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Research article

WATER AND PLANT RESOURCES OF GEORGIA IN SERVE OF HUMAN PROGRESS AND HEALTH PROTECTION

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Abstract

Fuel elements based on H_2S isolatied from Black Sea depth layers has been elaborated. The mineral and thermal waters of Caucasus region of Georgia have been characterized. Various phytocosmetic and medical facilities by using bioactive compounds based on natural plant resources have been recomended. The map describing regional distribution of some medical vegetation in Georgia has been created. **Copyright © IJACSR, all rights reserved.**

Key words: Natural resources, thermal, mineral, waters, phytoresources.

I. Introduction

Georgia is rich in significant natural resources such as barite, bentonites, zeolites, basalt, petroleum, natural gas, manganese, copper, mercury, arsenic, gold, medical mineral and thermal waters, and Black Sea reserves of hydrogen sulfide [1-3].

At this time, the important part of the natural and secondary resources of Georgia has been investigated successfully, for instance, obtaining of high purity metallic arsenic, “white arsenic”, biological active not-flying, stabile coordination compounds, etc.

During the last years by some Georgian research groups were carried out the investigations in order to create low material-spacious and high effective technologies for manufacturing of useful products from natural resources.

Among the natural resources one of the important places takes Black Sea resources, mineral and thermal waters of Georgia [3, 4].

II. Results and Discussion

We followed the next directions in our research:

- The creation of the new type of fuel elements based on hydrogen sulfide isolated from under-water layers of Black Sea;
- The characterization of medical thermal mineral waters;
- Using of the bioactive compounds containing plant resources of Georgia.

II.1. Creation of fuel elements based on H_2S isolated from depth layers of Black Sea

One of the unique characteristics of the Black Sea is its layered body. For instance, 120-160 surface layers are less salty and much lighter in comparison of the layers underneath. These differences are so evident that the waters from those two layers do not mix very easily. That explains the permanent existence of a hydrogen sulfide zone in a Black Sea at a depth greater than 120–160 m. Hydrogen sulfide is mostly generated by a specific bacteria and the concentration on the bottom flow of the sea is 11-14 ml/L, which is 23-29 times higher comparatively to the same levels of different seas. Outflow from the Black Sea through the Bosporus into the Sea of Marmara is not significant to reduce the level of hydrogen sulfide. But it is well established that the level of hydrogen sulfide varies in different parts of equator and is influenced also by the seasonal changes. However, the main level of the hydrogen sulfide in the depth of the Black Sea is unchangeable.

Among the different renewable energy sources the hydrogen, having a potential to replace the fuel on the existing oil markets, is one of the most promising alternatives for the electricity and environmentally friendly fuel. The key criteria for substituting electrical power generated by hydrogen are to create reliable, economic and ecological fuel elements capable to function by using hydrogen or hydrogen-containing raw materials. In the latter case, hydrogen is linked to the carrier molecules. Conversely using those types of raw materials as fuel is more cost effective in comparison of molecular hydrogen as it does not entails some expensive catalysts (e.g. Pt, Pd, Ru, etc.) and molecular hydrogen purification steps [5].

It is well-known that the Black Sea contains high level of hydrogen sulfide, which could be a serious ecological issue but on the other hand can definitely become a potential source for hydrogen. Additional opportunities to deploy hydrogen sulfide in petrochemical synthesis and in production of mineral fertilizers are considered as well.

During the past decade a growing interest has attracted the use of hydrogen sulfide as a renewable energy source but obtaining the pure hydrogen sulfide is an expensive procedure.

Several investigations were conducted to obtain the raw material fuel from hydrogen sulfide, but every single study involved the oxidation of gaseous hydrogen sulfide using expensive catalysts and composite materials under high temperature processing (800-1000^{o}C), which is not a commercially profitable approach.

As the Black Sea contains soluble form of H_2S, currently there is no literature data developing assays using of soluble H_2S as fuel elements.

The interesting results are obtained [5] in terms of use of hydrogen sulfide for creation of alternative fuel element. This gives additional incentive not only for rapid upsurge of country economy but also creates the new, ecologically pure source of energy which will replace petroleum fuel on the traditional market.

Consequently to the appropriate calculations and researches was established that annually it is possible to obtain about 100 billion kW/h electric energy and 70 ton of pure sulfur by means of reprocessing of hydrogen sulfide. Significant is the fact that hydrogen sulphide can be used as fuel-energy, in petrochemical syntheses and in production of mineral fertilizers.

