



108.01

工程地質

Engineering Geology

第四週

不連續面(弱面)

授課教師：邱雅筑

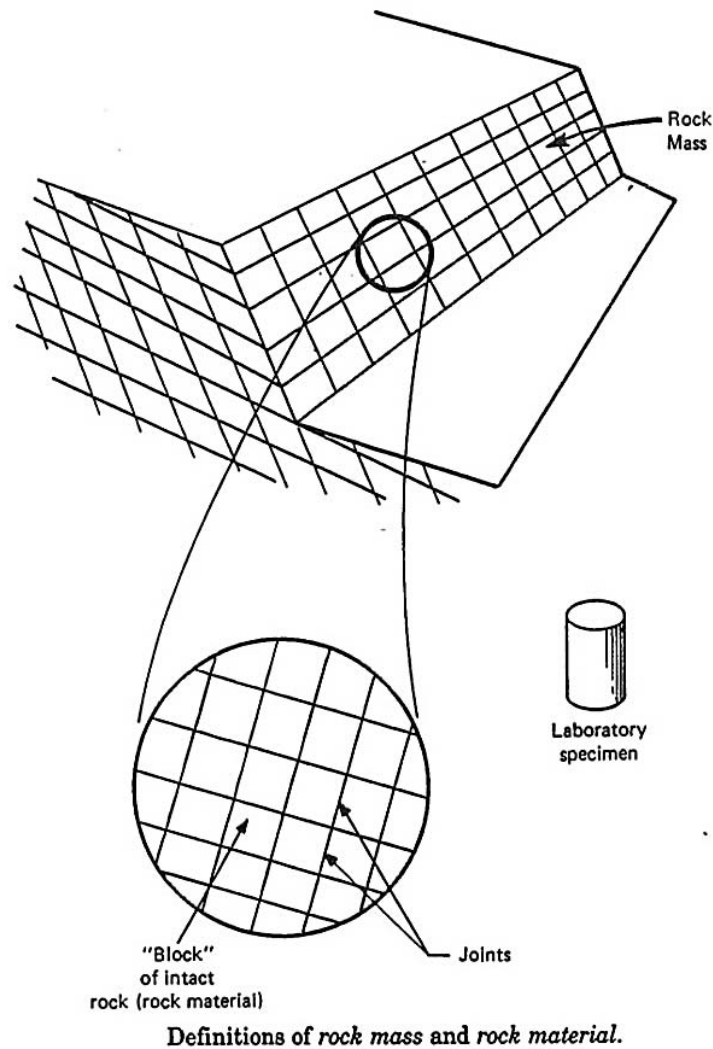
2019/10/07



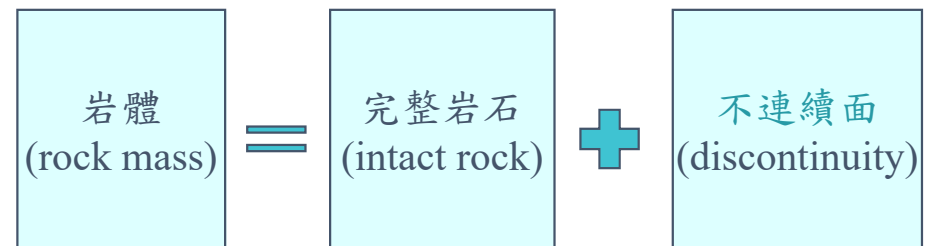


不連續面是什麼？

不連續面 Discontinuity



- 不連續面是指發育於岩體(rock mass)中，具有一定方向及延伸性，以及一定厚度的各種地質界面
- 斷層、節理、層理、葉理、不整合面都屬於不連續面
- 不連續面為岩體內的面狀構造
- 不連續面為岩體的弱面(weak planes)
- 使風化作用深入岩體，弱化岩體剪力強度





不連續面的類型

- 根據成因可分為原生、次生及表生三種
- 原生不連續面：成岩的過程中就形成的不連續面
- 次生不連續面：岩石成岩後受到構造應力作用，而在岩體內形成破裂面或破碎帶，如節理、劈理、斷層、層間錯動、剪裂帶等。
- 表生不連續面：岩石在地表淺處遭受風化作用、解壓及地下水的軟化作用所形成的不連續面

表 9.1 不連續面的類型

成因分類	原生不連續面			次生不連續面	表生不連續面
	沉積岩 不連續面	火成岩 不連續面	變質岩 不連續面	構造作用	解壓 及風化作用
主要地質類型	a.層理層面 b.不整合面 c.軟弱夾層	冷縮節理	葉理	a.斷層 b.節理 c.劈理 d.層間錯動 e.剪裂帶	a.風化裂隙 b.風化軟弱夾層 c.解壓節理 d.泥化夾層

原生不連續面

- 沉積岩的原生不連續面：沉積岩在沉積及成岩的過程中所形成的物質分異面，包括層面(層理)與不整合面。
- 層面(層理)：大多數沉積岩表現一層一層可以分離或坡開的層次，這種成層的構造稱為層理。
 - 岩性交界面
 - 垂直於層理的方向上，不連續面以沉積物的成分、顏色、粒度等的變化顯現出來
 - 反映沉積的間歇性
 - 側向延展甚廣
 - 可能呈透鏡狀，側向尖滅，有時呈犬牙狀相互交錯

層面(層理)



層面(層理)

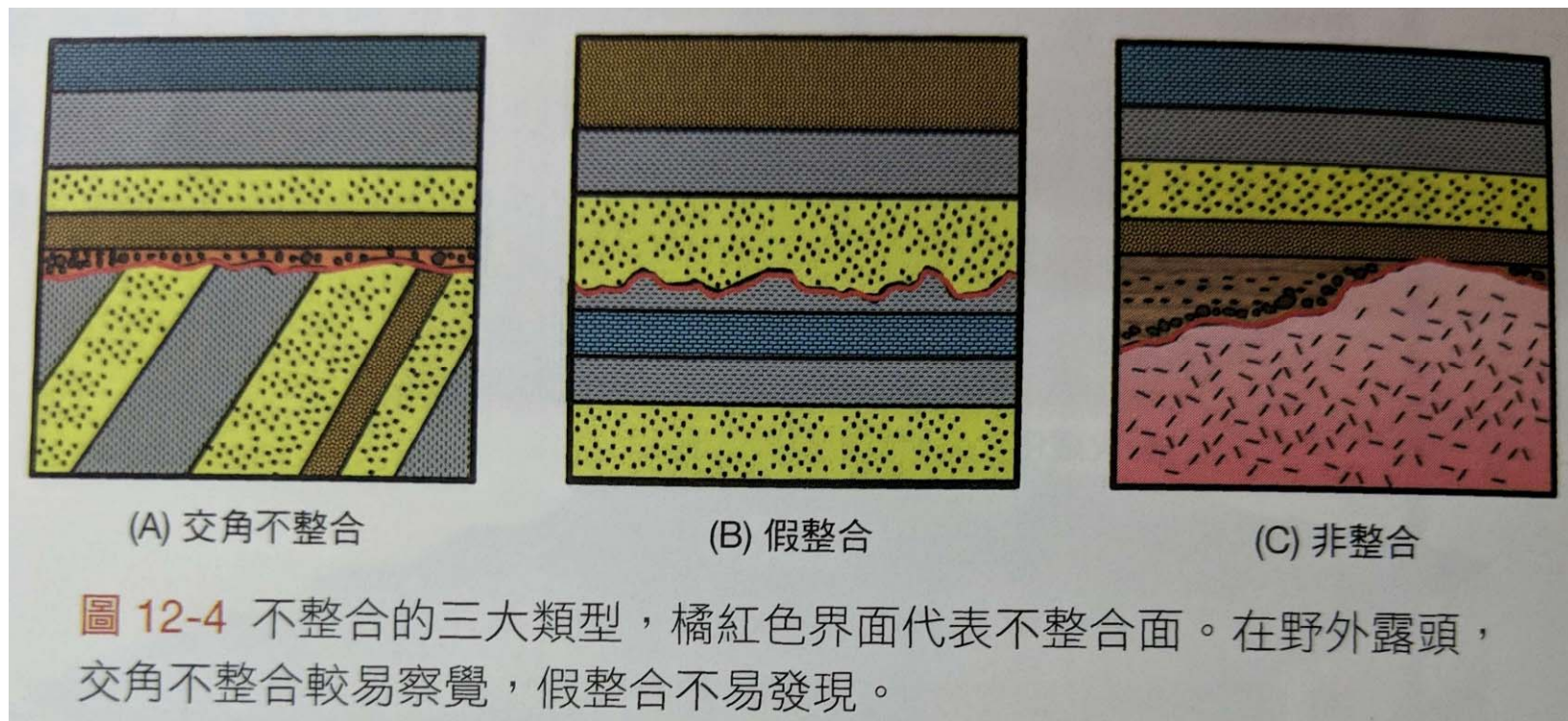


層面(層理)



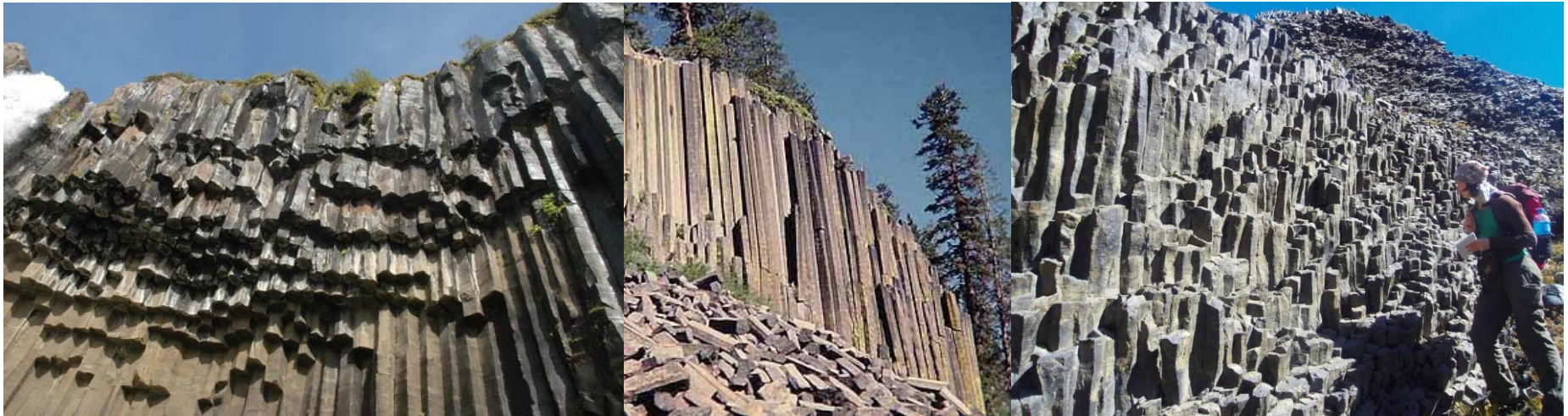
原生不連續面 不整合面

- 交角不整合：上(老)下(新)地層不平行且年代差距大
- 假整合：上(老)下(新)地層平行但被一侵蝕面分隔
- 非整合：專指介於沉積岩和它下面的火成岩或變質岩之侵蝕面



原生不連續面

- 火成岩的原生不連續面：主要指火成岩於冷卻收縮時所生成的冷縮節理，一般具有張力特徵，不利於岩體的穩定，尤其是淺成及噴出岩中的柱狀節理
 - 通常形成柱狀(節理)
 - 冷縮時產生的應力較均向，故冷縮節理常為多邊形



原生不連續面

- 變質岩的原生不連續面：變質岩的葉理(Foliation)，如板理、片理及片麻理。
- 葉理(Foliation)：重新結晶作用使片狀及柱狀礦物富集，並且呈定向排列而形成的平面構造
- 片狀礦物的面垂直於最大主應力方向，柱狀礦物的長軸則平行於最小主應力方向
- 原岩的泥質夾層變質後形成薄層的雲母片岩、滑石片岩、綠泥石片岩等。片理發達者容易受風化形成軟弱夾層。

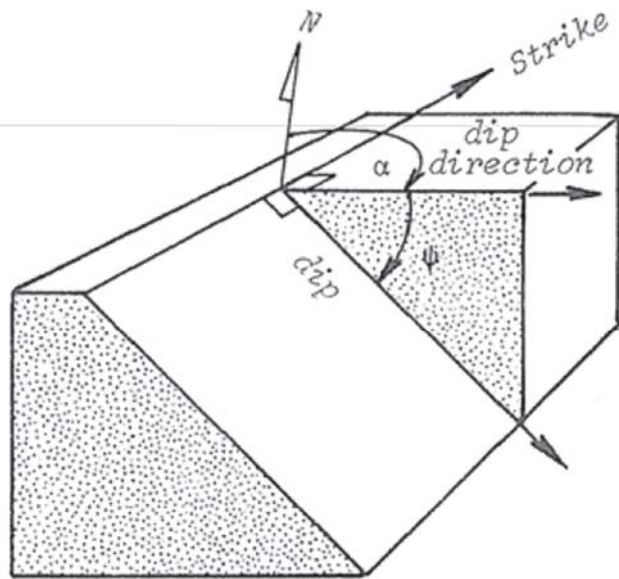


不連續面的描述與評估(ISRM, 1987)

1. 位態(位置、方位)
2. 間距
3. 持續性
4. 粗糙度
5. 內壁材料強度
6. 內寬
7. 軟弱夾心
8. 滲水情形
9. 組數
10. 弱面密度與岩體幾何形狀

立體投影法

1. 球形投影：等面積投影&等角投影(立體投影)
2. 空間中的面
3. 空間中的線
4. 空間中兩面之交線
5. 空間中兩線的共同面
6. 視傾角與真傾角
7. 空間中兩線之夾角
8. 空間中兩面之夾角
9. 線在平面上之投影
10. 極圖 polar net



Definition of geometrical terms

- 空間中的面

- 走向/傾角 strike/dip

N45°E/30°S,

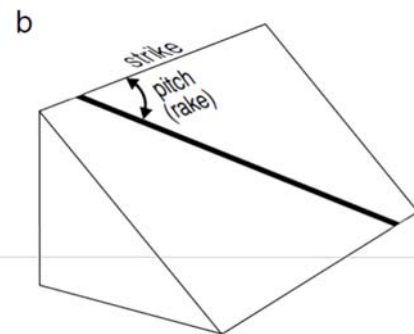
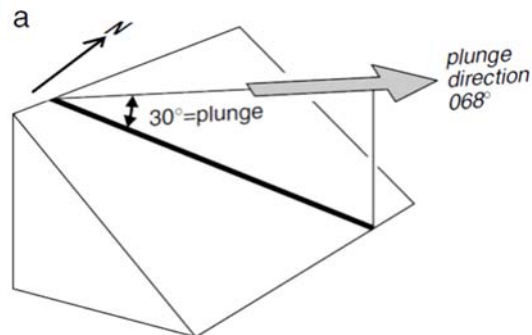
N45°E/30°SE

045/30°S, 045/30°SE

- 傾角/傾向 dip/dip direction

30/045 (傾向一定用方位角表示)

(方位角azimuth：由正北N順時針旋轉至目標軸的夾角)



- 空間中的線

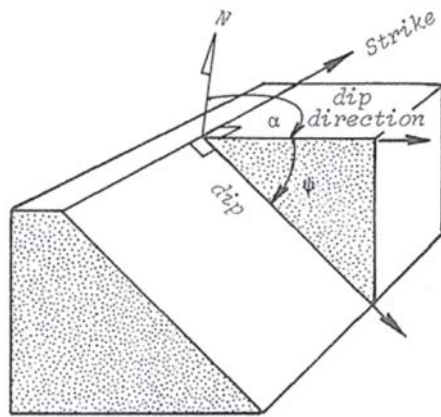
- 傾角/傾向 plunge/plunge direction

- 空間中平面+rake

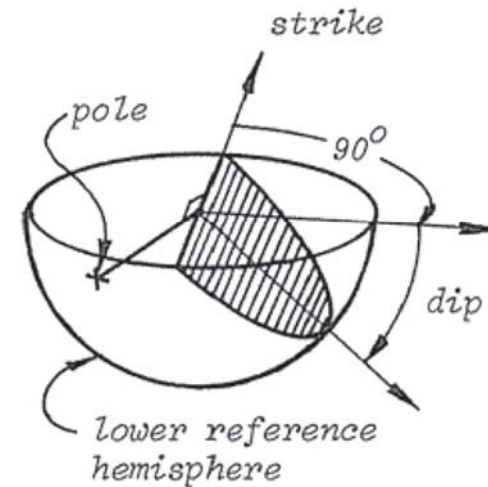
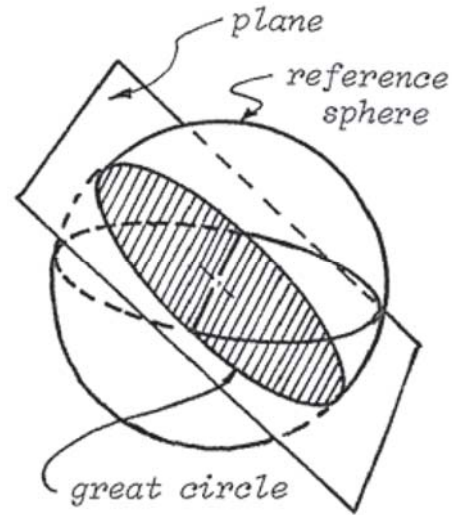
strike/dip, rake

