SNOW AND ICE HYDROLOGY PROJECT

UPPER INDUS BASIN

WAPDA — IDRC — WLU

HANDBOOK OF SNOW & ICE HYDROLOGY
V CONDUCT OF INVESTIGATIONS

HANDBOOK OF SNOW AND ICE HYDROLOGY

A set of manuals on the theory and practice of hydrology and investigations for water resource development in high mountains, focusing upon conditions in the Himalayan tributaries of the River Indus.

Volume 5

Conduct of High Mountain Operations

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Vol. 4 Runoff Hydrology of glacier and snow-fed streams

Vol. 5 Conduct of High Mountain Investigations

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Preface

The purpose of these handbooks is to provide scientific background and guidance on practice for water resource surveys, measurements and forecasting networks in high mountain areas. The focus is largely upon surface conditions and ground based investigations in snow-covered and glacierised catchments. While drawing upon world-wide experience and internationally accepted procedures we emphasise situations occurring in the South Central Asian high mountains, especially the Upper Indus Basin (U.I.B.), and the experiences of the Snow and Ice Hydrology Project (S.I.H.P.) (1985-1988). In order to meet the immediate needs of the Water and Power Development Authority (Pakistan) we have provided five manuals dealing with hydrometeorology, glaciers and snow-melt hydrology, runoff hydrology and the conduct of high mountain operations. It is anticipated and recommended that, as WAPDA's activities in this regard expand, the present manuals should be expanded and updated, and that additional volumes should be added as the scope of the work broadens.

In preparing the manuals we have been concerned to provide some basic background on the regional conditions in the U.I.B. and hydrological theory, but mainly to address the practical questions which face the field worker.

K. Hewitt

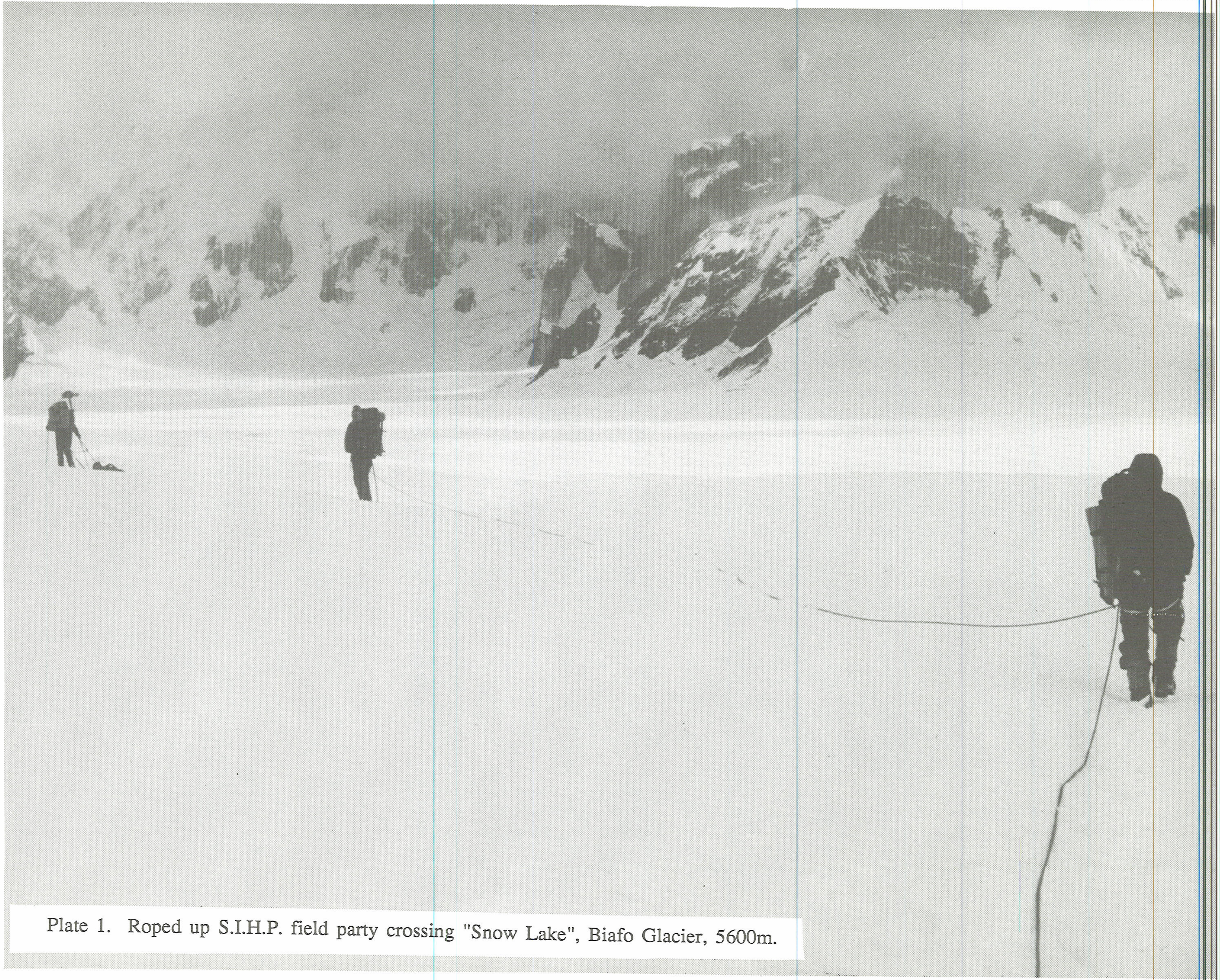
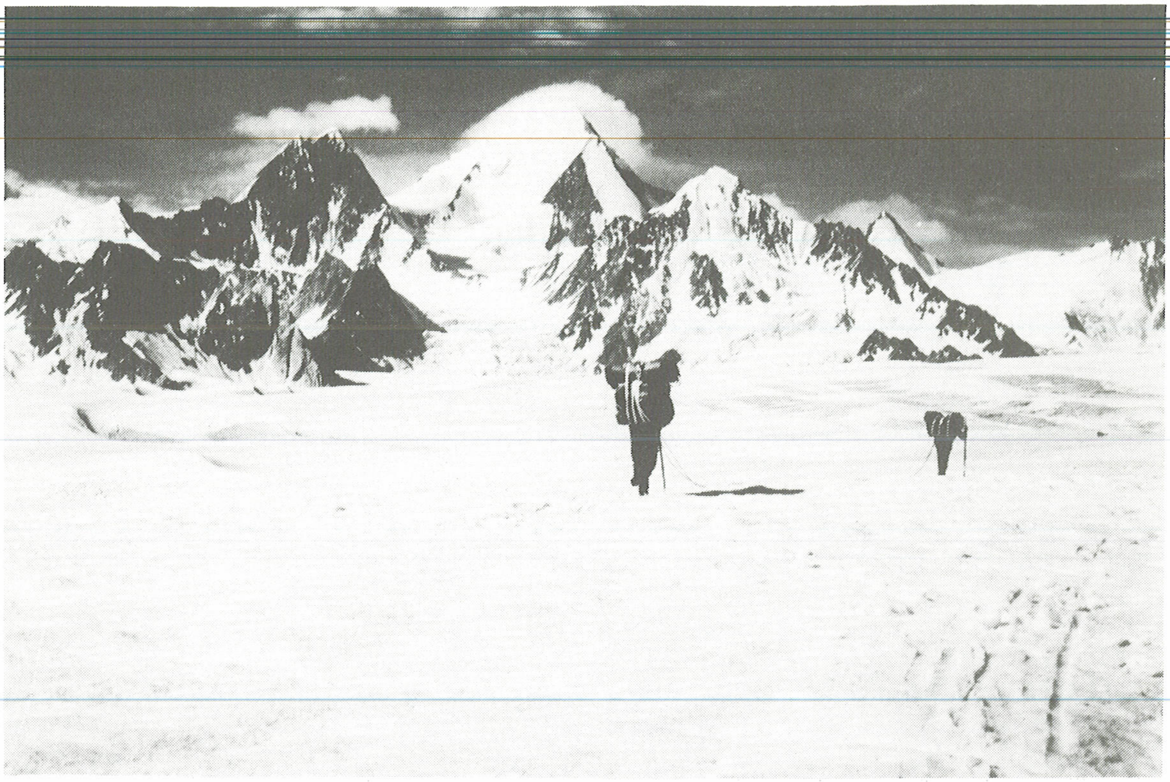


