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Direct Uses of Geothermal Energy in Argentina

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ABSTRACT

In Argentina the development of geothermal energy for direct applications is being given high priority, since the generation of electricity using geothermal fluids is not economical at present.

The direct use of geothermal fluids for space heating, in balneology, agricultural and industrial applications, etc. will contribute to the economies of certain regions of the country. Several projects are under development. The main ones are in: Río Valdez Thermal Area (hotel tourism and agriculture), Cerri Project (shrimp farming); Carrindanga Project (space heating), Médanos Thermal Area (recreational-therapeutic developments), Villa Elisa Thermal Area (thermal-therapeutic center) and Colón Thermal Area (thermal-tourism complex).

The most important direct uses of geothermal fluids in Argentina are: Balneology (over 84 establishments); Snow Melting: (Copahue-Caviahue Area); Greenhouse Heating (Cacheuta Thermae and in Bahía Blanca-Pedro Luro Area); Space Heating and Hot Water Supply (Domuyo Thermal Area and Bahía Blanca Thermal Basin); and Aquaculture (Gan Gan Thermal Area and Bahía Blanca Thermal Basin).

Introduction

In Argentina, as in most countries, the direct use of geothermal energy began with balneology, which is mankind's first use of natural heat from the Earth's interior. The early recognition of the therapeutic properties of thermal waters, as well as the numerous geothermal areas, resulted in the opening of many thermal centers in the country. Geothermal energy is also used for heating buildings and in washing operations. These traditional applications show the intimate relationship between man and geothermal energy. Direct use projects have developed due to the wide distribution of low-enthalpy thermal fields in Argentina, without any government financial support.

Geothermal studies started in Argentina in the 1970's. In the beginning, the work was directed toward the development of geothermal energy for electrical generation. The early geological and geochemical reconnaissance studies identified the best thermal areas to be investigated in further detail. This was followed by pre-feasibility and, in some cases, with feasibility studies. A binary 670 kWe pilot plant was installed at Copahue-Caviahue in the late eighties.

Since 1990 research on low- and high-enthalpy geothermal fields has been focused on the economic development of given areas based on direct use of geothermal energy. At the present time in Argentina it is more expensive to produce electricity from geothermal energy than from fossil fuels. This is true even for Copahue where the geothermal plant is being converted to natural gas, an abundant and cheap resource in the region. This plant has been off-line since 1996.

Due to the characteristics of Argentine geothermal resources, the use of geothermal fluids in direct applications was recommended. The energy will be used for heating buildings, in agriculture and industry, in hotels, tourism and balneology, to name a few of the applications.

Status of Geothermal Energy Development

The country's geothermal resources are reasonably well known, but the development of geothermal areas is still minor. At present, geological and geochemical surveys have been completed in 90% of the high-enthalpy fields, but only in 75% of those of low enthalpy. Studies in the Andes and nearby areas indicate that the potential for geothermal energy development is significant in the region. Geothermal reconnaissance studies have been carried out recently in the South (Patagonian Cordillera, Central Plateau of the Chubut Province) and in the Northeast (Entre Ríos Province). In 1999, two new areas in Santa Cruz Province (S) and in Corrientes Province (NE) will be studied in detail.

On the basis of the results of the geoscientific investigations, 19 geothermal areas (Figure 1) were studied in detail, including pre-feasibility studies. The high-enthalpy areas related to volcanic activity are: Tuzgle, Domuyo, Copahue and Valle del Cura. Low-enthalpy areas are: Cerri, Médanos, Carrindanga, Caimancito, La Quinta and El Palmar, Río Valdez, Santa Teresita, Suriyaco, Colon, Villa Elisa, Larroude, Telsen and Gan Gan.

The last exploratory wells were drilled in the geothermal areas of Copahue, Cerri, Médanos, Carrindanga, Colón, Villa Elisa, Federación and Larroude.