dip/dip direction, rake

球形投影 Spherical projection

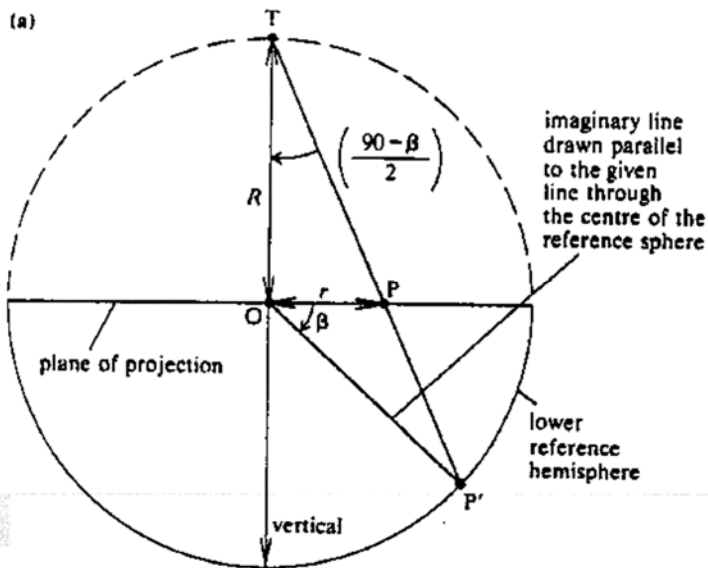


Definition of geometrical terms



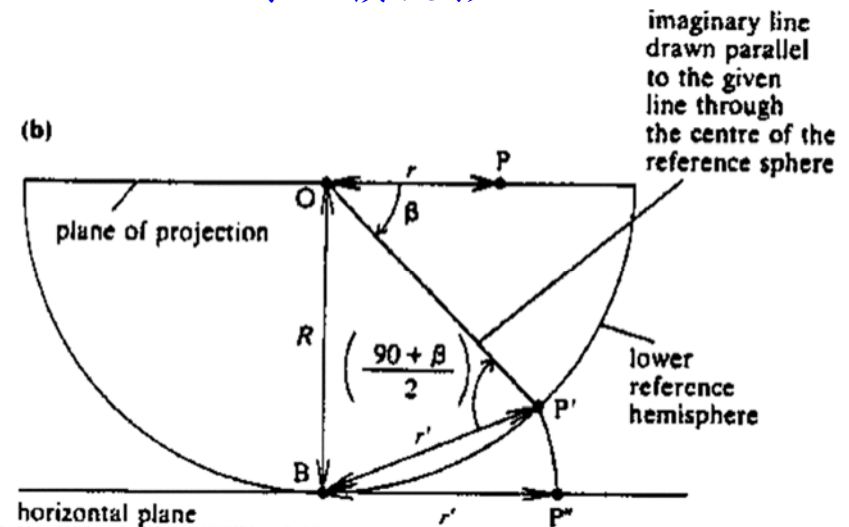
Equal-angle projection

等角投影



Equal-area projection

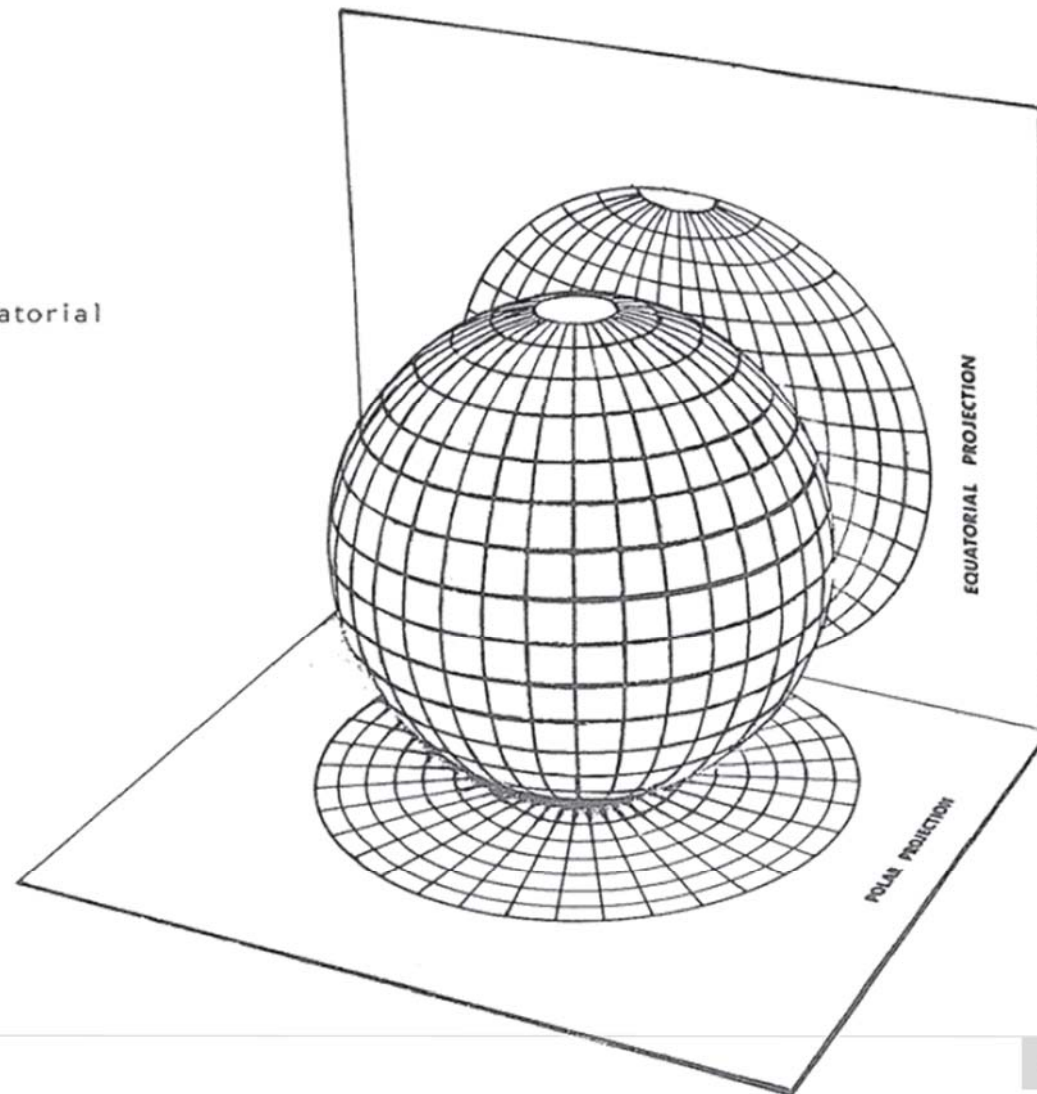
等面積投影



極投影 polar projection

赤道投影 Equatorial projection

Figure 13 : Polar and equatorial projections of a sphere.



Equal-angle projection 等角投影

(Stereographic projection, Wulff projection)
(Stereonet, stereographic net, Wulff net)

極投影
(極圖)

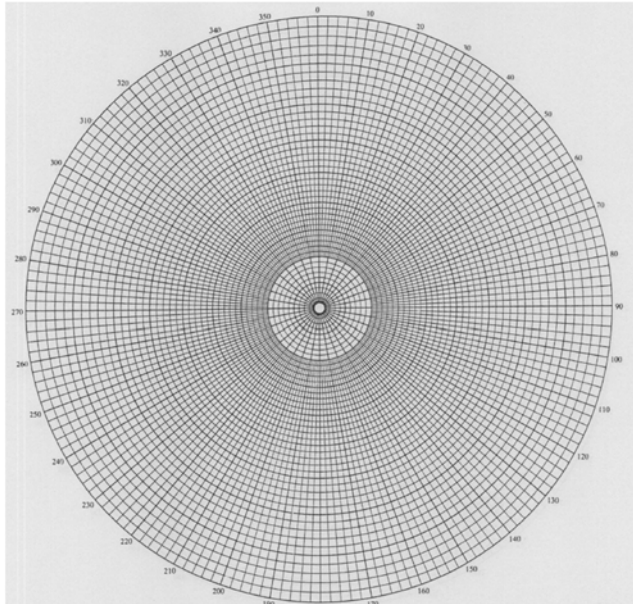


Figure 2.4 Polar equal-angle net.

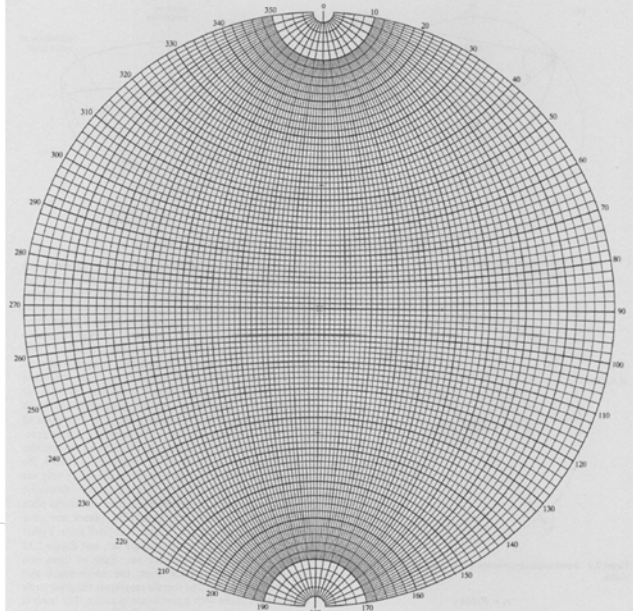


Figure 2.11 Equatorial equal-angle net.

Equal-area projection 等面積投影

(Lambert projection, Schmidt projection)
(Lambert net, Schmidt net)

赤道投影

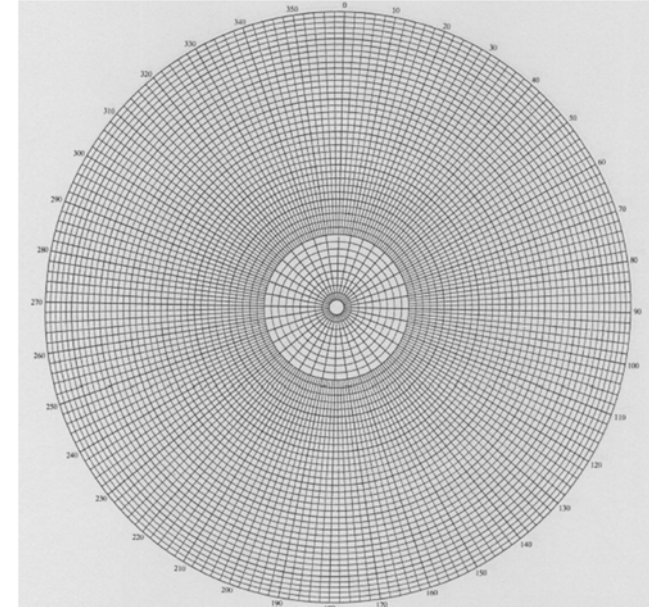


Figure 2.5 Polar equal-area net.

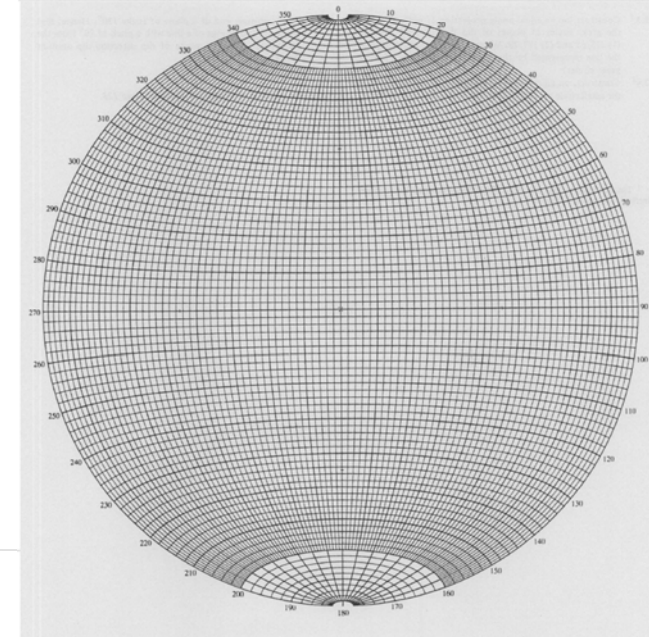


Figure 2.12 Equatorial equal-area net.

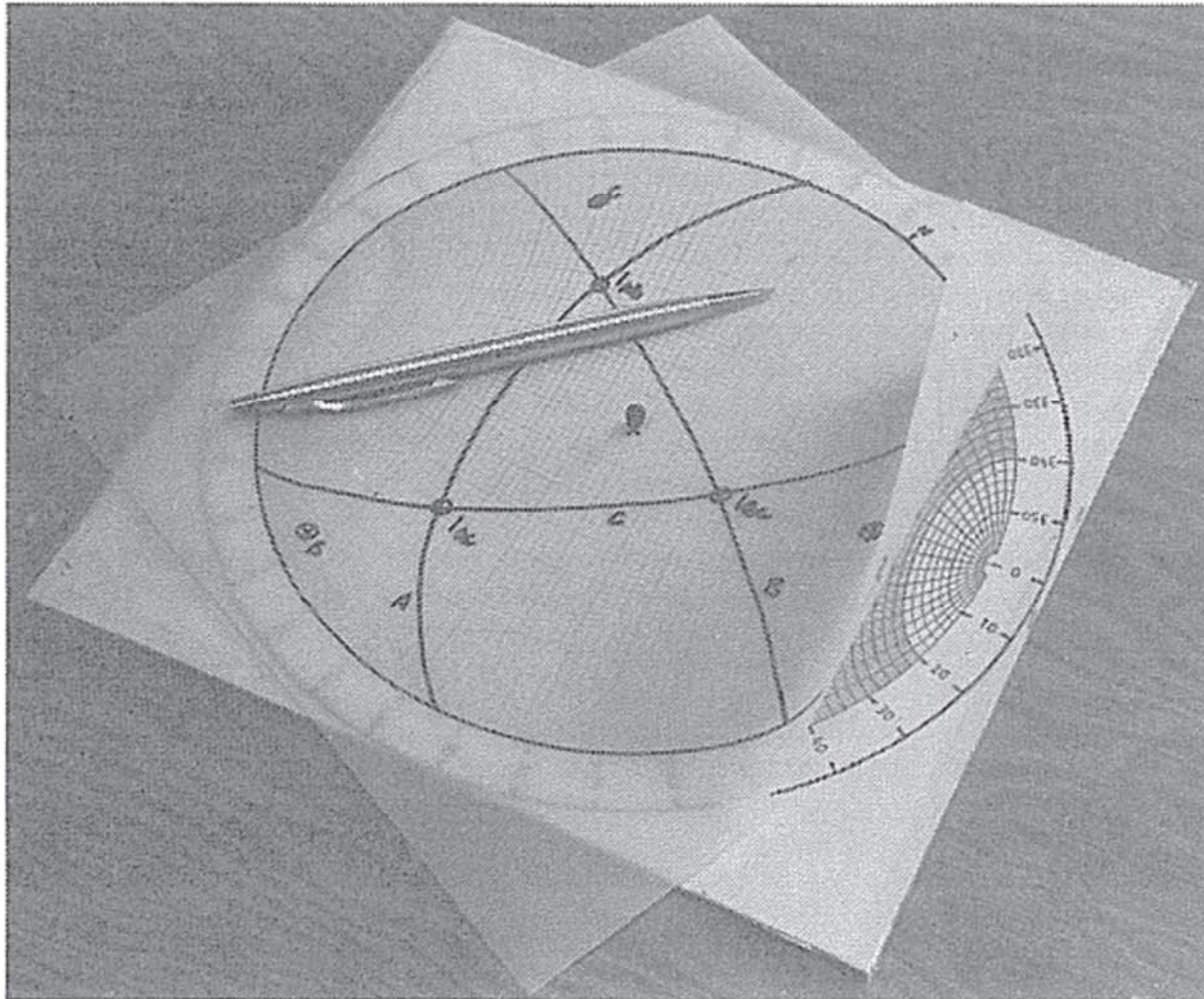
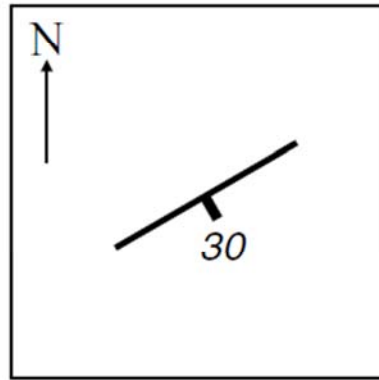


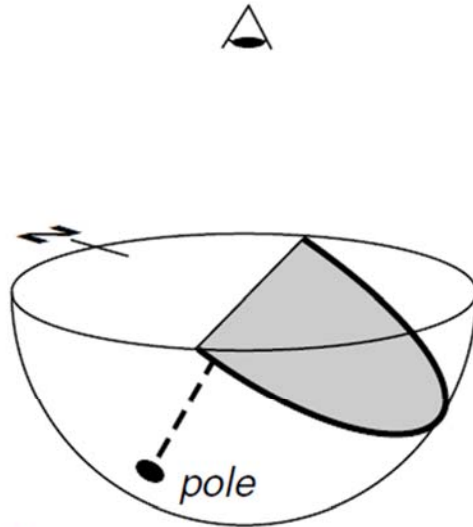
Figure 14 : Geological data is plotted and analysed on a piece of tracing paper which is located over the centre of the stereonet by means of a centre pin as shown. The net is mounted on a base-board of plywood or similar material.

