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**DCG30072**

# CARTOGRAPHY



Political Map

Physical Map



Thematic Map



Topographic Map







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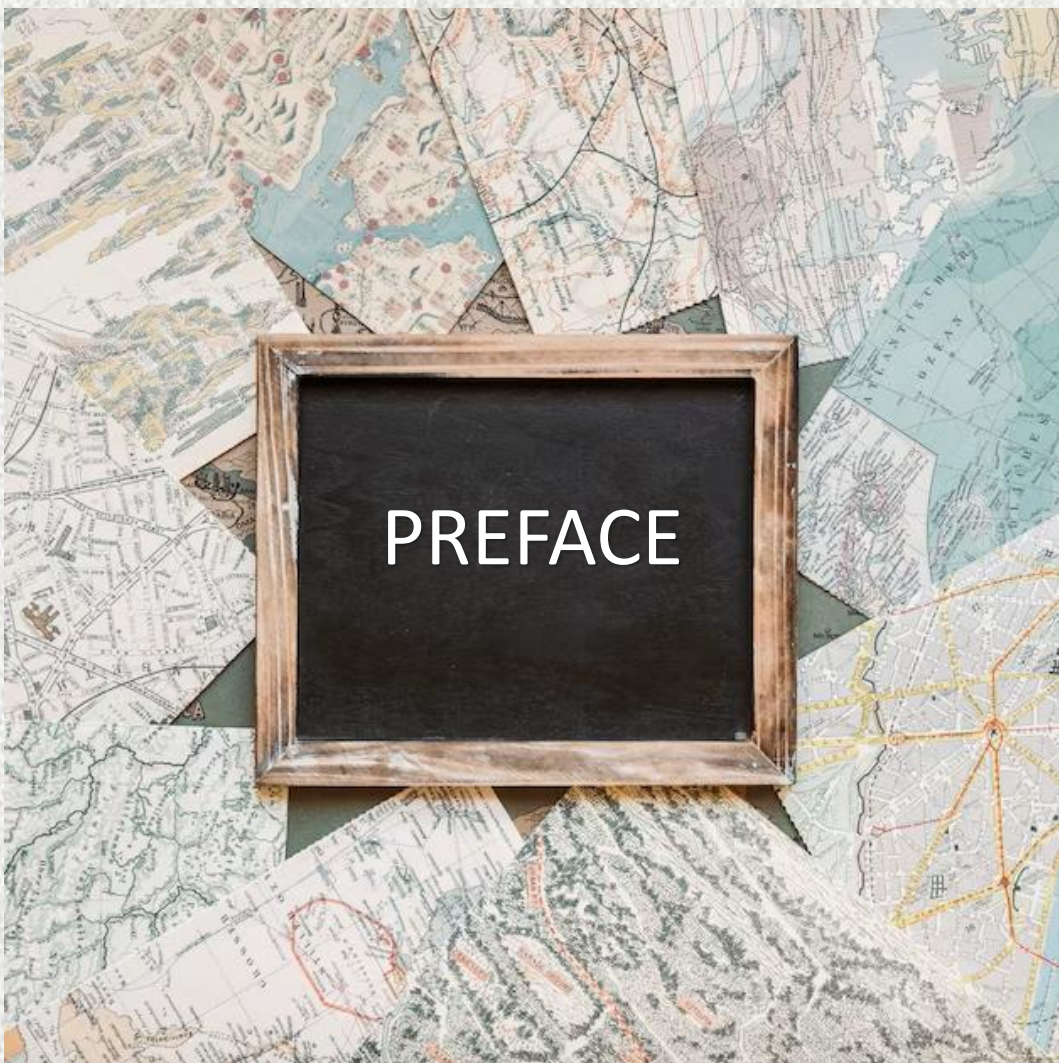
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With utmost gratitude to the presence of Allah SWT, this Ebook Cartography has successfully been published with His permission. This ebook is published as a guide or reference for all lecturers and students in the field of Geomatics, particularly at Politeknik Merlimau (PMM) and the entire POLYCC community. This ebook can be used as lecture notes and a reference in the teaching and learning process, specifically for the Cartography Course. As the author of this ebook, I would like to express my deepest appreciation to all the coordinators of the Cartography Course in all polytechnics in Malaysia and the PMM community who have greatly assisted me in completing this Ebook Cartography.

Thank you.

SURIAWATI BINTI JUSOH

AUTHOR OF EBOOK CARTOGRAPHY

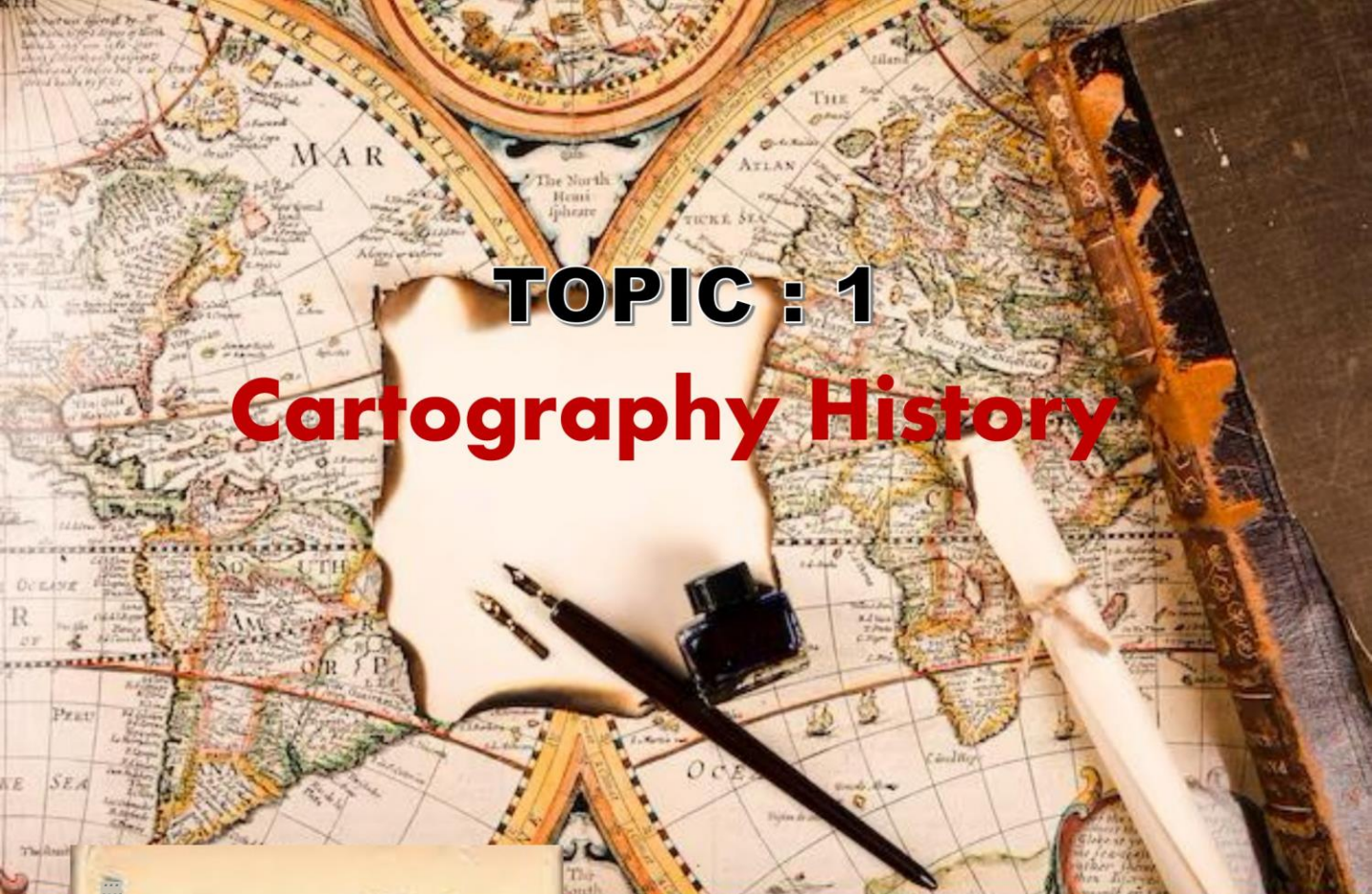
2023



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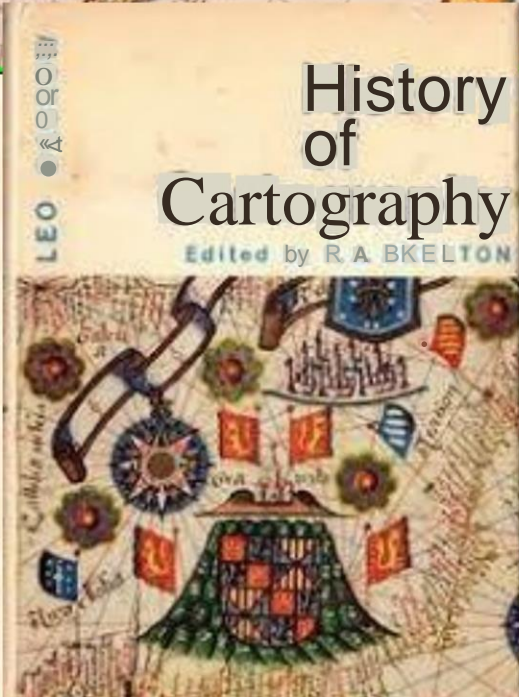
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# TOPIC : 1

