Rb—Sr ISOCHRON FOR OLDER GNEISSES OF THE TAFJORD AREA, BASAL GNEISS REGION, SOUTHWESTERN NORWAY

H. K. BRUECKNER, R. L. WHEELER, AND R. L. ARMSTRONG
Department of Geology, Yale University, New Haven, Connecticut, U.S.A.

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The older gneisses of the Tafjord area in the basal gneiss region of southwestern Norway yield a Rb-Sr whole-rock isochron age of 1.00 ($\pm$0.15)$\times 10^9$ years and a K-Ar biotite age of 383 ($\pm$12)$\times 10^6$ years. These ages are consistent with the geologic interpretation that the older gneisses are Precambrian rocks, recrystallized during Caledonian orogeny.

INTRODUCTION

The basal gneiss region, which lies west of the Trondheim basin and north of the Jotun-Bergen regions in southwestern Norway (Fig. 1), is composed of intensely deformed, high-grade gneiss and schist. Although the crystalline rocks in this region were originally considered to be part of an axial culmination of Precambrian rocks similar to those in southern Norway, Holtedahl (1938) demonstrated that Eocambrian and Early Paleozoic geosynclinal rocks were present and that these rocks were strongly metamorphosed and plastically deformed into large recumbent nappes during the Middle Paleozoic Caledonian Orogeny. He concluded that the basal gneiss region represents part of the core zone or infrastructure of the Caledonide orogenic system in Norway. Potassium-argon dates for metamorphic minerals from basal gneiss region rocks range from 385 to 575 million years (Kulp & Neumann 1961), consistent with Holtedahl's suggestion that the area underwent a major recrystallization during Caledonian orogeny. Muret (1960), Bryhni (1966), and others have suggested that gneisses of granitic to granodioritic composition underlying the lowermost Eocambrian or Early Paleozoic metasedimentary rocks may form part of a Precambrian basement that was strongly recrystallized and deformed during the Caledonian Orogeny. A Precambrian age for these rocks is suggested by their stratigraphic position, but, as a result of the intense Caledonian metamorphism, the evidence is inconclusive, and no exact correlations with Precambrian rocks in other areas have been possible.

