*Journal of Inclusion Phenomena and Molecular Recognition in Chemistry* **26:** 89–91, 1996.



# Strontium and Cesium Sorption of Some Anatolian Zeolites*

TANIL AKYÜZ
*Cekmece Nuclear Research and Training Center, PK.1 Havalimani, 34831, Istanbul, Turkey*

(Received: 14 November 1995; in final form: 14 March 1996)

**Abstract.** Zeolite samples of Tertiary age obtained from different areas of Anatolia (Turkey) are classified as Clinoptilolite, Analcime or Heulandite and we have investigated their sorption capacity for $Cs^+$ and $Sr^{2+}$ ions from aqueous solutions. Quantitative analysis of the zeolite samples untreated and treated with chloride salts of $Cs^+$ or $Sr^{2+}$ in aqueous solutions, for Na, Mg, Al, Si, P, K, Ca, Ti, Mn and Fe were performed using EDXRF. Chemical analysis indicated that the Clinoptilolite type zeolite from the deposits of Cankiri-Corum Basin of Anatolia is the best sorber for Sr and Cs ions.

**Key words.** Sr and Cs sorption, sorption, XRF, zeolite.

## 1. Introduction

Zeolites are crystalline hydrated aluminosilicates containing exchangeable alkaline or alkaline-earth cations. The framework of the mineral is honeycombed with large cavities which are accessible through small apertures and contain the exchangeable cations and water molecules [1].

In this study natural zeolite samples obtained from various deposits of Anatolia are classified [2] and their sorption capacity for Cs and Sr ions have been investigated using energy dispersive X-ray fluorescence (EDXRF) spectrometry. The aim of this study is to expand the applications of natural zeolites, which are abundant in Turkey, as cation exchange materials. This work is devoted to the possibility of using some Turkish natural zeolites as sorbents for radioactive $Cs^+$ and $Sr^{2+}$ extraction from solutions.

## 2. Experimental

Zeolite samples were obtained from the Kutahya, Canakkale-Biga, Cankiri-Corum and Manisa-Demirci regions of Anatolia and classified as clinoptilolite, clinoptilolite+analcime, clinoptilolite and heulandite, respectively, based on XRD, DTA and Scanning Electron Microscopy investigations [2]. Chemical analysis of the samples was performed on a Kevex 0700 EDXRF spectrometer. X-ray powder diffraction patterns of the samples were recorded on a Jeol JDX 19C diffractometer.

* Presented at the Sixth International Seminar on Inclusion Compounds, Istanbul, Turkey, 27–31 August, 1995.

Table I. Chemical analysis results of natural zeolites (wt.-%).

| Sample* | $Na_2O$ | MgO | $Al_2O_3$ | $SiO_2$ | $P_2O_5$ | $K_2O$ | CaO | $TiO_2$ | MnO | $Fe_2O_3$ | $LOI^+$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Zeolite-1 | 0.15 | 1.45 | 14.20 | 67.25 | 0.15 | 5.20 | 2.80 | 0.35 | 0.15 | 1.00 | 6.95 |
| Zeolite-2 | 0.90 | 1.65 | 12.85 | 70.00 | 0.16 | 4.30 | 2.60 | 0.07 | 0.03 | 0.75 | 6.24 |
| Zeolite-3 | 5.50 | 1.00 | 13.70 | 64.85 | 0.15 | 1.00 | 3.30 | 0.30 | 0.03 | 1.01 | 9.66 |
| Zeolite-4 | 0.45 | 2.10 | 13.35 | 69.70 | 0.20 | 1.80 | 3.00 | 0.20 | 0.20 | 1.00 | 7.80 |

*Anatolian zeolite samples are; Zeolite-1: Clinoptilolite, from the deposits of Kütahya Basin Zeolite-2: Clinoptilolite + Analcime, from the deposits of Biga-Canakkale Basin, Zeolite-3: Clinoptilolite from the deposits of Cankiri-Corum Basin, Zeolite-4: Heulandite, from the deposits of Manisa, Demirci-Bolu Basin. + LOI= Loss on ignition.

Table II. Chemical analysis results of zeolite samples after treatment with $Cs^+$ cations (wt.-%).*

| Sample | $Na_2O$ | MgO | $Al_2O_3$ | $SiO_2$ | $P_2O_5$ | $K_2O$ | CaO | $TiO_2$ | MnO | $Fe_2O_3$ | $Cs^+$ | LOI |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Zeolite-1 | 0.05 | 1.40 | 14.15 | 67.20 | 0.15 | 4.15 | 2.80 | 0.30 | 0.07 | 0.95 | 2.90 | 6.85 |
| Zeolite-2 | 0.50 | 1.65 | 12.80 | 69.90 | 0.15 | 4.05 | 2.60 | 0.07 | 0.02 | 0.70 | 2.25 | 6.10 |
| Zeolite-3 | 4.90 | 0.95 | 13.65 | 64.80 | 0.13 | 0.95 | 3.30 | 0.30 | 0.02 | 1.01 | 3.00 | 8.50 |
| Zeolite-4 | 0.01 | 2.10 | 13.30 | 69.50 | 0.18 | 1.50 | 3.00 | 0.20 | 0.18 | 0.97 | 2.90 | 7.00 |

*See footnotes to Table I.

