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LATE VARISCAN PALAEOMAGNETIC OVERPRINT ON GRANITOIDS IN SOUTHERN BOHEMIAN MASSIF (AUSTRIA)

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Abstract: Palaeomagnetic investigations on granitoids of the Austrian part of South Bohemian Pluton (48.5° N, 14.2° E) yielded two groups of ChRM-directions, one being characterized by SSW-declinations and positive inclinations (= A'), the other having same declinations but negative inclinations (=A). Both magnetizations are considered as magnetic overprints due to alteration processes in Upper Carboniferous - Lower Permian time, the obtained data being in agreement with reversed polarity of Kiaman interval. The VGP positions calculated from overall means correspond with results from other parts of the Bohemian Massif.

Key words: Bohemian Massif in Austria, South Bohemian Pluton, Variscan granitoids, palaeomagnetic overprint.

Introduction

The western half of the Austrian section of the Bohemian Massif (Fig. 1) is occupied by the granitoids of a Late Paleozoic magmatic complex referred to as the South Bohemian Pluton (SBP). The variety of intrusives exposed in the mentioned area can be devided into an older (Early Carboniferous), synorogenic and a younger (Late Carboniferous), late- to postorogenic group of granitoids (Finger et al. 1988,; Frasl & Finger 1991). A recent comprehensive investigation on the whole magmatic sequence accessible in the Austrian part of the SBP is intended to complete the palaeomagnetic data available for the Upper Paleozoic in the Bohemian Massif (e.g. Krs 1968; Soffel & Harzer 1991) as well as to contribute to the knowledge of remagnetization phenomenon in Central European Variscides (e.g. Edel 1987b). First results of the study are presented in this paper.

Geology

The most frequent rock types in the SBP are granites and granodiorites, locally associated with small dioritic to quartzmonzodioritic bodies (Finger et al. 1988). Whereas geochemical features classifying the granitoids into S-, I- and I/S-transitional-types are indicative of Variscan plate tectonic environment (Liew et al. 1989) interpretation of palaeomagnetism requires a well-defined time-table of magmatic activity. Unfortunately there is a scarcity of reliable radiometric data, but as a result of detailed geologic mapping the age relations between few larger plutons and numerous small intrusive bodies are well known (Frasl & Finger 1988 cum lit.). For the older granitoids of Rastenberg/Weinsberg unit (1B in Fig. 1.) U/Pb - dating of monazite, xenotime and zircon yielded equivalent Visean intrusion ages (330 - 320 Ma), an Upper Carboniferous age of the 2B - group is supported by an U/Pb - monazite age of 300 Ma for the Freistadt Granodiorite (Friedl et al. 1992a, b). Despite of clear older/younger - relationships deduced from outcrop-observations (Frasl & Finger 1988, 1991), K/Ar - dating established uniform cooling ages of Altenberg- (2A) and some Mauthausen-type (2B) granitoids, the data covering the interval 270 - 290 Ma for biotite and 300 - 310 Ma for muscovite (Frank, pers. comm.).

A large, but poorly exposed diorite-body related to the Weinsberg Granite (Frasl & Finger 1988, p. 17) was sampled at palaeomagnetic site BM-5. Another fine-grained diorite (BM-7) with a mottled structure due to titanite phenocrysts, displaying discordant contact to Weinsberg Granite, is intruded by Altenberg

