APPLICATIONS OF REMOTE SENSING IN SITE SELECTION

Dr. Pradeep K. Naik

B.Tech. (RSA), M.Sc. (IITR), M.S. (USA), PhD (IITR)

Acknowledgements

Sh. AVSS Anand, Sc. D

OBJECTIVES

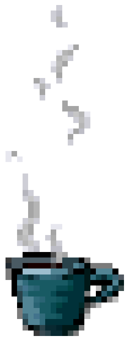
- At the end of the training, trainees shall be able to understand
  - the basics of remote sensing.
  - the applications of remote sensing.
  - the role of remote sensing in selection of sites for shallow or deep wells or any other feature for water storage and recovery.

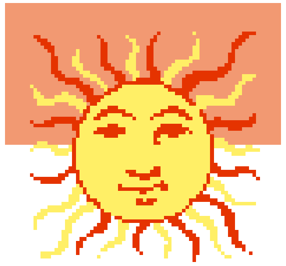
WHAT IS REMOTE SENSING?

- Collection of information about an object without being in physical contact with the object (Sabines, 1987).
- Use of electromagnetic energy/radiation sensors to record images of the environment which can be interpreted to yield useful information (Curran, 1985).

WHAT IS ENERGY?

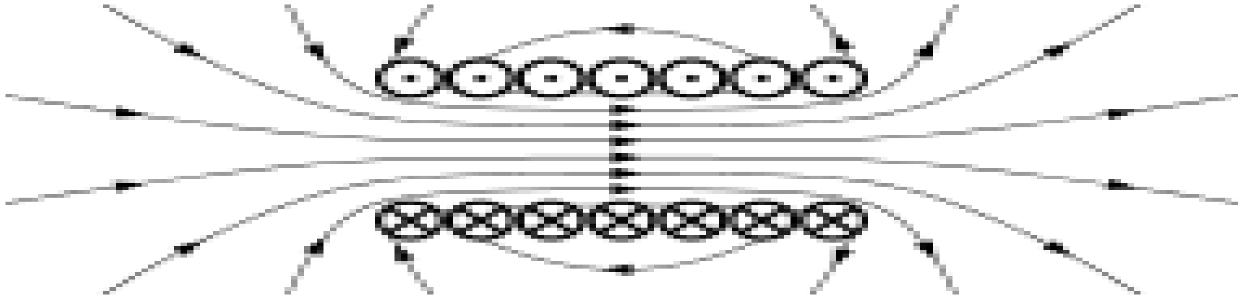
- Capacity for vigorous activity; available power (Dictionary.com).
- Property that must be transferred to an object in order to perform work, i.e., the capacity for doing work (Physics).
- Energy provides the ability to do work and by doing work energy is usually transferred from one point to the other by convection, conduction or **radiation**.





ELECTROMAGNETIC RADIATION (EMR)

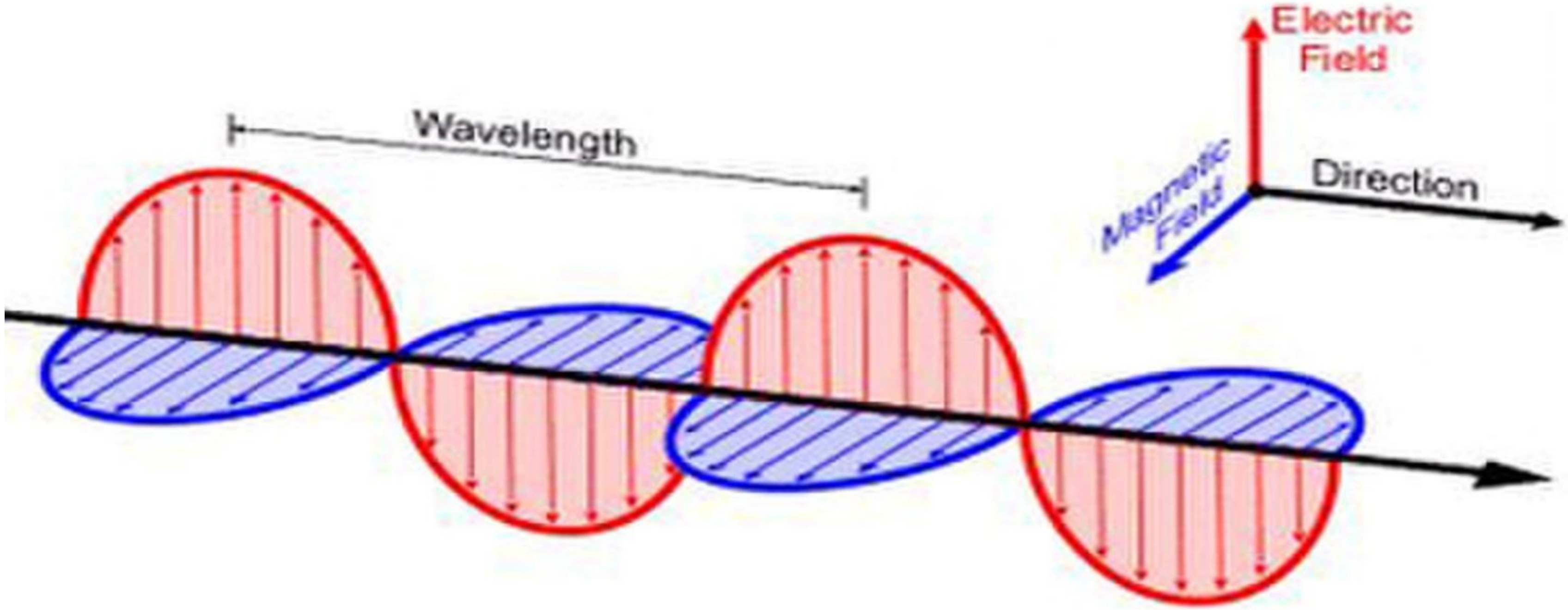
- The flow of energy at the universal speed of light through free space or through a material medium in the form of the electric and magnetic fields that make up the electromagnetic waves (classical physics).
- The flow of photons (also called light quanta) through space (modern quantum theory).

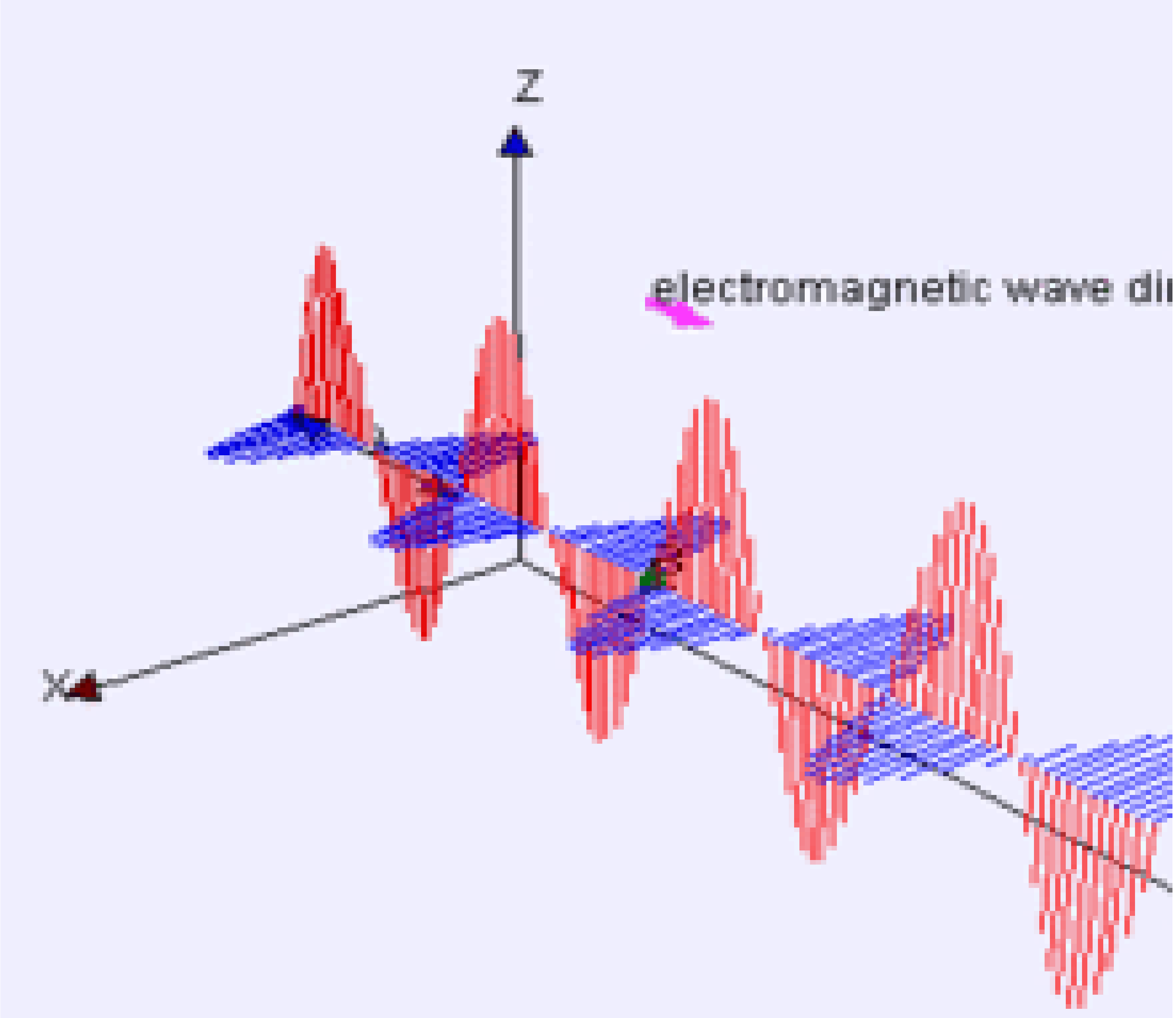


ELECTROMAGNETIC THEORY (Maxwell, 1873)

- The force of attraction or repulsion between electric charges is directly proportional to the product of their magnitudes or inversely proportional to the square of the distance between them.
- Magnetic poles come in pairs that attract and repel each other, much as electric charges do.
- An electric current in a wire produces a magnetic field whose direction depends on the direction of the current.
- A moving electric field produces a magnetic field, and vice versa.

ELECTROMAGNETIC RADIATION (EMR)





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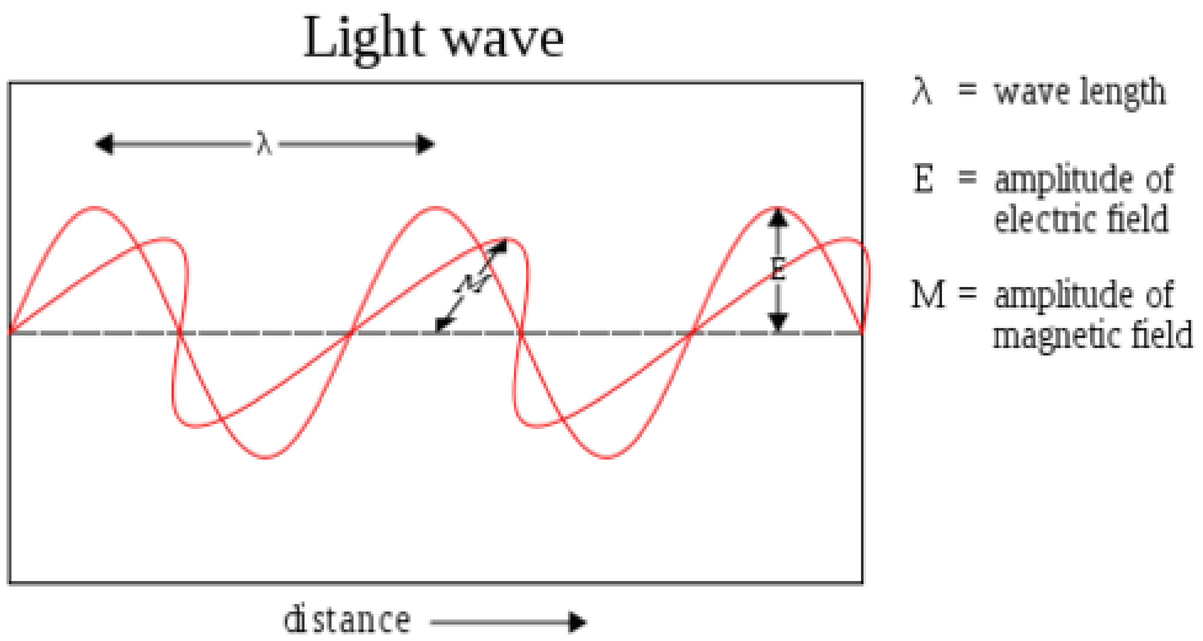
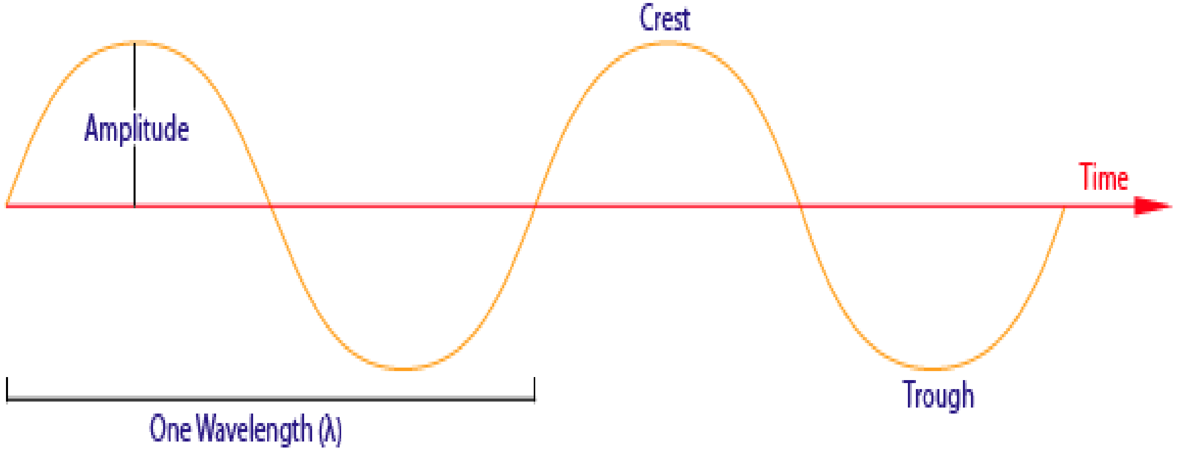
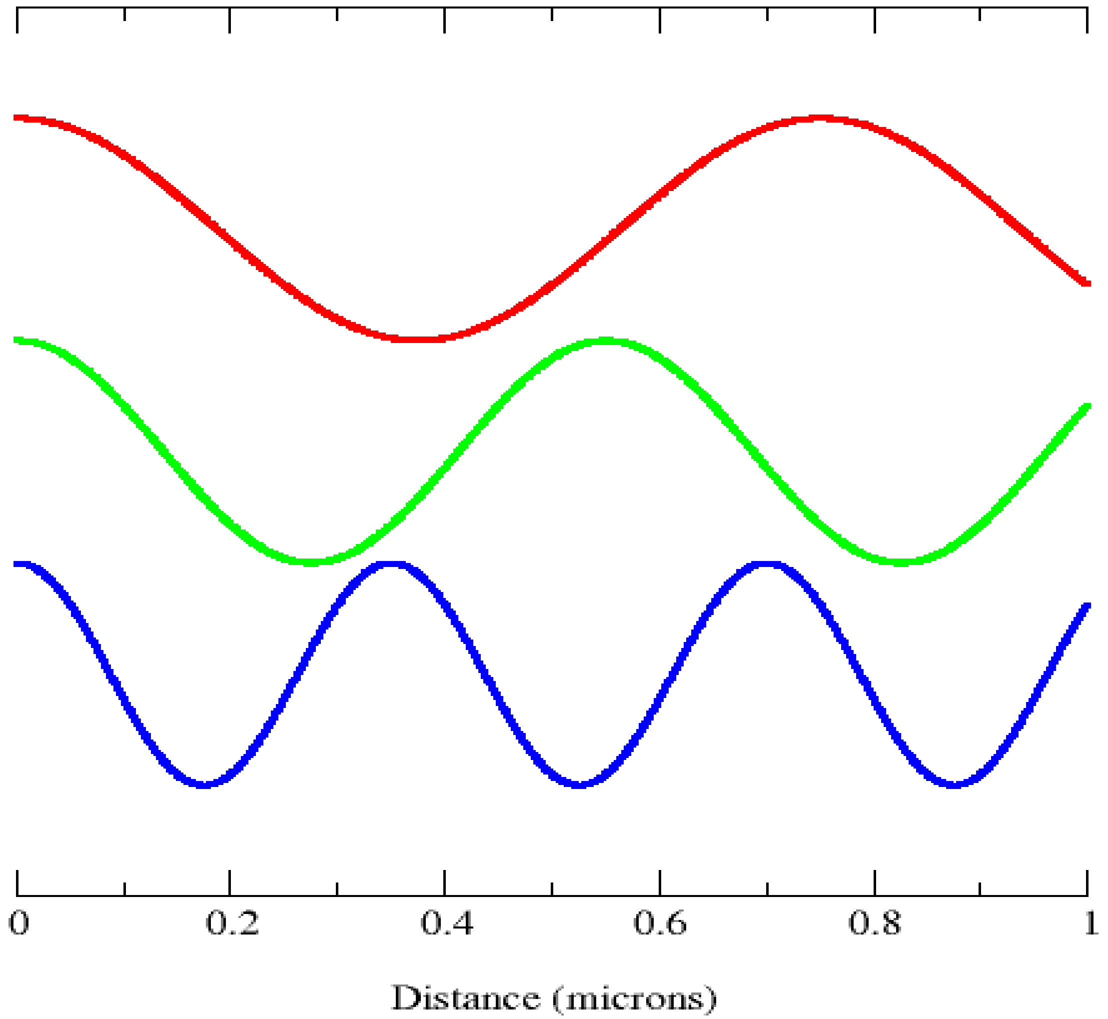
ELECTROMAGNETIC RADIATION (EMR)





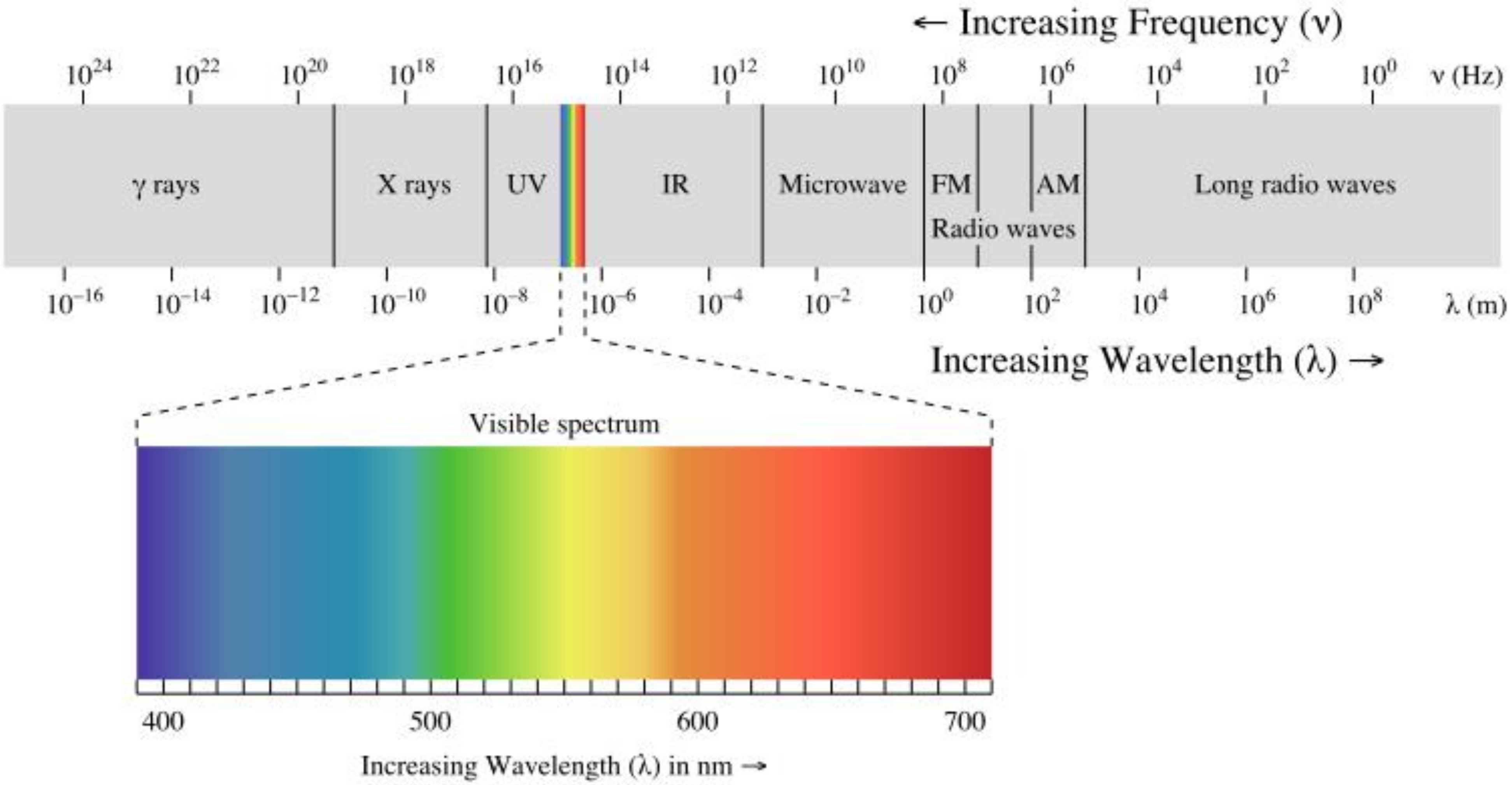
WAVE LENGTH AND FREQUENCY



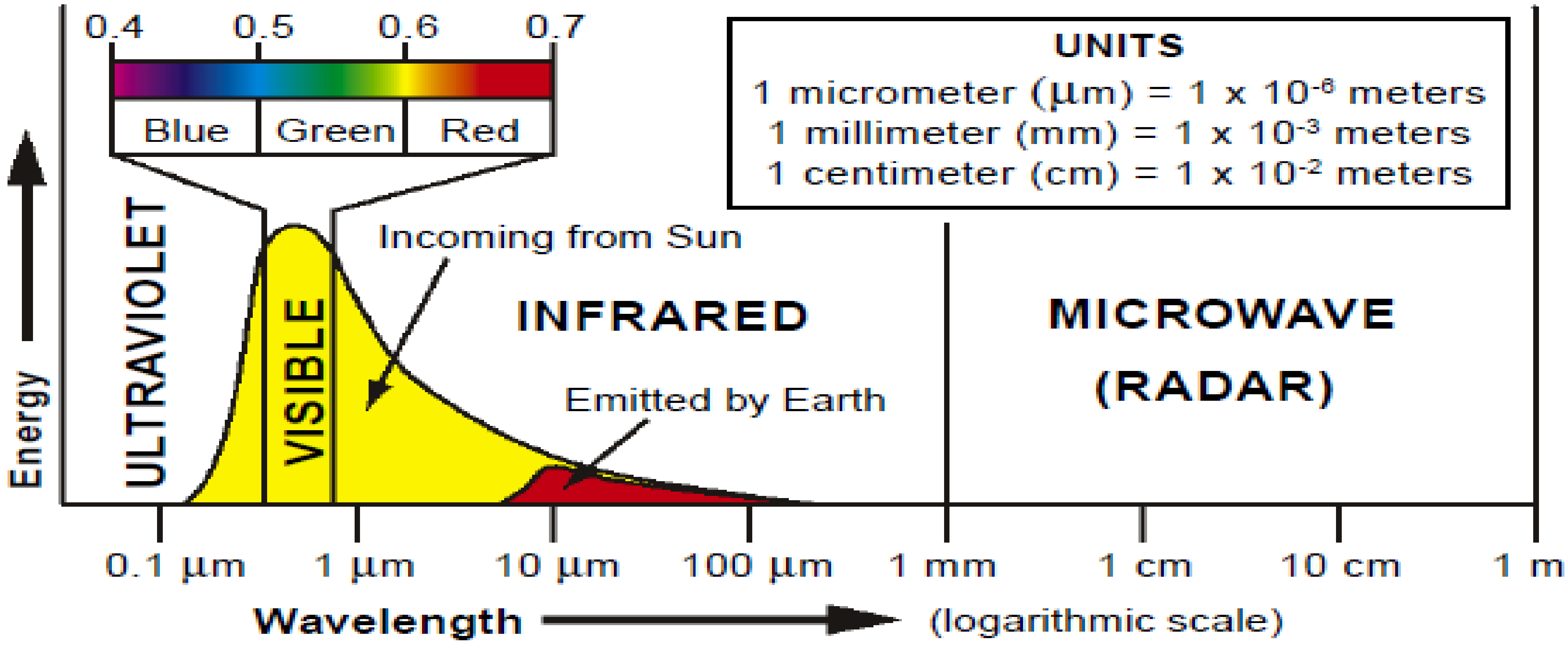
WAVE LENGTH AND FREQUENCY

- Frequency: No. of wave cycles per second, or hertz (Hz).
- A shorter wavelength has higher frequency because one cycle can pass in a shorter amount of time.
- A longer wavelength has a lower frequency because each cycle takes longer to complete.
- Wavelength tells the type of light and Amplitude tells about the intensity of the light.

