# 2. 地質構造測量及儀器使用

2.1 測距離

2.2 測高度或垂直距離

2.3 測方向

2.4 定位置

2.5 路線地質圖測量

2.6 平面構造量測

2.7 線性構造量測

2.8 地層厚度量測

2.9 地質構造空間表示

2.10 行動裝置地質調查

# 2.1 測距離

- 尺量(5 m or 30 m)
- 步測：我的一個複步是______公尺(將自己的步伐長度填入下表)
- 交通工具里程表
- 測量儀器：如雷射測距儀、視距測量(Stadia measurement) 經緯儀(transit)、照準儀(Alidade)、電子經緯儀(electronic theodolites)、電子測距儀。
- 目測：如中央大學科一館的長度是_86_公尺

| 複步 | 公尺 | 複步 | 公尺 |
|---|---|---|---|
| 1 | | 10 | |
| 2 | | 20 | |
| 3 | | 30 | |
| 4 | | 40 | |
| 5 | | 50 | |
| 6 | | 60 | |
| 7 | | 70 | |
| 8 | | 80 | |
| 9 | | 90 | |

我的步伐(複步)長度

# 2.2 測高度或垂直距離

- 氣壓計法(barometer method)
- 手持水平儀法(hand-level method)
- 視距測量(Stadia measurement)
- 勃氏羅盤儀測法(Brunton compass method)

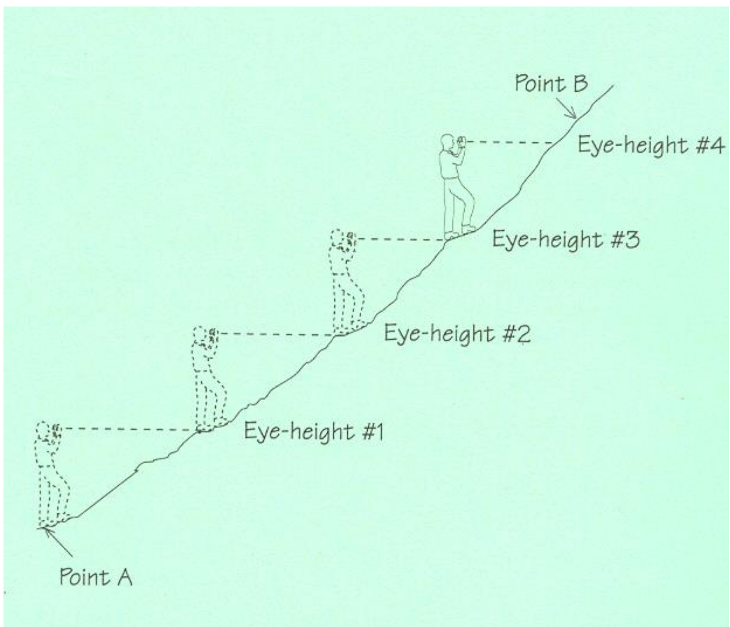
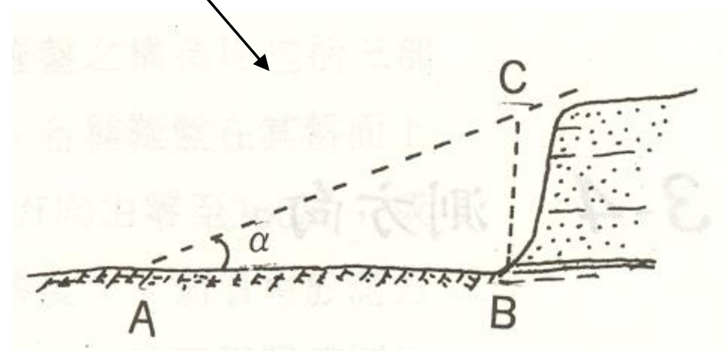
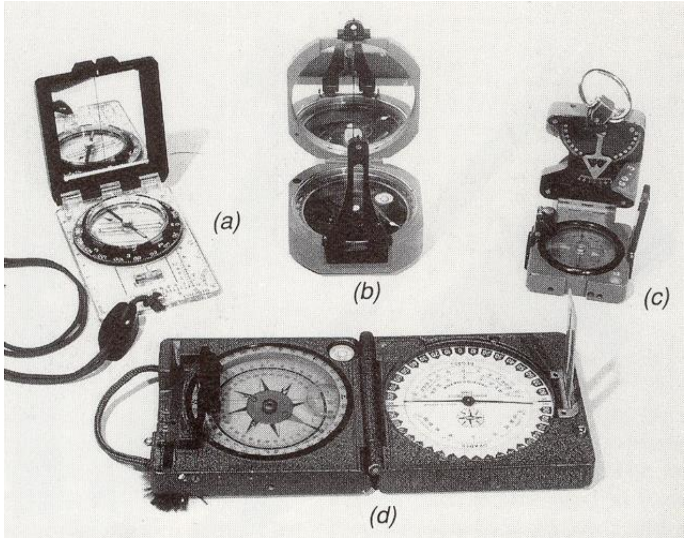



*Fig. 15. Determining difference in elevation by using a Brunton as a hand-level.*




BC = AB tanα

# 2.3 測方向




## 地質用羅盤儀

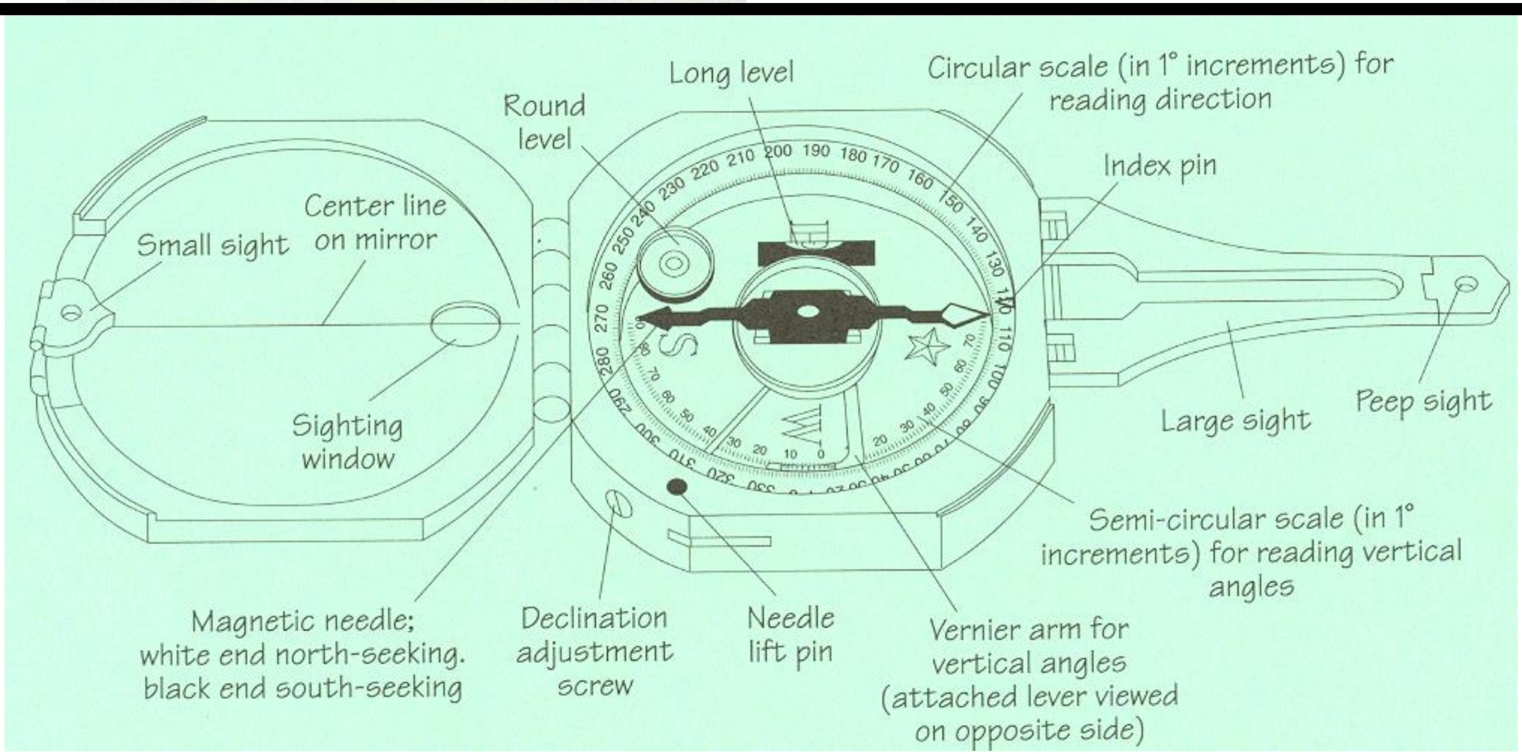
(a) Silva compass;

(b) 勃氏羅盤儀(Brunton compass);

(c) Meridian compass;

(d) Chaix-Universelle;

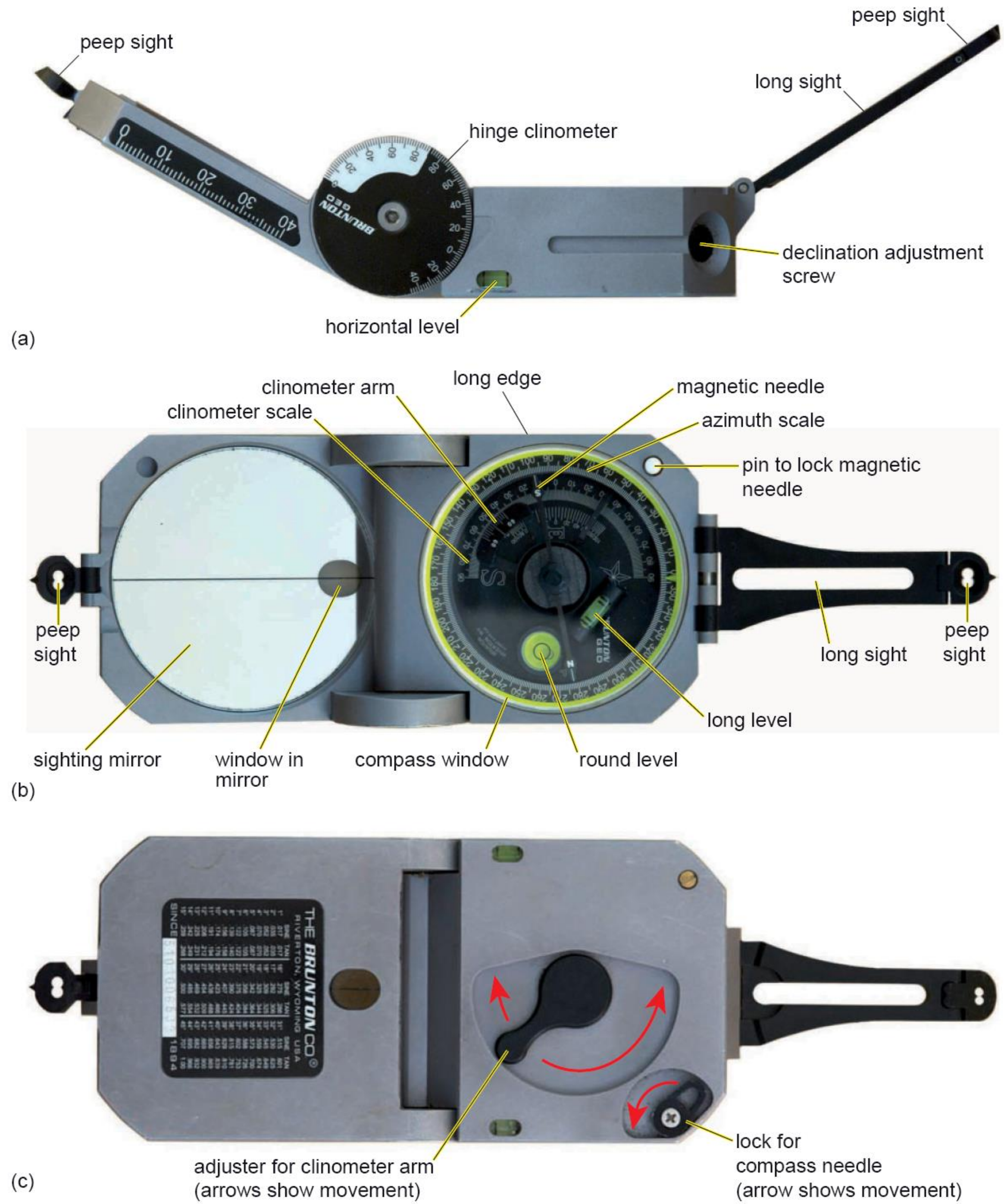
(e) 傾斜儀(Clinometer, not shown)




**Brunton compass 結構**

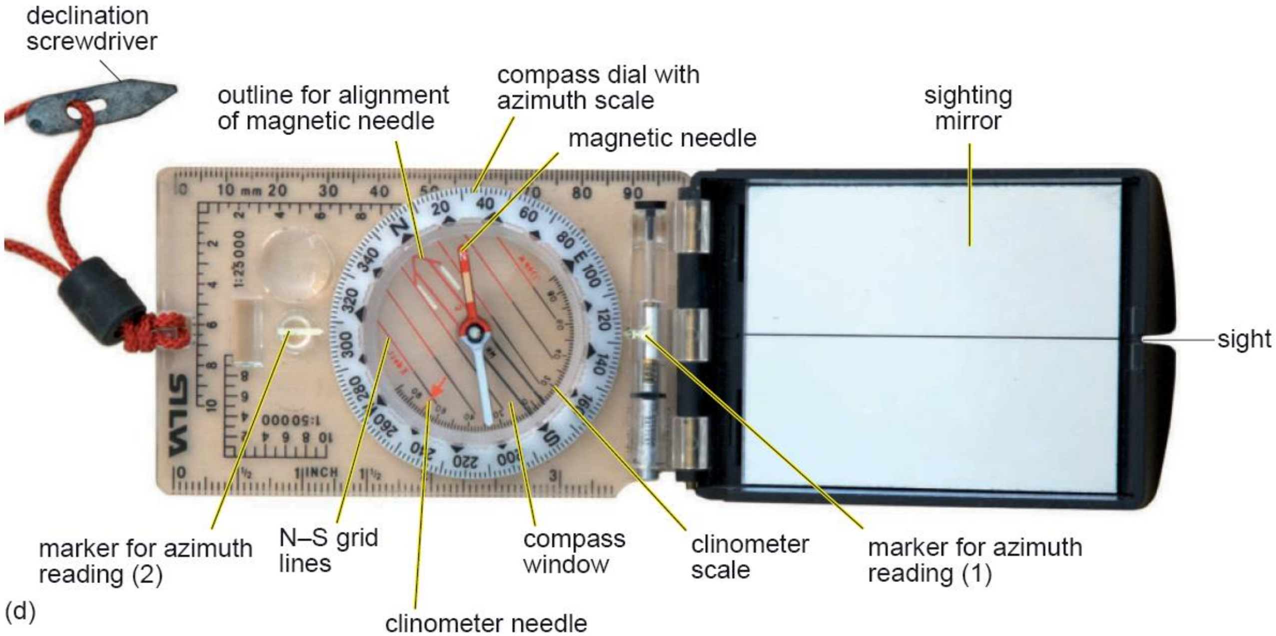
# Brunton-type

**Figure 2.3** Labelled photographs of the parts of two of the most commonly used types of compass - clinometer. These terms are referred to in the text and in other figures. (a) – (c) The Brunton - type compass - clinometer: in this case the Brunton Geo. Views: (a) side; (b) top; (c) bottom.

