

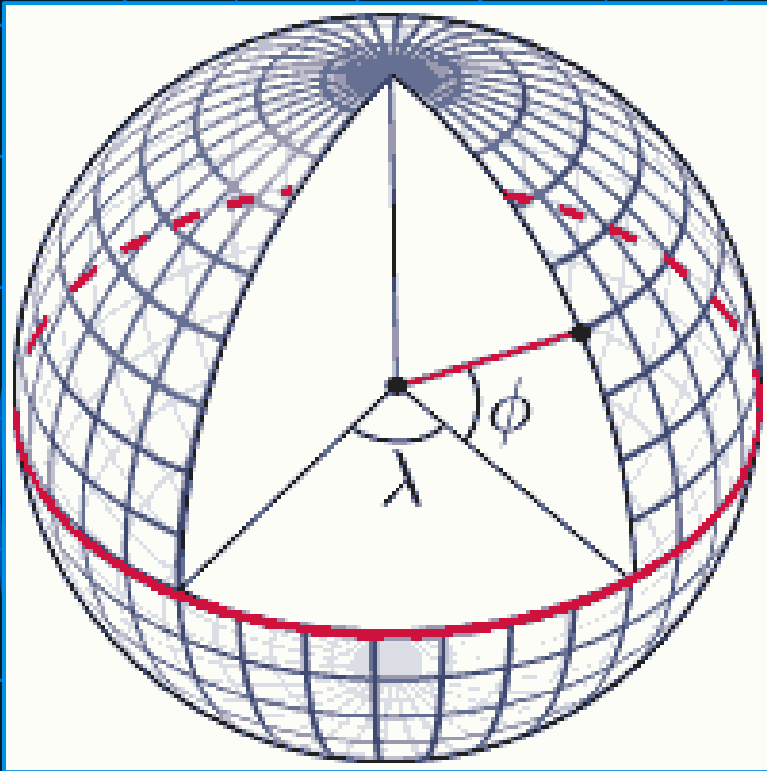


MAP PROJECTIONS
and
COORDINATE SYSTEMS

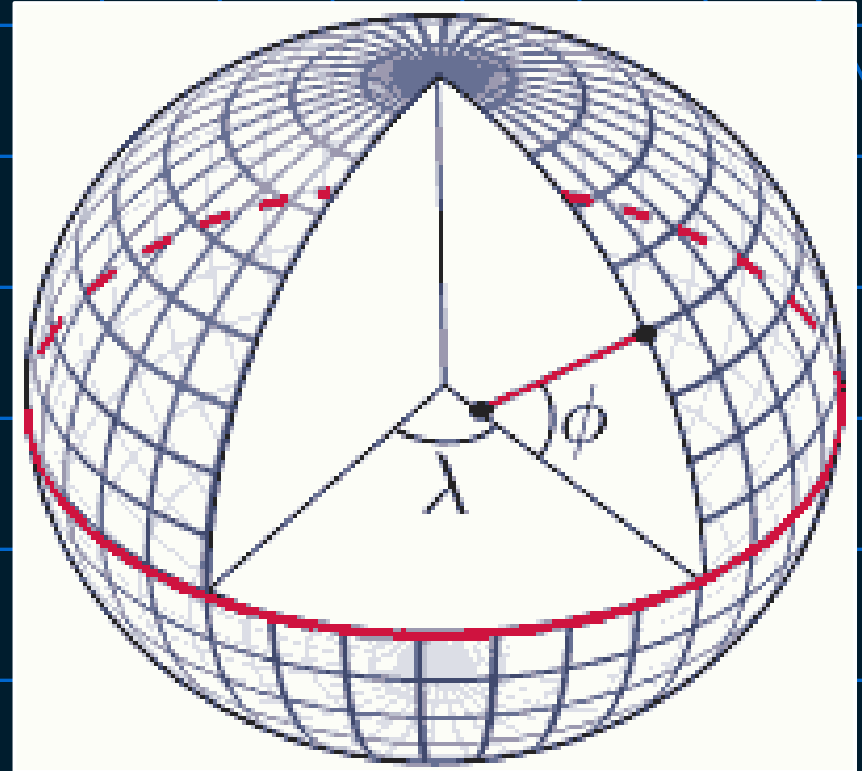
Parameters for Mapping

- ❖ A mathematical model of the earth must be selected; Spheroid.
- ❖ The mathematical model must be related to real-world features; Datum.
- ❖ Real-world features must be projected with minimum distortion from round earth to a flat map; Projection.
- ❖ and given a grid system of coordinates.

