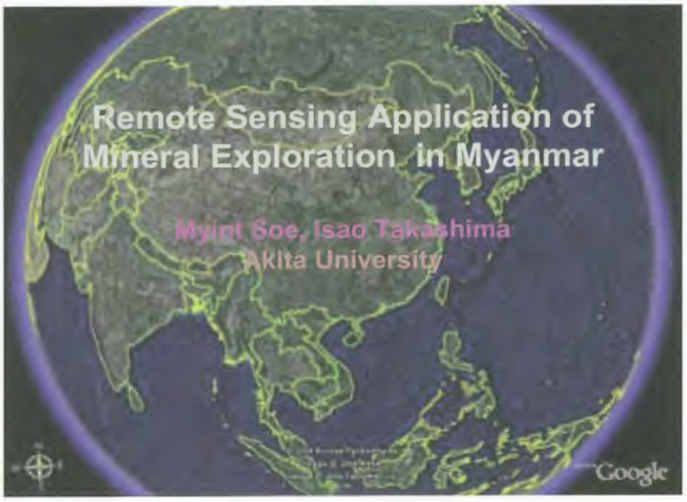
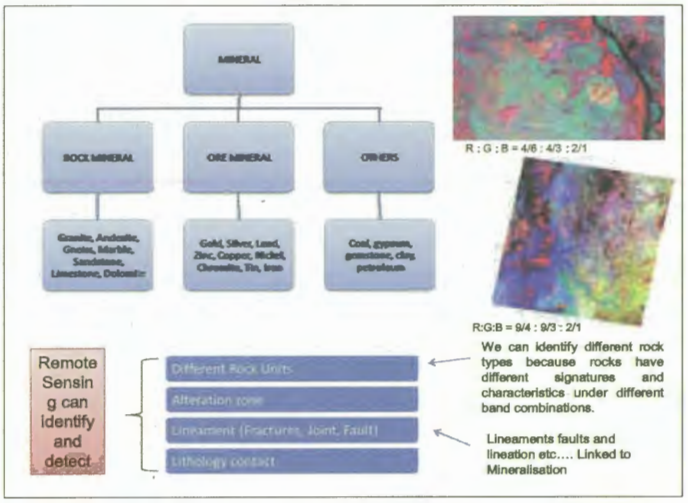
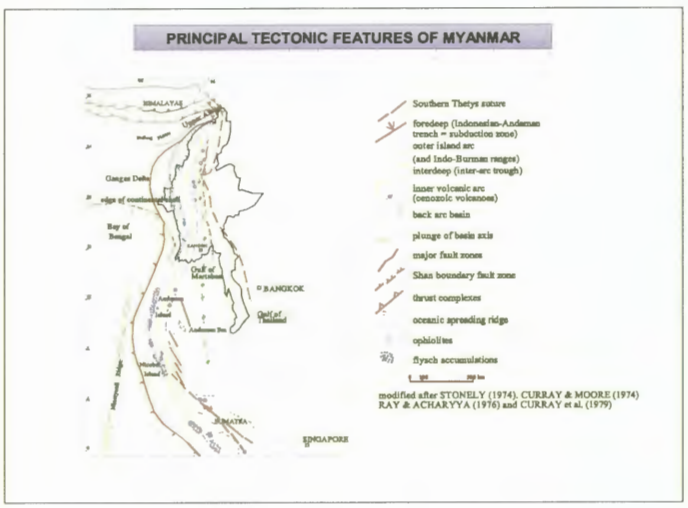
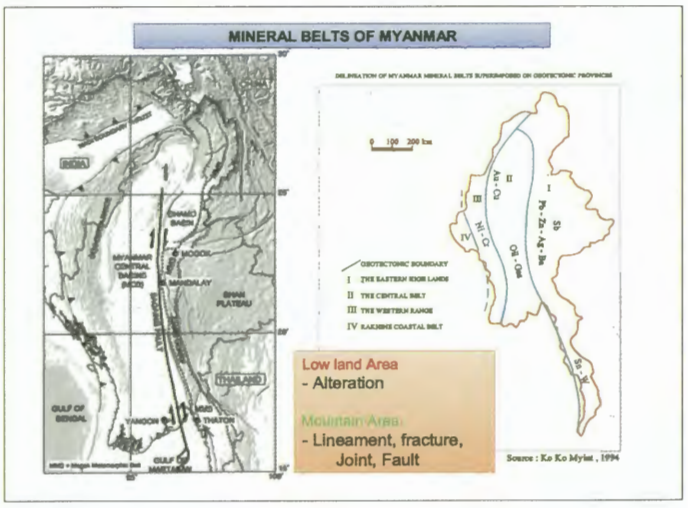
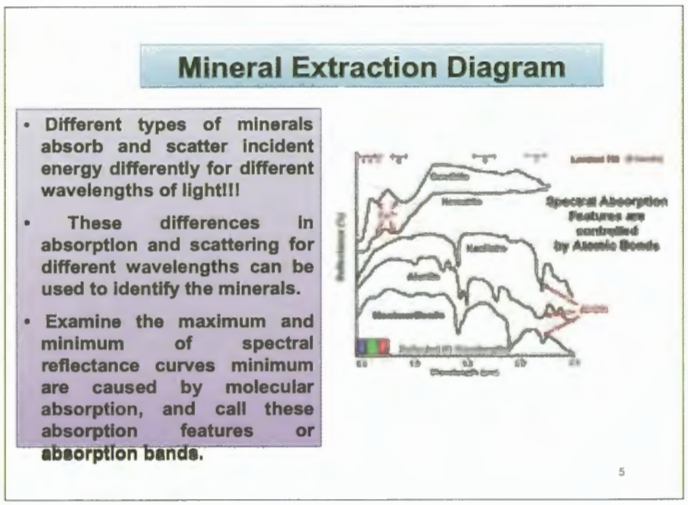