Plate 1. Roped up S.I.H.P. field party crossing "Snow Lake", Biafo Glacier, 5600m.



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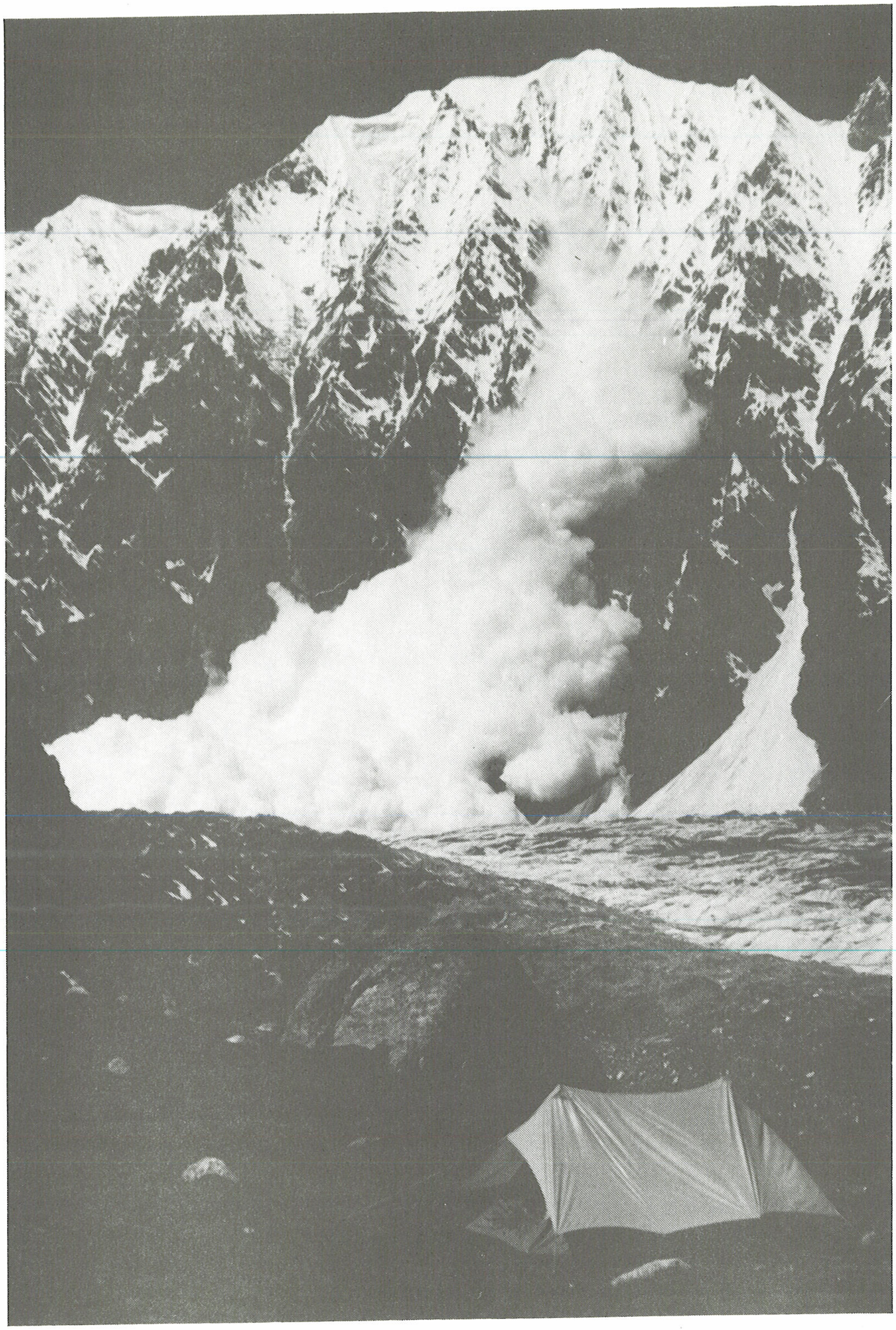

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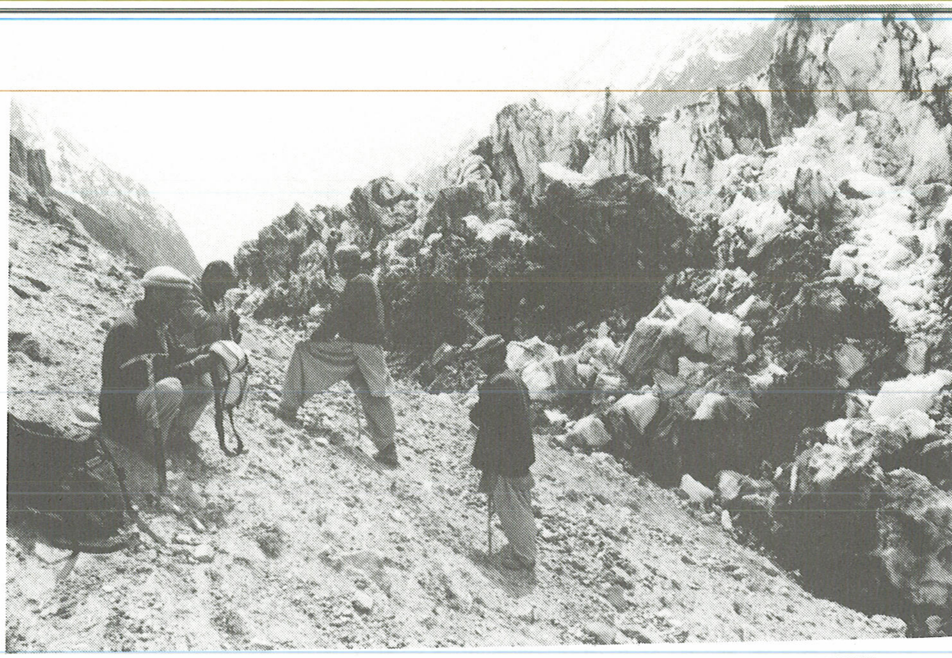

