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# Two Distinctive Granite Suites in the Southwestern Bohemian Massif: Reply to F. Finger and M. René

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We have carefully evaluated the comments of our colleagues F. Finger and M. René and we appreciate their interest in our work and the opportunity to further clarify our viewpoints. In our paper (Siebel *et al.*, 2008) we presented detailed geochemical and geochronological analyses of mainly crustal-derived late Variscan granites (328–321 Ma) from the Bavarian Forest, Moldanubian unit, Bohemian Massif. As an important observation, a high Ca–Sr–Y granite suite south of the Pfahl zone was distinguished from a low Ca–Sr–Y granite suite to the north of this zone; this difference is clearly reflected in the Sr and Nd isotopic signatures of the granites (Siebel *et al.*, 2008, fig. 8). From these findings we concluded that the Bavarian Forest is made up of two different crustal blocks. We further concluded that the Bavarian Pfahl shear zone represents a terrane boundary within the Moldanubian unit. Our study supports the terrane-based division of the Bavarian Forest into a Bavarian terrane and an Ostrong terrane as originally proposed by Fiala *et al.* (1995). Finger & René (2009) added data from the Weinsberg granite north of the Pfahl zone, from two granites of the Austrian Mühl zone (Haibach, Altenberg) and from a flasergranite close to the Pfahl zone near Regen, Bavaria. Their compilation (Finger & René, 2009, fig. 1) does not support our classification, leading them to query the validity of the terrane concept.

## GRANITE SUITES

To set the stage for commenting on the specific points raised by Finger & René (2009) we start with an outline of our sample coverage. This is done because it was noted by Finger & René that 'The fairly clear geochemical separation presented by Siebel *et al.* (2008) for the plutons north and south of the Pfahl fault is an artefact that results from a database that is too small'. Our study program encompassed many years of research, involving comprehensive geochronological and geochemical studies on all major plutons from the Bavarian Forest. In total, the dataset includes 52 samples from 29 granite intrusions almost equally distributed north and south of the Pfahl shear zone. We consider this dataset as the currently most representative compilation for granites from the Bavarian Forest. As outlined above, we identified a consistent relationship between the geochemical features of the granites and their regional distribution pattern. The only significant exception to this pattern is the Weinsberg-type Finsterau I granite from the Ostrong terrane, which, as we mentioned on p. 1876 (Siebel *et al.*, 2008), 'has geochemical features more akin to the granites from the Bavarian terrane'. We certainly agree with Finger & René (2009) that Weinsberg-type rocks occur on both sides of the Pfahl zone and have characteristics of high-Ca granites. In our opinion, this could be explained by different conditions

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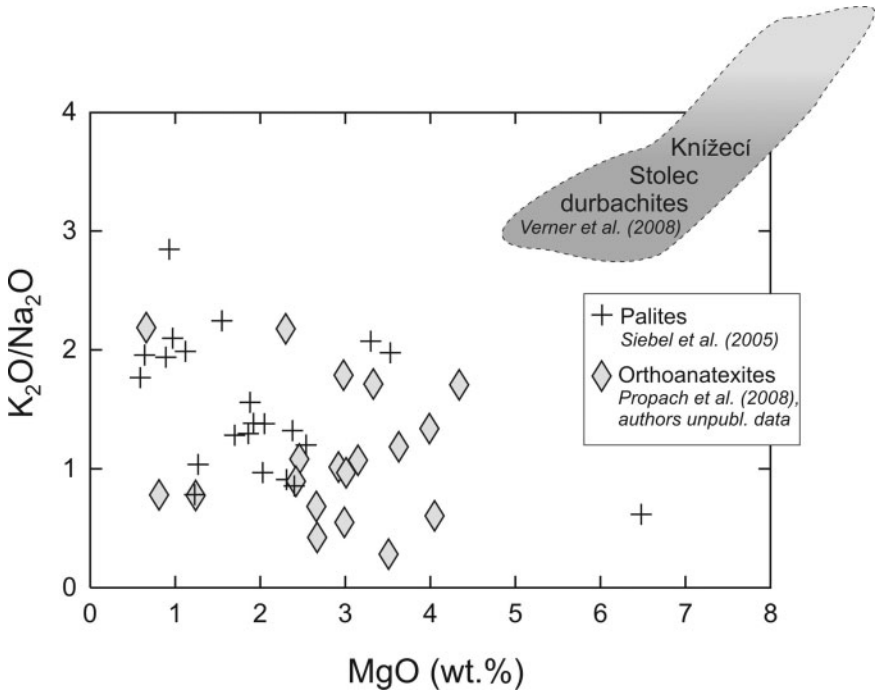


**Fig. 1.** Plot of MgO (wt %) vs $K_2O/Na_2O$ ratio for durbachites from the Knížecí Stolec pluton, north of the Pfahl zone [outlined field based on data of Verner *et al.* (2008) and K. Verner, personal communication], and ortho-derivative rocks south of this zone (palites, orthoanatexites; Siebel *et al.*, 2005; Propach *et al.*, 2008; and authors' unpublished data). The two groups clearly define different compositional fields.

and processes during their generation; for example, higher degree of melting, or more significant contribution of mantle material compared with the low-Ca granites. In the case that the Weinsberg-type granites were sourced by melts from deeper crust (e.g. Finger & Clemens, 1995), the basement north and south of the Pfahl zone might have had similar lower crustal compositional characteristics.

We focused on late Variscan undeformed granite plutons from both sides of the Pfahl zone and we did not include special rock types such as flasergranite or palite [palite: a dark-coloured diatexite migmatite (Frentzel, 1911)] from the southern side in our investigation, as these rocks have no equivalents in the opposite crustal block. As we noted in our paper (p. 1866), granites located close to the northern edge of the Pfahl zone (Rinchnach, Patersdorf) have probably tapped the southern crustal block. The reason for this could be an inclined or inflected terrane boundary. Thus, we think that deviant behaviour of magmatic bodies in or adjacent to the Pfahl zone corridor is not an argument against the terrane model.

From careful evaluation of the data presented by Finger & René for comparison (their fig. 1), it is discernible that their data were specifically chosen, introducing a strong selection bias. Thus, the authors did not provide a balanced compilation from either side of the Pfahl zone. Moreover, as can be checked on the regional geological map (Geologische Bundesanstalt, 1965), Finger & René included data from a granite situated south of the Rodl shear zone (Altenberg granite) in their fig. 1. The Rodl shear zone is a major strike-slip fault that runs perpendicular to the Pfahl shear zone (Brandmayr *et al.*, 1995) and this fault defines either a major offset or the termination of the Pfahl shear zone. Any terrane assignment beyond this zone is highly speculative and, for a better constrained comparison, it would be essential to omit data from south of the Rodl zone. In the following, we will present new data and graphics from the Bavarian basement unit, which will substantiate our viewpoint.

## BASEMENT LITHOLOGIES

As for most crustal root zones, the geology of the Moldanubian sector of the Bohemian Massif is extremely complicated in detail. It was noted by Finger & René (2009) that the basement blocks north and south of the Pfahl shear zone display similar structural and metamorphic features. However, Finger & René disregard the fact that the basement units of the Bavarian Forest developed under different complex conditions before they were collectively overprinted by late Variscan metamorphism.

Finger & René (2009) noted that 'Finger *et al.* (2007) have pointed out that some prominent pre-Variscan lithologies from north of the Pfahl zone continue into the area south of the fault'. As a prominent example, Finger *et al.*

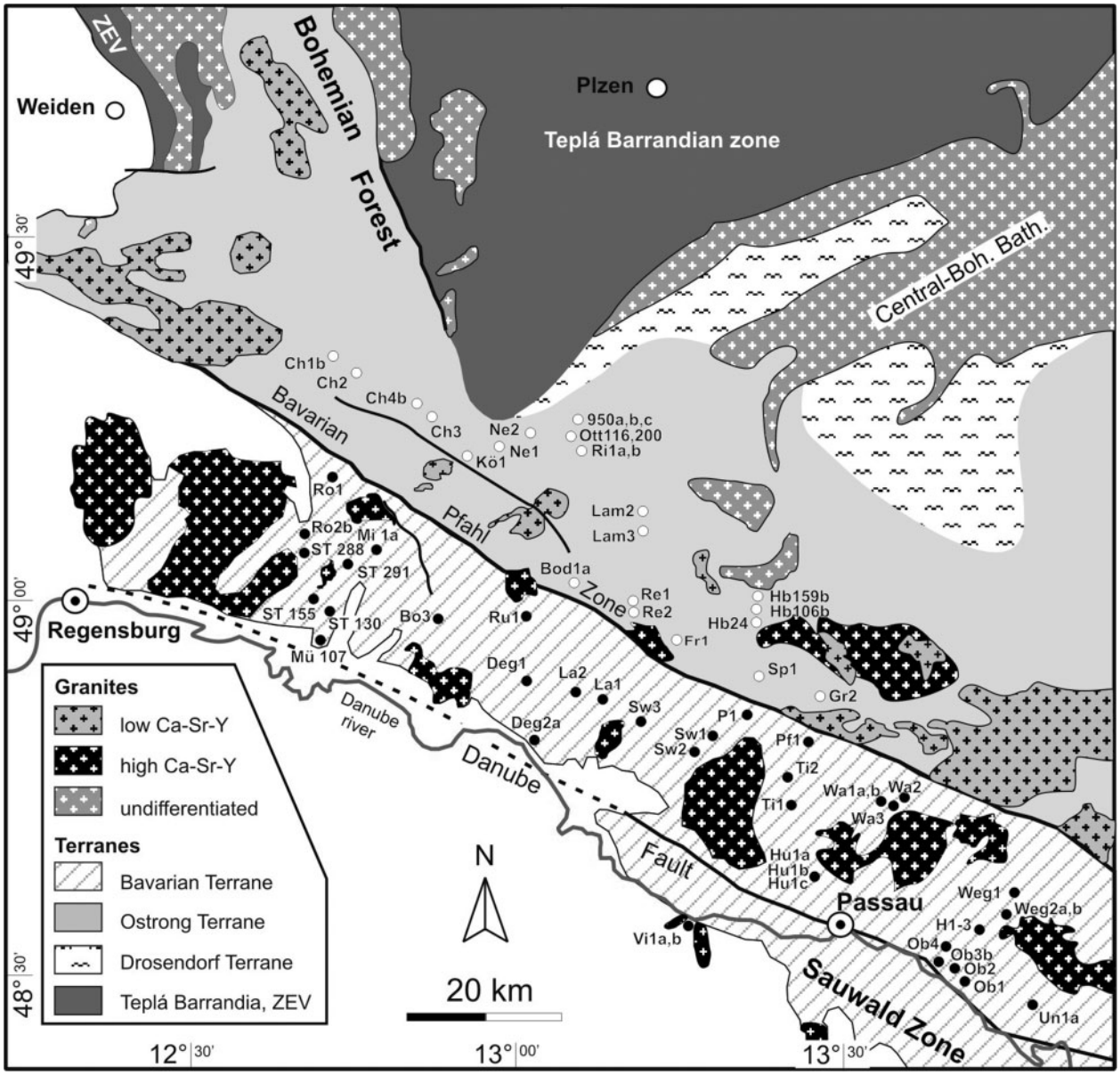


**Fig. 2.** Simplified geological map showing location of samples from the Bavarian basement plotted in Fig. 3. This figure was redrawn from Siebel *et al.* (2008) with adjusted assignments of some granites north of the Pfahl zone.

(2007) referred to the link between durbachites (north) and palites (south). If this would be true, it could be taken as an argument against our terrane model. However, we strongly reject this viewpoint for the following reasons.

(1) In their original work (Finger *et al.*, 2007, p. 14) this correlation was claimed as a theoretical model (i.e. not substantiated by analytical data). Concerning the Bavarian Forest, there is ample field evidence that all major basement lithologies north of the Pfahl zone (cordierite–sillimanite and cordierite–K-feldspar garnet-bearing gneisses, mica schists) are significantly different from lithologies south of the Pfahl zone (biotite–plagioclase gneisses, anatectic gneisses, variegated group rocks, meta-igneous lithologies, such as palites or orthoanatexites). For the two major basement lithologies on each side of the Pfahl zone, it turns out that most of the cordierite-bearing gneisses (north) are melt-depleted residue-rich rocks (low in sodium, high in aluminium, frequently garnet bearing) whereas the diatexites (south) generally have non-residual compositional characters. In short, a given rock assemblage has no genuine equivalent on the other side of the Pfahl zone and, as far as we know, no

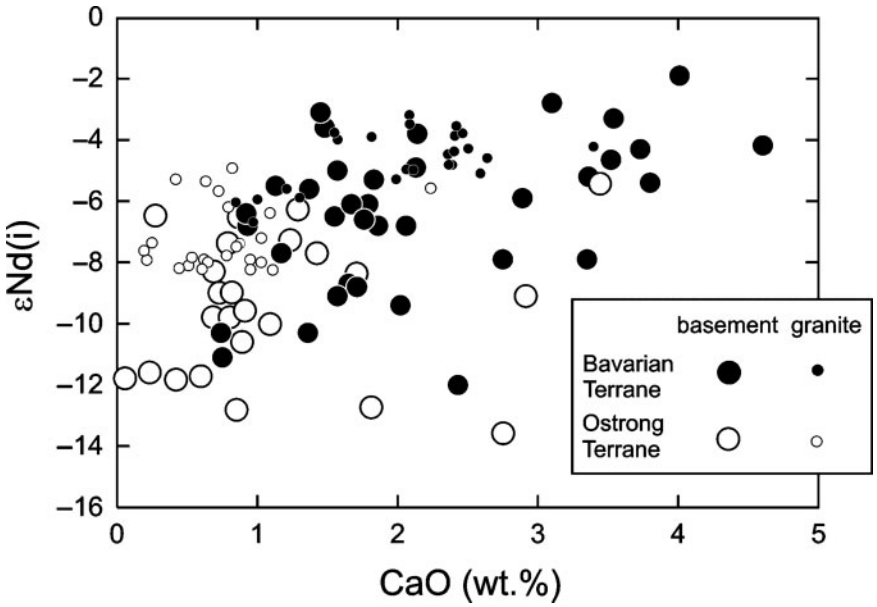


**Fig. 3.** Plot of CaO (wt %) vs initial $\varepsilon$Nd value (calculated for $t = 325$ Ma) for 64 whole-rock samples covering all major Bavarian basement lithologies (large symbols). Data for granites (Siebel *et al.*, 2008) are shown for comparison (small symbols).

firm correlation could be established so far between rocks from south and north of the Pfahl zone.

(2) Irrespective of these field observations, Finger *et al.* (2007) proposed the theory that palites (south) and durbachites (north) belong to the same igneous suite. From a geochemical comparison between the palites and the nearest durbachite intrusion, the Knížecí Stolec pluton (Verner *et al.*, 2008; K. Verner, personal communication), it becomes evident that the durbachites have a completely different whole-rock composition (Fig. 1). They are more potassic (6·2–7·5 wt % $K_2O$), have much higher $K_2O$/$Na_2O$ ratios (3·0–4·5) and significantly higher MgO concentrations (5–9 wt %) compared with the palites (for palite data, see Siebel *et al.*, 2005). According to their compositional features [as well as the new conceptual views presented by Propach *et al.* (2008)], it seems much more reasonable to assume that the palites have equivalents in the Bavarian terrane itself (i.e. the orthoanatexites of the Passauer Wald) but not in the region north of the Pfahl zone.

## NEW DATA ON BASEMENT COMPOSITION

Finger & René (2009) object to our conclusion that the Pfahl shear zone has juxtaposed two compositionally distinct Variscan basement units: 'we see no compelling evidence for linking this feature [i.e. the predominance of high-Ca granites south of the Pfahl zone] to a different compositional nature of the crust'. Here Finger & René raise the key issue and their comment provides us with an opportunity to address this item in the light of new data. We have already pointed out the differences in lithologies between the basements of the Bavarian terrane and the Ostrong terrane. More recently, we have performed further work on the different basement units to shed more light on their compositional characteristics. The expanding body of data comprises 85 whole-rock analyses (geochemistry) from which 64 samples were investigated for Sr and Nd isotope composition by the isotope dilution technique (Shang *et al.*, 2008). Figure 2 shows the distribution of the 64 samples considered for isotope analyses. We present this figure to demonstrate our region-wide sampling, which covers all of the major basement lithologies from both sides of the Pfahl shear zone in the Bavarian Forest. Concerning the question of whether or not a systematic geographical difference in basement composition exists, the answer turns out to be yes. As can be seen from Fig. 3, the differences discovered in the granites can also be observed in the basement domains. The basement of the Bavarian terrane, on average, has higher CaO concentration and more radiogenic Nd isotope composition (2·2 wt % CaO, $\varepsilon Nd_{(325\ Ma)} = -7{\cdot}2$, $n = 37$) compared with the basement of the Ostrong terrane (1·1 wt % CaO, $\varepsilon Nd_{(325\ Ma)} = -9{\cdot}9$, $n = 25$). This difference is the same as found in the granites (granite data are shown for comparison in Fig. 3), lending support to the idea that the granites have partly inherited the source characteristics from two distinct basement units.

## CLOSING STATEMENTS

Geochemical data on late Variscan granites from the SW Bohemian Massif reported by Finger & René (2009) are apparently inconsistent with our data from the Bavarian Forest. It has to be noted that the samples presented by Finger & René were selectively chosen and cannot be considered as a representative dataset. Besides, the authors include data SE of the Rodl zone (i.e. from outside our terrane allocations). Thus, we have to conclude that their data inhibit an objective evaluation of the terrane model.

Correlation efforts between lithologies north and south of the Pfahl shear zone, such as those between palites and durbachites (Finger *et al.*, 2007), are highly tentative and are not supported by geochemical data.

Supporting evidence for the terrane concept comes from the rocks of the two Bavarian basements units themselves, which, in the same way as the granites, show different lithological and compositional features. Taking these new observations into account, we reiterate our viewpoint that the Pfahl shear zone evidently is a major crustal divide.

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