ELECTROMAGNETIC SPECTRUM



THE ELECTROMAGNETIC SPECTRUM



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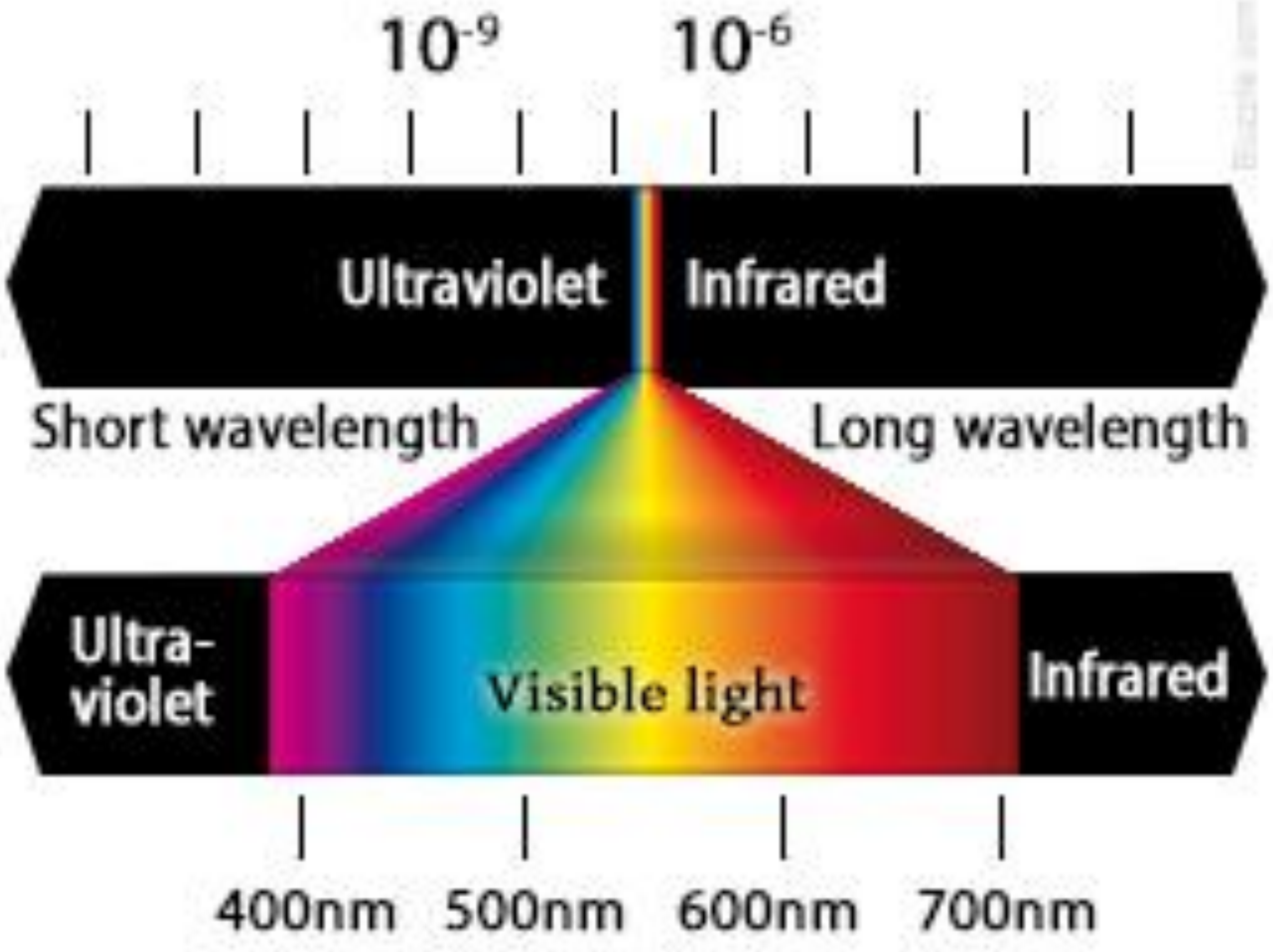

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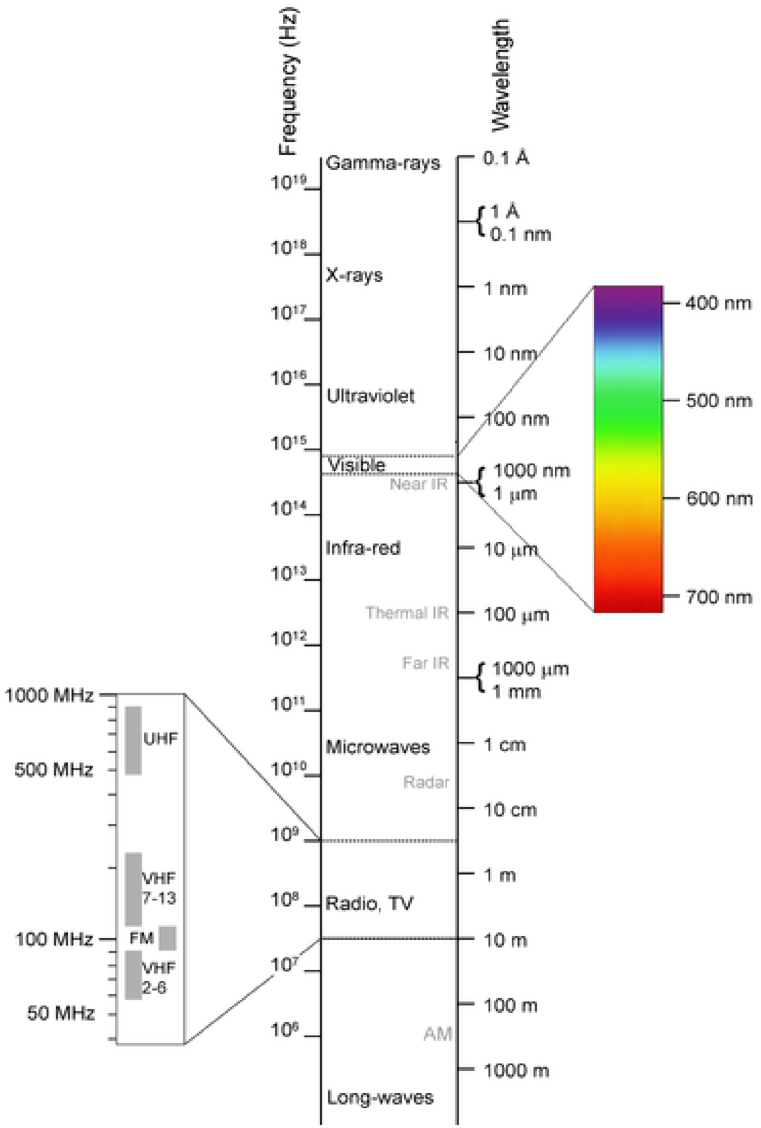
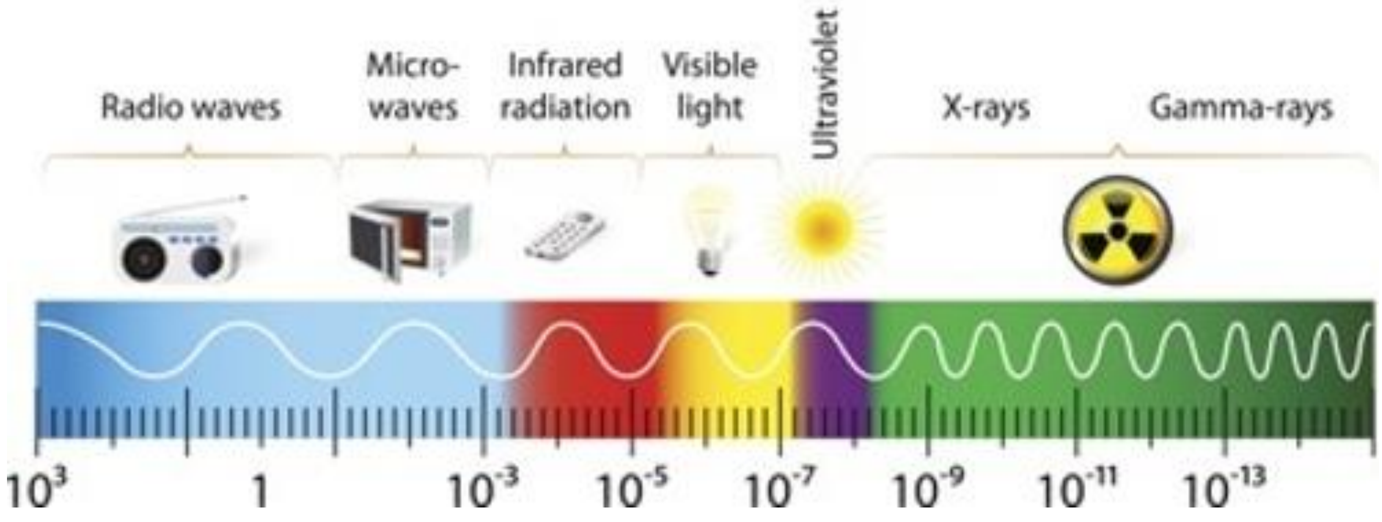
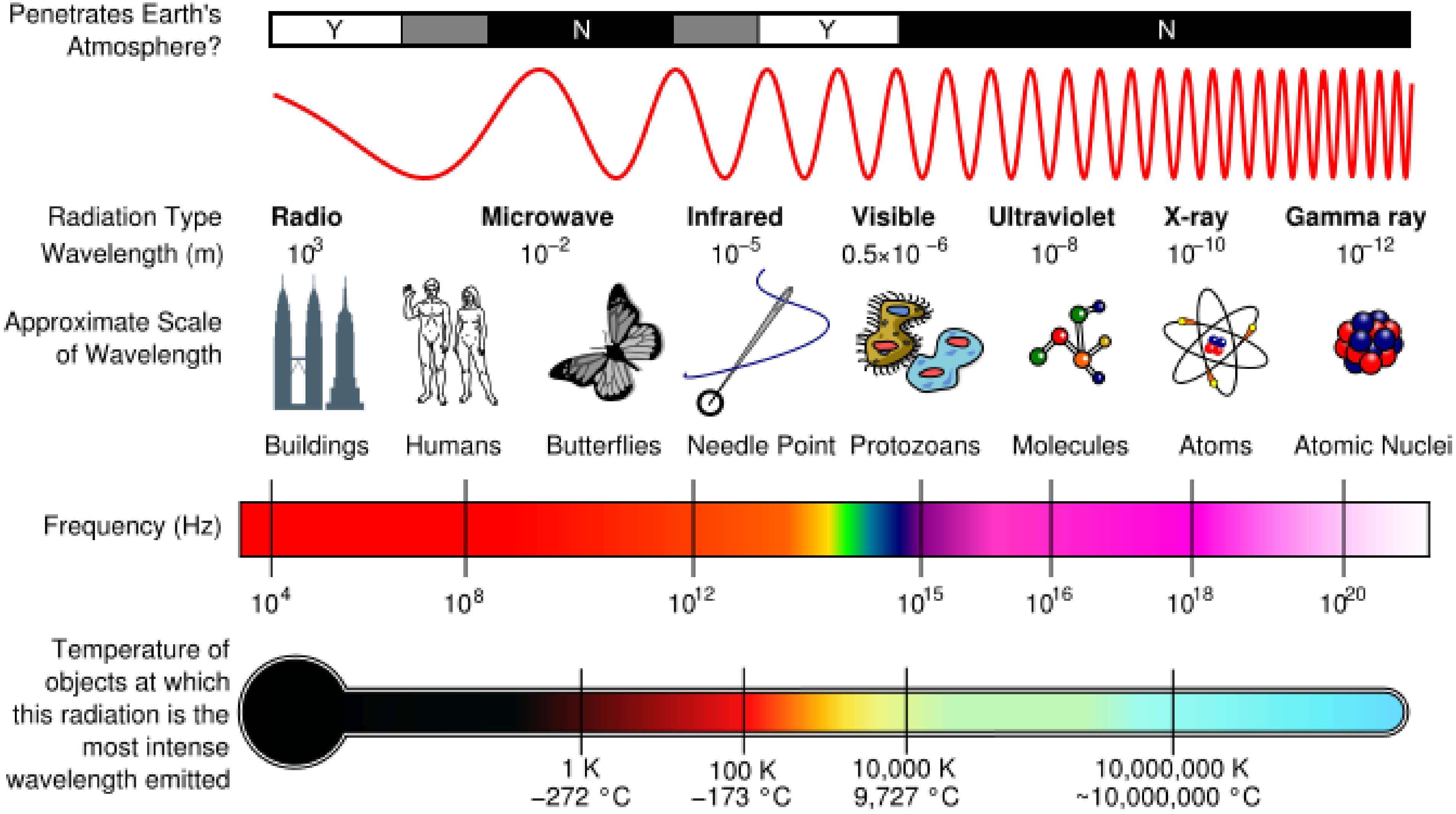
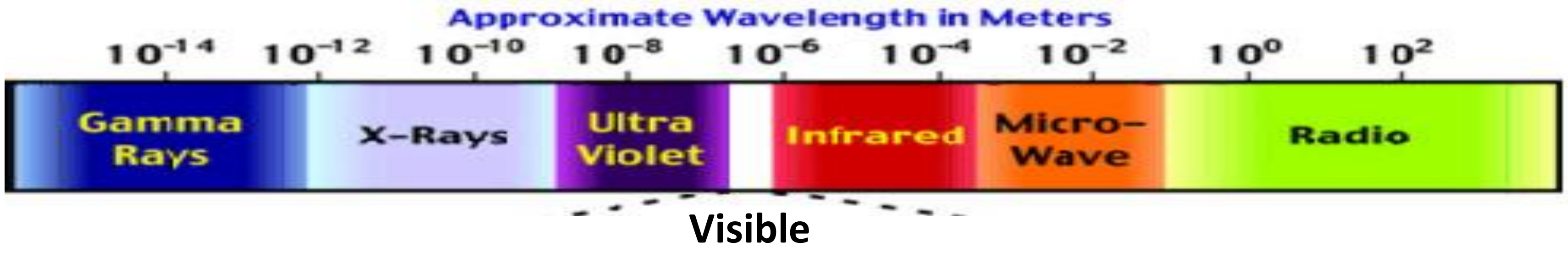




ELECTROMAGNETIC SPECTRUM WITH RADIATION TYPES

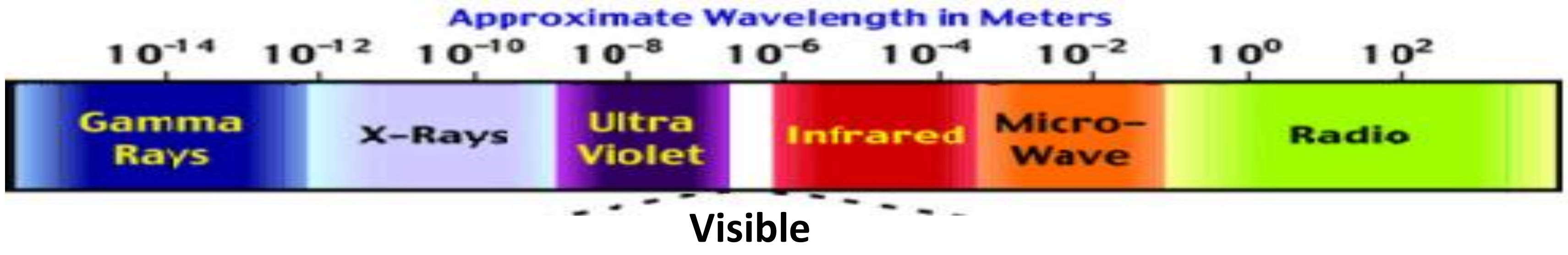


RADIO WAVES



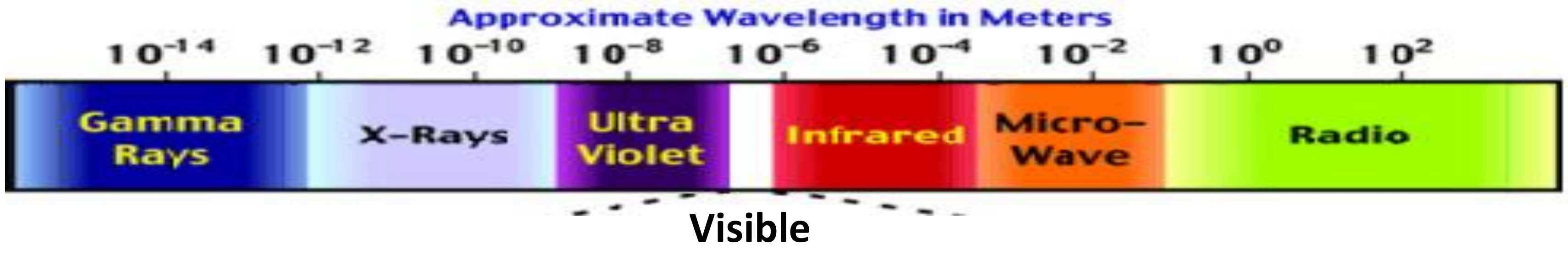
- Radio waves are at the lowest range of the EM spectrum, with frequencies of up to about 30 billion hertz, or 30 gigahertz (GHz), and wavelengths greater than about 10 millimeters (0.4 inches).
- Radio is used primarily for communications including voice, data and entertainment media.

MICROWAVES



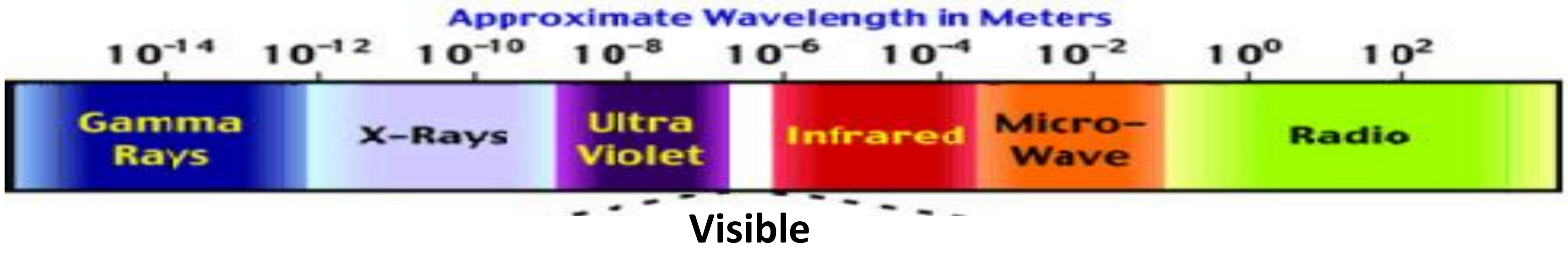
- Microwaves have frequencies from about 3 GHz up to about 30 trillion hertz, or 30 terahertz (THz), and wavelengths of about 10 mm (0.4 inches) to 100 micrometers (µm), or 0.004 inches.
- Microwaves are used for high-bandwidth communications, radar and as a heat source for microwave ovens and industrial applications.

INFRARED (IR)



- IR has frequencies from about 30 THz up to about 400 THz and wavelengths of about 100 µm (0.004 inches) to 740 nanometers (nm), or 0.00003 inches.
- IR light is invisible to human eyes, but we can feel it as heat if the intensity is sufficient.

VISIBLE LIGHT

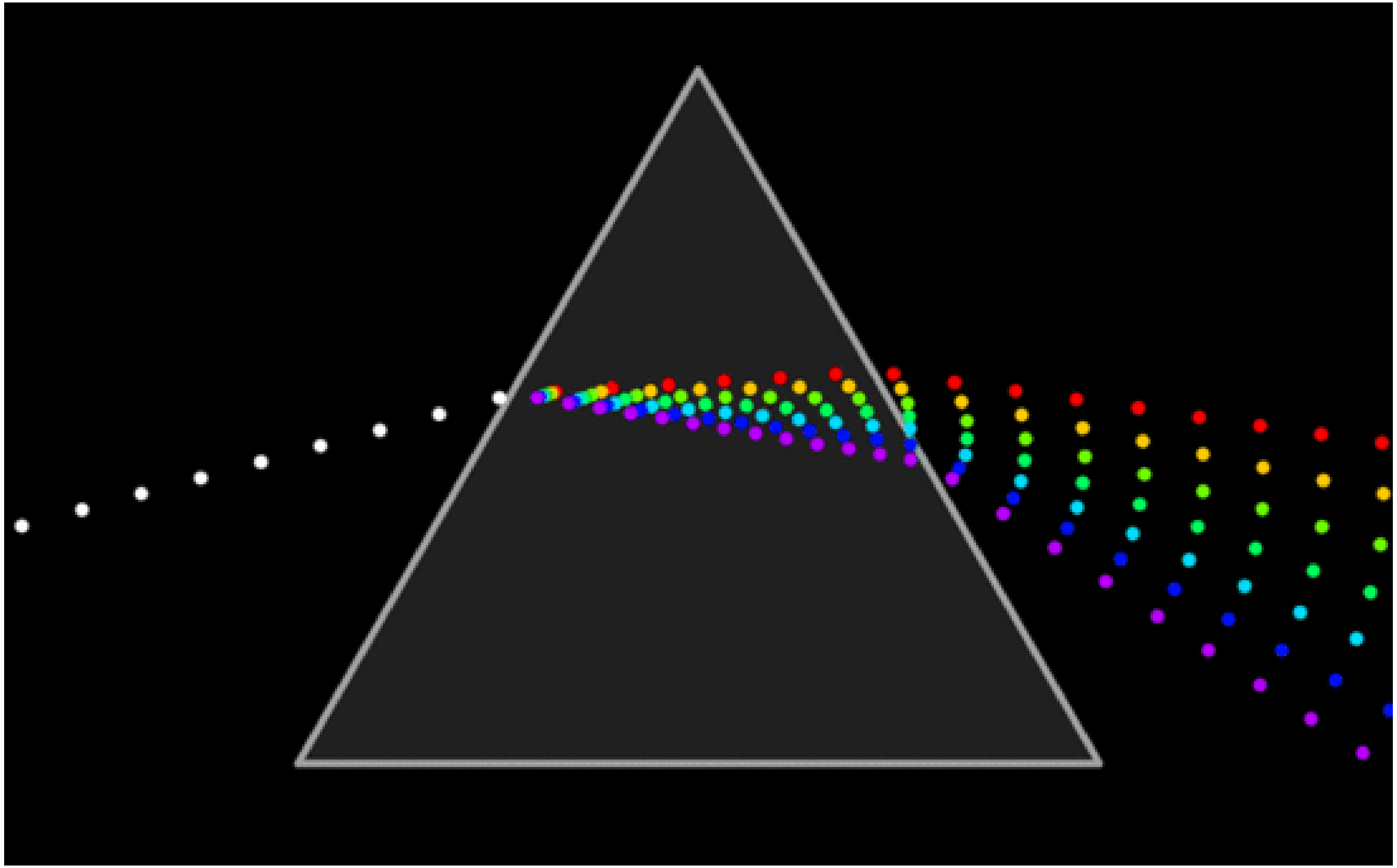


- Visible light is defined as the wavelengths that are visible to most human eyes.
- Visible light has frequencies of about 400 THz to 800 THz and wavelengths of about 740 nm (0.00003 inches) to 380 nm (0.000015 inches).

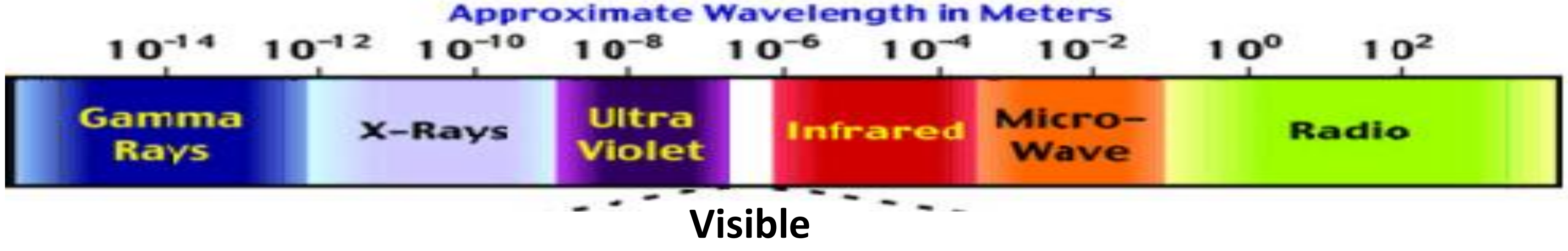
COLOUR REGIONS OF VISIBLE SPECTRUM

Colour Region	Wavelength (nm)
Violet	380-435
Blue	435-500
Cyan	500-520
Green	520-565
Yellow	565-590
Orange	590-625
Red	625-740

COLOR REGIONS OF VISIBLE SPECTRUM

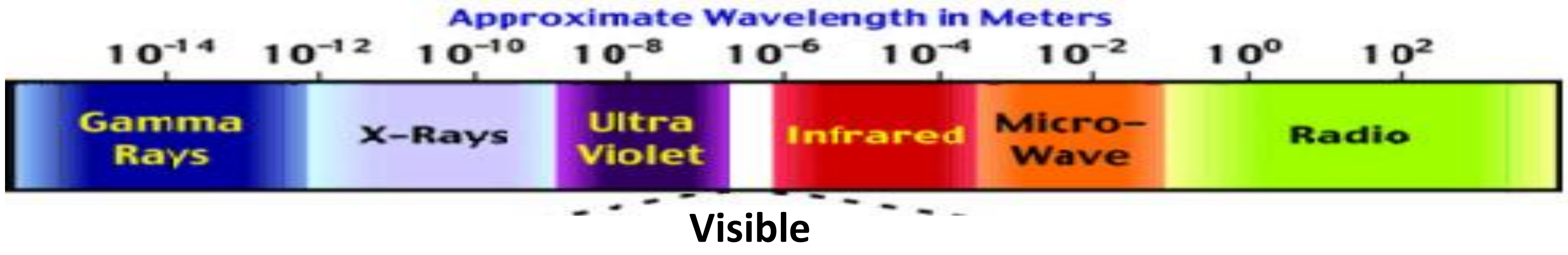


ULTRAVIOLET (UV)



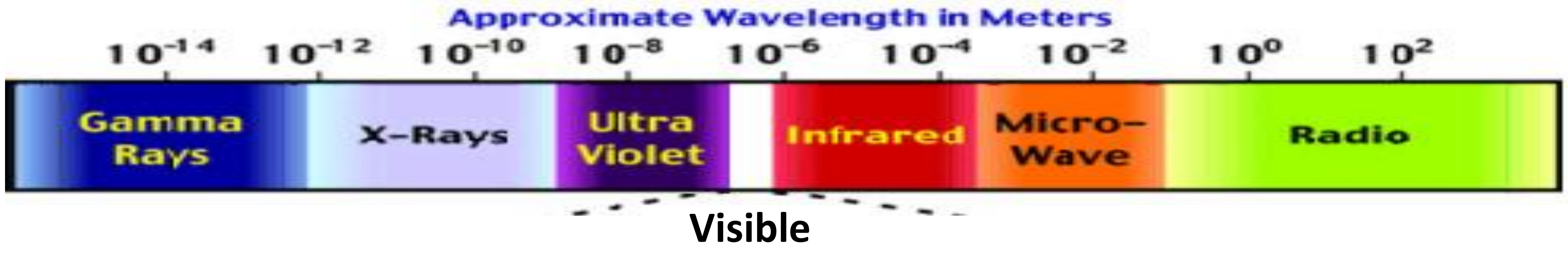
- Ultraviolet light has frequencies of about 8×10^{14} to 3×10^{16} Hz and wavelengths of about 380 nm (0.000015 inches) to about 10 nm (0.0000004 inches).
- UV light is a component of sunlight; however, it is invisible to the human eye. It has numerous medical and industrial applications, but it can damage living tissue.

