PRELIMINARY EXPERIMENT OF SIMPLE FIELD SPECTROSCOPY BY USING FILTERED COMMERCIAL DIGITAL CAMERA

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ABSTRACT

New digital filter photography remote sensing method is a good technique for detecting signs of alteration. CCD camera filter photo reflectance spectrum of iron oxide showed absorption in 450 nm and higher reflectance in 550 nm and 650 nm, and Hydroxyl alteration showed absorption in 600 nm and reflectance in 650 nm and 750 nm. This proposed analytical method can be applied to all types of digital filter CCD camera images, such as hand specimens and field outcrop photograph. The resolution of graphic analysis is very high because of the large number of pixels analysed are more than 1 million. Images used in an analysis of color should be either RAW or TIFF files and not JPEGs. The Spectral Angle Mapper (SAM) technique can be used for analysis. It has a great potential to aid many fields of survey.

Keywords: Remote sensing, alteration mineral, spectral analysis, CCD camera, filtered image

1. INTRODUCTION

The digital filter image taken by digital camera in the field works must be well focused with optical resolution superior to 2 million pixels. In principle, CCD digital filter camera with sensitivity in long wave range (up to 950nm) can be submitted to this technique.The aim of this study is to develop a flexible, low cost remote sensing system that can be applied in the detection of alteration minerals. The aim will be met through the following specific objective: (1) Develop a lightweight digital imaging system capable obtain high-resolution images. (2) Demonstrate the usefulness of the filter camera system for alteration mineral detection. (3) Demonstrate the usefulness of the filter camera system for first stage field survey and unreachable outcrop data acquisition.

The study area, Hachimantai, is located in North Eastern part of Japan (Fig. 1). Alteration zones are considered as a guide for exploration to find hidden geothermal systems. Digital filter photo methodology can detect absorption features in the spectra of minerals which are due to the presence of specific molecular group and, depending on wavelength position, shape and intensity. It is a main purpose to determine the mineral spaces with limited wave range (400-950 nm).

Many alteration and geothermal exploration studies were carried out (Akazawa and Muramatsu, 1988; Nakamura et al., 1970; Nakamura and Sumi, 1981; Sumi, 19689) and Matsukawa geothermal power plant is operating.

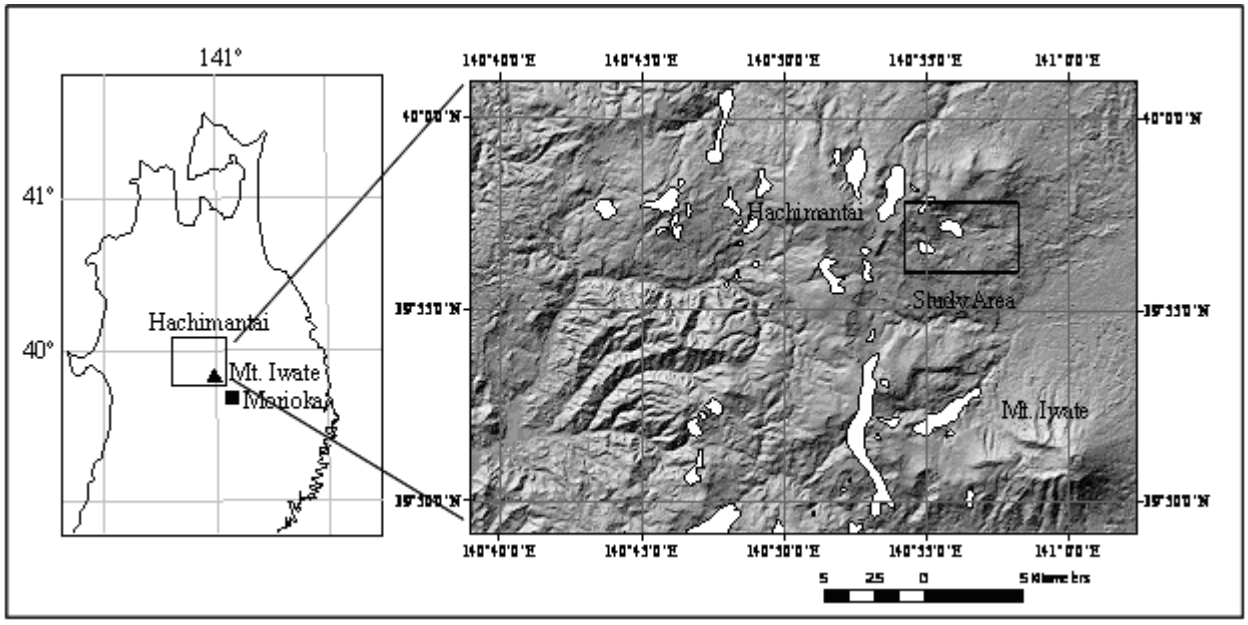

Fig. 1 Location map of study area and alteration zone of Hachimantai area. (The white polygons are alteration zones mapped by geological survey of Japan (1988)).