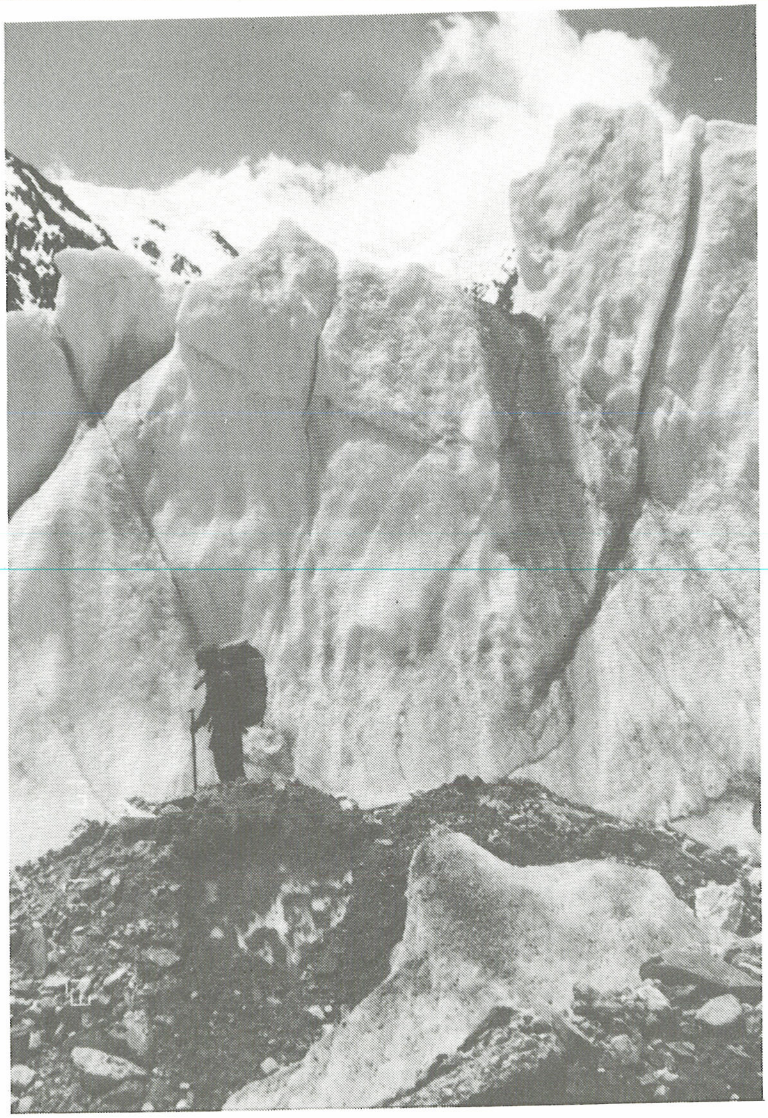

Plate 6. Problems of glacier travel.
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CONDUCT OF HIGH MOUNTAIN OPERATIONS

B. Bacsu, C. Bradley, K. Hewitt and E.Mattson.

I Introduction

Studying variations in water yield from mountain catchments requires work at high elevations, and on snow and ice surfaces. Such environments present inherent dangers to the field-worker which only proper equipment and experience can provide a satisfactory level of protection against. Field parties should avoid terrain and conditions of extreme nature which involves mountaineering merely to carry out operations. Even so there are risks and unusual demands on field workers.

A first principle of this work should be that parties not already trained and experienced to the extent of two or more field seasons, must be led or guided by one or more experienced mountaineers. This should be applied wherever work is conducted:

- i) on glaciers;
- ii) in winter;
- iii) above 3000 m a.s.l.;
- iv) in steep, snow covered areas.

In most parts of the U.I.B. local persons with mountaineering expedition experience are to be found. Unfortunately, for short-term programmes, hydrology field-work must compete with expeditions. Unless WAPDA can pay expedition rates at these times, it risks not having competent mountain guides. In the long term, a snow and ice programme will need permanently employed officers with mountaineering and guiding competance and training arrangements to provide for this problem. The present manual is designed as an indication of needs. It should not be treated as a substitute for experienced persons in actual field-work.

To complete monitoring programmes under high mountain situations it is essential to know how to recognise the symptoms of altitude sickness and be proficient in first-aid. While climbing skills and an ability to ski are of advantage when working in the accumulation area, at lower elevations it is possible to make do with an understanding of the basic skills of glacier travel. This involves an element of route-finding, understanding the dangers from avalanches and rock-falls, and being able to recognise crevasses, and hence skirt around them, but having experience in the techniques of crevasse rescue. It is possible to minimise the dangers if one is fully prepared (i.e. properly clothed and equipped).

Again field parties should contain at least one person who is fully experienced in mountain techniques, rescue and recognition of hazards. Unless the majority of the other members have at least one season's experience, time should first be spent in a mountain training camp and basic skills, such as crevasse rescue, should be practised before field work commences.

II Clothing and Equipment for Mountain Travel

When travelling and working in the mountains one should be properly clothed and prepared for any of the rapid changes in weather that are typical of this environment. The clothing should also be able to dry quickly and be sufficiently tough to withstand continual use.

It is generally accepted that the most appropriate clothing system should consist of a series of layers so that if one becomes too hot the outer layer can be removed to avoid excessive perspiration. There should be a total of four layers:

1) Wicking layer.
2) Middle layer.
3) Insulation layer.
4) Wind/Waterproof layer

The wicking layer should be next to the skin, and serves to wick moisture (sweat) away from the skin and keep it dry. Wool, polypropylene, or silk underwear performs best. Cotton should be avoided because it is hard to dry once wet and if wet will take heat away from the body.

The middle layer takes the moisture from the wicking layer. It could be made of wool or a synthetic material.

The insulation layer acts to maintain body heat. It could be a wool sweater, pile jacket, or insulated parka, depending on the temperature and what the wearer feels most comfortable in.

The wind/waterproof layer keeps the other layers dry. It could be coated nylon or a waterproof, breathable fabrics like Gortex. Having a jacket and trousers of this material provides a flexible combination of clothes which are also very useful when working at lower elevations.

It should be remembered that different combinations of the above will be required depending on the temperature, but also on the degree of energy being expended by the individual. While walking in the mountains a lot of energy is used which helps keep one warm, and may reduce the need for one or more of the above clothing layers. It is extremely important however, that some spare clothes are carried which can be worn on stopping. If one is to work with a theodolite at 4000 m, for example, different combinations of clothes will be needed than if one is to drill a stake at 4000 m, even if the weather is the same.

Having correct footwear is very important when working in the mountains. A combination of leather hiking boots with gaiters generally works well. A gaiter is a covering for the top of the boot and the bottom of the leg. Gaiters help keep the feet dry and prevent stones from entering the boot.

The leather boots should be full-grain leather and sufficiently stiff for flexible crampons to be used. Many mountaineers now use plastic boots but these are uncomfortable to walk any distance with. Even leather boots may take some time to break-in, and it is always worthwhile to do some walking to break the boots in before the start of field-work.

