الجمهـــوريـــــة الجـــــزائريــــة الديمقـــراطيــــة الشعبيــــة
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Introduction to toporaphy and cartography

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This handout is intented for archaeological Master's students

2022-2023

SUMMARY

This course is the logical culmination of our daily work as teachers and researchers, which is to gather information from various sources (books, journals, articles, published technical reports, webography), to cross-reference this information, to assimilate it in its entirety so as to acquire the knowledge and hindsight necessary for teaching and, finally, to pass it on to our students who are ambitious about geometric issues in the field or operations and generally passionate about archaeology.

The main purpose of topography is to produce maps and plans on which all the information relating to the topology of the terrain and its natural and artificial details are represented in symbolic form. This mapping of existing data can be used, for example, to find one's way around the terrain or to study certain old buildings.

Topography involves learning the various operations to be carried out on the ground in order to be able to represent them on a piece of paper called a Plan or Map, carrying out a direct topographic survey, representing the area under study on a plan with details of its constituent elements, determining the differences in altitude between 2 nearby locations, establishing the topographic profile of a plot of land and drawing up a topographic map using a computer.

topographic profile of a plot of land and draw up a topographic map using a computer.

The shape of the earth has always been a subject of dispute among the ancients. Indeed, many believed that the earth was flat. Or probably a disc or a square ?

Thalès (v. 625 - v. 547 av. J.-C.) shows that stars describe circles around the pole.

Anaxagore (Vè siècle av. J.-C.), is the first who thought, that the earth have a spheric shape.

Topography has always fascinated humanity. In ancient times, topography seems to have stemmed from the need, in Egypt and Babylonia in particular, to draw up plans of landholdings.

The Greeks used levels, staffs and chains and knew how to measure angles, but they did little to advance topography.

This course is subdivised on three parts.

1. The fist part concern, définitions and using the topographic maps

2. The second part permit to explain how we elaborate a topographic profile

3. The third part for exercices and applications.

PART I.

I. Définitions

Several disciplines are directly linked to topography and are grouped together under the heading of geodesy. So, before developing the use of topography and cartography in the geosciences and more specifically in archaeology, we feel it is necessary to give some general notions on the subject.

I.1. Geodesy

It enables the shape of the Earth to be determined mathematically. Geodetic observations lead to numerical data: the shape and dimensions of the Earth, geographical coordinates of points, altitudes, deviations from the vertical, arc lengths of meridians and parallels, etc.

I.2. Topography

It is considered by some scientists to be the sister of geodesy.

It deals with the same quantities, but on a smaller scale, and goes into ever finer detail in order to draw up maps at different scales and follow contour lines step by step. Topometry is the mathematical part of topography.

I.3. Cartography.

It can be used to draw up maps, often with an artistic touch.

I.4. Géography

It enables us to observe and describe our physical environment and its changes.

II. Topography

Topometry: from the Greek *topos* meaning place and *metrie* meaning the operation of measuring. Topometry.
All the techniques used to obtain the metric elements needed to produce a map on a large or very large scale.
These elements require various measurements in the field, followed by numerous calculations, diagrams and sketches. It's a vast field that requires a wide range of skills for which IT tools are now indispensable.

Topography : association of *topos* and *graphein* which in greek meaning describe. It is therefore science that provides the means for graphical or numerical representation of a terrestrial surface.

The difference between these two techniques lies in the fact that in topography the terrain is represented in situ, whereas in topometry the calculations and transfers are phases subsequent to the work on the site.

Topology : is the science that analyses the general laws of landform formation by the slow deformations of deformations of continental areas called epirogenic movements, subsequently attenuated by external actions : erosion by sea, wind, ice, water and snow.

Etymologically, topography is a science that studies the configuration of the earth in order to represent it on a flat surface. It is therefore a science that deals with the physical surface of the earth, i.e. the real surface with all its details, in order to arrive at a representation on a projection plan by deducing the natural dimensions according to a reduction factor known as the scale.
Topography is not a separate science ; it is closely linked to cartography, geodesy, geography, geology, archaeology, architecture etc...
Topography is extremely useful because it is involved in a wide range of projects:

- In mines, for the layout of galleries, directions and levels, percussion and core drillings,

- In quarries to carry out a quarry project, set up boundary stakes, slopes for inclines and ridges, carry out surveys, check for subsidence, etc..,

- In the metallurgy industry, for checking overhead cranes, tilting chimneys, levelling inclines, and controlling the movement of land subsidence using geometric levelling,

- In archaeological work, for the layout of ancient cities for example.

- In the geological work for siting boreholes and small wells,

- In D.C. works (design and construction) for the layout of buildings, roads, piping, etc.,

- On railway lines, for the layout of track axes, curves, etc..

La topographie est ainsi subdivisée en deux branches principales :

- Planimetry is the representation, using a drawing, of details of the terrain on a horizontal plane (comparison plane or dimensioned plane). In planimetry, angles and distances are measured..

- Altimetry: This is the representation on a horizontal plane of the relief of the ground (altitude measurements). It involves levelling or indicating the 3rd dimension on a dimensioned plan..

Including two types of representations :

Maps : Major topographic operations are intended to represent a large area of a few area of a few Km² and the documents produced are called maps (small-scale and medium-scale).

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Planes : When the work concerns a portion of land (plot, district, town), the documents produced are topographical plans (on a large scale).

II.1. The geographical, topographical and geological maps

The General reference maps show general geographic information about an area, including the locations of cities, boundaries, roads, mountains, rivers, and coastlines (Fig. 1).

Fig. 1. Geographical map sample

Topographic maps are a detailed record of a land area, giving geographic positions and elevations for both natural and man-made features. They show the shape of the land the mountains, valleys, and plains by means of brown contour lines (lines of equal elevation above sea level) (Fig. 2).

Fig. 2. Topographical map sample

Geological maps provide a visual representation of the geology of a region, including rock types, faults, folds, and other geological features. The purpose of these maps is to help geologists understand the geological history and structure of a given area, which can be used for a variety of purposes, such as mineral exploration, natural resource management, and hazard assessment. (Fig. 3)

Fig. 3. Geological map sample

II.2. Projection systems

The aim of map projections is to obtain a flat representation of the ellipsoidal model of the Earth's surface.

Commençons par des définitions. A projection that preserves the angles is called *conformal*. An equivalent projection is one in which the surfaces remain the same. An equivalent projection cannot be conformal. When the distances from a given point are preserved, it is called an equidistant projection.

The most commonly used projections are conformal projections because of the importance of angles in measurement operations. However, on small scales, an equivalent projection is often used. A projection that is neither conformal, equivalent nor equidistant is called aphylactic. But in any case, no projection can preserve all distances.

Another way of approaching the different projection systems is to look at their grid, i.e. the image of the meridians and parallels. There are three main categories: *conic, cylindrical and azimuthal.*.

II.2. 1. Conical projections (Fig. 4 and 7)

In conical projection, we project onto a cone tangent to a parallel of the terrestrial sphere and whose axis passes through the poles. The images of the meridians are half-lines that converge at a point that is the image of the pole, and the parallels are circular arcs that are concentric and equidistant around this point.

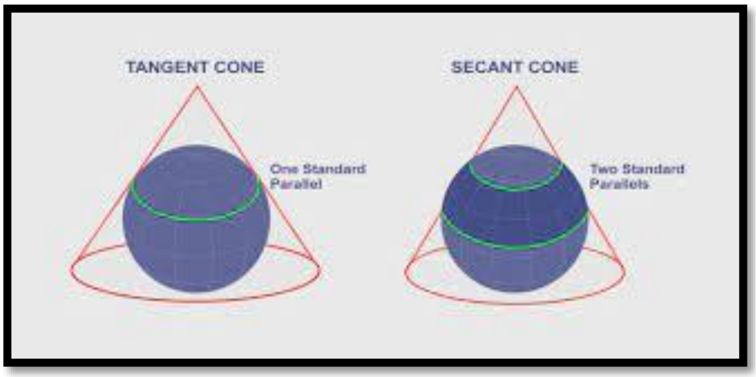


Fig. 4. Conical projection

II.2. 2. Cylindrical projections (Fig. 5 and 7)

Cylindrical projections are produced by enclosing the Earth in a cylinder tangent to the equator. The meridians are represented by equidistant vertical lines and the parallels by horizontal lines. The further you are from the equator, the greater the distances. The polar zones are therefore highly disproportionate and distorted, but the map shows the proportions of the regions in real life.

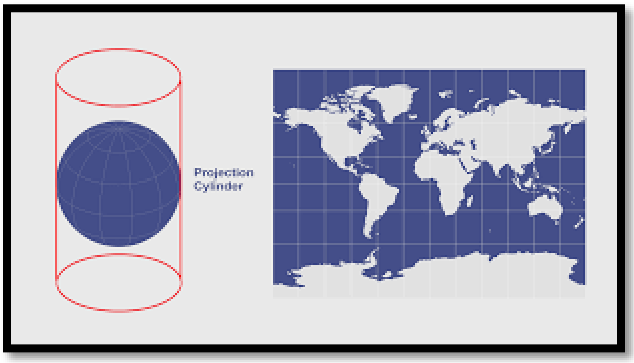


Fig. 5. Cylindrical projection

II.2. 3. Azimutal projections (Fig. 6 and 7)

It is a projection onto a tangent plane to the globe at any point. When this point is the pole, the images of the meridians are half-lines which intersect in the image of the pole and the parallels are concentric circles around this point..

A distinction is made between gnomonic, orthographic and stereographic planar projections. The gnomonic projection corresponds to rays projected from the centre of the Earth. In orthographic projection, the source of the rays is at infinity, and maps designed using this method give the impression that the Earth has been photographed from space. In the case of stereographic projection, the source of the rays is the point diametrically opposite to the contact point of the terrestrial sphere and the plane on which the projection is made.

