THERMOMINERAL WATERS OF BOSNIA AND HERZEGOVINA AS A FUNCTION OF BALNEOLOGICAL TOURISM

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Spa tourism is a branch of the tourism industry which is based on thermomineral waters as primary resource. This natural resource is one of the earliest used resources, and represents base to the oldest tourism industry called balneology (lat. balneum-bath, gr. logos-science). Treatment with the thermomineral waters, usage of mineral spring waters for drinking and inhalation of vapors at the site of efflux of thermo-mineral water is a very ancient therapeutic method, almost old as the civilization.

Age of spas is confirmed with stone baths founded in the archaeological excavations of ancient civilizations, as well with oikonyms, especially those from the Roman Empire, named after hydronyms of warm waters. Most of oikonyms in Bosnia and Herzegovina are related to hydronym "banja", and refers to the place of hot spring water. Such name is Aqua S, Roman name for Ilidža, whose name is taken from the Turkish language, which translated into Bosnian means bath. In Bosnia and Herzegovina, type of mineral water appoints to some oikonyms, among which is the most common "kiseljak". One of the settlements near Sarajevo has a name Kiseljak.

Thermomineral water is defined with elevated temperatures and high content of mineral matter dissolved in them. Traditionally hot waters, with temperatures similar to the human body temperature, are called spas. In hydrogeological literature, thermal waters are waters whose temperature is higher than average temperatures of place where the hot spring is situated.

Bosnia and Herzegovina is one of the richest countries according to numbers of mineral and thermal springs. Usage of mineral, thermal and thermomineral waters in Bosnia and Herzegovina has a long tradition - since Greek and Roman periods. During these periods, Greeks and Romans have recognized the healing power of geothermal springs.

Key words: *spa, balneology, thermomineral waters, hydrogeology, oikonyms, hydronyms*

INTRODUCTION

Thermomineral waters are studied by hydrogeology, by the part of the mainland, which, among other deals with the thermomineral waters. Considering that they are hot and contain the minerals, which have a beneficial effect on the human body, they are called balneological waters (lat. Balneum - swimming). Balneology is medical science, which studies the therapeutic effects of thermal, mineral and thermomineral water on the human body.

Often we can find balneography as part of Balneology (lat. Balneum - swimming, gr. grafo - describe), the science that deals with the use of improved facilities for swimming baths, as well as all other supporting infrastructure facilities. They all serve for therapeutic treatment and therefore collectively referred to as spas. The therapeutic method of bathing, inhalation of vapors and their use of drinking water, with medical supervision, is a very old method; as many as human civilization.

Therapeutic and other health resort use of thermomineral waters during the stay of visitors is recorded in tourist traffic. Therefore, spas, except medical treatment, incorporated into a tourist destination and spa tourism in the lucrative tourist industry, whose tourist season lasts all year.

Thermomineral waters, their classification and genesis, topographic diversity and their valorisation in tourism of Bosnia and Herzegovina are the object and the subject of this paper. Spa tourism in addition to health motives belongs to recreational tourism, which is increasingly practiced by younger visitors. This type of tourist traffic is the most developed, because of organized and planned duration of stay of tourist groups and their shift during the year which collectively affect the minor seasonal fluctuations in the number of visitors of spa destinations. Therefore, this tourist offer is one of the most stable and most profitable tourist industry.

The paper used methods: content analysis, field prospecting, statistical, cartographic and hydrological methods. Work methodology rests on an analytical procedure, and refers to the evaluation of thermomineral waters for the purpose of development of balneological tourism.

MINERAL, THERMAL AND THERMOMINERAL WATERS

Mineralization of groundwaters

According to international standards, mineral water is called groundwater if in one liter contains more than 1 g or more than 0.1% dissolved solids in one liter of water. If the amount of minerals in one liter of water over 50 grams, or 0.5%, then they are called solutions (Duhot 1963).

Evident border between mineral water and other groundwater, does not really exist. Therefore, the question arises occurrence of mineralization of groundwater. Mineralization of groundwater is often explained by juvenile, inflilitrative and sedimentation genesis.