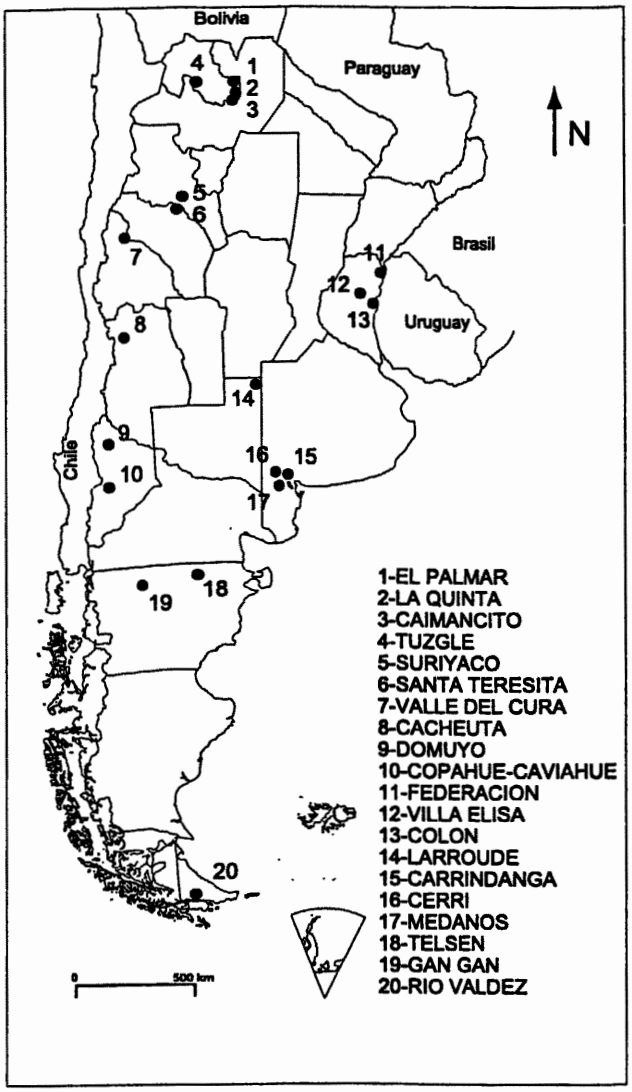

Figure 1. Argentina. Thermal areas mentioned in the text.

Direct Use of Geothermal Energy

The development of projects for the direct use of geothermal energy was recognized as a means to improve regional economies. The national government, provincial authorities, and private companies cooperated with the Subsecretaría de Minería in the selection of the most promising areas, in the evaluation of their resources and in the planning of the commercial development of geothermal fields. The most important direct use projects are shown in Figure 2.

Main Direct Heat Projects (Ongoing and Under Development)

Río Valdez Thermal Area

Direct use: Hotel, tourism and agricultural applications.

The Río Valdez project is located on the western slope of the Cordillera Fueguina chain, 10 km south of the eastern border of Fagnano Lake in Tierra del Fuego Province, at an elevation of 200 masl. This geothermal area is particularly important for the development of the regional economy. It could attract winter sport enthusiasts (such as alpine skiers), as well as summer vacationers. Due to the long winters in Tierra del Fuego there are excellent opportunities for direct geothermal energy applications, such as space heating and supplying hot water to homes and greenhouses.

The following is a summary of the main features of Río Valdez Thermal Area (Los Baños and Turbal Caliente thermal baths). The geothermal waters are of meteoric origin (residence time of more than 50 years) and of sodium bicarbonate type (pH 7,8-8,2; conductivity: 631-658 µs/cm).

Geophysical studies indicate a 5 km long reservoir at about 500 meters depth, with a resistivity of 2000 ohm/m. The conducting body begins at 200 meters depth and is found along the Río Valdez NNE alignment. This line is related to structural controls such as faults, joints and the intersections between different structural systems.

