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CAMBRIDGE LADAKH EXPEDITION 1985

PATRON: PROFESSOR SIR HANS KORNBERG, FRS, MASTER OF CHRIST'S COLLEGE.

MEMBERS:

Stuart RAEBURN	Leader, Christ's College,Cambridge.
Andrew BARHAM	Finance Officer
Mark TREWIN	Medical Officer
Jeremy REVANS	Food Officer

OBJECTIVES: Scientific research and ethnomusicological study.

Study of:1)Glacial geomorphology and Quaternary history of a 50 sq.km area around Nimaling,Markha,Zanskar range, Ladakh

2)Origin of yellow silts in Lamayuru basin Lamayuru,Kargil,Ladakh,India

3)Folk songs and music of the Ladakhi mountain villagers in Markha valley.

4)Glacial hydrology by conductivity measurements of meltwater.

Project Leaders: 1,2&4 : S.Raeburn; 3: M.Trewin

DATES: 3/8/85-10/8/85:Travel from London to Leh,Ladakh including 3 day delay in Srinagar,J&K, due to monsoon causing blockage of road over the Zoji-La (pass).

10/8/85-12/8/85:Visiting contacts & arranging supplies

12/8/85-18/8/85:Trek to and research in the Markha valley below Nimaling.

18/8/85-29/8/85:Mapping in Nimaling.

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29/8/85-31/8/85:Trek back to Leh via Hemis.

1/9/85-2/9/85:Restocking of provisions in Leh.

3/9/85-8/9/85:Sedimentological study in Lamayuru.

9/9/85-12/9/85:Bus journey to Padum,Zanskar.

13/9/85-19/9/85:Research on trek from Padum to Darcha.

19/9/85-24/9/85:Return to Delhi and London.

Weather Conditions: Excellent.Only precipitation during our stay was a 15 minute hailstorm. Skies usually cloudless(80% of days).On overcast days high peaks(>5,500m) hidden by cloud on 10% of days.Winds usually light,lightest during the middle of the day.Greater than force 5 on only 2 days in 4 weeks.

ESTIMATED COST: £3000

SUMMARY OF FINDINGS:

Ladakh:1) Introduction.

The geomorphology of Ladakh has a regional individuality owing to its position within the Himalayan rain shadow. The area is the domain of high and dry subtropical mountains,the humid air masses of the monsoon are prevented from coming from the south by the barrier ranges.The average daily temperature in Leh,the capital,runs from -8 C (January) to 17 C (July). The total rainfall is 80mm water/yr. It mainly falls during winter,as,snow, which melts very quickly during the spring producing a large quantity of run-off,an inportant factor in determining present morphology.

The flora is restricted in diversity and number - dwarfed and stunted shapes are common.Shrubby forests are located in flood plains at lower altitudes e.g. Skiu-Markha at 3,500m. The use of wood for building and fuel has accelerated the disappearance of the riverain forests.

2) Geology.

The geology of the Zanskar range where we carried out most of our work proved to be very complex. The whole region has suffered a complex deformational history;at least three deformational events: DH1, DH2, DH3 were observed in the calcschists near Markha. The major period of folding DH2 shows fold axes running North with variable plunges. The lithostructural units observed included:

1: Calcschists
2: Quartzites
3: Molasses/coglomerates
4: Baked siltstones
5: Gneisses and Granites

The calcschists have well developed primary cleavage SH1 frequently crenulated by further fabrics. There is abundant calcite veining which has an appearance similar to quartzo-feldspathic veins in injection gneisses.

The quartzites are pink on weathered surfaces forming resistant features. The boulders of quartzite found within the moraines are also very resistant to weathering - no taphoni were ever found developed within them.

The molasse/conglomerate is a remarkable assortment of boulders,gravel and matrix. Some of the clasts,particulrly those of sandstone,are very large,up to 30cm. in diameter.