While in the mountains precautions should be taken for protection from the sun. At high altitudes and on snow and ice surfaces, the sun's power is greatly increased, especially through reflection. Sun glasses, called 'glacier goggles' <u>should be worn at all times</u>, even on cloudy days. A floppy hat is also useful to shade the face. Sun screen and blocking creams should be used on exposed skin. Zinc oxide creams work well in this regard.

In Appendix I there is a list of personal clothing and equipment that should probably be included for working in the mountains.

III ROUTE FINDING

Travel and work in the mountains involves finding a way safely over a wide variety of terrain; in rugged and, for the inexperienced, bewildering topography, and where sudden changes in weather and large changes in conditions with elevation, are to be expected. Route finding, to minimise physical strain; recognise and avoid dangerous or unstable areas, and achieve work goals efficiently, is an essential skill. Again, there is no substitute for experience, and routes should always be chosen, and in new areas, led by a fully experienced mountain guide. However, all members of the party need to be equipped and prepared to act competently if unexpectedly stranded or in an emergency. That means each member must have, in addition to the proper clothing, an emergency food and medical kit, and the means to find a way to safety. Hence everyone in the party must have the best available topographic map of the work area; must carry a compass, and be familiar with both before work commences. Map reading is basic. Orientation and route selection skills should be part of the background of field officers expected to go on regular duty in the mountains.

3.1 Maps

Sets of topographic maps for field areas identifying instrument sites, established routes, camp sites, and places of refuge should be held in the office where the field party members normally are based. They should be familiar with these maps. Where possible they should be supplemented with satellite images and a photographic archive from previous visits. In going into the field, each officer should have a copy of the topographic map for his use. Since these maps are often expensive, sets of photocopies may be made of work areas. The map should be carried in a waterproof container in the individual's personnel gear Ideally the topographic map should be of a scale 1:50,000 or better, with contour intervals of 100 m or better. In many parts of the U.I.B. such maps are not available, but 1:250,000 are. For areas of major activity it will be useful to have these blown up photographically, and detail added in areas of recurring field-work, or routes to permanent monitoring sites.

Officers should know how to interpret a contour map, how to orient the map and use it in conjunction with a compass. They should become familiar with the features the map shows - and does not show. Local detail, critical for way finding and safety, is lost on 1:250,000 maps, and in steep terrain, cannot be shown even in the most detailed maps. Here is where photographs and information from previous visits, and, above all, local guides are invaluable. As a general rule, local guides should be hired, at least when working in new areas, but the field team must build its own knowledge of the terrain, and be prepared for the possibility of being without a guide.

Each field party should carry at least one altimeter to keep a check on altitude changes. This serves both to supplement and check positions determined with map and compass, and as a log of acclimatization. Note that an altimeter responds to atmospheric pressure and hence is only an approximate index of elevation. Expect them to be accurate to no more than +/- 50 m.

As a general rule, above 3000 m a party's sleeping altitude should not be increased by more than 300 m a day. This may be relaxed somewhat for teams that have been at higher elevations for some weeks. Sites to be visited and returned from in a day may be as much as 700 m apart in elevation. However, parties should avoid even this much height gain in a day if inexperienced above 5000 m.

Some basic principals of backup for route-finding in high mountain areas are

i) Never proceed along a route you are doubtful of being able to return along, or find again.

ii) Always be equipped for emergency survival if benighted, caught in a storm, or otherwise unable to return to base camp or your vehicle.

iii) Be sure the general whereabouts and programme of each field party is known to and logged at the base camp or other permanently occupied site with outside communications.

Route finding is also about knowing how to travel, and negotiate difficulties associated with rough and unstable ground, crossing streams, travelling in, or avoiding, thick bush, and avoiding avalanche and land-slide prone slopes. For the latter, experience and experienced guides are essential.

Another basic requirement of field personnel is that they be in good physical condition and know how to avoid severe fatigue. These have been two large problems for SIHP, and we advise fitness awareness sessions and training camps for beginners in this work, before any actual field activity.

IV Glacier Travel

4.1 Introduction

In addition to general problems of elevation and rugged terrain glaciers raise some special problems. There are glacier areas of the U.I.B., such as the middle regions of the Biafo, offering excellent and relatively safe surfaces for travel. Such relatively level, unbroken and clean ice is also valuable for locating a variety of monitoring and experimental activities in glacier hydrology. However, much of the glacier area of interest, and often enough, getting to the more congenial areas, involve a variety of hazards to field parties.

Hazards of note include debris covers over the ice surface ('ablation moraine')' seracs and icefalls; large and swift supra-glacial streams; 'moulins' or glacier mills (deep shafts into which meltwater streams plunge); soft snow avalanches, and especially crevasses hidden under snow.

In negotiating most of these hazards, local guides will prove invaluable. Often they will know well-tried routes which avoid the highests risks - in particular along the 'ablation valleys' that offer excellent travelling. Avalanche risks are dealt with later. The one hazard which field parties will have to be trained and equipped to deal with for all glacier work is that of falling into a crevasse.

In winter, in the upper snow-covered areas of the ablation area in summer, and throughout the accumulation zones there is always danger of crevasses, partly or wholly hidden under the snow. We assume that, normally, parties can avoid open crevasses on clear ice. However, if they must cross heavily crevassed or serac areas, not hidden by snow, the drills prescribed here should be applied, since someone may slip and fall.

In snow buried ice, crevasses may still show as depressions and breaks in the snow. Often they are completely hidden. Yet, the snow covering them may not take the weight of a person. Beneath the snow, there may be empty space to the bottom of the crevasse - as much as 20-30 m deep and metres wide in places. Crevasses usually have near vertical or overhanging walls and possibly icy water at the bottom. If someone falls into one unroped, there is little chance of survival, if not killed by the fall itself, they may quickly die from exposure or drowning.

Although falling into a crevasse is a relatively rare experience. During S.I.H.P. over roughly some 4600 man-days on glaciers, and perhaps 1400 where falling into crevasses was a strong possibility, only a dozen cases occurred and none in which the person could not with the aid of the rope, get himself out. In one sense we were lucky, however we were also prepared. All parties in crevassed areas and throughout the ablation zones trained in crevasse rescue. In hazardous areas the lead person probed for crevasses through the snow. We all knew that just one bad fall, one individual moving unroped, could change a good safety record into a bad one.

In sum, field parties should not be terrified by the crevasse problem. They should respect it and be fully prepared. What follows describes what the preparation should be.

4.2 Crevasse Rescue[1]

A fall into a crevasse is one of the greatest dangers for anyone walking on glaciers. Falling down a crevasse requires technical methods for rescue, and must be accomplished quickly to minimise injury from the cold. The necessary skills can only be achieved through practice and experience. If travelling on glaciers for a long time it is expected officers must have lessons from an experienced person before work begins. All members of a fieldwork team should practice and discuss techniques for crevasse rescue so that each is confident of the abilities of the rest of the team. Crevasse rescue is not a technique that one can expect to use first-time with success, unless one has the opportunity to practice the different variants.

