# Enhancement and Detection of Koopan Laterites (Zagros, Iran), Based on Landsat satellite Data

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## Abstract

Koopan regional laterites located in North East of Shiraz, Fars province.The rock strata, Koopan Laterits set on Neyriz ophiolites that these ophiolites are actually part of a series Zagros ophiolite with of Upper Cretaceous age. These laterites are covered with Nummulitic limestone equivalent Jahrom formation with Eocene age. The lateritization should be occurred after the Upper Cretaceous in which case it can be assumed Paleocene age for this event. The aim of the current study, detection of Koopan regional laterites has been by remote sensing techniques. For this purpose LANDSAT images were prepared and pre-processed.The geographical location of the rock units was recorded by GPS. Then, in the main processing, using the spectral reflectance curves of laterite, used to identify the best Colour combinations. This study showed that the combination of RGB = 321 for the red laterite and also the yellow laterite is the best detection to follow. Principal component analysis (PCA) method that with all the bands as well as the enhancement on them was performed the best difference for detection and enhancement of Laterits was followed and finally by using the training field points and the use of standard PCA, operations supervised classification done that studies indicated supervised classification method with Maximum Likelihood algorithm associated with the greatest enhancement.

**Keywords:** Zagros; Koopan laterite; Landsat; Zagros; Shiraz.

## 1- Introduction

The use of remote sensing techniques, have long been in the various branches of earth sciences particularly in the field of detection and separation of rock units and mineral exploration applications. The purpose of this technique is that the integration of remote sensing data and field information can spend less time and costs and also using more accurate digital methods, operations enhancement (Enhancement), identification (Detection) and separation (Slicing) different units to carry out (Gupta, 2003) for example, Taherzadeh and others (2010), Sekhavati and colleagues (2011) and Faridi and colleagues (2011) noted. Landsat satellite is the first satellites series of earth resources observation which was launched in the early 1970s. The satellite was originally 30 meters spatial resolution. Remote sensing is particularly important in geological studies so that this technology can extract valuable information about the studies, including linear structures, identify alteration zones, geomorphological phenomenon and etc (Yetkin, 2003). Identify alteration zones of hydrothermal solutions using satellite data due to the large number of geologists is seeking deposits. Porphyry deposits associated with hydrothermal alteration such as phyllic, potassic, propylitic which in these areas hydroxyl minerals are abundant. On the other hand, oxides on many porphyry facies spread and that the two groups can be detected by using remote sensing techniques. Identify alteration zones for mineral exploration based on remote sensing date back to the '70s (Hellman *et al*., 2004). For example, studies conducted by Ranjbar *et al* (Ranjbar *et al*, 2004) in porphyry copper alteration by using the +ETM in the southern part of the central Iranian volcanic can be noted. Due to the low spectral resolution of Landsat, application of Landsat TM only to identify areas with iron oxides and hydroxyl is limited.

**2- Geology of the area**

The study area Koopan located at Zagros folded–Thrusted belt (Fig. 1). Description of the field points are taken from rock units in (Fig. 2). Figure 3 shows the general regional Laterites outcrop. The outcrops of red Laterit and yellow Laterit in this area can be seen in the series of Neyriz ophiolite that covered by Nummulitic limestone Jahrom formation (Fig. 4). According to the series of Neyriz ophiolite with Upper Cretaceous age (Sabzeei *et al*., 1994) and also for Jahrom formation Eocene age is mentioned (Khosrotehrani, 1988). Therefore, the formation time of Zagros laterites in Koopan area should be between the Upper Cretaceous to the Eocene. In the other words, the occurrence of lateritization of Zagros likely occurred in the Paleocene. Figure 5 also position of Koopan laterites associated with serpentinized peridotites and also display Nummulitic limestone area.