## Cartography History



### History of Cartography

Edited by R.A. BAKELTON

1.1 Interpret the history of cartography

1.1.1 Describe the historical development of cartography in different areas which is Prehistoric Era, Medieval Era, Renaissance Era, Early Modern cartography and Modern Cartography

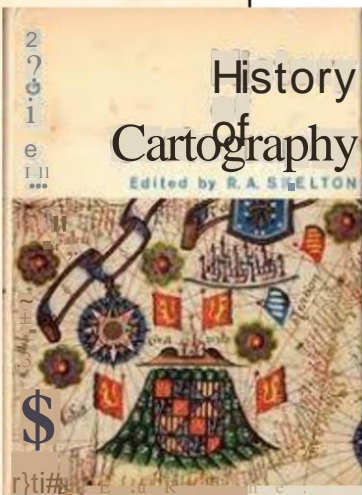
1.1.2 Explain the definition of cartography

1.1.3 Explain the importance of cartography



## 1.1 Interpret the history of cartography

A. Classical Ages of cartography according to historian, the development started from the Old Greek age before 900 BC. During the centuries, the founder of cartography (CLAUDIUS PTOLEMY). He has discussed on;



- i. How the map are produce
- ii. The problem to display spherical surface to a plane surface
- iii. Map projection deformation

iv. Providing the estimation value of latitude and longitude

iii. Exist creation 'circular of map' or known as 'T & O' map' as figure below.

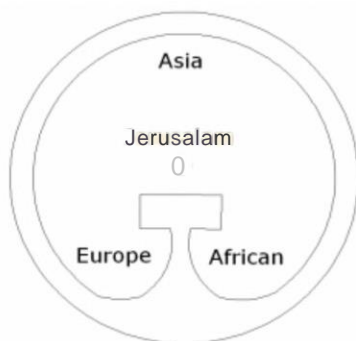


Figure 10 : Circular of Map

B. Dark Age In this age, the knowledge of cartography gradually disappears. Cartography material in the classical age has been destroyed due to;

- i. old-fashioned beliefs
- ii. Assumed that the world was flat with four corners



## 1.1 Interpret the history of cartography

### C. Life back ages

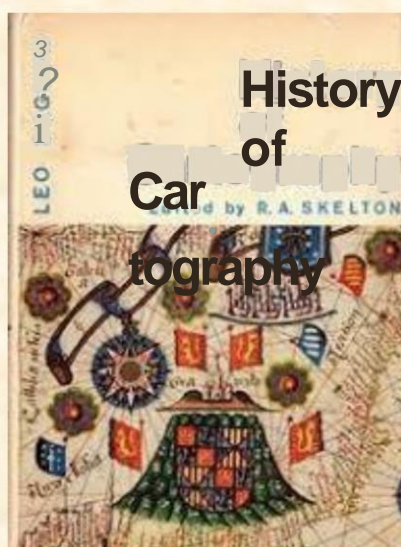
- i. PTOLOMY map of the Arab land
- ii. Many edpeditions by Columbus Da Gama and involving various maps
- iii. Printing starts

### D. Modern Cartography Early Ages

- i. more wars - requiring an accurate map
- ii. start of topography map to represent earth surface

### E. 20 Century Cartography

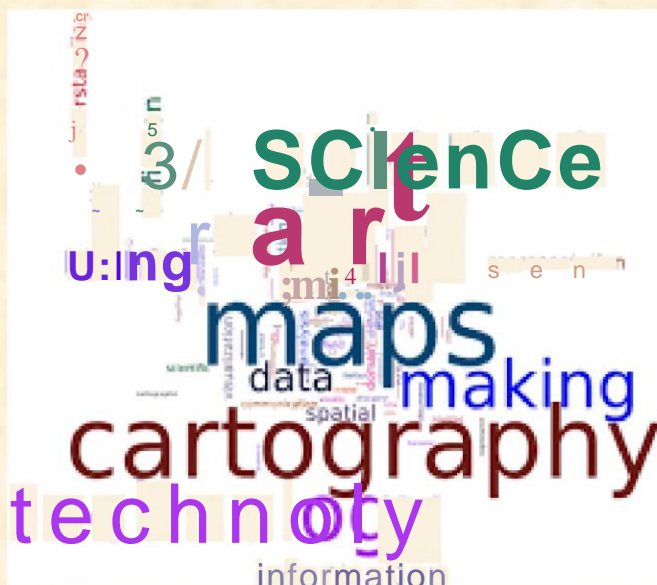
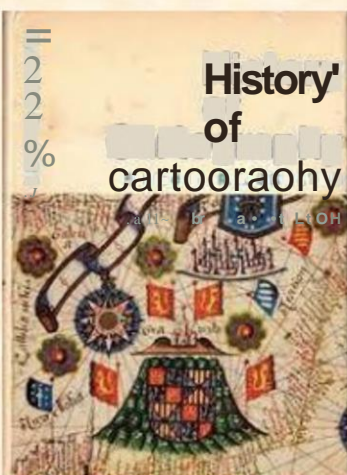
- i. color printed map
- ii. world war 1 and 2 has required an accurate map
- iii. thematic maps - more specific such as railroads, population and others.
- v. Photography maps are used by airplane - aerial photography



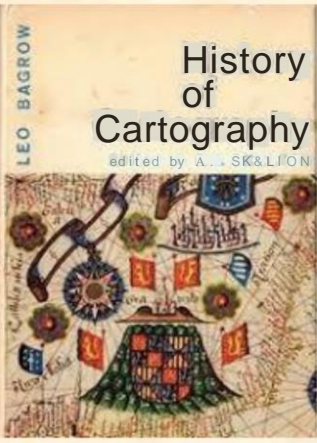


## 1.1.2 Explain definition of cartography

Definition of cartography; According to International Cartography Association (ICA); "The arts, science and technology of making maps together with their study as scientific document. The maps include plans, chart, etc"







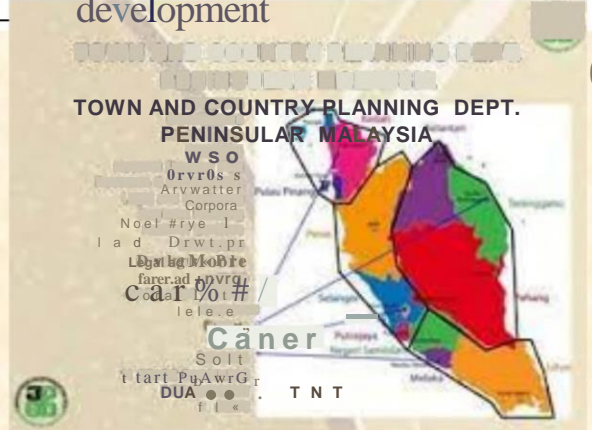
# 1.1.3 Explain importance of cartography

**Why are maps important?  
And why maps are useful for people?**

Humanities-6C Ye Eun Kim

see a maps. Me can see the maps from phone, pc, GPS. If we don't have this things to see maps whats wit be # happen?

Development planning and administration purposes	Military
<ul style="list-style-type: none"> <li>a. for residencies and to produce license/land grant</li> <li>b. for tax charge</li> <li>c. to facilitate construction task such as railroads, railways and piping</li> <li>d. to locate benchmark, county lots, district, state and international boundary accurately</li> <li>e. for learning including map study and geography related to economic and development</li> </ul>	<ul style="list-style-type: none"> <li>a. map as an important document for war strategy. For example to strategic location of bastion, weapon plant and others</li> <li>b. to facilitate the determination of enemy location, military operation, determination of foods and water source location and others</li> <li>c. As a military secret to show the underground lane when war occur</li> </ul>







Question  
&  
Tutorial

(a) Briefly explain the definition of Cartography according to 'International Cartographic Association' (ICA).

*Terangkan maksud kartografi mengikut Persatuan Kartografi Antarabangsa (ICA)*

[5 marks]

[5 markah]



(b) Show **TWO (2)** the importance of cartography.

*Tunjukkan **DUA (2)** kepentingan kartografi.*

[10 marks]

[ 10 markah]

(c) Interpret the **FIVE (5)** eras in cartography history.

