CRP

CRP514-term122

Term paper presentation

The feasibility of Remote sensing systems \techniques in mineral exploration

Presented by:
Ammar J.Abdlmutalib
Supervised by:
Dr. Baqer Al-Ramadan

May.12,2013

Outlines:

- Introduction.

  Remote sensing definition\systems\techniques.

- Objectives & methodologies
- Literature review.
- Case study1
- Case study2
- Discussion\conclusion

Introduction:

- Remote sensing is defined as obtaining images using aircrafts or satellites, processing, interpreting and relating them through detecting interactions between material and electromagnetic spectrum (Sabin, 1997).

Introduction:

- Table summarizes various RS systems used in mineral exploration:

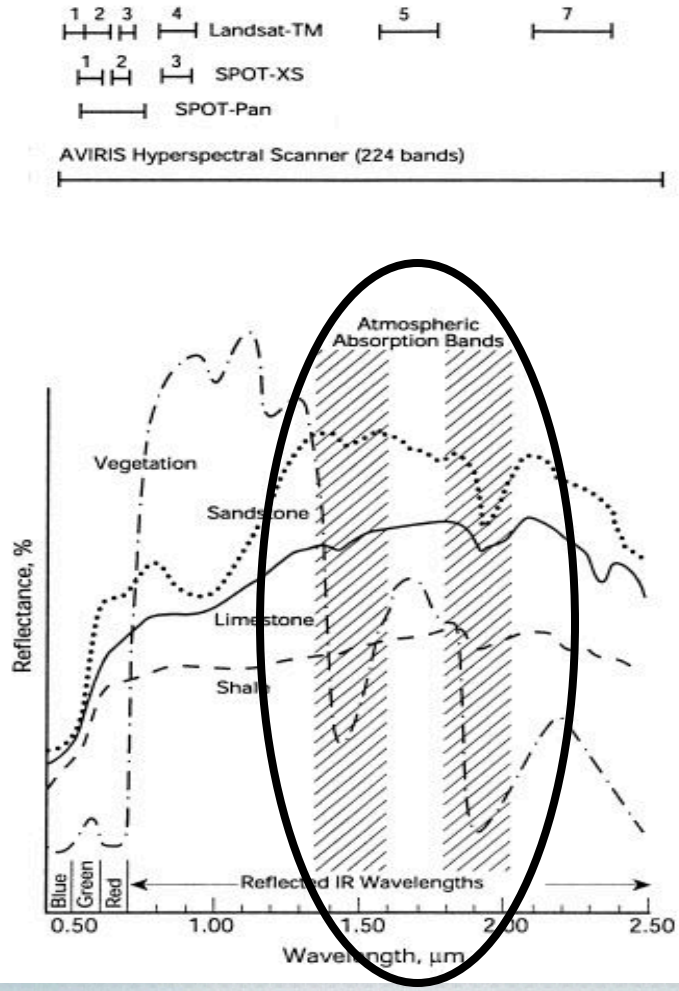
Table 1
Remote sensing systems for mineral exploration

