Introduction

3001. Map reading is the extraction of the information shown on the map; knowing the relationship of the ground to the map and the map to the ground and knowing what the map means. However to make full use of a map it is necessary to be able to give and to read grid references, to take bearings and to measure distances.

3002. The purpose in instructing cadets in map reading is to enable them to find their way about the countryside and to recognise features on the ground and on the map, to enable them to understand the information given on the map so that they can picture the ground even though they have not seen it, and to enable them to transmit and receive quickly and accurately, information concerning positions, directions and movement of personnel.

3003. The map contains a wealth of information that is not apparent to the untrained user. For example, a cadet trained and experienced in map reading can, by studying the map:

a. visualise the shape of the ground;

b. determine the height of hills and mountains;

c. select points of observation and estimate those that will be able to be seen from that point;

d. calculate the gradient of any particular slope;

e. determine roughly the density of timber or scrub in any area;

f. identify by type and relate roads and tracks, bridges, houses, post offices, schools, churches and factories to the ground.

Definition of a Map

3004. A map is a representation of part of the earth's surface drawn to scale on a flat surface showing natural and artificial features.

Type

3005. A map is a simplified picture of the ground. Simplified because a map is much smaller than the actual area it covers on the ground and also a large amount of detail on the ground is not necessary on the map. The type of maps used by the cadets of the AIRTC will most frequently be Military Maps. These are topographical maps that show a variety of natural features such as hills, valleys, lakes, rivers, buildings, transmission lines, etc. A map shows the ground as seen from above, and so features on the ground look more like a map if they are viewed from an elevated position, such as a hilltop or from an aircraft.

Map Titles and Marginal Information

3006. On the margin around the map is given information that will be needed when the map is being used. Neither the layout, nor the items of information will necessarily always be the same, as they vary with different editions and different scales of maps. The information includes the title, edition and map number that are necessary when ordering the map and passing grid references. Also essential for effective use are the scale, contour, interval, legend of topographical features, magnetic variation, date of survey and titles and numbers of adjoining maps.

Topographical Features

3007. The natural features of the landscape such as hills, mountains, valleys, plains, rivers, etc, are known collectively as its topography, whilst each one is known individually as a topographical feature.

3008. The more commonly encountered features which the student should know both on the ground and on the map are as at Annex A together with a contour plan of each feature.

Methods of Topographical Representation

3009. A map is drawn on a flat surface whereas the ground it represents is a three dimensional object. Some method must be found to represent this third dimension, the relief of the ground. To be a proficient map reader you must first and foremost be capable of visualising the shape of the ground from the information supplied on the map.

3010. The ways of representing relief on a map are:

a. hill shading,

b. layer tinting,

c. hachures,

d. contours,

e. form lines, and

f. spot heights.

The method usually employed in Australian Military Survey maps is a combination of contours and spot heights with hill shading.

3011. Hachures They are short lines drawn in the down direction of the slope. Fine hachures far apart indicate gentile slope, and heavy and close together indicate steep slope. This method is not used within Australia.

3012. Hill Shading This shows by depths of shading (using a pattern of dots) the pattern of physical features. This is produced by assuming a bright light is shining across the map from one direction, usually from north-west or north-east, so that one side of the hill is in the shade while the other side is in the light., This gives a vigorous idea of relief. Hill shading obscures other detail to a certain extent. Contours are often used with hill shading to provide a means of measuring accurately height with slope.

3013. Layer TintingLayer tinting is the colouring of the map between certain contour layers, and as a method of showing relief is not used on Australian Military Maps.

3014. Spot Heights They are definite points shown on a map with the exact height above mean sea level printed against them. On hachured and shaded maps they give the only exact information as to height contained on the maps. For showing exact heights of features that lie between contour lines they are invaluable. Usually spot heights are marked by a dot, but where the point was very accurately surveyed and used for survey is called a major control point (formerly a trig point) and marked by a triangle, while the circle is a minor control. point. Vertical height is measured from a datum which is mean sea level at Sydney. A Bench Mark is a permanent mark usually cut in a wall or metal plate attached to a wall, these marks are heights which have been specially fixed by levelling and even more accurate than a major control point. When marked on a map it means the height of the mark and not the ground on which it stands.

Contours

3015. The use of Contour lines is the most usual way of showing the shape of the ground on modern maps. This is done extremely well when the contour lines are used in conjunction with hill shading. Contours make an attempt to give visual illusion of relief. They are entirely conventional but once the convention is understood a general idea of the country can be got very quickly without detailed study of the map, and heights and slopes at any point can be read or calculated from the map.

3016. A contour is an imaginary line on the, surface of the ground at the same height above mean sea-level throughout its length. If a person were to walk round a hill at a certain level, going neither up hill or down, that person would be following a contour for that level. His path drawn on a map would be a contour. If this would be repeated a number of times, each time the person moving to a point 20 metres vertically higher than the previous circuit, then these paths when drawn on a map would give a contoured plan of the hill with vertical interval of 20 metres.

3017. The shape of the contour line indicates the shape of the ground. Imagine again a person walking around a hill at successive levels. Where the slope of the hill is gentle the path will be a considerable distance horizontally from the previous path below. Where the slope is steep, the paths will be much closer together. If that person comes to a spur and keeps straight on, would have to climb to go over it. To remain on the same level as the rest of the path that person would have to turn away from the hill. When coming to the end of the spur must then turn inwards towards the hill. In the same way, where there is a spur the bend in the contours points out away from the top of the hill, and where there is a re-entrant the contour bends will point towards the hill.

3018. Each topographical form, such as a col, cliff or knoll produces its own particular pattern of contour lines, except for a re-entrant (valley) and a ridge, where the pattern is similar. Annex A shows examples of typical forms of topographical patterns together with the type most likely to be encountered. A knowledge of these patterns is an essential part of map reading, and cadets must be able to find and identify contour lines and features. The patterns formed by a re-entrant and a spur are the same. It is necessary to determine the slope of the land to distinguish between them. A spur points away from the high point, while a re-entrant points towards it. A re-entrant usually has a watercourse marked across its contours at the point of greatest curvature, a spur never does.

3019. These are the most important things to remember about contour patterns:

a. contour lines spaced close together mean steep slopes;

b. contour lines spaced far apart mean gentle slopes;

c. when contours are evenly spaced the slope is uniform. No natural slope is perfectly uniform, and such slopes will always have small undulations;

d. when the spacing of the contours is closer together on the lower slopes than on the higher slopes the slope is convex;

e. when the contours are further apart on the lower slopes than the higher, the slope is concave;

f. meandering contours at varying distances apart, but never very close, mean undulating ground;

g. gently curving contours indicate a country of rounded slopes. As the country becomes steeper the contours come closer together, as it becomes more rugged the curves become less regular.

Contour Interval

3020. On a map each contour is drawn at a specific height above sea level and every contour is the same vertical distance above the one below. The difference in vertical height between contours is called the Vertical Interval (VI).

3021. The heights of the contours are written into the contour lines at intervals along their length. Depending on the density of the lines, the height is usually written on every second contour lines. For example, with contours 20 metres apart the height will be written on 400, 440, 480 and omitted on 420 and 460. The contour lines for the even hundreds e.g. 400, 500, 600 are printed as heavier lines. The figures are printed in such a way that they read correctly when the reader is looking up hill. This helps to determine the direction of the slope in flattish country and provides a quick way of distinguishing between contour patterns of a spur and that of a re-entrant.

Scales

3022. When used in connection with a map, a scale is the ratio that the distance between two points on a map bears to the horizontal distance between the same two objects on the ground. The reliability of maps depends partly on their scale. Even more the amount of detail that can be shown depends on the scale. A 1:250000 map shows details of towns and major roads whereas a 1:25000 would show details of house, roads, tracks, river and creeks and most all fine detail. Annex B shows the differences between scales.

3023. Generally speaking maps with a scale of 1:50000 give all the detail that is ordinarily needed for map reading and cover a fairly wide area.

