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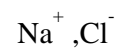
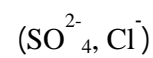
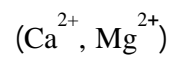
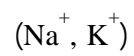
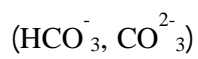
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* گروه زمین شناسی دانشگاه آزاد اسلامی واحد ارومیه

** گروه زمین شناسی دانشگاه تبریز



Hydrogeochemical Evaluation of Groundwater and Its Suitability for Various Uses in the Salmas Aquifer, Northwest of Iran

N. Aghazadeh*, A.A. Mogaddam** and A. Kemiayi**

* Geology Department, Islamic Azad University of Urmia

** Geology Department, Tabriz University

Abstract

Analytical results of 29 groundwater samples are used to evaluate the quality of groundwater in the Salmas area, Northwest of Iran. Based on the analytical results, groundwater quality in the Salmas area is generally fresh and varies from hard to very hard. The dominant hydrochemical facies of groundwater in study area is Mg, Ca -HCO₃. Alkali earths(Ca²⁺, Mg²⁺) and weak acids(CO₃²⁻, HCO₃⁻) are slightly dominating over alkalis(Na⁺, K⁺) and strong acids(SO₄²⁻, Cl⁻). Consideration of rocks composition in the north part of the study area shows that evaporation formation(limestone, marl, shale and intercalated with gypsum and salt) caused increased Na⁺, Cl⁻ concentrations and salinity of the groundwater. The results of calculation saturation index show that the saturation index for carbonate minerals is positive and for sulfate minerals, CO₂ and H₂ gases is negative. According to the parameters and international standards, except groundwater of north part of the study area almost all of groundwater in the study area is suitable for drinking and agricultural purposes.

Keywords: Groundwater, Hydrogeochemistry, Salmas, Saturation index, Water type.

Subramani et al., 2005; Coetsiers et al.,
(2006)

Foster and et al., 2000;)

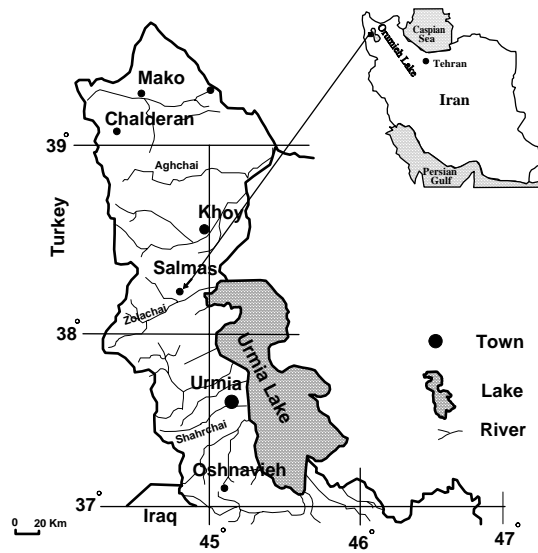
Guler, 2004;)

Olajire and Imeokparia, 2001; Menda et
(al., 2007

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EC pH

Surfer

(APHA, 1995)