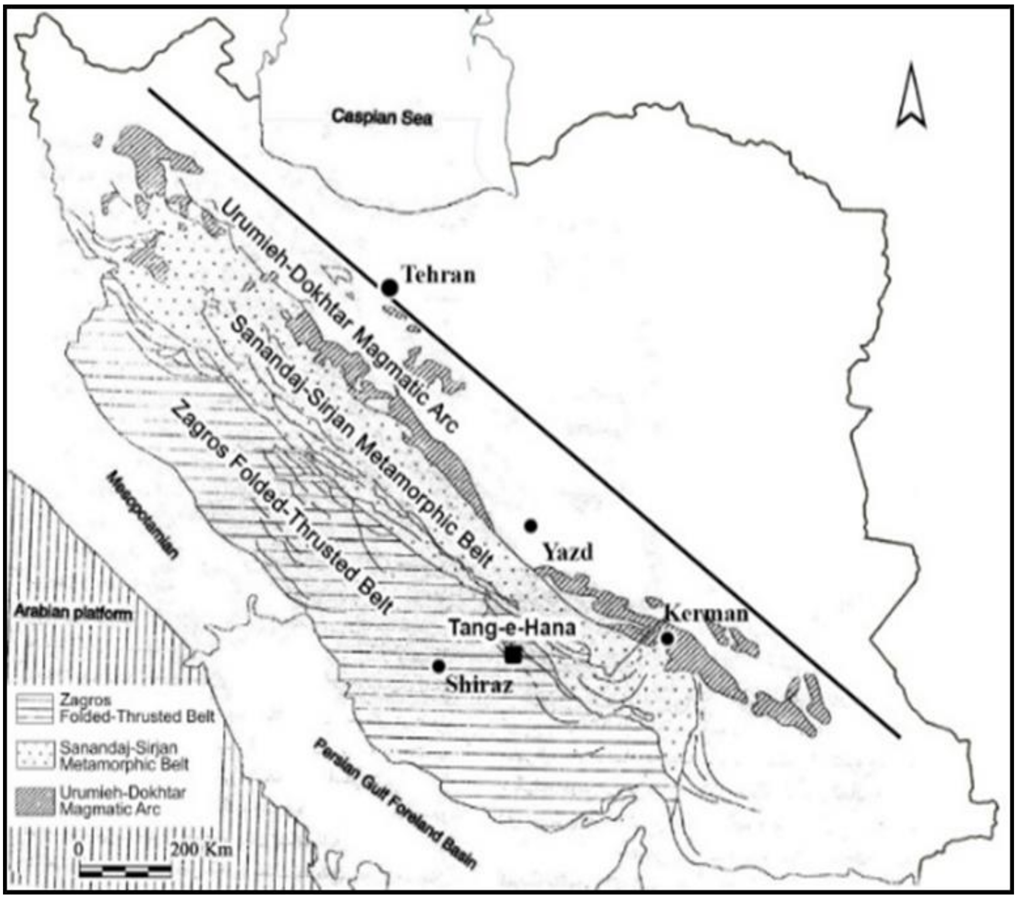


*Figure 1) The location of Koopan area North of Shiraz, in Zagros Folded-Thrusted belt (Base map from Ghorbani, 2007).*

**3- Remote sensing studies**

For remote sensing studies in this research, Landsat images were used. These studies were performed by using satellite imagery processing operations at three levels of (1) pre-processing, (2) the main processing and (3) final processing. Initially they considered under a processing and correction to prepare images for the main processing. The geometric and Radiometric correction of this process are the most common. After initial corrections, the main process was initiated with the aim of detection and enhancement of Koopan Lateritic areas. The methods were used in this part of the process are as follows:

- Preparation of spectral reflectance curves

- Preparation of Colour combinations (Colour Composite)

- Principal Components analysis (PCA Method)

- Classification (Classification Method)

Using the above techniques, detection and enhancement of rock units was done and initial maps were prepared then the final processing was done on initial maps that the result of the processing is final maps (Finalized Map), which the following discussion of this section, recent cases are discussed.