When walking on glaciers it is normal to rope together if there is any danger of falling into a crevasse. The rope should be 45-50 m long, 7-11 mm thick, 9 mm is probably the most appropriate thickness being both light and strong. The rope will check the momentum of a fall into a crevasse, but only if it is used correctly. Each person should wear a harness, preferably a full-body or 'sit-harness' with a chest harness which helps keep the wearer upright on falling, an advantage especially when wearing a heavy rucksack. The rope should be tied onto each person's harness. There should be 9 m (30ft) of rope between each person, more if there are wide crevasses in the vicinity. Extra rope should be coiled around the body and shoulders. For a

[1] This discussion is largely based upon March, 1988. Diagrams have been taken from this book with the author's permission.

group of three, the middle person should tie the rope to the harness using a double bowline (Figure 4.1). The end people should have 6-7 coils of rope over their shoulders. The rope should be tied to the harness before the coils using a figure of eight knot, and attached to the harness with a locking carabineer so that extra rope can be released if required. The end of the rope should be tied directly to the harness with a figure of eight knot.

Two prusik loops should be kept on the rope in front of the harness, to help escape from any crevasse (see Figure 4.1). A 5-6 mm thickness prusik loop works best on a 9 mm rope. The loops should be of two sizes, one of 48" for stepping into with the leg, and one of 24" for attachment to harness. The longer loop is kept closer to the harness than the shorter, it may be kept in a pocket to be retrieved quickly when needed, as discussed below. The shorter loop is used as a handle to keep the rope under the foot.

While walking all people in the group should maintain a high level of concentration and the rope should be kept taut. This is very important as it reduces the distance one falls into a crevasse. One must be aware of any changes in pace, and try to prevent the rope dragging on the ground, or pulling other members of the team off their feet. All members of the group should carry an ice-axe which is used to probe for crevasses. It may be helpful to have a wrist loop to prevent dropping the axe. If the leader finds a crevasse he should shout "Crevasse" and mark the spot using his ice-axe so that his followers may avoid it or jump over the crevasse.

When experienced in glacier travel it is acceptable to rope together in groups of two. If anyone is not experienced, roping up in groups of three is much safer. In this case if one in the party falls, there are two people to arrest the fall and begin the procedure for rescue. To reduce the chance of falling, if possible the group should walk at right angles to the crevasses. Here an understanding of glacier morphology and the likely distribution of crevasses is an advantage.

In some cases travelling parallel to the line of crevasses may be unavoidable, in which case the chance for all three of a roped team to fall can be minimised if the middle man walks out to the side from the other two.

Training for crevasse rescue should cover the following drills.

If anyone in the group falls into a crevasse he should shout "Falling". The other people on the rope should arrest his fall by falling to the ground, and digging in with hands, feet and ice-axe (Figure 4.2). The ice-axe may help if on ice. Drop to the ground and roll onto ice axe lying diagonally across the body, while digging feet and axe into the ice. Holding a fall on a snow surface is much easier. Plunge the ice axe into the snow at once to prevent the person falling any further a turn of the rope should be put around the ice-axe.

If the crevasse is small it may be possible to climb out unaided using the prusik loops. One or both feet should be placed in the longer prusik loop, and the prusik knot of the smaller loop (attached to the harness) should be pushed up the rope. Sitting in the harness the knot of the longer loop should then be pushed up the rope. Stepping into the longer loop the procedure should be repeated until the top of the crevasse is reached.

If it proves impossible to climb out unaided, the other people on the rope-team, having arrested the fall of their colleague, should construct a belay (i.e. fix the rope) and prepare for a rescue attempt. They should first try to make contact with the victim to see if he can help in the rescue, but at all times they should remain tied to the rope, and should not approach the edge of the crevasse too closely.

In a snow belay a trench is dug parallel to the crevasse and a small slot placed perpendicular to the middle to form a 'T' shape. A sling is then placed around the middle of a rucksack or ice-axe and placed in the trench with the sling coming out of the slot. The axe or rucksack is then buried with snow as deep as possible, and the surface compacted by stamping. A carabineer is then attached to the end of the sling.

Where there is only a poor snow cover an ice screw should be used. The ice screw must be secured at an angle just back from the perpendicular, with an ice axe used for leverage if necessary. Having placed the anchoring screw a prusik loop should be tied onto the anchor carabineer, and tied off with an overhang slip knot (Figure 4.2). A second carabineer is then tied onto the master carabineer (Figure 4.3). The main rope should be secured with an Italian hitch and overhang slip knot. The rescuer unties from the rope and advances to the crevasse edge, safeguarded by the prusik loop A. Two figure of eight on the bight knots X, Y are tied 30 cm apart, and 3 m from the crevasse edge (Figure 4.3). A figure of eight on the bight is tied at the free end of the rope. A pulley and carabineer is clipped onto this loop and lowered to the victim who clips the carabineer to his harness. The victim is pulled out of the crevasse by taking up the slack on the anchor X.

If the victim has lost consciousness, or is injured and cannot help in the rescue a 6-to-1 pulley system should be used as shown in the diagram.

4.3 Avalanche Hazard

Another serious and common hazard found in all mountain environments is that of avalanches. This is particularily true for the snow covered areas within the U.I.B. which display avalanche activity through out the entire year. Although avalanches pose a serious threat to researchers, knowledge of their characteristics can greatly aid in their avoidance.

Avalanche hazard is greatest during and immediately following a snow fall event of 20 cm or more. There is an additional increase in hazard if the snow falls during a period of low temperatures and dry air conditions followed by a warming trend. This is due to the fact that the lower levels of the snow pack cannot support the over-lying heavier layers due to weak interparticle bonding. Rapid changes in air temperature also cause the snow pack to metamorphose causing it to become unstable. Long periods of warm weather or rainfall may cause wet snow avalanches.

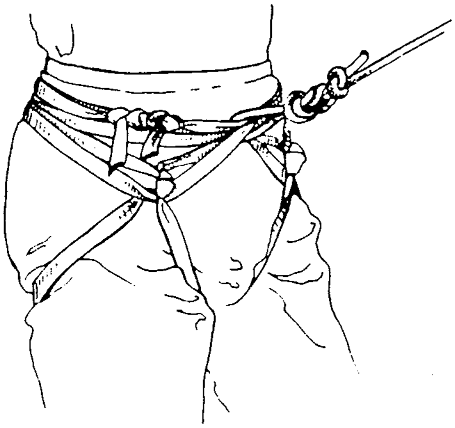
Local topography is also an important consideration. Leeward slopes are much more avalanche prone due to the fact that they contain deeper deposits of drifted snow. In addition, these wind blown deposits often contain wind-slabs which act as natural slip planes. Aspect, relative to the sun, is also important. North facing slopes are more prone to avalanche activity in the winter while south facing slopes are more prone in the spring and summer. Due to the extreme ranges in elevation found within the U.I.B. avalanches tend to be dominant above 3,000 meters during the winter and spring but by late summer they usually take place above 5,000 meters. Avalanches most commonly occur on slopes which range from 30 to 45 degrees but may also take place on slopes ranging from 25 to 60 degrees.