空間中的面

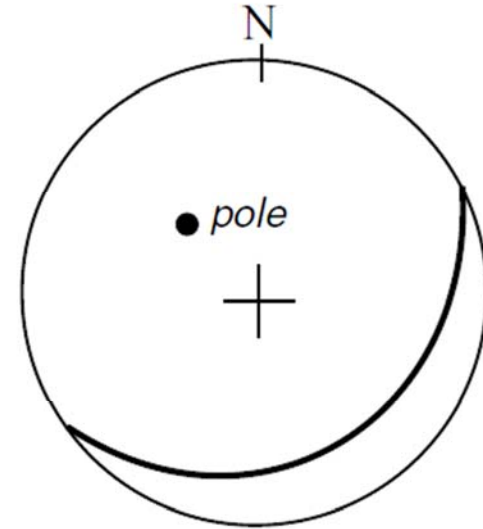
To plot the plane 060/30SE



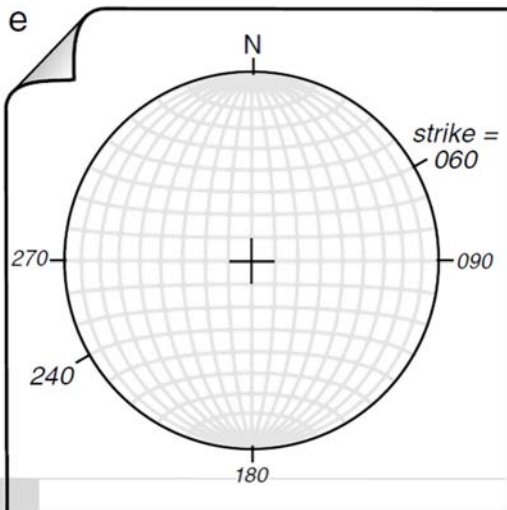
a map symbol



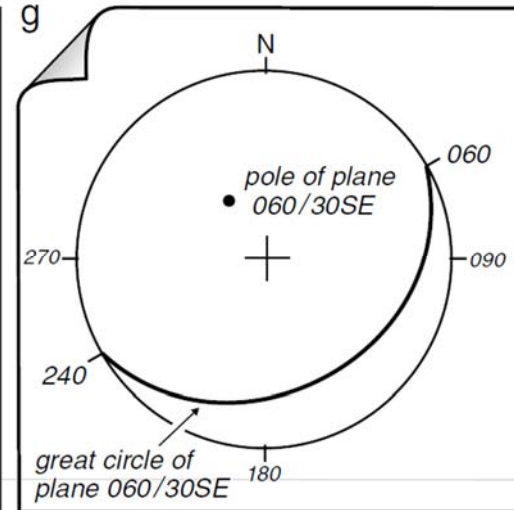
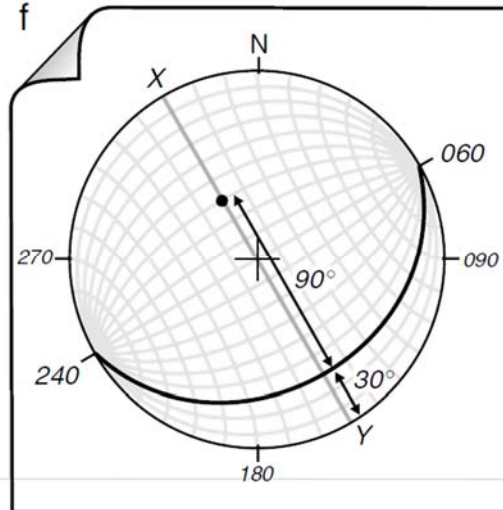
b "bird's eye view"



c sketch stereogram

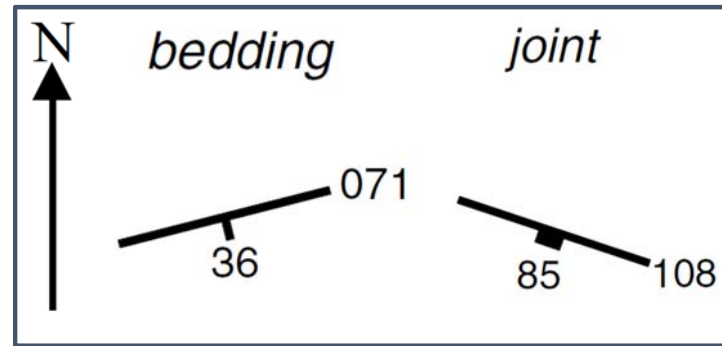


20

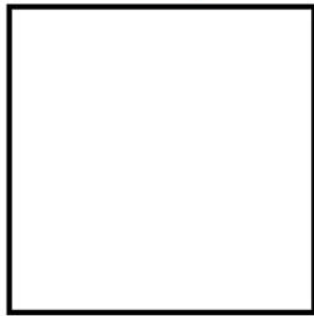


練習 1 : bedding plane 030/20NW joint plane 030/70NW

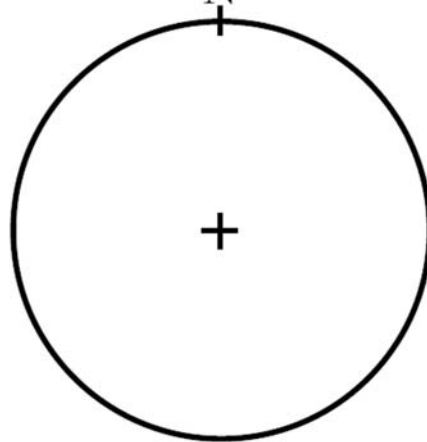
Map symbols



Map



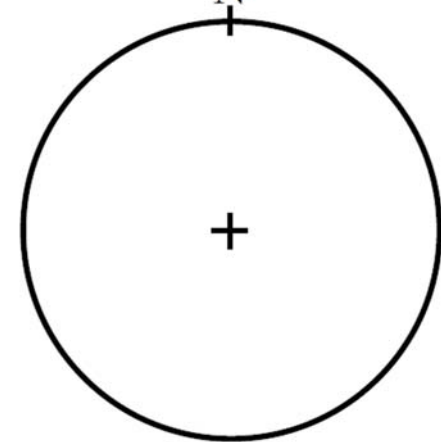
N



Map



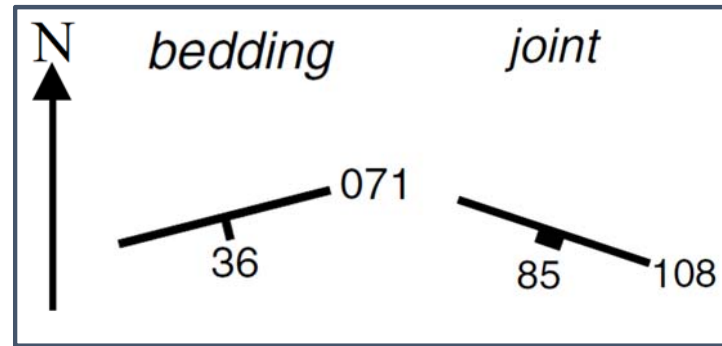
N



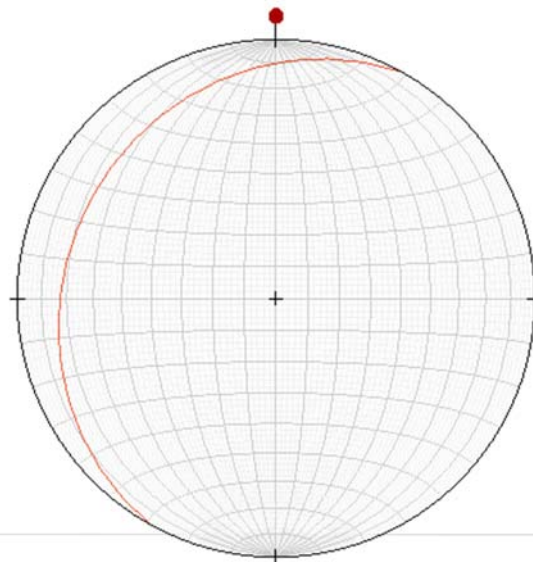
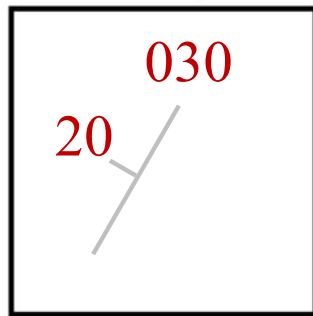
練習 1 : bedding plane 030/20NW joint plane 030/70NW

走向/傾角

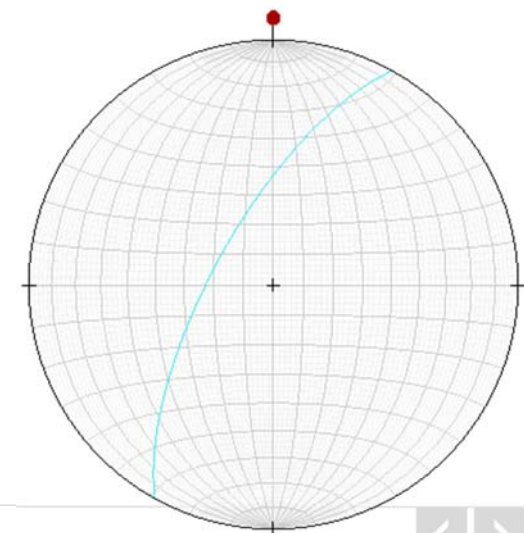
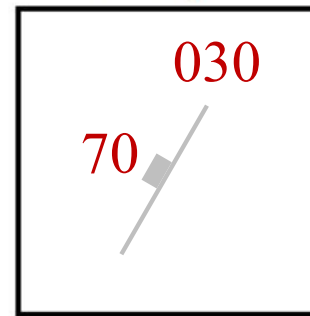
Map symbols



Map



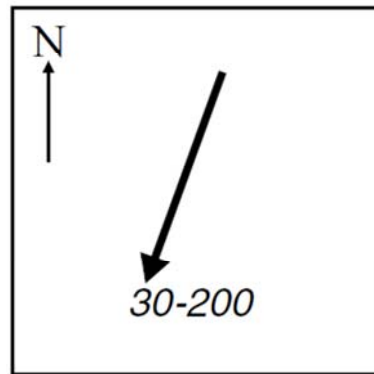
Map



空間中的線

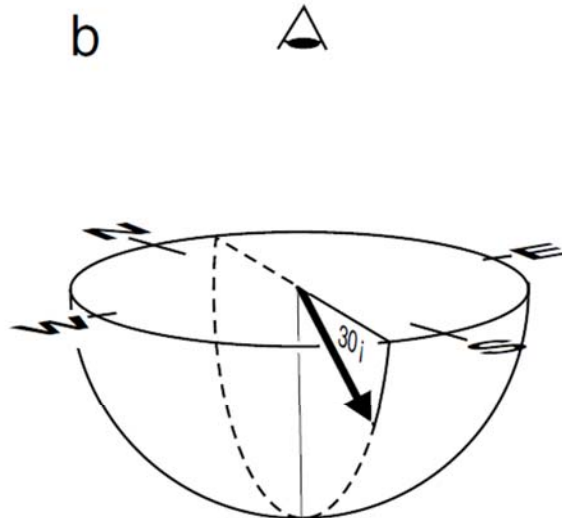
Plot the line 30/200 傾角/傾向

a



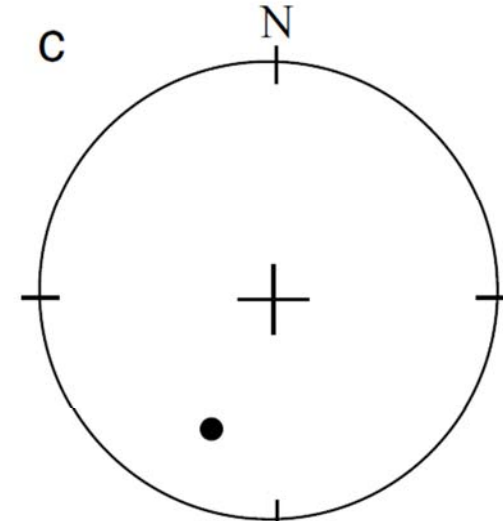
map symbol

b



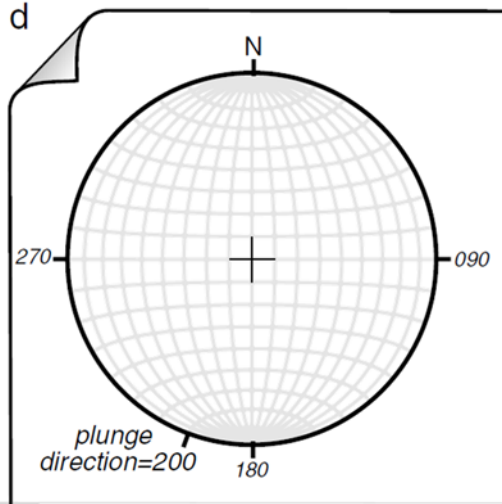
"bird's eye view"

c

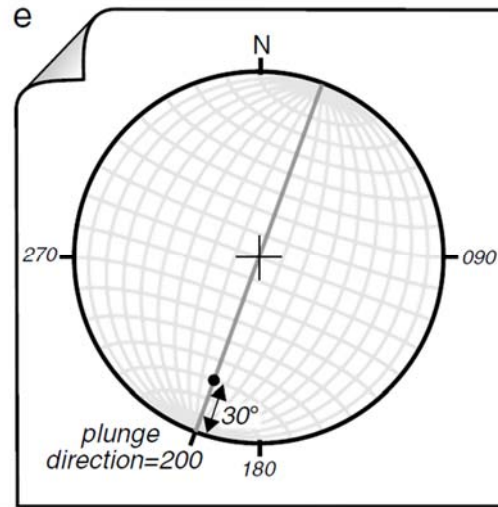


sketch stereogram

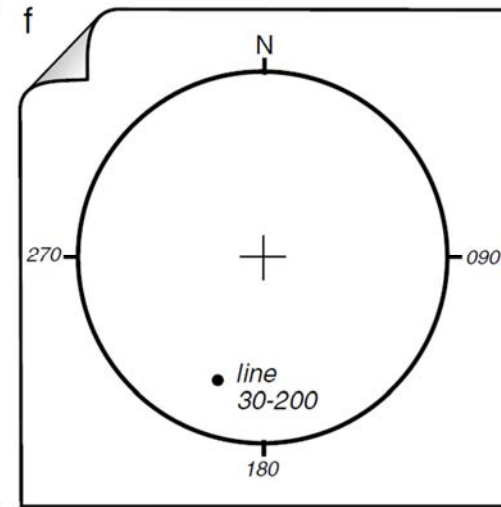
d



e



f



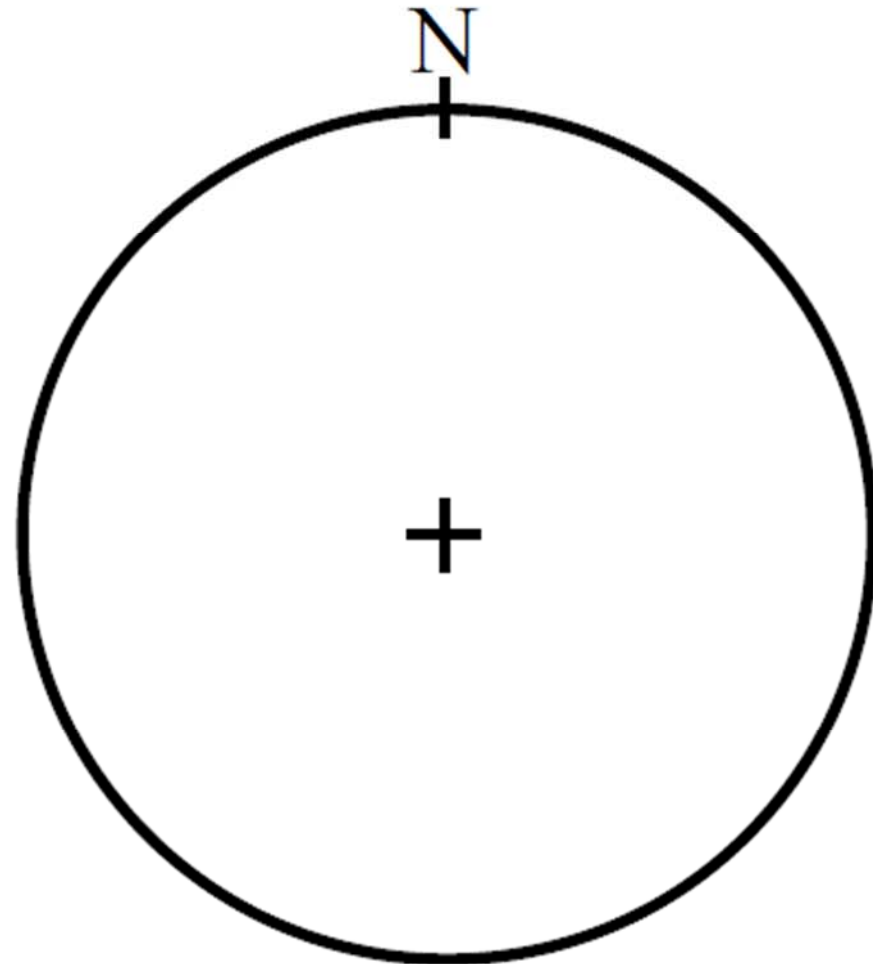
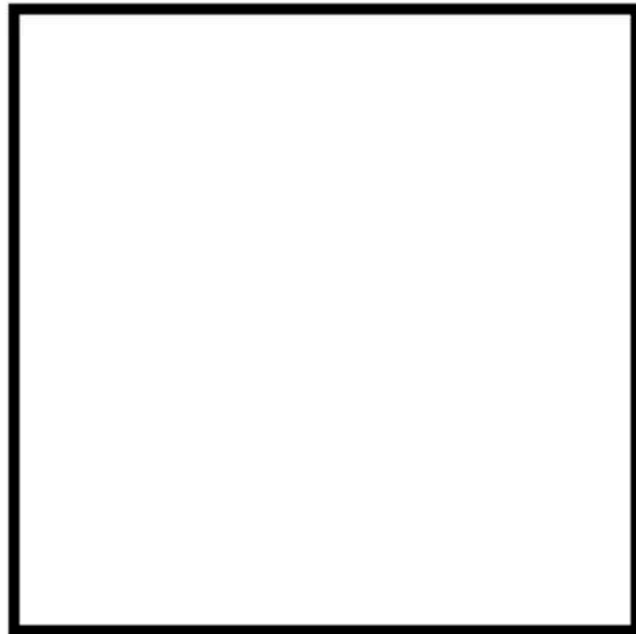
練習2 : Plot the line 10/290



