



SECOND CIRCULAR

**September 24th
to October 3rd**

CCVG

COMMISSION ON THE CHEMISTRY OF VOLCANIC GASES

IAVCEI

**INTERNATIONAL ASSOCIATION OF VOLCANOLOGY AND
CHEMISTRY OF THE EARTH'S INTERIOR**



INVITATION

On behalf of the Instituto Geofísico de la Escuela Politécnica Nacional (IG-EPN), the Parque Nacional Galápagos, the Commission on the Chemistry of Volcanic Gases (CCVG) and the International Association of Volcanology and Chemistry of the Earth Interior, we are glad to invite you to the 13th Gas Field Workshop to be held in Ecuador, from September 24 to October 3, 2017.

The main objectives of the workshop are to discuss and share new and existing direct sampling, in situ sampling and remote sensing results, collect complementary volcanic gas measurements from local volcanoes, and to discuss the latest theories and observations related to volcanic degassing.

The workshop will include four days of conference meetings and presentations, five days of field measurement and sample collection at Tungurahua, Guagua Pichincha, Pululahua and Cotopaxi volcanoes and two optional four and five days field excursion to Reventador volcano and to the Galápagos Islands.





Scientific Programme

The program will include a 4-day scientific meeting focused on geochemistry of magmatic gases and fluxes from volcanoes, followed by a 5-day field excursion to allow participants to acquire plume measurements, diffuse soil flux measurements and direct fumarole and water samples from local volcanoes. Details of the scientific program and field campaign are outlined below.

Conference:

- 1. New developments in direct, in situ, remote, and diffuse volcanic gas and aerosol sampling/measurement techniques, including but not limited to advancements related to measurement accuracy and precision, acquisition, automation and analysis.*
- 2. Geochemical observations and interpretations of volcanic and hydrothermal systems.*
- 3. The effect of volcanic plumes on atmospheric chemistry, natural hazards and environmental and human health.*
- 4. Modeling of volcanic degassing processes.*
- 5. Integrating volcanic gas observations with complementary datasets to elucidate volcanic processes*

Scientific Committee

Patrick Allard	Ryu Kazahaya
Santiago Arellano	Taryn Lopez
Nicole Bobrowski	Agnes Marzot
Mike Burton	Yuri Taran
Maarten de Moor	Franco Tassi
Tobias Fischer	Fatima Viveiros

Field Campaign:

1. Remote plume measurements (Tungurahua and Cotopaxi).
2. Measurements of soil degassing (Pululahua).
3. Direct sampling of fluids emitted from thermal springs and fumaroles (Tungurahua and Pichincha)

Ecuador is a small country in northwestern South America, bordered by Colombia on the north, Peru on the east and south, and the Pacific Ocean to the west. Ecuador also includes the Galápagos Islands in the Pacific, about 1000 kilometers west of the mainland.

Spanish is the official language and is spoken by a majority of the population, though 13 indigenous languages are also recognized, including Quichua and Shuar. The capital city is Quito, with 4 million inhabitants. In reflection of the country's rich cultural heritage, the historical center of Quito was declared a UNESCO World Heritage Site in 1978.

