Integration geoConvention 2013 — geoscience engineering partnership

Interpretation and processing of Landsat ETM+ data for 1:50,000 scale lithological mapping in Eagle Plain, Northern Yukon

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Summary

An interpretation and processing technique of Landsat ETM+ data for 1:50,000 scale lithological mapping has been developed and assessed in the present study. This technique is applied in Mount Raymond, Eagle Plain, Northern Yukon to carry out the lithological mapping of the Mount Raymond area. A Principal Component Analysis (PCA) has been performed on the 6 Landsat ETM+ bands. A supervised Maximum Likelihood classification realized from PCA results and based on an existing geological map enables seven lithological units identified within the study area. This study assesses the accuracy of the satellite remote sensing technique for detailed lithological mapping. The application of the satellite remote sensing technique is hindered by the presence of vegetation cover. Despite the potential problems posed by vegetation cover, a lithological map with a satisfactory overall accuracy and Kappa coefficient are achieved. The results of this study demonstrate that the processing and interpretation of Landsat ETM+ remote sensing data set can be employed as a powerful tool to improve lithological discrimination and enhance the overall mapping performance.

Introduction

Multispectral satellite remote sensing technology provides a relatively efficient and low cost method for the geological mapping of terrains that are geologically complex or poorly or expensively accessible. Remote sensing data, such as aerial photographs and multispectral imagery data can provide more continuous and detailed information and quantitative interpretations can be made for large areas, thus enabling even the most inaccessible terrain to be mapped. However, the results of a digital image processing and analysis require a field investigation in some selected testing areas in order to estimate the accuracy of the geological interpretation.

This study focuses on the processing and interpretation of Landsat ETM+ satellite imagery data to carry out the lithological mapping of the study area. The study area is located in region between latitudes 66º15' N and 66º30'N, longitudes136º00' W and 136º30'W, which is a part of Eagle Plain. This study tests and evaluates this Landsat ETM+ data interpretation by analyzing and comparing the lithological units interpreted and extracted from Landsat ETM+ to the 1:50,000 scale map compilation based on field investigations in the study area, Mount Raymond (NTS 116-I-08). In addition, this study investigates whether the lithological mapping performance in the study area can be enhanced through the interpretation of remote sensing data.

Method

The methods performed in this study employs the image processing and analyzing geospatial imagery techniques provided by software ENVI 4.8 to carry out the lithological classification on Landsat ETM+ image. The methodology consists of three steps which are pre-processing, lithological classification, and post-processing and is outlined in Figure 1. PCA was performed in order to extract the pertinent information from the different bands and reduce the redundancy of information in highly correlated bands. Maximum Likelihood classification was chosen to perform the supervised classification.

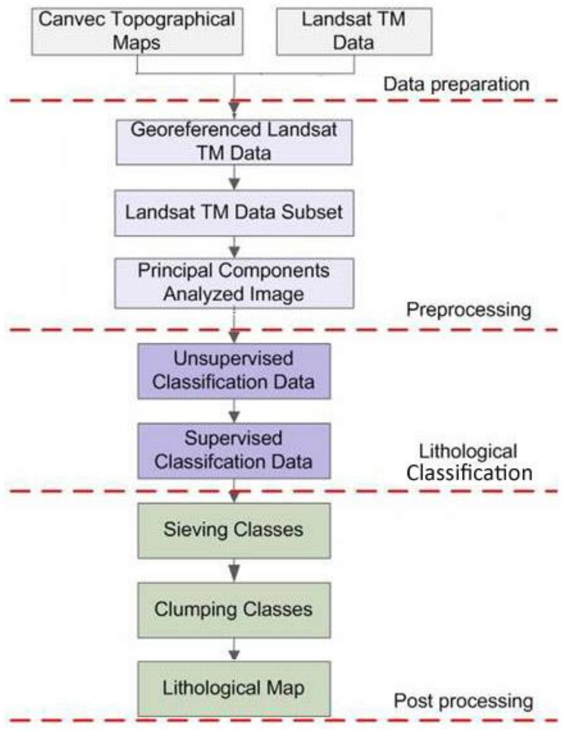

Figure 1: Overview of methodological approach for lithological mapping.

