NOTES – *NOTISER*

Radioelement and heat production measurements in the Trysil granite, east Hedmark, Norway*

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The mean radioelement contents of the Trysil granite have been measured by gamma-ray spectrometry. The potassium content lies in the range of values for an alkali granite, while the mean thorium and uranium concentrations are lower than for granitic averages reported in the literature. It appears that the Svecofennian metamorphic event did not cause appreciable enrichment of thorium and uranium in the Trysil granite, as is commonly found in granites of Sveconorwegian ages.

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An irregularly shaped area of granite covering roughly 300 km^2 occupies part of the Trysil district, eastern Hedmark, in southeast Norway (Fig. 1). The Trysil granite is elongated in a northwest to southeast direction, and runs parallel to, and in faulted contact with, an acid volcanic complex to the east referred to as the Trysil porphyries. Dons (1960) described the Trysil granite as comprising both 'basic' and 'acid' types: 'the basic being intruded by, and occurring as inclusions in granitic types. The most dominant type is a rather massive, red, biotite granite'. Trysil granites and porphyry continue into Sweden as the Dala porphyries and granites. Rb/Sr age determinations by Priem et al. (1970) indicate the sub-Jotnian granites and porphyries of the Trysil area and their Swedish equivalents give the same age of 1570 m.y. The same authors found evidence of the Sveconorwegian (Dalslandian) metamorphic event at 925 m.y. by K-Ar dating. A reconnaissance Rb/Sr age dating of five rocks collected for this study indicated an apparent age of 1507 ± 100 m.y. (2σ); ($\lambda = 1.39 \times 10^{-11}$ yr^{-1}) and an initial $^{87}Sr/^{86}Sr$ ratio of 0.7105. Our analytical data are given in Table 1. Priem's results were based on the 1.45×10^{-11} yr^{-1} decay constant. When referred to the longer half life used by us the age obtained by him will be 1664 m.y. This is older and outside the uncertainty range quoted by us.

The granite is difficult to sample being to a great extent covered by overburden and heavily forested and therefore outcrops are sparsely distributed.

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A total of 53 samples were collected in the area of the Trysil granite and analyzed for Th, U and K by gamma-ray spectrometry.

