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SHORT COMMUNICATION

U/Pb ages of zircons from a plagiogranite-gneiss in the south-eastern Bohemian Massif, Austria – further evidence for an important early Paleozoic rifting episode in the eastern Variscides

by *F. Finger*[1] and *A. von Quadt*[2]

Abstract

A plagiogranite-gneiss occurring within an ophiolite-like complex in the high-grade metamorphic south-eastern Bohemian massif (Raabs unit, Buschandlwand area) was dated at 428 ± 6 Ma (U–Pb zircon age, upper intercept). Considering the regional geological situation, this age is best interpreted in terms of an important early Paleozoic rifting event. The supposed rift zone is indicated by a north-south trending line of ophiolites along the western margin of the Moravo-Silesian plate, and may perhaps be correlated with the Saxothuringian or the Rhenohercynian suture of the central European Variscides via an arc structure in the Sudetes.

Keywords: Bohemian Massif, Austria, U/Pb age determinations, zircon, plagiogranite, rifting, Variscides.

Introduction

In the central and western European section of the Variscan orogen, three main east-trending oceanic suture zones are commonly distinguished (Fig. 1): the Rhenohercynian and the Saxothuringian suture in the north and, on the southern flank of the fold belt, the Massif Central suture (MATTE, 1986; FRANKE, 1989). The latter probably continues eastwards into the Alpine basement. There exist, however, very contrasting views, how these sutures pursue into the tectonically highly disturbed Bohemian Massif (see e.g. MATTE et al., 1990; FRANKE, 1989).

Many correlation problems between eastern and western European Variscides apparently result from the fact that only little radiometric age information is available for the highly metamorphosed ocean floor remnants of the Bohemian Massif. Several ophiolite-like complexes are, for example, accompanying the eastern margin of the Moravo-Silesian plate (Fig. 1). These have recently been interpreted as remnants of an important early Paleozoic rift zone, that reached the size of a small ocean (FINGER and STEYRER, 1995). In this paper, we present U/Pb ages of zircons from a plagiogranite gneiss that was sampled in one of these complexes (Buschandlwand; see Fig. 1).

Geological setting

The south-eastern Bohemian Massif exposes a high-grade metamorphic nappe pile, that formed at ca. 340 Ma (FRIEDL et al., 1993) in the Variscan continent-collision zone between Gondwana and Laurasia (see Figs 2 and 3). The nappes emplaced towards north-east, onto a Cadomian foreland plate (Moravo-Silesicum or Brunovistulicum, DUDEK, 1980), in connection with the forceful indentation of a Moldanubian block from the south (FRITZ and NEUBAUER, 1993). Remnants of a former oceanic rift zone (Raabs unit) are present within the nappe pile (FINGER and STEYRER, 1995). This Raabs unit overlies a pas-

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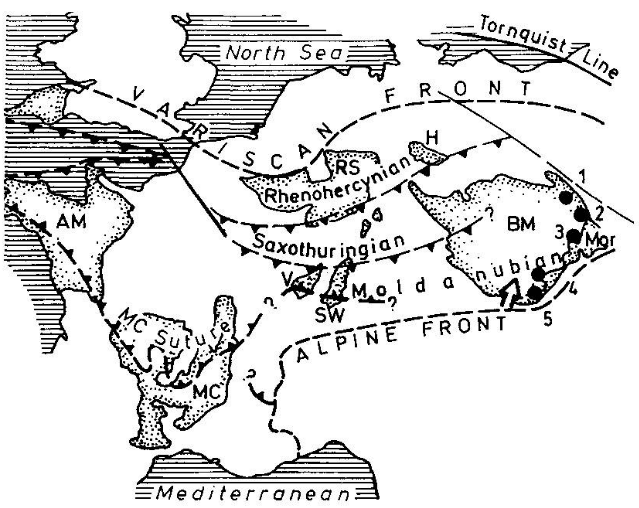