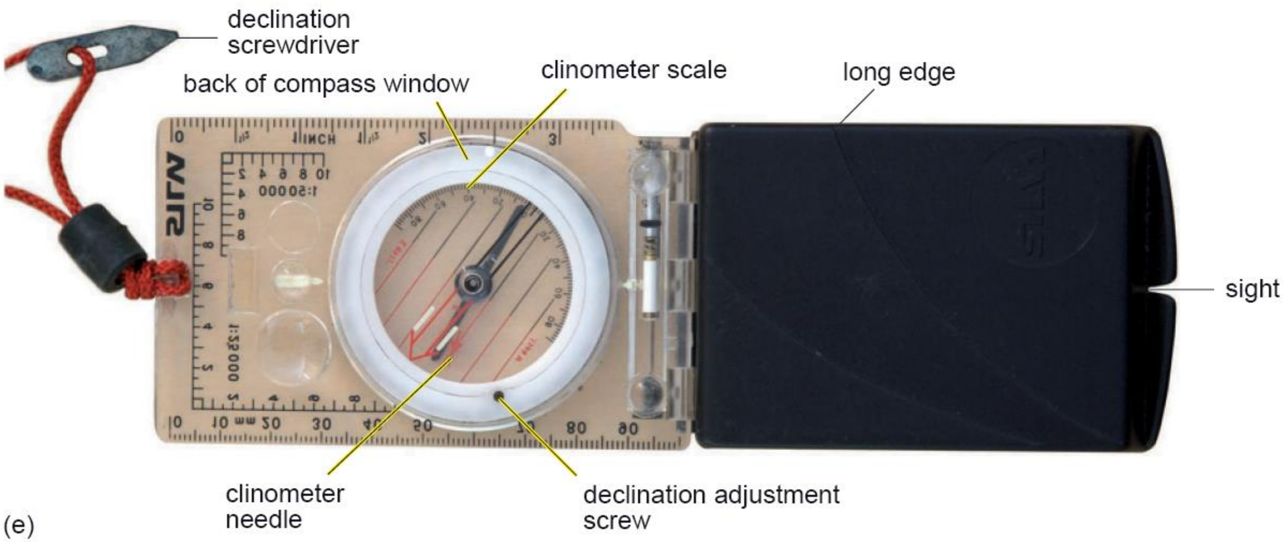


# Silva-type

(d) – (e) Silva - type compass-clinometer: in this case the Silva Expedition 15TDCL. Views:(d) top; (e) bottom. There are small variations from model to model, with more features on some models.
Compass - clinometers from other manufacturers have similar features.



(d)



(e)

# 地磁偏差校正

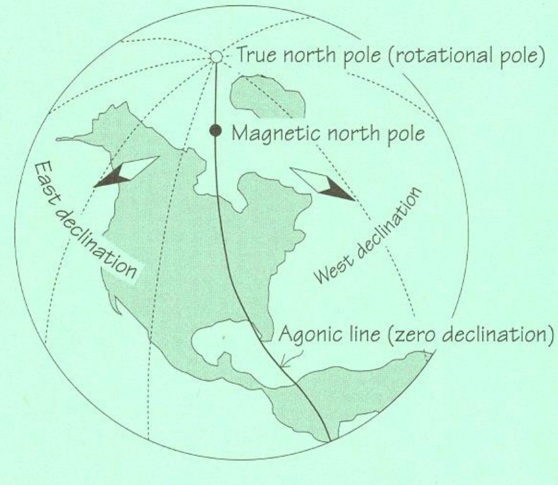
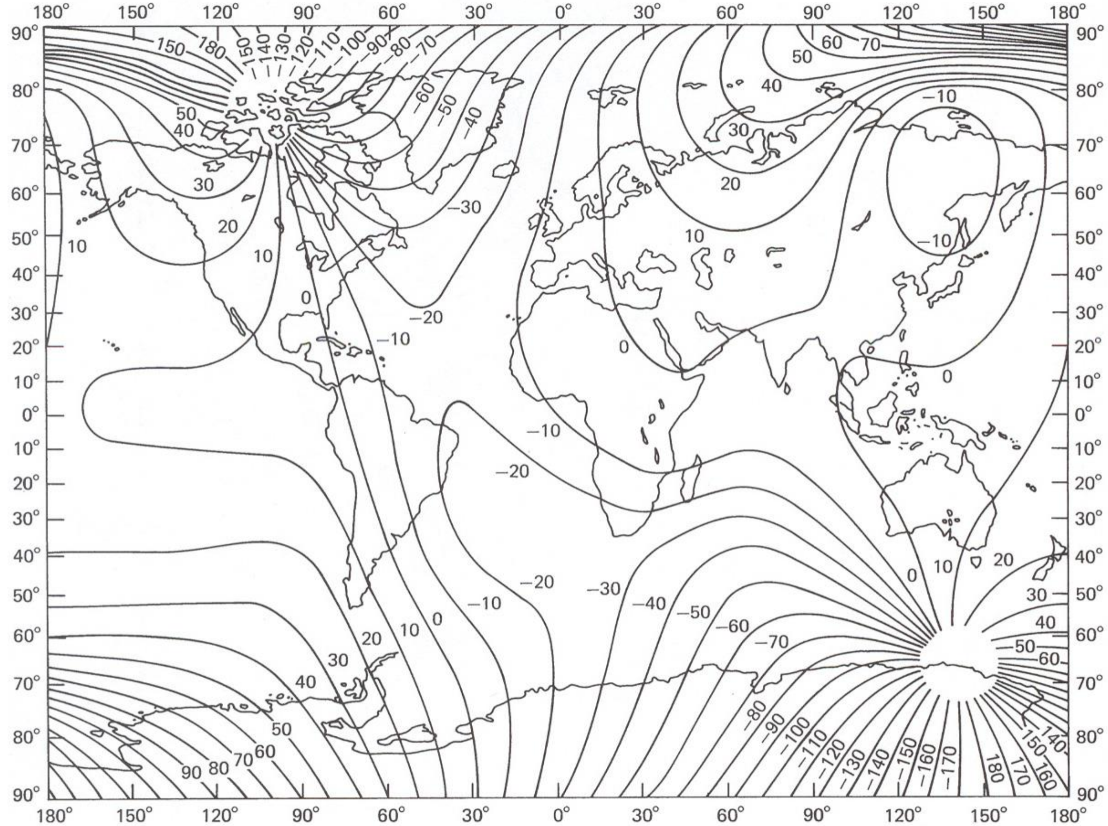
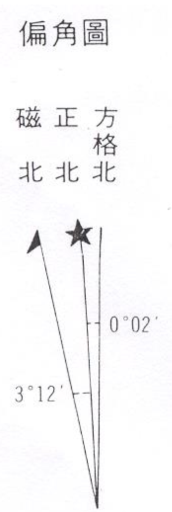



*Fig. 4. White arrowheads that point toward Earth's magnetic north pole diverge (or decline) from meridians (dotted lines), which converge on 'true north' pole. Along the agonic line, directions to the two poles are the same. That is, along the agonic line a magnetic needle is parallel to a meridian.*



## 使用compass前須先校正磁偏角!

台灣的磁偏角約2~3度西，右圖為新竹某一1/5,000相片基本圖的偏角圖。根據這個偏角圖，校正您的Brunton compass (逆時針旋轉刻度盤3度，使得index pin指向N3W) 。




Example

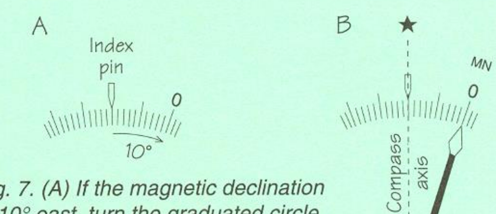



*Fig. 7. (A) If the magnetic declination is 10° east, turn the graduated circle 10° clockwise. (B) Then, if the compass is rotated so that it reads due north (by bringing the north-magnetic-seeking needle to zero degrees), the axis of the compass aligns with true north.*

# Brunton Compass執法

## 1. 目標物的仰角約小於25度，俯角約小於15度時

Step 1.

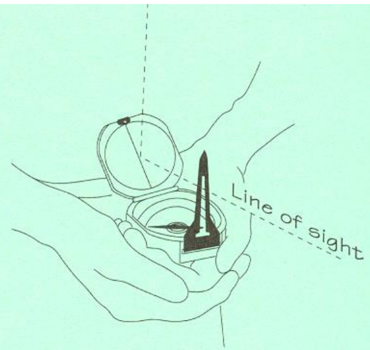


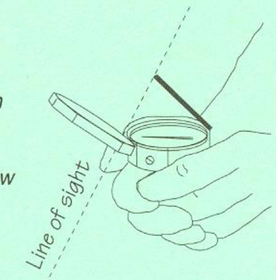

*Fig. 8. How to hold a Brunton when measuring the direction to an object whose elevation is not more than a few tens of degrees above—nor more than approximtely 15° below—the elevation of the viewer.*

Step 2. Read the bearing or azimuth indicated by the **white** (north-seeking) end of the needle.

## 2. 目標物的俯角約大於15度時

Step 1.

*Fig. 9. How to hold a Brunton when measuring the direction to an object whose elevation is more than approximately 15° below that of the viewer.*




Step 2. Read the bearing or azimuth indicated by the **black** (south-seeking) end of the needle.

## 3. 目標物於腰高的視線被擋住時

Step 1.

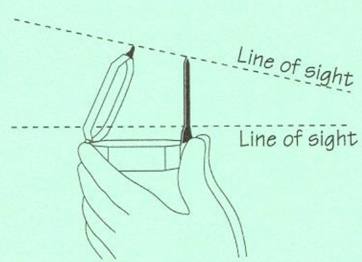
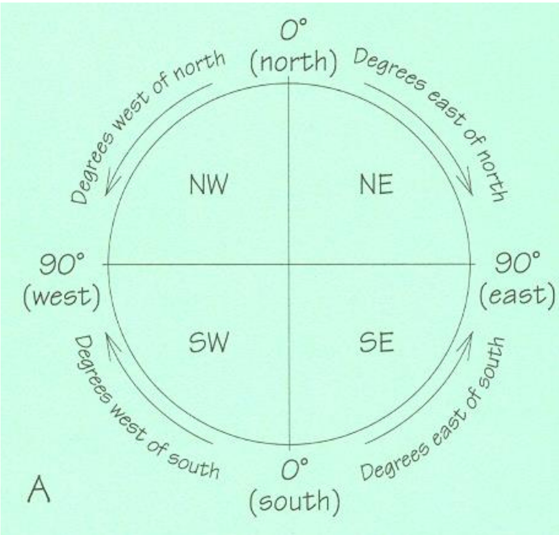



*Fig. 10. How to hold a Brunton when measuring the direction to an object in a case where your waist-high line-of-sight to an object is blocked by some obstacle.*

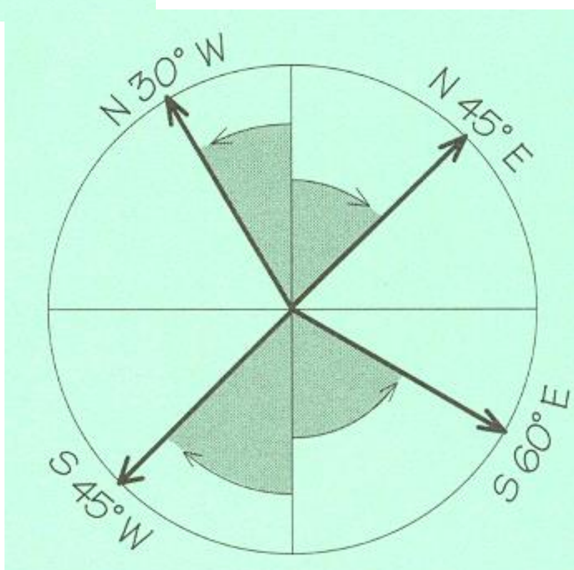
Step 2. Read the bearing or azimuth indicated by the **black** (south-seeking) end of the needle.