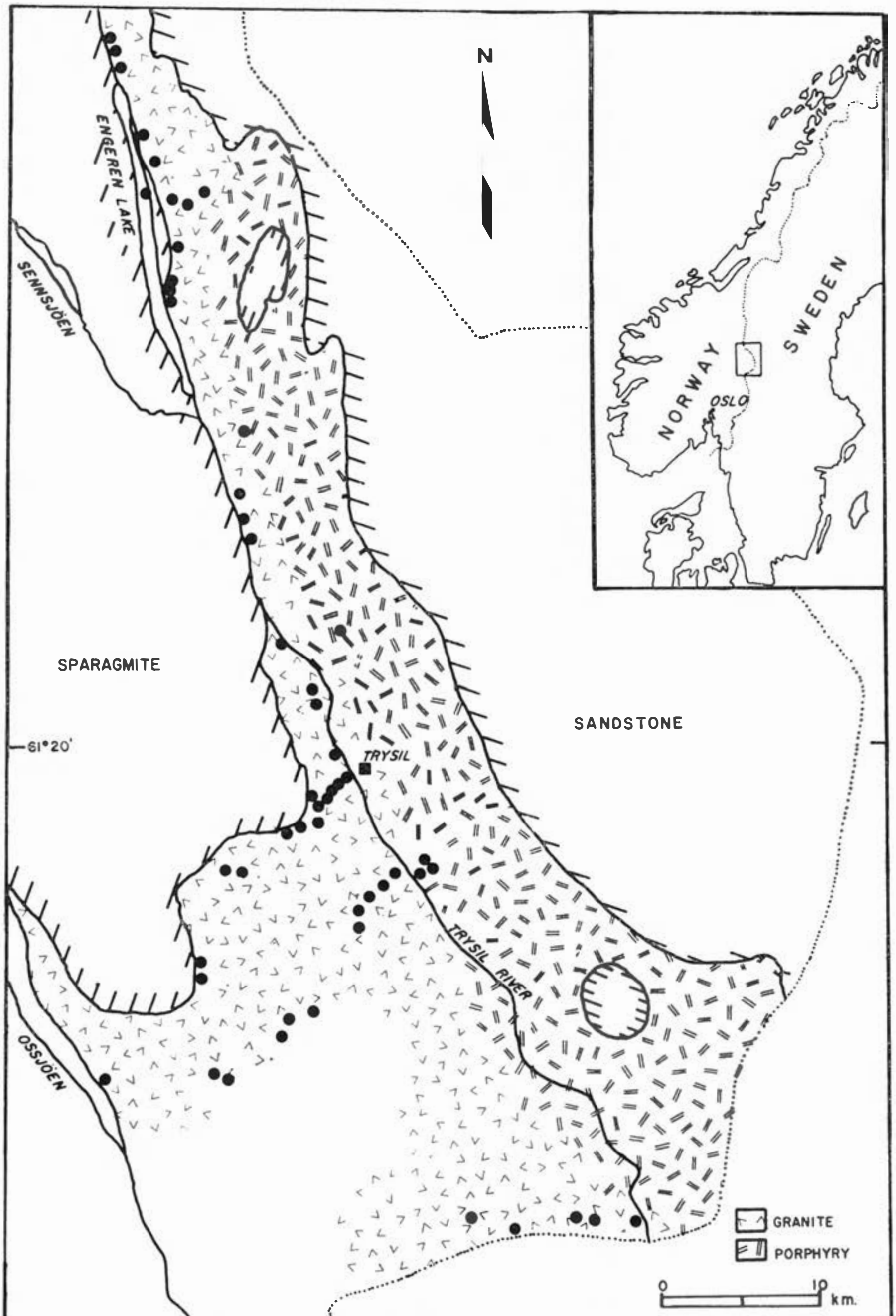

Fig. 1. Location of the Trysil granite showing sample collection sites.

Table 1. Rb/Sr data for the Trysil granite.

Sample No.	Rb/Sr	$^{87}SR/^{86}SR$
TY4	1.41 ± 0.015	0.80248 ± 0.00010
TY20	4.16 ± 0.042	0.96376 ± 0.00020
TY32	0.85 ± 0.001	0.76254 ± 0.00015
TY36	3.15 ± 0.032	0.90369 ± 0.00017
TY45	1.58 ± 0.016	0.80961 ± 0.00010

Age = 1507 ± 100 m.y.
Ri = 0.71049 ± 0.00203
(Sample number and location from Killeen & Heier 1975).

Gamma-ray spectrometric analytical technique

The samples were analyzed by standard gamma-ray spectrometric techniques (Adams & Gasparini 1970). Sample weights averaged greater than 700 grams of crushed rock placed in a cylindrical container, in contact with the face of a 5″ × 5″ NaI(Tl) detector. Gamma-ray counts were recorded by a 400 channel gamma-ray spectrometer. The three energy peaks used for Th, U and K determinations were 2.62 Mev (Tl-208), 1.76 Mev (Bi-214), and 1.46 Mev (K-40), respectively. Calibration of the instrument has been discussed in detail by Raade (1973). The accuracy attainable for average granites with the analytical equipment is within ± 5 % for U, ± 3 % for Th and ± 1 % for K. Further discussion on the precision and accuracy of the equipment has been given by Killeen & Heier (1975) and by Raade (1973). The data analysis by computer has been described briefly by Killeen (1973).

Results of radiometric analyses

The results are presented in histogram form in Fig. 2. The geometric means, arithmetic means, and standard deviations are given in Table 2. The results for two samples are excluded from the calculation of the means in Table 2, as they are from basic inclusions in the granite. Original data from which the above mean values are computed are listed in tables by Killeen & Heier (1975). For comparison purposes, Table 3 gives granitic averages and surface continental crustal averages estimated by several authors.