3024. Scales may be expressed in three ways:

a. by a statement in words, eg. 1cm to 1km; 2cm to 1Km;

b. by a representative fraction (RF) written either as a fraction or expressed as ratio eg. 1:50000 means that one millimetre of length or one centimetre or one inch or one unit of length on the map corresponds to 50,0000 of the same units on the ground;

c. by linear scale. This is a line or several lines, usually at the bottom of the sheet suitably divided so that a distance on the map can be converted quickly and accurately to miles, kilometres or nautical miles depending on the graduation of the scale.

3025. The scales used on the more modern Australian Military Maps are: 1:25000; 1:50000; 1:100000 and 1:250000.

3026. Distance between two points on the ground can be calculated by measuring the distance between the same two points on the map, multiplying by the denominator of the RF and dividing by the appropriate conversion figure as shown below:

a. the distance between two points on a 1:50000 map is 5.81cm, what is the corresponding distance on the ground?

$$\text{Distance on Ground} = \frac{5.81 \times 50000}{100}$$

$$= 2905 \text{ meters.}$$

3027. To measure the distance in a straight line between two points on a map, lay the straight edge of a piece of paper against the two points and at each point mark with a tick. Then lay the piece of paper along the appropriate line with the right hand mark against one of the primary divisions and left hand opposite the secondary divisions. The distance is then the distance to right of zero plus the fraction left of zero.

3028. To measure a distance that is not straight, such as along a winding road, two methods may be used. A piece of cotton may be laid (not stretched) along the road and then the cotton transferred to the scale line. The second method uses a piece of paper in a similar way to that described in para 1.27. The road is considered to be made up of a number of straight sections. Lay a piece of paper along the first section, put a tick at the commencing point and at the point where the road swings away from the edge of the paper. Taking care not to move the position of the second tick on the road, pivot the paper about the second tick, until the next section of road is along the edge of the paper. Keep repeating this process until the finishing point is reached. The total distance then is recorded as a straight line between the first and last tick, and can be measured on the linear scale.

System of Grid Reference

3029. One of the essential requirements of a map is that the user must be able to give a quick and accurate reference to the position of any point on that map. The method of doing this employed on the Australian Military Map series is called the Australian Grid System. The position of a point on the map is indicated by a six figure number which is called the Grid Reference. On any one map sheet every point has a grid reference that is difference from the grid reference of all other points.

3030. This requirement is met on Military maps by the use of a series of lines drawn on the map running both north-south and east-west, and being parallel to one another. These lines are numbered from 00 to 99 for each 100km square and are at a fixed distance apart - namely 1000 meters.

3031. Those lines that run north-south are numbered from west to east, and called EASTINGS. Those lines that run east and west are numbered from south to north and are called NORTHINGS.

3032. The four figure grid reference will indicate one grid square, that is, a square 1000 metres by 1000 metres and is achieved by the following steps:

a. follow the vertical line (Easting) which forms the left hand edge of the square, either up or down to the margin of the map or until you find a two figure number (grid number) on the map and write the number down;

b. next, follow the horizontal line (Northing) which forms the bottom of the square and write those two grid numbers after the first two.

3033. In order to locate a specific point on a map more accuracy is required and the six figure grid reference is achieved as follows:

a. locate the grid square which contains the object or feature to be indicated and divide the square into tenths vertically and horizontally;

b. follow the steps as for the four figure grid reference but this time add the extra numbers first after the two numbers for the easting and then after the two for the northing.

3034. In the example shown at Annex C the reference at the square containing the object marked "P" would be written down G.S.2909. The "G.S." denotes, that it is the grid square being indicated. The object marked "P" would be written as G.R.297095. The "G.R." stands for grid reference and means that a specific feature is to be located.

3035. Remember, the eastings are always measured by moving from left to right across the map and are always the first three figures of the grid reference. The northings are always measured from the bottom upwards and are always the last three figures of the grid reference.

Use of the Romer

3036. To read or plot a six figure grid reference accurately a romer may be used. his is simply a piece of cardboard graduated in divisions of 100M appropriate to map scale. This is then employed to measure the third figure of the eastings and northings.

3037. To use the romer, place the point of the corner on the position to which the reference is being given, making sure that the edge of the scale is parallel to the sides of the square. Read the easting first on the map cuts, the scale on the top edge of the romer. Read the northings next where the northing on the map, cuts the scale on the right edge of the romer.

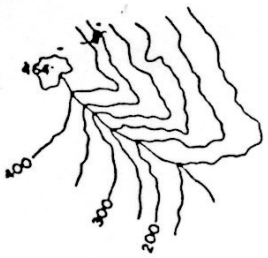
Annexes

A Typical Forms of Topographical Patterns

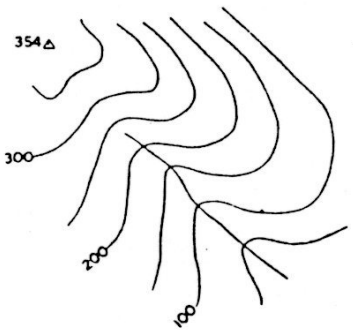
B Map Scales

C Example of Grid Reference

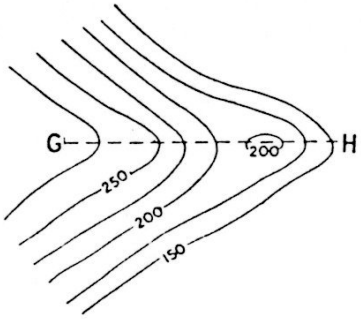
TYPICAL FORMS OF TOPOGRAPHICAL PATTERNS



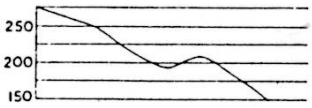
Rugged country.



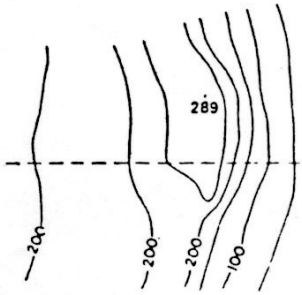
Rolling country

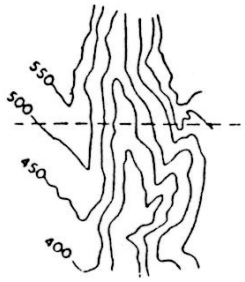


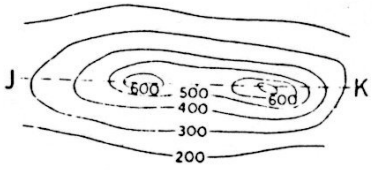
Spur and re-entrant.

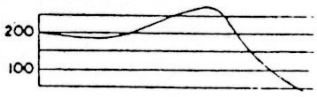


Spur with knoll.

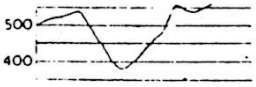




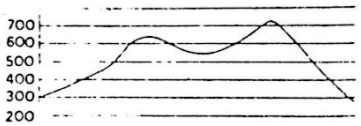




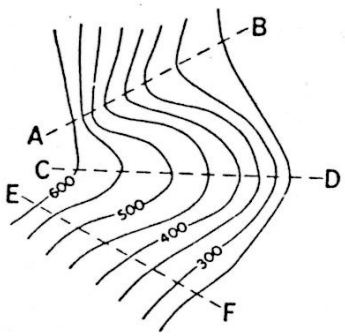
Escarpment

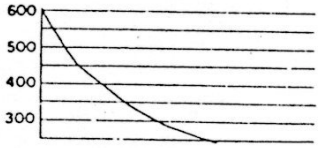


Ravine

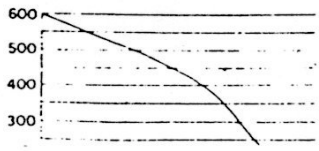


Ridge with a col.

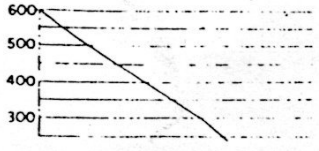




Section AB – Concave slope.