Geographic coordinates

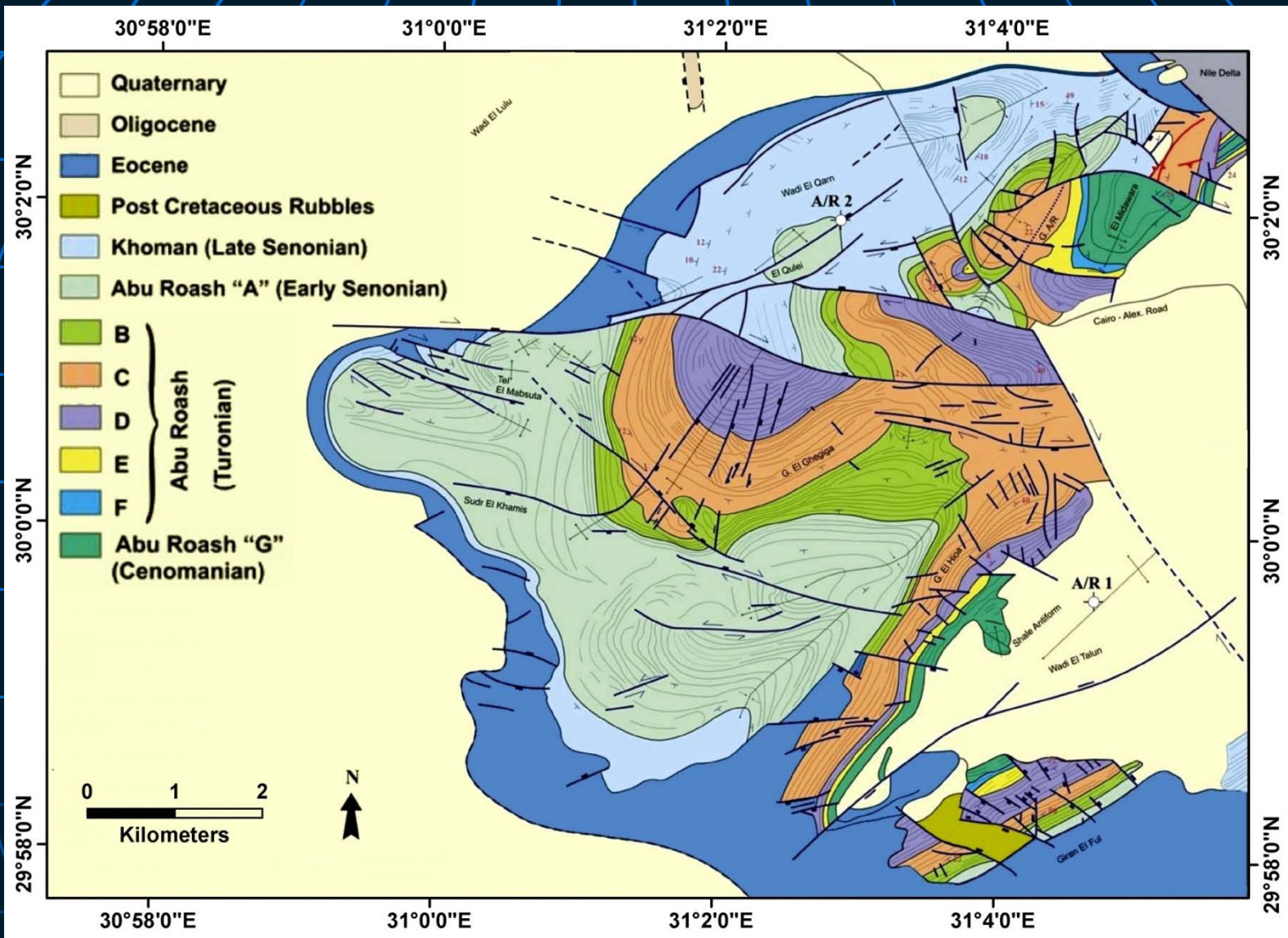


Latitude and longitude on spherical Earth (geocentric latitude).
Graticule spacing of 10 degrees.

