



**INER**

Instituto Nacional de  
Eficiencia Energética y  
Energías Renovables

# Geothermal Development in Ecuador: History, Current Status and Future

**Technical Workshop on Geothermal Regulation Environmental Licensing and  
Reservoir Modelling – Andes**

**Santiago de Chile, 26-30 May 2014**

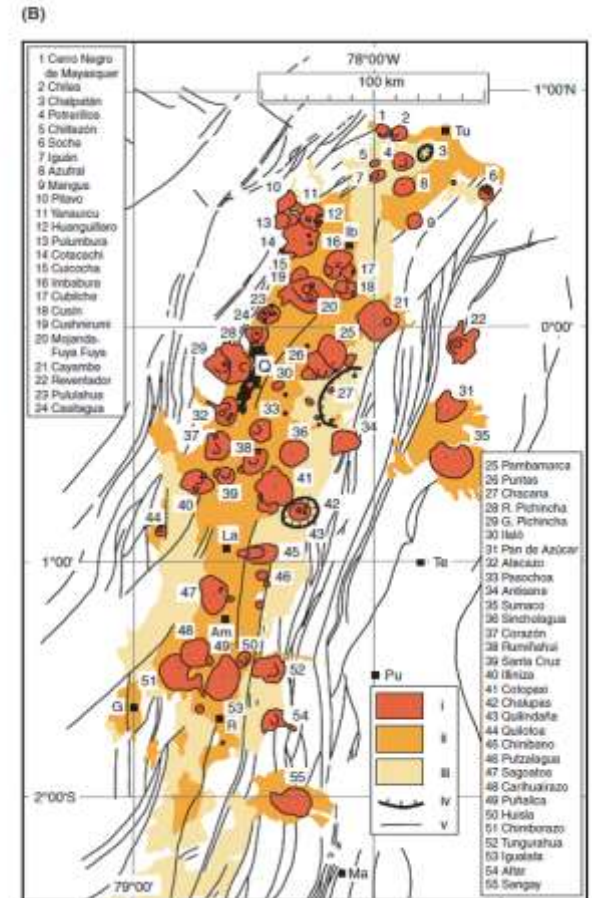
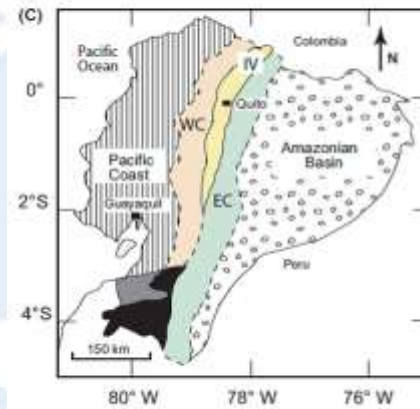
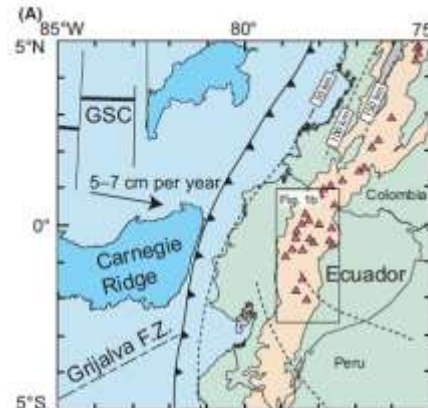
**M.Eng. Andrés Lloret**

# Presentation Content

- *Introduction*
- *Background*
- *Current Status of Geothermal Prospects in Ecuador*
- *Undeveloped Prospects*
- *Future Developments*



# Introduction



**Ecuador is located alongside more than 40 active volcanoes!**



# Introduction

- The Geothermal Energy Association (GEA) estimated Ecuador's geothermal potential at 1700 MWe in 1999.
- If rhyolitic calderas and their equivalent in andesitic magma are also considered, between 30 and 40 volcanoes could increase the overall theoretical potential up to 8000 MWe (Beate, 2010).
- The current installed capacity of Ecuadorian interconnected system, equals to 4700 MWe (CONELEC, 2013).



Cotopaxi Volcano (5,897 m a.s.l.) viewed from Quito city.

