# EFFECT OF GEOLOGICAL FORMATIONS ON QUALITY OF QUATERNARY AQUIFERS

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**Abstract** - Providing fresh water for irrigation, industry and drinking is one of the most important limitations for progress especially in arid and semiarid regions. In these areas, the main source of water belongs to underground water, and the quality of water depends on the geological formation and salinity of upper players of the aquifer. So, the chemical properties of sediments and geological formations of the studied areas are very important.

The effect of various geological formations from Pre- Cambrian to the recent Era in Iran has been considered to see their effects on water quality. The kinds and concentration rates of different materials in water depend on rocks and composited materials, which are in contact with water.

According to the geological map of Iran, there are 212 geological formations in Iran with different properties such as: lithology, erodibility, and rate of chemical weathering, salinity and so on.

The study was done in 4 different provinces named as: Fars, Hamadan, Semnan and Zanjan. There was a flood spreading research station in each province. Soil and water samples were collected from soil surface, groundwater and corresponding rivers and analyzed for EC, PH, cations, anions and calculation of SAR. The results showed that geological formation is one of the most important and effective agents on the quality of water. Also sedimentary formation with respect to igneous and metamorphic ones plays a large role in quality of water. However, Miocene, marl formations affected the groundwater quality and increased it's concentration and EC.

**Key words**: water quality, Quaternary, Geological Formations.

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## Introduction

Geological formations consisted from one or more lithology that the properties of watershed directly related to them. Considering to the sediment, cementing materials, different minerals and lithostratigraphy units have especial manners and properties to erosion and weathering. According to the kind of petrology of each formation, water may effects on geological formation and dissolves different cations and anions, which finally changes the quality of water [2 and 8].

Evaporated deposits such as gypsum, anhydrite, marl and salts are sensitive to erosion and weathering.

So toxic ions such as $C\bar{l}$, $S\bar{\bar{o}}4$ and $Na^{+}$ can separate from them easily and decrease the quality of water.

The lithology of most carbonate formations consists of lime, dolomite and sandstone, which are not sensitive to erosion, and they have high infiltration rate of water, which can be fine for water storage. The quality of such harvested water will be high [6 and 7].

Quaternary sediments, which are the most important reservoir of underground water resources, have been formed from physical and mechanical weathering of upland formations. Properties of sedimentology of quaternary can determine the hydrology and hydrogeology of water of the reservoir. Quaternary sediments are very important in Iran because they covered more than 50% of the area of country [5 and 9].

## Method

The base of this study was the original geology information's of the upper plains including the properties of structure, petrology, infiltration and geomorphology of outcrop geology in studied regions, which were selected in 4 different provinces such as Fars Hamadan, Semnan and Zanjan. Required information's were selected from the geological maps (with 1:100000 scale) of the studied plains.

Quantitative information's related to the distribution of different lithostratigraphic units were studied in subplains and main plains. The amount of erosion and sediment were determined from the geological point, in plains and subplains of the studied areas. We selected a flood spreading research station in each province at the lower plain of studied area which was created from the Quaternary system.

The study was conducted by getting samples of different sources of waters such as surface and underground waters across the plain of studied areas. Collected water and soil samples were analyzed for electrical conductivity (EC), reaction (PH), ions (cations and anions), gypsum, lime and calculated of sodium adsorption ratio (SAR) was done.

**Results**

The result of different research stations were summarized as follows:

**1- Fars province**

The area is located at Zagros mountain ranges northwest to southeast. Salty domes are erected on land surface and exposed deposited materials from Miocene to Pliocene ages.

Shut river which flows southward of area (Gerbaygan Plain) is moving across the salty domes and other formation such as evaporated Hormos, Gachsaran and Razak marls formations and evaporation gypsyferous and salty layers which belong to Aga-Jary formation. These formations affect on physicochemical properties of soil and water resources.

The plain is located on the alluvial fan of Bishehzard. This alluvial fan is resulted from last rainy periods. Bioclimatic parameters affected on last geology of area and resulted in erodable gypsum and salt deposited of the area of the Gerbaygan catchments.

The quality of groundwater depends on the chemical properties of alluvial fan and land formation surrounding the area of Gerbaygan plain. According to the data, the average electrical conductivity (EC) of Bishehzard is about 2.1 dS/m, which is in a moderate situation. Getting close to the southwest of the plain across the Stream of Shur River, the salinity of the soil increases of about 10 dS/m, which is very high and restricted to use it for irrigation. The main source for increasing the salinity of water of Shur River is the existence of salty domes and other salty deposited materials, which are located in the way of rivers. Minimum and maximum amounts of electrical conductivity (EC) and chloride ion ($c\bar{l}$) of different areas are presented in Table 1.

Table 1- Minimum and maximum amount of EC and $c\bar{l}$ of different locations

| Location | Minimum | | Maximum | |
|---|---|---|---|---|
| | $EC_e$(dS/m) | $c\bar{l}$ (mg/1) | $EC_e$(dS/m) | $c\bar{l}$ (mg/l) |
| Rouniz | 0.6 | 31 | 6.8 | 824 |
| Miangangal | 0.3 | 14.2 | 6.5 | 710 |
| Fasa | 0.4 | 21 | 4.1 | 480 |
| Gharbolugh | 0.3 | 14 | 1.1 | 96 |
| Shibcoh | 1.1 | 96 | 9.4 | 2094 |

**2- Hamadan Province**

The research station is located at northwest of Kabudar Ahang city between 48°, 15' to 49°, 35' east longitude and 35°, 33', 30" to 35°, 1', 30" north latitude. From the geological point, the area belongs to Razan zone. The oldest rocks exposed in this zone are the slightly metamorphosed slates and schists of Late Triassic-Jurassic age, which are locally comprised of crystallized limestone intercalation in the lower part. These rocks are locally and disconforably upper Jurassic conglomerate and limestone.