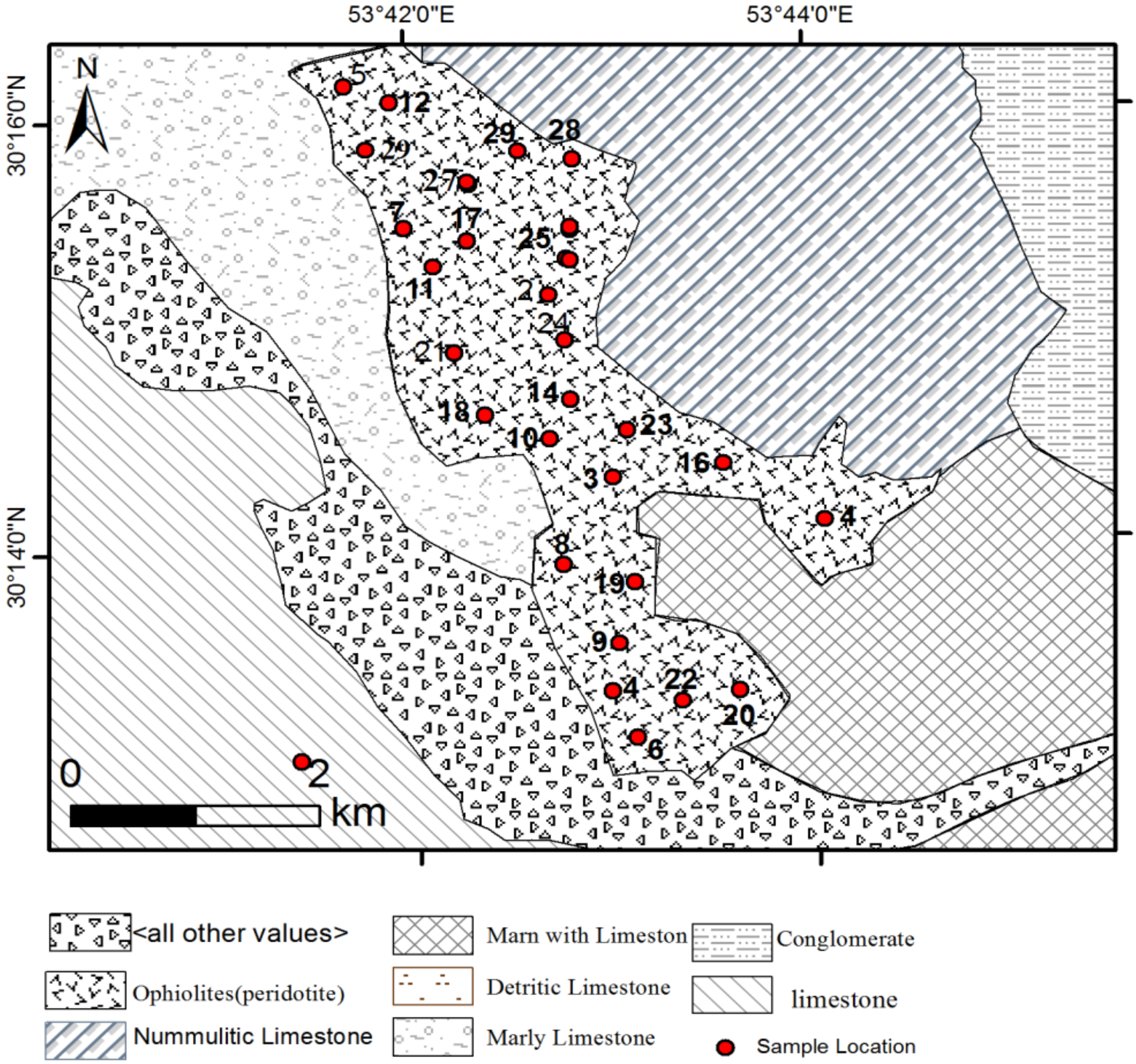


*Figure 2) The location of samples.*

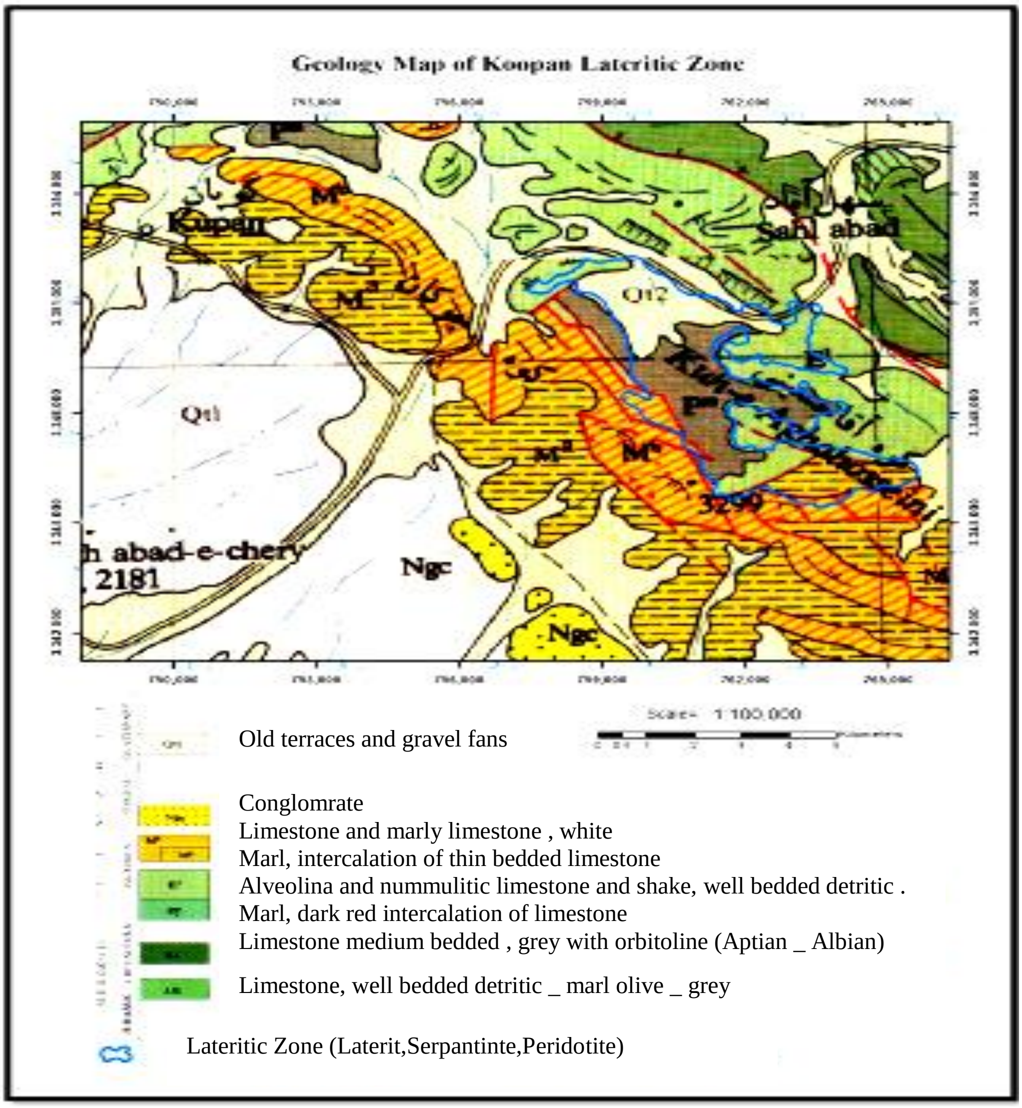


*Fig 3- Slice of the geological map of Koopan area (derived from the geological map 1: 250,000 GSI).*

*Figure 4) General laterite outcrops of Koopan below Nummulitc limestone Jahrum Formation (Eocene).*

*Figure 5) Its field Koopan laterites with serpantinized peridotites (lower part) and Nummulitic limestone (upper section).*

### 3.1- Preparation of spectral reflectance curves

ENVI software control of each individual pixel values, evaluation of statistical parameters of an image after a series of processing, view the histogram, and so on. The spectral information is often used image analysis. Studying spectral reflectance curves of Landsat According to the rocks units showed that bands 1, 2, and 3 for red laterite and also yellow laterite have the highest percentage of their reflection (Figs. 6 and 7) Therefore the use of these bands have the best color combination for the detection of red laterites and yellow from other rock units.