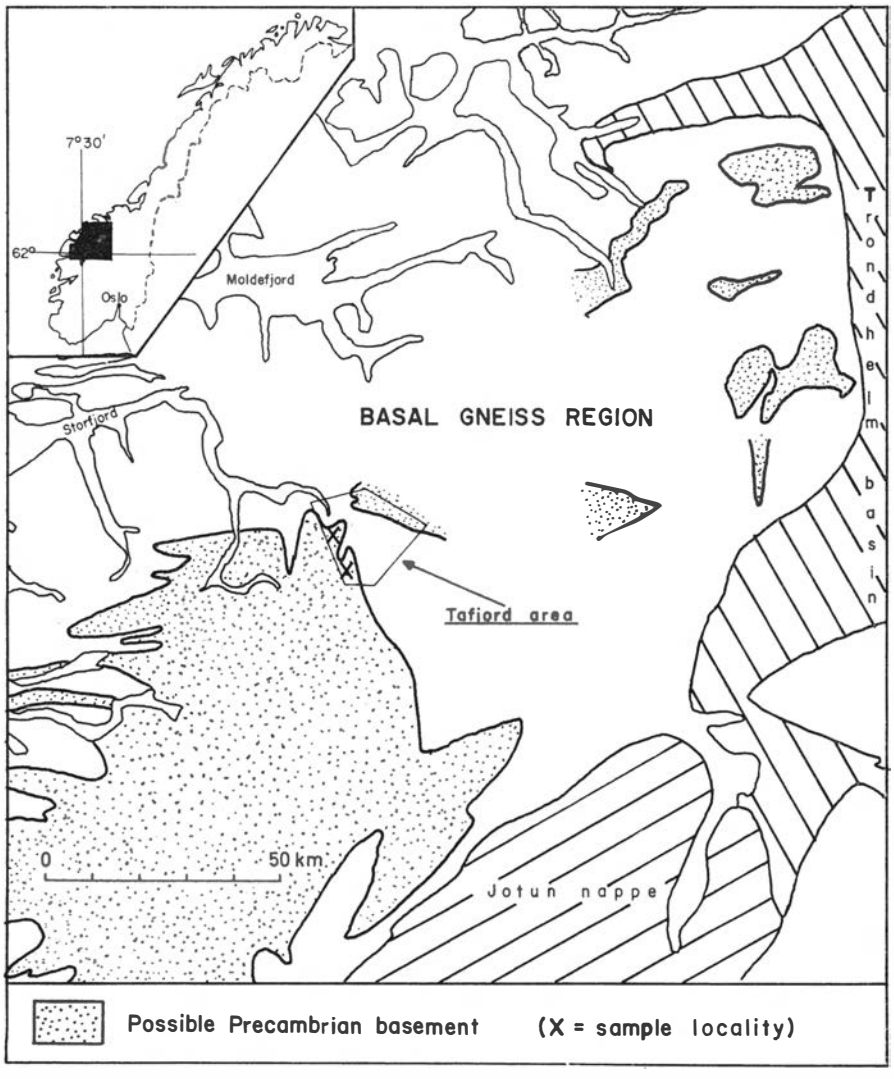

Fig. 1. Index map showing sample localities of the older gneiss, Tafjord area, southwestern Norway. The insert shows the area of Norway covered by the figure.

The Tafjord area is located in the middle of the basal gneiss region, near the easternmost extremity of Storfjord (Fig. 1). The rocks there can be divided into two groups: a sequence of supracrustal rocks of possible Eocambrian and Early Paleozoic origin and a group of uniform, strongly banded gneisses containing no obvious metasedimentary or metavolcanic features (Brueckner 1968). It was suspected that the latter group formed the Precambrian crystalline basement upon which the supracrustal rocks were either deposited or thrust. To examine this possibility, seven samples of this gneiss were selected for isotopic analysis on the basis of their Rb/Sr ratios as determined by X-ray fluorescence.

METHODS

Rb-Sr:—Hand samples were crushed to less than 200-mesh and analyzed for rubidium and strontium by standard isotope-dilution techniques. All measurements were made on a single-focusing, 6-inch radius, 60° sector field mass spectrometer equipped with a single filament, thermionic source. Peak heights were measured with an expanded scale recorder. Strontium isotopic compositions were obtained on spiked runs using Sr^{84} spike and normalizing Sr^{86}/Sr^{88} ratios to 0.1194. Analyses of a strontium isotope standard (Eimer and Amend lot No. 492327) made at the same time as the analyses reported in this paper ranged from 0.707 to 0.709 and averaged 0.708 for Sr^{87}/Sr^{86} (normalized to Sr^{86}/Sr^{88}= 0.1194). The results are in good agreement with those obtained in other laboratories (Faure & Hurley 1963). Values of radiogenic Sr^{87} to Rb^{87} ratio obtained for standard biotite and muscovite agree with reported values within one percent. The uncertainties of the reported Rb/Sr ratios are probably less than ± 3 percent and of Sr^{87}/Sr^{86} ratios probably less than ± 0.003. Uncertainties reported for the isochron relate only to the scatter of points about the isochron. All dates are calculated using a Rb^{87} half life of 47×10^9 years.

K-Ar:—Biotite obtained from sample K-65 (See Table I) was analyzed for K using a Perkin-Elmer atomic absorption spectrophotometer. Ar analysis was done by isotope dilution using conventional gas preparation and mass spectrometric techniques. The 95 percent confidence limits for the K-Ar date are ± 3 percent. The constants used are: $K_{\lambda\beta}=4.72\times10^{-10}yr^{-1}$, $K_{\lambda e}=0.584\times10^{-10}yr^{-1}$, $K^{40}/K=0.0119$ atom percent.

Table 1. Rb-Sr data and computed isochron. Older gneiss, Tafjord area.

