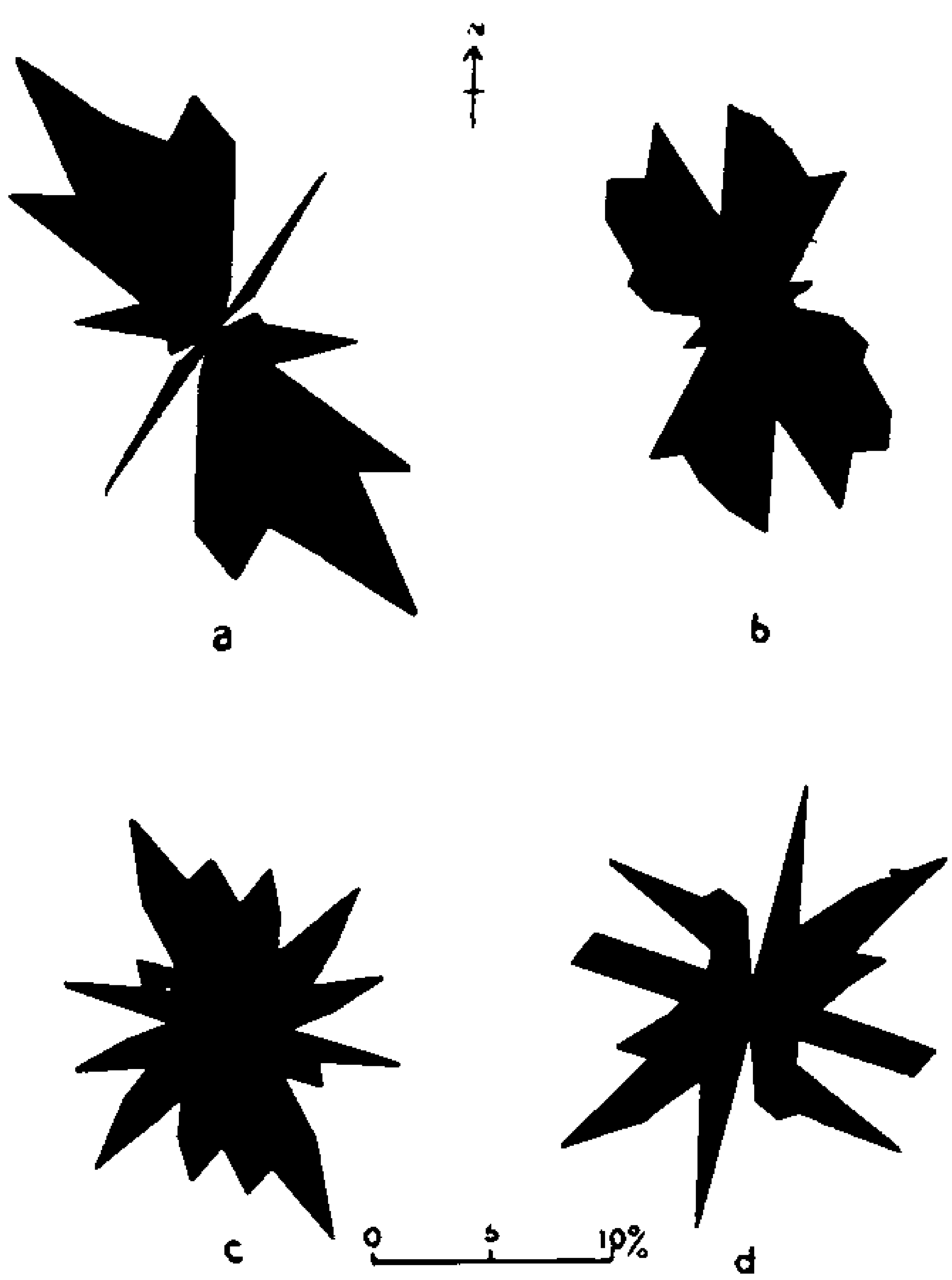

FIG. 3. (*a*) Strike of 48 major magnesite veins. (*b*) Strike of 97 minor magnesite veins. (*c*) Strike of 253 joints. (*d*) Strike cf 135 joints ln peridotite.

