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# Evaluating the Hydrochemistry of Geno Hot Spring in Southern Iran

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Geno hot spring is located in Hormozgan province in south of Iran where an arid climate dominates. Hydrochemistry of Geno hot spring has been considered within the study. Major anions and cations were measured and the dominant water type was determined as sodium and chloride ions. The abundance of salt domes within the study area may be introduced as the main reason of such water type appearance. Furthermore, gradual decreasing trend of spring flow rate during last decades has also enhanced the salinization process. Due to very high salinity as well as sodium alkali hazard (extreme values of sodium absorption ratio), no agricultural use may be considered for such water. As the main use of water in the study area is contributed to agriculture, implementing modern mechanized irrigation techniques accompanied by planting crops with low water demand and high tolerance against salinity may be recommended.

**Key Words: Geno, Hot spring, Hydrochemistry, Salinity.**

A hot spring is a spring that is produced by the emergence of geothermally heated groundwater from the Earth's crust. There are geothermal hot springs in many locations all over the crust of the earth[1,2].

Because heated water can hold more dissolved solids, warm and especially hot springs also often have a very high mineral content, containing everything from simple calcium to some rare elements. Because of both the folklore and the claimed medical value some of these springs have, they are often popular tourist destinations and locations for rehabilitation clinics for those with disabilities[3,4]. Sulfur is among the elements that are usually observed in hot springs. The occurrence of sulfur in hydrothermal waters has been investigated for many active hydrothermal systems throughout the world[5,6]. Elemental sulfur may occur near hot springs and volcanic regions, especially along the Pacific Rim[7]. Substantial deposits of elemental sulfur occur in salt domes along the coastal zone of the Gulf of Mexico, as well as in evaporite form in eastern Europe and western Asia. These occurrences are thought to derive anaerobic bacteria acting on sulfate minerals, but native sulfur may be also simply be produced by geological processes. However, fossil-based sulfur deposits from salt domes have, until recently, been the main source of commercial production in all around the world[8].

A salt dome is a type of structural dome formed when a thick bed of evaporite minerals (mainly salt, or halite) found at depth intrudes vertically into surrounding rock strata, forming a diapir[9]. Generally, geopogenic sources may adversely affect the water bodies' quality especially when being influenced by anthropogenic propellers[10,11].

**Study area:** Being located in a 33 kilometer distance from Bandarabbass city (Hormozgan provine), Geno hot spring is one of the most famous ones in Iran.

With an annual average precipitation of less than 170 mm and maximum temperature of 47 ºC, an arid climate dominates within the whole province. However, a narrow strip along the coastline may experience humid climate as well.

Salt domes may be introduced as the main geomorphologic units of the area. More than 80 ones are detected within the province; some of the most famous ones may be introduced as Anguran, Siahou, Ahmadi, Larak, Qeshm and Hormoz.

In order to investigate the hydrochemistry of the hot spring, the sampling campaign was performed. Parameters like pH, temperature, total dissolved solids (TDS), major cations ($Na^+$, $K^+$, $Ca^{2+}$ and $Mg^{2+}$) and major anions ($CO_3^{2-}$, $HCO_3^-$, $SO_4^{2-}$ and $Cl^-$) were taken into consideration.

pH and temperature of water samples were measured at the sampling point by a digital pH and thermometer, respectively. Total dissolved solids was determined gravimetrically at 105-110 ºC[12]. Samples were filtered through polycarbonate filter (0.45 mm pore size) and were divided in two parts. One part was used for analysis of anions, while second part treated with 2 mL of concentrated $HNO_3$ for metal analysis.

The acid-treated water samples were analyzed for the determination of major cations. $Ca^{2+}$, $Na^+$ and $K^+$ were

TABLE-1
HYDROCHEMICAL ANALYSIS OF GENO HOT SPRING

| Sample | Anions (meq/l) | | | | Cations (meq/l) | | | | pH | TDS mg/L | T ºC | Σ Anions | Σ Cations |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $Cl^-$ | $SO_4^{2-}$ | $HCO_3^-$ | $CO_3^{2-}$ | $Na^+$ | $K^+$ | $Ca^{2+}$ | $Mg^{2+}$ | | | | | |
| Geno spring | 134.1 | 15.6 | 4.4 | ND* | 109.2 | 3.5 | 25.7 | 19.2 | 6.9 | 9300 | 44 | 154.1 | 157.6 |

*Not detected

measured by flame photometry, while $Mg^{2+}$ was determined by the flame atomic absorption spectrometer. In case of anion concentrations, sulfate, chloride, bicarbonate and carbonate have been measured by HACH DR/2000 (direct reading spectrophotometer) using the method number 8051, through argentometric course using the method number 2330 and through titration using the method number 4500[13], respectively.

