Installation of GNSS receivers and Laser Reflectors in Volcanoes and Hills surrounding the Arequipa Station

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ABSTRACT

In the station of Arequipa, were consecutively the stations SAO-2 from 1970 to 1990 and TLRS-3 of NASA from 1990 to date, it works under a Scientific Cooperation Agreement between NASA and UNSA, which allows proposing local research projects [1]. There is also the zero order station AREQ (GPS from 1994-2017 and GNSS since 2010) operated by UNAVCO-JPL/NASA, station AREG GNSS since 2013 operated by CNES, the DORIS station since 1990 and operated by IGN/CNES. The city of Arequipa in Peru is located in the Arequipa Valley, along the southern slope of the Western Cordillera, and the northern edge of the Arequipa depression, within a complex of extensive and sliding faults. in a tectonically active region associated with subduction of the Nazca plate beneath the South American plate. The very close presence of the Misti volcano, the most recently active building of a group of Pleistocene volcanoes, along with Chachani (inactive) and Pichu Pichu (extinct) have inspired numerous studies to monitor volcanic and seismic conditions in the area. The displacement detected in the Arequipa station as a consequence of the Earthquake of 2001, 0.50cm to the west and 0.05cm of depth, processed with SLR data from the NERC (United Kingdom) and DGFI (Germany) in the SLR stations Arequipa, Monument Peak, Greenbelt and Grasse in July 2001 with passes from the Lageos1 and Lageos2 satellites and corroborated with data from the GPS and DORIS techniques. http://www.cddis.gsfc.nasa.gov/pub/reports/slrmail/2001/slrmail. The project presented to the University was accepted in 2016, but its implementation began in 2017. An important antecedent is the monitoring of deformation of the crust in Parkfield-California by the USGS since 1984 with an EDM (Electronic Distance Meter)[2], equipment with laser of 2 colors (red and blue), that allowed to measure up to 12 Km, the results reveal an important rate of transitory sliding along the fault of San Andres. This consists of an increase in the failure slip rate of 3.3 ± 0.9 mm/year during 1993 to 1998. Our project began, studying the local topography, to determine the points of observation in the volcanoes and surrounding hills of Arequipa. We rely on similar studies carried out in the Misti Volcano with GPS stations. The first challenge was to check the line of sight to the possible points, for which field visits were made between 2017 and 2018. During these visits, the topography and climatic conditions were verified for the location of GNSS receivers, laser reflectors and meteorological station. An important point was the arrival of the green laser beam in the day and night. For the purposes of return verification, a laser reflector of Target C of the TLRS-3 was used, at distances 1.3, 1.5 and 4.0 kilometers, obtaining returns and performing a test type of Target with the TLRS-3 system. Due to the budget, conditions of access and security, a reduced number of observation points was determined, which is essential for the initial study.

