Zeitschrift: Eclogae Geologicae Helvetiae

Herausgeber: Schweizerische Geologische Gesellschaft

Band: 64 (1971)

Heft: 3

Artikel: Rb-Sr age determinations on biotites and whole rock samples from the Mandi and Chor granites, Himachal Pradesh, India

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DOI: https://doi.org/10.5169/seals-163993

Eclogae geol. Helv.	Vol. 64/3	Pages 521-527	4 figures in the text and 1 table	Basle, Dec. 1971

Rb-Sr Age Determinations on Biotites and Whole Rock Samples from the Mandi and Chor Granites, Himachal Pradesh, India

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ABSTRACT

Rb-Sr age determinations on three biotites and four whole rock samples from the Mandi granite, Himachal Pradesh, India, were performed. All the apparent biotite-ages fall in the range 24–31 m.y. pointing towards the intense phase of Himalayan metamorphism evidenced by their parent rocks during that period. The total rocks give an age of 500 ± 100 m.y. suggesting the time of formation of these rocks, which were later remobilized during Himalayan metamorphism.

One sample of biotite separated from a granitic sample from Chor area gave a mineral age of 50 ± 10 m.y.

Introduction

Himalayan granites pose a problem for geologists as regards their age and origin. Opinions differ as to the age and mode of origin of these rocks. Himalyan granites were assigned ages by different workers on the basis of various criteria such as nature of the xenoliths, field relationship with the country rock, petrographical similarities, structural trends, degree of metamorphism, geochronometry, etc.

Based on these evidences, earlier workers like MCMAHON (1897), GRIESBACH (1891), AUDEN (1933) and WADIA (1933) grouped the Himalayan granites into the following age groups:

I. Late Palaeozoic granites
II. Post Carboniferous-Early Tertiary granites
III. Tertiary granites

KRUMMENACHER (1961) and SARKAR et al. (1964) have reported a few K-Ar ages for minerals separated from Himalayan granitic samples, but no Rb-Sr whole rock ages have been published for the Himalayan granites.

In this investigation Rb-Sr age determinations were made on three biotites and four whole rock samples from the Mandi granite. For comparison one biotite from the

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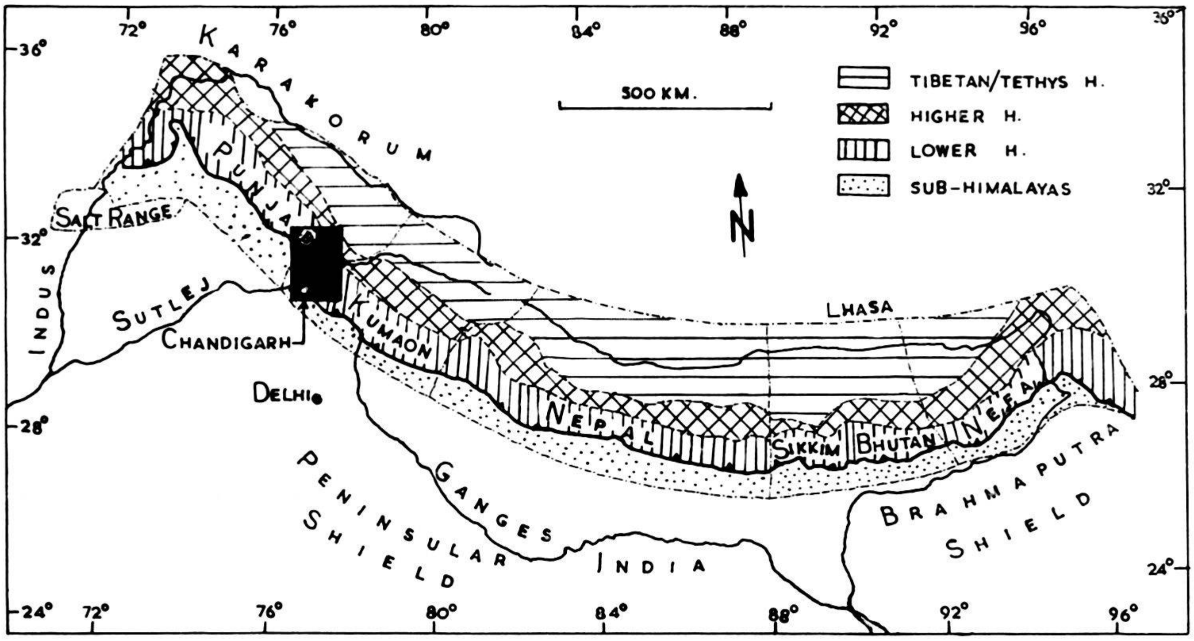

