



## Remote Sensing Images

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### *Types of Remote Sensing Images*

- Based on recording of remote sensed data
  - Photographic
  - Digital
- Photographic RS – Restricted to Aerial RS
  - Panchromatic
  - Photographic Infrared
  - Natural Colour
  - Multispectral
  - False Colour



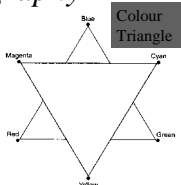
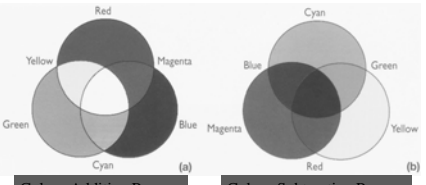
### *Photographic RS*

- Panchromatic (B&W)
  - Records EMR in the visible range (0.4-0.7  $\mu\text{m}$ )
- Photographic Infrared (B&W)
  - Records EMR in the range (0.76-0.88  $\mu\text{m}$ )
  - Useful for delineating land-water interfaces
  - Drainage systems with and without water
  - Vegetation surveying
- Natural Colour Photography
  - Human visual system can differentiate thousands of colours but only few grey levels
  - Colours produced according to human perception




### *Natural Colour Photography*

- Primary Additive Colours
  - Red, Green and Blue (RGB)
- Complementary Colours
  - Cyan, Magenta and Yellow
- Colour Triangle

(a) Colour Additive Process      (b) Colour Subtractive Process

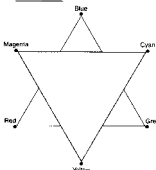
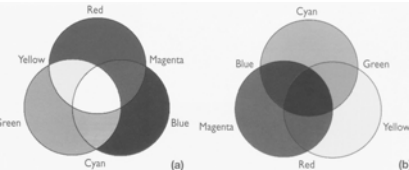


### *Natural Colour Photography*


- If three primary colours are superimposed in unequal amounts, then number of colors are produced.
- If three primary colours are superimposed in equal amounts, then greys ranging from black to white are produced.

**Subtractive colours**

- If white light is passed through a colour filter it is possible to subtract one of the primary colours
  - E.g., Yellow filter subtracts blue light but passes green and red

(a) Colour Additive Process      (b) Colour Subtractive Process



### *Photographic RS (Contd..)*

- Multispectral
  - Involves simultaneously obtaining images on the same scene at different wavelengths
  - Four: Blue, Green, Red and NIR parts of EMR
  - Multispectral imaging allows the examination of single band images
  - Natural and False colour composites can be produced
- False Colour
  - True colour composite (TCC):

## Photographic RS (Contd..)

- False Colour
  - True Colour Composite (TCC)
    - Red band – Red; Green band – Green; Blue band – Blue
  - False Colour Composite (FCC)
    - Any other combination of colours
    - E.g., Blue band – Red; Red band – Green; Green band – Blue
    - E.g., Blue band – Red; Red band – Green; NIR band – Blue
  - Standard False Colour Composite (FCC)
    - E.g., NIR band – Red; Red band – Green; Green band – Blue
    - In IRS: Band 4 – Red; Band 3 – Green; Band 2 – Blue

## Color Composites - Data

### Landsat TM

Average Orbital Height: 700 km (440 Miles)

Spatial Resolution: 30 m, except band 6 which is 90 m

Records Data in 7 Wavelength Intervals (bands)

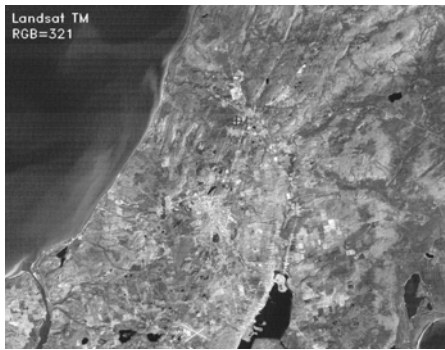
1. Visible Blue (0.45 to 0.52 microns)
2. Visible Green (0.52 to 0.60 microns)
3. Visible Red (0.63 to 0.69 microns)
4. Near Infrared (0.76 to 0.90 microns)
5. Mid Infrared (1.55 to 1.75 microns)
6. Thermal Infrared (10.4 to 12.5 microns)
7. Mid Infrared (2.08 to 2.35 microns)

Bands 1,2,3,4,5, and 7 record reflected energy

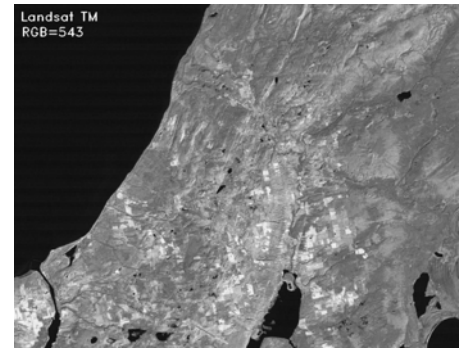
Band 6 records emitted thermal (heat) energy

Satellite Images of the Keweenaw Peninsula, USA

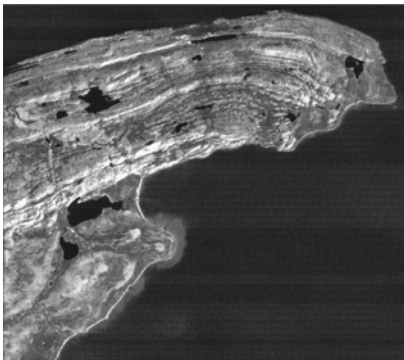
## Band 321 (TCC)