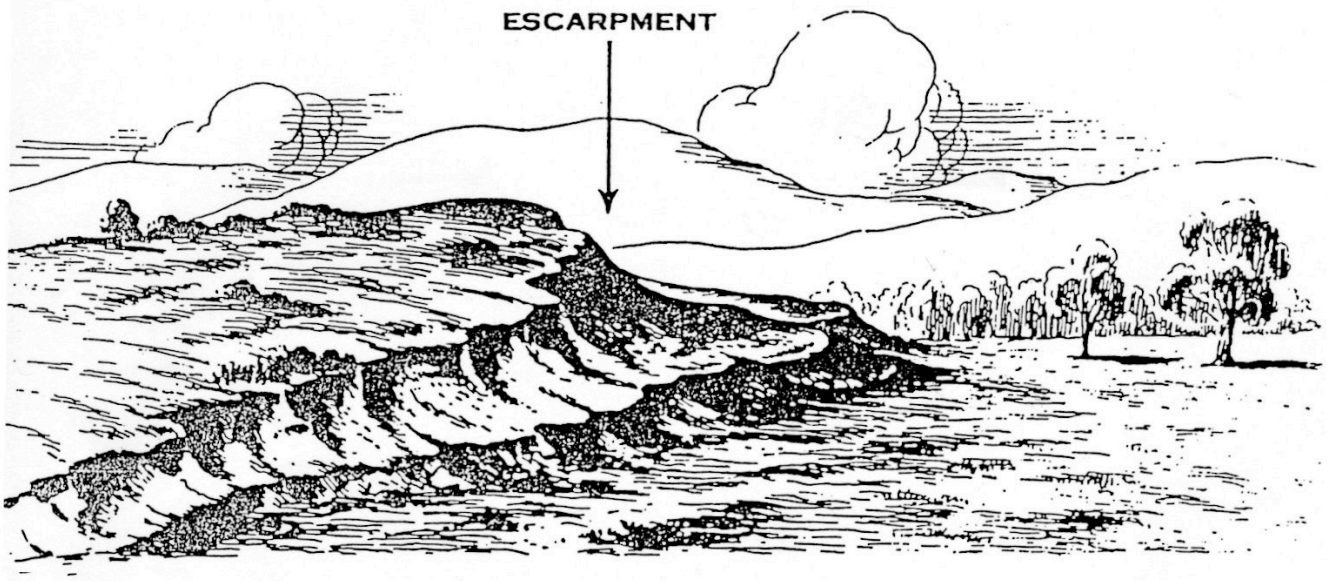
Section CD – Convex slope.

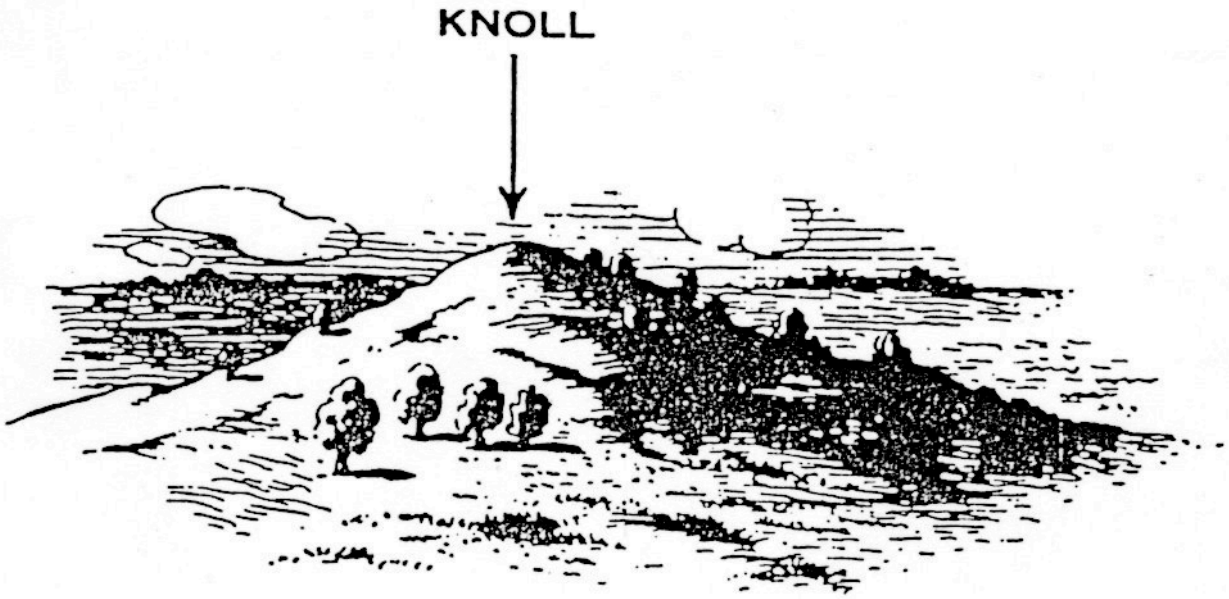


Section EF – Uniform slope.