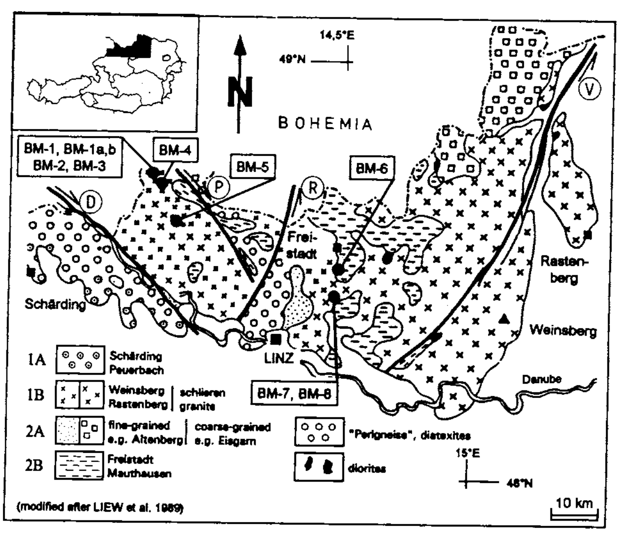

Fig. 1. Geological sketch-map of the western half of Bohemian Massif in Austria (modified after Liew et al. 1989) with sites of paleomagnetic sampling indicated. Numbers of legend refer to older (1) resp. younger (2) generation of granitoids, letters A/B denote subdivisons with S-type/I-type characteristics. Main tectonic features are Danube (D)-, Pfahl (P)-, Rodl (R)- and Vitis (V)- Fault. Insert shows position of study area within Austria.

