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The History of the Blue Lagoon in Svartsengi

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ABSTRACT

As early as 1978, people suffering from psoriasis began bathing in the bluish colored geothermal fluid of a small lagoon adjacent to the Svartsengi geothermal combined heat and power plant. The relaxation and relief the people got in the lagoon initiated the development of the Blue Lagoon complex of today. Today, the Blue Lagoon consists of the Blue Lagoon Bath, Blue Lagoon Clinic, and Blue Lagoon Skin Care. Research and Development is an important foundation for the company and its operation. The paper describes the three decades long development of the Blue Lagoon and the core operation of each of the three units. The scientific background of the operation is emphasized.

1. INTRODUCTION

The Blue Lagoon is an innovative company in health, wellness and skin care powered by geothermal energy. Its operation is powered completely by Iceland's clean geothermal energy. Located in the heart of the Svartsengi Resource Park, Blue Lagoon is significant for the geothermal energy - an increasingly important element in today's world.

2. HISTORY

The Blue Lagoon was formed in 1976 following the operation of Hitaveita Suðurnesja (today HS Orka hf) – the local environmentally friendly geothermal power company. It is located on the Reykjanes peninsula in south-western Iceland that is primarily composed of porous lava. An image of the Blue Lagoon is displayed in Figure 1.

Figure 1: The Blue Lagoon

The Blue Lagoon is a part of an ecocycle which is an example of the unique relationship between nature and technology.

The high-temperature geothermal areas in Iceland are found inside the spreading zone of the two tectonic plates which Iceland straddles, the American and the Eurasian plates, and are closely associated with the country's active volcanic systems. Cold ingressed fluid, a mixture of sea water and ground water, comes into contact with cooling magmatic intrusions at great depths, is rapidly heated and ascends towards the surface. The temperature of the geothermal fluid exceeds 200°C at depths of less than 1 km.

HS Orka hf extracts the geothermal reservoir fluid from wells either vertically or directionally drilled deep into the reservoir. The wells are as deep as 2000 meters, and the fluid attains temperatures as high as 240°C.

This geothermal fluid is then used to heat freshwater for central heating purposes and to produce electricity. This unusual and ecologically sound power plant, the only one of its kind in the world, sustainably provides about 17.000 people with hot water for central heating. Some 45,000 people get their electricity from the power plant.

As shown in Figure 2, the geothermal reservoir fluid is led directly to the Blue Lagoon Bath and Clinic where people bathe in the geothermal fluid for healing and wellness purposes. It is also brought to the Research and Development Center where its active ingredients are isolated. HS Orka hf also provides the Blue Lagoon with hot and cold water and electricity.

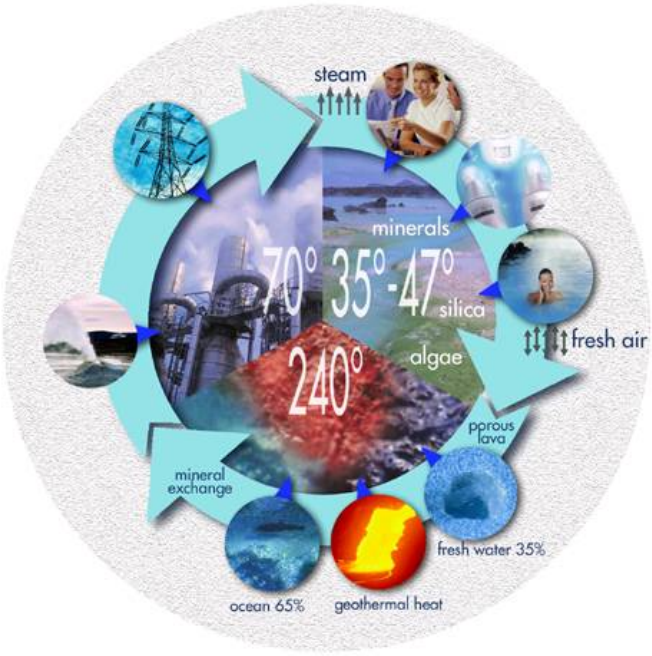

Figure 2: The Blue Lagoon Eco cycle.

