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Post – Conference Tour: Volcano Villarrica

Introduction

The Villarrica volcano is the volcano with most eruptive activity in South America. Since 1558 it has experienced around 60 well-documented eruptions. The last one occurred in 2015 and the eruptions have presented a wide variety of magnitudes and eruptive styles. The main cone is covered by a glacier of 1.17 km³ (Rivera et al., 2014) and during winter season snow covers a large area of the volcano. The strong relation between high eruptive frequency and the availability of ice and snow, has produced lahars that have transported large sediment volumes to the valleys, which have been deposited radially around the volcanic cone. Additionally, close to the volcano there are urban centers with a relevant population (inhabitant and touristic), this is the reason because it is considered as the most risked volcano in Chile by the geological service of Chile (SERNAGEOMIN, 2019).

The fluvial systems located in active volcanic environments such as Villarrica, are very sensitive to eruptive processes (Pierson and Major, 2014). They are affected by the damming of the drainage network by the lava flows, impoundments of the valleys by the pyroclastic flows and accumulated material, or the collapse of glaciers located by the head of the valleys. These geophysical processes correspond to the major disturbances for rivers systems, changing rapidly the erosion-deposition dynamics in a short period of time with consequences on the fluvial geomorphology at different spatial scales. At the same time, when lahars occur there are fast modifications of the physical and chemical properties of water (increases in acidity, turbidity, and suspended sediment concentration).

In this context, the aim of this fieldtrip is to observe one of the Villarrica volcanic valleys where lahars flooding has occurred during recent eruptions. We will observe the main characteristics of the fluvial regime affected by lahars, in contrast to other Villarrica valleys. We hope to motivate a discussion about the influence of geology and geomorphology on fluvial systems, recognizing the channel evolution downstream forced by extreme events.

The proximal and distal zones of the Zanjón Seco valley will be visited (Fig.1). This valley is located in the north face of the Villarrica volcano, from this point we will observe the glacio-volcanic interactions that have promoted the generation of lahars, and the topographical features of riverbeds, sediment size distributions and longitudinal slopes.

