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Structural and geophysical study of Masaya Caldera

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Masaya Caldera (Western Nicaragua) possesses a complex structure represented by nested calderas, summit pit craters, and scoria cones that reflect the heterogeneous eruptive activity the area has undergone in recent geological history. Major faults connect several of these features, revealing a strong interplay between the structural framework of the volcano and its historical and present activity. The magma reservoirs responsible for the current state of unrest, as well as the remnants of past magma chambers emptied after the occurrence of several Plinian eruptions since 6000 BP might be revealed by studies addressing the distribution of sub-superficial densities over the caldera. Magnetic studies could shed light on the presence of local structures such as extension faults postdating the subsidence and collapse of the caldera floor, which may have been filled by geological materials with different magnetic susceptibility values than those forming the typical volcanic succession present in the area. They can also be used to understand the three-dimensional distribution of the Marie Curie point (and therefore, the depth to any magma bodies underlying the caldera). Structural studies can give an insight on the controls that the fault framework of the volcano has exerted on its activity.

This study has been carried out in order to understand the history and future evolution of Masaya Caldera using a variety of geological and geophysical techniques. Complementary relative gravity studies have been used to generate two Bouguer anomaly maps. The first, with spacing between measurement points ranging from 50 m to 300 m, covers the whole caldera floor using the network of trails within Masaya National Park. This reveals a strong gravity gradient across the park in a NNE-SSW direction (with increasing gravity values towards the NNE), as well as a locally anomalous area centered on the presently active volcanic complex (San Pedro, Santiago, Nindiri and San Fernando craters). The second relative gravity map was generated using data points collected every 50 m across the central pit craters. This data indicates a relative gravity high in the central area of Nindiri, to the Norhtwest of the presently active Santiago crater. A series of magnetic profiles across Masaya Caldera show anomalous magnetic values that coincide with a theorized ring fault that would connect almost all the main volcanic cones, edifices and fissure swarms which are present currently within the Caldera. In addition, sites of fumarolic activity, eruptive centres, extension faulting and other related structures have been mapped and their geographical distribution strongly suggests that volcanic activity has been primarily structurally controlled over the last ∼2 ka (i.e. since the last Plinian eruption). All of these datasets have been combined to provide a more complete picture of activity at this persistently degassing volcano, as well as offer a potentially useful insight on the possible behaviour of the volcano in the future.