



Research paper

Mineralogical study of zeolite from New Mexican deposits (Cuitzeo area, Michoacan, Mexico)

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ABSTRACT

The zeolitic minerals have been observed in volcanic sequences of recent geologic age (Pliocene–Miocene) that have been located around the Laguna de Cuitzeo and near Morelia (Capital of the State of Michoacan, Mexico). The zeolites of the Cuitzeo area were studied by scanning electron microscopy (SEM), X-ray powder diffraction (XRPD), X-ray fluorescence (XRF), FTIR and Raman spectroscopy in combination with thermoanalytical methods (thermogravimetric analysis – TG/DTG – and differential thermal analysis – DTA). The main mineral constituent is an intermediate type of the isomorphous series heulandite–clinoptilolite end members. Trace of feldspars, biotite, and smectite (and an amorphous fraction) were also detected. Chemical composition ($\text{Ca}_{1.44-2.00} \text{K}_{1.44-0.74} \text{Na}_{0.05-0.53} \text{Mg}_{0.67-0.92} \text{Fe}_{0.02-0.10} [\text{Si}_{29.04-29.85} \text{Al}_{6.31-7.04} \text{O}_{72}] 13.5 \text{H}_2\text{O}$ and some chemical features ($\Gamma = 0.96\text{--}1.08$), (Si/Al ratio 4.47; Al + Fe³⁺ of 6.36 to 7.13) with 2.38 (Mg + Ca) > 1.43 (Na + K) correspond to the intermediate member of the clinoptilolite–heulandite isomorphous series. The dehydration rate of the Cuitzeo zeolites, especially in the range from 150 to 400 °C, as well as spectroscopic features (FTIR and Raman), external cation exchange capacity (135 meq kg^{−1}) and porosimetric data are also characteristic for this intermediate clinoptilolite–heulandite member. The value of the BET specific surface area (20.3 m²/g) is about 1.5 times higher than that relative to clinoptilolite-rich tuff powders of different geographic origin and previously characterized. Cuitzeo zeolite deposit is of a great economic interest, considering that it is the unique and richest among the zeolite formations in Southwestern Mexico with zeolite content higher than 70 wt.%. This value is relatively high: most of the exploited zeolitic tuffs from the Oaxaca State (the most studied and well known deposits of natural zeolites in the south of Mexico) have been estimated to contain less than 60 wt.% zeolite minerals. Based on the above properties the zeolite from Cuitzeo area could be a very effective tool for technological application (such as agricultural use, decontamination of water and soils, cement industry, etc.), particularly due so far of the complete absence of zeolitic deposits in the central region of Mexico.

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1. Introduction

The geology of Mexico shows a widespread and abundant distribution of volcanic rocks deposited in lacustrine and marine environments (Ostrooumov et al., 2002). Prominent volcanic activity during the Oligocene and Miocene developed a huge volcanic plateau in western Mexico, the Sierra Madre Occidental, largely from rhyodacitic and rhyolitic pyroclastic flows marking regressions of the Cretaceous and Tertiary inland seas. Large accumulations of glassy pyroclastic rocks were deposited, some of which later altered to zeolites. From the late Miocene onward, a chain of volcanoes formed across Mexico. In closed basins and fresh lacustrine and marine environments rhyolitic and rhyodacitic pyroclastics diagenetically altered to zeolites. Secondary zeolite minerals appear to be much

more common and widely distributed in Mexico than hydrothermal zeolites.

Since the report of Mumpton (1973) on the existence of some deposits of zeolites in sedimentary/volcanic environments north and south of the city of Oaxaca (Oaxaca State), a lot of work has been done not only on these minerals but on many other Mexican zeolitic materials discovered afterwards (Ostrooumov et al., 2002). After this first discovery of zeolites in Mexico, some other zeolitic species have in fact been reported. In particular, as a result of geological and petrographical investigations (Ostrooumov and Ostrooumova, 2006; Ostrooumov et al., 2005), large accumulations of sedimentary zeolite have been found in the tuffs from the Mexican Volcanic Belt (MVB) geologic province in the State of Michoacan (southwestern Mexico). The formation consists of tuffaceous sediments that have accumulated in the margins of a fresh-water lake. These zeolite deposits are of great interest because of their abundance and potential economic value.

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