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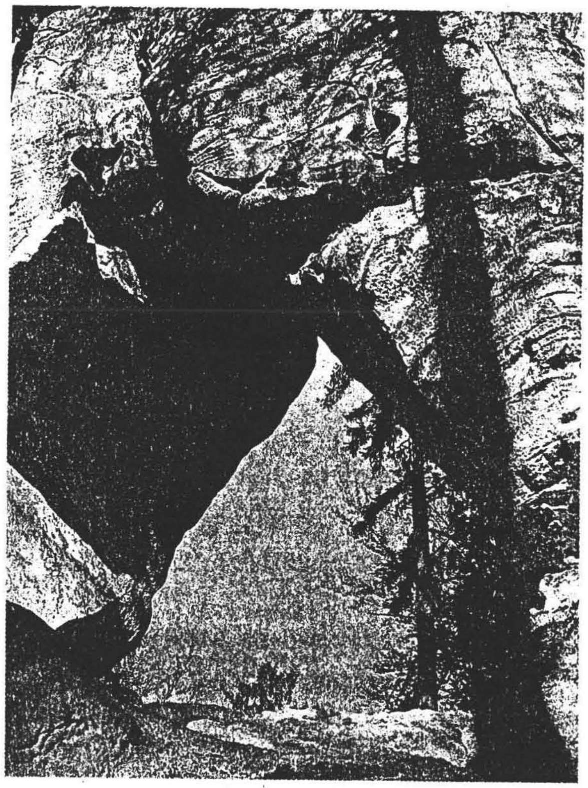

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K-Ar DATING IN THE TEPLÁ-DOMAŽLICE ZONE AT THE WESTERN MARGIN OF THE BOHEMIAN MASSIF

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Abstract

K-Ar dating on hornblendes and micas from the Teplá-Domažlice zone revealed a pattern of dates which significantly deviates from the mid-Carboniferous to early Permian one that is found in the adjacent low-pressure metamorphic Moldanubian and Saxothuringian. Especially for the Mariánské Lázně metabasic complex, confirming early Czech determinations, the dates resemble the early Devonian pattern determined for the Münchberg Gneiss Massif and the Erbendorf-Vohenstrauß zone of northeastern Bavaria. This supports the idea that all three units are remnants of a huge complex which suffered a metamorphic overprint under medium-pressure conditions, probably in the early Devonian. Strong rejuvenation is found in the southern part of the Teplá-Domažlice zone by which micas and even two hornblendes were reset to mid-Carboniferous ages. According to the geological setting, part of the apparently pre-Devonian dates may be explained by inherited argon from earlier metamorphic and magmatic events, e.g. the high-pressure metamorphism documented in eclogitic relics. However, excess argon, caused by the mid-Carboniferous overprint cannot be excluded.

Introduction

In the course of the multi-disciplinary studies in northeastern Bavaria for the site-selection of the German Continental Deep Drilling Program (KTB) a nappe structure has been established for the Münchberg complex (Bavaria) using geological and geophysical arguments (e.g. Franke 1984; Haak — Blümecke, Schmoll, Weber in Weber — Vollbrecht 1986). Moreover, a nappe situation is probable for the Erbendorf-Vohenstauß zone (Bavaria) and was also postulated for the Teplá-Domažlice zone of western Bohemia (Blümel 1985 (unpubl. lecture), Weber — Vollbrecht 1986). The three units are regarded as remnants of one huge nappe complex. This assumption is confirmed by the contrast in the polymetamorphic evolution in respect to the surrounding Moldanubian and/or Saxothuringian: As pointed out by Blümel (1983) the crystalline nappes of the Münchberg gneiss core and the Erbendorf-Vohenstrauß zone as well as the Teplá-Domažlice zone suffered a last metamorphic overprint under medium-pressure conditions. In contrast, the adjacent,

