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# Presence of the chabazite in the volcanic zeolitic tuffs from the Apostolache area

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## Abstract

*In this paper, it was studied the presence of the zeolites and the crystallized minerals in the volcanic zeolitic tuffs from Dobrota Valey (Apostolache area, district Prahova) , using X – ray Difraction and proving the presence of the chabazite in these tuffs using more methods .Presence of the chabazite like majority phase in the zeolitic tuffs from our country, both from interior and out of the Carpathians arc, represents a great premiere and could have practical importance in various domains.*

**Key words:** *tuff, chabasite, Apostoloche area, XRD, SEM.*

## Introduction

Chabazite is a crystallized natural zeolite in trigonal sistem, having lattice made of the double prisma, formed by tetraedra in hexagonal arangements [1].

Its ideal formula is: $Ca_2\ [Al_4\ Si_8\ O_{24}] \times 13H_2O$ and its name came from the word „chabazios", that means „stone", in the old greek language [2].

Chabazite is one of the most porous natural zeolites, with a specific surface of 500-600 $m^2/g$. Si /Al ratio range between 1.4 and 2.8. Maximum diameter of the „window" is 5Å.

Being given by the total quantity of cations, which compensate negative fixed charge of the alumosilica lattice, ion-exchange capacity depends on the chemical composition of the zeolite; the lower molar ratio $SiO_2/\ Al_2O_3$ , the higher ion-exchange capacity. [3]

In the table 1 is shown some data of the chabazite in comparation with the clinoptilolite, which is the most frecvently natural zeolite met in the zeolitic volcanic tuffs from our country.

**Table 1.** Ion-exchange capacity of an powdered zeolites [3]

| Zeolite | Average Ratio Si/Al | Type of chanels | Free Volum, $cm^3/cm^3$ | Efective Size of pores, Å | Ion-exchange capacity, mili echiv. /g anhidrous | hidratated |
|---|---|---|---|---|---|---|
| **chabazite** | 2.3 -2.5 | 3-dim. | 0.47 | 3.7 × 4.2<br>2.6 | 5.0 | 3.9 |
| **clinoptilolite** | 4.5 | - | 0.34 | 2.4 × 6.1<br>3.8 × 4.5<br>4.1 × 6.2 | 2.6 | 2.3 |

Purpose of this work was to prove presence of the chabazite in the volcanic origin tuff from the Apostolache area and to mention posibilities of using in practice.

## Sample conditions. Macroscopic aspect

From Apostolache area (Dobrota Valey) was sampled after an previous removal of the 10-20 cm alterated blancket, washed by rain water. Is observed grey-white and brittle visual aspect of the tuff.

## Work Procedure

Upon the sampled tuff the next analises were executed:

- XRD (X-Ray Difraction) analysis
- SEM- (Scanning Electron Microscopy ) and
- EDAX analysis, which detects X-rays and separate them in the spectrum after their energy, wherefrom come the name of spectrometry after energy (EDS).

## X-ray Diffraction

X-Ray diffraction analysis of data from the present work was obtained byusing the crystalline powder method (Bragg-Brentano). An X-Ray Diffraction equipment, having like X-Ray source an Co-anticathode was used. Tuff sample was powdered and exposed at X-ray, pressed in the special carriers.

In the crystalline structure of the sample, it was evidenced, at the first sight, in the difractogram (see figure 1), difraction specific peaks for *Chabazite*: $Ca_2$ [$Al_4$ $Si_8$ $O_{24}$] × $13H_2O$ (sheet ASTM 10.370) [2], majority phase, with very intense and high peaks at d=2.96 Å ( I=100) and d=4.314 Å (I=85), following others peaks specific for chabazite,which could be observed from the left to the right side on the difractogram at: d=9.36Å, d=6.86Å, d=5.59Å, d=5.05Å, d=3.594Å, d=3.476Å, d=2.625Å, d=2.556Å, d=1.814Å, d=1.751Å.

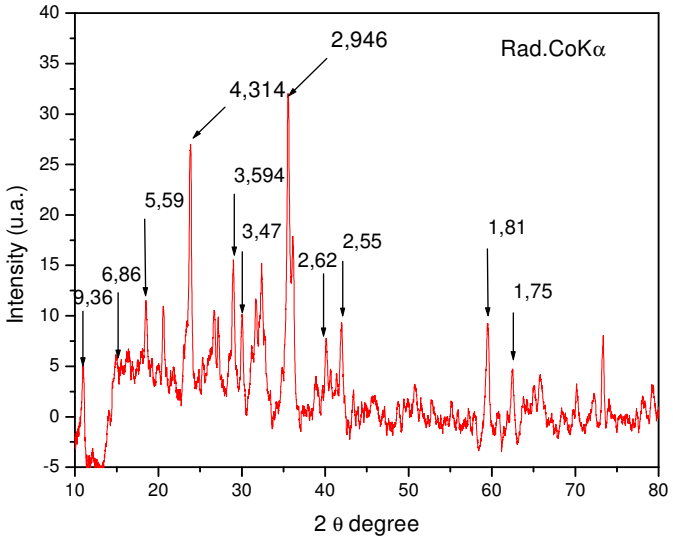


**Fig.1.** X-ray Diffractogram of the Apostolache tuff.

Presence of the chabazite identified by XRD, is an sureness, by the existence of the all main peaks from the characteristic spectrum.