Bahía Blanca-Pedro Luro Thermal Basin.

Three thermal projects are being developed in this large geothermal basin:

a) Cerri Project

Direct use: Aquaculture (Shrimp farming).

The Cerri area is optimal for shrimp farming because of its accessibility to sea and geothermal waters. The pilot project is located south of the town of General Cerri, Buenos Aires Province, north of the main channel and west of the Sauce Chico River. The main channel forms the upper part of the Bahía Blanca marine estuary which is affected by sea tides. The best areas for shrimp farming occupy more than 6 hectares that are not flooded during high tide periods. An important factor contributing to the economic viability of the project is the nearby flowing well that produces 40 m^3/h of 58° C sodium-bicarbonate chloride water of low mineral content. The well, owned by the Translink S.A. packing plant, is 1200 m from the project. The area has a well-developed infrastructure (i.e., roads, electricity, telephones, etc.).

The pilot project will consist of a one-hectare, 1.5-m deep rectangular pond; its bottom can be made of sand or mud. It will have a hydraulic gate which allows the circulation and exchange of water needed to keep appropriate water quality for shrimp breeding. Mixing paddle wheels will be used to avoid temperature, salinity and pH stratification and to push wastes towards the center of the pond. During high tides, seawater

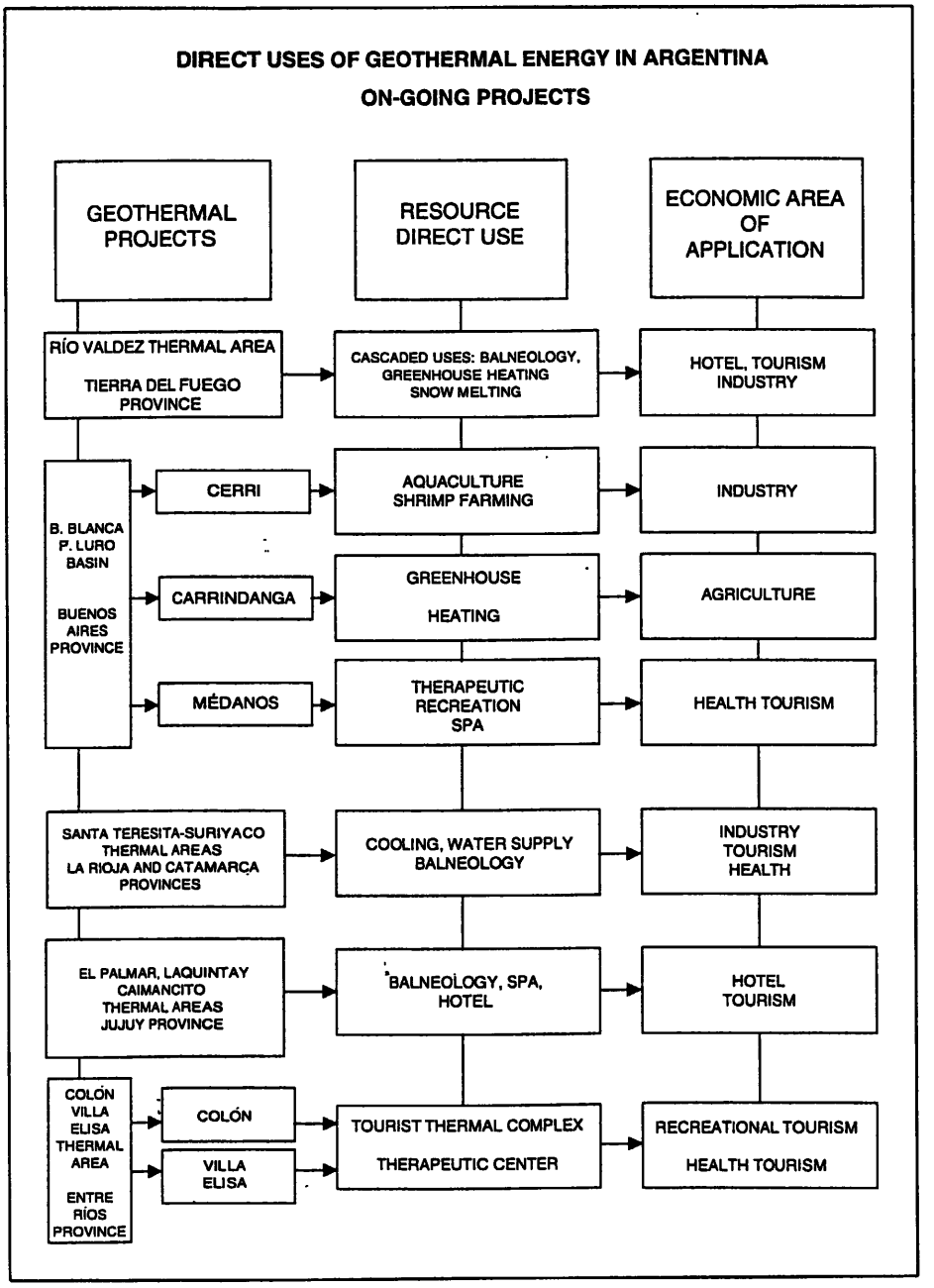

Figure 2. Direct application of geothermal energy in Argentina. On-going projects.

may be added to the pond through a man-made channel that will connect the final reaches of the Sauce Chico River and the marine estuary.

Because it is easy to breed and because of its high commercial value, the species *Penaeus Monodon* is chosen for farming, not only in Argentina but throughout the world. This type of shrimp requires temperatures between 23 and 31°C and adapts to quite low water salinities (16 to 24 ppm). It will be fed with fishery and agricultural by-products which are easily and cheaply obtained in the area.

Other factors that contribute to the economic feasibility of the project:

- Land costs: Coastal land tends to be relatively cheap in the area.