Cation treated zeolites were prepared by immersing the natural zeolites (100 mg) in aqueous solutions of Cs and Sr chlorides (0.1 M), in bottles, at room temperature, for one day. They were then filtered and washed several times with deionized water and dried in an oven at 100°C.

## 3. Results and Discussion

The chemical analysis of the untreated natural zeolites and cation treated ($Cs^+$ and $Sr^{2+}$) zeolites are given in Tables I–III, respectively. Comparison of Tables II and III with Table I indicates the presence of correlations between sorbed Cs ions

Table III. Chemical analysis results of zeolite samples after being treated with $Sr^{2+}$ cations (wt.-%).*

| Sample | $Na_2O$ | MgO | $Al_2O_3$ | $SiO_2$ | $P_2O_5$ | $K_2O$ | CaO | $TiO_2$ | MnO | $Fe_2O_3$ | $Sr^{2+}$ | LOI |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Zeolite-1 | 0.15 | 1.30 | 14.20 | 67.20 | 0.15 | 5.20 | 2.20 | 0.33 | 0.12 | 0.97 | 0.95 | 7.15 |
| Zeolite-2 | 0.90 | 1.50 | 12.80 | 69.95 | 0.16 | 4.30 | 2.20 | 0.06 | 0.03 | 0.75 | 0.90 | 6.25 |
| Zeolite-3 | 5.50 | 0.90 | 13.65 | 64.80 | 0.14 | 1.00 | 2.70 | 0.30 | 0.03 | 0.01 | 1.75 | 9.20 |
| Zeolite-4 | 0.45 | 1.80 | 13.35 | 69.70 | 0.15 | 1.80 | 2.70 | 0.20 | 0.20 | 1.00 | 0.90 | 7.60 |

*See footnotes to Table I.

Table IV. Sorption of $Cs^+$ and $Sr^{2+}$ ions on zeolites studied.

| Sample* | $Cs^+$ (mg eq./g) | $Sr^{2+}$ (mg eq./g) |
|---|---|---|
| Zeolite-3 | 2.26 | 2.00 |
| Zeolite-1 | 2.18 | 1.09 |
| Zeolite-4 | 2.18 | 1.03 |
| Zeolite-2 | 1.70 | 1.03 |

*See footnotes to Table I.

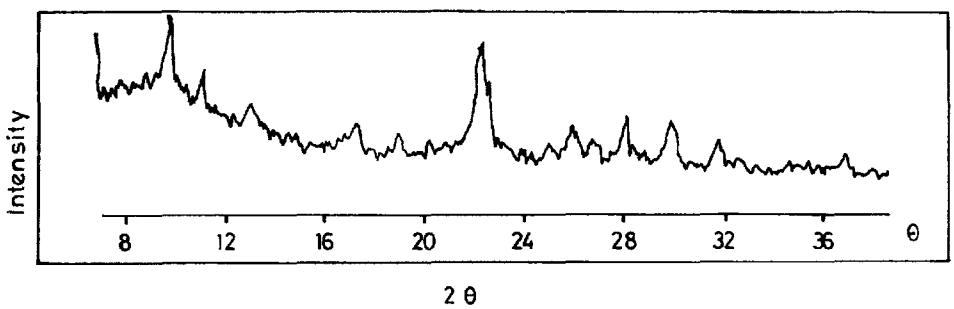


Fig 1. X-ray diffraction pattern of zeolite-3 (CuK$\alpha$).

and desorbed Na and K ions and sorbed Sr ions and desorbed Mg and Ca ions. The amount of sorbed Cs and Sr cations (1.7–2.3 mg eq./g ) in Cs and Sr treated zeolites respectively, are given in Table IV. Our results are found to be compatible with those for other natural zeolites [3,4]. The cation exchange capacity of natural Clinoptilolite from Nevada is known to be 1.7 mg eq./g [4].

It is found that the Clinoptilolite type zeolite from the deposits of Cankiri-Corum Basin (zeolite 3), is the best sorber for both Cs and Sr ions and can be used for the treatment of radioactive waste water. The XRD pattern of this natural zeolite is given in Figure 1.

## References

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