Remote Sensing Application of
Mineral Exploration in Myanmar
Myint Soe, Isao Takashima
Akita University
Google


MINERAL
ROCK MINERAL
ORE MINERAL
OTHERS
Granite, Andesite, Gneiss, Marble, Sandstone, Limestone, Dolomite
Gold, Silver, Lead, Zinc, Copper, Nickel, Chromite, Tin, Iron
Coal, gypsum, gemstone, clay, petroleum
R : G : B = 4/6 : 4/3 : 2/1
R:G:B = 9/4 : 9/3 : 2/1
Remote Sensing can identify and detect
Different Rock Units
Alteration zone
Lineament (Fractures, Joint, Fault)
Lithology contact
We can identify different rock types because rocks have different signatures and characteristics under different band combinations.
Lineaments faults and lineation etc.... Linked to Mineralisation


PRINCIPAL TECTONIC FEATURES OF MYANMAR
HIMALAYAS
Ganges Delta
Bay of Bengal
Gulf of Martaban
BANGKOK
Gulf of Thailand
Andaman Sea
SUMATRA
SINGAPORE
Southern Thetys suture
foredeep (Indonesian-Andaman trench = subduction zone)
outer island arc
(and Indo-Burman ranges)
interdeep (inter-arc trough)
inner volcanic arc
(cenozoic volcanoes)
back arc basin
plunge of basin axis
major fault zones
Shan boundary fault zone
thrust complexes
oceanic spreading ridge
ophiolites
flysch accumulations
modified after STONELY (1974), CURRAY & MOORE (1974)
RAY & ACHARYYA (1976) and CURRAY et al. (1979)


MINERAL BELTS OF MYANMAR
INDIA
MYITKYINA
BHAMO
MOGOK
MANDALAY
SHAN PLATEAU
THAILAND
GULF OF BENGAL
YANGON
PEGU
THATON
GULF OF MARTABAN
DELINEATION OF MYANMAR MINERAL BELTS SUPERIMPOSED ON GEOTECTONIC PROVINCES
0 100 200 km
GEOTECTONIC BOUNDARY
I THE EASTERN HIGH LANDS
II THE CENTRAL BELT
III THE WESTERN RANGE
IV RAKHINE COASTAL BELT
Low land Area
- Alteration
Mountain Area
- Lineament, fracture, Joint, Fault
Source : Ko Ko Myint , 1994


