostatic uplift (Halden, 1929, 1933, 1936).

According to von Post (1934) the Siljan – Orsasjön lake basins became isolated from the Baltic slightly after the Ancylus Lake maxima, and had an out-flow (River Dalälven) in the southeast trough the now dry so called 'Åkerö channel', just south of Leksand. The lake level in this situation should have been around 168.5 m a.s.l. (Siljan is today at c. 162 m a.s.l.). This ancient lake level is according to von Post traceable along lake Siljan and up into Lake Orsasjön, where is said to had formed the so called 'Bonäs line', a shore terrace at c. 180 m a.s.l., 15-20 m high. This terrace should have formed due to gradual down-cutting in the Mora delta deposits as Lake Orsasjön up here in the NW had a falling shore level due to glacioisostatic uplift, while the shore line was at a stationary level at the out-flow position at Leksand. The Mora delta hosts the largest aeolian dune field in Sweden, which is also said by von Post (1934) to be cut by this shore terrace, and the dune field should thus be older that the shore terrace. With a shoreline at c. 180 m on the NW and a shore line in the SW at 168.5 m a.s.l., there is an apparent gradient of gradient of 2.2 m / 10 km. If an isobase direction of land uplift is assumed to be NNE-SSW, then the mean true gradient should be 3.3 m /10 km (von Post, 1934), this due to the differential uplift between Bonäs and Leksand (Fig. 2).

von Post (1934) argued that there was a later, more or less catastrophic relocation of the Dalälven outlet at Leksand (Fig. 3). The outlet was before the drainage though the now dry Åkerö channel, but at the drainage, Dalälven found a new outlet slightly to the north, and cut through the silty-sandy sediments to a level that was at least 4.5 m before the former, and more probable, a down-cutting of 5-6 m. This drainage should immediately have terminated the shoreline terrace formation at Bonäs, which according to von Post (1934) is the explanation for the preservation of this beach terrace.

von Post (1934) made corings in the Åkerö channel at two positions, in the Åkerö pond (organic deposits down to -4.4 m, then sand), and in the Åkerö bog (c. 6 m organic deposits, and then sand). von Post (1934) remarks that this is a 'typical' lake infill succession, and stated that the transition from sand to organic sediments mark the drainage shift, when Dalälven left the Åkerö channel. Based on pollen analysis, this drainage event should in time have coincided with the start of the Littorina max or slightly thereafter, i.e. approximately at 65000 yr BP. We have already cored the Åkerö bog and dated the lowermost organic sediments, suggesting that the deposition of organic sediments started some 2000 years earlier than suggested by von Post (-520 cm: 8539+/-50 cal yr BP; -510 cm: 8402+/-37 cal yr BP; -500 cm: 8110+/-55 cal yr BP).

von Post (1934) also cored a peat bog at the former cement factory at Heden, c. 2 km to the south. This area should have formed a bay in Lake Siljan before the Åkerö channel drainage event, but became isolated from Siljan at the drainage, forming a small lake basin due to its threshold altitude at c. 164 m a.s.l. Also here is a typical lake infill succession according to von Post (1934), but here a basin with organic sediment deposition both before and after the drainage event. The cored stratigraphy is 7.8 m deep, with peat continuing into gyttja at depth. von Post mentions in particular the high content of mica in the gyttja (a bed E), terminating in lake mud (a bed D) and argues that this boundary represents the isolation of this basin from Siljan at the Åkerö drainage event. After this event, the mica should not have entered the basin.

What is it that we now want to do in a master's project?

We want to re-evaluate this paleoenvironmental change as described in von Post, as a part of our ongoing project *"The Siljan Lake district – Quaternary geology from deglaciation into present time".* Do we have this drainage event as described by von Post (1934)? And if, what is its timing?

The master's project should centre on the lake infill succession at Heden (Fig. 3). This bog should be cored again. The retrieved core should be investigated to its sediment stratigraphy, followed by a comprehensive investigation of its composition by means of XRF analysis and also long-core magnetic susceptibility, all for identifying the position in the stratigraphy of the drainage event. However, the exact methods have to be decided first after the core is retrieved, to see what possibilities there are. This should be followed by radiocarbon dating at a number of levels, and see if a possible isolation level chronologically coincides with those ages already obtained from the Åkerö channel.

