New Directions

Mountain Maps

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(Plates 34, 35)

People in mountains need maps. We need them to help attain our goals, whether they are humble attempts to find a roadside crag, or ambitious plans for a three-month state-of-the-art expedition taking in a new line on an 8000m face. Most map users regard maps as tools chosen for their use in solving specific tasks: in other words, providing objective information with a specific functional purpose. Maps are, however, not just cold mechanistic devices to achieve an end. We need them to help to remind us why we climb: the best maps stimulate the imagination like all works of art. C E Montague talked of this in his classic essay 'When the Map is in Tune': maps enable us to imagine the mountains, to relive past experiences and dream of new ones.[1] There is a kind of reciprocity between the best maps and the map user, a two-way process involving both efficient use and powerful reciprocal influence upon the map readers. Thus we both use maps of mountains and are influenced by their seductive power. We believe the well graded path will materialise out of the Scottish mist because it is on the map and because we think we understand the cartographic language. Few users, however, fully understand the process or the conventions which govern the depiction of the path, or the inherent subjectivity of the map as a medium of information, or fully appreciate the influence of the map.

This essay then is concerned with the uses of mountain maps, both functional and aesthetic. There is insufficient space here to discuss the full range of map-reading skills – interested readers should use the excellent recent works by Keay,[2] or the MOD Navigation Manual.[3] My intention here is to get behind the conventions, to look at the cartographic, political and economic factors influencing our use of maps of mountain areas. At the same time I will suggest some practical solutions for those wishing to find the 'right' map, and speculate upon future trends in mountain mapping.

1. MAP USE

All maps are designed with users in mind. The problem for climbers is that our needs are not always met by cartographers.

Maps as sources of objective spatial information serve an essential functional purpose. For instance, climbers need maps to locate, measure, name or compare

Table 1: Factors to consider when evaluating which maps to choose

Scale	The resolution at which information is portrayed, usually given in a representative fraction, eg 1:50 000. For a doubling of scale there is a quadrupling of the number of maps required (and therefore the cost). Do you need a large-scale map covering a small area in detail or a small-scale overview?
Content	Which features are mapped. Most general purpose topographic maps include: relief, water features, settlements, lines of communications, land cover/vegetation, and boundaries. Within any one of these general categories the amount of information provided will vary very greatly. Which features are most important to you?
Reference Structure	Is the map gridded, does it show lines of latitude or longitude, or coordinates, does it indicate the map projection, does it indicate northings? A useful indication of the map quality, and essential for scientific work.
Design	Is the cartographic display a good design? Is it coloured, are appropriate line point and area symbols used? Is the data shown at an appropriate level of generalisation, so that a balance exists between clarity and provision of information? Is the map well layed out, does it incorporate legend and other marginal information? Are place-names shown to a consistent style? Well designed maps are much easier to read.
Coverage	Does the map or map series cover all the areas you need?

Ease of use	The media and format of the map. Is the format suitable? Folded? Waterproof? The right size? Do sheetlines overlap?
Accuracy	The precision with which features are located on the map, relative to their true position on the earth, their true height above a datum, eg how accurate do you need spot heights to be?
Currency	The date of the information in the map; which elements of the map content are revised to which dates, eg has a new road been shown on the map, has the avalanche that destroyed an easy access route been mapped?
Consistency	Whether the information in the map is consistent over the whole of the area of interest, eg are all climbing huts shown, or just Austrian Alpine Club huts?
Source of data	How was the data collected to compile the map? May be from ground survey, derived from other mapping, from statistical data, from aerial photographs or from satellite imagery.
Availability	Is the map published, and available, can the map be seen in a map library, can it be bought?
Cost	Is it affordable?
Reliability	Are the sources used in the map compilation to be relied upon? A combination of many factors, eg an apparently modern map may be based upon a poor early 20th-century ground survey.