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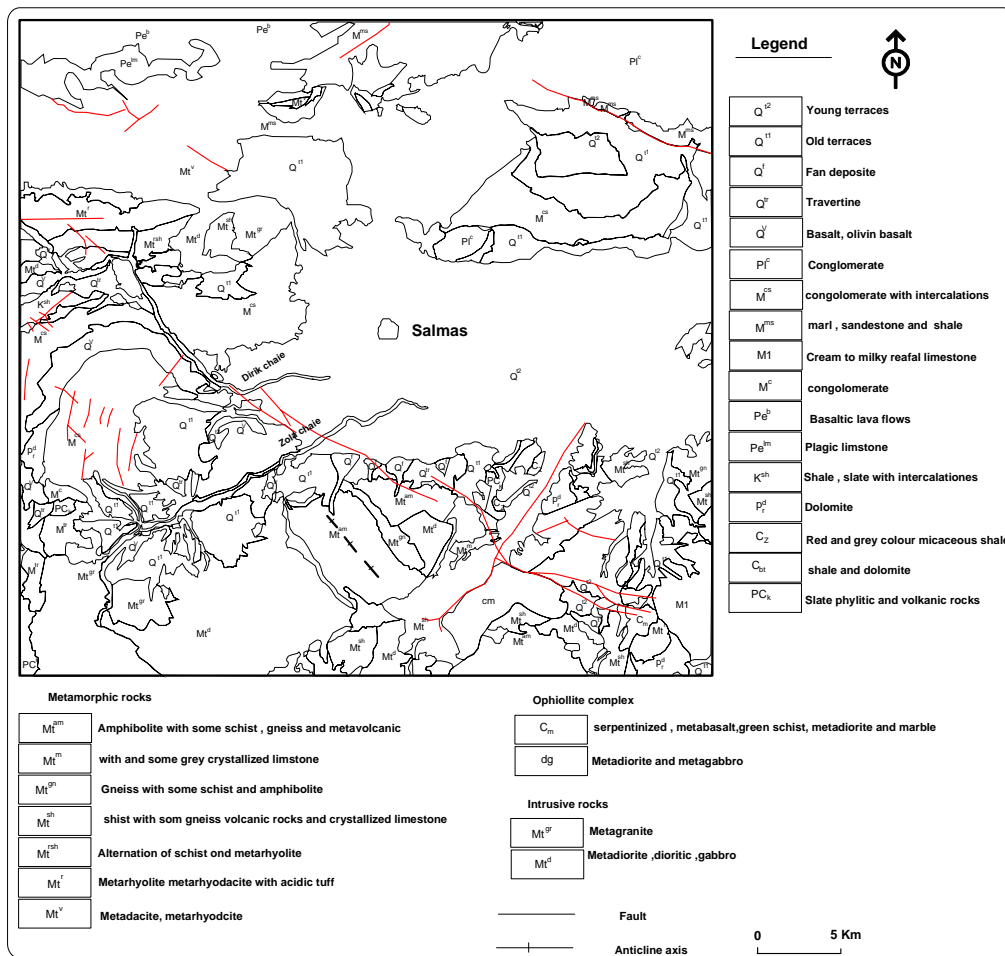
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PHREEQC

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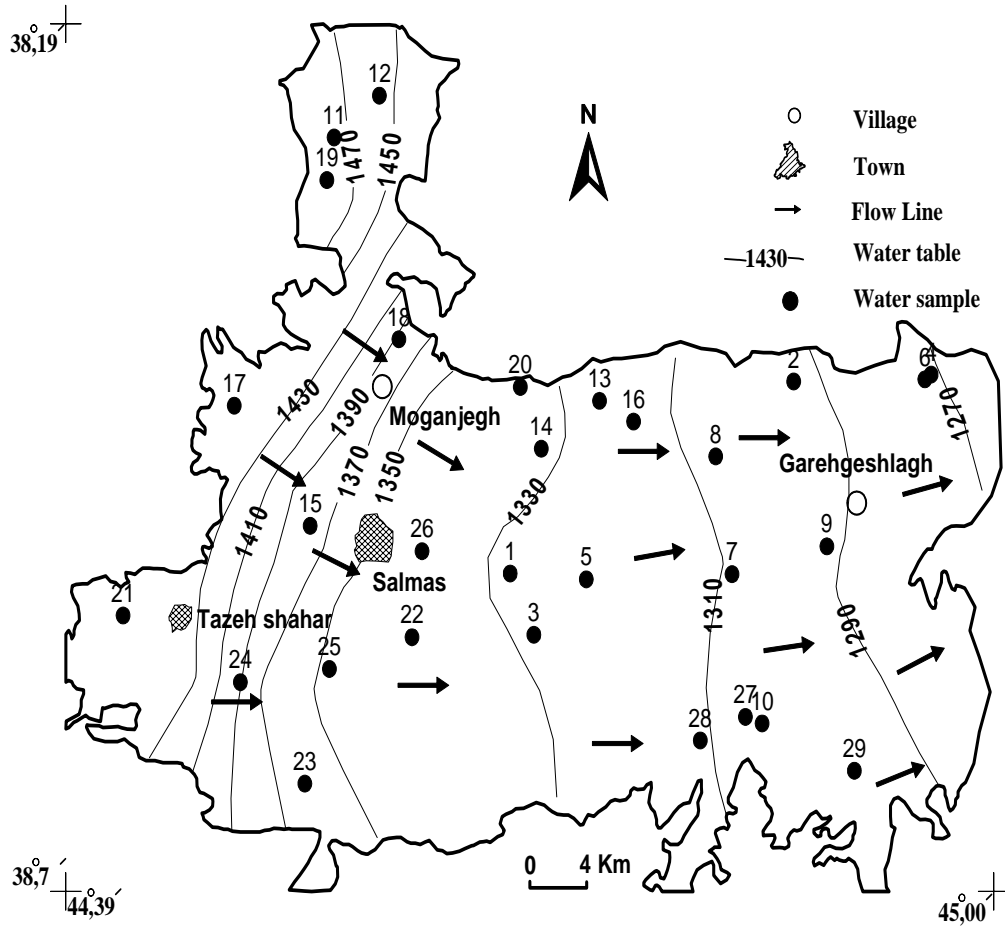
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%		-	
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(Na⁺)

