A new method for quantitative petrography based on image processing of chemical element maps: Part I. Mineral mapping applied to compacted bentonites

Dimitri Prêt,[1,2,*] Stephane Sammartino,[2,5] Daniel Beaufort,[1] Alain Meunier,[1] Michel Fialin,[3] and Laurent J. Michot[4]

[1]HYDRASA (Hydrogéologie, Argiles, Sols et Altérations), UMR 6269 CNRS-INSU-Poitiers Université, 40 avenue du Recteur Pineau, 86022 Poitiers Cedex, France
[2]Etudes Recherches Matériaux, 40 avenue du Recteur Pineau, 86022 Poitiers Cedex, France
[3]Camparis, Université Paris 6, 4 place Jussieu, 75252 Paris Cedex 5, France
[4]Laboratoire Environement et Minéralurgie, UMR 7569 CNRS-Nancy Université, 15 avenue du Charmois, 54501 Vandoeuvre-les-Nancy Cedex, BP40, France
[5]Laboratoire Environnement Méditerranéen et Modélisation des Agro-Hydrosystèmes, UMR 1114 CNRS-INRA, Université d'Avignon et des pays de Vaucluse, Domaine Saint Paul, Site Agroparc, 84914 Avignon Cedex 9, France

Abstract

Most natural rocks or engineered materials display a multi-scale heterogeneity ranging from the nanometer to the centimeter. Their spatial textural heterogeneity can be approached from chemical element maps acquired using various techniques (SEM, EPMA, SXAM, synchrotron μ-XRF, TEM), depending on the chosen magnification. Chemical map processing that yields quantitative petrographic information is improved here according to newly developed mineral thresholding methods that accommodate mixtures and solid solutions. The complex case of an MX80 compacted bentonite is used as a test case. The 14 major chemical elements of this sample were mapped using an electron probe microanalyzer, and chemical map processing yielded a quantitative map of the 18 mineral species of bentonite with a spatial resolution of a few micrometers. The textural heterogeneity of the solid part of the sample is thus visualized and quantified on an area ranging between 0.1–1 cm^2. The method also provides a complete modal analysis of the sample. The methodology is expected to have broad applications in Earth and materials sciences.

Keywords: Chemical map, mineral map, software, modal analysis, image analysis, texture, microstructure, electron microprobe