These different attributes are interrelated. Careful consideration of them all can improve the chances of choosing the most appropriate map.

features in an area. What is the best camp site for a given ridge? How far is it from Gilgit to Concordia? Directions relative to a compass reading may need to be established and the relationship of magnetic north to grid north clarified. Climbers need maps to navigate to a crag, to plan a route to a camp or hut, or to work out the logistics of a journey. Scientific work in mountains requires other more specific uses.[4] Thus base maps may be needed to plot collected data, sampling frames may need to be derived from maps to provide a framework upon which data can be collected. Maps are also needed to interpret other available spatial information about an area, such as satellite images or aerial photographs: whilst available mapping may not be sufficient to plan a new line on an unclimbed face, an available oblique aerial photograph used in conjunction with a large-scale map can greatly improve the chances of success, and add to the experience of the mountains.

Maps as sources of thematic information can also be useful for scientific or logistic reasons: an indication of climatic data in map form can, for instance, tell you whether a pitch is likely to be iced, when the monsoon is most likely to arrive, or indicate whether rock type or dip will help or hinder the climb.

Maps of mountains have other uses off the hills: as illustrative, educational devices. A map in a journal article or book both illustrates a climb and can provide an integrating framework around which a story can be told. A guidebook without topos and location maps is less successful than one incorporating well drawn graphics.

In addition to these functional and objective uses the artistic power of mountain maps can be important. Maps can serve a very useful persuasive purpose. A well produced map can convince a sponsor to support an expedition, or convince a key climber to join a team. Finally, of course, the map has an artistic role to play. Few can fail to be stirred by the images of the Alps conveyed in the superb official mapping produced by the Bundesamt fur Landestopographie in Switzerland, or by the National Geographic Map of Everest, or by the recent French exhibition of mountain maps.[5]

Successful use of maps to meet these needs depends upon both the ability of the user to understand the map content, upon technical issues inherent in the map's design, and upon the context in which the mapping is produced. It also depends upon knowing which maps to use for which purpose, and getting access to the mapping.