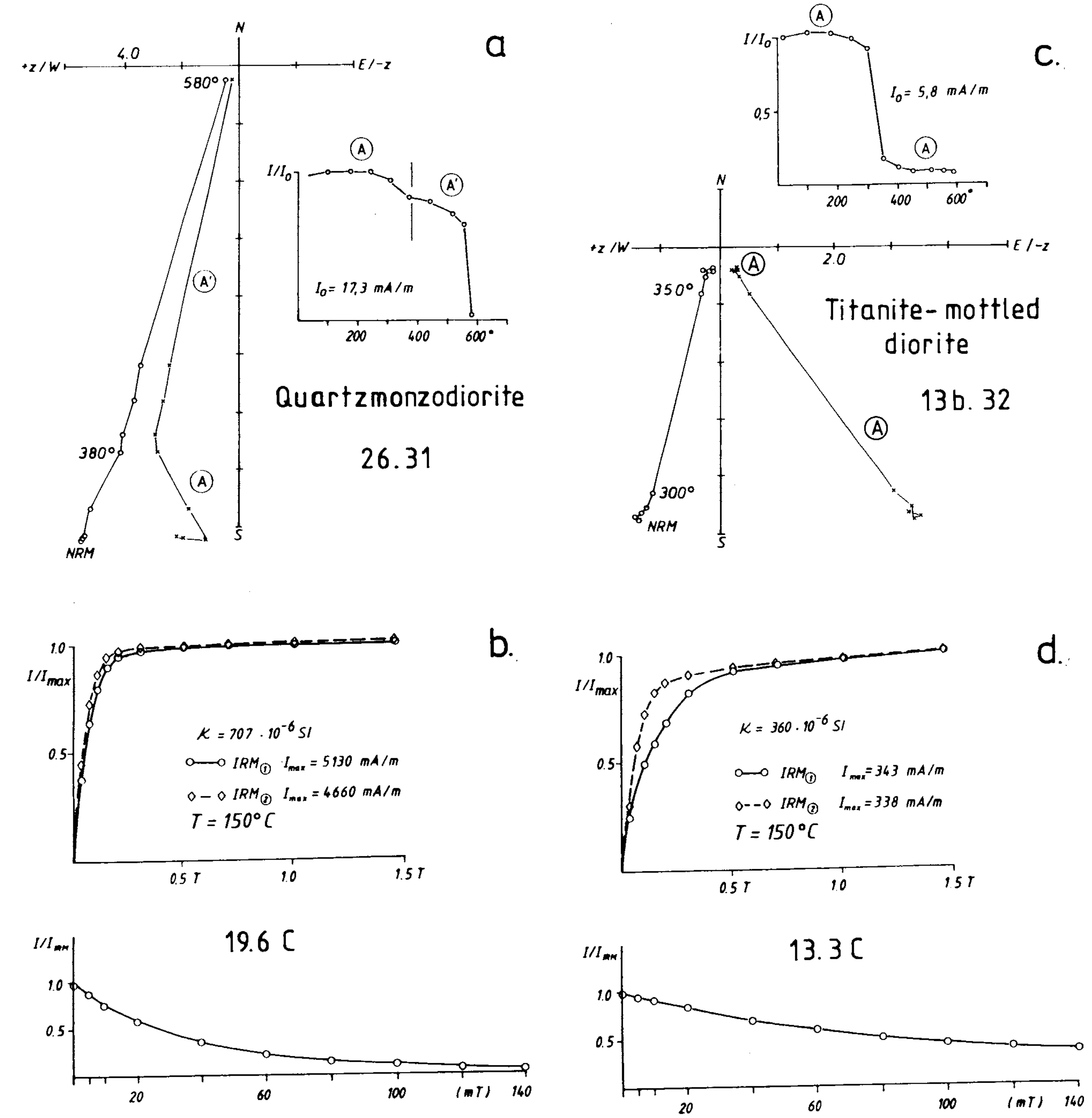

Fig. 2a - d. Typical thermal demagnetization curves and Zijderveld diagrams (circles in horizontal plane, crosses in vertical plane) for specimens of **a** - quartzmonzodiorite (BM-1); **c** - titanite-mottled diorite (BM-7); **b** and **d** - show IRM-acquisition-curves (IRM_1 in natural state, IRM_2 after heating to 150 °C) and AF-demagnetization of IRM_2 for specimens from the same sites.

Granite (BM-8) in an outcrop described by Frasl & Finger (1988, STOP 15). In a roadcut south of the type locality material of Freistadt Granodiorite (BM-6) was obtained. Local quartzmonzodioritic intrusions associated with Mauthausen-type granites were sampled in two quarries (BM-1, BM-4) south of the Pfahl shear-zone. Besides the homogeneous, fine-grained quartzmonzodiorite (QMD) site BM-4 collection comprises some drillcores from coarse-grained "Schlierengranite"-enclaves. In the other quarry (Frasl & Finger 1991, STOP 8.) a more complex situation was open to sampling: an irregular network of fine- to medium-grained granitic dikes (BM-2) with diffuse boundaries to the countryrock penetrates the QMD - intrusive body (BM-1). Both are cut by aplitic (to aplogranitic) dikes (BM-3) with sharp contacts. In vicinity to the dikes, the QMD locally shows a slight increase of grain-size accompanied with a change in colour from dark to medium grey. QMD-samples showing those features were collected in "contact"-sites BM-1a and BM-1b.

Magnetic methods and measurements

Depending on size of exposure a palaeomagnetic site covers some m^2 to several tens of m^2. If different granitoids were sampled in an outcrop (roadcut or quarry), each rock type was treated as an individual site. Sampling was done by drilling oriented cores in the field. The cored samples, 25.4 mm in diameter, were cut into 22 mm long specimens. Remanent magnetization measurements were performed on modified Digico equipment (Strasbourg) and on 2G-cryogenic system (Leoben/Gams), in both labs Digico bridge being used for susceptibility determination. In granitic rocks NRM intensities vary from 0.1 to 10 mAm^{-1} with susceptibility values between 10^{-5} to 10^{-4} SI units. Rocks dioritic in composition are stronger magnetic, with NRM intensities ranging from 1 to 100 mAm^{-1} and susceptibilities varying from 10^{-4} to 10^{-3} SI units. In pilot studies applying AF- as well as thermal cleaning, the latter procedure turned out to be more efficient and therefore was used as standard method for stepwise demagnetization. Possible mineral changes due to heating were controlled by measuring susceptibility after each thermal step.

