NEOGENE IGNIMBRITES IN THE AREA OF AREQUIPA, SOUTHERN PERU: PALEOMAGNETIC CORRELATIONS AND FLOW DIRECTION.

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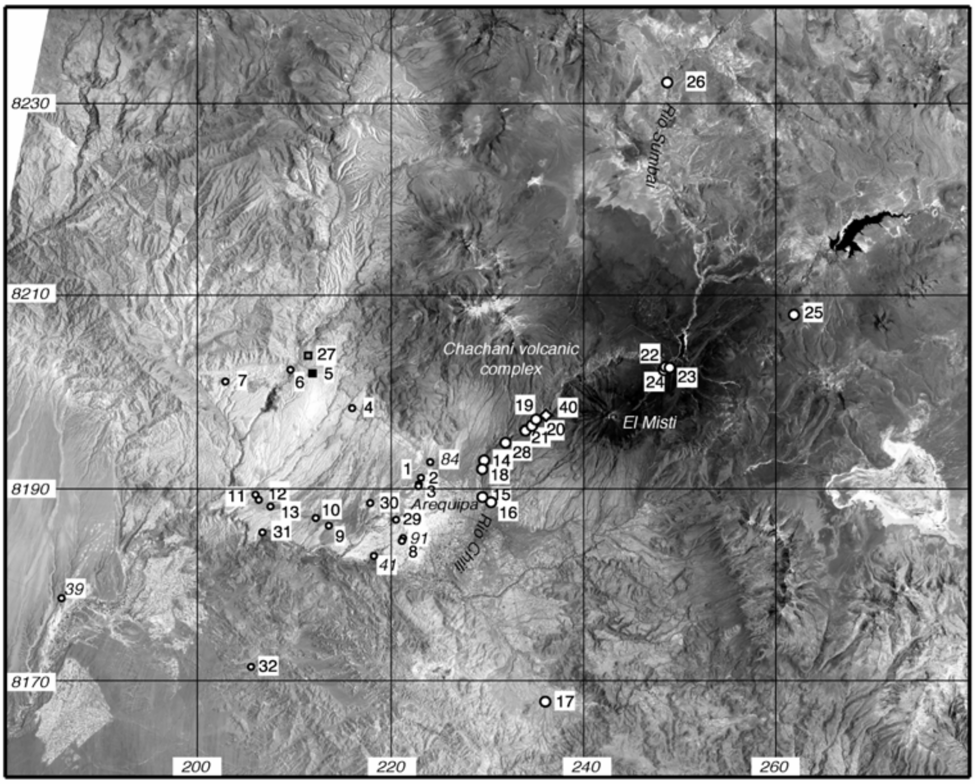
INTRODUCTION

In the area of Arequipa, the ignimbrites termed "sillars" (Jenks and Goldich, 1956) are indurated, nonwelded pyroclastic-flow deposits of dacitic and rhyolitic composition and middle Miocene to late Pliocene in age. In a companion abstract (Thouret et al., this volume), we aim to establish correlations based on petrology, mineralogy and Ar-Ar datings. We have also undertaken a detailed paleomagnetic sampling of 35 sites within most of the ignimbrites in the Arequipa region. Here we report preliminary paleomagnetic results.

PALEOMAGNETIC SAMPLING

Most sites were drilled to the west of the city of Arequipa where most quarries in the “sillar” can be found. The ignimbrite units are several tens of meters thick. Within the quarries in the depression of Arequipa, the main sillar has always a typical white color. This white unit is covered by a nonwelded pink unit. Field evidence suggests a gradual transition between these two units. The unit drilled at site 31 is however beneath the white “sillar” and separated by about 10 meters of volcanoclastic sediments. Site 32 was drilled in the ignimbrite filling valleys carved in the Mesozoic Batholith. Site 39 corresponds to poorly welded ignimbrite interbedded within late Neogene conglomerates overlying the Moquegua Formation. Sites 5,6 and 27 were drilled in non welded tuffs near the locality of Yura.
It is especially difficult to follow the “white sillar” when we cross the Arequipa’s city toward the canyon of Chili river eastward. Several outcrops of ignimbrites are found in the Chili canyon (sites 14, 15, 16, 18, 19, 20, 21 and 40) and near the Aguada Blanca dam. At this locality, sites 22 and 23 were drilled in the same unit, while site 24 corresponds to a lowest unit. On the Altiplano north of El Misti, only two other sites were drilled. Unfortunately, no result is yet available for site 25. Site 26 corresponds to a thick ignimbrite sampled near the Rio Sumbay valley. Finally, site 17 corresponds to an ignimbrite about 30 km southeast of Arequipa.