The baked siltstones are fine-grained,compact rocks,with a concoidal fracture and a very dark colour,almost black. Their baking was confirmed by the discovery of an intrusive granite in contact with the siltstone,unfortunately not in situ.

I will describe the granites and gneisses prevalent in Zanskar when I consider that part of the journey. All the units have suffered very low grade metamorphism although Professor Georges H Mascle of Grenoble,who I met in Ladakh told me of the discovery of blueschists by his team this summer indicating high-pressure low temperature metamorphism. This is compatible with the plate tectonic story of the Indus suture zone. A subject worth further study would be the relationship between the various deformations and metamorphic maxima.(cf study in the Eastern Alps of Europe).

3)Valley morphology:

The Zanskar range through which the Markha Valley has been cut consists of several parallel and sharp ridges. The calcareous rocks (calcschists) form spikes and spires . In contrast the selective dissection based on resistance to weathering has exploited the alternation of shale and sandstone/conglomerate accurately reflecting the thickness of the beds. Much of the fine debris blanketing the slopes of the mountains which imprison the river Markha are formed by frost shattering of the intensely tectonically fragmented shales and calcschists. The general morphology is of long valley sides covered with frost-clastic screes developed below gentle slopes or debris slides dissected by rills and affected by snowy soliflucion - so-called "slush flows"(Washburn A.L. 1973 "Periglacial Processes & Environments" Arnold,London)

4)Glacial morphology:

In the upper Markha Valley,above Nimaling ,the present snowline is at 5,200m (N-facing slopes) and 5,400m(S-facing slopes). There are numerous glaciers below summits exceeding 5,500m, mostly cirque glaciers which extend via piedmont glaciers to valley tongues fringed by lateral and frontal moraines. the extremity of the tongue is frequently covered by a layer of debris which reduces ablation and hence the rate of ice retreat. Near the Chakdang-La we found a large kettle lake, approximately

1 km long below a large piedmont glacier ,altitude 5,100m. Lower down the valleys, glacial remains are patchy. A first stage appears around 4800m,close to the present glaciers,recognized by morainic ridges and the abundance of kames implying a debris covered glacier type. Several stationary stages related to prehistoric ice fronts were observed lower in the valley. However all these stages seemed to be related to one period of glacial retreat(with occasional phases of zero movement); I could find no evidence to separate glacial retreats into two major periods (Nimaling and Hankar stages as defined by Fort in Contrib. to Himalayan Geology Vol 2 p39, 1982 Hindustan Publ. India). The morainic boulders are largely of the Rupshu granite (mapped by A.Baud's Swiss team outside our mapping area). In addition there are boulders of baked siltstone and quartzite. The calcschists have all been shattered by frost wedging to a fine covering of micaceous dust and shards of rock. The lowest trace of glacial deposits was at 4000m, just above the village of Hankar and consisted of granite erratics sitting 100m above present river level on a slope of frost-shattered calcschist. they represent the lateral moraine of the Markha glacier at possibly its lowest altitude. Lower still no definite glacial deposits were seen. This could be due to the gorges which occur sporadically along the Markha Valley and isolate the upper part of the mountainous valleys from the lower part. Alternatively morainic deposition may have been removed by subsequent river discharge associated with the annual rapid melting of snow. Glacier tongues probably extended lower than Hankar since a U shape profile to the valleys is a common feature.

There are frequent occurences of slush flow fans produced by sudden and rapid discharges appearing below deglaciated but snow covered slopes. These slush flow fans are well exposed near

Nimaling as a thick (200m) accumulation of coarse clastic fragments embedded in a fine matrix showing good layering. This cold type of solifluction occurs as a result of an abundant snow cover,able to melt in a very short time (due to high altitude and low air humidity).