*Tafsirkan **LIMA (5)** era dalam sejarah kartografi.*

[10 marks]

[ 10 markah]



# TOPIC: 2

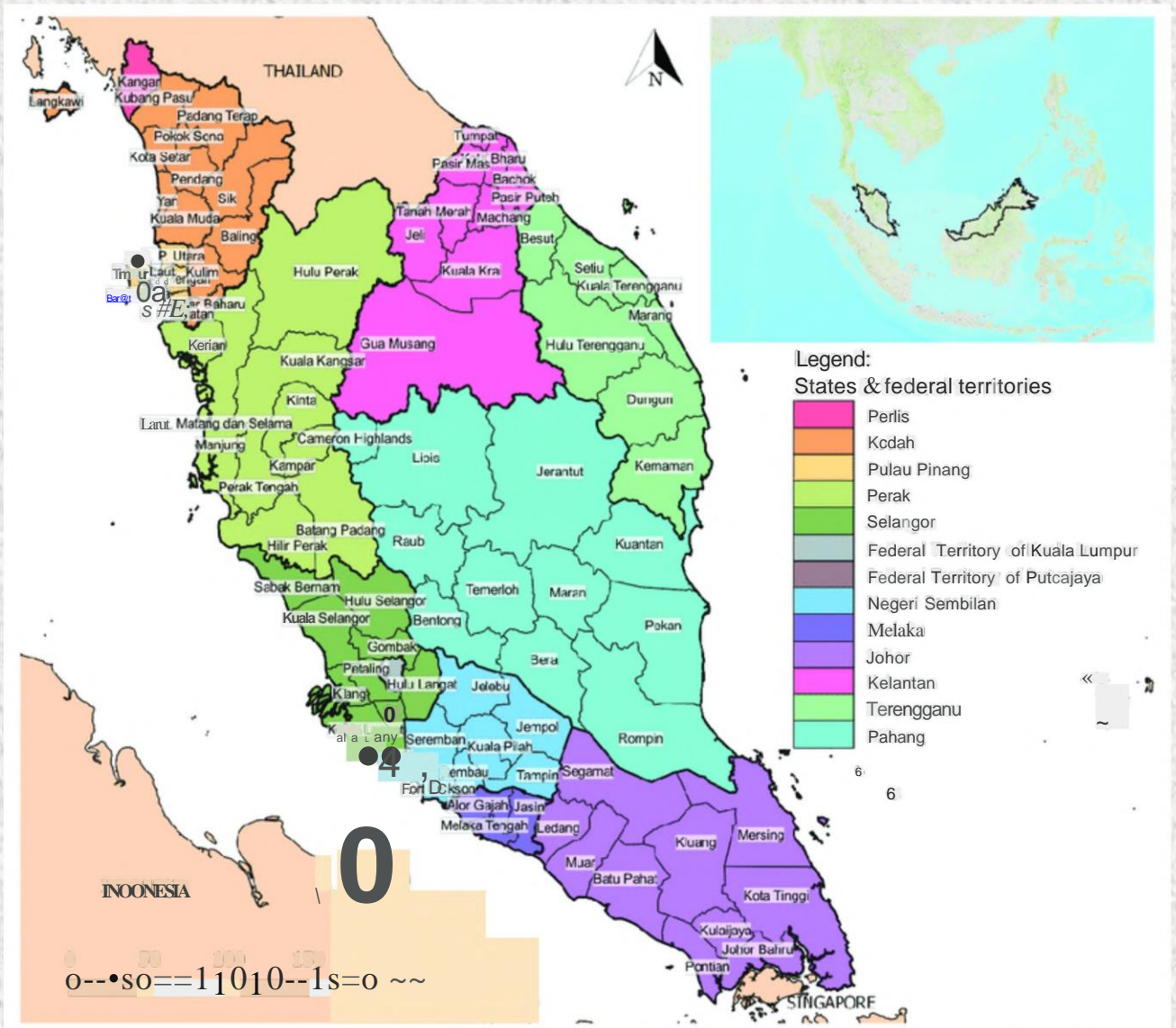
## MAPS

### 2.1 Interpret the elements of maps

#### 2.1.1 Define maps

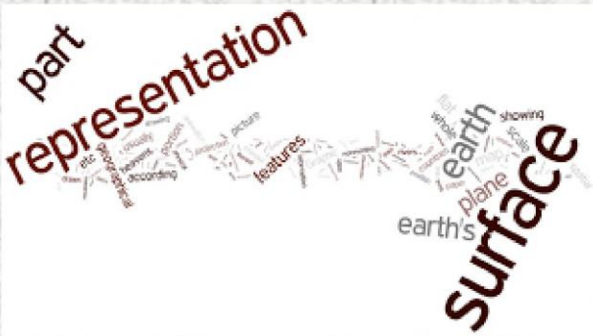
#### 2.1.2 Explain the characteristics of maps

#### 2.1.3 Identify types and uses of maps





# Definition



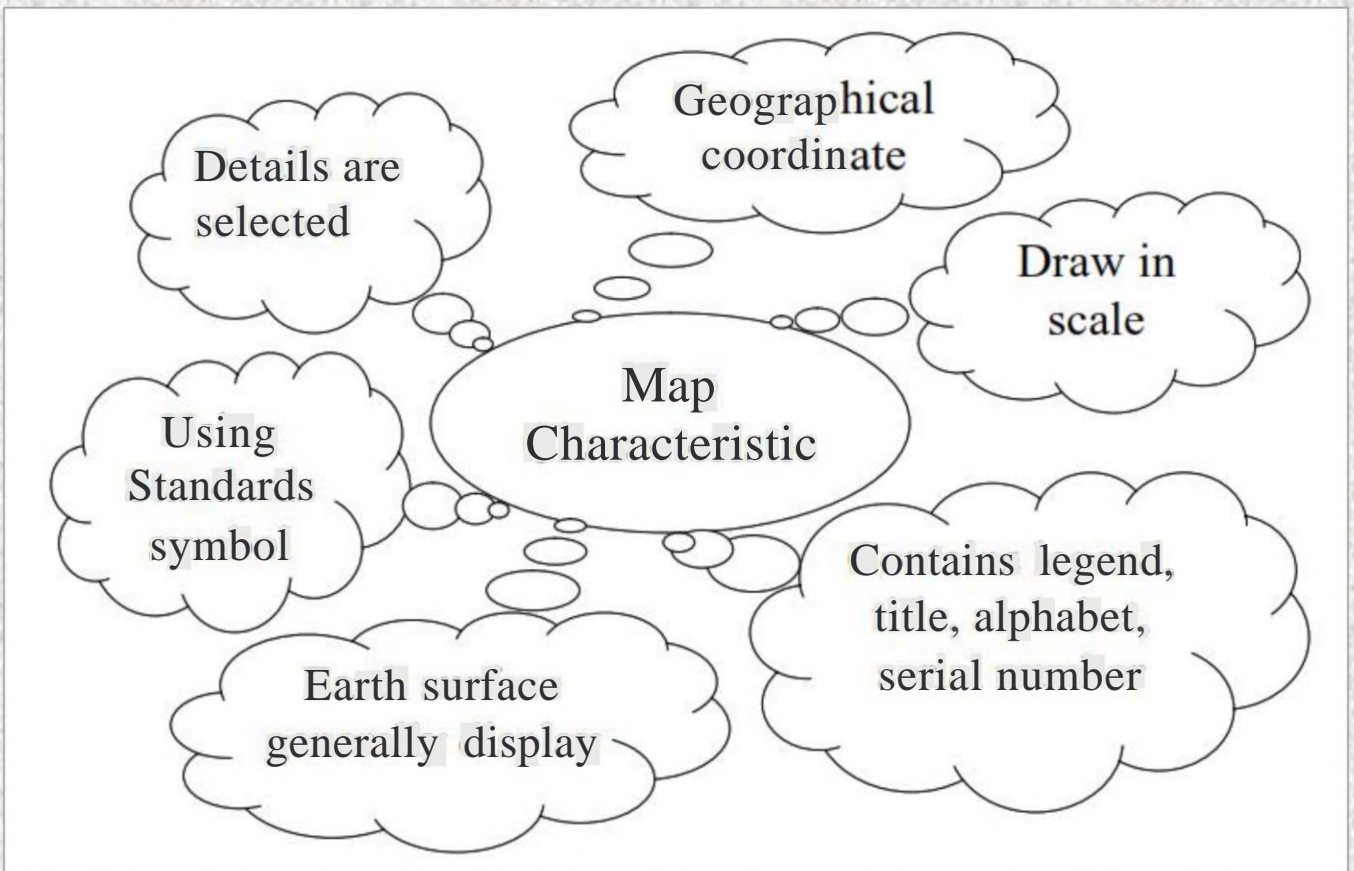
Definition:

'A drawing to display an area in the form of symbols and made according to measurement; either same shape, same distance, same shape or same direction.'





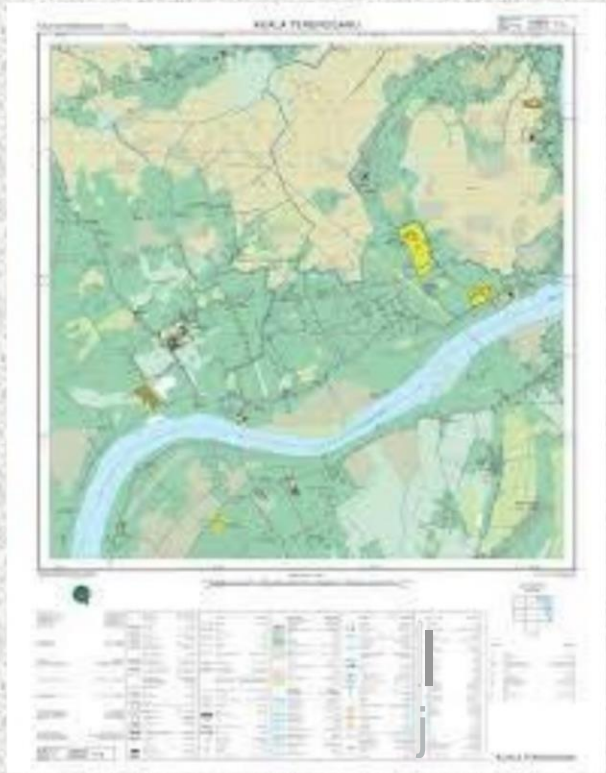
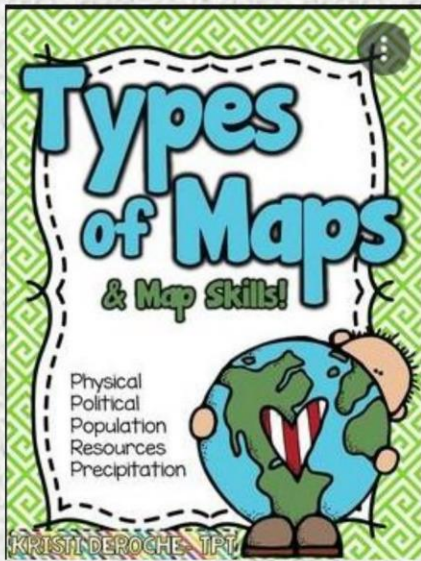
## Explain the characteristics of map



Explains the characteristics of map.