# Background

- Reconnaissance and exploration of geothermal resources in Ecuador began in 1979.
- The Ecuadorian Institute of Electrification (INECEL) and the Latin American Energy Organization (OLADE) were the first involved in geothermal exploration activities in the country.
- Other private companies were also interested in participating.

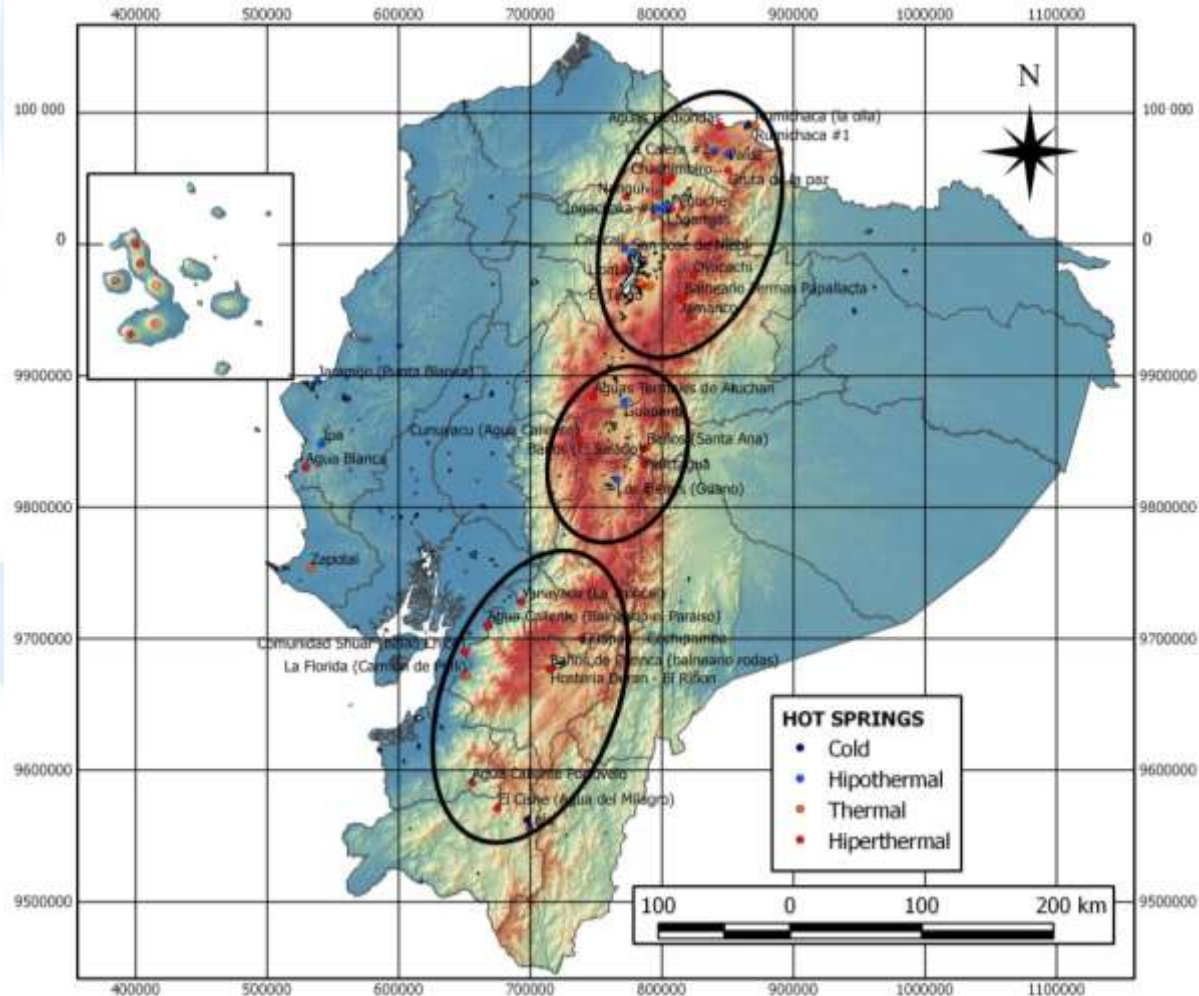


# Background

- The “Geothermal Investigation Project” was the first reconnaissance study in Ecuador (1979).
- The objective was to select areas suitable for geothermal exploration of high enthalpy resources for electricity generation purposes.
- Government entities and private companies participated in the study.
- The project comprised a two stage research.