In order to evaluate the remote sensing technique used in this study, the classification accuracy for the study area was assessed. Accuracy assessment is typically achieved by comparing the classifications made by an algorithm to the known classifications at selected, sampled reference locations. The sampled data are then characterized in a confusion matrix and a variety of descriptive and analytical measures can be used to summarize the accuracy of classification (Lewis 2002, Congalton 1991). For each set of input variables, the classification accuracy for the entire mapped area was assessed using the overall (OA), user's (UA) and producer's (PA) accuracies and the kappa coefficient (K) derived from a confusion matrix (Grebby et al., 2002, Congalton, 1991). The OA is the percentage of all validation pixels correctly classified, whereas the UA and PA provide information regarding the commission and omission errors associated with the individual classes, respectively. Unlike the OA, K takes into account the possibility of agreements occurring by chance in a random classification (Grebby et al., 2002, Brown et al., 1998).

Examples

A total of seven lithological units including Dempster formation, Road River Group, Loucheux formation, Vuntut formation, Canol formation, Imperial formation, Tuttle formation and water for the study area were indentified using the satellite remote sensing technique described above(Figure 2). With comparison of the four classification approaches including Parallelepiped, Minimum Distance, Mahalanobis Distance, Maximum Likelihood classification, Maximum Likelihood classification is considered as the optimum classifier for the study area. The OA for Maximum Likelihood classification is 73.2317%, and the kappa coefficient for this classifier is 0.6791. Figure 3 shows the individual class accuracies for Maximum Likelihood classification.