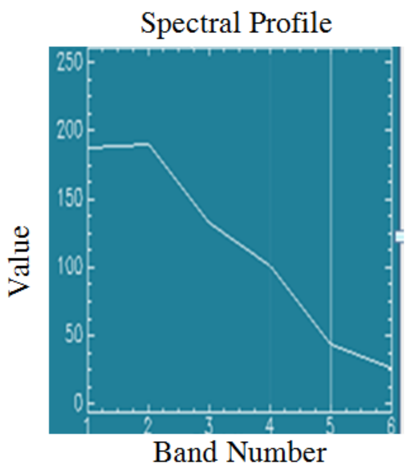


*Figure 6) Yellow laterite spectral reflectance.*

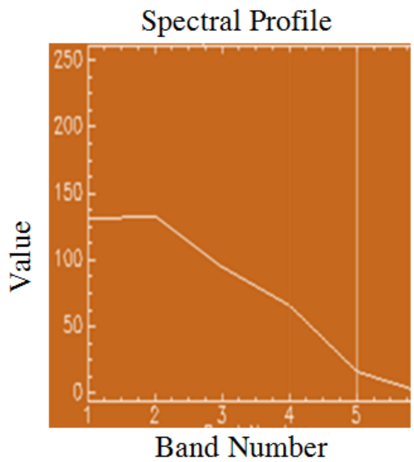


*Figure 7) Red laterite spectral reflectance.*

### 3.2- Preparation of spectral reflectance curves

According to the spectral reflectance curves (Fig. 5 and 6) the bands have reflecting higher than other bands were used to make Colour combinations of red laterite and yellow laterite so RGB = 321 were considered for red laterite and also for yellow laterite. These compounds were able to make help in the detection of laterites (Figs. 8 and 9). In combination of RGB = 321 for red laterite and 321 for yellow laterite seen to colour marron.

### 3.3- Principal component analysis Method

The principle component analysis method based on calculation of variance, covariance and standard deviation of different bands were done, the way to reduce compliance between different bands of data in multi-dimensional space makes clear a special phenomenon. PCA is a power statistical technique that can be used for image compression and eliminating the unwanted effects (Alavi Panah, 2003). PCA is done in both standard and optional methods. The standard method is used for all bands of enhancing rock units and optional method is used only for high reflection bands. Standard method was used in this study (Fig. 10) .As a result, red and yellow laterites Colours respectively bright yellow and bright green be seen.