2 METHOD

Minerals observed are determined by X-ray diffraction.(XRD). Surface of samples for observed rocks is identified and confirmed by XRD (Fig. 2).

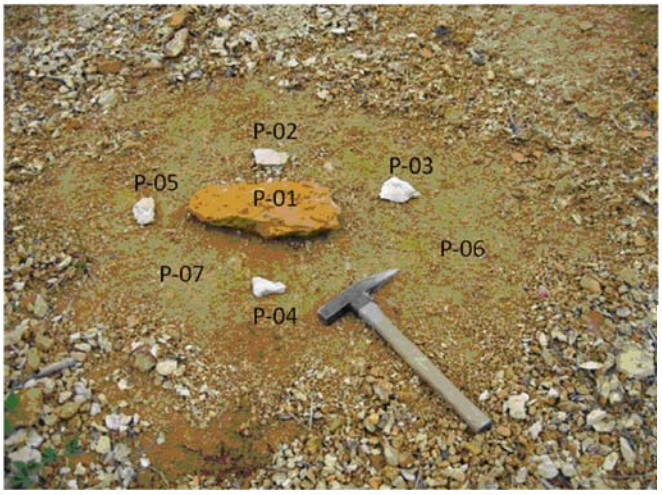

Fig. 2 Digital filter camera image PS08061201 and XRD analysis result.

X-ray diffraction analyses confirmed that the silica is the dominant mineral in the analyzed area. Mixtures of minerals with overlapping absorption bands can be difficult to interpret with spectroscopy but XRD has provided those mixture. According to XRD analyses, the samples contain iron oxide (goethite), a variety of clay minerals such as kaolinite, montmorillonite and illite, and siliceous minerals (Fig. 3).

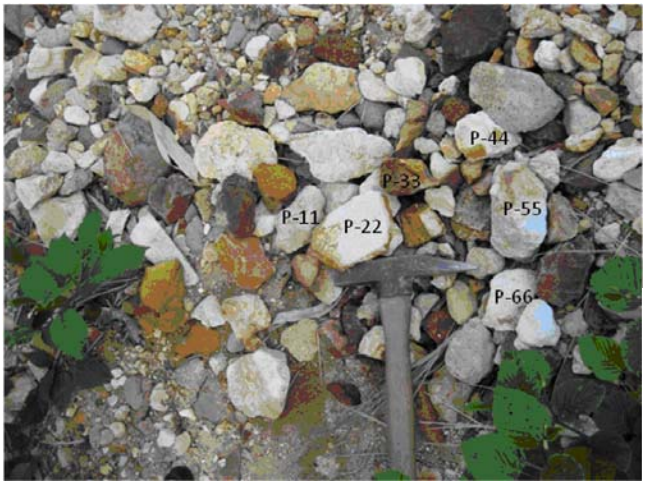

Fig. 3 Digital filter camera image PS08061202 and XRD analysis result.

The digital filter photography system consists of digital camera, filter, filter holder, and ball head tripod (Fig. 4). Konica Minolta Dimage 7, digital camera is used for array of charge coupled devices (CCD) sensitive to various portions of the EM spectrum to provide snapshots of the landscape. It can store images as uncompressed TIFF image or RAW files. In digital photography, the reflected light that enters the camera is focused onto a chip that is known as a charged coupling device (CCD). The surface of the CCD contains an array of light-sensitive photo diodes. One of the highlights of the Dimage 7 is that F 2.8, 7X optical zoom Minolta GT lens. The focal range is 7.2 - 50.8 mm. Five mega pixel camera gives an output 2560×1920 pixel images (4915200 pixels).

Fig. 4 CCD boasts 5.2 million pixels camera, filter, filter holder, and ball head tripod.

The CCD used in digital cameras is sensitive to near infrared light. In dark conditions, the CCD automatically turns up the gain to enable focusing. The filteres used are 400 nm, 450 nm, 500 nm, 550 nm, 600 nm, 750 nm, 800 nm and 950 nm of CORION (Holliston, USA) with an bandwidth of ± 25 nm. Most of the energy given off by the sun is in the visible and near-infrared wavelength range. Shooting filter photographs is simple, but following process is need to get good photos in the field.