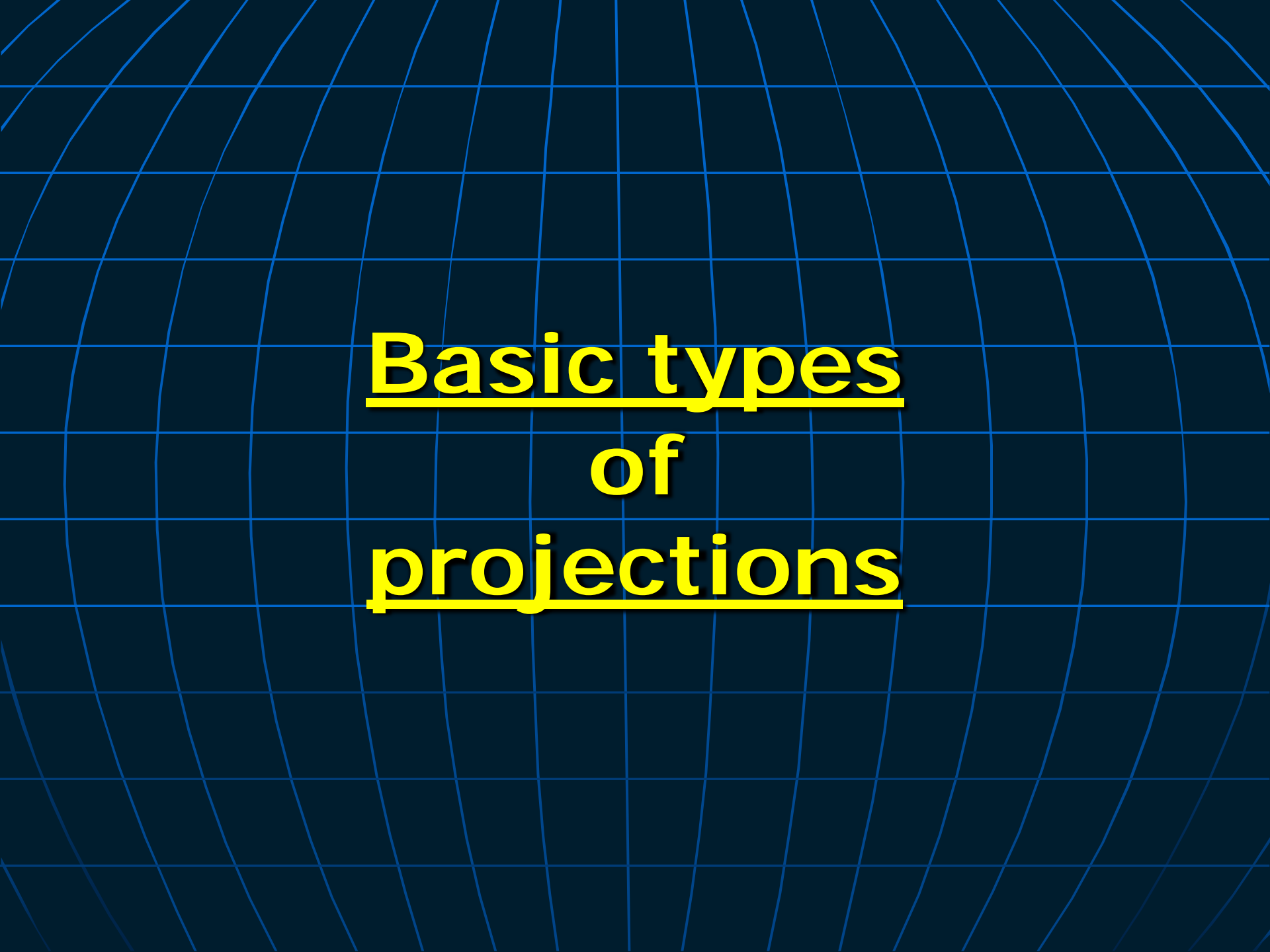


Latitude and longitude on ellipsoidal Earth (geodetic latitude).
Graticule spacing of 10 degrees.

ϕ = Latitude angle, λ = Longitude angle



The location of a any map is defined by its bounding coordinates

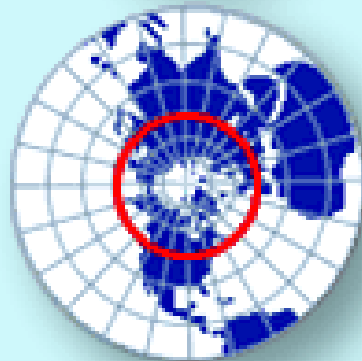
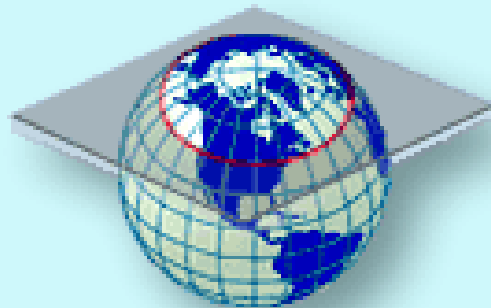


Basic types
of
projections

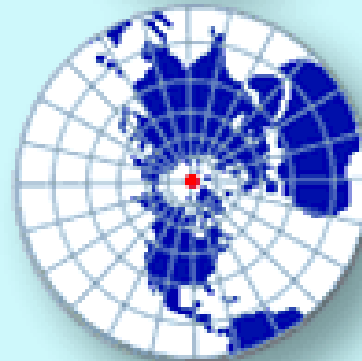
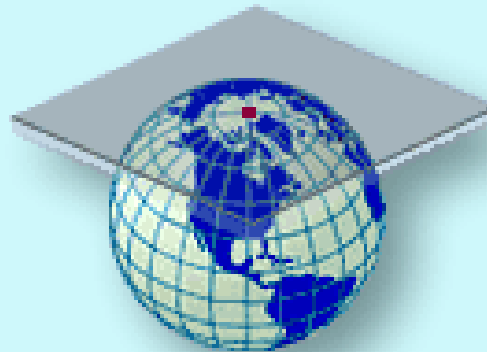
Planar projection

Planar Projection

Secant

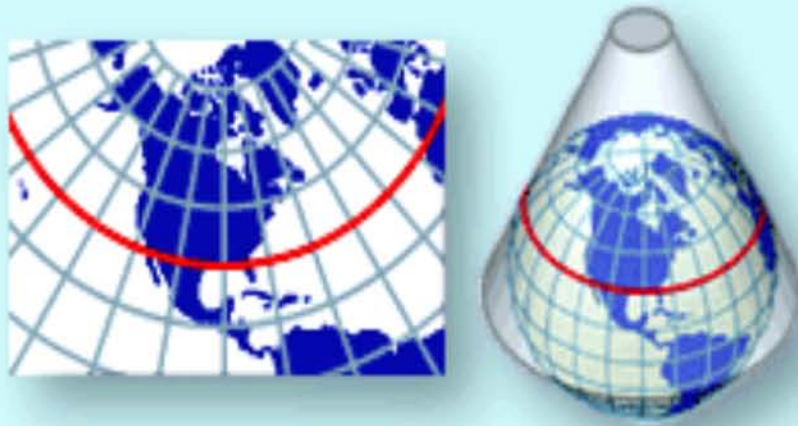


Tangent

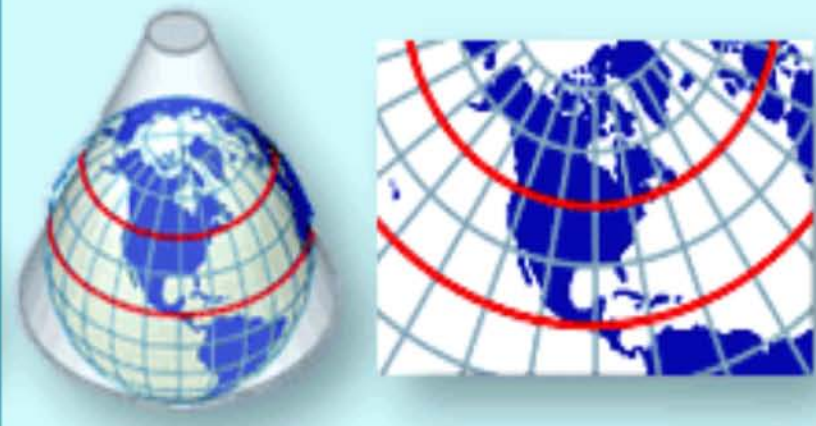


Conical projection

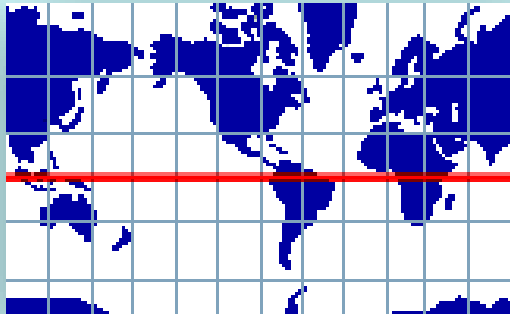
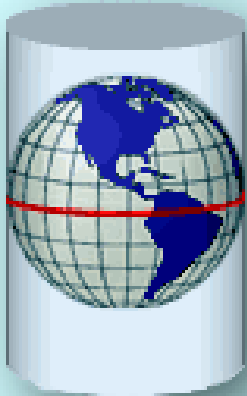
Tangent at a single parallel



