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Exhumation of the North Alpine Foreland Basin- Quantitative insights from structural analysis, thermochronology and a new thermal history model

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Due to a wealth of geological and thermochronology data the northern foreland basin of the European Alps is an ideal natural laboratory for understanding the dynamics of foreland basins and their interaction with surface and geodynamic processes. We present an unprecedented compilation of thermochronological data from the basin and quantify cooling and exhumation rates in the basin by combining published and new vitrinite reflectance, apatite fission track and U-Th/He data with a new inverse burial and thermal history model. No correlation is obvious between inferred cooling and exhumation rates and elevation, relief or tectonics. We compare derived temperature histories to exhumation estimates based on the retro-deformation of Molasse basin and the Jura mountains, and to exhumation caused by drainage reorganization and incision. Drainage reorganization can explain at most 25% of the observed cooling rates in the basin. Tectonic transport of the basin's sediments over the inclined basement of the alpine foreland as the Jura mountains shortened can explain part of the cooling signal in the western part of the basin. However, overall a substantial amount of cooling and exhumation remains unexplained by known tectonic and surface processes. Our results document basin wide exhumation that may be related to slab roll-back or other lithospheric processes. Uncertainty analysis shows that thermochronometers can be explained by cooling and exhumation starting as early as the Miocene or as late as the Pleistocene. New (U-Th)/He data from key areas close to the Alpine front may provide better constraints on the timing of exhumation.