Fig. 1 Uncovered massifs and major tectonic structures of the European Variscides (simplified after FRANKE, 1989 and MATTE, 1986).
Shown are also some major occurrences of ophiolite remnants along the western Moravo-Silesian plate margin (according to FINGER and STEYRER, 1995, and references therein: 1 Nova Ruda, 2 Stare Mesto, 3 Letovice, 4 Raabs Window, 5 Buschandlwand). Arrow marks the supposed indentation of a Moldanubian block (FRITZ and NEUBAUER, 1993).
Abbreviations: AM Armorican Massif, BM Bohemian Massif, H Harz, MC Massif Central, Mor Moravo-Silesian unit, RS Rheinisches Schiefergebirge, SW Schwarzwald, V Vosges.

sive continental margin terrane (Variegated unit, Moravo-Silesian terrane), and is itself tectonically overlain by an active-continental-margin terrane (Gföhl unit – CARSWELL and O'BRIEN, 1993).

Previous age determinations of rocks of the Raabs unit yielded equivocal results: In a conference abstract, GEBAUER and GRÜNENFELDER (1982) mentioned an upper-intercept zircon age of ca. 600 Ma for an anorthosite from the Rehberg amphibolite complex near Krems. Other amphibolites of the Raabs unit (Weitental) were considered as still older Precambrian series on the basis of Rb–Sr WR dating (FRANK et al., 1990). These data seemed to confirm the previously very common assumption that the ophiolite remnants in the Bohemian Massif are substantially Precambrian in age (see e.g. MISAR et al., 1984).

Sample description

The dated Hartenstein gneiss (STEYRER and FINGER 1995) occurs in the so-called Buschandlwand amphibolite complex of the Raabs unit, near the castle of Hartenstein (see inset in Fig. 2). It forms small layers and lenses within amphibolites and was mapped as "quartz-dioritic gneiss" by MATURA (1976). The sample used for dating was fine-grained and consisted of ca. 70% oligoclase, 15% quartz, 10% hornblende, some K-feldspar, biotite and diopside, and accessory zircon, apatite, allanite, sphene and opaque phases. The rock experienced penetrative recrystallization during Variscan metamorphism.

A close primary relationship between the gneiss and the surrounding amphibolites may be already inferred in the field from the permanent intimate interlayering of both rock types on a centimetre to metre scale. Judging from this observation, and because of its leuco-quartz-dioritic composition, the gneiss is likely to represent a plagiogranite melt, that formed contemporaneous with the amphibolite protoliths.

Chemical data of the gneiss are presented in STEYRER and FINGER (1995). The low K_2O (~ 0,5 wt% at 70% SiO_2), the high Na_2O (6,5–7%), and the flat trace-element and REE patterns (e.g. ~ 10 ppm Rb, ~ 150 ppm Y and 1000–1500 ppm Zr) also suggest that the rock was a former plagiogranite.

Zircon fractions

The Hartenstein gneiss contains many stubby to normal prismatic zircons between 100 and 400 µm length. The grains display uniformingly a {100}+{101} dominated morphology, as is particularly typical in plagiogranites (see e.g. PUPIN, 1980).

Most zircons are, however, not perfectly euhedral and show more or less rounded edges. Thin, irregular and probably metamorphic outgrowths and overgrowths are sometimes developed.

When studied in transmitted light, many zircons turned out to be highly porous. Some grains were so rich in small pores, that they appeared almost black. Based on mineralogical observations, FRASL and FINGER (in prep.) suggest that these highly porous, unzoned zircon domains formed through partial recrystallization during Variscan metamorphism.

In order to date the protolith age of the rock, we have tried to select fractions of clear, nonporous zircons. For fractions 1 and 3, selected zircons were all clear, colourless, euhedral to subhedral, and free of any overgrowths. Slight oscillatory magmatic growth zoning was commonly visible in these grains in transmitted light. Inherited cores were never observed, but some inclusions of apatite needles were mostly present.