X-RAYS



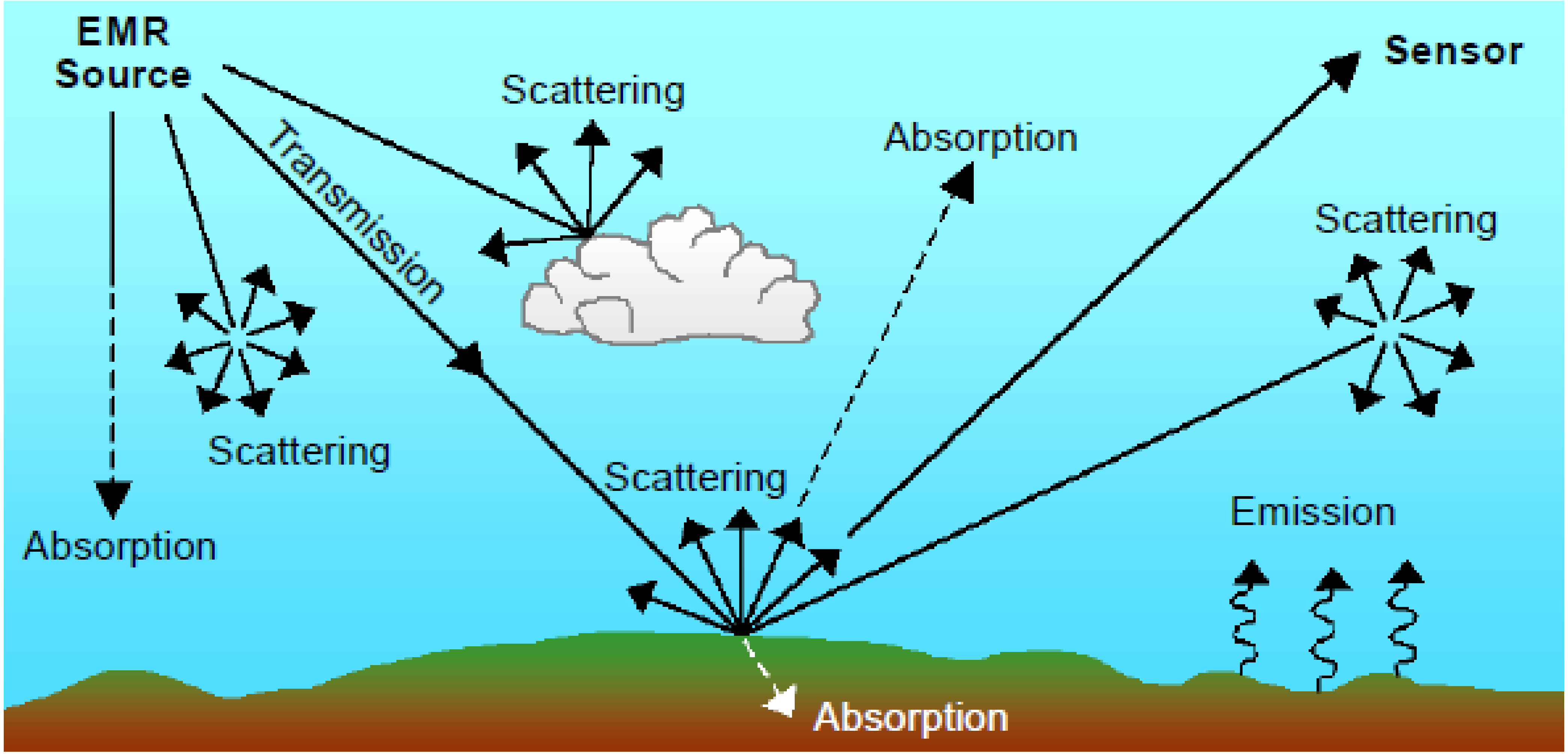
- Soft X-rays: Frequencies of about 3×10^{16} to about 10^{18} Hz and wavelengths of about 10 nm (4×10^{-7} inches) to about 100 picometers (pm), or 4×10^{-8} inches.
- Hard X-rays: same region of the EM spectrum as gamma rays.
    - The only difference between them is their source: X-rays are produced by accelerating electrons, while gamma rays are produced by atomic nuclei.

GAMMA-RAYS



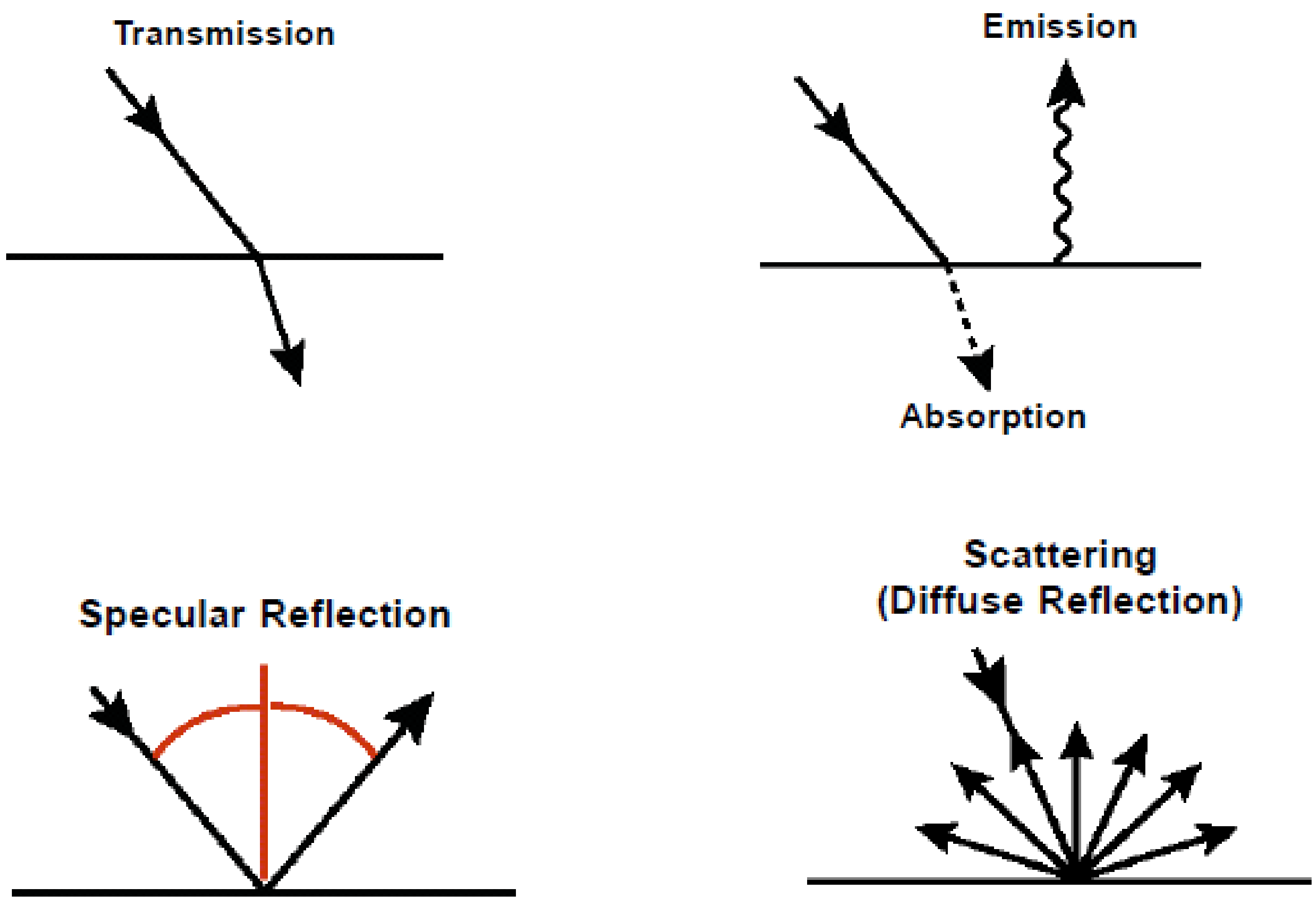
- Gamma-rays have frequencies greater than 10^{18} Hz and wavelengths of less than 100 pm (4×10^{-9} inches).
- Gamma radiation causes damage to living tissue, which makes it useful for killing cancer cells when applied in carefully measured doses to small regions. Uncontrolled exposure, though, is extremely dangerous to humans.

INTERACTION PROCESS IN REMOTE SENSING



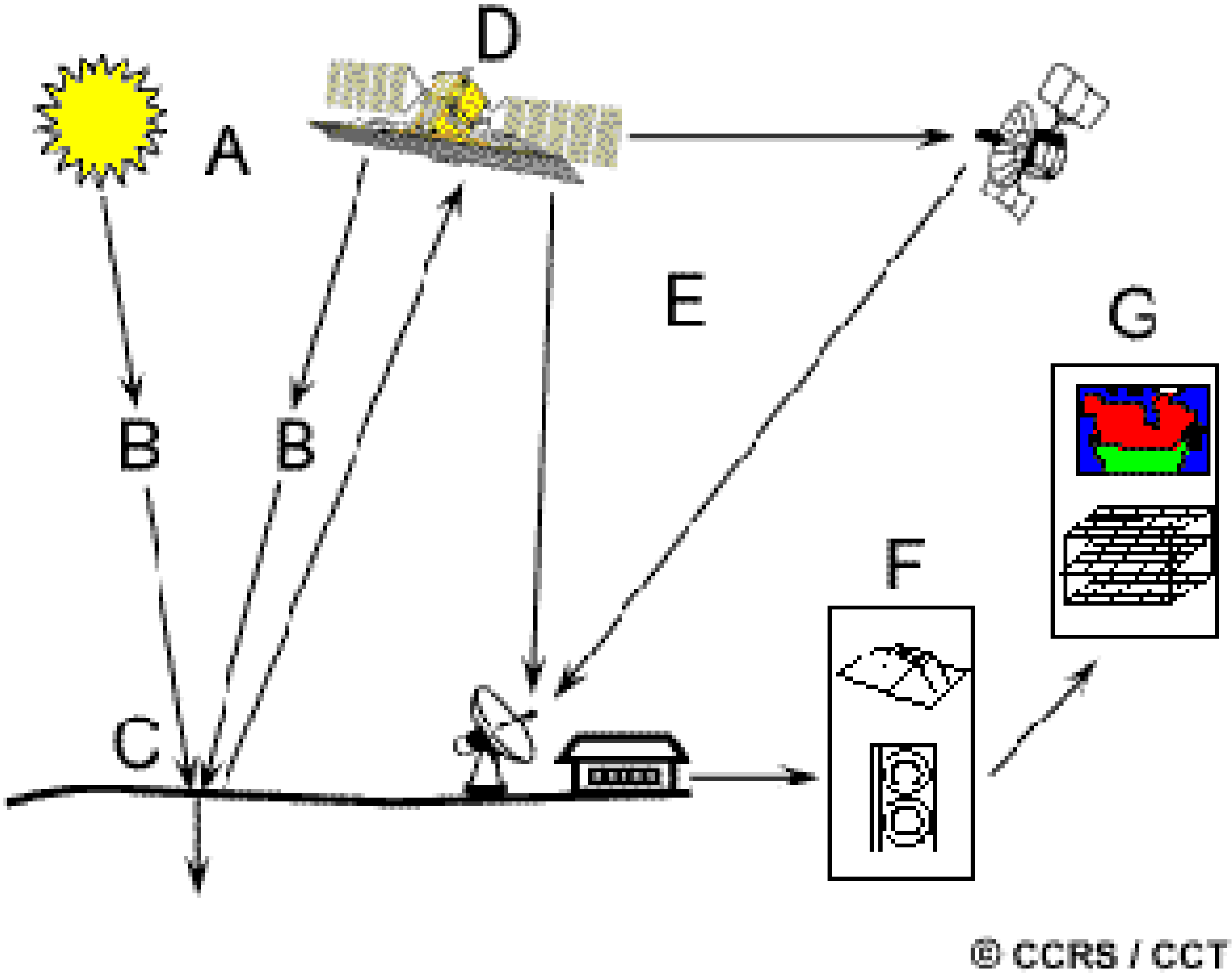
Typical EMR interactions in the atmosphere and at the Earth's surface.

INTERACTION PROCESS



REMOTE SENSING: THE PROCESS

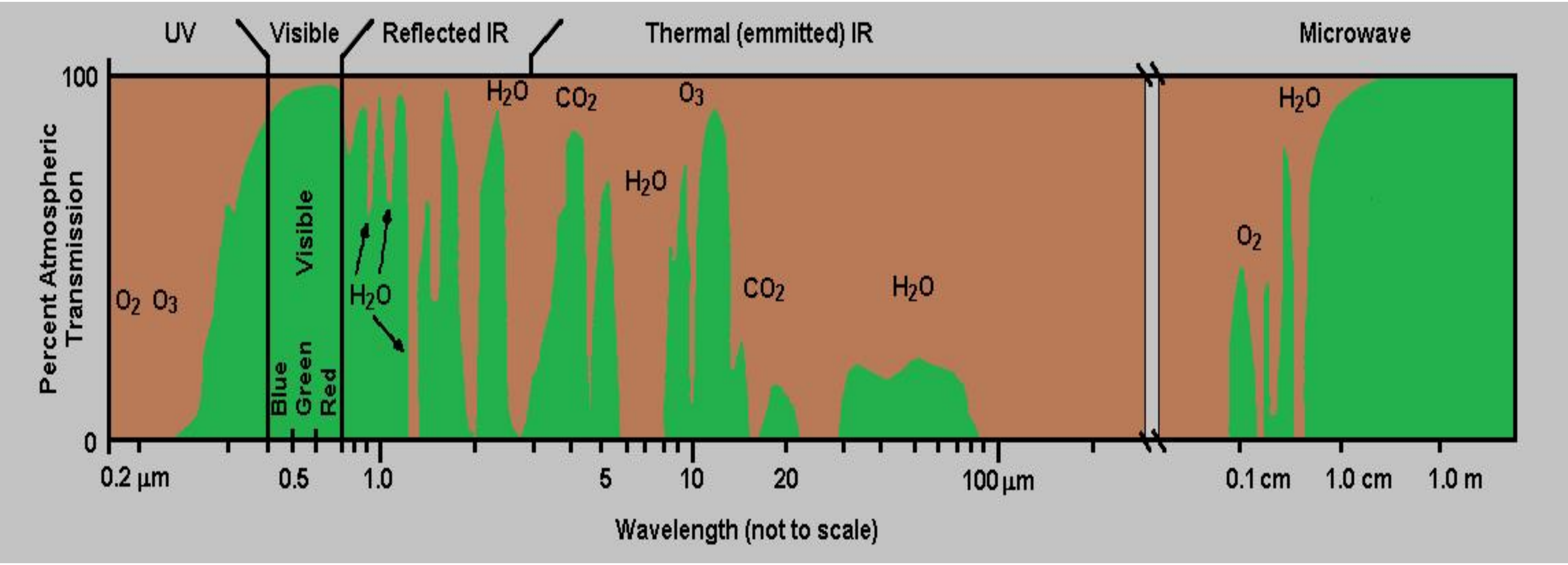
1. Energy Source/Illumination (A)
2. Radiation and Atmosphere (B)
3. Interaction with Target (C)
4. Recording of Energy by Sensor (D)
5. Transmission, Reception, and Processing (E)
6. Interpretation and Analysis (F)
7. Application (G)



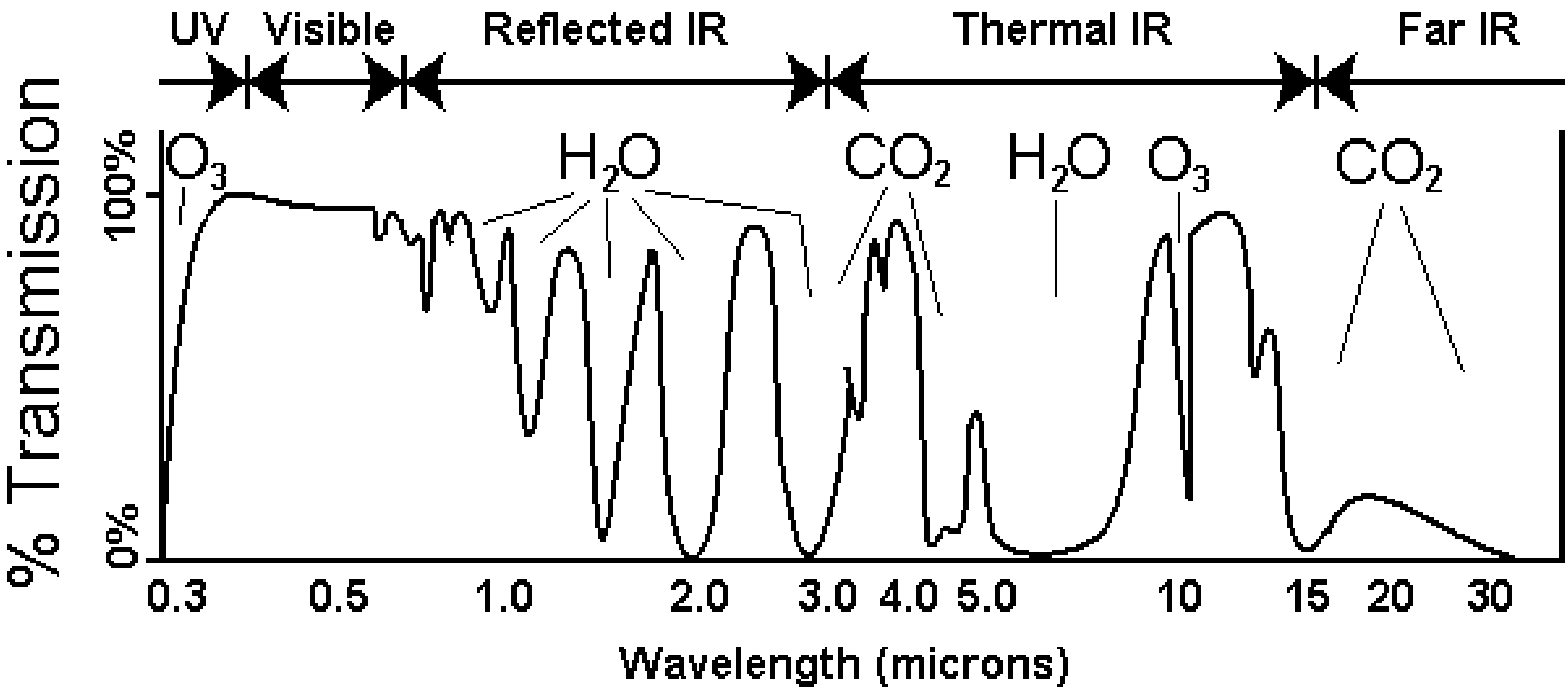
Video

ATMOSPHERIC WINDOWs

The wavelength ranges in which the atmosphere is transparent are called atmospheric windows



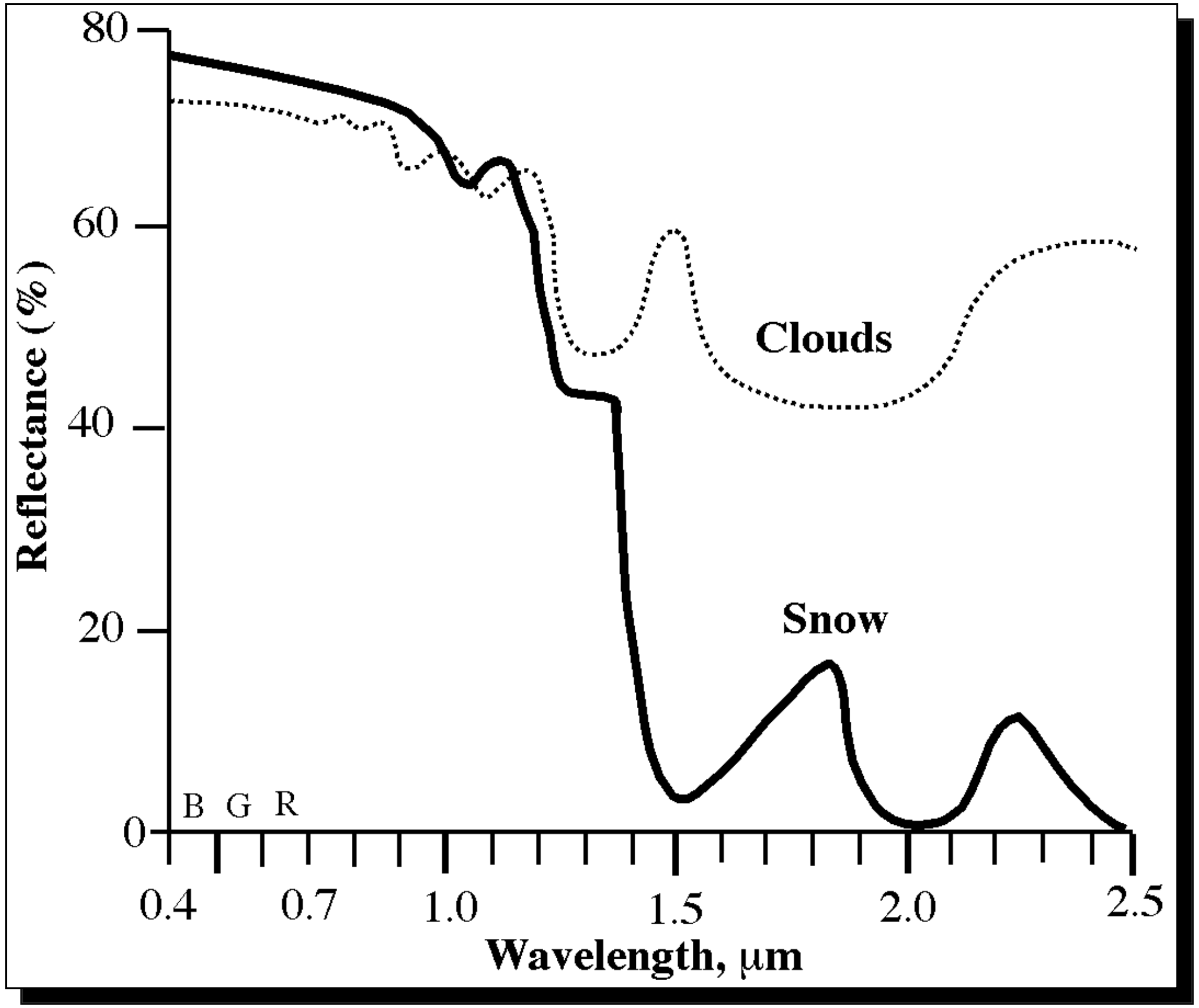
ATMOSPHERIC WINDOWS



SPECTRAL SIGNATURE

Variation of reflectance or emmittance of a material with respect to wavelengths

(i.e., reflectance / emmittance as a function of wavelength).



SPECTRAL SIGNATURE

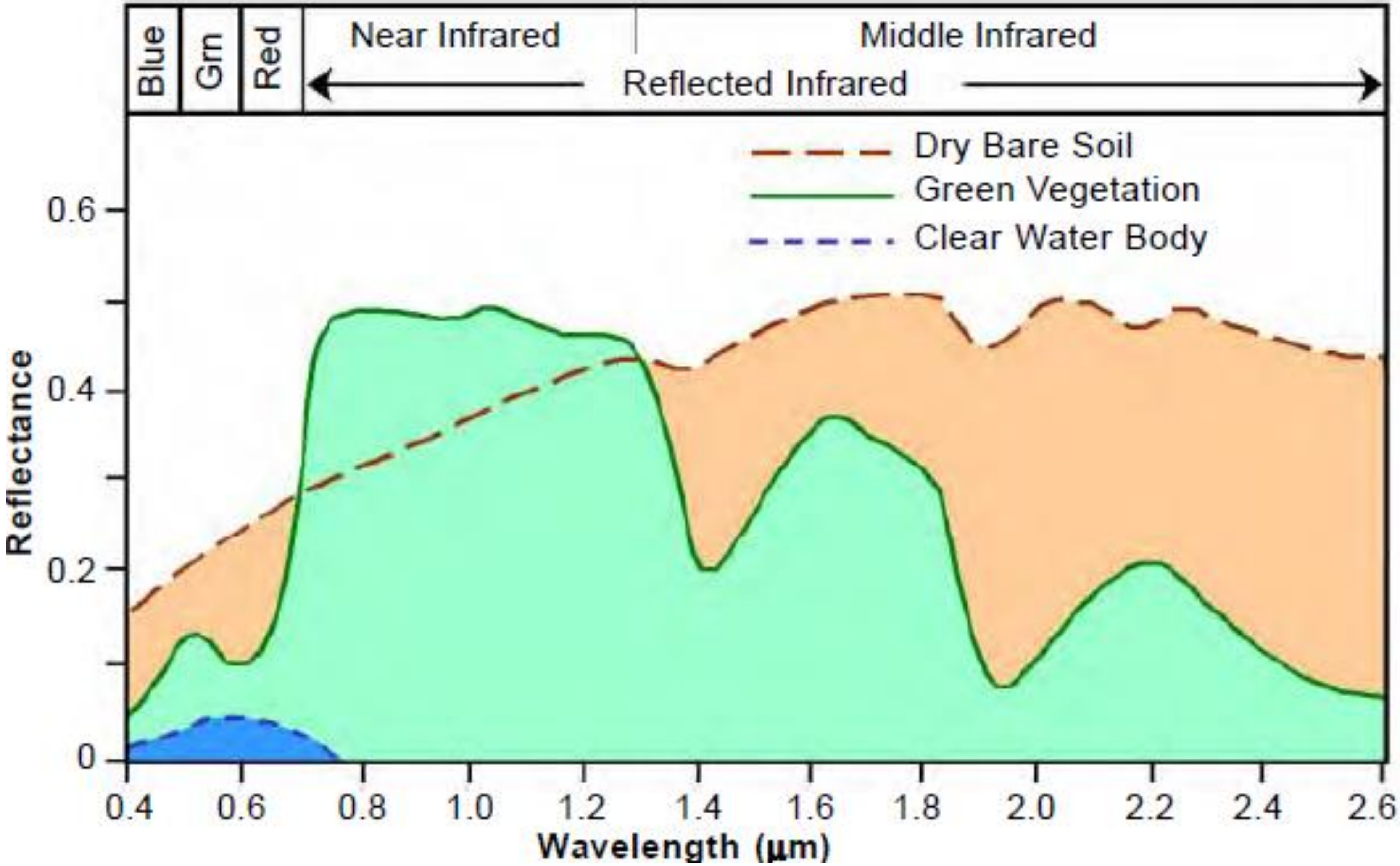
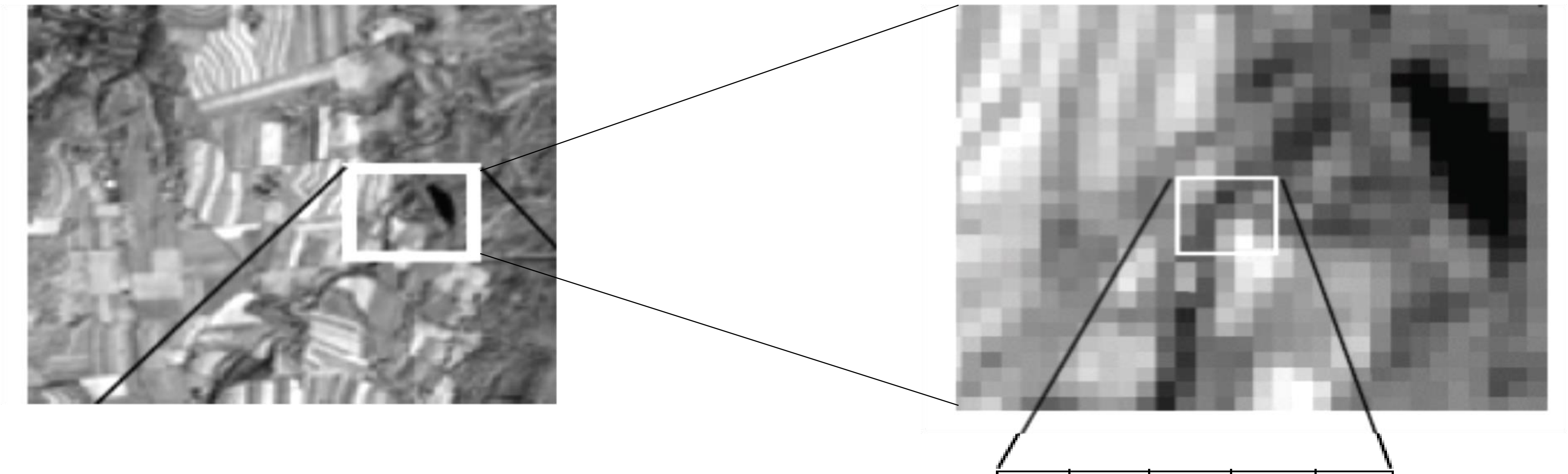


IMAGE ACQUISITION



115	111	71	67	74
111	89	52	77	95
87	66	74	87	80
89	64	102	125	90
70	65	113	144	119

Electronic sensors generate an electrical signal with a strength proportional to the amount of energy received and transmitted electronically in digital form (as a series of numbers)

REMOTE SENSING SENSORS

Sensor :

Common Definition :

