EVIDENCE OF VARISCAN GRANITES AND THE EVOLUTION OF THE VARISCAN CRUST ALONG THE DEKORP MVE-90 PROFILE (ERZGEBIRGE)

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Late- to post-Hercynian granites occur widely, but sparsely throughout the Variscan Belt of Central Europe and are historically well known for their important mineral deposits. A reconstruction of the tectonic setting and the interpretation of the seismic dataset in the surroundings of the KTB drilling site (Oberpfalz) and along the DEKORP MVE-90 line (Erzgebirge) is inconceivable without the involvement of granitic magmatism. Even though various detailed petrological, geochronological and geochemical studies on the Variscan granites along the northern and northwestern margin of the Bohemian Massif have been accumulated during the recent years, the knowledge of emplacement, growth, shape and dimensions of the granitic intrusions still remains very poor.

Assessment of geophysical datasets along the DEKORP MVE-90 seismic section reveals that the significant gravity minimum of the Erzgebirge and adjacent areas is caused by large volumes of granitic material. Using gravity data for a determination of the amount of granites in the crust, it seems that up to 30 vol.% of the present-day crust (ca. 30 km) is occupied by granitic intrusions. In the Erzgebirge volumes of granitic material of nearly 54,000 km^3 have been estimated with thicknesses from 8–15 km, e.g. Eibenstock/Karlovy Vary Granite. Consequently, considerations for a reconstruction of the granitization processes, magma ascent and emplacement have been made. Thus, by assuming the calculated volume of the granites in the Erzgebirge, the required nature and origin of the protolith and the remaining residuals were derived, from which the pre-granitic Variscan crustal thickness was estimated to be >60 km. Two dimensional modelling yielded that the integrated thicknesses of the granitic intrusions were originally 12–20 km. Considering a granodioritic composition of the protolith and partial melting temperatures of 700–800 °C, melting rates of <20 vol.% will result. Magmas with such a melting rate cannot ascend due to viscosity. Therefore theoretical rates of 20–30 vol.% were derived for the melting of the granitic magma in the West-Erzgebirge.

The emplacement of the Oberpfalz Granites occurred for 325–310 Ma. Considering the cooling period (max. 10 Ma), the ascent (max. 10 Ma) and the melt formation up to ascent fertility (15–25 Ma), the position of the intrusions in the Variscan space-time evolution reveals their late- to post-orogenic history. The seismic data of the MVE-90 profile yield crustal thicknesses of 27–33 km in the Erzgebirge. Hence, attempts have been made to explain the processes which were responsible for the reduction of the pre-granitic Variscan crust from > 60 km to the present-day thickness. It seems reasonable that only post-variscan extensional tectonics could lead to this considerable thinning of the overthickened Variscan crust through collapse, exhumation and subcrustal as well as superficial erosion.

Extensional reflection patterns in the MVE-90 seismic sections, thinned crust, large volumes of late to post-orogenic granites, are merely some arguments for a significant post-Variscan structural evolution of the crust in the Erzgebirge.

HEAT AND MOTION DURING LATE VARISCAN MOUNTAIN BUILDING IN THE MOLDANUBIAN OF BAVARIA

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The Moldanubian gneisses of eastern Bavaria have recorded high-temperature metamorphism at low confining pressures during Carboniferous time. This type of metamorphic evolution is a widespread phenomenon in the Variscan belt of Europe, and is rare or absent in most other collisional orogens. Low-pressure, high-temperature regional metamorphism cannot be easily reconciled with conventional tectono-thermal models for convergent mountain belts with a cycle of burial by crustal or lithospheric thickening, followed by heating due to relaxation of isotherms, uplift and erosion.

Three hypotheses can be formulated to explain the origin of regional low-pressure, high-temperature metamorphism. They are summarized as follows: (1) Vertical "telescoping" of thick crust by tectonically driven extension. (2) Fast, adiabatic uplift without associated crustal deformation. (3) Advective heat transfer from the deep crust or from the Earth's mantle by fluids or magmas on a regional scale.

Analysis of the crustal deformation and kinematics associated with metamorphism, and reconstruction of changes in pressure and temperature, and the rates of the changes are the techniques used here to test these hypotheses.

Structural analysis of the Moldanubian in the studied area reveals at least three phases of ductile deformation associated with the peak of low-pressure metamorphism and partial anatexis. Its structures overprint older fold and foliation fabrics of two deformation phases of unknown age. The first of the three deformations produced large strains, a steep foliation and stretching lineation and a reverse (top-to-SW) sense of shear. Deformation geometry is plane strain to slightly oblate, and indicative of NE-SW directed crustal shortening and subvertical stretching. Strain geometry also shows that finite vertical stretching is moderate, thus despite large deformations the net effect of the deformation on crustal thickness was not very large. The second phase produced up to ten-km-sized, tight folds with steep axes and unknown facing. Folding kinematics is unclear, but this deformation certainly produced further NE-SW directed horizontal contraction. The youngest phase is expressed in NE-SW trending folds with steeply dipping axes and axial planes, supporting NW-SE directed coaxial contraction. It is evident from the data that none of the three deformation phases resulted in vertical shortening and horizontal extension.

Peak temperatures during low-pressure metamorphism have most likely exceeded 750 °C, and may locally have been higher than 800 °C. Garnets with chemically homogeneous cores, assuming former growth zoning during metamorphism indicate time periods for the thermal event between less than one million years (Ma) and 29 Ma, depending on sampling locations and assumptions about the maximum temperatures of metamorphism. "Geospeedometry" applied to disequilibrium compositions in garnets acquired and preserved during cooling point to extremely rapid temperature drops after the metamorphic climax. Minimal cooling rates are found to be 70 °C/Ma, but locally cooling rates as high as 600 °C/Ma are inferred from garnet zonations in metapelitic gneisses. Geothermometric analysis of garnet-biotite and garnet-cordierite pairs reveal "freezing" of diffusive exchange of elements at temperatures between 550 °C and 700 °C. The pressure-temperature evolution observed and its kinetics are incompatible with models based on conductive heat transfer in a collisional mountain belt.

The only hypothesis that can at present explain all observed phenomena in the Moldanubian gneisses of eastern Bavaria is that of large scale advective heat transfer by fluids or magmas. Fast and almost isobaric heating and cooling in a regime of moderate crustal thickening define a tectonic regime of "regional contact metamorphism", and the large spread of equilibration and cooling rates may simply portray different distances from moving heat sources. The nature of the external heat source remains enigmatic, but the observed high peak metamorphic temperatures point to intrusion of mafic igneous rocks into the deep crust, or upwelling of hot mantle material beneath the Moldanubian Moho.

EARLY-HERCYNIAN OROGENIC PROCESSES MIRRORED BY LOWER TO MIDDLE DEVONIAN SANDSTONE COMPONENTS OF THE EASTERN RHEINISCHES SCHIEFERGEBIRGE AND ITS BIOSTRATIGRAPHIC CONTROL

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Components of siliciclastic sediments in the Rhenohercynian Basin near Marburg reflect the plate tectonic evolution of their source rock area if we follow their variation through time and space. Continuous change in composition due to long term geological processes like isostatic uplift contrasts with discontinuous changes during orogenic processes like strike slip movements or nappe transport cutting through different strata of the source region. Synorogenic volcanic and plutonic rocks form clear - cut detrital fingerprints too. To date the coming and going of different source areas biostratigraphic