- a. Drawn to a predetermined scale. Each earth surface placed in the right direction and distance accordance to the map scale
- b. Optionally drawn. only the essential/importance earth surface selected according to the map purpose
- c. Drawn using standard symbols
- d. shows the earth surface in general through cartography process such as generalisation, exaggeration and others according to the map scale and purpose
- e. usually have specific characteristics such as legend, titles, letters, references serial numbers and specific information related to the map
- f. usually associated with a geographical coordinate system (latitude, longitude)

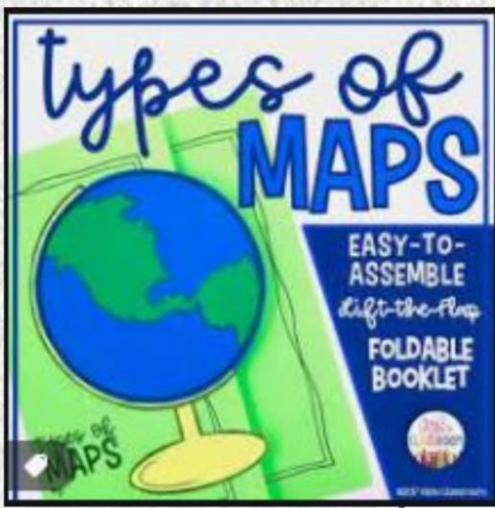




## Topography Map

- i. Displays all natural and man-made features. Example: ground level, plant, irrigation system
- ii. published in accordance to a particular scale depending on the map use. Usually between 1: 2 500 - 1 : 1 000 000. Example: Building state - require a large scale topography map to facilitate the planning and administrating
- iii. Usually printed in 3 or more colours. Example : Man• made feature - black, water - cyan, contour line - brown  
Note: Topography map published by JPNM (Malaysia Mapping Department) uses another 3 extra colours; railroad - red, plant - green and sandy area/paddy field - yellow
- iv. Topography map as a specific source and important in planning, developing, economic and military.





# Thematic Map

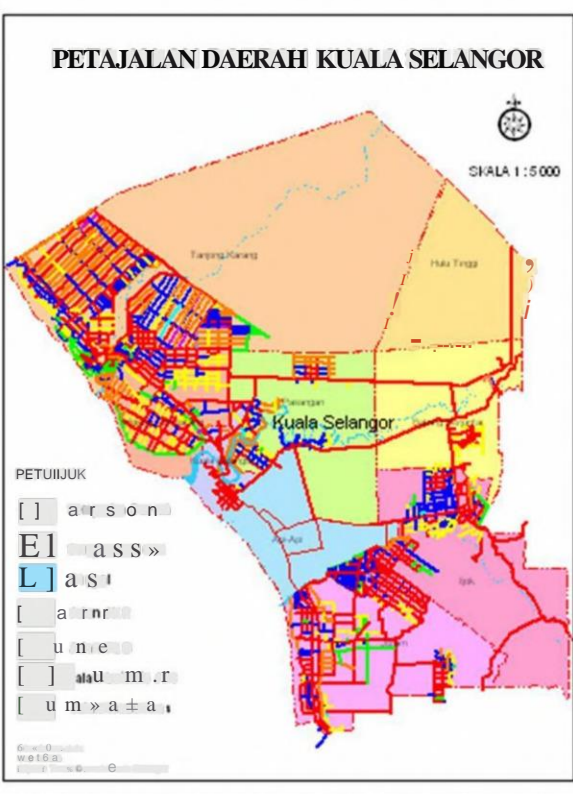
- A thematic map is a type of map or chart especially designed to show a particular theme connected with a specific geographic area. These maps "can portray physical, social, political, cultural, economic,



## city map

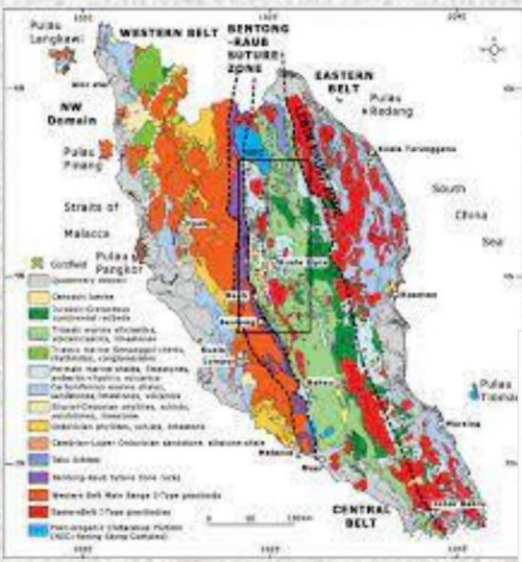
- Contains road, railroads, road names, public area and public facility
- Use in administration, economic, traffic and residential
- Usually scale base on city area/size 1: 3000, 1: 5000, 1: 700, 1:10000 and 1: 12500
- Printed in various colors
- Printed in a foldable piece and easy to open

## Road map /



- Contains road, railroads and highways as important information
- For drivers and road users
- Information related to railroad system : distance between places, road condition according to season, bridges, railway, tunnel, pond, recreation place, fuel station
- Scale depends on population density  
 Populous → 1:200 000  
 Rare → 1:500 000 ~ 1:1 000 000



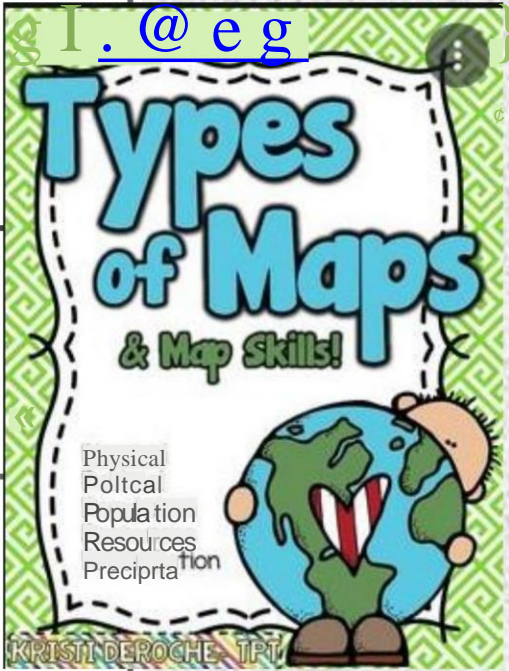


**Geology map**

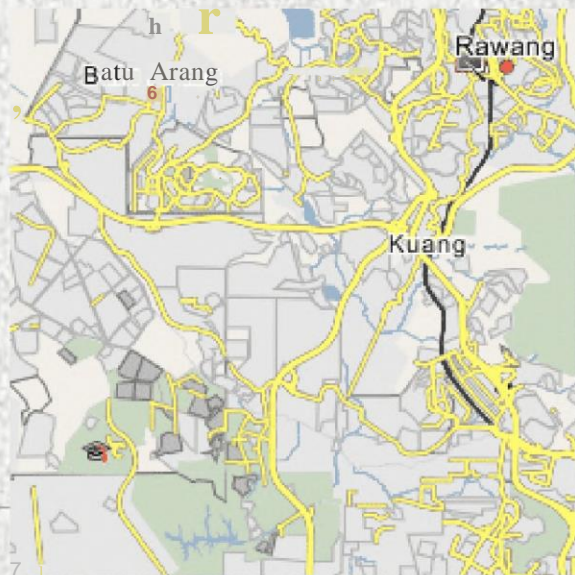
**Physical map**

**Wall map**

**Atlas map**



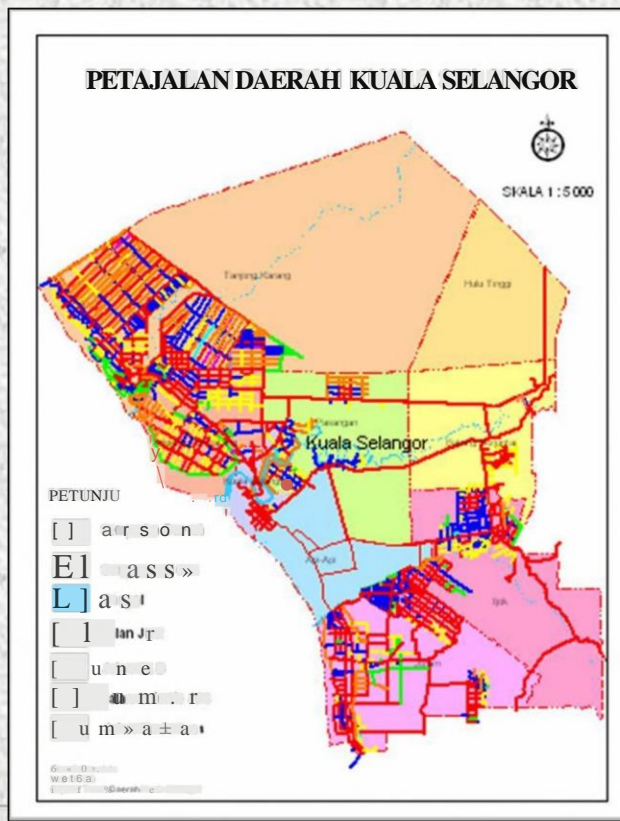




### **Urban/City Map**

- i. Display road, railroads, road name, public area and public building. Some of the map shows the information of economic activity and residence area, play ground and public residential park.
- ii. Used in administrating, economic, traffic and population
- iii. Typically scales are based on the size/area of the city. Normally between 1: 3000 -- 1 : 25 000. Map published by JPNM usually 1: 3000, 1: 5000, 1: 7500, 1: 10 000 and 1 :12 500
- iv. Usually printed in various colour to differentiate the information
- v. Most of it is printed in folded pieces and easy to be read.