- Sensors are Sophisticated devices that are frequently used to detect and respond to electrical or optical signals
- A Sensor converts the Physical parameter into a signal which can be measured electrically

REMOTE SENSING SENSORS

Sensor :

Definition in Remote Sensing :

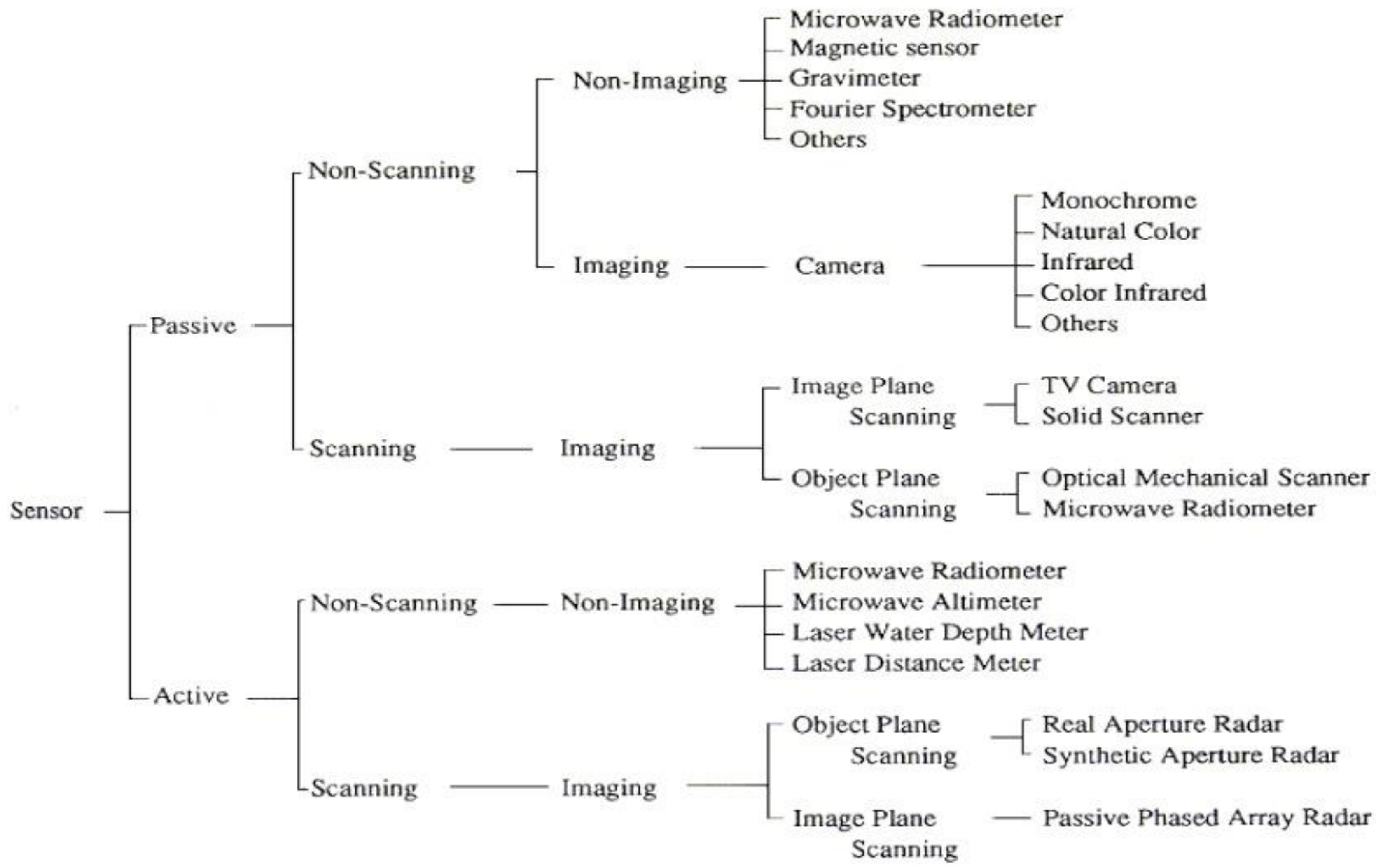
- **Sensor is a device that gathers energy (EMR) converts into signal and present it into a signal and present it in a form (image) suitable for obtaining information about the objet under investigation**

REMOTE SENSING SENSORS

- Active sensors: provide their own source of energy to illuminate the objects they observe. The sensor then detects and measures the radiation that is reflected or backscattered from the target.
- Passive sensors: detect natural energy (radiation) that is emitted or reflected by the object or scene being observed. Reflected sunlight is the most common source of radiation measured by passive sensors.

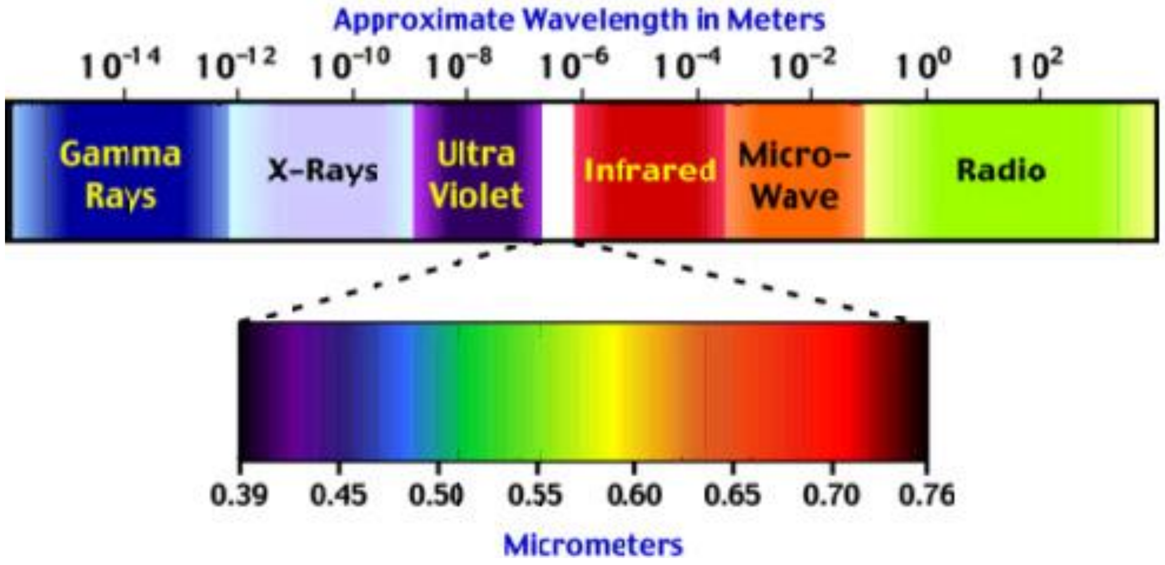
REMOTE SENSING SENSORS

Types of sensors :



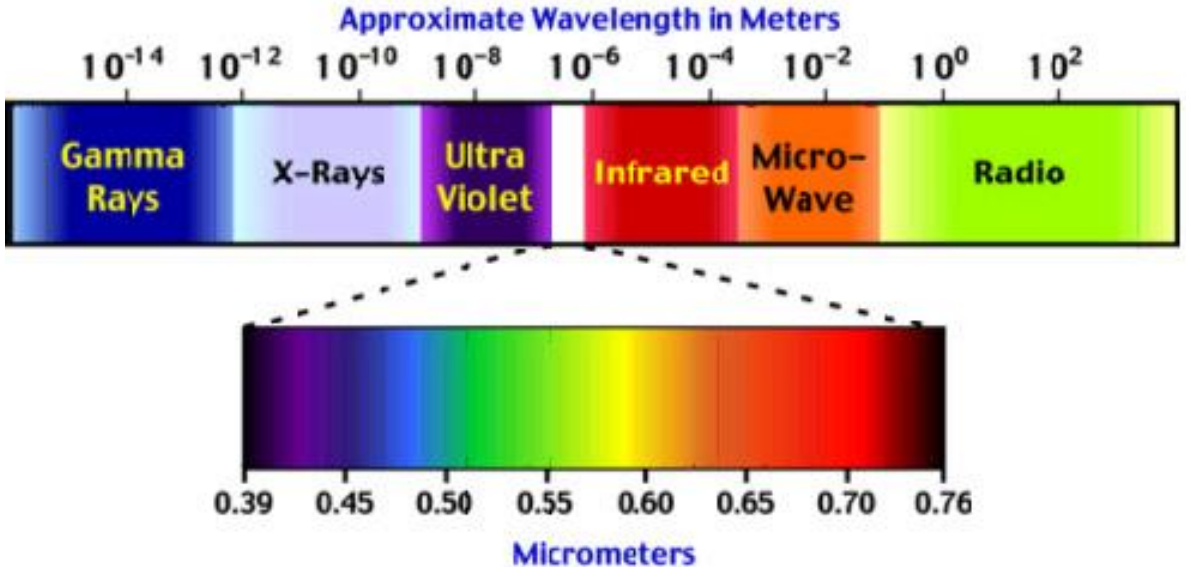
ACTIVE SENSORS

- The majority of active sensors operate in the microwave portion of the electromagnetic spectrum, which makes them able to penetrate the atmosphere under most conditions.
  - Laser altimeter
  - Lidar
  - Radar
  - Ranging Instrument
  - Scatterometer
  - Sounder



PASSIVE SENSORS

- Most passive systems operate in the visible, infrared, thermal infrared, and microwave portions of the electromagnetic spectrum.
  - Accelerometer
  - Hyperspectral radiometer
  - Imaging radiometer
  - Radiometer
  - Sounder
  - Spectrometer
  - Spectroradiometer



Video

REMOTE SENSING PLATFORMS

Types of platforms :

- **Ground based platforms**
  - Short range systems(50-100 m)
  - Medium Range Systems (150-250 m)
  - Long range Systems (up to 1 km)
- **Airborne platforms**
- **Space-borne platforms**

REMOTE SENSING PLATFORMS

Types of platforms :

Ground Based Platforms:

Mobile hydraulic platforms (up to 15 m height)

REMOTE SENSING PLATFORMS

Types of platforms :

Portable Masts

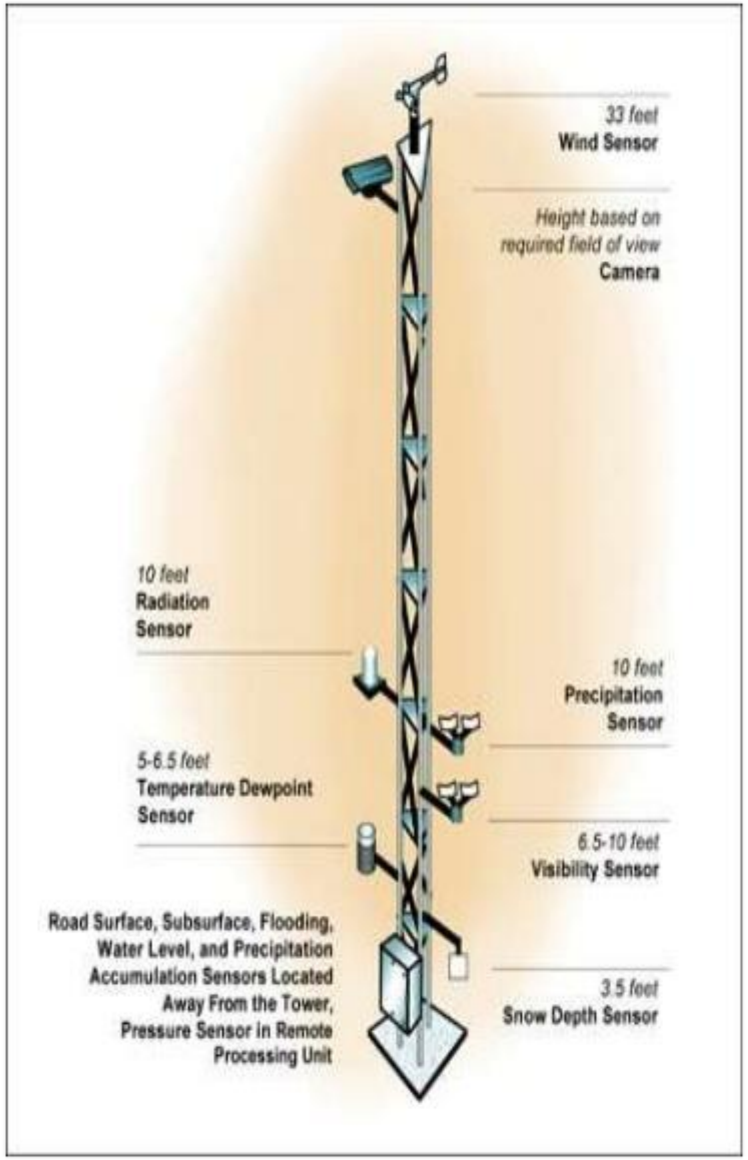
- Unstable in wind conditions

REMOTE SENSING PLATFORMS

Types of platforms :

Towers:

- Greater rigidity than masts

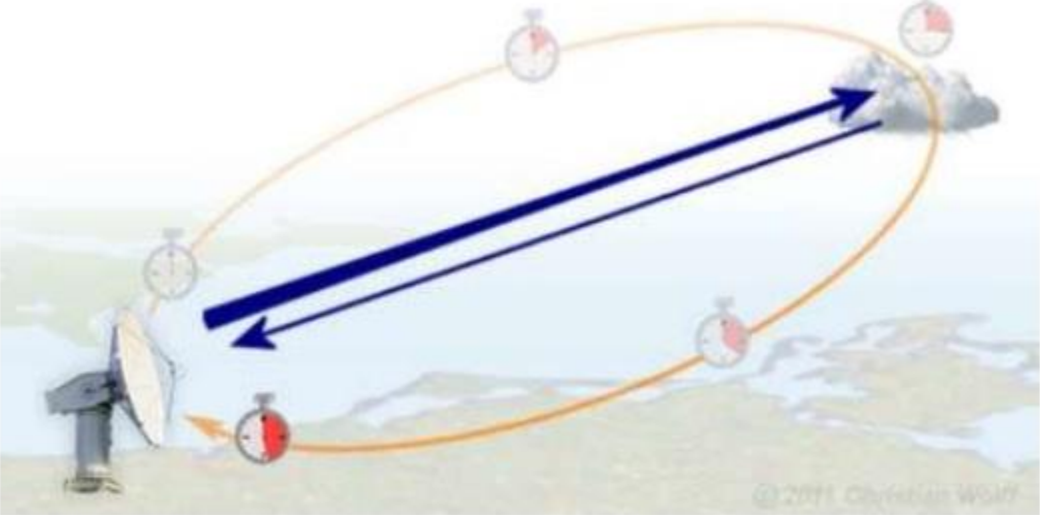


REMOTE SENSING PLATFORMS

Types of platforms :

Weather Surveillance Radar

- Detects and tracks typhoons and cloud masses



REMOTE SENSING PLATFORMS

Types of platforms :

Airborne Platforms:

Balloons based :

- **Altitude range is 22-40 km**
- **Tool to probing the atmosphere**
- **Useful to test the instruments under development**

REMOTE SENSING PLATFORMS

Types of platforms :

Airborne Platforms:

Radiosonde:

Measure pressure, Temperature and Relative humidity in the atmosphere

Rawinsonde:

Measure wind velocity, temperature, pressure and relative humidity

REMOTE SENSING PLATFORMS

Types of platforms :

Aircraft:

Advantages:

- **High spatial resolution (20 cm or less)**
- **Analog photography is possible (analog photo gives high resolution)**
- **Easily change their schedule to avoid weather problems**
- **Sensor maintenance and repair is easy**

REMOTE SENSING PLATFORMS

Types of platforms :

Aircraft:

Dis Advantages:

- **Permission to intrude into foreign airspace is required**
- **Many passes to cover larger area**
- **Swath is much less compare to satellite**
- **High cost per unit area**

REMOTE SENSING PLATFORMS

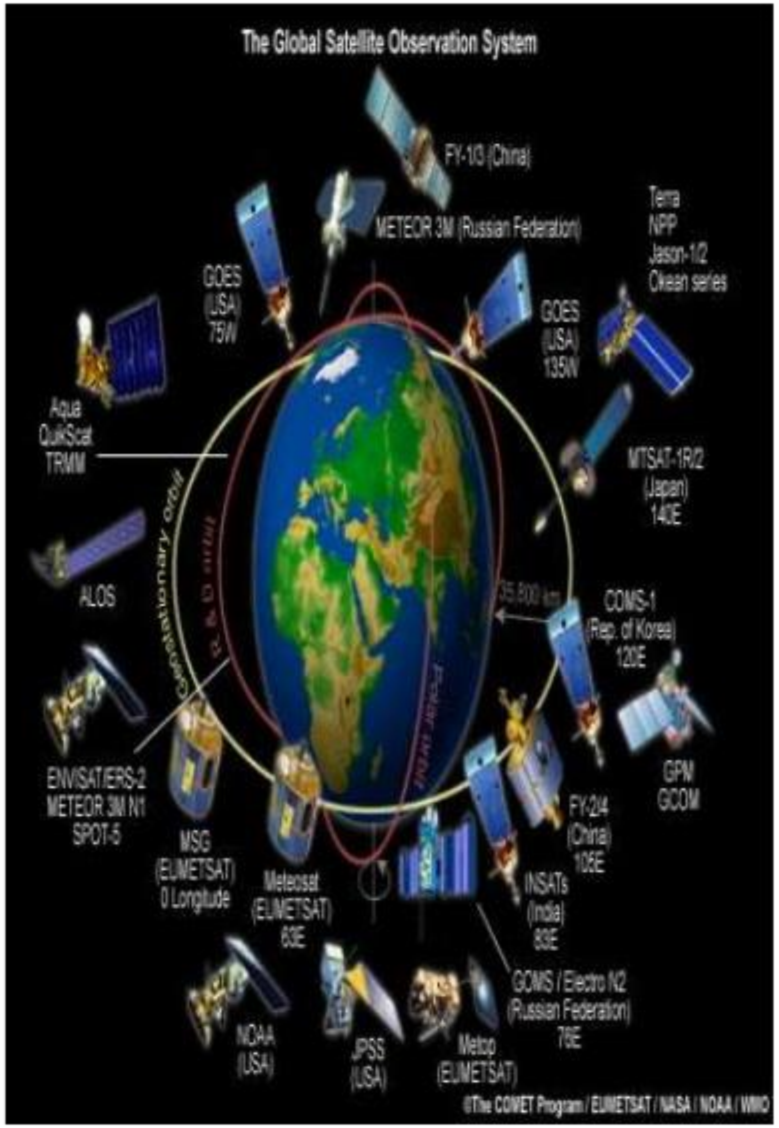
Types of platforms :

Space borne platforms:

- Sensors are mounted on-board a spacecraft
- Rockets , satellites and space shuttles

Advantages :

- Cover large area
- Repetitive coverage of an area of interest



REMOTE SENSING SATELLITES

- Numerous satellite sensors depending on applications.
- Each of these satellite-sensor platform is characterised by the **wavelength bands** employed in image acquisition, **spatial resolution** of the sensor, the **coverage area** and the **temporal coverge**, i.e. how frequent a given location on the earth surface can be imaged by the imaging system.

REMOTE SENSING SATELLITES

Satellites based on Resolution

- Low resolution systems (approx. 1 km or more)
- Medium resolution systems (approx. 100 m to 1 km)
- High resolution systems (approx. 5 m to 100 m)
- Very high resolution systems (approx. 5 m or less)

REMOTE SENSING SATELLITES

In terms of the spectral regions used in data acquisition, the satellite imaging systems can be classified into:

- Optical imaging systems (include visible, near infrared, and shortwave infrared systems)
- Thermal imaging systems
- Synthetic aperture radar (SAR) imaging systems

REMOTE SENSING SATELLITES

Optical/thermal imaging systems can be classified according to the number of spectral bands used:

- Monospectral or panchromatic (single wavelength band, "black-and-white", grey-scale image) systems
- Multispectral (several spectral bands) systems
- Superspectral (tens of spectral bands) systems
- Hyperspectral (hundreds of spectral bands) systems

CHARACTERISTICS OF SENSORS

1. **Spatial resolution**
2. **Spectral resolution**
3. **Radiometric resolution**
4. **Temporal resolution**

SPATIAL RESOLUTION

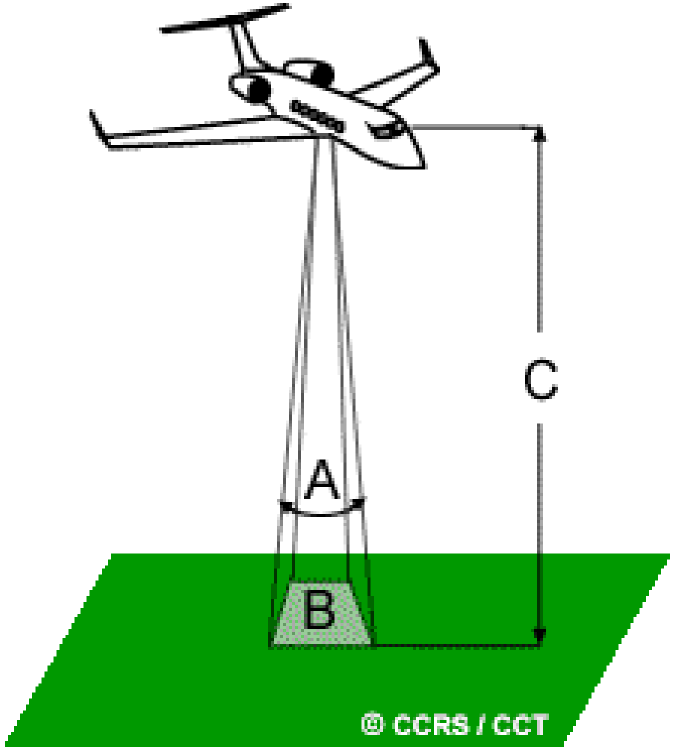
- Also known as Ground Resolution
- Ground area is imaged for the Instantaneous Field of View of the Sensing Device.
- Ground Surface area that forms one pixel in the satellite image.
- Ex: LISS III – 23.5m (Linear Imaging Self Scanning)

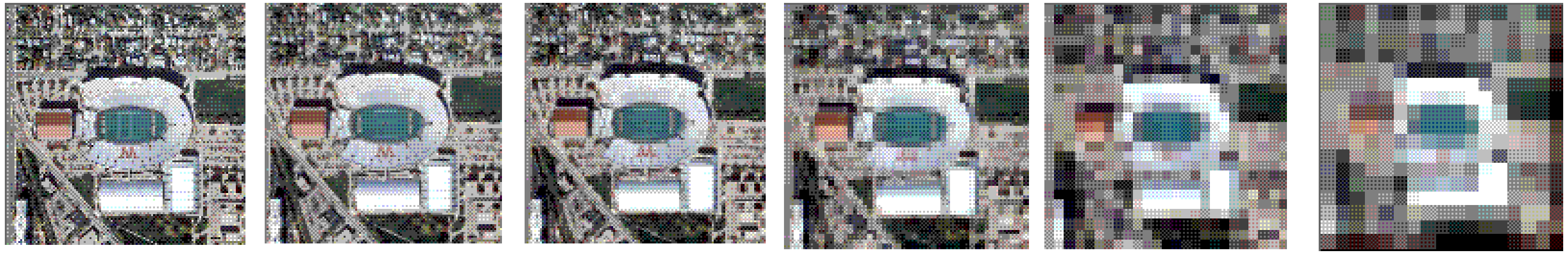
  LISS IV – 5.8m

  TM & ETM – 28.5m for MS

  14.5m for Panchromatic

SPATIAL RESOLUTION

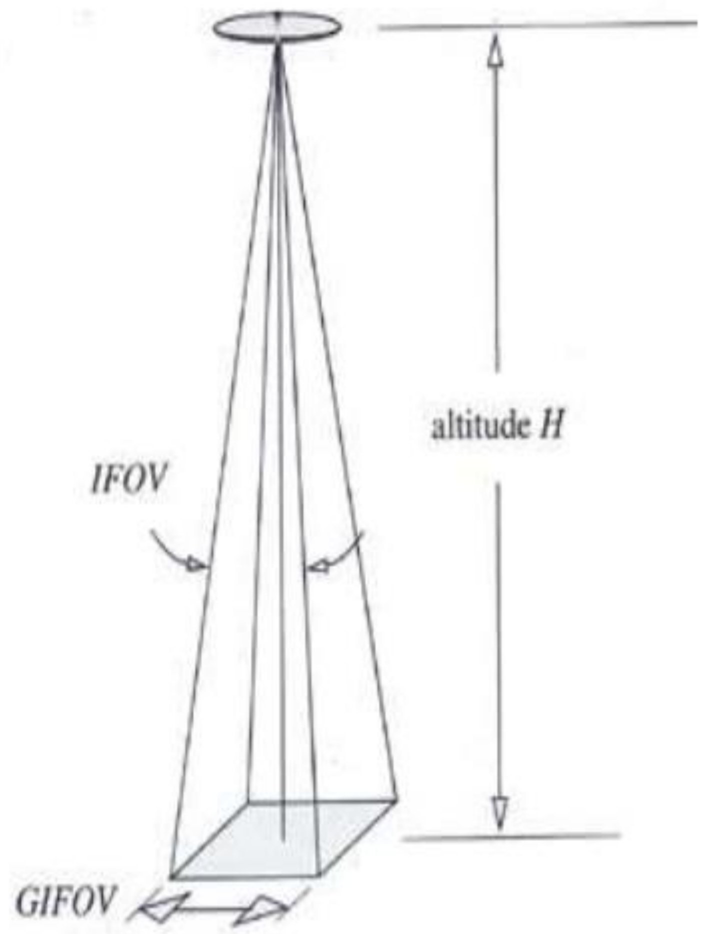




CHARACTERISTICS OF SENSORS

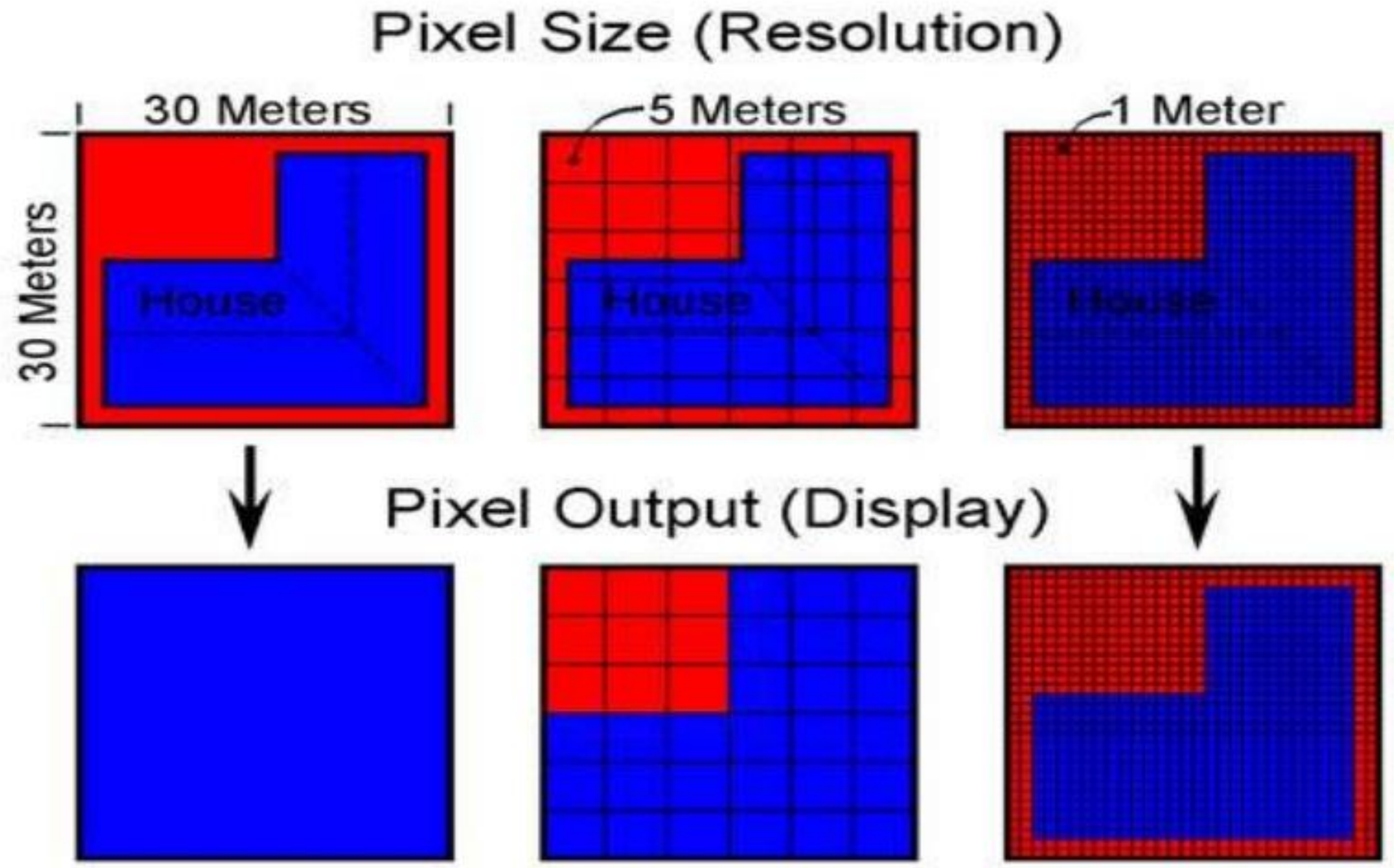
Spatial resolution

- **It refers to the size of the smallest possible object that can be detected**
- **It depends on the Instantaneous Field Of View (IFOV) and the height of the satellite orbit**
- **It tells the pixel size on the ground surface**