Since travel through hazardous areas is sometimes necessary, several precautions should be taken. Firstly, never travel on slopes which display new avalanche activity. This includes slopes which are releasing small sun balls or snow cartwheels or contain streaked tracks of the above. Secondly, test the stability of the slope by belaying a person down onto the questionable slope to attempt to initiate an avalanche deliberately. Thirdly, when ever possible, remain on the ridges as apposed to the valley sides or floor and if travelling in a wooded area avoid the open avalanche paths and remain in the forest. Fourthly, when climbing up a dangerous route, employ the step kicking method of travel opposed to the switchback method which may undercut the snow. Fifthly, wear warm clothing and carry all equipment loosely on your body. Finally, but most importantly, attach about 50 meters of brightly colored rope to your harness and trail it behind you or wear an approved electronic signalling device on your body.

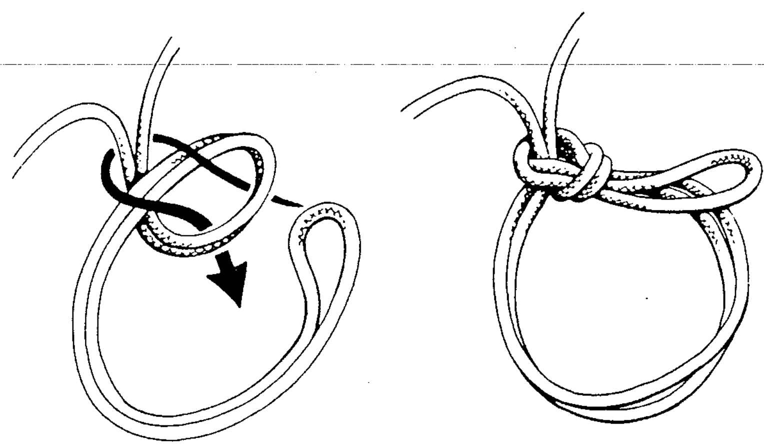
In the event that an avalanche does occur do not attempt to out run it. Move as quickly as possible to the side of the slope or find a tree or rock to hold onto. If this is not possible, remove all equipment and arrest yourself with your ice axe. If the avalanche removes you from your protection attempt to keep on the surface by swimming on your back with your head upslope. In the event that you become buried in snow, inhale deeply and hold your hands in front of your face to produce a breathable space. This must be done while you are in motion with the snow.

In the event that another party member becomes buried immediate steps must be taken for a safe resue. Firstly, identify the points on the slope where the victim was caught, last seen and where the point of disappearance on the avalanche stopped. Tie in all of the above locations to stable surrounding points. Secondly, after setting up an escape route and posting lookouts, mark the two upper sites and move immediatly to the lower site looking out for clues as to the victims whereabouts. While doing this shout at intervals but remain silent while listening for a resonse. Thirdly, once any clothing or equipment is found begin to probe and dig in the vicinity. If nothing is found mark the third site and begin to probe with your taped ice axe or ski pole. In the event that the victim was wearing a electronic beacon all members switch to receiving mode and start searching. The closer they get to the transmitting signal the lowder the signal will become. Once the victim is found and unburied, first aid begins. As soon as the head is exposed, the victims mouth and throat is cleared, and mouth-to-mouth resuscitation is started. Check the victim for bleeding or internal injuries and initiate treatment for shock and hypothermia.

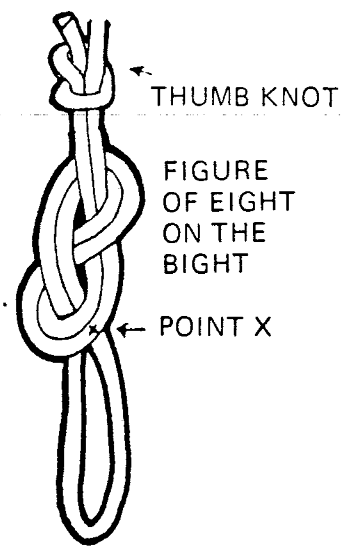
Figure 4.1. Essential knots to be known for glacier travel.

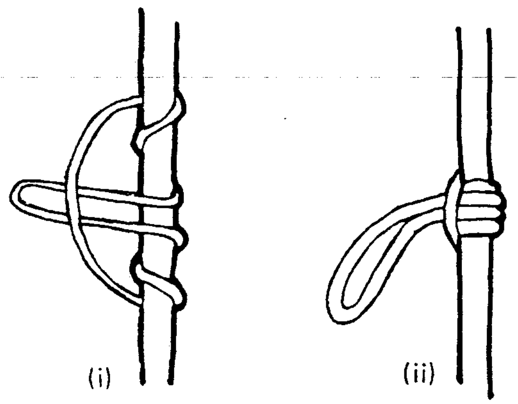


Tying into a harness.



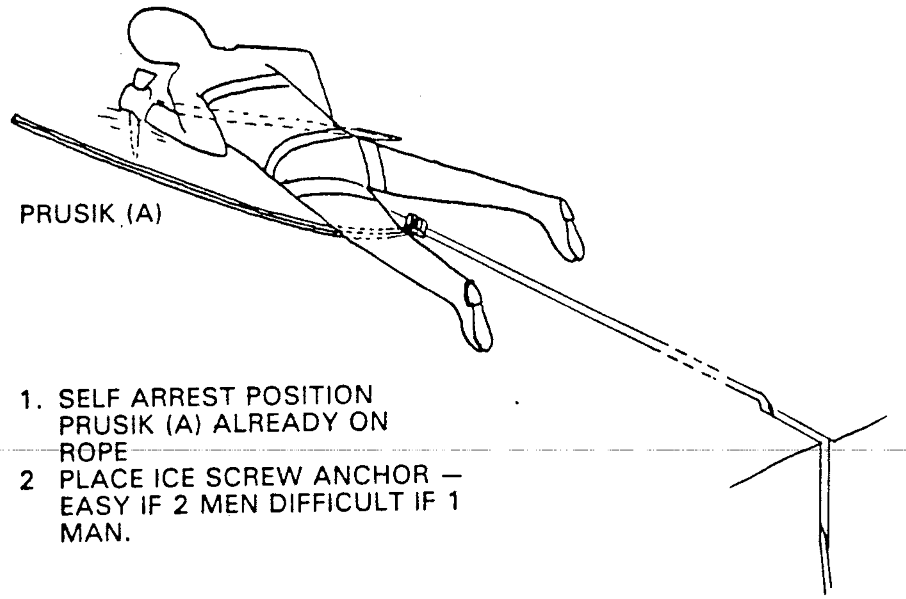
Double bowline.





PRUSIK KNOT

Figure 4.2. Self arrest position and the first steps to secure the rope (from March, 1988).



