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Total Rock and Mineral Ages of Granites from the Southern Schwarzwald, Germany

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ABSTRACT

Total rock samples and selected minerals (mainly muscovites) of granitic rocks of the Southern Schwarzwald have been dated by the Rb/Sr- and (only minerals) K/Ar-method. The total rock isochrons yielded ages of 284 m.y. for the Bärhalde granite, 315 m.y. for the Schluchsee granite and 276 m.y. for the porphyry cutting both granites. An isochron of the Malsburg granite yielded 310 ± 10 m.y., i.e. it is not significantly different from the age of the Schluchsee granite.

Concordant mineral Rb/Sr and K/Ar ages (324 m.y.) of the Schluchsee granite confirm the total rock isochron age, while the corresponding results for minerals from the Bärhalde granite are in agreement with the "Schluchsee-age" but are significantly higher than the total rock age estimate. These results indicate that the Bärhalde granite may not be treated as a closed system but is influenced by a later event, possibly the intrusion of the porphyry. The micas, however, seem to have preserved their age record.

Introduction

The Schwarzwald, one of the Hercynian orogenic complexes, has been the subject of much radiometric dating for some time.

MEHNERT (1958) published K/Ar ages of K-feldspars between 240 and 300 m.y. The great differences between the apparent ages of the different samples may be explained by possible loss of argon from the K-feldspar.

FAUL and JÄGER (1963) have dated samples from different Hercynian mountain ranges in Middle Europe and reported ages from 280 to 330 m.y. Four mica samples of the Schwarzwald yielded concordant K/Ar and Rb/Sr ages of 300–320 m.y., i.e. the mica ages proved to be considerably higher than K-feldspar ages mentioned by MEHNERT.

In our present study, by applying different dating methods and taking different samples and minerals, we intended to find out which seems to be the most realistic age for the intrusion of some granites located in the Southern Schwarzwald (Fig. 1).

Assuming that a sufficiently large rock sample represents a closed system, the Rb/Sr total rock isochron of a sufficient number of these samples should yield an age, which can be interpreted as the primary age of emplacement or the age of the last intensive metamorphism. With these assumptions, apparent ages of minerals should be concordant with the total rock age if no later geological event has influenced the rock. In all other cases the mineral ages should be expected to be lower.