Blue Lagoon is part of the Svartsengi/Reykjanes Resource Park - a world unique concept based on: Multiple uses of a variety of subjective and objective resources of different

nature is the very core of the concept Resource Park. The Resource Park "equally" accentuates ecological balance, economic prosperity and social progress. The Resource Park bridges different technical and social cultures and endeavour not to waste any resource. The Resource Park is a lodestar on the way to sustainable development. The Svartsengi/Reykjanes Resource Parks could be a preferable paradigm for harnessing all types of energy/geo resources. HS Orka hf established the Svartsengi Resource Park in 1977. In addition to the Blue Lagoon, ORF and Carbon Recycle are examples of companies founded on sustainability. They operate within the Svartsengi Resource Park and base their operation on the natural resources that HS Orka hf provides: renewable geothermal energy and CO_2 for possible use in growing microalgae.

2.1 Cooperation

The operations of HS Orka hf and Blue Lagoon hf are connected in many ways. HS Orka hf has been a lead investor in the Blue Lagoon since the company's foundation in 1992. Together, the companies have amassed valuable operational and scientific know-how that flows seamlessly between the companies. The employees of both companies are building up valuable experience and knowledge in the area of harvesting geothermal energy.

2.2 Education

Eldborg, an educational and conference center located in the Resource Park, is a unique example of the partnership between the two companies. Owned by HS Orka hf, the center was built with the vision of increasing knowledge of the area's geology and geothermal activity as well as provoking interest in the subject among students, international visitors, and the general public. The Blue Lagoon, now a leading tourism company in Iceland, runs and operates Eldborg. This partnership provides a good example of the parallel relationship between the two companies and transfers knowledge between the companies and to the public.

A high-temperature geothermal area is located at the Svartsengi area, and the power plant complex of Hitaveita Suðurnesja commenced its commercial operation in 1976. The Blue Lagoon was first created when hot brine from a nearby geothermal power plant was discharged into the adjacent lava field. Soon after the lagoon had been formed, its healing effects on psoriasis patients were discovered. Members of the Icelandic Psoriasis foundation built a very primitive shelter to make it possible for the members to change clothes and shower after bathing. Later, the members were given a mortuary that was no longer in use and which served its new purpose at the Blue Lagoon for a number of years. In 1987, the first bathing facilities for the public opened. Until then, both the public and people with psoriasis had been bathing in the lagoon and using the primitive available housing. The Blue Lagoon Ltd., which now runs the Blue Lagoon, was founded in 1992 to lead health-related tourism related to the Blue Lagoon. The company took over the operation of the Blue Lagoon facilities in 1994. The same year, the Blue Lagoon opened a treatment center for psoriasis patients in cooperation with Icelandic Health authorities. Scientific studies on the healing power of the Blue Lagoon conducted in 1992-1996 [1,2,3,4] provided the scientific data essential for the Blue Lagoon to become recognized by the Icelandic Health Authorities as an official treatment center for psoriasis.

Figure 3: Blue Lagoon Dermatology Clinic where the Blue Lagoon psoriasis treatment is offered.

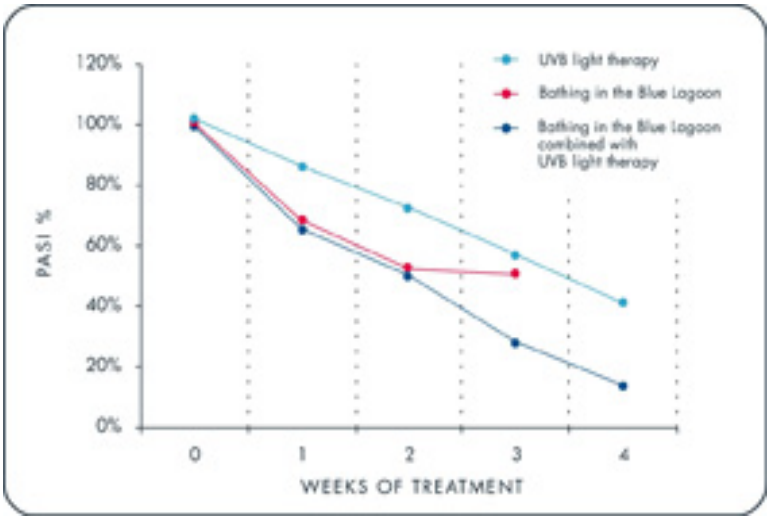

Figure 4: Graph shows comparison of PASI scores for psoriasis patients that only bathed in the Blue Lagoon, those that bathed in the lagoon and received UVB light therapy as well, and those that only received UVB light therapy. In order to facilitate comparisons, all PASI scores are shown as a percentage of initial scores.