Fig. 1. Sketch map of the Himalayas, location of Fig. 2 is indicated by a black rectangle.

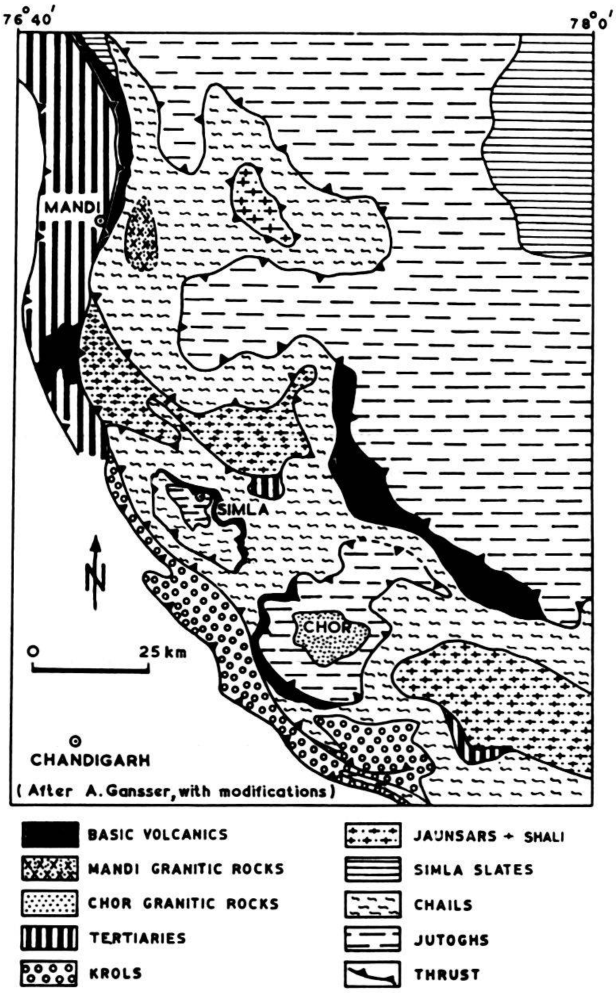

Fig. 2 Geological map of the Mandi and Chor area. Chandigarh is situated 220 km N of Delhi.

Chor granite was also dated. From the biotite analyses the influence of the Himalayan orogeny on these rocks can be studied. The total rock results could reveal the previous history of these rocks.

Geological setting and petrography

According to FUCHS (1967), the Mandi granite forms the front part of the crystalline nappe, other geologists believe that the Mandi granite occurs in the core of an anticline of Chail sediments and that it belongs to the Chail unit and not to the crystalline nappe. In a recent paper FUCHS (FUCHS and GUPTA 1971) also considers the Mandi granite to be part of the Chails. BHANDARI made several traverses through the northern part of this granitic body, along and parallel to Mandi-Kulu road, as well as across the granite body. A description of the observed features is given in the following paragraphs (Fig. 2 and 3).

The granitic body, as a whole, is oblong in shape with its elongation following the regional trend of the metasediments (NNW–SSE). There is no sign of gradation between the metasediments and the granite at the contacts where exposed. These contacts are quite sharp and there is little variation in the grain size of the granite near the contact zone. However, at the eastern contact on the Mandi-Kulu road, there is a complex series of granitic sheets intruding along the foliation planes of the metasediments. Sheets more than a few meters wide are normal porphyritic gneisses, but the smaller sheets tend to be fine grained.