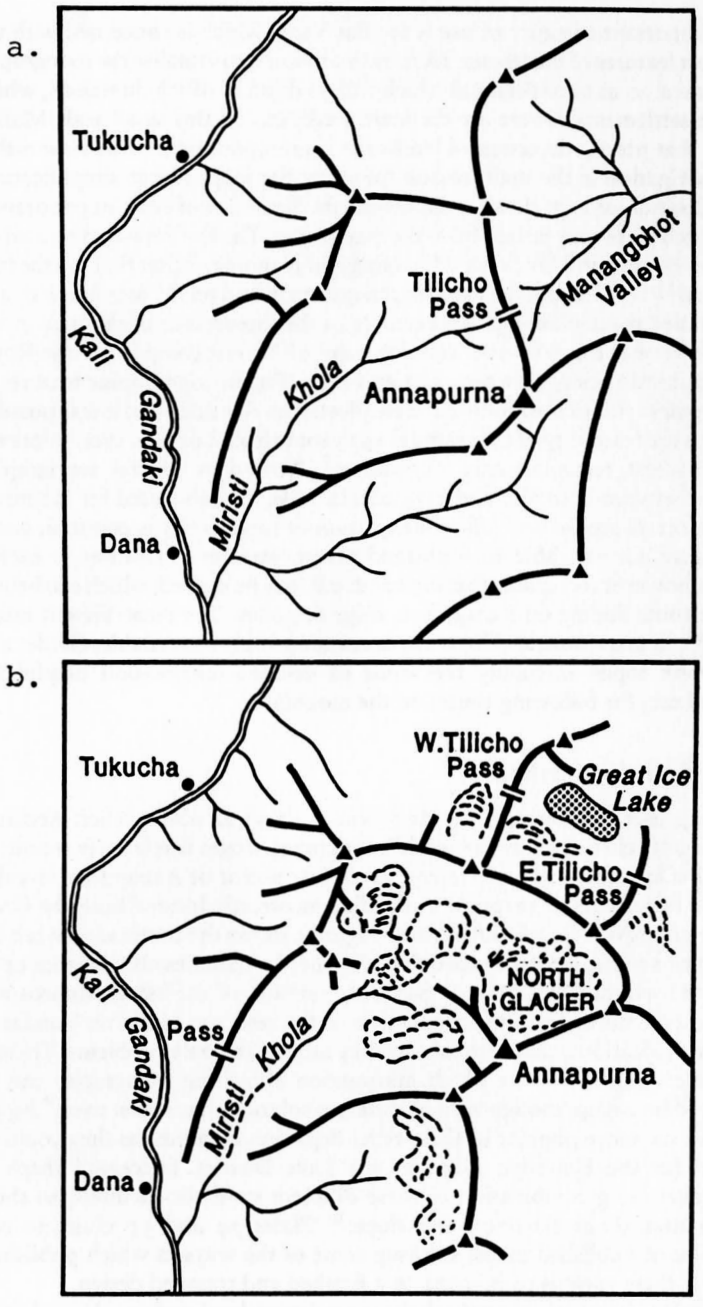
2. THE NATURE OF MOUNTAIN MAPS

Table 1 shows the attributes that are relevant to the user of maps in mountains. Scale and depiction of relief are probably the most important elements to the map user in mountains and deserve a fuller consideration.

Scale

Derek Maling identifies three levels of map use in mountains. He suggests that functional map use differs according to scale of depiction of the landscape.[6]

Figure 1: The Annapurna Massif



a. From Survey of India mapping prior to Herzog's expedition
b. From Maurice Herzog's *Annapurna*

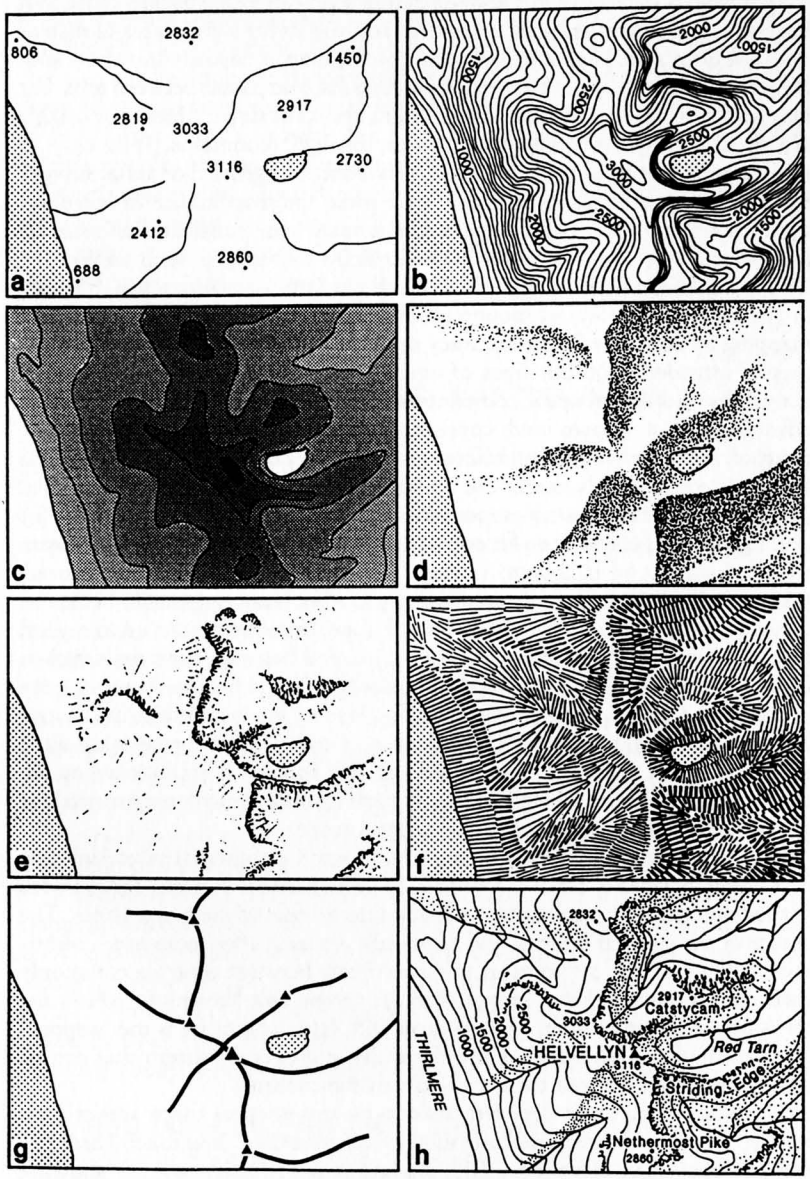
An important category of use is the **Far View**, which is concerned with the broadest features of the terrain. Here the intention is to visualise the topography of the area, so as to understand which valleys drain in which directions, where are the settlements, where are the main peaks etc. At this small scale Maling claims that precise depiction of landscape is unimportant; an overview rather than navigation is the main reason for using the map. Hence simplification, generalisation of map detail, even deliberate distortion of scale in panoramas and sketch maps may be helpful to the map reader. The Far View is to be used on a winter evening in Manchester dreaming and planning, rather than on the hill.