## Electron Microscopy & EDAX Analysis

Electron Microscopy executed upon the same samples, confirms the presence of the chabazite by the specific aspect of the crystals. Pictures with the magnitude 500× and 5000× were obtained (see figure 2 and 3). Both pictures show the characteristic habits of chabazite crystals, known from the literature.

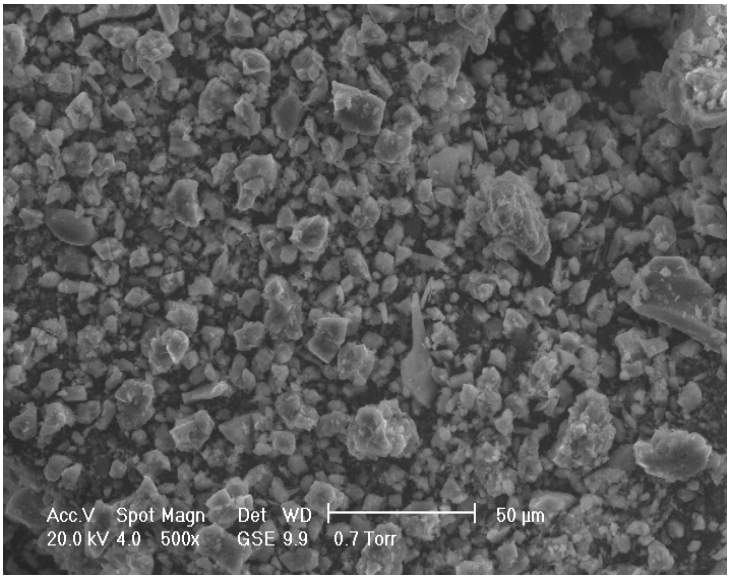


**Fig.2.** Electronomicroscopic Micrography of the Apostolache tuff (500×)

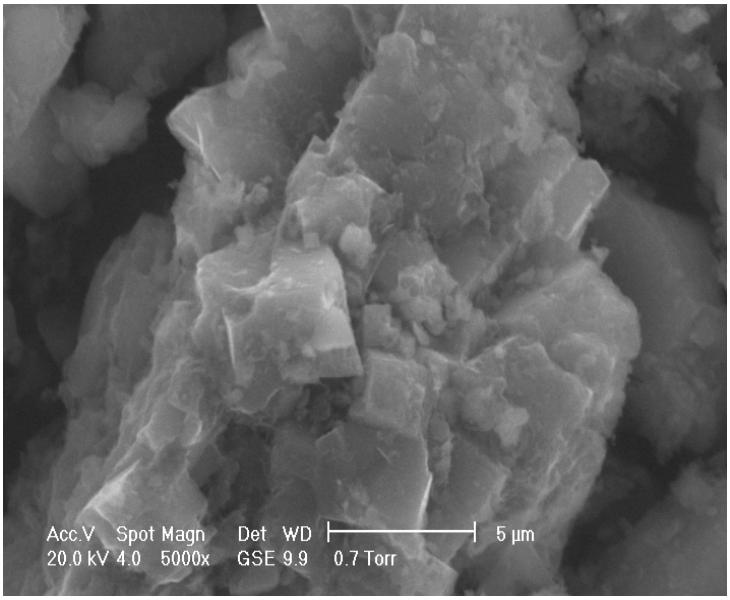


**Fig.3.** Electronomicroscopic Micrography of the Apostolache tuff (5000×).

For executing the requested experimental researches, an Scanning Electron Microscop Philips type ESEM XL 30 TMP, with a spectrometer EDAX attached was used.

Similarly to all Scanning Electron Microscops also ESEM could be used spectrometric measurements which realize identification of chemical elements by measuring the lenght of the wave after measurement of the emited X-ray energy.

EDAX analyser detects X-ray and separates in the spectrum after their energy.

Spectrometers EDS could be programed to analyse some interesting elements, point by point, in time of the sample scanning with electrons beam, being possible to obtain qualitative and quantitative compositional results from the single point on the surface, on the selected direction (liniar profile) or distribution of the elements on all analised surface.

The elements of interest were considered the constituent elements of the tridimensional silicates lattice (Si, Al, O), alkaline metals and earth-alkaline (Na, K, Ca, Mg) and iron; for these weight procentage and atomic procentage were determinated ( see figure 4 and table 2).

Si/Al atomic ratio is 2.99, in comparison with Si/Al ratio of the clinoptilolitic tuff from the Slănic area, obtained with the same equipments, at a value 5.43. This is another reason which confirmes presence of the chabazite in Apostolache tuff, althought in the literature, in the absence of a more serious study, it was considered a tufite (i.e. tuff with low zeolite content) or a clinoptilolitic tuff. Also the presence in abondance of the calcium could suppose presence of the calcium chabazite in detriment of the sodium chabazite.