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TDS EC (Cl⁻)
()

(EC)

()

:

Mg²⁺ > Ca²⁺ > Na⁺ HCO₃⁻ > SO₄²⁻ > Cl⁻
> K⁺

Na⁺, Cl⁻

Ca²⁺, Mg²⁺
HCO₃⁻

()

) (HCO₃⁻)

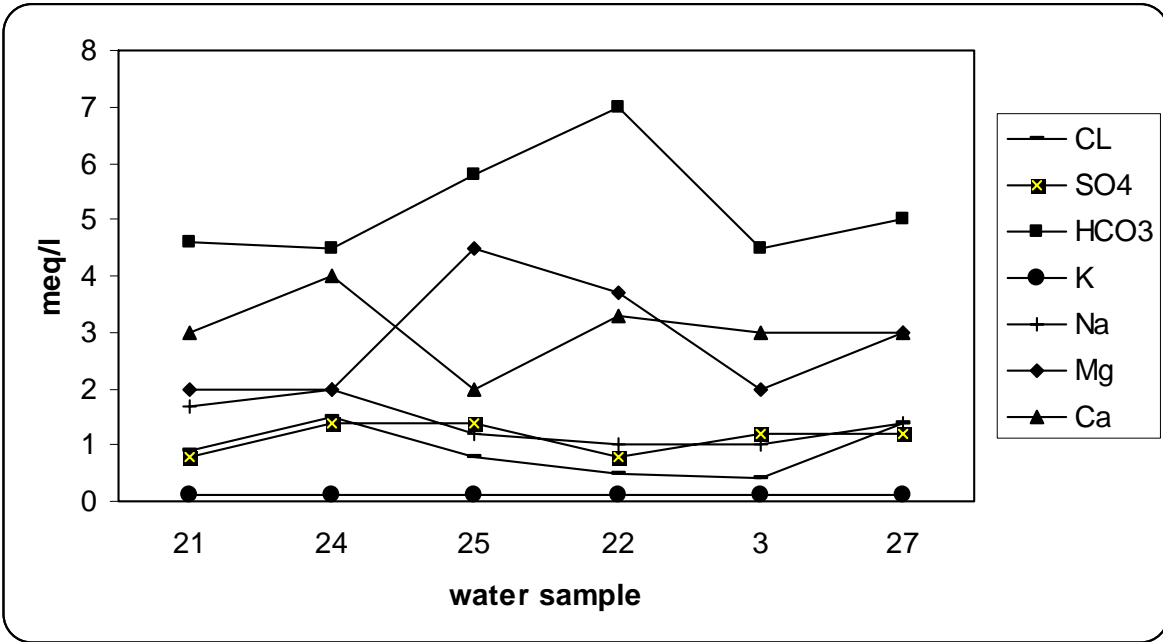
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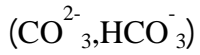
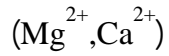
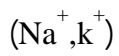
:

/	/	/	/		PH
				Micro mohs/cm	EC
/			/	mg/l	TDS
/	/			mg/l	Na ⁺
/	/	/		mg/l	K ⁺
/				mg/l	Ca ²⁺
/	/		/	mg/l	Mg ²⁺
/			/	mg/l	Cl ⁻
/	/			mg/l	HCO ₃ ⁻
				mg/l	CO ₃ ²⁻
/			/	mg/l	SO ₄ ²⁻
/				mg/l	TH
/	/	/	/		SAR
/	/	/	/	%	%Na
/	/		/	meq/l	RSC
/	/	/	/	%	PI
/	/	/	/	meq/l	CAI1
/	/	/	/	meq/l	CAI2
/	/	/	/	-	SI _{calcite}
/		/	/	-	SI _{dolomite}
/	/	,	/	-	SI _{aragonite}
/	/	/	/	-	SI _{gypsum}
/	/	/	/	-	SI _{anhydrate}
EC: Electrical conductivity TDS: Total dissolved solids TH: Total hardness SAR: Sodium adsorption ratio				RSC: Residual sodium carbonate PI: Permeability index CAI: Chloro alkaline index SI: Saturation index	

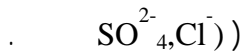
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(Piper, 1944)



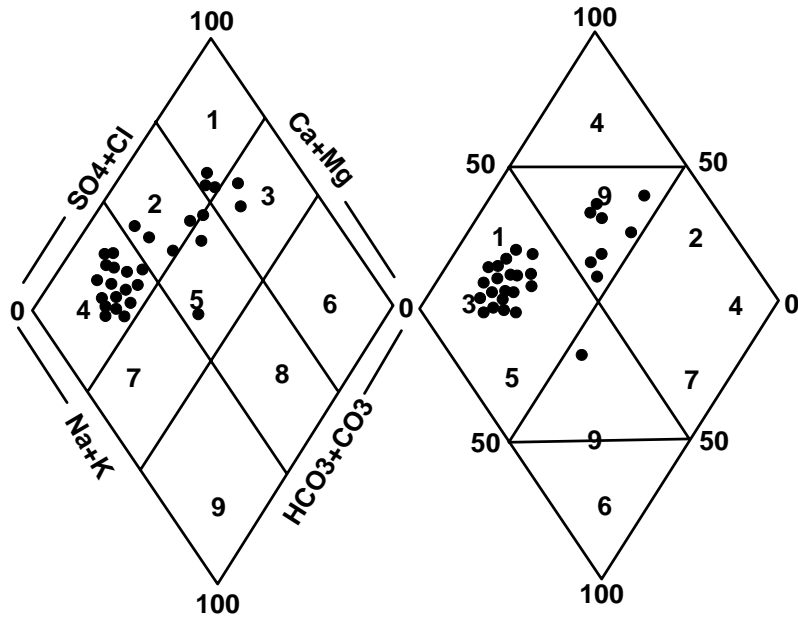
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Na-Cl