Juvenile hypothesis mineralization of groundwater associate with magmatism, regardless of whether if it is Plutonian or effusive, which juvenile sources supply by mineral and thermal properties. Juvenile hypothesis relates to the unstable morphostructures of Earth in which have been completed or are still ongoing magmatic activity. Areas of modern volcanism give to groundwater high termal hydrocarbon and nitric acid component, which are at greater depths overheated and whose temperature reaches over 300°C. Juvenile water on the topographic surface releases of high hydrostatic pressure and emerge on the surface in the form of a fountain, which is called a geyser.

Outside the field of contemporary volcanism genesis of mineral springs and wells are brought into direct connection with the processes of infiltration and sedimentation. The genesis of ionic salts enriched with specific mineral components in groundwater occurs from surface lithologic layers, which are the subject of complex absorption and biochemical processes with water. These processes involved in the formation of mineral water are determined by geological and hydrogeological conditions chronology.

Infiltrative mineral waters are less associated with geotekture of platform's shape, and more for geosyncline morphostructures. Geotekture platform, usually produce high mineralization mineral water. Their mineralization is related to the deep artesian strata. Within geosinklinalnih morphostructure genesis of mineral and thermal waters, most often, is

related to tectonic fractures in the cold border of volcanic rocks and strata of subsequent sedimentation of carbonate.

An important role in the formation of mineral waters have gas, resulting in post volcanic activity and during sedimentation. These waters are called gas water.

According to the pH-value of the mineral water is classified in acidic and alkaline. This feature determines their physiological tolerance in balneotherapy use, because some have favorable, others less favorable or unfavorable effect on the human body. Thus, for example, alkaline water have good effect on the metabolic processes in the organism. Based on the pH, mineral waters are divided into: very acidic (pH <3,5), acidic (3,5≤ pH ≤5,5), slightly acid (5,5≤ pH ≤6,8), neutral (6,8≤ pH ≤7,2), slightly alkaline (7,2≤ pH ≤8,5) and alkaline (pH ≥8,5).

Thermal characteristics of mineral waters

International Standards classifie spring water according to temperature into: normal - cold or akrotopege and thermal - hot or akrototerme. Both of these can be mineral. Normal spring water are the ones that can grow undisturbed average air temperature of topographic places in which emerge to the surface. If the temperature of spring water is lower than these, and usually around 4°C, they are called the very cold waters.

Spring water whose temperature is higher than normal temperature water sources are referred to as thermal and divided into:

- hypothermal,
- homeothermal and
- hypertermal spring water.

Table 1. Distribution of mineral waters according to the prevailing content of minerals and gases

Name of mineral water	Mineral components	The minimum amount of mineral matter (g/l)
Water springs	Free radioactive carbon	0,750
Sulphurous	Hydrogen Sulfide (General)	0,010
Iron (ferrous)	Iron	0,010
Arsenic	Arsenic	0,001
Brominated	Bromine	0,025
Iodine	Iodine	0,010
Borne	Boric acid	0,050
Silicijumske	Silicon	0,075
Radioactive	Emanation of radium	10^{-11}

Source: Kissin (1976).

Hypothermal water with a temperature between 20ºC and 34ºC, homotermalne have an approximate temperature of the human body temperature (34ºC to 38ºC), while hyperthermal sources have a higher water temperature of 38ºC. If thermal waters are mineral then they are called thermomineral waters.

Balneological characteristics of mineral and thermal waters

Mineral and thermal water thanks to the general mineralization, ion composition, the content of gases, the presence of therapeutically active components, as mineral, and organic, and some radioactive elements, alkalinity or acidity and elevated temperatures, have a beneficial physiological effect on the body of man and, as such, are widely used in balneology and, as already mentioned, are used differently. For the purpose of hydrotherapy, primarily are used thermal mineral water.

The mineral water includes a large number of natural elements which are, with balneological aspects, divided into four groups.

The first group of mineral water contains: Fe, Co, As, S, Br and B possible, elements with expressed pharmacological action.

The second group consists of the elements affecting the hormonal and fermentalne processes in organisms such as J, Fe, Cu, Mo, Zn, Co, Mn, and Ni and Ba as possible.

The third group of mineral waters belong to elements that are toxic to the human body, and especially: As, Pb, Se, Hg, V, F.

The fourth group consists of elements that are found in the tissues and fluids of the human body, and whose biological role has not yet been determined. They belong to: Ti, Zr, Ir, Cs, Ge, and many others. When the gas in question, balneological be considered, above all CO_2, H_2S and Rn.