150 sq km is shown in Fig. 3 *c*. Three major trends, *viz*., WNW-ESE, NNW-SSE and NE-SW with corresponding mean trends of N75W-S75E, N25W-S25E and N55E-S55W are observed. Maximum number of joints trend NNW-SSE. The corresponding mean trend of N25W-S25E coincides with the mean strike of major veins. These fractures, developed after the amphibolite facies metamorphism, belong to one of the two regional fracture systems that control the drainage in the area[1]. One of the two mean trends, observed in the minor veins, *viz*., N45W-S45E, also approximates this direction.

The strike of joints in peridotite host rock is shown in Fig. 3 *d*. Four major trends with the corresponding mean strike directions along N70W-S70E, N45W-S45E, N15E-S15W and N55E-S55W are evident. Except the N15W-S15E direction, the rest are comparable with the observed regional pattern. But as far as mineralisation is concerned the N15W-S15E direction, though significant only in peridotite, assumes importance because one of the two major trends observed in the case of minor veins nearly coincides with it. Since the fracture pattern observed in peridotite is in general comparable with the regional joint pattern, joints in the host rock and the country rocks have a common origin.

From the above it is seen that there is close affinity between magnesite veins and fractures in the rocks. Mineralising solutions have particularly preferred the NW-SE trending regional fractures as most of the major and a large number of minor veins follow this trend. Further, in the case of minor veins the NNW-SSE trending fractures, prominent mainly in the host rock, have also acted as favourable sites for mineralisation. Structural control exercised by NW-SE and NNE-SSW trending fractures in localising magnesite mineralisation has important bearing on future prospecting for magnesite in the Attapadi area.

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DEPENDENCE OF LINEAR THERMAL EXPANSION COEFFICIENT ON THE RATIO OF GROUNDMASS TO PHENOCRYSTS OF METAVOLCANICS OF INDUS SUTURE ZONE, KASHMIR HIMALAYA

LINEAR thermal expansion coefficient (a) characterizes the capacity of rocks to expand, and determines the change in dimensions when heated. This is of considerable geological significance in determining the joint and fracture pattern in igneous rock masses. The present note gives the preliminary results on thermal expansion of metavolcanics from the Indus suture zone, Kashmir Himalaya and in particular on the dependency of (a) on the groundmass to phenocryst ratio (G/P).

(a) upto 800° C is measured using the dilatometer technique (Ramana[1], Reddy, Rao and Ramana[2]), with a heating rate of $\leq$ 2° C/min. If the length of the sample at a temperature T° C is given by (L_t), and if its length at ambient conditions is (L_a), then (a) is evaluated from the relation, $L_t = L_a(1 + aT)$. The results of (a) are obtained in 1 cm. cores (L_a = 2 to 3 cm), in the temperature range 40° C–600° C only, since the apparent linear thermal expansion coefficient of rocks is affected beyond the fracture initiation temperature (T_g), as reported by Ramana and Sarma[3].

TABLE I

Physical Properties of metavolcanics

Sample No.	Rock type	Density g. cm^{-3}	Porosity %	Groundmass/ phenocryst ratio	Linear expansion coefficient (a) $\times$ 10^{-6}/°C
SK–30	Spilitic diabase	2·83	0·3	38·4	6·0
SK–44	Metadolerite	2·87	0·7	32·0	4·9
SK–26	Trachy basalt	2·82	0·7	21·5	9·1
SK–2	Augite metabasalt	2·91	1·9	23·5	11·8
SK–56	Metabasalt	2·82	1·8	20·5	5·3
SK–47	Spilite	2·89	1·4	22·5	11·1
DRN–5	Metabasalt	2·77	2·0	38·7	6·8
DRN–16	Metabasalt	2·81	..	16·8	8·3
DRN–4	Metabasalt	2·87	0·4	48·8	8·4

Note : SK : *Sanko-Kargil region.* DRN : *Dras region.*

Petrologically, the metavolcanics vary from spilitic to trachytic type, and are highly porphyritic with phenocrysts (mostly plagioclase, $Ab_{60}An_{40}$–$Ab_{80}An_{20}$, and a few of augite), varying in size from 0·8 mm to 2·2 mm enveloped in a microcrystalline groundmass made up of saussuritized plagioclase, chlorite, actinolite, epidote glass and iron ore. In general, the study of the metavolcanics is of considerable geodynamics interest, since they form a part of the ophiolitic sequence of the Himalaya (Gansser[4]).