ANNEX A

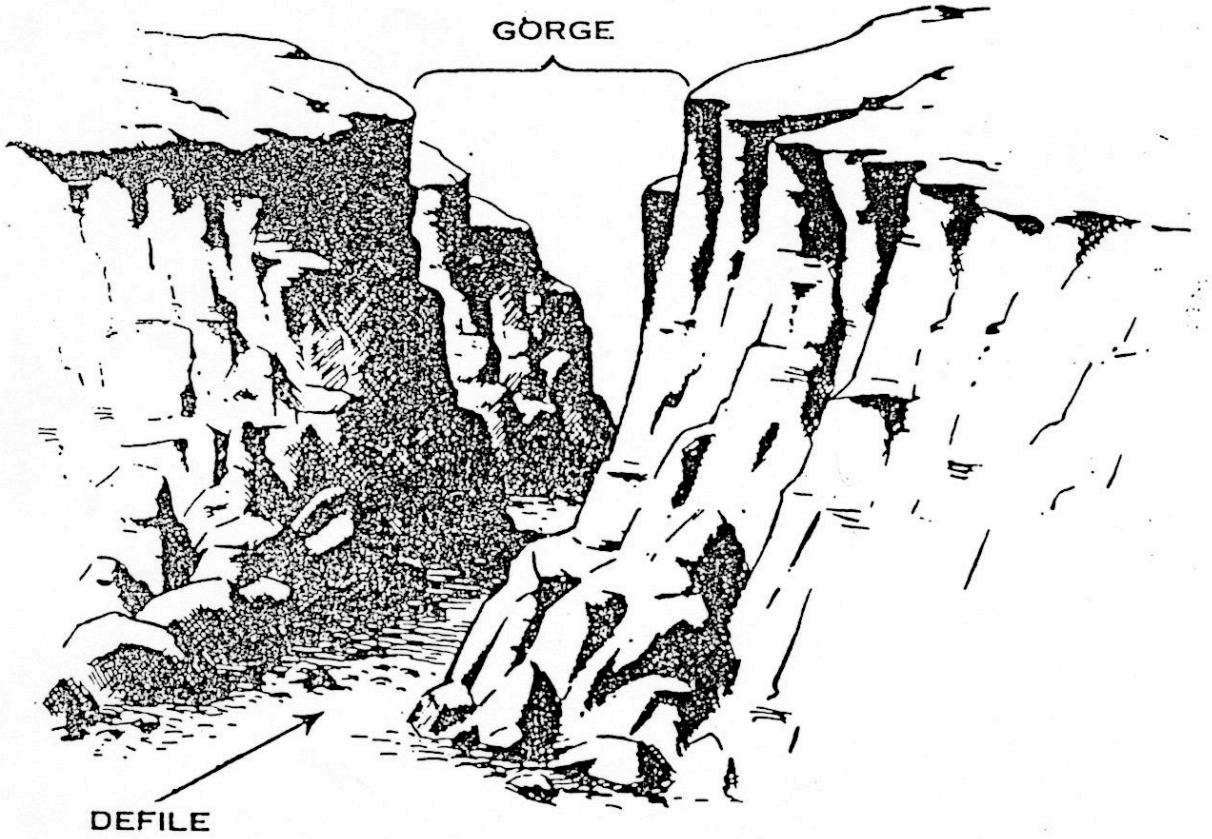
TOPOGRAPHICAL FORMS

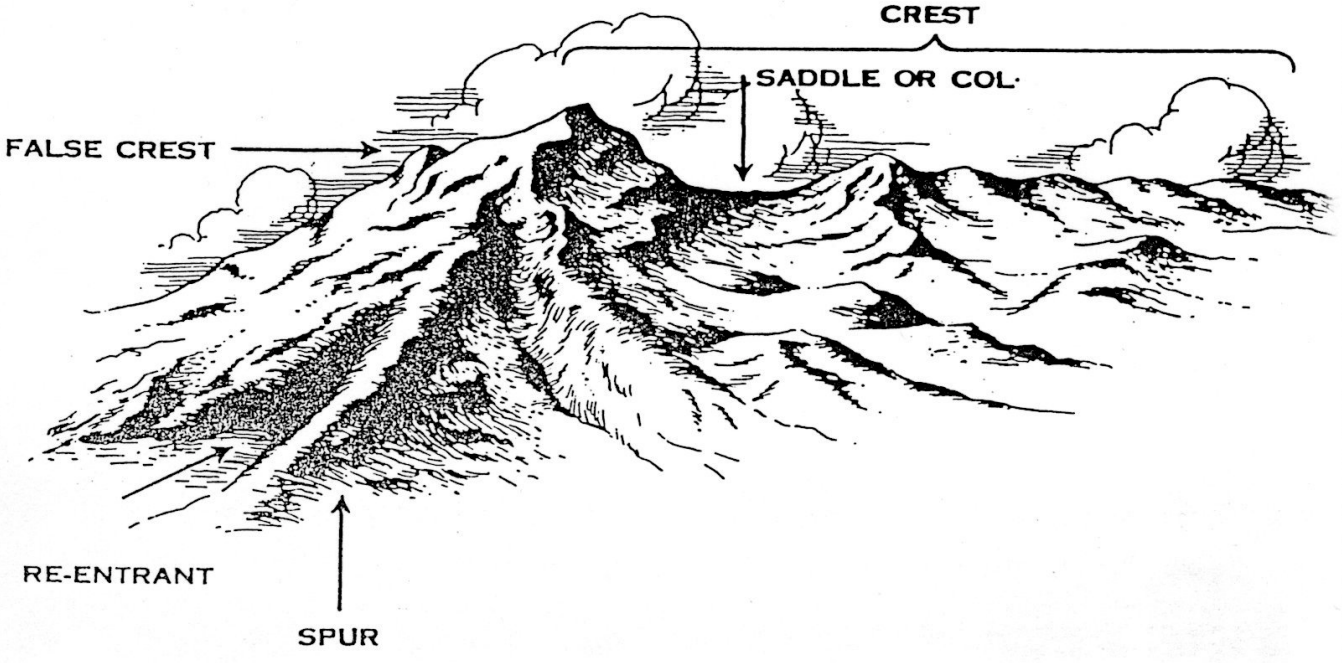




ANNEX A

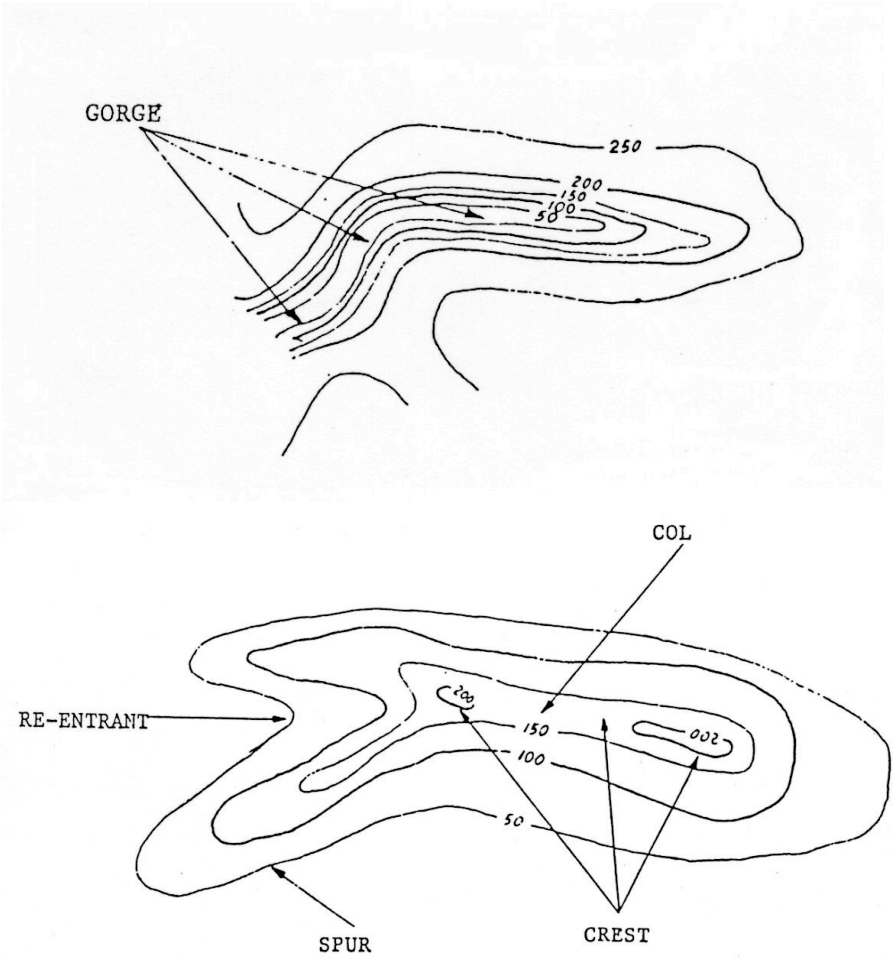
TOPOGRAPHICAL FORMS

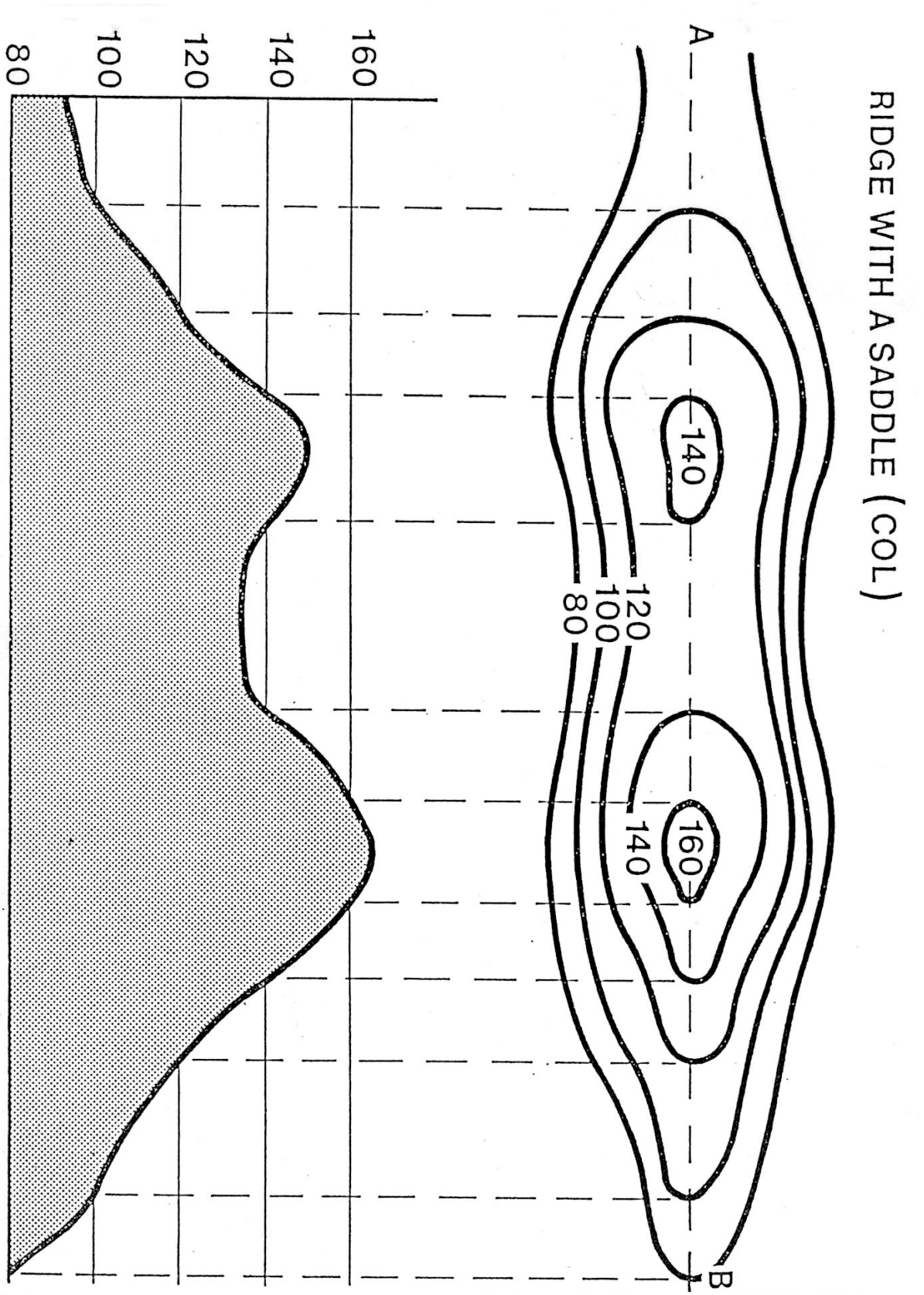


