GEOCHEMICAL STUDY OF CLIFTON SPRING WATER, KARACHI, PAKISTAN

K. A. MALLICK, M. A. HASHMI, and I. A. KHAN

ABSTRACT

The study of Clifton spring water of Karachi county situated near the beach shows no appreciable effect of sea water in its taste and chemical composition.

Possible source for the water of spring and the constituents estimated from the spring water have been discussed. The realtive enrichment and depletion of the constituents estimated with regard to Monghopir warm spring found at a distance of about ten miles from Clifton have also been explained.

INTRODUCTION

Informations regarding the thermal and ordinary temperature springs of the Indo-Pakistan sub-continents are found in many of the records of Geological Survey of Pakistan and India. MACPHERSON [1854] and SCHLAGINTWEIT [1864] are considered pioniers in describing the springs of the sub-continent. OLDHAM [1882] published a catalogue of the hot springs known at that time. In 1950 GHOSH read his presidential address on the thermal springs of India and Pakistan in the Indian Sciences Conference. The officers of the Geological Survey of Pakistan have added useful informations on the occurrence of springs in various parts of Pakistan.

The reports of the above mentioned workers do not provide informations regarding the origin, discharge, temperature record, chemical composition, radiometric studies and therapeutic value of the springs.

The present paper is an effort to describe the physical and chemical properties of the potable water of the spring of Clifton, which is a well known beach site of Karachi Coast. Effort has also been made to discuss the origin of the water and to compare it with the warm spring water of Monghopir, situated at a distance of about ten miles south-east from Clifton spring.

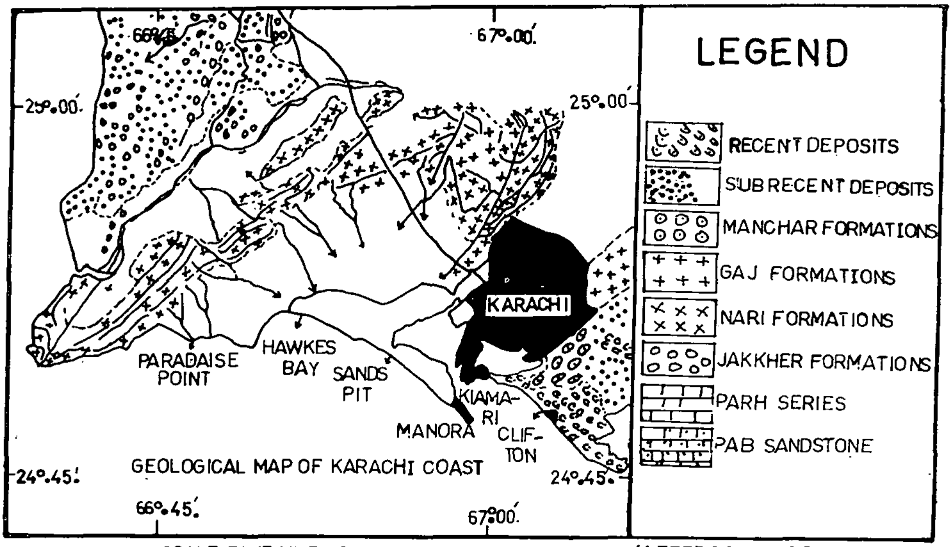
The geochemical behaviour of the elements, estimated from the water of the spring has also been discussed. A comparative account of the compositional relationship between the waters of Clifton spring and that of the Monghopir spring has been given to illustrate the possible origin and compositions of Clifton spring water.

GENERAL GEOLOGY

The Clifton spring is situated at a distance of about 12 miles south west of the Karachi University Campus and is easily accessible by metalled road. The spring is about three furlongs from the beach of Clifton. The water of the spring is potable and oozes at the contact of Pliocene Shale and Sandstone. Local inhabitants use the water for drinking purpose.

The discharge of the water is slow but regular and it is not affected very much during the change of seasons. It does not show appreciable change in discharge of water even when there is no rain for a couple of years.

The rocks exposed in this area are Pliocene Shale and Sandstone. Conglomerate is also present above the sandstone, but it is said to be unconformable with the sandstone and hence younger in age *(Fig. 1)*. The dips of the beds range between 3 to 5° towards the sea.