# 方向紀錄法

## 象限法 (quadrant (or bearing) method)




由北方(或南方)往東、西方向起算。如N45°E(或S45°W),N30°W(或S30°E)。




## 方位角法 (azimuth method)

磁針北端在360度分度圈上所指度數。360度由北方順時針起算。

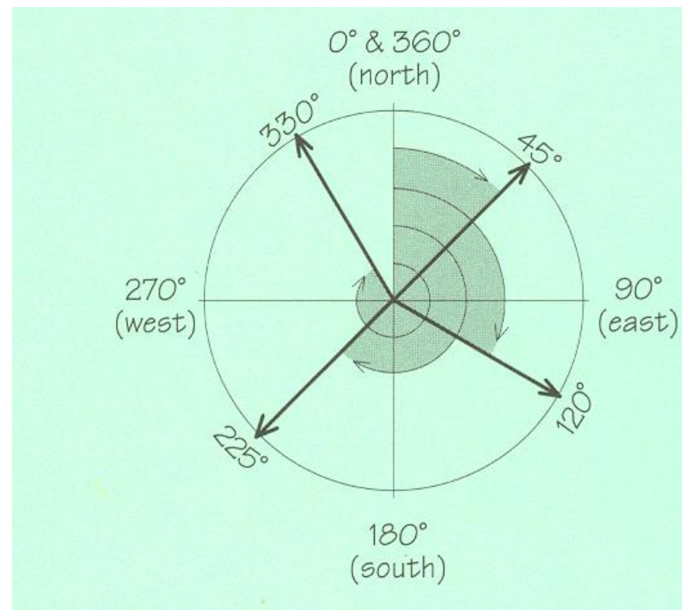


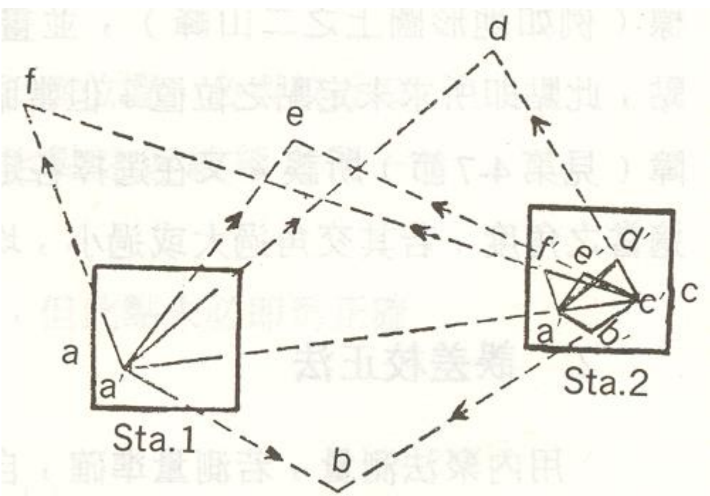

*Fig. 2. The azimuth method of stating direction.*

# 2.4 定位置

定位誤差需在圖上1 mm 內。也就是說，於1/10,000比例尺的圖上誤差需在10 m 內；於1/25,000比例尺的圖在25 m 內。

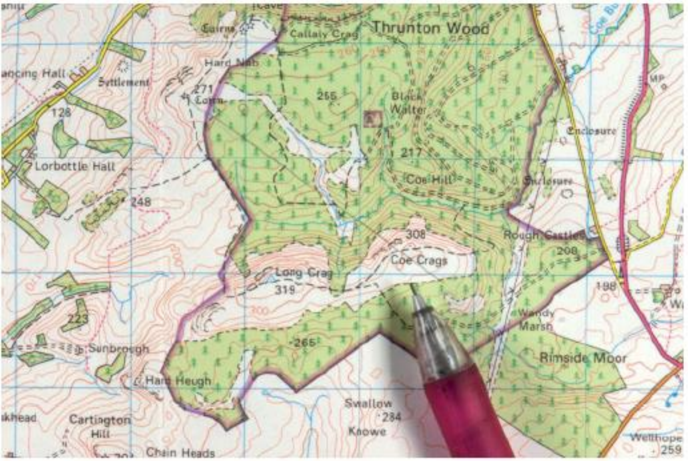
## 前方交會法 (intersection)

以兩定點為測站，各向未定點瞄視，羅盤所測定之二方向在前方交於一點，即為所測未定點之位置。




## 後方交會法 (resection)

測站在未定點，自其瞄測二個或三個已知位置之目標(例如地形圖上之山峰)。畫方向線，使這些方向線交於一點，此交點即為所求之位置。2方向線交角最好介於60~90度間。




## 1. Identify features

Identify two features on the map and on the ground on which to take bearings. In this case the purpose was to identify the location along the exposure known as Coe Crags (shown on the map by the end of the pencil). Various landmarks can be picked out on the hills to the north.

## 2. Measure azimuth

Hold the compass horizontal at waist height with the back of mirror towards you and the mirror at about 120° to the compass window. Line up the feature so that you can see the feature through the long sight in the mirror, ensuring that the compass is level using the round spirit level.

Read off the azimuth.

## 3. Orientate the map

Put the compass-clinometer on to the map with the long edge of the compass-clinometer parallel to a N–S grid line. Check that you have the compass the correct way round and not 180° out, i.e. that the north needle is pointing roughly north on the map. Rotate the map and compass together until the north needle is at its zero mark.

**Figure 2.11** Triangulation using a Brunton - type compass.

The map is now orientated. Note that the long edge of the compass is parallel to the N–S grid line and the compass needle is at its 0° mark. Note also that the compass has been corrected for magnetic declination.

**4. Transfer azimuth to the map**

Keeping the map orientated in exactly the same way, place the long edge of the compass so that it runs through the feature that you sighted. Rotate just the compass until the compass needle shows the azimuth of the feature that you sighted off.

Draw a feint line along the edge of the compass. You are somewhere along this line.

**5. Repeat stages 2 to 4**

Repeat for at least one more feature. The point at which the lines intersect marks your position. See further notes on checking your position in Sections 2.3.3 and 10.3.

**Figure 2.11** Triangulation using a Brunton - type compass.

# 2.5 路線地質圖測量

**Geologic traverse map (路線地質圖)**

The purpose of a geologic traverse is to investigate and measure a sequence of layered rocks along a path (traverse). The geologic information is then plotted along the traverse. The traverse consists a series of points connected by straight lines. The survey itself consists of measuring the **bearing** and **distance** from station at one end of the course to some station ahead, and from that station to another, and similarly to the far end of the course. Geologic features are examined and plotted sequentially along the traverse, thus forming a skeletal geologic map.

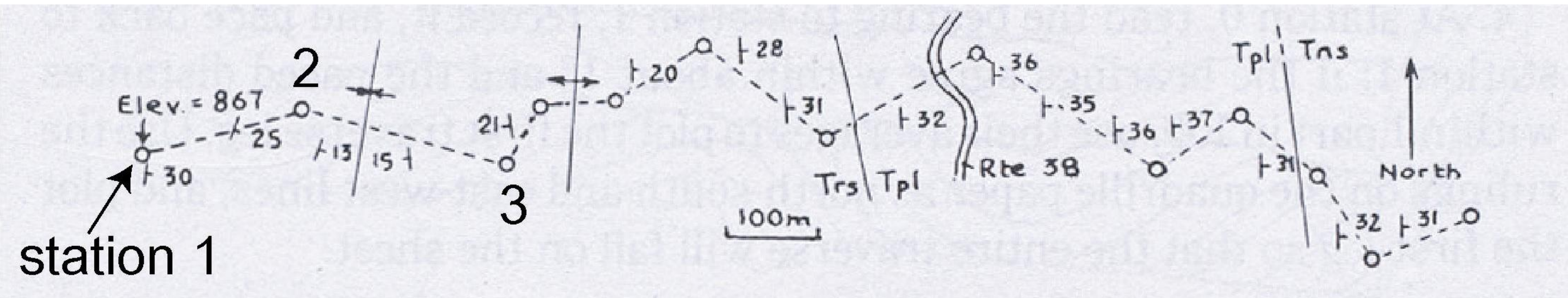



**Fig. 5-1.** Map of traverse across several formations (indicated by letter symbols), with small circles marking traverse stations and dashed lines traverse legs. The scale of the figure is about one-third that of a typical field sheet.

# Traversing may proceed by these steps

1. Standing at an end station (station 1) sight ahead to select the clearest course for the first traverse leg, then walk ahead to the farthest point from which station 1 is visible.
2. Mark this point (station 2) with a stake or stone and read a bearing back to station 1.
3. Record the bearing, and pace and record the distance back to station 1.
4. At station 1, read the bearing to station 2, record it, and pace back to station 2; if the bearings agree within about 1 degree and the paced distances within 1 part in 100, use their averages to plot the first traverse leg on the map.
5. The geology along the first leg can be studied and mapped.
6. The survey can be continued by similar steps noted above.

# Take notes

Notes taken on traverses are traditionally numbered by the distance from the last traverse station. Thus, data observed 21 m along the first traverse leg would be numbered 1+21, and an outcrop 8 m along the second leg, 2+8.

# Recording geologic information on a traverse

1. Contacts between rock units (e.g. formation, member), faults, anticlines, synclines …
2. Strike and dip of bedding (attitude should be plotted wherever it changes significantly, such as by 10$^\circ$ in strike or 5$^\circ$ in dip.
3. Area of exposed outcrops and the lithology of outcrops.
4. Area covered by vegetation …(i.e. no exposure).

# Recording geologic information on a columnar section

The thickness of rocks and other geologic features can be plotted and recorded in a vertical column – a stratigraphic columnar section.

# 111.3.10 中央大學測量路線圖

1. 一百公尺跑道測量複步長度(上午10點集合), 將測量結果填入野外紀錄簿
2. 測繪路線圖(A至E), 測量並紀錄沿線平面構造的位態
3. 分別於A點測量機械館高度、C點測量環工化工館高度
4. 將沿路線的機械館(AB路線) 、大型力學實驗室(CD路線)紀錄其沿路線分布的位置與長度(如大型力學實驗室C+16m=30m(表示本建築物的起點沿路線距C點16m,建築物沿線長度為30m,這裡的建築物代表野外露頭)

用具

Compass
量角器
直尺
文具
野外紀錄簿
計算機
30 m捲尺


Outcrop
Quiz
1. What is the nature of this outcrop?
2. How do you know the age of faulting?
第四紀
河階礫石
利吉層
花蓮富里富池橋

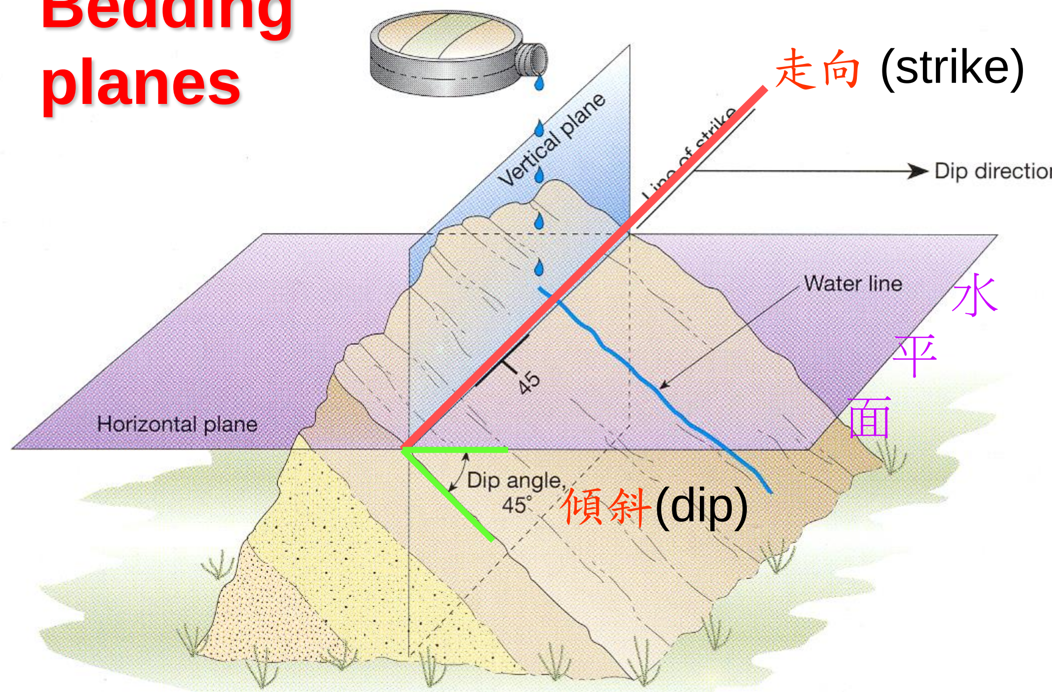
# 2.6. Measurements and recording of planar structures

**Attitude (位態)** is the orientation in space. Attitude of a **plane** is expressed as its ***strike*** **(走向)** and ***dip*** **(傾斜)**; the attitude of a **line** is expressed as ***trend*** **(趨向)** and ***plunge*** **(傾沒)**.

## Planar structures

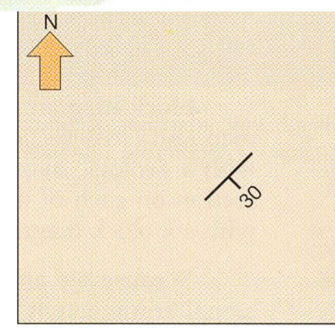
- Bedding planes
- Fault planes
- Joint planes
- Cleavage planes
- Foliations
- Fold axial plane (imaginary)
- unconformable surfaces

## Bedding planes




紀錄走向和傾斜的方向和角度

如 N45°E,30°SE
走向　傾斜



N45°E, 30°SE

紀錄走向時，讀取compass的北偏東(或西)，非南偏西(或東)。

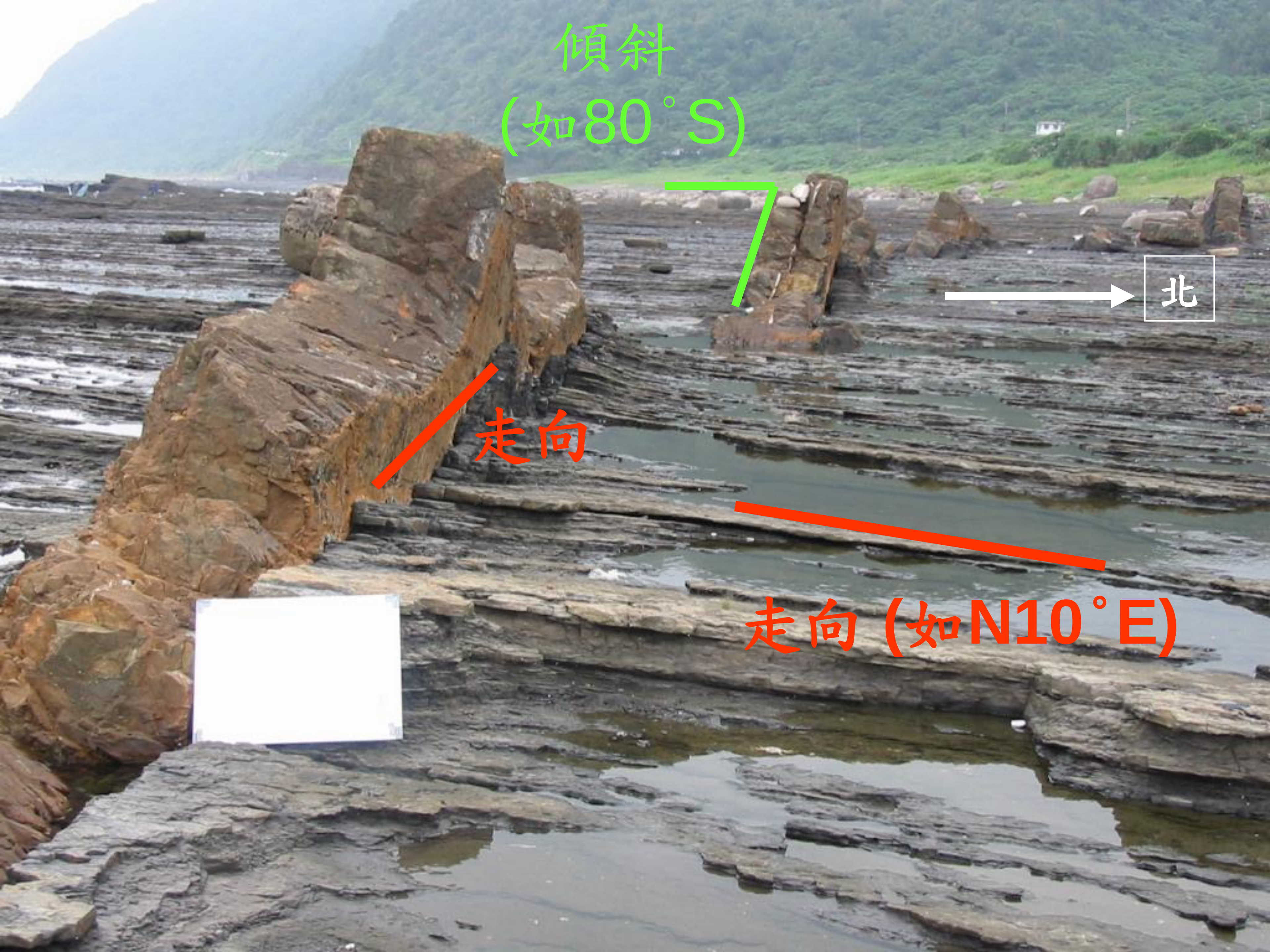

傾斜
(如80°S)
北
走向
走向 (如N10°E)

**Figure 2.7** How to use the Brunton - type compass - clinometer to measure the orientation and dip of a plane using the contact method. The parts of the compass - clinometer are shown in Figure 2.3 a – c.