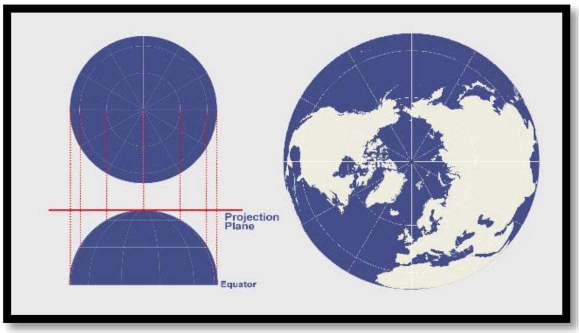


Fig . 6 Azimutal projection

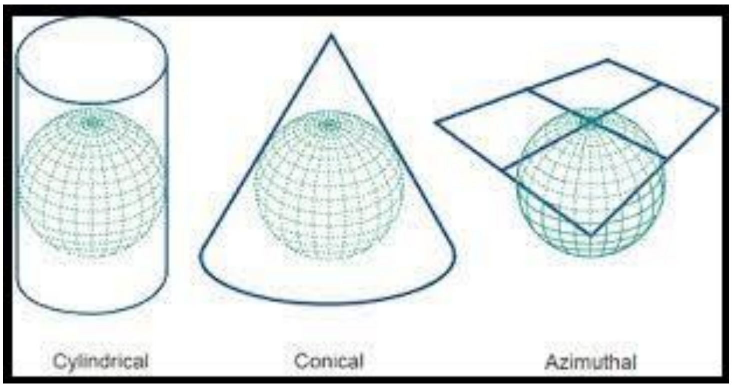


Fig. 7. The three projection systems

II.3. Geographic coordinates

A **spatial reference system** (**SRS**) or **coordinate reference system** (**CRS**) is a framework used to precisely measure locations on the surface of the Earth as coordinates.

It is thus the application of the abstract mathematics of coordinate systems and analytic geometry to geographic space. A particular SRS specification (for example, "Universal Transverse Mercator WGS 84 Zone 16N") comprises a choice of Earth ellipsoid, horizontal datum, map projection (except in the geographic coordinate system), origin point, and unit of measure. Thousands of coordinate systems have been specified for use around the world or in specific regions and for various purposes, necessitating transformations between different SRS.

All geodesic points defined by their planimetric coordinates and their cote altitude (altimetry).

II.3. 1. Geocentric coordinate system (or Earth-centered Earth-fixed)

A three-dimensional cartesian coordinate system that models the Earth as a three-dimensional object, measuring locations from a center point, usually the center of mass of the Earth, along x, y, and z axes (Fig. 8) aligned with the equator and the prime meridian. This system is commonly used to track the orbits of satellites, because they are based on the center of mass. Thus, this is the internal coordinate system used by Satellite navigation systems such as GPS to compute locations using multilateration.

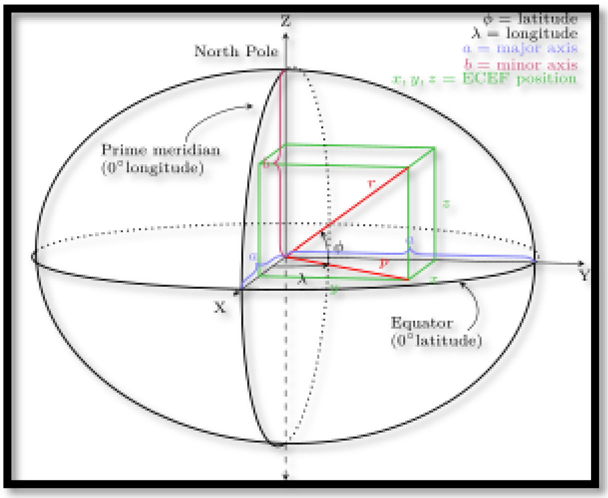


Fig. 8. Geocentric coordinate system

II.3. 2. Geographic coordinate system

The geographic coordinate system (GCS) is a spherical or geodetic coordinates system for measuring and communicating positions directly on the Earth as latitude and longitude. It is the simplest, oldest and most widely used of the various spatial reference systems that are in use, and forms the basis for most others. Although latitude and longitude form a coordinate tuple like a cartesian coordinate system, the geographic coordinate system is not cartesian because the measurements are angles and are not on a planar surface.

A full GCS specification also includes a choice of geodetic datum (including an Earth ellipsoid), as different datums will yield different latitude and longitude values for the same location.

II.3. 2. 1. Latitude (Fig. 9 and 10)

The "latitude" (abbreviation: Lat., ϕ, or phi) of a point on Earth's surface is the angle between the equatorial plane and the straight line that passes through that point and through (or close to) the center of the Earth. Lines joining points of the same latitude trace circles on the surface of Earth called parallels, as they are parallel to the Equator and to each other. The North Pole is 90° N; the South Pole is 90° S. The 0° parallel of latitude is designated the Equator, the fundamental plane of all geographic coordinate systems. The Equator divides the globe into Northern and Southern Hemispheres.

II.3. 2. 2. Longitude (Fig. 9 and 10)

The "longitude" (abbreviation: Long., λ, or lambda) of a point on Earth's surface is the angle east or west of a reference meridian to another meridian that passes through that point. All meridians are halves of great ellipses (often called great circles), which converge at the North and South Poles. The meridian of the British Royal Observatory in Greenwich, in southeast London, England, is the international prime meridian, although some organizations—such as the French Institut national de l'information géographique et forestière—continue to use other meridians for internal purposes. The prime meridian determines the proper Eastern and Western Hemispheres, although maps often divide these hemispheres further west in order to keep the Old World on a single side. The antipodal meridian of Greenwich is both 180°W and 180°E. This is not to be conflated with the International Date Line, which diverges from it in several places for political and convenience reasons, including between far eastern Russia and the far western Aleutian Islands.

The combination of these two components specifies the position of any location on the surface of Earth, without consideration of altitude or depth.

The table below shows the difference between geocentric and geographic reference system

Coordinates system	**Reference system**
Cartesian (X, Y, Z)	+ Reference system
Geographic (Latitude, Longitude ellipsoidal height	+ reference system + ellipsoid+ projection

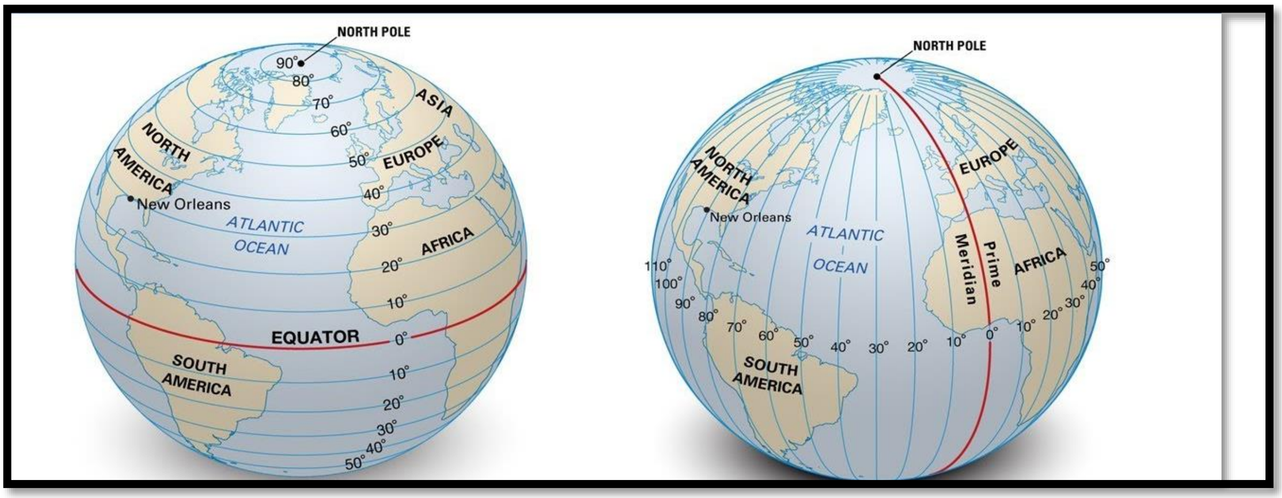


Fig. 9. Longitude and latitude

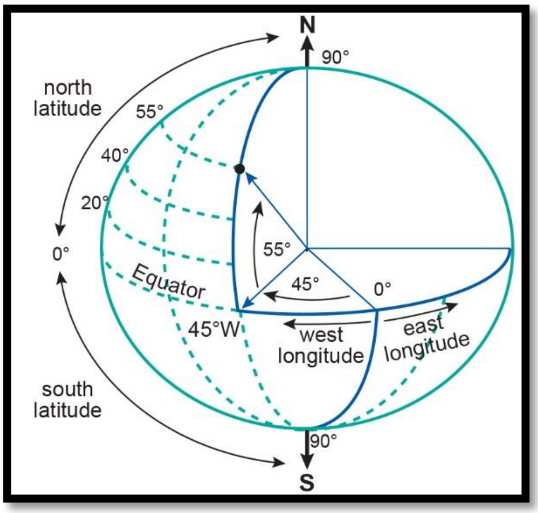


Fig. 10. Latitude and Longitude determination

Determination of geographical coordinates

By convention, the geographical coordinates are written indegrees, minutes and seconds, for example:

45° 45′ 35″ north, 4° 50′ 32″ east.

In this example, it should read “forty-five degrees, forty-five minutes, and thirty-five seconds north latitude, and four degrees, fifty minutes and thirty-two seconds east longitude.”

Important : There is only one point on earth with these coordinates.

II.3.2. 3. Geographical coordinates of Algeria

As shown on figure 9, Algeria is located on northern Hemisphere. The Greenwich meridian crosses Algeria near Mostaganem (Fig. 11). All points in Algeria have a north latitude and an east or west longitude.

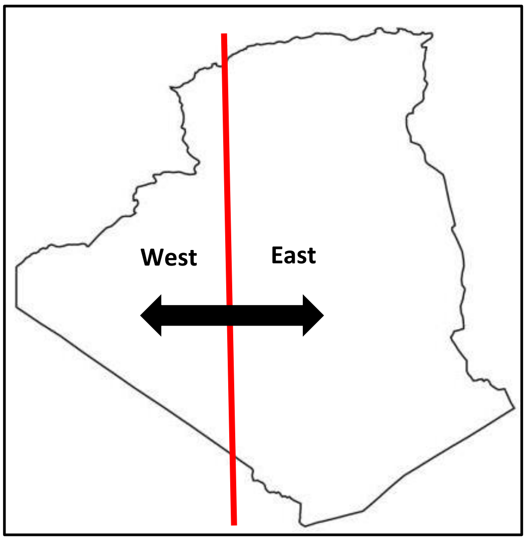


Fig. 11. Longitude in Algeria.

Some examples

On the table below, you can find some geographic coordinates concerning :

The most important cities in Algeria.