Lamayuru: The village of Lamayuru and the monastery itself stand on top of deeply dissected river gravels approximately 50m high. To the east of the monastery lies the basin 4km x 2km x 200m deep. About 20% is covered by layers of yellow silts from 20m thick at the western end of the river valley to 100m thick towards the eastern extremity. The degree of dissection of the silts varies with distance from the centre of the basin; maximum dissection occurs high up on the sides of the mountains to the NE. On close inspection the yellow silts are laminated on a scale of 1cm. The laminations reflect varying Fe-content so some are brown, others a very light yellow. The bands also show good parting suggesting they reflect bedding surfaces. In addition small displacements(1cm.) occur throughout the silts suggesting a settling or slumping possibly associated with dewatering. The most astounding feature of the silts is the constant height of the uppermost beds. The top of the deposit defines a contour line around the valley edge about 200m above present river level. In addition the base of the silts varies around the valley sides. It can be seen as a sharply defined contact with the shale dust debris blanketing the lower slopes of the hills to the North of Lamayuru. The silts can often form upstanding mounds rising above the general silt level in the centre of the basin.

The remarkable homogeneity and constancy of maximum extent of the silts suggests a lacustrine environment. The layers (1cm thick) could represent annual sediment input. the hypothesis that the deposit is loess(Erik Norin,1925, Preliminary notes on the late Quaternary glaciation of the NW Himalaya,Geografiska Annalen) can be refuted since there are occasional larger lithic fragments,often of shales or sandstones ranging from 1 to 8 cm,too large to have been carried by wind. These could represent an increase in velocity of rivers feeding the lake from time to time.

The mechanism for firstly blockage of the basin to form the lake and subsequently its removal and draining of the lake could be either glaciological or tectonic. Tectonic movement could cause blockage of a river by landslip material; tilting would produce a suitable geometry for deposition of lacustrine sediments. Later, further movement or erosion breaking through a debris barrier could drain the basin and allow preservation of the silts. These would subsequently be incised by the present river. Alternatively, the basin could have been a huge ice-dammed lake produced by differential ice melting rates. Eventually the ice dam itself would waste away and the basin would empty. The tectonic mechanism seems more likely to me since I saw no glacial varves characteristic of ice-dammed lakes. In addition, the plate tectonic model for the region suggests Earth movements in recent times are a possibility.

Zanskar: The fourth project, the glacial hydrology study, had to be all but abandoned when NERC Equipment Pool informed us two weeks before departure that the conductivity meters which we were expecting to use were no longer available. It was therefore decided to try some very rough measurements on flow rates and suspended sediment load at Nimaling (see fig.3). In addition we decided to trek through Zanskar (from Padum to Darcha) and compare the geomorphology there with that seen in Ladakh.

The striking difference between Zanskar and Ladakh is the amount of vegetation. The rainfall in Zanskar is significantly higher and this is displayed by the abundance of ground height vegetation. It is also colder in Zanskar, and this fact combined with greater precipitation means that present glaciers are found at lower altitude. One of the more remarkable sights of the journey from Kargil to Padum was that of a glacier front at an altitude of only 3,800m standing 20m above the river into which it flowed. Ice was being calved off and there were even small icebergs (a few metres across) floating in the river.

The Padum plain, altitude 3,500m is a flat lying expanse,marked by the confluence of the Doda and Zanskar rivers. It was apparently created by a glacier moving down the valley from the Pensi-La (below which there is still a glacier today) and by another glacier moving south along the present Zanskar Valley (in the opposite direction to present river flow). The two glaciers joined and progressed a few 100m SE of Padum up to the Lunak gorge. This marks the limit of glaciation since it is obviously a water-cut gorge. This gorge extends for some 20km before broadening out beyond Testa into another glaciated terrain. We identified four separate moraine stages along the Doda Valley, including Kame terraces above Padum. The details of these can be seen in the accompanying map(fig 4). A full explanation of all our research will appear in our final report.

CONCLUSIONS:

I recommend anyone interested in glacial geomorphology to visit Ladakh. The features descibed in geography text books are well illustrated in this region. In addition the metamorphic geology of the area deserves further study.