### 1. General orientation

Determine the general direction of strike to within *c.* 20° by noting where the maximum dip lies; the strike is at 90° to this. In some cases it may be necessary to smooth out the variations on the surface by placing a notebook or clipboard on the bedding plane but take care to ensure that this is not biased by a small irregularity. Hammer shows the plane chosen in this case.

### 2. Strike direction

Place the long edge of the compass-clinometer down where you roughly estimate the line of strike is. Using the round spirit level, position the compass exactly horizontal by both:

(i) Tilting the compass about its short axis so it is horizontal (as shown by the red arrow);

(ii) Slightly pivoting the long edge of the compass in contact with the bedding plane about its central point (as shown by the red arrow) to obtain the exact line of strike within your 20° window.


Take the reading of the strike from the dial. In this case it is 008° or the other end of the line, 188°.

### 3. Dip magnitude

Remembering exactly where the line of strike is, place the long edge of the compass-clinometer at 90° to this on the bedding plane. Ensure that the clinometer scale is on the side in contact with the rock. Move the clinometer arm until the bubble in the long spirit level indicates that it is level.


Read off the maximum dip. In this case it is 12°.

### 4. Dip direction

The last measurement is the direction of dip to the nearest cardinal point (e.g. NW or SE, E or W). In this case it is east.

### 5. Record

Record the orientation of the plane in your notebook; in this case 008/12E. Note that the strike is always recorded as a 3-digit number to avoid any confusion and that the degree symbols are not normally shown to prevent any confusion with zeros.

**Figure 2.7** *Continued*

# Terms that describe planar features

**Strike (走向)**

The bearing of a horizontal line contained within an inclined plane. The strike is a line of equal elevation on a plane. There are an infinite number of parallel strike lines for any inclined plane.

**Dip (傾斜)**

The vertical angle between and inclined plane and a horizontal line perpendicular to its strike. The direction of dip can be thought of as the direction water would run down the plane.

---

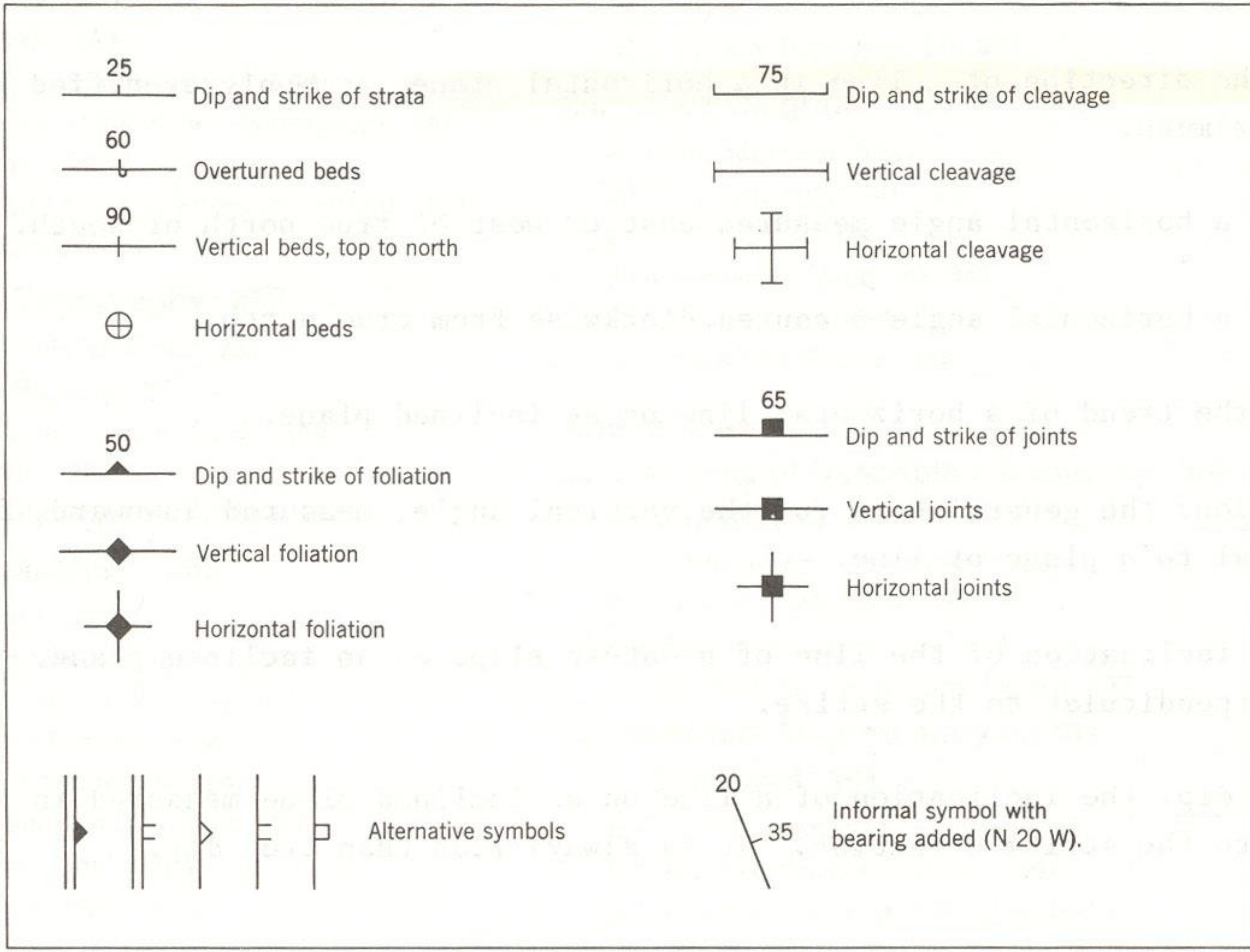
**Apparent dip (視傾斜)**

The vertical angle between an inclined plane and a horizontal line that is not perpendicular to the strike of the plane. For any inclined plane (except a vertical one), the true dip is always greater than any apparent dip. Note that apparent dip is defined by its trend and plunge or by its pitch within a plane.

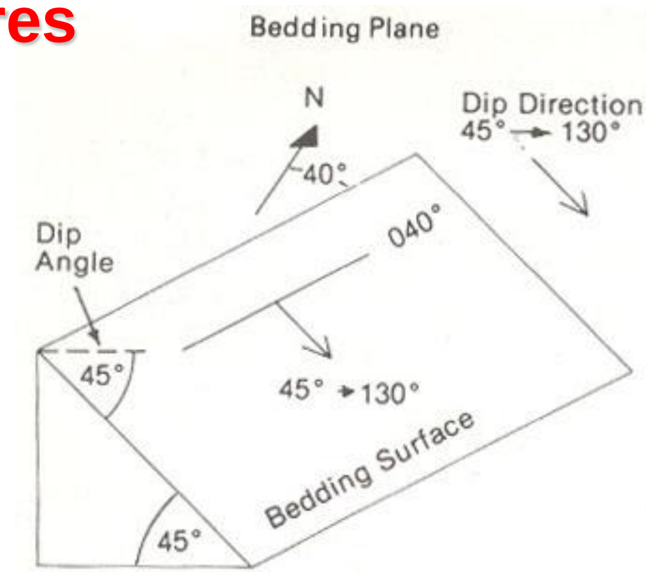
**Bearing (方位)**

The horizontal angle between a line and a specified coordinated direction, usually true north or south; the compass direction or azimuth.

# Map symbols for structural planes



# Recording Attitudes for planar structures




## 1. Strike and dip method

Recording bedding strike and dip directions.

### A. Quadrant method

紀錄走向時，讀取compass的北偏東(或西) ，非南偏西(或東) 。

如 N40°E,45°SE
走向　傾斜

### B. Azimuth method

Expressing strike as an azimuth value (0-360 from north). But a strike line has two direction, a choice must be made. Two solutions:

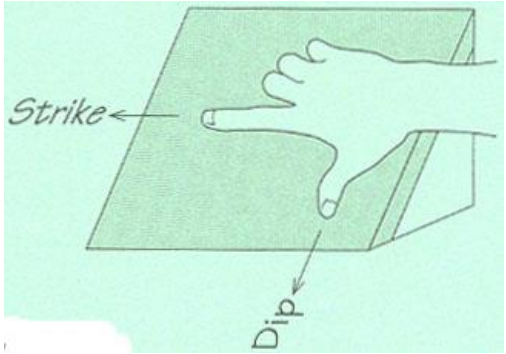
1. N40E, 45SE: quadrant method
2. 45.040: right-hand rule (American)
3. 45.220: the other right-hand rule (British)
4. 45⟶130: dip and dip direction

B1. **Right-hand rule** (or right-arm rule) for American geologists: Dip direction is to the geologist’s right arm. The dip direction lies to the right—clockwise—of the azimuth of strike.

For the bedding plane of the upper right figure, its attitude is: strike 40, dip 45 SE. It may be recorded as 45SE 040 (meaning that the bed strikes 040 and dips 45 in a SE direction) or as 45.040 (format: dip magnitude.three digits.
Three digits represent strike direction using the right-hand rule.

Right hand rule

B2. **The other right-hand rule** for British geologists: Position your right hand on top of the planar surface so that the thumb of your right hand points down-dip while the heal of your hand is flat on the bed's surface. Your index finger is extended to point in the direction of the recorded strike. Result: strike direction opposite that derived from the "right-arm rule" above. The bedding of the figure in the previous slide is recorded as: 45.220.

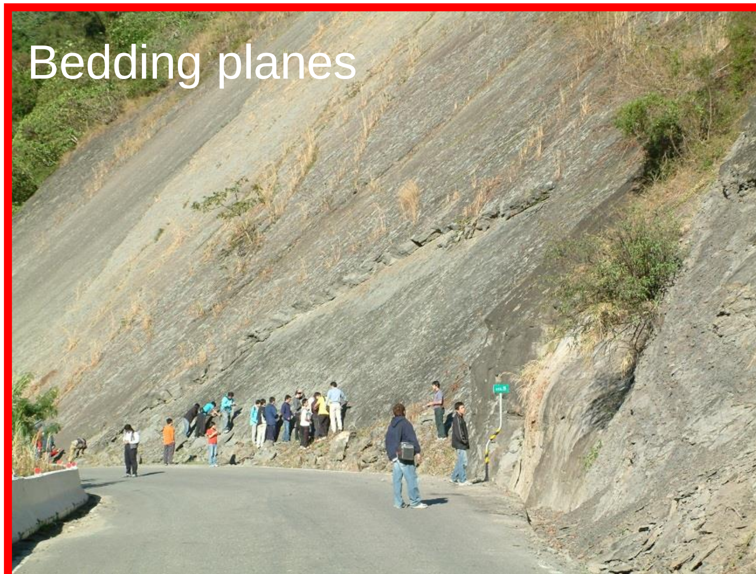



## 2. Dip and dip-direction method

A better solution to the problem, because it is easier to remember, is to record the dip and dip direction (in the above example the bed attitude would be recorded as 45 $\longrightarrow$ 130) rather than dip and strike.

# Examples of planar features

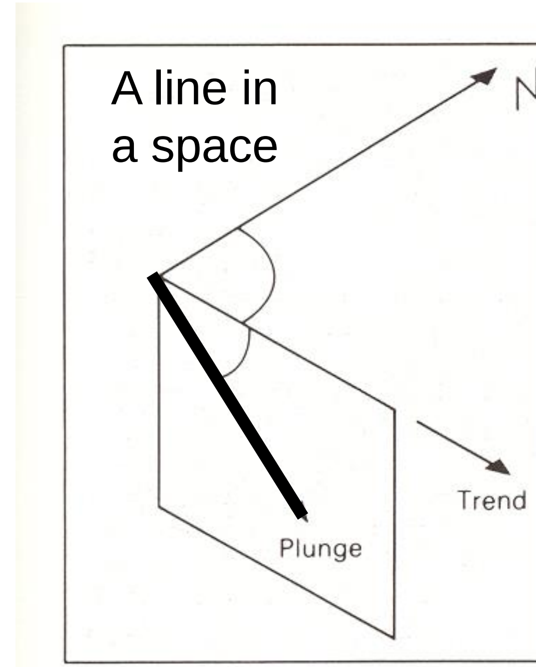
- Bedding planes
- Fault planes
- Joint planes
- Cleavage planes
- Fold axial plane (imaginary)
- unconformable surfaces






# 2.7. Measurements and recording of linear structures

## Terms that describe linear features




**Trend**

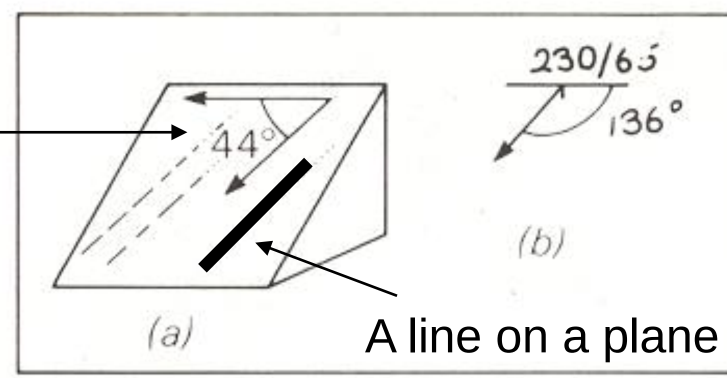
The bearing of a line when viewed from vertically above. (e.g. lineations have no strike, but trend).

**Plunge**

The vertical angle between a line and the horizontal. The plunge is the angle of inclination of a linear feature (lineation)

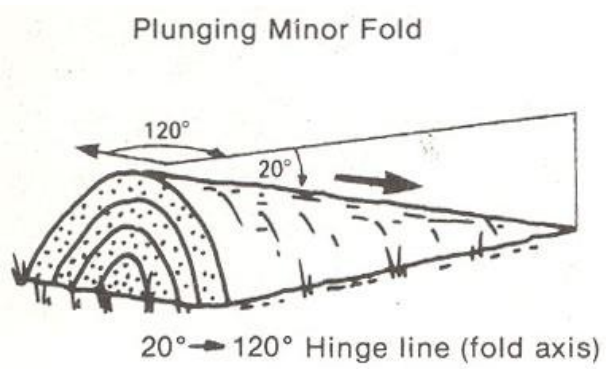
**Pitch (or rake)**

The angle measured within and inclined plane between a horizontal line and the line in question. Also called rake.