The laboratory models of fuel element based on mentioned above raw materials was created. Experimentally cheap electrode material, stable toward H_2S and its oxidation were chosen (wt. %): Fe – 70.00; Cr – 17.55; Ni – 9.50; Mn – 1.61; Ti – 0.41 and with a little quantity of V, Nb, Mo, Cu) [6]. Besides electrode function, this material carries out catalyst role too. The each current process on specific electrode of fuel element was studied in condition of supply of H_2S solution in various speed and concentration (300 ml/hrs or 500 ml/hrs). The density of current (I, mA/cm^2) and capacity (P, ml watt) required for process, quantities of energy and voltage by visible area of given electrode was calculated during the experiment (Fig. 1).

Anionic membrane (Ralex–AM-PP) with period of use – 320 hours was chosen. Formation of electromotive force in catalytic oxidation (with oxygen) of hydrogen sulfide and their further use in the form of hydrogen for production of non-carbon energy by using of mentioned above electrode and membrane were established. This

possibly will solve the greatest ecological problem of megalopolises and is important mainly in terms of air pool contamination.

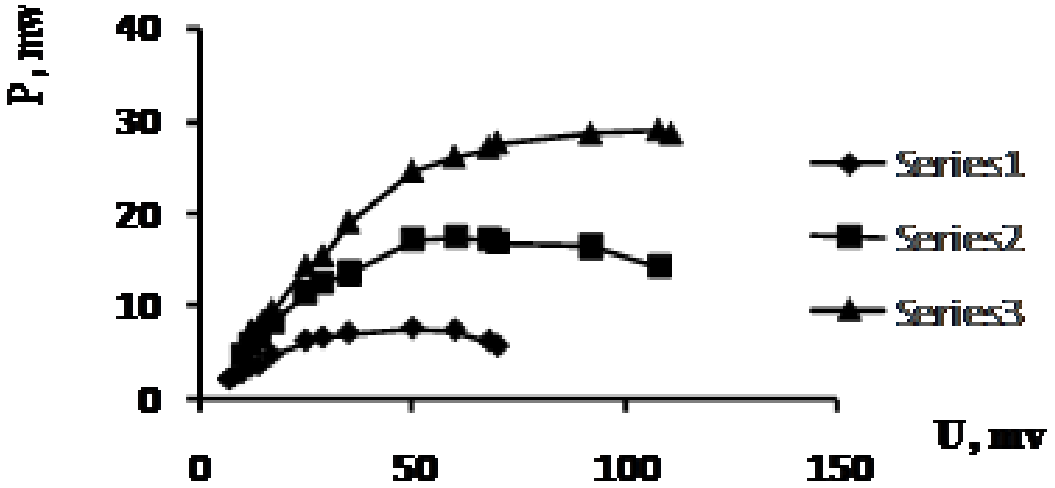

Figure 1. Dependence of arising voltage (on model of fuel element) on density of current electrode: metallic multicomponent electrode-catalyst; $H_2S_{conc.}$: 1 - 50 mg/L; 2 - 150 mg/L; 3 - 220 mg/L; solution supply speed - 300 ml/hrs

II.2. Cracterization and use of mineral and thermal waters of Georgia

Georgia is rich in mineral water resources. At territory of Georgia is registered up to 2000 medical mineral waters, total flow rate of which is more than 150 mln liter per day. Georgian mineral waters are formed from infiltrate and sedimentative relict waters because of influence of natural factors; in some cases, the possibility of juvenile waters participation is not eliminated [4].

High prevalence of carbonic acid mineral waters in fold systems of Great Caucasus and Adjara-Trialeti is in direct relation with fresh volcanic formations: carbonic acid gas, which is a basic factor of formation of mentioned waters, at great depths is generated. Chloride waters within Georgian belt represent combination of sedimental and infiltrate waters.

Distribution of micro components in pressure underground waters of deep circulation, as well as chemical and gas composition is preconditioned by the nature of hydrogeological structures and peculiarities of development history. Based on this fact, we have carbonic acidic waters of HCO_3^-/Na^+ and $HCO_3^-/Cl^-/Na^+$ composition in intensively folded and elevated parts of Greater Caucasus and Lesser Caucasus, while in deeply buried structures of intermountain depression are spread highly mineralized waters of methane $Cl^-/Na^+/Ca^+$ composition. For carbonic acidic waters high contents of boron and lithium, somewhere arsenic, cesium, rubidium are characteristic, while for methane waters high contents of bromine, iodine and boron are distinguished.

