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An Inactive Volcano an Active Community - Indigenous Community of Yanaconas Guachicono and the Recreational Project: Las Chizas

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ABSTRACT

The indigenous community of Guachicono is preparing for the challenges that lie ahead in the future, as many communities in Cauca-Colombia or other countries. Among these challenges, it is possible to identify the growth of its population and therefore its financial sustainability far from the violent and illegals activities. The indigenous communities in Colombia have been very reluctant to open up to the community in general. Particularly, the community of Guachicono has a place within its territory where there is a poor thermal source; in spite of this the community persists in the probable use that it would have as a recreational project: Las Chizas.

This paper describes the experience with the indigenous community, which wants to work in balneology and tourism. It was carried out a study to determine the feasibility of the site. Within the methodology for the study, it includes measurements of temperature, water quality, flow and geological-geotechnical characterization. The results obtained show the challenge to configure the project but the community persists in continuing the study to find alternatives of total feasibility because the natural environment and landscape sightseeing. One of the most important conclusions of the project, it is that as long as the will of the involved communities (indigenous) exists, the geothermal projects may finally be configured even by means of unconventional alternatives. Additionally, the projects of this kind provide a channel for communication between multiple communities.

1. INTRODUCTION

The indigenous community in Colombia are facing challenges about economic sustainability because of their growing population. Violent and illegals activities for young indigenous people are presented as an option because they ae found in places where national law enforcement does not have jurisdiction, and illegal groups harness this scenario. Antecedents of invasions, violations of rights, illicit crops and illegal land exploitation, make the indigenous populations apathetic to the arrival of new advance proposals, then it left few options for economic growing. Particularly, the community of Guachicono has a place within its territory where there is a poor thermal source; in spite of this the community has started an entrepreneurship in the probable use of this thermal source, and has bet in a recreational project called Las Chizas.

This option, for indigenous communities, has very high potential because Colombia is part of the Pacific fire belt, with about 269 registered hydrothermal manifestations; which are mostly in indigenous territory. This research was developed with the indigenous community of Yanaconas- Guachicono indigenous reservation, the community takes refuge in the greatness of the Colombian Massif, in the department of Cauca; which are located in the skirt of Sotará Volcano, which, although categorized as Active, there is no record of historical eruption, its current activity is manifested by seismic activity and the presence of fumarolic fields.

Within the research framework of geothermal energy, this project analyzes, in the first instance, the possibility of initiating in the Guachicono indigenous reservation the tourist thermal exploitation of a source never studied before, and leaves the possibility of continuing with other direct and energetic uses strongly linked, inside the zone.

2. THEORETICAL FRAMEWORK

2.1 Colombia

Colombia has a privileged geographical position and favorable geology for geothermal exploitation, because part of the territory is located in the Pacific Fire Belt, an area where the natural temperature gradient of the subsoil, near the surface, is anomalously high. and it manifests with high volcanic activity. This potential can be seen in areas adjacent to the Chiles, Cerro Negro, Cumbal, Azufral, Galeras, Doña Juana, Sotará, Puracé, Nevado del Huila, Nevado del Ruiz and Nevado del Tolima, volcanoes where the recent eruptive history and the presence of sources of thermal waters, fumaroles and superficial hydrothermal alteration zones indicate adequate characteristics for its energetic, recreational and medicinal use (Marzolf, 2015).

The Colombian Geological Service (SGC) is the entity in charge of the constant monitoring of the volcanoes present in the country and the characterization of geological materials in the physical, chemical, mechanical, petrographic, mineralogical and metallurgical components.

This is why Colombia is considered one of the most important hot spring sources on the planet, with an estimated 296 hydrothermal manifestations registered (Figure 1). Among the best known recreational uses are Santa Rosa de Cabal, in Risaralda; Paipa, in Boyacá; Rivera, in Huila; Paratebueno, Machetá or Chocontá, in Cundinamarca, and Puracé, in Cauca, where small waterfalls, natural pools and volcanic steam chambers are part of the landscape and promise a stay away from the stress of daily life (Pedraza & Mariño Martinez, 2016).

