

The age of the Hernes granite, Lower Bergsdalen Nappe, western Norway

IAN R. PRINGLE, ANDERS KVALE & LIV B. ANONSEN

Pringle, I. R., Kvale, A. & Anonsen, L. B.: The age of the Hernes granite, Lower Bergsdalen Nappe, western Norway. *Norsk Geologisk Tidsskrift*, Vol. 55, pp. 191–195. Oslo 1975.

Rb-Sr whole rock analyses for the Hernes granite pluton in the Lower Bergsdalen Nappe are reported which yield an isochron age of 1274 ± 48 Ma ($\lambda^{87}\text{Rb} = 1.39 \times 10^{-11} \text{ yr}^{-1}$.)

I. R. Pringle, Department of Geodesy and Geophysics, Madingley Rise, Madingley Road, Cambridge, England.

A. Kvale & L. B. Anonsen, Geologisk Institutt, Avd. A., Joachim Frielesgt. 1, Universitetet i Bergen, 5014 Bergen, Norway.

The geology of those parts of the Bergsdalen Nappes lying within the Bergsdalen quadrangle has been described in detail by Kvale (1946, 1948) who proposed that the supracrustal rocks forming the nappes were equivalent to those of the Telemark Suite and had been thrust into their present position during the Caledonian Orogeny. The foliated granite plutons which occur in both nappes presented a problem in this interpretation in that they apparently displayed evidence which would imply either a pre-Cambrian or a Caledonian age for their time of emplacement. Kvale discussed this problem at length and concluded that these plutons were probably intruded during the Caledonian Orogeny and in fact were not completely consolidated during nappe emplacement.

Brueckner (1972) determined a Rb-Sr isochron age of 1004 ± 90 m.y. for the Hodnaberg granite (referred to as the Hamlegrøvatn granite by Brueckner) in the Upper Bergsdalen Nappe which he suggests demonstrates that this was a Sveconorwegian intrusion and that the rocks forming the nappes are remobilized portions of the Sveconorwegian geochronological province.

The results presented here are for granite specimens from the Hernes pluton in the Lower Bergsdalen Nappe (Fig. 1) and form the first part of a comprehensive geochronological study of this nappe region which is being undertaken in an attempt to elucidate the geological history of the area.

Geological setting

The Bergsdalen Nappes are two complex thrust nappes of essentially metasedimentary and metavolcanic rocks which were thrust over the autochthonous Cambro-Ordovician sediments and underlying pre-Cambrian basement gneisses during the Caledonian Orogeny.

