Use of zeolitites from Central Italy in an integrated cycle aimed at water and chemical fertilizers saving 
(ZEOLIFE - LIFE+10ENV/IT/000321)

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Introduction

The project “ZEOLIFE - Water pollution reduction and water saving using a natural zeolitite cycle” has been conceived to test an innovative integrated zeolitite application having the aim to reduce the NH₄ content in livestock effluents and correct agricultural soils, with improvement of the yield and economization of water for irrigation and fertilizers. This project leads to a reduction of fresh and groundwater pollution and avoids excessive exploitation of the water resource. For further details visit the website www.zeolife.it.

The first goal of the project was to carry out a chemical and physical, as well as mineralogical characterization of several zeolitite samples, coming from different quarries located in Central Italy, in order to select the most suitable raw material to be used throughout the entire project.

Samples from the following seven localities were analyzed: Sorano (Gr), Sovana (Gr), Farnese (Vt), Grotte Santo Stefano (Vt), Corchiano (Vt), Nepi (Vt), and Riano (Rm). All the mentioned localities are the closest to the experimental field (Codigoro, Ferrara); in each quarry non-marketable material, namely broken blocks or blocks with irregular shape and size, is available. This material represents an already available reserve of zeolitic tuff that best fit the purposes of this project.

Besides the technological properties of the raw material, the final choice also took into account factors of environmental (e.g. carbon footprint) and economic (e.g, cost, full and immediate availability) concern.

Experimental

In order to obtain representative samples from each examined locality, an appropriate procedure was followed by picking out a total amount of 10 kg of raw material from different points of the quarries. The collected material was accurately ground, and repeatedly quartered until obtaining the needed sample amount.

Quantitative mineralogical analyses were carried out using the Rietveld method via the General Structure Analysis System (GSAS) software package [1], combined with the Reference Intensity Ratio (RIR) method for the determination of the amorphous phase [2].

Whole rock chemical analysis was carried out on pressed pellets via a wavelength-dispersive X-Ray Fluorescence (XRF). Loss On Ignition (LOI) was determined by sample heating in a oven at 1100°C. CEC determination of exchanged Ca²⁺, Mg²⁺, Na⁺, and K⁺ cations was achieved via Atomic Absorption Spectrometer (AAS) measurements. Apparent density was determined as the ratio between the mass of ground sample which fills a measuring cup in loose conditions and the volume of the cup. Water retention was determined using a modified Campbell’s methods [3].

Results and discussion

As demonstrated by plenty of experimental scientific works (e.g., [4] for a review), chabazite is very effective not only in NH₄ uptake from swine manure, but also in successive
controlled NH₄ release in soils. Other zeolite species, such as phillipsite, have great potential for NH₄ adsorption and retention, but not the same capacity as chabazite in exchanging NH₄ with circulating solutions and plant root systems in soils.

A comparison between samples from studied quarries is reported in Fig. 1. As can be observed the Sorano zeolitite shows the best features (e.g., high zeolite content and high CEC).

![Fig. 1. Stacked histogram of the (a) total zeolite content (the contribution of the three identified species chabazite, phillipsite, and analcime is shown), and (b) CEC values for Ca, Mg, Na, and K.](image)

Conclusions

The K-rich, Na-poor zeolitite from the Piandirena quarry (Sorano, Gr) resulted to be a first-rate material for the project purposes. It is in fact characterized by high zeolitic content (with dominant chabazite and very subordinate phillipsite), as well as by high CEC value. In addition to the extractable zeolitite, the material available in dumps, whose technologic properties are perfectly suitable for the purposes of the present project, must be also taken into account (in a 2003 geologic study, 650.000 m³ of this material were estimated). This aspect is of paramount importance from an economic and environmental point of view, taking into account that the scrap material amounts to about 30% of quarry production and is currently unused.

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References