Sample Number	Rb ppm	Common Sr ppm	Sr^{87}/Sr^{86}	Rb^{87}/Sr^{86}
3-7	104	1517	0.704	0.199
5-9	151	414	0.752	0.057
7-12	190	439	0.721	1.26
3-5	193	419	0.724	1.34
6-11	213	392	0.727	1.57
K-65	339	322	0.749	3.05
IV-56	281	256	0.750	3.17

Computed Isochron:
Slope: 0.0148 Intercept: 0.704
Date: 1.00 ($\pm$0.15)$\times10^9$ years (95%)

DISCUSSION

The seven analyzed samples of the older gneiss from the Tafjord area define a 1.00×10^9 year isochron with an initial Sr^{87}/Sr^{86} ratio of 0.704 (Fig. 2). This calculated age is similar to those obtained on rocks of the Precambrian shield of southern Norway (Kulp & Neumann 1961, Kulp et al. 1963), and the simplest interpretation is that the older gneiss is an igneous complex of approximately the same age as the Precambrian crystallines of southern Norway. The initial Sr^{87}/Sr^{86} ratio is low enough to indicate that a complex history of isotope evolu-

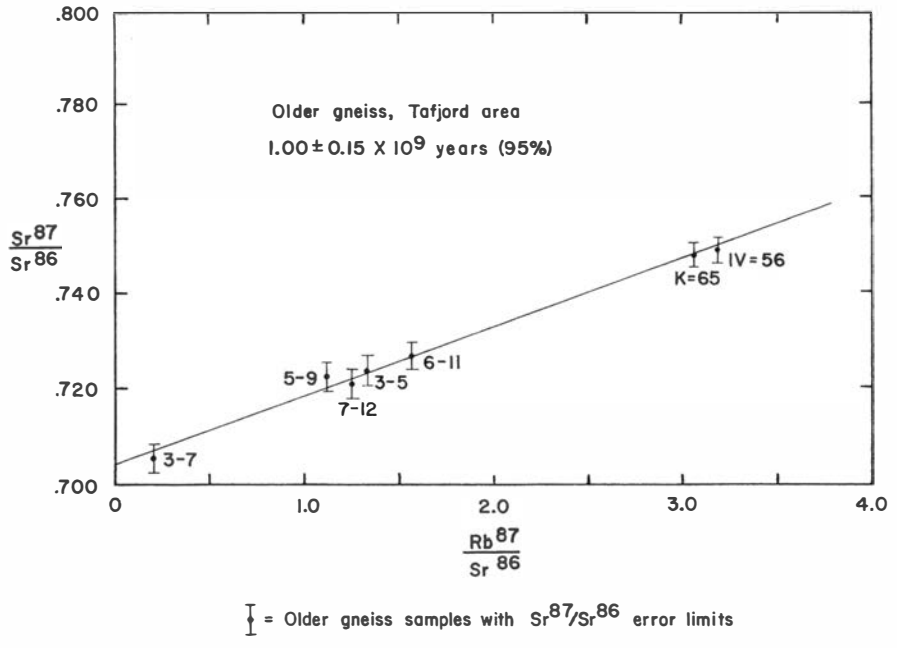

Fig. 2. Isochron plot of analytic results from the older gneiss of the Tafjord area.

tion in the crust is unlikely. The isotopic and stratigraphic data do not rule out the possibility that the analyzed rocks are Eocambrian arkoses, derived from 1.00×10^9 year old rocks, or that the rocks are much older than 1.00×10^9 years and were subjected to Rb or Sr redistribution during Caledonian or pre-Caledonian orogenies, but these alternatives are considered less likely.

The tectonic fabric of the older gneiss in the Tafjord area is parallel to that in the Eocambrian and Early Paleozoic supracrustal rocks, suggesting that it formed during the Caledonian Orogeny. The K-Ar date of 383 (±12)$\times10^6$ years (7.54% K, average of two analyses; 128.2×10^6 cc STP, radiogenic Ar^{40}; air correction 11%) for biotite from sample K-65 is similar to other dates from the basal gneiss region (Kulp & Neumann 1961, McDougall & Green 1964) and thus is not in conflict with the fabric interpretation.

The results presented above suggest the existence of recrystallized Precambrian basement rocks in the Tafjord area of southwestern Norway. The extent of Precambrian rocks in the rest of the basal gneiss region is still unknown. Work presently underway at the laboratories of the Southwest Center for Advanced Studies may extend our knowledge of this problem.

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Department of Geology, Yale University,
New Haven, Connecticut, U.S.A.
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[1]Present address: H. K. Brueckner, Geoscience Division, Southwest Center for Advanced Studies, Dallas, Texas, U.S.A.
Present address: R. L. Wheeler, Department of Geology, Princeton University, Princeton, New Jersey, U.S.A.

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