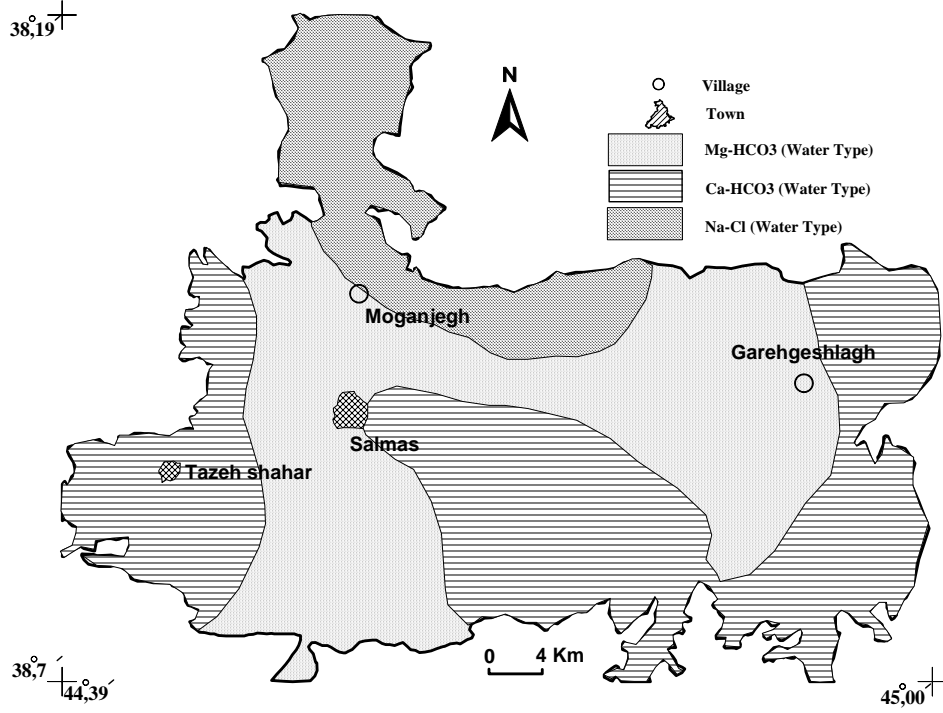
Ca-HCO₃, Mg-HCO₃, :

() Na-Cl

Mg, Ca-HCO₃



38,19



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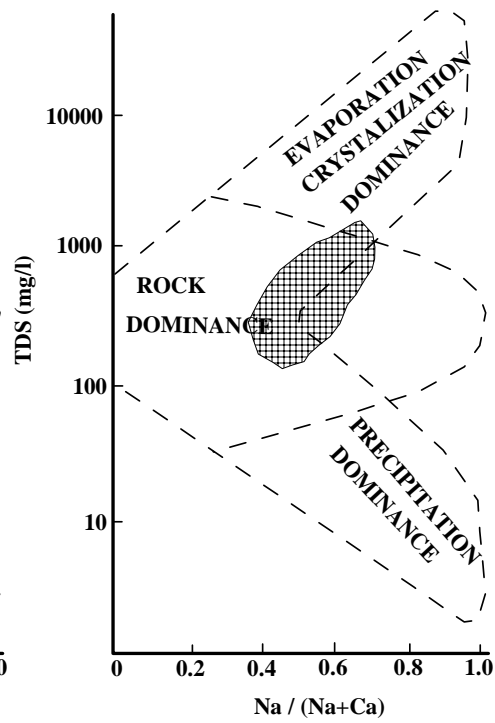
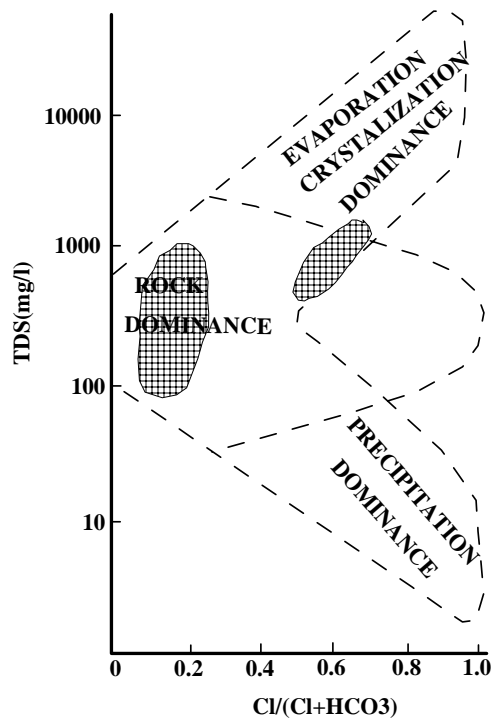
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(Rock Dominant)

Subbarao,

()

(2001)



(Saturation index)

PHREEQC

(Parkhurst and Appelo, 1999)

()

$$SI_{\text{calcite}} = \frac{[Ca^{2+}][CO_3^{2-}]}{K_{sp}} + SI_{\text{aragonite}}$$