The **Middle View** is to be used for navigation in and on the mountain(s), and for detailed route planning. An example of the importance of the map in the Middle View is the 1:50 000 'running map' of Everest compiled at the Royal Geographical Society between 1933 and 1945. Precise topographic features of the Nepalese side of the mountain were plotted on this map, and it was possible to assess the feasibility of the eventual 1953 route from London, even before the 1951 Everest reconnaissance expedition.[7] Nowadays official topographic surveys between 1:20 000 and 1:75 000 in scale, are most used for mountain navigation. A precise and efficient depiction of topography is essential, and a convenient format, able to withstand severe weather conditions is useful. Maling however recognises that further detail may be needed, which can help in precise route finding on a crag, face, ridge or gulley. The **Near View** is rarely available in map form, and for many areas completely unavailable. Guides and guidebook topos exemplify the kinds of detailed information helpful for detailed use, for following routes on the mountain.

Relief depiction methods

The map user in mountains needs to know above all about relief. Accurate mapping of relief of many the world's mountain ranges is relatively recent: in the Himalaya, for instance, Herzog's epic first ascent of Annapurna revealed that the best available mapping at the date incorrectly located both the Great Barrier and NW ridge of Annapurna.[8] *Figure 1* shows the contrast between the image prior to and after the expedition. Height of mountains also depends upon accurate topographic survey. In Scotland, revision of the list of Munros and tops became necessary after completion of the resurvey to metric standards. However, locational and vertical accuracy are not the only problems. There is no single optimal way in which information about the topography can be conveyed on a map, though various different solutions have been tried.[9] *Figure 2* shows the more popular of these relief depiction methods, as they could be applied for the Helvellyn ridges in the Lake District. Successful maps of mountains use a combination of these different symbolic methods, to show information about elevation and slope.[10] *Plates 34 and 35* illustrate two examples of published maps, showing some of the ways in which publishers combine these various techniques, in a finished and rounded design.