Most of the rocks investigated display a two component magnetization with corresponding unblocking temperatures in the range of 1: 350 - 400 °C, and 2: 550 - 580 °C (Fig. 2., Tab. 1.). Whereas intensity of remanence shows a more or less dramatic decrease at the lower unblocking temperature magnetic susceptibility remains stable up to 580 °C in all cases. This leads to the interpretation that titanomagnetite and magnetite are the main carrier minerals of NRM. If the lower unblocking temperature were predominantly due to presence of (titano)maghemite and/or sulphides their disintegration should be indicated by substantial change in susceptibility (Soffel 1991). On the other hand IRM-acquisition behavior (Fig. 2.) reveals the existence of some high coercivity phase besides (titano)magnetite, even after heating to 150 °C. In some cases AF-treatment with a peak field up to 140 mT results in a demagnetization of only 50 per cent of IRM-intensity. Solution of this problem requires further rock-magnetic investigations.

Palaeomagnetic results and conclusions

Due to the lack of sediments in the granitoid terrain of South Bohemian Pluton only the in-situ directions of remanence can be used for interpretation. The investigated rocks exhibit two components of characteristic remanent magnetization (ChRM): one with SSW-declination and negative inclination, the other with SSW-declination and positive inclination. Both directions, labelled as A resp. A' in Tab. 1 and Fig. 3., are quite common in the Variscan belt of Central Europe (Edel 1987b). A remanence age within the reversed Kiaman interval is supported by the fact that only 4 of 176 specimens compiled in Tab. 1 are carrying a normal polarity magnetization with NNE-declination and shallow inclination. The VGP positions calculated from the overall means are in good agreement with Upper Carboniferous - Lower Permian data from western margin (Soffel & Harzer 1991) as well as from central and eastern part (Krs 1968) of the Bohemian Massif.

Although being consistent with a Late Paleozoic magnetization age radiometric data from the granitoids investigated are insufficient to clarify the mechanism responsible for NRM-acquisition. If one accepts an Upper Carboniferous (Lower Permian) age of the A' (A) - components, inferred from palaeogeographic models (e.g. Edel 1987b), it is unlikely that the cooling history of different intrusive rocks in any case results in two equivalent spot readings of a latitudinal drift. Another argument

Table 1: Palaeomagnetic results obtained from Austrian part of South Bohemian Pluton (48.5N, 14.2E).

site	rock type	max.t_b	dir	Dec	Inc	n	K	α_{95}	VGP °N	VGP °E
BM-1	quartzmonzodiorite (QMD)	350-400	A	201.9	-17.0	14	46.0	5.9		
		550-580	A'	204.2	11.8	37	127.0	2.1		
BM-1a,b	QMD-contact to dikes	350-400	A	197.3	-25.7	6	180.7	5.0		
		550-580	A'	202.1	10.2	9	169.1	4.0		
BM-2	granitic dike	550-580	A'	207.1	7.5	6	62.6	8.5		
BM-3	aplitic dike	350-400	A	198.8	- 26.1	5	221.1	5.2		
BM-4	quartzmonzodiorite,enclaves	350-400	A	201.2	-25.8	21	54.1	4.4		
		550-580	A'	205.8	15.1	5	50.8	10.8		
BM-5	diorite	550-580	A	192.1	5.5	11	61.3	5.9		
BM-6	Freistadt Granodiorite	350-580	A	208.9	-22.6	14	28.1	7.6		
		350-580	A'	196.5	11.5	2				
BM-7	Titanite-mottled diorite	350-400	A	198.3	-34.3	27	52.5	3.9		
		550-580	A	204.1	-13.5	9	26.0	10.3		
BM-8	Altenberg Granite	350-580	A	205.8	-30.0	13	34.4	7.2		
Means										
A				202.1	-24.8	8	113.6	5.2	49.9	159.0
A'				202.2	10.1	5	134.6	6.6	33.0	167.5

max.t_b = maximum unblocking temperature, dir = direction-label of characteristic remanent magnetization (ChRM); Dec/Inc = in-situ Declination/Inclination of ChRM; n = number of specimen carrying the considered direction; K, α_{95} = Fisher statistics parameter.