1) Make sure no light can leak through the filter attachment mechanism and turn off the camera's automatic flash.
2) Set the camera to the highest ISO rating and remember to use the tripod.
3) Just shoot with the filter, then remove it and take a next shot.
4) The two images will be in perfect register.
5) Focusing was a problem because the infrared is so dark, the camera cannot see anything to focus, and it took going to take some work before.
6) Make sure there is a lot of light.

RAW files are the direct product of the CCD array are usually 12 or 16bit. This means that they can display a wider variety of colors and are generally linear because most CCDs are linear. One problem with RAW files is that they can differ between manufactures and even between camera model, and so special software and/or 'plug-ins' may be needed, or the software provide by the manufacturer must be used, to convert the images to other file formats. RAW files can also be converted into 16 bit TIFF files, which show higher accuracy than 8 bit TIFFs and may highlight extra detail.

For this study, eight separate digital filter images were applied to the image data cube (Fig. 5). The pixel purity index (PPI) was used to find the most spectrally pure (extreme or unique) pixels in the image data cube. In general, the most spectrally pure or unique pixels typically correspond to mixing endmembers.

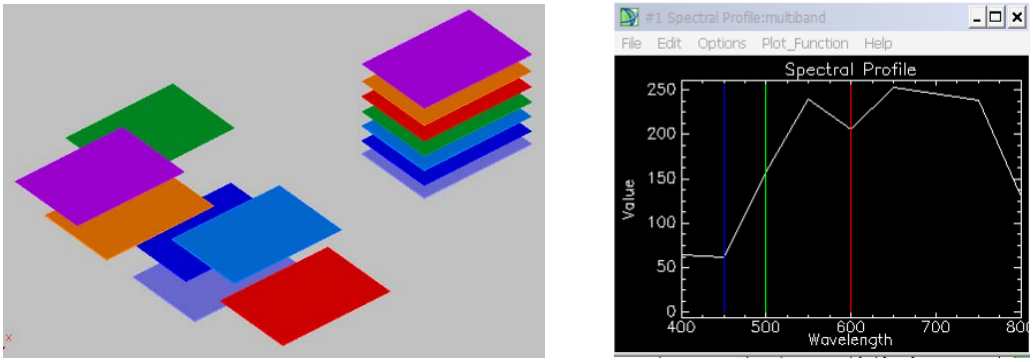

Fig. 5 Separate digital filter images and Image data cube.

In most image analysis is utilizing ENVI. Such process is shown in Fig. 6. First, training signatures are developed. Training signatures, often referred as spectral endmember, are good examples of the different "pure" materials that can be found in the image. Second, every pixel in the image is compared to the endmembers to measure similarity. This step can be carried out using a variety of the available algorithms within ENVI. Spectral analysis is carried out by SAM method.

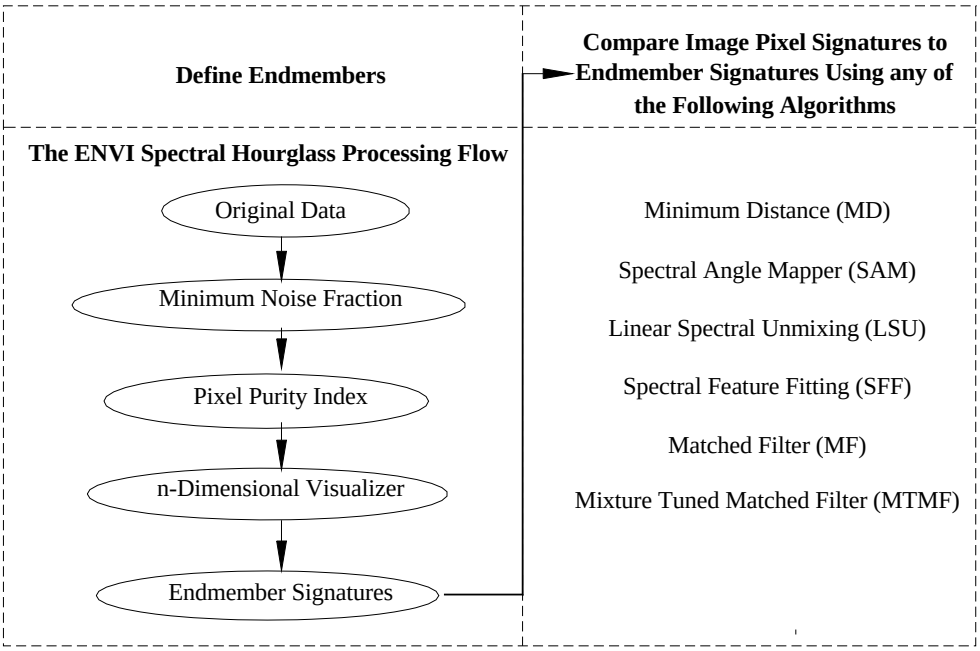

Fig. 6 The ENVI processing work flow.