Some archaeological sites

The four extreme points in Algeria

City	Longitude	Latitude
Algiers	**3°03'30.55'' East**	**36°46'37.22'' North**
Oran	**0°38'05.61'' West**	**35°41'39.02'' North**
Constantine	**6°36'42.11'' East**	**36°21'17.32'' North**
Bir El Ater site	**8°03'06.00'' east**	**34°43'48.00'' North**
Tipasa site	**2°26'36.11'' East**	**36°35'34.82'' North**
Cuicul site	**5°44'11.65'' East**	**36°19'13.69'' North**
Timgad site	**6°28'08.22'' North**	**35°29'02.45'' North**
Extreme south point (Tin Zaouatin)	**3°21′41″ East**	**18°58′48″ North**
Extreme north point (Marsa, Skikda)	**7°12′42″ East**	**37°05′11″ North**
Extreme east point (border with Lybia and Niger)	**11°58′30″ East**	**23°30′54″ North**
Extreme west point (Tindouf state)	**08°40′04″ West** **08°40′04″ West**	**28°39′27″ North** **27°18′57″ North**

II.4. Elements of topographical Maps

According to all scientists, the topographic maps represent a representation in **PLANE** of earth's portion (Fig. 12). Its represent a transformation of 3D system (length, width, heigth) to 2 D system (plane). This transformation is possible by using a scale (Fig. 12a).

There is a range of information useful for understanding a topographic map, including scale, contour lines and orientation.

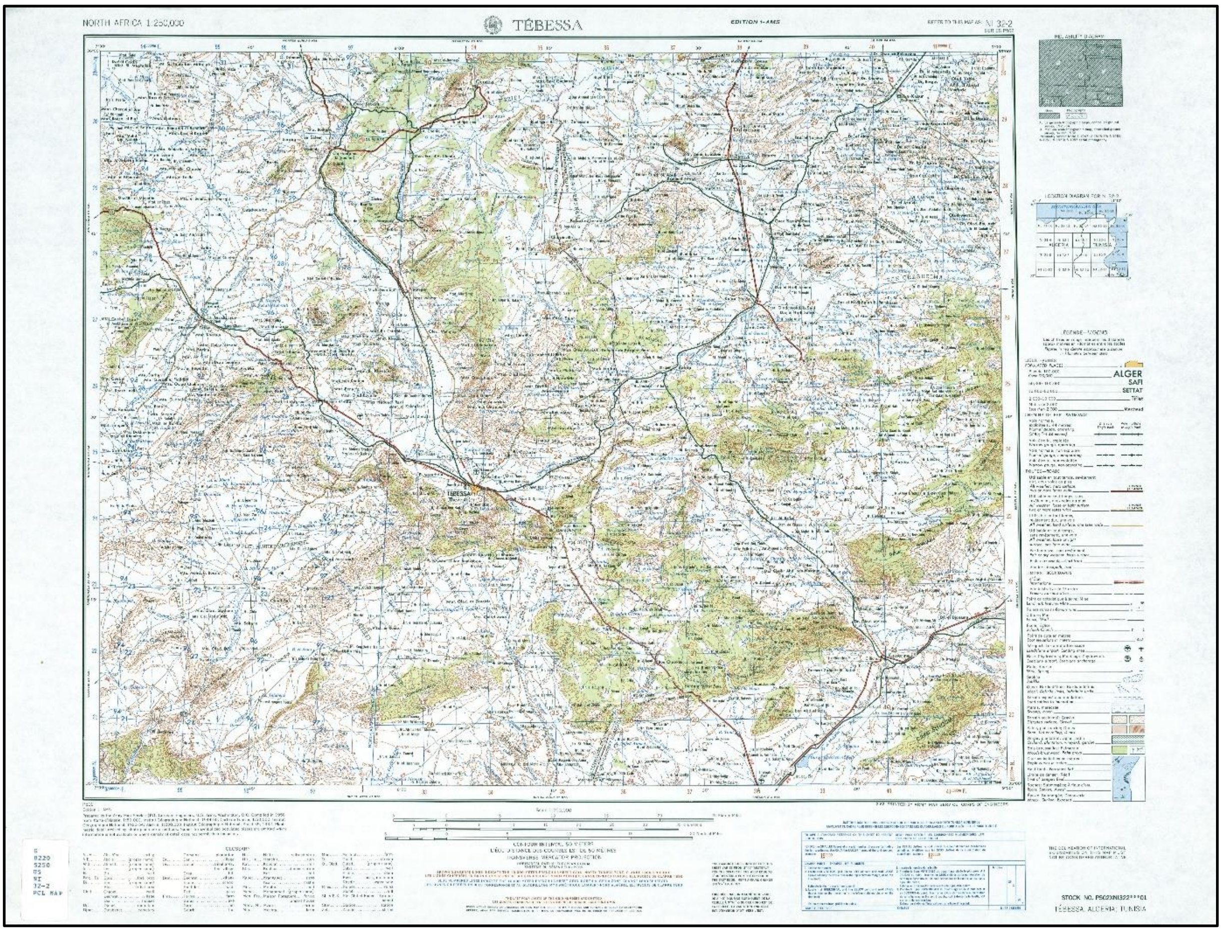


Fig. 12. Topographic map of Ain Sefra

As mentioned above, topographic maps are a detailed record of a land area, giving geographic positions and elevations for both natural and man-made features. They show the shape of the land the mountains, valleys, and plains by means of brown contour lines (lines of equal elevation above sea level).

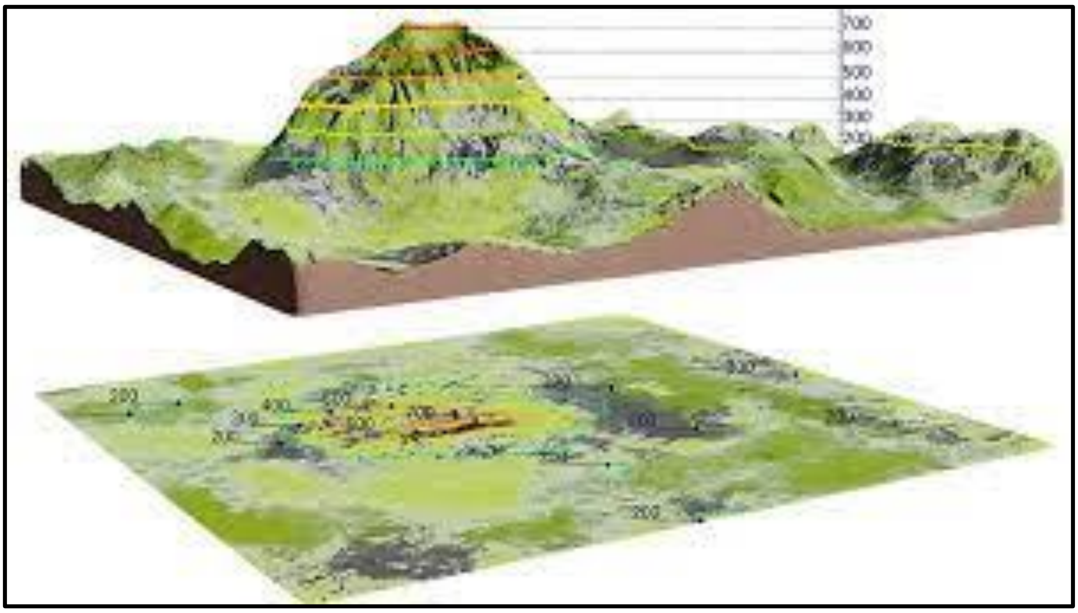


Fig. 12a. 3D to 2D Example

II.4. 1. Scale's representation

The scale can be displayed on a map either numerically or graphically.

II.4. 1. 1. Numerical scale

The numerical scale corresponds to the expression as a fraction of the ratio of the measured distance on the map and the distance measured on the ground, regardless of the terrain.

To find the scale, simply divide the length or width on the plan by the actual length or width. The calculation formula is: Scale = Dimension on the plan / Actual dimension (Fig. 13).

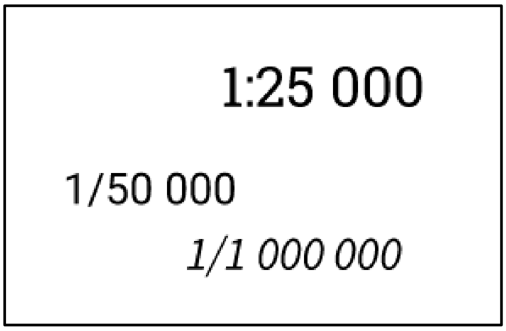


Fig. 13. Numerical scales

II.4. 1. 2. Graphical scales

The graphical scale represents the same ratio, but as indicated on a ruler drawn on the map and graduated starting from 0 to the values of the actual distance (Fig. 14). The value of the graphic scale can not be read directly and is estimated by comparison with the map.

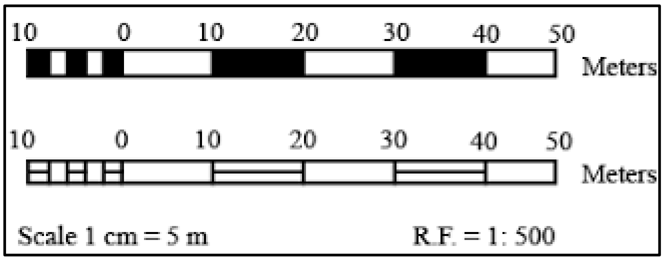


Fig. 14. Graphical scale

II.4. 1. 3. Conversion between the two scales (Fig. 15)

Graphical methods, carried out by hand, provide approximate qualitative information on actual distances.

The digital scale gives a true picture, as it relates to a ratio between the actual distance and the distance measured on the map.

The figure 15 provides a good example of these conversions, so we have :

4cm on map representing 1km, and four numerical scales (1 :200000, 1 :100000, 1 :50000 and 1 : 25000). So, you can see that the last one give us a better view of more details for the same surface.

