Mineral Exploration Using Remote Sensing

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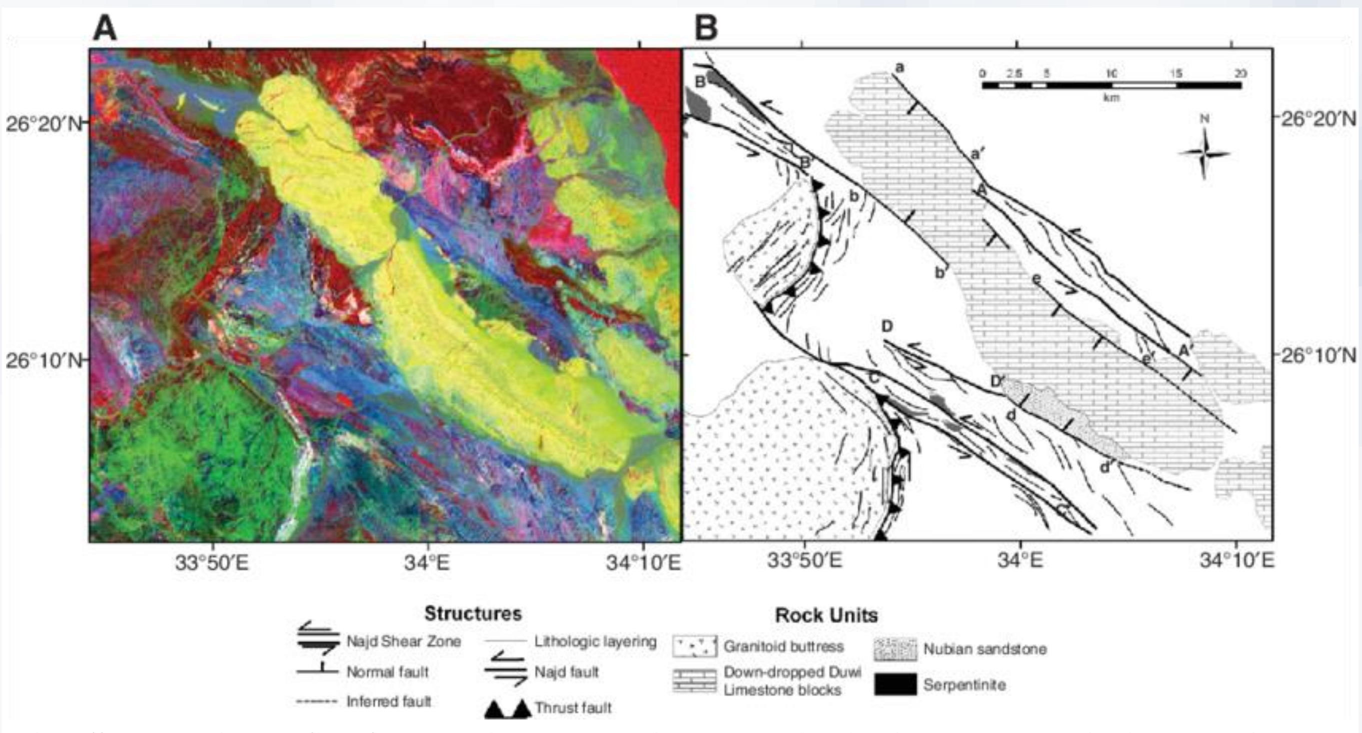
Mineral exploration is the process of finding mineral and ore deposits in commercially viable concentrations. This requires prospecting, mapping and surveying to locate a potential mineral or ore deposit, followed by sampling and analysis to estimate the quality and concentration of the deposit which will determine whether extraction is practical.

Why Remote Sensing?

Before the use of remote sensing, mineral exploration was limited to near surface processes which required extensive field work. Other variables such as poor access to the exploration area due to remoteness or difficult terrain and poor weather conditions over a prolonged period affected the process. Satellites and aircrafts are not restricted by terrane and images acquired cover large areas on the ground which allows an area to be identified much faster. Remote sensing images can produce geologic maps and identify structures such as faults, fractures and lineaments, which can aid in mineral exploration.



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Summary of the main spectrally active minerals in relation to different alteration styles and environments of formation.