# Background



Areas analyzed in the reconnaissance study of 1979



# Background

- In 1981, stage one prefeasibility study was executed in Chachimbiro and Chalupas.
- In 1986, AQUATER and OLADE provided technical assistance to continue prefeasibility studies in Tufiño-Chiles-Cerro Negro project.
- Between 1983 and 1990, INECEL and the International Atomic Energy Agency (IAEA) carried out geochemical studies in Chalupas and Chachimbiro to gather more information about their potential for generation purposes.
- In 1993 scientific research related to geothermal reconnaissance and exploration ceased due to political reasons and financial cutbacks.



# Background

- In 1996, the Economic Commission for Latin America and the Caribbean (CEPAL) and the European Union (EU) presented a project called “Development of Geothermal Resources in Latin America and the Caribbean”.
- In 1998, the government formally requested technical assistance from CEPAL to develop a strategy for future exploitation of geothermal resources in the country.
- From 1999 to 2001 geochemical and isotopic studies were resumed in Chachimbiro and Tufiño, with the assistance of IAEA.

# Background

- Geothermal exploration was interrupted again in 2002, when Ecuador went through an internal financial crisis.
- Five years later, in 2007, the need to diversify the country's energy matrix became a national policy.
- In 2008, CONELEC hired a former INECEL researcher to deliver a project outline for the Chalupas prospect and an abridgment of all geothermal prospects from 1979 up to the present.
- In 2009, the Ecuador Electric Corporation (CELEC EP) commissioned the prefeasibility studies for the Chacana prospect.