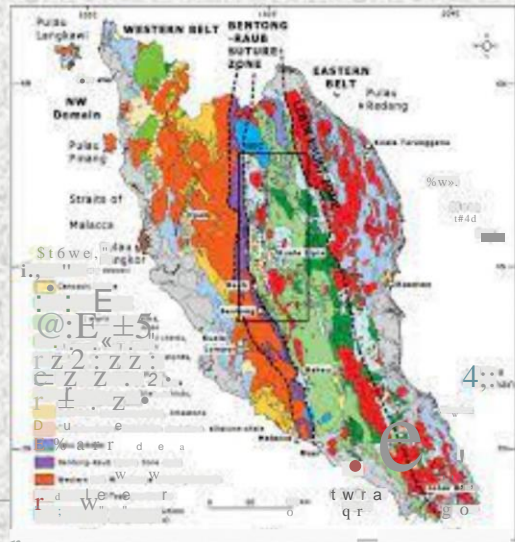




## Road Map

- i. Map that shows railroads and highway as the important information
- ii. The map users are drivers and road users
- iii. Information provided are the railroad systems and its category, distance between places, seasonal road condition, bridges, railways, tunnel, pond, recreational park and fuel stations.
- iv. The map scale depends on the population density. Dense region 1: 200 000, Rare region 1: 500 000 - 1: 1 000 000
- v. Colour
  - a. Place name Black
  - b. Aqueous area cyan
  - c. Plant Green
  - d. Road -- > Red/Yellow/Orange depend on road types





## Physical Map

- i. Generally the scale and format is similar as Administrator/Government Map
- ii. The main information are the topography ground level
- iii. Used to know overall concept of the earth surface for a specific area
- iv. Representation method of relief information are layer tints, spot height, contour, hachure, hill shading and others



## Geology Map

- i. Map for exploration of minerals on the seabed to get oil, ore, gas and others
- ii. To determine valuable area and important for dam construction, industry planning, city planning, research, agriculture and etc
- iii. Printed in overlay format for geologist
- iv. Scale depends on the area





## Wall Map

- i. The map above in the form of sheets or volumes
- ii. Wall maps are pasted on a piece of cloth and wrapped with plastic and framed



## Atlas

- i. A group or map series that are bound as a book
- ii. As a reference map for education purpose
- iii. Usually uses small scale depending on the map purpose and use
- iv. It covers all types of map including topography or thematic map





Question  
&  
Tutorial

a) Explain the definition of map.  
Terangkan definisi peta.

[5 marks]  
[5 markah]



(b) In cartography there are various types of map that we can see. Classify **TWO (2)** type of maps in cartography.

*Di da/am kartografi terdapat pe/bagai jenis peta yang biasa dilihat. Kelaskan **DUA (2)** jenis peta dalam kartografi.*

[10 marks]

[10 markah]

(c) Identify **FIVE (5)** characteristics of map in cartography.

*Kenalpasti **LIMA (5)** ciri-ciri peta dalam kartografi.*

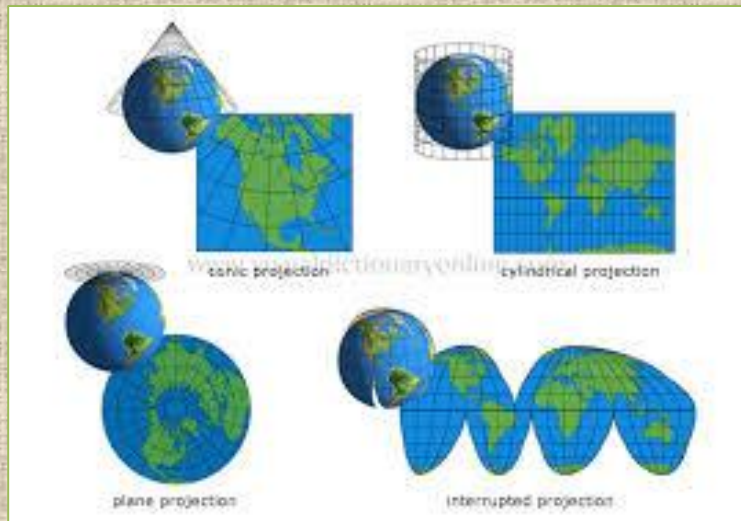
[10 marks]

[10 markah]



# TOPIC : 3

## MAP PROJECTION



### **3.1 Identify the map projections**

#### **3.1.1 Define map projections**

#### **3.1.2 Explain the classification of map projection such as Cylindrical projection, Cone projection and Azimuthal projection**

#### **3.1.3 Explain the qualities to preserve map projection in terms of area, distance, direction and shape**

### **3.2 Explain projection systems used in Malaysia**

#### **3.2.1 Rectified Skew Orthomorphic (RSO) system for Peninsular Malaysia**

#### **3.2.2 Borneo Rectified Skew Orthomorphic (BRSO) system for Sabah and Sarawak**

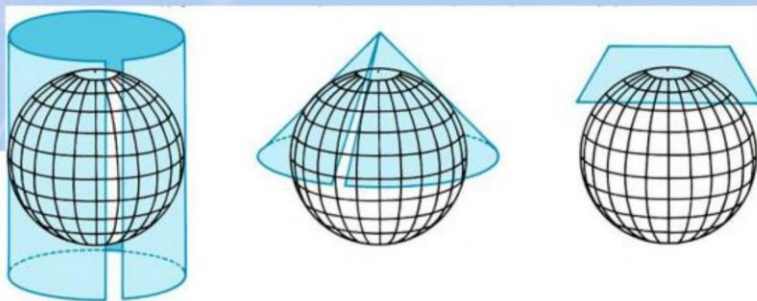
#### **3.2.3 Cassini-Soldner system**

#### **3.2.4 Geocentric Datum of Malaysia 2000 (GDM2000)**

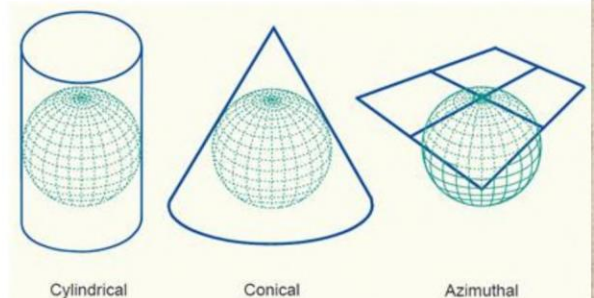


# Introduction

- Generally discuss the ways in which a point on the **sphere-shaped surface** is transferred to **the plane / flat**.



- Options?
- Stretch out some areas
- Cut out some areas
- Shrink some areas

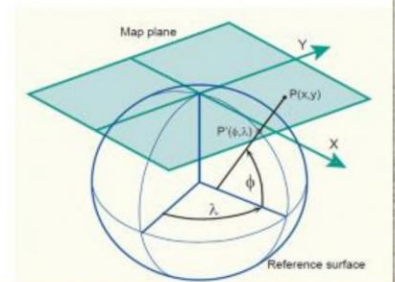




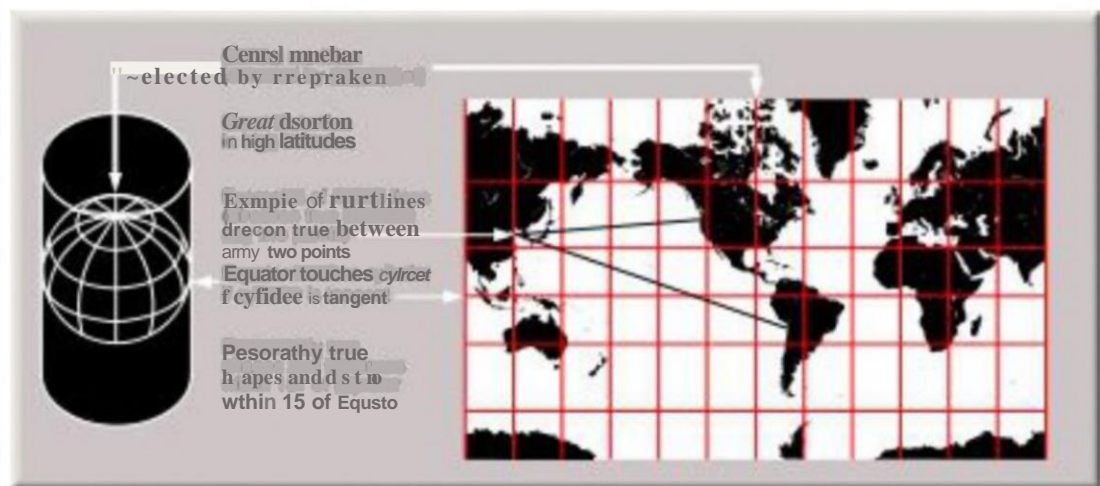
# Map Projection Definition

- Map Projection:

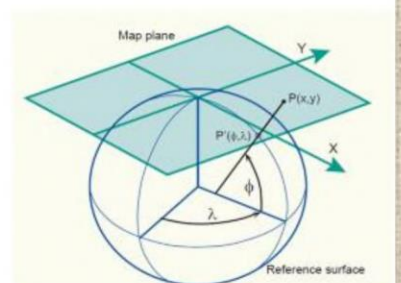
*"Any systematic arrangement of meridian and parallel portraying the curved surface of the sphere or spheroid upon a plane"*



- Sphere to plane surface



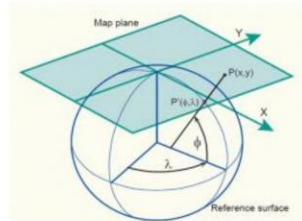
- First map projection is a geometrically (points on the globe is moved to a same position on a map).
- The transfer of graphical projection of a map projection. It changed when the principle of mathematical formulas were understood.
- The main purpose is to transform the map projection surface to a plane, but to minimise the effect of changing.





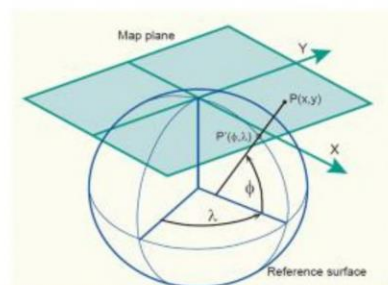
# Map Projection Usage

- **Surveyor and cartographer** :  
to *express position of points* and calculate the distance and direction on a plane.
- **Geographer** :  
to view a wider area than what they saw to the study (habitation, vegetation, etc).



## The need to map projection

- Why do we need to project sphere to plane surface form?
  - a. Easier and practical
  - b. Easier to produce/printout
  - c. Easier to do calculation on a plane map compare to sphere map.

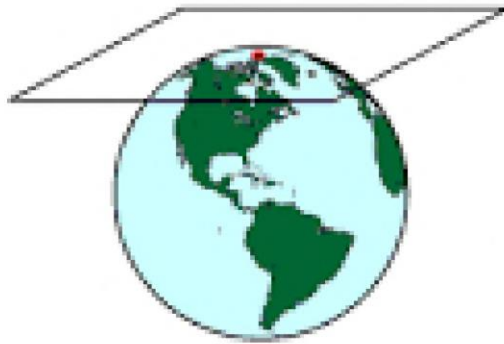




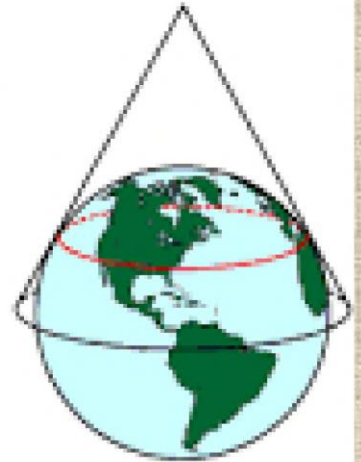
## Basic Types of Map Projections



Cylindrical



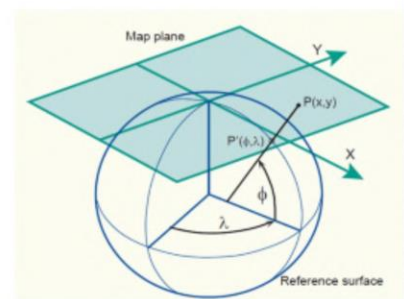
Azimuthal



Conic

## Map Projection Classification

- There are 2 types of map projections;
  - Linear System : by Maurer
  - Parametric classification : by Tobler
- Generally it is classify into 3 main types;
  - Zenithal / Azimuthal Projection
  - Conical/Cone Projection
  - Cylindrical Projection

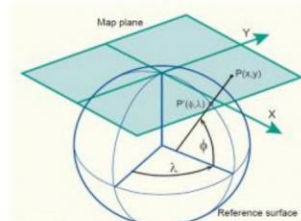




# Zenithal / Azimuthal Projection

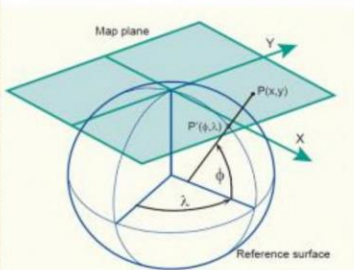


- Divided into 3 form;
  - **Polar**
  - **Oblique**
  - **Equatorial (Khatulistiwa)**

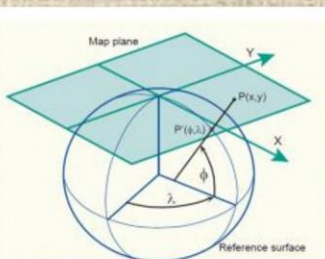


- Azimuth projection is the result of corollary (siratan) projection line to the surface projection of the tangent plane to the globe in the following perspective from a point source;

- Nomantic** : Perspective from globe centre. If point **A** is transferred to a tangent plane, the position is **A'**.



## Planar Projection

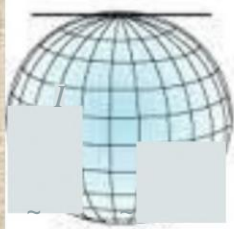


- Stereographic** : Perspective stems from a point opposite the center point of the tangent plane. If point **A** is to be transferred to the tangent plane, its position is at **A''**.

- Othographic** : Perspective comes from infinity. If point **A** is moved to the tangent plane, its position in **A'''**.



## Planar Projection



Polar



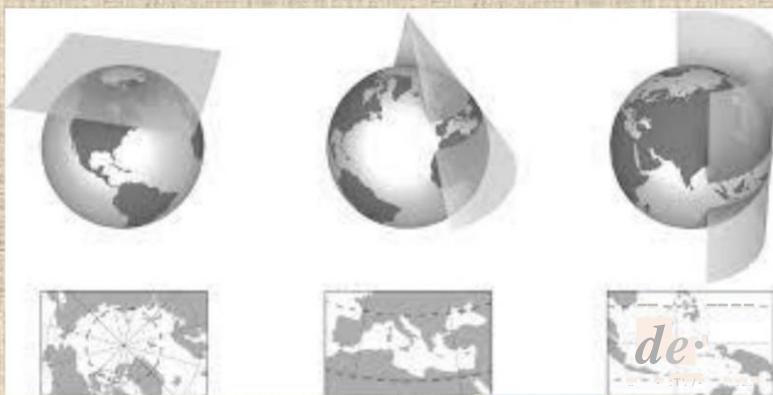
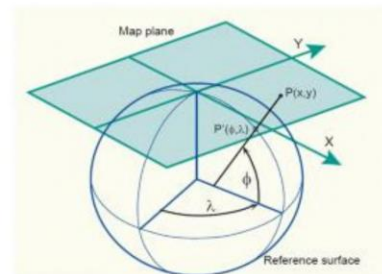
Equatorial



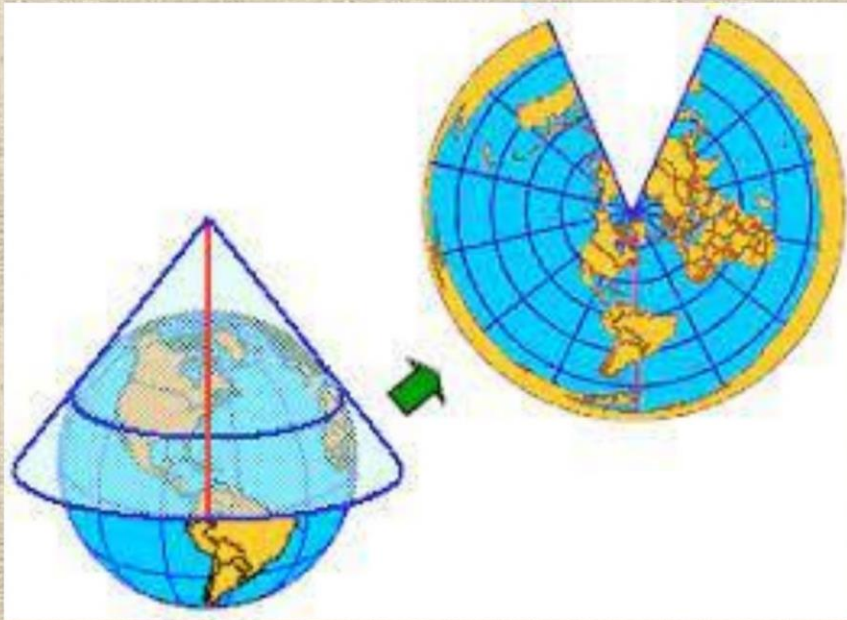
Oblique

### • General characteristics of Azimuthal / Zenithal projection;

- ✓ Small area near the center of projection, the image produced is not satisfactory .
- ✓ The relationship between places can be shown accurately and clearly
- ✓ Directions from the center is always right
- ✓ Correct distance in all directions
- ✓ The projection is easy to build

