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INVESTIGATIONS IN THE VÄSTERVIK AREA, SOUTHEASTERN SWEDEN,

2. Isotopic age determinations

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ABSTRACT

Whole-rocks of three granites and a gneiss from the Västervik area, south-eastern Sweden, have a Rb-Sr age of 1750 ± 50 million years: (late) Svecofennian. Age measurements on three separated biotites disclose the imprints of younger, probably Gothian events, but a discordance exists between the K-Ar and Rb-Sr ages: 1465 ± 30 and 1380 ± 50 million years, respectively. A pegmatite yielded a Rb-Sr whole-rock age of 1425 ± 50 million years.

The present communication reports the results of Rb-Sr and K-Ar age measurements in the Västervik area, south-eastern Sweden. The datings were made in connection with investigations in that area by the Department of Mineralogy and Petrology of the Free University, Amsterdam. A report of these investigations is given in the foregoing paper by W e s t r a et al. (1969).

The Västervik area belongs to the Svecofennian orogen. As is discussed in the paper by Westra et al. the area is made of a wedge of metasediments compressed between broadly folded massifs of gneissose granites (the so-called Småland and Loftahammar granites). The granites, together with sediments in which they have intruded, were tectonized and metamorphosed during the successive deformation phases. Metamorphism was of a low-pressure type. A more elaborate discussion of the geology of the Västervik area and a review of previous investigations is given in the paper by W e s t r a et al.

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Age determinations were made on five whole-rock samples and three biotite concentrates. In table I the sampling sites of the measured rocks are listed. The whole-rocks were dated by the Rb-Sr method, the biotites by the Rb-Sr and K-Ar methods. Rubidium and strontium measurements were made by isotope dilution. A mass-spectrometer was used with thermal ionization and multiplier detection. The whole-rocks were also analysed by X-ray fluorescence spectrometry. Argon was determined by isotope dilution on a Reynolds-type glass mass-spectrometer. Potassium was measured by flame-photometry using a lithium internal standard. The results are recorded in tables 2 and 3.

Within the limits of error the Rb-Sr whole-rock ages of the granites and gneiss are identical, about 1670 ± 50 million years: (late) Svecofennian. For the granites it may thus be concluded that their emplace-

TABLE 1
Locations of the samples dated

Sample No.	Rock	Sampling site
66 Väst 1	Microcline pegmatite	Island Lillaräto, about 11.5 km NNW of Västervik.
66 Väst 2	Gneissose biotite granite	Idem.
66 Väst 4	Sillimanite-muscovite gneiss	Island Vinökalv, about 12.5 km NNW of Västervik
66 Väst 5	Gneissose granite ("Småland granite")	Near Trumphult, 100 m E of the radio-mast, about 3.5 km SSE of Västervik.
66 Väst 6	Gneissose porphyric granite ("Loftahammer granite")	On the road 1 km E of Algenäs, about 18.5 km NNE of Västervik.

TABLE 2

Analytical data and computed Rb-Sr ages

Sample No.	Material	Rb ppm Wt.	Sr ppm Wt.	$^{87}Sr/^{86}Sr$ a)	rad. ^{87}Sr ppm Wt. b)	Age c) million years
66 Väst 1	whole-rock	318	30.7	1.3793	1.907	1427± 40
		312++	31.1++	1.3905+		
66 Väst 2	whole-rock	223	194	0.7877	1.564	1665± 80
		212++	191++	0.7883+		
	biotite	1199	13.8	11.351	6.97	1383± 50
		1201	13.8	11.010		
66 Väst 4	whole-rock	78.5	21.4	0.9734	0.544	1644± 40
		78.5++	21.3++	0.9720+		
	biotite	592	7.06	10.486	3.440	1386± 60
		588	7.09	10.421		
66 Väst 5	whole-rock	385	55.8	1.2423	2.786	1716± 50
		366++	52.3++			
66 Väst 6	whole-rock	267	56.0	1.0559	1.859	1651± 50
		259++	56.0++			
	biotite	1399	10.5	35.668	8.07	1371± 60

a) All $^{87}Sr/^{86}Sr$ ratios normalized to a $^{88}Sr/^{86}Sr$ ratio of 8.3752.

b) Calculated with an initial $^{87}Sr/^{86}Sr$ ratio of 0.705 for the whole-rock samples.
For the biotites, the initial ratios were computed as 0.719, 0.749 and 0.765, successively, using a graphical analysis according to Compston & Jeffery (1959).

c) Calculated with ^{87}Rb decay constant: $\lambda = 1.47 \times 10^{-11} yr^{-1}$.

