Appendix A2

Guidelines for engineering geological mapping

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A2.1 Introduction

High quality engineering geological maps form the basis of many of the geotechnical assessments and it is clearly vital that the maps are of the highest possible quality. Circumstances are often difficult with adverse weather conditions, altitude, remoteness and a relatively short season and procedures must therefore be made as easy as possible for the field mapper. Add to this the patchy availability at best of base maps and images and the inaccessibility of some of the locations and it becomes clear that certain practical compromises must be made and these may vary according to particular conditions.

A2.2 Base maps

Where possible it is better to map onto an accurate and up to date base map. It should be noted that the locations studied are likely to be in young and changing landscapes and that the landforms may change more frequently than maps are published or aerial photographs taken. Further, weather in the mountains is often bad and satellite images may be obscured by cloud or excessive snow cover. Thus it is often necessary to use the most recent acceptable image irrespective of whether it is a satellite image, an aerial photograph or a published topographical map.

If aerial photographs are available these are often preferable in their detail and clarity but certainly at the altitudes under consideration in the Himalaya, they are very rare. Even in the Andes, where some aerial photographs exist, they are infrequent and one is very fortunate if the area of interest has been flown recently. At the assessment stage it tends to be prohibitively expensive to commission aerial photography.

In the absence of aerial photography, satellite imagery is often the most appropriate and certainly the most up to date. Use of the more economical imagery tends to limit the scale of the mapping possible whereas the high resolution imagery tends to be expensive, perhaps prohibitively so at assessment or feasibility stages.

At best, the most recent published topographical maps tend to be taken from recent (or not so recent) aerial or satellite photographs and, as such, only introduce a layer of interpretation and possibly error. It is likely that published maps will only be used as a last resort if the original imagery is unavailable or unaffordable.

It may be necessary to produce base maps especially, either by commissioning a topographical survey or by sketch mapping topography at the same time as geology either by baseline and offset or by triangulation or planetable mapping. It is likely that these will only be appropriate for localised areas of particular significance or at remediation stage. A Global Positioning System (GPS) can be used to store data and subsequently to calibrate the sketch. Experience shows that the precision of a hand held GPS system in these circumstances may be only fair (to within ~10 m or so), especially in deeply incised valleys with only limited access to overhead satellites. The usefulness of such a system is particularly limited in measuring altitude, where accuracies of tens of metres are more common. A hand held GPS is therefore best suitable to reconnaissance type studies.

A2.3 Scales

The scale of mapping that is appropriate depends on the particular objective and stage of the procedure. For regional mapping and the downstream valley, smaller scales will generally be more appropriate than in the immediate environs of the lakes themselves. In the downstream valley, scales such as 1:20,000 or 1:25,000 will probably be found most suitable and in regional mapping it may be possible to use 1:50,000. For mapping around a lake or glacier system 1:10,000 is likely to be the smallest feasible scale and it will often be found necessary to map the detail of particular features at 1:200 or 1:500. In these latter cases it will almost certainly be necessary simultaneously to sketch map the topography.

A2.4 Methods

It is better to do as much preparation in the office as possible before leaving for the field area. It is often possible to use remotely sensed information to produce a credible basic map before embarking on the field visit. If the project data is to be manipulated in a GIS, it is preferable to enter base map(s) and other desk study information before visiting the field. Basic digitising of clearly distinguishable features, such as rivers, can then be undertaken to prevent time being wasted in the field. The visit itself can then be used to ground truth the remotely sensed data and to collect detailed information. This is, nevertheless, the single most important part of the mapping exercise.

It is important that mapping is carried out on stable materials to avoid distortion of the information in what may be extreme climatic conditions. Such materials can be prepared with the base map in the office, and include thick drafting film or flexible laminate that can be bonded to the base map.

Most of the areas in question have a high degree of exposure and thus ‘exposure mapping’ is generally the most appropriate method. In many cases the exposures may be difficult to reach, or exposures may be so large that parts of them are inaccessible. In these cases it may be necessary to map from a vantage point, of which there are usually many as a consequence of the relief. There may be specific features, such as potential breach routes at a lake, which are better mapped in detail by an engineering geological traverse.

Features of greatest interest are slopes and discontinuities (Figure A2.1). Slopes can be mapped by dividing the terrain into sensibly uniform facets bounded by concave or convex breaks of slope. Slope angle and orientation within these facets are particularly important together with a description of the materials that make up the slope. Angles and orientations can be measured using a compass clinometer and/or a hand level. In specific localities where a full topographical survey is being carried out, it will be possible to obtain reasonably accurate gradients by measuring from the survey, although it is still valuable to carry out check sightings. Mapping of features such as breaks of slope or ridges, or the locations of exposures, springs or other significant localities, can be carried out using a hand-held GPS.