SCALE=FOUR MILES TO ONE INCH (AFTER COLOMBO PLAN MAP 186

Fig. 1

The shale is light and dark grey in colour in the spring area but in other localities yellow, brown, reddish brown and yellow colour of the shale can also be seen. The thickness of the shale increases as it approaches the sea from the land. It is soft and massive in structure.

The grey sandstone is coarse to medium grained and loose in texture due to the presence of argillaceous cement. The grains are sub-rounded to rounded. The thickness of the sandstone varies from place to place but in the area under study it is 45 feet thick.

The pebbles of the overlying conglomerate is heterogenous in composition. The pebbles are mainly soft sandstone, arenaceous and argillaceous limestone similar in composition to the limestones of Oligocene and Miocene ages. Pebbles of limestone containing foraminifera are also found. The size of the pebbles is variable and ranges up to 9 inches in diameter. The pebbles are mostly angular to sub-angular.

PHYSICAL PROPERTIES

The Clifton spring is about 50 feet above sea level and the discharge of water is about 1000 gallons of water every day. The water of the spring is potable. No smell of any gas is felt in it.

The temperature, colour, turbidity, specific gravity, viscosity, refractive index and electrical conductivity of the water is not affected appreciably with the change of seasons.

The physical properties like taste, specific gravity, surface tension, viscosity, refractive index and total hardness of the warm spring of Monghopir, situated at a distance of about 10 miles from the spring described in the present paper, show much similarities with each other. No similarities in the estimated values of temperature, turbidity, electrical conductivity etc for the Monghopir warm spring and Clifton spring could be found (Table 3). The colour of the two waters differs but the difference is not very great.

In the light of the result of chemical analysis data the Clifton Spring Water can be classified as chloride water, because the concentration of chloride (220 ppm) is much higher than the concentration of sulphate (104.06 ppm). The concentration of nitrate (0.369 ppm) and nitrite (0,024 ppm) is not very significant to name the spring water after these constituents. Phosphate, silica and hydrogen sulphide could not be estimated due to their very negligible concentration and were beyond the estimation range.

Among the metalloids and metallic radicals calcium (66.57 ppm) has got the highest relative concentration in the water of Clifton Spring. Potassium is the next

TABLE 1

Physical Properties of Clifton Spring Water

1. Temperature	27 °C
2. Turbidity	1.40
3. Odour	Odourless
4. Colour	Colourless
5. Taste	Pleasant
6. Specific gravity	1.0013
7. Surface tension	71.90
8. Viscosity	0.00787
9. Refractive index	1.3328
10. Electrical conductivity at 25 °C	0.00135
11. pH	7.6

TABLE 2

Chemical Properties of Clifton Spring Water

Contents	*Quantity (ppm)*
1. Salinity	34230.00
2. Chloride	220.00
3. Sulphate	104.06
4. Phospate	traces
5. Nitrate	0.369
6. Nitrite	0.024
7. Hydrogen sulphide	nil
8. Silica	traces
9. Oxygen absorbed at 27 °C	0.30
10. Total hardness	325.00
11. Permanent hardness	155.00
12. Temporary hardness	170.00
13. Iron (total)	0.08
14. Calcium	66.57
15. Magnesium	25.87
16. Potassium	34.44
17. Albuminoid ammonia	0.076
18. Free ammonia	0.028
19. Total solid (after evaporation)	687.00

TABLE 3

Similar Physical Properties of Monghopir Warm Spring and Clifton Spring

Characteristics	*Monghopir Warm Spring*	*Clifton Spring*
1. Odour	Odourless	Odourless
2. Colour	Live bond unit yellow	Colourless
3. pH	7.2	7.6
4. Specific gravity	1.0019	1.0013
5. Refractive index	1.3327	1.3328
6. Surface tension	70.95	71.90
7. Viscosity	0.00781	0.00787
8. Total hardness	371.5 ppm	325.0 ppm

TABLES 4

Relationship between Chemical Properties of Monghopir Warm Spring and Clifton Spring Waters