Samples to water were carried out from 9 exploitation wells, meanwhile at 10 points, soil samples were collected and analyzed. The results are shown in Table 2.

Table 2- Changes in chemical properties of underground water

| Parameter / Treatment | PH | EC (dS/m) | m.eq/lit | | | SAR | Infiltration (cm/h) |
|---|---|---|---|---|---|---|---|
| | | | Ca+Mg | Na | K | | |
| Control | 7.30 | 1.60 | 3.95 | 10.10 | 1.70 | 5.11 | 2.25 |
| Plots (Mean) | 7.54 | 2.64 | 5.82 | 22.62 | 1.96 | 7.49 | 1.95 |

**3- Semnan Province**

The studied area consisted of gravelly alluvial fans with mild slope and medium to high stream channel and gally erosion. Its parent material consisted of young alluvial fan with deep gravelly soil. Its vegetation was poor to medium.

Runoff coming from the upland geological formations was distributed on the soil surface of the studied area to control the flood hazards and increasing the underground water resources by artificial recharge. The spreaded water changed the chemical properties of the soil profile. The results are shown in Table 3.

Table 3- Changes in chemical properties of the soil profile

| Parameter / Treatment | PH | EC (dS/m) | m.eq/lit | | SAR | Sediment (cm) | Infiltration (cm/h) |
|---|---|---|---|---|---|---|---|
| | | | Na | Ca+Mg | | | |
| Control | 7.90 | 0.90 | 6.00 | 5.60 | 1.00 | 0 | 2.40 |
| Plots (mean) | 7.70 | 1.40 | 2.70 | 11.70 | 0.50 | 9.3 | 0.25 |

**4- Zanjan Province**

The studied area is located at the northwest of Iran, between 36°, 20' to 36°, 55' north latitude and 48º, 10' to 48°, 55' east longitude. From the geological point. It is located on the sediment quaternary and surrounded by Soltanieh and Tarom mountains. These erected mountains belong to Precambrian, Paleozoic and Mesozoic periods which, were shown as Horst in the Cenozoic period. Some of these geological formations, which are located on the base, consisted of about 5000 meter of sediments belong to the upper Precambrian, Paleozoic and Mesozoic periods with about another 5000 meter of sediments and volcanic rocks of Cenozoic period. The quality of underground water was changed by geological formations. The result is shown in Table 4.

Table 4- Changes of chemical properties of underground water

| Parameter / Treatment | PH | EC (dS/m) | m.eq/lit | | | | | | SAR |
|---|---|---|---|---|---|---|---|---|---|
| | | | $Na^+$ | $Ca^{++}+M^{+}g^{+}$ | $K^+$ | $c\bar{l}$ | $S\bar{\bar{o}}4$ | $H\bar{co}3$ | |
| Control | 7.73 | 0.43 | 0.55 | 3.41 | 0.03 | 0.26 | 0.86 | 2.66 | 0.41 |
| Plots (mean) | 7.76 | 1.30 | 2.20 | 11.63 | 0.05 | 0.50 | 9.41 | 2.69 | 0.91 |

**Discussion and conclusion**

Regarding this study, there are various factors that effect on the quality of water resources (surface and under groundwater). Geological formations and composition of rocks are the most important factors, which may effect on water quality of quaternary aquifers [1 and 3].

Water has been passed through the evaporated formations have a high-suspended load and salinity level. The results of chemical analyses of water samples, which were collected from different rivers at the southern part of Fars province, are shown in Table 1. The results indicated that from Shibkuh to the end of the area the electrical conductivity (EC) and the amount of chloride ion ($c\bar{l}$) increased with highest amount at kuhgar region. Saline and marl gypsyferous regions such as Hormos salty formation, located at the south of Iran have been the main factor for this limitation on the water quality.

Similar results are present in Table 2 for the soil samples collected from the studied area in Hamadan. The area was treated with floodwater coming from upper plains with evaporated and marl geological formations. The amount of sodium adsorption ratio (SAR) was increased and affected on the amount of infiltration rate of the soil.

The result of soil samples which were collected from the Ghosheh plain (in semnan province) is presented in Table 3. The studied area was treated with floodwater coming from the upper plains with the geological structure and lithology of desirable geological formations such as carbonate rocks, which belong to the Cretaceous period. Comparing the amount of different ions such as $Na^{+}$ and $Ca^{++}+Mg^{++}$ in control and treated plots we can consider to the increment of the amount of $Ca^{++}+Mg^{++}$ and the decrease of $Na^{+}$ in treated plots because of the desirable formations which are established at upper plain.

The results of underground water (qanat) samples are shown in Table 4. There are some differences between the quality of underground water of control and treated zones. These data show that after the treatment, the type of out flow water has been changed from Ca (HCO3) 2 to CaSO4 because there is a Ca So4 layer beneath the Soil surface and it can change the quality of underground water.

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