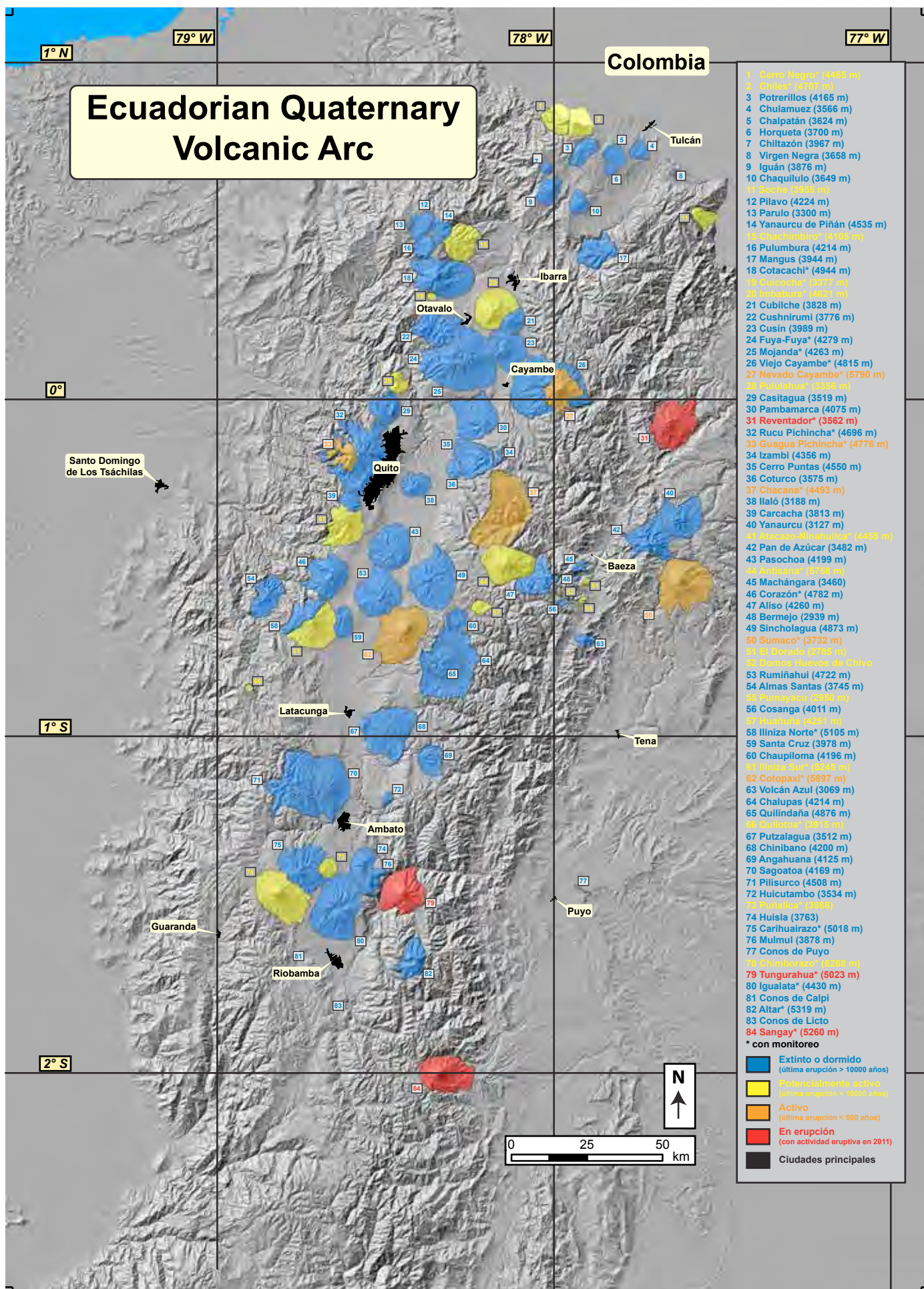
Ecuador has a developing economy that is highly dependent on commodities, namely petroleum and agricultural products. The country is classified as a medium-income country. Ecuador is a democratic presidential republic. Ecuador is also known for its rich ecology, hosting many endemic plants and animals, such as those of the Galápagos Islands. It is one of 17 megadiverse countries in the world.

Ecuador is a volcanic country, with ~84 volcanic edifices within the Ecuadorian Quaternary Volcanic Arc. Five of these volcanoes have been active in the last 20 years including: Sangay, Guagua Pichincha, Tungurahua, Reventador and Cotopaxi. Activity is frequently explosive, producing gas and ash plumes and pyroclastic flows, though effusive activity is also observed in the form of lava flows and domes. The Galápagos islands are the result of the activity of a hot spot since about 23 My. Recent volcanic activity in the islands is focused in the western side of the archipelago mainly focused on Isabela and Fernandina islands.