Mineral Extraction Diagram
Different types of minerals absorb and scatter incident energy differently for different wavelengths of light!!!
These differences in absorption and scattering for different wavelengths can be used to identify the minerals.
Examine the maximum and minimum of spectral reflectance curves minimum are caused by molecular absorption, and call these absorption features or absorption bands.
Spectral Absorption Features are controlled by Atomic Bonds
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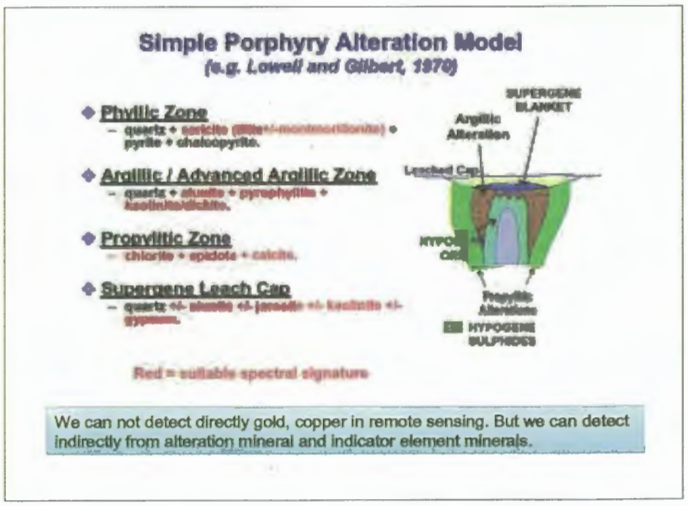
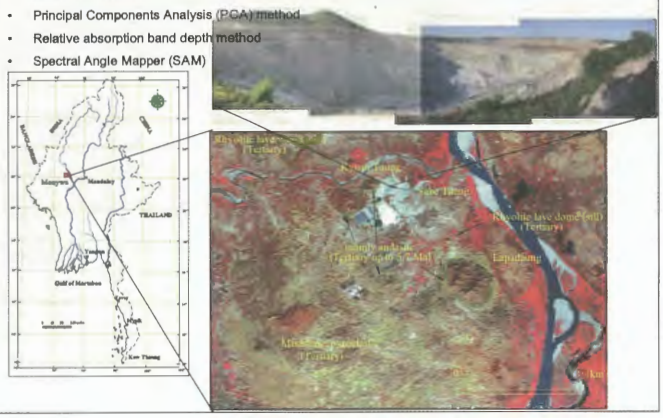
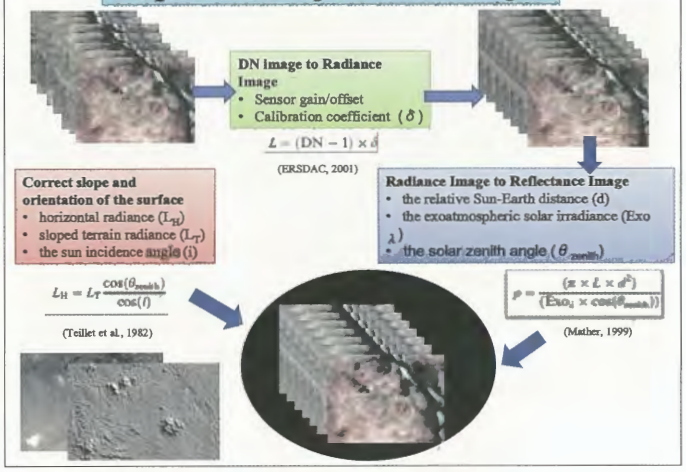

Simple Porphyry Alteration Model
(e.g. Lowell and Gilbert, 1970)
Phyllic Zone
quartz + sericite (illite+/-montmorillonite) + pyrite + chalcopyrite.
Argillic / Advanced Argillic Zone
quartz + alunite + pyrophyllite + kaolinite/dickite.
Propylitic Zone
chlorite + epidote + calcite.
Supergene Leach Cap
quartz +/- alunite +/- jarosite +/- kaolinite +/- gypsum.
Red = suitable spectral signature
SUPERGENE BLANKET
Argillic Alteration
Leached Cap
HYPOGENE SULPHIDES
Propylitic Alteration
We can not detect directly gold, copper in remote sensing. But we can detect indirectly from alteration mineral and indicator element minerals.

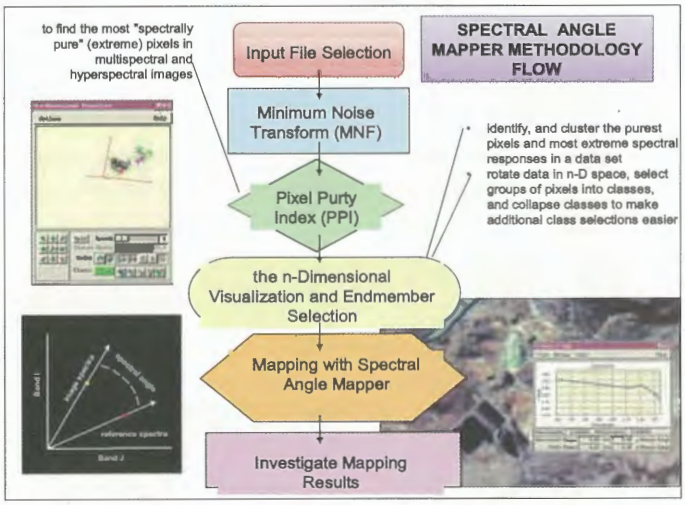
Alteration detection by Image Processing Methods