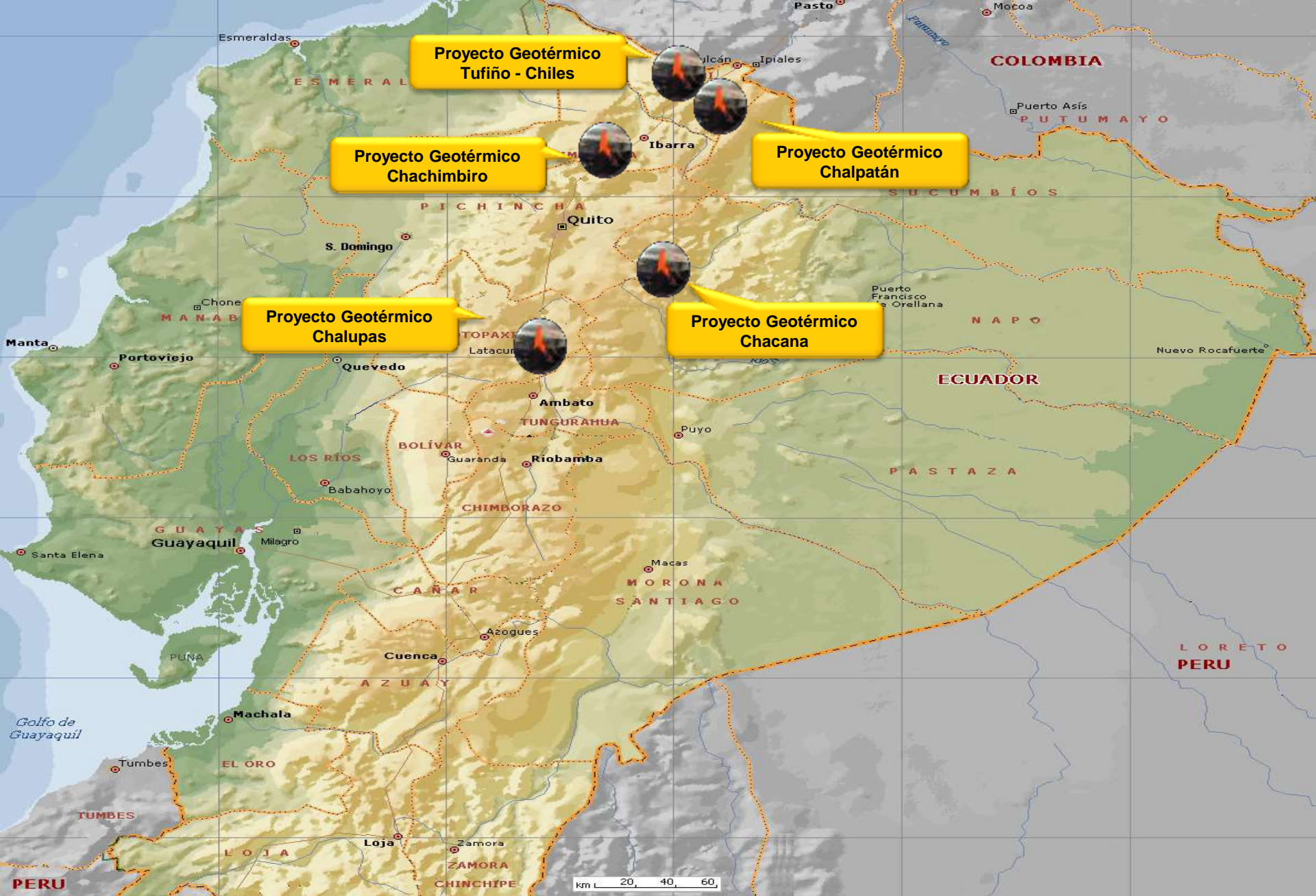
# Background

- in May 2009, the first geothermal exploration slim hole in Ecuador was completed, reaching a depth of 554 meters.
- In 2010, MEER requested a “Plan for the Development of Geothermal Resources”, which was entrusted to the same experienced consultant that delivered the prefeasibility studies for the Chalupas prospect.
- in 2012, ESPE University carried out prefeasibility studies at the Chachimbiro prospect.
- In 2012, the National Institute for Pre-investment Studies (INP) commissioned the study of the Chalpatán prospect to a private consulting firm (CGS) and CELEC.

# Current Status

## Current Status of Geothermal Prospects in Ecuador





# Current Status

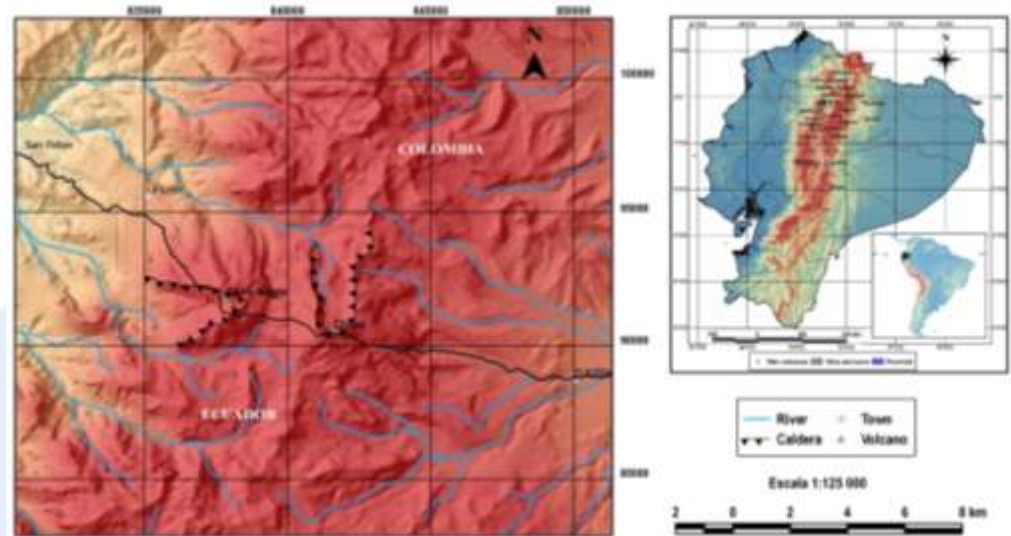
- Additional geological and geochemical studies are required to enhance the conceptual models of the prospect.