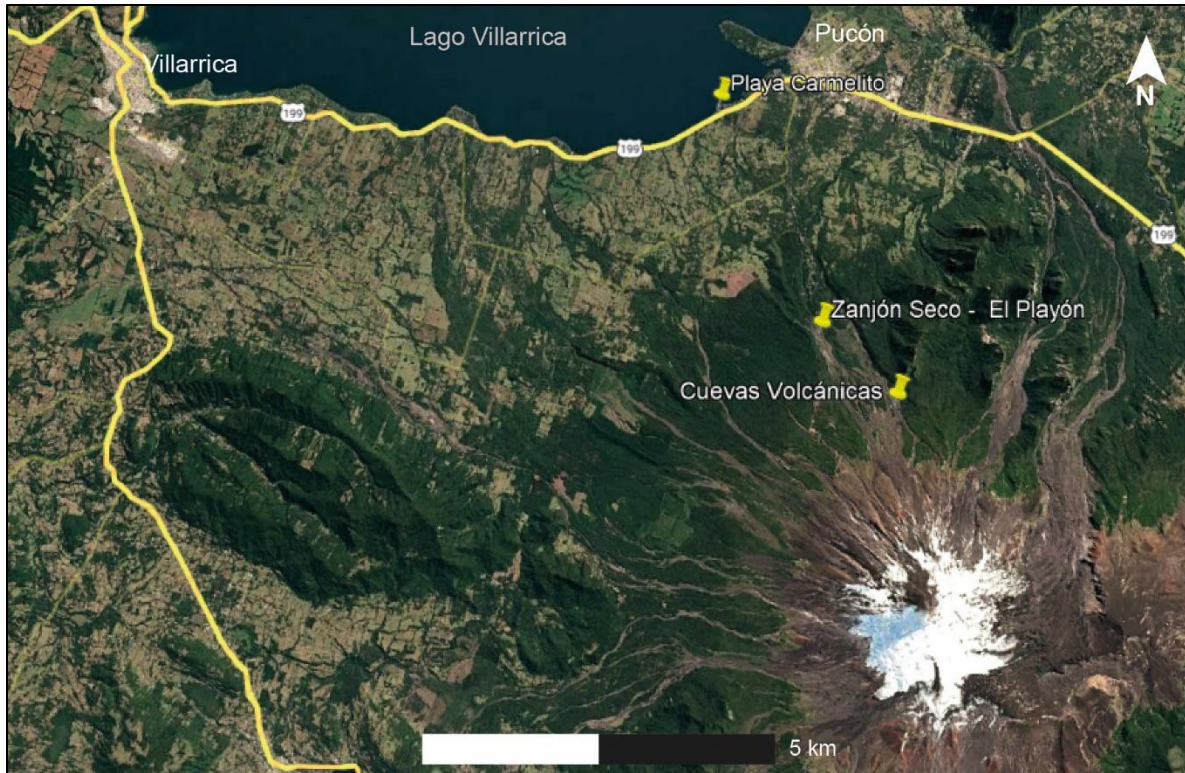


Figure 1. Locations of the points to visit, Cuevas Volcanicas, Zanjon seco and Playa Carmelito.

Site visits:

Station 1. Cuevas Volcánicas

This point is located 5 km from the main active crater of the volcano, in the transitional zone between proximal zone dominated by a cone volcanic morphology, which corresponds to a recent volcanic structure with high slopes, to a glacial valley morphology where the hillslopes decrease, at the beginning of the deposition zone of material that has been transported by the lahars (Figure 2).



Figure 2. The photo shows a southern view from the Cuevas Volcánicas area. In the upper part we observe the sediment sources of the lahar occurred in 2015 in the Zanjón Seco valley and in the bottom part the sediment deposit are observed.

At this location, there is a volcanic monitoring station with a camera that records images of the crater. These photos are transmitted in real-time to the *Observatorio Volcanológico de los Andes del Sur* (OVDAS) in Temuco, where they are processed and analyzed with additional variables from multiple sensors in the station.

The monitoring variables can be found in real-time in the follow link:

<https://rnvv.sernageomin.cl/volcan-villarrica/>



This QR code allows you to access the Villarrica survey website.

We will discuss here the lahar generation mechanisms, the deposition facies of the debris flows, the sediment sources of the lahars, the transition of the lahars flow regimes, the role of lithology and the subsurface permeability, among other topics.

Station 2. Area El Playón, Zanjón Seco valley

This area is located approximately 8 km from the active crater of the Villarrica volcano. It corresponds to the bottom of a valley of glacial origin of ca. 1.3 km wide, which has been permanently filled with material of volcanic origin and its rework from ca. 14 ka, with abundant lava flows, lahars, and pyroclastic flows (Moreno & Clavero, 2006). Figure 3 shows a wide area of deposition of material transported by lahars.



Figure 3. Area “El Playón”, sediment deposition and discharge section during the lahars.

Here we will talk about sediment transport in lahars, the influence of volcanic activity and its deposits on hydrography, the influence of geology on drainage networks and fluvial dynamics. A comparison with the Turbio river valley could also be useful to analyze. as a contrast between two nearby valleys with notoriously different fluvial characteristics.

Station 3. Playa Carmelito

We will visit the estuary of the Carmelito stream in Lake Villarrica, at a distance of 15 km from the active crater. We will observe the fan morphology in this area, and a few meters upstream, multiple terrace levels associated with historical lahars from 2015 and 1971 (Figure 4).

It is a place of interest for the study of subaqueous facies in lahars, rates of aggradation and dynamics of the alluvial fan. Additionally, it is important to note the development of infrastructure

such as houses, constructions for tourism purposes, and critical elements such as bridges and roads in hazard zones to discuss risk management measures.



Figura 4. Terrace stages at the mouth of the Carmelito stream at the Villarrica Lake.

References

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