Figure 1: Volcanoes monitored by the Colombian Geological Service. Source SGC webpage, 2018.

2.2 Department of Cauca

The Department of Cauca, located in the south west of Colombia, has the presence of approximately 14 volcanoes (active and inactive) within its territory, of which only the Volcanoes Puracé, Sotará and Nevado del Huila have constant monitoring by part of the Colombian Geological Service; giving a focus mainly to the Puracé volcano.

This location makes the Cauca possess a large number of fumaroles and thermal springs, achieving categorization in the fourth national position in terms of geothermal richness, see Figure 2.

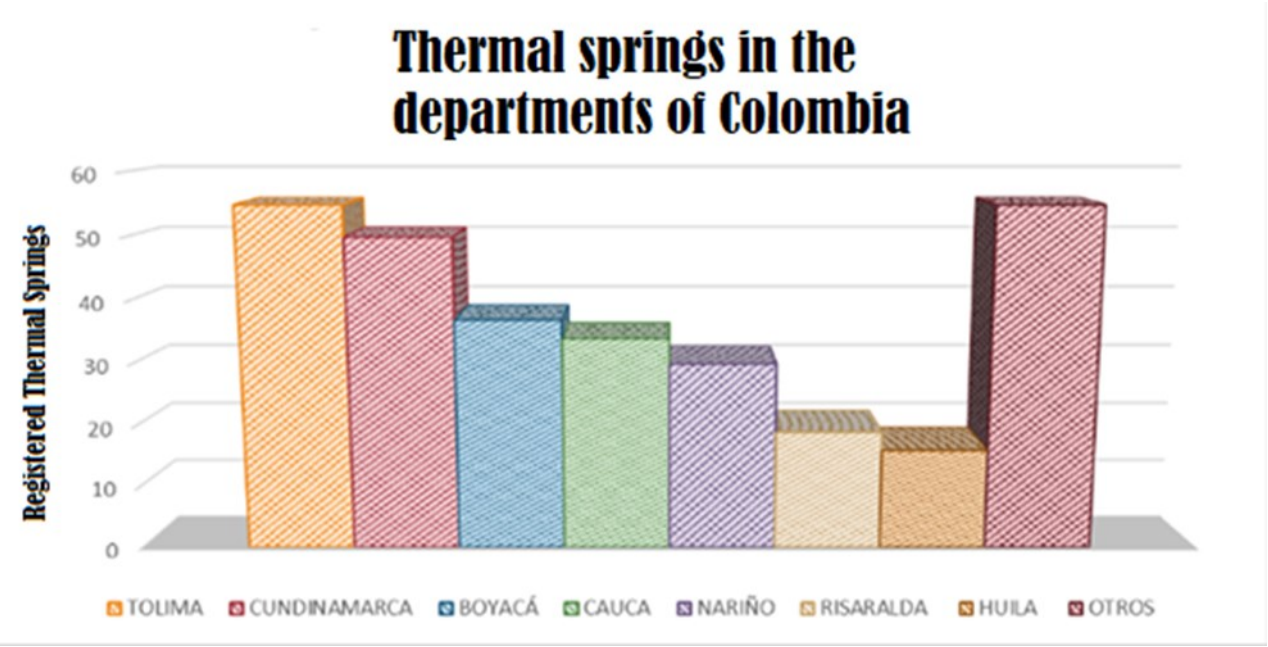

Figure 2: Thermal springs registered in Colombia - Sub departmental division. Data taken from the SGC. Own source.

In order to contextualize the reader and get them to know some important aspects about the department and municipalities that have an important role in the development of this research and the future of geothermal energy in Cauca, we invite you to access the website: *https://resguardoindigena.wixsite.com/guachicono*.

3. DEPARTMENTAL SOCIAL FRAMEWORK

Colombia has 102 indigenous peoples, of which 87 are recognized by the 2005 national census. The departments of La Guajira, Cauca, Nariño, Córdoba and Sucre account for approximately two thirds of the country's indigenous people.