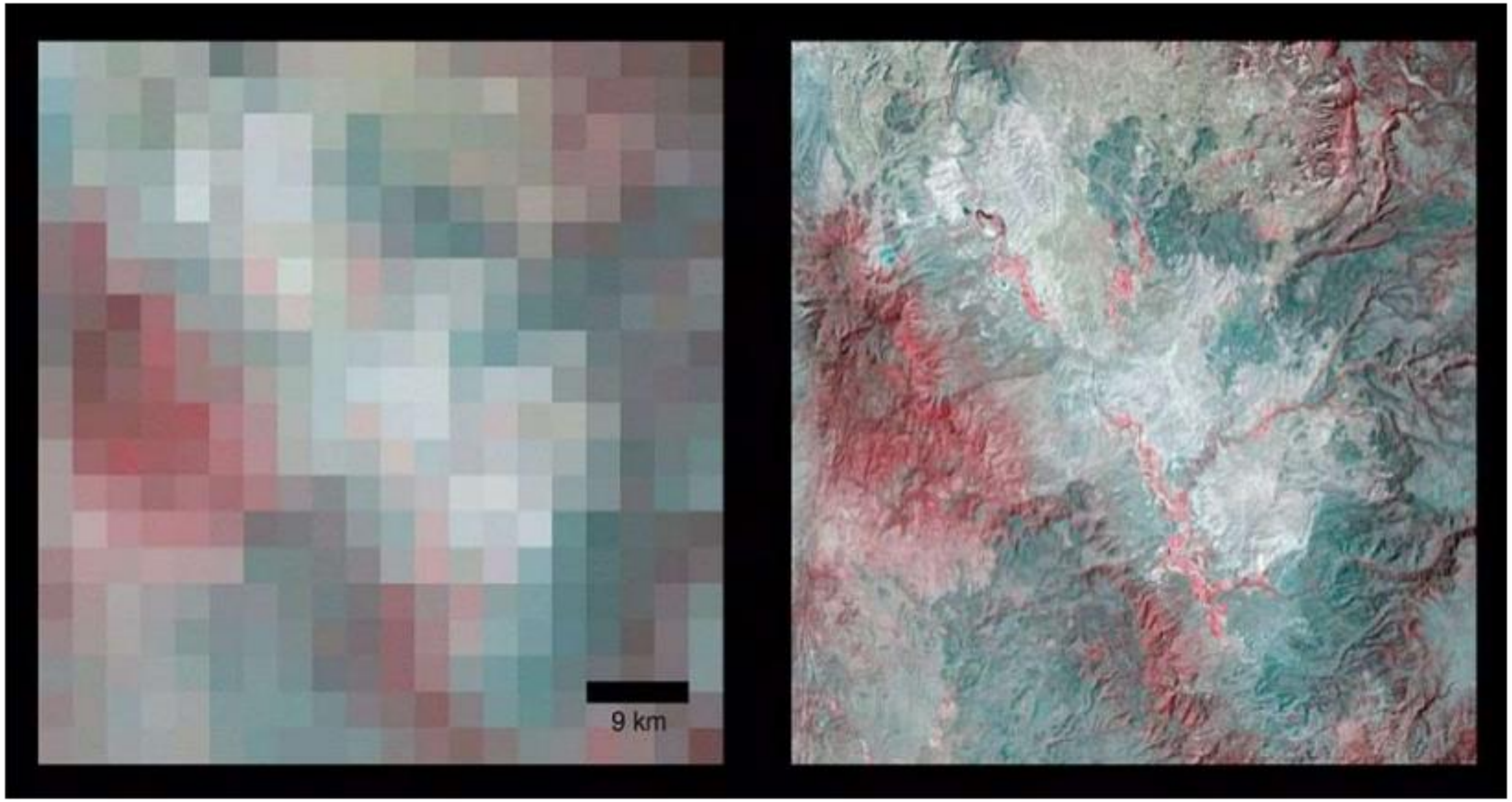
CHARACTERISTICS OF SENSORS

Spatial resolution

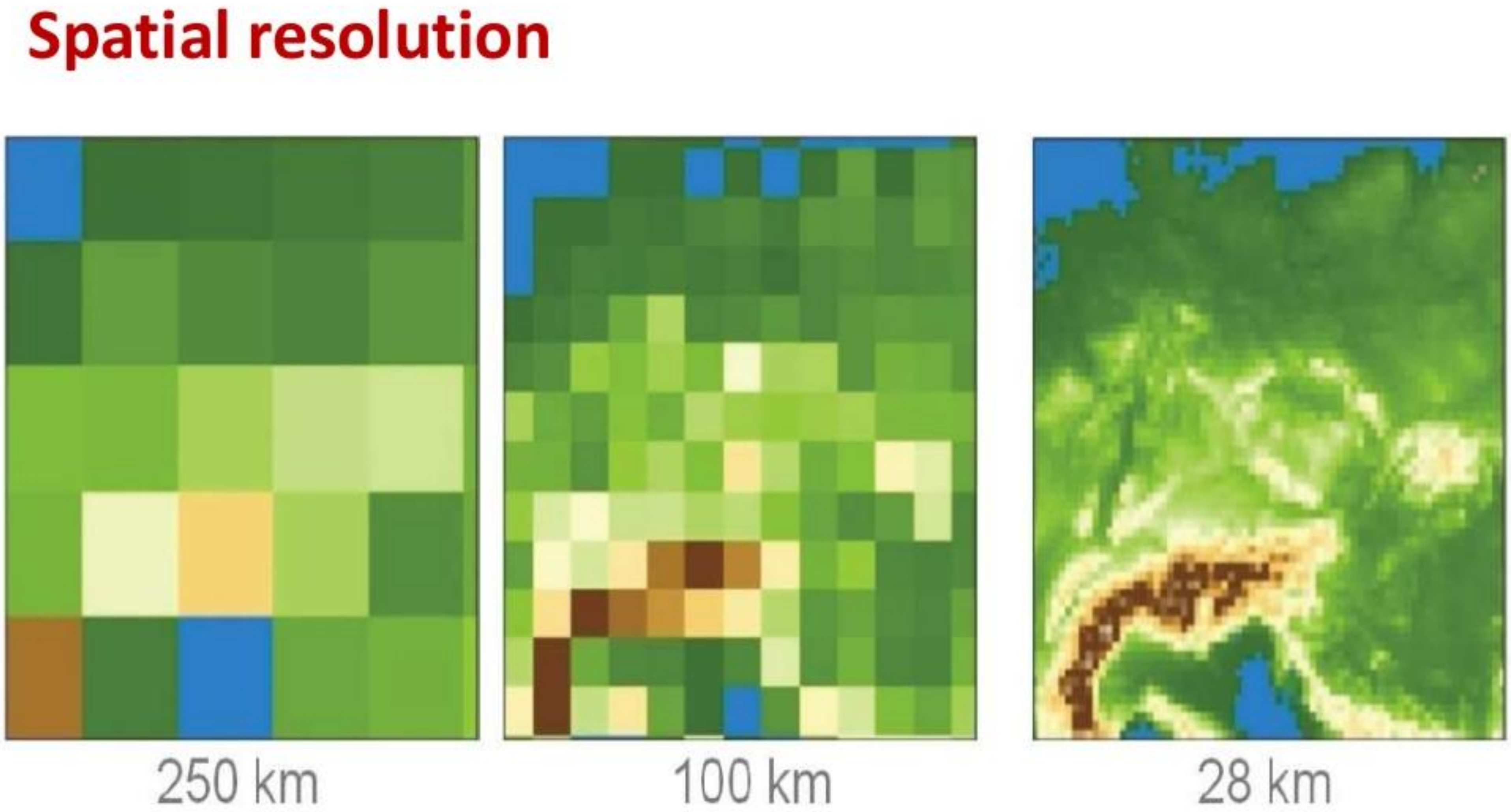


CHARACTERISTICS OF SENSORS

Spatial resolution



CHARACTERISTICS OF SENSORS



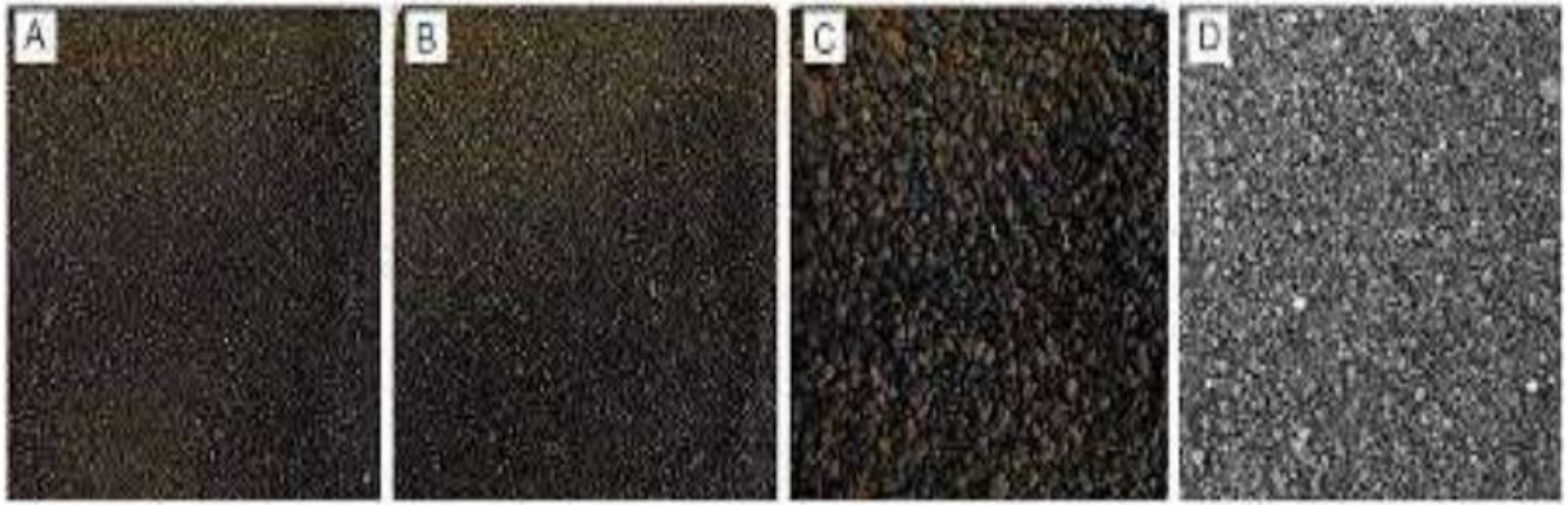
SPECTRAL RESULTION

- **Spectral resolution** describes the specific wavelengths that the sensor can record within the electromagnetic spectrum. For example, the “photographic infrared” band covers from about 0.7 – 1.0 micrometers.

CHARACTERISTICS OF SENSORS

Spectral resolution

- **It describes the ability of a sensor to define fine wavelength ranges**
- **Sand is appear as coarser in finer wavelength bands**



RADIOMETRIC RESOLUTION

- **Radiometric resolution** refers to the number of possible brightness values in each band of data and is determined by the number of bits into which the recorded energy is divided. In 8-bit data, the brightness values can range from 0 to 255 for each pixel (256 total possible values). In 7-bit data, the values range from 0 to 127, or half as many possible values.

CHARACTERISTICS OF SENSORS

Radiometric resolution

- It describes the ability of sensor to discriminate very slight differences in energy
- The number of brightness levels depends upon the number of bits used

RADIOMETRIC RESOLUTION

- **Radiometric resolution** refers to the number of possible brightness values in each band of data and is determined by the number of bits into which the recorded energy is divided. In 8-bit data, the brightness values can range from 0 to 255 for each pixel (256 total possible values). In 7-bit data, the values range from 0 to 127, or half as many possible values.

CHARACTERISTICS OF SENSORS

Radiometric resolution

TEMPORAL RESOLUTION

- **Temporal resolution** is a description of how often a sensor can obtain imagery of a particular area of interest. For example, the Landsat satellite revisits an area every 16 days as it orbits the Earth, while the SPOT satellite can image an area every 1 to 4 days.

CHARACTERISTICS OF SENSORS

Temporal resolution

It refers to how often it records imagery of a particular area, which means the frequency of repetitive coverage

IMAGE PROCESSING & ANALYSIS

- Image Enhancement.
- Image Classification.
- Image Interpretation.

LANDSAT 1-5 MULTISPECTRAL SCANNER (MSS)

- The **Landsat Multispectral Scanner (MSS)** was carried on Landsats 1-5.
- Images consist of four spectral bands with 60 meter spatial resolution (Original MSS pixel size was 79 x 57 meters; production systems resampled the data to 60 meters.).
- The approximate scene size is 170 km north-south by 185 km east-west.
- Specific band designations differ from Landsats 1, 2, 3 to Landsats 4,5.

Landsat 1-5 Multispectral Scanner (MSS)

Landsat MSS 1, 2, 3 Spectral Bands	Landsat MSS 4 & 5 Spectral Bands	Wavelength	Useful for mapping
Band 4 - green	Band 1 - green	0.5 - 0.6	Sediment-laden water, delineates areas of shallow water
Band 5 - red	Band 2 - red	0.6 - 0.7	Cultural features
Band 6 - Near Infrared	Band 3 - Near Infrared	0.7 - 0.8	Vegetation boundary between land and water, and landforms
Band 7 - Near Infrared	Band 4 - Near Infrared	0.8 - 1.1	Penetrates atmospheric haze best, emphasizes vegetation, boundary between land and water, and landforms

LANDSAT 4 AND 5 THEMATIC MAPPER

- The **Landsat Thematic Mapper (TM)** sensor was carried on Landsats 4,5.
- Images consist of six spectral bands: spatial resolution of 30 meters for Bands 1-5 and 7 (TM Band 6 was acquired at 120-meter resolution, but resampled to 30-meter pixels).
- The approximate scene size is 170 km north-south by 183 km east-west.

	Bands	Wavelength (micrometers)	Resolution (meters)
Landsat 4-5 Thematic Mapper (TM)	Band 1 - Blue	0.45-0.52	30
	Band 2 - Green	0.52-0.60	30
	Band 3 - Red	0.63-0.69	30
	Band 4 - Near Infrared (NIR)	0.76-0.90	30
	Band 5 - Shortwave Infrared (SWIR) 1	1.55-1.75	30
	Band 6 - Thermal	10.40-12.50	120* (30)
	Band 7 - Shortwave Infrared (SWIR) 2	2.08-2.35	30

LANDSAT 7 ENHANCED THEMATIC MAPPER PLUS (ETM+)

- The **ETM+** sensor is carried on Landsat 7.
- Spatial Resolution: 30 m (Bands 1-5,7) and 15 m for Band 6 (originally acquired at 60m)
- The approximate scene size is 170 km north-south by 183 km east-west.

Band	Wavelength	Useful for mapping
Band 1 - Blue	0.45 - 0.52	Bathymetric mapping, distinguishing soil from vegetation, and deciduous from coniferous vegetation
Band 2 - Green	0.52 - 0.60	Emphasizes peak vegetation, which is useful for assessing plant vigor
Band 3 - Red	0.63 - 0.69	Discriminates vegetation slopes
Band 4 - Near Infrared	0.77 - 0.90	Emphasizes biomass content and shorelines
Band 5 - Short-wave Infrared	1.55 - 1.75	Discriminates moisture content of soil and vegetation; penetrates thin clouds
Band 6 - Thermal Infrared	10.40 - 12.50	Thermal mapping and estimated soil moisture
Band 7 - Short-wave Infrared	2.09 - 2.35	Hydrothermally altered rocks associated with mineral deposits
Band 8 - Panchromatic (Landsat 7 only)	0.52 - 0.90	15 meter resolution, sharper image definition

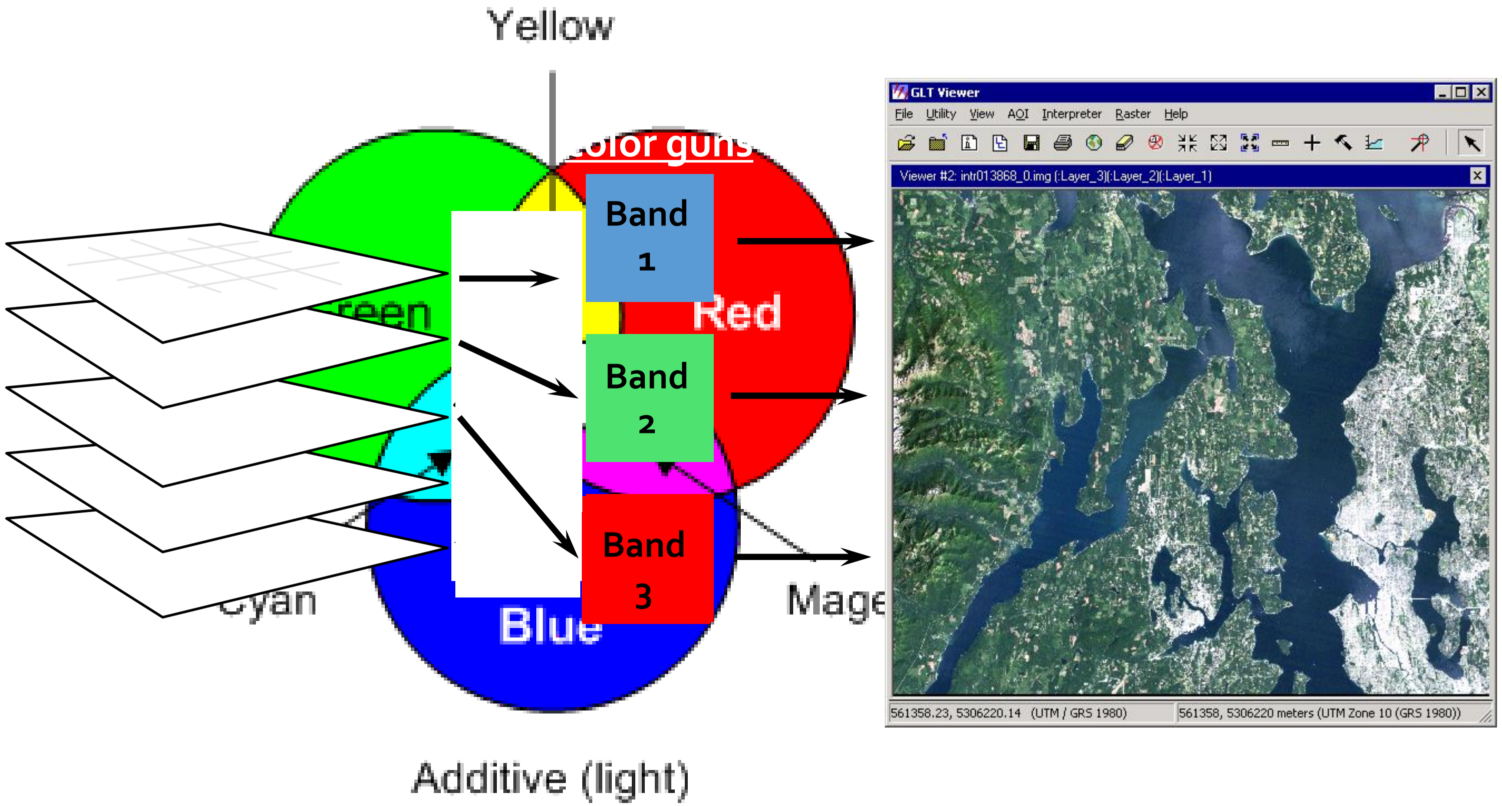
LANDSAT 8 OPERATIONAL LAND IMAGER (OLI) AND THERMAL INFRARED SENSOR (TIRS)

	microns	**The approximate scene size is 170 km north-south by 183 km east-west**
Band 2 – Blue	0.45 - 0.51	Bathymetric mapping, distinguishing soil from vegetation, and deciduous from coniferous vegetation (30m spatial resolution)
Band 3 - Green	0.53 - 0.59	Emphasizes peak vegetation, which is useful for assessing plant vigor (30m resolution)
Band 4 - Red	0.64 - 0.67	Discriminates vegetation slopes (30m resolution)
Band 5 - Near Infrared (NIR)	0.85 - 0.88	Emphasizes biomass content and shorelines (30m resolution)
Band 6 - Short-wave Infrared (SWIR) 1	1.57 - 1.65	Discriminates moisture content of soil and vegetation; penetrates thin clouds (30m resolution)
Band 7 - Short-wave Infrared (SWIR) 2	2.11 - 2.29	Improved moisture content of soil and vegetation and thin cloud penetration (30m resolution)
Band 8 - Panchromatic	0.50 - 0.68	15 meter resolution, sharper image definition
Band 9 – Cirrus	1.36 - 1.38	Improved detection of cirrus cloud contamination (30m resolution)
Band 10 – TIRS 1	10.60 – 11.19	100 meter resolution, thermal mapping and estimated soil moisture
Band 11 – TIRS 2	11.5 - 12.51	100 meter resolution, Improved thermal mapping and estimated soil moisture

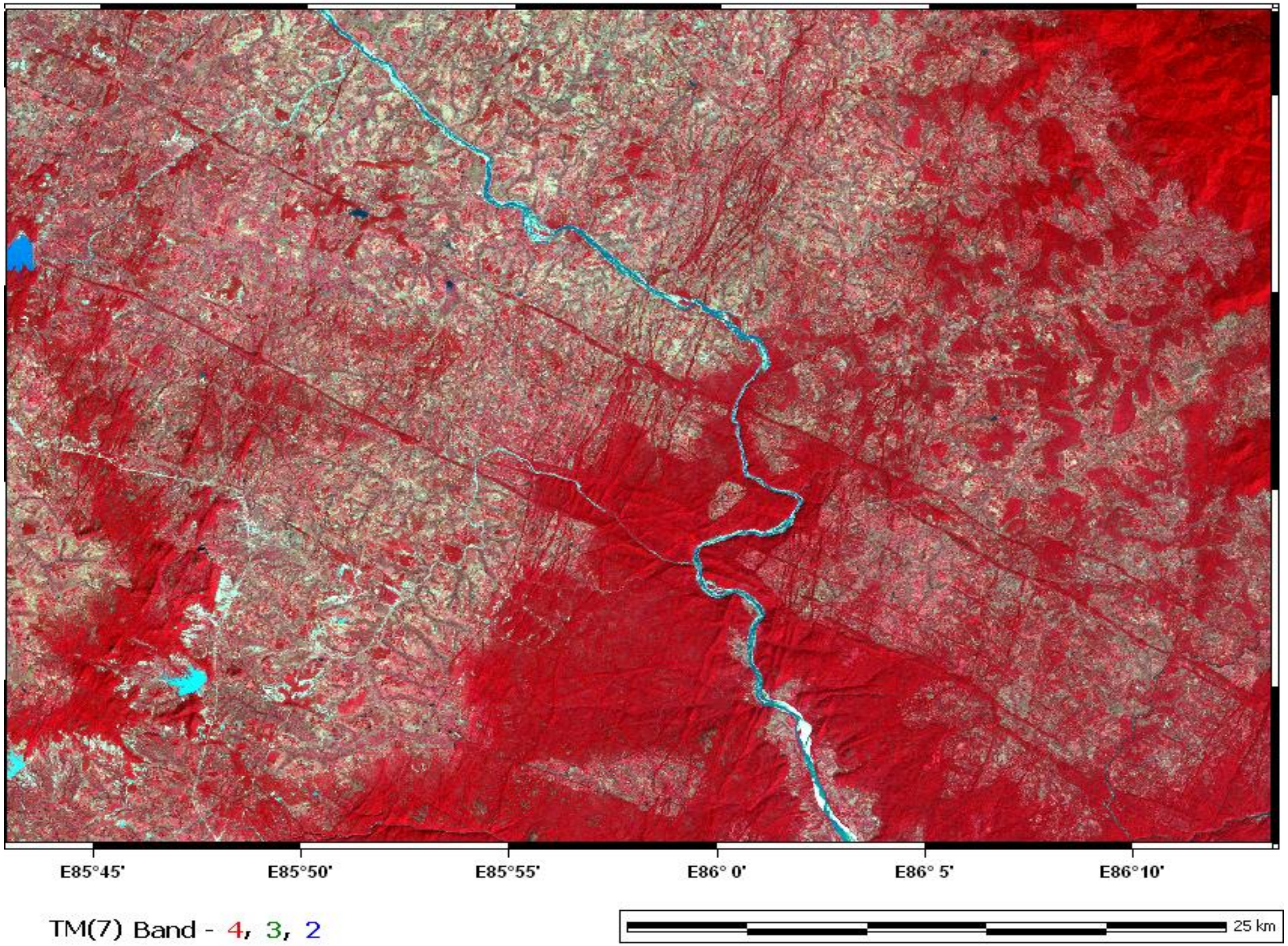
LANDSAT 8 OPERATIONAL LAND IMAGER (OLI) AND THERMAL INFRARED SENSOR (TIRS)

- **Landsat 8 OLI and TIRS** images consist of nine spectral bands
- Spatial resolution: 30 m (Bands 1 to 7 and 9); 15 m (Band 8); 100 m (Bands 10,11).
- The ultra blue Band 1 is useful for coastal and aerosol studies.
- The resolution for Band 8 (panchromatic) is 15 meters.
- Thermal bands 10 and 11 are useful in providing more accurate surface temperatures and are collected at 100 m.
- The approximate scene size is 170 km north-south by 183 km east-west.