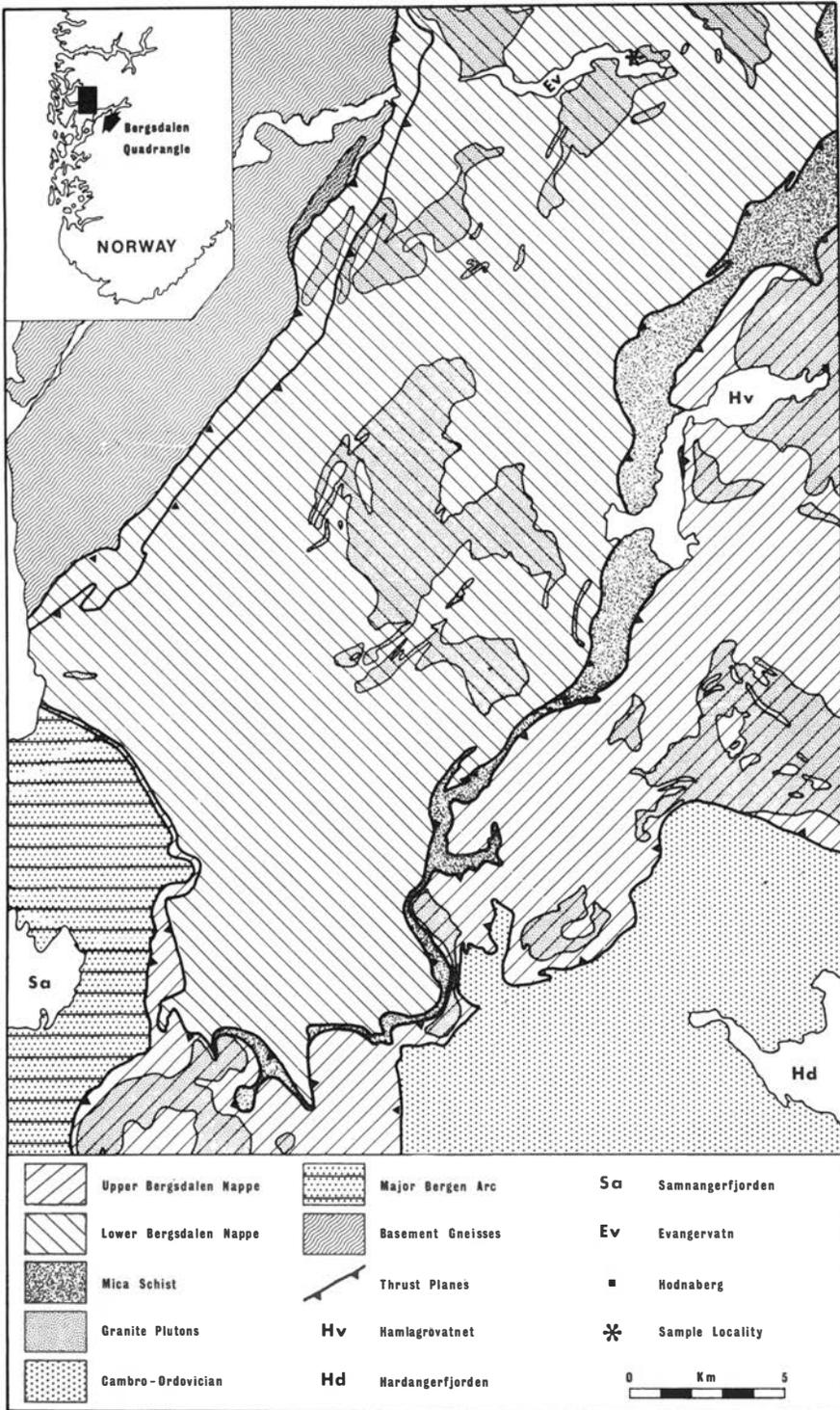


Fig. 1. Generalized geological map of the Bergsdalen quadrangle. After Kvale (1946).

The supracrustal rocks occurring in these nappes comprise quartzite, quartz schist, metabasalt, metadacite and metarhyolite (Kvale 1946, 1948). These supracrustals are cut by intrusions of saussurite gabbro, quartz diorite and granite. The similarity of the mineralogy and chemical composition of the metavolcanics and their plutonic equivalents led Kvale to conclude that they were co-magmatic. He further noted that they may have formed a differentiated series. However, following the criteria defined by Balk (1937), Kvale interpreted the textural and structural evidence in the granite plutons as being of primary, igneous origin and concluded that, although the supracrustals and other plutonic rocks were pre-Cambrian and probably equivalent to the Telemark Suite, these granite plutons were intruded during the Caledonian Orogeny. The age of 1004 ± 90 m.y. obtained by Brueckner (1972) for the Hodnaberg granite pluton in the upper nappe, however, indicates that the granites are probably of a pre-Cambrian rather than a Caledonian age.

Analytical techniques

All samples were analysed by standard isotope dilution techniques using ^{87}Rb and ^{84}Sr 'spike' for Rb and Sr analyses respectively. The analyses were carried out on an Atlas CH4 mass spectrometer equipped with 'peak switching' and punched paper tape digital output.

All Sr isotopic data were normalized to $^{86}\text{Sr}/^{88}\text{Sr} = 0.1194$ and ages were

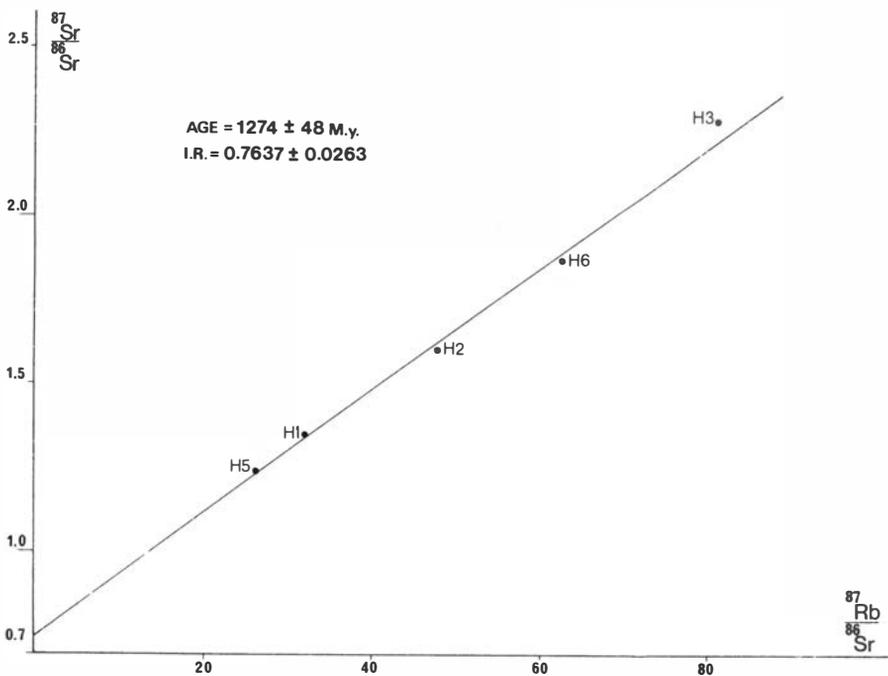


Fig. 2. Isochron for samples from the Hernes granite pluton in the Lower Bergsdalen Nappe.

Table 1.