- Three harvests per year: The local climate normally allows two annual crops; three will be possible using appropriately heated waters.
- Abundance of geothermal waters of low mineral content: Wells completed in the thermal aquifers of the basin produce large volumes of 58 to 60°C waters.
- Low feed cost: Components used in shrimp feed are of low cost because they are locally produced; fishing and agriculture are important activities in the region.

In summary, shrimp farming based on the use of geothermal waters has the potential of becoming an important industry that will help the economic development of the Bahía Blanca area.

b) La Carrindanga Project

Direct use: Greenhouse heating.

Heating of greenhouses with geothermal energy is economically competitive in marginal agricultural areas like Bahía Blanca where costs tend to be low. Such projects allow to increase the use of the land and the productivity of the soil, reduces harvest damage and permits the capture of new markets.

The 6 hectares area chosen for the project is 5 km east of Bahía Blanca. An existing well produces 25,000 m³/h of 57°C water. The water has an electrical conductivity of 0.85 mMho and could be use for human consumption. From this well, hot water can be sent to buildings, greenhouses or to a 600,000 liter storage tank.

The water used to heat homes and greenhouses has a temperature between 32 and 35°C. The homes are heated using radiant panels (pipes embedded in the floor). At the entrance of the houses the heat is transferred to distilled water (the geothermal water has a low concentration of calcium carbonate that could deposit scale in the pipes).

Two 40m x 6 m greenhouses have been built with sliding glass side panels, sprinklers and buried ground heating system. Different crops (ornamental plants, trees, herbs, flowers and vegetables) will be grown in 40 cm x 60 cm wooden boxes heated from below. Under controlled conditions, germination can be hastened. Typically in this area plant cuttings need about a month for the optimal root and foliage development needed for transplant. By controlling the temperature and moisture in the greenhouse, the required time can be reduced by half.