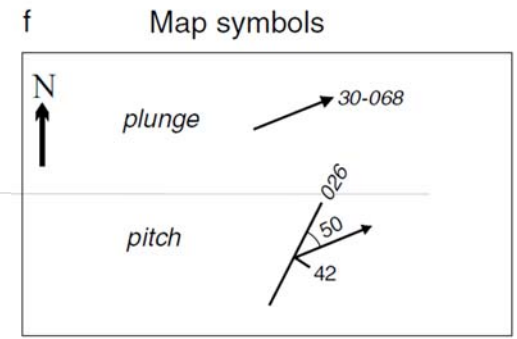
f Map symbols

N ↑	<i>plunge</i>	
	<i>pitch</i>	

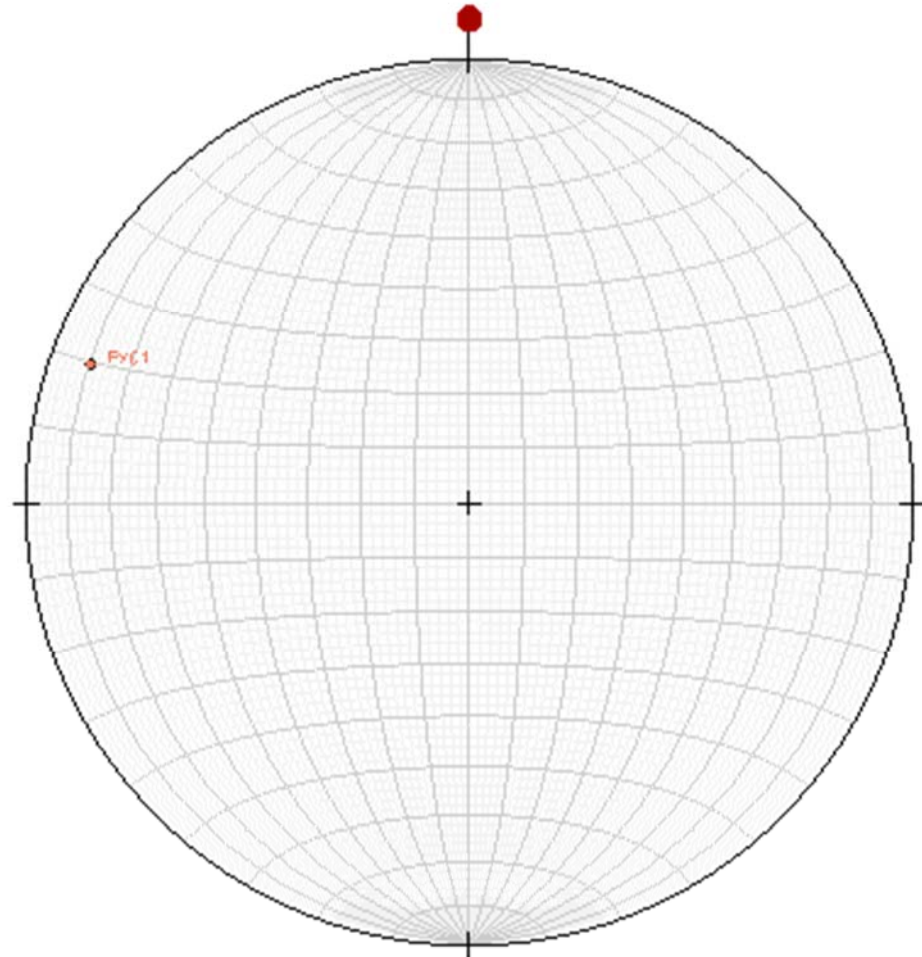
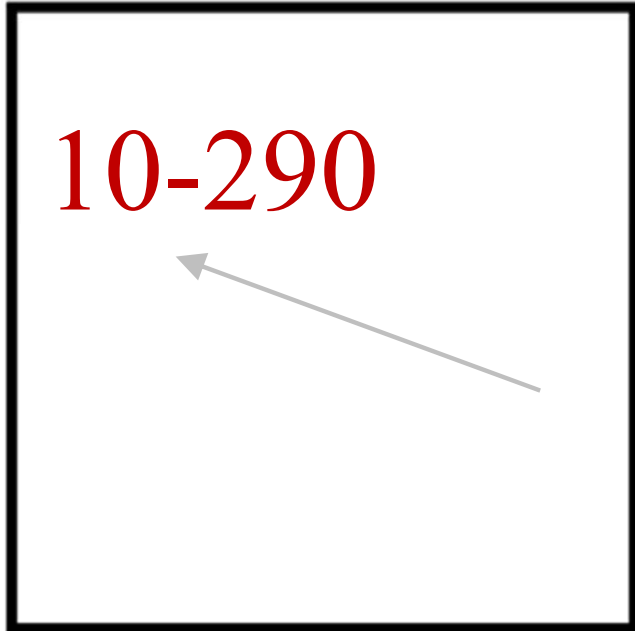
Map



練習2 : Plot the line 10/290

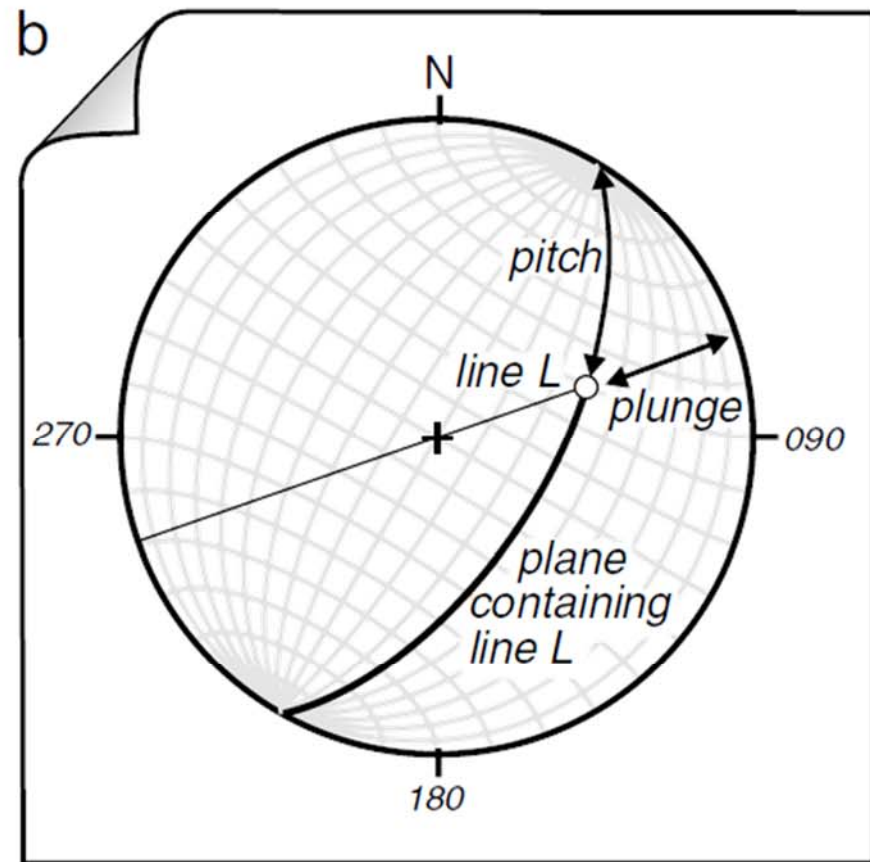
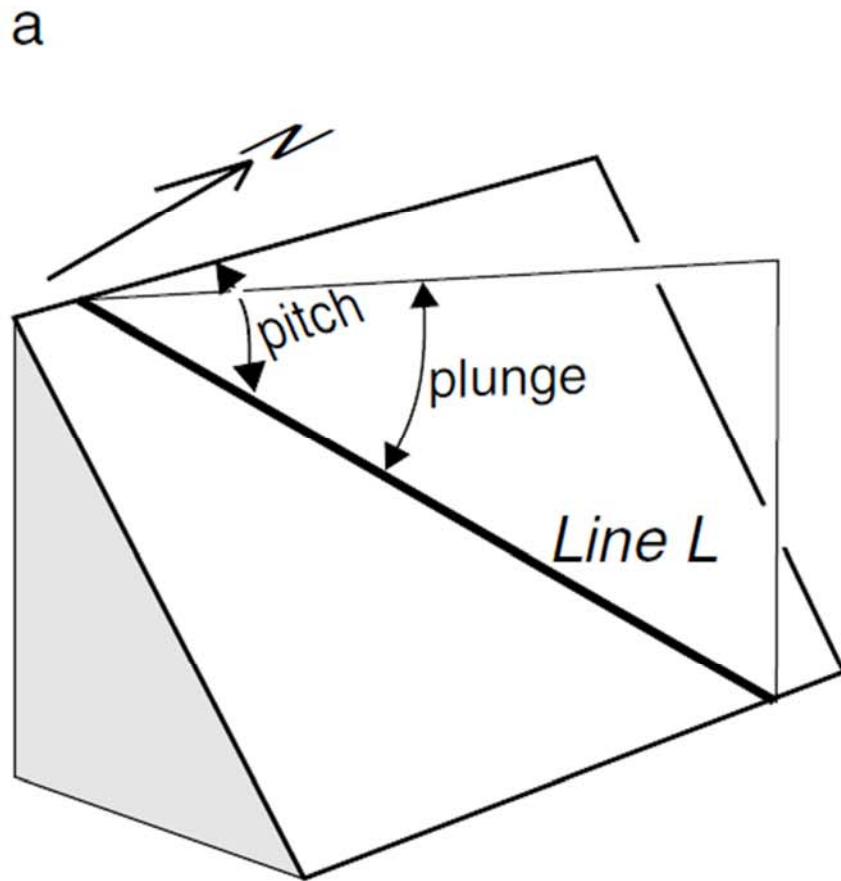


Map



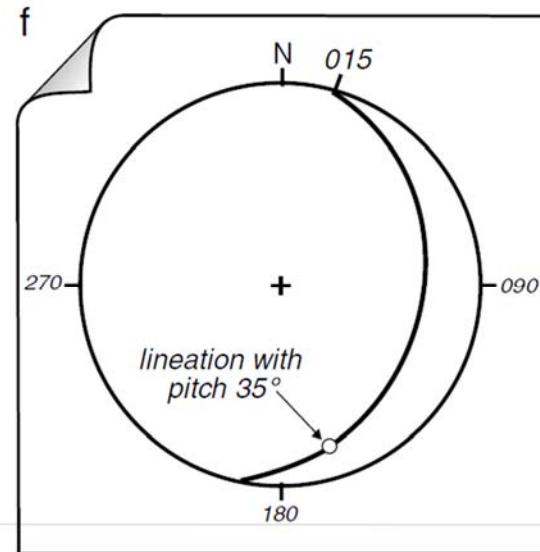
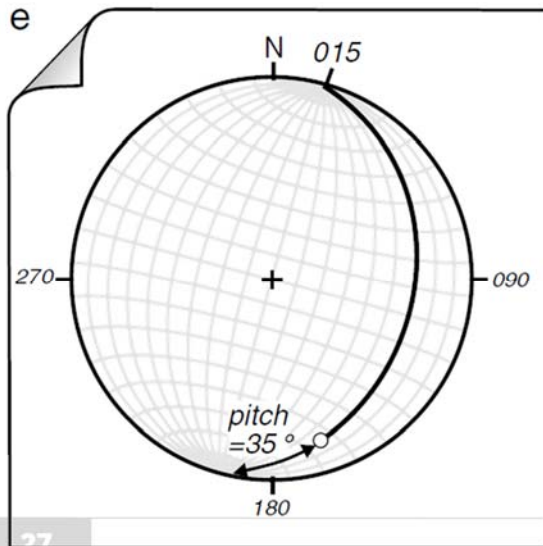
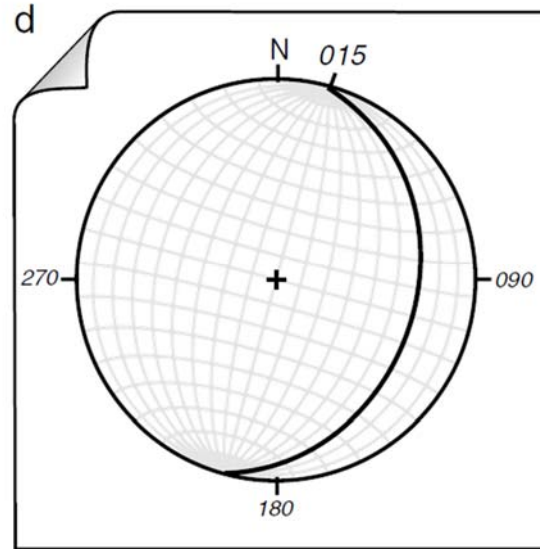
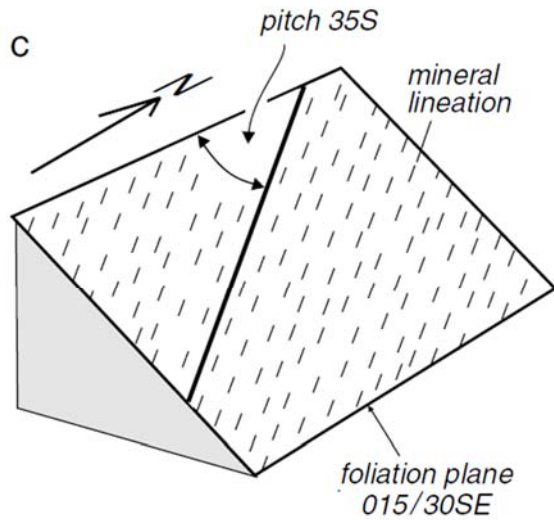
空間中的線

Where the line is known from its pitch



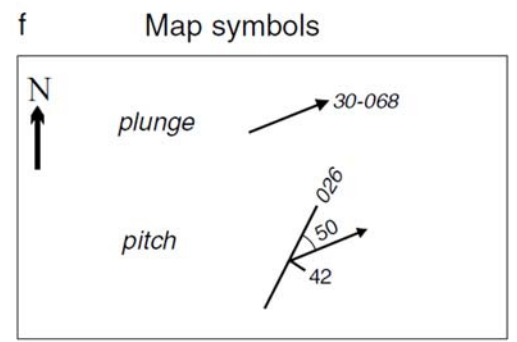
空間中的線

A lineation defined by aligned amphibole crystals pitches 35S on a foliation plane which dips 015/30SE 走向/傾角

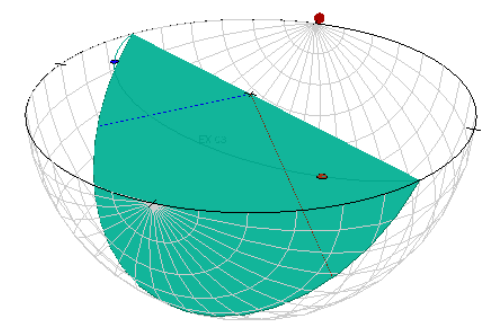
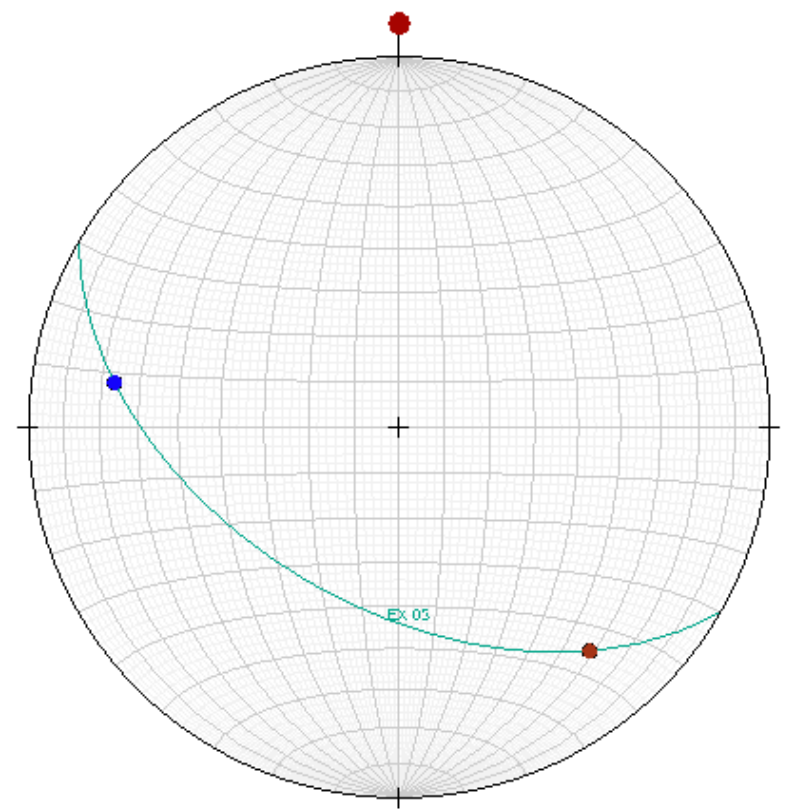
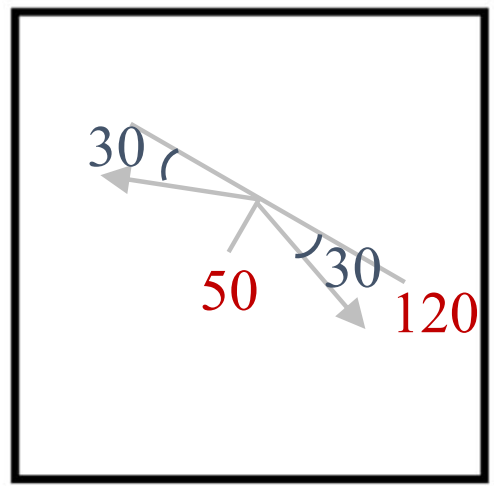


練習3：A line pitches at 30° on the plane 120/50S.
 What are the possible plunge directions of the line?

