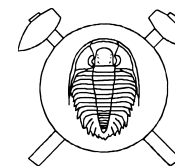


Carboniferous exhumation of thickened lower crust through wedge tectonics and subsequent lateral spreading in the middle crust: Moldanubian zone of the Bohemian massif

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The lower crustal wedge structures prescribed by recent numerical models in theory originate due to localised shear on inherited lower and mid-crustal weak zones. In these models wedge geometry dictated by prescribed boundary conditions simulates well sub-vertical fabric pattern of positive structural fans as well as exhumation of lower crust into supracrustal levels without major changes in geometry of synconvergent fabrics. However, there are new structural observations e.g., from the Scandinavian Caledonides and Western Alps showing that vertical fabrics may collapse in mid-crustal levels due to gravitational instability generated by strong negative buoyancy of a thickened orogenic root.

We present results of detailed structural and petrological work from large-scale, 50–70 km wide, lower crustal wedge structure (along-strike length of studied section is 50 km) rimming the eastern margin of the Variscan collisional front. The present erosion surface allows observation of different structural levels of this huge wedge structure allowing precise determination of fabric successions which are interpreted in terms of continuously developing plastic instabilities during crustal shortening. The eastern part of the crustal wedge is characterised by three out-of-sequence thrusts connected with the underthrusting of the Brunia foreland to the east. The most external thrust zone transported Ky-granulites and overlying middle crust of Ordovician and Devonian age (Varied group) to the east over the Neo-Proterozoic Brunian foreland. Continuous shortening resulted in more westerly (internal) and younger, eastward thrusting of the highly molten lower crustal Raabs unit (with eclogitic boudins at the base) over the easterly middle crustal Varied unit. The most internal and deepest Gföhl gneisses exhibit the shape of a NNE-SSW elongated, several kilometres wide vertical tabular body rimmed by granulite sheets in the east and mantle rocks in the west. This unit represents the core of the wedge structure and acted as a low viscosity channel, which was symmetrically extruded over mid-crustal rocks of the Monotonous unit to the west and already exhumed lower crustal rocks of the Raabs unit to the east. The steeply- or intermediate-dipping fabrics of the wedge structure are locally affected by late sub-horizontal shear zones accommodating the gravitational collapse of steep fabrics. The originally HP mafic and kyanite-bearing granulites within the Raabs and Gföhl units show decompression textures indicated by decomposition of clinopy-

roxene-garnet to orthopyroxene-plagioclase or development of sillimanite and hercynite in Ky granulites and kinzigites. This is consistent with late thrusting in relatively shallow crustal levels but still at very high temperatures.

Further to the north the wedge-like geometry is only sporadically preserved. Here, the lower crustal rocks of the Gföhl and Raabs unit exhibit flat fabrics developed in middle crustal levels at conditions of 9–12 kbar. However, relics of crustal eclogites and Ky granulites within the flat structure indicate the existence of HP metamorphic fabrics. This is attested by relic structures as near-isoclinal folds and cross-cutting relations in low-strain domains which indicate, that the flat lying high grade fabric is reworking an originally steeper one.

Our structural investigation shows that the shortening in the crustal wedge level is oriented E-W, while the fabric in the flat Gföhl and Raabs units is connected with NNE-SSW stretching and dominantly top to the NNE oriented ductile movements. The flat fabric is interpreted as a result of kinematic continuity resulting in late wedge-lateral shearing parallel to the indenting Brunia margin. However, the transition from vertical fabrics into flat structuration in mid-crustal levels cannot be explained only by obliquity of indentation. We suggest that gravitational forces, which originated due to extremely fast development of localised topography above the core of the wedge contributed to vertical shortening and subhorizontal spreading of low viscosity rocks in relatively shallow crustal levels. This scenario would have been in the past interpreted in terms of orogen-parallel extension.

The traditional interpretation of the flat structure of the Gföhl unit discordantly overlying steeply dipping mid-crustal fabrics suggested large-scale nappe tectonics in the Variscan belt. However, we disagree with the concept of large-scale nappe tectonics and enormous tangential movements in the frame of the Moldanubian root. However, the alternative hypothesis requires an objective re-evaluation of structural wedge-like patterns in the area of Moldanubian root together with large scale domains of flat lying fabrics in the Gföhl unit developed on the territory of the Czech Republic. We note that the reason for the switch between a steep wedging tectonic regime and horizontal spreading of extruded lower crustal units cannot be explained using any existing tectonic models.