With properly planned greenhouse activities, a more efficient and profitable cycle is possible. For example, production of vegetables during the off-season commands higher prices. Growing plants in geothermally heated seedbeds permits cultivation under denser and more controlled conditions, which reduces costs and crop losses, and allows a more confident commitment to future delivery contracts.

c) Médanos Thermal Area

Direct use: Therapeutic and recreation.

The so-called Health Tourism has recently become a very important and lucrative activity worldwide. Integrated health spas are well known, and have a good reputation in Argentina. In Médanos, some 45 km southeast of the city of Bahía Blanca city, there is a 1175 m deep well that produces large volumes (2000 L/min) of 74°C water of sodium chloride type (with about 2000 ppm TDS).

An evaluation of the thermo-mineral characteristics of the thermal water suggests the possibility of different direct use applications. A therapeutic and recreational center would contribute to the development of the area.

Villa Elisa Thermal Area

Direct use: Therapeutic thermal center.

This thermal area is located 4 km NW of the town of Villa Elisa, Entre Ríos Province; 360 km NE from Buenos Aires, the capital. During the first quarter of 1996, a 1032 m deep well reached an artesian aquifer at 942 m in Mesozoic sediments of the Chaco-Parana Basin. The well produces 12 m³/h of 40.2°C water of sodium chloride-sulfate type (pH: 7.7; TDS:14,500 mg/L; electric conductivity: 18,900 µs/cm).

Colon Thermal Area

Direct use: Tourist Thermal Complex

The government of the province of Entre Ríos is particularly interested in developing their low-temperature geothermal resources for therapeutic uses and tourism. At present, various places such as Colón, Villa Elisa and Federación attract visitors because of their thermal waters. Different areas have been studied and many of them are being developed, while other projects are in the feasibility stage.

The thermal area is in the city of Colón city, 320 km NE from Buenos Aires. In 1996, a 1502 m deep well was drilled to extract thermal waters for their Thermal Complex Center that is under development. The well is artesian (2.1 kg/cm² wellhead pressure); during a 72-hour test showed a maximum flow rate of 135 m³/h. Chemical analyses classify the thermal water as of sodium-bicarbonate type and medium mineralization, pH: 8.5 and electric conductivity: 1,180 µs/cm.

Summary of Direct Use Projects

The main direct applications of geothermal energy in Argentina are balneology, snow-melting, heating of greenhouses and buildings, and aquaculture. The location of the main projects is given in Figure 3.

Balneology

Throughout the country, 84 balneology establishments use low-temperature geothermal fluids. The temperature of the manifestations and wells being produced vary between 25 and 98° C.

Snow Melting

In the Copahue-Caviahue Thermal Area, geothermal steam is used for heating streets and the access road to Villa Copahue, Neuquén Province. The steam is produced from the 1,400 m deep CPO4 geothermal well located in the most productive thermal area of Copahue Thermal Field. 30 ton/h of steam are produced from a secondary reservoir at 1,260 m depth. Steam is transported through 2,600 m long pipeline. Winter temperatures in the area are as low as -12°C; winds can reach 160 km/h; snow depths average 4 m. With this thermal road heating, the temperature in the streets is between 12 and 16°C.

The heating is done by using radiant panels underneath the road surface, consisting of serpentine hot water distribution pipes, covering 2,200 m² of road surface. The panels are located in the access road, main streets of Villa Copahue and by the Copahue Thermal Center. The waste water is finally discharged at the surface through a collector pipeline.

Greenhouse Heating

In two areas greenhouses are heated with geothermal waters: i.e. Cacheuta Thermas, Mendoza Province and in the Bahía Blanca- Pedro Luro Thermal Basin, Buenos Aires Province. The first one is a small operation that supplies vegetables to hotels. The second one was described earlier (La Carrindanga Project).

