Constraining the timing of Holocene aeolian dune activity in Arctic Sweden

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Aeolian parabolic sand dune fields are widespread over northern Sweden and reveal extensive aeolian activity (Stammler et al. 2023). The initial formation of these dunes presumably immediately followed local deglaciation, but their stabilization and reactivation history remains less clear. Stratified sand deposits forming dune cores likely represent initial dune formation and movement, while multiple overlying homogenous sand units separated by podzols indicate a long history of repeated phases of dune reactivation and stability. In some locations, this activity continues to the present, as witnessed by extensive active blow outs and hollows on dune surfaces. As well as their timing, the environmental or human controls on these activity and stability phases are also unclear, although the presence of charcoal layers underlying some of the reworked sand units suggests that fire activity may be a key factor. Whether this local burning is linked to wider climate or land-use forcing, however, remains uncertain.

Critical in resolving this uncertainty is detailed, independent dating of multiple individual dunes and dune complexes. To date, no such chronological framework exists for Arctic dunes in Sweden. As such, here we test and apply protocols for both quartz optically stimulated luminescence (OSL) and potassium feldspar post-IR infrared stimulated luminescence (pIR-IRSL) dating in detail at multiple dune sites located in the pine (*Pinus sylvestris*) forest, mountain birch (*Betula pubescens*) forest, and tundra zones of Arctic Sweden. Furthermore, we apply detailed AMS ^{14}C dating to charcoal fragments recovered from dune profiles to constrain fire history and cross check luminescence ages. A double single aliquot regeneration (SAR) protocol is required for OSL dating, due to likely feldspar microinclusions within quartz, but most aliquots pass internal tests and resultant pIR-IRSL and OSL ages are generally consistent with ^{14}C ages and are in stratigraphic agreement. Low quartz luminescence sensitivity and feldspar contamination limits precise OSL age assignment in samples from stratified sands that likely represent early dune movement prior to initial stabilization post-ice retreat, as well as some of the youngest reworked sand layers, and necessitates the use of pIR-IRSL. Our dating results suggest repeated and long lasting aeolian activity in Arctic Sweden throughout the Holocene. They also hint at periods of wide-scale dune activation, perhaps linked to broader climate forcing, although there are also numerous differences in detail between dune chronologies across Arctic Fennoscandia.

References

Stammler, M., Stevens, T., Hölbling, D., 2023: Geographic object-based image analysis (GEOBIA) of the distribution and characteristics of aeolian sand dunes in Arctic Sweden. *Permafrost and Periglacial Processes 34*, 22–36.