Seismic activity at Irazú volcano after the 5th September 2012 Nicoya Earthquake, Costa Rica

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I_ Introduction

At 8:42 a.m. on September 5th, 2012, a Mw = 7.6 earthquake occurred 20 km south of Samara, Peninsula de Nicoya, Guanacaste (Fig. 1). The maximum displacement was 2.5 m with a maximum vertical motion about 60 cm at Playa San Juanillo (OVSICORI Report on September 11th, 2012). The fault displacement continued until the end of September through post-seismic motions, slow earthquakes, visco-elastic response and aftershocks (> 2500 during the first 10 days following the Nicoya earthquake). The seismicity spread to most of the country (Figs.1 and 2).

Regarding the volcanoes, the 5th Sept . 2012 Nicoya Earthquake generated an important seismic activity especially in the volcanic complexes Irazú-Turrialba (Fig. 2) and Poás as well as an unusual seismic activity mainly for Miravalles, Tenorio and Platanar-Porvenir. No important changes in the superficial activity were noticed, but an unusually high seismic activity continued for several days.

Volcanically speaking, the main effect observed was the activation of tectonic faults associated to the volcanoes, either in Costa Rica or in Nicaragua. The Nicoya quake generated swarms of volcano-tectonic events nearby most active and some resting volcanoes. However, no significant change in the volcanic seismicity strictly speaking was noticed, neither external signs (phreatic eruptions, unusual gas emission, etc) for any of the active Costa Rican volcanoes. Important changes happened at some volcanoes of Nicaragua (San Cristóbal, Telica, Apoyeque), however, these cannot be directly attributed to the quake of Nicoya even if it probably contributed as they were intermittently active these last years. Volcanic changes can occur after an important earthquake because it modifies the static and dynamic field of stress. While passing, the seismic waves induce dynamic fluctuations, and the strain induced by the fault dislocation produces static changes. In both cases, a volcanic system responds with delay due to its visco-elastic properties and to the diffusion constants of the fluids involved (*Brodsky et al, 2003).* In order to generate a volcanic reaction, a magmatic body must be saturated in gas within a shallow magma chamber. Hence , only a few magmatically active volcanoes showed modification of their activity with the occurrence of a high magnitude earthquake nearby (*Cannata et al., 2010).*

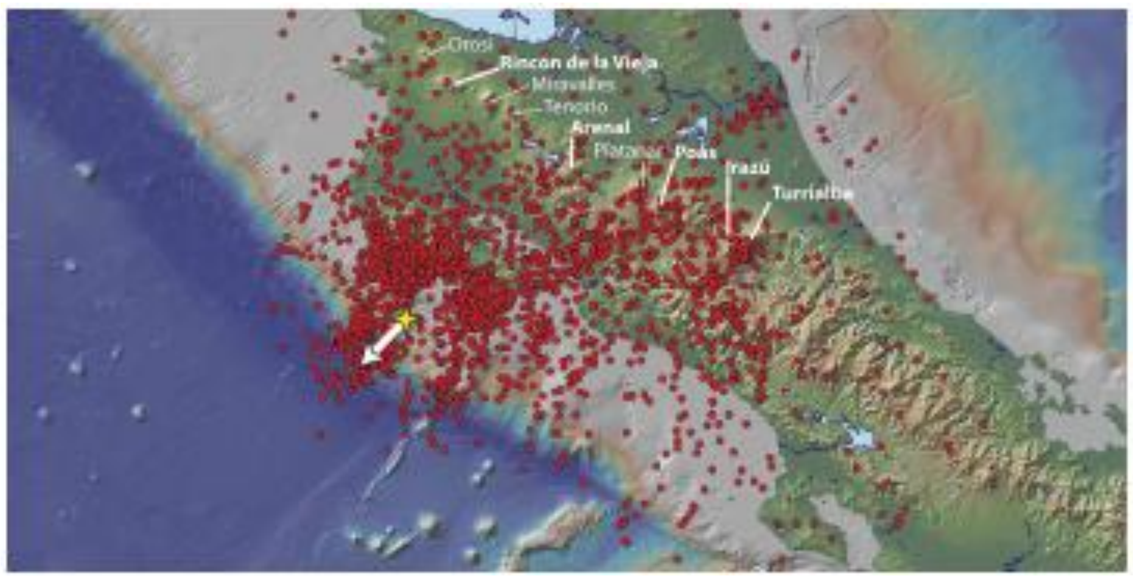

Figure 1: Seismicity in September 2012 and location of the main volcanoes. Yellow star: epicenter of the Nicoya quake on September 5th, 2012 (Mw = 7.6). White arrow: direction of the displacement due to the Nicoya quake (map: Walter Jiménez Urrutia, Evelyn Núñez, and Floribeth Vega from the Seismology group of OVSICORI-UNA).