Near the margin, the Mandi granite is a porphyritic gneiss which grades into a coarse-grained nearly non-porphyritic gneiss and then into a medium to-coarse-grained homogeneous granite towards the core. The porphyroblasts of feldspars occuring in the porphyritic gneiss are mostly microcline wrapped around by biotites and are of varying sizes. The foliation – although often indistinct – follows the structural pattern of the country rock. The most prominent direction of elongation of feldspars is NW–SE. The feldspar crystals are often fractured, a fact which points to their having being affected by the Himalayan Orogeny. Next variety of marginal granite is a coarse-grained rock with smaller feldspar crystals and a poorly defined foliation. This unit of the granite is well-jointed and traversed by cross-cutting veins of aplite and pegmatite which do not strictly follow the joint planes. This granite is moderately rich in biotite. Samples SMK 4 and SMK 5 are from this gneissose granite.

A third type of rock is a coarse-grained homogeneous granite consisting mainly of feldspars (plagioclase predominating over K-feldspar), quartz, biotite and muscovite. Muscovite occurs in two generations. Samples PHS 1, PHS 2, PHS 3 and PHS 4 were collected from this type.

Near the contact a number of xenoliths of biotite-schist and talc-schist, varying in size from a few centimeters to more than a few meters, were observed in the granite and porphyritic granite.

Microscopically, the central granitic rocks are generally recrystallized and are suggestive of a metamorphism at low temperatures which is indicated by the common occurrence of secondary sericite at the margins of perthite and muscovite. The biotite in these rocks has a "wavy" colour, usually pale brown to pale green, and has intergrowths of secondary muscovite. Bands of recrystallized quartz and sericite occur between the feldspars and the mica grains and fill the fracture surfaces along which they have been broken.

According to PILGRIM and WEST (1928), the Chor granite (Fig. 2) is a granite of laccolithic nature, intruded into a syncline of Jutogh beds. This syncline and the granite intrusion within it have been overturned by a powerful movement from the NE. The Chor granite is a coarse-grained, usually foliated rock, with abundant phenocrysts of orthoclase, and can be called a porphyritic biotite granite. Inclusions of zircon and apatite are common. Though biotite is the predominating mica, it rarely occurs in large crystals. Muscovite in subordinate amounts is present, along with quartz, sphene and epidote. Sample CA 3 was collected from a place about 1 mile from Nauraghat village in the Chor area.

Analytical data and age results

Table 1 summarizes the analytical data and age results. The total rock analyses are presented in the NICOLAYSEN diagram (Fig. 4).

The young Rb-Sr ages on biotites show the influence of the young Himalayan metamorphism in the Mandi granite. A young Rb-Sr age result was found on the biotite from the Chor granite. This biotite concentrate was not very well separated, resulting in a high content of common Sr and a high error. But there is no doubt that this age is young, too.

