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Improved stratigraphic dating at a low accumulation Alpine ice core through laser ablation trace element profiling at sub-mm depth resolution

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The small scale Colle Gnifetti glacier saddle (4450 m asl, Monte Rosa region) is the only ice core drilling site in the European Alps with a net accumulation low enough to offer multi-millennia climate records. However, a robust interpretation of such long term records (i.e. mineral dust, stable water isotopes) at the Colle Gnifetti (CG) multi core array is strongly challenged by depositional noise associated with a highly irregular annual layer stratigraphy. In combination with a relatively large vertical strain rate and rapid layer thinning, annual layer counting gets increasingly ambiguous as of approximately 100 years. In addition, this prevents clear attribution of likely volcanic horizons to historical eruption dates. To improve stratigraphic dating under such intricate conditions, we deployed laser ablation (LA) ICP-MS at sub-mm sample resolution. We present here the first LA impurity profiles from a new Colle Gnifetti ice core drilled 73 m to bedrock in 2013 at a site where the net snow accumulation is around 20 cm w.e. per year. We contrast the LA signal variability (including Ca, Fe, Na) to continuous flow analyses (CFA) records at cm-resolution (Ca, Na, melt water conductivity, micro- particle) recorded over the whole core length. Of special concern are the lower 28 m to bedrock, which have been continuously profiled in LA Ca, thus offering the direct comparison of Ca-signals between CFA and LA. By this means, we first validate at upper depths LA based annual layer identification through agreement with CFA based counting efforts before demonstrating the LA based counting still works at depths where CFA derived annual layers become spurious since embedded in strong, multi-year cycles. Finally, LA ice core profiling of our CG core has potential for not only dating improvement but also reveals benefits in resolving highly thinned basal ice sections including accounting for micro-structural features such as grain boundaries.