There is great variety in the Ecuadoran climate, largely determined by altitude. It is mild year-round in the mountain valleys, with a humid subtropical climate in coastal areas and rainforest in lowlands. The Pacific coastal area has a tropical climate with a severe rainy season (January - March). The climate in the Andean highlands is temperate and relatively dry, and the Amazon basin on the eastern side of the mountains shares the climate of other rainforest zones. Because of its location at the equator, Ecuador experiences little variation in daylight hours during the course of a year. Both sunrise and sunset occur each day at the two six o'clock hours.



Location of Ecuador in South América. Physiographic regions of the country. Map of the Quaternary volcanic edifices of Continental Ecuador.



September 24

09:00- 17:00	Registration of participants and handout Congress material
	Hotel Check In starts at 13:00
15:30-16:30	Ice Breaker- Welcome cocktail and invitation by Congress hosts.
17:00-18:30	Ecuadorian Party bus "Chiva" with music and drinks.
	Free for Dinner (on your own)
	Lodging Hotel Reina Isabel

September 25

	Breakfast
09:00- 12:00	Travel to Baños
13:00-14:00	Free time to check in or walk around town
14:00-15:30	Lunch at Hotel
15:30-18:30	Afternoon conference with Coffee break and snacks
19:00-20:30	Dinner at Hotel
	Evening Free & Lodging at Hotel Sangay

September 26

	Breakfast
09:00-12:00	Conference with Coffee break
12:30-14:00	Lunch at Hotel
14:30-18:30	Afternoon conference with Coffee break and snacks
19:00-20:30	Dinner at Hotel
	Evening Free & Lodging at Hotel Sangay

September 27

	Breakfast
09:00-12:00	Conference with Coffee break
12:30-14:00	Lunch at Hotel
14:30-18:30	Afternoon conference with Coffee break and snacks
19:00-20:30	Dinner at Hotel
	Evening Free & Lodging at Hotel Sangay

September 28

	Breakfast
Group 1 09:00- 16:30	Full Day DOAS and Tungurahua volcano observatory with Box Lunch
Group 2 09:00- 16:30	Full Day Sampling Thermal Springs Casa del Arbol with Box Lunch
17:00- 19:00	Free afternoon
	Free for Dinner (on your own)

September 29

	Breakfast
Group 1 09:00- 16:30	Full Day DOAS and Tungurahua volcano observatory with Box Lunch
Group 2 09:00- 16:30	Full Day Sampling Thermal Springs Casa del Arbol with Box Lunch
17:00- 19:00	Free afternoon
19:00-20:30	Dinner at Hotel

September 30

	Breakfast
10:00-13:00	Check Out and return to Quito
	Remainder of the day Free.
	Free for Dinner (on your own)
	Lodging Hotel Reina Isabel

October 1

	Breakfast
Group 1- Guagua Pichincha	
06:00-16:30	Full Day Guagua Pichincha Box Lunch
Group 2- Pululahua	
07:00-16:30	Full Day Pululahua with Box Lunch
	Remainder of the day Free.
	Free for Dinner (on your own)
	Lodging Hotel Reina Isabel

October 2

Group 1- Pululahua	
07:00-16:30	Full Day Pululahua with Box Lunch
Group 2- Cotopaxi	
07:00-16:30	Full Day Cotopaxi with Lunch at Tambopaxi
	Remainder of the day Free.
	Free for Dinner (on your own)
	Hotel Reina Isabel

October 3

09:00-13:00	Seminar #1 with Coffee break and snacks
09:00-13:00	Seminar #2 with Coffee break and snacks
09:00-13:00	Seminar #3 with Coffee break and snacks
	Free for Lunch
16:30-18:30	Final Conference Meeting with Coffee break
19:30-21:30	Farewell Dinner
	Lodging Hotel Reina Isabel