Software like Aqqa, Excel and SPSS11 were considered for statistical analysis through data processing.

The average annual flow of the hot spring during last decades has been monitored (Fig. 1). An overall decreasing trend of flow is observed during last 40 years. Such decrease may be regarded as a major cause of enhanced salinity within regional water and soil resources.

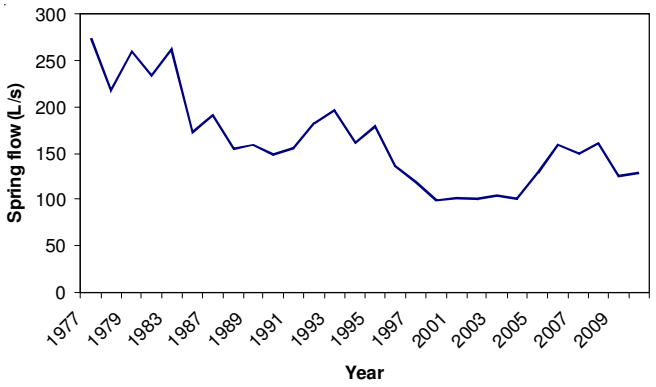


Fig. 1. Average annual flow rate of Geno hot spring during recent decades

The results achieved from hydrochemical analysis of water samples are shown in Table-1. According to the data, the water may be classified as neutral and warm due to the class of pH and temperature.

In order to determine the water type regarding major anions and cations the piper diagram has been considered. As it is seen in Fig. 2, the dominant water type is sodium and chloride ions. Sulfate ions of the water is estimated to be more then 10 % of total anions while calcium and magnesium may contribute to more than 20 % of total cations.

**Conclusion**

Hydrochemistry of Geno hot spring in southern Iran has been considered within the study. Major anions and cations were measured and the dominant water type was determined as Na-Cl. The abundance of salt domes within the study area may be introduced as the main reason of such water type appearance. Furthermore, gradual decreasing trend of spring flow rate during last decades has also enhanced the salinazation process. Due to very high salinity as well as sodium alkali hazard (extreme values of sodium absorption ratio), no agricultural use may be considered for such water. Water resources

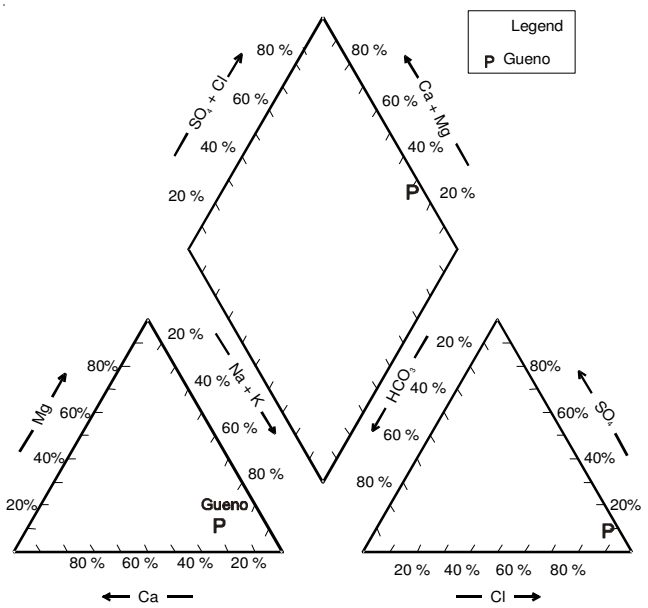


Fig. 2. Piper diagram indicating the water type of Geno hot spring

salinization is one of the major challenges in the way of sustainable development in places with arid climate where extreme drought is coupled with excessive usage. Central and southern Iran is among the regions that are highly exposed to such threat and several studies have discussed the case[13-15].

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