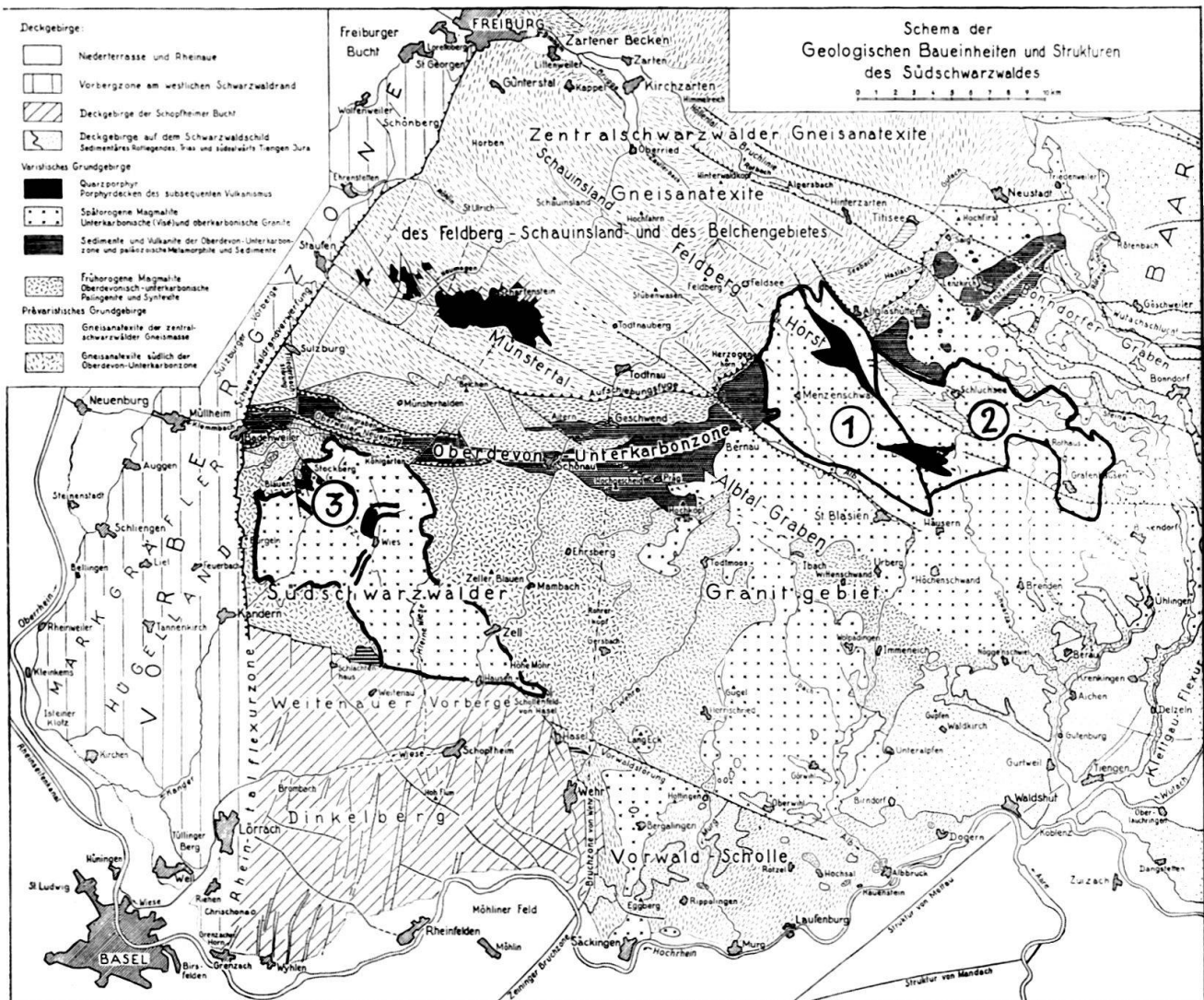


Fig. 1. Geological Sketch-map of the Southern Schwarzwald (after METZ and REIN 1958).

1 = Bärhalde granite 2 = Schluchsee granite 3 = Marlsburg granite

Results

2.1. Total rock analyses of the Bärhalde granite, Schluchsee granite and the porphyry.

In a prior work (BROOKS, WENDT and HARRE, 1968) Rb/Sr total rock analyses of the Bärhalde granite, the Schluchsee granite and the porphyry yielded isochrons with the following age estimates [λ (Rb) = $1,47 \cdot 10^{-11} \text{ a}^{-1}$]:

| | |
|--------------------|----------------------------|
| Porphyry | $274 \pm 7 \text{ m. y.}$ |
| Bärhalde granite | $284 \pm 6 \text{ m. y.}$ |
| Schluchsee granite | $315 \pm 10 \text{ m. y.}$ |

These results are in good agreement with geological field relationships. The Bärhalde granite is judged to be a little younger than the Schluchsee granite, because its contact zone influences the Schluchsee granite. The porphyry, which cuts both granites must be younger than these. Although the Rb/Sr isochron age estimates

do not contradict this observation, the difference in age between the Bärhalde (and porphyry) and Schluchsee granite appears to be too great. While the latter has an Upper Carboniferous age the Bärhalde granite would have to be placed almost near the Carboniferous/Permian boundary.

HAHN-WEINHEIMER (personal communication) obtained for the Bärhalde granite a total rock isochron with an age estimate of 266 ± 15 m. y. (calculated for $\lambda(\text{Rb}) = 1,47 \cdot 10^{-11} \text{ a}^{-1}$) and additional samples with extremely low Sr-concentrations from the western part of this granite yielded even lower "ages".

