# Lithologic Controls on Yardang Morphology from Field Observations of the Cerro Blanco Ignimbrites of Argentina

Abstract #3202

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## Introduction

Yardangs are streamlined eolian erosional features found on Earth [1], Mars [2-4], Titan [5], and perhaps Venus [6]. When viewed from above, they are regularly spaced and much longer than they are wide, while in profile they have boat-shaped cross sections with prominent, wind-facing prows (Fig. 1). The yardangs in the ignimbrites of the Puna plateau of Argentina were described by de Silva et al. (2010) with regard to how lithologic variations affect the yardang positions, orientations, and physical dimensions [3]. In this work, we aim to investigate the lithologic variations in ignimbrite from the Cerro Blanco caldera, the material for the Campo de Piedra Pomez (CPP) and related deposits [3], in more detail so as to separate their influence on yardang morphology from the influence of regional aerodynamic forces such as flow separation and erosion by sand suspended in vortices [7].

The Cerro Blanco caldera in the southern Puna last erupted at about 70 ka, depositing four lobes of ignimbrite to the south, northwest, north, and northeast [8] (Fig. 2). Yardangs are formed in some areas of these units with orientations corresponding to the regional NW-SE wind pattern. The northeastern ignimbrite lobe includes the CPP yardangs. From this location and others we collected samples of different depositional facies in the ignimbrite deposits. For the investigation discussed here, we describe the petrographic characteristics that affect induration in each ignimbrite facies, such as porosity, clast size, and mineralogy. By comparing these characteristics to yardang dimensions and morphology, we will attempt to qualitatively predict the petrographic characteristics of other ignimbrites according to the types of yardangs that they host.

Fig. 1 (below) - **Comparison of Terrestrial and Martian Yardangs** in CPP, Argentina, Earth (top left and bottom left); on Mt. Sharp, Gale Crater, Mars (top right); and in the Medusae Fossae Formation (MFF) (bottom right). The friable volcaniclastic material and lack of aqueous alteration in the CPP yardangs are unusual for sites on Earth but typical for Mars [2]. The lithology of Mt. Sharp is variable [9,10] and is unknown for the MFF, but the presence of yardangs indicates relatively low induration, perhaps similar to ignimbrites in the CPP [4]. Sources: MSL Mastcam image 1994.51779597474, HiRISE image ESP_35558_1830, Google Earth.

