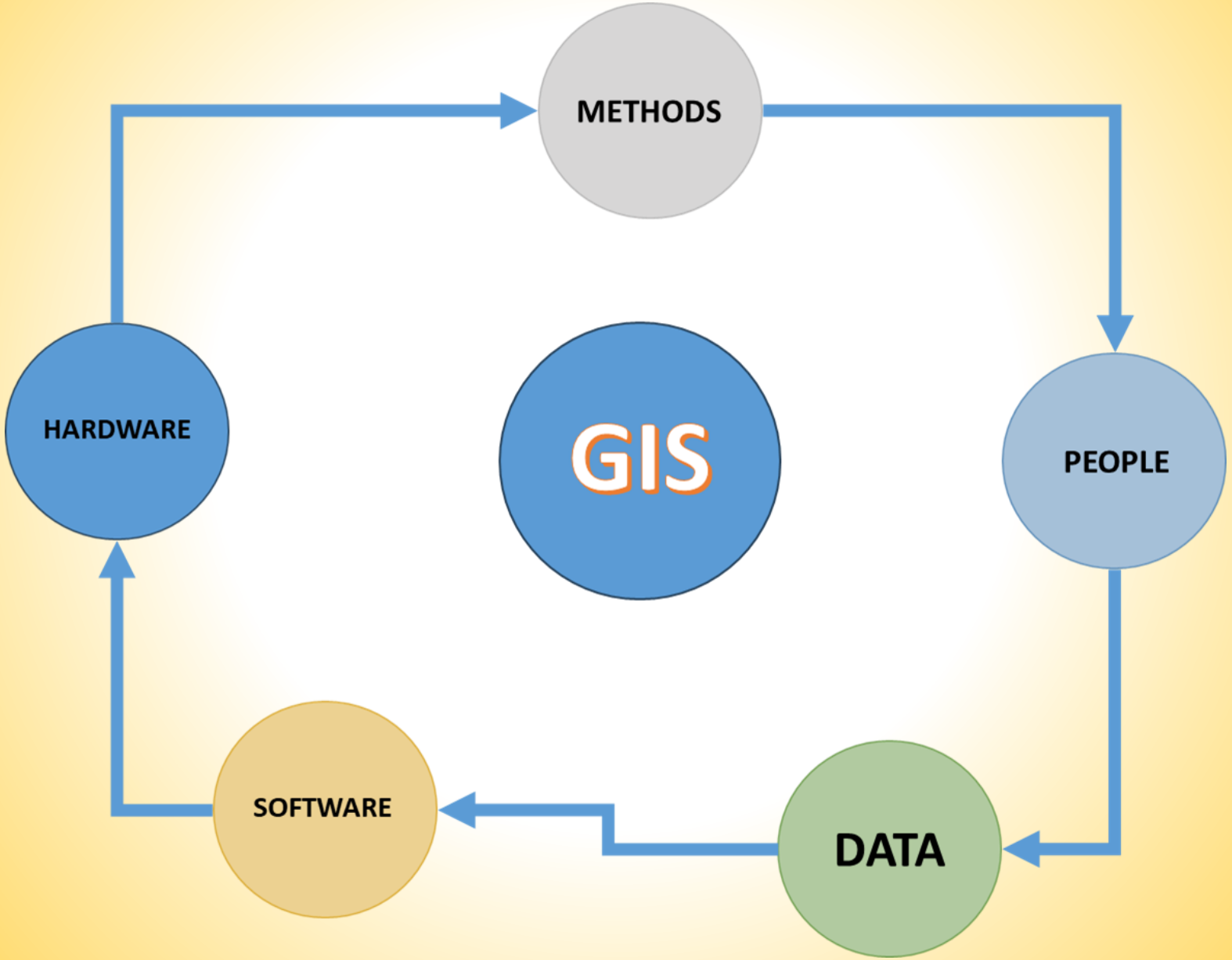
GIS & Remote Sensing Applications in Mineral Exploration

How we can use them in Zimbabwean context

Geographic Information System (GIS)

- GIS, is a computer-based system that collects, manages, analyzes, and visualizes spatial (geographic) data on maps.
- **Data integration:** GIS brings together and links spatial data (where things are) with all types of descriptive information (what things are like).
- **Mapping:** It creates maps that display data in a visual format, combining traditional map-making with database operations.
- **Analysis:** GIS provides unique tools for spatial analysis, allowing users to identify patterns, relationships, and situations that might not be obvious otherwise.
- **Visualization:** It organizes layers of information into visualizations, including maps and 3D scenes, to help explain events and predict outcomes