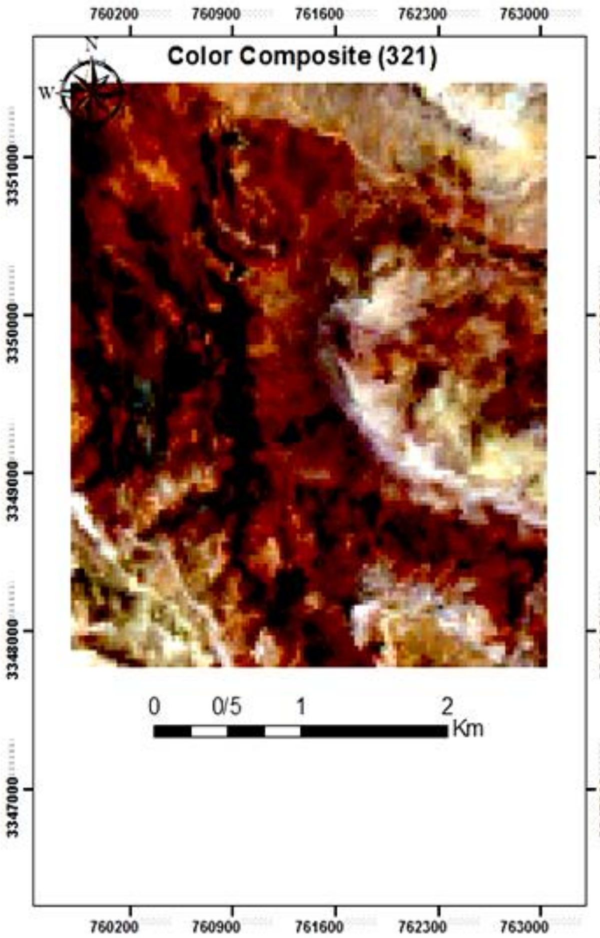


*Figure 8) The 321 compound for detection of red laterite.*

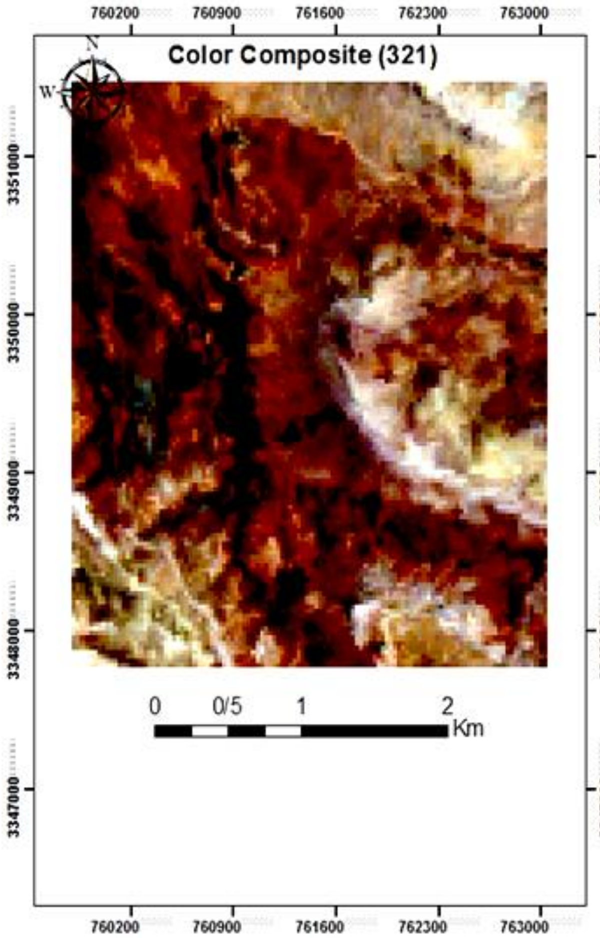


*Figure 9) The 321 compound for detection of Yellow laterite.*

### 3.4- Classification Method

Similar spectral sets separation and division of its class that has the same spectral behavior the classification of satellite data said. In other words, the classification of the pixels forming images, assign each pixel to a class or a particular class, the classification of satellite data say. When all pixels in the image were allocated into a certain class, thematic maps obtained. Classification of satellite data in supervised methods and unsupervised split. In supervised classification method chosen number of pixels for sample and specifications those through the computer software used to be the rest of the pixels according to specific instructions that are classified. In this study, supervised classification was used on the standard PCA. First six class was defined for lithological units area then The most similarity algorithm (Maximum Likelihood) is the most widely used algorithms were used (Fig. 11) As can be seen using this technique enhancement, red laterites seen to red color and yellow laterites to yellow color which is indicative of the success of this technique.

