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4D geometry of lower crustal channel flow in hot orogens exemplified by the Variscan eastern margin

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Recent considerations of detailed petrological, geochronological, geophysical and structural data allow us to make progress in understanding mechanisms of crustal-scale exhumation of orogenic lower crust associated with lithospheric indentation. Current numerical models (e.g. Beaumont group) suggest an emplacement of “hot-nappes” in subsurface channel-flow powered either by gravity potential or by an indentation of a weak hot root with a lower crustal rigid promontory attached to the subducting plate. Geological examples of channel-flow are based on localized occurrence of high-grade rocks along the S. Himalayan front resulting from ductile extrusion driven by gravitational collapse and focused erosion.

We present an example of several thousand square kilometres of flat-lying orogenic lower crust underlain by a basement promontory located at the retroside of the Variscan orogen along a 300 km long collisional front (Poland, Czechia and Austria). Gravity surveys show that the limit of basement promontory extend about 100 kilometres towards the internal part of the orogenic root from todays exposure of the orogenic front. Combined structural and petrological studies revealed that the orogenic lower crust (high-pressure granulites and mafic eclogites) was vertically extruded from depths of about 70 kilometres parallel to the western steep margin (ramp) of the basement promontory. The observed transition from steep to flat fabrics occurs in different depths from 35 to 15 kilometres and is marked by different P-T-t paths of exhumed lower crustal blocks. The vertically extruded rocks are reworked by flat fabrics reflecting the flow of hot material into some horizontal channel developed between the upper boundary (flat) of the basement promontory and the overlying orogenic lid. The flow kinematics in this horizontal channel are controlled by plate movements as docu-

mented by structural and paleomagnetic investigations. A simple 2D thermokinematic model is used to show that the differences in P-T-t paths are controlled by three major parameters: thickness of the indenter, plate velocity and thermal structure of the orogenic root. We suggest that the exhumation of orogenic lower crust in large hot orogens is an extremely heterogeneous process controlled by local parameters, essentially driven by indentation. Orogenic flat fabrics commonly reported in hot orogens result neither from lower crustal flow nor gravity driven collapse of an orogenic system but rather reflect the deformation fronts and geometries of crustal indentors.