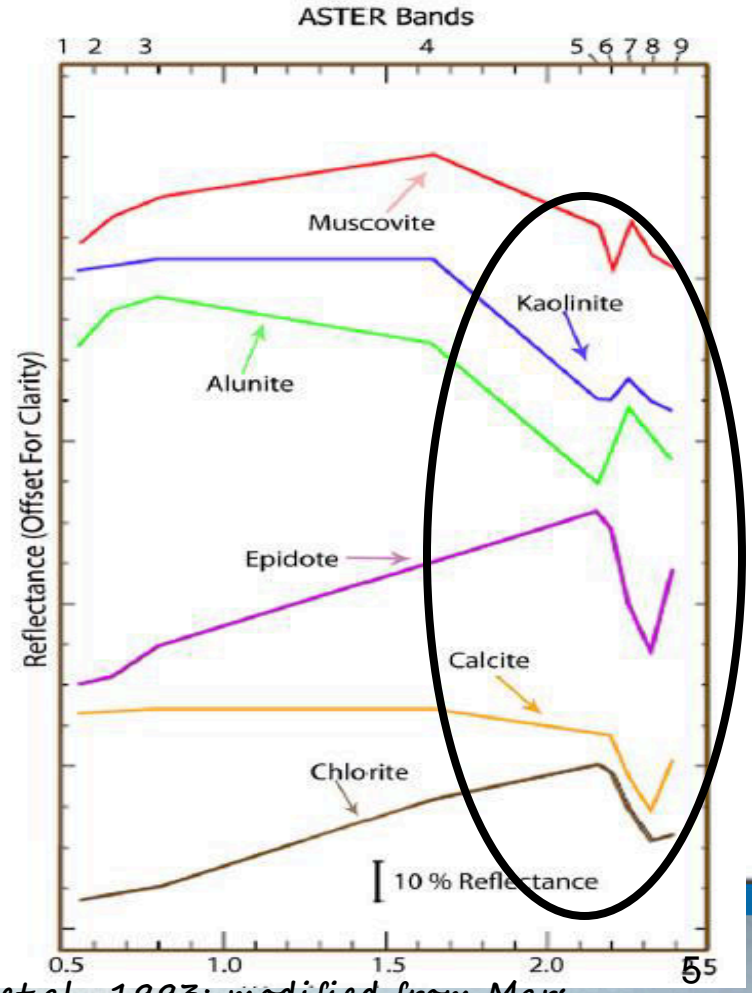
Characteristic	Landsat 4, 5 thematic mapper (TM)	Landsat 7 enhanced TM	SPOT multispectral scanner (XS)	SPOT panchromatic (Pan)	AVIRIS hyperspectral scanner
Spectral region					
Visible and reflected IR	0.45 to 2.35 μm	0.45 to 2.35 μm	0.50 to 0.89 μm	–	0.40 to 2.50 μm
Panchromatic	–	0.52 to 0.90 μm	–	0.51 to 0.73 μm	
Thermal IR	10.5 to 12.5 μm	–	–	–	
Spectral bands	7	8	3	1	224
Terrain coverage					
East to west	185 km	185 km	60 km	60 km	10.5 km cross-track
North to south	170 km	170 km	60 km	60 km	
Ground resolution cell					
Visible and reflected IR	30 by 30 m	30 by 30 m	20 by 20 m	–	20 m
Panchromatic	–	15 by 15 m	–	10 by 10 m	
Thermal IR	120 by 120 m	60 by 60 m	–	–	

(Sabin,1999)

Introduction:

Advanced Spaceborne Thermal Emission and Reflection Radiometer data ASTER:





(Clark et al., 1993; modified from Mars and Rowan, 2006).

Introduction:

- Techniques:

- Principal component analysis
- Band Ratio Images
- Color Composite ratio image
- Classification image (supervised\unsupervised).
- Minimum Noise Fraction..

Objectives & methodologies:

- Many publications have been reviewed are covering different systems of Remote Sensing. Outcomes of these systems were processed using different techniques (mentioned in the previous sections). All system and techniques were evaluated in term of statistics (number of publications) and their quality in detecting zones associated with mineral existence zones.

Literature review:

- **Targets:**
- Hydrothermal altered zones recognition:
- Geological and fracture patterns mapping at small and large scales

Geological and fracture patterns mapping at small and large scales:

Rowan and Wetlaufer (1975) studied the relationship between ore occurrences and lineament patterns using landsat mosaic in Nevada, they showed that mining districts are associated always with lineaments and especially in the lineaments intersections.

Literature review:

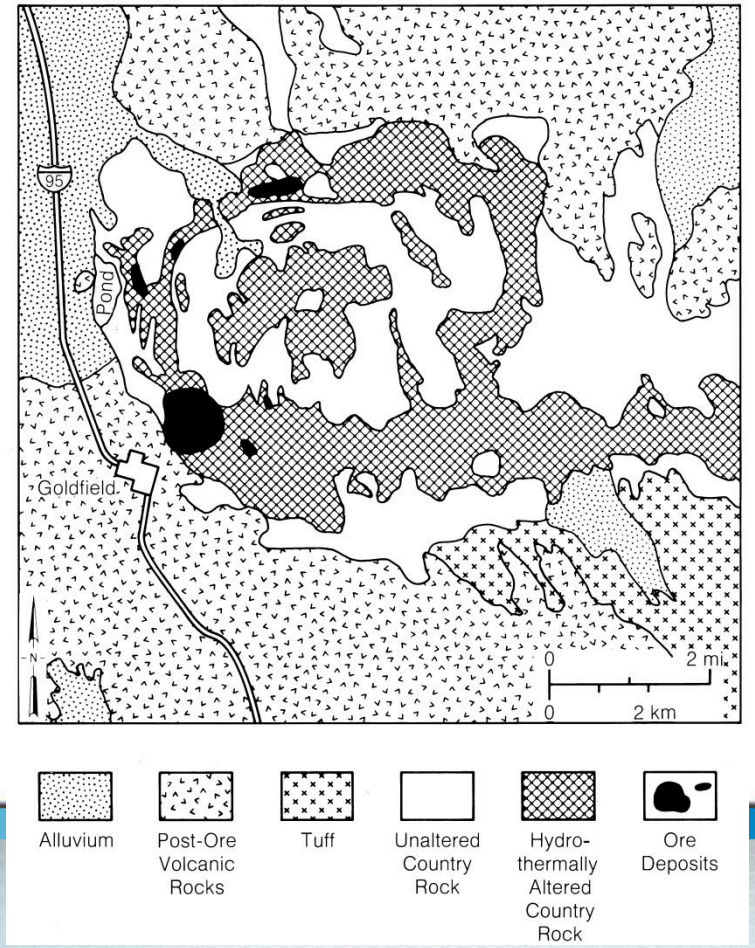
Locality	Reference	Comments
Western North and South America	Spatz and Wilson (1994)	Summarizes published remote sensing studies of 12 major mining districts from British Columbia to Chile.
Altiplano, Bolivia	Knepper and Simpson (1992)	TM color ratio composite images used to recognize hydrothermally altered rocks.
Canada	Singhroy (1991)	10 papers on mineral exploration using Landsat and radar.
Chile, Peru, and Bolivia	Eiswerth and Rowan (1993)	TM color ratio composite images used to recognize hydrothermally altered rocks. Field studies evaluated results.
Jordan	Kaufmann (1988)	Mapped hydrothermal alteration using digitally processed TM images.
Jordan	Abdelhamid and Rabba (1994)	A variety of digitally processed TM images identified a historic Cu/Mn deposit and located prospects.
Sonora, Mexico	Bennett et al. (1993)	TM data were integrated with field and laboratory data to discover several prospects.
Nevada	Watson et al. (1990)	TIMS data were processed to recognize silicified rocks associated with gold deposits.
Spain	Goosens and Kroonenberg (1994)	TM ratio images were used to identify altered rocks overlain by residual soil.
Sudan	Griffiths et al. (1987)	Landsat MSS images and field work showed gold occurrences are concentrated along regional shear zones in mafic metavolcanics.
Arizona	Abrams et al. (1983)	Mapped hydrothermal alteration using digitally processed aircraft multispectral images.
Montana	Rowan et al. (1991)	Compared the association of linear features with ore deposits in Butte region.
Idaho and Montana	Segal and Rowan (1989)	Mapped hydrothermal alteration in the Dillon region.
Utah	Murphy (1995)	Used hyperspectral data to map jasperoid.
Zaire, Zambia, Angola	Unrug (1988)	Major lead–zinc vein deposits occur at intersections of Landsat lineaments with folds and thrust faults. Unexplored intersections are potential targets.

Literature review:

- Crosta et al, (2003) applied Principal Component Analysis on ASTER SWIR\VNIR bands for targeting epithermal gold deposits related minerals in Los Menucos, Patagonia, Argentina. Their results showed that PCA techniques can detailed mineralogical spectral information.
- Velosky et al. (2003) used ASTER band ratio image of (4\2,4\5,5\6) to distinguish massive sulfide mineralization in host rocks of gossan. This was done in Wadi Bidah shear zone south western Saudi Arabia.
- Xu et al. (2004) recognized many hydrothermally altered zones around epithermal gold deposits through utilizing PCA\ band ratio image to delimit vegetation clay minerals and iron oxides.