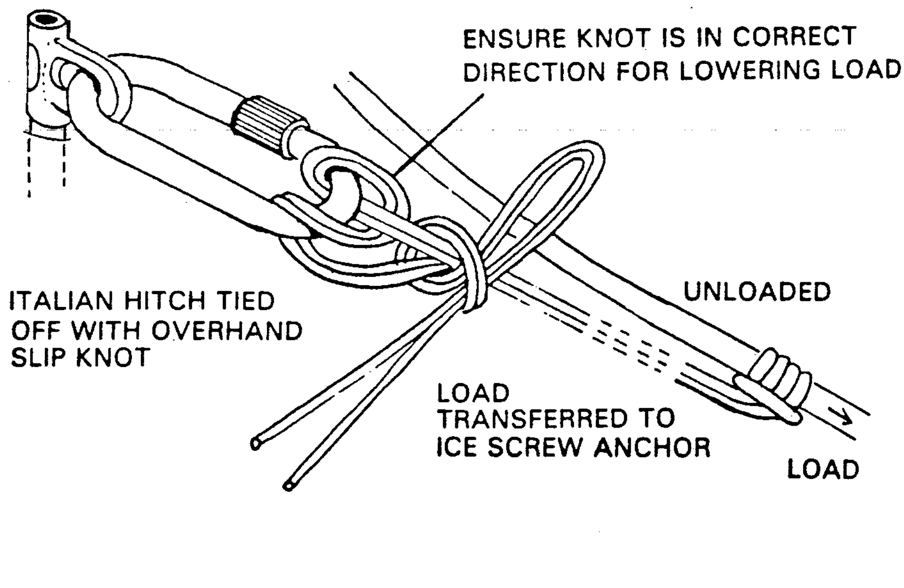
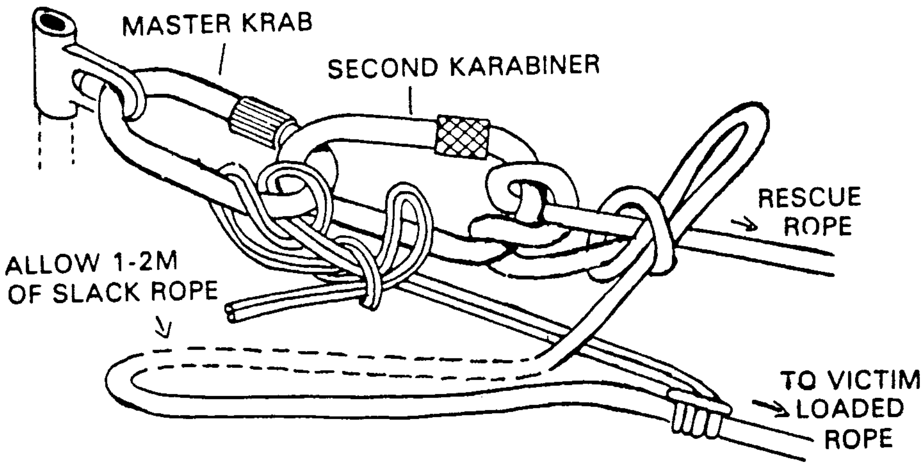
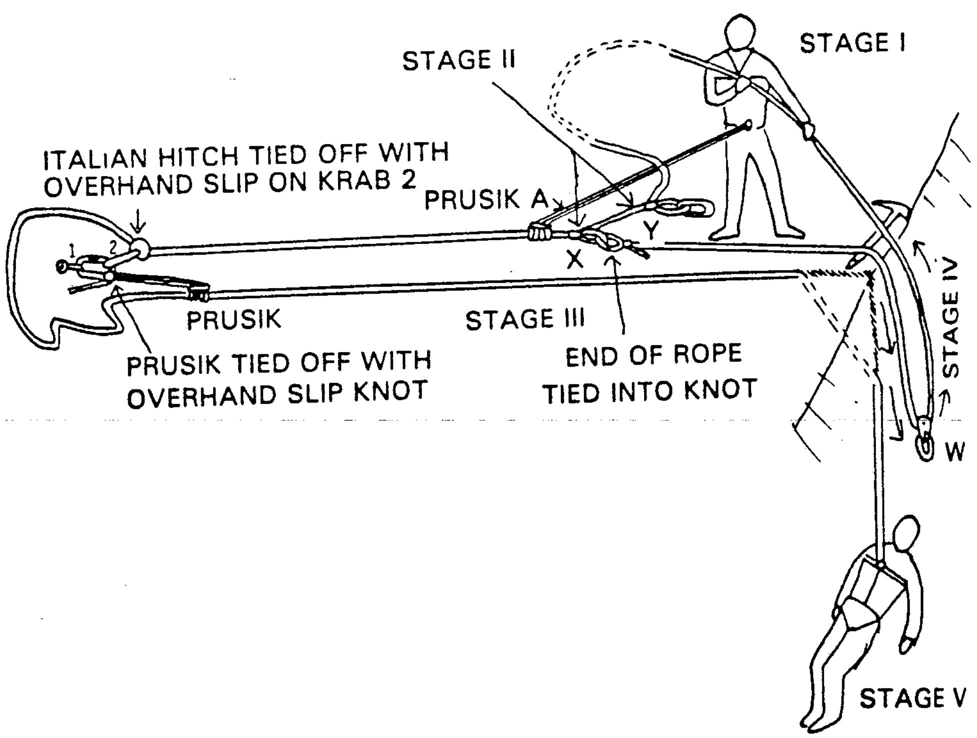


Figure 4.3. Stages in crevasse rescue, using a pulley system (from March, 1988).





V BASIC MOUNTAIN MEDICINE

All regular programmes in high altitudes should have a competent physician to advise on health measures. Medical problems deserve considerable attention when in the mountains since slight complaints can soon assume serious proportions if not given correct treatment. Many health problems are preventable given experience in practical First-Aid. Some potential ailments can be treated prior to leaving for the mountain. A doctor and dentist should be visited before leaving, both for treatment and to discuss the contents and use of drugs in the medical kit. It is also useful if one or two members of a group have attended a First-Aid course. In any case a pocket medical guide should be among the contents of the medical kit. As a general rule avoiding unboiled or untreated water at all times is good sense, since a variety of parasites, notably giardia are found at almost all altitudes where surface water exists.

A list of possible health problems which field parties should be fully warned about, prepared for, and keep up-to-date with medical advice on are:

1. Altitude sickness
   (see below)
2. Frostbite.
3. Snow blindness
4. Severe sunburn
5. Dehydration
6. Blisters
7. Hyperthermia
8. Heat stroke
9. Salt deficiency
10. Giardia
11. Hepatitis
12. Round worm
13. Tick, lice and other insect bites

Among porters and Northern Area helpers they may encounter eye infections, boils, T.B., goitre, anthrax and various intestinal problems. It will be good management to be able to recognise, and advise on and in some cases (consult your physician) provide medicines for, or direct the person to a hospital.

In the present manual we will deal in a little more detail with specific problems of high altitude.

a) Altitude sickness

Above altitudes of 3000 m (10,000 ft) humans cannot survive for long periods unless they have acclimatised to the different conditions. The body slowly adapts to the lower oxygen content of the air, hence to minimise the effects of altitude one should take a few rest days at 1000 m before attempting to travel any higher. After 3000 m one should not spend the night more than 300 m (1000 ft) higher than the previous day.

The most noticeable effect of altitude is a severe headache, which tends to last a couple of days. Problems with sleeping are also common, which can be helped by taking Diamox tablets.