VIEWING IMAGES



FALSE COLOUR COMPOSITE



ELEMENTS OF IMAGE INTERPRETATION

- Tone
- Texture
- Shape
- Size
- Pattern
- Association
- Shadow

HOW IS IT USED IN SITE SELECTION

High Moisture Areas

Hydrogeomorphic Features

Structures and Lineaments

HYDROGEOMORPHOLOGICAL FEATURES

- Pediplain
- Denudational, Structural Hills
- Peneplain
- Valleys
- Alluvial Fans
- Flood Plain
- Delta
- Palaeo Channels
- Drainage Pattern
- Karsts

Hydrogeomorphic Units	Description	Ground water prospect
Flood Plain (Young)	Very gently sloping plain of alluvial sediments with more than 50 meter of thickness	Excellent
Flood Plain (Old)	Very gently sloping plain of thick alluvial sediments with calcrete & kankar	Very Good
Alluvial Plain (Deep)	Very gently sloping plain of alluvial sediments with more than 20 meter of thickness	Excellent
Channel Bar	Small alluvial patch forming part of the riverbed	Excellent
Point Bar	Small crescent shaped alluvial patch formed on the concave side of the meandering river	Excellent
Flood Plain(Deep) with Ravines	Highly dissected flood plain	Good
Alluvial Plain (shallow) Ravines	Highly dissected Shallow Alluvial Plain	Moderate
Valley fill deposits	Narrow depressions filled with alluvial and colluvial matter of 10-15 meter of depth	Good to Moderate
Deep Buried Pediments	Weathered rocky surfaces covered with colluvial and alluvial sediments due to fluvial action	Moderate
Pediments	Gently sloping smooth surface of erosional bedrock with thin veneer of detritus	Moderate to Poor
Inselbergs	Massive, barren, rocky, usually smooth and rounded hills abruptly rising above surrounding plains.	Poor
Denudational Hill	Remnants of weathering and denudation and generally occur as isolated hills in the pediment zone, made up of boulders & sand showing rounded crests and attaining relief of about 100 to 300m.	Poor

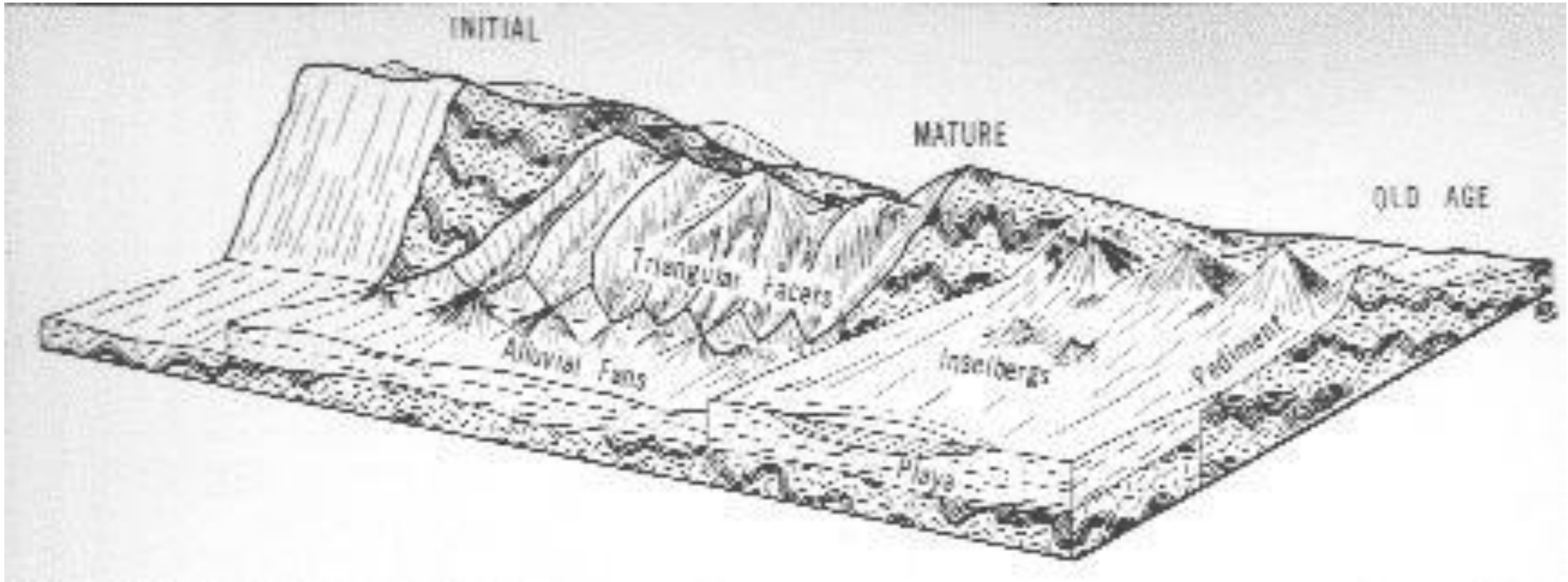
PIEDMONT

A gentle slope leading from the foot of mountains to a region of flat land.

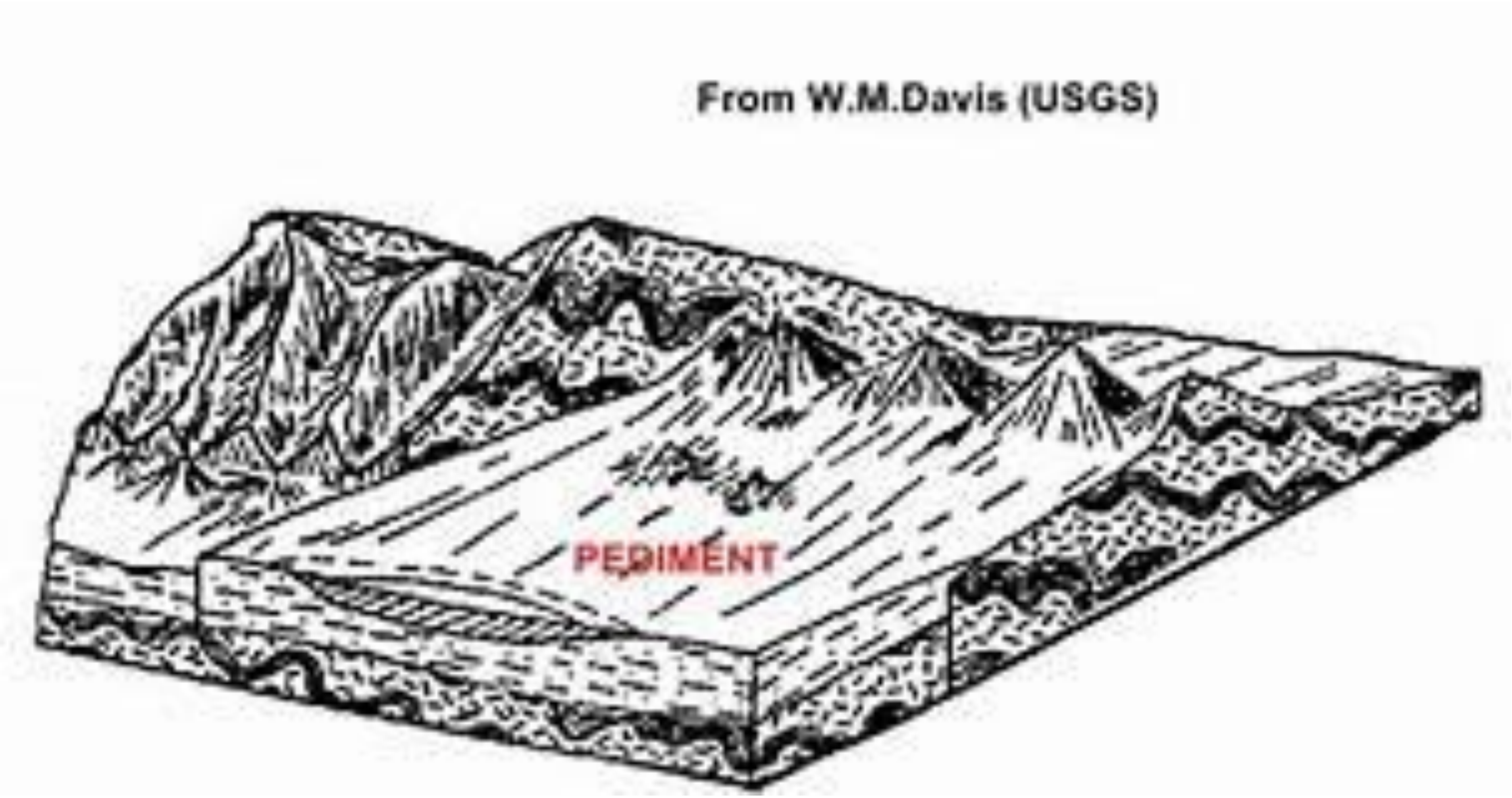
PEDIMENT

- A very gently sloping (5°-7°) inclined bedrock surface.
- typically slopes down from the base of a steeper retreating cliff or escarpment, but may continue to exist after the mountain has eroded away.
- Thinly covered with fluvial gravel that has washed over it from the foot of mountains produced by cliff retreat erosion.