Case study:

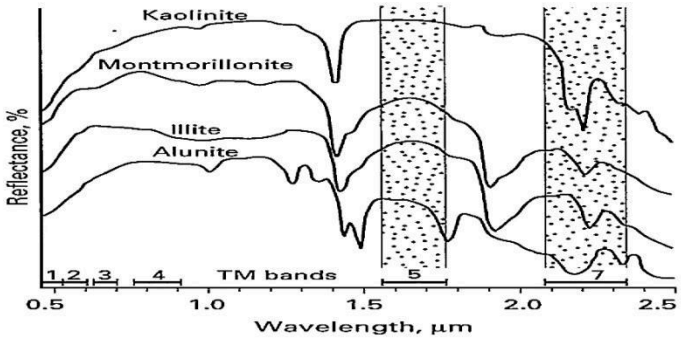
Mapping hydrothermal alterations at epithermal vein deposit – Goldfield, Nevada:



- Systems:
  - Landsat (TM)
- Techniques:
  - Band ratio image.
  - Color composite.
  - Unsupervised classification.

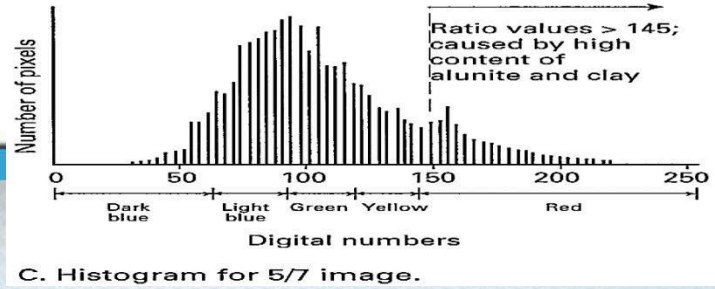
Case study:

Band ratios 5\7 & 3\1

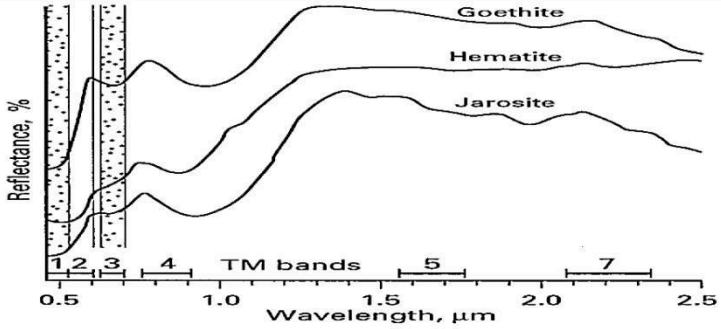


A. Laboratory reflectance spectra.

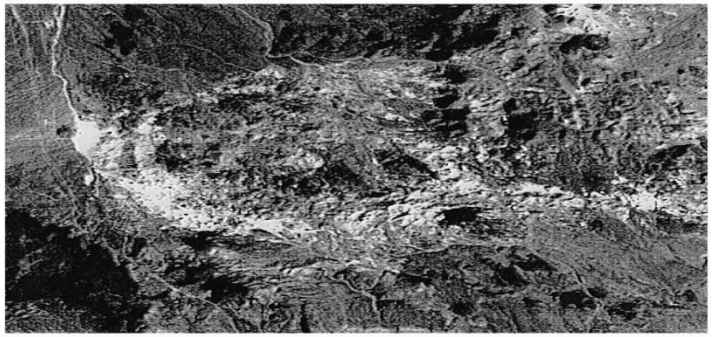
B. Ratio image of TM bands 5/7.



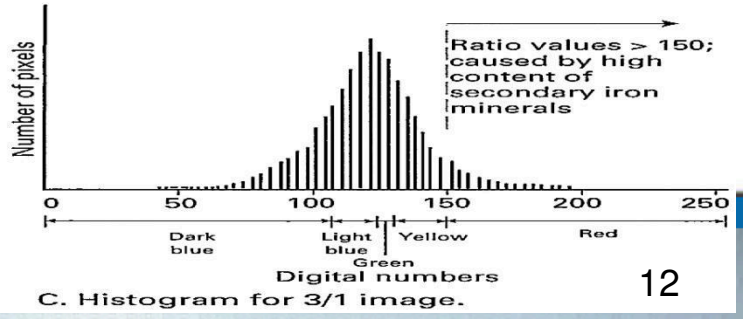
C. Histogram for 5/7 image.