The Blue Lagoon psoriasis treatment is now offered at the new Blue Lagoon Clinic that opened in 2005. It is a dermatology research center specializing in psoriasis treatment. The treatment is natural and without side effects. The Clinic includes a specially designed room for guests to relax in after bathing and light therapy. Massage rooms and rooms for medical examinations and doctor's appointments are onsite. Spacious changing rooms and a private area for disabled and special-needs patients is available. The Clinic includes a hotel area available to patients and other guests.

The Blue Lagoon psoriasis treatment is offered in cooperation with Icelandic Health authorities. Scientific studies on the healing power of the Blue Lagoon conducted in 1992-1996[1,2,3,4] provided the scientific data essential for the Blue Lagoon to become recognized by the Icelandic Health Authorities as an official treatment center for psoriasis. Continuous psoriasis research is conducted in cooperation with the Landspitali University Hospital.

The Blue Lagoon treatment is also recognized by health authorities in the Faroe Islands and Denmark. Psoriasis patients from more than 20 countries have enjoyed the Blue Lagoon psoriasis treatment

2.3 Blue Lagoon Bath

The Blue Lagoon Bath is the heart of Blue Lagoon's operation. It is one of Iceland's most visited sites with more than 400,000 visitors annually. The bathing lagoon has an area of 5000 m^2. At any one time, the lagoon holds six million liters of geothermal brine all of which is renewed in 40 hours. Blue Lagoon's guests actually bathe between two continents as the Euro – Asian and American tectonic plates meet at the Blue Lagoon.

The facility opened in 1999, and was enlarged and re-designed in 2007 to offer guests more comfort and service. In addition to the lagoon itself, Blue Lagoon offers its visitors a range of services including in-water spa treatments and massage and access to geothermal steam baths, saunas, a geothermal waterfall and an indoor pool. Guests can choose between general changing facilities and a VIP area offering a private changing room and relaxing area. Restaurant service is offered at the Lava restaurant built into the lava cliff surrounding the Blue Lagoon. For six consecutive years, the Blue Lagoon has been awarded the Blue Flag environmental recognition granted to beaches and marinas.

Figure 5: Blue Lagoon - The distinctive blue color of the lagoon is caused by the reflection of sunlight from very small silica molecules in the geothermal seawater. This is similar to what takes place in the atmosphere and gives the sky its blue color Blue Lagoon Skin Care Line

A Blue Lagoon skin care line based on the Blue Lagoon's geothermal brine and its elements was launched in 1995. The initial products were developed with the needs of people with psoriasis and sensitive skin in mind. Three years later, a line including spa and wellness skin care was introduced. As a result of intensive research on the Blue Lagoon's geothermal brine revealing its skin barrier strengthening and anti aging effects, a new Blue Lagoon skin care line with anti-aging properties was launched in 2007. The Blue Lagoon skin care line now has 54 products including both retail and professional lines. The skin care line classified as Naturceutical provides a link between pure natural products and cosmeceuticals. The Blue Lagoon geothermal brine and its unique active elements are the foundation of the skin care line. Blue Lagoon active ingredients, or the bioactive molecules in the Blue Lagoon skin care products, are harvested in perfect harmony between nature and science.

Figure 6: Blue Lagoon Skin Care Line – based on the Blue Lagoon geothermal brine and its unique bioactive elements.

2.4 Blue Lagoon City Spa

Further development of its spa services led to the opening of a Blue Lagoon City Spa in Reykjavík. The spa offers a selection of spa treatments developed by Blue Lagoon's specialists. All treatments are based on the use of Blue Lagoon skin care and its active ingredients.

2.5 Blue Lagoon Shops

Blue Lagoon shops focusing on selling Blue Lagoon skin care products opened in 2005. The shops are located in the Reykjavík City Center and the Keflavík International Airport. The skin care is distributed worldwide through the company's online shop on www.bluelagoon.com. It is also available through retail in Denmark and Germany.

2.6 Blue Lagoon Research & Development Center

Research & development powered with green energy has been one of the pillars of Blue Lagoon's operations from the beginning. The Blue Lagoon Research and Development team works with some of the world's most distinguished scientists, creating a strong, professional network and knowledge in bio-technology, dermatology and marine cosmetology. Key R&D projects include basic research on the Blue Lagoon geothermal brine and its elements (i.e. microbial community, silica and minerals; comprehensive screening of active ingredients), efficacy and clinical studies on the healing power, development of harvesting and processing methods of Blue Lagoon active ingredients, and the development of Blue Lagoon skin care products and treatments. The Blue Lagoon research & development center is located in the heart of Svartsengi Resource Park powered by renewable geothermal energy.