Carbonic acidic waters of Jurassic slates are distinguished by high concentration of micro components among water-containing complexes of the southern slope of Great Caucasus. Along with the structure's sinking in carbonic acidic waters of eastern immersion intermissive of mentioned complexes are observed increase in mineralization and variation of chemical composition according to the following scheme: $Ca^+ \rightarrow HCO_3^-/Cl^-/Na^+ \rightarrow Cl^-/HCO_3^-/Na^+$; that is accompanied by increase of content of micro components. In the mentioned zonality the separate sections (destruction intersection nodes) are singled out: Karobi, Utsera, Likoki, etc., where especially high contents of micro components are observed (lithium – 30 mg/l, cesium – 4 mg/l, boron – 100 mg/l, arsenic – 6 mg/l etc.) [7,8].

Along with more deepening of horizons' occurrence in methane waters of Georgian intermountain depress ion region, increase of total mineralization and content of microcomponents: bromine, lithium, iodine etc. takes place in parallel.

As concerns to nitric thermae, which are basically spread in artesian basin of Kolkheti and within fold zone of Adjara-Trialeti, them do not distinguish by particular content of micro components, though there are exception here,

namely, the zone of eastern immersion of Adjara-Trialeti region, which stands out by especially high concentrations of fluorine (5-28 mg/l), where nitric alkaline thermal waters are spreaded.

Georgia is one of the richest regions in the world according to the availability of mineral waters [8]. Here are found more than 2000 mineral springs which belongs to almost all kinds of mineral waters. Two-thirds of them are located in West Georgia (62% of groundwater resources of Georgia). The largest number (about 1700) of mineral waters belongs to natural phenomena and about 200 are obtained by boreholes. The fresh underground water in Georgia compiles 49.5 million m^3 in a day and 573 m^3/sec in total [9]. Some of them, for instance, Borjomi mineral water are of volcanic origin. But there are a lot of less well-known springs which are located far away from settled areas throughout the country. Some of them are located along the roads and thus are easy to access. Their total discharge per day is 120 million liters [8]. This data are changed according to the large variety (Fig. 2).

