Abstract

The Lost Mine Trail (LMT) area of the Chisos Mountains lies just outside the north-eastern margin of the Pine Canyon Caldera (PCC). The South Rim Formation (SRF) in the high Chisos Mountains is thought to involve two separate and distinct peralkaline magmas, one producing the lava flows of the Pine Canyon Rhyolite (PCR) and Boot Rock Members (BRM), and the other producing the lava and tuff of the Emory Peak Rhyolite (EPR). Included in the SRF is a swarm of dikes that strike west-southwest from the north-eastern margin of the PCC toward extra-caldera vents at Casa Grande, Toll Mountain, and Emory Peak. Detailed field mapping at a 1:10,000 scale of the LMT area has recorded a more accurate spatial distribution of these dikes, as well as providing some new information on the structure and general geology of the area. Mass balance modeling combined with further trace element modeling has provided evidence for a co-magmatic relationship for the dikes on top of the LMT, and the Casa Grande Lava Dome. Pearl element ratios indicate that these dikes and the Casa Grande Lava Dome are related to the source magma for the PCR and BRM, and not the source magma of the EPR. The geologic map combined with the geochemical modeling provides evidence for a complex plumbing system that connects the PCC to the extra-caldera vents at Casa Grande. Ideas are also proposed about the structure and sequence of geologic events in the area.

Petrogenesis

Differential crystallization of the dikes of the Lost Mine Trail area and Casa Grande lava dome has been modeled using single-stage fractional crystallization. No assimilation of crustal rock is apparent when looking at trace element data. Also, the narrow band of activity between the emplacement of the dikes and the eruption of the lava dome leads to the low probability that assimilation would have been a significant factor in the differentiation of these rocks. Major element mass balance modeling suggest that differentiation of the trachytes and rhyolites from 68.9% (TXCH-66) to 96.6% (TXCH-OSR03D3) can be achieved by 58.2% fractionation of an assemblage consisting of 72.7% feldspar, 15.6% quartz, 3.0% clinopyroxene, 0.6% ilmenite, and 0.6% fayalite. Major element data for these phases were provided by White et al. (2006). The residual sum of squares ($\sum r^2$) is the major element model was good at $\sum r^2 = 0.045$. The results of the mass balance model were enough to further test the hypothesis using trace element modeling shown in figure 8.

Geology of the Lost Mine Trail Area

Introduction

The Lost Mine Trail is one of the most popular trails in Big Bend National Park. It also happens to be in a very interesting area just outside the north-eastern margin of the Pine Canyon Caldera. The area host Paleogene rocks of the Chisos Formation and South Rim Formation. The Chisos Formation in this mapping area is made up of two mafic flows; the Ash Spring Basalt (40.92 +/- 0.07 Ma) and the Bee Mountain Basalt (34.03 +/- 0.17 Ma to 33.07 +/- 0.15 Ma) (Turner and others, 2016). Two of these lava flows lie in between interbeds of differentiated tuffaceous sediments. The South Rim Formation is made up of felsic extrusive and intrusive rocks associated with multiple episodes of volcanism between 32.04 Ma and 32.40 Ma (Turner and others, 2011). The South Rim Formation is made up of felsic extrusive and intrusive rocks. The Pine Canyon Rhyolite, the Boot Rock Member, and the Emory Peak Rhyolite. Also included in the South Rim Formation are the dikes, and the large intrusions that frame the Basin area.

Field Observations

The geologic map in this paper shows the spatial distribution of these dikes and intrusions between the western margin of the Pine Canyon Caldera and the extra-caldera vents at Casa Grande, Toll Mountain and Emory Peak. Most of the dikes do not have continuous surface expressions through the area and many are arcuate in nature. The general orientation of the dikes seem to begin at the northwest wall of the Pine Canyon Caldera near the top of Lost Mine Trail. At this location they have a general strike of 265 to 275 degrees and make a slight curve going into Juniper Canyon as their orientation changes from 230 to 240 degrees (fig. 1). The set of dikes on top of Lost Mine Trail can be traced going into Juniper Canyon to the west, and ending at the south face of Casa Grande Mountain (fig. 2). Folding and uplift of Chisos Formation rock units took place between the time of the eruption and partial erosion of the Bee Mountain Basalt, and the eruption of the Boot Rock Member. This folding is visible in the trace element model used in the differentiation data (fig. 4) toward the top of Lost Mine Trail. Dips were measured at over 40 degrees in the Chisos Formation in this area. An angular unconformity is present between the Bee Mountain Basalt and the Boot Rock Member implying that this folding event took place before the eruption of the flow of the Boot Rock Member in the area.

Small scale faulting of the Chisos Formation was observed along the eastern wall of Juniper Canyon. A larger fault structure mapped on the northern wall adjacent to the switchbacks, causes significant off-set of Chisos units, but very limited offset in the Boot Rock Member. Fractures and small offset are observed in the Boot Rock Member, but could be from reactivation of this fault. A pair of fault structures causing significant displacement of rock units was discovered on the southern wall of Casa Grande. The specific cause and timing for the faulting in this area is not yet known.

Progression of Events

The progression of geologic events starts with the deposition and eruption of Chisos Formation sediments and mafic lava flows (Maxwell and others, 1987). This was followed by the eruption of the Pine Canyon Rhyolite and the subsequent collapse of the Pine Canyon Caldera. (Ogle, 1978) showed that events collected from recent mapping suggest that the next event involved the large intrusion/lava dome emplacement causing the uplift and folding of the Chisos Formation. The Boot Rock Member was then erupted out of multiple vents in a semi-circular arc around the PCC as well as outside the caldera. These maar-type vents erupted rich gas rich surge deposits followed by the emplacement of lava domes. There are multiple lava domes located in the area surrounding the PCC, including Pumpe Peak, Lost Mine Peak and Crown Mountain. Outside the PCC lies the extra-caldera vents capped by lava domes at Casa Grande, Toll Mountain, and Emory Peak. (Urbanczyk and White, 2000)

Conclusion

Major element data for these phases were provided by White et al. (2006). The residual sum of squares ($\sum r^2$) is the major element model was good at $\sum r^2 = 0.045$. The results of the mass balance model were enough to further test the hypothesis using trace element modeling shown in figure 8.

Petrography

The Casa Grande lava dome and dike samples range from per-alcaline trachyte to rhyolites (figures 6b thru 7), and show the presence of minerals such as sanidine, arfvedsonite, quartz, apatite, iron oxides, and aegerine-augite in their groundmass. The rocks of both localities show a similar Or content in both phenocrysts and groundmass feldspars. However, there are differences in the distribution of these minerals as well as differences in the texture of these rocks that become apparent after detailed study.