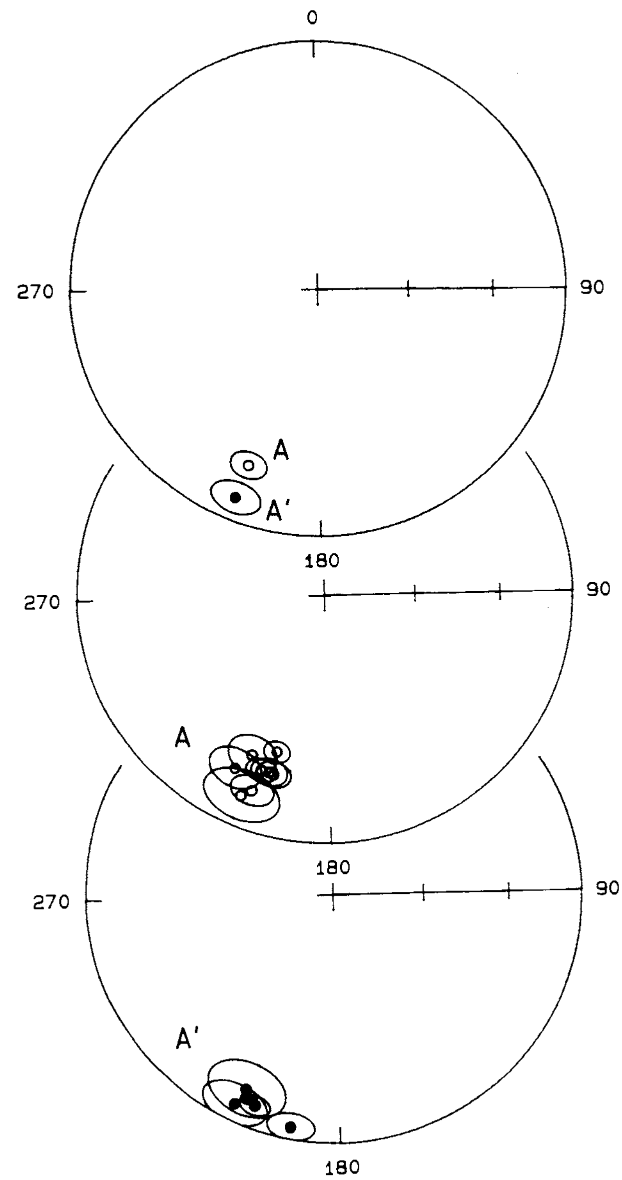

Fig. 3. Equal area projection of in-situ directions of site means and overall means of ChRM components A and A' (listed in Tab. 1) together with 95 per cent cones of confidence. Closed (open) symbols: positive (negative) inclination.

against a simple thermoremanent magnetization (TRM) is provided by sites BM-6 to BM-8, where lower (350 - 400 °C) as well as higher (550 - 580 °C) unblocking temperatures are due to the same ChRM-direction.

Alternatively, uniform directional patterns found even in outcrops with complex magmatic features (sites BM-1 to BM-3) suggest chemical remanent magnetization (CRM) as predominant type of remanence. This assumption is in agreement with petrographical studies revealing mineral changes in the temperature range of 200 - 400 °C caused by hydrothermal processes (Jawecki et al. 1992) in granitoids of South Bohemian Pluton. Alteration-CRM due to low-temperature oxidation of titanomagnetite (titanomaghemite) in igneous rocks has been reported by Walderhaug (1992).

The palaeomagnetic sites being spread over a vast terrain which is cut into several segments by prominent shear zones (Fig. 1), the well-grouping of site-mean directions corresponding with results from other parts of Bohemian Massif leads to the conclusion that major block-rotations did not concern the study area in post-Variscan time.

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