II_ Irazú Volcano

II_1 Irazú V.: Summary of the main events in 2012

Irazú volcano did not show noticeable changes whether for the degassing level of the fumaroles nor the geochemistry of the thermal springs in 2012, except for the tectonic seismic activity following the September 5th Mw 7.6 Nicoya earthquake. The level of the lake in the Main Crater stayed low all year with fluctuations and reached a minimum at the end of the year.

II_2 Irazú V.: Seismic Activity

Irazú volcano kept having an important tectonic-seismic activity possibly reflecting changes in the local and regional field of stress. The seismic peak occurred immediately after the Nicoya quake on September 5th, 2012 (Mw 7.4). Figure 2 shows the location of the volcano-tectonic events that occurred during the first week after the Nicoya quake. The current network does not allow enough precision in the location to associate the events with the identified fault systems in the volcanic range. The quakes are uniformly spread in the whole range with a peak under the summit of the volcano, between the surface and 5 km depth. Seismic activity was recorded throughout year 2012 with 3 peaks on January 9th, June 27-28th and September 5-8th (Fig. 3). In January, the events were located southeast of the Main Crater, in June they were north and northeast of the crater, and in September they were mostly under the summit area of the volcano.

Also worth to note is that the 5th September 2012 Nicoya earthquake caused a *perturbation of the amplitude and inter-event time of LP events.* The volcanic seismic activity was dominated by LPs. This seismicity showed an almost –stable periodicity pattern until September 2012, then LP events start to happened more often.
LP events are monochromatic with a dominant frequency of 1.56 Hz and variable amplitude (Fig. 4). The amplitude ranged between 1 and 30 microns/sec, at station VIRE, and the inter-event time varies between 30 hours in September and 15 hours at the end of November and in December. This variation is probably a perturbation of the volcanic system, produced by the September 5th earthquake of Nicoya.
The system seems to have almost recovered after 8 months.

