Short Communication

GEOCHEMICAL STUDY OF SOME NON-THERMAL SPRINGS OF SINDH, PAKISTAN

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Abstract

The waters of some non-thermal springs of Sindh, Pakistan, have been analysed. The results obtained are correlated with the geology of the adjacent areas. The geochemistry of underground reactions and the possibility of important minerals are also studied.

Introduction

Information regarding the location, geo-chemical study and the geology of the adjacent areas of non-thermal springs in Pakistan are nearly absent. Most of the non-thermal springs are situated in the northern and north-western part of Pakistan including Kashmir. Sindh in its eastern part consists of Indus Flood plane and is devoid of springs. However, some such springs are present in the western hilly region of Sindh. The physical and chemical aspects of these springs have not been studied though some research work on geochemical aspects of Clifton beach spring along with the thermal springs of Karachi was carried out in this laboratory (1-4). The mineral constituents present in the springs depict a great influence of the geology of the area.

The two springs selected for this study, are located in Sindh province of Pakistan, one in Sehwan area and another from Karachi area. The spring No.1 near Sehwan gushes out from the Lakhi group of rocks of early Eocene period in the Lakhi Range in western Sindh. The Lakhi Formation is about 400 ft. thick and the rocks are mostly limestone; some marl, calcareous shale and lateritic clays are also present.

Rocks exposed in Karachi area where spring No.2 is located are of Neogene age and consist of limestone, gypseous and calcareous shales and clays and congolomerates of sub-recent origin.

Sindh Univ. Res.Jour. (Sci.Sr) Vol.21(1): 62 - 66 (1989)

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The spring No.1 is situated about one mile south of Sehwan city on Indus Highway (26 20°N, 67 56° E) and is known as the spring of Qalandar Shah. A little plantation is found near the spring. The spring is a dug hole about 2 x 2 sq. ft. The water level is about one foot below the surface and does not go down even on continuous consumption by the visitors who consider the water sacred. The soil around the spring is sandy. Sand dunes and small ridges are situated near-by. Spring No.2 is an artesian flow, situated in a vegitated valley to the east of University road, near Karachi University. The water oozes through a steel pipe of 6" diameter fixed in the ground. The height of the steel pipe above the ground is about 6 feet. The water is used for cultivation of a small garden. The nearby area is all covered by low hills of limestone.

Material & Experimental

Measurements of Physical and chemical properties of the springs waters were conducted in the laboratory while some observations were recorded on the spot. The samples were collected by standard procedure in the clean plastic bottles duly rinsed by the same spring water. A sample of 10 L was collected from each spring; the bottle was sealed and set aside for analysis in the laboratory. The temperature of the water was noted by dipping the thermometer below the surface of water and at the oozing spot. The pH was noted on the spot with the help of a universal indicator paper and in the laboratory, by pH meter (Pye Unicam 290) about five hours after the collection of the samples. The specific gravity was determined in the laboratory by means of R.D. bottle. The colour of the water was observed vertically and refractive index were measured by Stalagometer, Viscometer and Abbe Refractometer respectively. For specific conductance Cambridge Conductometric Bridge was used.

The double distilled water used during these experiments passed through strong cation and anion resins charged with H^+ and OH^- ions respectively. The pH of this double distilled water was 6.5 and the electrical conductivity was less than 0.1 micro mhos/cm. Total solids were determined by evaporating 100 ml samples of each spring on water-bath and then dried in the even at 100-115 °C. The alkalinity value calculations were made by titrating the samples with a standard acid. To get the total equivalent cation values, the filtered samples were passed through strong cation resin, charged with H^+ ions. The effluents were titrated with a standard base. Total hardness were determined by EDTA titration using Erichrome Black T as indicator. The permanent hardness was determined by boiling the samples and

titrating with EDTA after filteration. Temporarry hardness was calculated by the difference of the two values.

Sodium and potassium contents were measured by a flame photometer, calcium by EDTA titrations and magnesium was determined gravimatrically as $Mg_2P_2O_7$. The quantities of chloride were observed by Argentometric titration. The chlorinity values were utilised for salinity calculations. Sulphates were estimated as $BaSO_4$. Gravimatric method was used for phosphate estimations. Iron was determined by the same spectrophotometer with o-phenon-throline as colouring agent. Arsenic tests were made by treating the samples with zinc and sulphuric acid. The evolved arsene was measured semi-quantitatively on a silver nitrate paper strip. Boron was determined by titrating the samples containing d- manitol with pH meter). The absorbance of silver, copper nickel and zinc were noted by Pye Unicam Sp 90B Atomic Absorption Spectrometer. The organic matter was counted under microscope with known amounts of samples.