Elevation values are shown relative to a datum level and are derived from information collected in topographic survey of the area. The datum level used on the mapping varies from country to country and may be changed over time.



a. Spot heights
b. Contours
c. Hypsometric relief tinting
d. Hill shading
e. Rock drawing
f. Hachures
g. Ridge-line mapping
h. Composite of various methods

Spot heights identify points above a datum level – there are usually more spot heights in mountainous areas, and more spot heights for a given area of map as the scale decreases. High and low points on the map are usually shown by spot heights. These usually include peaks, depressions, and passes between tops, but may also label heights of huts, or significant breaks of slope. More spot heights are usually shown on well used routes through mountains. It is easy to misinterpret spot heights. Is the height derived from a ground or aerial survey? How accurate is it? Does the map scale force the map maker to leave out significant bumps on a ridge? Is the height permanent or transient? For instance, on a glacier, or in areas prone to mass slope movements such as rock or landslides, height must be regarded as having a considerable margin of error.

The surface elevation of mountainous areas is usually depicted on modern mapping by **contours**. Their accuracy needs to be known if reliable use of the map is intended. Contour lines of equal height above a datum are usually derived by photogrammetric compilation from aerial photographs: this has the advantage of a known and consistent accuracy. Contours may also be interpolated from a limited number of ground survey control points: in this case the accuracy depends upon the number and density of known heights. Interpretation of contours assumes a knowledge of contour intervals, rules for dealing with slopes too steep for contours, labelling conventions and the way in which the contour is drawn, its hue, line weight and form. Intervals on topographic mapping are usually equidistant but may on smaller scales be varied in order to best represent breaks of slope. In mountainous areas several official mapping organisations choose an interval between contours which is further apart than for flatter areas, in order to strike a balance between map legibility and information provision. Too close an interval results in contour lines too close together for clear relief interpretation. Index contours are often used to help the map user: every fourth or fifth contour is emphasised on the map and labelled with a height value. Sometimes different colours are used for contours according to the nature of the land cover.

Layer colouring or hypsometric tinting of maps is a method of relief depiction best suited for small-scale overviews of a large area. Areas between contours are shaded according to a consistent schema into a series of elevation zones. The choice of the contour interval and of the colours used affect map use. Colours are usually of sufficient contrast to discriminate between zones; a commonly used conventional scheme ranges through greens and browns to whites for areas above the snow-line. The problem with layer colouring is the 'stepped' effect created: its advantage is the simplicity and overall pattern that can be clearly presented without the complexity of the contour.

Slopes are sometimes depicted directly on topographic maps rather than relying upon the indirect interpretation of contour data. It is much harder to depict slopes than elevations. **Hill shading** is an effective way of showing variations in slope and relies upon the principle that a strong and oblique source of light will cast a shadow, which will help the map user to pick out steeper slopes. Thus tonal variations on the map emphasise the steeper areas: ridges are stressed. The light source is often from the NW quarter of the map. Hill shading works best when combined with a more precise method of relief depiction such as contours.

Hachures are lines drawn parallel to the steepest gradient of a slope, drawn closest together where the slope is steepest. No absolute elevation information is included, but individual landscape features which may be missed between contours can be emphasised using hachures. Steep cliffs and rock faces are often depicted on mapping by **rock drawing**. On larger scales a direct representation of rock forms may be possible, for instance on Swiss topographic mapping. Elsewhere cliffs may be shown by a standard symbol.

Other methods of relief depiction that are relevant to the mapping of mountains include perspective drawings of simulated oblique views of mountain ranges, and **ridge-line mapping** which, when used in conjunction with hachures, can provide an effective simple overview of mountain topography.

3. THE CONTEXT OF MAPPING: MAP PUBLISHERS

Most mapping of mountain areas is not compiled for the climbing market. Most topographic maps are either produced by national surveying and mapping organisations charged with the geodetic, topographic and sometimes cadastral surveying and mapping of their state, or else derived from data collected by these organisations. Hence the specifications of mountain maps are not always perfect for the map user on a climbing expedition, because the maps have been designed for multi-purpose uses, and are constructed primarily for the administration of the state, rather than with recreational needs in mind. Some official surveys now incorporate the views of outdoor recreation bodies in their customer feedback mechanisms, and are beginning to include specifications which are relevant to climbing. However, maps are only produced where there is a market: the more remote the area, the greater the chance that mapping with unsuitable specifications will be available.