A short work schedule:

1. Field work (4-5 days) with coring at Heden in September, 2019.

2. Lab work with core description and analysis (LOI, XRF, magnetic susceptibility; possibly some pollen and/or macrofossil analysis). Sampling for radiocarbon dating.

3. Writing the whole thing up after all data analysed.

Supervisors: Dan Hammarlund, Karl Ljung, Per Möller

References

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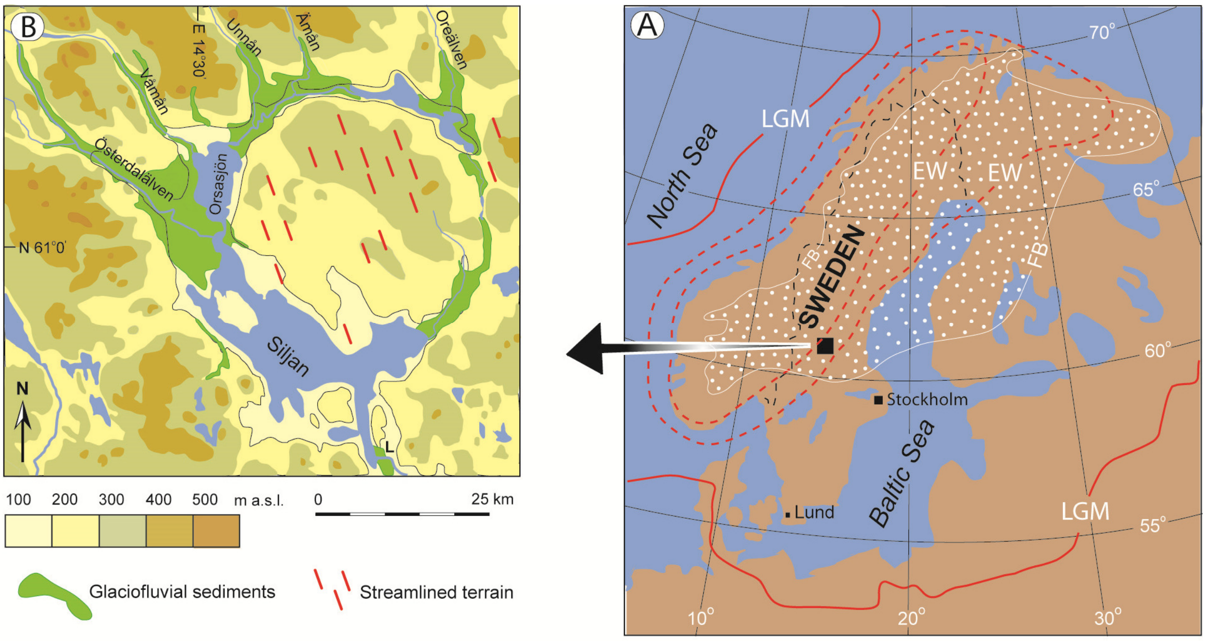

Fig. 1. Overview maps. A) Fennoscandia with schematic ice-sheet outlines for Late Weichselian maximum (LGM). B) Topography within and around the Siljan impact structure and main distribution of glaciofluvial sediments and streamlined terrain. Areas above the highest shoreline, c. 205 m a.s.l. at River Dalälvens out-flow from Lake Siljan at Leksand (L) and at 220 m a.s.l. in the northwest and north, are roughly delimited by the black line.

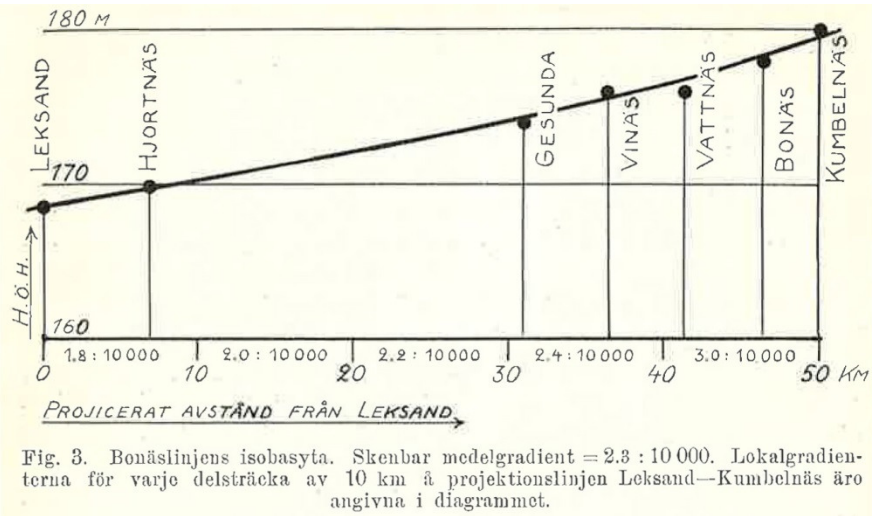

Fig. 2. The von Post (1934) shoreline diagram for the 'Bonäs line' stage.