- Band Ratio method
- Principal Components Analysis (PCA) method
- Relative absorption band depth method
- Spectral Angle Mapper (SAM)



Digetal Number Image to Reflectance Image





Approach for PCA comprises calculation

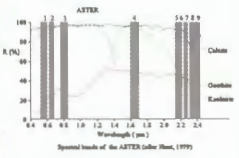
The approach for the computation of the principal components (PCs) comprises the calculation of;

- Covariance or correlation matrix
- Eigenvalues, vectors
- PCs

Applied to ASTER data VNIR and SWIR (Band 1,2,3,5,7 and 9).

Table The factor scores (eigenvectors) and factor loadings (degree of correlation) of each component from the matrix, ASTER Band 1, 2, 3, 5, 7 and 9.

Axis	Band1	Band2	Band3	Band5	Band7	Band9
PC1	0.3263	0.5168	0.1488	0.4841	0.5103	0.3310
PC2	-0.2036	-0.2109	0.9550	0.0327	0.0279	0.0097
PC3	0.6483	0.4066	0.2544	-0.3679	-0.3816	-0.2620
PC4	0.6496	-0.7167	-0.0294	0.0706	0.2422	0.0150
PC5	-0.0990	0.0984	-0.0009	-0.3834	0.7944	-0.4809
PC6	-0.0049	0.0077	0.0116	-0.6909	0.1960	0.6957



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Result of alteration detection by Principal Component Analysis

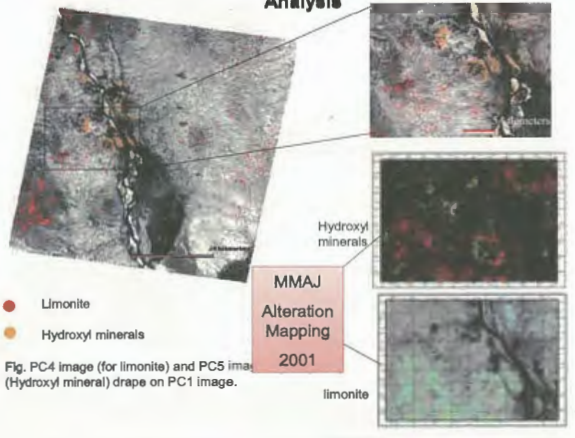

Fig. PC4 image (for limonite) and PC5 ima (Hydroxyl mineral) drape on PC1 image.

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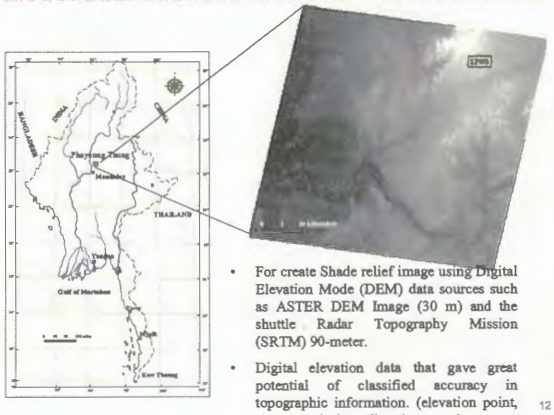
➢For Mountain Area

ASTER Dem Image of Phayaung Taung area, Myanmar



- For create Shade relief image using Digital Elevation Mode (DEM) data sources such as ASTER DEM Image (30 m) and the shuttle Radar Topography Mission (SRTM) 90-meter.
- Digital elevation data that gave great potential of classified accuracy in topographic information. (elevation point, slope angel, slope direction etc…)