\+ Direct measurement on unspiked sample.

++ Measurement by X-ray fluorescence spectrometry. These data were not used for the age calculations.

TABLE 3

Analytical data and computed K-Ar ages of biotites

Sample No.	K %Wt.	rad. ^{40}Ar ppm Wt.	Atmospheric ^{40}Ar (% total ^{40}Ar)	Age a) million years
66 Väst 2	7.94	1.248	19.6	1480 ± 30
	7.97	1.272	15.0	
66 Väst 4	7.57	1.191	17.1	1460 ± 30
	7.64	1.182	16.5	
66 Väst 6	7.64	1.178	16.5	1450 ± 30
	7.70	1.181	16.1	

a) Calculated with ^{40}K constants: $\lambda_e = 5.85 \times 10^{-11} yr^{-1}$,
$\lambda_\beta = 4.72 \times 10^{-10} yr^{-1}$, and
$^{40}K = 0.0118$ at. % total K.

ment took place in connection with Svecofennian orogenesis. Regarding the sillimanite-muscovite gneiss, however, the meaning of this age is less obvious. According to Westra et al., this gneiss is a paragneiss, derived from shallow-water sediments deposited before intrusion of the granites took place. If these sediments remained closed systems with regard to rubidium and strontium during the granite intrusions and subsequent folding movements, then this age may indicate that the sediments were derived from a not much older hinterland and were deposited shortly before the Svecofennian granite emplacements.

From the biotite ages it is evident that a younger event has affected the rocks in the Västervik area. There is, however, a systematic difference between the Rb-Sr age of the biotites (1380 ± 50 million years) and their K-Ar age (1465 ± 30 million years). With the decay constant of $1.39 \times 10^{-11}\,yr^{-1}$ for ^{87}Rb instead of the value of $1.47 \times 10^{-11}\,yr^{-1}$ used in our calculations the Rb-Sr age would equal the K-Ar age, but, as the physically determined constant of $1.47 \times 10^{-11}\,yr^{-1}$ is nowadays generally preferred and usually gives ages concordant with K-Ar ages, we think it should not be realistic to use the lower decay constant. In our opinion, therefore, this discordance between Rb-Sr and K-Ar ages of the biotites in the Västervik area is real. Possibly, this phenomenon might be interpreted as reflecting (episodic) loss of radiogenic strontium by processes of base exchange (cf. Kulp & Engels, 1963), due to hydrothermal activities long after the main metamorphic (thermal) event recorded in the K-Ar age of 1465 ± 50 million years. This metamorphic event may be ascribed to the Gothian episode.

The whole-rock Rb-Sr age of 1425 ± 50 million years determined for the microcline pegmatite lies between the Rb-Sr and K-Ar ages of the biotites. The significance of this age is, as yet, not clear. Possibly, we are dealing with a pegmatite formed in connection with Gothian events.

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REFERENCES

Compston, W., and Jeffery, P.M. (1959) – Anomalous "common strontium" in granite. Nature 184, p. 1792-1793.

Kulp, J.L., and Engels, J. (1963) – Discordances in K-Ar and Rb-Sr isotopic ages. In: Radioactive Dating, Proceedings of the 1962 Athens symposium sponsored by the International Atomic Energy, p. 219-238.

Westra, L., Elbers, F.J., and Sijperda, W.S. (1969) – Investigations in the Västervik area, southeastern Sweden, 1. Structural geology and genesis of the "younger" granites. Geol. & Mijnb. *48*, p. 529