- Complementary magneto-tellurics (MT) and time-domain electromagnetics (TDEM) surveys will also provide a better understanding of the resistivity anomaly in the main area of the prospect.

- Re-analysis of geological, geochemical and geophysical surface exploration data was endorsed to a private consulting group which is currently executing field activities

- Beate (2010) states in his review an estimate of 138 MWe for the Tufiño prospect, based on surface data geology presented by Almeida (1990).

## Tufiño-Chiles-Cerro Negro



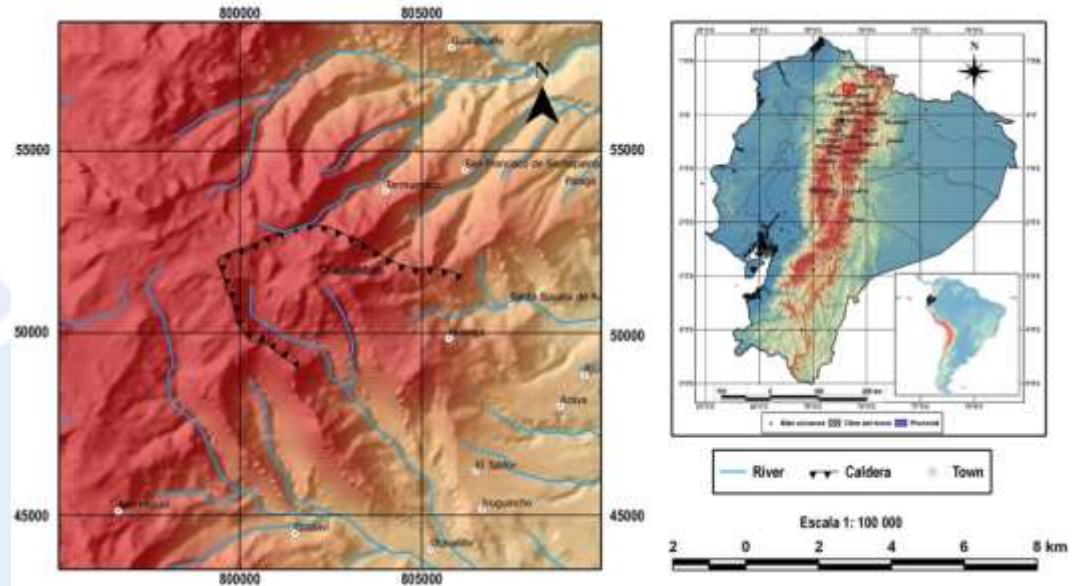
Location of Tufiño prospect



# Current Status

## Chachimbiro

- Preliminary feasibility studies in the Chachimbiro prospect concluded in 2011.
- A low cost 1500 m depth slim hole is recommended to determine the sustainability of the resource for long term production.
- The project is currently undergoing environmental impact assessment.