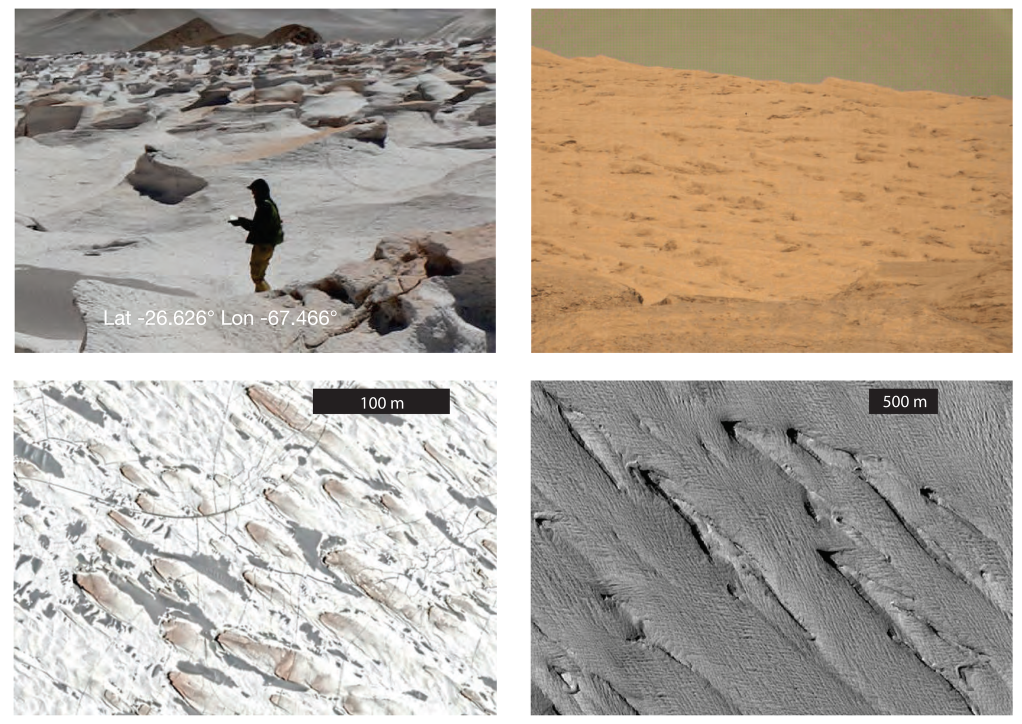
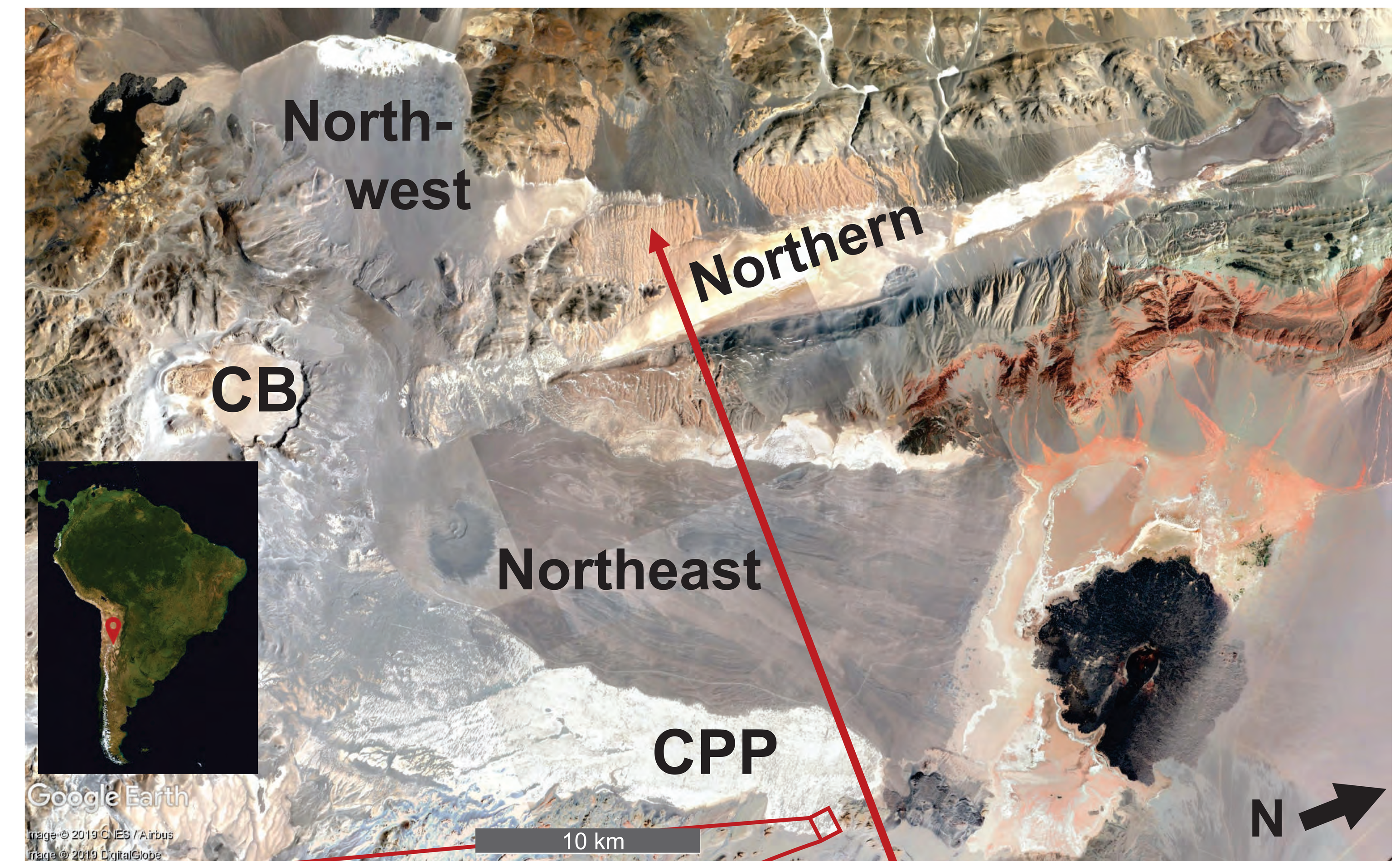



Fig. 2 (on right and below) Maps of the study area, with the caldera labeled "CB" and the main yardang fleet labeled "CPP". Individual ignimbrite lobes are labelled with their direction relative to the caldera. The left image shows traverses and sample locations. Imagery source: Google Earth. South America image source: Wikipedia.