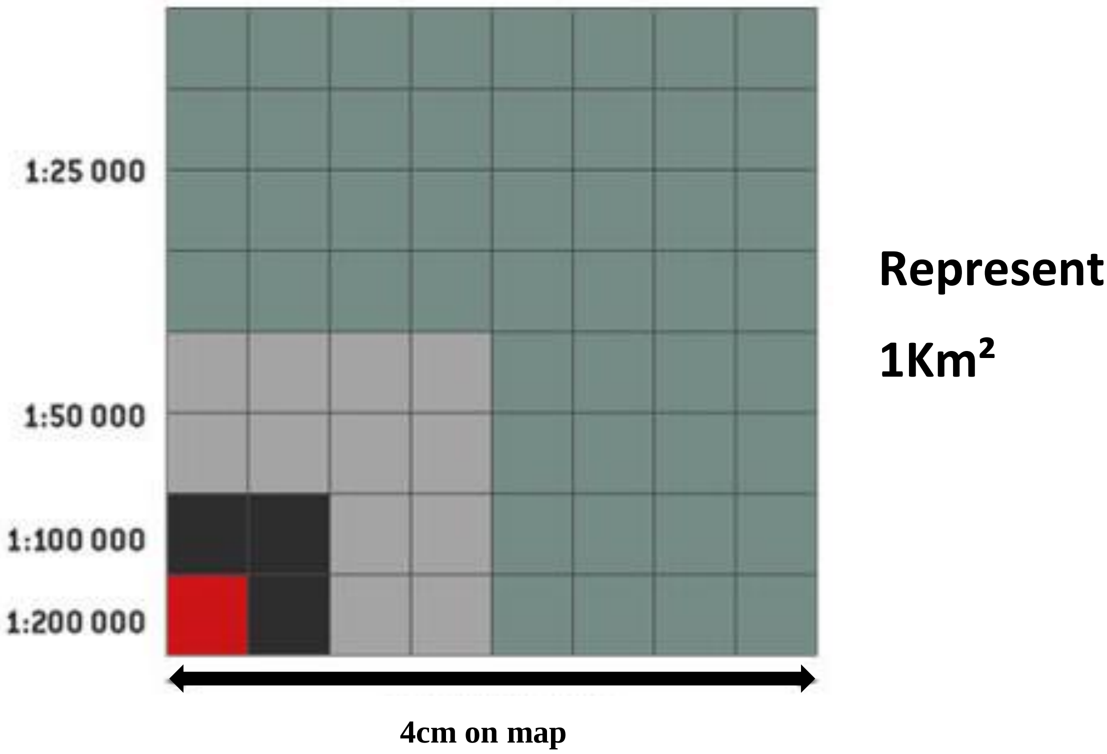


Fig. 15. Conversion between graphical and numerical scale

II.4. 2. Orientation

The edge of the map is a meridian which indicates true north. Consequently, when a map is consulted, the top of the map indicates geographic north.

The orientation of a map is the key to reconciling the map with the terrain. To orientate the map, place the compass on the map and rotate the map to align the magnetic compass needle with the northerly grid lines on the map, making sure the red end of the needle points to north on the map.

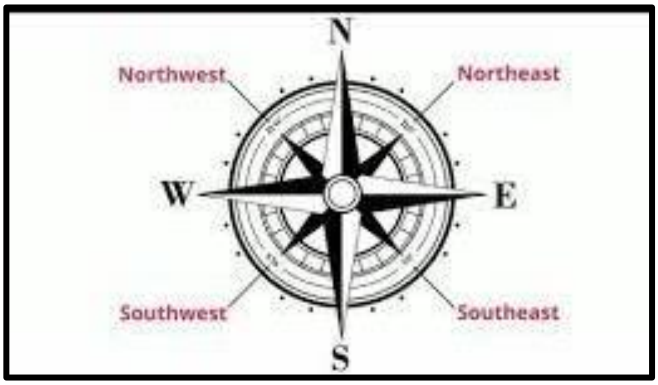


Fig. 15. Orientation

II.4. 3. Contour lines (Fig. 16)

Contour lines are curved, straight or a mixture of both lines on a map describing the intersection of a real or hypothetical surface with one or more horizontal planes. The configuration of these contours allows map readers to infer the relative gradient of a parameter and estimate that parameter at specific places.

There are three types of contour lines, all in brown on the map.

- The normal curves, drawn with a thin continuous line.
- The master or guide curves, also known as the main curves, which are drawn in a thick continuous line.
- Rarely we can find an intermediate curves, drawn in dotted lines on the map and located at half-equidistance.

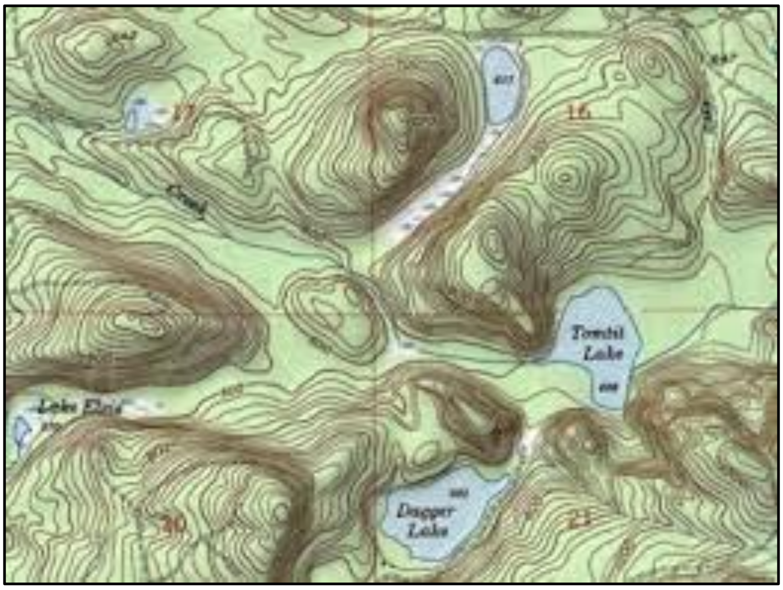


Fig. 16. Example of contour lines

II.4. 4. How to elaborate contour lines

The topography of the earth's surface is represented by contour lines. A contour line is the intersection of the topographic surface with a horizontal plane plane of given altitude. It therefore joins a set of points of the same altitude. The difference in altitude between the horizontal planes is called the contour **equidistance**.

IMPORTANT : Do not confuse between equidistance and spacing.

Equidistance should not be confused with the spacing of projected curves on the map. Equidistance is constant and represents a vertical measurement. The spacing is variable, depends on the relief and represents a horizontal measurement. The equidistance is either indicated in the legend at the bottom of the map or calculated.

Consider a series of horizontal planes (H2, H2 and H3) that are parallel, equidistant and intersect surface (a hillock, for example).mound, for example) (Fig. 17). The intersections of the hill with these planes are plotted on the plane P. These projections are called contour lines (Fig. 18).

e represent equidistance

d represent spacing

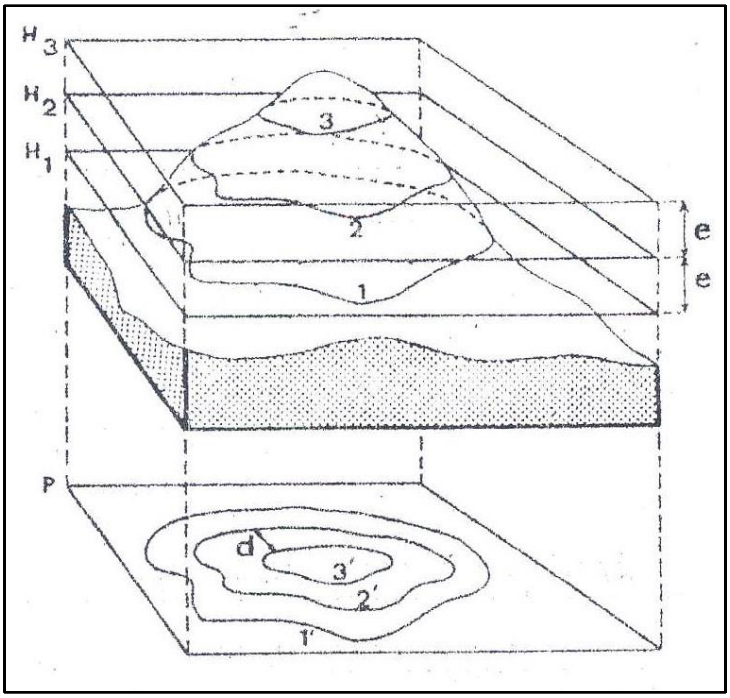


Fig. 17. Horizontal planes and equidistance

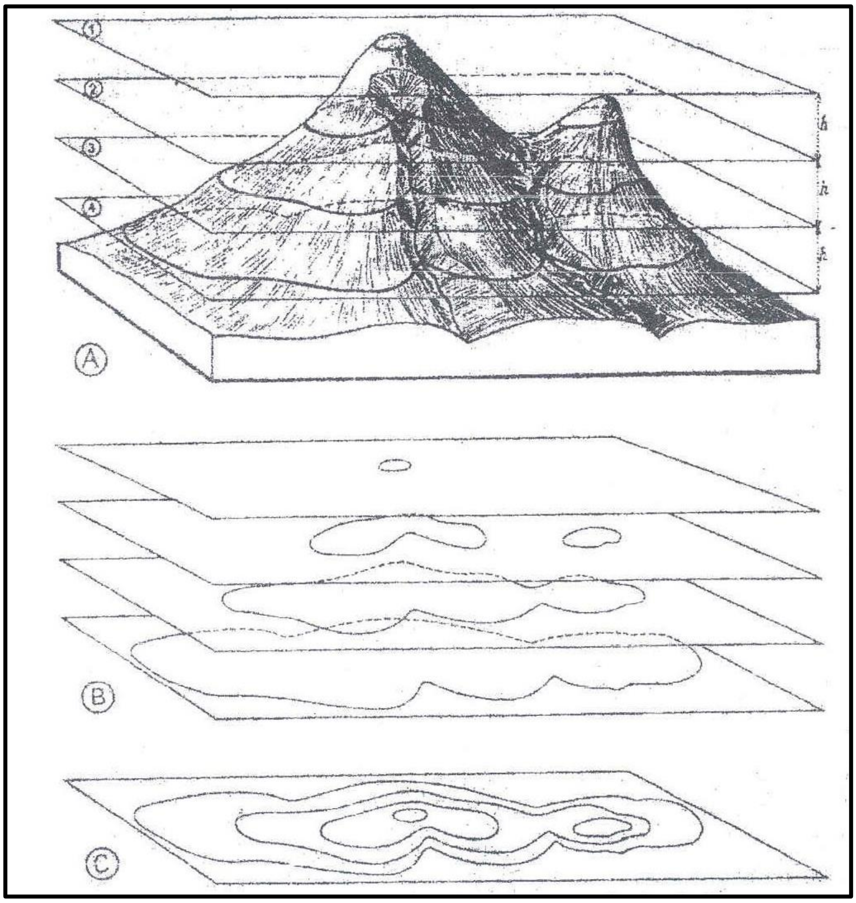
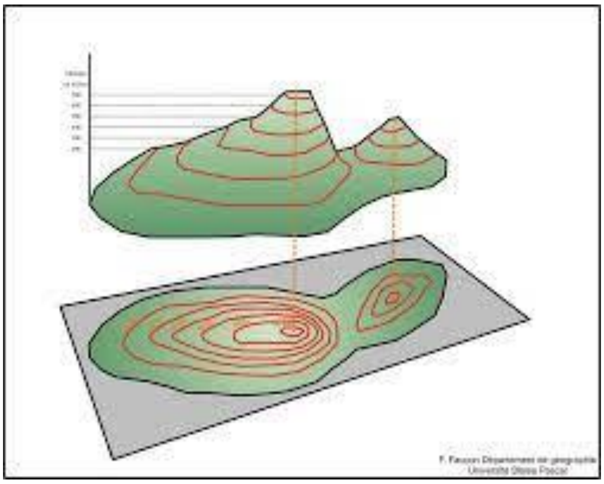


Fig. 18. Contour lines at the end



Basically, we can explain the earth's relief as a succession of high and low points (peaks and troughs).