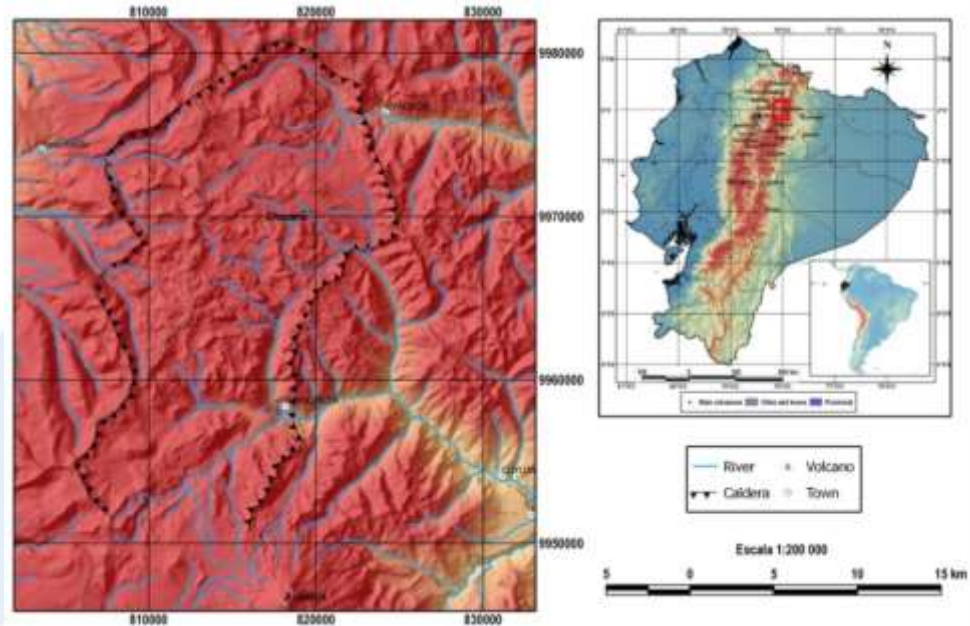
Location of Chachimbiro prospect

- The geothermal potential of Chachimbiro is estimated to be 81 MWe.

# Current Status

- Preliminary feasibility studies in the Chacana prospect were concluded in 2012.
- Next stage consists of drilling two exploratory slim holes to depths of 600 m and 900 m.
- The project is currently undergoing environmental impact assessment.

## Chacana



Location of Chacana prospect

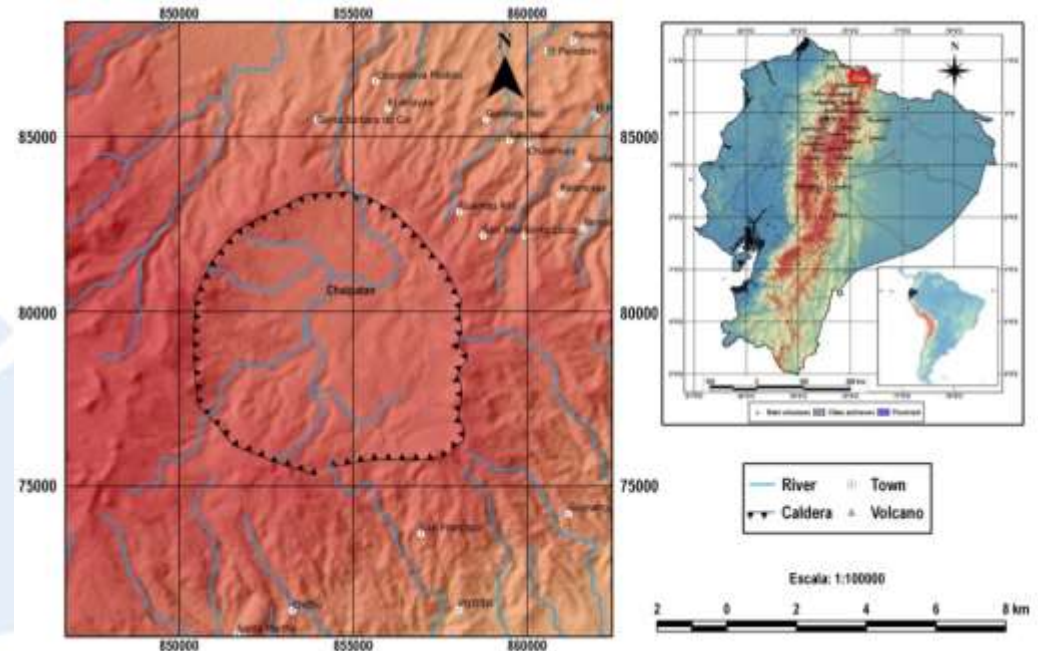
- The estimated potential of Jamanco is 13 MWe and of Cachiycu is 39 MWe.