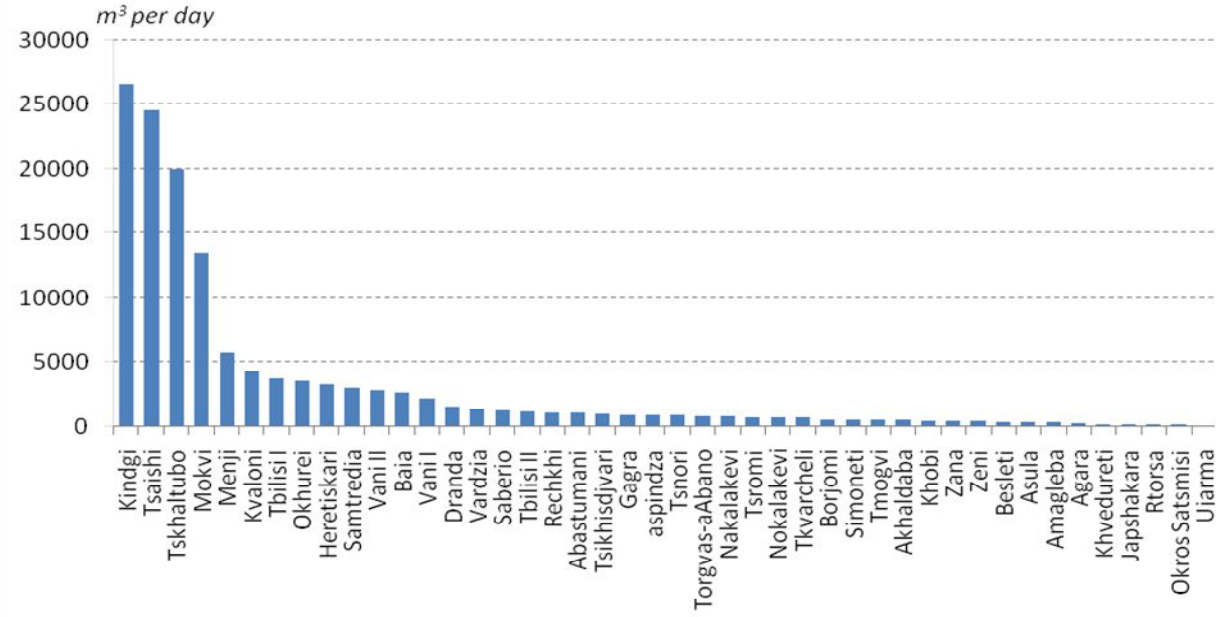

Figure 2. Discharge of Thermal Mineral Waters in Georgia

The mineral waters of Georgia have unique properties, exceptional and interesting tastes (Table 1). They have different curative factors and are used for different purposes: for health-restoration and balneology procedures. The efficiency and prophylactic actions of mineral waters are determined by their complex chemical composition. They also contain different healthy minerals like iodine, calcium, iron, bromine and others. Some mineral waters are indicated for the treatment of patients having diseases of nervous system, circulation and respiratory organs, also patients afflicted with heart and pulmonary diseases, with concomitant gynecologic disorders and with diseases of locomotive system and peripheral nerves. For instance, the diseases of circulation and locomotive organs are indicated Tskhaltubo, Menji, Akhtala etc. Number of plants produces bottles of medical and curative-table mineral waters: “Borjomi”, “Utsera”, “Nabeghlavi”, “Mitarbi”, “Likani”, “Sairme”, “Plate”, “Uraveli” etc. (Table 2). The most of the resorts functioning nearby of the mineral sources are operate in summer-time (June-September). Drinkable mineral waters are used not only at resorts and in Georgia, but far beyond its borders. Among the mineral waters of Georgia with especial medicinal properties distinguish “Sairme” (pebble diseases of the kindey and bladder), “Borjomi”, “Nabeglavi” and “Ucera” (gastrointestinal problems), that gradually go to the world market. “Mitarbi”, “Zvare” and “Likeni” have real prospect on this direction as well.

Water resources are distributed unequally on the territory of Georgia. Distribution and chemical composition of mineral waters in Georgia are determined by location of geologic and geotectonic zones. Territory of Georgia is divided into 5 large tectonic units (Table 1).

Table 1. General characterization of mineral waters of Georgia

Large Tectonic Units	Main Orographic Units	Predominate composition of mineral waters	Predominate thermal conditions of waters	Water resources, m^3/sec
Anticlinoria of the Great Caucasus	Main Watershed of Great Caucasus	Carbonic and hydrocarbonated-nitric	Cold	295
Rock Bend System of Southern Slope of the Great Caucasus	Southern slope of Great Caucasus	Carbonic and hydrocarbonated	Cold	
Intermountain Depression/Boulder of Georgia	Lowlands of Colchis, Inner and Kvemo Kartli, Alazani	Sulfide, methane and nitrogen, also with chloride or sulphate composition sulfides, chlorides	Cold, thermal and super thermal	165
Lesser Caucasus Plicated System	Adjara-Imereti and Trialeti Ranges	Carbonic and hydrocarbonated or chloride-hydrocarbonated, weak sulfide, nitric, sulphate-chloride or carbonate-bicarbonate	Cold and thermal	54
Tori-Artvin-Bolnisi Boulder	Javakheti Plateau, Ranges of Javakheti, Samsari, Erusheti and Nialiskuri	Carbonic and hydrocarbonated or chloride-hydrocarbonated, weak sulfide, nitric, sulphate-chloride or carbonate-bicarbonate	Cold and thermal	59

Table 2. Chemical Composition of Mineral Waters of Georgia

Name of Springs	Main Chemical Composition	Other Substances
Borjomi	Acidulous hydrocarbonate, sodium	Carbone dioxide, chlorine ions, small amounts of Br, Li, Ba etc.
Nabeglavi	Acidulous, hydrocarbonate sodium	Silicic acid
Sairme	Acidulous, hydrocarbonate calcium-sodium	------
Tsagveri	Acidulous, hydrocarbonate, magesium-calcium-sodium variety	Fe, biologically active microelements
Uraveli	Weak sulfide sulphate-chloride sodium-calcium	Silicic acid
Utsera	Acidulous, hydrocarbonated sodium and hydrocarbonated calcium	Ferrum
Zvare	Acidulous, chloride-hydrocarbonate, calcium-sodium	Sodium

