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Pucarilla-Cerro Tipillas Volcanic Complex: The oldest recognized caldera in the southeastern portion of Central Volcanic Zone of Central Andes?

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1. Introduction

In the southeastern portion of Central Volcanic Zone of the Central Andes there are vast outcrops of pyroclastic and minor effusive deposits which lack of previous volcanological and petrological studies. We group individual pyroclastic deposits into the Pucarilla-Cerro Tipillas Volcanic Complex (PCTVC), relating them to a caldera structure.

Deposits from this complex are located in the southeastern margin of the Puna Plateau, constituting one of the first important expressions of magmatism in this zone. This might be important because it coincides with the onset of major uplift in this region of the Puna (Isacks 1988; Allmendinger *et al.* 1997), thus contributing to crustal thickening which is in part attributed to magma addition (e.g. Allmendinger *et al.* 1997).

2. Results

Units of PCTVC lay unconformably above Paleozoic granitic basement and folded sediments (Marrett *et al.* 1994; Hongn and Seggiaro 2001) of the Eocene-Pliocene Payogastilla Group.

We include and group into the PCTVC the deposits that were alternatively assigned to *Laguna Blanca Formation* (Turner, 1962), “*Tobas dacíticas*” (Navarro García, unpublished), “hornblendic welded tuff” (Sparks *et al.*, 1985), “*flujos ignimbríticos*” (Castillo and Aguilera, 1988), “*andesitas y dacitas Tebenquicho*” (González, 1992), “welded tuff” (Marrett *et al.*, 1994), “*Ignimbrita Pucarilla*” (Hongn and Seggiaro, 2001) and “*Ignimbrita Pampallana*” (González *et al.*, 1999).

Most of the recognized deposits are located in a NNE-SSW elongated inter-mountain relief

(25°49'-26°37'S and 66°16'-66°43'W). Three massive pyroclastic lithofacies are recognized as medium to high grade ignimbrites, the most developed of which is *Pucarilla* Ignimbrite. The latter corresponds to the most welded and devitrified pyroclastic unit and was dated at 12.11 +/- 0.11 Ma (Marrett *et al.*, 1994)

Some authors as Hongn and Seggiaro (2001) and González *et al.* (1999) have suggested a relationship between *Pucarilla* Ignimbrite and the hornblendic welded tuff dated in 15.83 +/- 0.44 Ma and 14.75 +/- 0.4 Ma by Sparks *et al.* (1985). Cropping out in the surroundings of Alto de Las Lagunas depression, this unit is a pink-welded and devitrified ignimbrite that needs to be considered as a separated unit, due to slight differences in its petrography. Nevertheless, it is texturally and compositionally very similar to *Pucarilla* Ignimbrite; for this reason we include it in the PCTVC as a single unit. The stratigraphic relation between both units is still unknown.

Compositionally, all the recognized units are metaluminous to peraluminous andesites and dacites of the calc-alkaline series and are characterized by a high crystal (33-48%) and low lithic content (<3%); normal pumices/fiammes content varies between 5 and 35%. As a characteristic feature all of them have pink fiammes (< 1%) and grey juvenile fragments (<1%). We did not recognize all outcrops possibly related to the complex, so areas farther west and south of the interpreted emission centre should be examined and might increase notably the areal distribution and volume of the PCTVC.

3. Characterisation

Major characteristics of the PCTVC are: (i) most deposits are intensely welded tuffs (ii) their welded characteristics persist at least for distances of 50 km, (iii) no initial plinian deposits are recognized, (iv) the magmatic event ends with effusive activity, (v) extruded magma volume is at least 20 km³, (vi) the minimum areal distribution is 650 km² (vii) the greatest actual topographic difference between the deposits of the complex is about 2,2 km. In light of the described characteristics and a detailed field work, discriminating and correlating facies, we invoke a volcanic structure such as a caldera being responsible for this succession.

We propose a probable centre linked to the depression of Alto de Las Lagunas (26° 09'S-66° 43'W) where some field evidences can be related to a non resurgent collapse caldera. These include: (i) an intense hydrothermalization in the borders of a topographic depression which is (ii) surrounded by pyroclastic units of PCTVC and (iii) lavas in proximal facies, (iv) absence of basement (paleozoic granites).

Deposits from PCTVC have an age averaging between 15 and 12 Ma, revealing that the magmatic activity in this region is more developed than previously thought. This caldera becomes the easternmost and one of the oldest known examples in the Central Volcanic Zone of Central Andes.

4. Conclusions

Given the spatial proximity between Galán Caldera and PCTVC it should be interesting to evaluate their relationship, which is still unclear given the few complete geochemical published data. Nevertheless a first approximation shows: a) bivariate diagrams show possible correlatable trends, b) rare earth elements patterns show more enrichment in LREE and depletion in HREE in Galán rocks compared to PCTVC c) multi-element patterns are rather similar. For this, although they have somewhat different geochemical patterns, they could indicate a recurrence in the volcanism between 12 and 2 My in the south eastern end of the Altiplano Puna plateau. The magma signature of both eruptive periods (12 and 2 Ma), could be useful to test the geochemistry as a tool, in order to gain insight into the knowledge of crustal thickening. Detailed comparisons of them are still under study.

Considerable work remains to be done to elucidate the history of this volcanic complex and its relationship with the evolution of the southeastern portion of the Altiplano-Puna plateau.

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