GIS COMPONENTS



GIS COMPONENTS

- **People**: Analyse, and interpret the data.
- **Hardware**: Computers, servers, plotters, and GPS devices.
- **Software**: GIS software like ArcGIS and QGIS, ILWIS which run on the hardware.
- **Data**: Geographic and descriptive information that the system processes. Spatial data, such as vector and raster data, and the attribute information associated with it.
- **Methods**: The rules, procedures, and workflows used to operate the GIS, manage the data, and perform analysis to solve problems.

Zimbabwean Context

- **Data**
  - ZGS repository of all geological data
  - All data are spatial
  - Various sources
  - Various levels of precision, accuracy and detail
  - Most data in analogue format
- **People**
  - Geologists training
  - Technicians – Digitise the analogue data
- **Hardware**
  - Computers and plotters
- **Software**
  - Cost and availability
- **Methods**
  - Training and body of knowledge

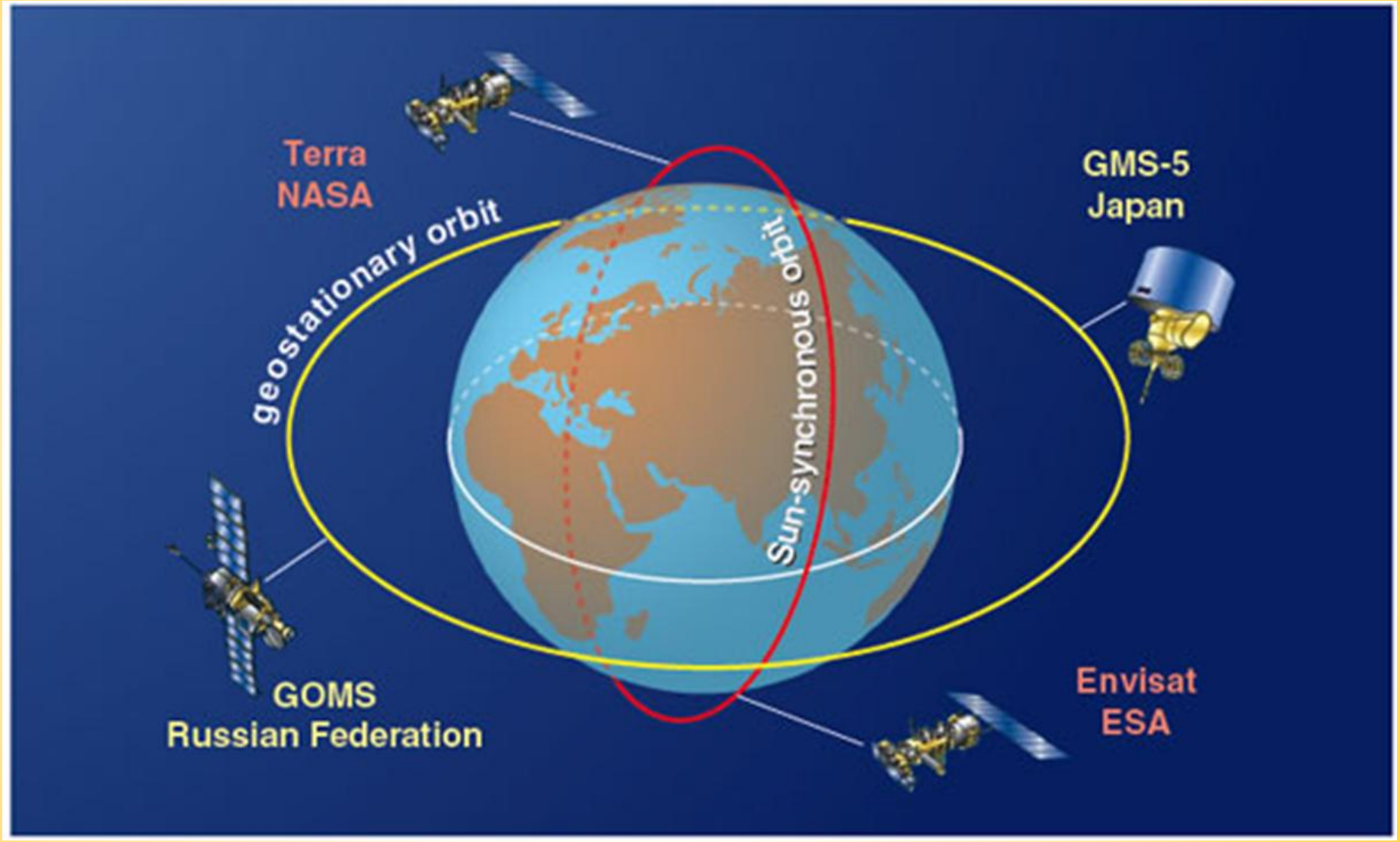
REMOTE SENSING

- RS is the **science** (and to some extent, art) of acquiring information about the Earth's surface without actually being in contact with it.
  - *This is done by sensing and recording reflected or emitted energy and processing, analysing, and applying that information.*
- Remote sensing is the process of detecting and monitoring the physical characteristics of an area by measuring its reflected and emitted radiation at a distance (typically from satellite or aircraft).
  - Special cameras collect remotely sensed images, which help researchers "sense" things about the Earth.

History of remote sensing

- More than 150 Earth-observation satellites are currently in orbit.
- Carry sensors that measure different sections of the ***visible, infrared and microwave*** regions of the electromagnetic spectrum.
- The majority of Earth-observation satellites carry **"passive"** sensors, measuring either reflected solar radiation or emitted thermal energy from the Earth's surface or atmosphere.
- Newer satellites also employ **"active"** sensors that emit energy and record the reflected or backscattered response, from which information about the Earth can be inferred.
- NASA launched Landsat 1 in 1972 to monitor Earth's land areas to assess the utility of Earth observation in forestry and agriculture