According to the predominant mineral composition, mineral waters are divided into sorrel, sulfur, iron, arsenic, brominated flame, iodine, boron, silicon and radioactive water (see Table 1). Of these the most important are: water springs, sulfur, iron, arsenic, bromine, iodine and silicon water.

Water springs are widely distributed mineral water in nature. Dissolved CO_2 (>500 mg/l) gives the therapeutic effect of the beverage to water, and the carbon dioxide concentration higher than 1400 mg/l) makes water curative for external treatment. In addition to the high concentration of dissolved CO_2 in the gas capacity of 80 to 100%, the healing properties of the water is determined by the composition of the anion in which the biggest part has HCO_3. The high concentration of gases is the largest in comparison to all other ground water, where it can be dissolved 18 m^3 of CO_2, in 1 m^3 of water and gives to acidic sources a pulsating effect of leaking.

Sulfur (sulfide) mineral waters have medicinal properties conditioned by the content of free sulfur-hydrogen and hidrosulfidnog ions (H_2S+HS^-). Their content depends on the acidity or alkalinity of the water environment. In acidic waters H_2S is dominantly present, and in an alkaline HS. Sulphurous mineral waters are characterized by high diversity of chemical composition, mineralization and the concentration of H_2S and HS^-. Within this group of water are encountered hydrocarbon, sulfate and chloride water with high levels of mineralization, which often exceeds 500 g/l. Sulphurous waters in balneology are used for bathing where some diseasesed are cu, primarily: skin, rheumatic, nervous and others.

Therapeutic properties of mineral waters, such as: iron, arsenic and those with high contents of Al, Cu, Zn, etc. Of elements is determined primarily by the dissolved iron and arsenic.

Ferric water naturally occur in the form of weak mineralization with relatively low content of iron, while the iron sulphate, mine, water belong to the highly mineralized waters in which the iron content amounts go up to 80 g/l. Iron water is usually formed in the

oxidation zone of sulphide mineralization. According to the basic chemical composition, iron water are usually sulfuric or hydrocarbon class. Sulfuric water containing Fe, Al, Cu, etc. Elements, sometimes at concentrations up to 1 g/l water. Hydrocarbonaceous water have only Fe^{2+} and are characterized by a neutral or weak alcaline reaction.

Arsenic mineral waters contain a basic component of arsenic in the form of arsenic acid (H_3AsO_3) and its ions. In nature occur as water springs of arsenic acid water.

Bromine and iodine mineral water are related to the highly mineralized water of chloride class, sodium, sodium-calcium and Calcium-sodium group, in which the gas composition are predominantly methane and nitrogen. This group of healing waters is used for drinking and bathing. Bromine water are underground mineral water with the basic content of Br greater than 25 mg/l, and an iodine mineral water have a iodine content higher than 5 mg/l of water.

Silicon water are usually thermal and hightermal mineral water, whose temperature can be more than 35°C, and the content of silicon in the form of silicon acid (H_2SiO_3), not less than 50 mg/l. In these waters can be dissolved and the other therapeutic components such as Rn, CO_2, etc. microelements.

THERMOMINERAL SPRINGS IN BOSNIA AND HERZEGOVINA

Classification of mineral waters in Bosnia and Herzegovina

Mineral water as it is presented in Table 1, are distinguish by its content of minerals. According to the principal minerals groundwater are appointed. Also they are appointed to the thermal properties, as stated in: akrotopege whose temperature is below 20°C and akrototerme with temperature is higher than 20°C. The most famous mineral waters in Bosnia and Herzegovina are contained in Table 2.

Bosnia and Herzegovina is one of the richer countries in the number of mineral and thermal waters. The most famous akrotopege include acidic water: Tešanj, Kiseljak, Dubica near Zvornik, Salt water in Tuzla, Guber near Srebrenica and others.

Among Bosnian hypotermal waters a special place have: Gornji Šeher, Laktaši, Fojnica, Olovo, Kulaši and Višegrad. In homotermalne water we include: Ilidža, at Gradačac, Vrućica in Teslić, Banja near Gračanica and Gata near Bihać. Among hyperthermals in Bosnia and Herzegovina, the most popular are: Ilidža near Sarajevo, Dvorovi near Bijeljina and Slatina near Banja Luka.