The department of Cauca has 21.55% of the departmental population belonging to the Indigenous ethnic group, where the largest and most important communities are the Vaupés, Guambianos, Kokonucos and Yanaconas.

The municipality of La Vega - Cauca has 24.24% of its population belonging to the Yanaconas ethnic group. The corregimiento that contributes more to this percentage is the Indigenous Reservation of Guachicono. It is located to the south-east of the Department of Cauca; 39 kilometers south-east of the municipal seat La Vega and 104 kilometers from Popayán, capital of the Department. Its communication and transport routes are taxiways, bridleways and satellite telephony.

3.1 Approach to the Communities

Since 2017, an approach to the indigenous communities of Cauca has been initiated in order to determine the department's energetic geothermal potential. It is at this point, where the communities first know many of the benefits that their location near a volcano can bring them. The greatest achievement of this first stage was to have the support and support of 3 indigenous communities and a municipal mayor's office. However, some of these communities did not have geothermal characterizations of their thermal births, so it was impossible to determine the departmental energy potential.

However, the leader of the indigenous community of Guachicono-Pueblo Yanaconas, wanted to go ahead and requested to characterize the Las Chizas thermal spring, which had no study or record before the Colombian Geological Survey.

3.1.1 Indigenous Reservoir of Guachicono – Yanaconas Community.

The indigenous reserve of Guachicono (see Figure 3) is part of the Colombian massif the most important water star in Colombia. It is identified as reservoirs of water, because it is the source of great rivers where some of the country's main ones are found such as Cauca, Caquetá, Patía, among others. It contains 362 lagoon bodies in the High Mountain, 13 Páramos and ecosystems rich in flora and fauna. It is for this reason that the main objective of the shelter is to protect and care for the environment.

Figure 3: Indigenous reservation of Guachicono. Own source.

Its main source of sustenance in the last 30 years was the cultivation of Poppy, which was used mostly for the manufacture of psychoactive substances.

This community is preparing for the challenges that lie ahead in the future. Thinking about the growth of its population and the lack of economic income, I urge the community to want to start talking about geothermal energy. However, the constant fear of the dispossession of land, the entry of multinationals and the "theft of water" were one of the main doubts that we are currently focusing on clarifying. Today, the community sees in geothermal a promising future, legal and friendly with the environment, and it is they who continue to promote the advance of geothermal projects in the department.

4. STUDIES

The first characterization of the thermal birth of the shacks, belonging to the indigenous chapter of Guachicono started in May 2018 and ended in January 2019. Within the research, the following activities were developed:

- Detailed topographic study of the entire area
- Geological characterization of the zone with seismic refraction lines.
- Biological and chemical monitoring of the composition of the thermal water and the nearby tributary.
- Hydraulic studies for the determination of the existing flow and isolation of Guachicono river waters.

To date the registration of the thermal spring before the Colombian Geological Service is being managed.

4.1 Results obtained

According to the geological study, the geographical location of the birth point presents a stratigraphy of deposits of pyroclastic flows, mud and epiclastites (NgQf). Its main feature at first sight is the presence of rocks in gray outcrop and weathered a yellow-brown color. They consist mainly of ash flows, welded tuffs and mudflow. This composition indicates that it is volcanic soil. That is why it confirms the existence of an aquifer of magmatic origin, heated by volcanic rocks, where thanks to the process of dilution-concentration acquires large amount of chloride as a trace element. The transport of this fluid to the point of outcrop is driven by the topography of the area and its ascent to the surface is allowed by the cracks in the rock that make up the aquifer; however, these fissures allow the descent of surface water, resulting in a thermal spring of mixed wáter.

Although it is true that all the characteristics of the thermal tributary are essential, in the TABLE, those that represent certain importance when characterizing the thermal source for recreational use are considered.