Blue Lagoon holds exclusive rights to harvest active Blue Lagoon geothermal brine and the thermophilic "hitakærar" microorganisms on the Reykjanes peninsula.

In vitro and in vivo studies prove that the Blue Lagoon active ingredients (silica and two types of algae) strengthen the skin's natural barrier function, prevent UV induced collagen degradation, and stimulate the skin's own collagen production[7]. These findings have been patented.

2.7 Blue Lagoon Harvesting Center

The harvesting of the exclusive Blue Lagoon active ingredients takes place at the company's innovative green production center located on the Blue Lagoon site at the center of the Svartsengi Resource Park.

Blue Lagoon uses green production methods to harvest the natural and unique Blue Lagoon active ingredients: geothermal brine, silica, minerals and algae known for their healing power and positive effects on the skin.

The production and all processes are powered by renewable geothermal energy.

2.8 Biotechnology - Microalgae Production

Blue Lagoon produces microalgae and its extracts year-long for use in cosmetics. The company is active in microalgae research: screening of new types of algae in the geothermal area, producing valuable ingredients for use in cosmetics, nutritionals, fish feeding, lipid production and production of biofuel. Blue Lagoon has the exclusive right to research microorganisms on the Reykjanes peninsula. The production takes place in Blue Lagoon's biotechnology center located in the heart of the Svartsengi Resource Park. The production is environmentally friendly and controlled using a tubular bioreactor system and renewable energy directly from the natural geothermal sources.

Two types of Blue Lagoon algae, filamentous and coccoid, are produced in the Blue Lagoon Harvesting Center for use in the Blue Lagoon skin care range. Scientific studies on the geothermal seawater brine have shown that the microbial community is unique, since 60% of the organisms are novel on a species level. The Blue Lagoon algae is among these[5,6].

2.9 Research on the Utilization of Carbon Dioxide to grow Microalgae

A new project run cooperatively by HS Orka hf and Blue Lagoon hf concerning the utilization of "raw" geothermal gas/carbon dioxide from HS Orka´s geothermal energy plant in Svartsengi to grow microalgae has been undertaken. The Blue Lagoon will also test different algae types for lipid production and utilization in cosmetics, nutritionals, fish feeding and in future biofuels. This project is supported by the National Energy Fund.

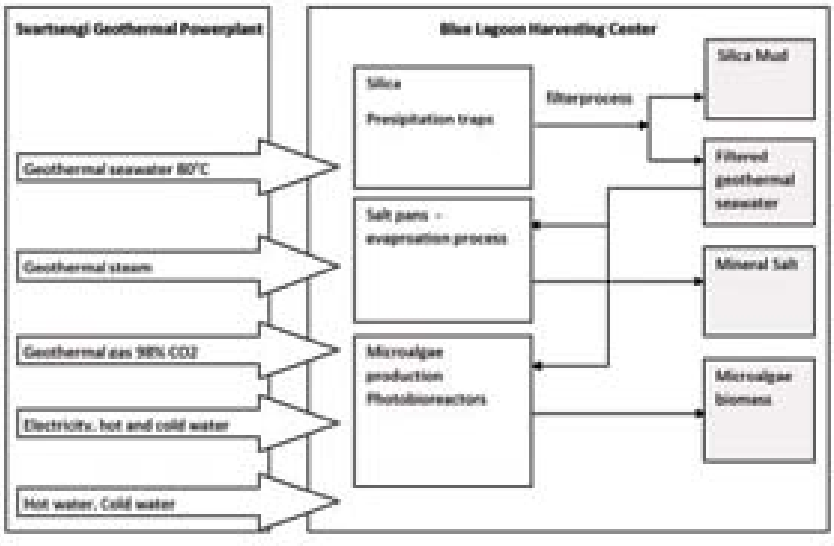

Figure 7: The production and all processes at the Blue Lagoon Harvesting Center are powered by renewable geothermal energy sources from HS Orka´s Geothermal Power Plant in the Svartsengi Resource Park.

Figure 8: Microalgae production for use in Blue Lagoon Skin Care products takes place at the Blue Lagoon Harvesting Center in the heart of the Resource Park in Svartsengi.

2.10 Silica Production

Blue Lagoon silica is a natural product harvested with sustainable methods free of carbon emissions. It is harvested from the silica rich Blue Lagoon geothermal brine with precipitation for use in cosmetics as an active ingredient for a skin barrier strengthening effect[7], skin renewing effect, and deep cleansing effect.

The production takes place in the Blue Lagoon's Harvesting Center located in the heart of Svartsengi Resource Park powered with renewable geothermal energy.

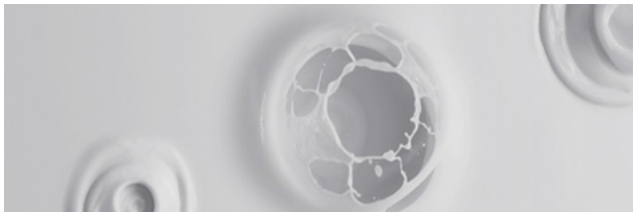

Figure 9: Blue Lagoon silica is known for its beneficial effects on the skin. The silica is produced with environmentally friendly and carbon emission free processes at the Blue Lagoon Harvesting Center in heart of the Svartsengi Resource Park.

The Blue Lagoon silica (SiO_2) is the most characteristic element of the Blue Lagoon geothermal brine. This pure, white silica is a dissolved primary rock directly from the Earth's mantle and enriched with essential minerals. Silicon is the second most abundant element in the eart crust (oxygen is the most abundant), and it has the symbol Si. In nature, silicon is normally found in chemical compounds with other elements and not in its pure form. Pure silicon is conventionally processed from rocks and sand using energy intensive methods. In geothermal areas, many substances including silicon are dissolved in hot water or hot brine as in the case of Svartsengi. When dissolved in water, silicon is chemically bound to oxygen and hydrogen in a form of so-called silicic acid. When hot brine from Svartsengi is discharged into the Blue Lagoon, it cools down and the silicic acid´s solubility is decreased. Due to the cooling, the brine becomes supersaturated with the silicic acids which in turn precipitate as silicon oxide. The white “silicon mud” of the Blue Lagoon is thus not the element Si but a compound of silicon and oxide called silica. Microparticles moving in the brine may act as nucleation sites for the silica precipitation. Consequently, the particles grow and fall to the bottom of the Blue Lagoon, where they form a fine white mud. In a similar way, larger stone such as the lava rocks surrounding the lagoon may also behave as nucleation sites when they come into contact with brine supersaturated with silisic acid.

One form of the Blue Lagoon silica is a white mud known for its healing power and anti-aging effects. It is an important element in the Blue Lagoon treatment offered at the Blue Lagoon Dermatology Clinic. The silica mud is the star product of the Blue Lagoon skin care line.

2.11 Mineral Salt Production

Natural minerals are extracted from the mineral-rich Blue Lagoon geothermal brine with an evaporative process using geothermal steam. The minerals are known for their revitalizing and soothing properties and are an important ingredient in the Blue Lagoon Skin Care Products. The production takes place in the Blue Lagoon's Harvesting Center located in the heart of Svartsengi Resource Park.

3. CONCLUSION

The history of the Blue Lagoon is a unique example of the multiple uses of natural geothermal energy. The relationship between the innovative geothermal energy company, HS Orka hf., and Blue Lagoon shows how parallel ways of thinking in terms of finding new solutions are an important bridge between the science and harnessing of geothermal energy and transferring it to new products and services that represent wellness and healing.

The international cosmetics market makes increasing demands on environmentally sound production methods and the use of green chemistry. The knowledge the Blue Lagoon has built up in the cosmetic industry has great potential for further growth in this area. Environmentally friendly production of Silica (SiO2) as is carried out in the Blue Lagoon‘s Harvesting Center is likely to bring new opportunities to the cosmetic industry as silicon is conventionally processed from rocks and sand using energy intensive methods. Microalgae production is becoming increasingly important in connection with production of next-generation biofuels. The project, building on years of experience and cooperation between Blue Lagoon and HS Orka hf, is an important step for the further development of geothermal resources.

Clear vision and innovation has led to a unique concept, and the Svartsengi Resource Park represents the harmony between nature and science. Renewable and sustainable methods in utilization and harvesting are emphasized. The geothermal brine is utilized in all stages of its temperature (240°C – 0°) until it is pumped back into the earth. The rich natural resources of Svartsengi Resource Park and the Reykjanes peninsula such as environmentally sound energy, hot and cold water, carbon dioxide (CO2), geothermal brine and cold seawater, coupled with the knowledge that has

been built up within Blue Lagoon and HS Orka hf, bring further opportunities for development in green industry.

Sustainable utilization of geothermal resources can only become more valuable in the global community as sustainability becomes more of a necessity.

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