

Joseph SAMAN

The Properties of the Curative Water and its uses for Therapeutical Treatment in Jordan



Abstract

The paper discusses some of the natural agents in Jordan with particular emphasis on thermal mineral water.

Despite the scarcity of water resources in this Semi-Arid Country, Jordan enjoys the abundant presence of sources of thermal and mineral waters distributed all over its territories along the Rift Valley. The eastern flank of the valley comprises some 150 thermal water springs and many wells ranging in temperature from 300- over 600 °C.

The thermal springs were used in ancient time for therapeutical purposes. The conclusion, that these thermal waters are curative, is based actually on their chemical and physical characteristics as well as medical indications and field experiments. Generally stated, the thermal waters of Jordan are very promising. Jordan is moreover famous for its touristic and archeological sites which enable it to be a therapeutical center allowing millions of tourists to investigate its different archeological sites and enjoy treatment in its spas and thermal springs.

This requires of course the developing of its therapeutical sites in different aspects, unless the present status of most of the sites will not fulfill international requirements, unless improvement and better advertisement are implemented.

Further research is of the utmost importance in order to optimize the use of the thermal waters, which could be a main support for the economy of the country.

Introduction

Jordan lies within a semi-arid to warm mediterranean climate. It is a country with scarce Water Resources, but enjoys the abundant presence of Thermal and Mineral Waters distributed all over its territories and especially along the Rift Valley to the South of Sea Genezareth towards the southern part of the Dead Sea.

The Dead Sea is rich in Minerals, which have proved its effectiveness in the treatment of skin diseases, especially psoriasis.

The thermal water springs, with their physical and chemical properties are widely spread in all the kingdom areas. In the north we find mineral waters in Himma area and north Shunah.

This is in addition to the middle areas, particularly Azraq Oasis and main spas and the Zara area overlooking the Dead Sea. In Tafila south of Jordan we have the Afra and Barbeeta thermal springs.

These springs are highly effective for the treatment of various diseases, in particular Skin and rheumatic diseases. This makes of the medical treatment waters in Jordan one of the most important pillars of curative tourism in Jordan.

The sites of curative waters enjoy also special climatic conditions with long dry summers and cool

wet winters with air oxygen concentration increasing, with decreasing elevation towards the Dead Sea.

Jordan is qualified to be therapeutic center due to its touristic and atmospheric attraction. However it is enowed by an abundance of archeological sites.

Millions of people can be attracted to seeing and enjoying the treatment of its curative spas.

In earlier times, as can be seen from the remaining ruins surrounding the thermal springs and as reported in historical romans and Nebatean eras, where thermal waters were used widely for therapeutic purposes.

The descendants of the old Nebatean, the bedouines as the native Inhabitants of this area used these waters for the treatment of these ailments.

Jordan hot springs have certainly attracted visitors at least 2.000 Years, ever since Herod the Great took the cure at Zarqa Main, now the Site of the middle east most modern mineral water health-spa. These waters were also highlyappreciated as a healing curative tool (Heilende Kraft). In some cases where modern medicine was unable to help, the thermal waters were of overwhelminmg success.

It requires of course the improvement and development of its therapeutic sites according the Intenational norms. Since the present stand of most of sites do not fulfil the requirments for Intenational competion such as services, standard advertisement and proper marketing.

Special emphasis should be stressed on further Investigstion and research of the properties of the curative waters, which has an economical importance and very valuable resource.

Definition and characteristics of curative water:

According to the classification of the International Society of Medical Hydrology, the Societe International de Technique Hydrothermale (SITH), The International Association of Spas, Health Resorts and Balneology and the German Health Resorts Association, Deutscher Badeverband, a water source can be classified as curative if posseses one or more of the Following Properties;

1. 20 mg/l Fe, (iron mineral water)
2. 1 mg/l I, (iodide mineral water)
3. 1 mg/l H₂S, (hydrogensulphide water)
4. 18 nCi/l (nano-Curie) radon, (radon water)
5. 1000 mg/l CO₂, (carbon dioxide water-acidic water)
6. 1 mg/l fluoride, (flouride rich mineral water)
7. In Jordan water is considered thermal if its teperature exceeds 27°C

The therapeutic characteristics of the water

The therapeutic characteristics are categorized according to:

- The type of positive or negsative ions present which exceed 20% of the total positive and negativ ions in the water.
- The presence of an active substance such as iron, sulfur, fluoride or radon.
- The water temperature.
- In order to assign therapeutic properties to a water source, it is necessary to define its chemical and physical properties and to classify them according to the international norms.
- Topography, setting of the area, climate and environment are also of importance for the curative water.

15 thermal springs out of 200 have been subjected tointensive studies in order to identify their phsical, hydrological, geological and chemical characteristics thermal spring location.

After Salameh E., five medical experiments have been conducted on patients suffering from various rheumatoid diseases in the following areas:

1. Afra thermal spring
2. Main thermal spas
3. Azraq thermal well
4. North Shuna thermal well
5. Himma of Jordan

Source and origin of minerals, gases and physical properties: The chemical constituents of the thermal waters are derived from the percolated rocks. Some of these rocks possess unique properties.

1. Metamorphosed oil shales in north Jordan along the slopes of the Yarmouk river and in the Qatraneh and Dabba areas, 40-60km SSE of Amman.
 2. Phosphatic rocks containing trace elements in abundance (U, Zn, Mo, Ba, V, etc.) and covering large areas of Jordan, i.e. Russeifga some 10 km E of Amman, Hasa 130 km S of Amman, Shadiya 240 km SSE of Amman.
 3. Sandstone of lower cretaceous and other ages containing heavy sand trace metals like Fe, Mn, Pb, Zn, U, Ni, Co, etc.
- These areas and types of rocks are percolated by the waters of the thermal springs.

Normal gases

- Oxidation processes can explain the high concentration of carbon dioxide and hydrogen sulfide gases, where the dissolved oxygen in the water reacts with the organic matter in the rocks or in the water itself. The water contents of heavy and trace elements such as Fe, Mn, Cd and Zn etc. are attributed to dissolution processes of rocks and minerals percolates
- Salts: Some springs have high salt contents, which are attributed to mixing of infiltrating water with old salty water in the aquifers or with the Dead Sea water along the interface of fresh/salt water.

Radioactive substances

When the infiltrating water passes through phosphatic and granitic rocks, or through oilshales or old sandstone, it dissolves parts of the Uranium minerals present in these rock types.

Radon: is one of the unstable (radioactive) elements in the Uranium 238 disintegration series, which constitutes 99% of the Uranium isotopes.

U 235 and Th.232 disintegrate also and give other isotopes of radon with very short half life time (radon 219 ca.4 seconds, radon 220 ca.55 seconds whereas radon has a half life time of 3.82 days.

Radon is characterized by its presence as a gas under normal pressure and temperature conditions. It dissolves in water as a gas and escapes as soon as it is in contact with the atmosphere the radon gas disintegrates to another radioactive substance, namely polonium in a solid state and which in turn disintegrates within the uranium series to lead 206. The half-life time from radon 222 to lead 206 lasts around 21 years.

In the following are the two-disintegration series (thorium-232 And uranium-238), which produce radon at two different stages.

Curative waters and springs in Jordan

There are numerous springs and water seeps in Jordan. These are grouped into two types according to source and temperature.

Fresh springs (hypothermal)

With temperature 20-30°C. These are of less importance, they issue from the carbonate rocks (Upper Cretac.) in age. Two important springs of this group are worth mentioning.

Ain Ez-Zarqa

It issues from the cenomanian limestones in the upper part of Wadi Zarqa-Main. The total discharge is about 80 m³/h.

Uyun Musa

These springs issue from the bottom of the turonian limestone (A7). Temperature of the springs ranges from 18-21°C. They reach their maximum discharge in march (95 m³/h) and decrease to 58 m³/h towards the end of july.

Thermal springs

They are concentrated along the eastern Jordan rift valley, from south to north Tafila area, (Wadi El-Hasa, Wadi Afra)

- **Wadi Afra Springs**

The hot springs are concentrated near the confluence of Wadi Afra and Wadi El-Hasa. The total discharge is about 450 l/s. The water emerges from the Kurnub Sandstone (Aptian /Albian), it is overlain by limestone, dolomites and marls of upper cretaceous. The temperature of the discharged water is almost constant and ranges from 47-49 °C, indicating that minor or no mixing with surface water take place. The chemical composition shows that the water is of alkaline earth type with increased portion of alkalis and prevailing chloride. The water is radioactive with an activity equal to 7.2 nCi/l. The curative properties of this water are based on the elevated temperature, CO₂-content, bromide and radioactivity could be of medical value.

Medical Indications:

Restoration of general activity, arthritis, chronic arthritis peripheral circulation troubles, muscular contractions, muscle cramp, regulation of gland secretions, gynecological diseases, general health recovery, infertility, pain soothing, nervous prostration, rheumatism

- **Wadi El-Hasa thermal Spring (Burbetah)**

It issues from the bed gravel of Wadi El-Hasa. Its water originates from the lower cretaceous sandstone underlying the gravel. The thermal water seeps to the surface at different places from the aquifer. In comparison to Wadi Afra, the water temperature here shows seasonal changes. It rises in summer to 46 °C and drops in winter to 24 °C. This change in temperature is accompanied by changes in the chemical composition indicating the mixed nature of the water. The radioactivity of the water ranges from 2 to 7 nCi/l. The high radioactivity due to radon 222 in both Afra and El-Hasa springs could be attributed either to the leaching of the uranium rich phosphatic rocks or the dissolution of uranium oxides within the sandstone units or both. The presence of thick marl, sand, marly limestone beds separating the phosphatic rocks from the spring sites supports the probability that the radioactivity originates from the sandstone. The curative properties of this water are based on its high temperature and radioactivity. The Fe (iron) content could be of medicinal value. These properties are equivalent to those of Afra.

Lisan area (Ghor El-Karak, Wadi Dhira, and Wadi Ibn Hammad)

- **Lisan Thermal Springs**

The thermal waters in this area are discharged to the Lisan and from there to the Dead Sea.

- **Wadi El-Dhira Spring**

Many springs issue in the lower portion of Wadi Dhira along fault planes trending NNE-SSW parallel to the main flexure trend in Ghor El-Safi area. The Main spring discharges as a bubbling spring from lower cretaceous sandstones at an elevation of 100m,a.s.l. The amount of water discharged is about 30 l/s. with a constant temperature of 33 °C.

Medical Indications:

Peripheral circulation, troubles, chronic constipation, muscle contractions, diuretic, general health recovery, rheumatism, urinary lithaiasis, sandstone underlying the gravel

Zarqa Main and Zara area (Wadi Zerka-Main)

- **Zara and Zarqa Main Thermal Springs**

The Zara thermal spring area lies 1 to 4 km to the south west of Zarqa main area and some 100 – 1000 m to the east of the Dead Sea shore. The thermal spring discharges from the upper part of the sandstone aquifer low. cretaceous) in age, partly covered with recent sediments of travertine and gravel. The water normally issues along N-S trending faults. The temperature of the different springs is constant over the year and goes up to 63 °C the chemical composition is very similar to those of Zarqa Main, which proves that both springs are of the same Origin. In summer the water is alkaline earth with prevailing alkalis and increased portion of chlorides. It includes together 26 thermal springs within the Zara area. The estimated total discharge into the Dead Sea is about 17MCM/a; including the fresh water of some springs in the area H₂S is discharged with the water, and gives the area its distinctive smell. The water is radioactive with up to 3.7 nCi/l and a bromide concentration of about 5 mg/l.

Jerash - Deir Alla area (Zerka River)

Two thermal springs issue along the Zerqa River course.

- **Himmat Jarash**

This spring issues at an elevation of 220 m a.s.l. from consolidated Wadi gravel about 2 km east of the new Jerash bridge on the road from Amman to Jerasah.. The underlying sediments consist of lower cretaceous sandstones. The temperature ranges from 27 °C in summer to 29 °C in winter. It indicates alkaline water with prevailing chlorides in summer and alkaline earth water with prevailing alkalis and increased portion of chloride in winter. The water can be used both internally and externally.

- **Deir Alla Spring**

This spring issue from Wadi gravel covering the Zerka River bed in the area where the Zerka river leaves to the Jordan graben. The water temperature ranges from 35 °C in summer to 38 °C in winter indicating the mixed nature of the water. The source of water is not clear but it seems to have its origin in the jurassic and cretaceous rocks. The great changes in the chemical composition varies (e.g. Cl 44 mg/l in summer and 1720 mg/l in winter) showing the high mixing ratio changes during the seasons of the year. The water is alkaline with prevailing chlorides in winter and alkaline earth with prevailing bicarbonates in summer. Iron oxides precipitate as soon as the spring water mixes with the Zerka river water. CO₂ gas is discharged with the water.

Therapeutic uses:

Ankylosis, arthritis, and central circulation troubles. Peripheral circulation troubles, chronic constipation, muscle cramp, general health recovery, Influenza, respiratory system troubles rheumatism, urinary lithaiasis urethritis

- **Himma and Wadi El Arab thermal Springs**
Three Wadis are herein included: Yarmouk River; Alhimma Spring

Himma of Jordan, Mukheiba and North Shuna

- **Wadi El Arab, North Shuna well, Wadi (Hammam Abu Thableh) Spring**
- **Himma Springs**

The thermal springs are concentrated along the lower reaches of the Yarmouk river. They emerge from the chalk marl unit at an elevation of 115 m below sea level. The changes in chemical composition over the seasons indicate the mixed nature of the water. In summer the water is alkaline earth with prevailing carbonates and chlorides, whereas in winter it changes to alkaline earth with prevailing bicarbonates and increased amount of chloride. This water can be used both internally and externally with some restrictions to its use internally.