Satellite Orbits

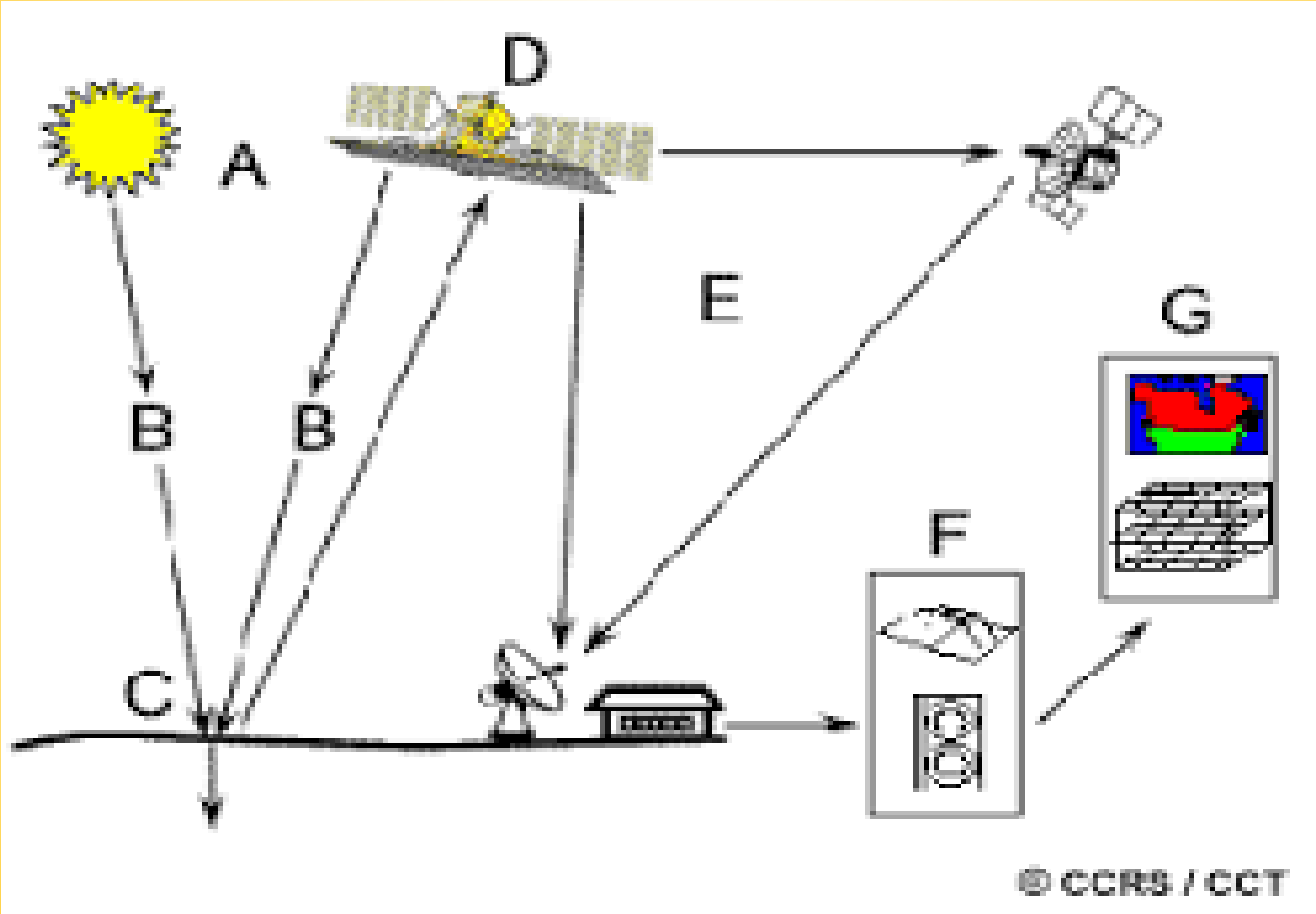


The satellite's orbit follows the Sun-illuminated section of the Earth (Sun synchronous) or remains over a fixed point on the Earth (geostationary) all vary between satellites and their sensors.