Table 1: Summary of the Characterization of Las Chizas thermal springs

Characterization of Las Chizas Thermal Springs	
FLOW (L/s)	0.84
TEMPERATURE (°C)	39.22
CLASSIFICATIONS	
According to the temperature	Mesotermal
According to the thermal sensation	Hot
According to the pH	Acid - Basic
According to the chemical component	Chlorinated

Note: Own Source

The exact dimensions of the pools to be made depend clearly on the decision of the community and the entities in charge, however, a Pre-Dimensioning is proposed in order to demonstrate the viability of the project.

Within the Colombian regulations, the daily percentage of water renewal that a public use pool should have is not established, however, it is usual to use a 5% renovation percentage within the design of a conventional pool. Since the water to be used does not have any previous treatment, it is considered to own criteria to establish a daily renewal percentage of 15%.

The Guachicono hot springs have a flow of 72.6 m3 per day, ready to cover 20% of the minimum requirement. In this sense it could perfectly supply the theoretical maximum volume of 363m3 (including losses by ETO).

The land belonging to the indigenous council of Guachicono has a notable advantage, since it has relatively distant level curves indicating a surface with gentle slopes. It should be considered that there is no vehicular access to the birth zone, therefore, all leveling work must be done by mingas.

It is for this reason that land should be used that does not require much leveling. The useable land for the construction of the swimming pools has an approximate area of 190 m2 and has as an additional advantage that it is totally continuous at thermal spring, avoiding losses generated by long transports.

5. TOOLS FOR THE DISSEMINATION OF RESULTS

The technical studies carried out provide valuable information for the future of geothermal energy. However, the fact that the communities directly involved are driving these projects is an invaluable aid for geothermal energy in Cauca. That is why the own tools of the project were created in order for the inhabitants of the Guachicono reservation to identify with the project and similarly serve as a reference to other communities.

Nowadays, the impact of the project has been positive, resulting in requests for characterization by other indigenous communities.

5.1 Own tools of the project

5.1.1 Logo and name of the project

In order to appropriate the community with the research and for the project to be easily recognized in any field, a short name was sought that could encompass its essence. It is here that the title of "A INACTIVE VOLCANO, AN ACTIVE COMMUNITY" is born, alluding to the contrast between the low recorded activity of the Sotará volcano and the high community support at the head of the Governor.

Figure 4: Logo of the Project. Own source.

In the same way so that the identification is also visual, a logo was designed that gathers important characteristics of the council and the project (see Figure 5), such as:

- The land: it is considered as the Pachamama (mother earth), since it is the base for the integral support of the natives, where all the agricultural activities are practiced according to the way it can be given, governed by astronomy and techniques own tillage, without altering its properties (Cabildo Indígena Yanaconas, 2005). It also symbolizes the great potential of water, fauna, flora and other special ecosystems that the territory possesses. It is represented by means of the illustration of the Sotará volcano sheltered by a thermal spring and accompanied by green fields on its foot.
- The rainbow: represents the Wiphala Yanacona, representative flag where each color has a social and labor meaning
- Ruana: is an element whose meaning is the general coverage coat, in equity and as a symbol of identity.
- The cane: it is carried by one of the cabildantes at the foot of the volcano, representing justice, authority and autonomy within the territorial scope. The colors consigned in the upper part belong to the Wiphala and give account of the different representative elements of the environment, history and customs: the green of nature; red represents the blood shed by indigenous martyrs, for territorial and organizational defense; blue symbolizes water wealth; the yellow makes allegory to the wealth of the energy that their gods contribute, both the sun and the moon, which is what determines the production and development for the indigenous survival.

5.1.2 Web page

In order to achieve broad dissemination and especially that those belonging to the indigenous council have easy access to the corresponding information of the project under development, a specific web page was created, focused on the community, its natural wealth and its tourism potential: https: //resguardoindigena.wixsite.com/guachicono. All the historical information was contributed by the Governor of the Cabildo and the community integrated to the project.

Additionally, it aims to provide the opportunity to start creating a historical database on the thermal births found in its territory. To this end, people belonging to the council were instructed on the use of the tools acquired to monitor the temperature and flow (see Figure 5). The community will have the possibility to upload the records to the web page and thus be able to take control over the thermal outcrops.

Figure 5: Data collection training for the community. Own source.