Therapeutic uses:

Arthritis, peripheral circulation troubles, muscle cramp, regulation of gland secretion, activation of ducts of sweat glands, general health recovery, inflammation of respiratory apparatus, rheumatism

- **Wadi El-Arab (North Shuna Well)**

This well was drilled 1981 to a depth 1000 m. At depth 970 m, the water became flowing to a height of 17 m. The discharge was 250 l/s with a constant discharge. The temperature was measured to be 56 °C. The aquifer is the so-called upper Ajloun (A7), massive limestone, turonian age. Great amount of H₂S gas is also discharged with the water, the concentration reaches 12 mg/l the chemical composition and the temperature. Gave the expected curative properties as the Himma Spring.

Therapeutic uses

Restoration of general activity, arthritis, muscle cramp, activation of ducts of sweat glands, general health recovery, pain soothing, rheumatism

- **Hammam Abu Thableh Thermal Spring**

This spring lies a few kilometers to the north of the historic city of Pella in the Jordan Valley Area. The spring surroundings are covered with travertine and other recent sediments, which are underlain by limestone of upper cretaceous age; the chemical composition indicates a mixture of two water types. In summer the is alkaline earth with prevailing carbonates and chloride and in Winter it is alkaline earth with prevailing carbonates and increased portion of chlorides. Little H₂S gas is discharged with the spring water. The water is radioactive with 4.9 nCi/l of Rn 222 activity. The H₂S content is high.

Therapeutic uses

Arthritis, peripheral circulation troubles, muscles cramp, regulation of gland secretions, activation of ducts of sweat glands, rheumatism.

Azraq thermal water well

This Well was accidentally encountered during drilling for oil exploration. This artesian well reached a total depth of 1299 m before the water became flowing from the lower cretaceous sandstones to the surface. The discharge water is constant, 39 °C, and the reservoir temp. Are 72 °C. H₂S gas is discharged with the water. The CO₂ concentration is 210 mg/l and the radioactivities 2.5 nCi/l. The water can be used both internally and externally. Due to its H₂S content it is recommended for moderate use internally.

Therapeutic uses

Arthritis, muscle cramp, inflammation of respiratory apparatus, rheumatism, skin diseases.

In northeast Jordan

Some 100 km east of Amman; an artesian well known as Azraq Well penetrates to a depth of 1299 m and produces thermal water with temperature of 56 °C.

Jordan Ghor Springs

The prevailing climate in this area is a desertic one with hot summer, with an average temperature of 31 °C. The humidity annual average is around 15 % and rainfall reaches 100mm/a., increasing towards north up to 300 mm/a. in North Shuna and 400 mm/a. in the Jordan Himmah area.

Mineral water in Jordan southern Ghore area

Hisban Spring

Two wells have been drilled in Wadi Hisban area. The water however found its way to the surface through fissures within the overlaying rock formation. The chemical and physical properties of this water do not change throughout the year. This water is considered thermal –mineral water, of sodium – calcium, chloride –bicarbonate type. The concentration of dissolved salts reaches 3 mg/l; the radon concentration in the water reaches 23,58 nCi/l with an average of 15,5 nCi/l.

Wadi Kafrein Wells

Three Artesian Wells in this area were drilled. The temperature varies between 32,5 – 37 °C. The physical and chemical properties are fairly stable. Although the concentration of dissolved solids does not reach 1000 mg/l, yet this water is considered thermal water of calcium-sodium-magnesium-bicarbonate-chloride type. The concentration of radon, carbon dioxide and hydrogen sulphide and hydrogen sulphide is minimal. The water could be used for therapy through drinking. Due to the relatively high Iron content, it is especially useful for patient with anemia. The physical and chemical components originate from the upper cretaceous aquifer.

Dead Sea Water

The surface of the Dead Sea lies at an elevation below 410 m b.s.l. Hence it is the deepest point on earth. The salinity of the water is around 10 times that of the oceanic water. The water is saturated with salt with around 33 %. It seems that the curative properties are attributed to the ratio of the different components and to the very high bromide concentration of 6.3 g/l which is the highest known of surface water worldwide. In the Dead Sea area psoriasis and vitiligo (pigment disappearance) can be treated. It is the only treatment place for psoriasis for which no other means of treatment has yet been found.