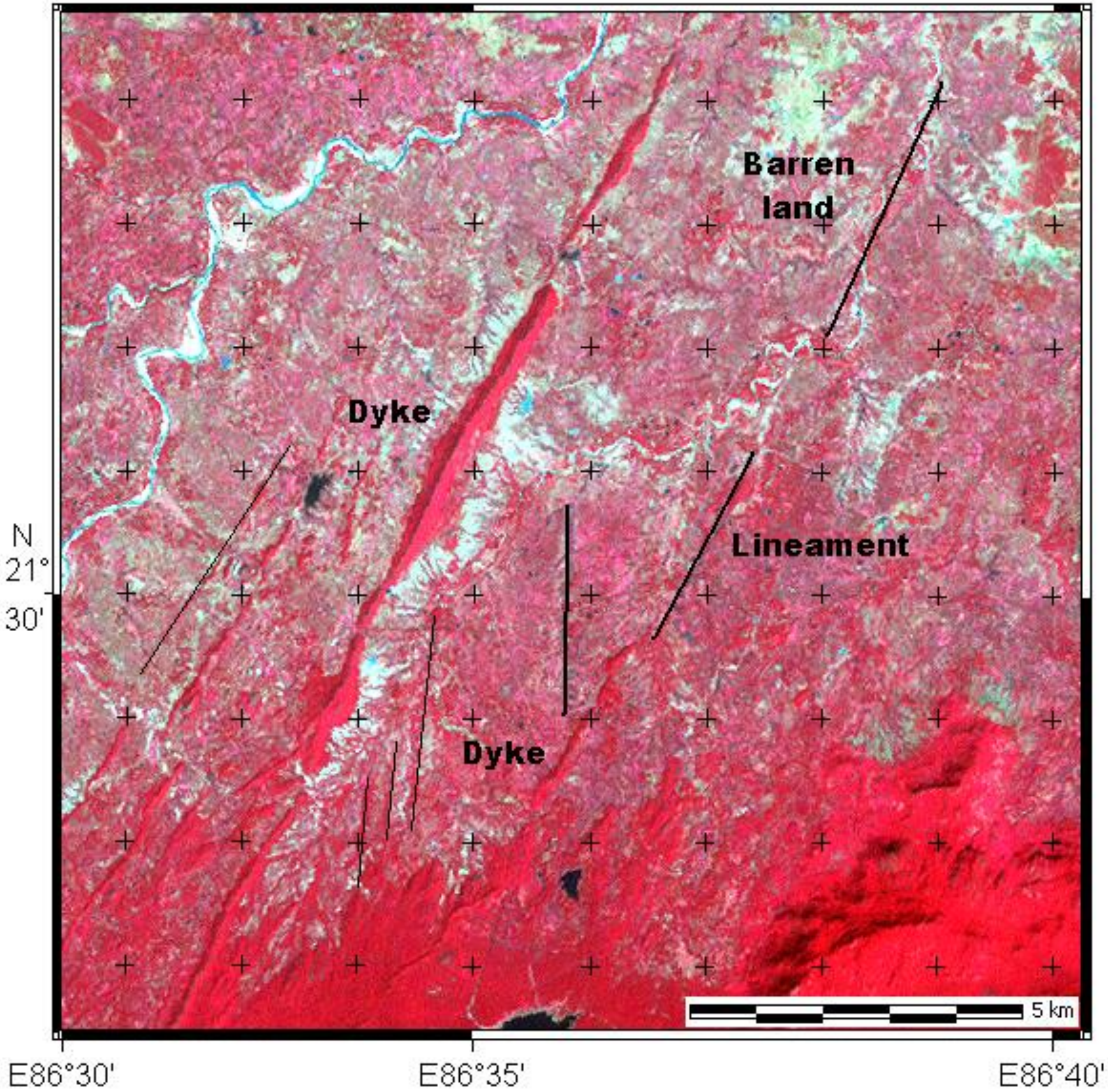
PEDIMENT


INITIAL
MATURE
OLD AGE
Triangular Facets
Alluvial Fans
Inselbergs
Pediment
Playa

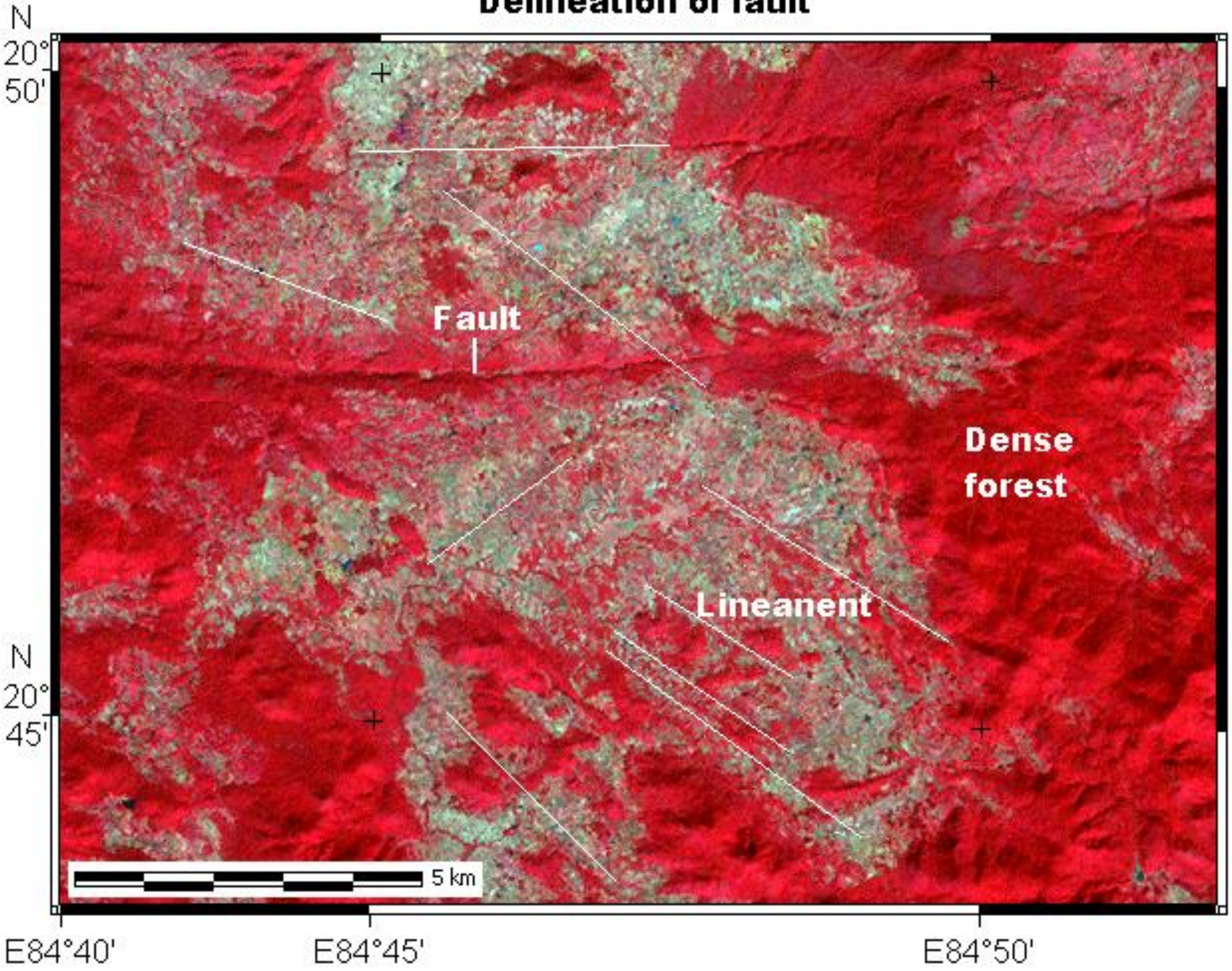
PEDIMENT

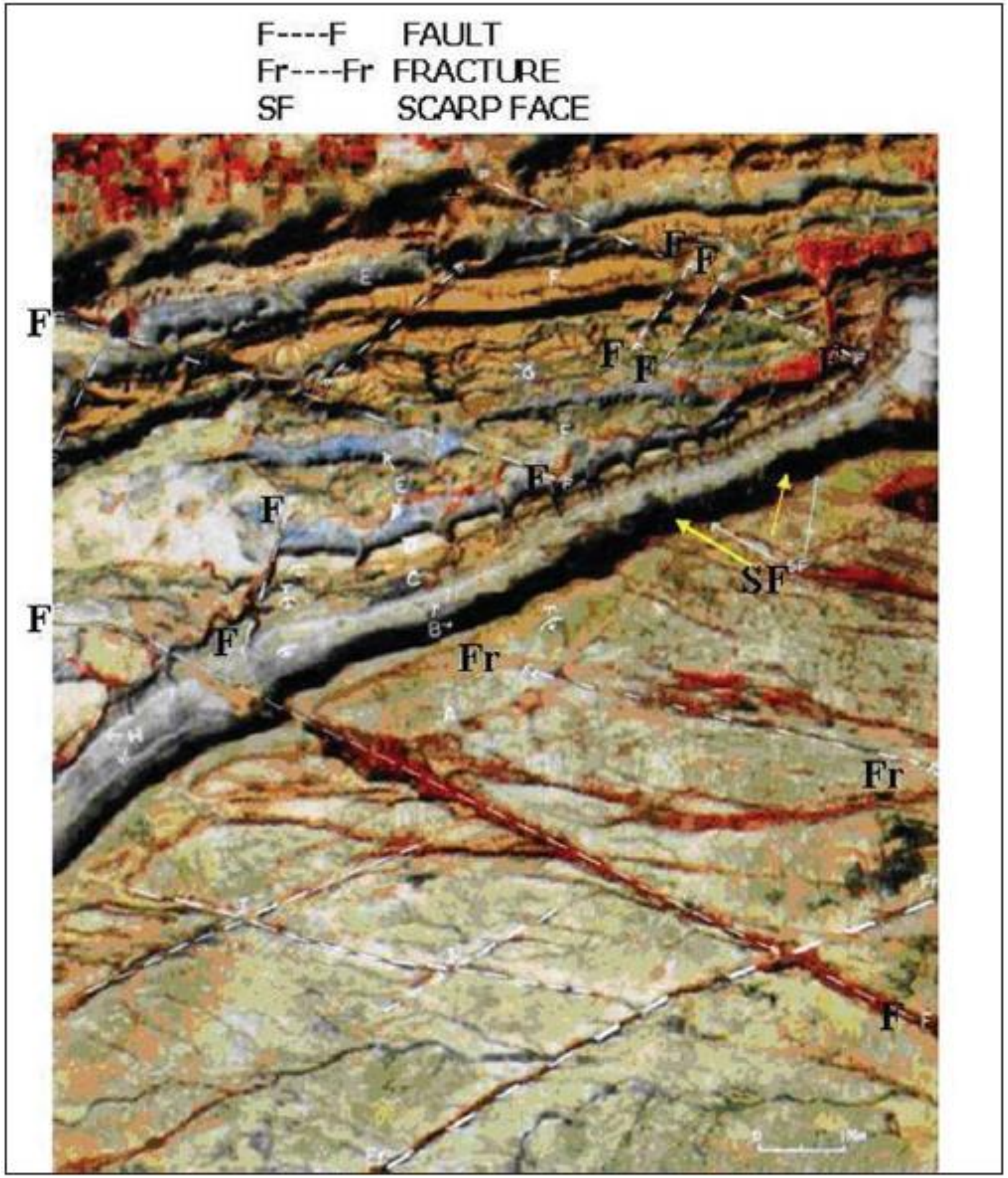


Granitic terrain with dyke emplacement



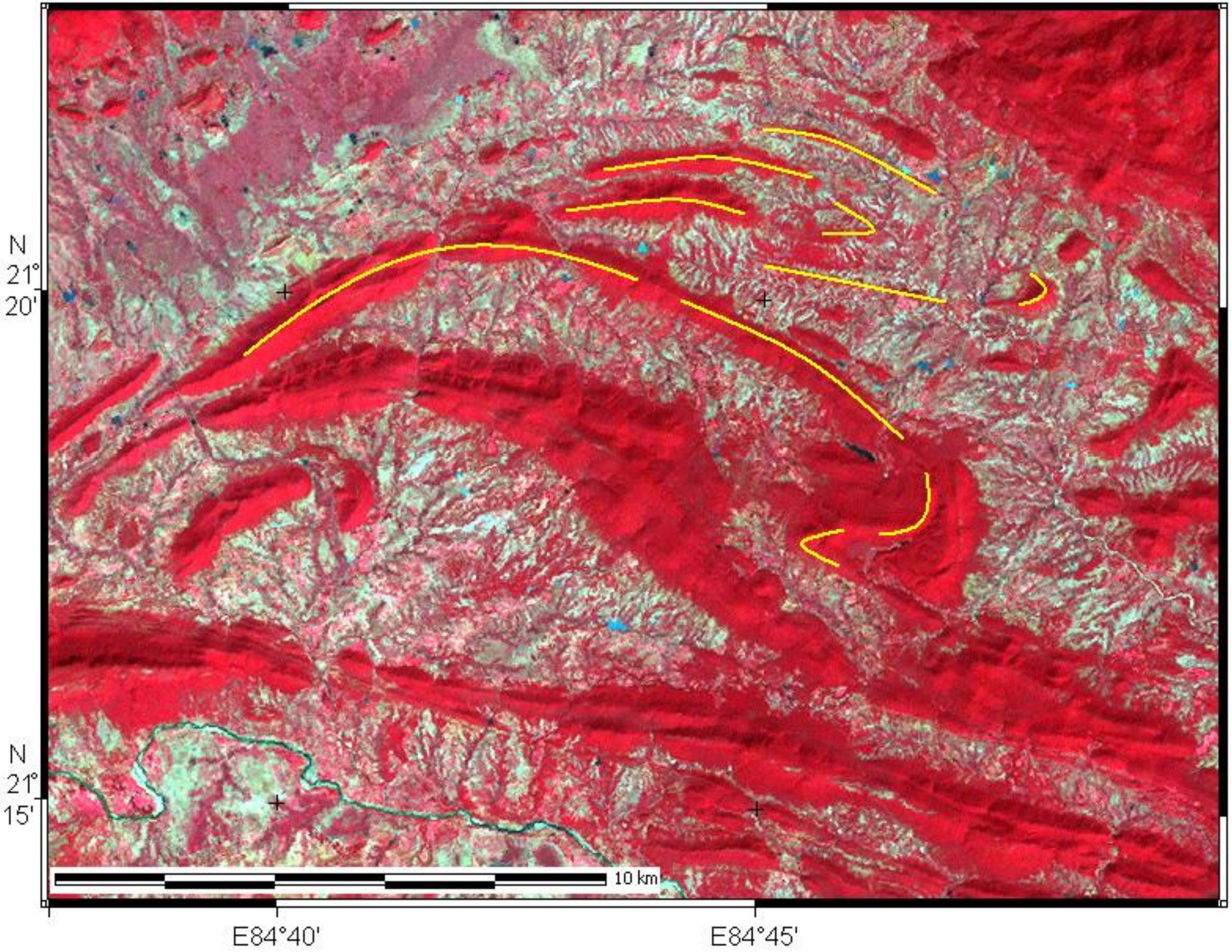
Delineation of fault



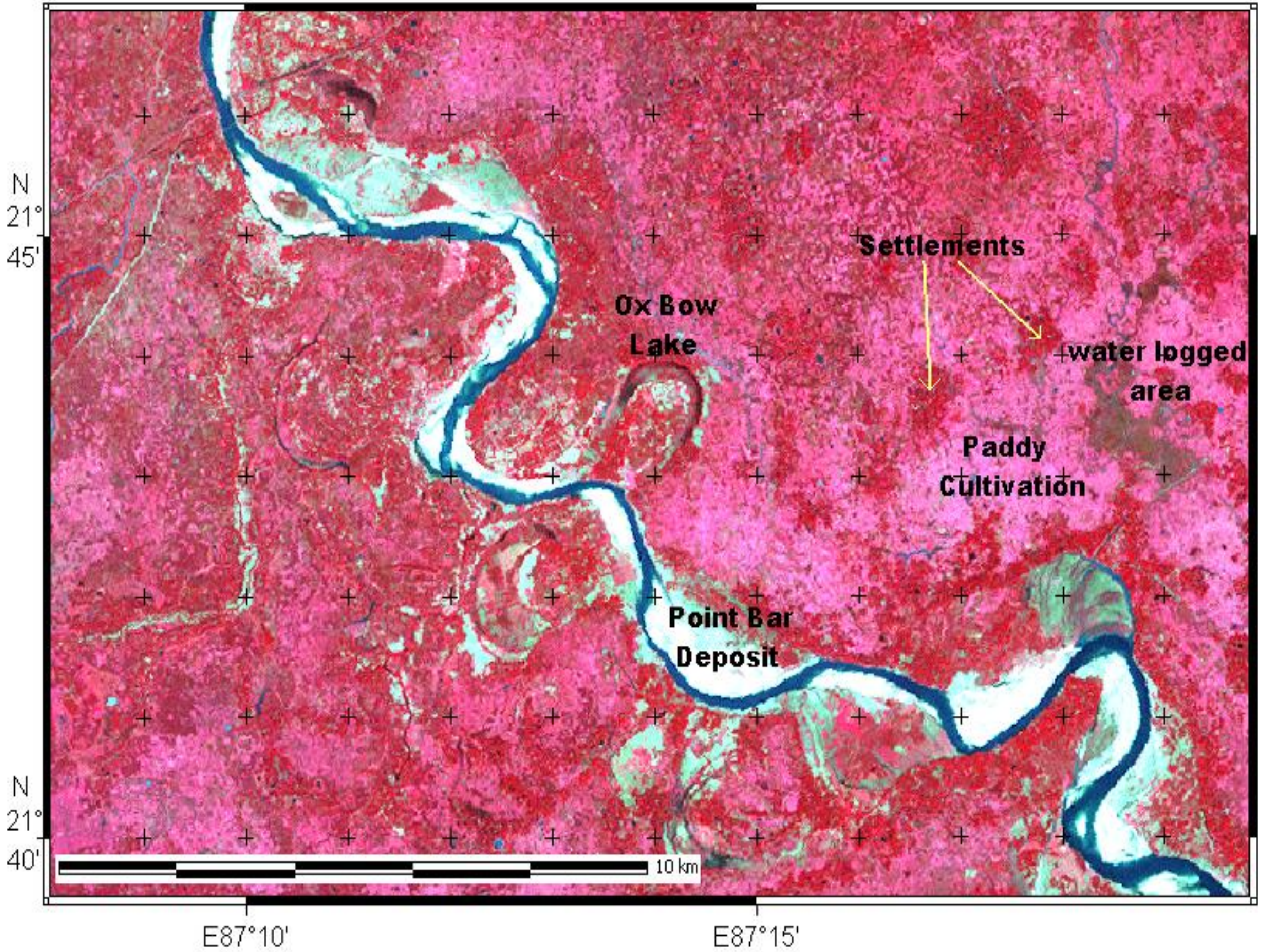


F----F FAULT
Fr----Fr FRACTURE
SF SCARP FACE
F
F
F
F
F
F
F
F
F
F
SF
Fr
Fr
F

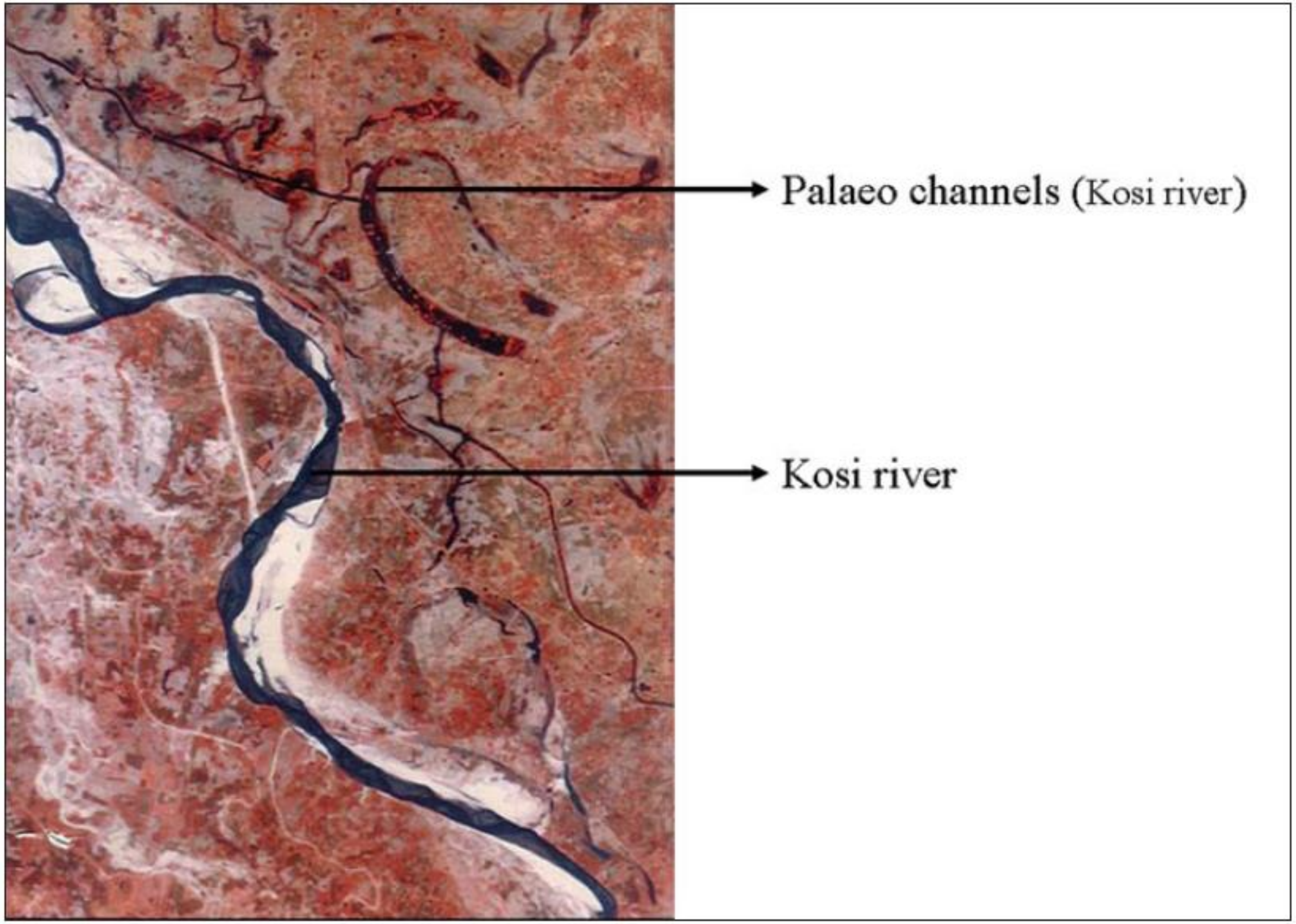
Interpretation of folds



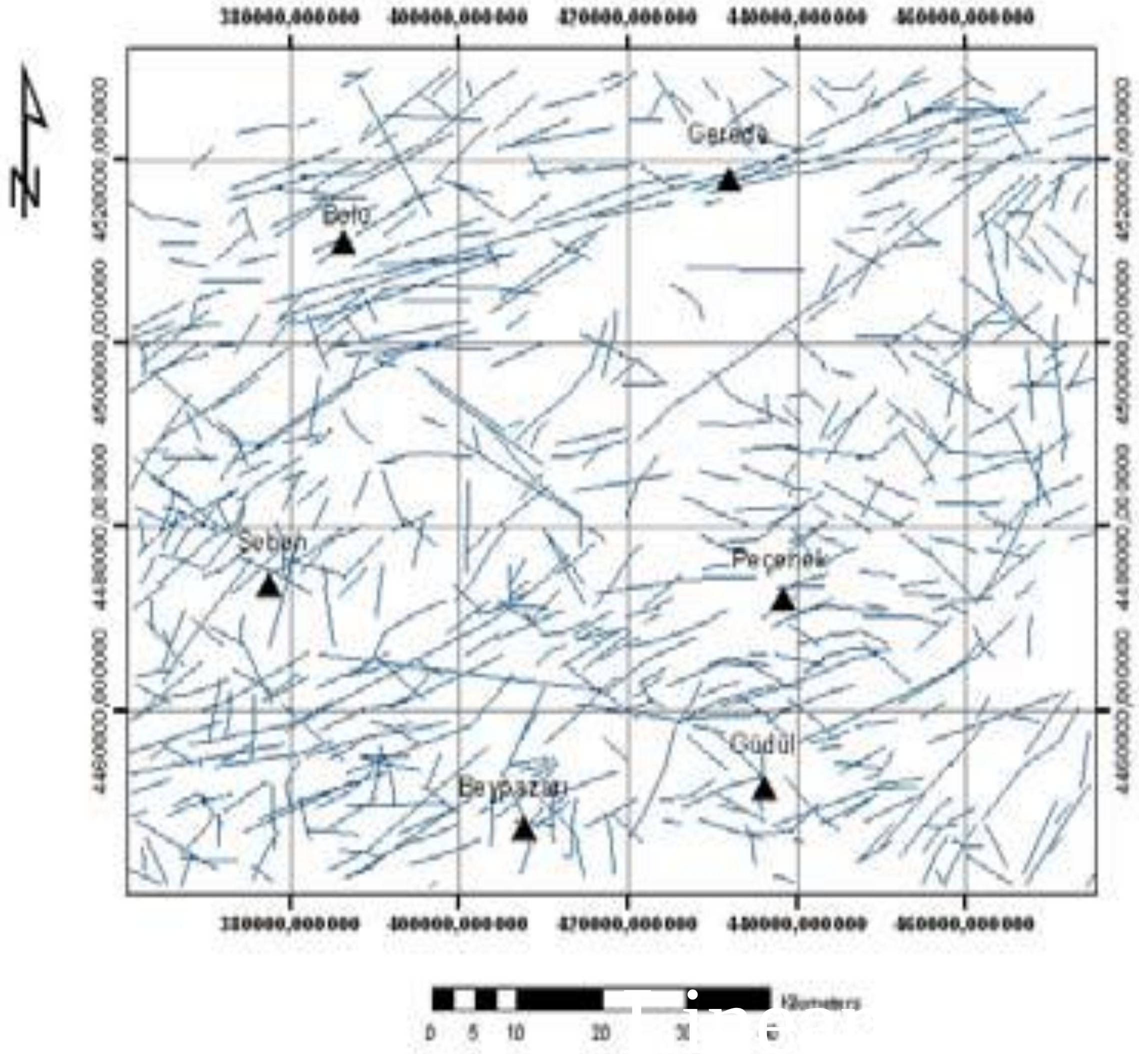
Meandering Stream

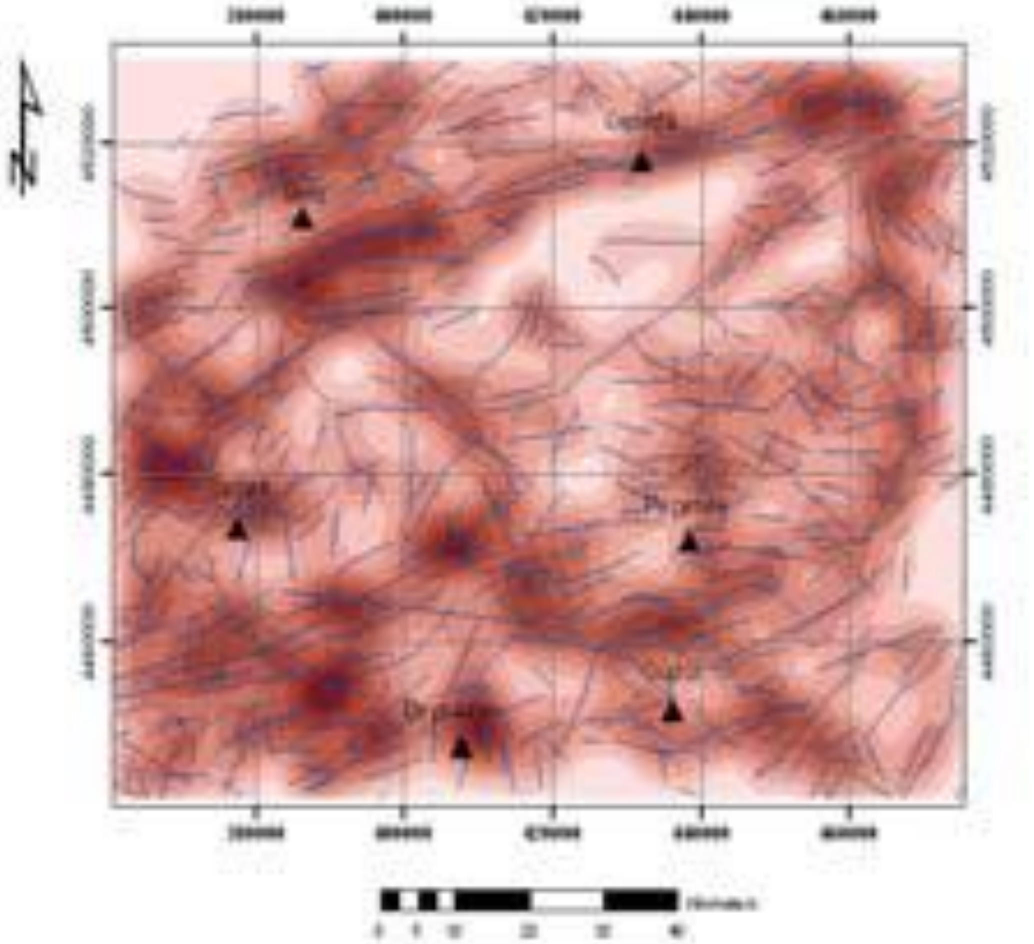


PALAEO CHANNEL

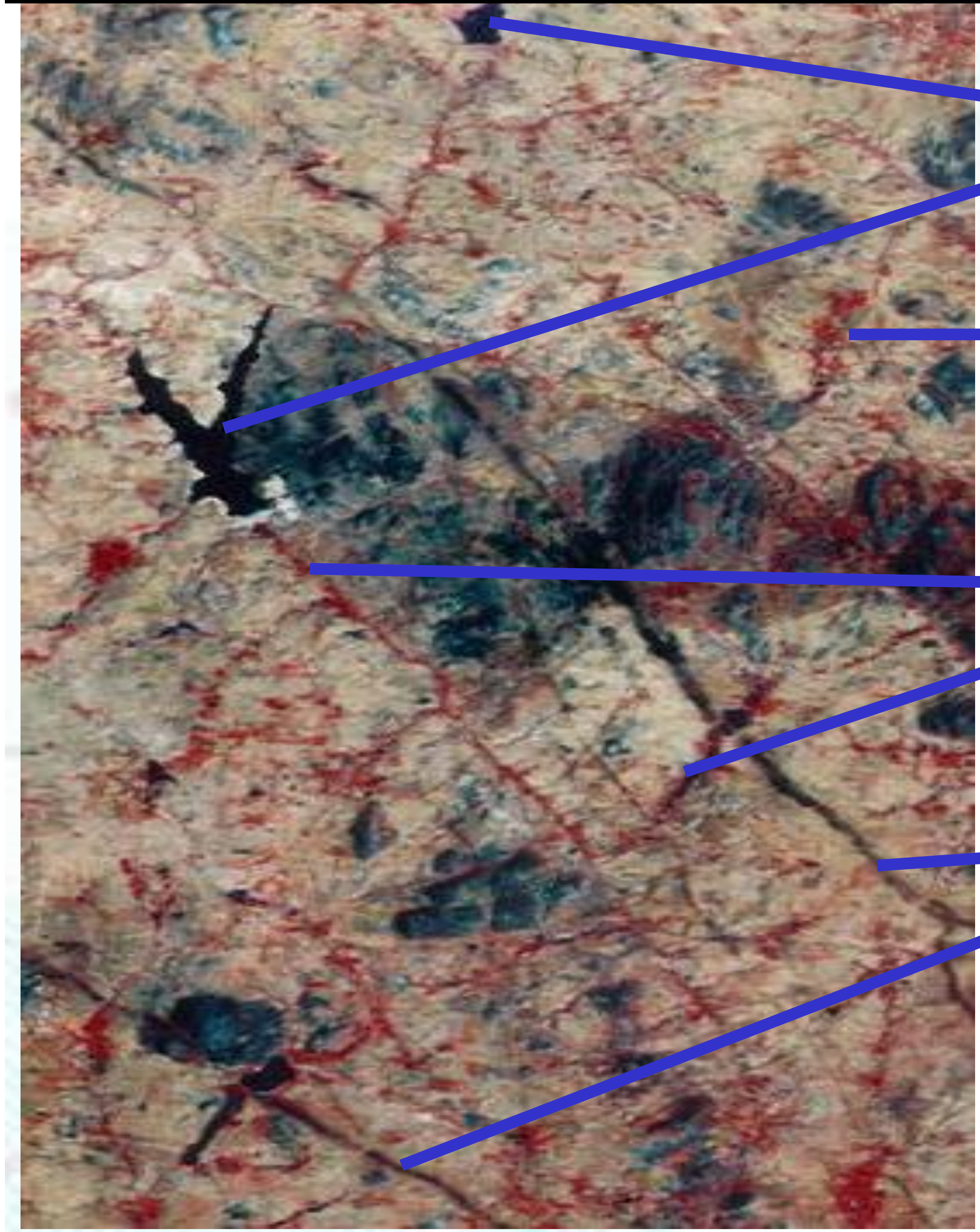


LINEAMENT MAP





ADVANTAGES OF SATELLITE DATA FOR GROUND WATER STUDIES



Hydrologic information
(Surface water bodies)

G.W.over exploitation
(Ground water irrigated area)

Conduits for G. W. movement
(Fracture / Lineament)

Barriers for G. W. movement
(Dolerite dyke)

Source NRSC

REMOTE SENSING SENSORS

Types of sensors :

Active sensors:

These sensors detect reflected responses from objects which are irradiated from artificially generated energy sources

Ex : Radar, camera with flash light

Passive sensors:

These sensors detect reflected EMR from natural source

Ex : camera without flash light (depends on solar energy), and all RS sensors

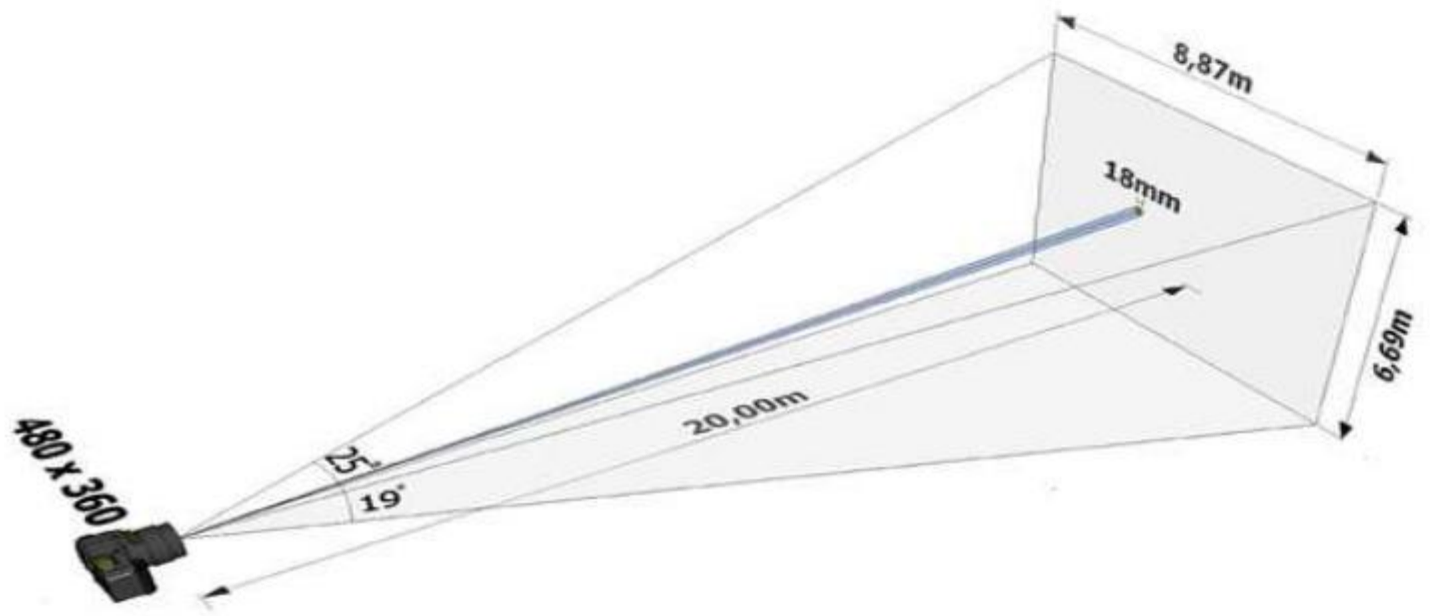
REMOTE SENSING SENSORS

Types of sensors :

Non Scanning or Framing sensors:

Measure the radiation coming from entire scene at once

Ex: Our eyes, Photo cameras



REMOTE SENSING SENSORS

Types of sensors :

Imaging sensors:

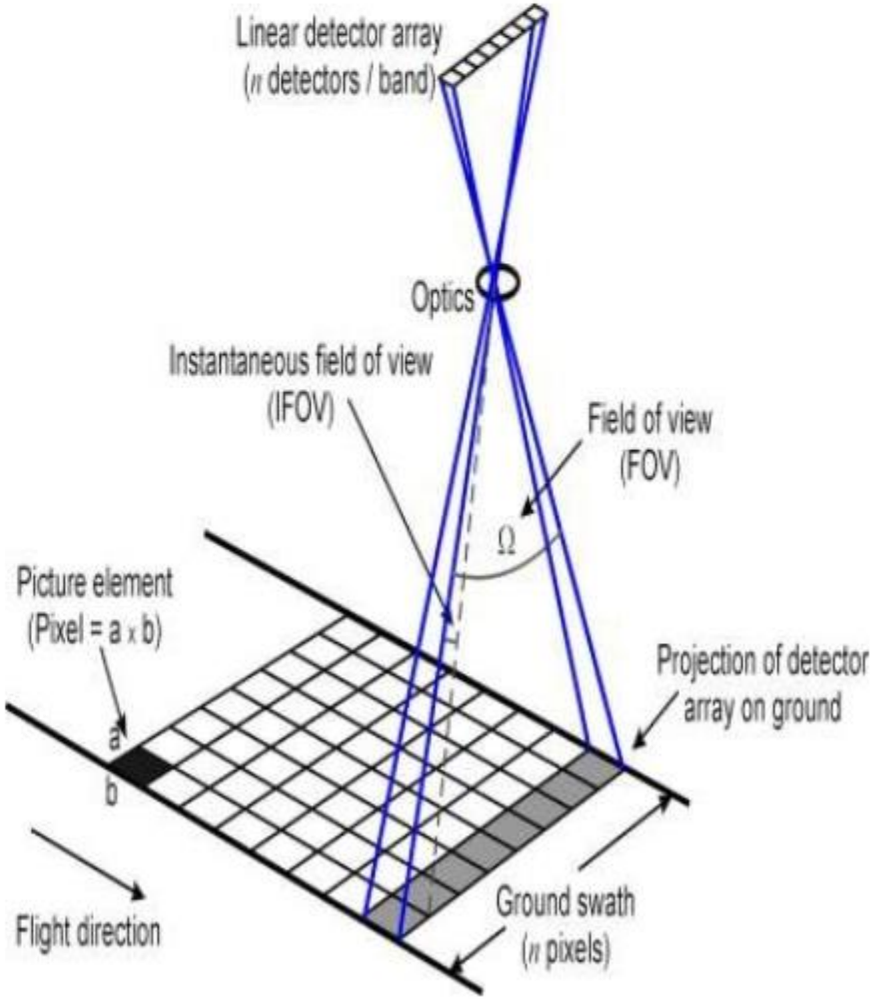
Form image by collected radiation

1. **Scanning sensors:**

The scene is sensed by point by point or measure the radiation coming from point by point (equivalent to small areas with in the scene)

Along track Scanners:

Image is acquired by line by line

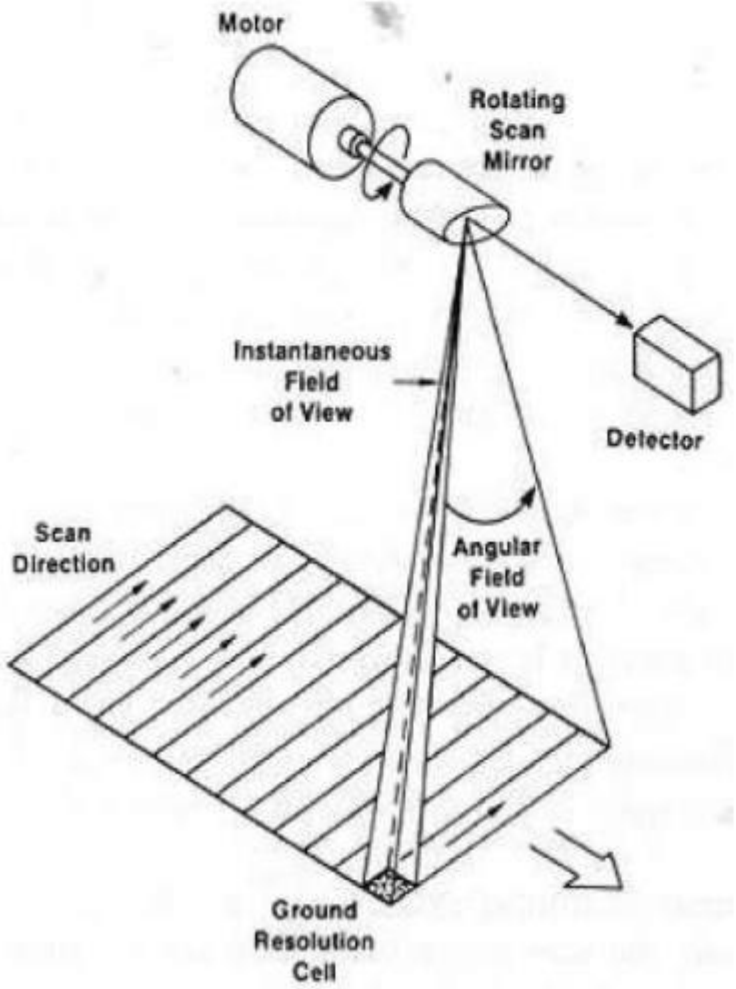


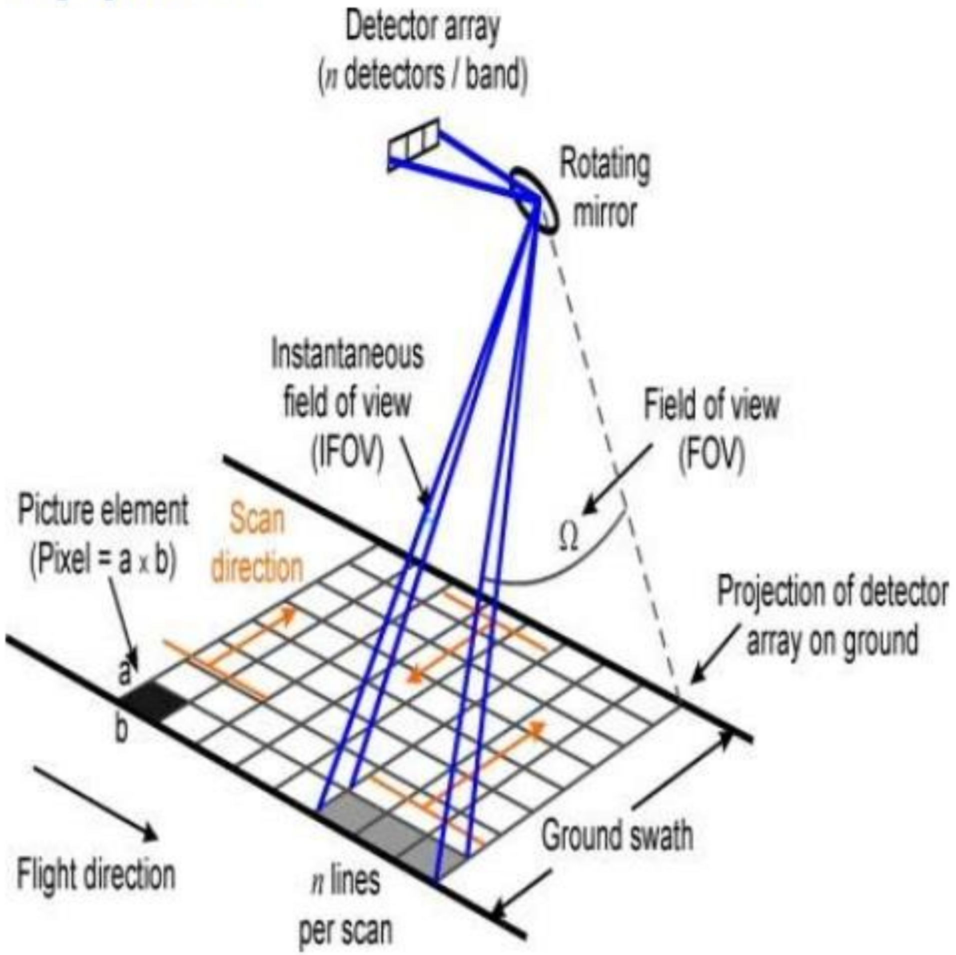
REMOTE SENSING SENSORS

Types of sensors :

Across track Scanners:

Image is acquired by pixel by pixel





REMOTE SENSING SENSORS

Types of sensors :

2. Non imaging sensors:

- These sensors do not form the image
- These are used to record spectral quantity or parameter as a function of time