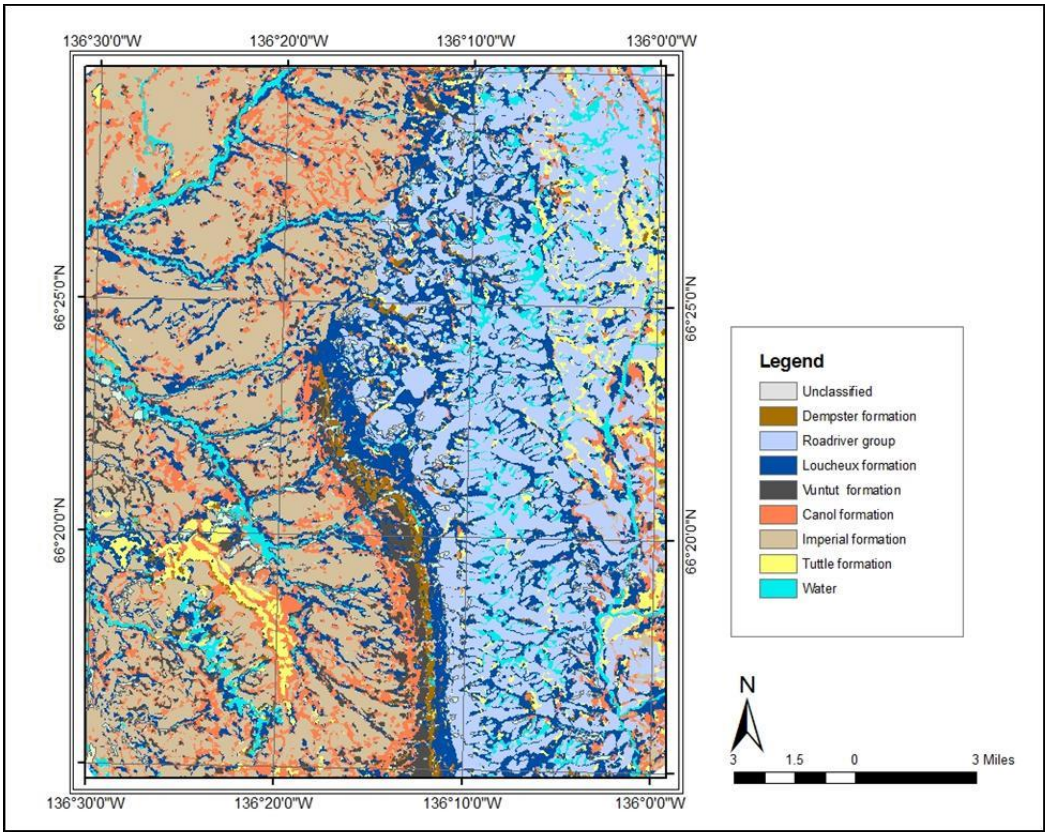

Figure 2. Maximum Likelihood classification image with seven lithological units.

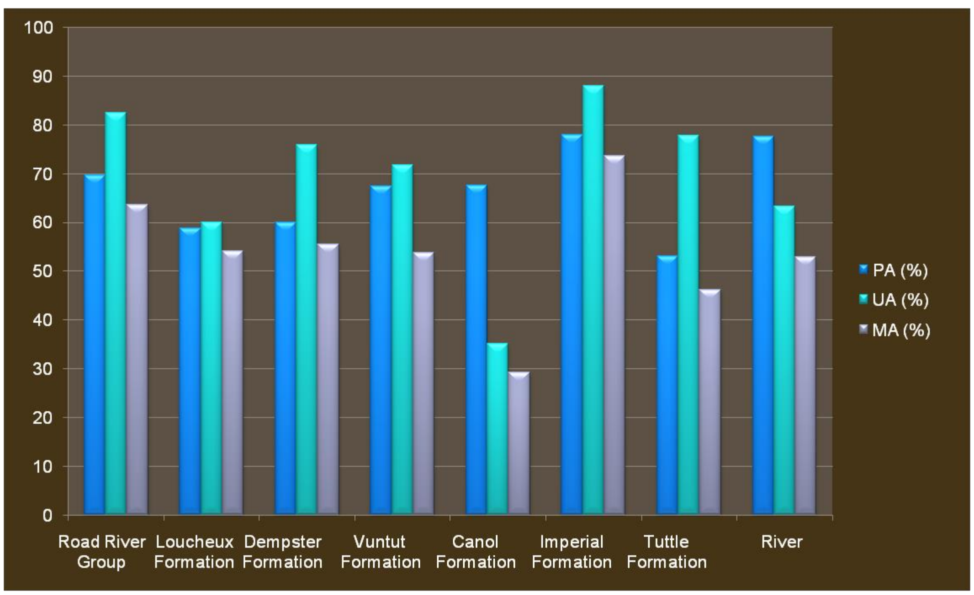

Figure 3. PA, UA and MA of individual units for the Maximum Likelihood classification.

Conclusions

The interpretation and processing of satellite remote sensing data for 1:50,000 scale lithological mapping has been studied using multispectral Landsat ETM+ data. This study uses a provisional geological map as a reference for defining test zones. The approaches utilized in this study consist of

- The Principal Components Analysis (PCA) that decorrelates the Landsat ETM+ data and extracts the pertinent information from the different bands and removes the redundancy of information in highly correlated bands.
- The Supervised Maximum Likelihood classification that uses the geological map to define the training data and assemble the Landsat ETM+ data with similar spectral features from the first three new components obtained by the PCA method. From the classification results, five lithological formations are classified.

The results of this study show that the Landsat ETM+ sensing data set can be used as an effective tool for lithological mapping. Although lithological mapping using the satellite remote sensing technique is somewhat hindered by the presence of vegetation cover and the spectral similarities between some of the lithological units caused by the similar vegetation cover, a lithological map with a satisfactory OA and K are generated through the Supervised Maximum Likelihood classification. Therefore, Landsat ETM+ remote sensing data can be used to increase lithological discrimination and enhance the overall mapping performance.

Acknowledgements

This project would not be possible without the financial support provided by GEM and Geological Survey Canada. Geological Survey Canada is greatly appreciated for providing map data and Landsat ETM+ image.

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