

Isotopic age determinations in Bergslagen, Sweden: VI. acid metavolcanics of the Bergslagen Supracrustal Series, Grythyttan-Hjulsjö area

I.S. Oen¹ & R.H. Verschure²

¹*Geologisch Instituut Universiteit van Amsterdam, Nieuwe Prinsengracht 130, 1018 VZ Amsterdam, The Netherlands;* ²*ZWO-Laboratorium voor Isotopen-Geologie, De Boelelaan 1085, 1081 HV Amsterdam, The Netherlands*

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Abstract

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Metavolcanic rocks of the Bergslagen Supracrustal Series in the Grythyttan-Hjulsjö area, central Sweden, are 1.9-1.8 Ga old according to published zircon U-Pb data. Rhyolitic rocks from Gillershöjden-Kullberget and Norr-Älgen and metatuffites from Salbosjön and Kranktorp give Rb-Sr whole-rock ages of 1.6 ± 0.1 Ga and 1.8 ± 0.1 Ga, respectively. The rhyolitic rocks show reset Rb-Sr whole-rock ages due to a thermal event related to the intrusion of 1.7-1.6 Ga old granites, whereas the Rb-Sr whole-rock ages of the metatuffites still approximate the age of emplacement and earliest metamorphism of the supracrustals.

Introduction

The Bergslagen Supracrustal Series in the Grythyttan-Hjulsjö area, West-Bergslagen, Sweden, includes a thick sequence of leptites and hälleflintas (i.e. fine-grained and extremely finegrained, mostly acid metavolcanic rocks), divided into a lower, a middle, and an upper group (Oen & Verschure 1982). The youngest volcanic formation in the upper group is the Upper Leptite-hälleflinta Formation of rhyolitic and ignimbritic rocks, agglomerates, and tuffs, occurring along the eastern boundary of the Grythyttan sedimentary basin (Fig. 1; Sundius 1923). The metamorphic grade is low greenschist facies. The Upper Leptite-hälleflinta Formation overlies leptite formations of the middle and lower groups, which in the Hjulsjö area consist predominantly of recrystallized acid pyroclastic tuffs (Van der Velden et al. 1982). To the E

of Hjulsjö the rocks are locally affected by higher grade metamorphism related to granite intrusions.

The Svecokarelian Supracrustals of the Baltic Shield are generally attributed an age of 2.2-1.9 Ga, because they are intruded by about 1.9 Ga old 'synorogenic' Older Granites (Welin 1970). However, Oen et al. (1982) have argued that the supracrustal acid metavolcanics and Older Granites in West Bergslagen form comagmatic units of volcano-plutonic complexes that were emplaced 1.9-1.8 Ga ago. Published zircon U-Pb ages of metavolcanic rocks and Older Granites of the Bergslagen Supracrustal Series show this 1.9-1.8 Ga age range (Welin et al. 1980; Åberg et al. 1983a,b).

This paper gives the results of a Rb-Sr whole-rock investigation of rhyolitic rocks of the Upper Leptite-hälleflinta Formation at Gillershöjden,

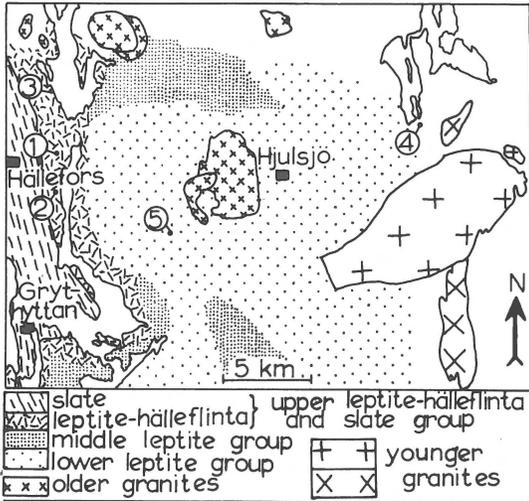


Fig. 1. Geological sketch map of the Grythyttan-Hjulsjö area. Sampling localities: (1) Gillershöjden, (2) Kullberget, (3) Norr-Älgen, (4) Salbosjön, and (5) Kranktorp.

Kullberget, and Norr-Älgen, and of metatuffites of the lower group of leptites at Salbosjön and Kranktorp. The data of the Gillershöjden and Kullberget samples were also presented at ECOG IV (Priem et al. 1976). The sample localities are shown in Fig. 1.

Petrography

The Gillershöjden, Kullberget, and Norr-Älgen quartzporphyritic potassium rhyolites have the flinty appearance of typical hälleflintas. The rocks show a very fine-grained quartzofeldspathic groundmass with accessory green biotite, chlorite, sericite, stilpnomelane, sphene, epidote, carbonate, and zircon. Small phenocrysts of quartz and K-feldspar and spherulitic, amygdaloidal, and flow structures are common. The Kullberget rocks often show somewhat darker fragments in a lighter matrix.