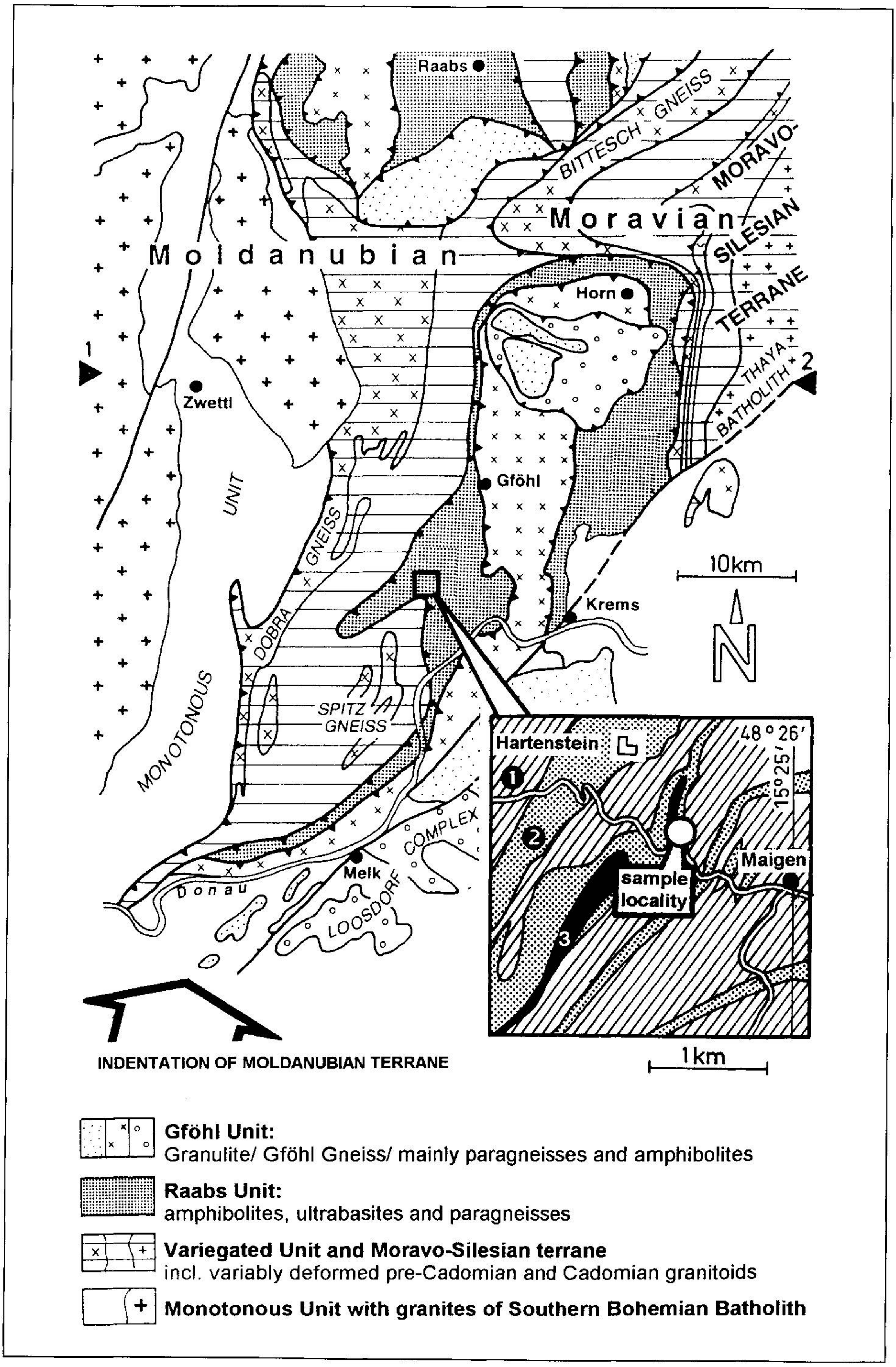

Fig. 2 Geological sketch map of the south-eastern Bohemian massif (FINGER and STEYRER, 1995). Inset shows a detail of the Buschandlwand amphibolite complex near the castle of Hartenstein, where the dated plagiogranite-gneiss was sampled (geology after MATURA, 1983; 1 paragneisses, 2 amphibolites, 3 Hartenstein gneiss).