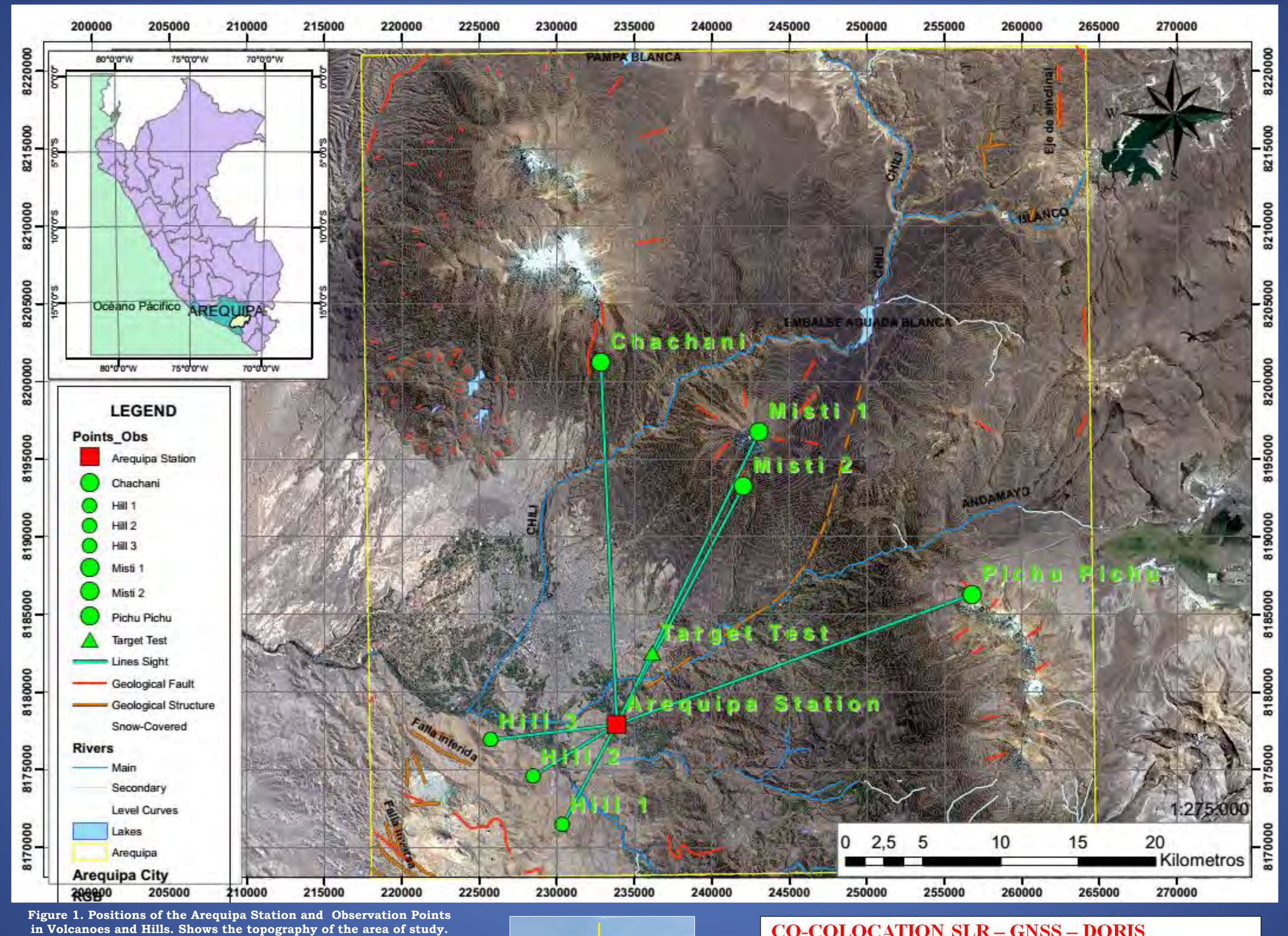

Figure 1. Positions of the Arequipa Station and Observation Points in Volcanoes and Hills. Shows the topography of the area of study.

Figure 2. Electronic Distance Meter (EDM -1984)

Figure 5. Test with green laser in the half of the Misti.

Figure 3. Colocation of GNSS Antenna and Laser Reflector (simulation).

TARGET	Time with ETM (ns)	Calculate Distance (m) (no corrections)
Test at ~ 1.3 Km	8,687.748	1,303.162
Test at ~ 1.5 Km	9,805.683	1,470.852
Test at ~ 4.0 Km	27,933.728	4,190.059

Table 1. Results from preliminary Target Test.

Figure 4. Co-colocation of 3 Space Geodesy Techniques. Local Ties in Arequipa Station, stable reference for the Observations Points.

Distance from the Arequipa Station to the Target Test is ~ 4.0 Km.

Distance from Arequipa Station to the Surrounding Hills: SW at 6,3 Km, SW at 6.6 Km and W at 8.34 Km).

Distances from Arequipa Station to the Volcano Misti (20.7 Km), Chachani (26.7 Km), Pichu Pichu (27.2 Km).

Data Frequency Measurement: GNSS will be collected continuely and SLR weekly.
Equipment: 8 GNSS receivers, SLR reflectors and wheather stations.
Sponsoring Institutions: UNSA(funding**),** NASA, UNAVCO, CNES.

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