A. Laboratory reflectance spectra.



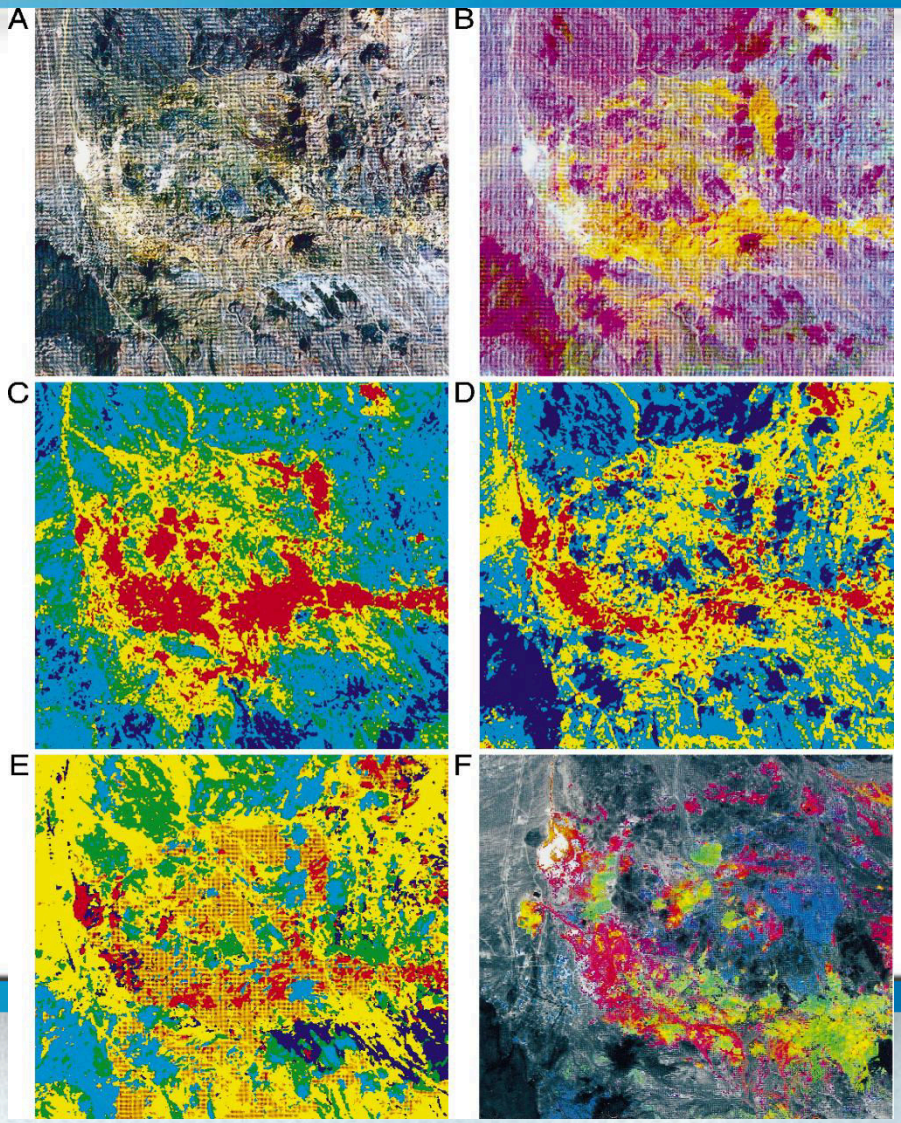
B. Ratio image of TM bands 3/1.