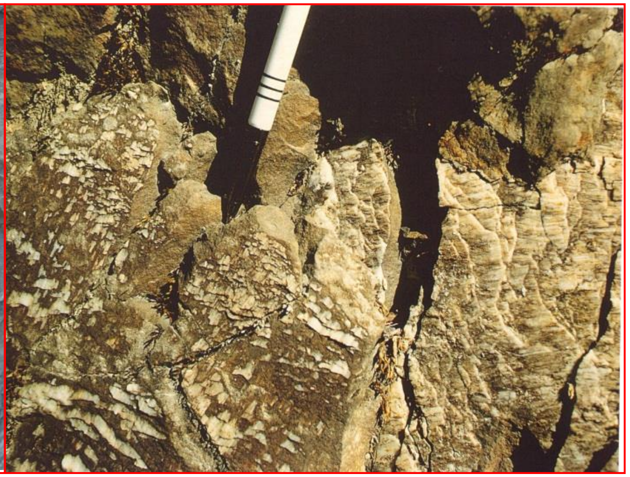
# Examples of geologic linear structures

- Minor fold axis




Intersections of two planes (e.g, planes of bedding, cleavage, joint, foliation, fault, …)

Slickensides (crystal fibre growth; Grooving (no crystal fibre growth)



Stretched objects
(e.g., minerals, gravels, fossils…)

Deformed reduction spots on a joint plane in slate.

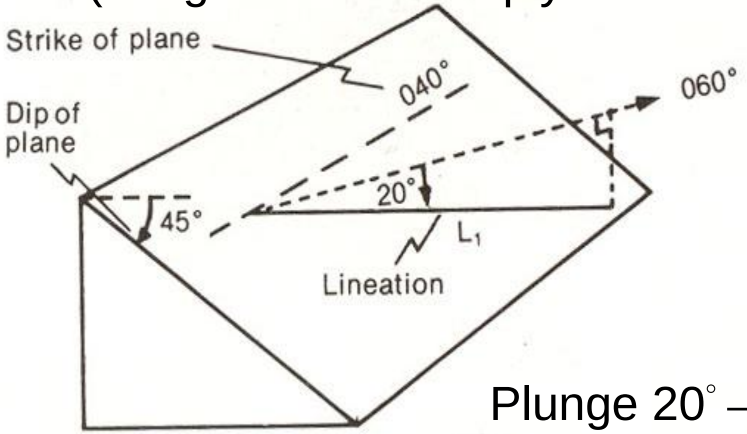
Tool marks

Flute casts

Ripple crests

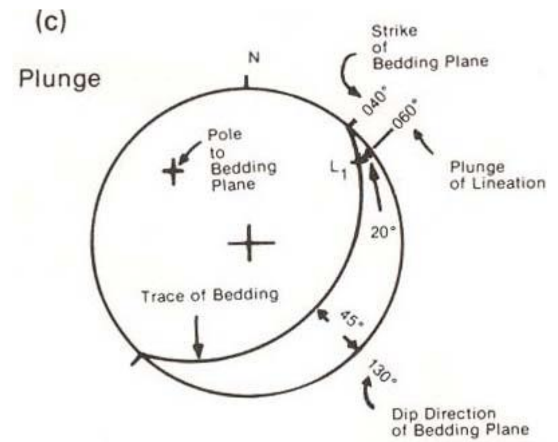
# Measurements for linear structures: Two methods

1. Trend and plunge (on a vertical plane)
   (not good for a steeply inclined line)

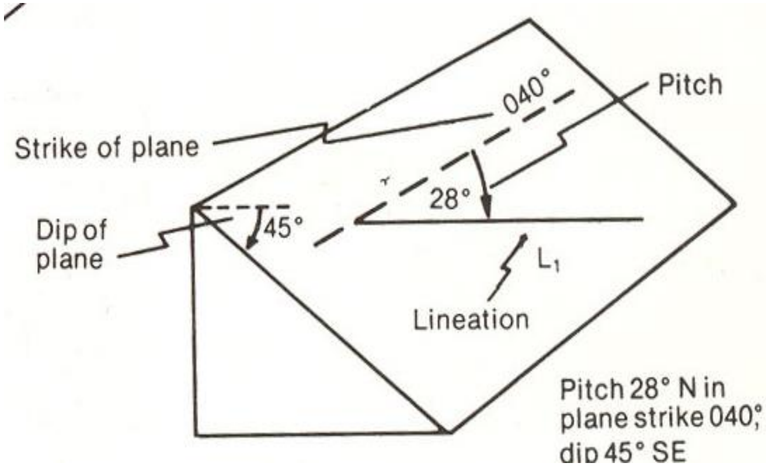



Plunge 20° ⟶ 060°
of lineation

Stereographic projections of trend and plunge for a lineation




2. Pitch (or rake) and bedding attitude




Pitch 28°N in plane strike 040°, dip 45°SE

Stereographic projections of pitch for a lineation

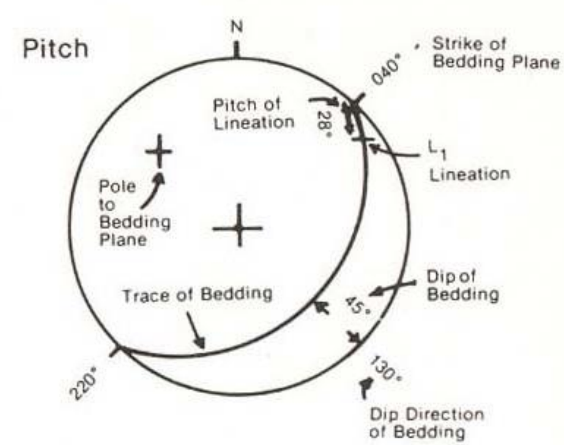


**Figure 2.9** Steps in the measurement of the azimuth and plunge of a linear feature (lineament) by the contact method – for both types of compass - clinometer. The parts of the compass - clinometers are shown in Figure 2.3 .

### 1. General orientation

Assess the linear feature and select a clear part to measure. In this case the feature is current lineation on a sedimentary bedding surface (parallel to the penknife). This feature can be used to obtain a palaeocurrent flow direction.

### 2. Azimuth

Place the edge of your notebook or clipboard on the linear feature, holding the book/clipboard vertical and parallel to the feature so as to create a vertical plane above it. Hold the long side of the compass-clinometer against the vertical side of the book and measure the azimuth of the lower end of the linear feature relative to north (i.e. the direction of plunge). For the Silva-type compass-clinometer you will need to rotate the dial until the magnetic needle is aligned with the north arrow of the compass. Ensure the compass window is horizontal before recording this measurement (for the Brunton-type compass you can do this by checking the round spirit level). In this case the azimuth is 148°.

Azimuth: Silva-type

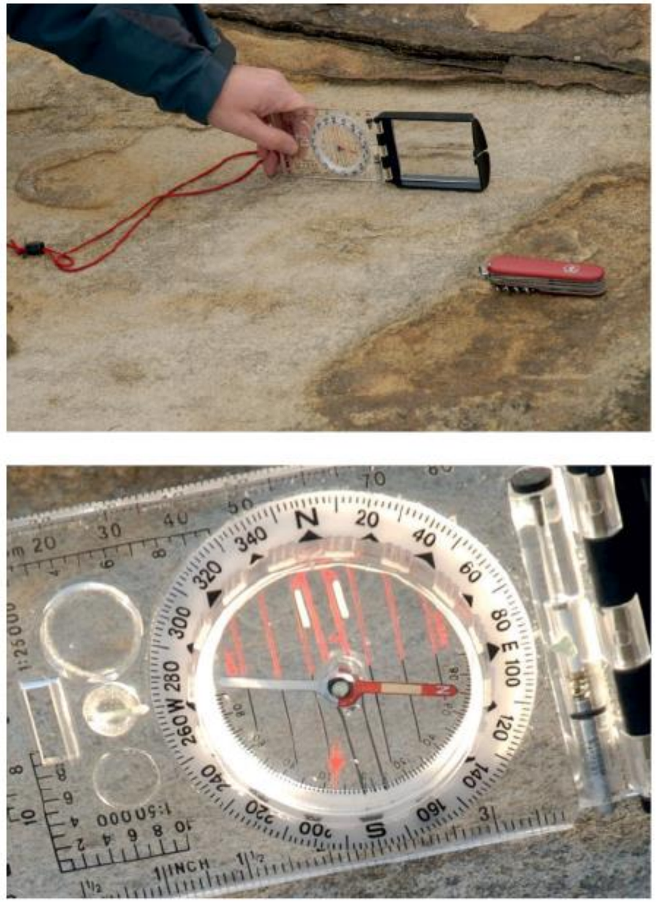
Azimuth: Brunton-type

**Figure 2.9**

## 3. Plunge

Set the compass dial so that the instrument can be used as a clinometer (see Figures 2.6, 2.7). Place the compass-clinometer along the linear feature and read off the plunge angle from the clinometer. In this case the plunge is 15°.

Plunge: Silva-type



Plunge: Brunton-type


## 4. Record

Record in your notebook the plunge as a 2-digit figure (15°) and the azimuth as a 3-digit figure (148°). For linear features the usual notation is the plunge first, then an arrow indicating 'to' and then the azimuth (15 → 148).

**Figure 2.10** Measurement of the azimuth and plunge of a linear feature (slickenside lineations) on a fault plane using the sighting method with the Brunton - type compass - clinometer. Insets show detail of line of sight.

### 1. Place pencil

Put a pencil on the exposure parallel to the lineation and then stand where you can look down the linear feature. Use a piece of tape to hold the pencil in place if necessary.

### 2. Measure azimuth

Holding the compass window horizontal (use the round level to check this), and with the mirror at about 120° to it, sight through the small peep sight at the end of the long sight through the sighting window at the base of the mirror and down the pencil (see inset). Read off the azimuth. If necessary use the locking pin to hold the magnetic needle in place while you note the azimuth.

### 3. Measure plunge

Hold the compass-clinometer on its edge so that the compass window is vertical and the clinometer is at the bottom. Fold the mirror in to the compass window at about 60°. Fold in the peep sight at the end of the long sight.

Sight through the peep sight at the end of the long sight, the window at the base of the mirror and down the pencil (see inset). Carefully adjust the angle of the mirror so that you can also see the long level. Adjust the clinometer so that the bubble in the long spirit level is in the middle. Read off the magnitude of the plunge.

### 4. Record

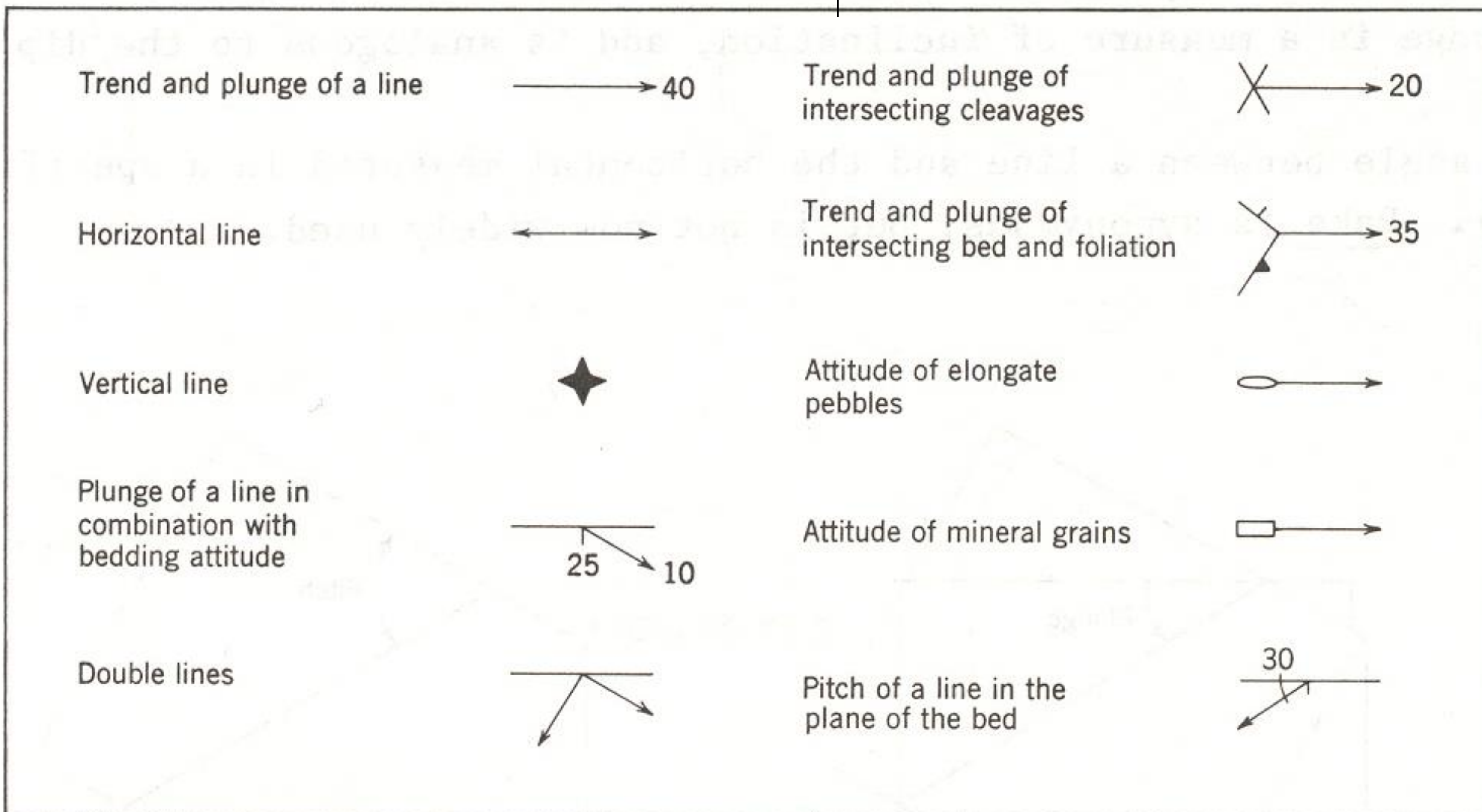
Record in your notebook the plunge as a 2-digit figure and the azimuth as a 3-digit figure.

## Recording

Plunge angle followed by the trend as bearing: 30°,S45°W: line plunges 30° toward S45°W. or 30°/225°: line plunges 30° toward 225° (S45°W).