More than 50 groups of thermal sources and wells are registered at territory of Georgia [10, 11]. They are distributed very nonuniformly there, though they are spread almost in all hydrogeological regions. Among them the region of interstitial (crack) waters of the Great Caucasus crystalline substrates is the only exception, where there are no data on thermal water outcrops. Total flow rate of naturally cropped out thermal waters with temperature from 20 to 100°C is more than 1000 Liters per second. Georgian thermal waters are distinguished by diverse chemical composition – from fresh hydrocarbonate-calcium waters to highly mineralized chlorine-sodium waters. According to gas composition they are divided into carbonic acid, nitric and methane waters.

The daily discharge of thermal waters is about 135000 m^3 per day. The major thermal waters are [12, 13]: Tsaishi (81-84°C), Kvaloni (94°C), Horga (98°C), Zana (101°C), Kindgi (103°C), Mokvi (105°C), Ohurei (104-110°C), etc. The hyperthermal mineral waters are extracted from the deep level by means of boring and partially are used for economic and municipal services. Thermal radioactive waters (mainly Tskaltubo and Tkvarcheli) are also significant mineral resources in Georgia.

II.2. Prospect of development of the phyto-cosmetic and medical agents based on Georgian region plants

Special actual resources and skilled human resources have been mobilized for the development of modern fine medical and prophylaxis natural solutions and phyto-cosmetic products, which is currently only a new trend for the development of cosmetics with specific characteristics and we currently deem it premature to suggest those as an alternative to existing cosmetic products. Although, new information obtained about them raises hopes that the outlook for the development of phyto cosmetics and phyto cosmetology is feasible [14, 15]. Presently new natural products for the treatment of skin (anti-inflammation, anti-carcinogenic, anti-allergenic, etc.), skin cleansing and soothing have already been developed on the base of medical purpose plants. These products based on various bioactive substances (alkaloids, lipids, flavonoids, glycosides, saponins, terpene, phenolic and triterpenic substances, organic acids, essential oils, etc.) are extracted from plants' leaves, membranes, roots, flowers (Fig. 3), as well as herbs and some of the fruits (peihoa, kiwi, etc.).

Hellrus caucasikus A.Br

Helleborus abchasicus A.Br

Jucca gloriosa L. Scop.

Tribulus estris

Rucus pontikus Woronow

Cotinus coggygria

Figure 3. The fictures of some plants containing bioactive compounds

We created the map (Fig. 4) describing the regions of Georgia with plants containing various bioactive compounds aimed for preparation phyto-cosmetic and medical agents.

Georgia is characterizing with diverse and contrast natural conditions which is determined by topographic peculiarities, rock character paleogeographic development, climatic and edaphic conditions, proximity of different floristic regions, and etc. According to the landscape diversity, per square km, Georgia is on the first place in the world [14]. There are almost all types of landscape zones (except savannas, deserts and tropical rainforests), which are represented by extra-humid, humid, semiarid and arid landscapes, which range from plain and foothills to high mountain alpine and glaciers zone. Due to diverse natural conditions of Georgia, a wide variety of medical herbs (some of those are listed on Fig. 4) can be found in the country. This is true in case of almost all regions and landscape zones of Georgia, where several varieties of medical plants grow. For point of view it is a very important that there is the sharply expressed vertical zonation of landscapes. Despite of strong anthropogenic impacts in some places, diverse, unique and virgin ones still remain in many territories. One further major peculiarities of Georgia is the existence of comparatively large area of the slightly changed landscapes. The great part (58 %) of its territory has relatively high percent of the non changed or less changed ecosystems [15]. Virgin forests occupy almost 10% of total territory of Georgia [15]. Besides the high mountain glacial landscapes, the most untouched area is in middle-mountain zone with beech and dark-coniferous forests. Moreover, against the global background, Georgia is a relatively unaffected 'island' with few environmental "hot spots" [19].