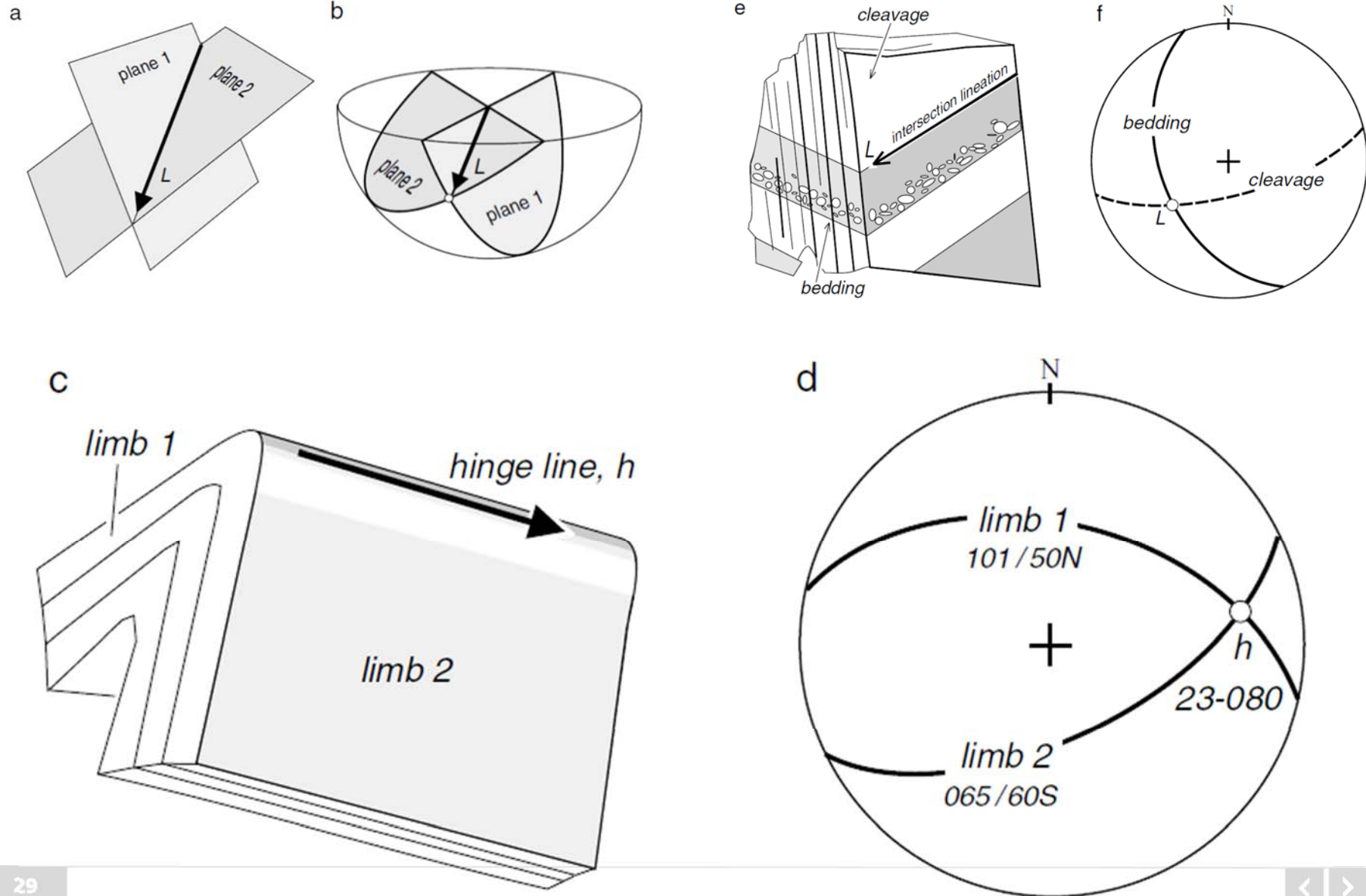
走向/傾角



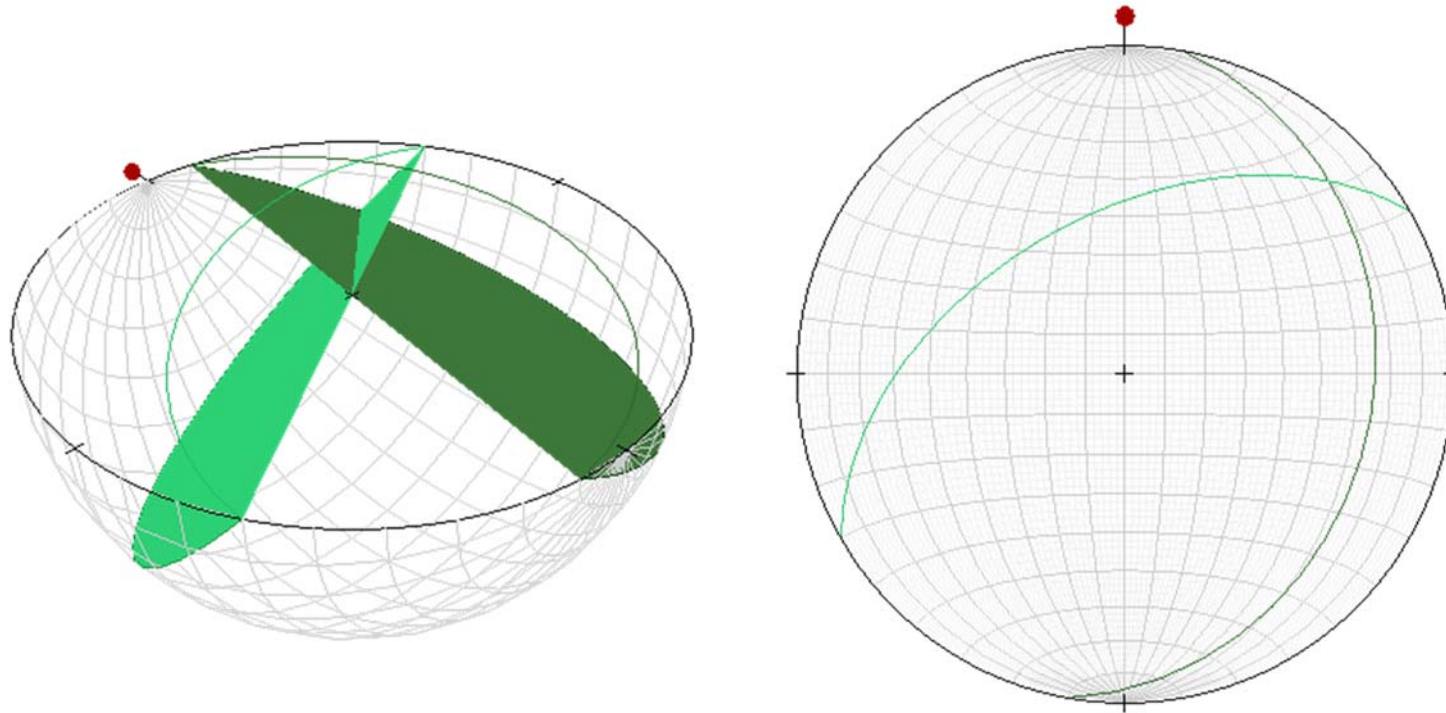
Map



空間中兩面之交線



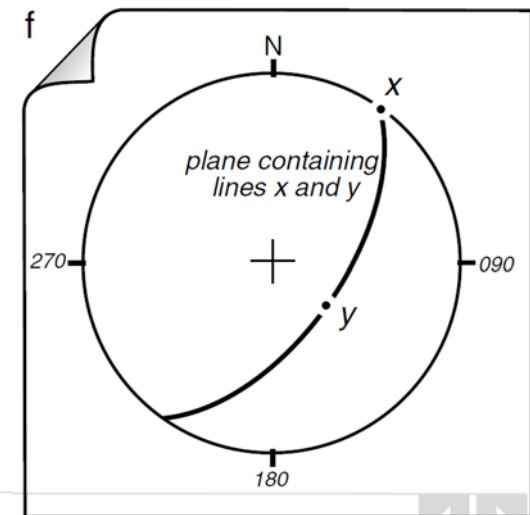
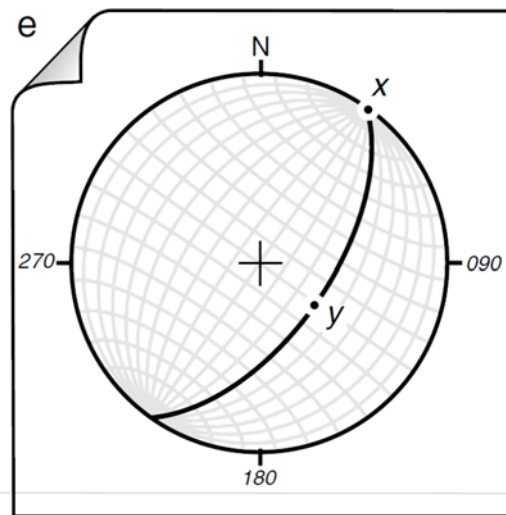
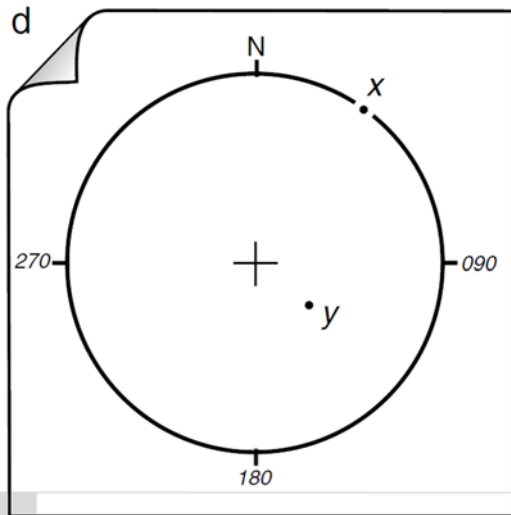
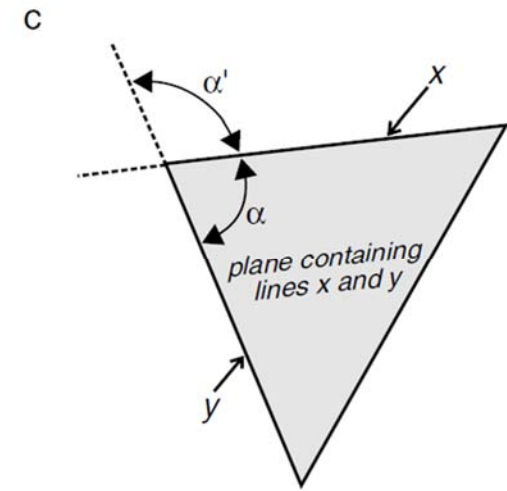
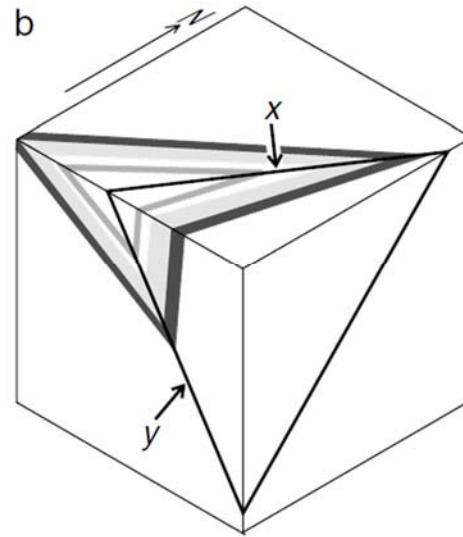
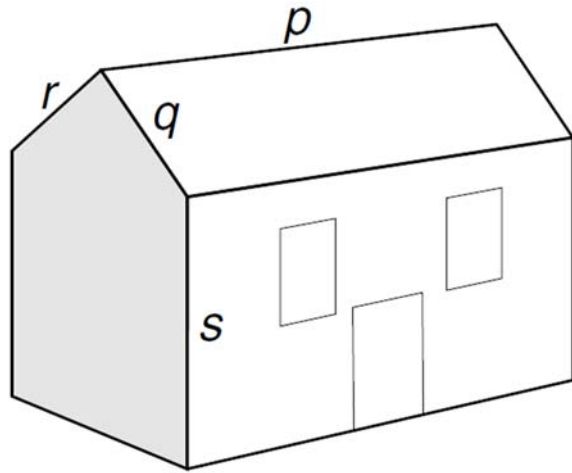
練習4：A fault plane with attitude 240/50N displaces beds which dip 010/25E. Calculate the orientation of lines on the fault which are the traces of bedding planes.



047-16

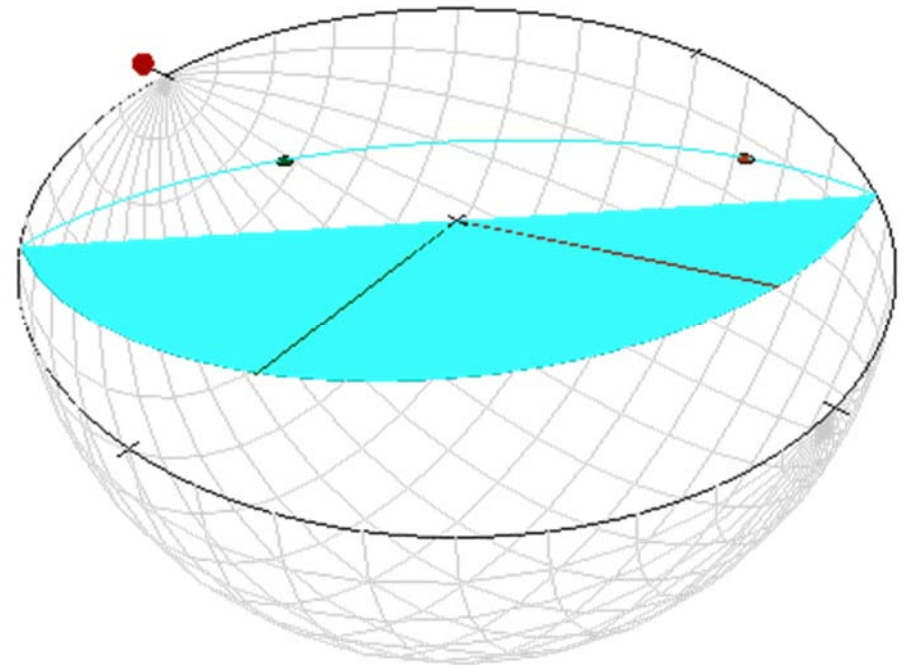
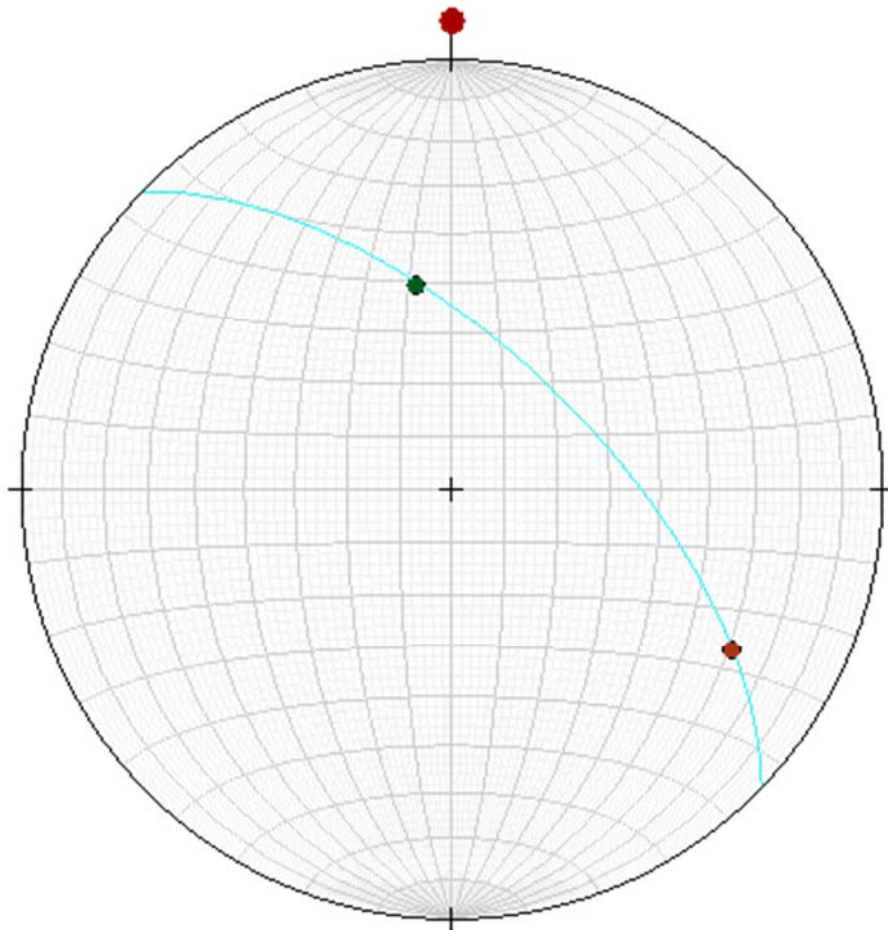
047/16