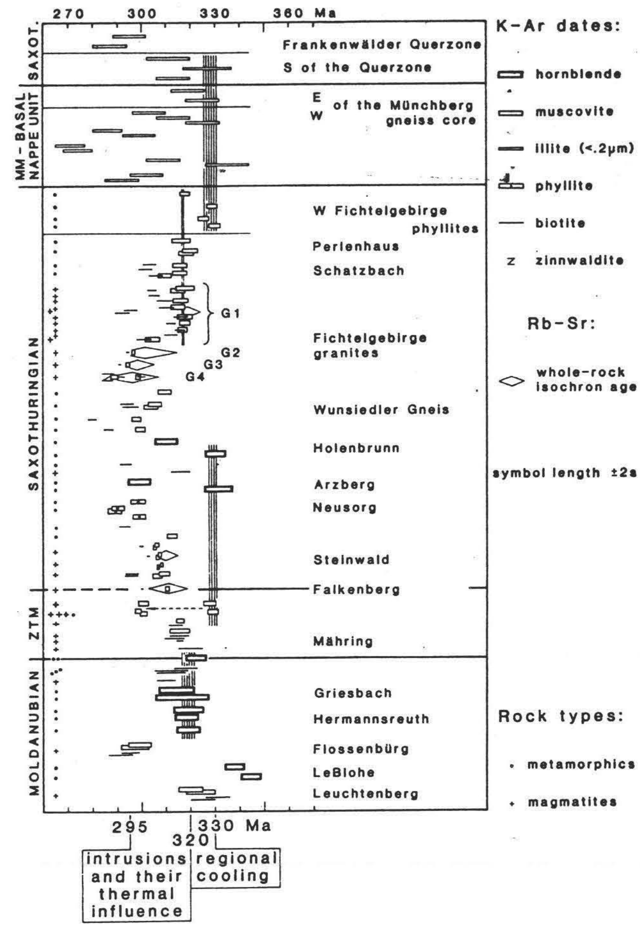

Fig. 1. K-Ar dates from the basal units of the Münchberg nappe pile (MM), the Fichtelgebirge Saxothuringian, the Tirschenreuth-Mähring zone (ZTM), and the adjacent Moldanubian. The dates are arranged roughly from north to south and some Rb-Sr whole-rock isochron ages of granites are included (after Kreuzer et al. 1985, Ahrendt et al. 1986, Wendt et al. 1986, 1988). The length of a symbol represents the analytical precision at a level of 95 % intralaboratory analytical confidence. A ruled background shows the respective precision of the weighted mean of a cluster of dates.

(relatively) autochthonous Moldanubian and Saxothuringian experienced a last metamorphic event of low-pressure type.

An additional argument for the nappe concept is provided by K-Ar dating on hornblendes and micas and by concordant U-Pb ages of monazites: Throughout the Bavarian part of the Moldanubian and the Saxothuringian at the western and northwestern margins of the Bohemian Massif mid-Carboniferous to early Permian dates were recorded. They prove a rapid uplift and cooling around 330 to 320 Ma which were followed by local thermal influences related to several pulses of post-deformative granite intrusions between 320 and 295 Ma (Teufel 1988, Kreuzer et al. 1989 and Fig. 1). In contrast, fairly consistent patterns of early Devonian dates around 380 Ma prevail in the crystalline nappes of the Münchberg complex, in the western part of the Erbendorf-Vohenstrauß zone, and in parts of the Teplá-Domažlice zone (Šmejkal 1962 and 1964, Vejnar 1962, Fischer et al. 1968, Gottstein 1970, Schüssler et al. 1986, Kreuzer et al. 1989). As an example the dates of the Münchberg Gneiss Massif complex are given in Fig. 2.

The early data for the Moldanubian of western Bohemia and the Teplá-Domažlice zone were not generally accepted because of the large range of dates from Cambrian to Permian, and because of lacking isotopic control for part of the analyses. Indeed, the early data are about 3 % too old because of missing atmospheric correction (Šmejkal—Melková 1969). This shortcoming, however, does not obscure the significant grouping (all dates recalculated with the IUGS-recommended constants):

1. Mid-Carboniferous to Permian dates in the Moldanubian and near the Bohemian Quartz Lode.

2. Fairly consistent early Devonian dates around 380 Ma more to the east, namely six muscovites between 397 and 370 Ma, on average 383 ± 8 Ma (standard deviation sd = 2.5 %), and nine biotites between 390 and 360 Ma, on average 380 ± 8 Ma (sd = 3 %).

3. Older dates ranging from 410 to 550 Ma.

Locally, similar results for muscovite and biotite suggest that some of the pre-Devonian dates might well be rough age estimates for earlier stages of the polyphase thermal history of the Teplá-Domažlice zone. This would be in accordance with the steep decrease of metamorphic grade of the medium-pressure overprint towards the east as visualized in the isograd pattern mapped by Vejnar (1972).

New K-Ar and $^{39}Ar/^{40}Ar$ determinations were initiated in order to verify the early Devonian event in the Teplá-Domažlice zone and to unravel the meaning of the seemingly older dates. In the present paper results of conventional total fusion dating are reported. All dates, including the cited ones, are calculated with the IUGS-recommended constants (Steiger—Jäger 1977). Errors are given at a level of 95 % confidence of the intralaboratory analytical precision. Our K-Ar date for the standard glaucony GL-O is 1 % younger than the average value of the compilation of Odin (1982). For analytical details see Seidel et al. (1982).