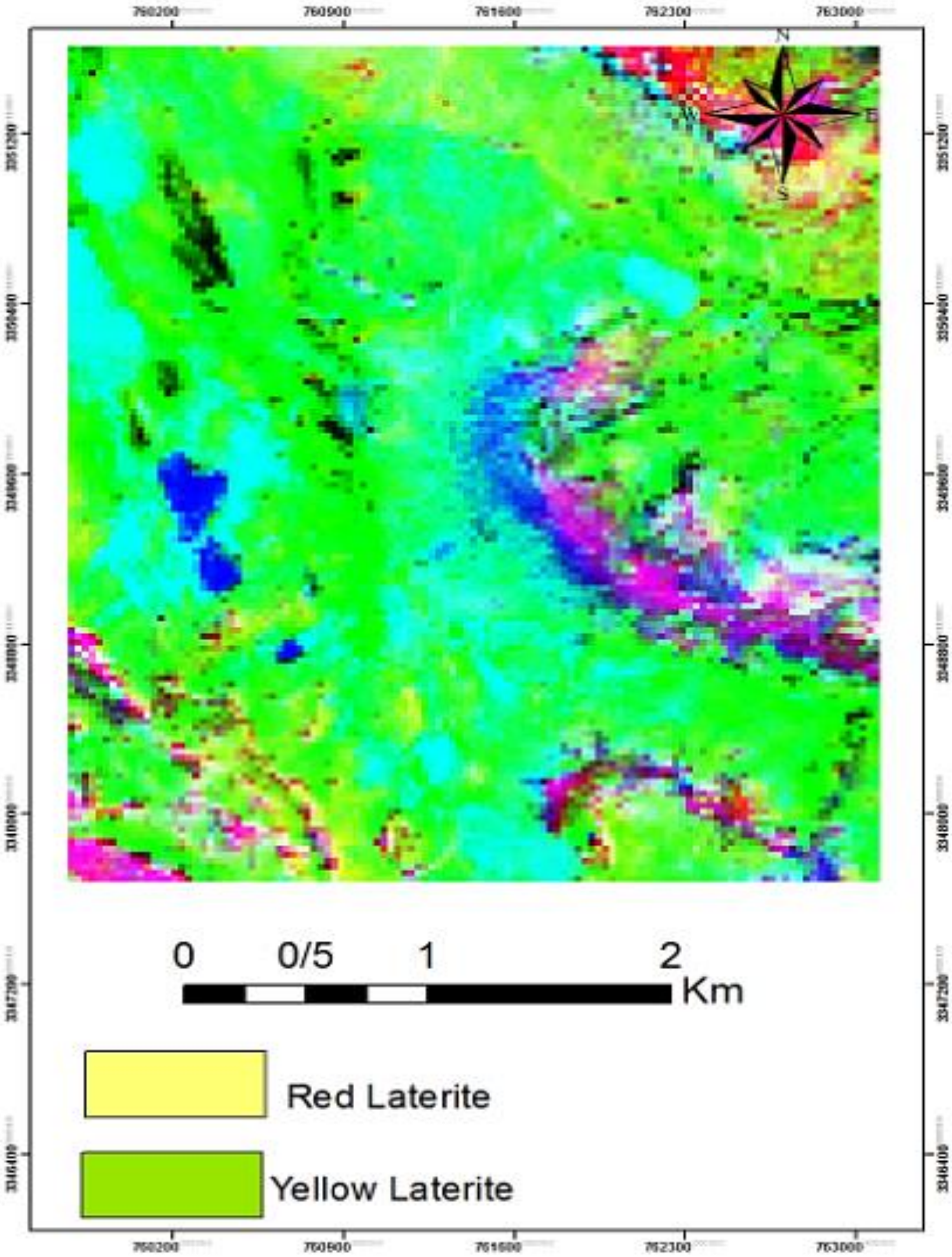


*Figure 10) Image of the standard PCA method for enhancing Koopan regional laterite.*

### 3.5- Final processing

At this stage before the preparation of area map final processing was done. The final processing through filtering 3 × 3 Kernel Size to remove the scattered pixels in the images of the final output was done. Image enhancement according to the regional rocks units after final processing after adding guide, coordinate system, scale and other necessary information became to zoning map of Koopan regional laterites.