3 RESULTS

The purest pixels showed 2D scatter plot of 450 nm and 550 nm for iron oxide minerals and 650 nm and 600 nm for Hydroxyl minerals. Figures 7 shows 2D scatter plot in PS08061201 image. Red color pixels represents iron oxide mineral (analysis of 450 nm and 550 nm data). This result is coincided with XRD analysis of samples.

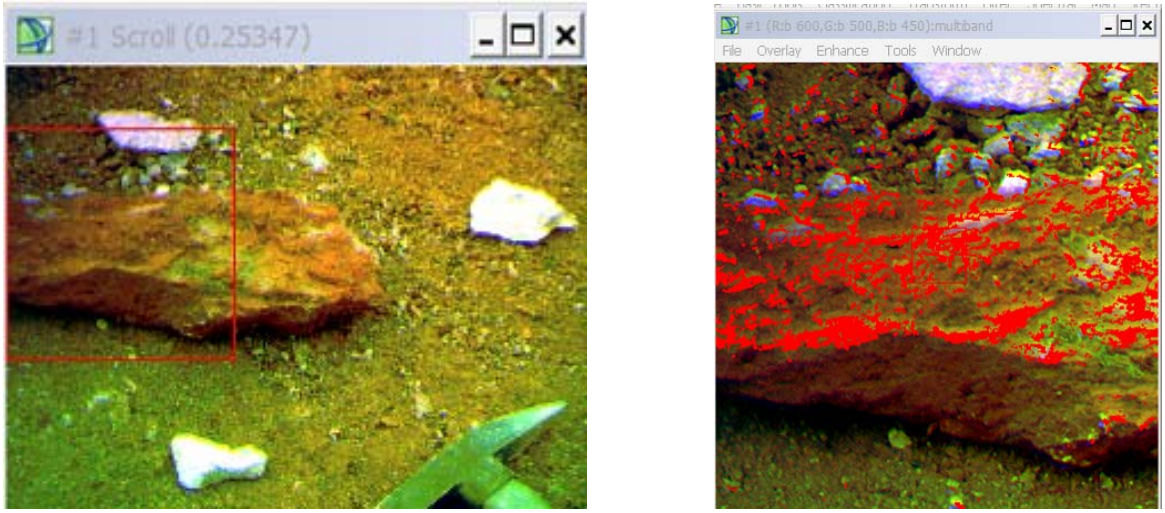

Fig. 7 Endmember spectral (pure pixel) examined for iron oxide by 2D scatter plot on PS08061201 image. Left is normal colored photo and right is analyzed iron oxide pixel (red color part).

Mini-library are created for goethite and hydroxyl minerals (kaolinite-montmorillonite-alunite) by the analysis of PS08061202 image (Fig. 8). It was tried to compare these with digital filter image spectral using SAM method to create surficial mineral map of each outcrop. The classification threshold minimum value used for iron oxides (goethite) is 0.05 and hydroxyl mineral is 0.1, respectively. The distributionof iron oxide (goethite) and hydroxyl minerals (kaolinite-montmorillonite-alunite) coincides with the XRD analysis.

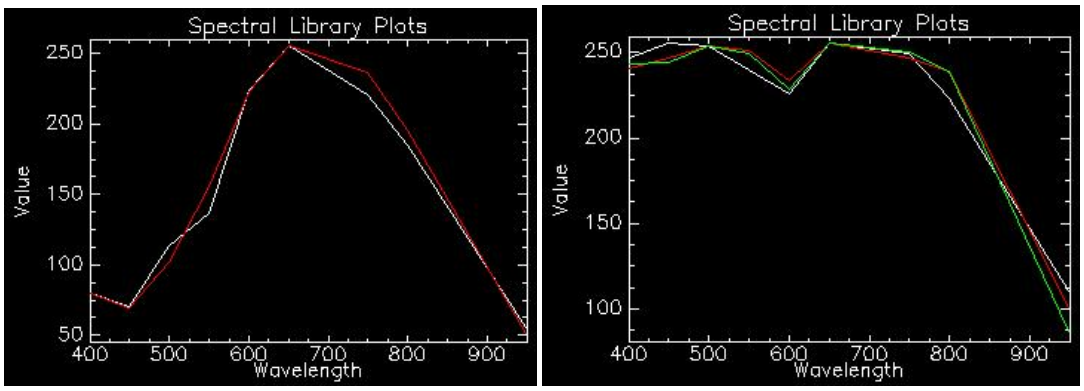

Fig. 8 Reference spectral of iron oxide (left) and hydroxyl minerals (right) based on PS08061202sample.
Mapping and abundance images showed a broad agreement between the spectral analysis algorithms.