5.1.3 Video

It should be noted the love and respect that the Yanacona people feel for Mother Earth and each natural resource that she offers them within her territory. That is why a video was made with unpublished shots of the journey to get there, the view of the town and the route to the research point, where you can appreciate each of these riches and even more important to demonstrate that it is possible that civil engineering go hand in hand with the care and preservation of the environment. The video that is animated with local music of the Cabildo and is narrated by the beauty of its landscapes, contextualizes the location of the project within Colombia and makes an invitation without words to know and take care of such a beautiful place.

5.2 Socialization and dissemination of results

5.2.1 Socialization with the community

When the field work was concluded, the results, conclusions and recommendations were presented at the annual council destination fund meeting (see Figure 6). In it were at least 3 representatives of each path belonging to the village, staff of the municipal mayor and community in general. Visual tools such as slides and video were used, a simile was made between the conditions found in the area and successful cases within the department, the tools acquired for monitoring the thermal source were handed over and doubts were clarified.

Figure 6: Exposition of results, first phase - community of Guachicono. Own source.

5.2.2 Socialization in the scientific field of the country

Annually, within the research framework of geothermal energy in Colombia, the National Geothermal Meeting (RENAG) is held. The development of this research and its particularities achieved that RENAG version 2018, carried out in the city of Bogotá, was interested in having the research group as speakers in the main event. The best of all, it is that the community take an active part (see Figure 7).

Figure 7: For the first time, three entities in Cauca are part of RENAG 2018. Own source.

This event, which brought together experts from Colombia, the Philippines, New Zealand, Canada, Chile and El Salvador, this research being the only case separated from the central zone of Colombia, provided the opportunity to disseminate the project internationally.

The work with the Cabildo, the results and the methods used were examples at the national level, since it was the only investigation that had the approval and support of the community directly involved.

Opportunities such as having the service of laboratories of the Colombian Geological Service of the city of Bogotá, being able to send samples for tests of fluid inclusions and diffuse gases for Canada, being able to bring experts from Chile to give lectures to the Universidad del Cauca and raise the possibility of a RENAG Popayán 2020, is the contribution that this research leaves to promote the start of Geothermal energy in the department of Cauca.

6. CONCLUSIONS

The own characteristics obtained from the thermal spring have high tourist geothermal potential. Its natural environment, constant flow, pleasant temperature and imperceptible smell, form a very complete set of ideal characteristics for the recreational use of thermal water. That is why it is given way to the continuation of the project in its next stages. (environmental studies, risk mitigation by the Guachicono river and architectural and structural design).

P By means of the studies carried out, it is concluded that from the thermal spring the Chizas sprouts mixed water. Its elevated temperature is due to heating by volcanic rock and some characteristics indicate its union with surface water. Additionally, it is classified according to its temperature (39.22 ° C) as mesothermal and hot to the touch, according to its pH as acid and according to its predominant component as chloridated. These characteristics make up the first characterization of a thermal birth within the Guachicono Indigenous Reserve and the only one, in the last 22 years, close to the area of influence of the Sotará Volcano.

The existence of a semi-confined aquifer is confirmed, where the water is transported by fractured rock. This implies the existence of other thermal springs in the area, even with a greater thermal gradient, considering the possibility of the absence of surface waters.

The support of the communities that for years have been concerned to take care of the territories surrounding the volcanoes, forms the most important pillar for the correct development of geothermal projects. The realization of this investigation gave a firm and important beginning to the start of geothermal energy in the south west of Colombia.

Develop methods for the correct dissemination of results, familiarization of communities with research and continuation of the project, provide the possibility that after communities feel interested in entering the field of geothermal energy.

Being part of the national geothermal meeting and the world geothermal congress are important tools to acquire knowledge and make dreams come true with the community.

As long as the will of the involved communities (indigenous) exists, the geothermal projects may finally be configured even by means of unconventional alternatives. Additionally, the projects of this kind provide a channel for communication between multiple communities.

This kind of projects give an alternative to economic growing of several indigenous communities, far away of the violent and illegals activities.

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