Automated mineral identification algorithm using optical properties of crystals

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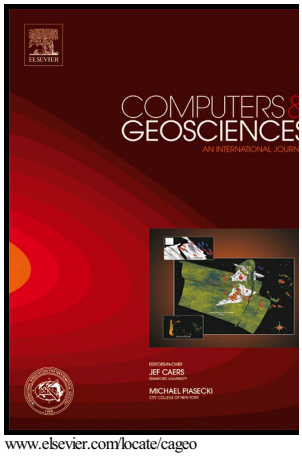

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Automated Mineral Identification algorithm using optical properties of crystals

Aligholi[1], S., Khajavi[2*], R., Razmara[1], M.

Department of Geology, Ferdowsi University of Mashhad, Iran
Earthquake Research Center, Ferdowsi University of Mashhad, Iran

Abstract

A method has been developed to automatically characterize the type of mineral phases by means of digital image analysis using optical properties of crystals. The method relies on microscope automation, digital image acquisition, image processing and analysis. Two hundred series of digital images were taken from 45 standard thin sections using a digital camera mounted on a conventional microscope and then transmitted to a computer.

CIELab color space is selected for the processing, in order to effectively employ its well-defined color difference metric for introducing appropriate color-based feature. Seven basic optical properties of minerals (A. color; B. pleochroism; C. interference color; D. birefringence; E. opacity; F. isotropy; G. extinction angle) are redefined. The Local Binary Pattern (LBP) operator and modeling texture is integrated in the Mineral Identification (MI) scheme to identify homogeneous regions in microscopic images of minerals.

The accuracy of mineral identification using the method was %99, %98, %96 and %95 for biotite, hornblende, quartz and calcite minerals, respectively. The method is applicable to other minerals and phases for which individual optical properties of crystals do not provide enough discrimination between the relevant phases. On the basis of this research, it can be concluded that if the CIELab color space and the local binary pattern (LBP) are applied, it is possible to recognize the mineral samples with the accuracy of more than 98%.

Keywords: Automated mineral identification, CIELab, Image processing, Local binary pattern (LBP)

1. Introduction

Rocks are mostly composed of microscopic-sized minerals. Identification of the constituent minerals, as a prerequisite for rock analysis scheme, is essentially required in several geoscientific disciplines such as mining, petrography, volcanology and underground construction (Autio et al., 2004; Jerram et al., 2003; Keulen et al., 2007; Fornaciai et al., 2008).

Different sophisticated techniques are available for mineral identification, such as X-ray diffraction, and electron microscopy. However, the manual mineral identification, in many cases, is still the cheapest and fastest method, which is widely and routinely used yet, while it is also reliable, reasonably accurate, and requires small samples as well (Mengko et al., 2000). In contrast to manual MI strategy, an automated computer-based scheme can systematically process the information gathered from mineral images, without inconsistency. This provides the capability to unify MI schemes, while enhancing reliable standards to describe mineral image contents.

[*] Corresponding Author:
E-mail: rezakhajavi@ferdowsi.um.ac.ir
Phone/Fax:+985118804374/+985118791191