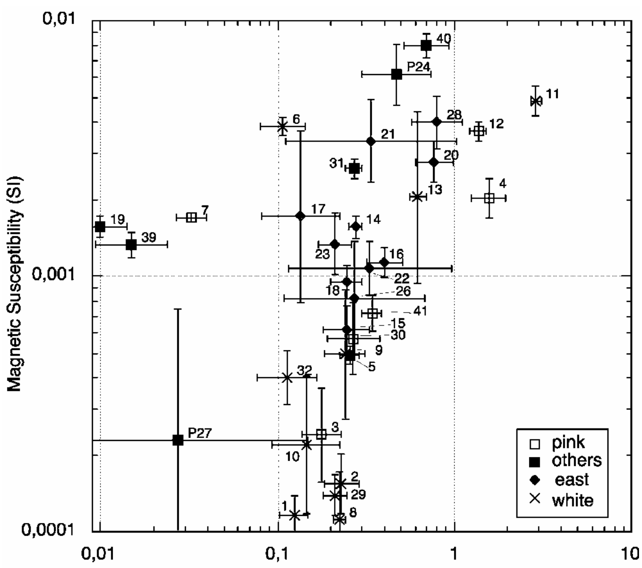


Figure 1 : Landsat image showing paleomagnetic sampling sites. Large circles correspond to sampling in or east of the Chili River. Small circles correspond to the paleomagnetic sampling within a composite thick unit to the west of the city of Arequipa. Different symbols are shown for sites 5, 24, 27 and 40, where we observe different paleomagnetic directions (see text).

Figure 2: Geometric mean values of NRM versus magnetic susceptibility and associated standard deviations. Open squares correspond to sites in the pink unit above the white “sillar” (crosses).

MAGNETIC PROPERTIES

Figure 2 shows the variations of magnetic susceptibility versus the intensity of the Natural Remanent Magnetization (NRM). The large variation in magnetic susceptibility from 0.0001 to 0.01 SI may be attributed to oxidation conditions during the emplacement of the ignimbrite. Sites with the lowest magnetic susceptibility correspond to the quarries where the bricks of ignimbrites are used for construction in Arequipa. All these sites are located to the west of the city. The highest magnetic susceptibility values are due to a significant content in magnetite and are usually (but not only) observed toward the base of the ignimbrite units. The very high stability of the NRM allows us to discard the hypothesis that susceptibility changes are due to post-emplacement alteration. Apparent significant alteration was only observed at few sites, especially at site 19. Sites with the lowest NRM values correspond to nonwelded rocks and we interpret the low NRM values as evidence for temperature of emplacement significantly lower than the Curie Point of magnetite (578°C).

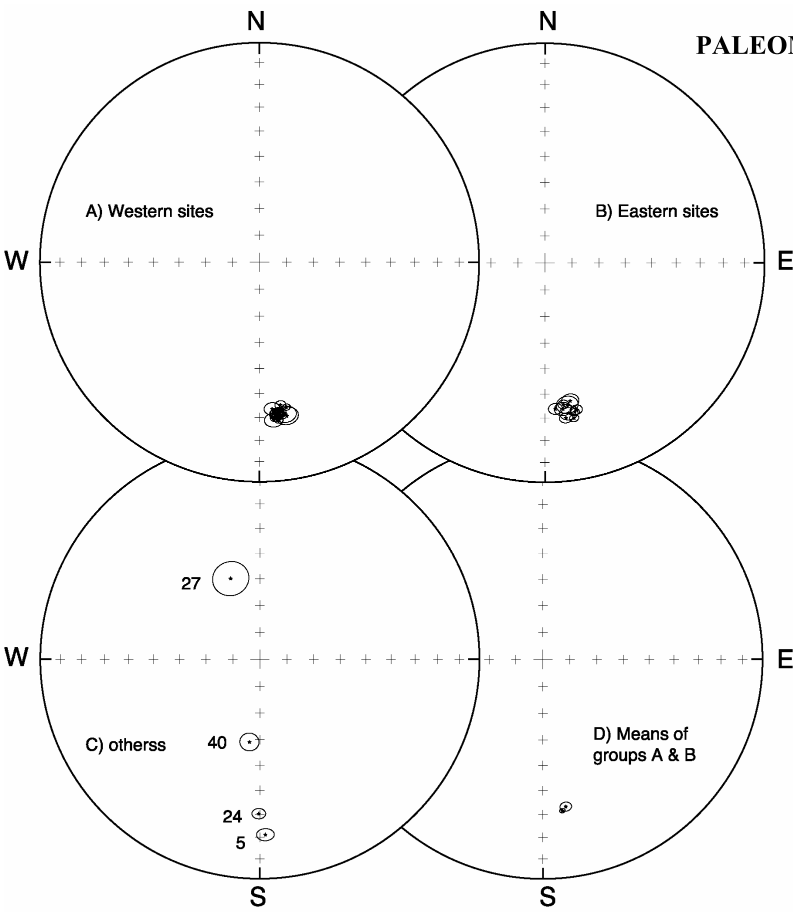


Figure 3: Equal-area projections of site-mean results.