The form of contour lines indicate the relief type. In topography, we can said peaks (high points) or valleys (low points).

II.4. 4. 1. Form of the peaks

At the summits, the contour lines close in, indicating a place of the same altitude. The rounded or angular shape indicates the real shape of the mountain. The proximity or distance of the contour lines indicates the steepness of the slope (Fig. 19).

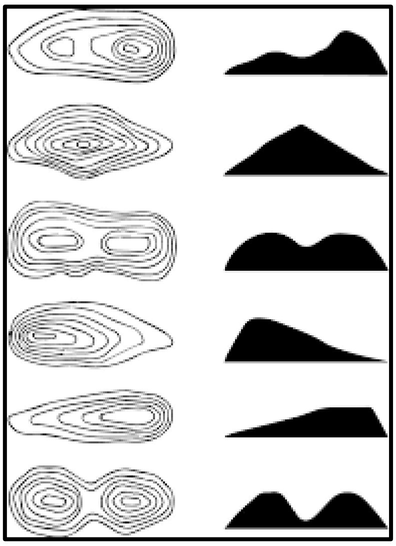
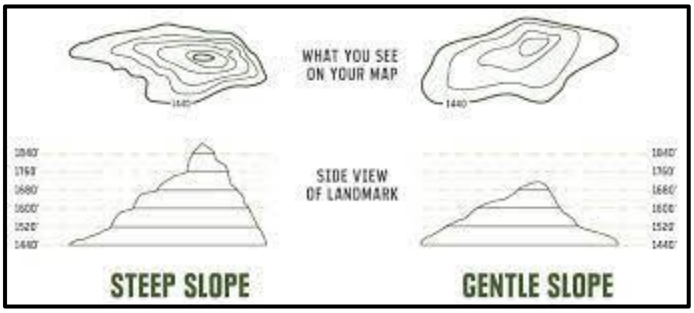


Fig. 19. Contour lines on mountains.



II.4 .4 2. Form of the valleys

In the valleys, the contour lines form a V shape (Fig. 20). The direction of the slope is given by the opposite orientation of the V of contour lines (Fig. 21). The narrowing of the contours also indicates the steepness of the slope.

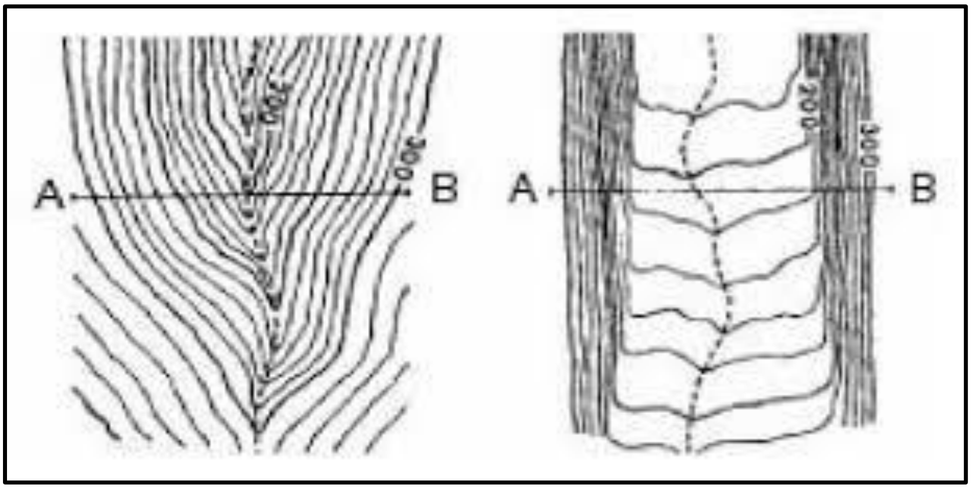


Fig. 20. Contour lines in valleys

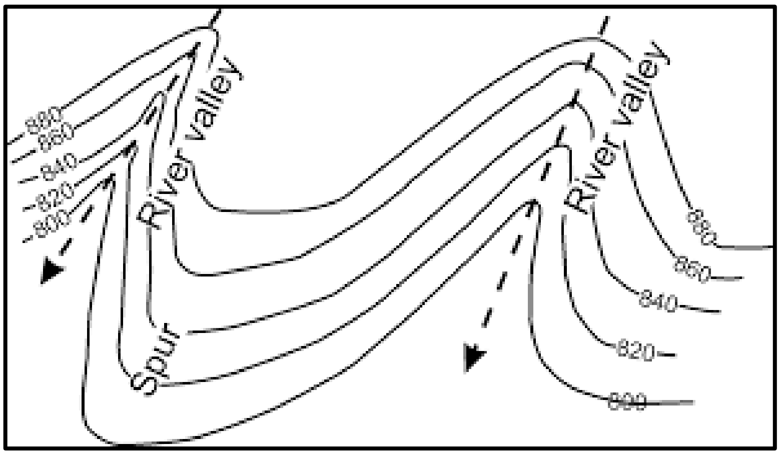


Fig. 21. Sense of slope in valleys

Conclusion of the first part

We hope that we have answered many of the questions asked by our students.

All the definitions have been covered and we have tried to summarise a large amount of data. The work has focused mainly on topography, which our students use in archaeology. The geodesy part is much more for geophysicists and the cartography part is for geologists. We have therefore dealt with them briefly.

PART II.

In this section, we can how the different steps to elaborate a topographic profile.