C. Histogram for 3/1 image.

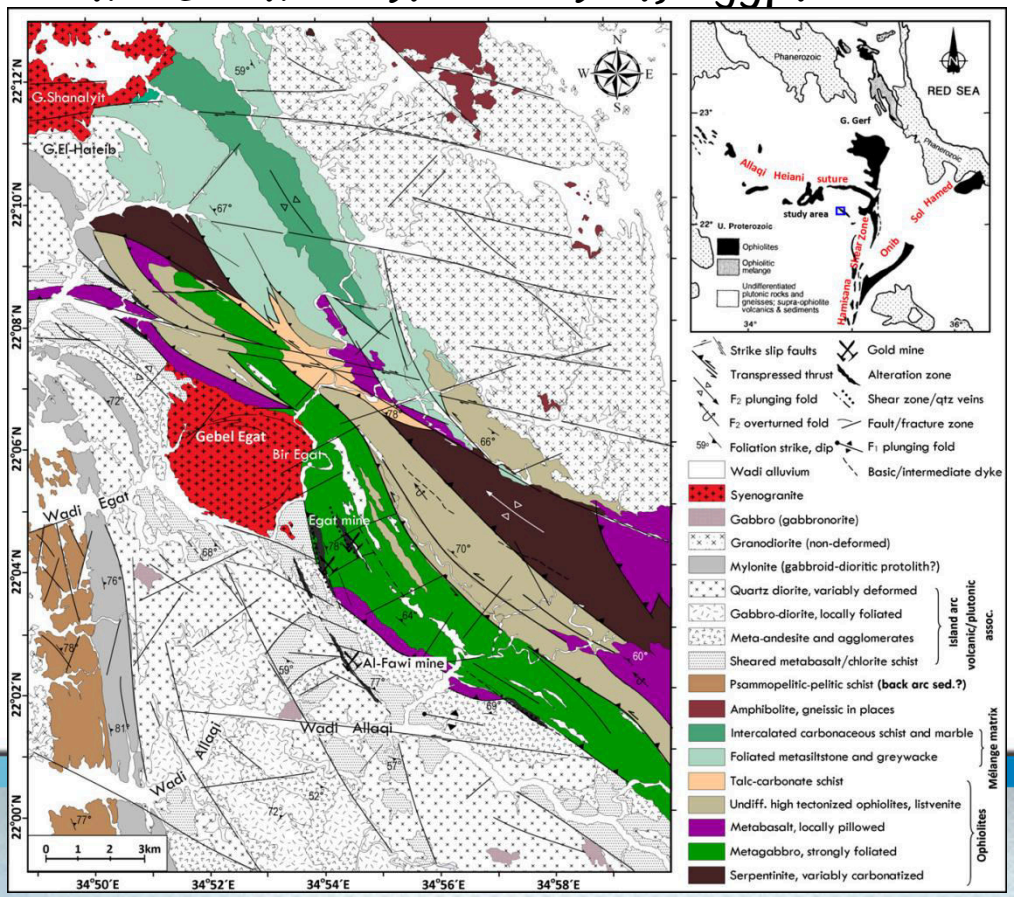
Case study:

A) TM 1-2-3 bands images
B) TM color ratio image 5\7 R,3\1G, and 3\5 B.
C) TM ratio image 5\7.
D) TM ratio image3\1.
E) TM unsupervised classification
F) Color composite ratio.