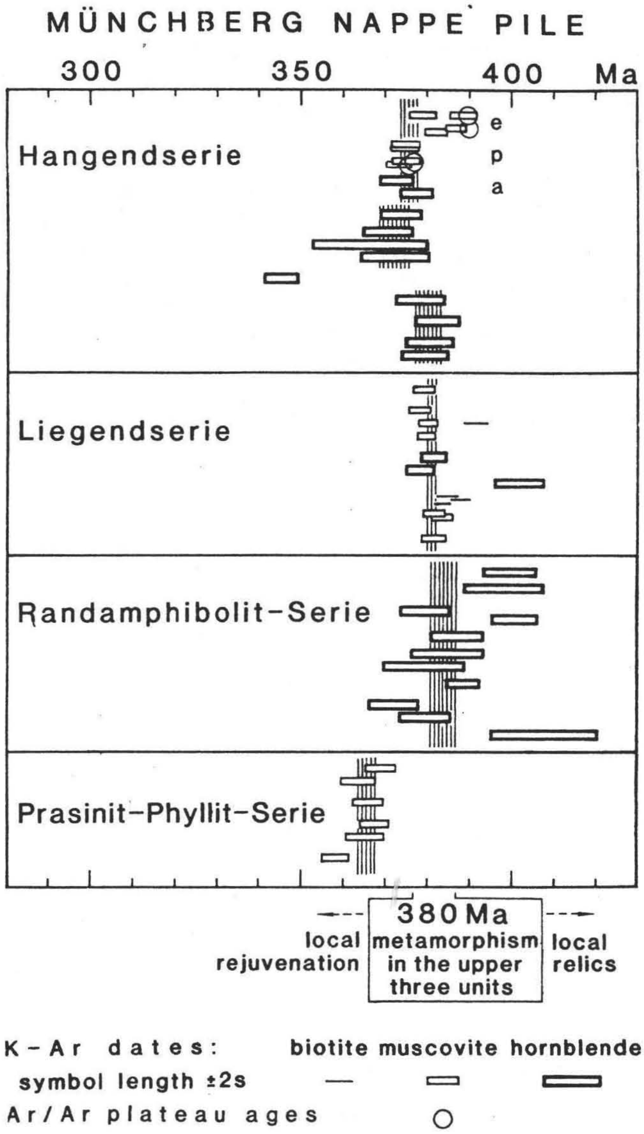

Fig. 2. K-Ar Dates from the upper units of the Münchberg nappe pile. The dates are roughly arranged from NE to SW (after Kreuzer et al. 1989, and unpublished $^{39}Ar/^{40}Ar$ stepheating data). For further comments see Fig. 1. Local consistency of the dates is compatible with the model of cooling ages around 380 Ma, i.e. early Devonian (NW Hangendserie, SW Hangendserie, two amphiboles and the muscovites from the Liegendserie. One grossly deficient hornblende date (Hangendserie) and biotite seemingly older than muscovite (Liegendserie) indicate local influences of an event later than about 380 Ma. The $^{39}Ar/^{40}Ar$ plateau ages of 390 Ma of 3T polytype muscovites from the Oberkotzau eclogite (e) suggest inherited argon within a realm of apparent cooling ages as indicated by the $^{39}Ar/^{40}Ar$ muscovite plateau ages of the unfoliated pegmatite (p) which cuts the eclogite and by two hornblende dates from amphibolites (a) from south of Oberkotzau.

On the meaning of K-Ar dates in polymetamorphic areas

Cooling ages

Generally, one believes that K-Ar dates are estimates of the ages of cooling to so called blocking temperatures of around 500° C for hornblende, 350° C for muscovite and 300° C for biotite (e.g. Gerling et al. 1965, Hart 1964, Purdy — Jäger 1976). Basic requirement for such an interpretation is that the dates are consistent on a local scale within the limits of error for each of the retentive minerals, regardless of rock type, grain size, and position within the structure, with ages in the proper order hornblende ≥ biotite. Examples of local consistency can bee seen in sections of Figs. 1 and 2.

Inherited argon

In contradiction to the model of blocking temperatures one may observe scattered dates, depending on the positions within the geological structure. Especially in lenses of undeformed rocks hornblendes and muscovites, but even biotites may retain an earlier age information although the rocks were heated well above estimated blocking temperatures (e.g. leses of undeformed tonalite within the amphibolite facies rocks of the Tauern Window (Besang et al. 1968, Friedrichsen et al. 1973, Raith et al. 1978)). An example of inherited argon can be seen in the upper part of Fig. 2: In the northeastern part of the Hangendserie (Münchberg Gneiss Massif) two hornblende dates point to an age of around 375 Ma; plateau ages of $^{39}Ar/^{40}Ar$ step-heating of muscovite (376 and 377 ± 4 Ma) from an unfoliated pegmatite are consistent with this age information (Kreuzer — Seidel, unpubl.). On the other hand the muscovites of 3T polytype from an eclogite cut by the pegmatite have significantly higher apparent ages. They show scattered conventional dates between 388 and 379 ± 3 Ma (Kreuzer et al., 1989) which exceed the regional pattern the more, the larger the grain size fraction is. Convincing $^{39}Ar/^{40}Ar$ plateau and isochron ages of 390 Ma (Kreuzer — Seidel, unpubl.) are consistent, within the limits of errors, with Sm/Nd isochron ages around 395 Ma which Stosch

— Lugmair (1987) found for two eclogites from the Münchberg complex. Thus, the relic 3T muscovites obviously preserved an earlier age information within a realm of an apparent cooling pattern.

Extraneous argon

The interpretation of scattered K-Ar dates is further complicated by the experience that in marginal parts of a thermal overprint biotite and hornblende use to trap radiogenic argon expulsed from the higher-grade area, leading to irrelevant high apparent ages. In contrast muscovites from such a marginal zone would show scattered "mixed ages" intermediate between the original and the thermal overprint ages, but rarely contain much excess argon (e.g. Stockwell 1963, Wanless et al. 1970). Thus concordant dates of muscovite and hornblende as in Figs. 1, 2, and in the upper part of Fig. 3 exclude significant influences of excess argon and indicate reliable age estimates. The slightly increased biotite dates from the Liegendserie (Fig. 2) indicate the existence of a moderate thermal overprint later than the age given by the fairly consistent pattern of hornblendes and muscovites.

Isochron treatments

Assuming that, within a small area like an outcrop, excess argon, that means extraneous and/or redistributed inherited argon, is rather uniformly distributed one can suppose that the same kind of mineral incorporated argon of the same isotopic composition in all places. If this holds true the K-Ar dates are negatively correlated with the ratios of potassium and atmospheric argon and the age of the overprint can be evaluated from an isochron. But often the dates are governed by the structure and the chemistry of the environment; moreover, an inhomogeneous distribution of excess argon is frequent even within a single mineral separate (e.g. Blankenburg — Villa 1988). Therefore, in presence of excess argon, it is likely that a correlation marks a trend rather than a real isochron.

Samples and results

Sampling localities can be taken from Table 1 and the sketch maps in Schüssler et al. (this volume: Figs. 1 and 2) who also give a short description of the investigated rock types. The conventional K-Ar dates from the Teplá-Domažlice zone are synoptically depicted in Fig. 3.