We carried out as many of our objectives as we could in the short time available - I would suggest anyone travelling to this part of the world give themselves more than eight weeks. Unfortunately our time was limited by the leader's commitments in Britain viz mapping project for his finals during July and a field course before the start of the University term.

ACKNOWLEDGEMENTS:

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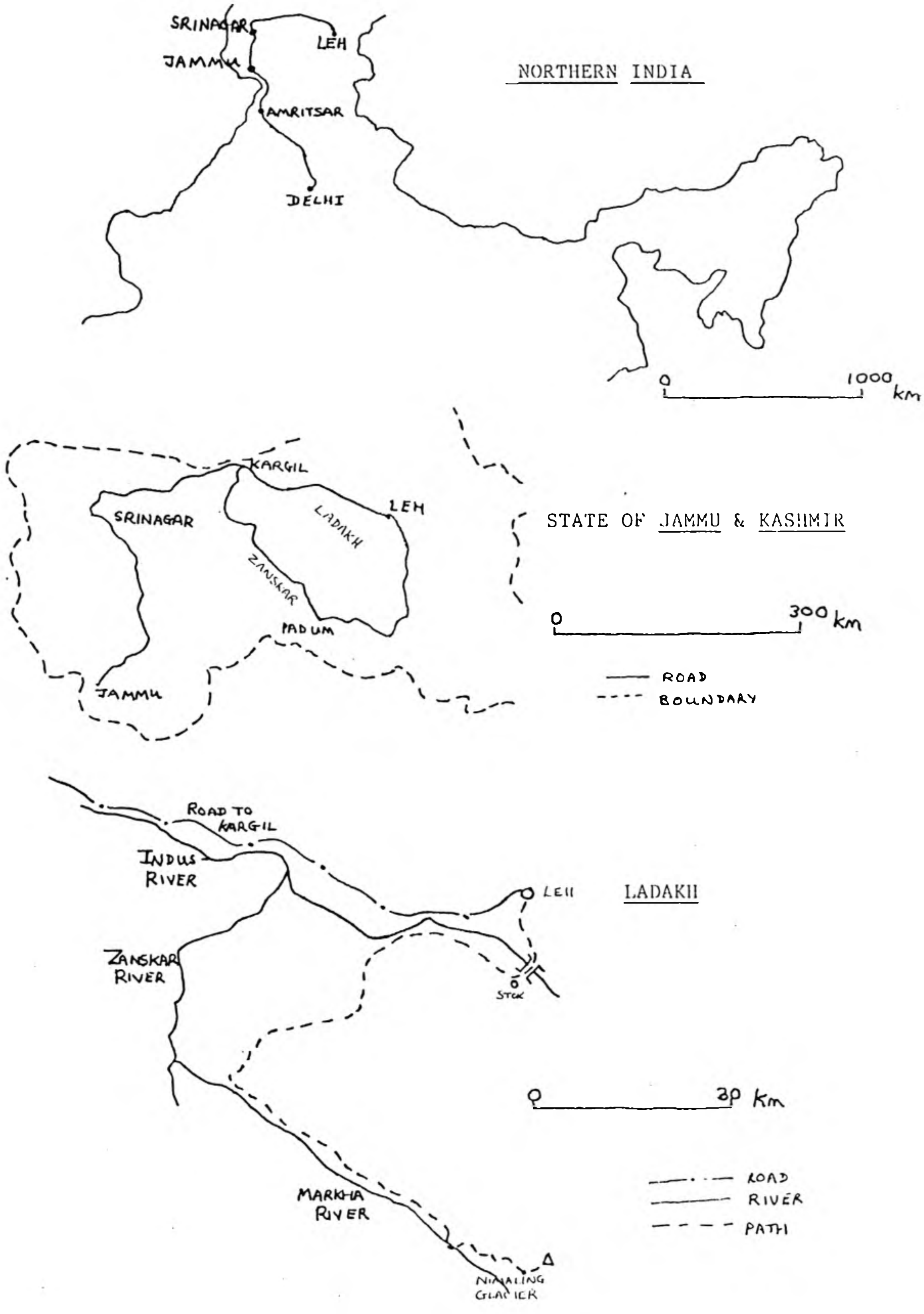

