



## **The last forests in Greenland, and the age of the ice sheet**

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Recently ancient DNA (aDNA) studies of the basal ice in the Camp Century ice core, northern Greenland, have shown that mixed coniferous-deciduous forest grew here before the area was invaded and permanently covered by the ice sheet. The coring site is situated only 100 km from the present ice margin and more than 500 km from the ice divide, indicating that since this last inception the northern part of the ice sheet never receded more than 100 km from its present margin.

Dating of the basal ice and obtaining an age for the forest and for the beginning of the ice sheet's permanency has been attempted by analyzing for optically stimulated luminescence (OSL), meteoric  $^{10}\text{Be}/^{36}\text{Cl}$  cosmogenic nuclides,  $^{234}\text{U}/^{238}\text{U}$  recoil. These methods all provide only minimum ages and show that the forest at Cap Century is older than 500 ka. Comparison with other Pleistocene "forest sites" in Greenland – the Kap København Formation in northernmost Greenland, the DYE-3 ice core in the south, the ODP boring 646 south of Greenland, as well as results from basal ice in the GRIP ice core - extends the minimum age to c. 1 ma. The maximum age is provided by the Kap København Formation, which must be older – or contemporaneous. The formation has recently been confirmed to date within the interval 2-2.5 ma, with a preferred age of 2.3-2.4 ma. Surprisingly, application of the molecular clock of insect COI sequences on the Camp Century aDNA now seem to push the minimum age just as far back – to 2.4 ma, suggesting that the timberline boreal forest at Kap København is contemporaneous with the mixed forest at Camp Century, 600 km to the south.

From this we conclude that the northern ice sheet dome, which today contains 85% of the total ice sheet volume, has remained within 100 km of its present margin for at least 1 ma, and possibly may go back as far as 2.4 ma. The ice sheet has therefore survived both interglacials and "super interglacials" that were both warmer and longer than the present. This may give us some hope for the future.