Mountainous areas are often near to the borders of countries, furthest from the centres of political and geodetic control. Maps of these areas are less likely to be available on the open market, and less likely to be of a high quality than mapping of economically important areas of a state. Mountain maps are more likely to be out of date, more likely to be politically sensitive, less likely to be topographically or geodetically accurate and less likely to be available.[11] Further information on the reasons for maps being unavailable, and the countries where problems are most likely to be met, is included in *World Mapping Today*, a second edition of which is currently being prepared.[12]

Commercial mapping is produced by some specialist map publishers for mountain areas where there is a tourist or mass climbing market. These maps are in the main derived from survey information collected by the official mapping agencies, redrawn and repackaged. Sheet-lines are more likely to be designed with the climber's needs in mind, rather than the official pre-occupation with grid or graticule based sheet divisions. How often have you suffered under mountain mapping's version of Murphy's Law: to have your area of interest depicted on the junction of four maps? For most European

ranges, the Himalaya, Rockies and Andes, a mix of publishers now produce quality derived mapping, often with useful overprinted information relevant to climbers' needs. The amount of commercial mapping reflects the market: the more visited the area, the more likely there will be readily available commercial products.

Orienteering mapping is often very useful in its depiction of mountain areas. This may be commercially available as a spin-off from mountain activities, such as the Harvey Walker's Map series, derived from mapping prepared for Karrimor Mountain Marathons. 'O' Map specifications are more useful for the 'middle view', than most conventional topographic maps, because they incorporate elements of map design useful for mountain navigation, like micro-topographic features, and enhanced navigational information.

An increasing number of expeditions are producing their own mapping, to supplement a national survey's information. In the Himalaya, for instance, in recent years the fine Japanese map of the Baltoro incorporates new survey information for an area until recently of notoriously difficult map availability. Other sketch maps are available to supplement unpublished expedition reports or climbs reported in the climbing literature.

4. SELECTING AND ACQUIRING MAPS

How can the climber find out what is published and available, and where can mapping of mountains be acquired? Clark provides a useful checklist of stages an expedition might go through in selecting maps.[4] He stresses the importance of creating a list of what is needed, relative to intended uses. Sharing knowledge of expedition members is important as is following up advice from all other relevant published sources, such as past expedition reports from the area. Once an idea of needs has been reached, a detailed search for available mapping can be carried out. It is important to try to look at a variety of available maps before attempting to buy. Map libraries with significant holdings of mapping of mountain areas are listed in various national and international directories. For the UK, Watt's listing (currently being revised) gives contact names, addresses and details of collections.[13] The more important are in London, and include the Royal Geographical Society and the British Library, but University and some major reference library collections with smaller worldwide collections are distributed across the country. Similar directories of libraries exist for other countries.

Not all the maps seen in libraries will still be available for purchase and there is no single in-print listing of mapping. *World Mapping Today* gives a useful introduction to differing map specifications in different countries and includes contact addresses for just about every significant map producer in the world, as well as reproducing graphics and details of significant available mapping.[12] *GeoKatalog* from ILH GeoCenter, is the most comprehensive sales listing.[14] Official publishers each produce catalogues or index maps to series. From a combination of these sources maps can be identified. Specialist map shops or wholesalers are probably the best source for acquiring maps. Cordee distributes a useful listing of the more common mountain maps and Stanfords and the Map

Shop, Upton, provide the best UK retail and postal service. Comprehensive, though expensive, collections are maintained by the world's largest map retailer: GeoCenter, Germany. See below list of addresses and contact information.