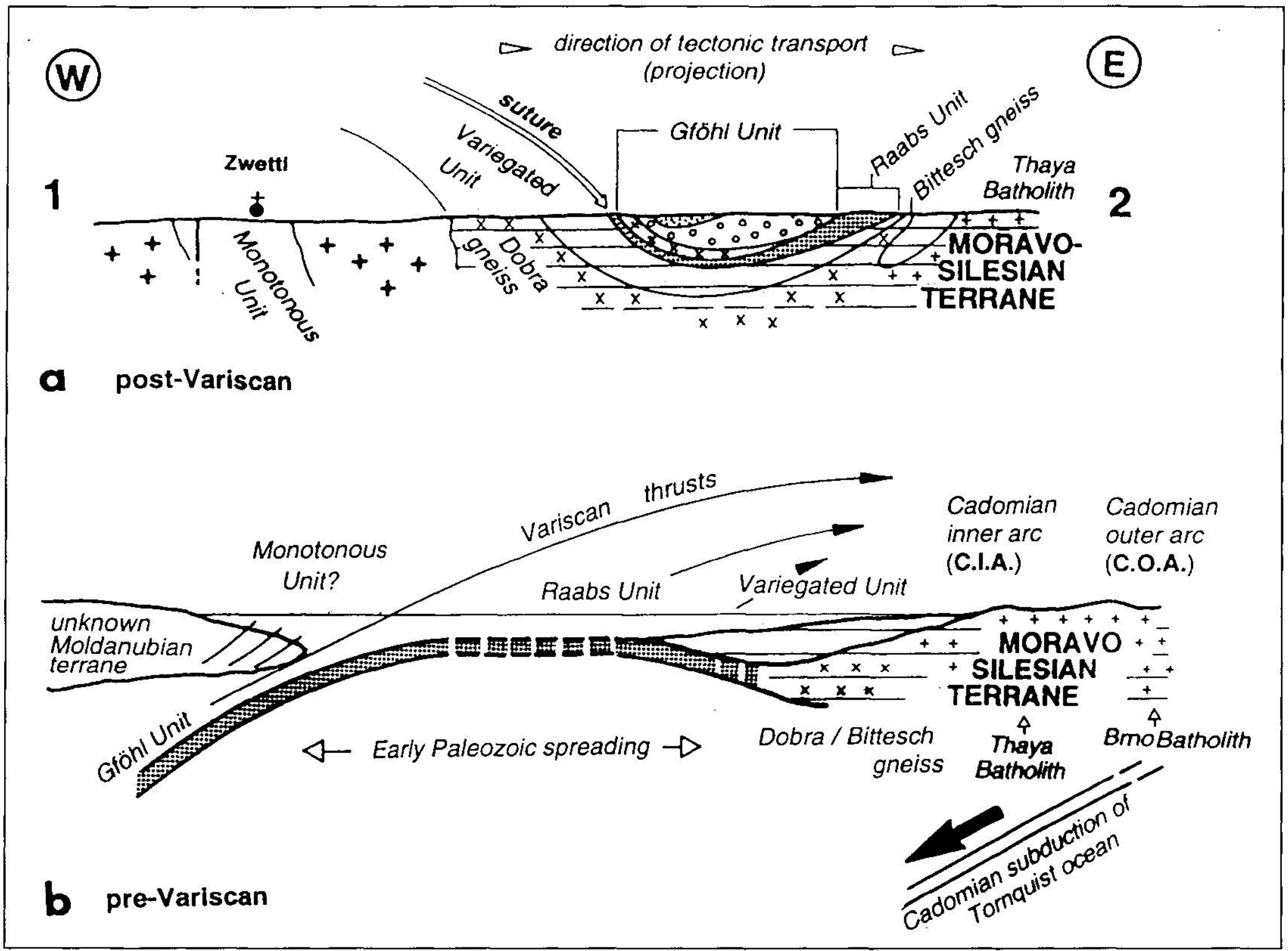

Fig. 3 Tectonic profiles showing the post-Variscan (= present day) and the inferred pre-Variscan situation (after MATURA, 1976; FINGER and STEYRER, 1995). Numbers 1 and 2 indicate position of profile a in figure 2.

