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(XRF, XRD, TG, DTG)

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Rb, Sr

Investigation of Mineralogy and Geology of Zeolitic Tuffs in Ardakan Area

J. Ghanei,^{*} B. Taghipour^{**}, Se. Taghipour^{***}

^{*} Department of Geology, Payame Noor University, (Taft Beach)

** Ph.D Candidate of Petrology, Geology Department, Faculty of science, Isfahan University Geology
*** MS.C Student of petrology, Geology Department, Faculty of science, Isfahan University

Abstract

The studied area is located in Cenozoic Magmatic Belt of Central Iran. The main constituents rocks are Eocene volcanic including: andesite, trachite, dacite and related pyroclastics. Field studies, mineralogy and result of analytical data (DTG, TG, XRD and XRF) have shown that the clinoptilolite is the main zeolite component of acid altered tuffs. Quartz, muscovite, biotite are minor minerals in the zeolitic tuffs. A closed hydrologic system is probably has formed this sedimentary type zeolite deposit, because the chemical composition of fresh tuffs are similar to zeolitic tuffs. On the base of geochemical data absorption behavior of zeolites in zeolitic tuffs are responsible to anomaly of Ba and Sr in the rocks. Volcanic rocks are originated from calc-alkaline type magma.

Keywords: Magmatism, Central Iran, Ardakan, Zeolite, Clinoptilolite

(Mumpton, 1999)

Gottardia,)

(1985)

Si/Al

SiO₄ , AlO₄

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Cu ,Zn ,Ca ,Pb

(Jillet, 1995)

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%

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(Holmes, 1999)

(Holmes, 1999)