1. Place the sheet of graph paper along the desired profile previously drawn on the map (cut line) (Fig. 22).

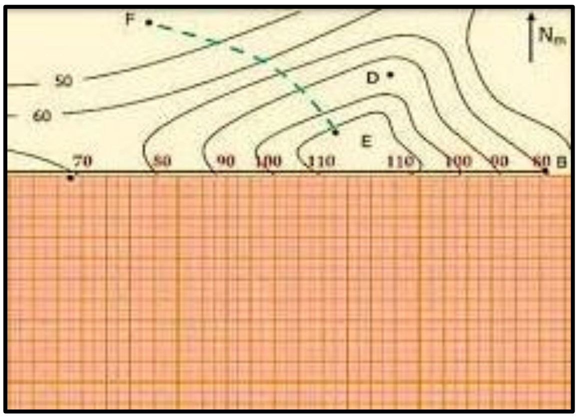


Fig. 22. Example of first step

2. Mark the limits of the profile with vertical lines to define the cross-section (Fig. 23).

Fig. 23. Limits of cross section

3. Choose an appropriate altitude scale (height) (Fig. 24).

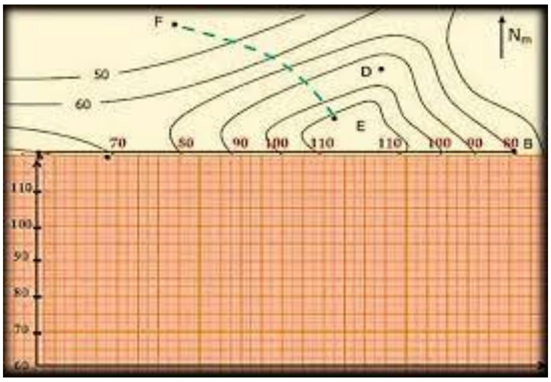


Fig. 24. Scale altitude on left

4. Identify the high and low points of the profile (Fig. 25).

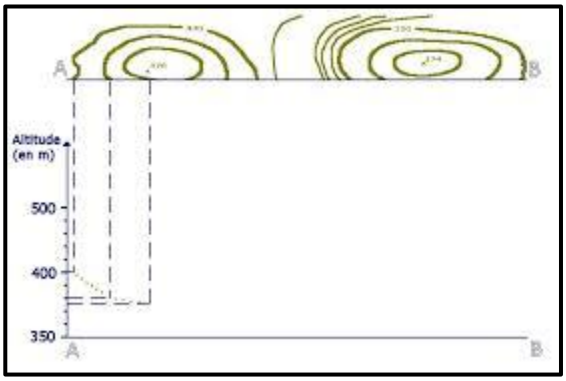


Fig. 25. High points in a profile

5. Add the intermediate points (contour lines that intersect the cut line).

6. Join points to elaborate the topographic profile (Fig. 26).

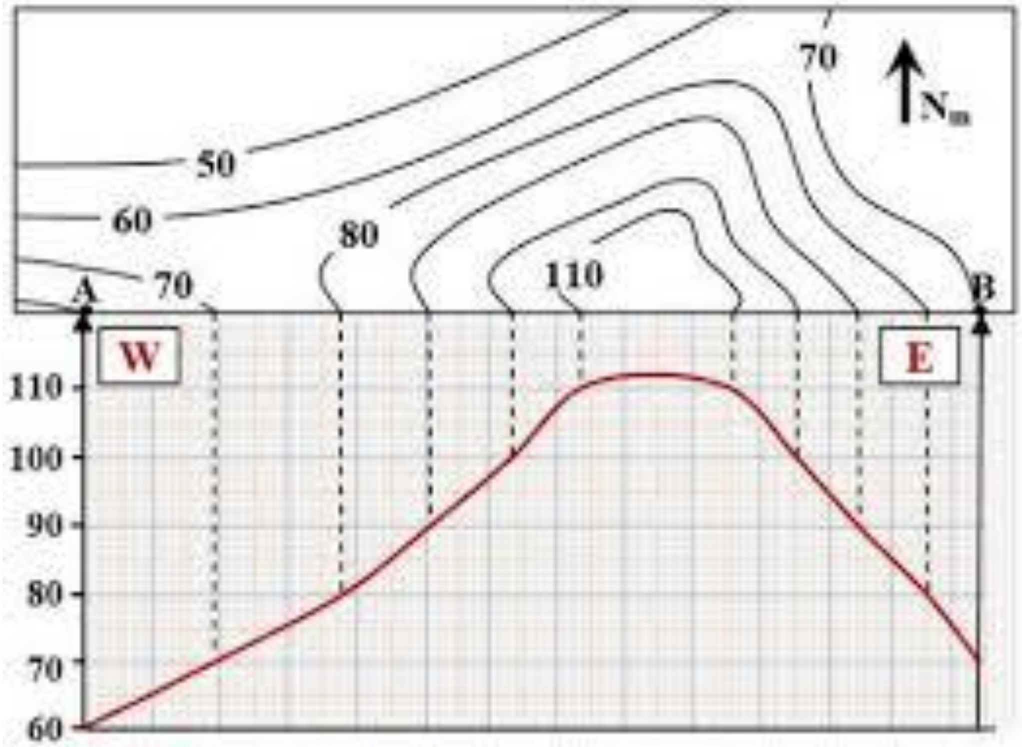
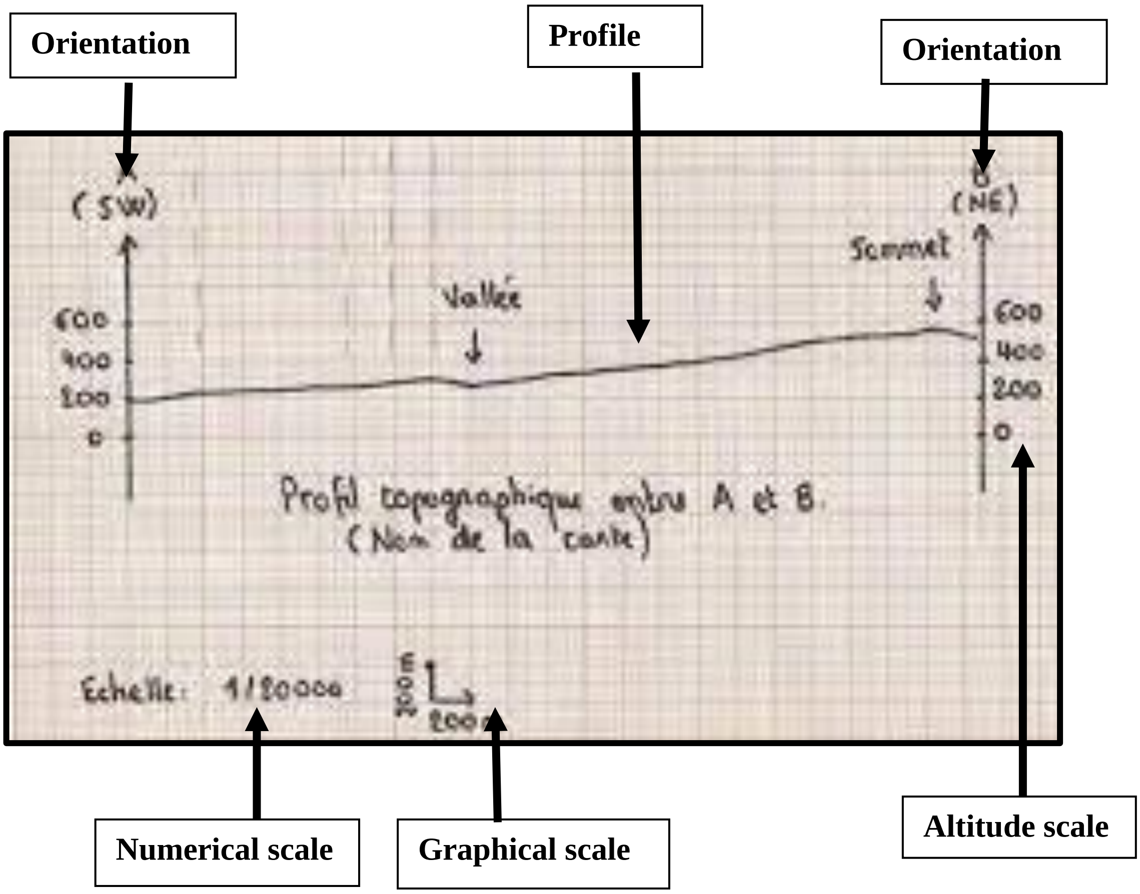


Fig. 26. A topographic profile

IMPORTANT. Do not forget the orientation. Do not forget to calcutate equidistance if necessary. Do not forget to identify side points.

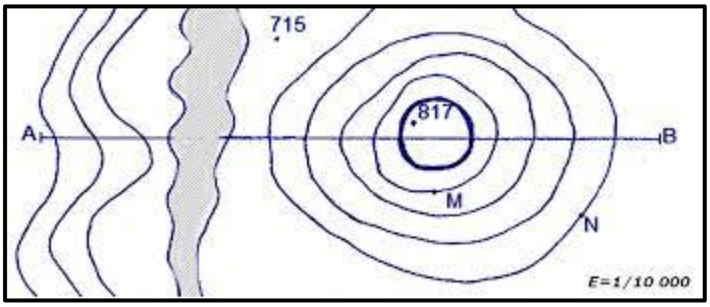
You can see above, all the indications reported in a topograhic profile.

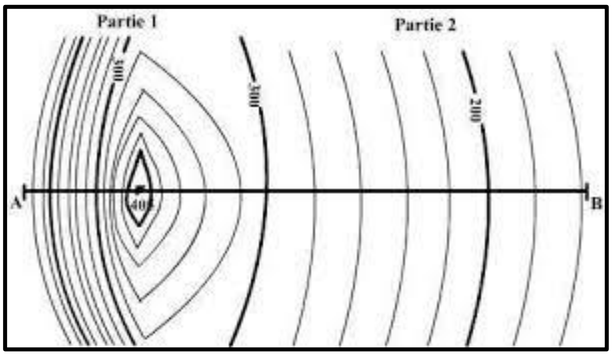


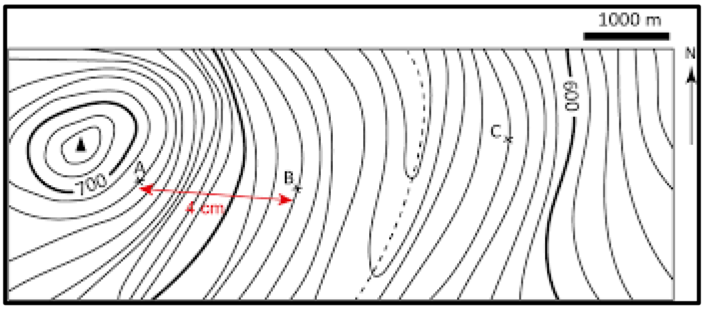
PART III

Exercises

1. Determine the equidistance value.



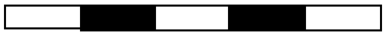




2. Give the numerical scale

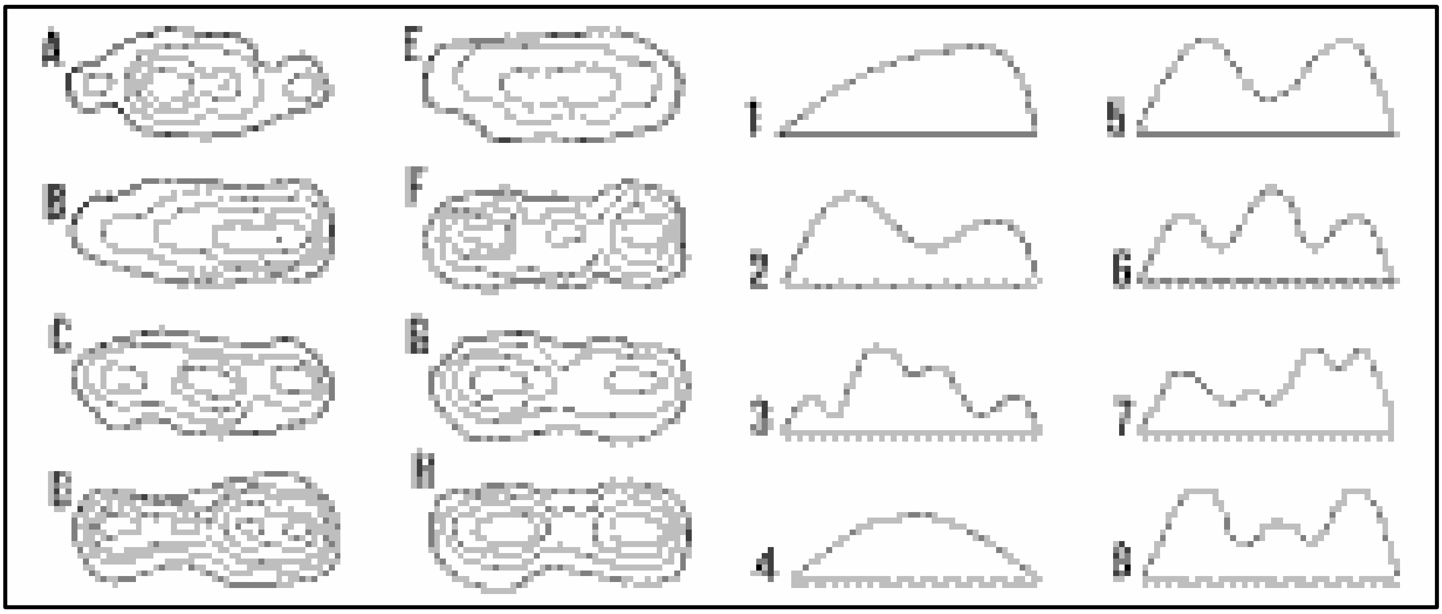
Measure on map	Actual measure	Numerical scale
1cm	**500m**	
2cm	**4km**	
2mm	**100m**	
5cm		**1 :50000**
0.5cm	**2000m**	
1mm	**50m**	
3cm	**1.5km**	
1cm		**1 :25000**
2mm	**1km**	
	1km	**1 :200000**
	500m	**1 :10000**
1cm		**1 :20000**
1mm		**1 :25000**
1cm		**1 :50000**
5cm		**1 :500000**