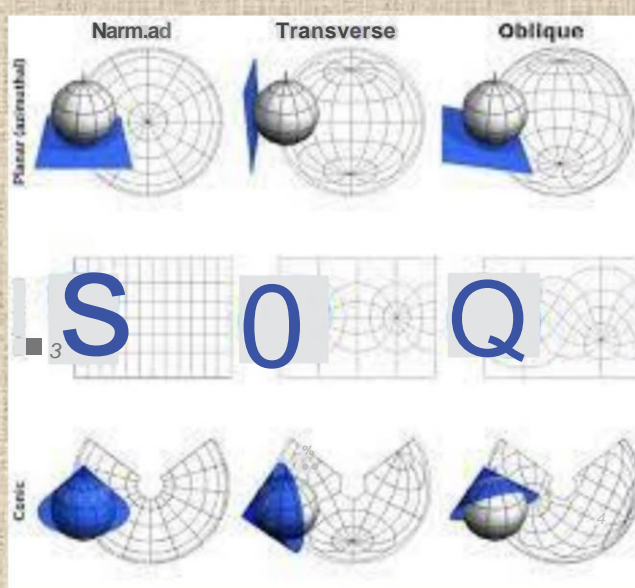
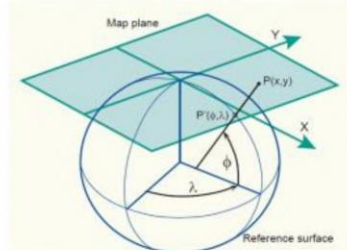






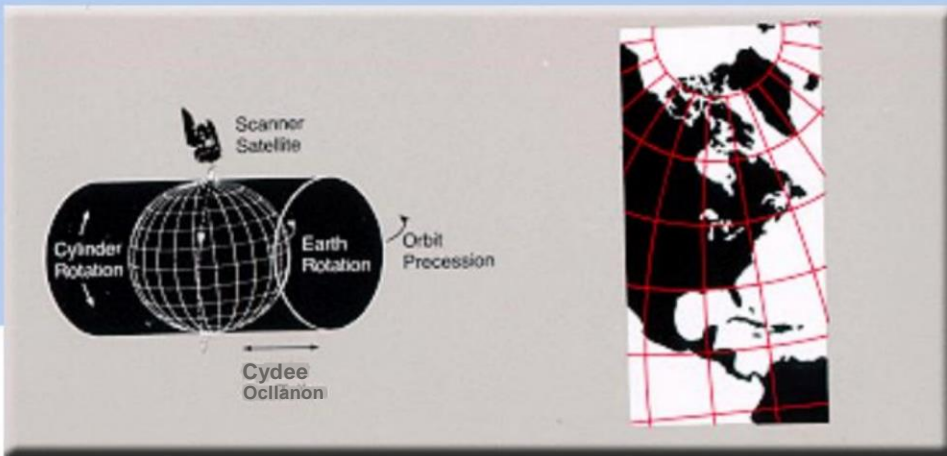
## Cone Projection

- Divided into 3 types which are **normal**, **transverse** and **oblique** (serong).
- Derived from the example of a globe wrapped with a roll of paper cone with vertex point coincides with the polar face and touching the paper over the latitude-chosen. The principle of projection is a secant Cone and the tangent plane.

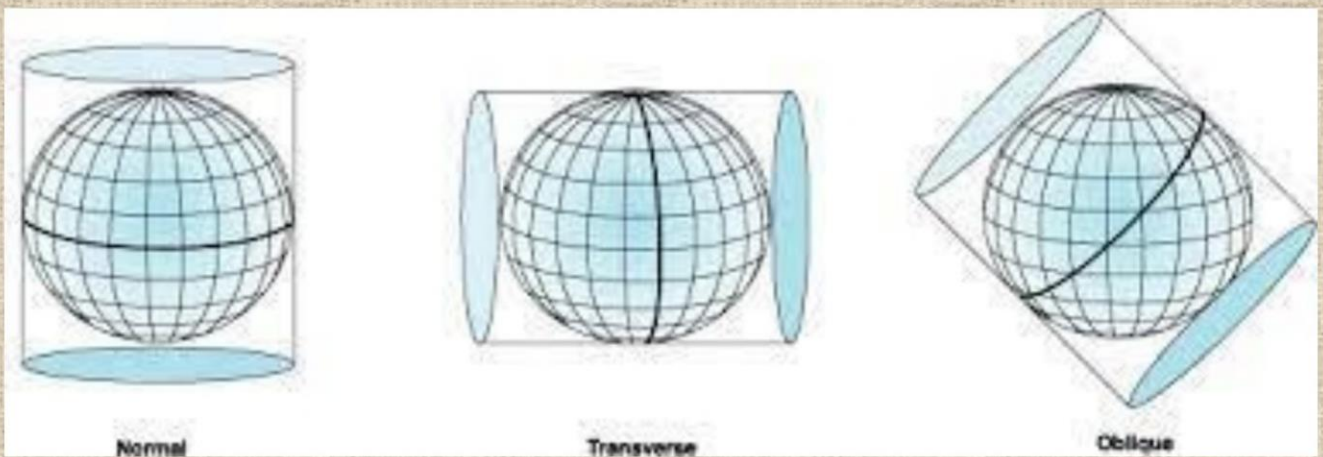
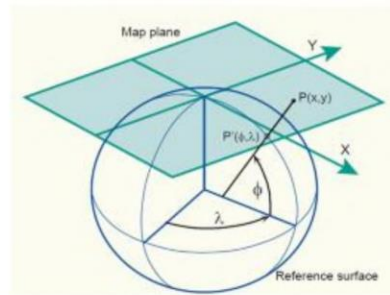




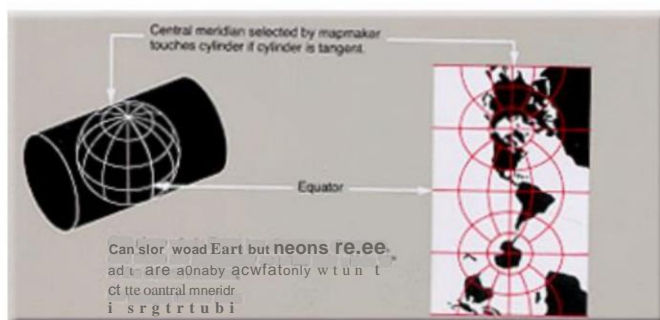
# Cylindrical Projection



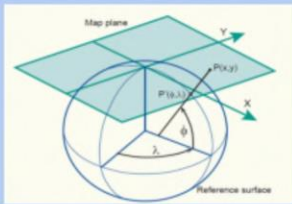
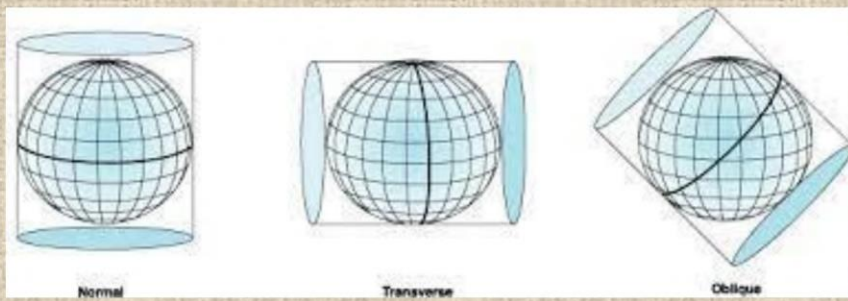
- Divided into 3 types :
  - **Normal**
  - **Tranverse**
  - **Oblique**



- Projections derived from the sample of wrapping a paper on a globe with a roll of paper that just touch along the equator.
- If the perspective from the center of the globe, all the latitude and the meridian are projected on the surface of paper rolls



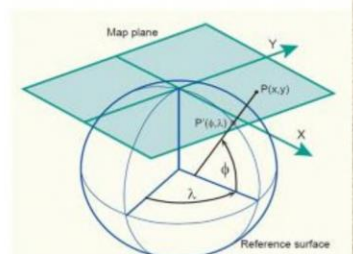




- General characteristic of cylinder projection;

- Lines of latitude are projected as parallel lines (in the same length). Only one standard line is considered correct measurement.
- The meridian line is projected as a straight line, same length and interval.
- The Meridian and straight line is perpendicular
- Revenue projections described in the rectangular oval

- The projection involved with mathematical principle. Some of these projection are;
  - a. Simple Cylinder Projection
  - b. Mercator Projection
  - c. Cassini @ Tilt Cylinder Projection
  - d. Tilt Mercator Projection
  - e. Universal Transverse Mercator (UTM)



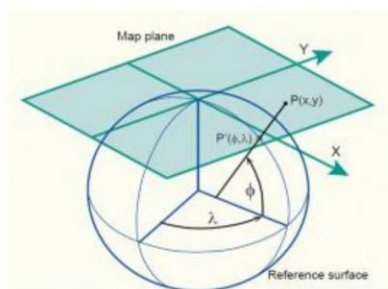


- Understand the map projection system used in Malaysia:
  1. Explain the qualities that must be preserved in map projection
  2. Explains the Rectified Skew Orthomorphic (RSO) system for Peninsular Malaysia
  3. Explains Borneo Rectified Skew Orthomorphic (BRSO) system for Sabah and Sarawak.
  4. Explains Cassini - Soldner system.