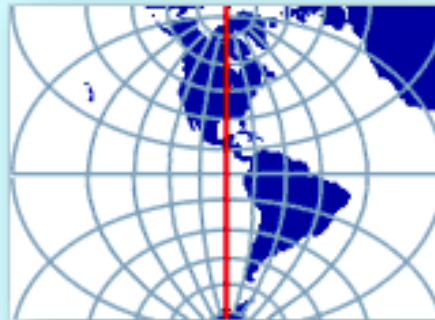
Secant at two parallels



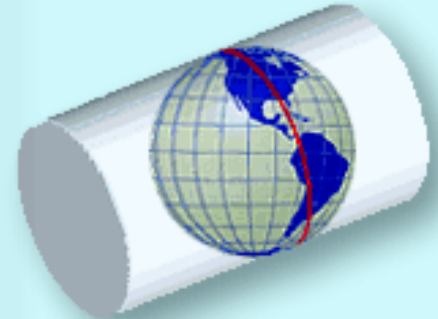
Cylindrical projection Mercator projection



Transverse Mercator



Oblique Mercator

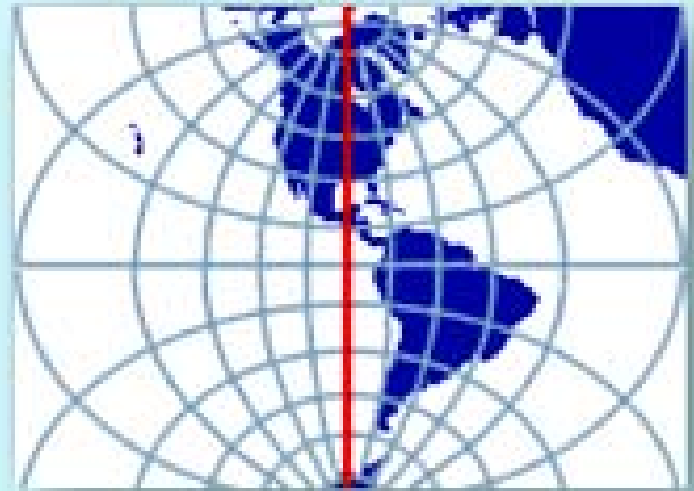




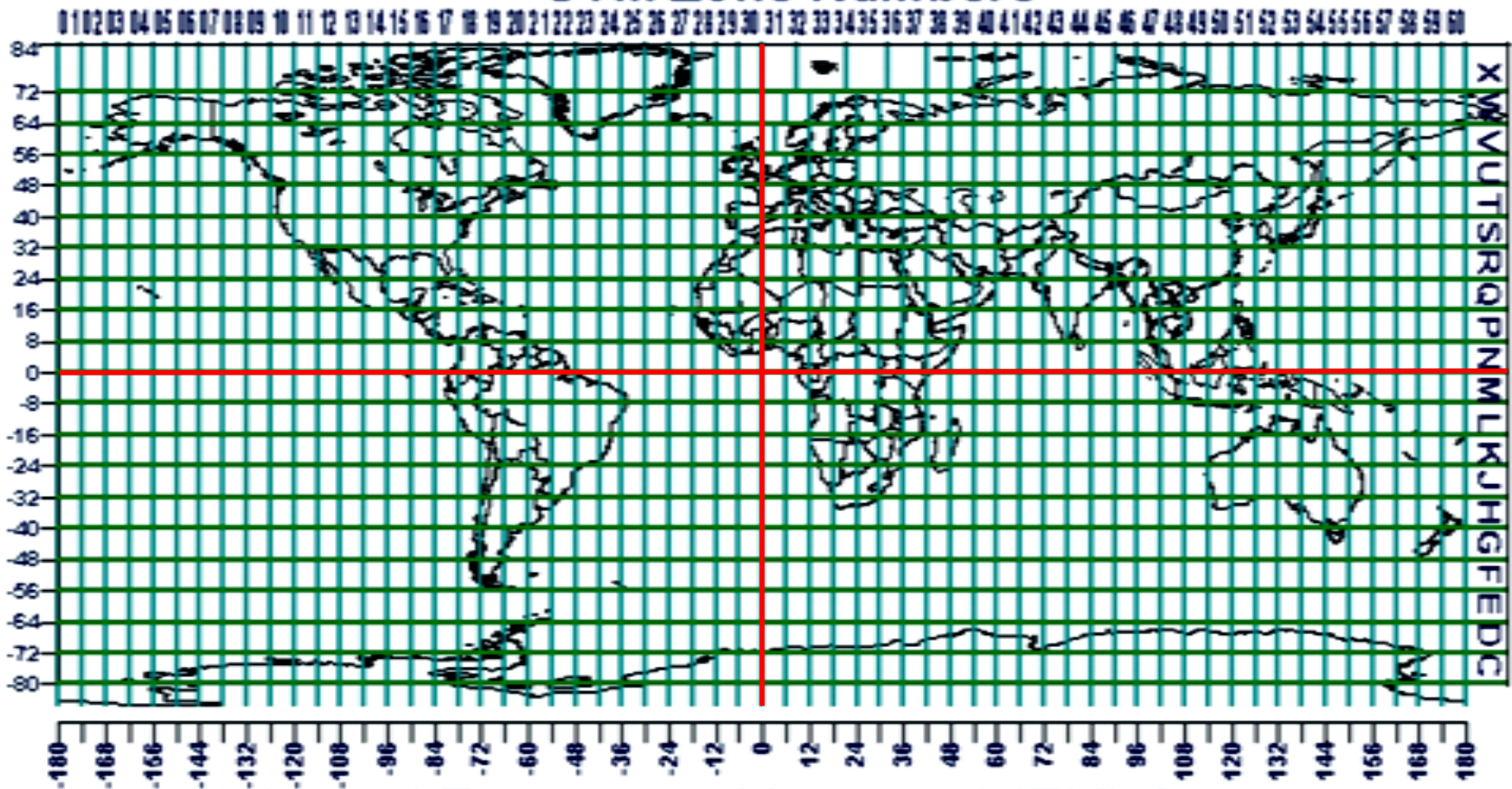
**Universal Transverse Mercator
(UTM) projection**