Point

°C ° C

ml/min

BH₂

TG , DTG

XRF, XRD

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XRF

990TA

(TG, ² DTG

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PW2400-PHILIPS

(XRD) X

1. Thermal Gravimetry :

2. Differential Thermal Gravimetry:

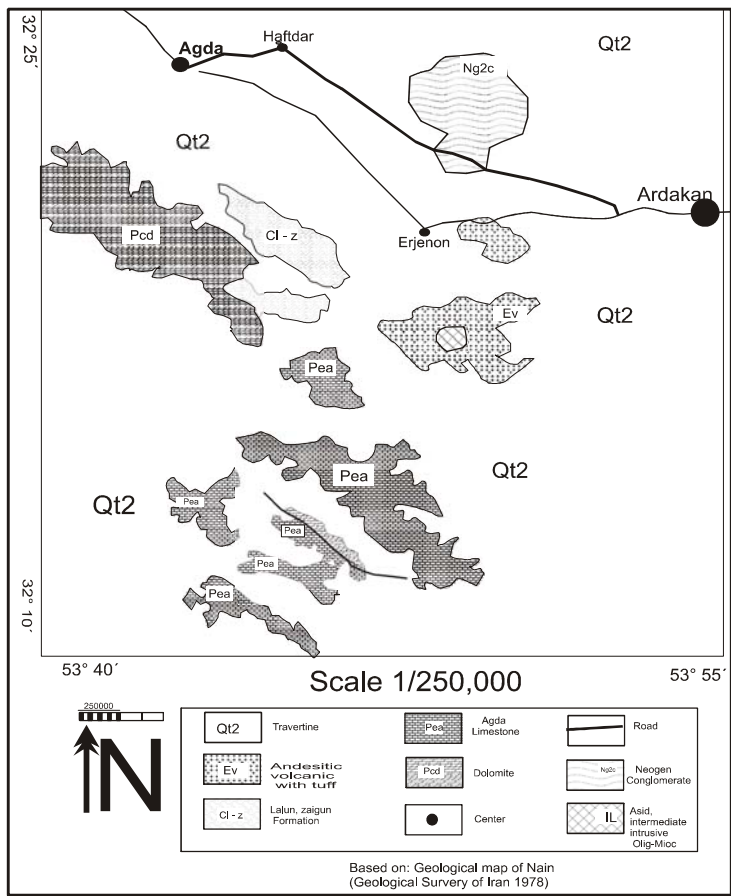
PW2400-PHILIPS

Wavelength- Dispersive)WDS
Cameca SX -50 EPMA (Spectrometer
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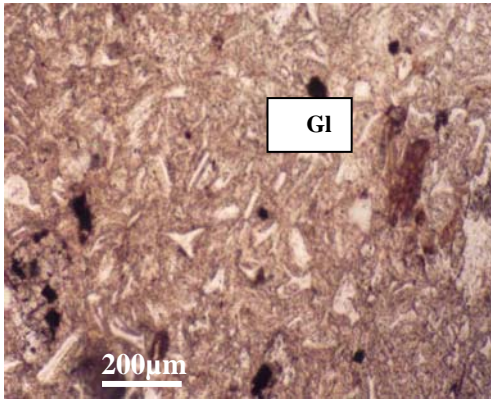


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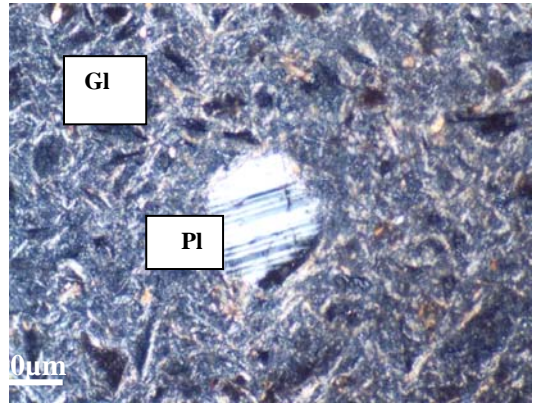
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(Zeolite tuff)



(Glass shard)



(Pl)

(Gl)

(Glass shard)

%

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XRD

		(Gottardi, 1985)	
d (Å)	%I / %I ₁	d (Å)	%I / %I ₁
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XRF

	1	2	3	4	5	6	7	8	9
SiO ₂ %	75.3	73.7	68.4	74.1	73.9	74.3	75.7	62.93	64.29
Al ₂ O ₃ %	14.5	15.5	15	15.5	16.1	15.6	14.8	12.98	13.1
TiO ₂ %	0.3	0.3	0.5	0.3	0.3	0.3	0.4	---	0.431
Na ₂ O%	1.2	0.6	0.7	1.1	1.1	0.6	1.2	3.43	1.92
K ₂ O%	1.5	1.4	2.5	1.5	1.5	1.4	1.6	1.44	2.17
MgO%	1.8	0.3	3.5	2.6	2.6	0.3	2.4	1.81	2.8
CaO%	1.8	2.2	4.5	2	1.7	2	1.2	1.68	1.7
P ₂ O ₅ %	0.04	0.07	0.09	0.01	0.01	0.09	0.01	0.05	0.02
MnO%	0.05	0.03	0.05	0.03	0.03	0.02	0.02		0.04
Fe ₂ O ₃ %	2	2.1	3.7	1.9	1.8	2.1	2.1	1.59	2.8
SO ₃	0.3	0.6	0.5	0.2	0.900	0.2	0.2		0.4
SrO	0.8	0.2	0.2	0.4	0.3	0.2	0.1		0.3
BaO	0.2	0.2	0.3	0.2	0.2	0.2	0.2		0.5
ZrO	0.430	0.37	0.35	0.42	0.25	0.38	0.39		0.37
Cl	0.36	---	0.6		0.22				0.09
LOI	1.29	3.87	0.82	0.54	0.8	3.06	-	12.36	10.1
Sum	99.89	99.97	99.76	99.58	99.84	99.77	99.43	98.27	99.37

XRF

SiO ₂ %	57.92	57.31	56.84	55.66
TiO ₂ %	0.46	0.46	0.13	0.17
Al ₂ O ₃ %	17.38	17.38	16.53	16.12
Fe ₂ O ₃ %	2.82	2.82	2.38	2.57
FeO%	3.81	3.81	3.22	3.47
MnO%	0.05	0.05	0.01	0.02
MgO%	5.76	5.76	4.86	4.41
CaO%	4.99	4.99	6.31	6.91
Na ₂ O%	1.86	1.86	3.07	5.19