The West Bohemian Moldanubian area

Two localities situated west of the Bohemian Quartz Lode have been investigated. The amphibolites of the outcrops near Mýto are intercalated with Moldanubian gneisses and form a possible continuation of the metabasites in the Tirschenreuth-Mähring zone (Bavaria), a transitional zone between the Moldanubian and the Saxothuringian. The Mutěnín body is interpreted as a Proterozoic ferrodiorite ring intrusion (Tonika 1979) which is situated close to the Bohemian Quartz Lode. In both localities mid-Carboniferous dates were found for hornblende and biotite (Table 1) as expected from the dates of Šmejkal (1964 and 1965) and Vejnar (1962) for the area west of the quartz lode.

Amphibolites from the Mariánské Lázně metabasic complex, and metamorphic rocks and granitoids from the Teplá anticlinorium

Amphibolites were collected from several localities within the Mariánské Lázně metabasic complex. Throughout the complex a weak retrograde overprint can be observed. Thus, it was not unexpected that the K-Ar hornblende dates are significantly scattered, covering the wide range from 386 to 362 Ma. The interpretation of these dates as an approximate age of an early Devonian thermal event is confirmed by a similar date of 369 ± 4 Ma for the single analyzed biotite. Striking support comes from concordant muscovite and biotite ages from the Teplá anticlinorium adjacent to the Mariánské Lázně complex (Gottstein 1970 and Fig. 3, Šmejkal 1964, Vejnar 1962). The K-Ar ages demonstrate that the Mariánské Lázně metabasic complex and the Teplá anticlinorium were subjected to a last regional metamorphic event contemporaneously with units of the Münchberg complex and the Erbendorf-Vohenstrauß zone in Bavaria.

The Černá Hora Massif

Hornblendes of amphibolites from three localities have been analyzed: five samplex from Černá Hora village (northern part of the massif), one sample from the host rock of the pyrrhotite mine Zámecký Vrch (centre of the massif), and three samples from Újezd Svatého Kříže quarry (southern rim of the massif, near the Bohemian Quartz Lode). Five of the nine dates (four from Černá Hora village and a single one from Újezd Svatého Kříže) scatter within the analytical uncertaities around a weighted mean age of 376 ± 5 Ma, an age which is well within the range anticipated from the Bavarian nappe units and from the Mariánské Lázně — Teplá area. The same age can be estimated from an uncorrected muscovite date of 386 Ma for a pegmatite from Hostouň (Šmejkal 1964, sample 20). Thus the early Devonian event is fairly well established for the Černá Hora area, too. The remaining four dates deviate significantly. They range from 407 to 491 Ma.

The cluster of the four consistent hornblende analyses from Černá Hora village and the analytical point with the significantly deviating date of 407 Ma are correlated like an isochron (Table 1), but we regard this as accidental.

Completely different is the pattern of data further to the south. For Zámecký Vrch the hydrothermal activity presumably related to the Bohemian Quartz Lode might have caused excess radiogenic argon in the hosting amphibolite leading to the apparently pre-Devonian date of 490 Ma. The Újezd Svatého Kříže quarry is situated near the quartz lode and a quartz dike cuts the amphibolite. Thus a strong Carboniferous to Permian influence had been expected leading either to excess argon or to argon loss. In contrast to Černá Hora village no possibly meaningful correlation can be deduced from the three analyzed hornblendes: The hornblende lowest in potasium and thus most sensitive to excess argon yielded the youngest date of 383 ± 12 Ma, well within the early Devonian range known from the Bavarian nappe units. This fairly consistent group of age estimates and the absence of younger dates suggest that part of the apparently pre-Devonian dates is due to argon inherited from an earlier metamorphic stage.

The Neukirchen area

Hornblendes from the gabbroamphibolites of the Blätterberg — Hoher Bogen area as well as from fine-grained amphibolites of the Warzenrieth area as well as muscovites and biotites from paragneisses related to both metabasite types were dated (Fig. 3). Part of the investigated metabasites show a retrograde overprint.

Almost consistent muscovite dates between 329 and 321 Ma and consistent biotite dates between 321 and 318 Ma as well as two dates of 334 ± 14 and 329 ± 10 Ma for hornblendes from gabbroamphibolites prove a strong mid-Carboniferous rejuvenation for wide areas of this southern tip of the Teplá-Domažlice zone. Strong rejuvenation has been found also to the