Characteristics	*Monghopir Warm Spring (ppm)*	*Clifton Spring (ppm)*
1. Chloride	600.000	220
2. Sulphate	336.69	104.06
3. Nitrate	0.369	0.369
4. Nitrite	0.001	0.024
5. Phosphate	nil	traces
6. Silica	traces	traces
7. Calcium	88.88	66.57
8. Magnesium	28.93	25.87
9. Potassium	14.50	34.44
10. Total iron	0.10	0.08
11. Consumed oxygen (at 27°C)	0.20	0.30
12. Free ammonia	0.004	9.028
13. Albuminoid ammonia	0.084	0.076
14. Hydrogen sulphide	nil	nil
15. pH	7.2	7.6

enriched in this water and its concentration is more than double of the Monghopir Warm Spring. There is slight difference in the concentration of magnesium in the waters of the two springs. The content of total iron is very low in the waters.

Similarly significant difference was found in the contents of chloride, sulphate, free ammonia, and evaporates of the two springs (Table 4).

Other characteristics like the concentrations of nitrate, phosphate, calcium, magnesium, total iron, consumed oxygen, hydrogen sulphide and the pH values of the two springs do not show any appreciable differences.

DISCUSSION

The recorded temperature of Clifton Spring Water is only 27 °C which is not very different from the normal surface temperature of a tropical region during summer season. Therefore, the calculation of depth of the reservoir, with the assumption that 1 °F of temperature increases at every 100 ft of depth in the subsurface of the earth can not be made. However, the estimated value of the temperature also can not be considered as the temperature of the reservoir. There are possibilities of exothermic reactions between the water and the mineral constituents during accumulation of water in the reservoir and in the channel of the spring. Similarly the dessipation of heat from the spring water into the channel rocks due to the factors like porosity, permeability and chemical reactions between the water and the country rocks can not be considered beyond imagination.

Higher turbidity (1.40) as compared to the warm spring of Monghopir may be attributed to the argillaceous nature of the sandstone through which the Clifton spring water oozes. If it is supposed that higher turbidity is not due to argillaceous nature of the sandstone but it is related to chemical reactions in the substratum, then the taste of the spring water would have been saltish or bitter.

Relatively higher elevation of the spring site from the sea and the impervious Cap of Guj limestone and the shale over the Guj Sandstone forming the reservoir of the water do not allow the sea water to affect the taste of the spring water. Moreover, the waste of the ground water is also minimized.

Insignificant effect of seasonal changes on the discharge of Clifton spring water may be attributed to large catchment are, higher porosity but less effective porosity due to the presecne of clays in the reservoir rock, the overlying shale working as cap rock, gentle slope of the beds towards the sea and tectonically less disturbed condition of the area. The above mentioned factors do not allow the water to go waste and thus regular supply of water persists throughout the years.

The lower content of sulphate in the water of Clifton Spring (104.06 ppm) as compared to Monghopir Warm Spring (336.69 ppm) is probably due to common occurrence of gypsum in the Nari shale which decomposes after coming in contact with warm water (38 °C) of the spring. The decomposition of gypsum is expected to affects the concentration of Ca also in the spring water but the content of calcium estimated does not show any marked difference in this connection. The insignificant difference between the contents of calcium in the two spring water may be probably because of the highly sensitive nature of calcium in solution and precipitation environments.

Magnesium does not show any significant change in its mobility with respect to the differences in temperature and the magnitude of depth which causes difference in pressure through the channels of the water of the two springs.

The higher concentration of potassium in the water of Clifton Spring (34.44) as compared to Monghopir Warm Spring (14.56) requires more work to put forward any logical arguments or to explain its geochemical behaviour in the areas of the present study.

It could be postulated that though the rocks encountered in the Clifton spring area are the same as in the upper part of Monghopir Spring, but the former area is a coastal region and it has emerged from sea much after the emergence of the later region, therefore, it may be considered as one of the cause of higher concentration of potassium in the water. The Clifton area is saline and water logged and because the salts of potassium are more soluble and stable in solution form, so the solution of potassium could have been reaching the ground water and thus the concentration of potassium is higher in the water of Clifton Spring.

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DR. K. A. MALLICK
Dept. of Geology, University of Karachi

DR. M. A. HASHMI
P. C. S. I. R. Laboratories, Karachi

DR. I. A. KHAN
Dept. of Chemistry, University of Karachi
Pakistan