K ₂ O%	2.62	2.62	2.81	0.48
P ₂ O ₅ %	0.15	0.15	0.09	0.10
LOI	1.45	1.44	1.23	1.73
Sum	96.35	96.40	96.25	95.1
Sr (ppm)	577	577	690	510
Zr(ppm)	138	138	121	95
Nb(ppm)	4	4	8	6
Ba(ppm)	783	783	732	391
Nd(ppm)	12	12	11	19
Sm(ppm)	19	19	12	11
Tb(ppm)	4.9	4.9	2.9	2.6
Yb(ppm)	0.75	0.75	0.34	0.18
Ta(ppm)	0.91	0.91	0.56	0.26
Eu(ppm)	0.95	0.95	1.6	1.00

Mumpton,)

.(1997

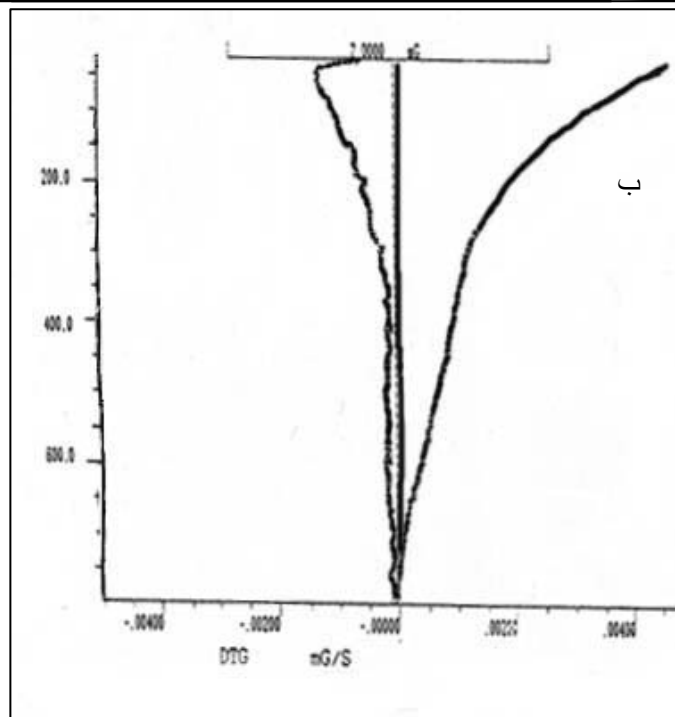
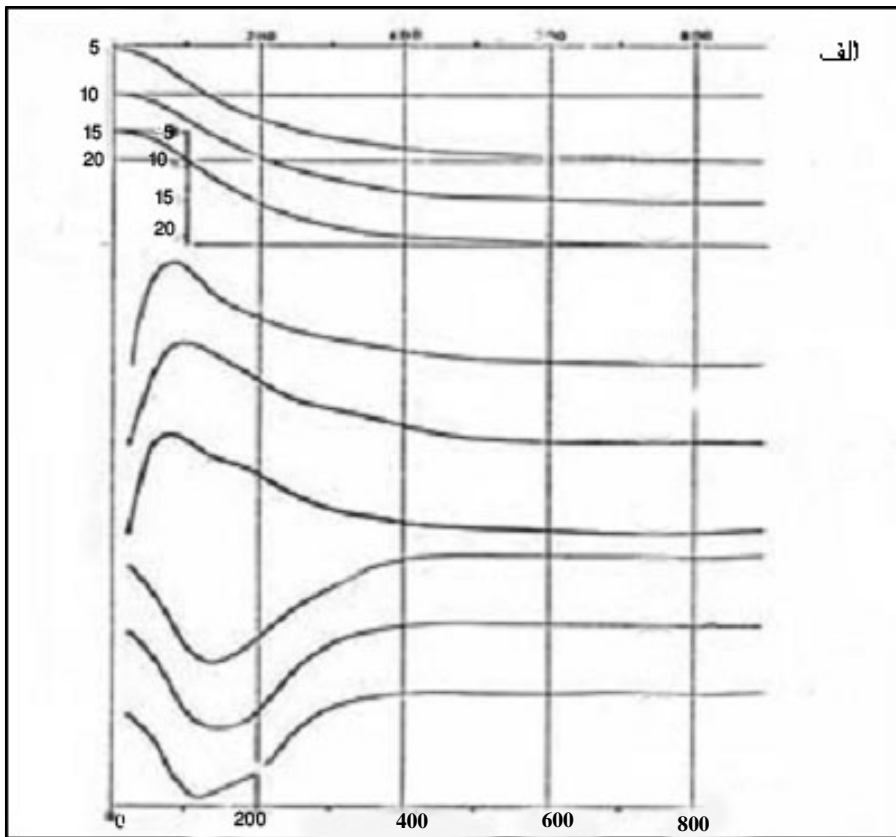
.(Bekkum, 2001)

