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Permafrost Distribution in Tropical Stratovolcanoes: Popocatépetl and Iztaccíhuatl Volcanoes (Mexico)

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Popocatépetl (19ž02'N, 98ž62'W; 5424 m) is located in the center of the Transmexican Volcanic Belt, approximately 70 km east of the center of Mexico City and west of Puebla. After several periods of activity and calm, current activity began on December 21, 1994, with the formation of lava domes inside the crater. Periods of dome growth and destruction continued, and were accompanied by explosive activity and pyroclastic flows. Spanish explorers reported the existence of perennial snows and glaciers. The remains of moraines are visible at a minimum altitude of 4150 m, and mark the maximum extension of the glacier during the 19th century. Since then, the glacier has receded due to climate-related causes. In February 1994, the glacier snout was located at 4760 m, but in 1995, volcanic activity caused it to retreat considerably and now glacier is nearly nonexistent (Tanarro et al. 2005; Andrés et al. 2007).

Iztaccíhuatl volcano (19ž11'N y 98ž39'W, 5286 m), is only 17 km from Popocatépetl and is inactive. Glacier landforms from several phases are visible on the mountain. The most recent phase occurred during the Little Ice Age and the glacial maximum coincided with that of Popocatepetl. The end moraines were located at a minimum altitude of 4330 m (Ayoloco Glacier). As climate change evolved during the last century, glacier recession increased. Today (February 2006) the snout of Ayoloco Glacier is at 5069 m.

Studies on glacier evolution in Mexico have advanced considerably in recent years (Vázquez-Selem, and Heine, 2004 and Lachniet and Vázquez-Selem, 2005). Glacier dynamic in tropical mountains is being the objective of many works but still there

is virtually no knowledge of permafrost dynamics in these areas and particularly on active volcanoes (Heine, 1994). The results discussed in this paper pertain to a five year study on permafrost distribution and, in general, on the distribution of ground temperature on Popocatépetl and Iztaccíhuatl. Thermal probes were installed to record air temperature and ground temperature at depths of 10 cm and 80 cm, at altitudes of approximately 4100, 4300, 4400, 4600, 4900 and 5100 m. All of the test sites had a northern exposure.

In contrast to what occurs on other active volcanoes, the ground temperature regime on Popocatepetl appears unaffected by volcanic activity and sudden variations in geothermal heat. In fact, the thermal data from Popocatépetl differed only slightly from that of Iztaccíhuatl. Permafrost is continuous from 4900 m on both volcanoes. The probe located at a depth of 10 cm recorded significant changes in daily temperature with more than 200 freeze-thaw cycles at altitudes from 4400 to 4800 m. Above this altitude, the ground is frozen for many days of the year. The probe at 80 cm depth showed temperature changes of 2-3 žC, and the number of freeze-thaw cycles was limited to 1 or 2 per year. These results indicate that periglacial activity on both volcanoes is only superficial. The influence of snow on ground temperature is minimal since snow permanence lasts only a few days every year on the ground, except on the glaciers.

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