空間中兩線的共同面

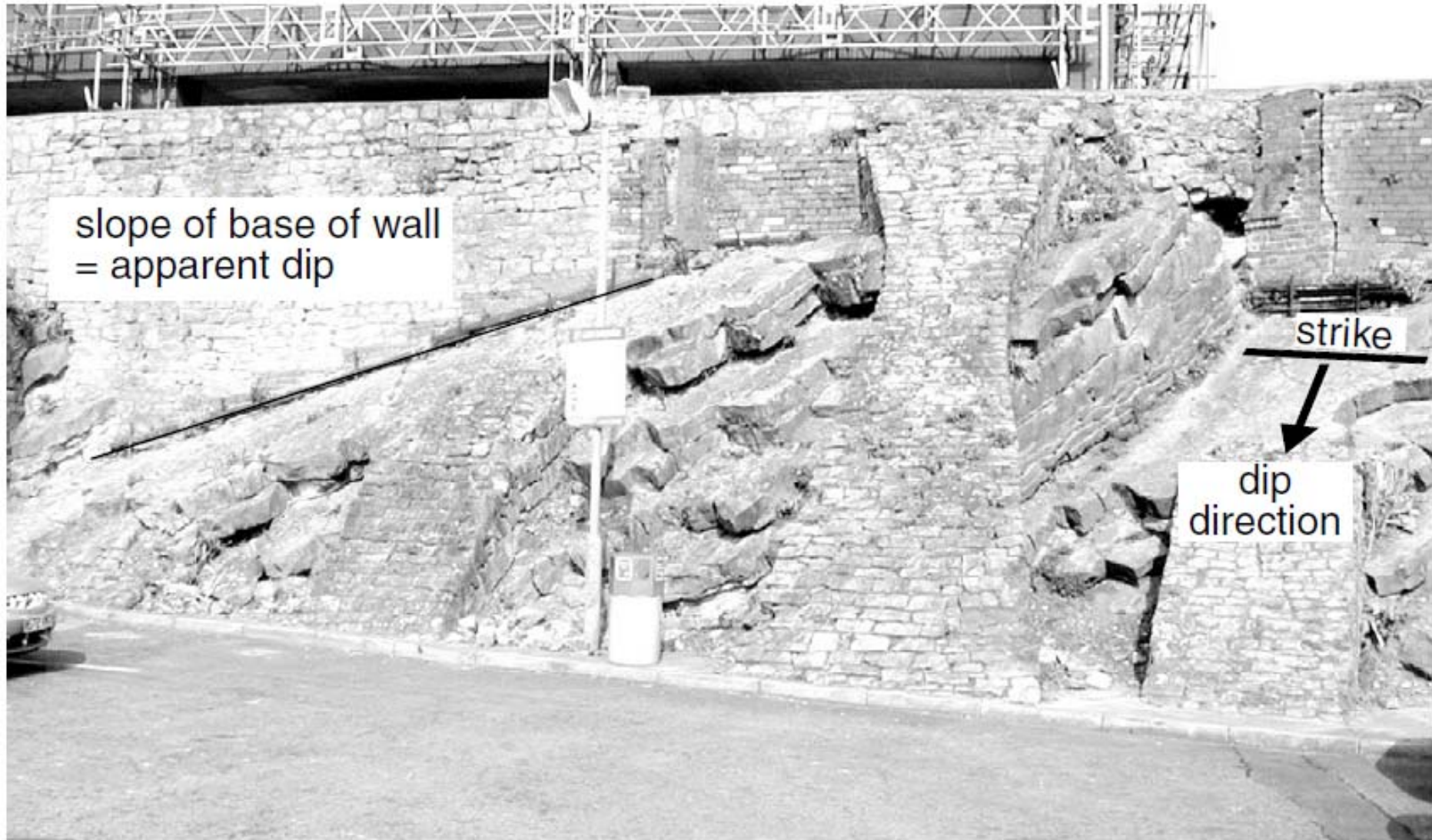


練習 5 : Find the attitude of the plane that contains the two lines 26-120, 50-350

傾角/傾向

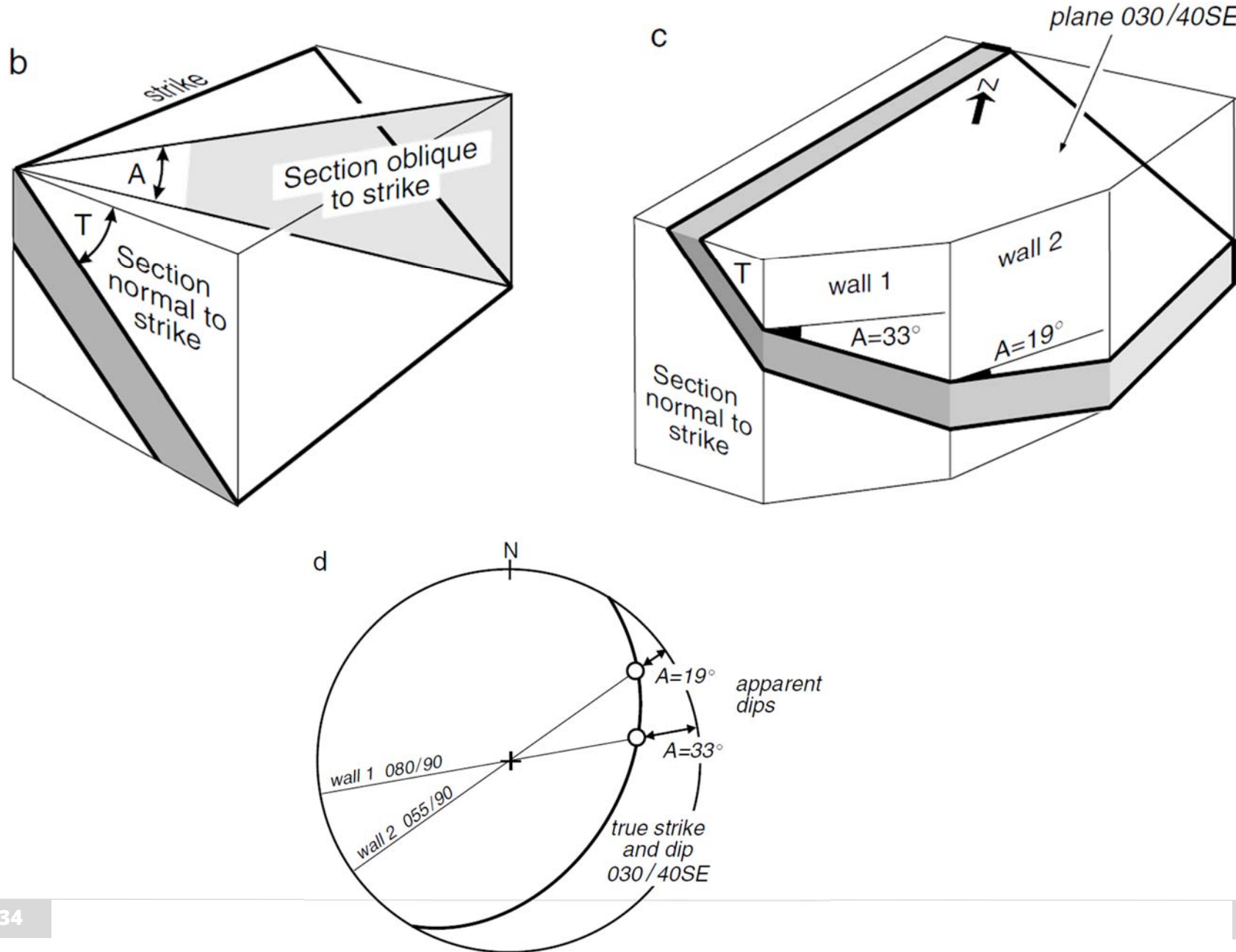


視傾角 Apparent dip

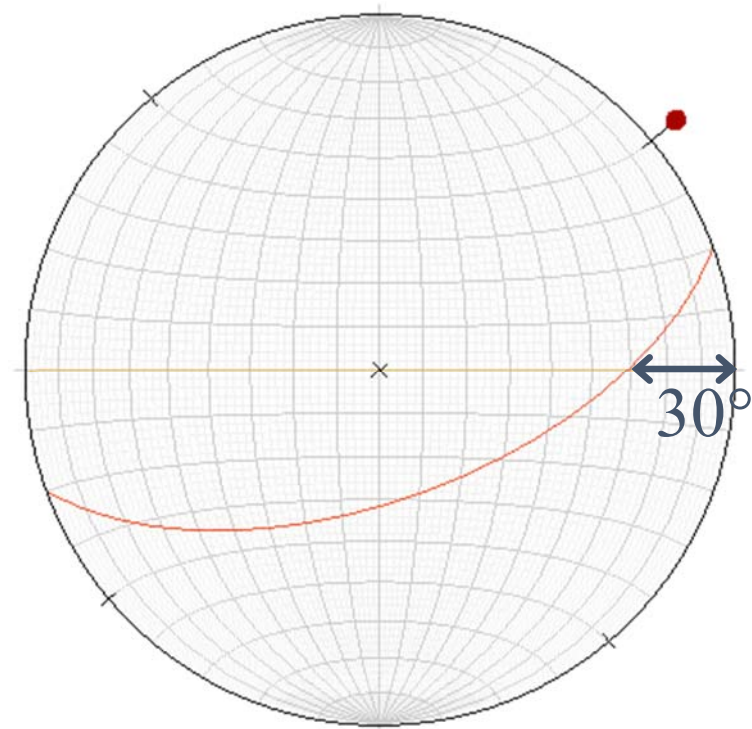
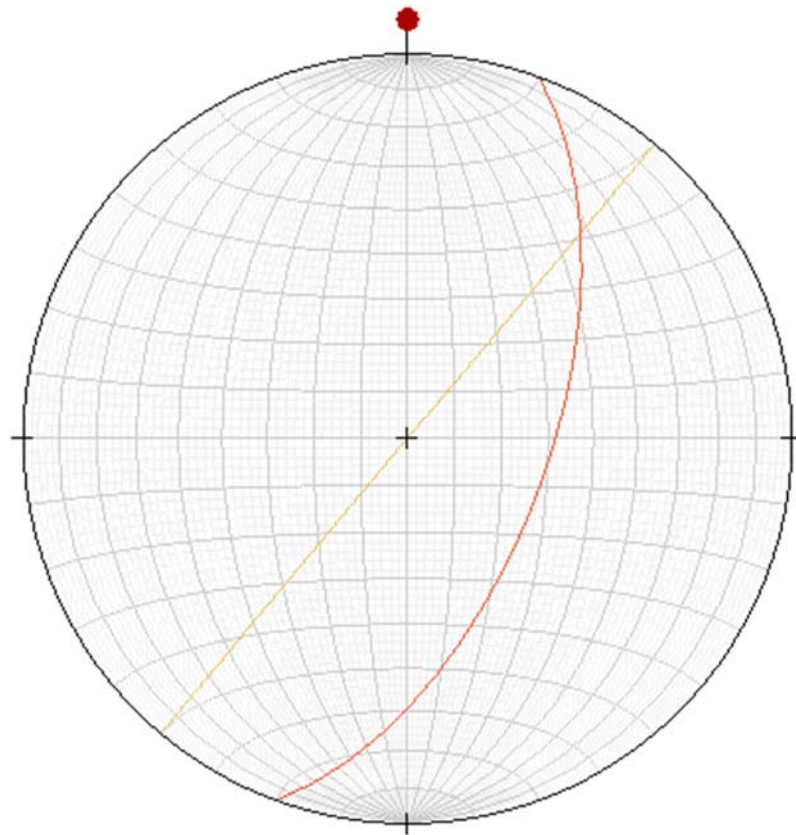


視傾角 Apparent dip

走向/傾角

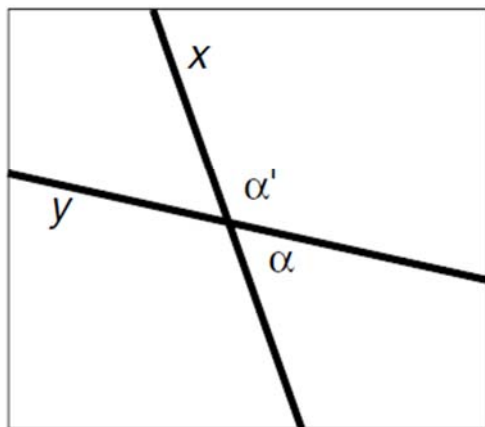


練習 6 : What is the apparent dip, on a vertical cross-section trending 040° , of beds with strike 020° and true dip 60°E ?

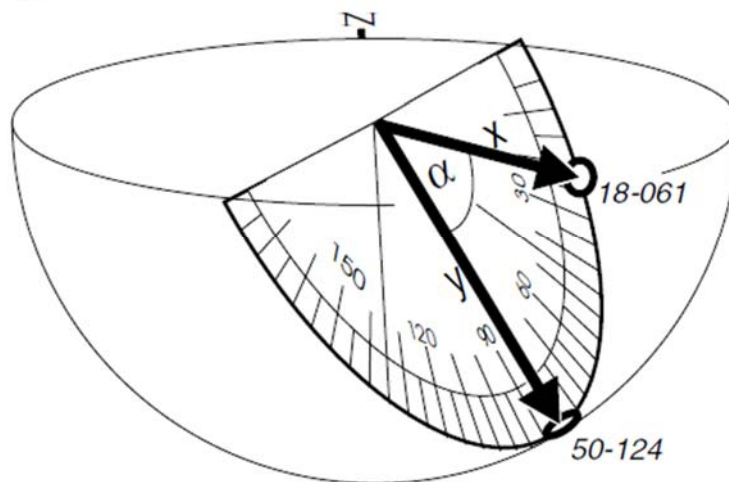


空間中兩線之夾角

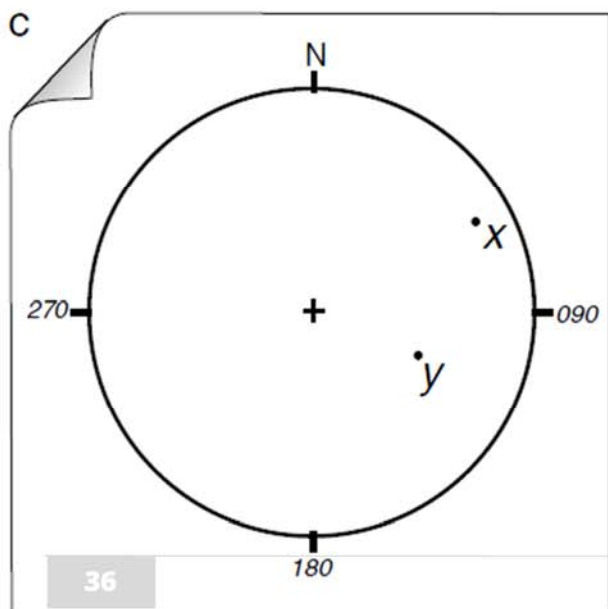
a



b

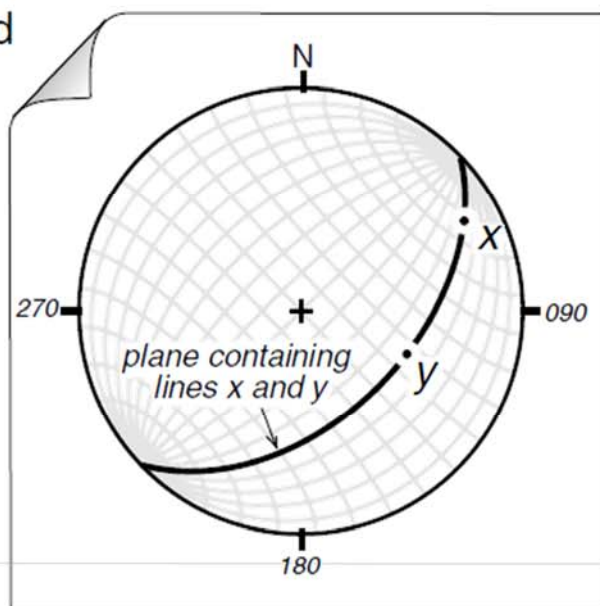


c

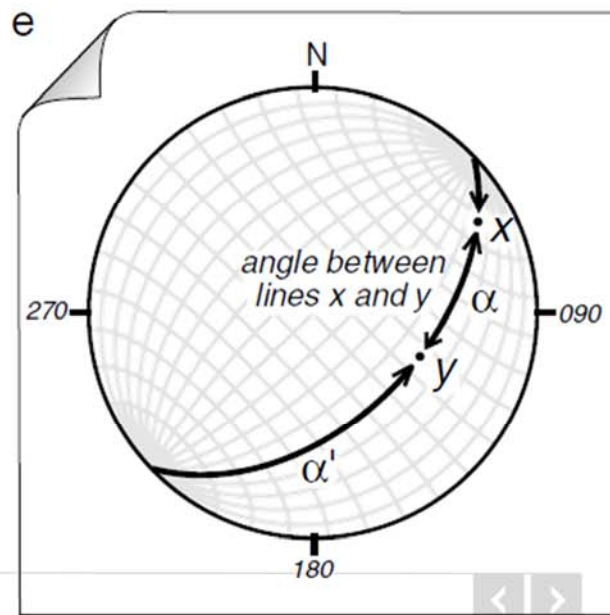


36

d

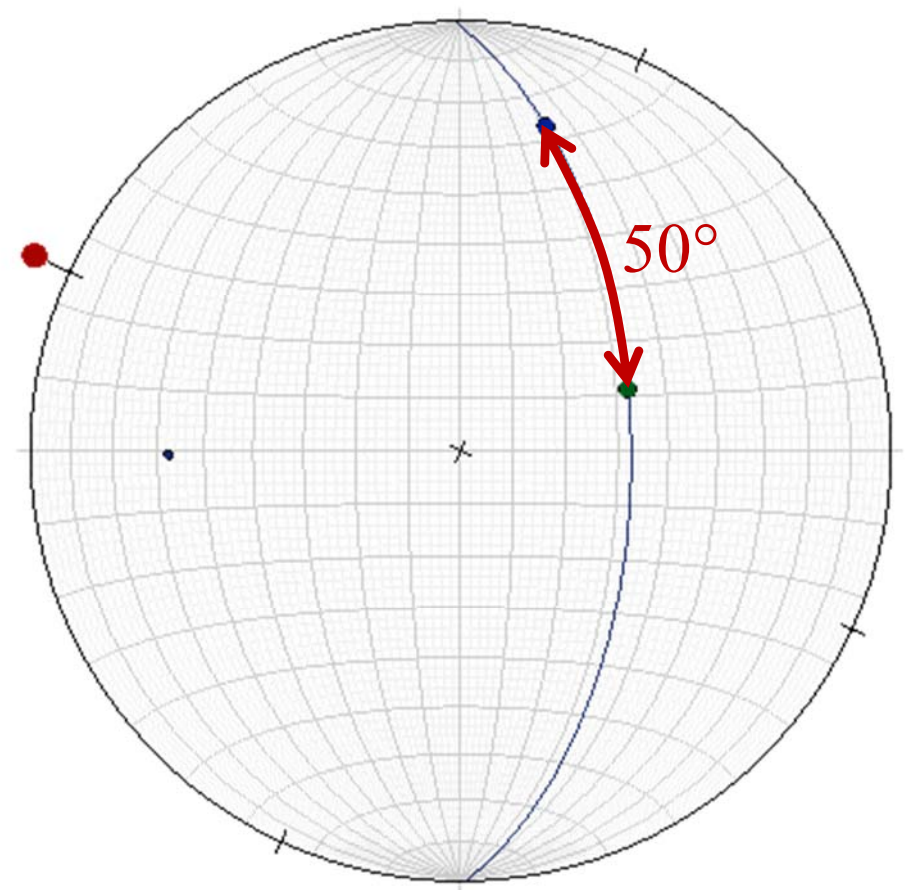
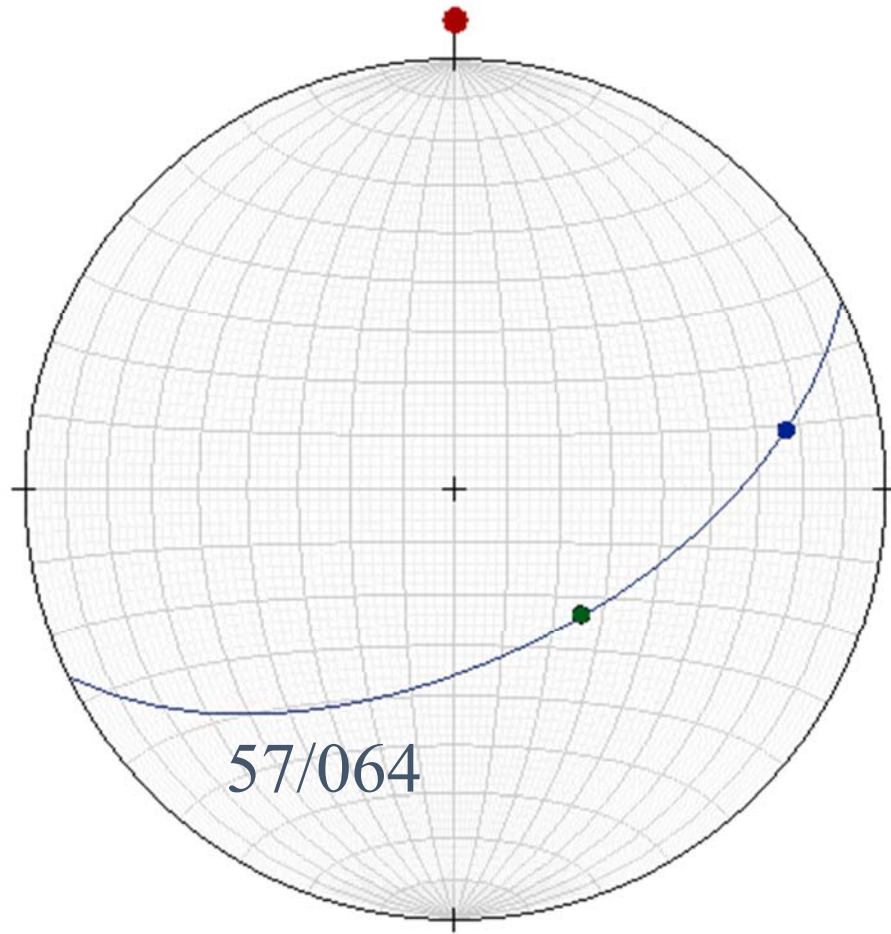