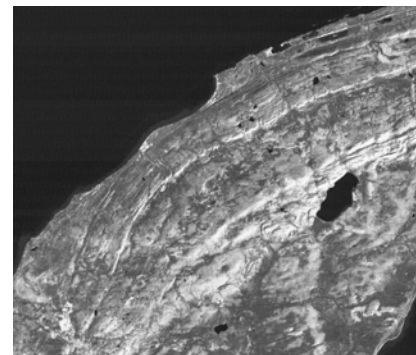
## FCC (Band 543)

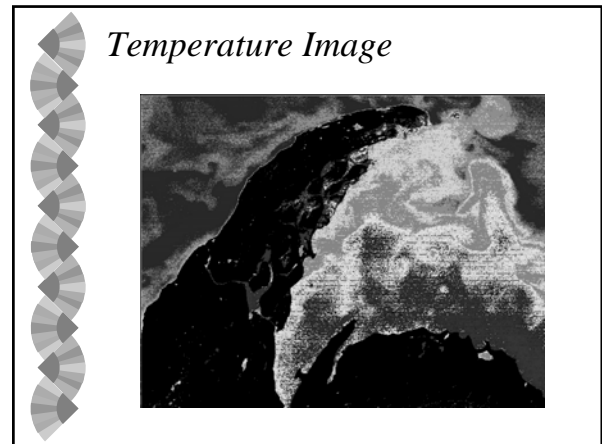
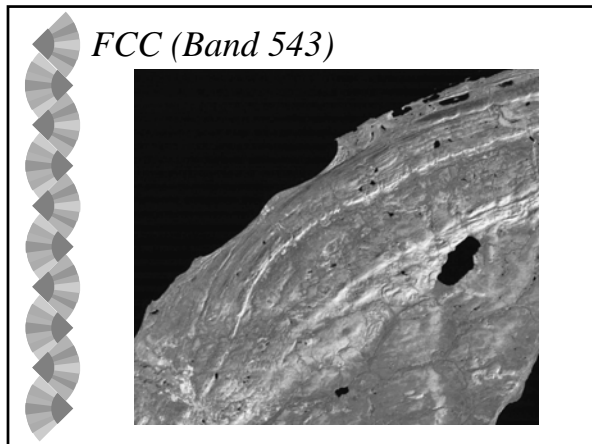


## Band 321 (TCC)



## Standard FCC (Bands 432)





### Digital Images

- Although images can be produced using film, they can also be recorded electronically
- Advantages
  - Film cannot record EMR beyond  $1 \mu\text{m}$
  - It is not possible to produce and store large amount of films from the satellites
  - Solid-state electronic devices are very reliable, use little power and are small & light
  - Data that are obtained digitally can be transmitted easily without any degradation
  - Digital data are in a form that can be readily processed on Computers
  - Digital image processing techniques are very powerful for image analysis

### Digital Image

Pixel location 1, 1

1, N

N, 1

N, N

Digital image made up of N x N pixels

12	17	23	31	3	8	22	28	27
29	25	32	44	99	65	76	47	8
22	28	75	99	107	111	107	151	8
10	29	85	64	107	102	98	102	1
12	24	15	23	100	100	100	100	22
8	13	38	41	83	100	107	100	102
8	19	27	53	83	102	102	100	76
8	13	80	80	102	102	104	8	8
8	5	26	76	75	85	94	42	3
8	8	5	11	30	23	13	19	22

Zoom showing pixel digital counts as brightness values

### Digital Images

- Digital image is a regular grid array of squares (**Pixels**) where each grid cell is assigned a digital number (**DN**)
- Low DN indicates Low reflectance and high DN indicates high reflectance
- Convention: Origin at the Top left corner
- CCDs: Charge Coupled Devices
- Systems employed to acquire digital data
  - Transverse Scanning System
  - Pushbroom System

26	200	2
200	100	50
0	150	255

Pixel (row 3, column 2)

### Transverse Scanning System

- Also called across-track or Whiskbroom scanning system
- Electro-mechanical device
- Narrow swaths of terrain are at right angles to the direction of the movement
- A scanning mirror sweeps across the scene and directs the reflected radiation towards the detectors

Detector 1

Detector 2

Detector 3

Scanning mirror

Radiation

Direction of flight

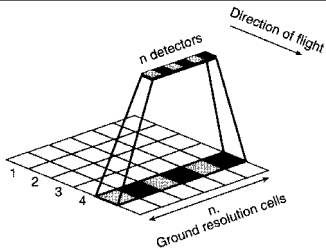
Ground sampling cell

Image swath

Variation in width of area imaged

### Pushbroom Scanning System

- Pushbroom system does not rely on scanning mirror
- A linear array of detectors are employed - Electro-mechanical device
- No. of detectors = No. of pixels per swath (or row)
- Lack of moving mirror makes the pushbroom system more reliable
- Detectors are extremely small in size ( $10^{-5}$  m) consisting of CCDs



### Scale of an Image

- Scale of an image relates distances on the ground measured in any given units to distances measured in the same units.
- A scale of 1:50,000 means that, if two features are separated by 1 mm on an image, then the two features on the ground are 50,000 mm apart
  - Actual unit does not affect the calculation
- Scale of 1:1 million and 1: 10 million are common for satellite images

#### • Problem

- Two buildings which are 360 m apart separated by 36 mm on image A and 18 mm on image B. Calculate the scale of image A and image B and state which of the two images has larger scale.

$$\text{Image A: } 36/360,000 = 1: 10,000$$

$$\text{Image B: } 18/360,000 = 1: 20,000$$

Image A is at a larger scale