Sorrel in Kiseljak, sorrel near Tešanj, Dragunja near Tuzla, Tomina near Sanski Most and Slatina near Banja Luka are among the alkaline and alkaline-earth water. Spring of Ilidža in Gradačac, Gornji Šeher and Spa in Tuzla are among the alkali-murjatične mineral water. In murjatične mineral water include Ljeskovica at Žepče and mineral water in Tuzla. Mineral water in Orahovica near Žepče, Guber and Mala sorrel near Srebrenica belong to ferreous waters. The most famous sulphurous waters in Bosnia and Herzegovina is hyperthermal water (57,5ºC) in Ilidža.

Table 2. The most famous mineral and thermomineral waters of Bosnia and Herzegovina

Topographic position	Temperature (°C)	Mineral compositon of water
Kiseljak – Kiseljak	12,2	Hydrocarbon-sulphate-calcium-sodium
Slatina – Banjaluka	40,7	Sulphate-hydrocarbon-calcium-magnesium
Banja Vrućica – Teslić	37,5	Hydrocarbon-chloride-calcium-sodium
Laktaši	30	Hydrocarbon-calcium-magnesium

Kulaši – Prnjavor	30	Hydrocarbon-chloride-calcium-natrium
Olovo	34,5	Hydrocarbon-calcium-magnesium
Fojnica	28,9	Hydrocarbon-calcium-magnesium
Višegrad	34,2	Hydrocarbon-calcium-sodium
Dvorovi – Bijeljina	56	Chloride-hydrocarbon-sodium
Gračanica	37	Hydrocarbon-sulphate-calcium-natrium
Slana banja – Tuzla	27	Chloride-sodium
Ilidža – Sarajevo	57	Hydrocarbon-sulphate-calcium-sodium
Gornji Šeher – Banja Luka	34	Hydrocarbon-sulphate-calcium-magnesium
Gata – Bihać	36	Sulphate-chloride-calcium-sodium
Tomina Ilidža – Sanski Most	29	Hydrocarbon-chloride
Mlječanica – Kozarska Dubica	14	Sulphate-hydrocarbonate-magnesium
Crni Guber – Srebrenica	12,4	The iron-arsenic
Ilidža – Gradačac	28,3	Hydrocarbon-sulphate-magnesium-natrium

Source: Jospipović (1971)

GEOGRAPHICAL POSITION OF THERMOMINERAL SPRINGS

Regional geographic and geotectonic position of thermomineral springs

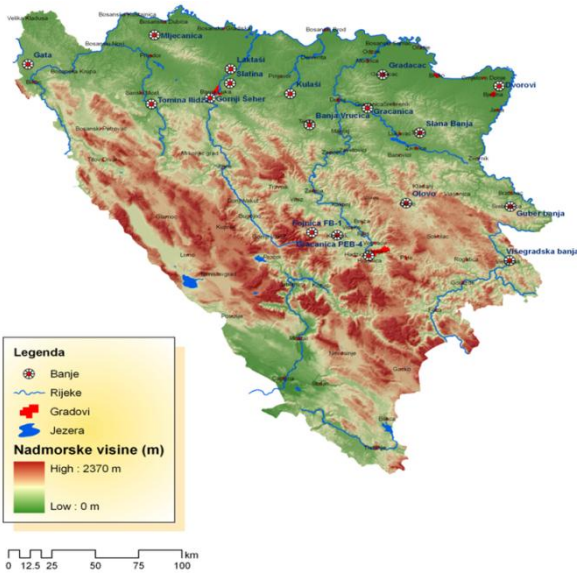

Fig. 1. Geographical position mineral and thermomineral waters of Bosnia and Herzegovina

Basic elements regionalgeography and physicalgeographical position: thermal mineral water in Bosnia and Herzegovina appeared in two geographic regions as follows: northern and central Bosnia. In northern Bosnia thermal mineral springs are located in the Una-Sana subregion in: Bihać, Sanski Most and Kozarska Dubica. In lower Vrbas and lower bosnian subregion mineral water encountered in: Gornji Šeher, Slatina near Banja Luka, Laktaši, Kulaši near Prnjavor and Vrućica near Teslić. Sprečko-Majevička subregion has mineral waters in Tuzla, Dvorovi near Bijeljina, Gradačac, Gračanica and Crni Guber near Srebrenica. Within the central Bosnian region of thermal mineral water are represented in the sub-region of the Sarajevo-Zenica basin and in Ilidža near Sarajevo, Olovo, Kiseljak and Fojnica.