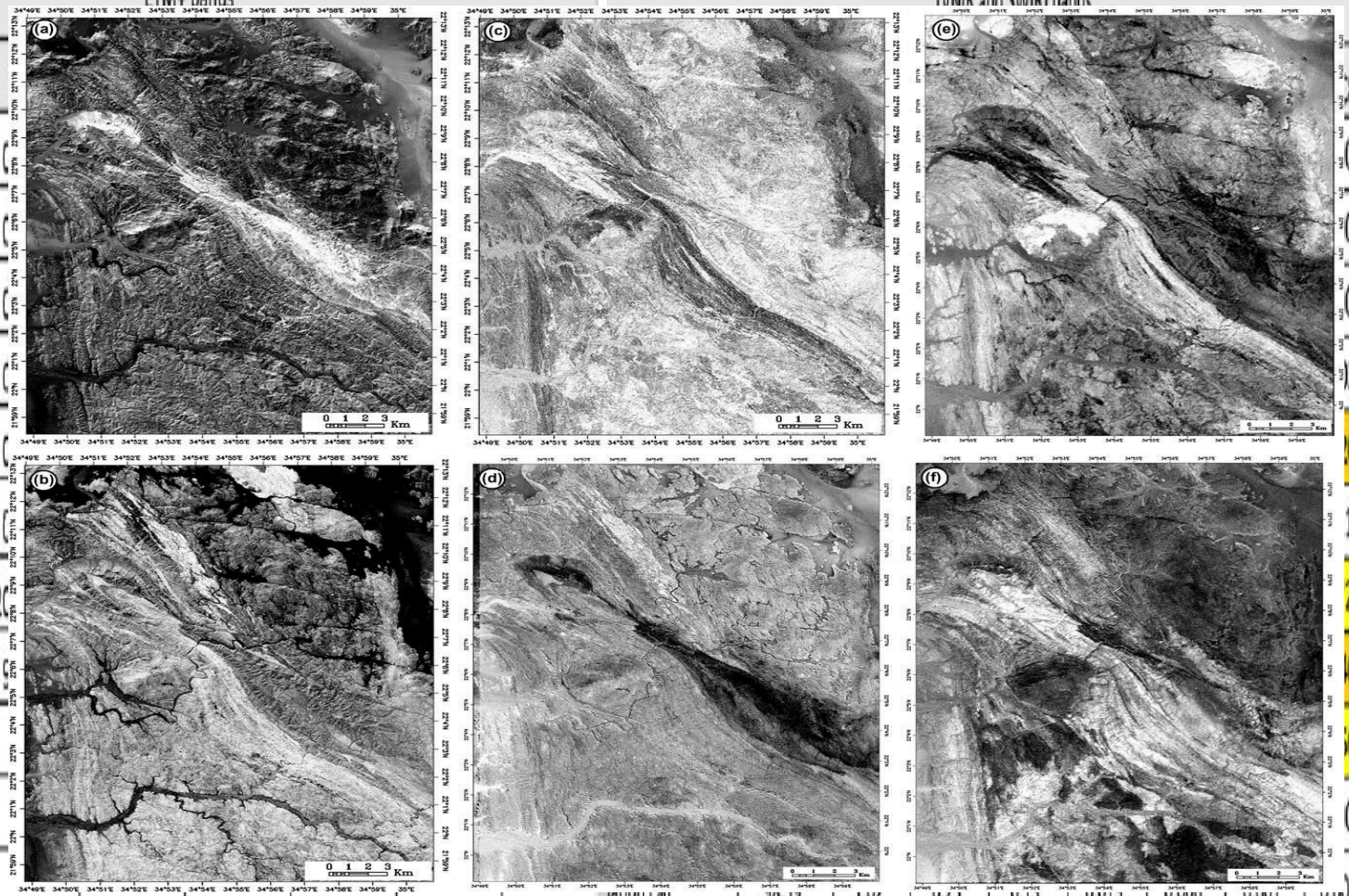
Case study:

Integrating geologic and satellite imagery data for high-resolution mapping and gold exploration targets in the South Eastern Desert, Egypt:



- Systems:
  - ASTER.
  - Landsat (TM).
- Techniques:
  - Principal Component analysis.
  - Band ratio image.
  - Color composite.

Case study:



Discussion\conclusion:

1- All systems of remote sensing have been used starting from landsat, SPOT, hyperspectral, and ASTER.

2- It is noticed that with time ASTER system became the more common used system and nowadays the number of publications which use ASTER exceeds that use other systems.

3- The use of ASTER system in mineral exploration is the most common because of the following reasons:

- The possibility of applying many processing techniques such as Principal Component Analysis , band ratio, and composite color.
- Spectral properties of ASTER because ASTER has a great sensitivity for hydrothermal altered zones.
- Broad terrain coverage 60*60 m which is beneficial for regional mapping.
- Cost effective method.

Discussion\conclusion:

4- Processing techniques are thought to be useful for enhancing raw images and to suppress area that is favorable to host mineral deposits such as: hydrothermally altered zones, intensively fractured areas, and rock types that hosts mineral occurrences:

- Ratio image method is valuable for hydrothermally altered zone identification i.e: zones expected to host mineral deposits, and to limited extent, they can recognize mineralization related fractures\lineaments.
- More than one band ratio image can be collected in only one composite ratio image, so more than one rock type can be seen in it.
- Principal Component Analysis gives more details than the previous types about rock types covering the area.
- All algorithms are complementing and integrating each other to have a complete picture.