- Divide the world into **60** vertical strips (**zones**), each spanning **6** degrees of longitude.
- Apply a custom Transverse Mercator projection on one strip (**zone**) and **rotating** the cylinder at **6** degree steps and combine the projected zones together.

Transverse Mercator



UTM Zone Numbers

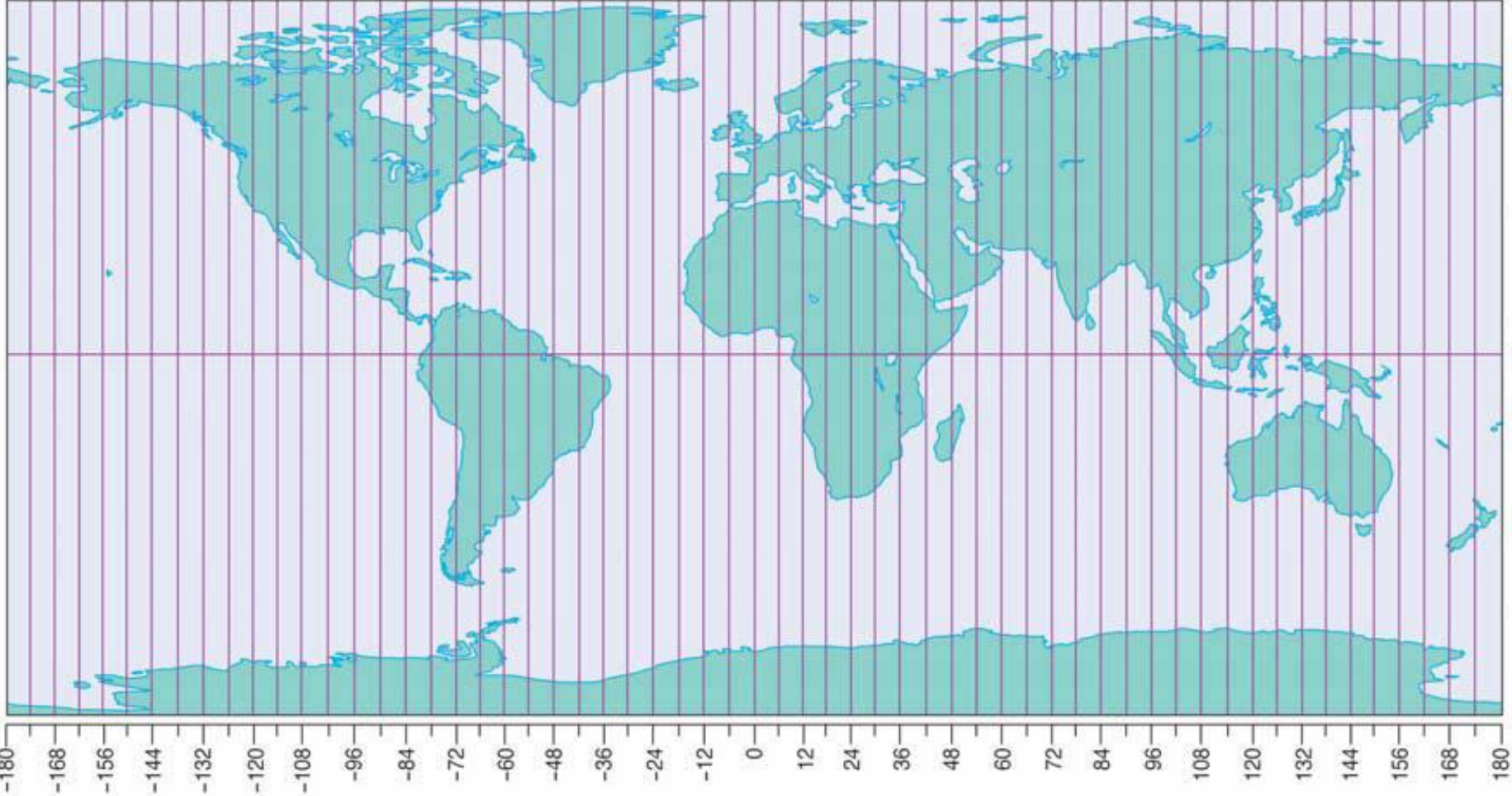


UTM Zone Designators

Universal Transverse Mercator (UTM) System

UTM Zone Numbers

01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60



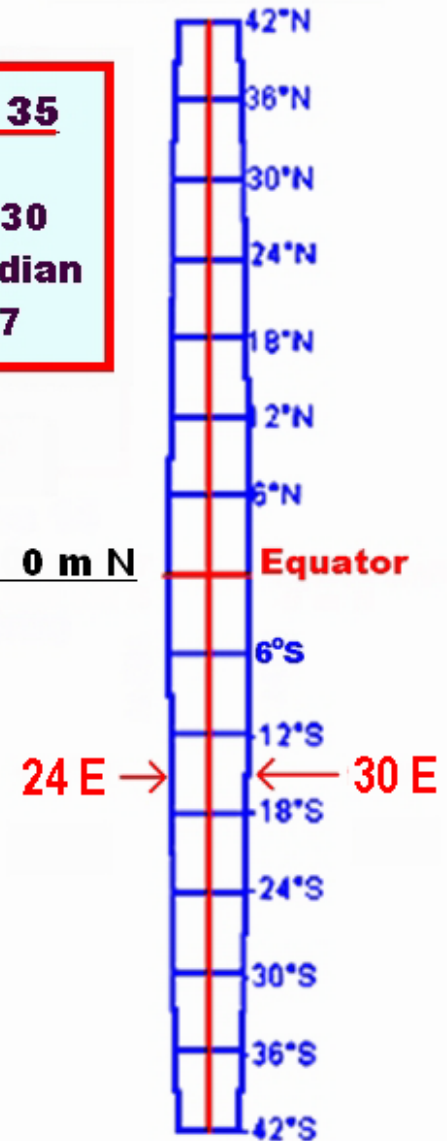
Universal Transverse Mercator (UTM) System