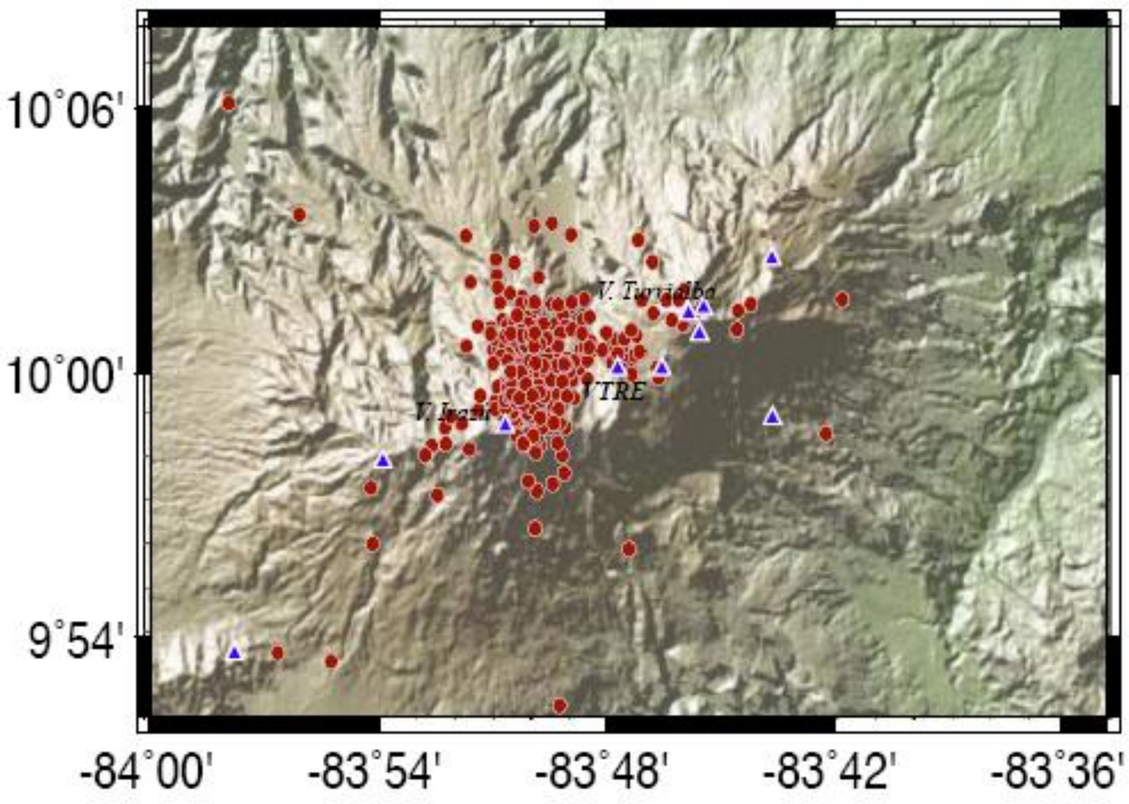

Figure 2. Tectonic seismicity recorded at Irazú and Turrialba volcanoes during the first week after the 5th September 2012 Nicoya earthquake.

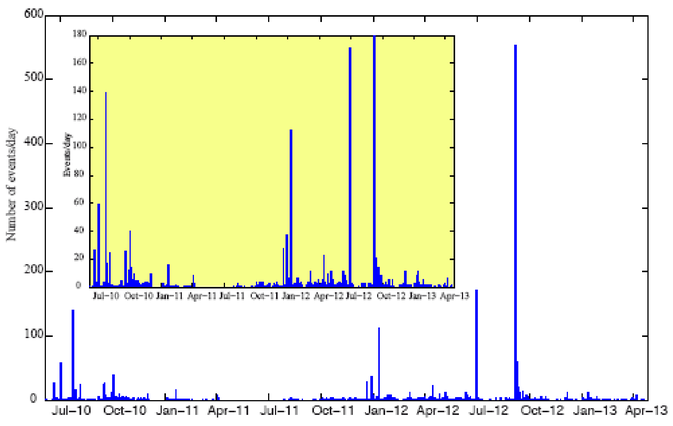

Figure 3: Number of daily volcano-tectonic seismic events recorded at Irazú volcano between July 2010 and April 2013.

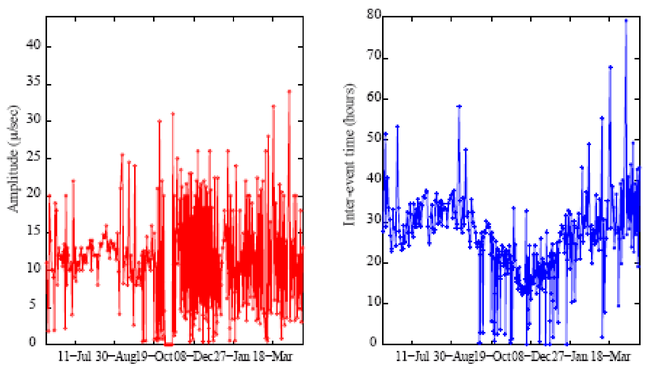

Figure 4: a) Amplitude variation in microns/sec of the LP events vs. time at Irazú volcano.
b) Variation s in inter-event times between LP events at Irazú volcano between July 2012 and April 2013.

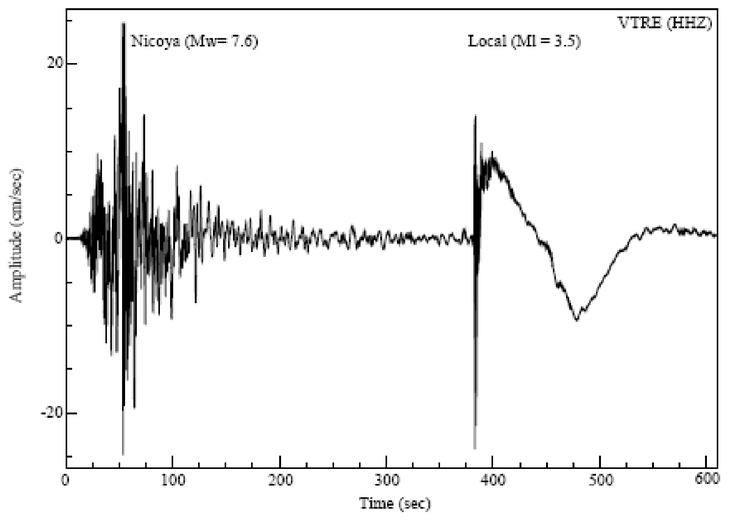

Figure 5: The 5th September Nicoya Earthquake followed by a VT quake at Irazú volcano registered by the seismic station VTRE located between Irazú and Turrialba volcanoes.