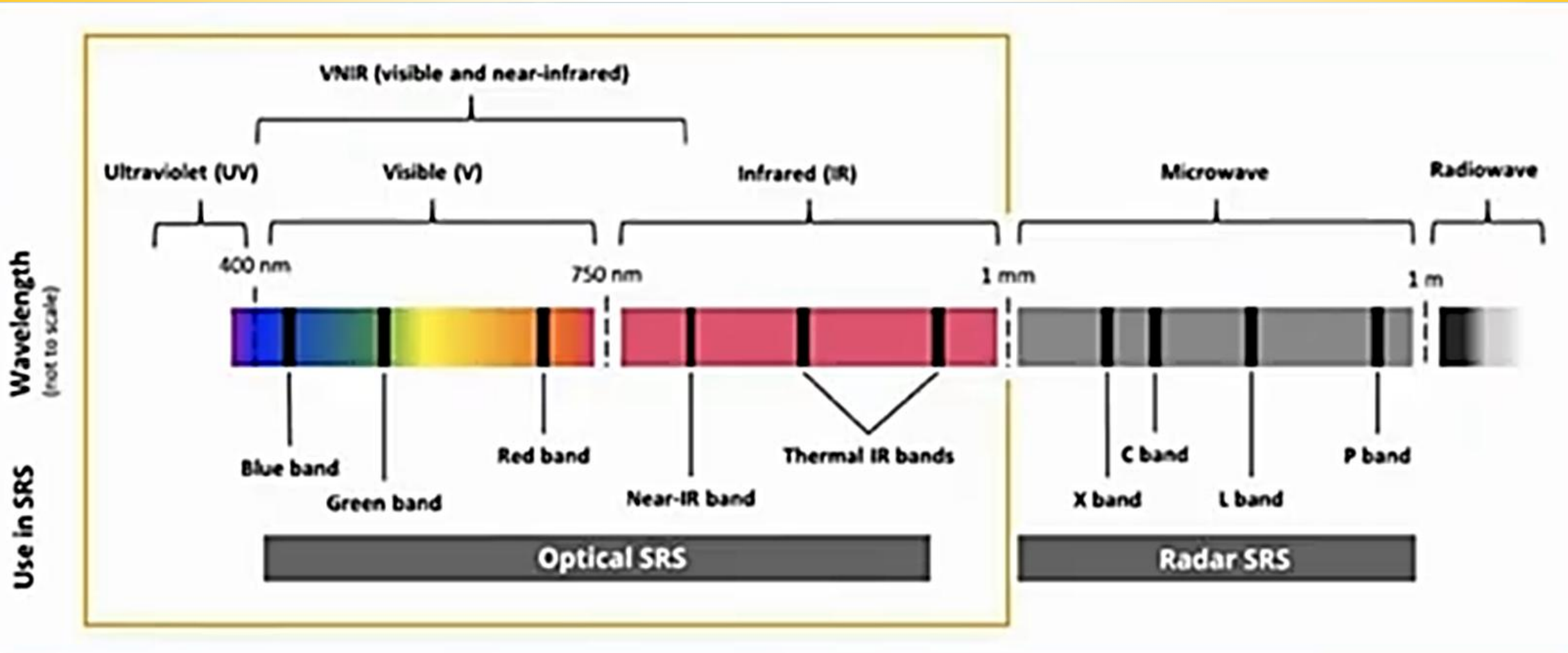
SATELLITE REMOTE SENSING ATTRIBUTES

- The minimum size of objects distinguishable on the Earth's surface **(spatial resolution),**
- The size of the region of the electromagnetic spectrum sensed **(spectral extent),**
- The number of digital levels used to express the data collected **(radiometric resolution)**
- The intervals between imagery acquisition **(temporal resolution).**
- The number of regions of the spectrum for which data are collected **(multi-spectral vs hyperspectral)**
- The time taken to revisit the same area of the Earth
- The spatial extent of images produced
- As data storage capacities and processing speeds increase, so has the ability of Earth-observation satellites to capture, process and return information.

