

## **Healing waters: Balneological classification of thermal springs in South Africa**

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### **Abstract**

The scientific study of the medicinal effects of thermal waters is known as balneology, or balneotherapy when applied in a medical context. In this literature-based article, the need for an up-to-date balneological classification of thermal spring waters in South Africa is highlighted. While balneotherapy is still not fully recognized at a global level, it has, over the past few centuries, evolved into a medical speciality in some countries. The effects of balneotherapy on the human body can be categorised into three broad areas, namely chemical effects, thermal effects and mechanical effects. Today there are about 30 thermal spring resorts spread around South Africa, but there is no longer any direct medicinal/balneological use of thermal spring waters in the country. Kent (1952) classified most of the best known thermal springs in South Africa into the following balneological water types: Indifferent waters, chalybeatic waters, alkaline waters, sulphate waters, salt waters, triple waters, silicious waters, lithium waters and sulphur waters. While detailed chemical analyses of most thermal springs in South Africa have taken place in recent years, these do not include balneological analysis. Many medical specialists, such as rheumatologists and dermatologists, now acknowledge the medical significance of balneotherapy. An updated balneological classification of South Africa's thermal springs, and indeed those of the many other African countries that have thermal water resources, could go a long way towards enabling these countries to establish themselves as part of the growing international health tourism industry.

**Keywords:** Thermal waters, hot springs, healing waters, balneology, balneotherapy.

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### **Introduction**

Thermal waters with a high mineral content are often termed 'healing waters' or 'medicinal waters', and are used in therapies in order to prevent illness and restore health (Erfurt-Cooper & Cooper, 2009; Kent, 1952; Rindl, 1936). In order for water to be classified as healing/medicinal water, the healing effects generally have to be proven through evidence-based research (Smith & Puczkó, 2009), although there is no universal agreement on this. The scientific study of the medicinal effects of thermal waters is known as balneology, or balneotherapy when applied in a medical context, derived from the Latin word 'balneum', meaning 'bath'.

Balneotherapy is often used in combination with other natural or complimentary remedies and referred to as 'health resort medicine' or 'spa therapy' (Agishi & Ohtsuka, 1998).

While balneotherapy is still not fully recognized at a global level, it has, over the past few centuries, evolved into a medical speciality, particularly in Europe and Japan (Altman, 2000; Lund, 2000). A range of adjunct therapies complement the use of balneotherapy (Bender *et al.*, 2004; Altman, 2000), and include aromatherapy, body scrubs, colonic irrigation, pelotherapy (mud pack therapy), fasting, herbal wraps, hydrotherapy (the use of ordinary tap water in any form or temperature for healing purposes, including aquatic exercise), the Kneipp kur (hydrotherapy combined with medicinal herbs), massage, oxygen therapy, ozone therapy, sauna, steam baths and thalassotherapy (the use of heated seawater for treatments), amongst others.

The effects of balneotherapy on the human body can be categorised into three broad areas, namely chemical effects, thermal effects and mechanical effects. Chemical effects occur when trace amounts of minerals such as calcium, magnesium, potassium and lithium are absorbed by the body, providing healing effects to various body organs and systems, as well as physical and mental relaxation (Altman, 2000). Thermal effects occur when thermal water gradually increases the body temperature, killing harmful germs and viruses in the process (Altman, 2000). Heat increases the secretion of beta-endorphin, a natural painkiller. Beta-endorphin also boosts the immune system and increases relaxation. Heat also prevents inflammation by increasing secretion of cortisol and catecholamines, two hormones produced by the adrenal glands. For this reason doctors often prescribe hot water baths to treat inflammatory conditions, such as arthritis or dermatitis, as well as auto-immune diseases (Harris, 2010).

Mechanical effects are similar to those produced by aquatic hydrotherapy exercise. An immersed body experiences a force applied by the water on all sides, called hydrostatic pressure, which can have many benefits (Harris, 2010). It reduces swelling in the lower legs and feet, decreases blood pooling and helps return venous blood to the heart. Another important mechanical effect is that of buoyancy, the upward vertical force of water, which counteracts the effects of gravity, and reduces the compression of joints (Harris, 2010). Many people who cannot exercise on land bearing their full weight can exercise comfortably in water. Increased hydrostatic pressure on the body due to immersion increases blood circulation and cell oxygenation, and also helps to dissolve and eliminate toxins from the body (Altman, 2000). The increased flow of oxygen-rich blood throughout the body brings improved nourishment to vital organs and tissues.