Langmuir, 1997; Jalali, 2006; Castillo)

(and et al., 2007

(SI >)

(Sastri., 1994)

(CAI 1,2)

(SI <)

(1977)

()

$$CAI_1 = \frac{Cl - (Na + K)}{Cl}$$

()

$$CAI_2 = \frac{Cl - HCO_3 - NO_3 - CO_3}{(Na + K) + (SO_4 + Ca^{2+} + Mg^{2+})}$$

SI_{gyp} SI_{dol} SI_{cal}

$$CAI = \frac{Cl - HCO_3 - NO_3 - CO_3}{(Na + K) + (SO_4 + Ca^{2+} + Mg^{2+})}$$

/ / Mg-HCO₃

K⁺, Na⁺

/ / Ca-HCO₃

/

Ca²⁺, Mg²⁺

/ / / Na-Cl

/

CAI

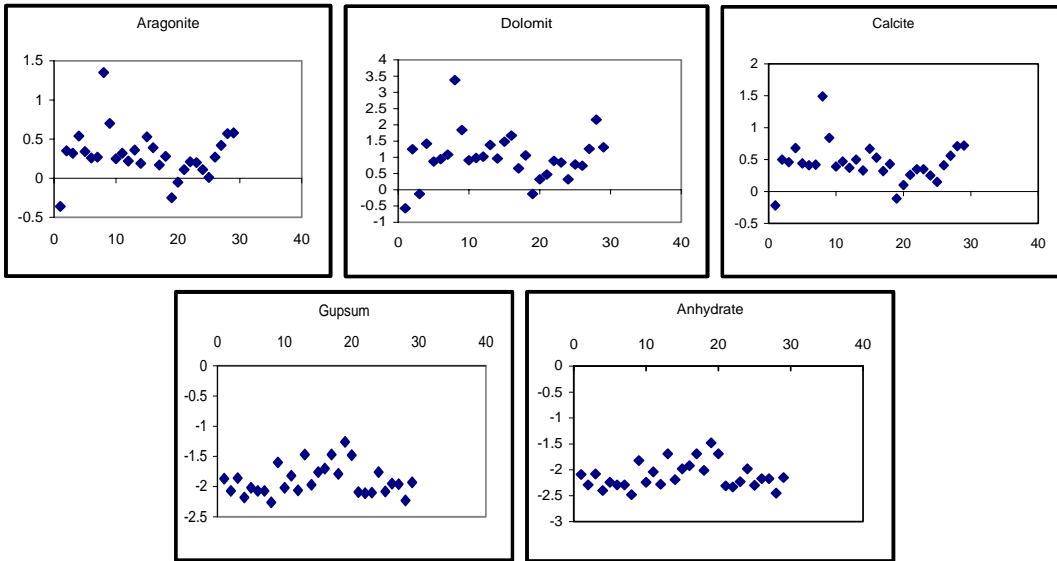
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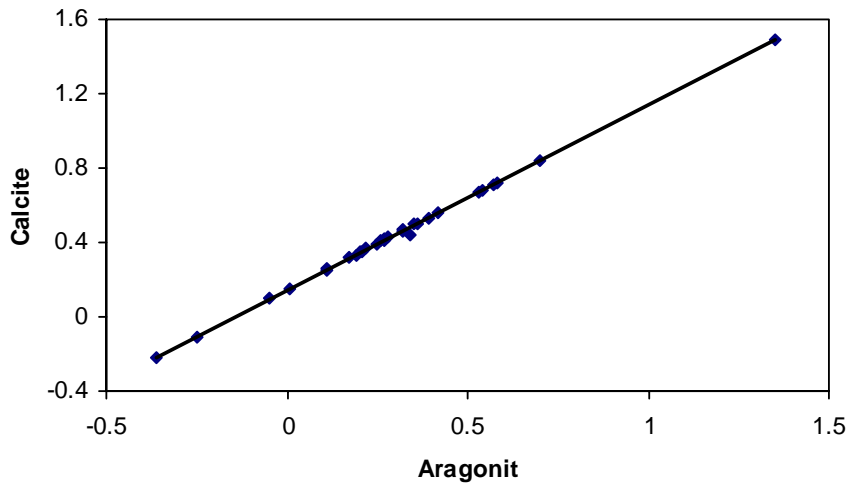
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WHO(1983, 1984, 1989)
APHA(1989,1995)