Environment of formation	Main spectrally active alteration minerals
High sulfidation epithermal	Alunite, pyrophyllite, dickite, kaolinite, diaspore, zunyite, smectite, illite
Low sulfidation epithermal	Sericite, illite, smectite, chlorite, carbonate
Porphyry: Cu, Cu-Au	Biotite, anhydrite, chlorite, sericite, pyrophyllite, zeolite, smectite, carbonate, tourmaline
Carlin-type	Illite, dickite, kaolinite
Volcanogenic massive sulfide	Sericite, chlorite, chloritoid, carbonates, anhydrite, gypsum, amphibole
Archean Lode Gold	Carbonate, talc, tremolite, muscovite, paragonite
Calcic skarn	Garnet, clinopyroxene, wollastonite, actinolite
Retrograde skarn	Calcite, chlorite, hematite, illite
Magnesium skarn	Fosterite, serpentine-talc, magnetite, calcite

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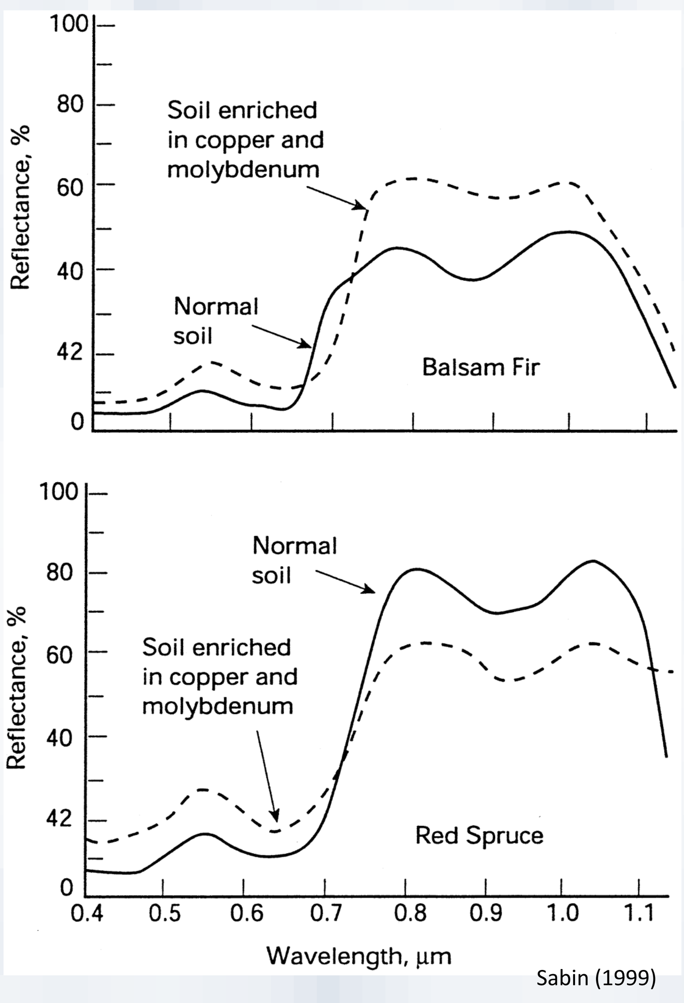
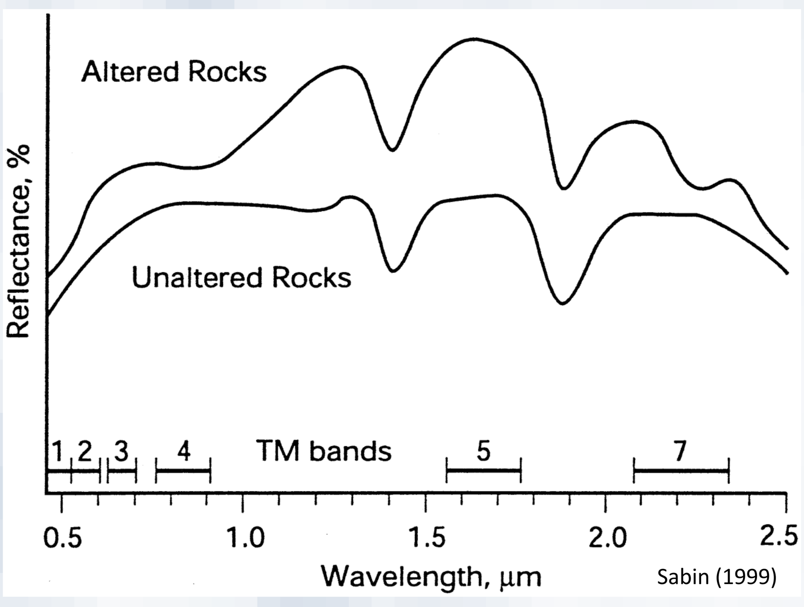
Remote sensing images can also be used to identify hydrothermally altered rocks which are often an indicator for certain types of deposits. This can be done by identifying the spectral signature of different minerals using many different remote sensing systems because every mineral has its own unique spectral signature. Hyperspectral system is the best for this because its sensors have hundreds of bands that cover a greater range of wavelengths. Altered mineral zones can also be analyzed to indicate areas that have potential for high vs. low concentrations of the mineral in the deposit.