The mean K content of the Trysil granite is that of an average alkali granite (Clark et al. 1966), while the mean Th and U contents and consequently heat production values are considerably lower than for any granite averages reported in the literature. The mean Th and U contents are similar to average surface continental crust concentrations given in Table 3. Although the potassium content is similar to many of the granites in the Telemark area (Killeen & Heier 1975a) and only slightly lower than some of the large late-kinematic granites, such as the Flå and Iddefjorden (Killeen & Heier 1975b), the Th and U contents are considerably lower. Therefore the

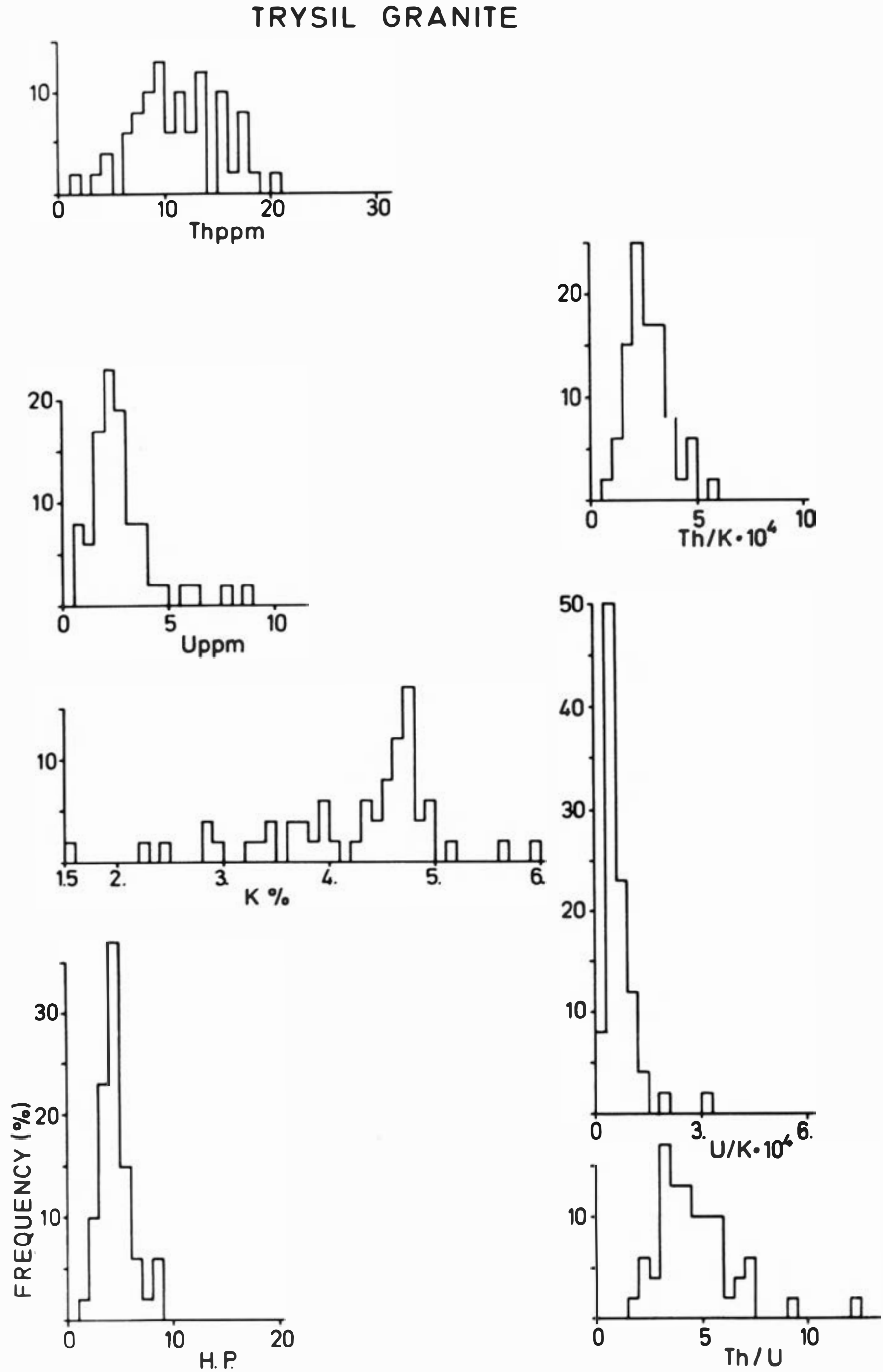

Fig. 2. Histograms of thorium, uranium potassium, their ratios and heat production for the Trysil granite data.

Table 2. Radiometric results for the Trysil granite (51 samples).[1]

	Th ppm	U ppm	K %	Th/U	Th/K × 10^4	U/K × 10^4	Heat production cal./cm^{3}sec.10^{-13}
A.M.	11.4	2.8	4.27	4.6	2.7	0.7	4.7
S.E.M.	0.6	0.2	0.11	0.3	0.1	0.1	0.2
S.D.	4.0	1.6	0.8	1.8	1.0	0.5	1.5
G.M.	10.7	2.5	4.19	4.3	2.5	0.6	4.4

A.M. = arithmetic mean
S.E.M. = standard error of mean
S.D. = standard deviation
G.M. = geometric mean
[1]Samples Ty-10, –35 not included

Table 3. Average Th, U and K contents of continental crust and granitic rocks.

	Thppm	Uppm	K %	H.P.*	
Continental	11.4	3.0	–	–	Adams et al. (1959)
crust (surface)	10.0	2.8	2.6	4.04	Heier & Rogers (1963)
	9.6	2.7	2.09	3.78	Taylor (1964)
Canadian shield	10.3	2.45	2.58	3.86	Shaw (1967)
Granitic	–	4.75	3.79	6.76	Heier & Rogers (1963)
rocks	17.36	–	3.47	6.69	Heier & Rogers (1963)
Granodiorite	9.3	2.6	2.55	3.78	Clark et al. (1966)
Silicic	20.0	4.7	4.26		Clark et al. (1966)
igneous			(alkali		
rocks			granite)		
Granitic	Th/K × 10^4 ratio = 4.9				Heier & Rogers (1963)