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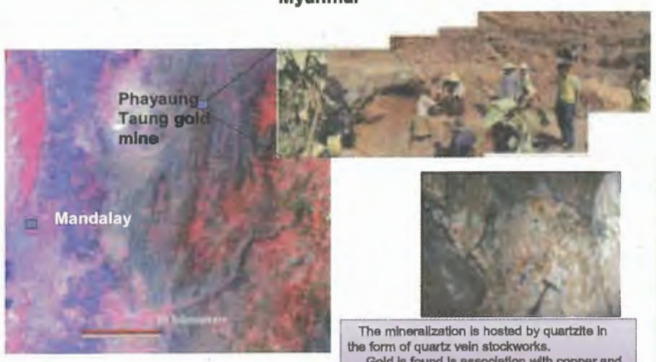
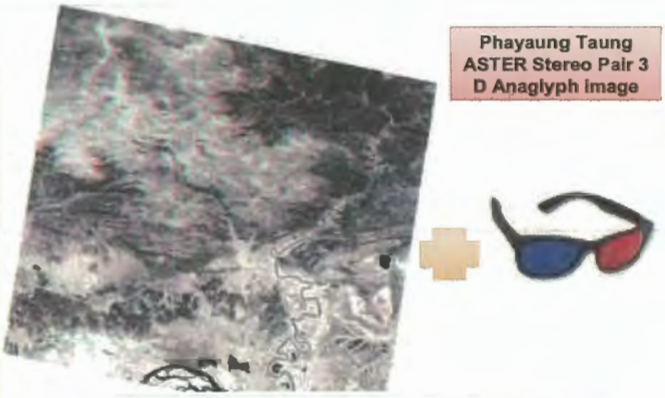
ASTER False Color Image of Phayaung Taung Area, Myanmar



The mineralization is hosted by quartzite in the form of quartz vein stockworks.
Gold is found is association with copper and iron sulphides.

Phayaung Taung ASTER Stereo Pair 3 D Anaglyph image



Viewing 3D Anaglyph image significantly improves interpretation of geological structures (i.e., folds and faults)

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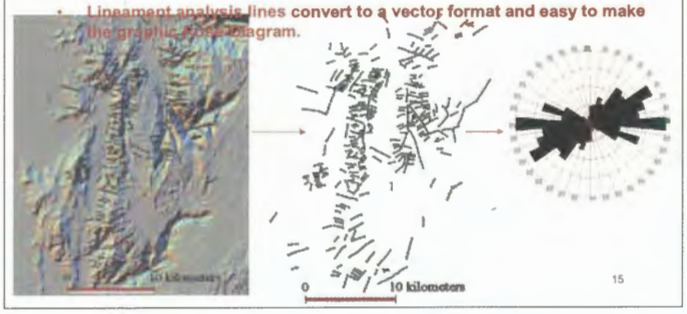
Phayaung Taung Area, Myanmar

- Shade relief image enhance for visual interpretation.
- But shade relief image interpretation is unlike air photo interpretation.
- The method can enhance lineaments by simulating topographic illumination under varied light directions.
- Low angle illumination sun angle is best depicts for lineament.
- Lineament analysis lines convert to a vector format and easy to make the graphic Rose Diagram.



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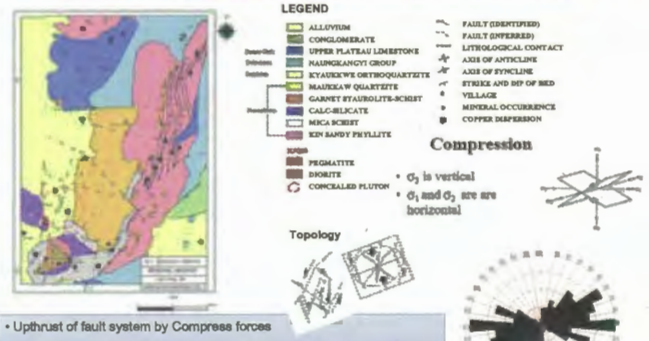
Relationship of lineament and Mineralization in Phayaung Taung Mine, Myanmar



- Upthrust of fault system by Compress forces
- Affected the phyllite-quartzite beds producing by shear folding small antiforms and synforms.
- Dilation zone have caused openings along crests, limbs and troughts to serve as channel gold mineralization .

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Conclusion

- Image processing Techniques are an effective tool for mapping outcropping hydrothermal alteration zones.
- The use of more than one technique should compare and finally can select the best ones for project.
- Shade relief image and 3D anaglyph image analysis may help for Myanmar Geological survey and mineral Exploration. Because Myanmar is a country with many mountains.
- Remote Sensing Application can provide study for mineral exploration (locating of new mineral prospects, fast and economic selection of target areas.)

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THANK YOU