Mineral exploration using remote sensing can be very useful when imaging bare land and rocks, but becomes more difficult when the terrain is covered. It can be used to explore the relationship between vegetation, soils and possible mineral deposits that are beneath because certain deposits, especially metal deposits, can contaminate the overlying soil which with cause changes in vegetation. Certain vegetation changes include the lack of vegetation, indicator plants and changes in spectral characteristics of vegetation.

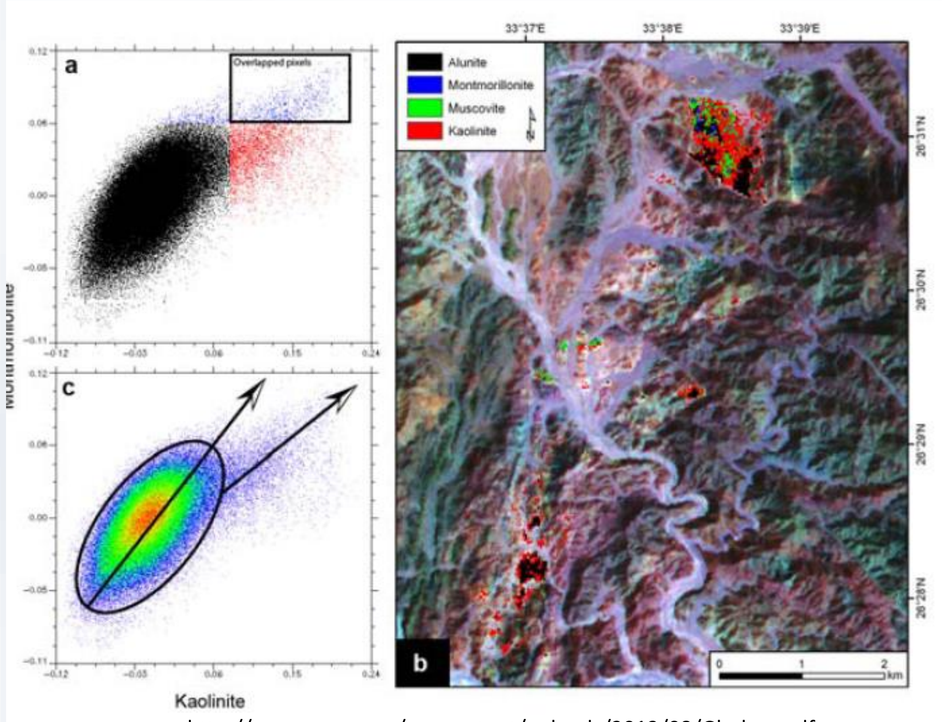


Remote Sensing Processes:

Band ratios images can be used in remote sensing to distinguish and map hydrothermally altered rocks from unaltered rocks. It is done using Landsat TM and comparing different bands. The 5/7 ratio image is used to identify alunite and clay minerals illite, kaolinite, and montmorillonite which are hydrothermal alteration and will result in a value greater than 1. Unaltered rocks will have a ration equal to 1. The 3/1 ratio image is used to identify iron oxides and sulfates which are indicators of hydrothermally altered rocks and result in high values and bright tones.



The Principal Components Technique (PCT) transforms correlated spectral band into uncorrelated spectral bands called principal components. The 1st principal component is the direction of the greatest variation, the 2nd principal component is the direction of the second greatest variation, and so on. PCT is useful for distinguishing certain spectral signatures from the background, but is not capable of eliminating topographic and atmospheric effects.



http://www.asprs.org/wp-content/uploads/2013/08/Ghulam.pdf

Summary:

Remote sensing has proven to be a reliable and useful approach to mineral exploration. The availability of different remote sensing systems to collect data, along with different techniques that can be applied to images has changed the way mineral exploration can be done. Although the use of remote sensing still encounters problems for locating mineral deposits, the field is rapidly advancing and new systems and techniques will be developed to further advance its use and accuracy.

References

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