Concave features may be indicative of old landslides. In rock slopes especially, the angle, orientation, frequency and nature of discontinuities are particularly important and, analogously in unconsolidated deposits, the structure and fabric of sediments are important. In rocks particularly, precise lithological type and material strength are usually less important, since rocks rarely fail other than along pre-existing discontinuities. An estimate of mass strength could, however, be very important in both soils and rocks. To this end, the state of weathering of the rock may provide a good indicator.

Changes in vegetation may be useful indicators of underlying lithological type, of landslide history and also of groundwater conditions. The last of these is also critical and it is very important that springs and seepages are noted along with any other indicators of hydrogeological conditions.

Upon completion, the results of the mapping exercise can then be re-imported into the GIS for incorporation with other data obtained on site or remotely sensed, and used to build up the risk model.

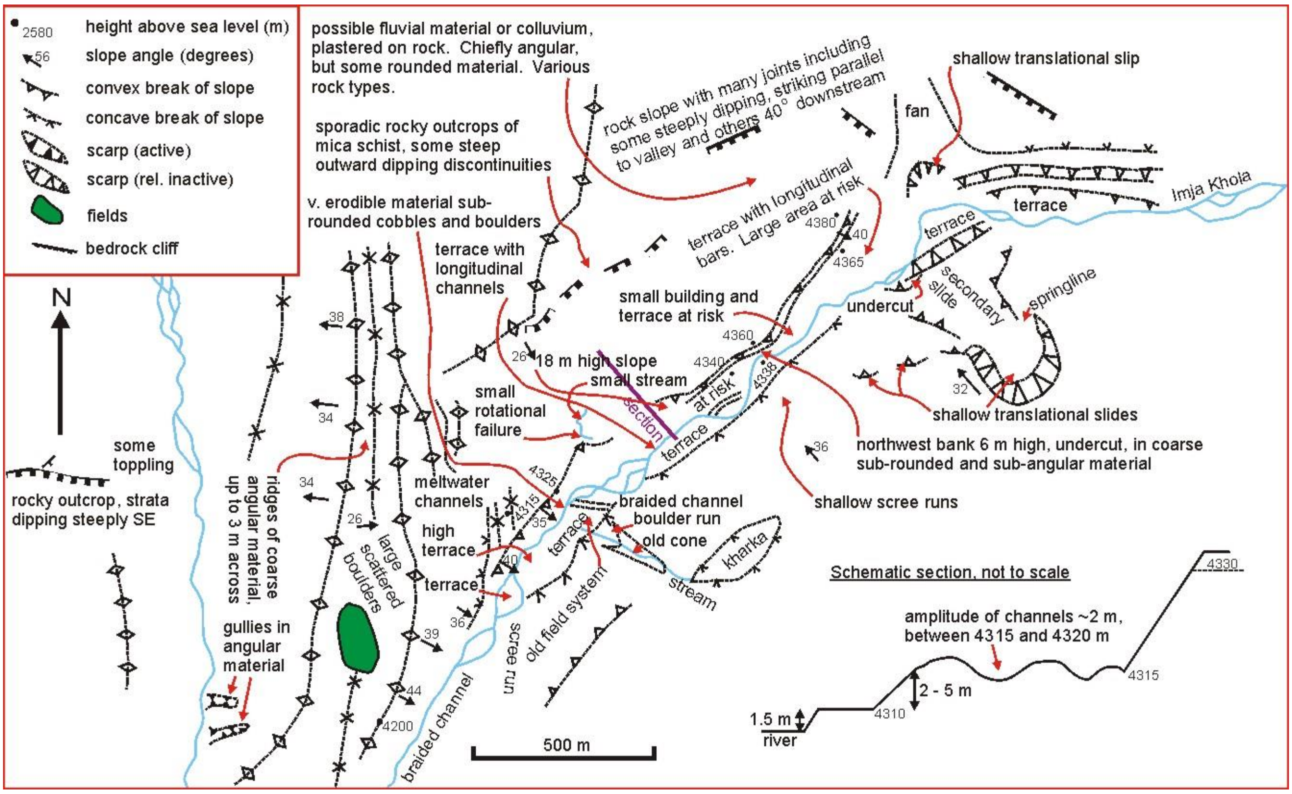

Fig. A2.1: Example engineering field map from the Imja valley, Nepal.