## Qualities that must be preserved in map projection

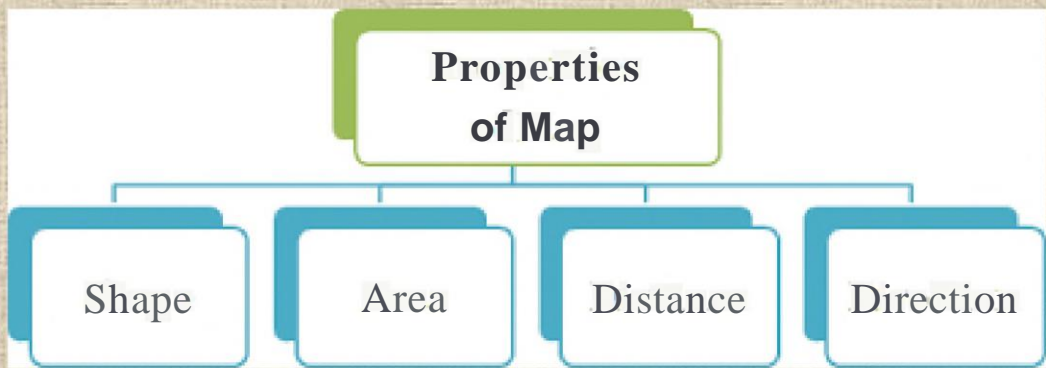
- To describe the surface of the globe into a plane is difficult. It is not possible to open the globe and spread out like a perfect plane. Therefore, the projection is not 100% accurate. This inaccuracy is called :

- Distortion*
- Stretching*
- Shrinking*



- **There are a few features on a map projection need to preserved;**
  - **Scale preservation**
  - **Area preservation**
  - **Shape preservation**
  - **Direction/Bearing preservation**
- Only one of the above features can be maintained in a projection system .





## Scale Preservation

- Generally scale factor is not fix in some direction:



Scale factor for N - S direction = 0.1

Scale factor for E - W direction = 0.9

- Scale factor = distance in projection/ground scale at Nominal scale (fixed scale)
- Scale as having no difference if it is between 2400/25000 - 2501/2500, from 0.99996 - 1.0004. (topo map limit). If less or more than this range, then distortion occurred more than they should.

## Area preservation

- Meet the following conditions :

$$\text{Scale factor X} \times \text{Scale factor Y} = 1$$

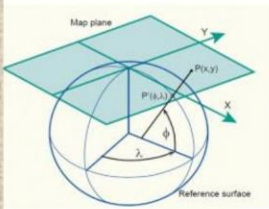
- The choice of this projection is based on factors;
  - a. The size of the area
  - b. The distribution of the angular deformation

A change in the shape of a body, generally due to **sheer stress**, such that a straight line connecting two points within the body before the deformation is not parallel with a straight line connecting them after the deformation.

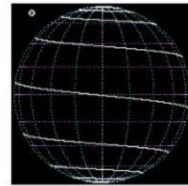


## Shape preservation

- Points have the same scale factor along the meridian and parallel. Meridian and the parallel was crossed at an angle of  $90^\circ$
- In this projection there are 'Rhumblines' (*Garisan bering tetap*) where a straight line that represent the same bearing. 'Loxodrome' (*garisan adoman*) specific to facilitate navigation.

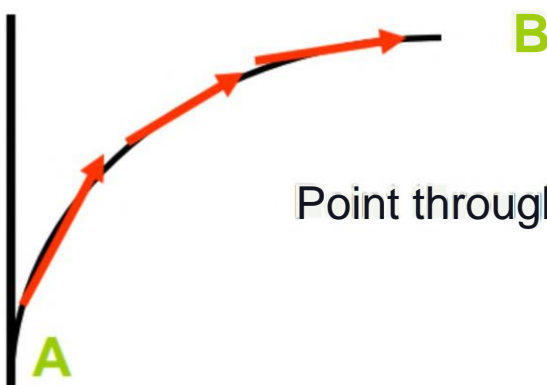


Example of pole to pole loxodrome



## Bearing/Direction Preservation

- For a long navigation purpose, important to know the accurate bearing.
- The projection for this purpose is Azimuthal / Zenithal.



Point through the large round



## MAP PROJECTION USED IN MALAYSIA



- In Malaysia, the construction and production of official maps has been assigned to JPEM.
- Many small-scale maps covering the entire country and states are issued by JPEM. Examples of administrative maps include road maps.
- Among the projection maps used for Malaysia are:
  - Cassini Soldner
  - Rectified Skew Orthographic (RSO)



## Map Projection for Malaysia

- Malaysia has 3 map projection system :
  1. **RSO** (Rectified Skew Orthomorphic)
  2. **BRSO** (Borneo Skew Orthomorphic) - for Sabah & Sarawak
  3. State **Cassini Soldner**
- Standard Sheet (cadastral lot) is using State Cassini Soldner projection whereas other maps such as Topography Map is using RSO projection.
- In order to standardize, JPEM is working on combining two map projection into one projection (datum at the core of earth) which names as **GDM2000**.



# RSO Projection

- To accommodate the special needs of **Peninsular Malaysia** oblique position, a projection called the RSO was introduced
- It resembles the Mercator Transverse projection, but has adapted to the form of Peninsular Malaysia with a **constant scale base line toward the diagonal from the meridian**
- With this projection, Peninsular Malaysia can be mapped with a **minimum distortion** where the scale factor at origin was **0.99984** and the **maximum difference in scale is 1: 6 000**

- Before the RSO projection was introduced, a few projections has been studied. Among these are *Lambert's equal-area conic projection* with latitude of 5°U.

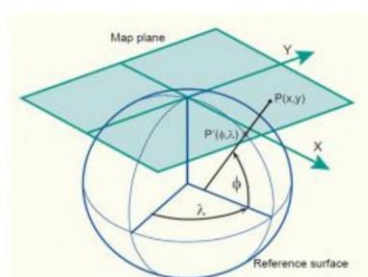
- The projection was based on certain latitude and suit for **elongated form** of the longitude
- This projection will have **maximum scale difference up to 1: 800**

- Another projection known as the Mercator projection is based on a specific meridians correspond to the horizontal longitudinal.
- When the projection is based on the meridian 102E of Peninsular Malaysia, the **maximum scale difference is 1: 2 500** with maximum difference of **1: 1650 on the east coast** and **1: 770** at the limited end of the grid in 9840'E.



## Continue RSO ...

- by adjusting the Mercator projection on a straight line that askew through the central of Peninsular Malaysia, it replacing a meridian, will cause a minimum difference 1: 6000 compared to other projections
  - the principle was referred as base design of RSO projection that use oval rectangular plane coordinate system
- 
- To facilitate mapping process, the main skew coordinate system with acute angle of 32 are modified by not adding more distortion on the grid coordinate system in which the northern grid met almost coincide with true north (*utara benar*).
  - This coordinate known as 'Malayan Rectified Skew Orthomorphic Coordinates'





# BRSO Projection

- Borneo Rectified Skew Orthomorphic or (BRSO) is a map coordinate system commonly used in the East Malaysian states of Sabah and Sarawak, and the Sultanate of Brunei.
- The first datum was established by the Directorate of Oversea Survey (DOS) 1948;
- This is based on Timbalai Datum and Everest Spheroid for reference

- The BRSO grid

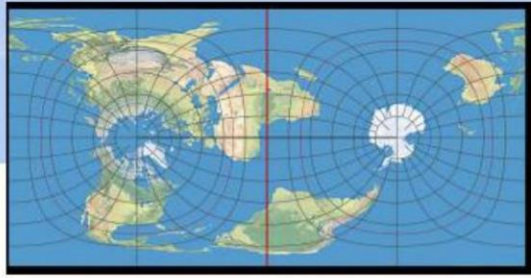


# Cassini-Soldner Projection

- Developed by Cesar Francois Cassini de Thury (1714-1784) for topographic mapping of France in the middle 18th century
- The Cassini-Soldner projection is the ellipsoidal version of the Cassini projection for the sphere.
- It is not conformal but as it is relatively simple to construct
- In Peninsular Malaysia, commonly use for cadastral mapping purpose



- The characteristics are cylindrical and Equidistant (same distance)



- It was extensively used in the last century and is still useful for mapping areas with limited longitudinal extent.
- It has a straight central meridian along which the scale is true, all other meridians and parallels are curved.
- The scale distortion increases rapidly with increasing distance from the central meridian.

- **Understand the map projection system used in Malaysia:**

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4. Explains Cassini - Soldner system.





Question  
&  
Tutorial

(a) Map projection is widely used in cartography. Explain the meaning of map projection.

*Unjuran peta digunakan secara meluas dalam kartografi. Terangkan maksud unjuran peta.*

[5 marks]

[5 markah]



(b) With suitable diagrams identify TWO (2) map projections type.  
*Dengan contoh gambar yang sesuai kenalpasti DUA (2) jenis unjuran peta.*

[10 marks]

[10 markah]

(c) Explain Rectified Skew Orthomorphic (RSO) and Borneo Rectified Skew Orthomorphic (BRSO) projection systems used in Malaysia.

*Terangkan sistem unjuran Rectified Skew Orthomorphic (RSO) dan Borneo Rectified Skew Orthomorphic (BRSO) yang digunakan di Malaysia*

[10 marks]

[ 10 markah]





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