Altitude effects are greatly aggravated by dehydration and exhaustion. It is a good idea to drink 4-5 litres of water a day, and to have a high carbonate, low fat diet. If problems persist then more water should be drunk, and a rest day taken. If the headache is not helped by taking aspirin, or Diamox then one should go down to a lower altitude to recover. All the time all members of the group should watch for symptoms of altitude sickness, and specifically:

A) AMS - Acute Mountain Sickness.
B) HAPE - High Altitude Pulmonary Edema.
C) HACE - High Altitude Cerebral Edema.
D) HARH - High Altitude Retinal Haemorrhage.

Acute Mountain Sickness

This affects people who did not acclimatise above 2500m, or who climbed too fast above that altitude.

Symptoms include headache, insomnia, fatigue, loss of appetite, nausea, dizziness, breathlessness. This can develop into more severe problems like HAPE, HACE, HARH. If hands, feet and face start to swell, this indicates peripheral edema, then one should consider resting, drinking more water, and if symptoms persist, descending to lower elevations.

High Altitude Pulmonary Edema

This is very dangerous, entailing a fluid build-up in the lungs, and can be fatal. It can be detected using a stethoscope, and if present breathing sounds like fingers running over a comb (called rales). The individual is likely to have problems with breathlessness on exertion, and while resting, and to suffer from lack of coordination (stumbling). If a person becomes quiet and subdued he should be checked for the symptoms above.

In advanced cases gurgling sounds may be heard, and quantities of rust coloured spectum are produced. Finger nails should also be examined for cyanosis, this is a blue colouring to the nails caused by lack of oxygen.

There is only one treatment for HAPE which is to descent immediately to as low an altitude as possible.

High Altitude Cerebral Edema

Symptoms are as for AMS, only worse, and include headache, vomiting, loss of balance, loss of motivation, and reduced urine output. In many cases people will also be suffering from HAPE.

This is a very dangerous condition, the only treatment is to descend immediately as loss of sight and unconsciousness soon occur.

High Altitude Retinal Haemorrhage

This involves bleeding on the retina of the eye. One should descend immediately and symptoms will clear.

Persistent visual problems at altitude may be caused by retinal haemorrhages, while symptoms such as double vision, or blind spots may indicate a more serious problem, whereupon one should descend at once.

VI Camps and Camp Discipline

Experienced parties will become skilled at identifying convenient safe camp sites; setting up camps quickly for comfortable and efficient operation; and ensuring against disease, environmental abuse and loss of amenity in repeated use. In general, a good camp should be on firm, level ground in a sheltered location. It should have a convenient, clear water supply and be free from the dangers of rockfalls, avalanches, flooding in heavy rain or melt periods. It should also be chosen so as to recognise and respect the activities and wishes of local inhabitants. That will include the location, use of food and presence of domestic animals. It is assumed that parties will be properly equipped with strong readily erected, easily transported tents; a full range of camp equipment for everyday use; and have a well thought-out appropriate store of food. By way of example we append a list of supplies and equipment used in SIHP high altitude camps.

In setting up a camp, at least if it is to be used for more than a few days and returned to in later seasons, the disposal of waste, personal hygiene and toilet arrangements should be carefully made and maintained. Most important to avoid the risk of contaminating the water supply. Officers of a water authority, in particular, should give leadership and example in mountains where surface waters might become polluted or watersheds harmed by damage to vegetation. At a base camp or frequently used site, a toilet should be dug and sand provided to cover after use. All garbage should be carried out for disposal unless it is readily burned. Plastics especially should not be burned but taken out to a proper disposal site.

APPENDIX I

Personal Clothing and Equipment:

Head:
- Wool hat.
- Head lamp with batteries and spare bulb.
- Glacier glasses with side shields.
- Floppy hat for sun,
- Wool/pile balaclava.

Hands:
- Wool mitts.
- Spare wool gloves.
- Overmitts.

Feet:
- Leather boots.
- Couple of pairs of wool socks.
- Gaiters.

Body:
- Wool/polypro underwear.
- Wool shirt.
- Wool trousers.
- Wool/pile jacket/parka.
- Waterproof/windproof jacket/trousers.

Hardwear:
- Ice Axe (approx. 70cm)
- Flexible crampons and straps.
- 1 Litre water bottle.
- Swiss Army knife.
- 5 mm prusik loops x2.
- Harness for glacier travel.
- Locking carabineers for glacier travel x2.

Miscellaneous:
- Sun screen/block - zinc oxide.
- Sleeping bag - synthetic or Down (sufficient for expected min Temps).
- Insulated Parka with hood (for very cold Temps.)
- Personal kit.
- Compass.

APPENDIX II

General Medical Kit

Analgesics (Pain medicators):
- Acetominaphen - for mild pain and headache
- Codeine - for severe pain
- Hydromorphone (Dilaudid) - powerful pain killer

Antibiotics:
- Cephalosporin - for skin infections and respiratory system
- Trimethoprim-Sulfamethoxazole (Septra) - for bacterial diarrhea.
- Metronidazole (Flagyl) - intestinal antibiotic.

Anti-diarrheas:
- Diphenoxylate (Lomitol) - anti-diarrhea in severe cases.
- Loperamide (Imodium) - diarrhea.

Altitude Sickness:
- Acetazolamide (Diamox) - for mild symptoms, and to help with edema while descending.

Stethoscope.
Polysporin Ointment.
Tetracyline Tablets.
Polysporin Eye/Ear Ointment.
Lasix Tablets 40 mg.
Demerol (1ml ampules) 100 mg/ml.
3 cc syringe #24g needle for I.M. injection.
Tylenol extra strength tablets 500 mg.
Dilaudid tablets 2 mg.
A.S.A. tablets.
Aspergum.
Anbesol tube.
3-0 silk sutures w/needle.
Suture strips.
Xylocaine S.C. 2%.
1 cc syringe #27g needle for S.C. injection.
Suture hemostat.
Suture Scissors.
Field dressing.
Elastoplast - large.
Elastoplast - small.
1" Gauze roll.
Telfa pads 3x3.
Telfa adhesive pads.
1" tape.

Inflatable splint.
Tonge depressor.
Second skin.
Mole foam.
Mole skin.
Drixonal nasal spray.
Tums.
Dimenhydrinate tablets 50 mg (Gravol).
Benzalkonium toweletts.
Lomitol 2.5 mg tablets.
Imodium 2 mg tablets.
Plastic airway #4, #5.

Medicine for Mountaineering - 3rd edition.
Mountain Sickness - Hackett.
Waterproof plastic container.

APPENDIX III

Sample equipment used on one SIHP expedition to Lukpe Lawo.

i) Mountaineering
9 mm climbing ropes x 4.
6 snow flukes - Gerry Bloom
7 Harnesses
50 m 5mm Perlon
6 ice axes
6 ice screws
20 carabiners

ii) Community.
2 Eureka wind river dome tents
2 Fitzroy tents
2 sleds
2 large black tarps
first aid kit
4 orange tarps
20 m webbing
4 candle lanterns
3 Tracksetter compasses
1 Ranger compass
3 extra pairs glare goggles
2 Optimus Kerosene Stoves
1 MSR Stove.

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