Results & Discussion

The water oozed by these springs are of meteroic origin. The waters of both the springs are colourless which indicates that both of them are rarely contaminated with coloured organic and inorganic substances. The spring of Qalandar Shah (Spring-1) is sweet and very pleasant in taste. This shows that it contains negligible amount of dissolved substances. In other words, the soluble substances are found rare in its passage. The spring of University east (Spring-2)

Results of Analysis:

Physical Characteristics:

S.No.	TEST	SPRING-1	SPRING-2
1	Colour	Colourless	Colourless
2	Odour	Smell of damp earth	Smell of damp earth
3	Taste	Sweet and pleasant	Unpleasant and saltish
4	Temperature	23 °C (73.4 °F)	27° C)(80.6 °F)
5	Specific Gravity	1.00175	1.00246
6	Surface Tension (dyns/cm at 30 °C)	83.1308	90.3372
7	Viscosity (Pois)	0.01031	0.01063
8	Refractive index	1.3325	1.3330
9	Specific conductance	$0.27x10^{-2}$	$0.64x1^{-2}$

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Chemical Characteristics:

1	Gases	Nil	Nil
2	p^H	7.51	8.52
3.	Filterable residue (ppm)	1786	3501
4	Alkalinity (ppm)	166	176
5	Total Cations (ppm)	1121	2695
6	Total Hardness	404	514
7	Permanent Hardness (ppm)	224	341
8	Temporary Hardness (ppm)	181	174
9	Sodium (ppm)	230	998
10	Potassium (ppm)	55	10
11	Calcium (ppm)	110	103
12	Magnesium (ppm)	32	63
13	Iron (ppm)	0.072	0.058
14	Chloride (ppm)	264	1467
15	Salinity (ppm)	477	2647
16	Sulphate (ppm)	596	317
17	Phosphate (ppm)	Traces	Traces
18	Silica (ppm)	Traces	Treaces
19	Boron (ppm)	0.51	Nil
20	Arsenic (ppm)	Nil	Nil
21	Silver (ppm)	Nil	Nil
22	Copper (ppm)	Nil	Nil
23	Nickel (ppm)	Nil	Nil
24	Zinc (ppm)	0.01	Nil
25	Organic Material Counts/100 ml.	Copepode-I	Copepode-7 Forminifera-4 shell

has a greater amount of dissolved substances which are responsible for its weakly saline taste. Nearly normal temperature of both the springs obviates the possibility of underground exothermic reactions and any connection with volcanic activity. The specific conductance ($0.27x10^{-2}$ mhos/cm) of spring -1 is nearly half of the value for spring-2 (0.64×10^{-2} mhos/cm). This indicates the relatively lower amount of dissolved substances in spring -1 than that of spring-2. The results of analysis were checked by multiplying the amount of mineral constituents with the conductance factor of ions. It was observed that the calculated conductance is very near to the observed value.

Spring No.	Observed Conductance (u mhos/cm)	Calculated Conductance (u mhos/cm)
1	$0.27x10^4$	$0.2569x10^4$
2	$0.64x10^4$	$0.6372x10^4$

The lesser amount of dissolved substances in spring-1 (1986 ppm) may indicate its small subsoil travel, while a higher value for spring-2 (3501 ppm) may

be due to its longer subsoil travel. Thus spring-2 can be classified as a mineral spring. These results were also confirmed by the estimation of total cations.

The viscosity of the water from the two springs is proportional to their respective amount of dissolved substances. The pH value of sample from spring-1 confirms the analytical values of alkalinity and hardness and indicates the probability of presence of dolomitic rocks in its underground course. The amount of sodium and chloride present in spring-1 & 2 indicates the trend of enrichment and depletion, while the case of potassium is reverse. A higher amount of potassium (about 1:4 ratio with Na) present in spring-1 than that of spring-2, shows that it may have some contamination with recent marine sediment. Presence of boron may also be relaled to contact with such sediments. However the enrichment with calcium and sulphate indidcates that the strata below the spring-1 has a greater amount of gypsiferous rocks. The higher amount of magnesium in spring-2 thatn that of spring-1 may be related to the possible presence of dolomite underground. The presence of zinc, although in little amount, may be of a significant economical value after exploration. Both the springs contain silica in only trace amounts, thus it may be inferred that the underground passage is not through the igneous rocks.

The water of spring-1 and-2, can not be used for drinking purposes due to exceeding of the limit of 500 ppm of dissolved substances. However water of spring-1 can be used for agriculture but its low discharge limits the uses. The spring-2 can not be used for agriculture due to high amount of dissolved substances. The spring-1 a may be of geological importance because of to its higher amount of potassium and the presence of precious metals boron and zinc.

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