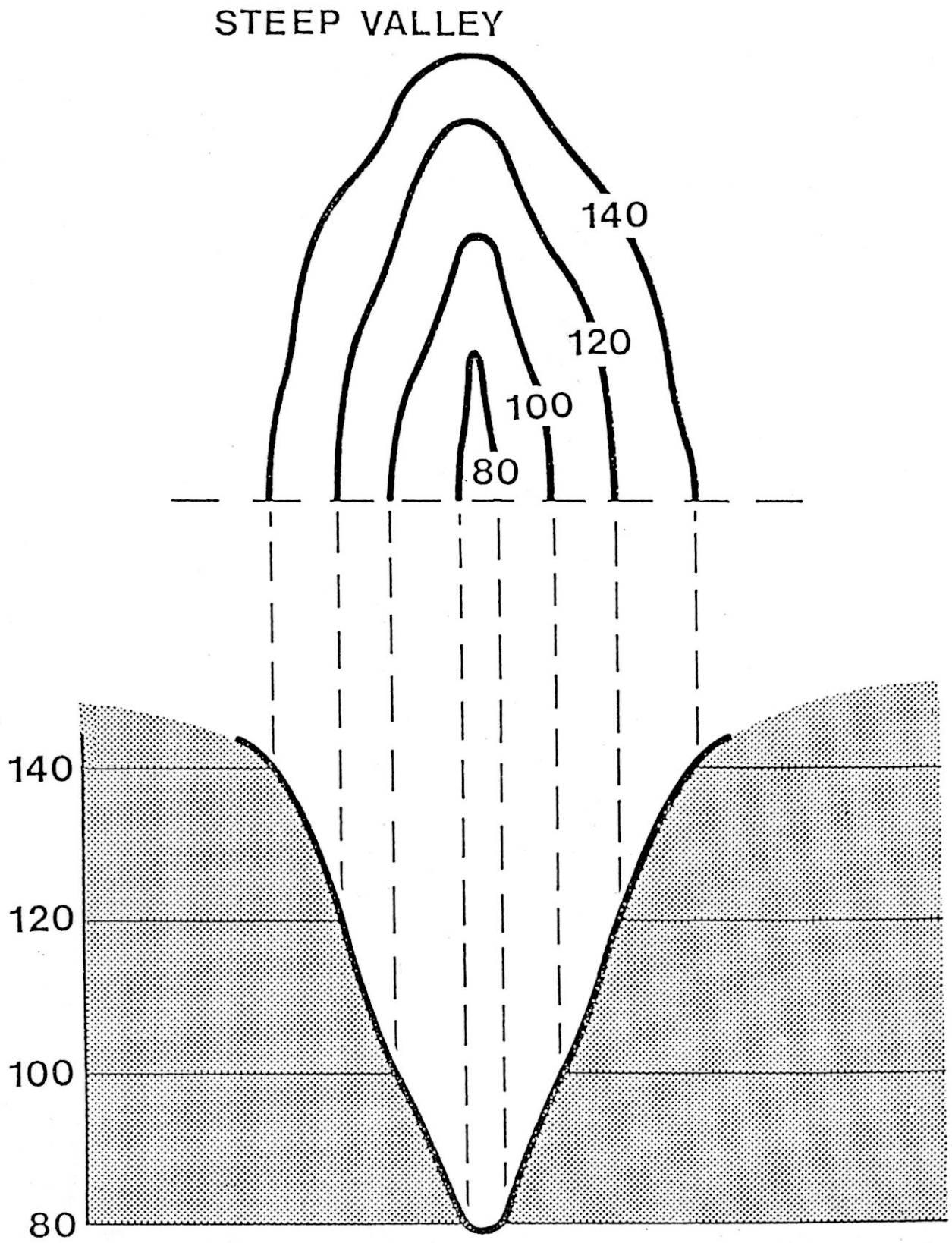


ANNEX A

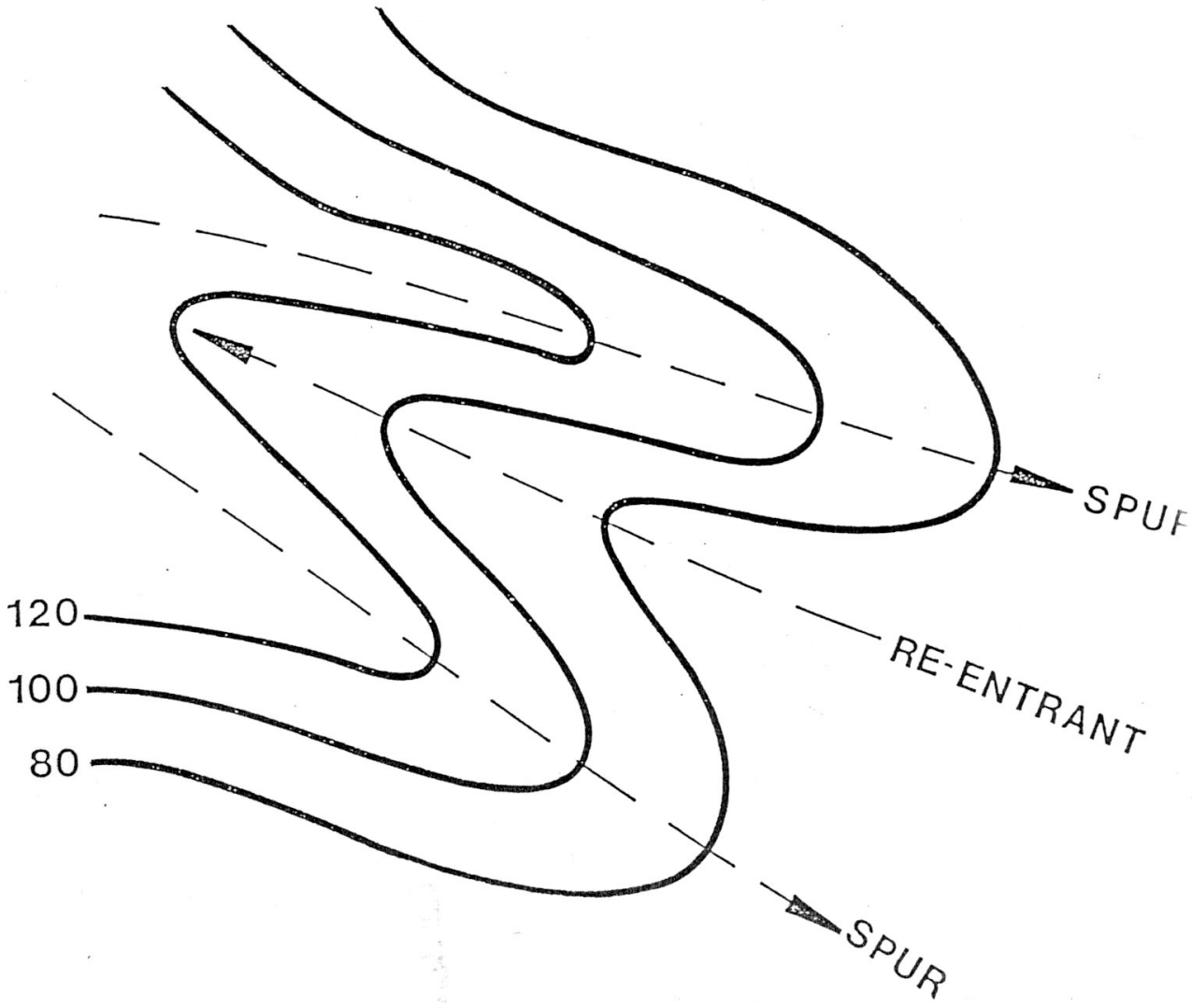
TOPOGRAPHICAL FORMS IN PLAN

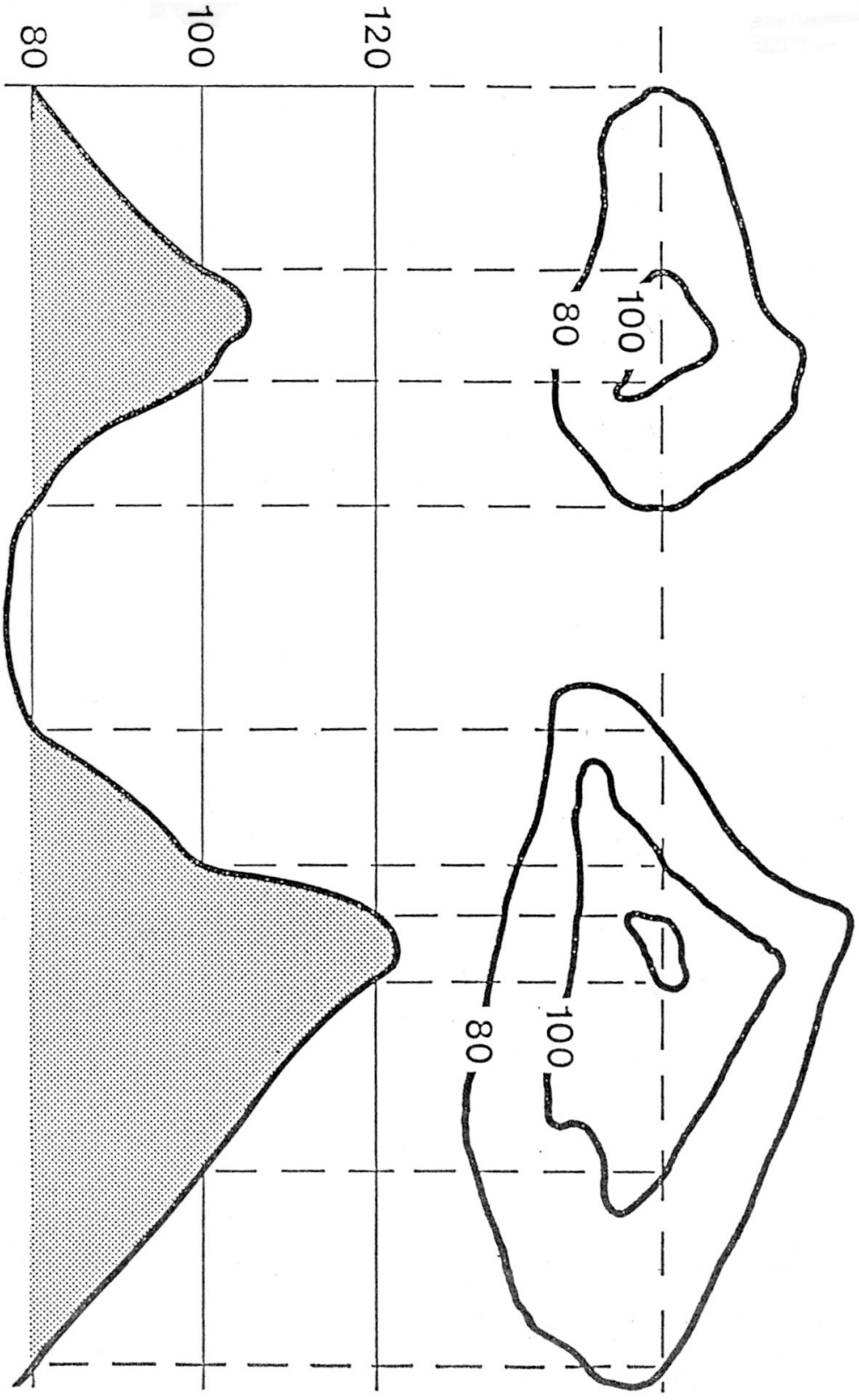


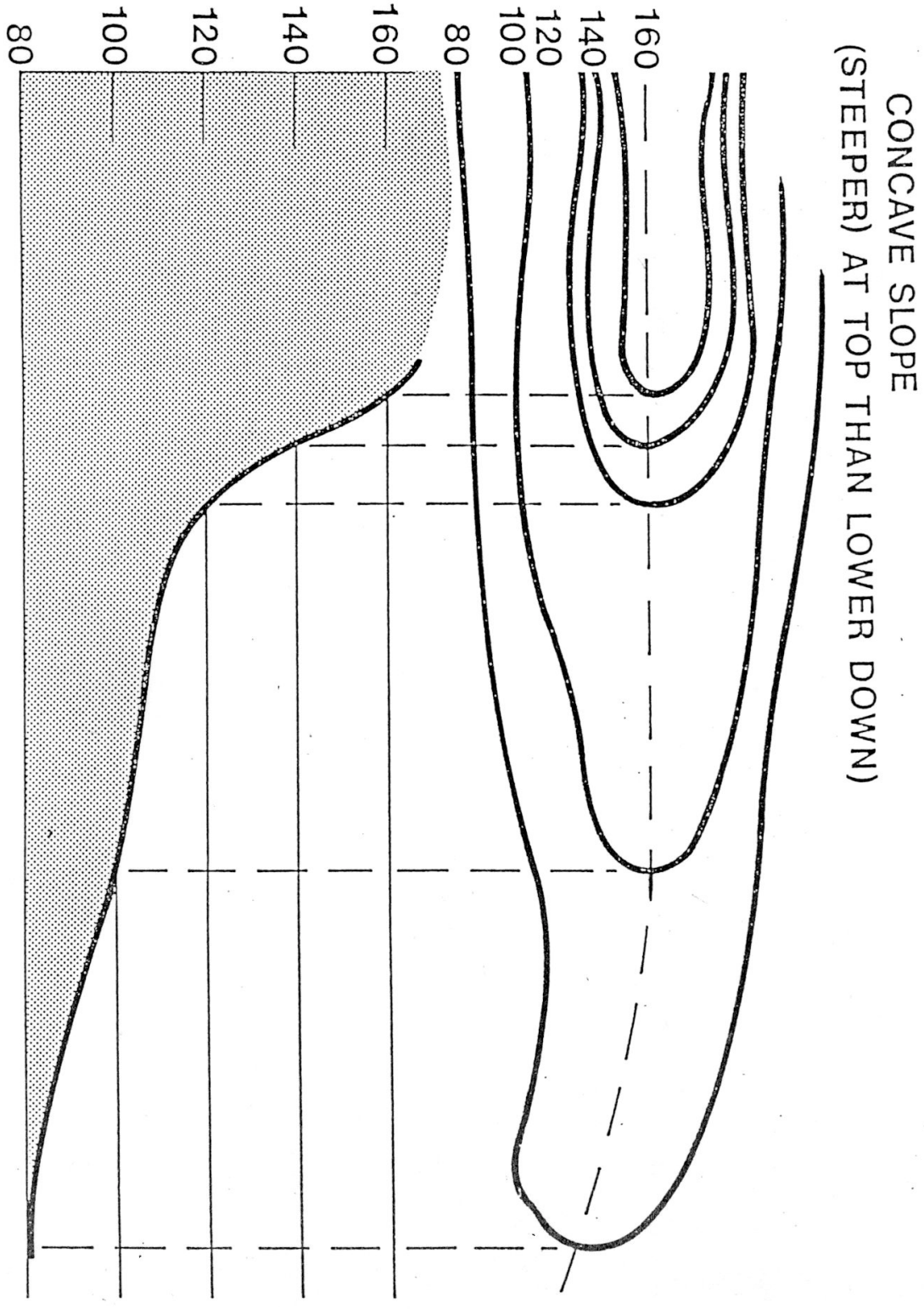

RIDGE WITH A SADDLE (COL)
A
B
140
160
120