## **Medicinal use and balneological classification of thermal waters in South Africa**

By the 17<sup>th</sup> century ‘taking the waters’ (bathing in thermal or mineral waters for healing purposes) had become popular among the upper classes of Europe, and many of the European thermal springs had been developed into sophisticated spa resorts. The Dutch settlers thus arrived in South Africa with a well-developed thermal spa culture, and soon the hot springs at Caledon, in the Western Cape, were being regularly visited for medicinal purposes (Booyens, 1981). The iron-rich thermal water was found to be highly effective for treating skin diseases and rheumatism. In 1893 a sample of Caledon’s spring water was submitted at the Chicago World Fair, where it was awarded first prize among the world’s leading mineral and thermal waters for its medicinal and curative properties (Booyens, 1981).

In 1902 the palatial three-storey ‘Caledon Baths and Sanatorium’ was built, and Caledon became known as the ‘Baden-Baden of South Africa’ (Booyens, 1981). In the words of an anonymous writer (Anon, 1940: 443), “The bathing establishment: This is an entirely separate and specially fitted up department, which possesses its own bath, massage, dressing and resting rooms, and provides for all types of modern electrical and hydrotherapeutic treatment. Diathermy and D’Arsonval high-frequency treatment, ultra-violet radiation, radiational and hot air baths, ionization, electric baths, Nauheim carbonic acid baths, massage douches, Plombières treatment, and indeed, all varieties of hydrotherapeutics are provided for”. Unfortunately the building was destroyed by fire in 1946 and all that remains today is a single thermal pool known as the ‘Victorian Spa Bath’, now fully restored as part of the Caledon Casino Hotel and Spa.

During the 19<sup>th</sup> century doctors placed considerable value on the use of the thermal springs of the Cape Colony (now the Western Cape) for medical purposes (Booyens, 1981). In 1866 the Colonial Medical Committee requested that the Governor compile a memorandum on existing thermal springs in the Cape Colony, together with their medicinal uses. This was carried out by Dr Philip Landsberg and published the same year in *The Cape of Good Hope Government Gazette*, where it was stated that the thermal waters of the Cape Colony had been found to be effective for treating a range of diseases, particularly chronic rheumatic diseases, but also, amongst others, wounds, skin diseases, hepatitis, indigestion and goitre.

Today there are about 30 thermal spring resorts spread around South Africa, with at least one in each of the nine provinces, except for Gauteng. These resorts vary quite considerably in size, as well as in the range of facilities and services offered.

While sophisticated wellness facilities are offered at Caledon Spa, Warmbaths (Bela-Bela) and Badplaas, there is no longer any direct medicinal use of thermal waters in South Africa, with thermal springs resorts now functioning primarily as family leisure resorts (Boekstein, 2012).



**Figure 1:** Balneologically classified thermal waters in South Africa (Source: Compiled by the author)

Thermal waters used for balneotherapy are generally classified according to the presence of a combination of cations, anions, trace elements and gases which have been found to have healing properties. Such cations commonly include sodium, magnesium, potassium and calcium, while anions include fluoride, chloride, sulphate and bicarbonate, and trace elements include arsenic, boron, iron, lithium, manganese, rubidium, selenium, silicon, strontium and zinc. Gases include carbon dioxide, hydrogen sulphide and radon.

The first balneological classification of some thermal springs in South Africa was done by Rindl (1936), and later by Kent (1952). Kent's classification includes most of today's best known thermal spring resorts in South Africa, as well as some that are no longer open to the public (Figure 1).

The following water types are distinguished: Indifferent waters, chalybeatic waters, alkaline waters, sulphate waters, salt waters, triple waters, silicious waters, lithium waters and sulphur waters (Table 1).

**Table 1:** Balneological classification of thermal waters in South Africa

Classifications	Descriptions	Locations
Indifferent (simple thermal) waters	Small amounts of dissolved solids, no dominant mineral	The Baths Goudini Spa Avalon Springs Baden Brandvlei Hot Spring <sup>†</sup> Cradock spa Caledon Spa Warmwaterberg Spa Calitzdorp Spa Toorwater <sup>†</sup>
Chalybeatic waters	Contain significant amounts of iron in solution, often accompanied by manganese	Warmbaths Badplaas Tshipise Die Oog Shu-Shu
Alkaline waters	Significant amounts of sodium carbonate and/or bicarbonate, pH always in the vicinity of 9	De Kelders <sup>†</sup> Malmesbury Warm Spring <sup>†</sup> Florisbad Thangami Safari Spa Natal Spa
Sulphate waters	Significant amounts of sodium or magnesium sulphate	
Salt waters	Significant amounts of sodium chloride	
Triple waters	Contain carbonates/bicarbonates, chlorides, as well as sulphate, all in significant amounts	
Siliceous waters	Silica is the dominant constituent	Lilani
Lithium waters	High lithium content	Nkolo Spa Aliwal Spa
Sulphur waters*	Sulphur is present as dissolved hydrogen sulphide, gives the water its characteristic 'sulphur' smell, which disappears soon after exposure to air	Cradock Spa Aliwal spa Tshipise Nkolo Spa Malmesbury Warm Spring <sup>†</sup>

\* Not a true classification. Only a tiny amount of dissolved hydrogen sulphide is necessary for the characteristic sulphur smell. Sometimes springs are described as sulphur springs, when in actual fact other minerals are dominant. The springs listed above under this category all have relatively high hydrogen sulphide contents, but are classified in other categories.

<sup>†</sup> Currently not open to the public

Source: Compiled from Kent (1952: 5-7)

While detailed chemical analyses of most thermal waters in South Africa have taken place in recent years, under the auspices of the South African Water Research Commission (Olivier, Venter & Van Niekerk, 2010; Tshibalo, Olivier & Venter, 2010), no balneological analysis has been undertaken.

While Kent's classification remains the only balneological classification of thermal waters in South Africa, it does not include all thermal spring resorts, some that are included are no longer open to the public, and trace elements such as rubidium and strontium, which have been known to have medicinal functions (Boekstein, 2012), have not been included.

Kent's classification is discussed in more detail below, with added insights gained by referring to Altman (2000), as well as other authors. It should be noted that Altman's information is based on a combination of academic and medical publications, as well as personal interviews with a number of medical practitioners specialising in balneotherapy. Altman (2000) emphasises that the material is presented in the spirit of historical, philosophical and scientific enquiry, and not as medical advice. Thermal waters found in South Africa, with their locations illustrated in Figure 1, are thus classified into the following groups:

### *Indifferent waters*

Indifferent waters, also known as simple thermal waters, contain small amounts of dissolved solids, without any dominant mineral. This classification corresponds to what Ghersetich, Brazini, Hercogova and Lotti (2001) and Altman (2000) refer to as 'lightly mineralised', or 'oligomineral' waters, and its therapeutic action is mainly attributed to its thermal properties, especially if higher than 35°C. Drinking this water is often beneficial to purify the system and for the elimination of toxins (Altman, 2000), and has been found to be remarkably effective for treating gout (Kent, 1952). It helps to reduce stress, increase body temperature and general circulation, relieve muscle and joint pain, and aids in the relief of rheumatic and other locomotive disorders (Altman, 2000). Since these waters are particularly good for drinking, many are bottled and sold commercially. Indifferent thermal waters in South Africa occur at The Baths (near Citrusdal), Goudini Spa and Brandvlei (near Worcester), and Avalon Springs and Baden (Montagu), all in the Western Cape, and at Cradock Spa, in the Eastern Cape (Kent, 1952).

### *Chalybeatic waters*

Chalybeatic waters contain significant amounts of iron in solution, often accompanied by manganese (Kent, 1952). Drinking and bathing in iron-rich water helps to prevent and treat anaemia, as well as to alleviate mental fatigue and stress-related conditions. Iron-rich water also helps to nourish the blood with oxygen and promotes the formation of red blood cells, thus helping to maintain the body's metabolism and better enabling the body to resist disease (Altman, 2000). In South Africa chalybeatic waters are found at Caledon Spa, Warmwaterberg Spa (near Barrydale), Calitzdorp Spa and Toorwater (near Uniondale), all in the Western Cape (Kent, 1952).

### *Alkaline waters*

Alkaline waters contain significant amounts of sodium carbonate and/or bicarbonate, with a pH in the vicinity of 9 (Kent, 1952). With drinking, alkaline waters act as antacids. They also have a diuretic action, and since they dissolve mucous they are useful to facilitate expectoration in cases of bronchial catarrh (Kent, 1952). Drinking water rich in bicarbonates stimulates the appetite and increases the secretion of gastric juices necessary for proper digestion. Bathing in alkaline waters helps to open the peripheral blood vessels of the body, improving circulation, especially to the extremities, and is recommended for people with hypertension and moderate atherosclerosis/hardening of the arteries (Altman, 2000). Alkaline waters occur in the northern parts of South Africa, at Warmbaths (Bela Bela), Die Oog (near Naboomspruit) and Tshipise (near Musina), in Limpopo, and Badplaas in Mpumalanga (Kent, 1952).

### *Sulphate waters*

Sulphate waters contain significant amounts of sodium or magnesium sulphate (Kent, 1952). Magnesium sulphate is more commonly known as Epsom salt. In general drinking water rich in sulphate is likely to be mildly aperient (laxative) as well as diuretic, and taken as baths will act as skin stimulants (Kent, 1952). Conditions that can be treated with sulphate waters include chronic infections of the respiratory tract, such as laryngitis, rhino-pharyngitis, bronchial catarrh and bronchial asthma, skin diseases such as chronic eczema, as well as rheumatism, and postoperative conditions relating to the locomotive system (Altman, 2000). In South Africa sulphate waters only occur at Shu-Shu, in Kwazulu-Natal (Kent, 1952).

### *Salt (sodium chloride) waters*

Salt (sodium chloride), or saline, waters contain significant amounts of sodium chloride (Kent, 1952). Sodium is an essential component of many body fluids, such as blood, tears and perspiration, and chloride helps regulate fluids both in and out of body cells, facilitates the digestion of food and the body's absorption of nutrients, and helps transmit nerve impulses to and from the brain (Altman, 2000). Sodium chloride waters are particularly recommended for bathing, and are indicated for treating skin diseases, rheumatic disorders, arthritis, central nervous system and peripheral nerve diseases, and posttraumatic, orthopaedic and postoperative disorders, as well as certain gynaecological diseases (Altman, 2000). South African springs with high sodium chloride content include De Kelders and Malmesbury Warm Spring (Western Cape), Florisbad (Free State) and Thangami Safari Spa (Kwazulu-Natal) (Kent, 1952).

*Triple waters*

Triple waters contain carbonate/bicarbonate, chloride, as well as sulphate, all in significant amounts (Kent, 1952). The medicinal uses of these minerals are explained in earlier sections. In South Africa this water type is found only at Natal Spa, near Paulpietersburg in Kwazulu-Natal (Kent, 1952).

*Siliceous waters*

Silicious waters have silica, usually present as silicon dioxide, as the dominant constituent (Kent, 1952), although at least some silica is found in almost all thermal waters. Silica plays a key role in bone formation and bone remineralization, and works synergistically with minerals such as calcium, magnesium and potassium (Altman, 2000). Silicon is a major constituent of collagen, the substance that joins cells together, and is important for proper elasticity of the skin, and for healthy hair and nails (Online Vitamins Guide, 2012). Silicate-rich water (silicate is a mixture of silicon, oxygen and other trace minerals) has been successfully used for treating atopic dermatitis, allergic rhinitis and conjunctivitis (Ghersetich *et al.*, 2001). In South Africa silicious waters are only found at Lilani in Kwazulu-Natal (Kent, 1952).

*Lithium waters*

Lithium waters have high lithium content. While little is known about the effects of trace amounts of lithium in thermal waters, many find that it helps to relax the mind and the emotions (Altman, 2000). In modern medicine lithium is mainly used to treat bipolar disorder. It acts on the central nervous system to stabilise a person's mood, helping people to have more control over their emotions, and to cope better with the problems of living (Mayo Clinic, 2012). In South Africa lithium waters are found at Nkolo Spa in North-West Province and Aliwal Spa in the Eastern Cape (Kent, 1952).