**Map symbols**, three parts:

1. A trend line.
2. An arrowhead in the direction of downward inclination.
3. A plunge angle written near the arrowhead.

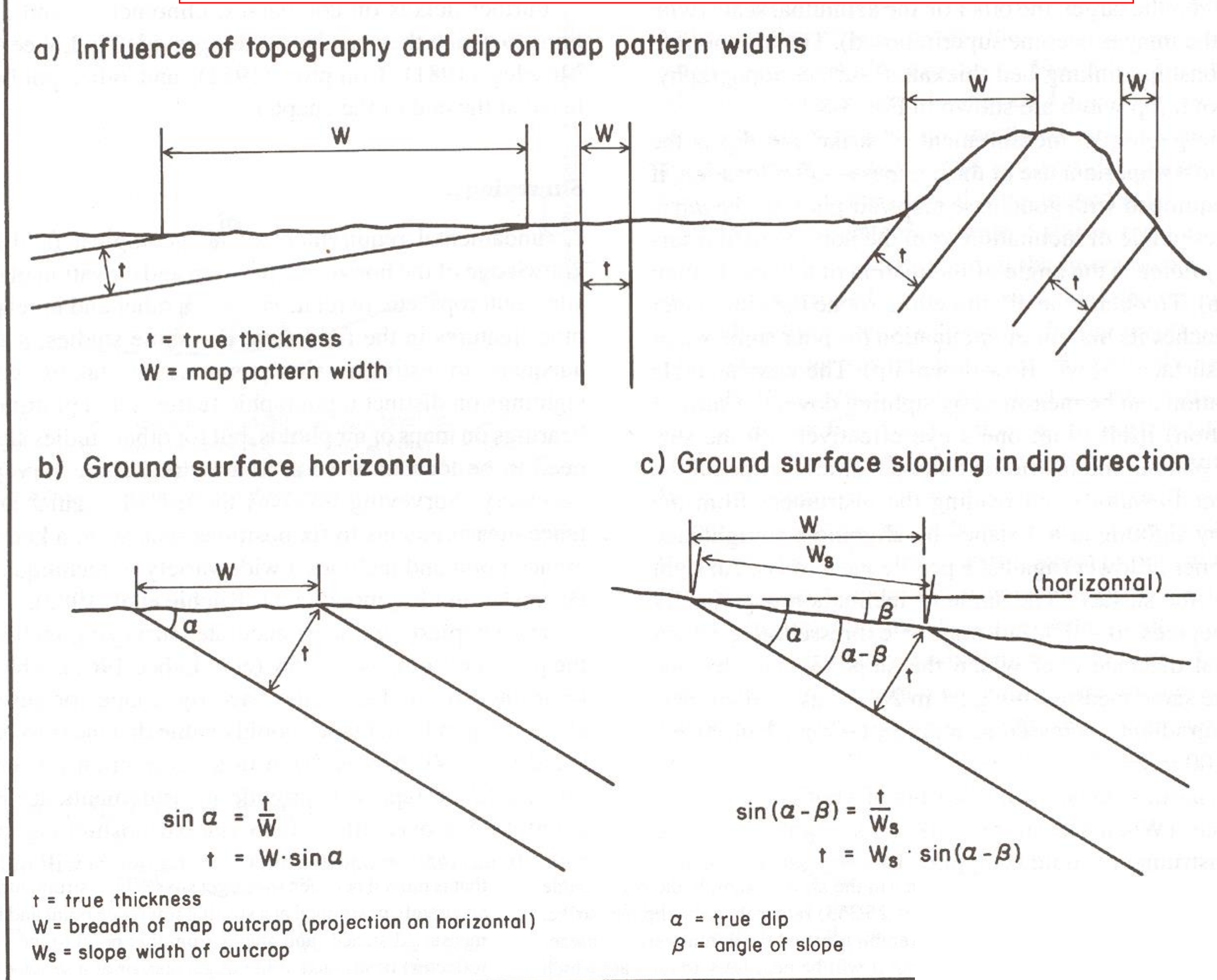



## Practical

The rock specimen (schist) of this photo will be presented in the class.

1. Can you differentiate different phases of structural deformation? (hint: brittle then ductile deformation) .
2. Imagine a line that represent the fold axis of the deformed quartz veins. Then measure the plunge and trend of this fold axis. Plot this fold axis on a stereographic net.
3. The left and right sides of this photo follow approximately the attitude of bedding planes. Measure these two planes and plot their attitude on a stereographic net. Find the plunge and trend for the fold axis.

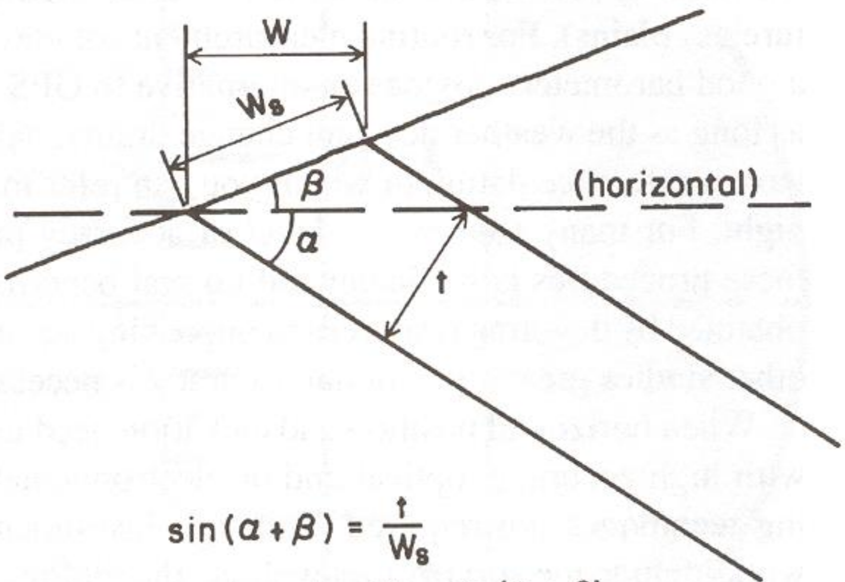
# 2.8. True thickness of a geologic unit




Examples of the relationship of the true and apparent thickness of units.
a~d for outcrops
e for boreholes

Borehole

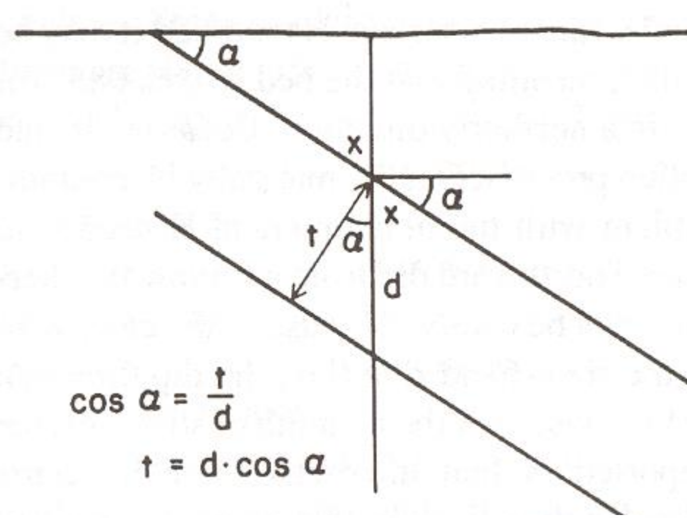
## d) Ground surface sloping opposite to dip direction




$$\sin(\alpha + \beta) = \frac{t}{W_s}$$

$$t = W_s \cdot \sin(\alpha + \beta)$$

## e) Length of drill hole intersection




$$\cos \alpha = \frac{t}{d}$$

$$t = d \cdot \cos \alpha$$

$t$ = true thickness
$W$ = breadth of map outcrop (projection on horizontal)
$W_s$ = slope width of outcrop

$\alpha$ = true dip
$\beta$ = angle of slope

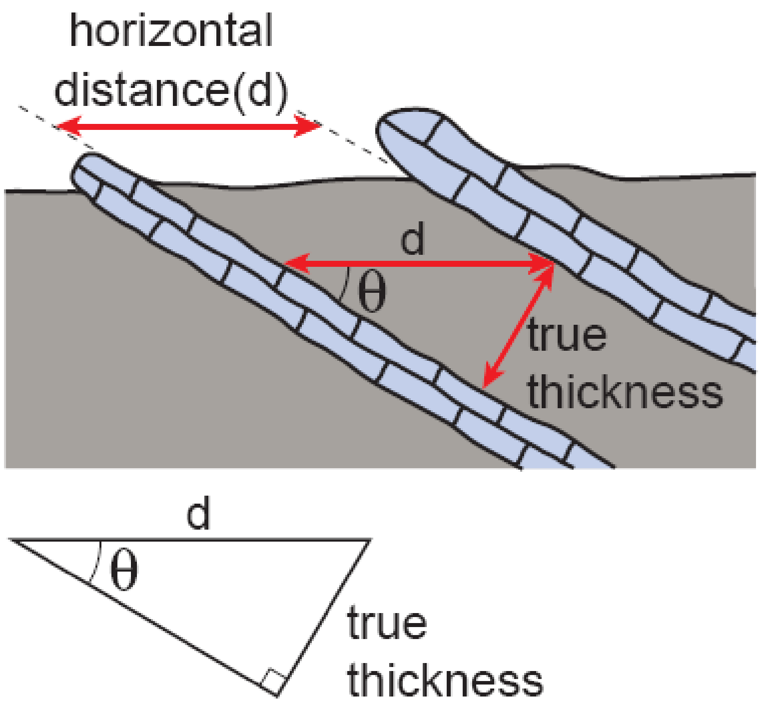



**Figure 2.14** Sketch to show the basic trigonometry for obtaining a true thickness by measuring the horizontal distance between dipping beds.

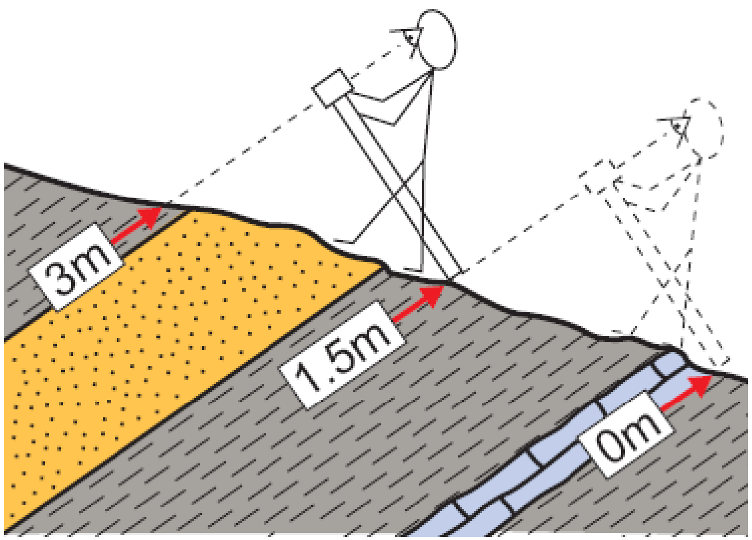



**Figure 2.15** Sketch to show how to measure thickness up a slope with a Jacob staff of 1.5 m length and a Brunton-type compass-clinometer.

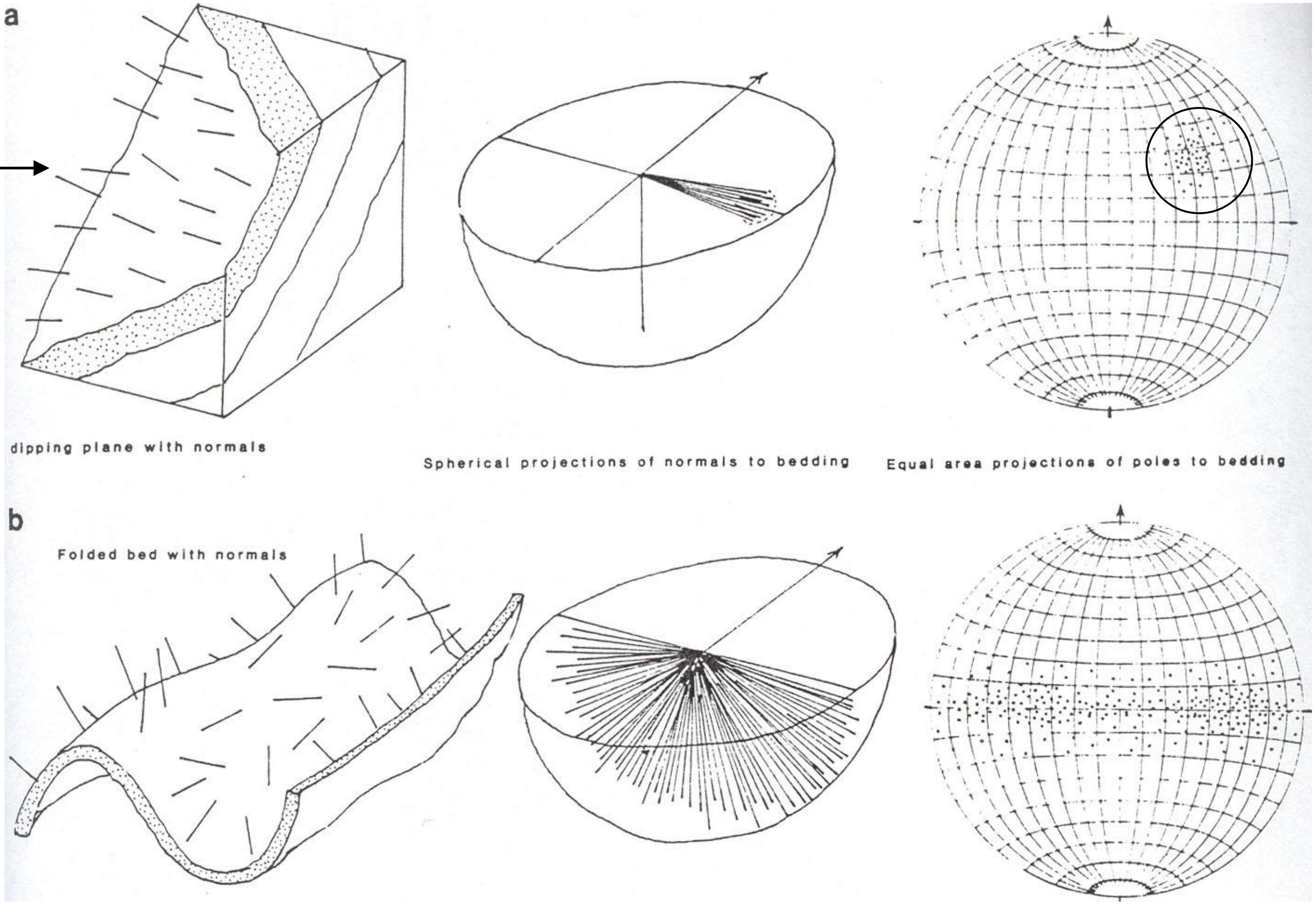
$$\text{True thickness} = d \times \sin\theta$$

# 2.9 地質構造空間表示

Geologists uses equal-angle (Wulff) nets or euqal-area (Schmidt) nets and plot data on them to represent 3-D data in 2-D.