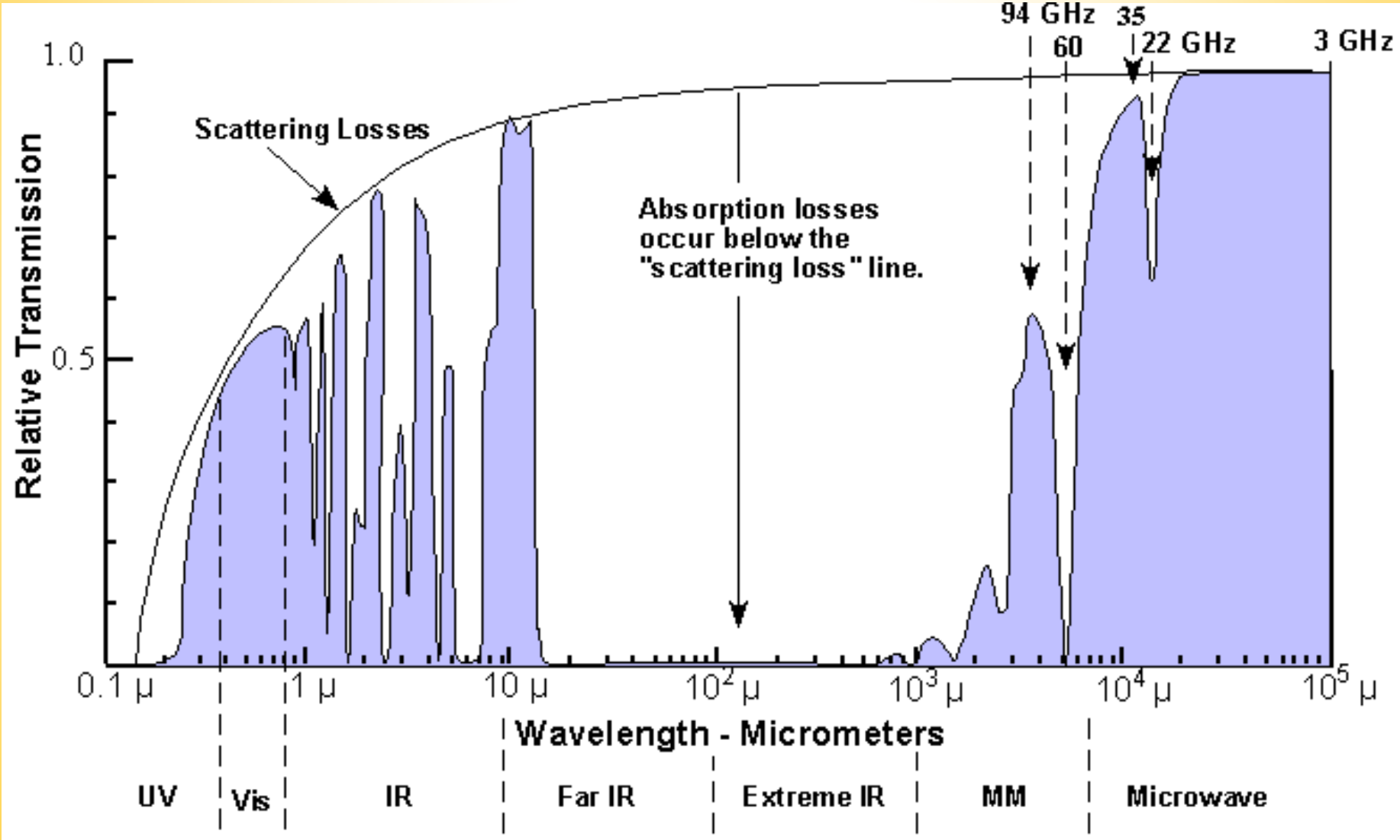
PRINCIPLE OF REMOTE SENSING



ELECTROMAGNETIC SPECTRUM



EFFECTS OF ATMOSPEHERE ON EMR



Application of Remote Sensing In Mineral Exploration

1. Mapping Surface Geology
2. Identifying Mineral Spectral Signatures
3. Vegetation Stress Analysis
4. Hydrothermal Alteration Detection
5. Topographic and Morphological Studies
6. Thermal Imaging
7. Subsurface Exploration
8. Assessing Environmental Impact
9. Monitoring Mining Operations
10. Land Reclamation and Restoration Monitoring
11. Risk and Disaster Assessment

ZIMBABWEAN CONTEXT

- **Geological Mapping**
  - Updating and new mapping
- **Mineral Exploration**
  - Area selection to attract investment
- **Ground and surface water monitoring and evaluation**
  - Improve water management
- **Environmental monitoring and Management**
- **Topographic and morphological studies**
- **Agricultural monitoring**