- In each zone:
- Each zone has its own longitude value termed the **Central meridian**
- Using **false eastings and northings** to make all projected coordinates positive.
- False easting = 500 km.
- In the northern hemisphere **false northing = 0.**
i.e. equator = 0 m. and
Northern pole = 10,000 km
- In the southern hemisphere **false northing = 10,000 km.**
i.e. equator = 10,000 km. and
southern pole = 0 m
- Data that **crosses zones** is subject to distortion.

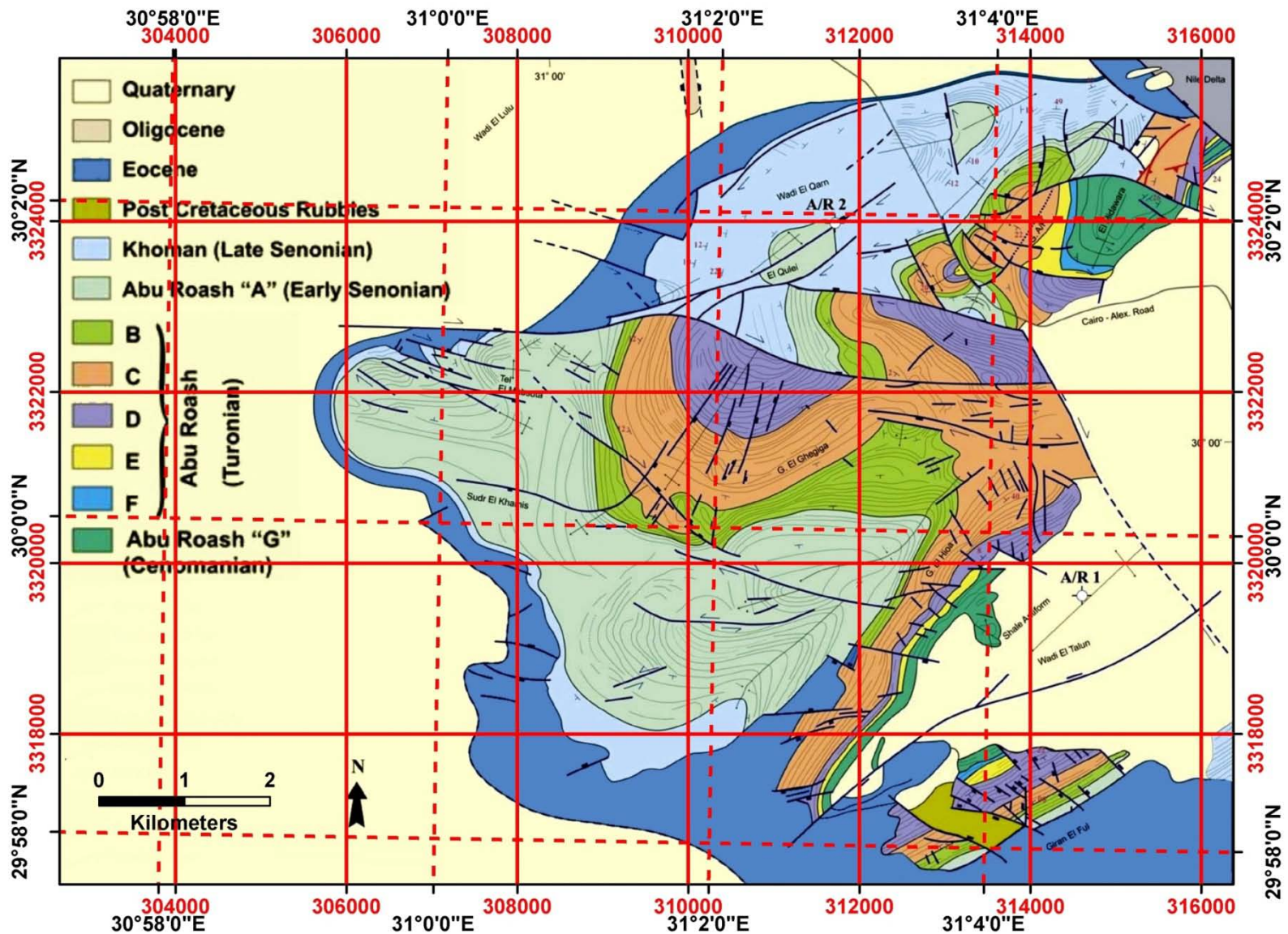
Central Meridain = Long. 27
False Easting = 500,000 m E