Sample No.	Rb (p.p.m.)	Sr (p.p.m.)	$^{87}\text{Rb}/^{86}\text{Sr}(\text{At.})$	$^{87}\text{Sr}/^{86}\text{Sr}(\text{At.})$
<i>Hernes Granite</i>				
H ₁	165.1	15.64	32.38	1.3422
H ₂	178.4	11.71	47.79	1.5909
H ₃	218.3	8.94	81.37	2.2737
H ₅	208.7	24.22	26.17	1.2390
H ₆	235.7	12.09	62.68	1.8560

calculated by York's model II (York 1969) regression analysis (and published data, where necessary, recalculated) using $\lambda^{87}\text{Rb} = 1.39 \times 10^{-11} \text{ a}^{-1}$. The experimental uncertainties are given at the 95% confidence level. The analytical data are given in Table 1 and resultant isochron plotted in Fig. 2.

Discussion of results

The data for the Hernes pluton define a whole rock isochron age of $1274 \pm 48 \text{ Ma}$ (Fig. 2) and as this pluton has suffered only epidote-amphibolite facies metamorphism and displays intrusive contacts (Kvale 1946, 1948) this date is considered to represent the age of intrusion. The age corresponds closely to the Rb-Sr whole rock isochron age of $1289 \pm 80 \text{ Ma}$ for the Dyrskard Group in the Hardangervidda-Ryfylke Nappe System (Andresen et al. 1974). On geological evidence the supracrustal series in these two nappe areas have both been correlated with the Telemark supracrustals (Natterstad et al. 1973) and the geochronological data support the proposal that all of these areas have been involved in the Sveconorwegian event (Andresen et al. 1974, Heier et al. 1972, Priem et al. 1973). In these other areas the dates in the range 1100 to 1300 Ma are interpreted as metamorphic dates whereas in the Bergsdalen area the age reported here for the Hernes pluton is considered to represent the time of intrusion. However, the very high initial $^{87}\text{Sr}/^{86}\text{Sr}$ ratio of 0.7637 ± 0.0263 for the Hernes pluton demonstrates that this intrusion was derived from pre-existing granitic crust which was remobilized during the Sveconorwegian event. As in Telemark this event 'involved anatexic melting and was accompanied by complete obliteration of the pre-metamorphic whole-rock Rb-Sr records' (Priem et al. 1973) an intrusive age of $1274 \pm 48 \text{ Ma}$ for such a granite is compatible with the similar metamorphic ages in these other areas in that the Hernes granite may be considered to be an extreme example of this anatexis.

The age of $1004 \pm 90 \text{ Ma}$ and initial $^{87}\text{Sr}/^{86}\text{Sr}$ ratio of 0.7068 ± 0.0056 for the Hodnaberg granite (Brueckner 1972) suggest that this granite and the Hernes pluton had different origins and intrusive and metamorphic histories. However, Kvale (1946, 1948) considers, on the basis of petrological and structural evidence, that all of the granite plutons occurring in these nappes are consanguineous. Thus, although considerably more geochronological and

isotopic work is obviously required to elucidate the history of acid igneous activity within the Bergsdalen Nappes, it is proposed that all of the granite plutons are probably of pre-Cambrian age and as such, fit into the pattern found in other parts of the Sveconorwegian geochronological province.

November 1974

REFERENCES

- Andresen, A., Heier, K. S., Jorde, K. & Naterstad, J. 1974: A preliminary Rb/Sr geochronological study of the Hardangervidda-Ryfylke Nappe System in the Røldal area, south Norway. *Nor. Geol. Tidsskr.* 54, 35-47.
- Balk, R. 1937: Structural behaviour of igneous rocks. *Geol. Soc. Am. Mem.* 5.
- Brueckner, H. K. 1972: Interpretation of Rb-Sr ages from the Precambrian and Palaeozoic rocks of southern Norway. *Am. J. Sci.* 272, 334-358.
- Heier, K. S., Naterstad, J. & Bryhni, I. 1972: A Rb-Sr whole rock isochron date for the Stavanger area, south Norway. *Nor. Geol. Tidsskr.* 52, 377-383.
- Kvale, A. 1946: Petrologic and structural studies in the Bergsdalen quadrangle. Part I. Petrography. *Bergens Mus. Arb.* 1945.
- Kvale, A. 1948: Petrologic and structural studies in the Bergsdalen quadrangle. Part II. Structural geology. *Bergens Mus. Arb.* 1946-47.
- Naterstad, J., Andresen, A. & Jorde, K. 1973: Tectonic succession of the Caledonian nappe front in the Haukelisæter-Røldal area, southwest Norway. *Nor. Geol. Unders.* 292, 1-20.
- Priem, H. N. A., Boelrijk, N. A. I. M., Hebeda, E. H., Verdurmen, E. A. Th. & Verschure, R. H. 1973: Rb/Sr investigations on Pre-Cambrian granites, granitic gneisses and acidic metavolcanics in central Telemark: metamorphic resetting of Rb-Sr whole rock systems. *Nor. Geol. Unders.* 289, 37-53.
- York, D. 1969: Least-squares fitting of a straight line with correlated errors. *Earth Planet. Sci. Lett.* 5, 320-324.