The physical properties of the metavolcanics are listed in Table I. The densities of these rocks vary within narrow limits, 2·77–2·91 g. cm^{-3}. It is observed that the (a) values of the metavolcanics vary from $4{\cdot}91$–$11{\cdot}83 \times 10^{-6}$/° C. These are in good agreement with the findings of Ramana[1] on Deccan basalts ($a = 4{\cdot}69$–$13{\cdot}85 \times 10^{-6}$/° C), and spilitic basalt from Bhowali-Kumaon Himalaya, showed a value of $9{\cdot}79 \times 10^{-6}$/° C (Ramana and Gogte[5]). However, Baldridge *et al.*[6] reported a higher value of $15{\cdot}9 \times 10^{-6}$/° C for Fairfox diabase, but its heating rate is not known.

In this study, an interesting correlation between the linear thermal expansion coefficient and the groundmass to phenocryst ratio has been observed. (a) is found to decrease with increasing (G/P) ratio yielding the least squares relation,

$$(a) = -0{\cdot}0642\,(G/P) + 9{\cdot}8456,$$ as shown in Fig. 1.

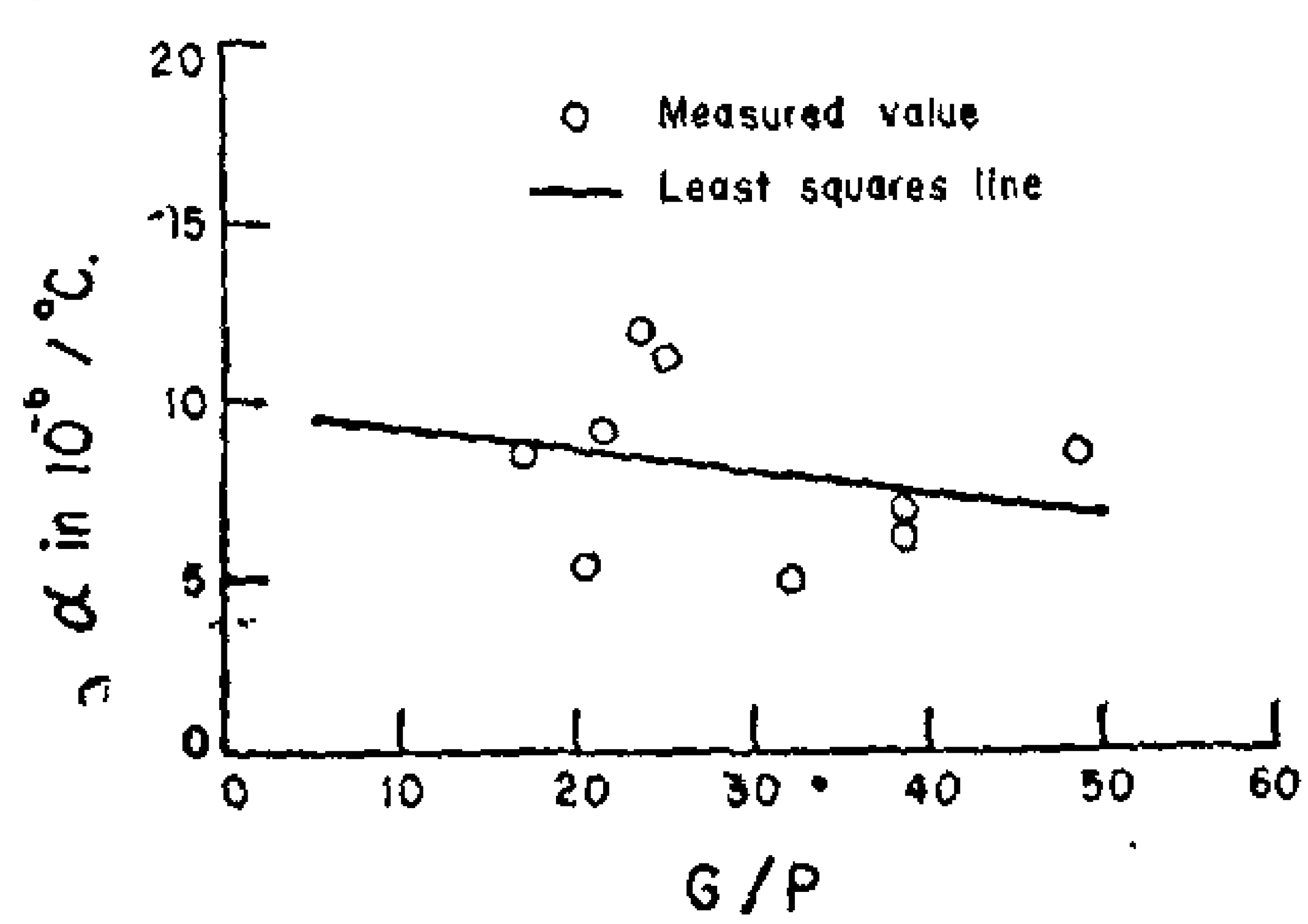

FIG. 1

The results suggest that groundmass–phenocryst ratio is an important contributing factor for the thermal expansion of rocks. As the volcanics become more porphyritic, the value of linear thermal expansion coefficient also increases. The elastic wave velocities and the compressive strength of metavolcanics are also found to increase with increasing (G/P) ratio (authors[7]). The crack porosity observed in the rocks is due to the differences in thermal expansion of augite and plagioclase *minerals* (Nur and Simmons[8]) that form the major minerals in basalts.

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THE ALAKNANDA THRUST

THE Alaknanda Thrust is referred to as a fault by many workers and recently by Kumar and Agarwal[1]. The thrust is exposed at 8 km north of Rudraprayag along the Rudraprayag–Kedarnath Motor Road, at 13 km northeast of Rudraprayag near Saterakhal, at 13 km east of Rudraprayag near Gholtir and Nagrasu, at 24 km east of Rudraprayag near Chatwapipal, and between Karnprayag and Nandprayag near Langasu and Kaleshwar (Fig. 1). The thrust is traced