UTM ZONE 35
 From
Long. 24 to 30
Central Meridian
at Long, 27

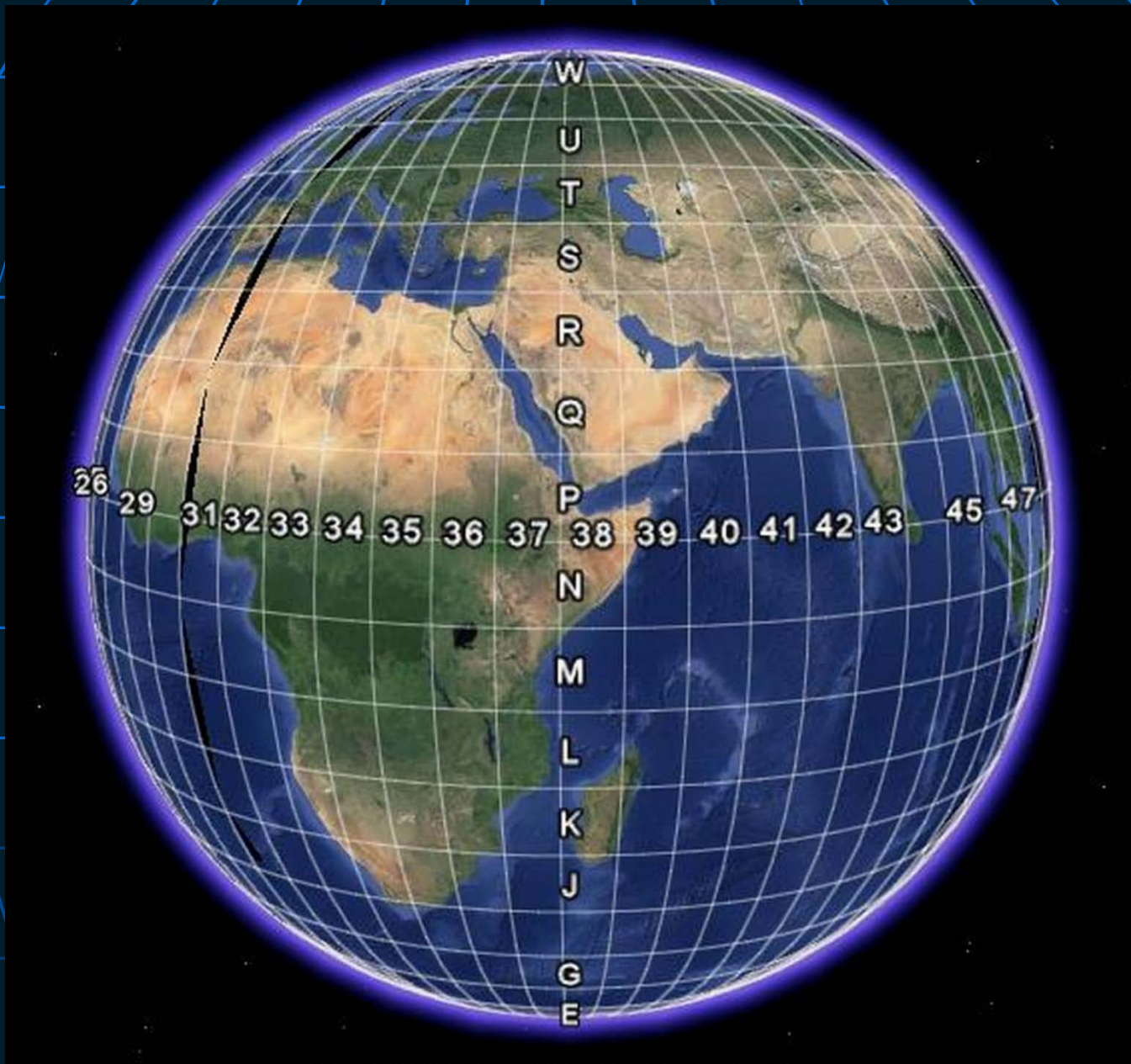
False Northing = 0 m N



False Northing = 10,000 m S



The map shows both coordinate systems (geographic coordinates in red. And UTM coordinates in red)