e

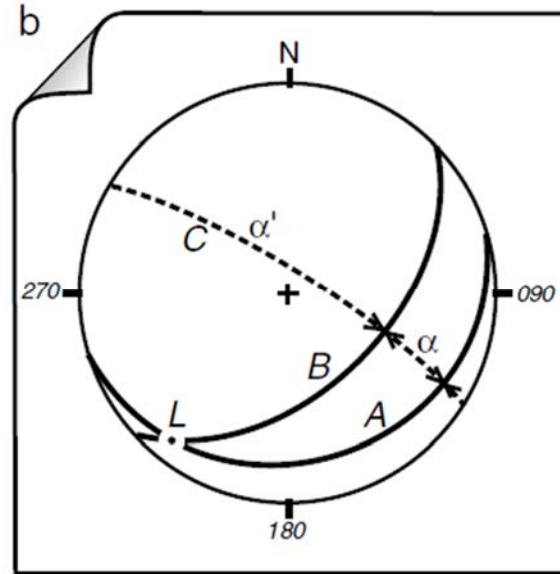
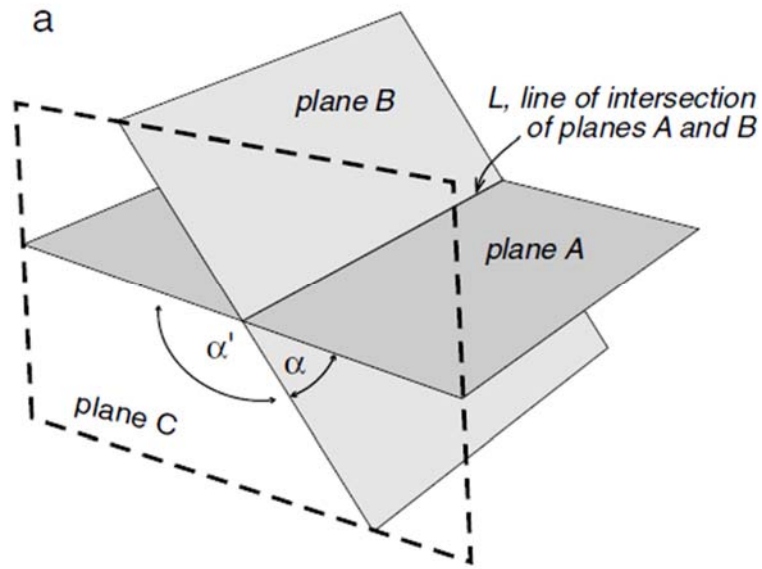


練習7： Calculate the angles between the following pairs of lines: 23-080 and 56-135;

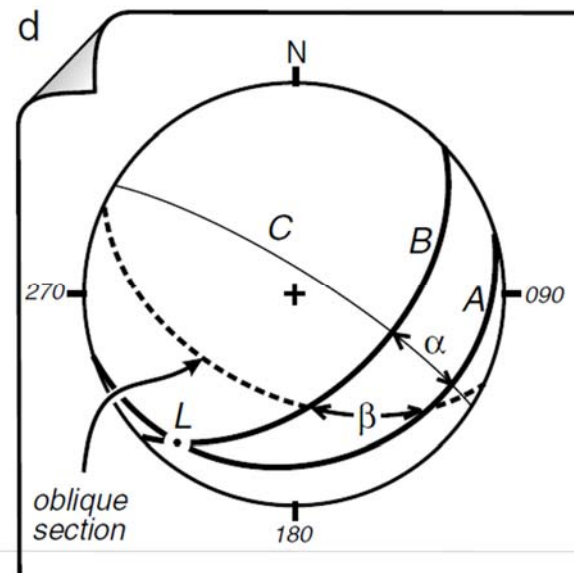
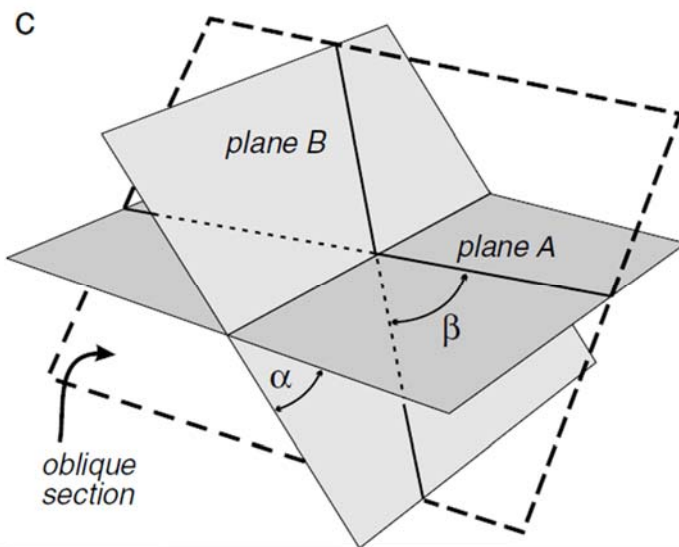
傾角/傾向



空間中兩面之夾角

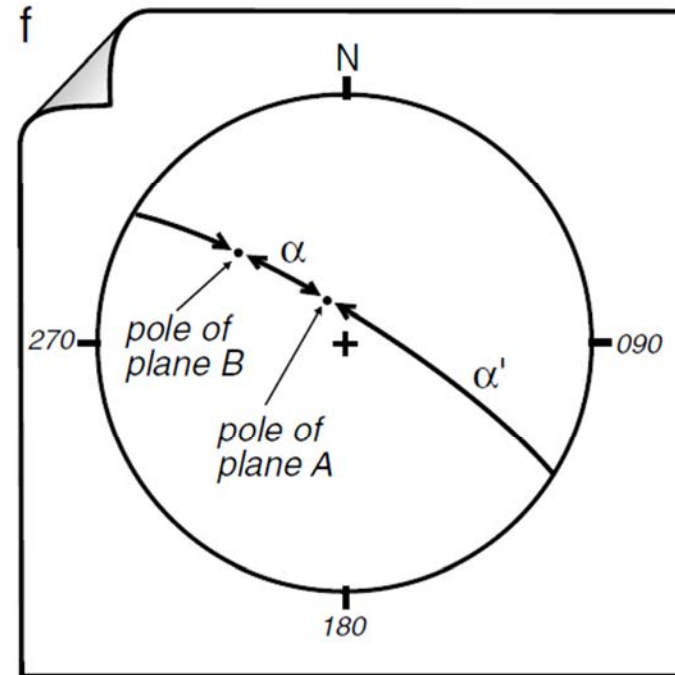
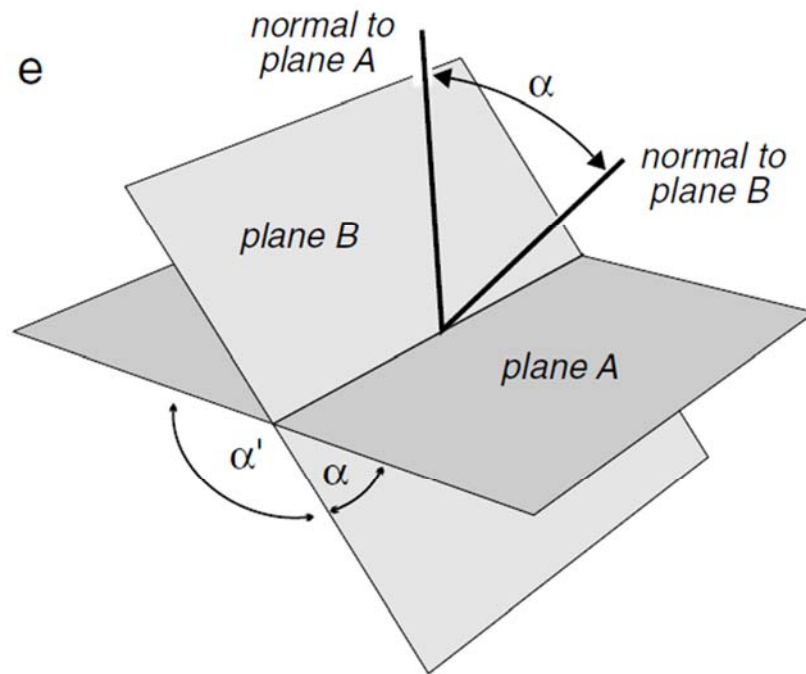


平面C垂直
線段L



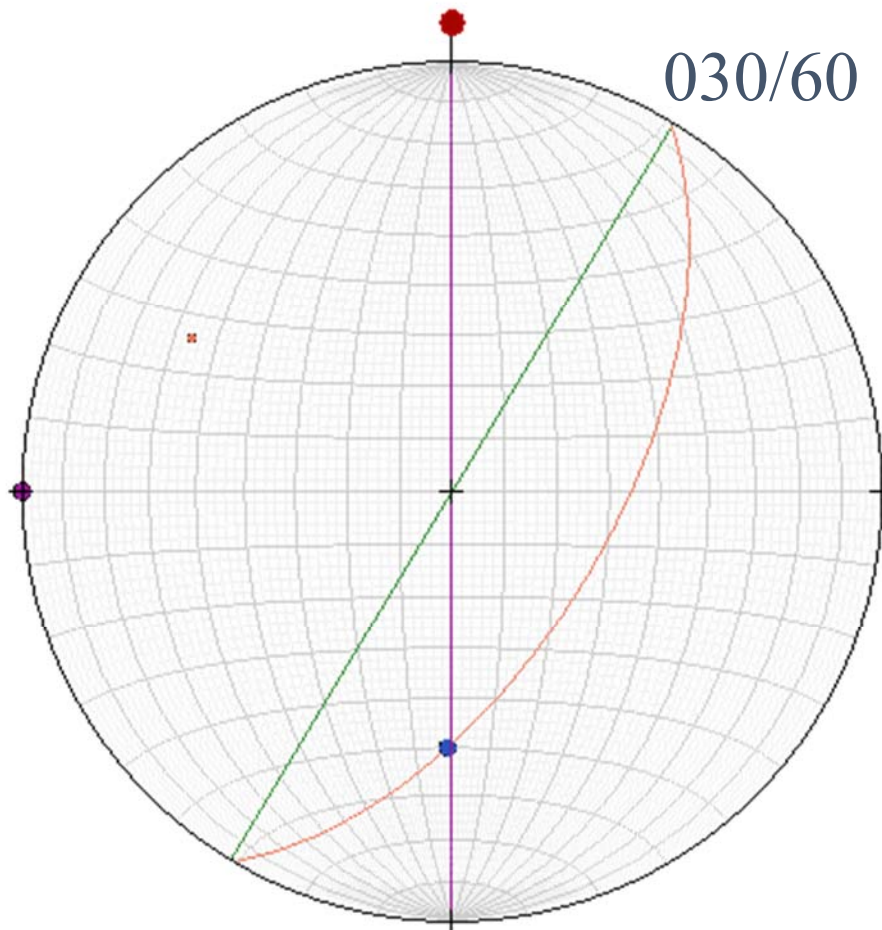
平面B不垂
直線段L則
求出的角 $>\alpha$

空間中兩面之夾角



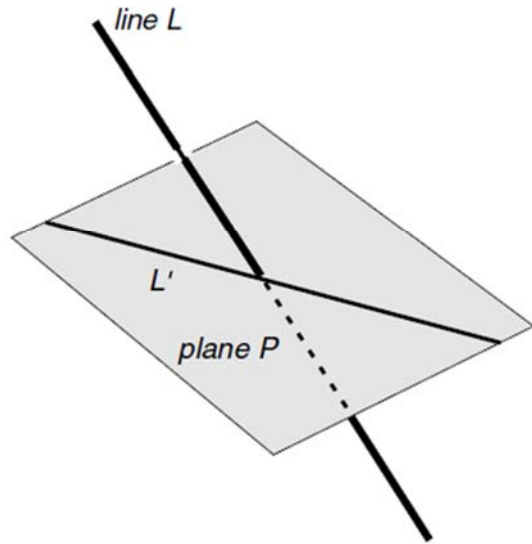
空間中兩面之夾角=其法向量之夾角

練習 8 : Bedding strikes in direction 210° and on a vertical N-S trending cross-section has an apparent dip of 40° . Find the angle of true dip.