DTG ,TG

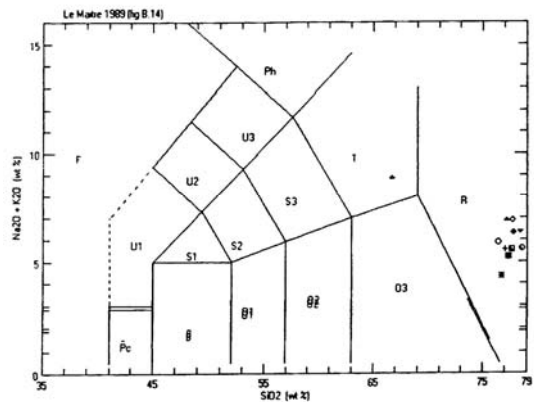
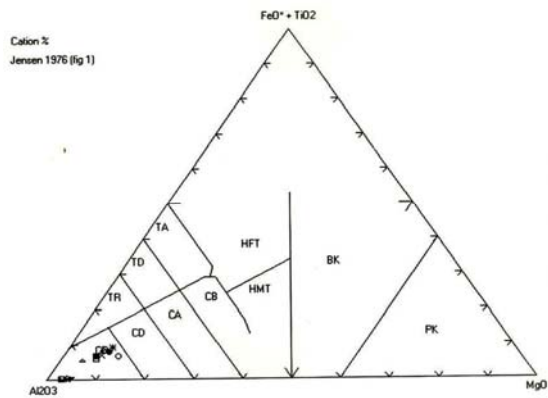
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(Gottardi, 1985)



TG, DTG ((Gottardi,1985))



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Na₂O +

(Le Maitre, 1989)K₂O / SiO₂

(Heulandite)

(XRD)

(Clinoptilolite)

(XRD)

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(d)

() (Jenson,1976)

,Al ,Ti⁺⁴ ,Fe⁺² ,Fe⁺³ Mg

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(Close system)

XRF

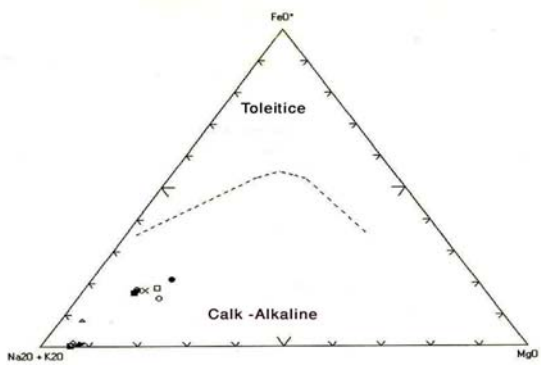
XRF

Winchester &) Zr / TiO₂

(Fresh)

