RECENT ACTIVITY

Cotacachi is considered a dormant volcano because there are no evidences of eruptive activity during the last 10.000 years. However, Cuicocha caldera which is the youngest part of the complex has had at least two eruptive phases in 3100 and 2900 aBP (Hillebrandt, 1989). That means that Cuicocha is a potentially active volcano according to Bernard & Andrade 2011.

VOLCANIC MONITORING

The seismicity and deformation of the Cotacachi Cuicocha Volcanic Complex (CCVC) is being monitoring by the IG since 1988 (Fig. 5). The main aim is to register all the changes in the volcanic activity.

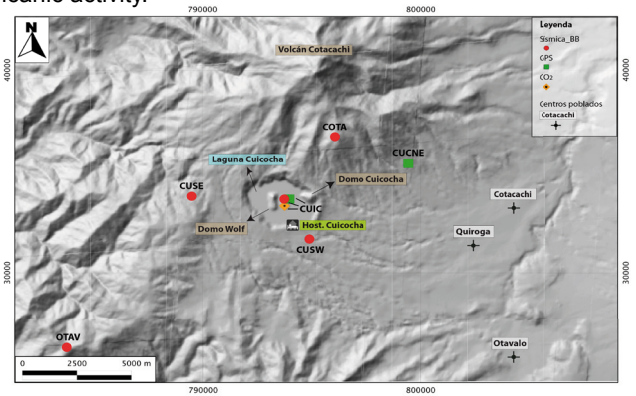

Figure 5: Location of the different monitoring stations of the VCCC. (IG-EPN).

Since 2011 the IG performs periodic measurements of diffuse CO_2 degassing in the Cuicocha lake. The objetive of this method is triying to identify changes in the carbon dioxide flux coming from the volcano (Fig. 6).

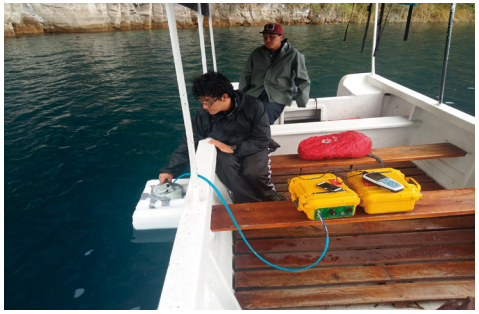

Figure 6: Measurement of CO_2 diffuse degassing at Cuicocha lake. Photo: D. Narváez, 19.12.2016, IG-EPN.

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POTENTIAL VOLCANIC HAZARDS

Mt. St Helens, USA Foto: Autor desconocido.

Laguna de Cuicocha Foto: M. Almeida.

Foto: Autor desconocido.

Mt. Sinabung, Indonesia.

Llaima, Chile. Foto: Autor desconocido.

Reventador, Ecuador. Foto: M Almeida.

Cotopaxi, Ecuador. Foto: M Almeida.

A) Debris Avalanche:
It forms due to the partial collapse of the volcanic edifice. It moves several cubic kilometers of rocks in a short period of time. This kind of phenomenon can occur due to: a shallow magmatic intrution close to the flank of the edifice, a large earthquake close to the volcano, or weakening of the volcanic edifice due to hydrothermal activity. Its reccurence is tens of thousand years (<1 event each 50.000 years). In the case of Cotacachi we can recognize two events, one at the northwestern flank and another one at the northeastern flank of the volcano.

B) Lava Flows and Domes:
These are partially or totally hot molten rock originated from a crater or craks on the flanks of the volcanoes. These flows go down the slopes and ravines with velocities of < 100 m/h. Sometimes, due to the high viscosity they form accumulations called lava domes. The final eruptive phase of Cotacachi was characterized by the formation of lava domes for example: Piribuela and Loma Negra to the East of the volcano and Wolf and Yerovi inside of the Cuicocha lake.

C) Pyroclastic Density Currents (PDC):
They are mixtures of volcanic gases, ash and rock fragments result of an explosive volcanic eruption. They can go down along the flanks of the volcano reaching velocities of 100-200 km/h and temperatures >200°C. Examples of this kind of phenomenon are the large deposits of pumice and white ash found in the vicinity of Quiroga and Cuicocha towns. These deposits stem from the recent eruptions of the complex that occured in 3100 and 2900 aBP.