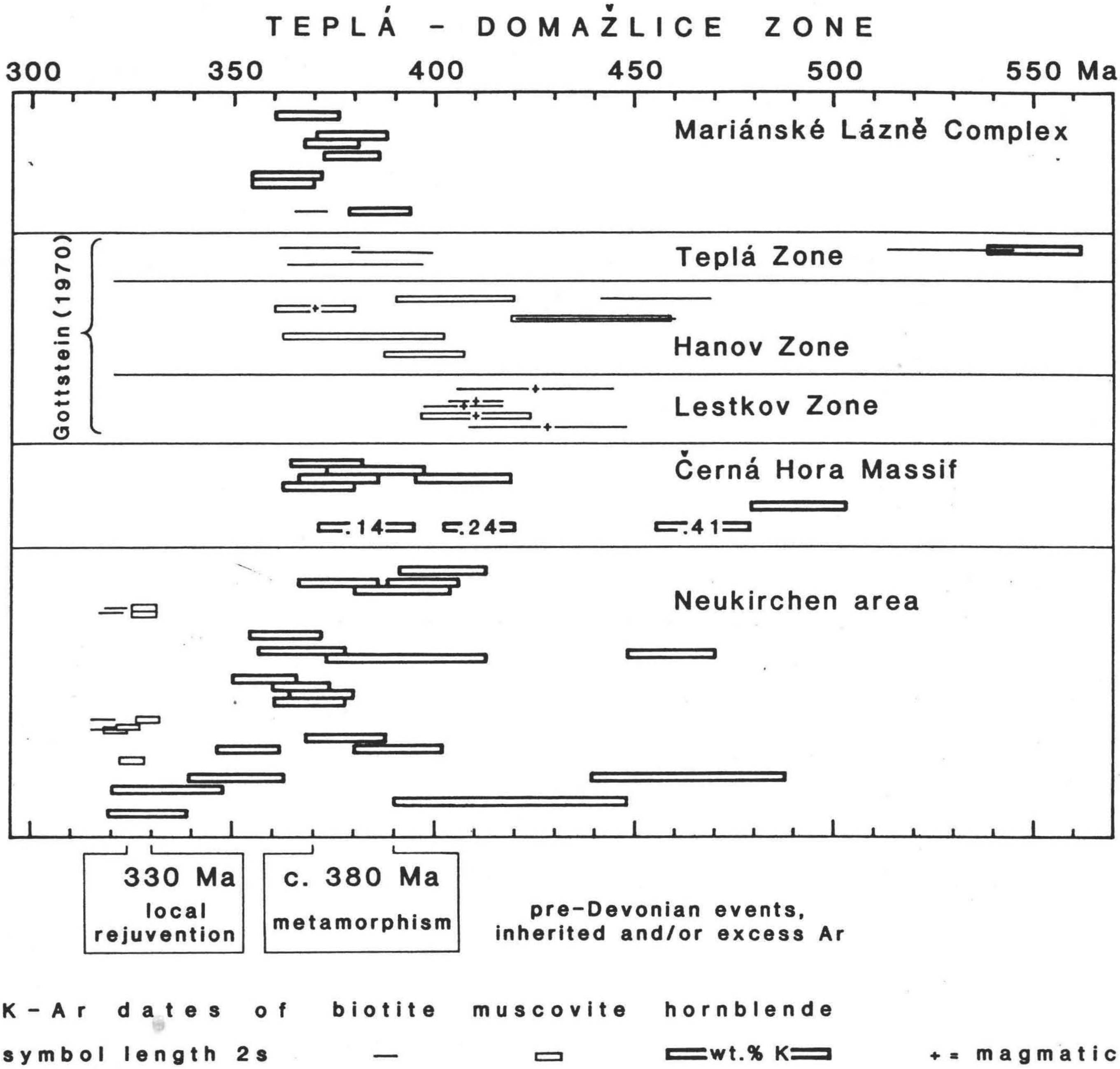

Fig. 3. K-Ar Dates from the Teplá-Domažlice zone. The dates are arranged roughly from north to south. The length of a symbol represents the analytical precision at a level of 95 % intralaboratory analytical confidence. Dates from the Teplá, Hanov, and Lestkov zones are recalculated from Gottstein (1979); the date of 392 Ma in the second line of the Neukirchen area is from Fischer et al. (1968). For further comments see Fig. 1.

north in the western part of the Domažlice area (Šmejkal 1964) which is intruded by the Babylon and Sedmihoří granitoid stocks of Carboniferous to Permian age (Vejnar 1962, Šmejkal — Vejnar 1965).

It is likely, but not proven, that part of the scatter of the hornblende dates from the Neukirchen area ranging from 329 to as high as 460 Ma is due to excess radiogenic argon trapped during the Carboniferous rejuvenation. Correlations like for Geleitsbachlüß (Table 1) are not convincing. On the other hand, 12 hornblende dates range between 350 and 390 Ma and may testify to the early Devonian metamorphic event.

Conclusions

Widely scattered dates ranging from 500 to 320 Ma have been determined for the Teplá-Domažlice zone. This pattern is distinctly different from the mid-Carboniferous to early Permian dates established for the bordering Moldanubian and Saxothuringian.

Fairly concordant dates around 380 Ma for hornblendes from amphibolites, and for muscovites and biotites from gneisses and granitoids of the Mariánské Lázně — Teplá area, in part also for hornblendes from the Černá Hora area resemble the ages determined for units of the Münchberg complex and for the western part of the Erbendorf-Vohenstrauß zone in Bavaria, in the latter confirmed by U-Pb dates on monazite (Teufel, 1988).

A much wider scatter of hornblende dates is recorded for the Neukirchen area in the southernmost part of the Teplá-Domaž-

Table 1 K-Ar Data from the West Bohemian Moldanubian area and the Teplá—Domažlice—Zone (ZTT)
Argon concentrations in nannoliter per gram at standard pressure and temperature. IUGS-recommended constants (Steiger & Jäger, 1977) used. Errors estimated at a level of 95 % intralaboratory confidence and given in the correct position(s) beneath the corresponding decimal place(s) of the results. Our K-Ar date for the standard glaucony GL-0 is 1 % younger than the mean value of the compilation of ODIN (1982). Abbreviations: EC = excess argon suggested by isochron treatment; IR = $^{40}Ar/^{36}Ar$ initial ratio; MSWD = mean squared wheighted deviation; P. = place in the map with altitude; qu. = quarry or abandoned qu.; amph = amphibole; bi = biotite; chl = chlorite; l = light phases; ga = garnet; hbl = hornblende; mu = muscovite; pl = plagioclase; px = pyroxene. If not otherwise mentioned the sieve fraction 125-63 μm was analyzed.