Equal-area projection
(Schmidt net)

Normal
to bed
(poles)



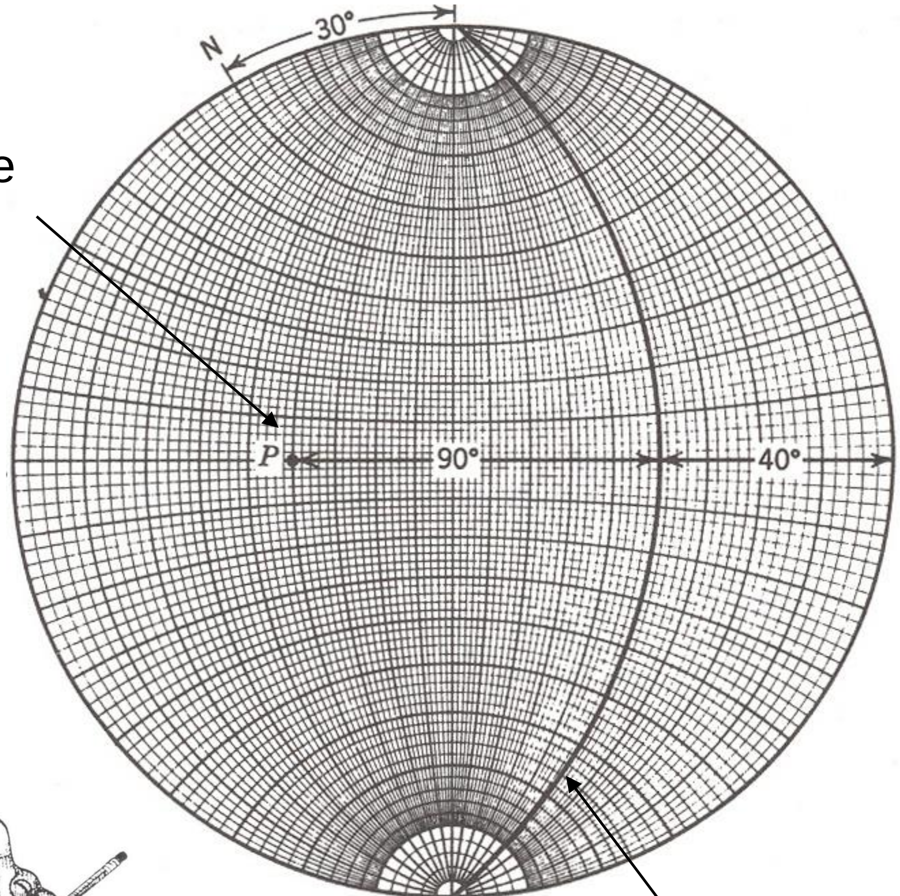

Poles to
bedding

# Stereographic plot of a plane and its pole

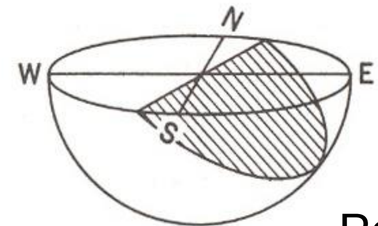
Equal-angle (Wulff) net

Bed: N30E,40SE

Pole

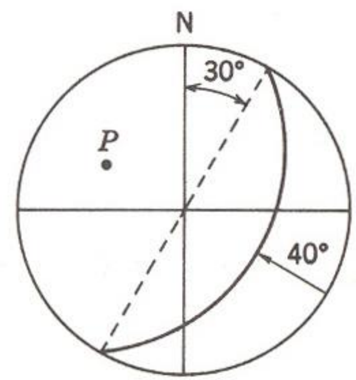



(b)




(a)

Perspective view




(c)

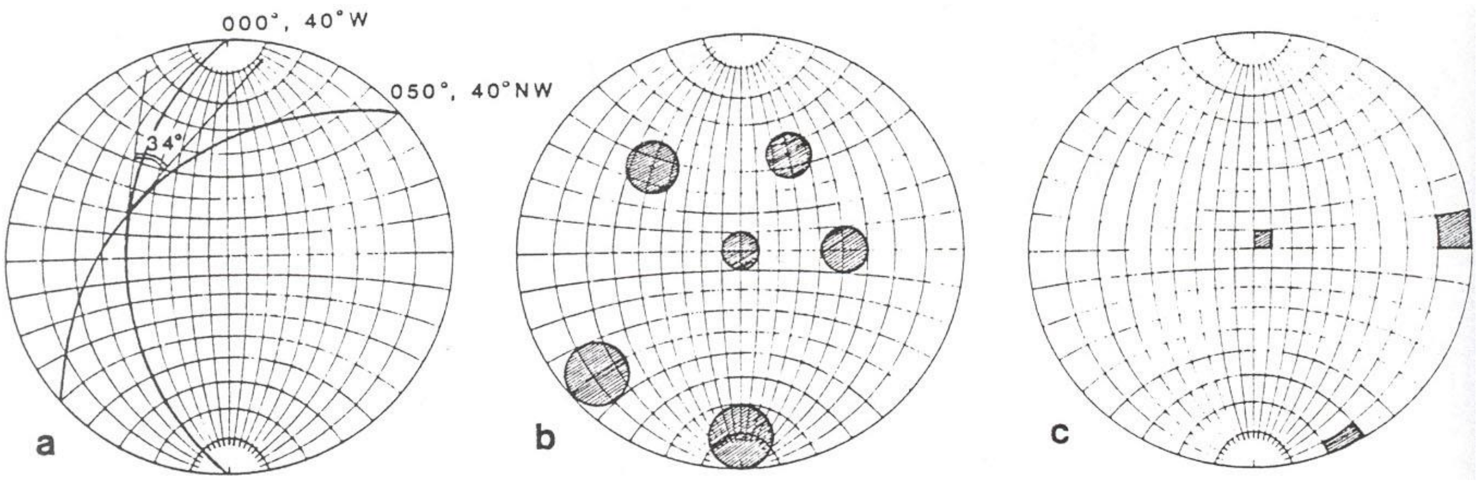
Pole

Great circle

# Two projections: equal angle vs. equal area

**1. Equal-angle projection (**one type of azimuthal projection, also called stereographic projection). The terms Wulff net or stereonet refer to grids drawn on a stereographic projection, and a stereogram refers only to a plot of points or curves on a stereographic projection.

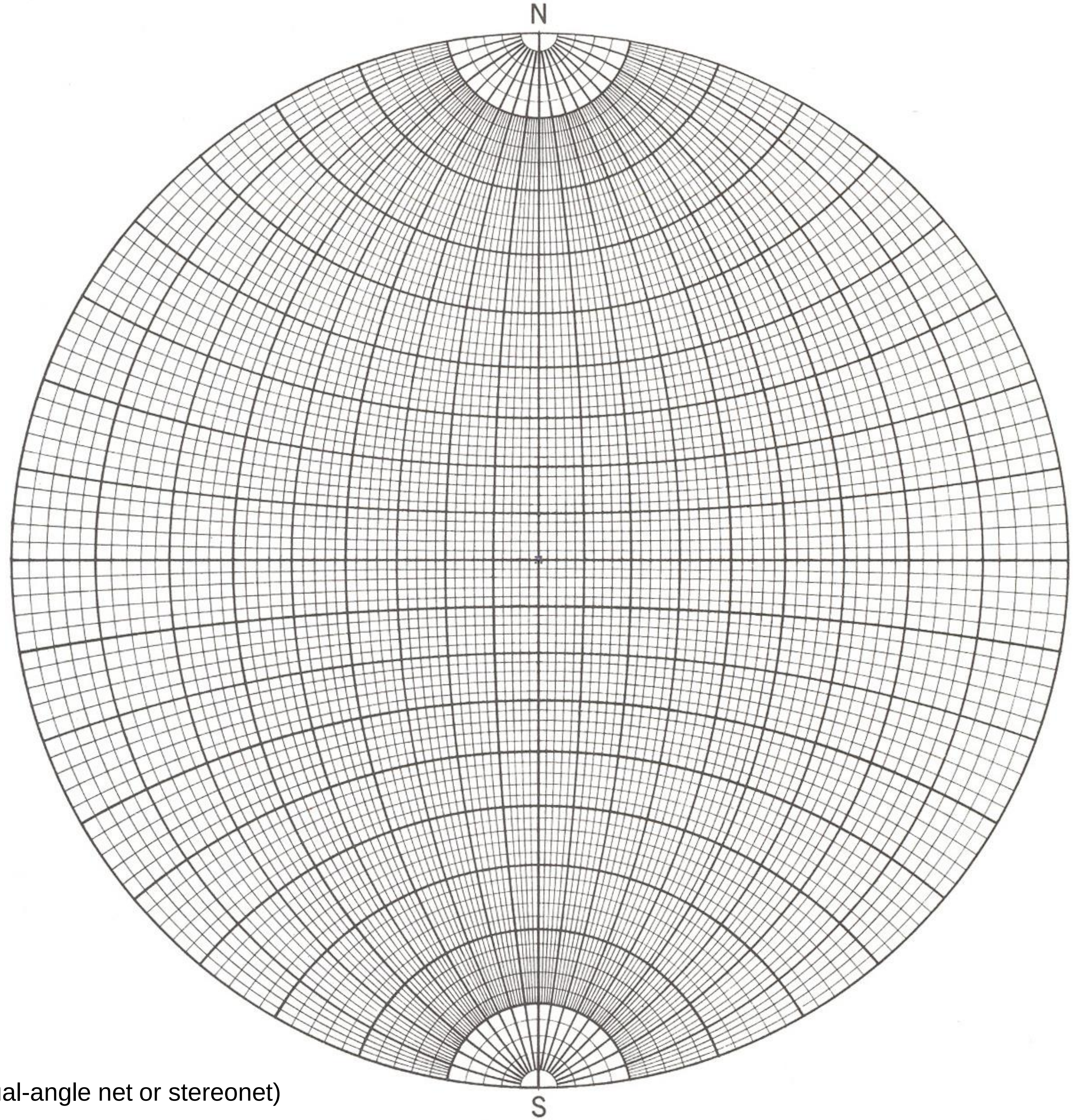
Properties of a stereographic or equal-angle projection.




The angle between two planes is the same as the angle between the tangents to the great-circle traces of the two planes.

Identical circles on projection sphere project as circles of different sizes.

10°x10° area at edge of projection is larger than at the center.



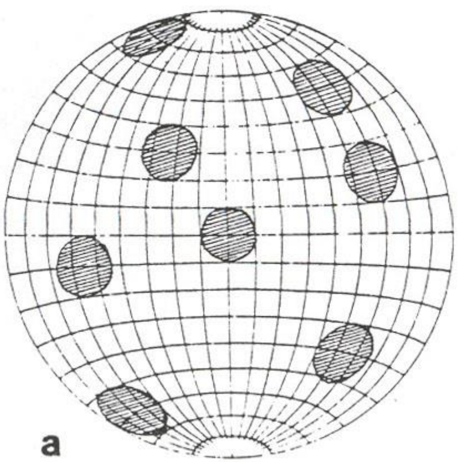

Wulff net (equal-angle net or stereonet)

**2. Equal-area projection** (one type of azimuthal projection): An equal-area projection is not a stereographic projection. The term Schmidt net refers to a grid drawn on an equal-area projection, and it is not the same as a stereonet.

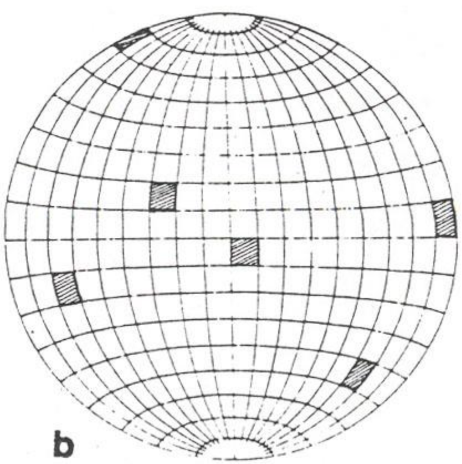
Formally, the term stereonet should be used only with respect to a grid on a stereographic projection,  and the term equal-area plot should be used or points or curves drawn on an equal-area projection. In practice, however, geologists tend to use the term stereonet loosely, to refer to either a Wulff net or a Schmidt net.

Properties of a stereographic or equal-area projection.

Identical circles on projection sphere project as ellipses with various axial ratios but have the same area.

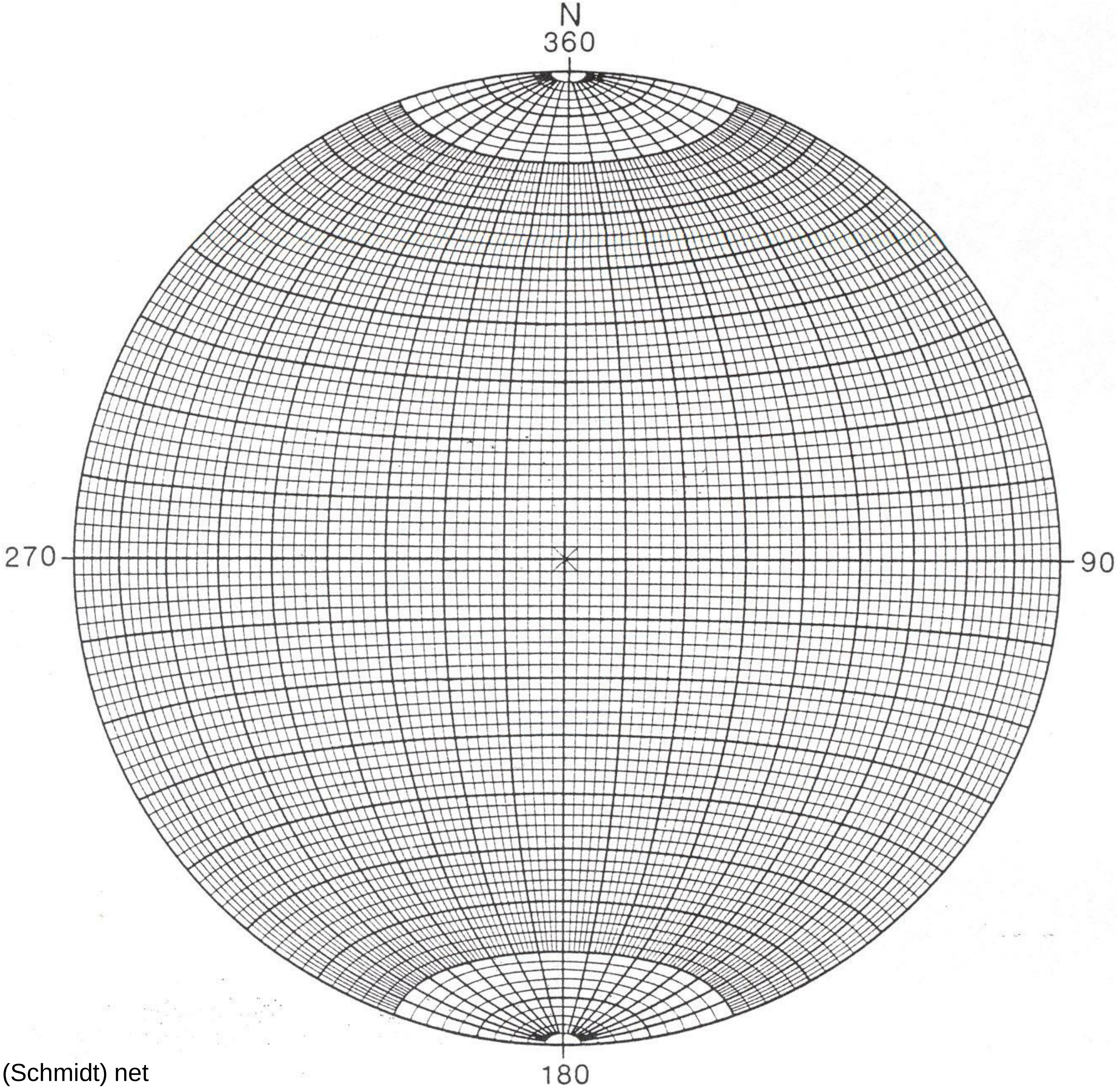


a



b

$10^{\circ}$x$10^{\circ}$ area at edge of projection is the same size as at the center.