## Sample Descriptions

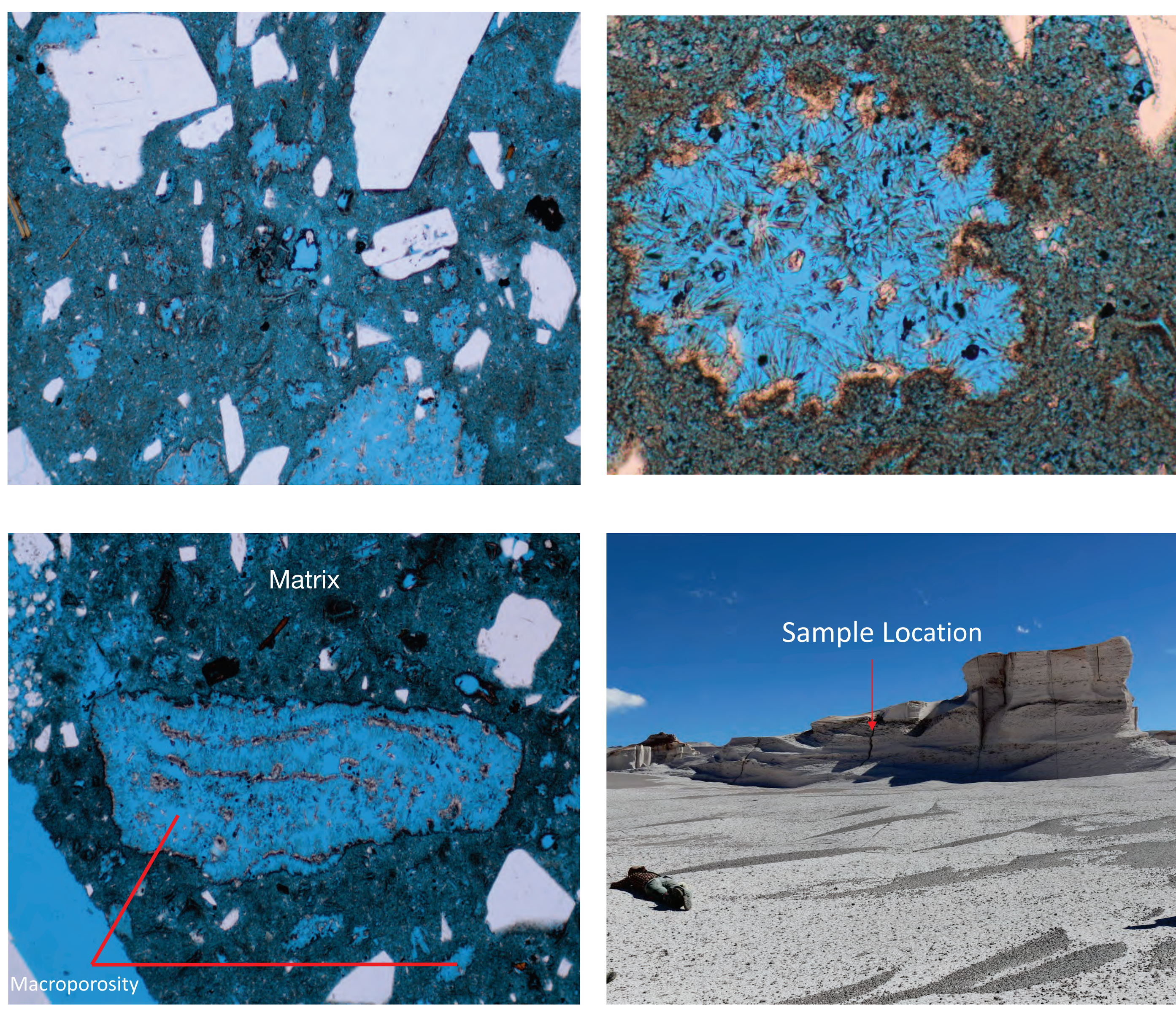
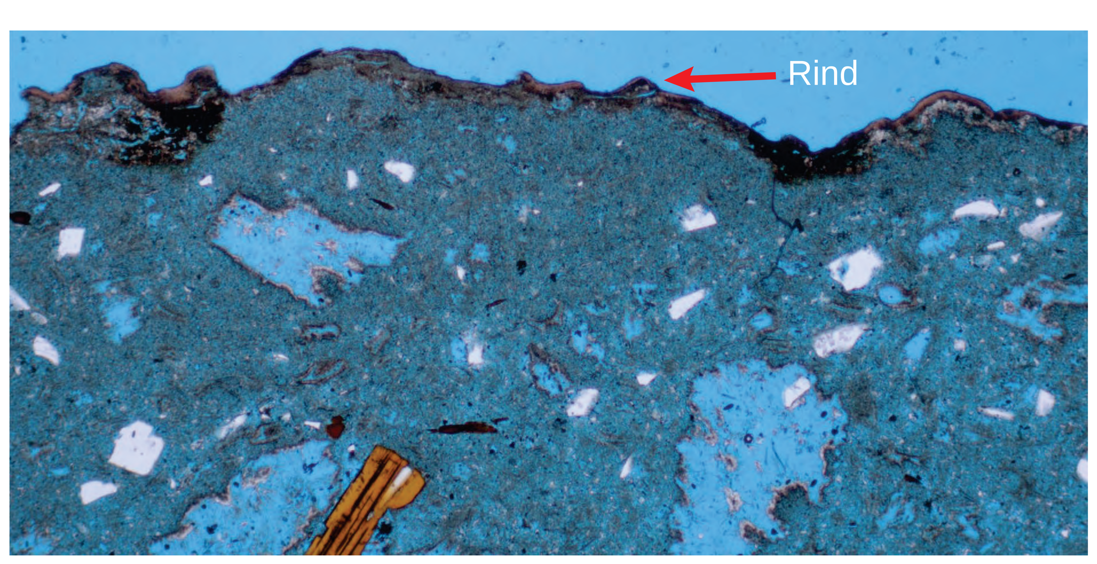



Fig. 3 – **Photomicrographs of the white facies** which dominates CPP. Like all of our thin sections, the porous regions have been impregnated with blue epoxy to create contrast with solid particles.This facies contains large pumice clasts and phenocrysts of plagioclase, quartz, biotite, and large secondary oxides (top left). The dark matrix porosity can be attributed to the abundandant vapor-phase deposited quartz and oxide crystals. This is particularly evident in the porous interiors of devitrified pumice grains (bottom left). Some relicts of elongated vesicles and glass shards in the matrix remain, but at high magnification the relicts are seen to be delicate sprays of crystallites (top right). Although the effect of devitrification on yardang scale induration and weatherability is unknown, it appears to reduce matrix porosity and increase pumice porosity, causing pumices to erode first.

Fig. 4 (below and right) - **Thin hard weathering rinds** form on the top surfaces of some yardangs in the white facies. Such yardangs are recognized in map view by the orange color of the uppermost weathered surface. The lack of thick alteration in the thin section (bottom right) indicates that the rind is due to case hardening and is not immediately caused by syndepositional alteration, although the rind may be produced from weathering of vapor phase deposited crystals.

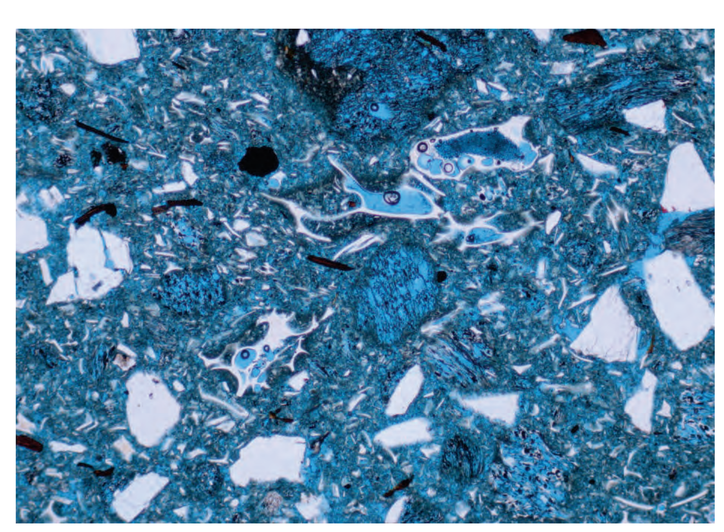
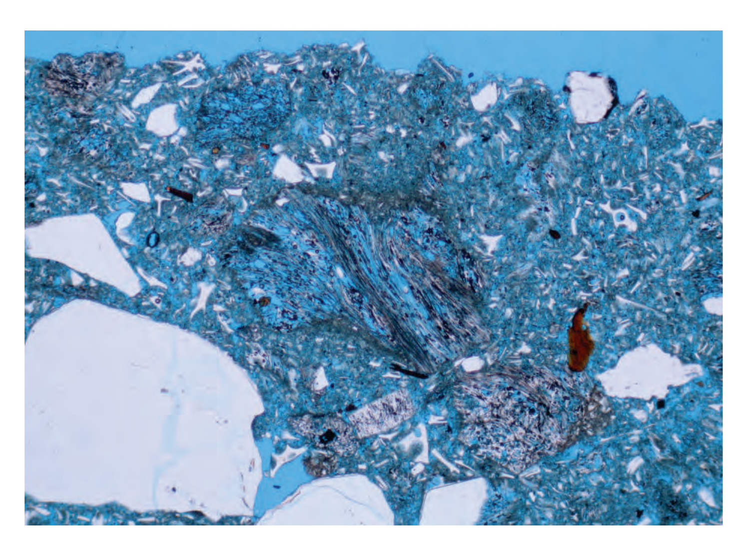




