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Two Standard Minerals, Biotite and Muscovite, for Rb-Sr and K-Ar Age Determinations, Sample Bern 4B and Bern 4M from a Gneiss from Brione, Valle Verzasca (Switzerland)

By *E. Jäger*, *E. Niggli*, and *H. Baethge* (Bern)[1])

With 1 figure in the text

Abstract

Two standard micas for age determinations were prepared: a biotite for the Rb-Sr age determination and a muscovite for the K-Ar method, both from the same rock. A short introduction to the geology and petrology of the rock is given. The amount of impurities and their distribution in the different samples were checked under the microscope. Rb and Sr of the standard biotite were made by four different laboratories with age results from 14.8 to 18.1 m. y. One K-Ar determination on muscovite from the same rock but not from the standard concentrate gives 19 m.y.

Zusammenfassung

Aus einer Tonne Gestein — Zweiglimmergneis von Brione / Valle Verzasca — wurden 2,4 kg Biotit und 4,5 kg Muskowit möglichst rein separiert. Der Biotit wurde in 183 Proben zu je 13 g, der Muskowit in 154 Proben zu je 30 g aufgeteilt. Da die beiden Glimmer als Standard verwendet werden sollen, Biotit für die Rb-Sr-Alters-Bestimmung und Muskowit für die K-Ar-Bestimmung, wurde auf eine möglichst homogene Aufteilung der Glimmerkonzentrate geachtet.

Neben einer kurzen Einführung in die Geologie wird eine knappe petrographische Beschreibung des Gesteins gegeben. Es wurden die optischen Eigenschaften der beiden Glimmer untersucht. Untersuchungen an Streupräparaten zeigten, dass die Konzentration von Fremdmineralien von Flasche zu Flasche nur um maximal einen Faktor zwei variieren kann. Die Rb- und Sr-Analysen von vier verschiedenen Laboratorien stimmen recht gut überein, vom Muskowit ist bis jetzt nur eine Analyse erhältlich, die nicht an demselben Konzentrat gemacht wurde.

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Both standard minerals, biotite and muscovite, were separated from the same rock, using 1000 kilos of rock material. For the *separation of the micas* we applied the usual methods, i. e. dry mica shaking table, magnetic separator and heavy liquids. The biotite was ground several times under alcohol in an agate mortar. 2.4 kilos of the final biotite were divided with a Jones sample splitter into 183 batches of 13 grams each, 4.5 kilos of muscovite were divided into 154 batches of 30 grams each.

Locality: Brione, Valle Verzasca, Canton of Ticino, Switzerland. Quarry "Togni" on the road from Brione to Soriolo. Coord. 703.750/128.250 of the "Landeskarte der Schweiz".

Geology: The rock comes from the region of the lower Penninic nappes of the Swiss Alps ("Lepontic region" after E. WENK). Geologic evidence points to metamorphic crystallization during to shortly after the main Alpine tectonic movements in this region (in Tertiary time). This gneiss is either a pre-Triassic granite meso-metamorphosed in Tertiary time or a product of Alpine granitization (E. WENK). The rock used is a leucocratic gneiss which forms layers in a series of more mica-rich gneisses and amphibolites ("Bändergneise von Lavertezzo").

Petrography: Quartz and feldspar rich, muscovite-biotite-gneiss, locally called "Verzascagneis".

Main minerals: Oligoclase, quartz, alkalifeldspar, muscovite, biotite.

Accessories: Chlorite, apatite, rutile, zircon and opaque minerals. Good gneissic foliation; crystalloblastic textures; grain size of major minerals: 0.5—2 mm.

One of the types of "Kerngneise" of granitic to quartzdioritic composition of the Lepontic region (E. WENK), which is characterized by strong Alpine (Tertiary) metamorphism.

Biotite: moderate brown 5YR 4/4, according to the Rock Color Chart, Geol. Soc. Am., 1951.

$N_y = 1.654 \pm 0.002$.

Mixture of 2 M and 1 M/3 T types; the 1 M/3 T type prevails (according to X-ray powder photographs).

The standard biotite contains less than 1 vol.% chlorite (mostly intergrown with biotite) and about 1 vol.$^0/_{00}$ of other minerals (muscovite, feldspars, quartz, apatite, rutile, opaque minerals); it contains less than 0.1$^0/_{00}$ apatite.

5$^0/_{00}$ of the biotite flakes contain some sagenite and ilmenite.

The uniformity of the different biotite samples was checked optically. When we had split the biotite and numbered the bottles, we prepared special samples for the optical examination. Nine samples, between bottles number 9 and 10, between 30 and 31, 50 and 51 and so on, were reserved for this check. From each of these nine bottles three batches of 2000 to 4000 grains were examined under the microscope. Grains consisting of at least 50% of other minerals, mainly chlorite and bleached biotite, were counted and compared with the number of biotite grains. Since we only counted the number of flakes and did not consider their thickness, the results we give in parts per thousand may not mean parts per thousand in volume. *Furthermore the method of counting is not exact.* In spite of this, differences larger than a factor of two in the amount of impurities should be detected.