D) Lahars:
They are mixtures of water, volcanic material (rocks and ash) and debris which go down the ravines of the volcano. *Primary Lahars:* they can occur due to the partial melting of a glaciar cap or the destruction of a crater lake. *Secondary lahars:* they form due to secondary procceses like heavy rains, thaws or even seismic events **(E.g. Cotacachi, 16 August 1868 described by Stubel & Reiss 1987)** which remove the unconsolidated deposits from the past eruptions of the volcano.

E) Ash Fallout:
These are volcanoclastic fragments result of the magma fragmentation which is erupted through an ash column or cloud towards the atmosphere. Its distribution is controlled by the wind. The biggets fragments of rock fall out close to the vent. Meanwhile the fine particles reach large distances from the vent. Fallout could affect crops, drinking water sources, and produce respiratory illnesses.

F) Volcanic Gases:
They are produced in the majority of the active and potentially active volcanoes. They are expelled before, during and after an eruption. Generally they increase with the eruptive activity. They could affect the respiratory system if the exposition is prolonged. They also could produce acid rainfall which is very corrosive.

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COTACACHI - CUICOCHA VOLCANIC COMPLEX

Photo: M Almeida.

GEOLOGY, RECENT ACTIVITY, MONITORING AND VOLCANIC HAZARDS

Marco Almeida

2017

INSTITUTO GEOFÍSICO
ESCUELA POLITÉCNICA NACIONAL

Translation: Francisco Vásconez, Anais Vásconez, Daniel Sierra

/instituto.geofisico @IGecuador /institutogeofisico

SISMOS ECUADOR

Ladrón de Guevara E11-253, Aptdo 2759.
Casilla 17-01-2759
Telef: (593-2) 2225-655; 2507-144; 2507-150 ext 631
Fax: (593-2) 2567-847
Quito - Ecuador
www.igepn.edu.ec

COTACACHI VOLCANO

The Cotacachi-Cuicocha Volcanic Complex CCVC is located in the Province of Imbabura, 10 km West of Cotacachi town and 13 km South of Otavalo city. The complex is part of the Western Cordillera of Ecuador. Its base area is aproximately 268 km^2 (Fig. 1).

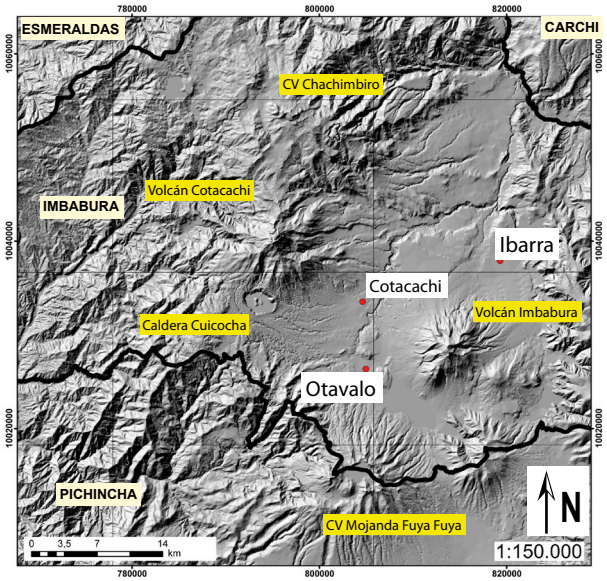

Figure 1. Location of the Cotacachi-Cuicocha volcanic complex.

The CCVC is formed by: a central edifice called Cotacachi whose summit is 4939 meters asl, four satellite lava domes: Cuicocha, Muyurcu, Loma Negra and Piribuela at the flanks of the central edifice and a volcanic caldera called Cuicocha (Fig. 2).

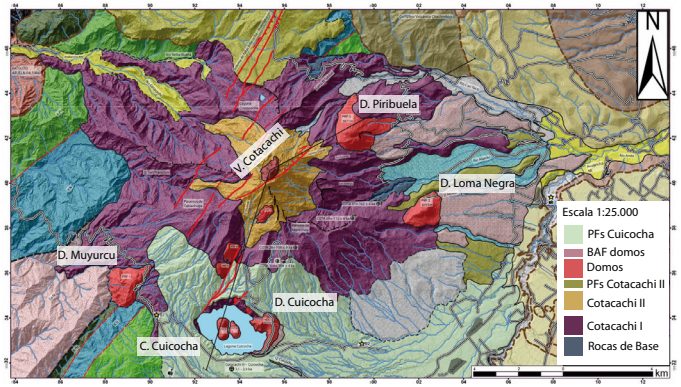

Figure 2. Geological map of the Cotacachi - Cuicocha volcanic complex. PFs: pyroclastic flow deposits, BAF: block and ash deposits. (Modified from: Almeida M, 2016. IG-EPN).