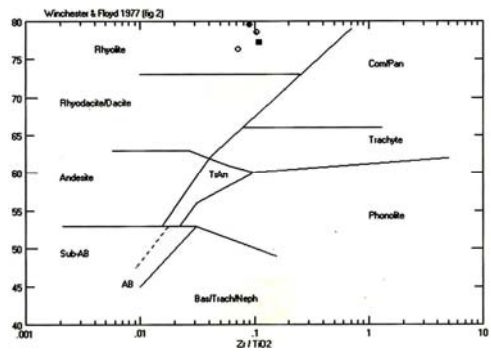
(Floyd, 1977

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) $\text{Na}_2\text{O} + \text{K}_2\text{O}, \text{MgO}, \text{FeO}^*$

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Zr/TiO_2

SiO_2

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Lable	F	Na2O	MgO	Al2O3	SiO2	P2O5	SO3	Cl	K2O	CaO	TiO2	MnO	FeO	BaO	Total
G1	0	3.63	0.3	13.6	71.83	0	0	0	2.58	1.52	0	0.01	0.01	0	93.2
G2	0.02	3.72	0	14	71.04	0	0	0.02	2.4	1.5	0	0	0.01	0	93.1
G3	0.14	3.73	0.3	13.9	71.13	0	0	0.01	2.62	1.45	0.01	0	0.03	0	93.1
G4	0.08	4.31	0.4	12.9	70.53	0	0	0	1.94	0.57	0.01	0	0.9	0	90.8
G5	0.11	4.05	0.6	13	71.51	0	0.02	0.01	1.64	0.71	0	0	0.03	0	91.6
G6	0	4.69	0.5	13	71.3	0	0.01	0.01	1.95	0.58	0	0	0.06	0	92
G7	0	4.31	0.5	12.6	70.75	0	0.04	0	1.85	0.53	0	0	0.06	0	90.9
G8	0.09	4.04	0.5	13	70.44	0	0	0.02	1.66	1.13	0	0	0.03	0	90.9
G9	0.11	4.02	0.5	13	70.66	0	0.03	0.02	1.6	1.25	0.02	0	0.03	0	91.2
G10	0	4.07	0.5	12.6	70.59	0	0	0.01	1.66	1.25	0.02	0.01	0.07	0	90.8

Ti ,Nb

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Irvin & Baragar,) $\text{FeO}^*, \text{Na}_2\text{O} + \text{K}_2\text{O}, \text{MgO}$

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(1971

Ba ,Sr

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Sr ,Ba

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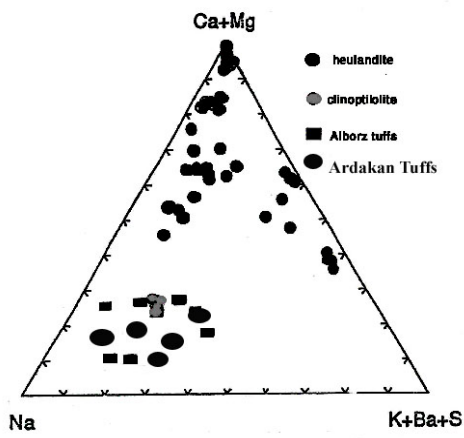
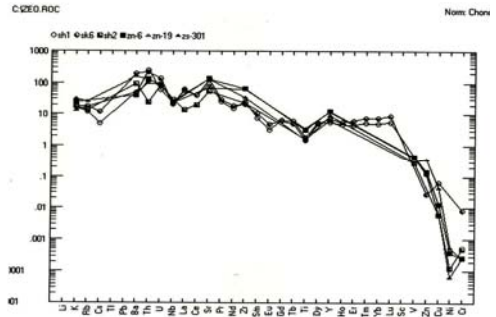
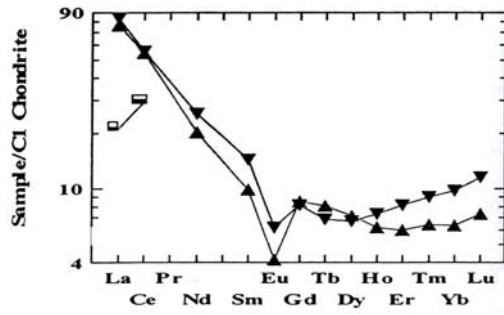
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Th ,Ba , Rb ,K