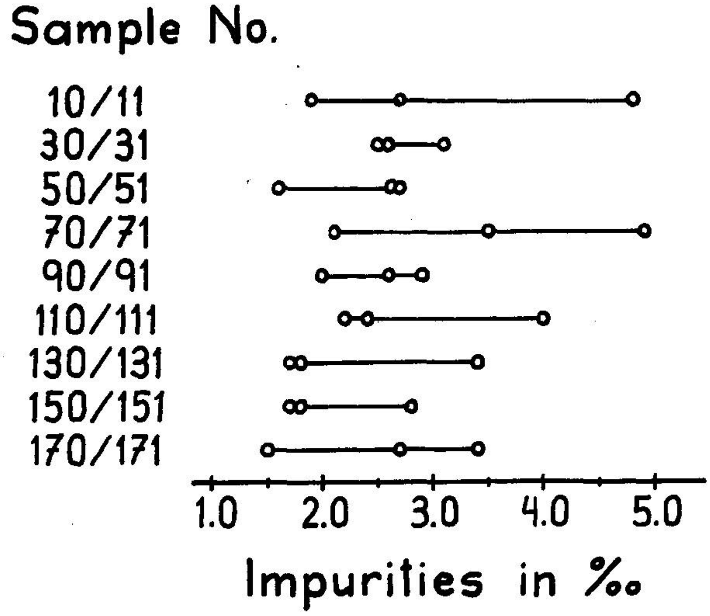

Fig. 1. Impurities in parts per thousand in nine different samples of the standard biotite. The lines connect the counts of three batches of biotite out of one bottle.

As fig. 1 shows, the spread between different counts out of the same bottle is about the same as the total range between different bottles. This means that the amount of impurities in different bottles does not vary by more than a factor of two. It means further, that the purity of the biotite was not significantly changed during the splitting procedure.

Muscovite: $N_y = 1.598 \pm 0.001$

$N_z = 1.603 \pm 0.001$

$2V = 37 \pm 2°$

2 M type (X-ray powder photograph)

The standard muscovite contains less than 1.5 vol.% of other minerals (almost entirely biotite, intergrown with muscovite).

ANALYTICAL RESULTS

From the *biotite* (Rb-Sr standard) analyses of four different laboratories are available, see Table 1.

Table 1. — *Analytical Data*

Rb-Sr data on the biotite

Analyst, Laboratory	Rb^{87} ppm	Sr^{87} rad. ppm	comm. Sr	% rad.[2])
G. FERRARA[3]), Laboratorio di Geologia Nucleare, Pisa, Italy	172	0.038	2.95	15.6
		0.045	2.86	18.3
G. FERRARA[4]), Laboratorio di Geologia Nucleare, Pisa, Italy	168	0.0448	2.57	20.2
R. K. WANLESS[4]), Geol. Survey of Canada, Ottawa, Canada	167.8	0.043	3.51	11
E. HAMILTON[4]), Dept. of Geology and Mineralogy, University Museum, Oxford	164	0,0354	1.88	
	161		1.93	
	164		4.02	
	161		3.10	
Our Data	169	0.0393	1.96	22.5
	167	0.0405	2.18	21.2
	168	0.0395	2.04	21.9
	168		2.00	
			1.94	

K-Ar data on the muscovite

Analyst, Laboratory	% K	Ar^{40} rad. ppm	% rad.[2])
E. JÄGER and H. FAUL[5]), U.S. Geol. Survey, Washington, USA	6.47	0.00888	26

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[2]) % rad. means: $\frac{Sr^{87}\text{ rad.}}{Sr^{87}\text{ rad.} + Sr^{87}\text{ comm.}} \cdot 100$ or $\frac{Ar^{40}\text{ rad.}}{Ar^{40}\text{ rad.} + Ar^{40}\text{ comm.}} \cdot 100.$

[3]) See G. FERRARA, B. HIRT, E. JÄGER, and E. NIGGLI, 1962.

[4]) Personal communication.

[5]) E. JÄGER, and H. FAUL, 1959.

The only available data on the *muscovite* (K-Ar standard) by JÄGER and FAUL (1959) are given also in table 1. They were not made from the standard sample. Since the analyzed muscovite was a very poor concentrate, both values K and Ar^{40} rad. should be higher in the standard.

Comments: In the Rb-determination we got better check and less fractionation during the mass-spectrometric measurement by using an etched tantalum filament.

We sometimes found higher values for common Sr. This was always caused by a dusty laboratory, when the air filters were old and the overpressure in the laboratory too small. By cleaning the laboratory and changing the air filters we were able to arrive at smaller values of common Sr (about 2 ppm). The Sr-contamination was never caused by chemicals. We think that the content of common Sr in the biotite itself is in the range of 1.9 to 2.0 ppm; higher values must be due to chemical contamination. Therefore this standard should be useful as a control of the Sr blank.

All the results from the different laboratories give Rb-Sr age values from 14.8 to 18.1 m. y., the K-Ar age on the muscovite is 19 m. y.

These young age values agree well with the general geological picture of this Alpine region, see E. JÄGER, 1962.

The standard micas are available from:

Labor für Altersbestimmung, Mineralogisch-Petrographisches Institut der Universität, Sahlistrasse 6, Bern, Switzerland,

or

Dr. A. Van Valkenburg, U. S. Dept. of Commerce, National Bureau of Standards, Washington 25, D.C., USA.

Analysts are requested to send their results to one of these addresses; a compilation of all the results will be published from time to time.

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