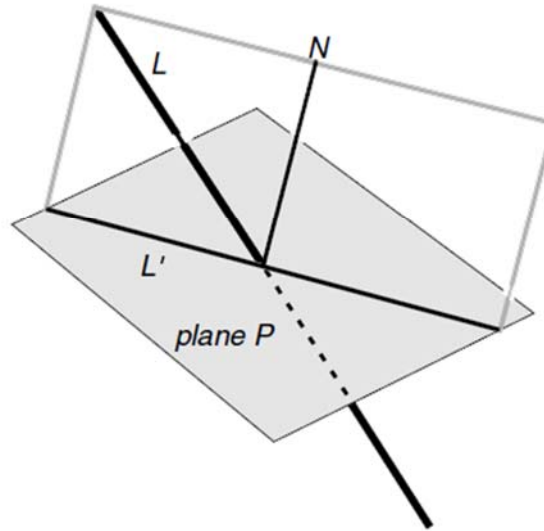


線在平面上之投影

a

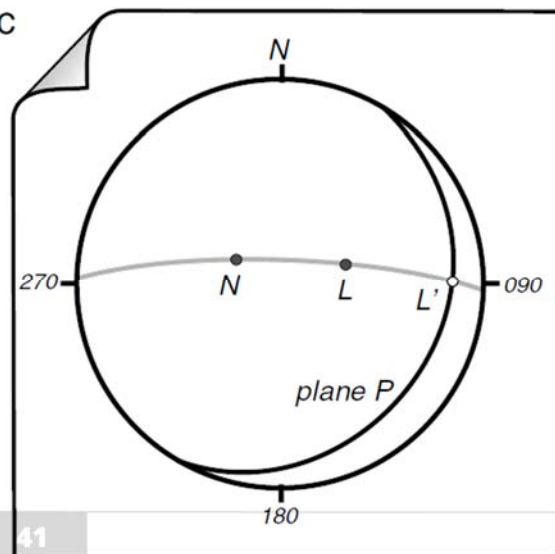


b

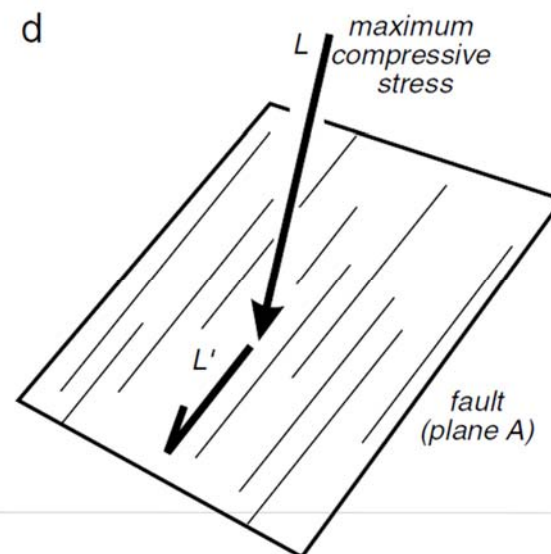


N 為平面 P 之
法向量

c



d



L' 為線段 L 在
平面 P 之投影點

等角投影極圖

The polar net
Equal angle projection

每一個方格代表1%

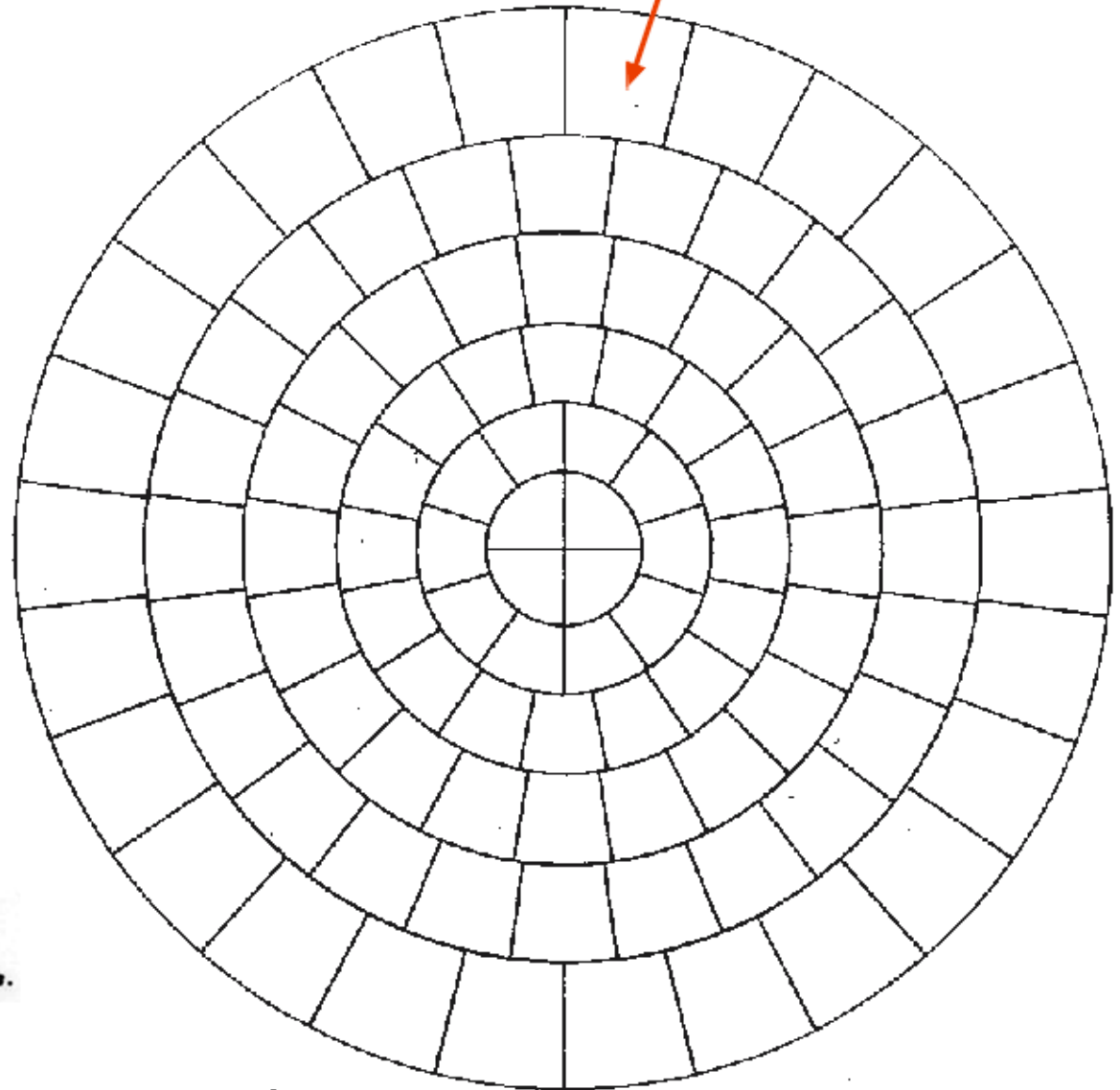


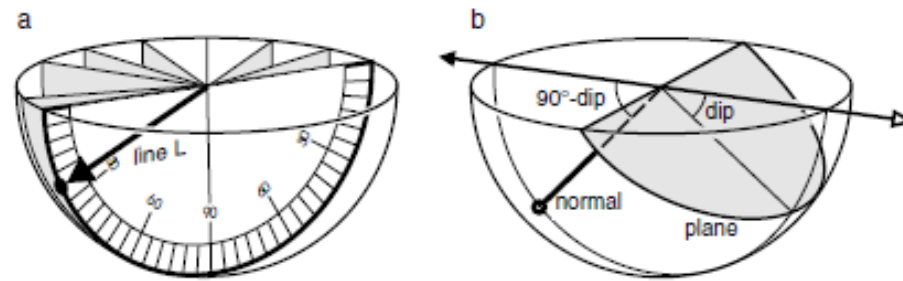
Figure 30 : Counting net for use in conjunction with the polar stereographic net given in figure 29.

Reproduced with permission of Pierre Londe, Coyne & Bellier, Paris.

The polar net

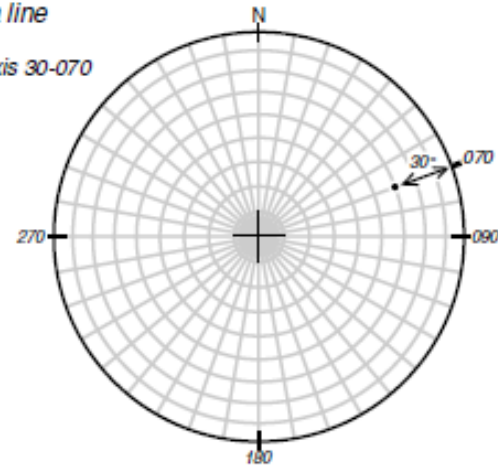
Equal angle projection

Lisle & Leyshon 2004, p. 43



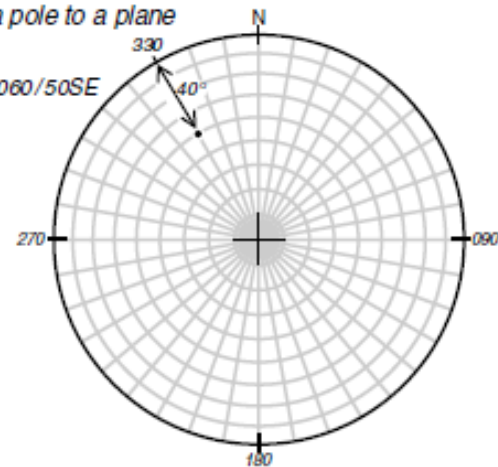
c *Plotting a line*

e.g. fold axis 30-070



d *Plotting a pole to a plane*

e.g. plane 060/50SE



The polar net

Equal angle projection

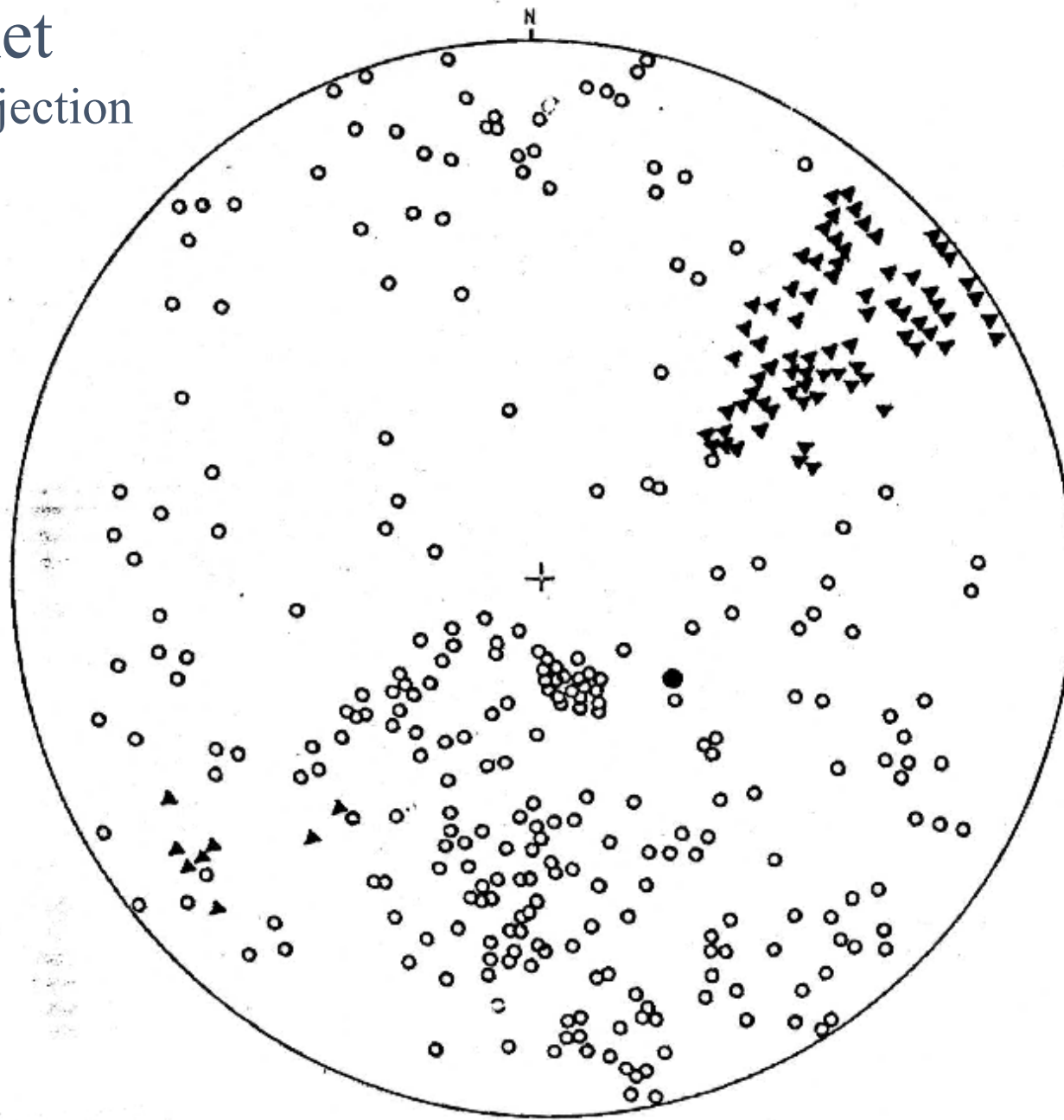


Figure 32 : Plot of 351 poles representing geological planes in a hard rock mass.

Total 351 poles

- ▲ Bedding planes
- Joints
- Fault

The polar net

Equal angle projection

1. 由極心密集程度定弱面主要方位
2. 由極心密集程度定弱面離散度

1. Based on density distribution, the major joint set/orientation can be determined.
2. Based on density distribution, the consistency of a joint set can also be observed.

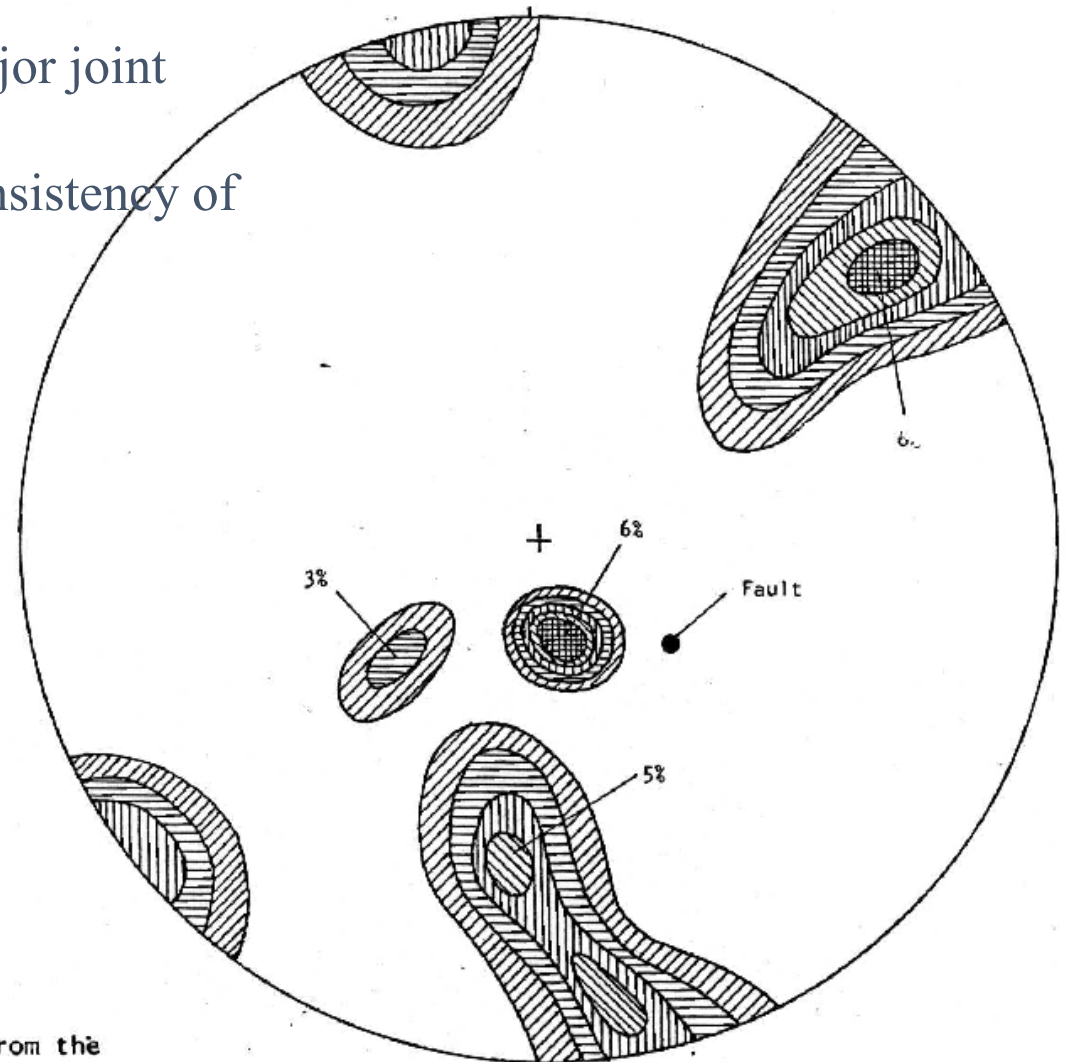
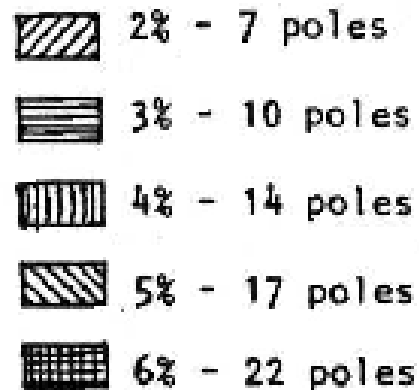


Figure 33 : Contours of pole concentrations determined from the pole plot given in figure 32.

地質羅盤app

Android

地質羅盤
捷連科技 工具
★★★★☆ 128 人
3+
這個應用程式與你所有的裝置都相容。
已安裝

還在使用傳統的地質羅盤嗎？
這可能是最好用的地質羅盤！
僅需幾個步驟，即可輕鬆顯示測量之走向、傾向、傾角，並為每次測量用照片做記錄。
1. 記錄
將手持裝置擺置於欲測量的層面上，點選記錄按鈕，即可記錄位態以及座標資訊於手持裝置中。
一張照片勝過千言萬語，點選照相按鈕，將圖片及其座標資訊記錄於手持裝置中。

[閱讀完整內容](#)

iOS

GeoCompass 2 - 地質羅盤 4+
HUNG HSUN LIN
★★★★★ 5.0 · 4 則評分
NT\$ 90

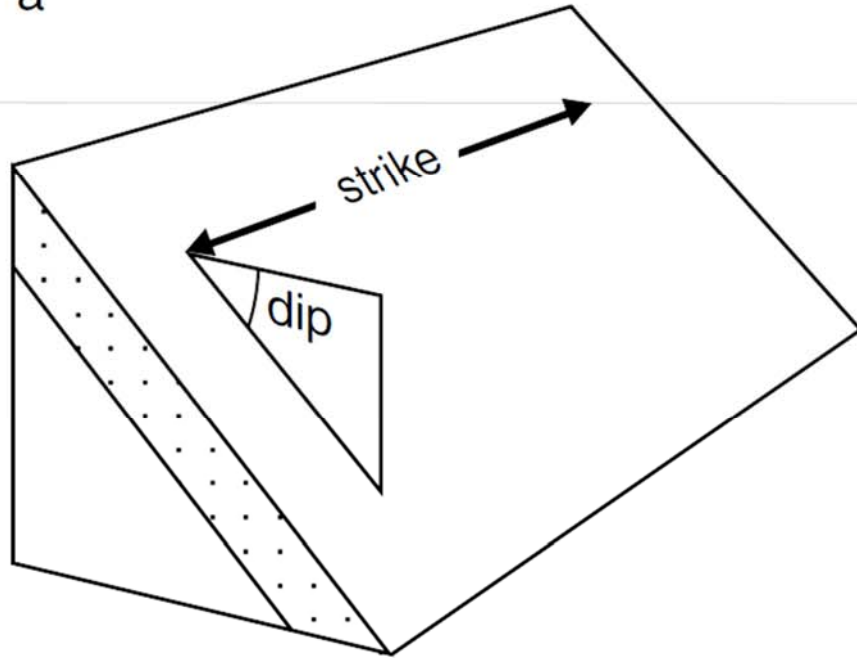
螢幕快照 iPhone iPad

位態
✓ 走向 ✓ 方位角
N52°W 128°
✓ 傾角 ✓ 傾向
45°SW 218°

地理資訊
緯度 25°0'20.12" ±5 m
經度 121°35'50.28" ±5 m
高程 124 m ±3 m
地點
台灣新北市深坑區萬福路11-47

管理	列表	編輯
	(25.00452, 121.59502)	
	✓ 走向 N64°E 方位角 244° 傾角 48°NW 傾向 334°	
	(25.01002, 121.60101)	
	✓ 走向 N42°E 方位角 222° 傾角 50°NW 傾向 312°	
	(25.00884, 121.59722)	
	✓ 走向 N56°E 方位角 236° 傾角 40°NW 傾向 326°	
	(24.99822, 121.59714)	
	✓ 傾角 33° 傾向 339°	
	(25.00602, 121.59753)	
	✓ 走向 N67°E 方位角 247° 傾角 35°NW 傾向 337°	
	(25.00602, 121.59753)	

a



b

Dipping beds, SW France



c



d