Fig. 5 (above and right)- **Photomicrographs of the orange facies** along the leeward edge of CPP, which seems to host smaller yardangs. It has coarse glass shards (above) and pumice clasts with elongated vesicles (right). The phenocryst mineralogy is dominated by quartz, feldspar, and biotite. The coarse glass creates the appearance of higher matrix porosity, evident in the lighter color of the matrix relative to that in the white facies. The complete preservation of glass shards and elongated pumice vesicles attest to the absence of welding and devitrification. This is corroborated by the lack of vapor phase deposited crystals and low abundance of opaque oxides.



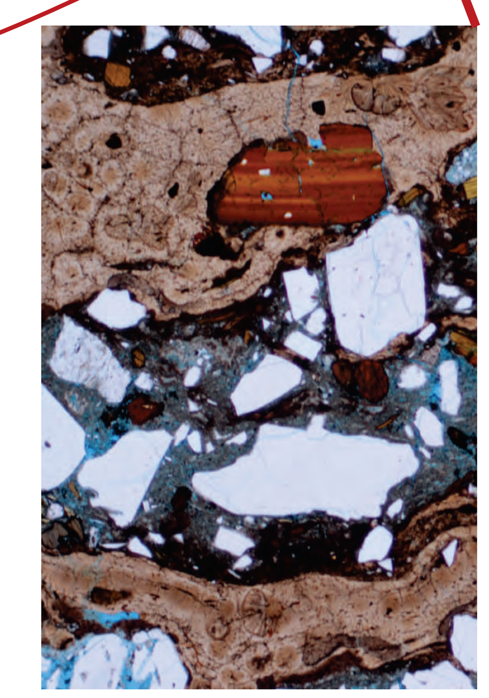


Fig. 6 (left) - **The red ignimbrite from the megayardangs in the Cerro Galan ignimbrite** adjacent to Cerro Blanco [8]. The brown layers are devitrified pumice clasts (fiamme) that have been flattened and welded by overlying material after deposition.
This eutaxitic texture, the absence of porosity, and the large phenocrysts contribute to these ignimbrites having a much greater degree of induration and therefore forming

Fig. 7 (below) - **Large pumice clasts with positive relief** in the northern yardang fleet. The less weathered pumice in this area should have lower porosity and thus exert more control on yardang dimensions.

## Conclusions

The eutaxitic texture in the megayardang-hosting Cerro Galan ignimbrites are key to their low porosity and correspondingly greater induration. This relationship could explain the difference in size between megayardangs and mesoyardangs like those in CPP.

Some features were notably absent from the CPP samples. Welding of pumice and eutaxitic textures have notable effects on induration and porosity, but they were not observed. Apparently these phenomena are not necessary for yardang formation in ignimbrites and may have additional effects on yardang morphology not described here.

**Textural descriptions of yardang materials in thin section show that matrix porosity and devitrification are qualitatively related to yardang dimensions.** In mesoyardangs (less than hundreds of meters in length), porosity is affected by welding, devitrification, and the size of phenocrysts. Porosity affects yardang morphology through its relationship with induration. These relationships should predict the porosity and textures of unsampled yardangs such as those in the northern yardang fleet (Fig. 7), where the positive relief of pumice clasts may indicate the absence of devitrification in those rocks. The refinement of methods for discriminating lithology will eventually enable the same capability for yardang-bearing materials on Mars and other bodies.

## Future Work

Before the next field season, these observations will be quantitatively linked to measurements from photos and orbital imagery. This will require detailed mapping to describe yardang dimensions and morphology as well as constraining other effects such as geologic structure and wind patterns. The analysis based on our integrated dataset will enable improved sampling during the next field season to better constrain the relationships described here.

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