3. Determine the graphical scale by using this sample



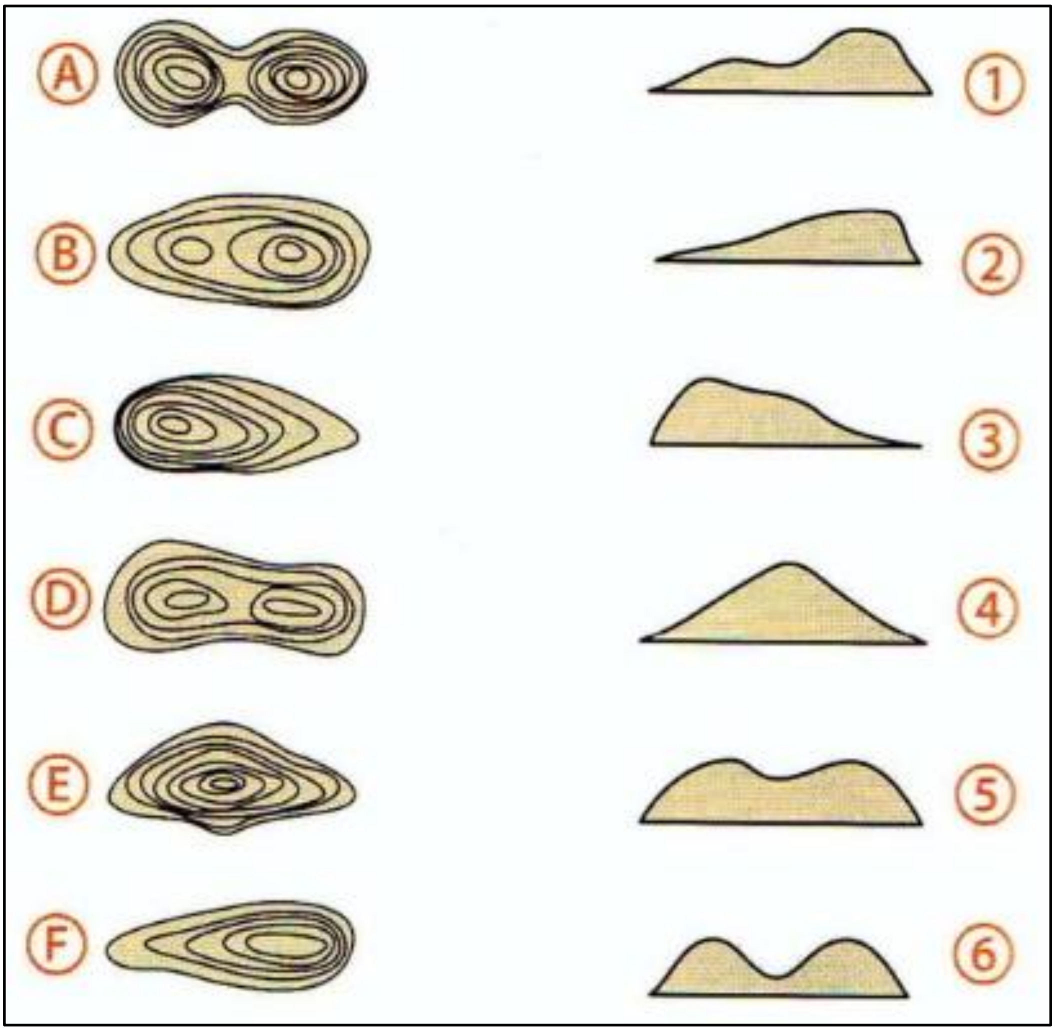
1 cm = 50m	
1mm = 200m	
1 : 25000	
1 :100000	
1 : 1000000	
0.5cm = 100m	
5cm = 500m	
1 : 10000	
1 : 20000	
2cm = 200m	
1cm = 10m	
2mm = 500m	
1 : 500000	

4. Give the correspondance



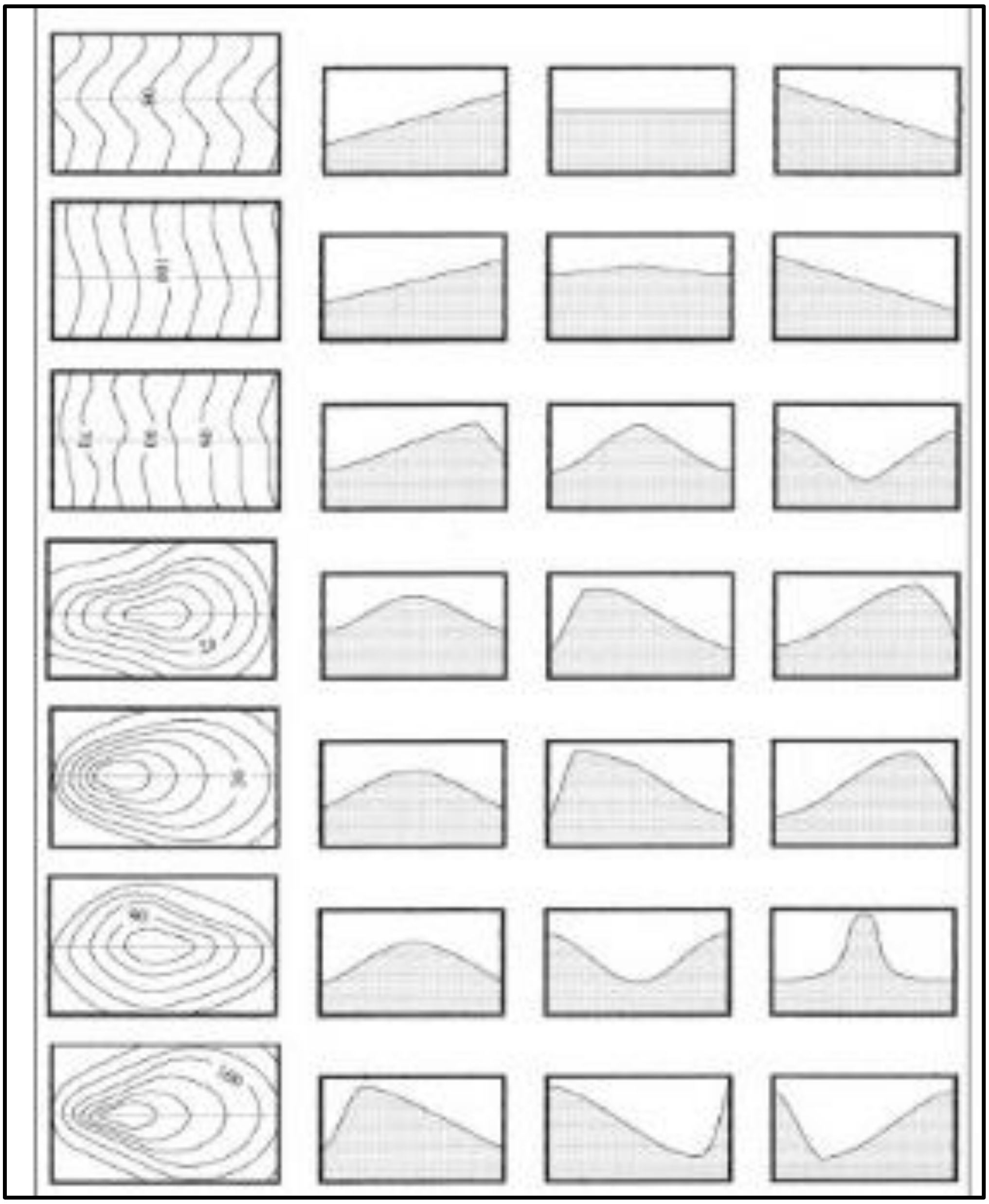
Answers :

5. Give the correspondance

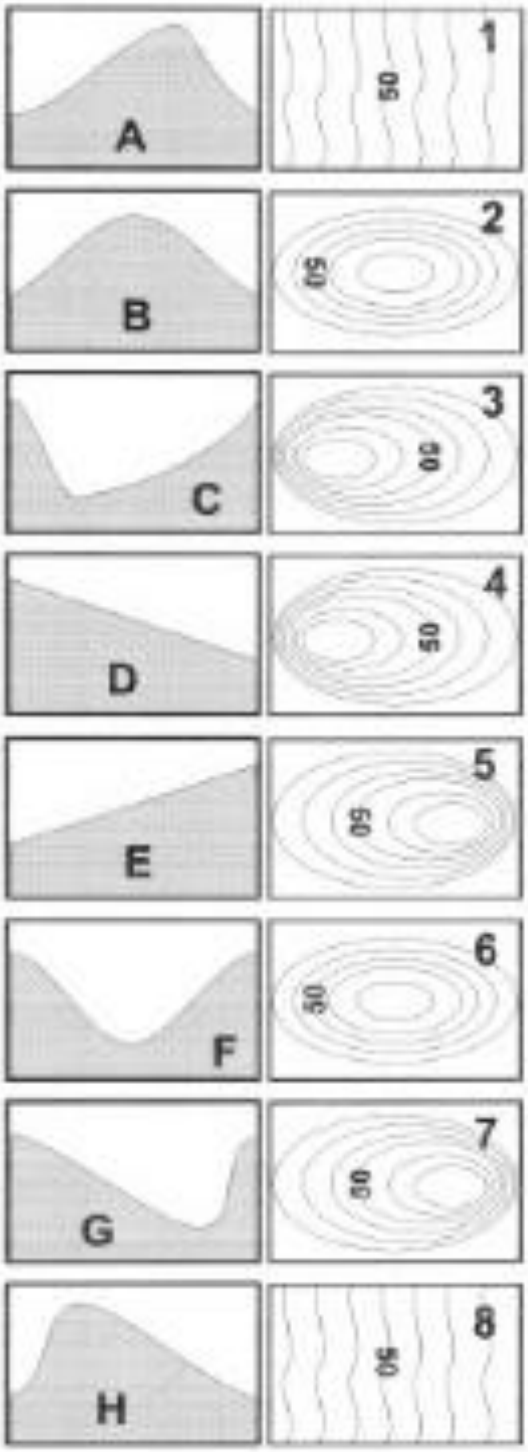


A	
B	
C	
D	
E	
F	
G	
H	

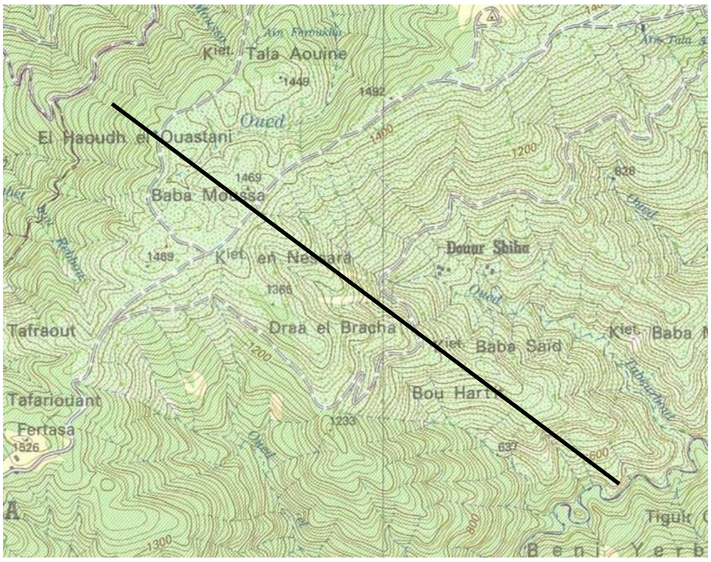
6. Draw The correspondant contour lines and reliefs