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TDS

TDS ()

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(Scholler,1967)

()

(TH)

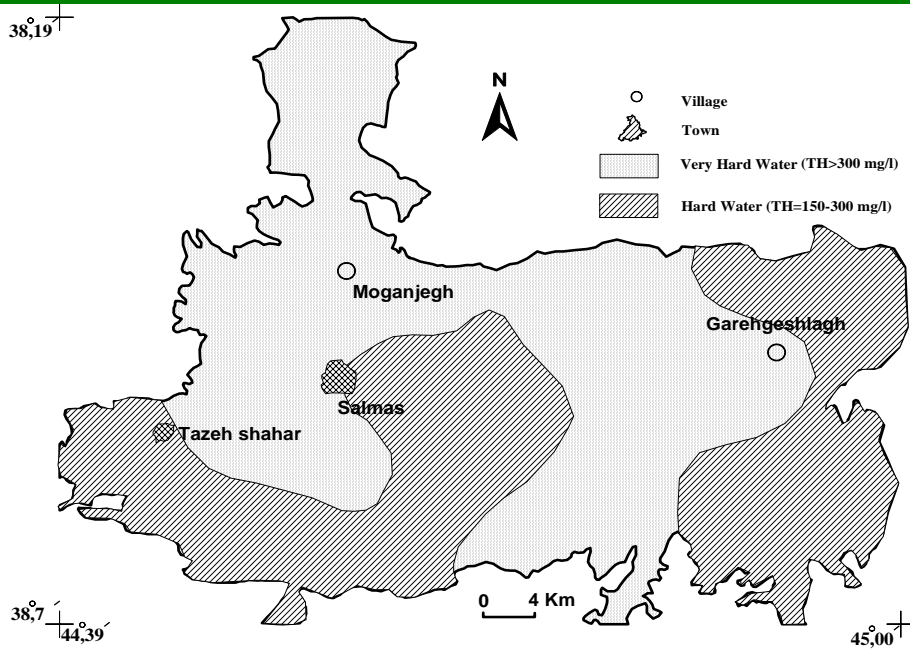
(TDS)

:

/ /	/	/	PH(mg/l)
			TDS(mg/l)
			TH(mg/l)
			Na ⁺ (mg/l)
			Ca ²⁺ (mg/l)
/			Mg ²⁺ (mg/l)
/			Cl (mg/l)
/			SO ₄ (mg/l)

(Subramani and et al., 2005)(TH)

	TH(as CaCO ₃),mg/l	
	<	
%		
%	>	



(TH)

()

()

()

()

()

EC

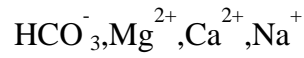
()

$$RSC = (HCO_3 + CO_3) - (Ca + Mg)$$

Sodium adsorption)
(%Na) (ratio

/

SAR
Karanth(1987)



$$SAR = Na / [2(Ca + Mg)]^{1/2}$$

meq/l

Permeability)

(index

(Wilcox,1955)

Subramani et al.,)

EC,SAR

:(2005

()

$$PI = 100[Na + (HCO_3)^{1/2}] / (Ca + Mg + Na)$$

C₃S₁

C₂S₁

%)