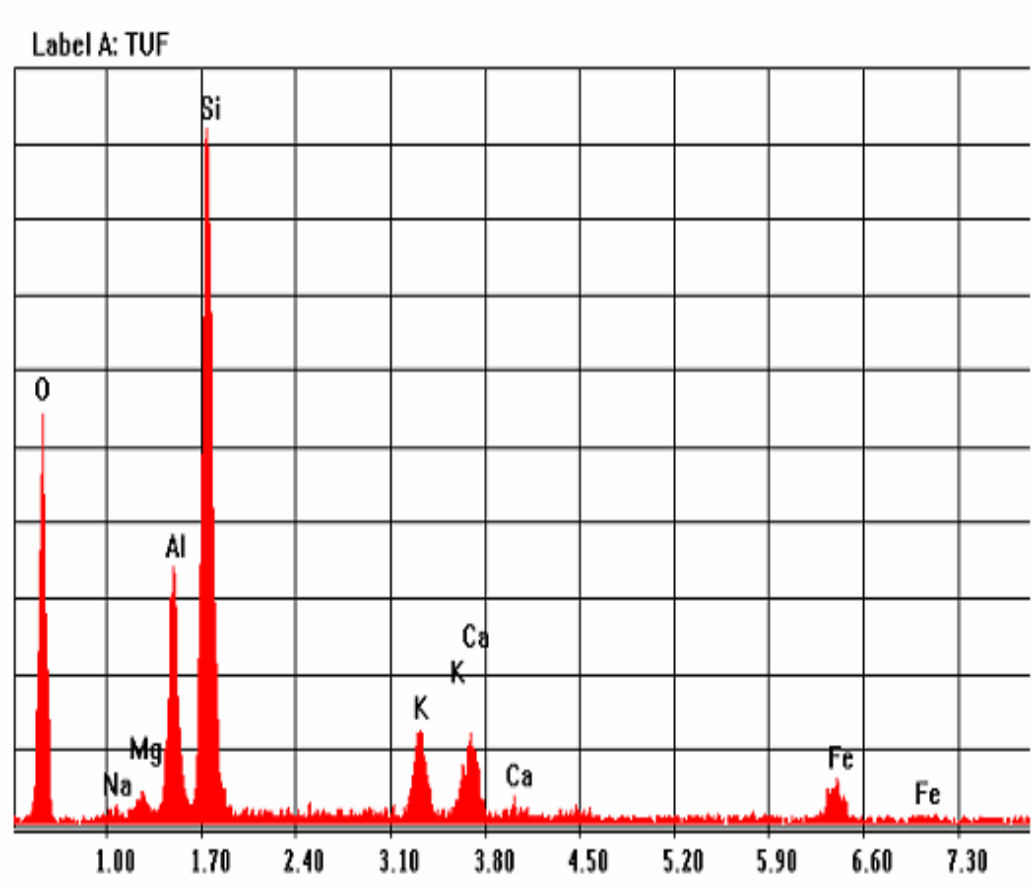


**Fig. 4.** EDS Spectrogram of the tuff sample

**Table 2.** Weight percentage Wt% and atomic percentage At% of the elements of interest from tuff

| Element | Wt% | At% |
|---|---|---|
| Si | 27.33 | 20.81 |
| Al | 8.77 | 6.95 |
| O | 47.58 | 63.6 |
| Na | 0.71 | 0.66 |
| K | 4.52 | 2.47 |
| Ca | 4.54 | 2.42 |
| Mg | 1.15 | 1.01 |
| Fe | 5.39 | 2.06 |
| Total | 100 | 100 |

## Using posibilities

After a heat treatment at 400°C, the water adsorbtion capacity of the chabazite is 17%. It is a good adsorbant for the carbon dioxide, sulfurated hydrogen, monoclormetan, diclormetan, metilamine, propane, n-butane [1]. Also it is posibile its use in the municipal and industrial waste water treatment.

## Conclusions

All three methods 0f advanced physical analysis, reach the same conclusions, i.e. sampled tuff from Apostolache area is certainly an chabazitic tuff, where the chabazite is the majority phase in an estimative percentage about 70-75%.

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# Prezenţa chabazitului în tufurile vulcanice zeolitice de la Apostolache

## Rezumat

*În articolul de faţă s-a studiat prezenţa zeoliţilor şi a mineralelor cristaline în tufurile vulcanice din Valea Dobrotei (perimetrul Apostolache, judeţul Prahova), folosind difracţia de raze X şi s-a demonstrat prezenţa chabazitului în aceste tufuri folosind mai multe metode.Prezenţa chabazitului ca fază majoritară în tufurile zeolitice din ţara noastră, atât din interiorul cât şi din exteriorul arcului carpatic reprezintă o deosebită premieră şi poate avea importanţă practică în diverse domenii.*