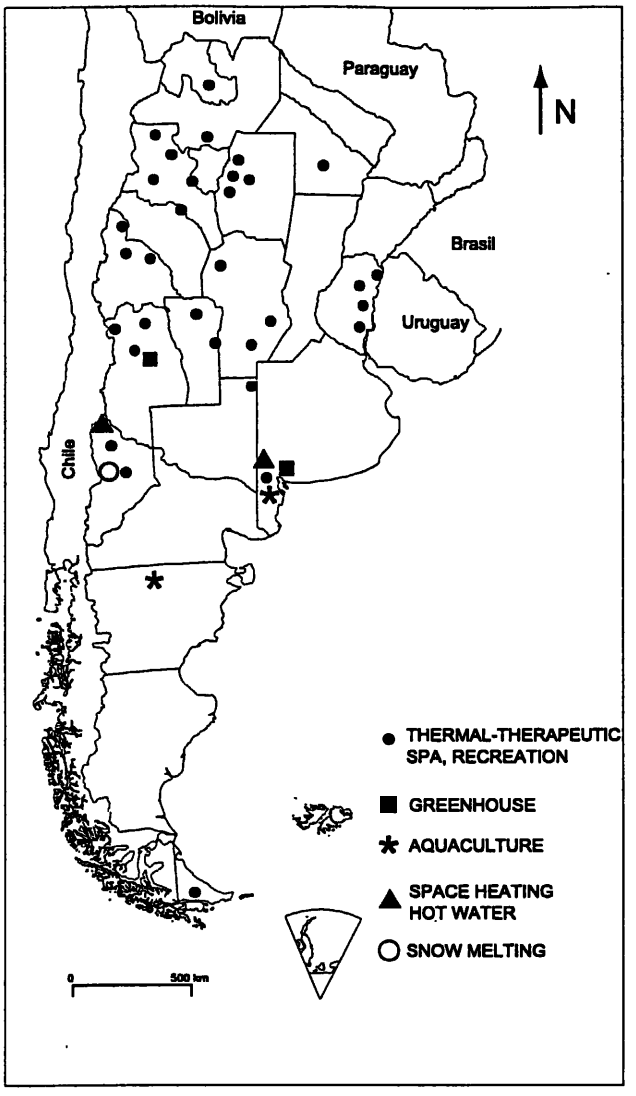

Figure 3. Direct uses of geothermal resources in Argentina.

Hot Water Supply and Heating of Buildings

In two thermal areas thermal waters are used to supply hot water and heat buildings, i.e., Bahía Blanca- Pedro Luro Thermal Basin (La Carrindanga Project) and Domuyo Thermal Area, Neuquén Province. In Domuyo, 61°C spring waters are piped to cabins in the vacation complex of Villa Aguas Calientes Villa (Fig. 3). The water is carried by a 150 m long, 48 mm diameter polypropylene pipeline that is insulated with 25 mm thick layer of polystyrene. The collector delivers a minimum of 3 m^3/h, of 58°C water to the cabins, with a temperature loss of about 3°C. Hot water is provided to the bathroom, kitchen and heating system inside the house. This system is composed of 2-inch diameter steel tubes, built in three interconnected parts with a total length of 12 meters.

Aquaculture

There are two geothermal aquaculture projects in Argentina. One is the Cerri Project described earlier. The second one is in the Gan Gan Thermal Area, Chubut Province (Figure 3) where trout are bred. In the cold and windy area, three wells supply the thermal waters for the operation (rate: 32,000 L/h; temperature: 21.5°C). This water is transported by propylene pipelines to the breeding pools. Heating the pools increases the rate of growth of the fish, obtaining the same weight in shorter time.

Conclusions

The future for geothermal direct use projects looks very promising in Argentina. A constant growth in the use of geothermal fluids is predicted. Now that the evaluation stage of projects has been completed, the development of the resources is being transferred to the private sector. It is expected that these direct application projects will contribute significantly to the regional economies.

Acknowledgment

I would like to thank Dr. Marcelo Lippmann for the review of this paper and his for his valuable suggestions.