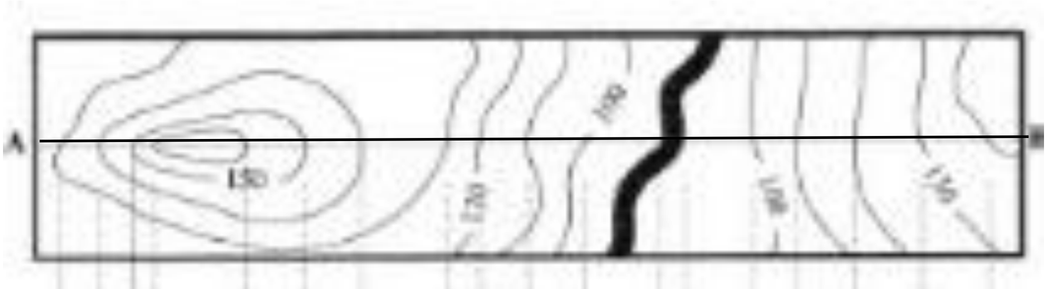
7. Give correspondance



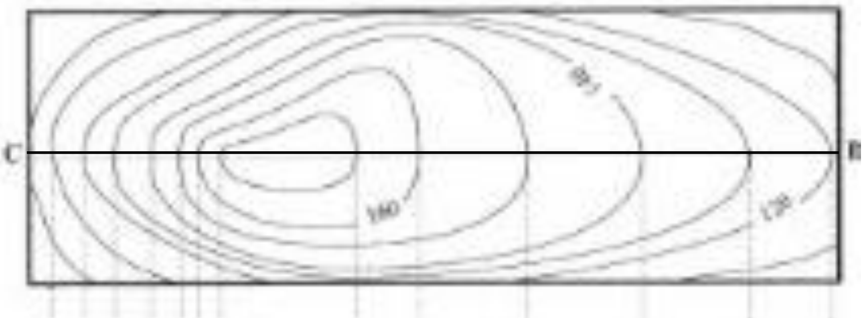
7. Draw the topographic profile.



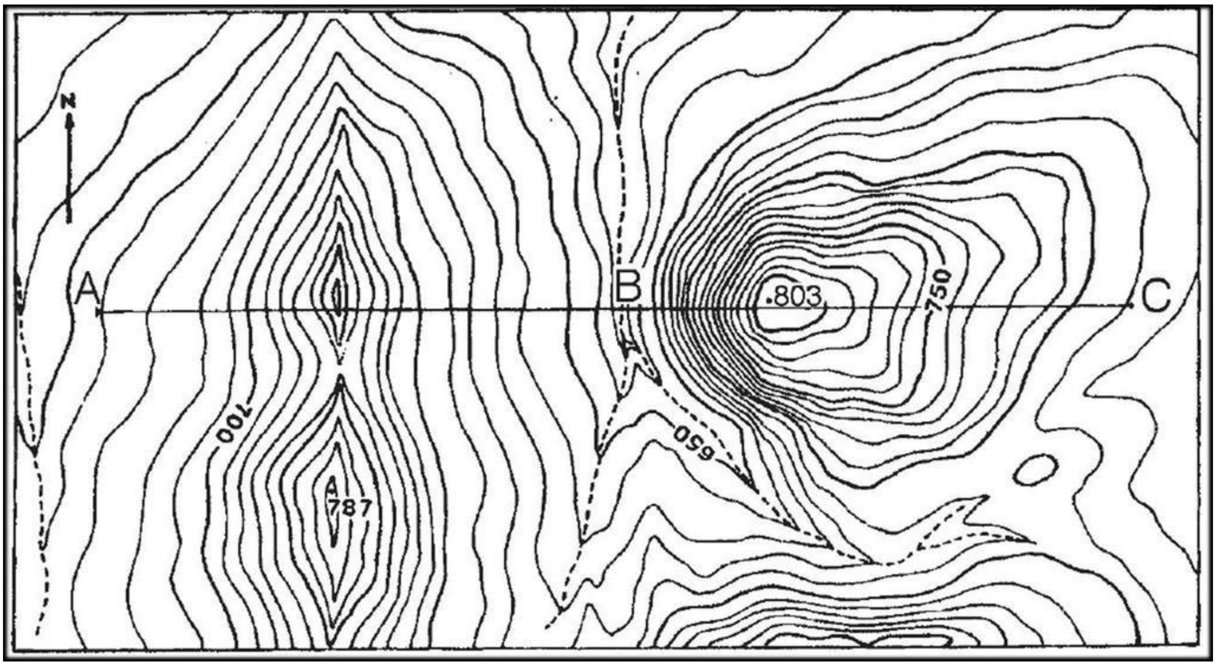
Scale 1 :20000



Scale 1 :10000



Scale 1 :10000


N
A
B
C
803
750
700
650
787

أهمية الخريطة

عمومبات

الخريطة هي محاولة لتمثيل سطح الأرض أو جزء منه على لوحة مستوية كما لو كانت ترى من مكان عال، وذلك لتمثيل بعض الظاهرات الطبيعية والبشرية وغيرها ذلك تبعاً لنسبة معينة يطلق عليها مقياس الرسم تقدم فن رسم الخرائط بحيث ظهرت خرائط مجسمة لإبراز مظاهر السطح من جبال وسهول وهضاب وتلال. وفي هذه الخرائط المجسمة نجد مبالغة كبيرة في تمثيل الجبال وذلك وفقاً لمقياس رسم الخريطة. "يطلق على العلم الذي يهتم بفن رسم الخرائط ووضع أسسها اسم "علم الخرائط" أو " الكارتوغرافيا Cartohraphy. وقد أصبحت الخريطة وسيلة حضارية مهمة لا يستغنى عنها أي فرع من فروع المعرفة، فهي وإن كانت مهمة للجغرافي فهي لازمة اذا للجيولوجي، و الاثريين و وغيرهم.

يُقصد بعلم الخرائط عمليات رسم الخريطة، بدءاً من عمليات المسح على الأرض وانتهاءً بطباعة الخريطة.

علم الخرائط ليس علماً تجريبياً كالفيزياء والكيمياء، وإنما علم يستخدم الطرق العلمية في تحليل البيانات والمعطيات الجغرافية من جهة، وقوانين وطرق تمثيل سطح الأرض من جهة أخرى. الفن في الخرائط يعتمد على اختيار الرموز المناسبة لكل ظاهرة، ثم تمثيل المظاهر (رسمها) على شكل رموز، إضافة إلى اختيار الألوان المناسبة أيضاً. أما التقنية في الخرائط، يُقصد بها الوسائل والأجهزة المختلفة كافة والتي تُستخدم في إنشاء الخرائط وإخراجها

محتوى الخرائط وميزاتها الأساسية

1- الميزات الأساسية للخرائط: تتميز الخرائط كافة بثلاث خصائص أساسية تؤثر في محتواها وهي:

أ - قانون رياضي تُوضع على أساسه الخريطة ويشمل ثلاثة عناصر أساسية هي:

- المقياس: ويهدف إلى إيجاد العلاقة بين أبعاد المظاهر على سطح الأرض وأبعادها على الخريطة. أي معرفة مقدار التصغير الذي يصيب سطح الأرض عند نقله من السطح الكروي إلى السطح المستوي. وهو نسبة طول على الخريطة إلى الطول نفسه على الأرض على سبيل المثال: $\frac{1}{10000}$ أو $\frac{1}{20000}$ أو $\frac{1}{1000000}$ ،

- المسقط : هو الوسيلة المساعدة التي تمنع تمزق سطح الأرض عند نقله من السطح الكروي إلى السطح المستوي، هذا السطح قد يكون اسطوانة وتدعى المساقط عندها مساقط اسطوانية أو يكون مخروطاً وتدعى مساقط مخروطية ، أو سطحاً أفقياً وتدعى مساقط أفقية.

هذه المساقط تُحدد العلاقة بين إحداثيات النقاط على سطح الأرض وبين إحداثيات النقاط على السطح المستوي. فعند معرفة هذه العلاقة يمكن حساب التشويه الذي حدث للخريطة. يتم اختيار المسقط المناسب لكل خريطة على حدة، ذلك بحسب الموقع المرسوم ومساحته ووظيفة الخريطة.

- شبكة (نظام) الإحداثيات : وهي خطوط الطول (360) خط، 180 خط شرق غرينتش و180 خط غربي غرينتش، وخطوط العرض 180 خط، 90 خط شمال خط الاستواء و90 خط جنوب خط الاستواء، يمكن من خلالها تحديد مواقع الأماكن على سطح الأرض، وتحديد الاتجاهات، إضافة إلى معرفة الزمن، وإمكانية قياس الأبعاد على الخرائط ومن ثم على الأرض.

ب - الرموز أو الترميز : تمثيل المظاهر الجغرافية يتطلب طريقة رسم خاصة يُستخدم فيها ما يسمى بالرموز الاصطلاحية، ذلك أن المظاهر الجغرافية لا تظهر على الخرائط كما هي في الحقيقة.

هذه الرموز قد تكون هندسية (دائرة، مربع، مثلث، معين شبه منحرف وغير ذلك) أو تكون تصويرية (فوتوغرافية)، أي صور مصغرة للظاهرة، أو رموز تعبيرية (تعبر عن الظاهرة المرسومة بوضوح)

- مقياس الخريطة من جهة، إذ إنه كلما كبر المقياس تقل عملية الانتقاء والتعميم وتظهر التفاصيل بشكل أكبر، وتحوي الخريطة مظاهر أكثر. على سبيل المثال خريطة مقياسها $\frac{1}{25000}$ تحوي تفاصيل ومظاهر أكبر من خريطة مقياسها $\frac{1}{10000}$.

Ackowledgements

I would like to say **THANK YOU** for all the the persons who made this book possible.

Especially, my colleagues and my students.

CONCLUSION

The book has therefore been designed as a beginners' course for students of archaeology. The teaching proposed is not theoretical, but is based on a number of exercises and applications, examples from real cases and numerous corrected exercises.

This handbook should be just as useful to a teacher as to master student in prehistory.

We hope that the publication of our course will be of service to colleagues and students in the field of prehistory. as well as students in the field.

We are interested in your opinion on our work and on how to improve and complete it. We look forward to hearing from you.

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