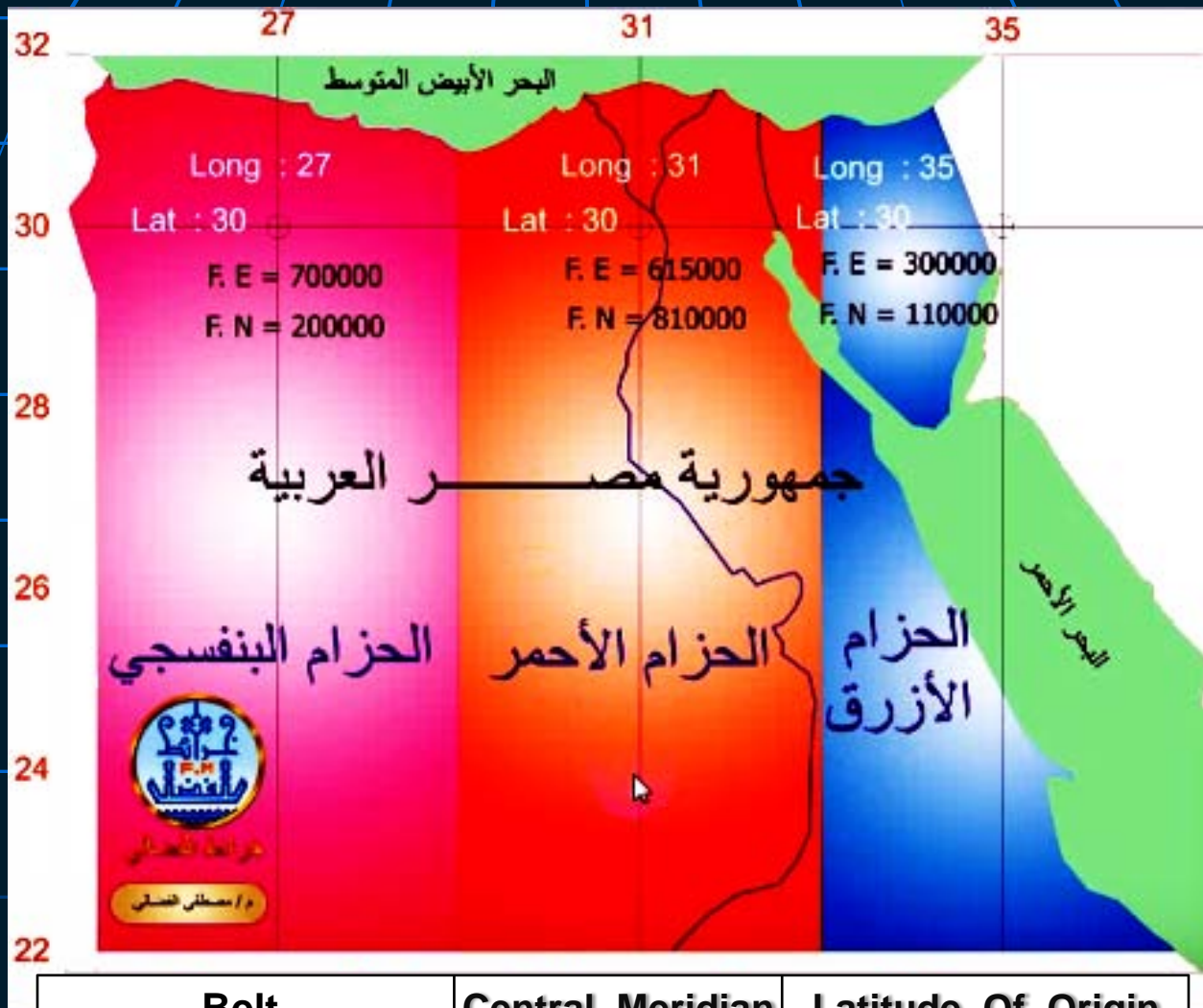
The UTM zones as seen on Google Earth

- **All satellite images (including Landsat) are arranged according to the UTM projection.**
- **In the header file of each scene, the number of the UTM zone in which the scene is located is stated.**

Coordinate systems

- A map projection transforms latitude and longitude locations to x,y coordinates.
- Two types of coordinate systems:
 - 1- Geographic coordinate system (GCS).
 - 2- Projected coordinate systems (PCS).
- Any data projected as projected coordinate system (PCS) has (in addition) its underlying Geographic Coordinate System (GCS).
- Geographic Coordinate System (GCS) has no projection.
- Projected coordinate systems are in meters or feet, and are defined with respect to a datum (**prime meridian**) specified by the projection system. In UTM system the prime meridian is the Greenwich zero longitude.

Local projection systems in Egypt



Belt	Central_Meridian	Latitude_Of_Origin
Egypt_Blue_Belt	35	30
Egypt_Red_Belt	31	30
Egypt_Purple_Belt	27	30

Local projection systems in Egypt

- Egypt Blue Belt

PROJCS["Egypt Blue Belt",GEOGCS["GCS_Egypt_1907",DATUM["D_Egypt_1907",SPHEROID["Helmert_1906",6378200.0,298.3]],PRIMEM["Greenwich",0.0],UNIT["Degree",0.0174532925199433]],PROJECTION["Transverse Mercator"],PARAMETER["False Easting",300000.0],PARAMETER["False Northing",1100000.0],PARAMETER["Central Meridian",35.0],PARAMETER["Scale Factor",1.0],PARAMETER["Latitude Of Origin",30.0],UNIT["Meter",1.0]]

- Egypt Red Belt

PROJCS["Egypt Red Belt",GEOGCS["GCS_Egypt_1907",DATUM["D_Egypt_1907",SPHEROID["Helmert_1906",6378200.0,298.3]],PRIMEM["Greenwich",0.0],UNIT["Degree",0.0174532925199433]],PROJECTION["Transverse Mercator"],PARAMETER["False Easting",615000.0],PARAMETER["False Northing",810000.0],PARAMETER["Central Meridian",31.0],PARAMETER["Scale Factor",1.0],PARAMETER["Latitude Of Origin",30.0],UNIT["Meter",1.0]]

- Egypt Purple Belt

PROJCS["Egypt Purple Belt",GEOGCS["GCS_Egypt_1907",DATUM["D_Egypt_1907",SPHEROID["Helmert_1906",6378200.0,298.3]],PRIMEM["Greenwich",0.0],UNIT["Degree",0.0174532925199433]],PROJECTION["Transverse Mercator"],PARAMETER["False Easting",70000.0],PARAMETER["False Northing",200000.0],PARAMETER["Central Meridian",27.0],PARAMETER["Scale Factor",1.0],PARAMETER["Latitude Of Origin",30.0],UNIT["Meter",1.0]]

- Egypt Extended Purple Belt

PROJCS["Egypt Extended Purple Belt",GEOGCS["GCS_Egypt_1907",DATUM["D_Egypt_1907",SPHEROID["Helmert_1906",6378200.0,298.3]],PRIMEM["Greenwich",0.0],UNIT["Degree",0.0174532925199433]],PROJECTION["Transverse Mercator"],PARAMETER["False Easting",700000.0],PARAMETER["False Northing",1200000.0],PARAMETER["Central Meridian",27.0],PARAMETER["Scale Factor",1.0],PARAMETER["Latitude Of Origin",30.0],UNIT["Meter",1.0]]

Length of a degree OF Lat. and Long (on WGS84)

At Latitude	Length of a degree of Latitude	Length of a degree of Longitude
0	110.574 km	111.320 km
15	110.649 km	107.551 km
30	110.852 km	96.486 km
45	111.132 km	78.847 km
60	111.412 km	55.800 km
75	111.618 km	28.902 km
90	111.694 km	0.000 km

N.B.:

Some of the figures and photos used in this lecture are used after previous iterations for the purpose of teaching for students.