The Salbosjön and Kranktorp acid metatuffites show a recrystallized, fine-grained groundmass of albite, K-feldspar, quartz, and accessory biotite, chlorite, sericite, sphene, epidote, carbonate, apatite, and zircon. The groundmass encloses mm-size lithic fragments, crystals, and crystal fragments of quartz, albite, and K-feldspar. The quartz and

feldspars often show annealing recrystallization in fine granular aggregates.

Experimental procedures and constants

The procedures and accuracies involved in the X-ray fluorescence determination of Rb, Sr, and Rb/Sr and in the mass-spectrometric measurement of $^{87}\text{Sr}/^{86}\text{Sr}$ are given in a previous paper (Oen 1982), in which the methods used for the calculation of the best-fit line through data sets and the Mean Squares Weighted Deviation (MSWD) are also indicated. The ^{87}Rb decay constant used for the age calculations is $1.42 \times 10^{-11} \text{ a}^{-1}$.

Results and discussion

The Rb-Sr whole-rock data of the metavolcanics and the results of age computations are given in Tables 1 and 2 and Fig. 2. The Gillershöjden and Kullberget data show very poor linear correlations. The best-fit line through all data-points of these two localities correspond to an age of $1574 \pm 71 \text{ Ma}$ (Fig. 2), but the MSWD value is extremely high (22). The result for the Salbosjön metatuffite is much improved by omitting sample 80 Br1 419; the remaining 6 samples give a best-fit line (MSWD = 0.5) corresponding to an age of $1794 \pm 33 \text{ Ma}$ (Fig. 2). The Rb-Sr whole-rock ages of the Gillershöjden-Kullberget and Norr-Älgen rhyolitic rocks of the Upper Leptite-hällefrinta Formation appear to fall in the range $1.6 \pm 0.1 \text{ Ga}$ (initial $^{87}\text{Sr}/^{86}\text{Sr} = 0.710 \pm 0.003$), whereas those of the Salbosjön and Kranktorp metatuffites of the lower group of leptites are in the range $1.8 \pm 0.1 \text{ Ga}$ (initial $^{87}\text{Sr}/^{86}\text{Sr} = 0.705 \pm 0.003$).

Welin et al. (1980) have obtained a Rb-Sr whole-rock age of 1726 MA (initial $^{87}\text{Sr}/^{86}\text{Sr} = 0.706$) from one Gillershöjden and one Kullberget sample and an U-Pb age of $1862^{+37}_{-27} \text{ Ma}$ for zircons from the Gillershöjden rhyolite. The zircon age of 1862 Ma is consistent with the age of 1.9-1.8 Ga assigned to the Bergslagen Supracrustal Series by Oen et al. (1982) and Moorman et al. (1982) on available geochronological and geological

Table 1. Rb-Sr whole-rock data of metavolcanics of the Grythyttan-Hjulsjö area, Bergslagen, Sweden.