Fig. 1 Sketch Maps of the region

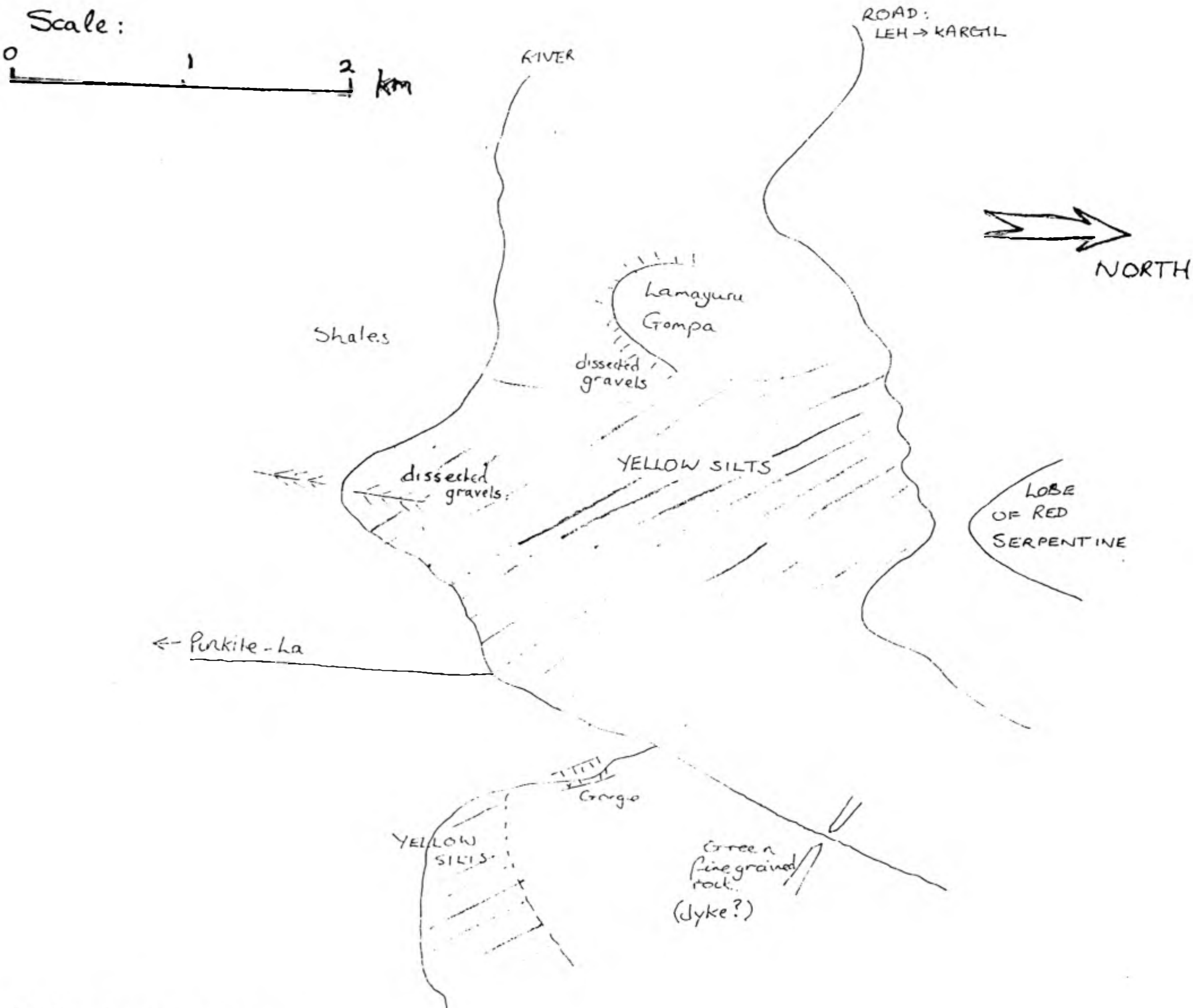

Fig 2. LAMAYURU