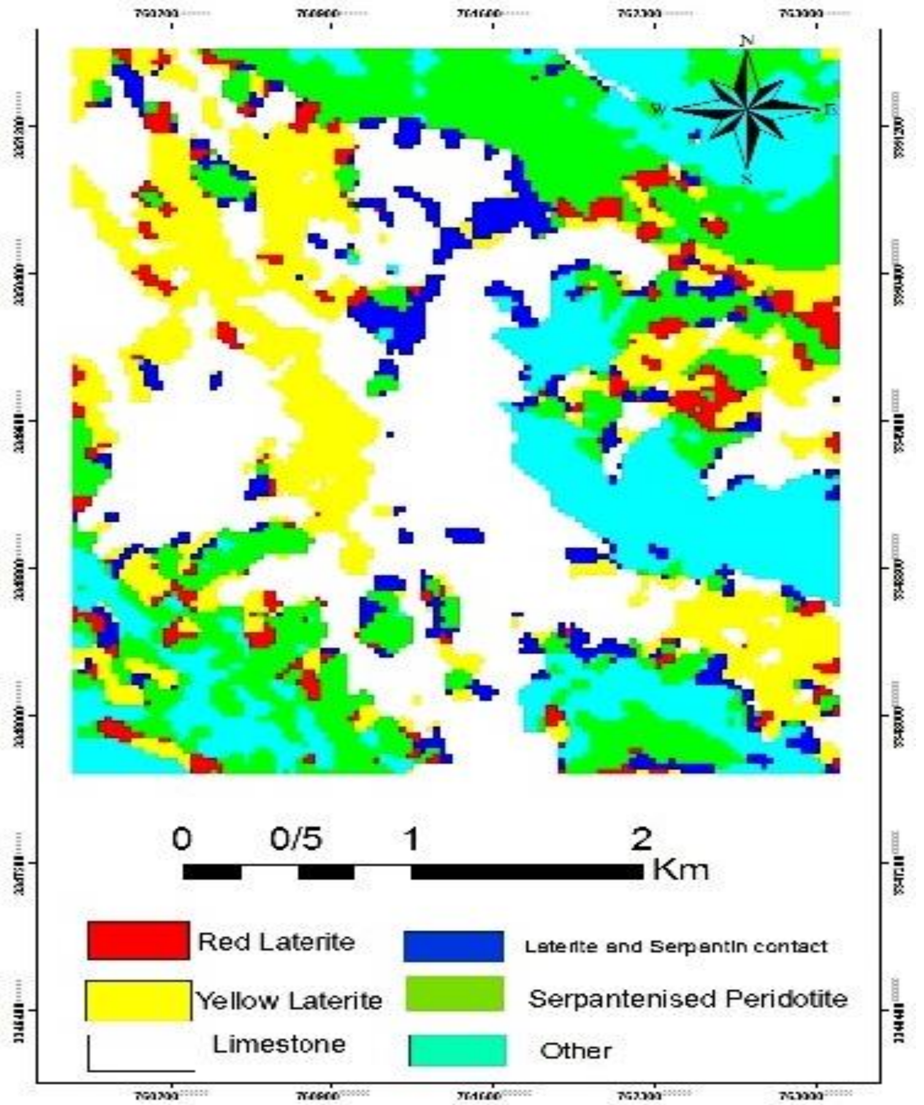


*Figure 11) Supervised classification for enhancing Koopan laterite.*

**4- Discussion and conclusion**

Field data together with remote sensing can be valuable information on how to extend the target rock units and their separation from the other units achieved. The processing on the images of Landsat it is concluded that the spectral reflectance curves in the enhancement of Koopan regional laterites are valuable. According to the spectral reflectance curves, color combinations of RGB = 321 contains the maximum amount of information are for the detection of red laterite and also yellow laterite. In these images, the pixels of red laterite and yellow laterite to marroon color appeared. Also using principal component analysis technique (PCA) the standard method was determined that the pixels of red laterite are bright yellow while yellow laterites are bright green. Also in detection of laterites the standard method by using 7 bands Landsat better quality than the optional method for the detection of these units showed. Investigation usual classification methods showed that supervised classification method by using harvested points and most similar algorithm (Maximum Likelihood) had the most successful in detection of the regional lateritic units, in this classification the overall accuracy and Kappa coefficient respectively have been 63.27% and 0.49%.

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