Thermal mineral water on the territory of Bosnia and Herzegovina are characterized by hypsometric azonality of 93 m, what is the altitude of thermomineral spring Dvorovi near Bijeljina up to a maximum 587 m which is the spa in Fojnica.

Climatically the largest number of locations of mineral resources in Bosnia and Herzegovina has a moderately warm and humid climate with warm summers (Cfb), while

the area of thermomineral waters in Dvorovi near Bijeljina has features moderately warm climate with hot summers (Cfa).

Thermal mineral springs in the narrow sense belong to the basin of the river Drina, Bosna, Ukrina, Vrbas, Una and immediate Sava river basin. To Drina river basin belong thermal waters of the Višegrad, Crni Guber near Srebrenica and Dvorovi near Bijeljina. To Bosna river belong thermal waters of the Fojnica, Olovo, Kiseljak, Ilidža near Sarajevo, Tuzla, Gračanica and Teslić. In Vrbas are thermal waters of the Gornji Šeher, Slatina near Banja Luka, and Laktaši. To Una basin belong thermal mineral springs in the Gata near Bihać, Tomina Ilidža near Sanski Most, and Mliječnica near Kozarska Dubica. Thermal mineral water in Kulaši near Prnjavor belong to the basin of river Ukrina, while to immediate Sava river basin belong thermal mineral water in Gradačac.

Thermal mineral water in Bosnia and Herzegovina occur within geotectonic complex: central and inner Dinarides. Most mineral and thermal waters are associated with deep fault zones, which conditioned the modern hydrothermal convection ascendant in deep karst. In addition, there may be in places sariaza Triassic carbonate chalk over fiche, subordinated, and primarily in the cold contact with Paleozoic carbonate rocks. It is not uncommon, cold contact of ultramafic and carbonate, and Jurassic-diabase floral series with carbonates.

In Central Dinarides thermal mineral water generate from the Mesozoic, mainly limestone and dolomite with middle-bosnian schistose mountains in the core, as well as those in Fojnica. Paleozoic sediments are the foundation for the emergence of mineral and mineral water in the Una-Sana and Drina Paleozoic, such as those near Bihać, Sanski Most, Srebrenica and Višegrad.

Central Jurassic-cretaceous and upper-cretaceous flysch zone, which is in geotectonic works also called Sarajevo flysch zone, belonging to the thermal mineral water: Ilidža, Kiseljak, Gornji Šeher, and Slatina and Laktaši near Banja Luka.

Within geotectonic complex of internal Dinarides spa water occur in the central Jurassic-dijabaznoj a pink series and ofiolitskoj zone, such as spas in the Olovo, Kulaši, Teslić and Kozarska Dubica. To Internal or northern Bosnian flysch zone belong thermal mineral water Gradačac, Gračanica and Tuzla.

Occurrence of thermo-mineral waters, except those in Srebrenica, are related to the tectonic fault ruptures. The faults are marker line mineral and thermal waters. These are warm contacts, formed by grinding or breaking the lava in the late stage of sedimentation of sedimentary rocks or in the stage of their formation. Fault lines indicate the juvenile genesis of thermo-mineral waters.

TOURISM VALORISATION OF THERMOMINERAL WATERS IN BOSNIA AND HERZEGOVINA

Importance of thermomineral waters for development of spa tourism in Bosnia and Herzegovina

Spa tourism belongs to one of the oldest forms of tourism in the world. Treatment of thermo-mineral waters in the baths, the use of drinking and inhaling their vapors at the point of rising is as old as mankind.

The main motives of the tourist movements to the spa destinations are health and recreation. The healing properties of water and the natural and social resources, complaisance, equipment and qualified personnel in the spas are decisive motives of tourist visits.

Natural motives bath spa destinations are: landscape diversity spa destinations, favorable climate, preservation of natural ambient value and unobtrusive incorporation of anthropogenic content. Attractive social-geography motives in spa destinations are: sacred anthropogenic activities, cultural events, educational activities (scientific conferences, congresses, symposia, etc.).