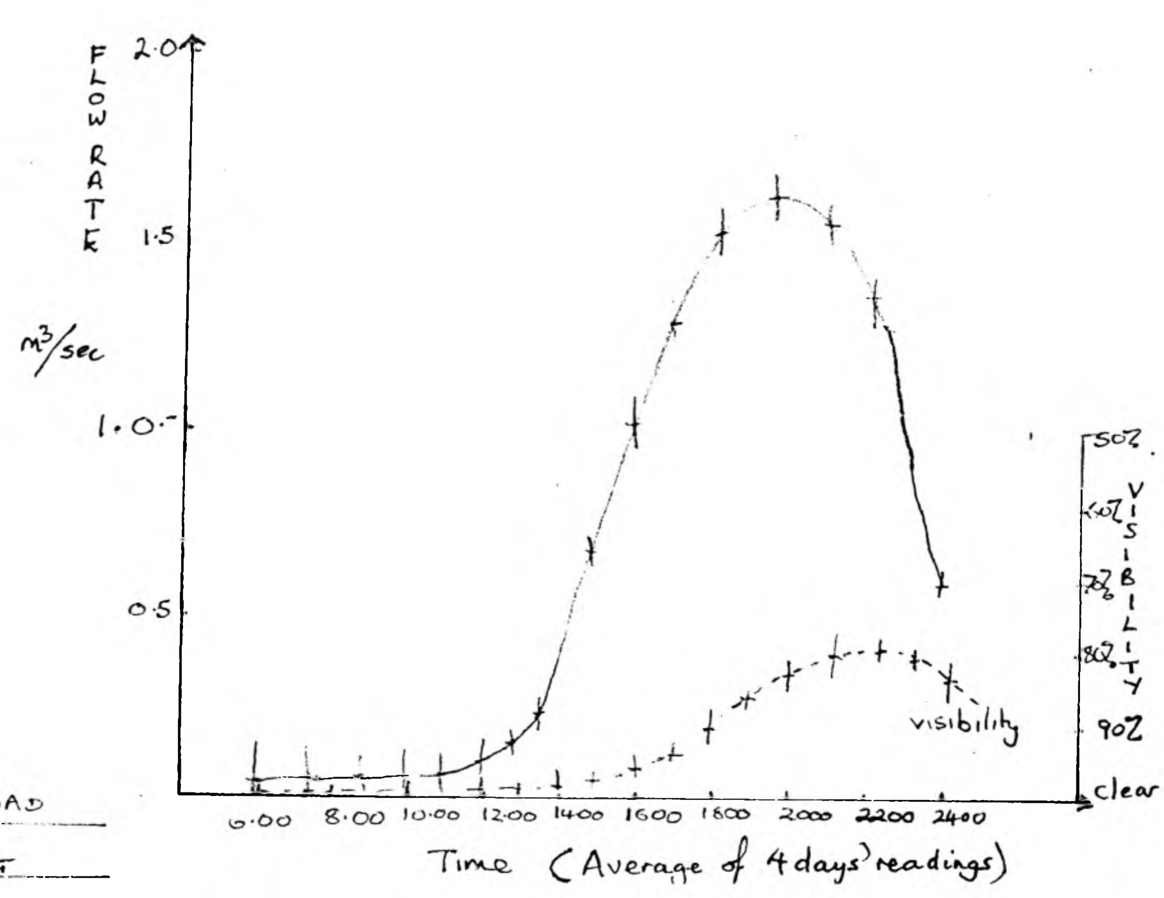

Fig 3 SEDIMENT LOAD
AT NIMALING

Fig 4: FEATURES IN ZANSKAR