Treatment in the Dead Sea area is not only achieved by using the water but is also related to the high oxygen content of the atmospheric air to the attenuation of UV radiation due to the thick atmospheric layer overlaying the Dead Sea Area.

The possibilities of geothermal energy in Jordan

The main surface manifestation of geothermal energy in Jordan is the thermal springs, which are distributed along the eastern escarpment of the Jordan and Dead Sea graben (200 km). The origin of volcanic and thermal spring's activity has been a subject of investigation for sometimes.

The modern: plate tectonic theory can provide an adequate explanation for these phenomena. Dually the earth crust is divided into a few large and rigid plates, which float on the mantle, and move

relative to each other at an average rates counted in centimeters/year. Geothermal fields are very common on plate boundaries, as the crust highly fractured and thus permeable, and sources of heat readily available. In such areas magmatic intrusions some times with partly molten rock at Temp. Over 1000 °C situated at few kilometers depth under the surface, heat up the ground water.

The hot water has lower density than the surrounding cold water and therefore flows up towards the surface along cracks and fractures. Mounting evidence suggests that the Arabian plate is moving north-eastward relative to the African plate and is colliding with the Anatolian and the Iranian plates. This collision was the cause of the uprising of the Taurus and Zagros belts at an earlier geological period.

The active Aqaba – Dead Sea transforming system consists, in its southern portion of a narrow graben limited by faults the graben displays a strong dissymmetry being morphologically and tectonically more complex on the eastern side. All the Jordanian potentially geothermal energy-producing zones belong to this portion. The movement of the Arabian plate, probably lasting from upper oligocene and still going now, has included a network of fractures in Jordan, especially concentrated along the eastern side of the plate boundary.

Due to the active plate boundary, positive heat flow anomalies are observed and evidenced by the numerous thermal springs located all over the eastern escarpment of Jordan and Dead Sea graben from Mukheiba in the north to Tafila in the south. However, the most important possibility seems to be in the Zarqa Main-Zara zone, which are not only showing positive heat flow anomalies and more or less important episodes of recent basaltic volcanism but also showing significant microearthquake activity in the recent years. Other possibilities, the basaltic plateau of Jebel Ed-Druz which shows weak geothermal anomalies represented by thermal water in some deep boreholes such as Azraq Well.

In Jordan plateau, mainly in the area south of Queen Alia Airport, many shallow wells are producing relatively thermal water (<45 °C).

Origin of heat

A hot body of magma or a hot mass exists below the Zarqa Main-Zara within a depth down to 5-7 km; this provides the heat needed for the formation of a hydrothermal zone above the intrusion. Five basaltic vents were identified near Zarqa Main and one near Zara. According to the K-Ar age determination (E.H. Mckee, 1983) the ages of the extrusion in the area range from 0.1-3.4 my respectively.

Deep circulation of water in more or less a normal geothermal gradient

The deep fault Zarqa Main acts as conduit for hot water from the deep confining strata. Hypothesis was used to explain anomalously high heat flow on the West Side of the Dead Sea rift. (Eskstein, 1979).

The lateral movement of faults of the Dead Sea Rift and the effect of a thick layer of poorly sediment that may underlie Dead Sea and form a thermal blanket which reflect the heat to the rift margins.

Conclusions

Jordan enjoys in addition to its moderate climate many other curative resources like the before mentioned thermal springs. The Dead Sea water and the special radiation and climate of aqaba area. The thermal springs possesses high curative characters. The following conclusions can be drawn:

1. In general thermal springs in Jordan can be used for; gynacological, dermatological and allergies diseases, rheumatism, arthritis and ankylosis, muscle cramp and contraction, central and peripheral circulation troubles, urethritis, urinary lithaiasis, diuretic, chronic constipation and intestinal troubles, general health improvement sedative, nervous diseases, regulation of gland secretions.
2. The thermal waters have its source in lower Cretaceous sandstones and upper, Cretaceous limestones.
3. Most springs represent mixing of one or two members
4. The geothermal gradient is found to range from 3,6 – 4,5 °C/100m
5. The trace elements and radioactivity originate mainly from the lower Cretaceous sandstones and phosphatic rocks.
6. H₂S and CO₂ can be attributed to reduction of sulfate in the presence of organic matter by anaerobic bacteria.
7. The Dead Sea water can be used for the treatment of psoriasis and vitiligo