Equal-area (Schmidt) net

# Which net to use?

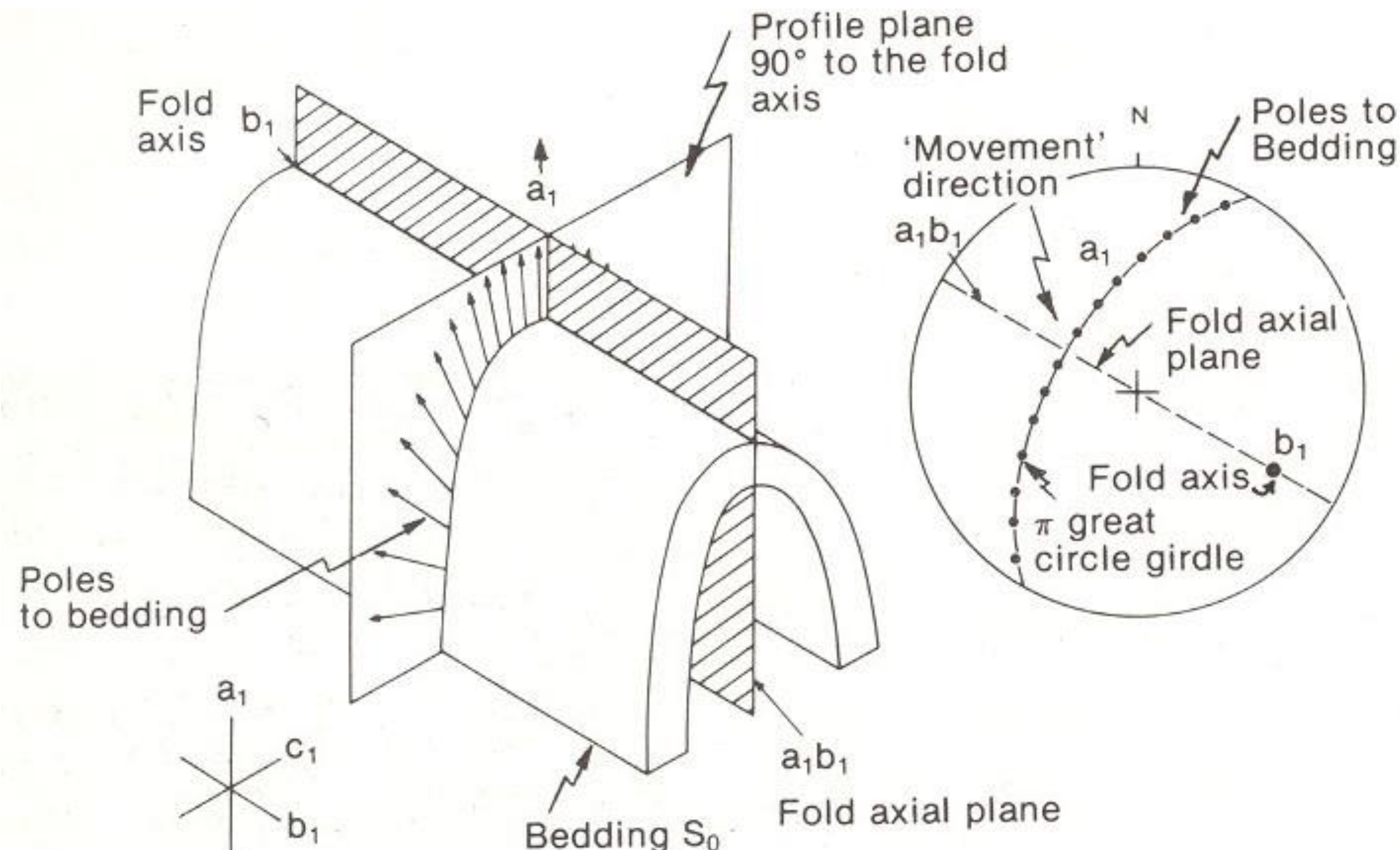
A Wulff net must be used where angles between structures on the net will be measured with a protractor. In applications where lines, planes, and poles are to be plotted for geometric calculations without a protractor, either Wulff nets or Schmidt nets can be used.

**The Schmidt net** must be used in applications where the concentration of points on the plot is significant; thus it is particularly applicable for analysis of a large number of measurements and it is good for statistical treatment of orientation data. The Schmidt net has the most common application for problems in structural geology and is usually the net that geologists carry with them to the field.

# Analysis of folding with an equal-area (Schmidt) net

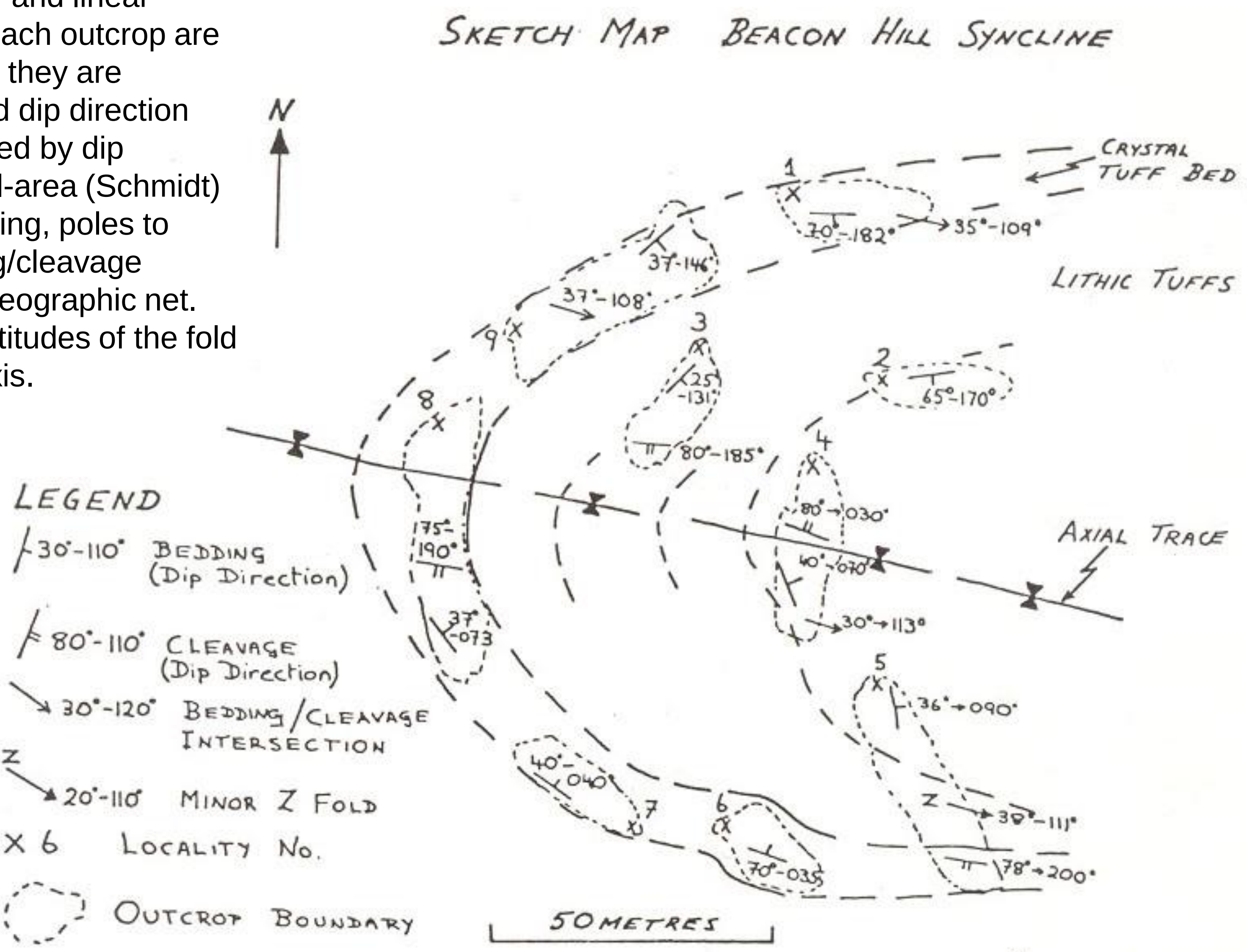
A π-diagram is an equal-area plot of poles to planes that are tangential to the folded surface. A π-diagram gives information on the orientation of a fold axis and contains clues to the form of the fold (e.g., open or tight).

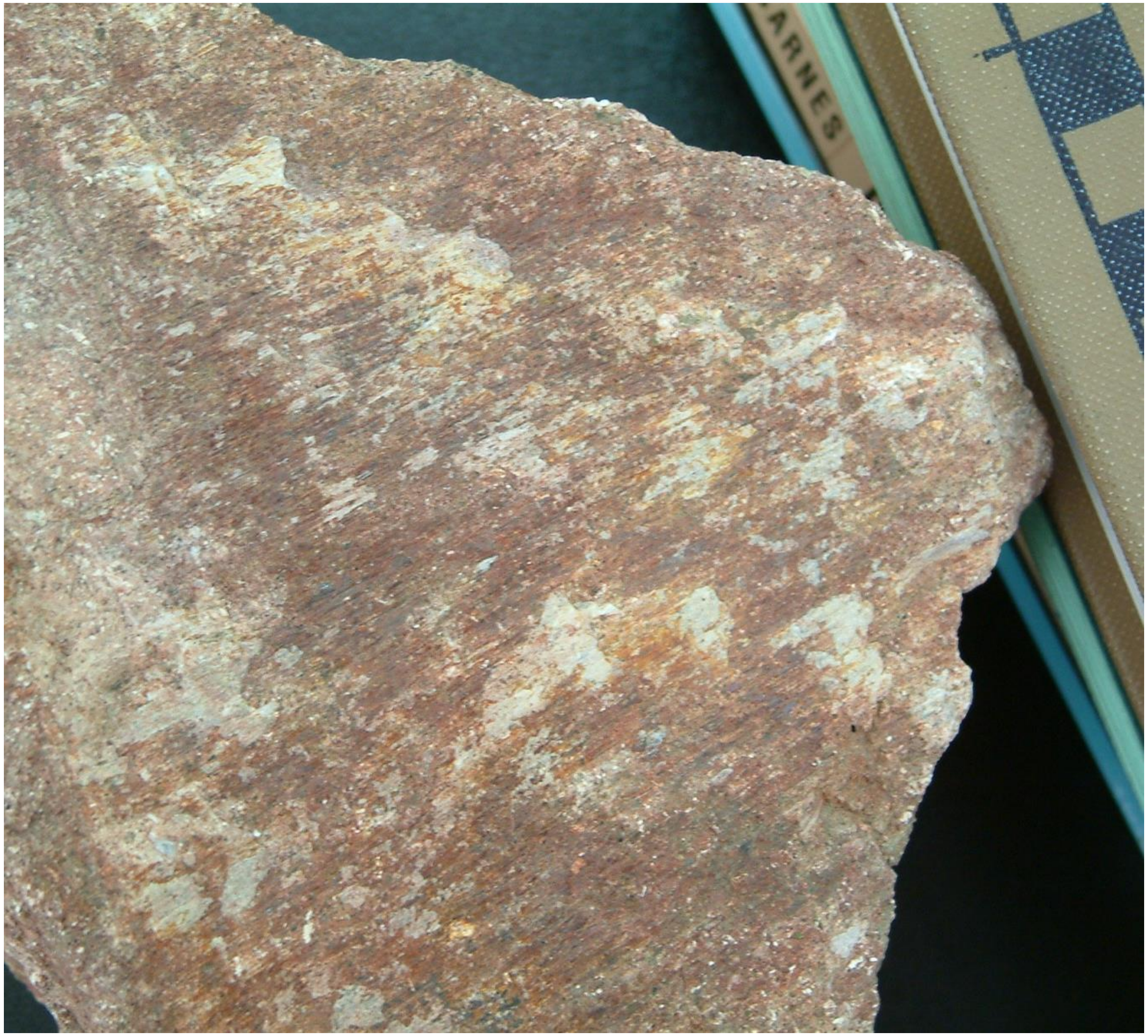
On a cylindrical fold, each of the poles is perpendicular to the fold axis (not axial plane); thus, the poles are parallel to a plane perpendicular to the fold axis. On an equal-area plot the poles approximate a grea-circle girdle, which is called π(great circle) girdle. The pole to the π-girdle is the π-axis, and it represent the fold axis.



# Practical: Determining fold axis and fold axial plane from stereographic projection of structural data measured around the fold. Due on March 21, 2019

This figure shows a sketch map of a fold. The attitudes of planar and linear geologic features for each outcrop are given in the figure and they are recorded using dip and dip direction method (i.e. dip followed by dip direction). Using equal-area (Schmidt) net, plot poles to bedding, poles to cleavage, and bedding/cleavage intersections on a stereographic net. Then determine the attitudes of the fold axial plane and fold axis.





## Practical

The rock specimen (limestone) of this photo will be presented in the class.

1. How was this structure formed? Can you determine the sense of fault movement?
2. Measure the attitude for this plane and pitch for this linear feature? Plot these data on a stereographic projection.
3. Measure the plunge and trend for this linear feature and plot the data on the above stereographic projection.
4. Compare the results. Are these two data points overlapped?