5. THE FUTURE

Mapping has changed more in the last 25 years than at any time in the history of cartography. Digital map data, capable of being stored, manipulated, displayed or output by computers is becoming more and more available. Remotely sensed satellite imagery is readily available (though prohibitively expensive) in both computer readable and hard copy form. Portable GPS receivers are already available which enable an individual to fix their position precisely on the earth's surface, independent of conventional survey control. Microcomputer and screen display technology have improved so much that a quality display of a digital map on a screen no larger than a large pocket is already possible. Whilst the technology of map production has changed, so too has the nature of the map producing industry: map making is now much more market-led, more commercial in emphasis, more responsive to customer demands. New products targeted at the mountain user are appearing: in the UK for instance cheap laminated Ordnance Survey products from Filomap, repackaged pocket-size laminations from Hill-master, and long-distance footpath maps from Footprint. New products are only likely where there is a proven demand, and are less likely to be published for obscure areas or to cater for limited or very specialised user needs.

Mountain use of maps can be expected to be influenced by these changes. It is possible that in the remote future mountain navigation based upon maps and compass work will become obsolete, if digital mapping of mountain areas becomes available and affordable, and if the technology to display and manipulate this data becomes cheap enough. A much more flexible use of the geographic information in the map would become possible: automatic measuring and optimal route selection, comparison of multiple data sets, even instantly updated maps received at remote sites via a satellite communication link, would be possible. Digital relief information is already available for many mountain areas. Easy to use packages to exploit this data, targeted at the outdoor recreation market, are, however, not yet available. We can expect that the output of paper-based maps of mountains will continue to increase, because of the cost advantages offered to conventional production by the new technologies, and because the market still demands this type of map. Some will be accurate, high quality, well designed maps. Others will not, for mapping operates in the marketplace, rather than directly reflecting user need. We can also expect that availability of mapping of mountains will continue to fluctuate, according to economic and political circumstances. Let us hope that future generations can continue to be inspired by mapping of mountains and that the power and flexibility of digital mapping results in innovative, visually stunning and aesthetically satisfying designs, to fire the imaginations of future C E Montagues.

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12 R B Parry, C R Perkins, *World Mapping Today*. London, Butterworth Scientific, 1987.

13 I Watt, *Directory of UK Map Collections*. 2nd ed. Southampton, British Cartographic Society, 1985.

14 ILH GeoCenter, *GeoKatalog*. Stuttgart, GeoCenter, in progress.

USEFUL ADDRESSES

Stanfords, 12–14 Long Acre, London WC2E 9LP

ILH GeoCenter, Postfach 80 08 30, D-7000, Stuttgart 80, Germany

The Map Shop, 15 High St, Upton Upon Severn, Worcs WR8 0HJ

West Col, Goring, Berks RG8 9AA

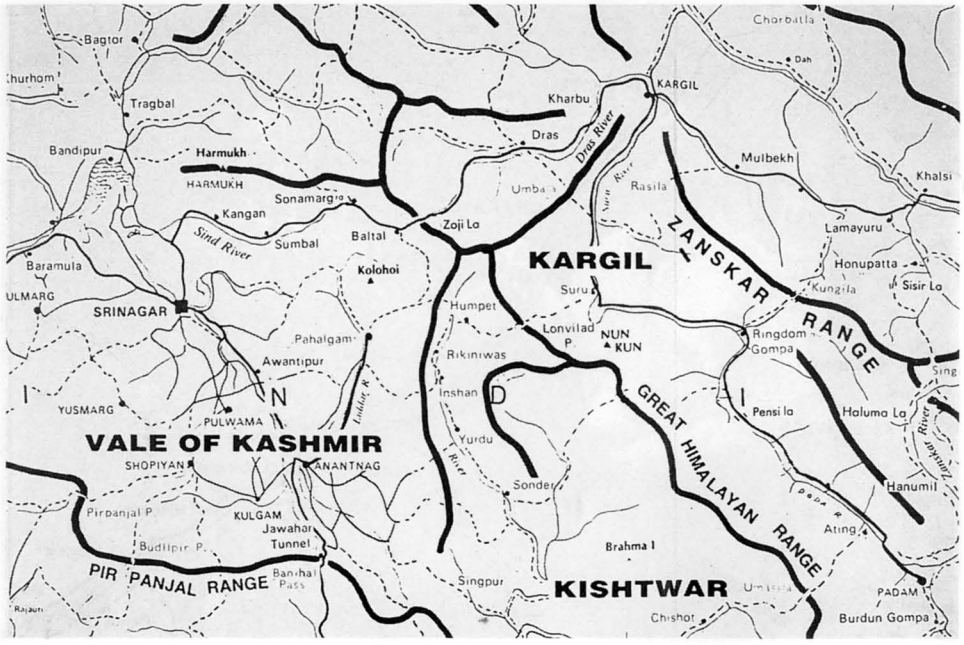
Cordee, 3A De Montfort St, Leicester LE1 7HD