rocks	U/K × 10^4 ratio = 1.2				Heier & Rogers (1963)
Canadian	U/K × 10^4 ratio = 0.95				Shaw (1967)
shield					

* H.P. (heat production) in units of 10^{-13} Cal/Cm^3/Sec. (assuming sp. gravity = 2.67 G/Cm^3). All values computed from given Th, U, K values using: H.P. = 0.62 Uppm + 0.17 Thppm + 0.23 K%.

source material for the granitic magma must have been low in Th and U. Both Priem's et al. (1970) and our data, Table 1, indicate that the magmatism occurred some 100 m.y. after the end of the Svecofennian orogeny. It appears that this event of acid magmatism at about 1500–1600 m.y. had no effect of differentiation or fractionation of Th and U contents to produce the higher concentrations observed in granites such as the Flå and Iddefjorden which were subjected to the Sveconorwegian event (Killeen & Heier 1975). The above-mentioned enrichment of Th and U cannot be attributed to the Svecofennian event since both the Trysil granite and the other granites mentioned above were not subjected to the same event.

It is interesting to note that the mean Th/K and U/K ratios which are quite low compared to average values given in Table 3 are similar to values determined for the 'light' hornblende-granite variety of the farsundite intrusion in south Norway which is a deepseated intrusion with a low mean heat production value. The mean Th/U ratio of the Trysil granite is slightly lower than for the light farsundite (Th/U = 5.8), Killeen & Heier (1975, 1975c).

Acknowledgments. – The age determination was done in the Department of Geology and Mineralogy, Oxford University, using their MS30 masspectrometer. The advice and assistance given by members of the Oxford age group is greatly appreciated.

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