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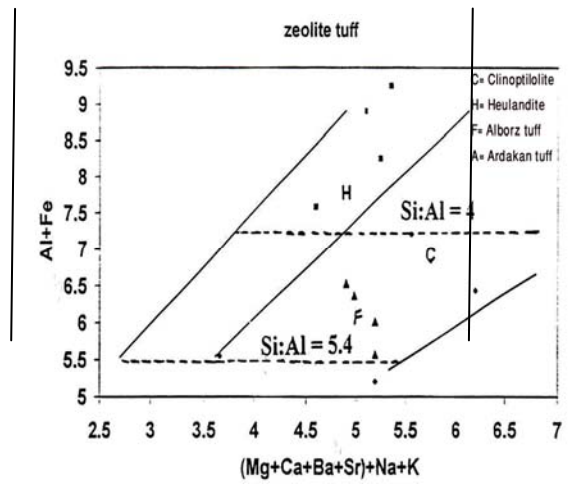
(HREE)

(LREE)



Ca+Mg, Na, K+Ba+Sr

(Benito, 1998)



(Mg+Ca+Ba+Sr)

Al+Fe

(Boles, 1972)

Eu

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Eu

(Henderson, 1982)

XRD , SEM

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(Glass shard)

XRF

(Mason & Sand, 1960)

Si/Al > 4

(Boles, 1972)

Mason &)

XRD

Al+Fe

(Sand, 1960

(Boles, 1972) Mg+Ca+Ba+Sr

Si/Al

Si/Al

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(,)

(Benito, 1998) K+Ba+Sr, Na, Ca+Mg

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Na, K

- (1985).
- 9- D.A, Hollmes, Zeolites, " Industrial minerals and rocks", N.93, 1- 39p. (1999).
 - 10- A, Iijima, Geology of natural zeolites rocks, In, Rees. L.V(edit.) proceeding of fifth international conference on zeolite, Hyden, 103-118p. (1980).
 - 11- T.N. , Irvine, W.R.A., Barragar, "A guide to the classification of the common volcanic rocks, can, Jour. S.C.I., No, p523 – 448. (1971).
 - 12- D., Jillett, N.D. Coombs, Clinoptilolite in the Ashley mudstone, Waihao River section, south Conterbury, New Zealand, vol. 38, 253-256p. (1995).
 - 13- R.W., Lemater, A classification of igneous rocks and glossary of term: Black Well Scientific publications, 195p. (1998).
 - 14- B., Masson, L.B., Sand, Clinoptilolite from Patagonia, the relationship between Clinoptilolite and Heulandite, Am, mineral, 45, 341-350p. (1960).
 - 15- F.A., Mumpton, W .C .Ormsby. Clay mineral, "morphology of Zeolites in sedimentary rocks by scanning electron micros coping, Vol, 24, 1-3p. (1976).
 - 16- I. A., Mumpton. "USCS of natural zeolites in agriculture and industry, vol,96 3463 – 3470p. (1999).
 - 3- H. V., Bekkum, E. M., Flanigen, P. A., Jacobs, J.C., Janson, Introduction to zeolite science and practice, Elsevier, New York, 1062p. (2001).
 - 4- R., Bentio, J. Carcia, Mineralogy, geochemistry and uses of mordenite – bentonite ash-tuff beds of loos Eseullos, Almerio, Spaen, Journal of. Geochemical Exploration, 229-240p. (1998).
 - 5- 2.D, Bish, J . M, Boak, " Clinoptilolite – heulandite nomenclature, Reviews in mineralogy and geochemistry, V. 45, mineralogy society of Am, 255 260p. (1997, 2001).
 - 6- J.R., Boles, Composition, optical properties, cell dimension and thermal stability of some Heulandite group zeolites, Am. Mineral, 57, 1463-1493p. (1992)
 - 7- a, G., Gottardi, i. E, Gall " Natural Zeolite", 711 p. (1985).
 - 8- R l., Hay, Geology of zeolites industrial rocks, mineralogy and geology of zeolites, Reviews in mineralogy, V. 4, min, society of Am, 53- 93p.