| Samp- le | nr | Rb (ppm Wt) | Sr (ppm Wt) | Rb/Sr (Wt/Wt) | ⁸⁷ Sr/ ⁸⁶ Sr | ⁸⁷ Rb/ ⁸⁶ Sr |
|--------------------------------|-----|----------------|----------------|------------------|------------------------------------|------------------------------------|
| Rhyolitic rock, Gillershöjden: | | | | | | |
| 75 Brl | 35 | 117 | 13.0 | 8.965 | 1.2995 | 27.44 |
| | 36 | 133 | 12.1 | 11.04 | 1.5193 | 34.70 |
| | 37 | 133 | 11.9 | 11.14 | 1.4491 | 34.82 |
| | 38 | 140 | 10.8 | 12.93 | 1.6448 | 40.88 |
| Rhyolitic rock, Kullberget: | | | | | | |
| 75 Brl | 25 | 19.3 | 84.7 | 0.2273 | 0.72555 | 0.6595 |
| | 28 | 6.41 | 82.2 | 0.0781 | 0.71629 | 0.2224 |
| | 30 | 20.4 | 108.0 | 0.1887 | 0.72440 | 0.5474 |
| | 31 | 55.1 | 51.9 | 1.062 | 0.78755 | 3.100 |
| | 32 | 60.8 | 51.3 | 1.184 | 0.79291 | 3.458 |
| | 33 | 89.8 | 57.5 | 1.564 | 0.80880 | 4.575 |
| | 34 | 1.14 | 86.0 | 0.0133 | 0.71067 | 0.0384 |
| Rhyolitic rock, Norr-Älgen: | | | | | | |
| 79 Brl | 404 | 105.5 | 53.7 | 1.970 | 0.84364 | 5.777 |
| | 405 | 88.7 | 42.7 | 2.077 | 0.85493 | 6.096 |
| | 406 | 119.5 | 62.0 | 1.928 | 0.84507 | 5.653 |
| | 407 | 71.9 | 69.6 | 1.033 | 0.78060 | 3.010 |
| | 408 | 39.6 | 110.0 | 0.3599 | 0.73337 | 1.044 |
| | 409 | 52.7 | 151.5 | 0.3483 | 0.73190 | 1.010 |
| | 410 | 115.5 | 55.4 | 2.087 | 0.85450 | 6.125 |
| | 411 | 130.0 | 35.4 | 3.669 | 0.96312 | 10.882 |
| Metatuffite, Salbosjön: | | | | | | |
| 78 Brl | 322 | 142.5 | 65.9 | 2.168 | 0.87199 | 6.374 |
| | 323 | 143.5 | 58.2 | 2.313 | 0.88115 | 6.806 |
| | 324 | 83.9 | 64.1 | 1.309 | 0.80457 | 3.823 |
| | 325 | 67.7 | 73.4 | 0.9232 | 0.77551 | 2.689 |
| 80 Brl | 416 | 120.9 | 37.2 | 3.254 | 0.95565 | 9.644 |
| | 418 | 84.7 | 36.1 | 2.344 | 0.88237 | 6.898 |
| | 419 | 137.1 | 89.9 | 1.526 | 0.81323 | 4.461 |
| Metatuffite, Kranktorp: | | | | | | |
| 79 Brl | 338 | 20.8 | 28.0 | 0.7426 | 0.76058 | 2.160 |
| | 340 | 18.9 | 32.9 | 0.5758 | 0.75009 | 1.673 |
| | 341 | 23.1 | 25.1 | 0.9217 | 0.77544 | 2.684 |
| | 342 | 8.6 | 29.3 | 0.2923 | 0.72810 | 0.8473 |
| | 345 | 52.5 | 30.0 | 1.747 | 0.83444 | 5.117 |
| | 347 | 17.8 | 30.6 | 0.5802 | 0.74899 | 1.685 |
| | 348 | 4.8 | 30.0 | 0.1612 | 0.71650 | 0.4668 |

evidence. The 1.6 ± 0.1 Ga Rb-Sr whole-rock age of Gillershöjden-Kullberget and Norr-Älgen rhyolites is interpreted as the result of a resetting of the Rb-Sr isotopic system due to a thermal event related to the intrusion of 1.7-1.6 Ga old granites (Grängen granite, Filipstad and other Småland-

Värmland Group granites; Welin et al 1977, Oen 1982, 1983). This conclusion agrees with that of Moorman et al. (1982), who found that the skarn rocks, metabasites, and acid volcanics in the area have K-Ar hornblende ages of 1.83 ± 0.05 Ga and K-Ar and Rb-Sr biotite ages of 1.69 ± 0.05 and 1.65 ± 0.04 Ga, respectively. Oen et al. (1982) argued that the metavolcanics and associated rocks of the Bergslagen Supracrustal Series were affected by syndepositional sub-seafloor metamorphism, so that the ages of emplacement and earliest metamorphism of the volcanics are essentially similar.

The 1.8 ± 0.1 Ga Rb-Sr whole-rock age of the Salbosjön and Kranktorp metatuffites approximates the presumed 1.9-1.8 Ga age of the Bergslagen Supracrustal Series. Possibly these strongly recrystallized, coarser grained metatuffites were less susceptible to resetting events than the fine-grained, flinty rhyolitic rocks. Despite the regional aspect of the 1.6 ± 0.1 Ga Rb-Sr isotopic resetting event restricted domains can be found where the Rb-Sr whole-rock age of certain metavolcanics still approximates the time of emplacement and earliest metamorphism. A similar conclusion was drawn in a study of the Horrsjö granite, which is comagmatic with the acid volcanics of the Bergslagen Supracrustal Series (Oen et al. 1984): suites of samples from two locations have Rb-Sr systematics corresponding to ages of 1.86 ± 0.12 Ga and 1.84 ± 0.44 Ga, respectively, in accordance with the zircon U-Pb age of 1850^{+8}_{-7} Ma reported by Åberg et al. (1983a, b), whereas at three other locations reset ages of 1.77, 1.71, and 1.27 ± 0.45 Ga, respectively, were obtained.