PI

(PI=

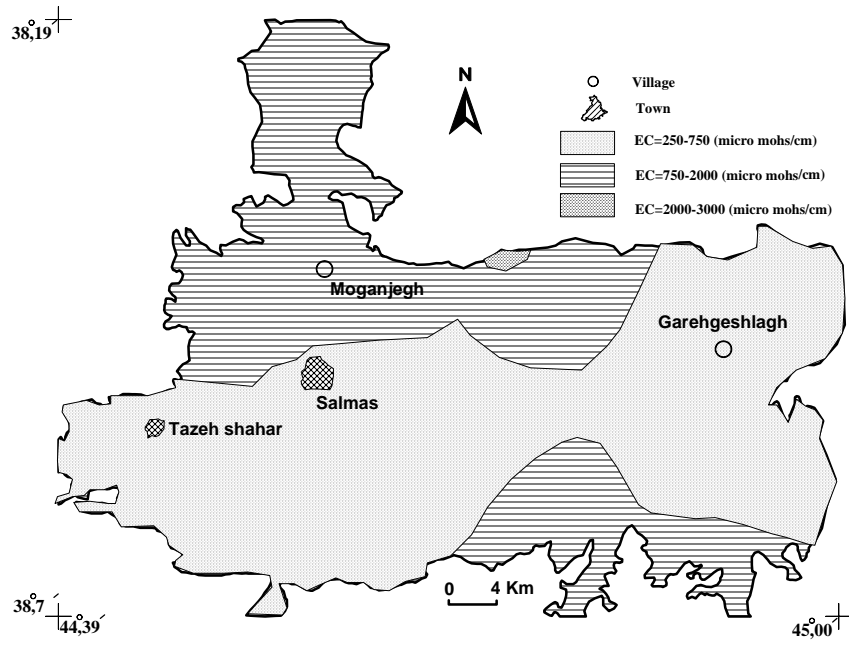
(Residual sodium carbonate)

.(Srinivasa,2005)

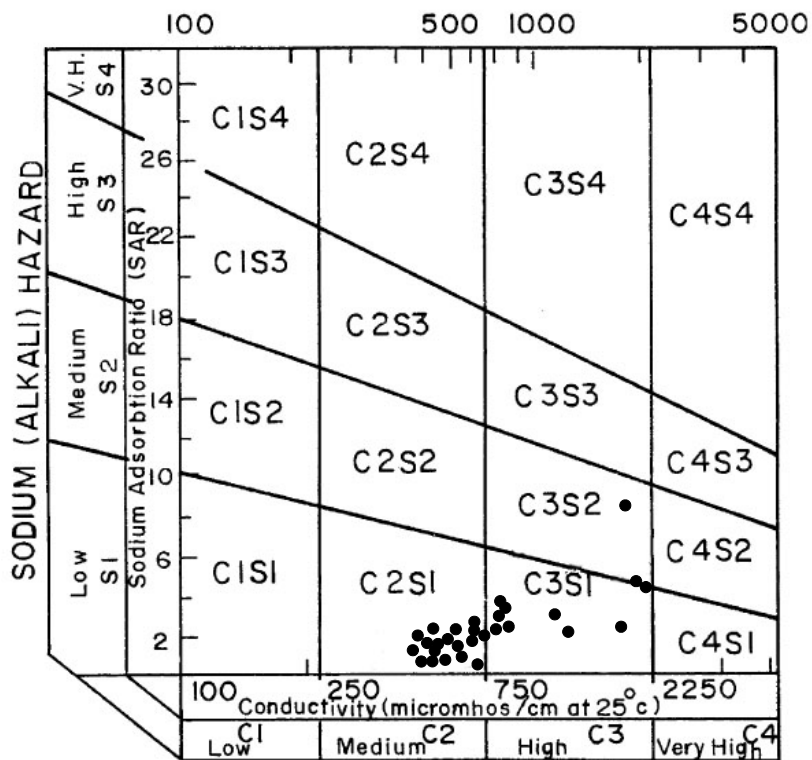
meq/l

(EC(Park et al.,2005

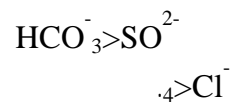
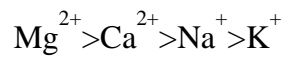
	EC()		
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(EC)



Wilcox



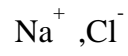
$$I_s = \text{pH}_m \quad (I_s)$$

$$\text{pH} \quad \text{pH}_m \quad - \text{pH}_s$$

$$\text{pH} \quad \text{pH}_s$$

$$I_s >$$

$$I_s <$$



$$I_s =$$

$$I_s$$

$$I_s >$$

$$I_s <$$

Mg, Ca -HCO₃

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(I_s)

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