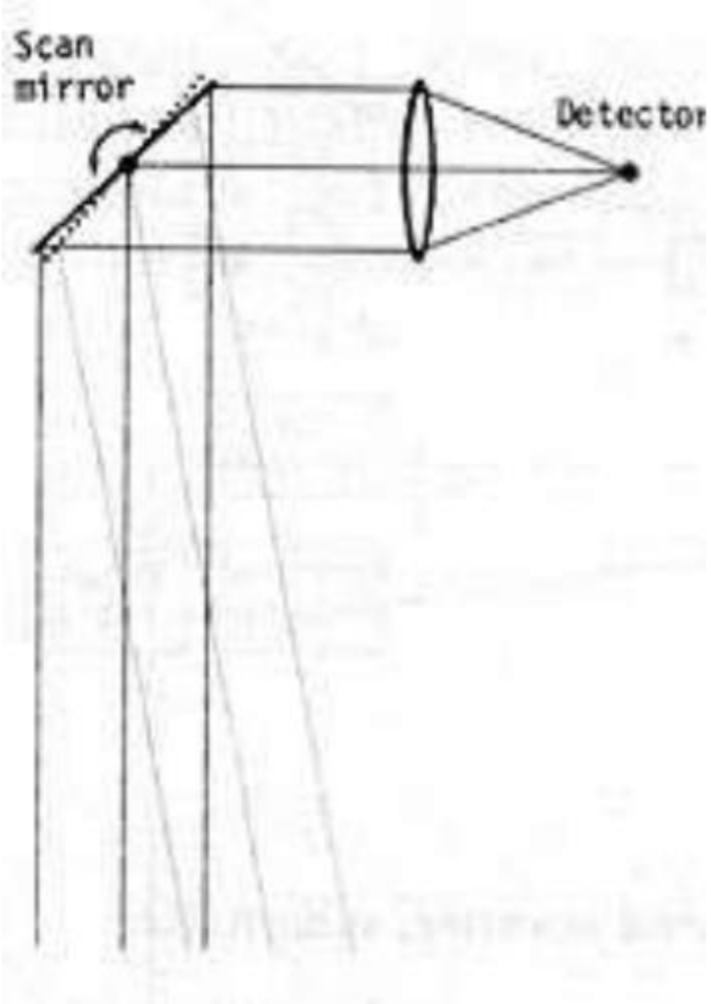
Ex: temperature measurement, study of atmosphere

REMOTE SENSING SENSORS

Types of sensors :

Image Plane Scanning:

Lens is used after the scan mirror to focus the light on the detector

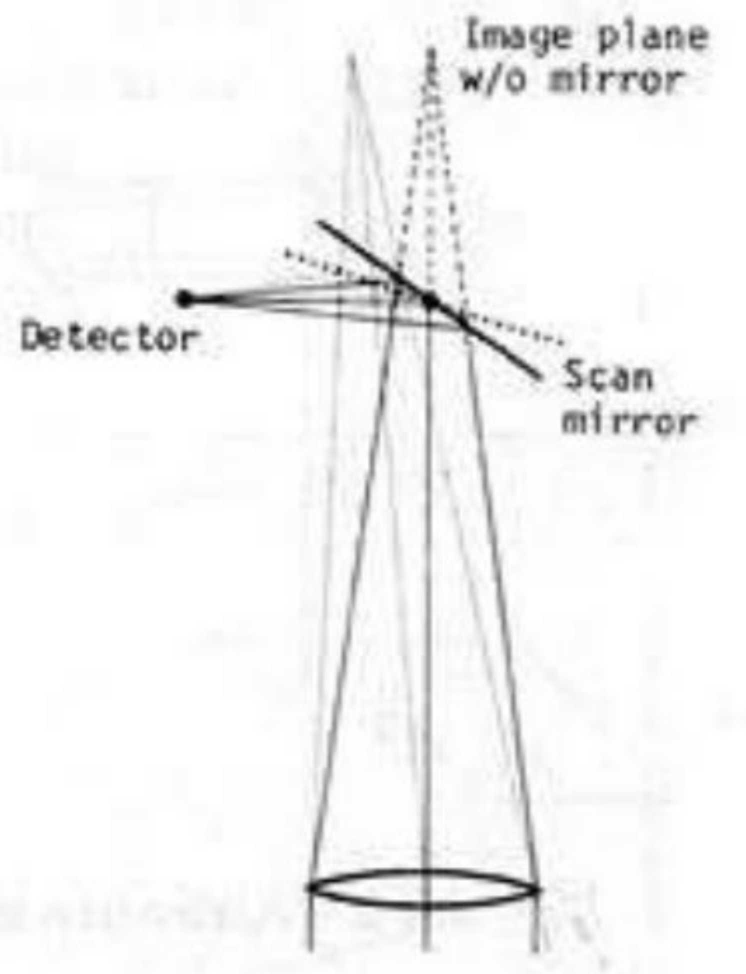


REMOTE SENSING SENSORS

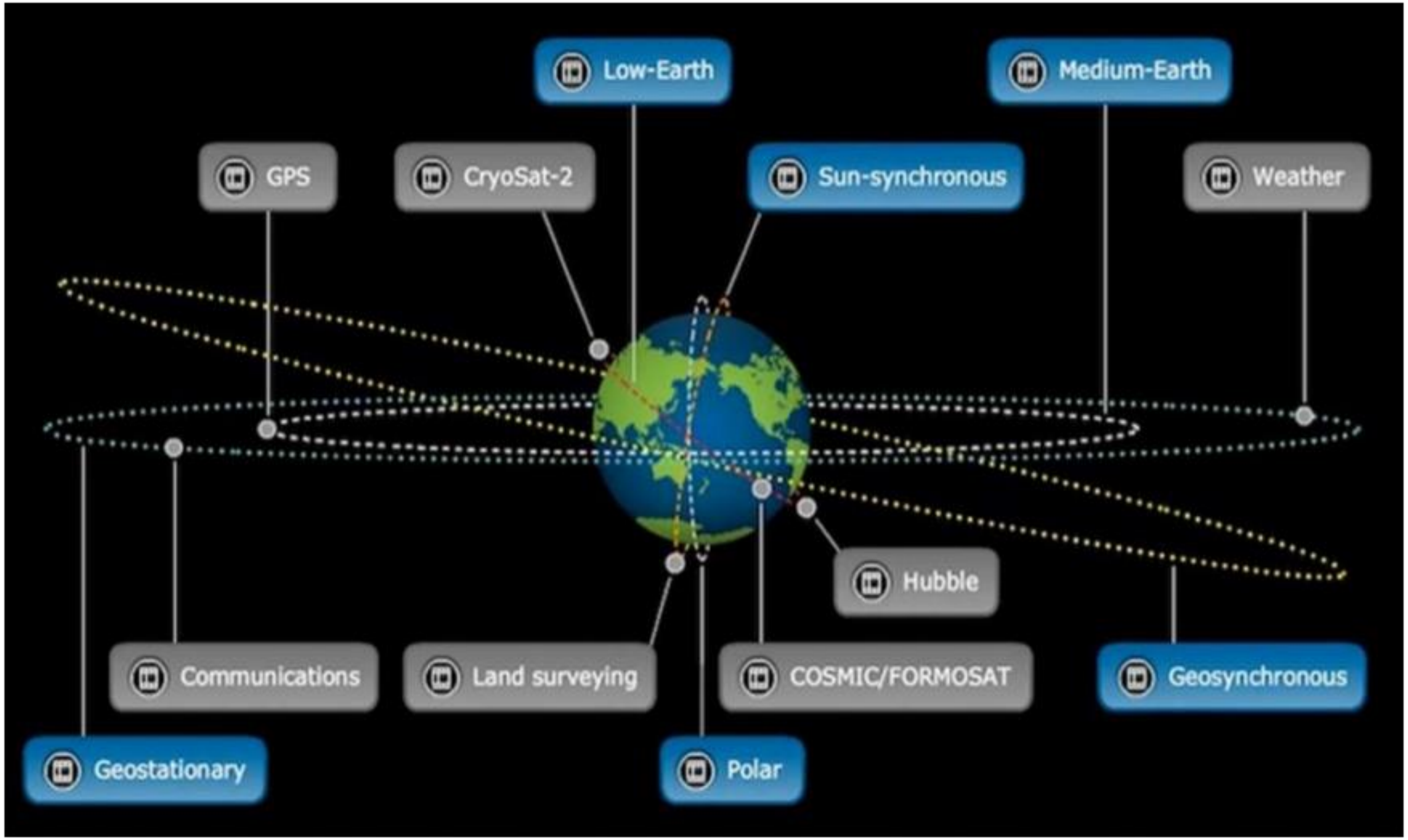
Types of sensors :

Object Plane Scanning:

Lens is placed before the scan mirror to focus the light on the detector



ORBITS OF REMOTE SENSING



ORBITS OF REMOTE SENSING

SATELLITE:

Satellite is any object man made or natural that revolves around the earth

TYPES OF ORBITS:

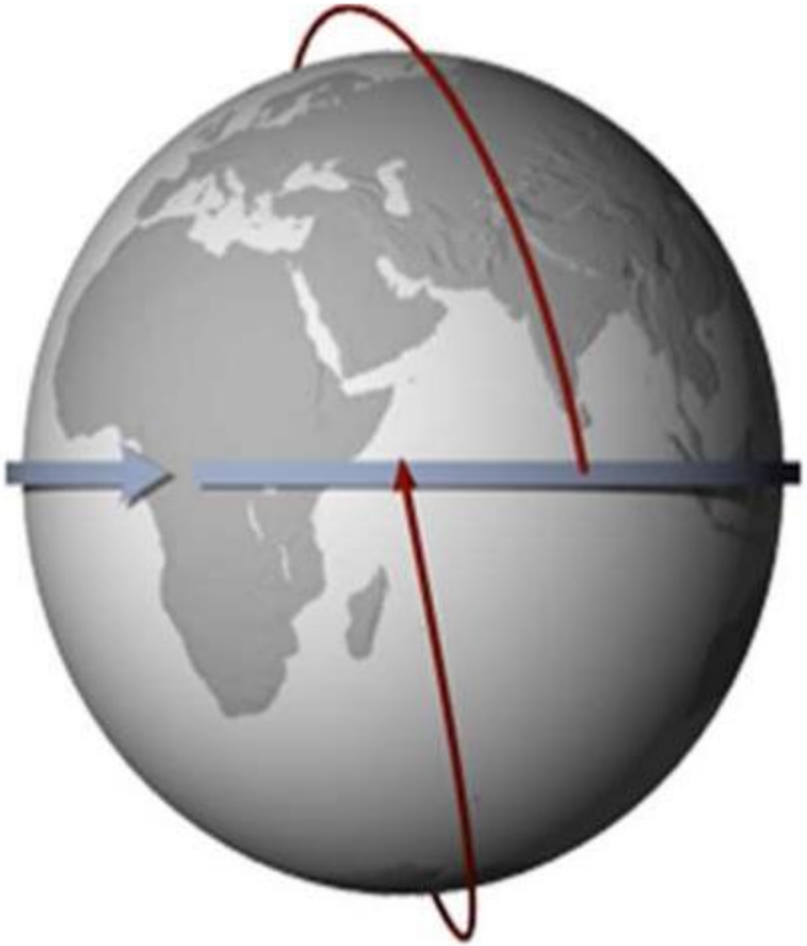
- Low Earth Orbit (LEO) < 2000 km
- Medium Earth Orbit (MEO) 2000-35786 km
- High Earth Orbit (HEO) > 35786 km

ORBITS OF REMOTE SENSING

Low Earth Orbit:

Polar orbiting satellites:

- **Satellite is pass above the earth poles**
- **High resolution of images is possible**
- **Crosses the equator at 90^o**

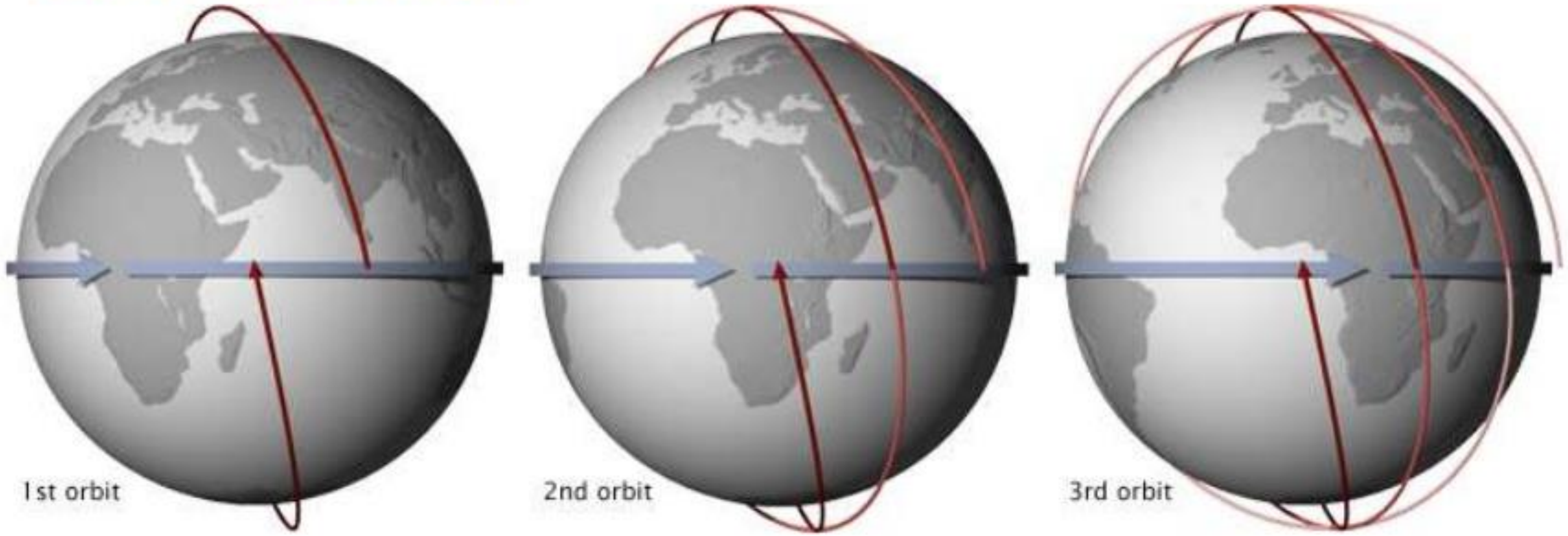


ORBITS OF REMOTE SENSING

Low Earth Orbit:

Polar orbiting satellites:

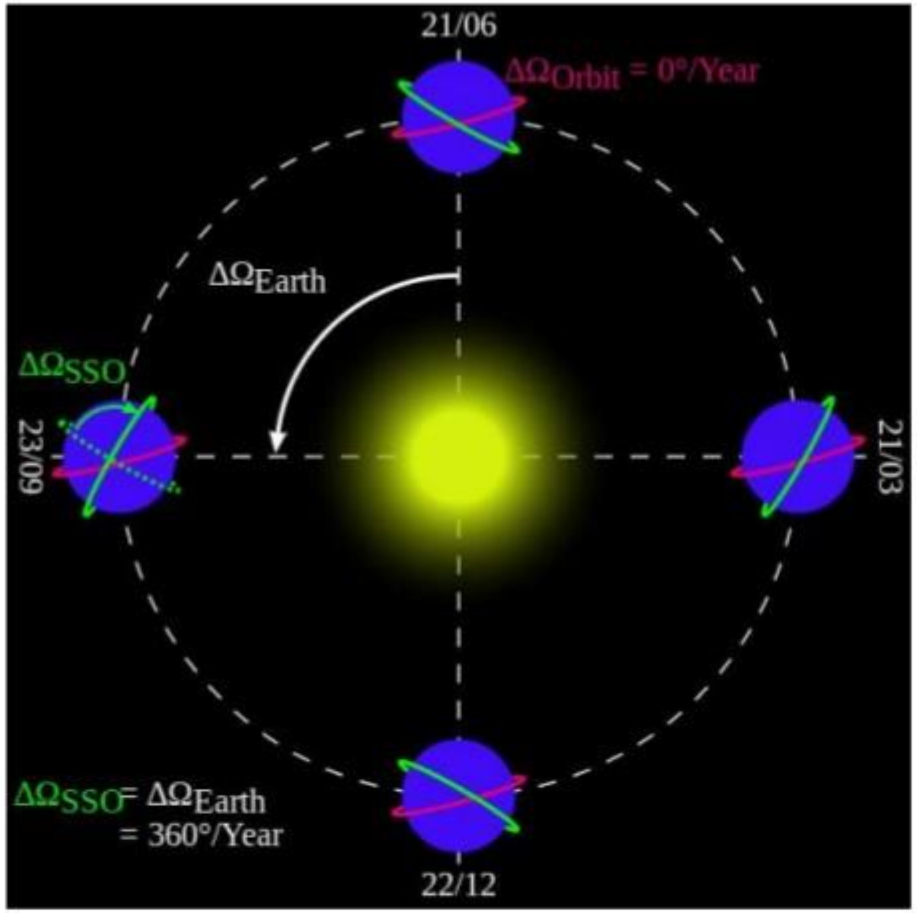
- **The advantage is every time the satellite view the newer segment on the earth surface because of earth's rotation**



ORBITS OF REMOTE SENSING

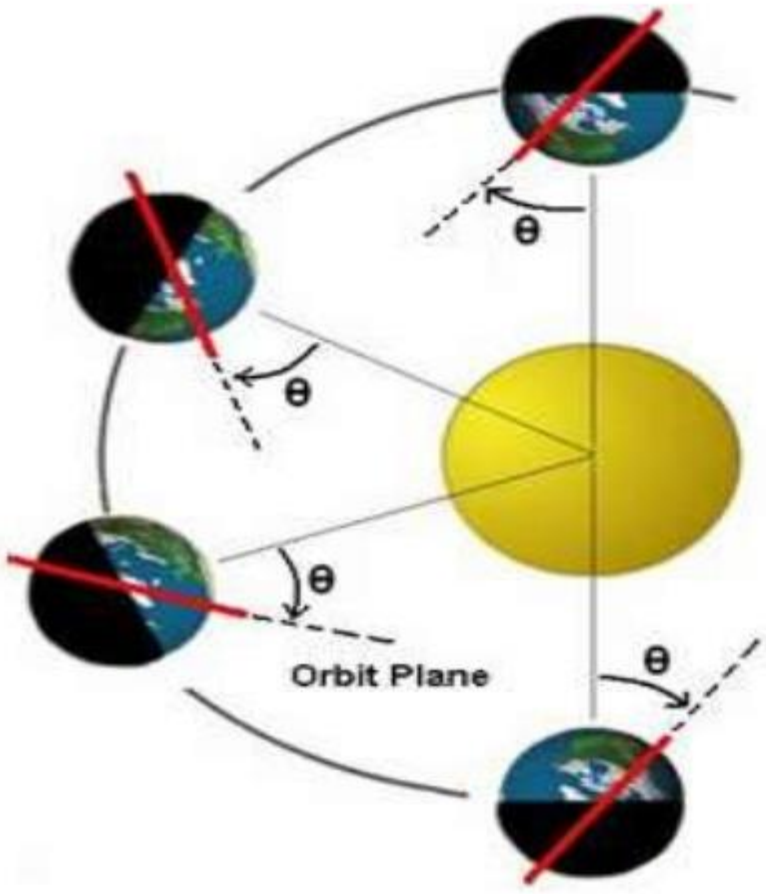
Sun Synchronous Orbit

- Angle of inclination of the orbit with respect to the sun through out the year is same
- Always crosses the equator precisely the same local sun time
- Mostly used for remote sensing



ORBITS OF REMOTE SENSING

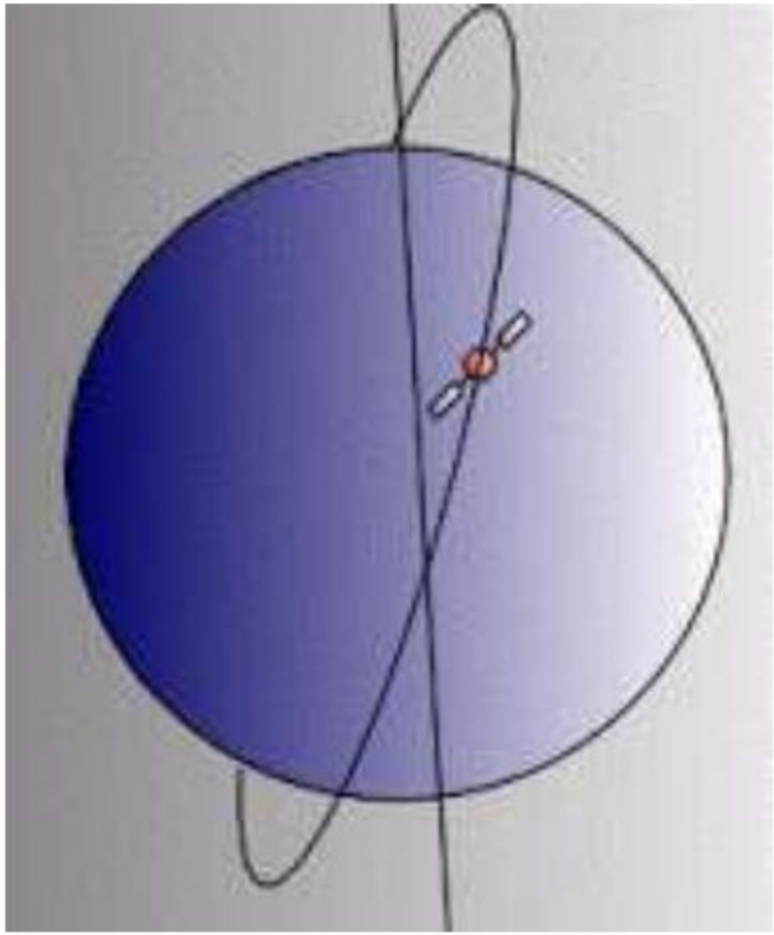
Sun Synchronous Orbit



ORBITS OF REMOTE SENSING

Near polar orbit

- **Orbital plane inclined at small angle with respect to the earth rotational axis**

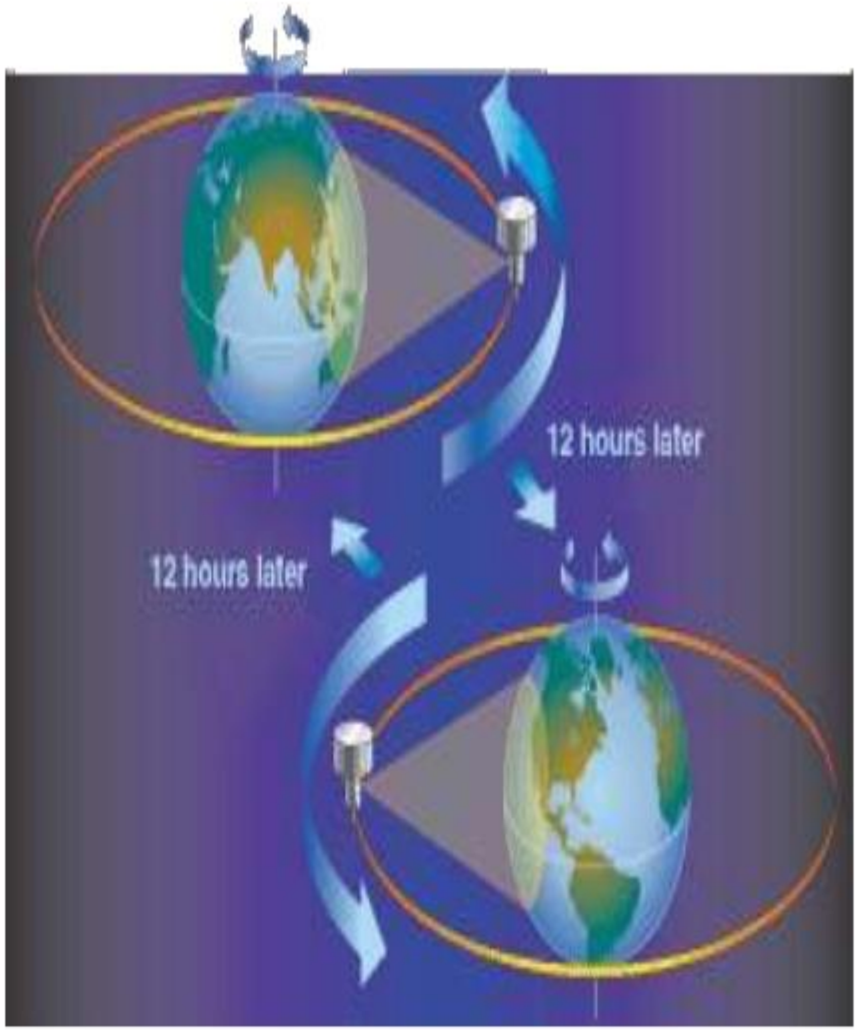


ORBITS OF REMOTE SENSING

High Earth Orbit

Geo stationary orbit

- **The satellite placed in this orbit is stationary with respect to the earth**
- **View the same area of the earth at all times**
- **View 50% of global surface (60^oN to 60^oS)**
- **Orbital period is 24 hours**



ORBITS OF REMOTE SENSING

High Earth Orbit

Geo stationary orbit

Advantages :

- **Useful for meteorological observation**
- **And also for commercial broadcast and communication purpose**

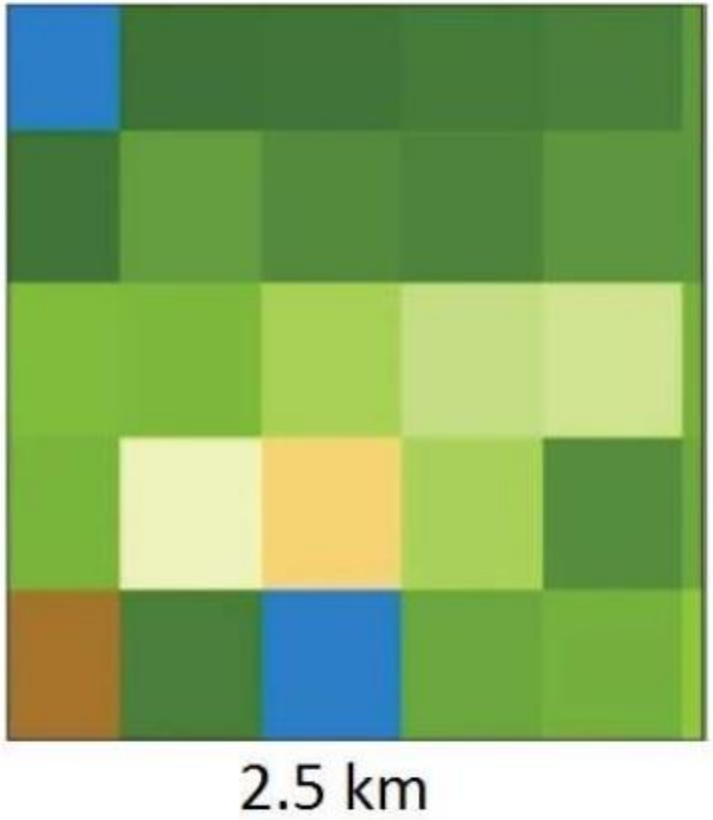
ORBITS OF REMOTE SENSING

High Earth Orbit

Geo stationary orbit

Dis-Advantages:

- **Low resolution**
- **Approximately a pixel size of 2.5 km on the ground**
- **Less information is obtained**



ORBITS OF REMOTE SENSING

Choice of orbit:

- It is dependent on the its mission
- Remote sensing satellites placed in LEO
  because it needs high resolution
- Commercial broadcast or Communication satellites are provided in HEO because it should receive and send signals from large geographical are

ORBITS OF REMOTE SENSING

Shapes of orbits: