Intrusive Geometries and Cenozoic Stress History of the Northern Part of the Bohemian Massif

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ABSTRACT: During its Cenozoic history, the Bohemian Massif (BM) located in the foreland of the Alpine Orogen was subjected to a series of regional intraplate stresses of different parameters. This article combines the former results of paleostress analysis with the analysis of geometries of K/Ar-dated intrusive bodies (77–9 Ma, n = 78) in order to refine the paleostress time scale for the northern part of the BM.

The mechanical model of magma emplacement into an elastic host rock formulated by Pollard (1973) was used as a basis for the determination of the direction of maximum principal stress component from the intrusion shape in horizontal cross section.

Compressional phase α_1 (Senonian) was associated with large-scale ductile deformations while the younger phase α_2 of NE–SW compression with reverse faulting and emplacement of dykes of the pre-rift series (Campanian–L.Eocene) SW of the Lužice Fault. The U.Eocene–M.Miocene extension-dominated period gave rise to the subsymmetrical structure of the Ohře Rift and subsequent graben formation. Uneven areal distribution of intrusive bodies indicative of rift-related N–S extension evidences progressive eastward spread of the rift. Paleostress phase β_1 of E–W to NE–SW extension was effective in the eastern part of the Ohře Rift and adjacent areas of the Bohemian Massif in the interval of 40–26 Ma. Phase β_2 of N–S extension, probably representing an autonomous stress regime of the Ohře Rift dominated at 34–24 Ma (central part) or 26–24 Ma (eastern part). Phase β_3 of approx. NW–SE extension with an increasing intensity between 24 and ?16 Ma resulted in the formation of the present fault-confined graben.

KEY WORDS: intrusive geometries, paleostress, Cenozoic, Bohemian Massif.

Introduction

Evolution of regional stress in intraplate settings has a considerable bearing on tectonic deformations, sedimentary basin formation and destruction, magmatic processes and migration of mineralizing fluids, surface processes of erosion and accumulation. *Paleostress analysis* of brittle deformations allows to determine the orientations and relative magnitudes of the principal components of regional stress, i.e. the characteristics and succession (relative ages) of the individual paleostress fields. The effects of any of these phases can be subsequently identified. Timing of the individual phases is constrained mostly geologically: deformations linked with a particular tectonic phase are considered younger than the rocks deformed. Constraints by minerals or rocks filling tectonic structures can be used on condition that their ages and relations to tectonic movements of the given phase are known. Especially the identification of young tectonic phases is highly demanded as the youngest deformations are potentially hazardous for certain construction activities (dams, nuclear power plants and nuclear waste repositories, etc.).

The intensity of magmatic activity and the character of regional stress field are probably interrelated. As the opening of existing ruptures under compressional or transpressional conditions is much less probable than under tensional or transtensional conditions, minima of magmatic activity are generally linked with periods of crustal compression. According to the model of emplacement mechanism based on the assumption of elastic properties of the host rock (Pollard 1973), geometries of intrusive bodies reflect (besides physical parameters of the ascending magma and the host rock) stress field conditions from the time of their emplacement. An analysis of the geometries (in a horizontal cross section) of bodies of known ages should, therefore, allow to infer stress field history for a given region. The present article is an attempt to combine the former results of paleostress analysis with the *analysis of geometries of radiometrically dated intrusive bodies* in order to refine the paleostress time scale for the northern part of the Bohemian Massif.

Structural framework of the northern part of the Bohemian Massif

The Bohemian Massif (BM) is one of the largest European exposures of the Variscan Orogen, consisting of a number of amalgamated terranes of various sizes. These are formed by complexes of Proterozoic to Lower Paleozoic medium- to high-grade metamorphosed rocks, bounded by early Variscan low- to medium-grade metamorphosed volcanosedimentary complexes and late Variscan plutonites at terrane boundaries. The main Variscan deformational event in the northern BM dates to the Famennian–Lower Carboniferous when the Saxothuringian terrane accreted onto the Moldanubian lithospheric block (Oczlon 1992) along a front now broadly arched to the north.

Cenozoic tectonomagmatic history of the BM is similar to that of other Variscan massifs in central and western Europe (Ziegler 1982, 1987). Some of it can be revealed combining field observations with *paleostress analysis*, which employs kinematic indicators on regional and minor fault planes and in their immediate vicinity to identify principal paleostress components (Angelier et al. 1982; Angelier in Hancock ed. 1994). Information on the Cenozoic paleostress history obtained from field mapping and paleostress analysis of shear faults in different areas of northern BM (Schulmann in Jiránek et al. 1989; Coubal 1989, 1990; Coubal and Klein 1992) allowed to recognize phases α_{1-2}, γ and δ of crustal compression and phases β_{1-3} and ε characterized by crustal extension (classification of phases after Coubal 1989).

The period of late Cretaceous rifting in the Alpine foreland allowed the formation of, and subsidence in, the transtensional Bohemian Cretaceous Basin (Uličný 1997) where preserved thicknesses of Cenomanian–Santonian sediments locally exceed 1,000 m. The Sub-Hercynian tectonic inversion in the Alps