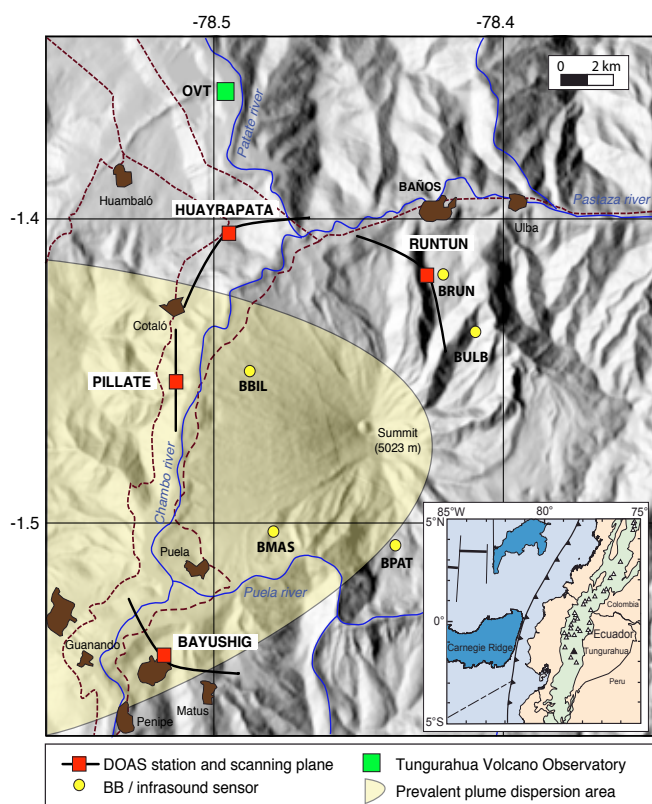
October 4

	All Day Transfers Hotel to the Airport
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September 28 and September 29



View from Casa del Arbol



DEM of Tungurahua volcano including the roads for potential traverses and the permanent seismic and DOAS stations.

The field activities around Tungurahua volcano are organized in two groups:

Group 1.

Every participant will get a box-lunch in the morning before taking the bus.

We will drive from Baños to the road Años - Puela or Huayrapata - Guanando, depending on the access to each of these roads. Both are ideal for making traverses using Mobile-DOAS or Flyspec in order to measure SO_2 below the plume which is usually driven by the wind from East to West. Ideally during a first traverse we will be able to determine the plume position and select places for fixed measurements using UV or IR cameras, Solar-FTIR or Multi-Axis DOAS. The bus will be available to continue making traverses on the selected road.

Around 15:00 or 16:00, depending on plume and weather conditions we will leave to visit the Tungurahua Volcano Observatory. This is a 20-30 minute drive.

We will be back for dinner at Baños.

Group 2.

Every participant will get a box-lunch in the morning before taking the bus. A bus will drive us to the three thermal sources around the volcano located at the foot of the volcano. As the sources are small, we will take one or two hours on each place so everyone can take enough samples.

Around 14:00 or 15:00, we will drive to Casa del Arbol, a touristic spot from where we will have nice views from the volcano depending on the weather. SO_2 cameras can be also used from this spot.

We'll be back for dinner at Baños.

Two roads cross Tungurahua from North to South (Baños - Puela or Huayrapata Guanando) while the wind direction is most of the time to the West. This gives a good configuration for making mobile traverses or to install fixed instruments like UV and IR cameras, Solar-FTIR and Multi-Axis DOAS instruments. SO_2 data can be compared with the results of the permanent NOVAC-I stations working at Tungurahua since 2007.

In Tungurahua the continuous presence of high-flow rate thermal springs at the base of the volcanic edifice and active fumaroles in the crater rim and some 1000 m bellow it, indicate the presence of a well developed hydrothermal system. Safe access to the summit fumaroles has not been possible since the renewal of volcanic activity in 1999. In contrast, access to the three hot-springs located to the north of Tungurahua, El Salado, La Virgen and Santa Ana, is very easy, given that they are actually profited as spas. These springs are located between 7 and 9 km from the volcano at elevations of 1750 and 1927 m.a.s.l., equivalent to ~3000 m below the summit. Five kilometers to the southeast of the summit there is another hot-spring named Palitahua, which is more difficult to access. The distribution of the northern springs is controlled by the contact between the metamorphic basement bellow the volcanic edifice and the older lava flows of Tungurahua I (Hall et al., 1999). These hot waters are one of the most important touristic attractions of the area and are well known since pre-Hispanic times, being considered as having curative properties.