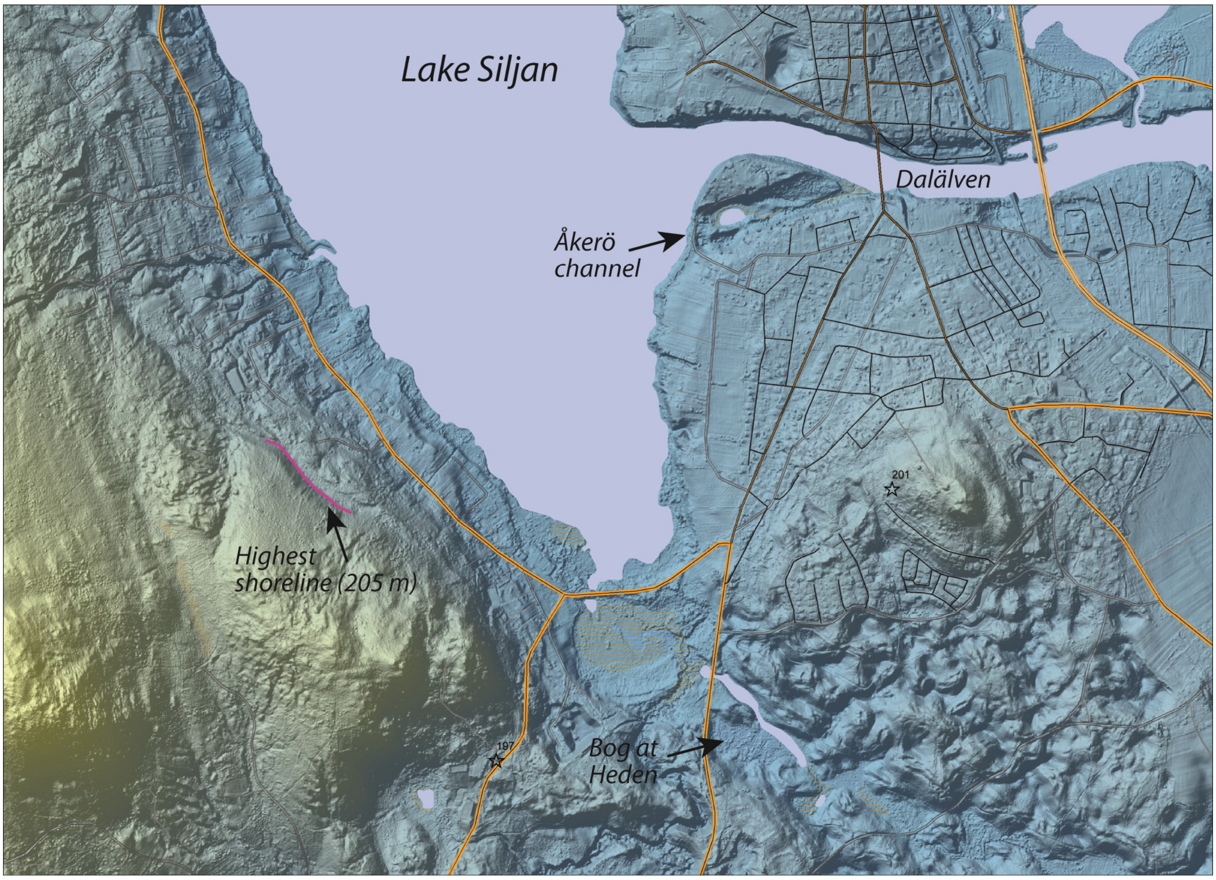

Fig. 3. A DEM of the outlet area for Dalälven at Leksand, showing the now dry Åkerö channel, and north thereof the present outlet.