The results of the SAM classification are shown in Fig. 9 for both iron oxide (goethite) and hydroxyl minerals (kaolinite, alunite, montmorillonite).

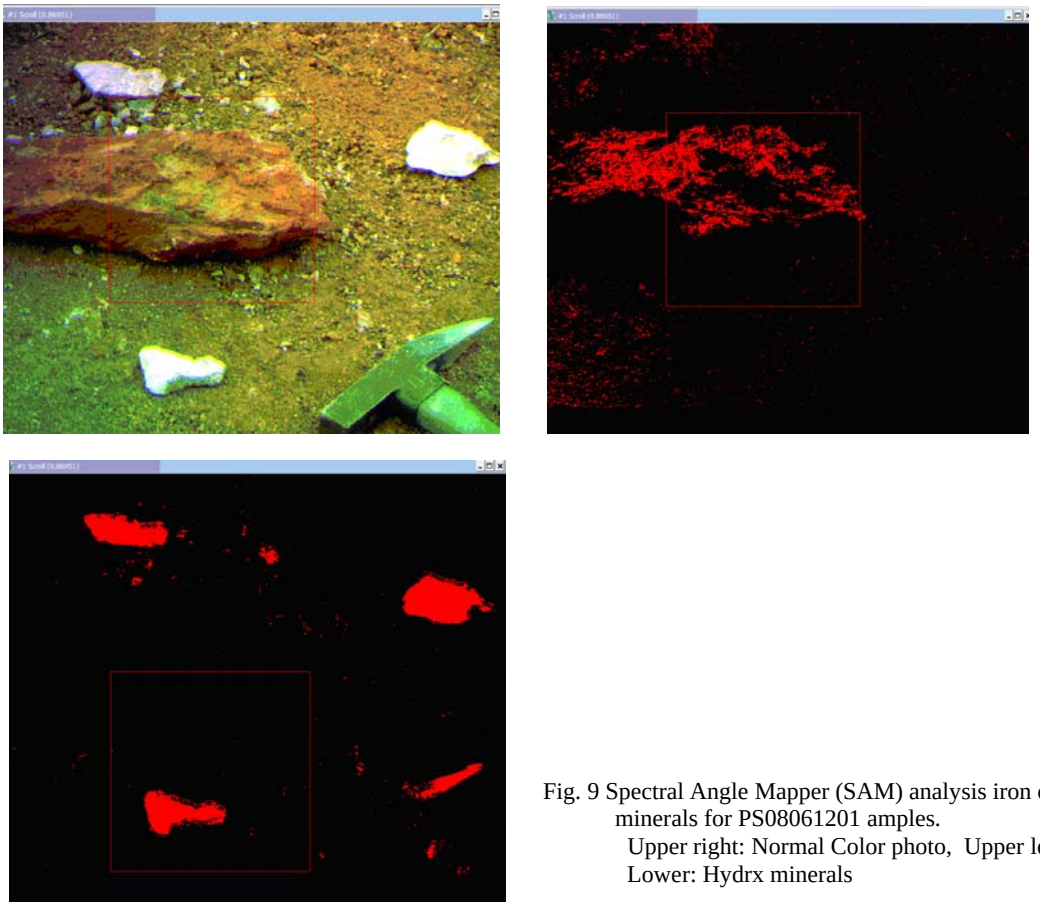

Fig. 9 Spectral Angle Mapper (SAM) analysis iron oxide and hydroxyl minerals for PS08061201 amples.
Upper right: Normal Color photo, Upper left: Iron oxide,
Lower: Hydrx minerals

4. CONCLUSIONS

This new digital filter photography remote sensing method is a good technique for detecting the alteration mineral distribution. It can apply to many kind of outcrops as alteration, open pit mine, trench, etc. The resolution of graphic analysis is very high because of the large number of pixels (more than 1 million). Images used in analysis should be either RAW or TIFF files and not JPEGs. The Spectral Angle Mapper (SAM) technique can be detected to outcrop data. It has a great potential to aid this digital CCD camera method. Combined with fieldwork, CCD camera data coincides well with actual mineral distribution. This method can save time and effort in performing geological survey and mineral exploration.

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