GEOLOGICAL HISTORY

Cotacachi is a dormant strato-volcano (Fig. 3). Over its entire evolution it had two big debris avalanches. Cotacachi volcano is divided into two edifices. The first one (Cotacachi I) was constructed from 162.000 to 108.000 yBP(years before present). It is composed of basaltic-andesitic lava flows at the base. On the top of that base andesitic lava flows and autobreccias are found. These deposits were strongly eroded by the glaciation. A debris avalanche is located on the right riverside of the Intag river at the northwestern flank of the volcano. According to the stratigraphy this event could have occured at the end of the construction of Cotacachi I.

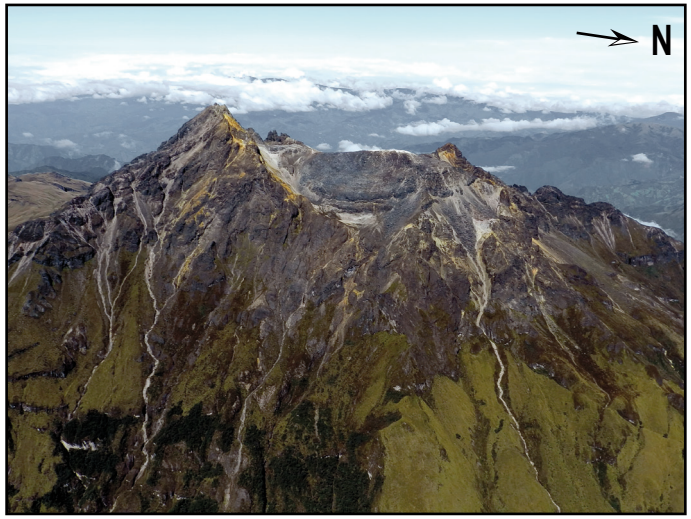

Figure 3: Overview of the Cotacachi volcano eastern flank. The crater at the summit was filled by lava flows. (Photo: M. Almeida, 2016. IG-EPN).

Later, the edifice Cotacahi II was constructed. It is shaped like an eroded pseudo-pyramide. It is composed of andesitic lava flows mainly at the southern flank. This sequence was intruded by small dacitic lava domes and dikes. While Cotacachi II was being constructed a debris avalanche occured to the Northeast destroying part of the edifice. The deposits are located along the Ambi river. This deposit is found on the top of the Cachimbiro volcano's avalanche and below the Imbabura volcano's avalanche.

According to the stratigraphy we consider that the Cotacachi II avalanche could have occured between 102.000 and 65.000 yBP. The end of the eruptive activity of Cotacachi II was marked by a sequence of lava flows filling the crater of the volcano (Fig. 3).

The deposists of the satellite lava domes (e.g. Piribuela, Cuicocha, etc.) are located over the volcano-clastic sequences of the Cotacachi edifices, including the northeast avalanche. That means that the formation of the lava domes probably occured around 44.000 yBP (relative age). This date includes the extrution of the Cuicocha lava dome.

CUICOCHA CALDERA

The Cuicocha lava dome was destroyed by a big explosion 3100 yBP, generating a caldera structure (Fig. 4) at the southern flank of the Cotacachi volcano. Several quarries of pyroclastic flows pumice deposits in the vicinity of the Cuicocha are the evidences of the big explosion. In some towns like Quiroga the pyroclastic flows can reach more than 18 m of thickness. After this first stage, the Cuicocha caldera produced a sequence of explosive eruptions with surges and fallout deposits. In 2900 yBP, the cycle of explosive eruptions finished with the extrusion of the lava domes Wolf and Yerovi in the central part of the caldera. Finally, when the eruptive activity ended the caldera was filled by meteoric water forming the Cuicocha lake how it is known nowadays.

Figure 4: Overview of the Cuicocha caldera from the northeast. In the center of the caldera the Wolf and Yerovi post caldera lava domes are located. (Photo: M Almeida, 2016. IG-EPN).