Sample No.	Rock type locality	Mineral fraction (μm)	K-Ar date (Ma)	K (wt. %)	Argon rad. (nl/g) STP	Argon atm.
West Bohemian Moldanubian area						
Amphibolites and Gneisses of Mýto (4 km W of Tachov)						
39	Gneiss with sillimanite and transverse mu, W part	bi + 5 % chl, l	309	7.95	104.1	0.338
	of the qu. at the road Mýto—Lučina, 1 km NW of Mýto	250-125	±3	6	8	31
40	Gneiss, rich in bi, W part	bi + 5 % chl, l	309	7.89	103.4	0.03
	of the qu. at the road Mýto—Lučina, 1 km NW of Mýto	250-125	±3	6	8	35
41	Amphibolite, poor in bi, NE part	hbl + cpx	315	0.408	5.46	0.21
	of the qu. at the road Mýto—Lučina, 1 km NW of Mýto		±6	8	4	4
44	Granite gneiss with sillimanite, W part	bi + hbl	309	7.30	95.6	0.03
	of the qu. at the road Mýto—Lučina, 1 km NW of Mýto	250-125	±3	6	7	34
		bi + hbl	300	6.04	76.8	0.16
			±3	5	6	29
Gabbrodiorite of Mutěnín (in the western vicinity of the Bohemian Quartz Lode)						
56	Diorite with ga, E wall of the quarry in the centre of the stock,	hbl	325	1.092	15.12	0.20
	300 m W of the road Mutěnín—Starý Kramolín	250-125	±6	22	12	9
		hbl	327	1.011	14.07	0.29
			±7	21	11	8
		bi	320	7.13	96.9	0.63
		250-125	±3	6	7	38
Teplá—Domažlice Zone						
Mariánské Lázně Metabasic Complex						
60	Amphibolite, 500 m S of Louka village,	hbl	379	0.276	4.54	0.256
	outcrops in a wood, 12 km NE of Mariánské Lázně		±9	7	3	40
61	Amphibolite, 500 m S of Louka village,	hbl	374	0.339	5.48	0.41
	outcrops in a wood, 12 km NE of Mariánské Lázně		±7	7	3	11
66	Amphibolite to ga-hbl gneiss, rail station Louka,	hbl	368	0.539	8.55	0.25
	at the bridge of the road Mariánské Lázně—Karlovy Vary		±8	12	7	4
68	Ga amphibolite, road cut down-river of the coffer-dam,	hbl	379	0.432	7.08	0.343
	1500 m NNE of Mnichow village, 12 km NE of Mariánské Lázně		±7	8	5	30
69	Schistose, banded amphibolite with calc-silicate, 2 hbl gen.,	hbl	363	0.303	4.74	0.371
	qu., 200 m S of the chapel, 600 m W of Prameny,		±9	8	4	21
	8 km N of Mar. Lázně					
70	Schistose, banded amphibolite with calc-silicate, 2 hbl gen.,	hbl	362	0.373	5.82	0.337
	qu. 200 m S of the chapel, 600 m W of Prameny,		±8	9	4	26
	8 km N of Mar. Lázně					
58	Banded amphibolite with bands rich in bi, upper quarry at the road	hbl	386	0.607	10.15	0.25
	300 m SW of Výškovice; a granite is c. 10 m apart;		±8	13	8	6
	7 km SE of Mariánské Lázně	bi	369	6.74	107.3	0.10
			±4	5	1.0	9
Amphibolites of the Černá Hora Massif (15 km NW of Horšovský Týn)						
46	Schistose amphibolite, from the trench	hbl	373	0.310	4.98	0.276
	for a gas pipe, 300 m NE of Černá Hora village		±9	8	4	28
47	Fine-frained, schistose amphibolite, from the trench	hbl	385	0.194	3.216	0.191
	for gas pipe, 300 m NE of Černá Hora village		±12	7	25	14
48	Schistose amphibolite, from the trench	hbl	407	0.154	2.743	0.214
	for a gas pipe, 300 m NE of Černá Hora village		±12	5	21	21
49	Banded amphibolite, from the trench	hbl	376	0.227	3.685	0.214
	for a gas pipe, 300 m NE of Černá Hora village		±10	6	28	21
50	Schistose, banded amphibolite, from the trench	hbl	371	0.337	5.40	0.317
	for a gas pipe, 300 m NE of Černá Hora village		±9	8	4	36
	hbl isochron data Černá Hora village:	40Ar/36Ar versus 40K/36Ar	342	IR = 820	MSWD = 0.6	
			±16	190		
		radiogenic Ar versus K	340	EC = 0.45	MSWD = 1.8	
			±14	0.14		
52	Schistose amphibolite with calc-silicate bands, mine	hbl	491	0.246	5.39	0.419
	Zámecký Vrch, 1 km SE of Svržno, 2 km S of Černá Hora village		±12	7	4	16
53	Schistose amphibolite with calc-silicate bands,	hbl	411	0.406	7.29	0.322
	quarry Újezd Svatého Kříže, 4 km S of Černá Hora village		±9	10	6	26
54	Schistose amphibolite with calc-silicate bands,	hbl	467	0.236	4.90	0.359
	quarry Újezd Svatého Kříže, 4 km S of Černá Hora village		±12	7	4	24
55	Amphibolite, unoriented, quarry Újezd Svatého Kříže,	hbl	383	0.143	2.367	0.361
	4 km S of Černá Hora village (near the Bohemian Quartz Lode)		±12	5	18	17

Table 1 continued

Sample No.	1:25000 Map No.	Grid r value h value	Rock type locality	Mineral fraction (μm)	K-Ar date (Ma)	K (wt. %)	Argon rad. (nl/g) STP	Argon atm.
Amphibolites and gneisses from the Neukirchen area								
10	6643	45 6990	Paragneiss with kyanite, quarry at the	mu	328	7.60	106.4	0.91
	Furth i. W.	54 6290	Hahnenberg, 1000 m NW of Warzenried	250-125	±3	6	8	37
				bi	321	7.56	103.4	0.78
				250-125	±3	6	8	31
11	6643	45 6990	Paragneiss with kyanite, quarry at the	mu	328	6.99	97.6	0.90
	Furth i. W.	54 6290	Hahnenberg, 1000 m NW of Warzenried	250-125	±3	5	7	33
				bi	320	7.48	101.8	0.10
				250-125	±3	6	8	27
12	6643	45 6320	Schistose amphibolite, Blätterberg,	hbl	402	0.193	3.379	0.35
	Furth i. W	54 6360	Vogelherd, quarry 200 m SE of P. 486		±11	6	26	4
15	6643	45 6377	Fine-grainde amphibolite, E of Blätter-	bhl	376	0.242	3.941	0.314
	Furth i. W	54 6303	berg village, quarry 75 m SSE of P. 485		±10	7	30	22
327	6643	45 6377	Amphibolite with long prism. hbl, E of	hbl	398	0.180	3.118	0.318
	Furth i. W	54 6303	Blätterberg village, qu. 75 m SSE P. 485		±10	5	24	22
401	6644/6744	45 7452	Schistose amphibolite, Hoher	hbl	363	0.297	4.63	0.39
	Rittsteig	54 2210	Hofberg, 250 m NE of P. 648		±9	7	4	8
405	6644/6744	45 7346	Schistose amphibolite,	hbl	367	0.134	2.122	0.428
	Rittsteig	54 6178	Dachsberg, 100 m W of P. 583		±11	4	16	36
407	6644/6744	45 7346	Schistose amphibolite,	hbl	459	0.306	6.22	0.264
	Rittsteig	54 6178	Dachsberg, 100 m W of P. 583	250-63	±11	8	5	23
408	6644/6744	45 7346	Schistose amphibolite,	hbl	393	0.125	2.137	0.206
	Rittsteig	54 6178	Dachsberg, 100 m W of P. 583		±20	7	16	13
416	6644/6744	45 7547	Schistose amphibolite,	hbl	372	0.341	5.48	0.198
	Rittsteig	54 5898	Geleitsbachlüß, 150 m SE of P. 663		±8	8	3	22
417	6644/6744	45 7547	Schistose amphibolite,	hbl	358	0.683	10.51	0.24
	Rittsteig	54 5898	Geleitsbachlüß, 150 m SE of P. 663		±8	15	8	5
418	6644/6744	45 7547	Schistose amphibolite,	hbl	367	0.496	7.86	0.277
	Rittsteig	54 5898	Geleitsbachlüß, 150 m SE of P. 663		±7	9	6	37
419	6644/6744	45 7547	Schistose amphibolite,	hbl	369	0.320	5.10	0.222
	Rittsteig	54 5898	Geleitsbachlüß, 150 m SE of P. 663	250-63	±9	8	4	23
		hbl isochron data Geleitsbachlüß:	40Ar/36Ar vs 40K/36Ar		347	IR – 910	MSWD – 0.7	
					±18	500		
			rad. Ar vs K		351	EC – 0.33	MSWD – 0.9	
					±14	0.27		
423	6644/6744	45 7289	Schistose amphibolite,	hbl	375	0.202	3.303	0.275
	Rittsteig	54 5741	Ständlberg, 20 m NW of P. 595		±10	6	25	16
1	6644/6744	45 7290	Non-oriented leucoamphibolite,	hbl	354	0.361	5.49	0.290
	Rittsteig	54 5735	Ständlberg, eastern slope		±8	9	4	25
3	6644/6744	45 7290	Non-oriented hornblendite,	hbl	391	0.294	4.99	0.322
	Rittsteig	54 5735	Ständlberg, eastern slope		±11	9	4	26
4	6644/6744	45 7290	Gneiss, boulder from the field	mu	325	8.92	123.6	0.68
	Rittsteig	54 5728	S of the Ständlberg	250-125	±3	7	9	32
301	6743	45 6628	Coarse, non-oriented amphibolite,	hbl	419	0.044	0.807	0.221
	Neukirchen	54 5635	Am Kohlriegel, fork Diensthüttenweg/		±29	4	6	13
			Neuweg					
304	6743	45 6557	Coarse, non-oriented amphibolite,	hbl	463	0.050	1.023	0.205
	Neukirchen	54 5682	Am Kohlriegel, 1000 m NW of P. 957	250-63	±25	3	6	20
305	6743	45 6557	Coarse, non-oriented amphibolite,	hbl	351	0.104	1.571	0.253
	Neukirchen	54 5682	Am Kohlriegel, 1000 m NW of P. 957		±12	4	12	20
314	6743	45 6540	Fine-grained, banded amphibolite,	hbl	329	0.138	1.943	0.216
	Neukirchen	54 5598	Am Grenzweg, 200 m E of P. 957		±10	5	15	36
314	6743	45 6540	Fine-grained, banded amphibolite,	hbl	329	0.138	1.943	0.216
	Neukirchen	54 5598	Am Grenzweg, 200 m E of P. 957		±10	5	15	36
16	6743	45 6580	Slightly schistose amphibolite With 2(?)	hbl	334	0.085	1.213	0.290
	Neukirchen	54 5620	gener. of hbl, road cut 220 m SW Diensthütte		±14	4	9	9
5	6743	45 7230	Fine-gr., metatectic paragneiss,	mu	329	7.34	102.8	1.57
	Neukirchen	54 5775	transverse mu, Atzelbg.,	250-125	±3	6	8	30
			100 m WSW od P. 590	bi	318	7.53	101.8	0.26
				250-125	±3	6	8	26
6	6743	45 7230	Coarse paragneiss,	mu	324	7.67	106.0	1.14
	Neukirchen	54 5775	Atzelberg, 100 m WSW of P. 590	250-125	±3	6	8	21
				mu	321	7.70	105.2	1.05
					±3	6	8	35
				bi	318	7.47	100.9	0.64
				250-125	±3	6	8	31

lice zone. The probably lower Devonian medium-pressure event, although well documented to the north, in the Poběžovice-Domažlice area, by critical metamorphic assemblages (Vejnar 1972), is only vaguely discernible in the pattern of K-Ar dates. On the other hand, the influence of the mid-Carboniferous (low-pressure) metamorphism, typical for the adjacent Moldanubian, is clearly documented by consistent K-Ar dates of muscovites, biotites and two hornblendes. Mid-Carboniferous K-Ar dates recorded in the eastern part of the Erbendorf-Vohenstrauß zone could be explained in the same way. However, in contrast to the Neukirchen area, there a thermal influence from the late Variscan granites is more probable because of their immediate neighbourhood (Schüssler et al. 1986, Kreuzer et al. 1989).

Medium-pressure metamorphism and early Devonian mineral ages are distinct features of the Münchberg Gneiss Massif, the western part of the Erbendorf-Vohenstrauß zone and the Teplá-Domažlice zone. These similarities support the idea that the two Bavarian units are related to the Teplá-Domažlice zone. Probably, they are remnants of one huge complex, presumably the western margin of the Teplá-Barrandian, resting upon the low-pressure metamorphosed Moldanubian and Saxothuringian in the Carboniferous. However, the belonging to the same stockwerk does not imply straight-foreward lithological correlations. On the contrary, geochemical differences of the metabasites point to different geotectonic origins of the former basalts even for parts of the same nappe unit (Okrusch et al. in press).

Apart from the medium-pressure metamorphism two other stages of overprinting are recognized in the three related tectonic units. A young retrogressive stage has been mentioned already, as well as an older metamorphic stage, evident from eclogitic relics, which are widespread in the Münchberg and in the Mariánské Lázně complexes, and sporadically present in the Erbendorf-Vohenstrauß zone (and in the Moldanubian). These relics testify to a formation under very high pressure (e.g. Franz et al. 1986, Klemd in press).

As a consequence of the polymetamorphic forming of many of the rocks, an assigment of the 380 Ma event to the medium-pressure metamorphism, as tacitly done in the present paper, is not generally accepted. The most divergent interpretation is given by Müller-Sohnius et al. (1987). From Rb-Sr whole-rock dating of paragneisses they conclude that the Liegendserie and the Hangendserie of the Münchberg complex were metamorphosed under medium-pressure conditions already in the early and in the late Ordovician, respectively. The early Devonian event around 380 Ma they regard as a medium-temperature mylonitization and as the first event which is common to all tectonic units of the Münchberg gneiss core. Others (in oral discussions) regard the Sm-Nd mineral-isochron ages around 395 Ma as the time of the medium-pressure metamorphism and the 380 Ma event as a stage of uplift and unroofing, analogously to the interpretation in the Erbendorf-Vohenstrauß zone which Teufel (1988) gave for the U-Pb zircon and monazite ages of about 390 and 380 Ma, respectively. Initially, Stosch — Lugmair (1987) had interpreted the 395 Ma age for two eclogites from the Münchberg complex as estimate of the age of eclogitization, but meanwhile Stosch — Lugmair (in prep.), by reason of new results, they tend to follow the suggestion of Müller-Sohnius et al. (1987) who more geologically argued from a Rb-Sr paragneiss isochron age and a reinterpretation of the zircon dates of Gebauer — Grünenfelder (1979) for an age of the high-pressure metamorphism around 435 ± 14 Ma. Similar ages of 427 ± 5 and 423 ± 8 Ma have been determined from Sm-Nd mineral — whole-rock isochrons for and eclogite and its country rock from the North-Bavarian Moldanubian (v. Quadt — Gebauer 1988). These authors suggest a successive Silurian convercontinents and terranes in the European Variscides.

The meaning of the scattered higher (> 400 Ma) K-Ar dates of hornblendes from the Teplá-Domažlice zone is uncertain. The existence of similar muscovite dates and rare concordant muscovite and biotite ages (e.g. Gottstein 1970: samples 15, 16, 17 which recalculated yielded 410 ± 7, 407 ± 10 and 410 ± 14 Ma) suggests that some of the pre-Devonian dates may reflect earlier metamorphic and magmatic events. But excess argon caused by mid-Carboniferous thermal influences cannot generally be excluded. More insight into the poly-stage pre-Devonian thermal evolution of the Teplá-Domažlice zone is expected from the initiated ^{39}Ar-^{40}Ar work.

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