# Current Status

- Preliminary feasibility studies in the Chalpatan prospect were concluded in 2013.
- These studies included the use of state of the art technologies, such as satellite and airborne infrared thermal imagery, Audio Magneto Tellurics, and Magnetometry.
- Drilling of shallow exploration wells will allow the quantification and evaluation of the geothermal reservoir

## Chalpatan



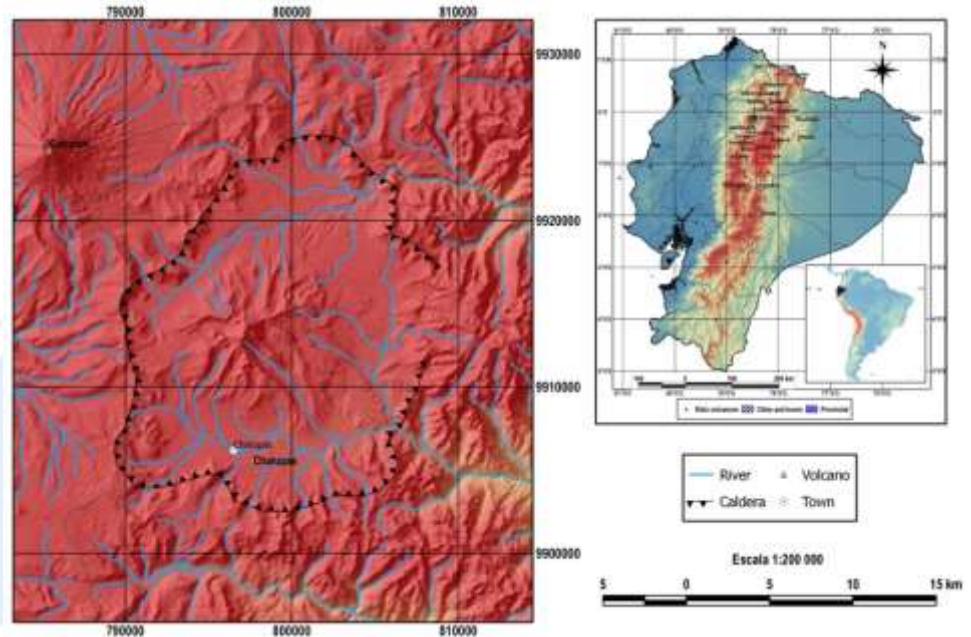
Location of Chalpatan prospect

- The National Institute for Energy Efficiency and Renewable Energy (INER) has showed interest in developing a low enthalpy research project in the area, once the exploratory wells are drilled.

# Current Status

## Chalupas

- Detailed geology, geochemistry and geophysics measurements must be performed using enhanced methodologies.
- Future work involves carrying out a Schlumberger resistivity survey with traversing (mapping) measurements at 500 m spacing (Beate and Salgado, 2010).
- The project has been temporarily put on hold by CELEC EP, and will be resumed once the feasibility studies are finalized in Chachimbiro.