Footprint, Unit 54 Stirling Enterprise Park, John Player Building, Stirling FK7 7RP

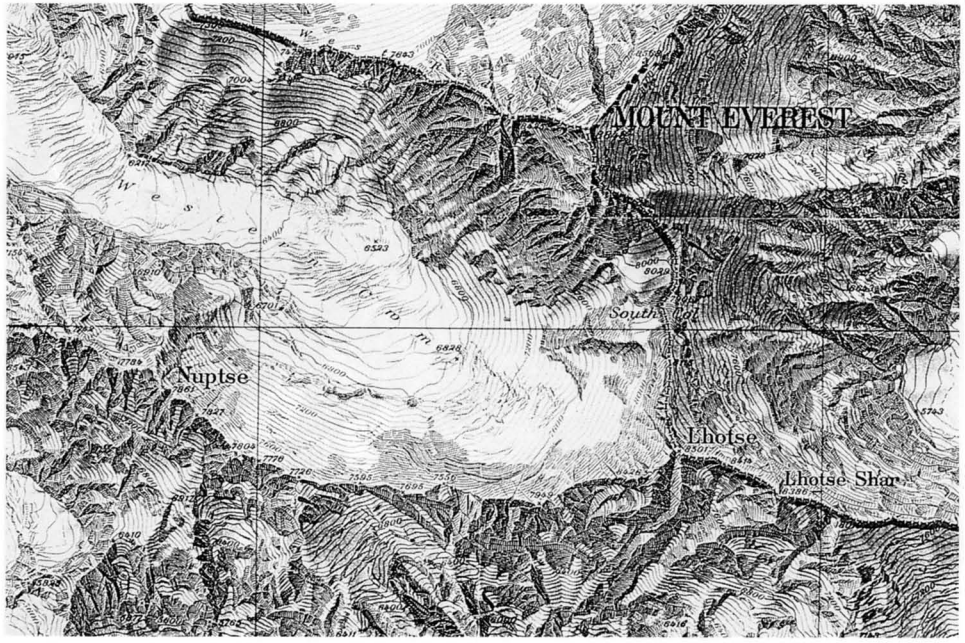
Harvey Maps, 12–16 Main St, Doune FK16 6BJ

Filomap, D and E Maps, Units 24/25 Knighcott Industrial Estate, Banwell, Avon BS24 6JN

Hillmaster Micromaps, 3A Inverleith Place, Edinburgh EH3 5QE



34. *Above* Extract from Leomann Trekking Map of Kashmir 1:200 000, a good example of a map using ridgeline depiction. (p167)



35. *Opposite below* Extract from National Geographic Map of Everest 1:50 000, a composite map using many different methods of relief depiction to produce a design admired for both efficient and effective communication of relief information and for its aesthetic qualities. (p167)





36. *Above left* Leaving the plateau on the headwall of Coire an Lochain, Cairngorms. (*Martin Burrows-Smith*) (p105)

37. *Above right* Looking down Garadh Gully on Ben Nevis prior to a descent. (*Martin Burrows-Smith*) (p105)