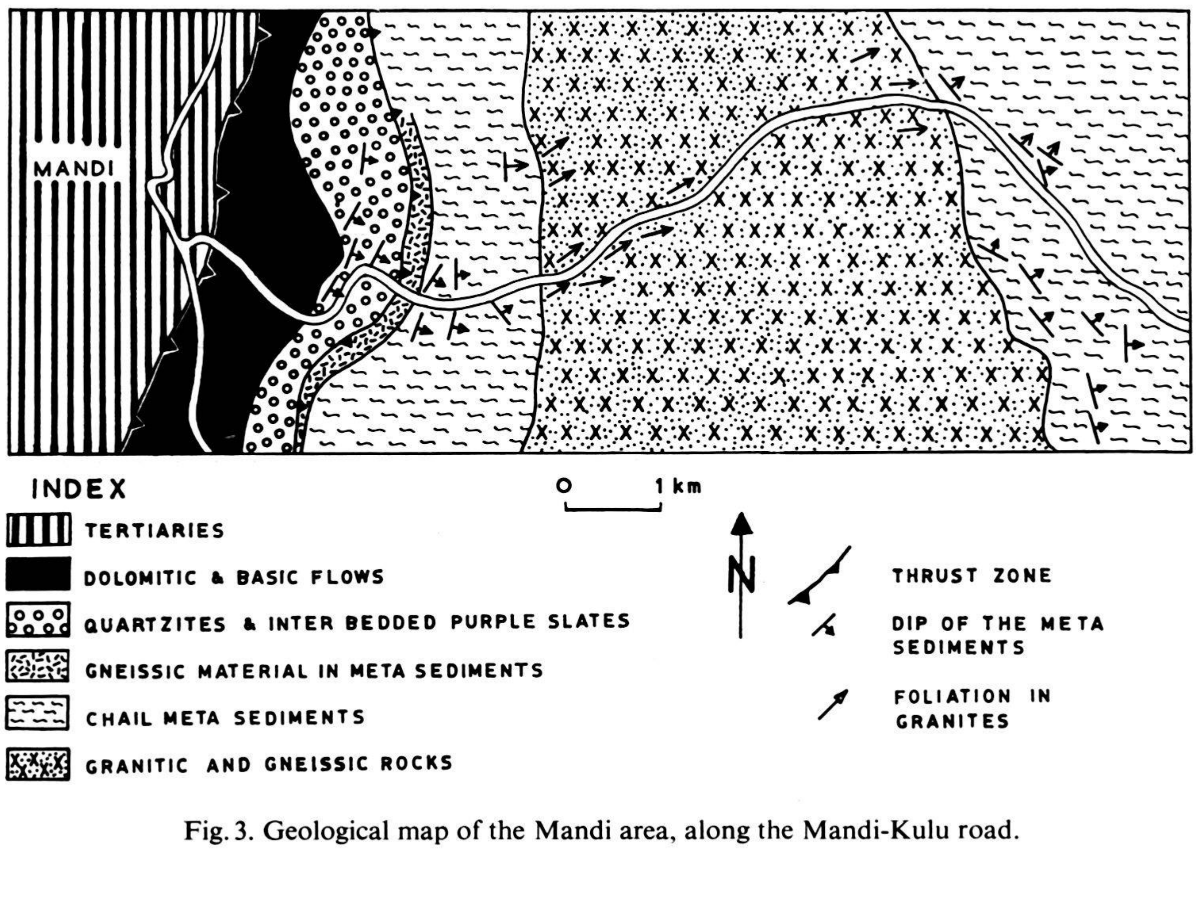

Fig. 3. Geological map of the Mandi area, along the Mandi-Kulu road.

Table 1. Analytical data and age results

Sample No.	Rock	Analyzed sample	ppm Rb^{87}	ppm $Sr^{87}_{rad.}$	% rad.	ppm Sr comm.	Rb^{87}/Sr^{86}	Sr^{87}/Sr^{86}	Age in m.y.
PHS 1	Mandi granite	Total rock	122	0.907	23.8	42.1	29.802	0.9322	
PHS 2	Mandi granite	Total rock	120	0.921	23.9	42.6	28.967	0.9314	500 ± 100
PHS 3	Mandi granite	Total rock	112	0.881	16.7	64.2	17.928	0.8502	
PHS 4	Mandi granite	Total rock	114	0.866	17.6	58.6	19.986	0.8608	
PHS 4	Mandi granite	Biotite	539	0.211	47.0	3.45	1 606.93	1.3379	20.5 ± 0.8
SMK 4	Mandi granite	Biotite	249	0.0877	18.3	5.69			24.0 ± 2.4
SMK 5	Mandi granite	Biotite	397	0.183	19.9	10.7			31.4 ± 2.9
CA 3	Chor granite	Biotite	255	0.188	9.9	24.7			50 ± 10

Constants: = $1.47 \times 10^{-11} y^{-1}$; Rb: 85/87 = 2.591; Sr: 88/86 = 8.432, 87/86 = 0.7091
The age of biotite PHS4 represents the isochron with the total rock, biotite SMK4, SMK5 and CA3 were calculated with the common Sr-values mentioned above.