PALEOMAGNETIC CORRELATIONS

At most sites, NRM directions are well grouped and the very high stability of the magnetization allows to use NRM directions for correlation purpose. Previous results obtained by one of us (O.M) based on detailed demagnetization confirms the high stability of the magnetization. Alternating field demagnetization was performed only for a few sites where evidence for secondary magnetization due to lightning was observed. Available results are shown in Figure 3.

Sites located to the west of Arequipa record the same paleomagnetic direction regardless they were drilled in the white or pink unit (Figure 3a). This confirms the stratigraphic succession and gradual transition observed in field. The average direction calculated from paleomagnetic results at 18 sites is (Declination : 172.7°; Inclination: 31.1°; α_{95}: 0.9°, k : 1426). The very high Fisher concentration parameter (k) demonstrates that all these sites correspond to a single or successive volcanic event only separated by at most a few tens of years.

Only near Yura, two different directions can be observed, one with a normal polarity (site 27) and one with reverse polarity (site 5).

To the east of Arequipa, a similar paleomagnetic direction was observed at 10 sites (Declination : 171.2°; Inclination: 32.6°; α_{95}: 1.9°, k : 656). Only two different directions of reverse polarity at site 24 and 40 are statistically distinct from this group.

CONCLUSION

Comparison of the average directions calculated from the groups east and west of Arequipa (Figure 3d) suggests that most ignimbrites in the Arequipa region may belong to a single or to a few successive units erupted during a major short-lived volcanic event. Available radiometric ages are in conflict with this hypothesis. Vatin-Perignon et al., (1996) report Fission Track age of 2.42 +/- 0.11 Ma old (Airport quarry) while an Ar-Ar age of 4.87 ± 0.02Ma on sanidine was determined for an ignimbrite near La Joya.

Ar-Ar ages of 13.8 ± 0.1 and 13.12 ± 0.05 Ma, on biotite single grain have been obtained for the ignimbrite sampled at site 40. These ages and the observation of a distinct paleomagnetic signature for this site (40) indicate that this ignimbrite could be of limited geographic extent.

Further high precision radiometric Ar-Ar dating are needed to confirm the hypothesis that most of the paleomagnetic sites were drilled in the same or contemporaneous ignimbritic flows.

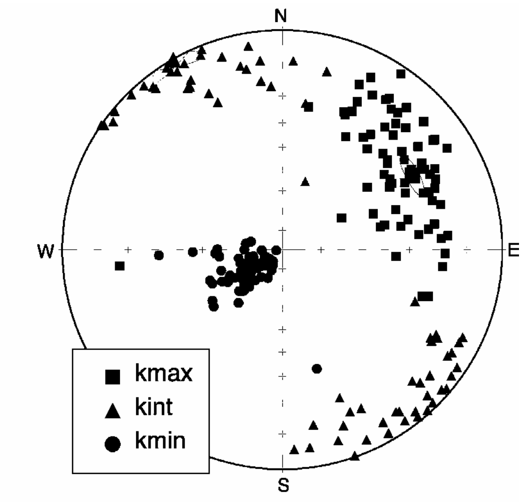


Figure 4 : Example of AMS data obtained at 5 sites (site 9,10,11,12,13) located on the south-western side of the Arequipa depression (see Figure 1).AMS data show imbrication foliations dipping about 20° toward the E-NE (N60) with magnetic lineations slightly more dispersed but oriented along the dip direction of the foliation plane.

Anisotropy of magnetic susceptibility (AMS) was performed for most sites. An example of AMS results is shown in figure 4. Magnetic foliations and lineations indicate a flow direction oriented roughly N60. Unfortunately most sites located in the Chili River have foliation planes less well defined than those located to the west. Two potential sources are proposed by Thouret et al. (this volume): one is thought to be buried beneath the Chachani volcanic complex ; the second source may be located in the Pampa Llantapallana north of El Misti volcano (Fig.1). At this stage, AMS data are too preliminary to constrain clearly a source for the ignimbrites.

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