Fraction 2 consists of big (300–400 µm long), feebly brown subhedral zircons. These grains showed a more pronounced oscillatory zoning, but were poor in pores and free of secondary overgrowth as well. Microprobe investigations revealed significantly enhanced U concentrations in the outer magmatic growth zones (~ 0,5% UO_2).

Results of dating

The analytical data are summarized in table 1. Fraction 3 is subconcordant at a $^{207}Pb/^{206}Pb$ age of 438 Ma, but has a quite large error (± 27 Ma). Fraction 1 is slightly discordant. It displays a similar $^{207}Pb/^{206}Pb$ age as fraction 3, but with smaller error (426 ± 6 Ma).

As expected, fraction 2 is more discordant. However, its $^{207}Pb/^{206}Pb$ age (421 ± 42 Ma) overlaps again with the $^{207}Pb/^{206}Pb$ ages of fractions 1 and 3. This suggests that the non-porous zircons of the gneiss experienced only recent, but no substantial Variscan lead loss.

A discordia line, drawn through fractions 1–3, gives an upper intercept age of 428 ± 6 Ma (Fig. 4).

Tab. 1 U–Pb analytical data for the dated zircon fractions (for details concerning the analytical procedure see VON QUADT, 1992).

FRACT.	U ppm	Pb rad	Pb com	$^{206}Pb/^{204}Pb$	$^{206}Pb/^{238}U$	error	$^{207}Pb/^{235}U$	error	$^{207}Pb/^{206}Pb$	error	$^{206}Pb/^{238}U$	$^{207}Pb/^{235}U$	$^{207}Pb/^{206}Pb$	CORR*
835-1	387.4	25.95	2.85	592	0.06583	± 11	0.50219	± 167	0.05533	± 16	411	413	426	0.61
835-2	1141.1	38.38	20.1	117	0.02807	± 22	0.21365	± 471	0.05521	± 106	178	197	421	0.52
835-3	286.9	19.6	8.49	153	0.06721	± 45	0.51575	± 791	0.05565	± 69	419	422	438	0.61

* = correlation coefficient: $^{207}Pb/^{235}U$–$^{206}Pb/^{238}U$

common lead correction: $^{208}Pb/^{204}Pb$ = 37.85, $^{207}Pb/^{204}Pb$ = 15.592, $^{206}Pb/^{204}Pb$ = 18.045 (STACEY and KRAMERS [1975], T = 420 Ma).