This topographic map illustrates the Cordillera Occidental region in Ecuador, centered on the summit area. The map features a grid with UTM coordinates (780000 to 790000 Easting, 9830000 to 9845000 Northing). Key locations include:

- Towns and Settlements:** Huambaló, Cotaló, Bilbao, Puela, El Altar, Matus, Palitagua, BAÑOS, La Virgen, El Salado, Santa Ana, and Ulba.
- Rivers:** Rio Palate, Rio Champo, Rio Varcu, Rio Pastaza, Rio Union, Rio Guamba, Rio Uvilla, Rio Ulba, Rio Laurel, Rio Las Flautas, Rio Naranjal, Rio Matus, Rio Chesi, Rio Palitagua, and Rio Quinapuro.
- Quelwas (Q.):** Q. Quesera, Q. Achupashal, Q. Mandur, Q. La Piramide, Q. Pingullo, Q. del Romero, Q. La Rea, Q. Choglantus, Q. Mapayacu, Q. Los Tiacos, Q. Arenal, Q. de las 7 Chorreyas, Q. El Niche, and Q. Uvilla.
- Geographic Features:** The summit is marked with a black dot. The map also shows the Rio Matus, Rio Chesi, Rio Palitagua, and Rio Quinapuro.
- Scale and Orientation:** A scale bar at the bottom indicates distances in Kilometers (0, 2.5, 10, 15). The map is oriented with North at the top.



- a. La Virgen, 52°C
- b.- El Salado, 47°C
- c.- Santa Ana, 44°C

Location of the thermal springs around Tungurahua and the sources themselves.

October 1

Group 1

We will leave early in the morning in order to get a view of the dome Cristal from the crater rim of Guagua Pichincha. Buses will bring us to the Refugio at 4550 masl. This ride will take approximately 1:30 hours. From here we need to hike 30 minutes to the crater rim at 4700 masl. Going down to the Cristal dome, where fumaroles are active, will take about 2 hours, as we need to descend 600 m. Direct sampling is planned in these fumaroles. Guagua Pichincha is an active volcano, so special care should be taken to go there. Last temperature measurements were performed on November 2016 yielding 80°C. Seismic signal as well as weather conditions will be checked before going into the crater.

Group 2

Pululahua crater floor has already been the subject of one CO₂ survey. This took place on 2006 and results were published by Padrón et al., (2008). Several places with high CO₂ emissions have been identified. Repeating the same sites of measurements could produce a new map of CO₂ diffused through soil and a comparative study. Pululahua is about 1:30 driving from Quito. We will be left at the bottom of the crater where we will split into different groups to cover the surface. A second day of measurements will be done on October 2.

October 2

The group 2, performing diffuse CO₂ at Pululahua will continue the measurements on October 2.

We will leave to Cotopaxi volcano. Driving from Quito to Cotopaxi will take about 2 hours. Depending on the activity of the volcano remote sensing methods could be performed to measure the volcanic plume. We will have lunch at Tambopaxi lodge and depending on plume and weather conditions we can stay until 16 hours at Cotopaxi and then come back to Quito. Cotopaxi has had low-level activity since November 2015, but usually a gas plume can be observed from the crater. DOAS stations from the IG-EPN network measure less than 500 t/day.

October 3

Three instructional workshops will be hosted, with potential topics including: data processing, field techniques and/or instrumentation. Titles of these seminars will be announced in the 3rd circular.

In the afternoon the whole group will reunite in order to make a short evaluation of the Workshop, decide the next location and elect the new CCVG leadership committee.

A farewell dinner will follow.