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Table 2. Results of age computations.

| | Locality | Number of samples | Age in Ma (best-fit line) | Initial $^{87}\text{Sr}/^{86}\text{Sr}$ | MSWD |
|-----|---------------------|-------------------|---------------------------|---|------|
| (2) | Kullberget | 7 | 1627 ± 140 | 0.71068 ± 0.00251 | 21 |
| (1) | Gillershöjden & (2) | 11 | 1574 ± 71 | 0.71119 ± 0.00204 | 22 |
| (3) | Norr-Älgen | 8 | 1664 ± 26 | 0.70818 ± 0.00106 | 1.2 |
| (4) | Salbosjön | 7 | 1797 ± 130 | 0.70462 ± 0.00881 | 7.4 |
| (4) | minus sample 419 | 6 | 1794 ± 33 | 0.70607 ± 0.00235 | 0.5 |
| (5) | Kranktorp | 7 | 1796 ± 88 | 0.70543 ± 0.00203 | 4.7 |

Errors are given at 95% confidence level as computed from the scatter about the regression line.

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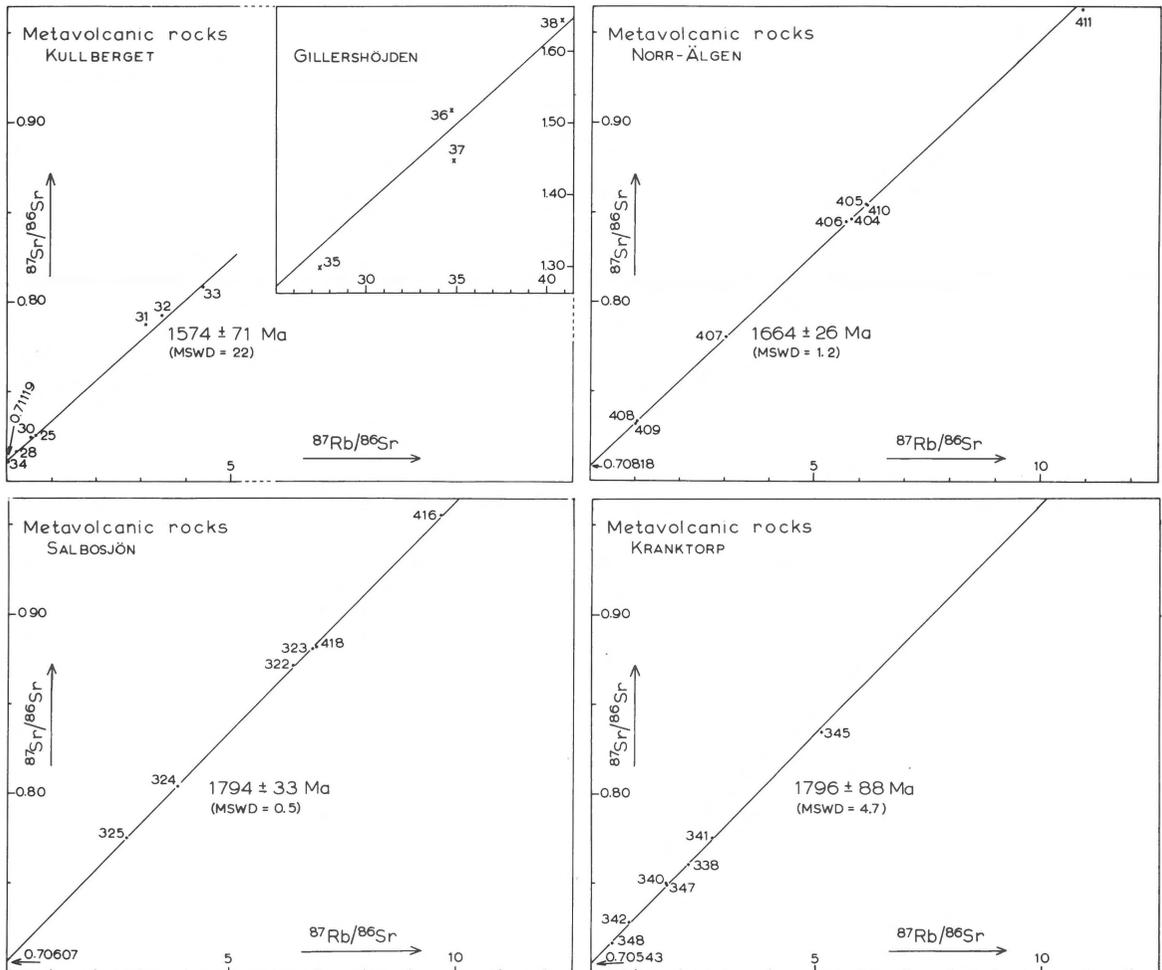


Fig. 2. Plots of whole-rock Rb-Sr data of the Gillershöjden-Kullberget and Norr-Älgen rhyolitic rocks and the Salbosjön and Kranktorp metatuffites.

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