*Sulphur waters*

Sulphur is often present in thermal water as dissolved hydrogen sulphide, which gives the water its characteristic sulphur smell. Kent (1952) maintains that this is not a true classification, since only a tiny amount of hydrogen sulphide is necessary for the sulphur smell. Sometimes springs are described as sulphur springs, when in actual fact other minerals are dominant (see Table 1). Breathing in vapours of waters rich in sulphur can help relieve problems of the nasal and respiratory passages, including chronic bronchial catarrh (Altman, 2000). Thermal waters containing high amounts of sulphur can also have a therapeutic effect on the skin, relieving psoriasis, dermatitis and fungal infections (Ghersetich *et al.*, 2001; Altman, 2000). Sulphur also possesses anti-bacterial



and anti-fungal properties, believed to result from it interacting with oxygen molecules in the epidermis to produce an acidic environment that prevents microbe growth (Harris, 2010). Sulphur can also be absorbed through the skin and have an analgesic (pain relieving) effect (Bender *et al.*, 2004). Thermal springs in South Africa with high hydrogen sulphide content include Cradock Spa and Aliwal Spa in the Eastern Cape, Nkolo Spa in North-West Province, Tshipise in Limpopo and Malmesbury Warm Spring in the Western Cape (Kent, 1952).

### *The possible role of radon*

Many thermal waters, including some in South Africa, are said to be 'radioactive', due to the presence of trace elements of radon, a radioactive inert gas. Thermal and highly mineralised waters, especially those rising from igneous rocks, are generally much more radioactive than normal surface and underground waters (Kent, 1952). Radon is easily absorbed by the body, especially by the respiratory passages, skin and digestive system, and although the subject is often controversial, bathing in water containing small amounts of radon gas can be used to treat a range of problems, including rheumatic disorders, arthritis, central nervous system and peripheral nerve diseases, post-traumatic, orthopaedic and postoperative disorders, gynaecological disorders, skin diseases and cardiovascular disorders (Altman, 2000). According to Zdrojewicz and Strzelczyk (2006), water containing radon appears to have analgesic (pain relief) effects and anti-inflammatory properties, but also provides neuro-vegetative balance, in other words it has a calming effect, helping to ease anxiety and maintain or re-establish emotional balance. While the exact mechanism of radon's effect on the human body is not completely understood, radon therapy also appears to aid in the recovery of the immune system, and among the conditions that have been treated at radon-rich spas with the greatest success are rheumatoid arthritis, bronchial asthma and psoriasis (Zdrojewicz & Strzelczyk, 2006). There appears to be little up-to-date data available on radon content of thermal springs in South Africa. Kent (1952) did not include radon in his classification, although in an earlier publication (Kent, 1949) he refers to the radioactivity of some South African thermal springs, including Badplaas, Malmesbury Warm Spring and Brandvlei, acknowledging Rindl (various publications between 1916 and 1931) as being the source of his information. Boekstein (2012) found measurable radon content in all of the thermal springs in the Western Cape, but at levels considerably lower than the minimum recommended for radon treatments at European spas.

## Conclusions

It has been found to be difficult to establish an exact correlation between chemical or mineral composition of thermal water, and its balneological properties (Björnsson, 2000, cited in Kristmannsdóttir, 2010). However, Nasermoaddeli and Kagamimori (2005) carried out an extensive review of literature on the use of balneotherapy in dermatologic, musculoskeletal, metabolic and psychological conditions that included clinical trials, and found that many medical specialists such as rheumatologists and dermatologists now acknowledge the medical significance of balneotherapy. Thermal spa therapy employs a number of different modalities, including balneotherapy and hydrotherapy, and the secret of its influence could be in the ‘wholeness’ of the therapy, the combination of heat, mineral content, radioactivity and the effect of a vacation that provides mental and physical relaxation (Wolf, 1996). Time spent at a thermal spa often has a special ‘therapeutic atmosphere’ of its own, and this may be due in no small part to a change in environment and lifestyle (Karagülle, 2009; Bender *et al.*, 2004).

While many thermal spa resorts in Europe are moving away from the traditional medical cure, based only on the curative properties of thermal water, and are starting to offer a combination of health (medical and wellness), relaxation and recreational activities, the medicinal value of thermal waters, which has contributed so much to medical treatment for hundreds if not thousands of years should not be underestimated. An updated balneological classification of South Africa’s thermal waters, and indeed those of the many other African countries that have thermal water resources, could go a long way towards enabling these countries to establish themselves as part of the growing international health tourism industry.

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