Guagua Pichincha



Pululahua



Cotopaxi



September 20	leaving from Quito to Reventador: Sleeping at hotel
September 21	hiking to Reventador: measurements : camping
September 22	measurements all day : camping
September 23	Hiking back, visit of Jamanco thermal springs : back to Quito

Reventador experienced a highly explosive event, which was followed by emplacement of two lava flows in November–December 2002. Silica contents range from 62 to 58 wt.% SiO₂ for the November 3 pyroclastic deposits to 58–56 and 54–53 wt.% SiO₂ for the successive lava flows. In November 2004 eruptive activity resumed supplying four new lava flows (56–54 wt.% SiO₂) between November 2004 and August 2005. Volatile contents in matrix glasses and glass inclusions from the November 3 pyroclastic deposits allow us to estimate the total amount of SO₂ and HCl released into the atmosphere during the paroxysmal phase (i.e. 80 kT of SO₂ and 280 kT of HCl). Pre-eruptive pressure-temperature conditions of the magmas range from 300 to 150 MPa and ~ 1000 °C with high water contents (~ 5 wt.%). Samaniego et al., (2008) propose the existence of an andesitic magma body located at ~ 7–12 km depth that is frequently intruded by more primitive, hydrous magmas from a deeper source. The initial crystallization of amphibole from the hydrous primitive magma seems typical of El Reventador, as well as the historically recurrent and regular periods of eruptive activity lasting several years. This eruptive behaviour coupled with the fractionation and mixing processes inferred from the 2002 and 2004–05 petrologic data suggest that deep magmatic recharge at El Reventador is frequent, and is probably responsible for the high frequency of eruptions. Nowadays activity is characterized by gas and ash plumes, pyroclastic flows and lava flows. Remote sensing can be performed from the caldera floor.

To get to Reventador there is a 5 hours drive from Quito and 3 to 4 hours hiking in the jungle. Heavy rain is typical of the place.

Only one flux measurement by mobile DOAS was possible in 2013 by helicopter traverse. We measured 500 t/day. No other gas measurements have been obtained.

REVENTADOR VOLCANO
Minimum 10 people, maximum 25

September 20 Leave Quito 08:00 to the Reventador area

- 12:00 Hike to the impressive San Rafael Waterfall, the highest in Ecuador. (1-2 hour hike R/T)
- 14:00 Lunch at Hostería El Reventador. After Lunch, free time to enjoy the serene area and the pool & waterslide.
- 17:00 Hike to see the colorful and rare Cocks of the Rock. Almost uaranteed observation of the noisy Cocks of the Rock in their natural environment. Possibility of seeing monkeys. (1-2 hour hike R/T)
- 19:00 Dinner and explanation about the hike into the Caldera of Reventador.

September 21 Hike into the Caldera of Reventador

- 08:00 Breakfast
- 09:00 Hike into the Caldera of Reventador (4-5 hours O/W)
- 13:00 Lunch at campsite Reventador
- 14:00 Exploration of the Caldera and Gas Workshop activities
- 18:00 Dinner at campsite. Free time to stroll around the area or sit by the bon fire. Sleep in general campsite.

September 22 Full day Gas Workshop activities in the Caldera

- Breakfast, Box Lunch and Dinner
- PM: Dinner at campsite. Free time to stroll around the area or sit by the bon fire. Sleep in general campsite.

September 23 Hike out of the Caldera

- 07:00 Breakfast
- 09:00 Hike out of the Caldera (3- 4 hours O/W)
- 13:00 Lunch and relaxation by the pool
- 14:00 Leave for Quito. Optional stop at the Jamanco Hot springs (\$3)
- 18:00-20:00 Arrive in Quito.

Doesn't Include:

- Additional beverages or snacks
- Light rain poncho & Large Knapsack to carry all your gear

Note: The hike up to the Caldera is strenuous. Every person must carry their own sleeping bag and mat

Date	time	Activities	Overnight
04/10/2017		Preparation for Galápagos	Hotel in Quito
05/10/2017	06:00	Travel to Galápagos	Hotel in Isabela
06/10/2017	07:00	1) Sampling at Minas de Azufre 2) Visit to Volcan Chico 3) Visit to volcanic areas	Hotel in Isabela
07/10/2017	07:00	1) Sampling at Minas de Azufre 2) Visit to Volcan Chico 3) Visit to volcanic areas	Hotel in Isabela
08/10/2017	07:00	1) Sampling at Minas de Azufre 2) Visit to Volcan Chico 3) Visit to volcanic areas	Hotel in Isabela
09/10/2017	05:00	Travel back to Quito	



Sierra Negra fumarolic field. T measurements performed in 2014 yielded temperatures between 80 and 250 °C.