100
80
140
160
120
100
80

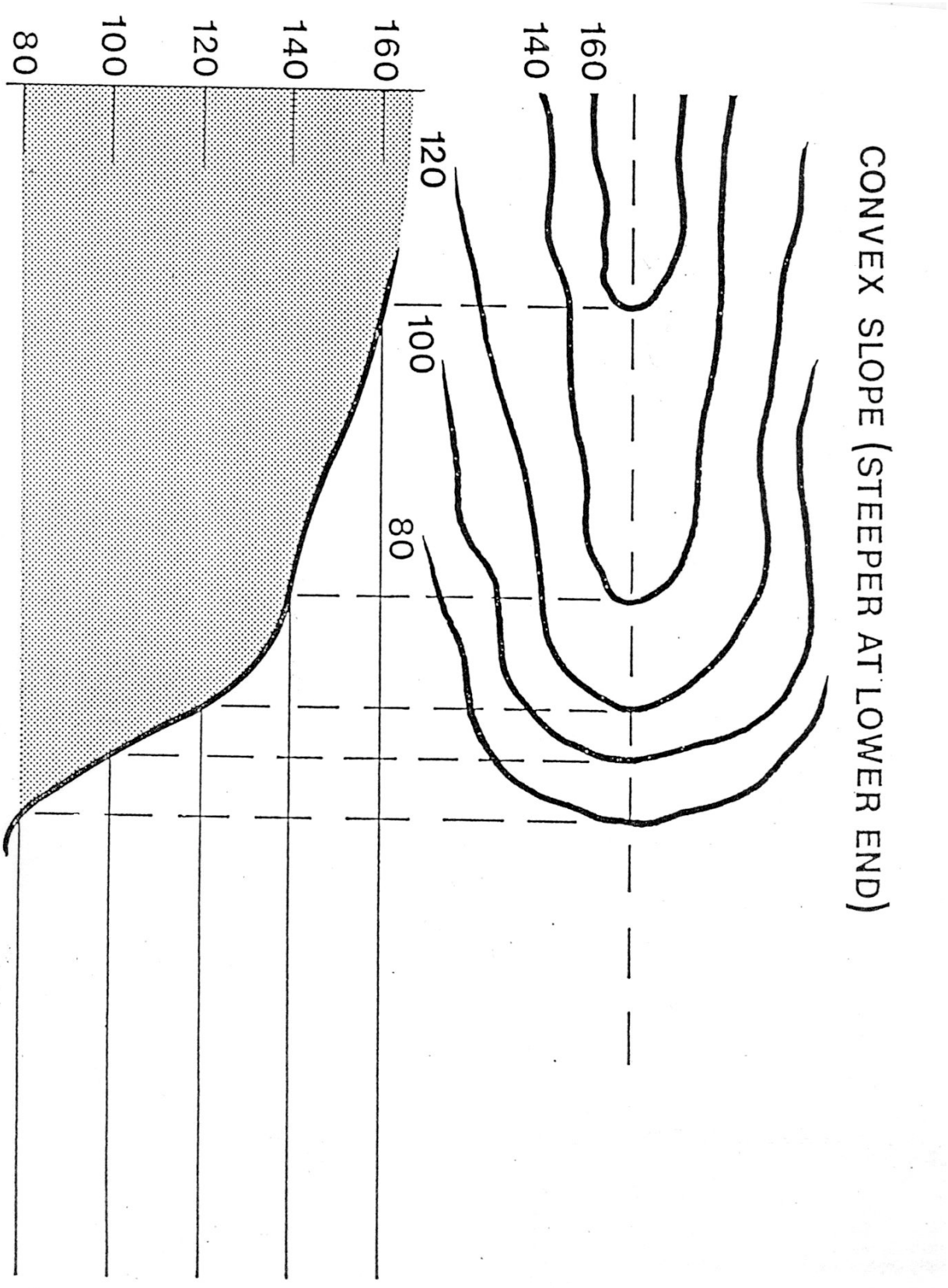

STEEP VALLEY
140
120
100
80
140
120
100
80

SPURS WITH RE-ENTRANT



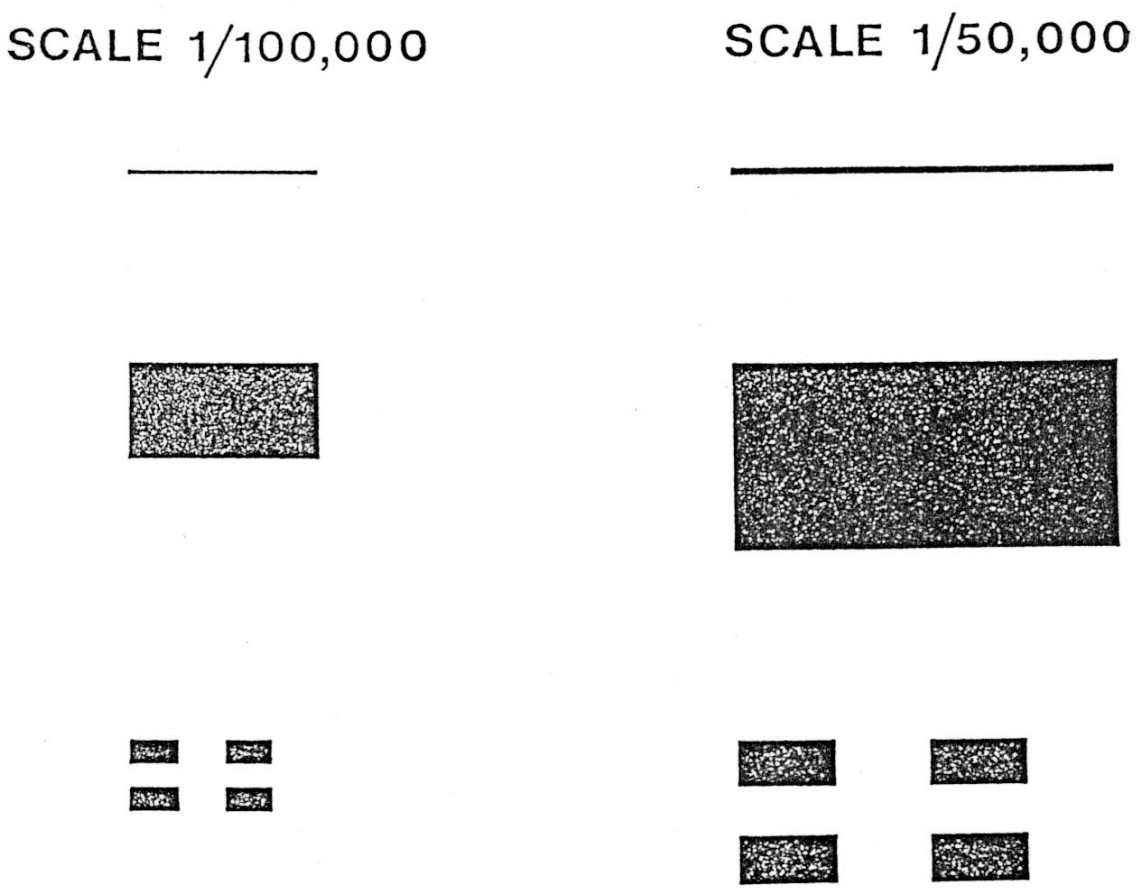

SEPARATE HILLS
80
100
120
100
80
100
80


CONCAVE SLOPE
(STEEPER) AT TOP THAN LOWER DOWN)
80
100
120
140
160
80
100
120
140
160


CONVEX SLOPE (STEEPER AT LOWER END)
80
100
120
140
160
80
100
120
140
160

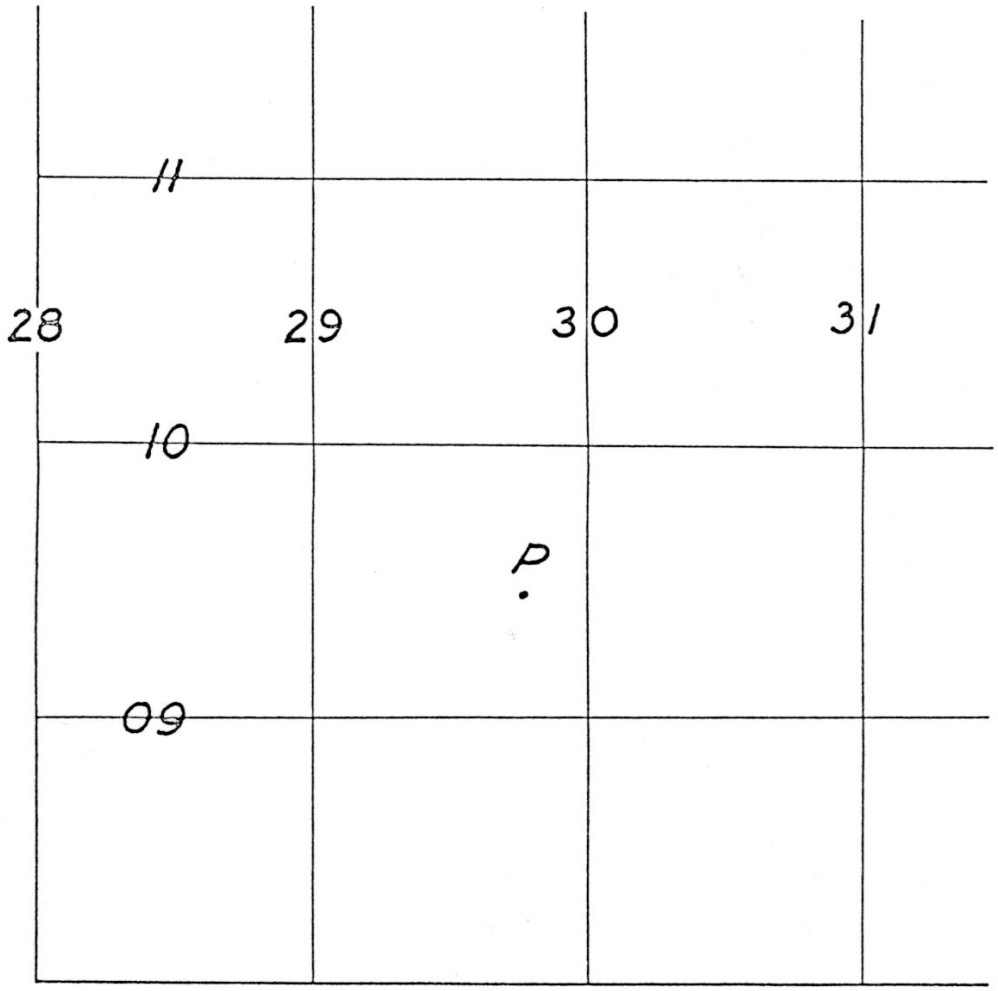
ANNEX B

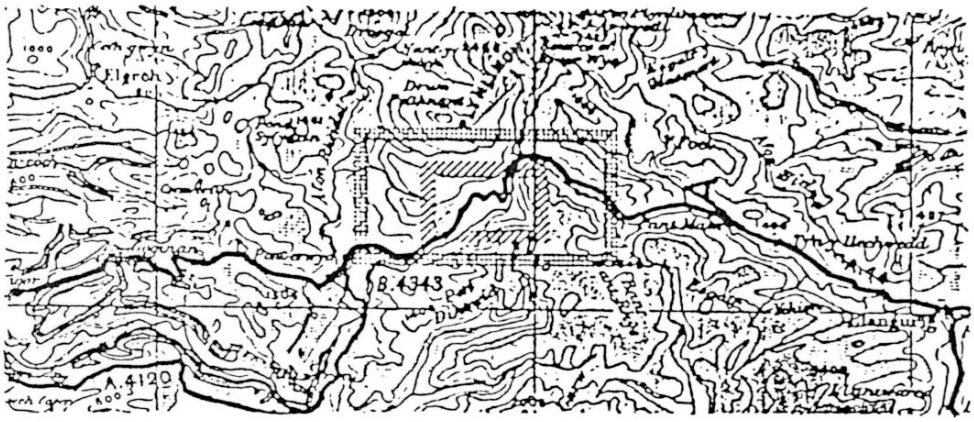
MAP SCALES



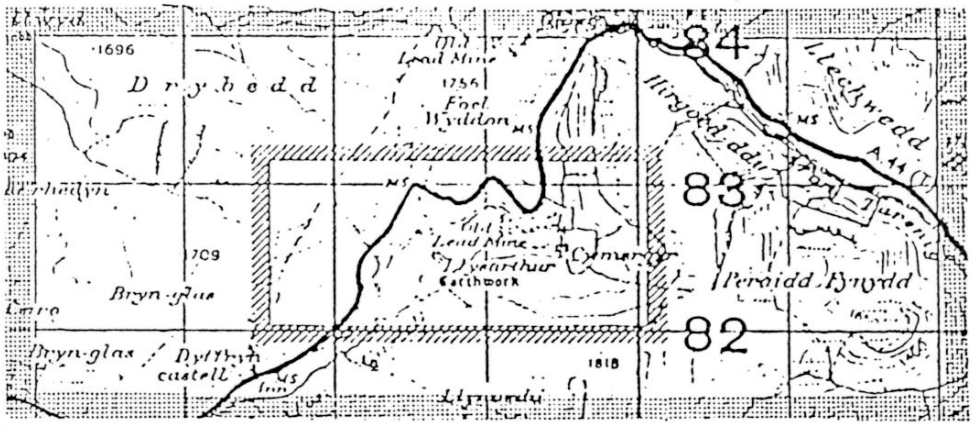
ANNEX C

EXAMPLE OF GRID REFERENCE

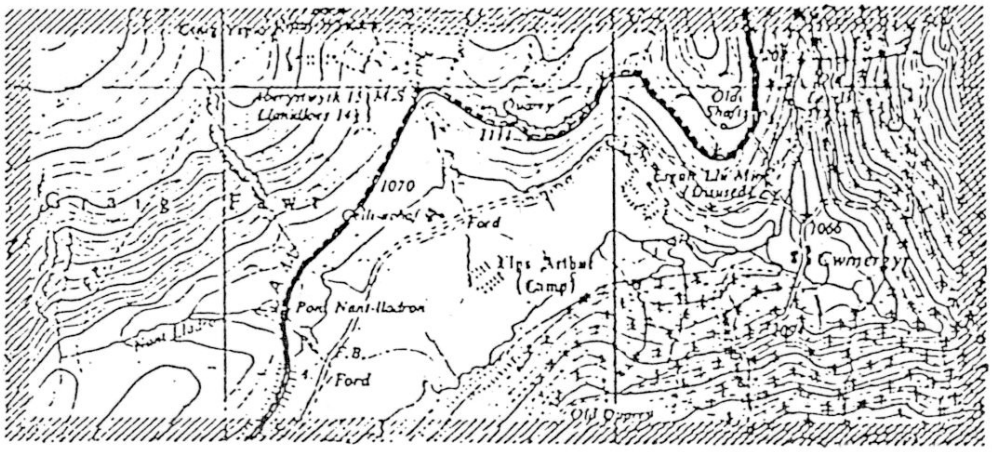




(a) Quarter inch to one mile



(b) One inch to one mile



(c) 1:25,000 (About 2½ inches to one mile)