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1.0 Introduction
Volcán San Salvador has a long history of hazardous volcanism and is located next to San Salvador, El Salvador’s capital city with more than two million inhabitants. Four generations have passed without notable volcanism at the volcano, leaving people unaware of the hazards that tower above them. The principal goal of this work is to inform people about the volcanic risks at Volcán San Salvador. There are four objectives; 1) to describe its geologic features, 2) to provide an eruption history of Volcán San Salvador, 3) to assess its volcanic hazards, and 4) to create hazard-zonation maps for the region. These results are based on previous work, new field observations, satellite image/aerial photo interpretation, geochemical analysis, and new age dating. This work is part of to a cooperative effort to better understand and mitigate hazards of El Salvador’s volcanoes.

1.1 Volcán San Salvador’s location
Like other capital cities in Central America, San Salvador is the largest city and the economic heart of El Salvador. It is located 7 km directly down-slope from the towering (1893m) volcano, which bears its name and has a history of devastating eruptions. The greater San Salvador region (which includes the upper slopes of Volcano San Salvador) produces much of the country’s coffee, sugar cane and maize (Figure 1.1). San Salvador has a population density of 2,067 inhabitants/km² and produces 70% of the country’s GNP (República de El Salvador website, 1998).

Volcán San Salvador is part of the active Central American Volcanic Belt (CAVB) and the Pacific “Ring of Fire.” The CAVB includes a 1100 km long chain of 41 active volcanoes, which extends from Guatemala to Panama (Simkin and Siebert, 1994) (Figure 1.2). Volcán San Salvador sits above a convergent boundary between the Caribbean and Cocos plates (Molnar and Sykes, 1969).
Figure 1.1: Regional map of Central America and El Salvador. The location of Volcán San Salvador, Largo de Ilopango, and Coatepeque are shown in red.
The convergent plate boundary is formed by the underthrusting of the Cocos plate and overriding the Caribbean plate along the Middle America Trench (Burbach et al., 1984). El Salvador’s nine active volcanoes are located in a east-west trough between two older mountain ranges. Some of the closest eruptive centers to Volcán San Salvador are calderas; Ilopango, 28 km to the east, and Coatepeque, 33 km to the west (Figure 1.1). Their ancient silicic deposits are a valuable aid in the interpretation of Volcán San Salvador’s stratigraphy (Rose et al., 1998).

Figure 1.2 Map of the active volcanoes along the Central America Volcanic Belt

SS = Volcán San Salvador, SM = Santa María, FU = Fuego, S-I = Santa Ana-Izalco, CN = Cerro Negro. Modified from Carr and Stoiber, 1990
1.2 Volcán San Salvador’s geomorphology

Volcán San Salvador is composed of two edifices and numerous flank deposits (Meyer Abich, 1954). Boquerón, a well defined edifice with a circular crater (13.736 N, 89.286 W) 1600m in diameter, is inside remains of a larger older edifice, San Salvador. The highest part of Boquerón is the southern rim at 1893 m. El Picacho, (1959 m, Figure 1.3) northeast of Boquerón is the highest point of an older crater (approximately 5km in diameter). El Jabalí, (~1400 m) a mountain north-west of Boquerón, is also a remnant of the rim of this older crater. All three summits (Boquerón, Picacho, and Jabalí) are part of the San Salvador volcanic complex, as are a number of flanking monogenetic lava flows, cinder cones and explosion craters (Figure 1.3).

1.4 Previous studies of Volcán San Salvador’s deposits

Volcán San Salvador’s deposits have not been studied in detail. Although geologists have studied some of the volcano’s deposits or the volcano in a larger context no one has attempted to study the entire volcano’s history until now. Meyer-Abich (1954) did the first reconnaissance mapping of Volcán San Salvador (Figure 1.3). Schidt-Thome (1975) mapped undated lava flows from Volcán San Salvador under deposits of ash from Ilopango Caldera (Figure 1.1, located within L. Ilopango) within the city of San Salvador. Hart (1983) described the extent of two ashfalls from flank vents and an ashfall from Boquerón, San Andrés Tuff (SAT) in the context of archeological sites in the eastern Zapatitán valley. Miller and Conyers (1994) studied the phreatomagmatic deposits of a flank vent that covered the Hoya de Cerén archeological site. Fairbrothers et al. (1978) studied a sequence of andesitic lavas from Boquerón that represents approximately one third of the volcano’s history.
1.5 Natural hazards around San Salvador

Historic records of volcanic and local earthquake activity goes back to the Spanish Conquest in 1524 A.D. There have been three eruptions at Volcán San Salvador, in the last 470 years. These events have consisted of Strombolian flank eruptions and lava flows. Larde and Lardin (1948)
wrote historical accounts of the eruptions of El Playón (in 1658) and of the 1917, flank and summit eruptions. Two early authors (Palacio and Ximenez) mentioned pre-20th century eruptions near El Playón in their memoirs (Larde y Lardin, 1948). Unfortunately these works are no longer available for review. Larde and Lardin, (1948) reported that Palacio visited a fresh lava flow near what is now El Playón in 1575 and than Ximenez described an eruption that began in August 9th, 1658, in the same region; El Playón. (Larde and Lardin, 1948)

The most recent eruption of Volcán San Salvador occurred in 1917. Thirty minutes after a devastating earthquake, steam billowed from the Boquerón Crater (Larde, 1956). At about the same time at least four fissures opened up along a N40W trending fault on the NW flank of the volcano. Within a month the former crater lake (then approximately 80 m deep) boiled off and was replaced by a cinder cone called Boqueroncito. The eruption lasted two months, Boqueroncito grew 30 m high and approximately 0.9 km$^3$ of lava (El Norte flow) was extruded on the NW flank.

After the 1917 eruption, fumarolic activity continued until the late 1970's (Fairbrothers et al., 1978). But there was no fumarolic activity present in 1996. This long period of eruptive repose may falsely suggest that a volcanic eruption is less hazardous than the more frequent regional earthquakes and landslides. Salvadoreans are keenly aware of the danger of earthquakes, since the majority of them have lived through one. Yet, very few of them were alive during the last eruption of Volcán San Salvador in 1917.

Non-magmatic earthquakes and landslides have been much more frequent and devastating than eruptions from Volcán San Salvador. The most destructive earthquakes in the region are the upper
crustal or shallow volcanic front type (White and Harlow, 1993). These earthquakes have destroyed the capital 11 times in the last 375 years. The most recent of these was in 1986 (Harlow et al., 1993).

Landslides commonly occur in this region because of thick, unconsolidated tephras, which are exposed by construction, and then triggered by earthquakes or after rainstorms. The last deadly landslide took place on El Picacho in 1992 (Finnson, 1994).

The last few centuries may not be a fair sampling of the potential hazards which the volcano really presents to El Salvador. Salvadoreans only know about the last two historic eruptions of Volcán San Salvador. These historic eruptions were not deadly and may lead to the false assumption that the volcano is a nuisance, rather than a real threat. Nevertheless, as this thesis will show, Volcán San Salvador is indeed a dangerous volcano with a long history of violent eruptions. In fact, the last deadly eruption likely took place around 800 years BP, and if it occurred today would kill thousands of people and cripple national transportation. Volcán San Salvador’s periods of tranquility deceive Salvadoreans about its true hazardous nature.