Registration Fee for Workshop, Tungurahua and Cotopaxi, Pululahua or Guagua Pichincha Field Trips

Single room: 1340 USD

Double room: 1135 USD

Students : 900 USD

These prices include:

- Workshop materials: T-shirt, pen, field notebook.
- Ice-breaker
- Transportation.
- Accommodation at Quito on 24 and 30 September and from 1 to 3 October.
- Accommodation and meals at Baños
- Field transportation and meals including coffee breaks and box-lunches.
- Transport to the airport only on October 4.

Not Included:

- One dinner at Baños
- Four dinners at Quito

Optional Pre workshop field trip to Reventador

Price: 450 USD

Includes:

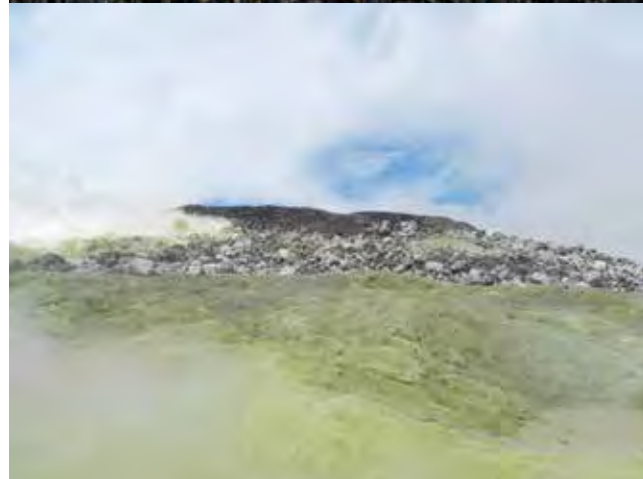
- Transportation from, during and back to Quito
- Local guides
- Excursions mentioned in the Itinerary
- Shared Lodging (1 night Hotel Reventador & 2 nights Camping)
- Full board (4 Lunches, 3 Dinners & 3 Breakfasts)
- Equipment: Rubber boots, Sleeping bag and Mat

Optional Post workshop field trip to Galápagos

Double room: 1800 USD

This price includes:

- Flight ticket from Quito
- Accommodation and meals
- Field camping at Sierra Negra
- Visit to Volcán Chico
- Visit to volcanic areas



Local Organizing Committee

Silvana Hidalgo

Patricio Ramón

Instituto Geofísico - Escuela Politécnica Nacional

Parque Nacional Galápagos

Logistics

Jonathan Hall, Ecuadorian Journeys

IAVCEI Organizing Committee

Franco Tassi, Leader CCVG

Nicole Bobrowski, Leader CCVG

Taryn Lopez, CCVG Secretary

Maarten de Moore, CCVG Editor & Webmaster

Important Note: Ecuador has placed a requirement to enter the country. Your passport must be valid for at least 6 months. It cannot expire within 6 months of your travels within Ecuador. You will not be allowed to board the plane to travel.

You are required to have Health Insurance to enter the country.

Important Dates

Third circular:

April 2017

Pre-registration and fee payment start date:

May 2017

Pre-registration and fee payment final date:

June 1, 2017

Abstracts deadline:

June 1, 2017

Registration fee payment final date:

August 15, 2017

Pre-conference Meeting

September 21 to September 24, 2017

Workshop:

September 24 to October 3, 2017

Post-Conference Meeting

October 5 to October 9, 2017

Pictures:

Cotopaxi: Marjorie Encalada, Benjamin Bernard, Silvana Hidalgo

Tungurahua: Silvana Hidalgo, Francisco Vásquez

Guagua Pichincha : Patricia Mothes

Pululahua : Patricio Ramón

Galápagos: Francisco Vásquez, Benjamin Bernard

Reventador: front page: Liz Gaunt, descriptive of the field trip: Francisco Vásquez