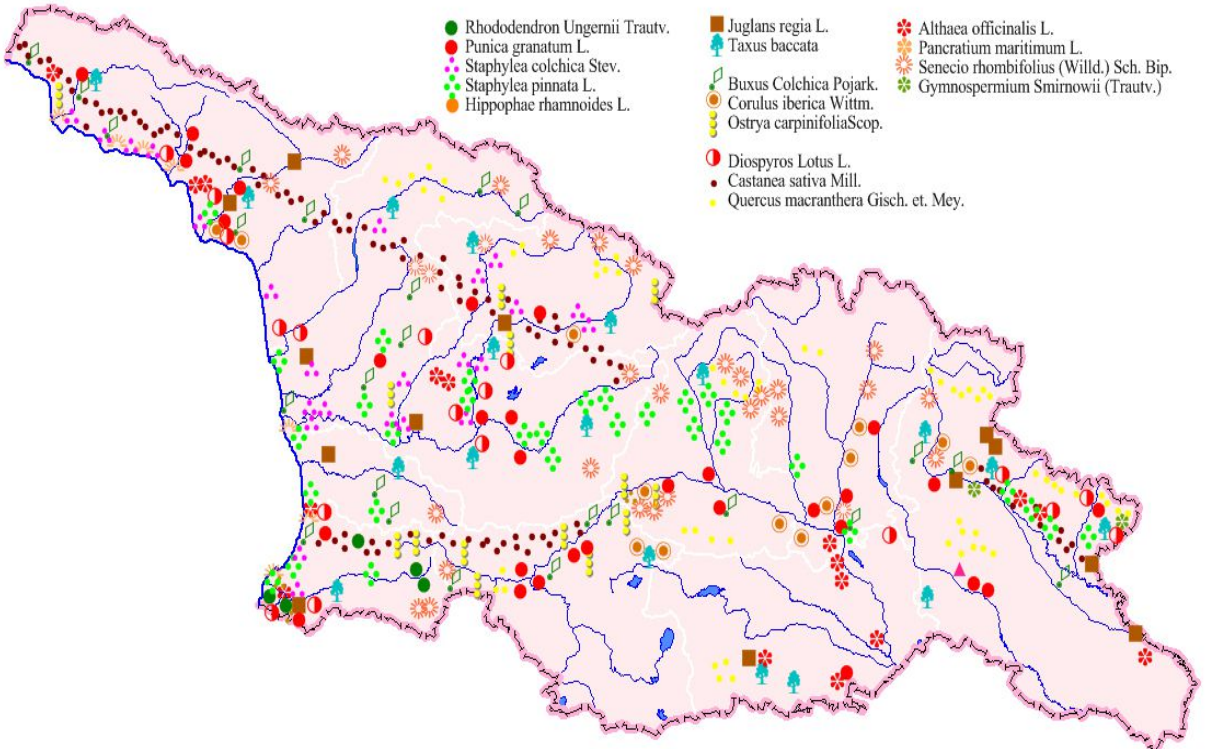

Figure 4. Distribution of Some Medical Vegetation in Georgia

Climatic-edaphic factors of the country are favorable for the creation of their industrial plantations which creates serious opportunities for the development of phyto-cosmetics and naturopathy enabling Georgia to obtain its place among the leading countries of the world in this sector and to contribute to further economic development of the developing region. The above-mentioned products rivaled with the synthetic substances the raw materials for which are based on oil and petroleum product, obtaining of which becomes increasingly difficult.

According to the medical plant, the most reach are plain and foothill humid, also high mountain alpine zone. Here are represented different species of medical plants. Another important area, rich with medical plants are low and Middle Mountain landscapes with beech and dark coniferous trees. These plants have been used by the people of Georgia for thousands of years. Information about traditional use of medical are scattered throughout the historical documents and literature [16].

On the other hand, over harvesting, mainly for the pharmaceutical industry, threatens many medical plants with local extinction and at present, some medical plants such as *Origanum vulgare, Helichrysum plicatum and Hypericum* are at risk of extension [16].

The Georgia School of Pharmacological chemistry was designed (Academician Eter Kemertelidze, *et al.*) and introduced scores of preparations and bioactive phyto products in the pharmaceutical and phyto-cosmetology practice [17].

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III. CONCLUSIONS

- Fuel elements based on H_2S isolated from Black Sea depth layers has been elaborated;
- The mineral and thermal waters of Caucasus region of Georgia have been characterized. Predominate composition of mineral waters and chemical composition of mineral waters of Georgia are given;

- Various phytocosmetic and medical facilities by using bioactive compounds based on natural plant resources have been discussed; their prospective use has been recomended;
- There is created the map describing regional distribution of some medical vegetation in Georgia.

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