GREAT DYKE CHROME MINING

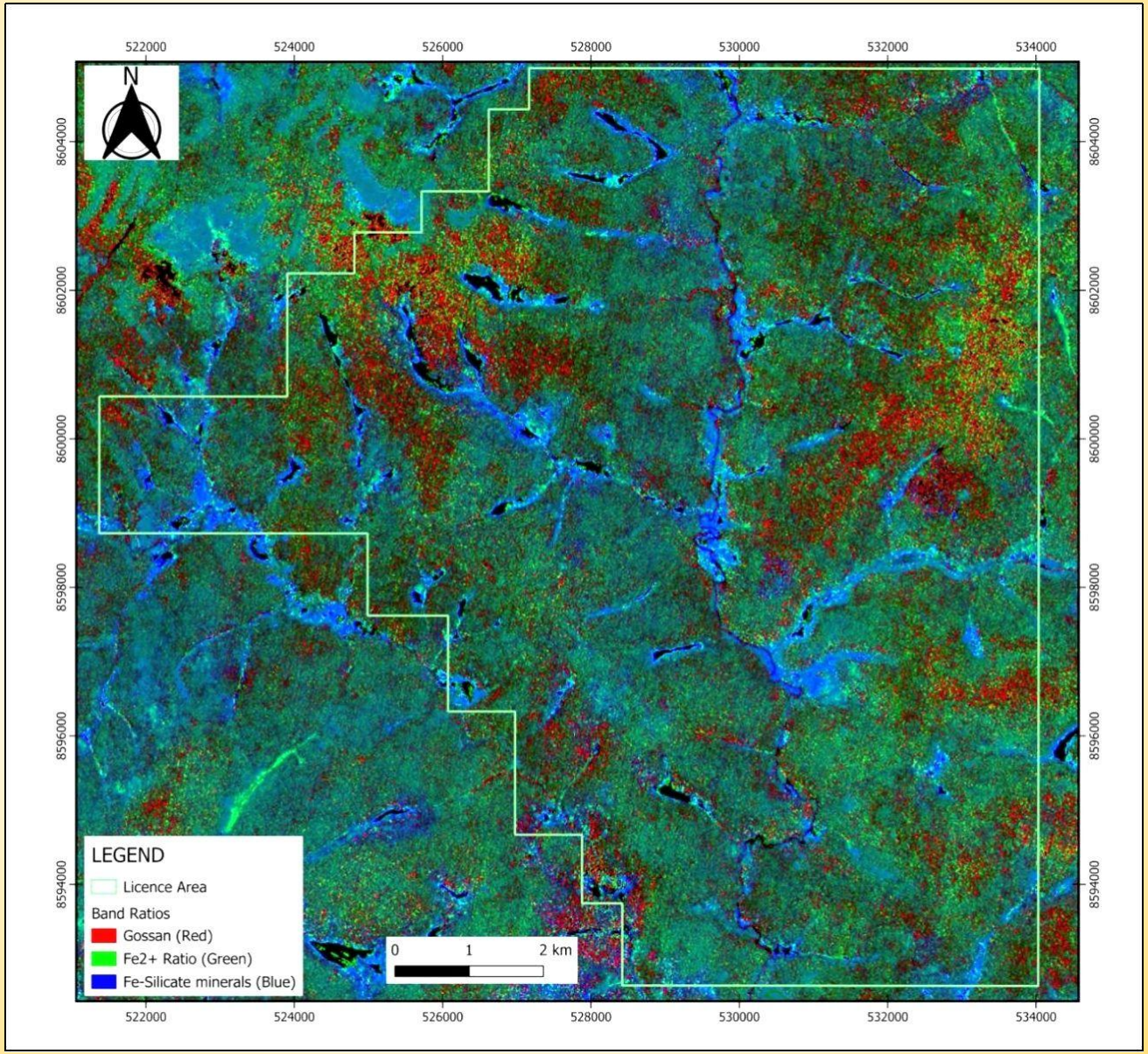
LOCATION OF EUREKA MINE

Radnor - Makaha

2018

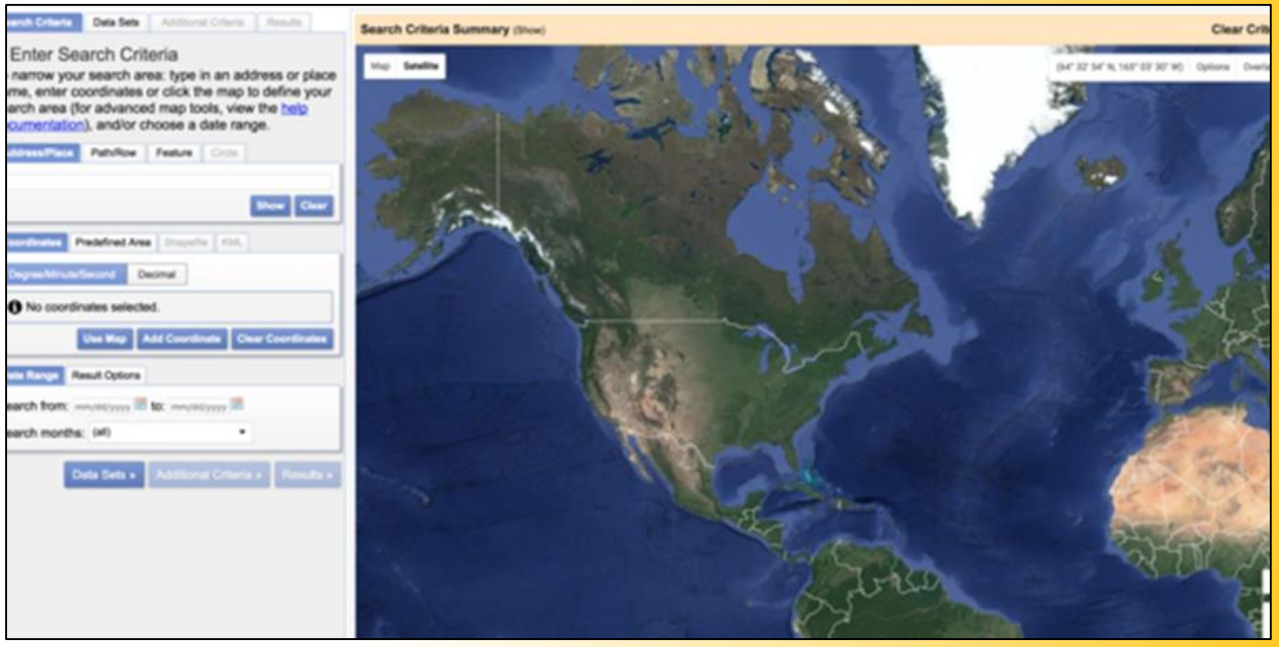
2025

Mineral indices mapping



DATA ACCESS

- In 2008, the Landsat products stored in the USGS EROS archive became available for download at no cost to users.
- ESA portal for Sentinel 2 data
- ASTER data from USGS portal
- SPOT and other commercial data sets by order I guess



CONCLUSIONS

- Large archive of geological data available in Zimbabwe
- Both Digital and analogue
- Need for digitising and create digital archive
- Have copyright on digital data which are more valuable
- Geochemical data from a Chinese national survey not publicised enough.
- JICA mineral exploration data need to be digitalised.
- DATA SHOULD BE FREELY AVAILABLE BUT NOT FOR FREE