2.2. Rb/Sr total rock analyses on the Malsburg granite.

In order to get more information about other granites of the Southern Schwarzwald four total rock samples¹⁾ of the Malsburg granite (Fig. 1) have been analysed (Table 1). The age estimate, derived from the total rock isochron (Fig. 2) was 310 ± 7 m. y. ($^{87}\text{Sr}/^{86}\text{Sr}$ initial: $0,7131 \pm 0,0012$). An additional sample of the porphyry, which cuts the Malsburg granite does not fit this isochron.

Tab.1. Rb/Sr analytical data of total rock samples from the Malsburg granite.

| Sample | ^{87}Rb ppm | Sr ppm | $^{87}\text{Rb}/^{86}\text{Sr}$ | $^{87}\text{Sr}/^{86}\text{Sr}$ | Isochron age estimate [my] |
|------------------|-------------------------|-----------------|---------------------------------|---------------------------------|-------------------------------|
| G _M 2 | $62,0 \pm 0,6$ | $217,0 \pm 2,0$ | $2,92 \pm 0,04$ | $0,727 \pm 0,001$ | 310 ± 7 |
| G _M 3 | $103,5 \pm 1,0$ | $30,1 \pm 0,33$ | $35,2 \pm 0,5$ | $0,873 \pm 0,002$ | |
| G _M 4 | $62,0 \pm 0,6$ | $104,6 \pm 1,0$ | $6,06 \pm 0,08$ | $0,741 \pm 0,002$ | |
| G _M 5 | $54,9 \pm 0,5$ | $326,7 \pm 3,6$ | $1,71 \pm 0,02$ | $0,719 \pm 0,003$ | |
| G _M 6 | $39,1 \pm 0,4$ | $76,8 \pm 1,0$ | $5,20 \pm 0,08$ | $0,720 \pm 0,003$ | |

The Malsburg granite, contrary to the above mentioned "youngest granites" is called a "young granite" by METZ et al. (1957 and 1958) and is placed into the Lower Carboniferous. According to our measurements its total rock age cannot be distinguished from the Schluchsee granite. However, it must be mentioned that the slope of the Malsburg isochron is determined mainly by sample GM 3 which is an aplite from a small dike, and aplites sometimes may lose strontium due to possible exchange with the country rock (JÄGER, 1970; SCHOELL, 1970; this volume). Furthermore, as will be pointed out later on, a Rb/Sr total rock isochron age estimate may be too low in respect to the mica apparent ages. For these two possibilities the age obtained could be too low.

2.3. K/Ar and Rb/Sr mica ages of the Bärhalde and Schluchsee granite.

In order to confirm the obtained age differences between Schluchsee- and Bärhalde granite, micas have been separated from the samples which already have been analysed by Rb/Sr as total rock (Tables 2 and 3). A comparison of the discussed age estimates is given in Table 4.

¹⁾ For mineralogical description of the samples one is referred to the publication of REIN (1961). The localities of our samples correspond to REIN's in the following way: GM2 = REIN Nr. 19/72, GM3 = REIN Nr. 19/72, GM4 = REIN Nr. 18, GM5 = REIN Nr. 61 and GM6 = REIN Nr. 61 (porphyry dyke).

Tab. 2. K/Ar analytical data of micas from the Bärhalde- and Schluchsee granite, Southern Schwarzwald.

| Sample | Complex | Sieving fraction | Kalium wt. % | rad. ^{40}Ar $10^{-7} \text{ cm}^3 \text{ STP/g}$ | $^{40}\text{Ar}/^{40}\text{K}$ ‰ | apparent age m. y. |
|--------|--------------------|----------------------------|-----------------|--|----------------------------------|--------------------|
| SW 2 | Bärhalde-granite | Muscovite 400–315 μ | 8,28 \pm 0,05 | 1183 \pm 12 | 20,9 | 327 \pm 5 |
| SW 4 | Bärhalde-granite | Muscovite 315–200 μ | 7,96 \pm 0,04 | 1128 \pm 11 | 20,8 | 325 \pm 5 |
| SW 5 | Bärhalde-granite | Muscovite 400–315 μ | 8,27 \pm 0,06 | 1164 \pm 11 | 20,6 | 323 \pm 5 |
| SW 10 | Schluchsee-granite | Biotite 315–200 μ | 6,45 \pm 0,05 | 905 \pm 9 | 20,5 | 323 \pm 5 |
| SW 12 | Schluchsee-granite | Biotite 400–200 μ | 6,51 \pm 0,05 | 929 \pm 9 | 20,9 | 327 \pm 5 |

Tab. 3. Rb/Sr analytical data of micas from the Bärhalde granite (B. G.) and Schluchsee granite (S. G.).

| Sample Mineral (Granite) | ^{87}Rb ppm | Sr (com.) ppm | ^{87}Sr (rad.) ppm | $^{87}\text{Rb}/^{86}\text{Sr}$ | $^{87}\text{Sr}/^{86}\text{Sr}$ calc. | apparent age m. y. |
|----------------------------------|----------------------|------------------|-----------------------------|---------------------------------|---------------------------------------|--------------------|
| SW 2 Musc. (B. G.) | 505 \pm 9 | 2,41 \pm 0,03 | 2,402 \pm 0,009 | 2139 \pm 43 | 10,90 \pm 0,10 | 324 \pm 7 |
| SW 2 Biot. ¹⁾ (B. G.) | 402 \pm 5 | 8,24 \pm 0,01 | 1,860 \pm 0,006 | 498 \pm 7 | 3,01 \pm 0,01 | (315 \pm 4) |
| SW 3a Musc. (B. G.) | 661 \pm 12 | 2,00 \pm 0,02 | 3,119 \pm 0,008 | 3374 \pm 69 | 16,67 \pm 0,17 | 322 \pm 6 |
| SW 4 Musc. (B. G.) | 523 \pm 7 | 4,18 \pm 0,04 | 2,464 \pm 0,010 | 1276 \pm 18 | 6,45 \pm 0,05 | 320 \pm 4 |
| SW 5 Musc. (B. G.) | 627 \pm 8 | 1,06 \pm 0,01 | 2,962 \pm 0,006 | 5989 \pm 110 | 28,88 \pm 0,39 | 321 \pm 4 |
| SW 10 Biot. (S. G.) | 250 \pm 4 | 11,00 \pm 0,08 | 1,197 \pm 0,006 | 232 \pm 4 | 1,820 \pm 0,009 | 326 \pm 5 |
| SW 12 Biot. (S. G.) | 239 \pm 2 | 3,18 \pm 0,04 | 1,137 \pm 0,005 | 766 \pm 12 | 4,38 \pm 0,05 | 324 \pm 4 |

¹⁾ Biotite with $\sim 10\%$ Chlorite

The K/Ar and Rb/Sr apparent ages of the micas are for both granites concordant within limits of error and range from 320–327 m. y. For the Schluchsee granite the mica apparent ages and the Rb/Sr total rock isochron age estimate are not significantly different within limits of error. Contrary to this result, the mica ages of the Bärhalde granite are equal to the mica ages of the Schluchsee granite, and distinctly higher than the age estimate derived from the Rb/Sr total rock isochron.

The interpretation of this obviously low total rock age remains difficult. If we assume that the most common isotopic redistribution in granitic rocks is the loss of radiogenic strontium out of K-feldspars and gain in plagioclase (BROOKS, 1968) we have to assume that in case of the Bärhalde granite this process cannot be treated as a

Tab. 4. Comparison of mineral ages and total rock ages.

| Sample | Mineral | Granite | Mineral age | | Total rock age m.y. |
|--------|---------|------------|---------------------------|--------------|------------------------|
| | | | Rb/Sr m.y. | K/Ar m.y. | |
| SW 2 | Musc. | Bärhalde | 324 ± 7 | 327 ± 5 | 284 ± 6 |
| SW 2 | Biot. | Bärhalde | (315 ± 4) | — | |
| SW 3a | Musc. | Bärhalde | 322 ± 6 | — | |
| SW 4 | Musc. | Bärhalde | 320 ± 4 | 325 ± 5 | |
| SW 5 | Musc. | Bärhalde | 321 ± 4 | 323 ± 5 | |
| | | | Av. 322 ± 2 ¹⁾ | 325 ± 3 | 315 ± 10 |
| SW 10 | Biot. | Schluchsee | 326 ± 5 | 323 ± 5 | |
| SW 12 | Biot. | Schluchsee | 324 ± 4 | 327 ± 5 | |

¹⁾ Biotite with ~ 10% chlorite (not used for average value)

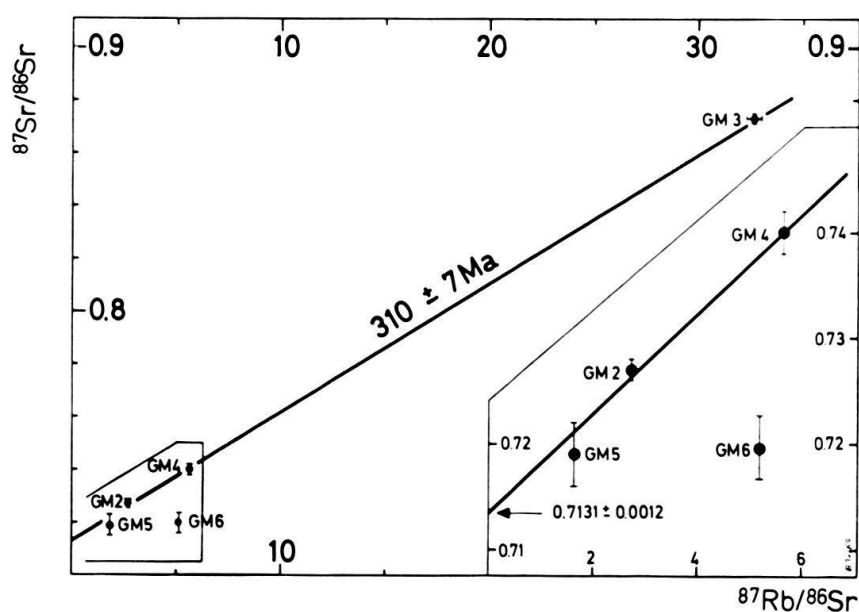


Fig. 2. Rb/Sr Total rock-Isochrone plot of Marlsburg granite Samples.

closed system, contrary to the micas which obviously retained rubidium and strontium. This hypothesis has to be checked by additional analyses on the feldspar phases of the Bärhalde granite.

Nevertheless, the fact remains that only for the Bärhalde granite and not for the Schluchsee granite any isotopic redistribution should have occurred, though there is no geological or petrological indication for any principal differences between the two granites. Thin-section examination yielded the same mineral composition, type and amount of secondary alteration of feldspars and biotites for both granites.

According to the results obtained, the Bärhalde- and the Schluchsee granite are of the same age, i.e. about 320 m.y. Also the Malsburg granite as well as the Hybrid-complex of Mambach and the Triberg granite dated by FAUL and JÄGER (1963) belong to the same age class. This is contrary to the opinion of METZ et al. (1957 and 1958), who placed the Malsburg granite as well as the Mambach granite into the Lower Carboniferous.

Conclusions

1) No radiometric ages obtained have proved the existence of granites in the Schwarzwald which definitely belong to the Lower Carboniferous.

2) The attempt to determine the age of the Bärhalde granite has shown that even the existence of a Rb/Sr total rock isochron does not necessarily prove that the rock can be regarded as a closed system.

In the case of the Bärhalde granite the micas yielded a higher age which obviously seems to be the correct one.

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