Location of Chalupas prospect

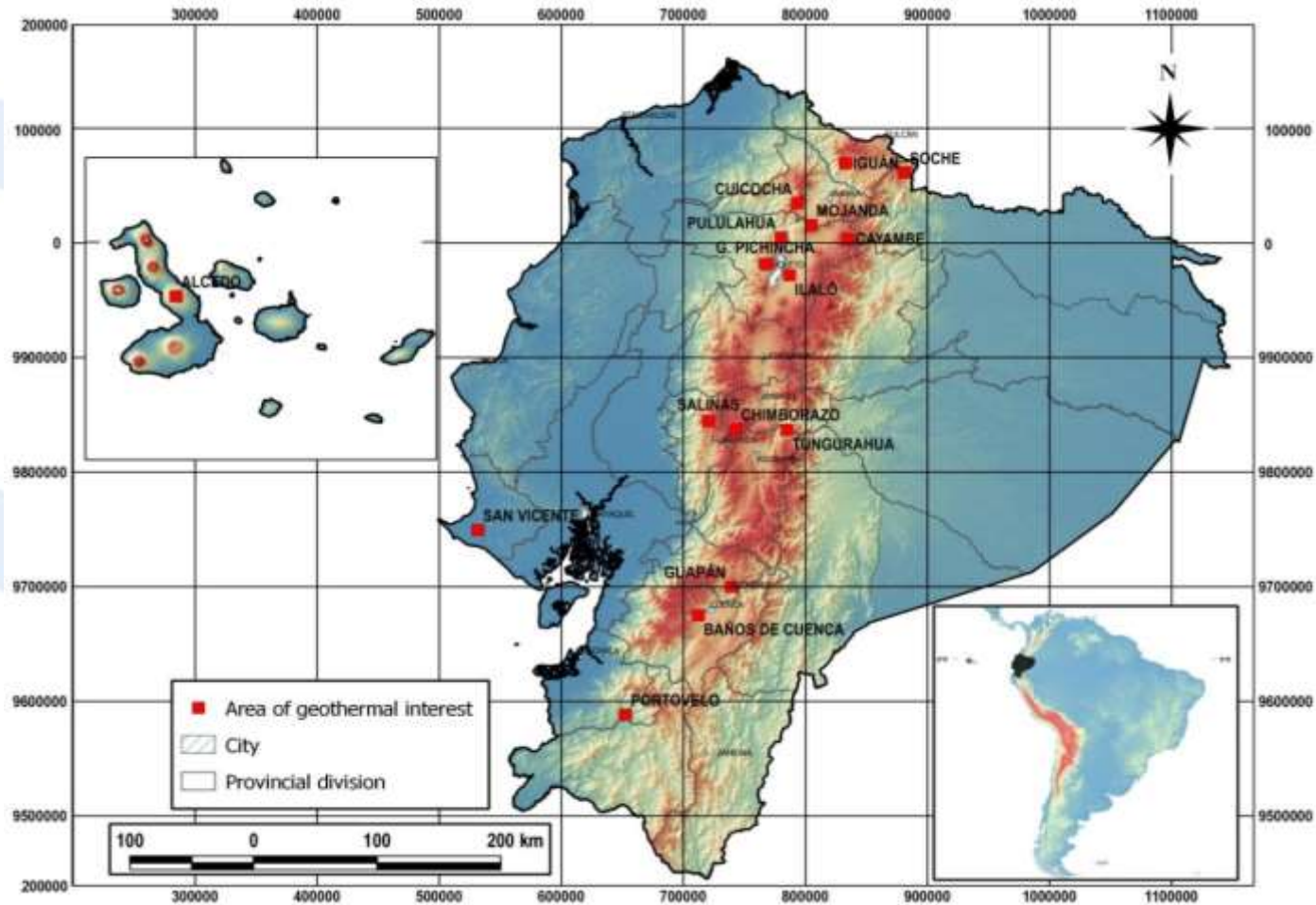
- Almeida (1990) determined an estimated potential of 283 MWe, based on surface data geology.



**Current Status**

Undeveloped Prospects

# Undeveloped Prospects





# Undeveloped Prospects

Pululahua



Aerial view of Pululahua Volcano

# Undeveloped Prospects

Cayambe



Aerial view of Cayambe Volcano

# Undeveloped Prospects

## Cuicocha



Aerial view of Cuicocha Caldera



# Undeveloped Prospects



Aerial view of Tungurahua Volcano

# Undeveloped Prospects

Guagua Pichincha



Aerial view of Guagua Pichincha Caldera





# Undeveloped Prospects

## Future Developements

# Future Developements



- Currently, utilization of geothermal resources in Ecuador is restricted to bathing resorts, balneology and swimming pools.
- The total installed capacity of geothermal energy for direct heat applications in 2009 was 5 MWt (Beate & Salgado, 2005), with a slight increase over the last five years.

# Future Developements

- Significant alternate uses remain unknown by Ecuadorian society.
- Currently, a portfolio of projects for direct use in fish hatchery, greenhouse heating, space heating, and industrial applications is being researched by universities and public research institutions.
- INER focuses on development of new research lines for future implementation of low enthalpy geothermal projects.
- Research involves mainly the direct use of geothermal resources for diverse applications, such as greenhouses, space heating and cooling, industrial processes and tourism related activities.
- A plan to carry out prefeasibility studies on twenty two undeveloped prospects is being discussed.

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# INER

Instituto Nacional de  
Eficiencia Energética y  
Energías Renovables

**Dirección:** Av. 6 de Diciembre N33-32 e Ignacio Bossano, edificio Torre Bossano.  
Quito – Ecuador

**Teléfonos:** ++ 593 (0) 2 3825420 / 2

**Sitio Web:** [www.iner.gob.ec](http://www.iner.gob.ec)

**E-mail:** [info@iner.gob.ec](mailto:info@iner.gob.ec)



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