For total rock analyses 4 samples of 30 kg were collected; but they were not selected according to their Rb/Sr ratio. As Figure 4 shows, the 4 analyzed samples fall on a straight line which is not well defined: it is a 2-point "isochron". This is the reason for the large error limit of both apparent age result and the initial Sr^{87}/Sr^{86}.

But still, there is no doubt that the Mandi granite gives a pre-Himalayan age. It would be worthwile to measure the total rock age more precisely by analyzing well selected rock samples. With a precise age result a minimum age for the Chail sedimentation of this area could be given. It would be interesting to prove more precisely that the intensive magmatic phase around 450 m.y., commonly found in Europe, is also present in the Himalayan region.

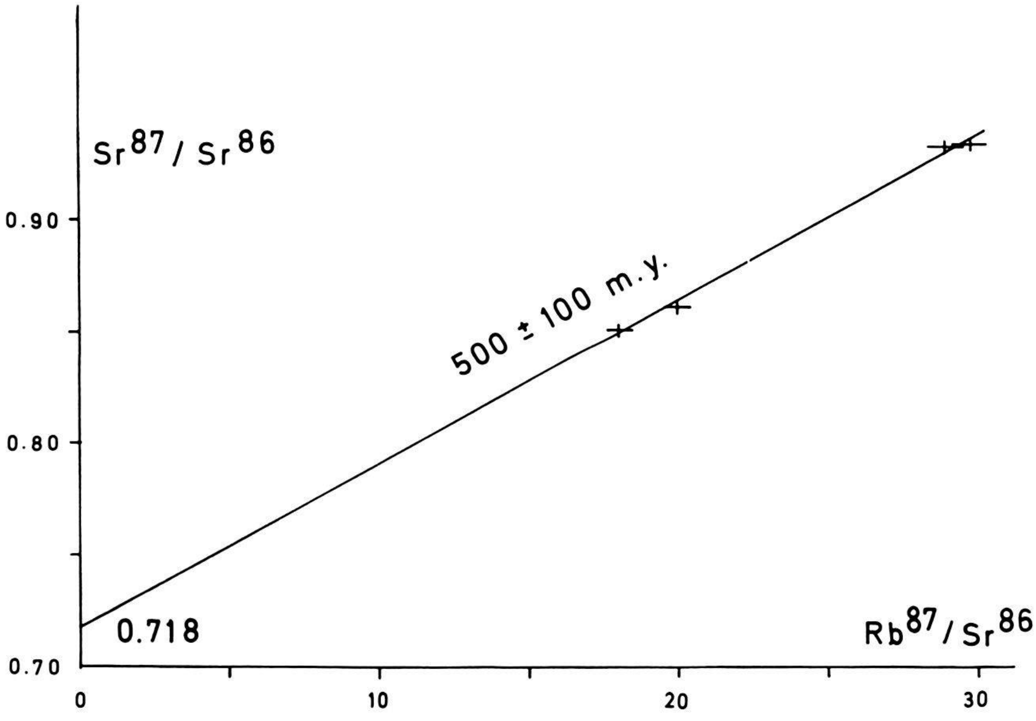

Fig. 4. Nicolaysen diagram on the total rock analyses from the Mandi granite.

Acknowledgments

We owe our thank to Prof. E. Wenk and Dr. W. Frank for reading the manuscript and for critical discussions. Thanks are also due to Mr. J. K. Bhalla for assistance in separation of minerals and for several useful discussions. We thank Professors I. C. Pande and B. C. Ghosh for permission to use the laboratory facilities available in their departments. One of us (A. K. B.) would like to thank the Council of Scientific and Industrial Research, India, for award of a Research Fellowship. We owe our thanks to the "Schweizerischer Nationalfonds zur Förderung der wissenschaftlichen Forschung" for financing the experimental work.

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