Spa tourism is often complementary to other types of tourist attractions, but also it can be a tourist destination that complements with other tourist motives of place and its environment in which it is located. Balneologically tourism has considerable economic advantages over other types of tourism. Its advantages are: the longer average stay of visitors in spa centers compared to other tourist destinations; smallest seasonal fluctuations in capacity utilization, varied tourist offer and higher safety of employees and thus their motivation for engaging in this kind of activities. For this reason, often in the scientific elaboration balneotherapy tourism ranks among the most stable type of tourist economy.

The tradition of using, in particular, thermal mineral waters in Bosnia and Herzegovina back many years where the backbone of the tourist developments were spas. Spa, in addition to tourist importance, have health role as the mineral and hot water used for therapeutic purposes. Their classification in health care institutions exists from those times. Bosnia and Herzegovina has more than 15 spa resorts, with different degrees of development, tourist affirmation and registered as medical institutions.

Balneological tourism in tourism traffic of Bosnia and Herzegovina

Bosnia and Herzegovina has more bath spa centers with different degrees of broader public. Tourist development of these centers is based on the facilities and landscaped areas designed for treatment and recreation visitors.

The basis of spa tourism are: tourist offer, spa facilities, type and quality of accommodation. Spa centers, in addition to the tourism offer in Bosnia and Herzegovina have developed a polyclinic and bathing service, which together with diet consist a base of the sources of income of spa resorts. In this way, spa centers affirm and other tourist facilities and turn them into comparative.

Symbiosis of health and tourism services spa tourism is sustainable and today in Bosnia and Herzegovina is the backbone of tourism development of some places. Data on balneotherapy tourist traffic in Bosnia and Herzegovina are very scarce, to be based on them could perform a valid conclusion about the importance and the participation of the tourism industry in the tourist traffic of Bosnia and Herzegovina. To this should be added the fact that most of the tourist facilities during the recent war devastated and has not been restored. In addition, some spas haven't built a tourist-health resort infrastructure and not treated in the work. In addition, the tourist traffic of individual spa resorts could not be fully considered as a tourist does not operate, ie. Do not have a defined numbers of nights for each year.

Based on all the above stated disadvantages of the data contained in Table 3, along with a presented are not entirely sure, do not allow the formal definition of spa tourist traffic. In addition, the uncertainty of the data presented, with no official reports of economic indicators limits the program studying of identification and evaluation of spas, health resorts in the overall strategy of tourism development in Bosnia and Herzegovina.

Table 3. Tourism traffic in some of the spa centers in Bosnia and Herzegovina

Spa	Number of beds	Number of nights					
		2005	2006	2007	2008	2009	2010
Mlječanica (Kozarska Dubica)	144	29 837	28 158	28 486	34 927	37 135	35 347
Laktaši	114	-	-	-	-	-	8 000
Slatina – Laktaši	308	-	-	-	-	-	77 671
Kulaši – Prnjavor	112	-	-	-	-	13 000	18 500
Vrućica – Teslić	898	97 485	122 312	126 753	129 505	92 122	118 008
Ilidža – Gradačac	150	34 706	37 470	39 707	41 381	38 669	37 757
Dvorovi – Bijeljina	117	-	-	-	-	-	15 000
Terme – Ilidža	400	-	-	-	-	-	-
Reumal – Fojnica	520	-	141 925	153 495	163 934	150 414	148 349
Aquaterm – Olovo	150	23 000	24 730	27 000	28 213	26 951	26 461

Data source: website spas and written documentation

CONCLUSION

Balenological tourism offers in Bosnia and Herzegovina have a tradition which can present base for the development of this tourism type. Spa tourism traffic is based on, once outside the boundaries known mineral and thermo-mineral waters, such as those from Guber near Srebrenica, which were pharmaceutically placed on the European market.

Spas in Bosnia and Herzegovina, among the others identificational tourism destinations are the backbone of a tourism development strategy. If to known and recognized spas are added others still unknown thermo mineral springs, with rather modest investment, our country could be classified among the countries that are rich in this tourism offer.

Revitalization of the known known and valorization of still unused thermomineral and mineral potential requires networked research with the aim of defining specific spatial plans for special purposes. Previously, it would be needed to define or redefine the strategy for tourism development in Bosnia and Herzegovina, particularly in the existing and new spa destinations.

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