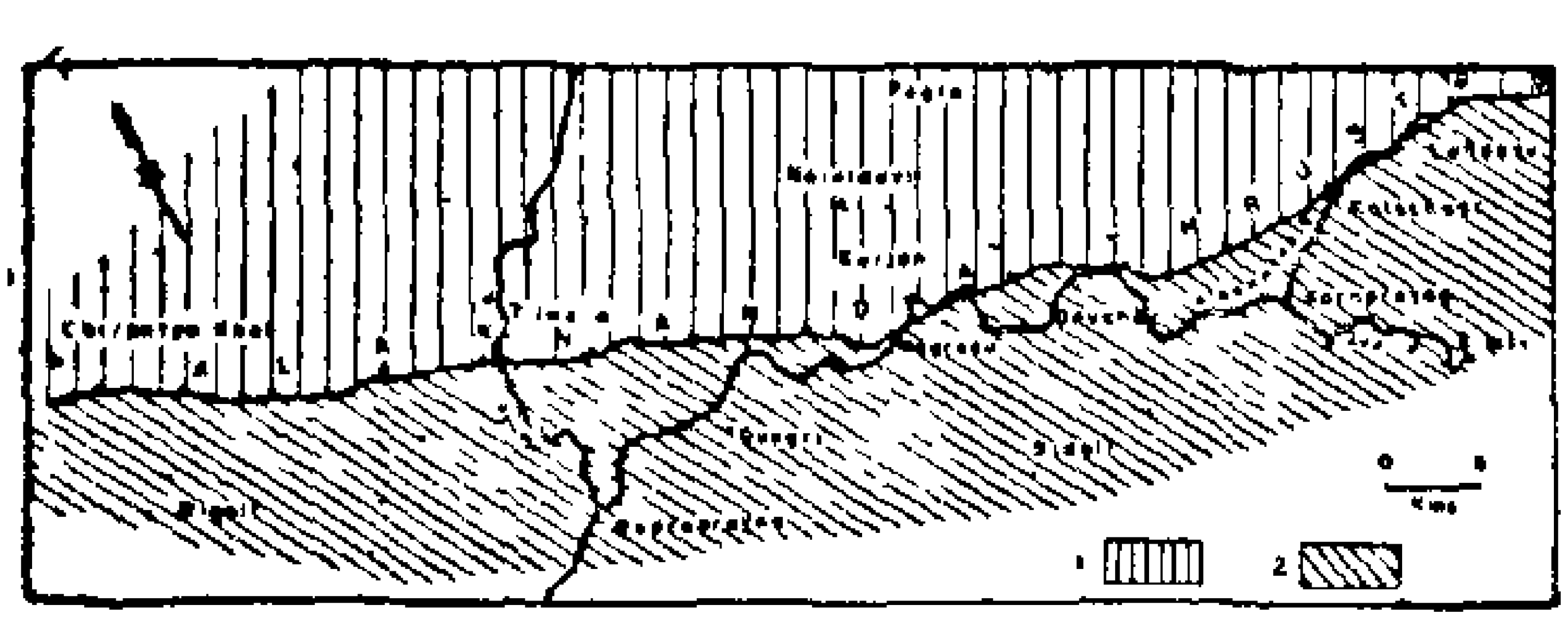

FIG. 1. Generalised litho-tectonic map of the area (modified after Kumar and Agarwal, 1975) to indicate the position of the Alaknanda Thrust, 1—Naini Group (metamorphics with intrusive Naini Granite and metabasics) and 2—Garhwal Group (unmetamorphosed sediments with basics).

for more than 45 km in length with a variable width of 1/2 to 2 km. There is a wide zone of crushing all along the thrust. The Alaknanda Thrust abruptly cuts through all the earlier structures and is the latest structure of the area (Rawat and Varadarajan[2]). From the following points it becomes clear that the Alaknanda Fault is a thrust :

1. The Alaknanda Thrust is a reverse fault with varying angles of dip, ranging from 30° (at Saterakhal) to as high at 70° (at Gholtir) towards north or northeast. It is a sub-vertical reverse fault which flattens to form a thrust or low angle reveres fault at places.

2. The structural set-up of the two regions in the south and north of the Alaknanda Thrust is quite different. This is evidenced by the contrasting strikes of the two areas. The strike of the rocks in the area south of the Alaknanda Thrust is NE–SW (Rawat[3]), while north of this the strike is NW–SE (Rawat and Varadarajan[2]).

3. The northern part is more intensely deformed and metamorphosed than the southern part with respect to the Alaknanda Thrust. The sediments in the northern part are regionally metamorphosed and intruded by Naini Granite, while those in the southern part are unmetamorphosed.

4. The northern part exposes the rocks of the Chail nappe (Valdiya[4]) or the Naini Group (Rawat and Varadarajan[2]), while the rocks in the southern part belong to Garhwal Group (Berinag nappe with quartzites, equivalent to Chamoli or the Haryali Quartzite or the Nagthat Quartzite). The Alaknanda Thrust separates the two groups from each other. This indicates that the older Naini Group is thrust over the younger Garhwal Group. It is also noted by the authors that no rock unit of the northern region repeats itself south of the Alaknanda Thrust thereby confirming the thrust.

In the Kumaun and the Garhwal Himalaya, Saxena[5] and many others have noticed that the Main Central Thrust, which is the southern tectonic unit of the Central Crystallines, does not appear to be a sharp tectonic line but consists of several parallel faults. These parallel faults appear to be the surface manifestation of a series of *en-echelon* reverse faults. The Alaknanda Thrust is one such reverse fault parallel to the Main Central Thrust, and represents one of the youngest tectonic features of the area.

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