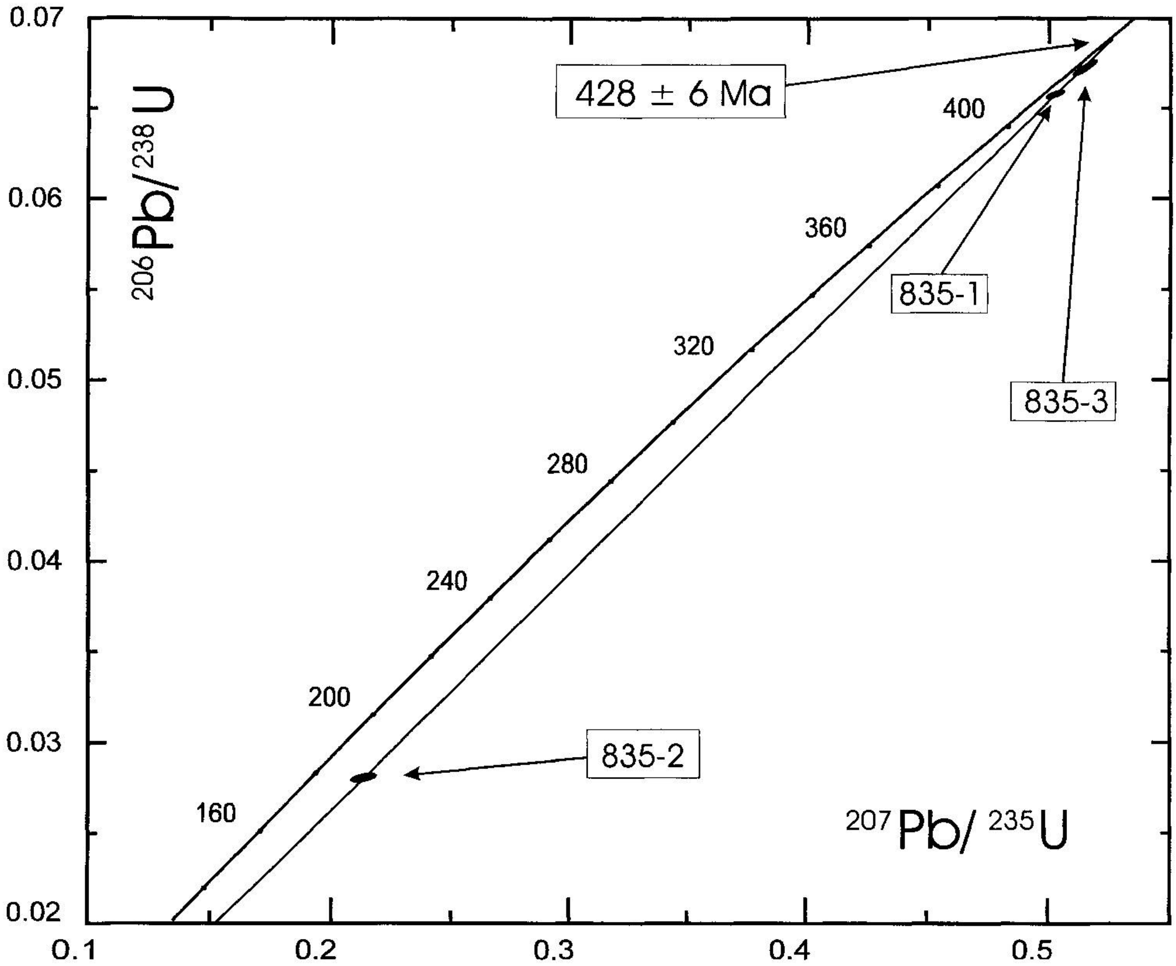

Fig. 4 Conventional $^{207}Pb/^{235}U$ vs $^{206}Pb/^{238}U$ concordia diagram with plots of the three dated zircon fractions of the Hartenstein gneiss.

This age is considered to be close to the protolith age of the Hartenstein gneiss and to date approximately the formation age of the entire Buschandlwand amphibolite complex (some uncertainties may lie in the high common lead contents of the zircons).

Discussion and conclusions

A number of ophiolite-like bodies are straddling the western boundary of the Moravo-Silesian plate between Austria and Poland (Fig. 1). One of these is the Sleza/Nova Ruda ophiolite complex in the Polish Sudetes, which was recently dated by OLIVER et al. (1993) at 420 Ma (+20/–2 Ma). Almost the same age has now been found for the Buschandlwand complex in Austria. Thus, a N–S trending oceanic suture of Early Paleozoic age seems to extend in the eastern Bohemian Massif, along the western Moravo-Silesian plate margin.

The granitoid basement of the Moravo-Silesian plate, although largely covered with Paleozoic sediments and Neogene molasse, has recently been recognized as a Cadomian, Pacific type, plate-margin terrane with an outer, or island arc, to the north-east (FINGER et al., 1995). This juvenile Cadomian crust in the north-east of the Moravo-Silesian plate was probably located very close to the late-Precambrian continental lip of Gondwana, where the Tornquist sea was subducted (cf. FRANKE, 1989; COGNE, 1990). Thus, the Moravo-Silesian plate was probably part of the external northern flank of the Variscan fold belt, just like the Cadomian basement of eastern England or northern Brittany (FINGER and STEYRER, 1995), and the Raabs unit may have had its former lateral continuation in the Saxothuringian or Rhenohercynian of Germany and western Bohemia, respectively. In this case, the northern flank of the Variscan fold belt would bend sharply southward in the north-eastern Bohemian massif. This "Sudetic arc" may well be the result of the forceful indentation of a Moldanubian terrane from the south, as illustrated in figures 1 and 2 (cf. FINGER and STEYRER, 1995).

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