Geophysical Research Abstracts
Vol. 13, EGU2011-12003, 2011
EGU General Assembly 2011


# Geotechnical characteristics of the Misti volcano lahar deposits of Holocene age: an example from the Rio Chili Valley, Arequipa, South Peru

Carlos Pallares (1,2), Claude Bacconnet (2), Denis Fabre (1), Aurélie Talon (2), and Jean Claude Thouret (3)

(1) Conservatoire National des Arts et Métiers, Paris, France (carlos.pallares@polytech.univ-bpclermont.fr), (2) Polytech Clermont-Ferrand, Université Blaise Pascal, Clermont-Ferrand, France (claude.bacconnet@polytech.univ-bpclermont.fr), (3) PRES Clermont, Université Blaise Pascal, UMR 6524 CNRS, Laboratoire Magmas et Volcans, Institut de Recherche pour le Développement-R163, Clermont-Ferrand, France (J.C.Thouret@opgc.univ-bpclermont.fr)

Arequipa city is located in a tectonic basin drained by the Rio Chili Valley in the southwestern Peruvian Andes. About one million people in this city are exposed to seismic and volcanic hazards. Besides earthquakes (e.g. 23 June 2001), the persistent threat is the active El Misti volcano, located 17 km NE from the city historical center. Lahars (volcanic debris flows locally termed huaycos) are amongst the most destructive and lethal volcanic hazards. Unfortunately, Arequipa is exposed to three types of lahars, namely: syn-eruptive, post-eruptive and non-eruptive. Post-eruptive and non-eruptive lahars as well as flash floods are the most recurrent flow types in the city area. The first lahar category is linked to the volcanic eruptions of Misti volcano (e.g. AD 1440-1470 and c.2030 yr BP); the second group is associated to intense rainstorms on 10 years time intervals, which can occur between December and March (e.g. 33 mm in 3 hours in February 1997). The third lahar category is related to the potential breakup of artificial or natural dams; five water and power supply dams are located in the Rio Chili canyon, upstream from the city. The aim of this study is to characterize the main geotechnical characteristics of Holocene and Late Pleistocene lahar deposits on which the city of Arequipa is built.

Geological observations point out the existence of three types of lahar deposits in the Arequipa region: fine hyperconcentrated-flow deposits (FHF), coarse hyperconcentrated-flow deposits (CHF), and debris-flow deposits (DF). We have carried out measurements of three physical characteristics (dry density, grain-size distribution, methylene blue tests) on 41 soil samples. Two types of geotechnical tests were also performed: (i) 39 in situ dynamic cone penetration soundings using a PANDA-type penetrometer, in 10 different sites along the Rio Chili; (ii) Casagrande shear-box tests and oedometric tests on the three main categories of soils (fine-grained fraction: <400$\mu$).

Our geotechnical results confirm two principal groups that match with the initial geological classification: FHF-CHF and DF. The size of the major grains is the only distinction between FHF and CHF. Last group shows similar mean rd values (1.25 g/cm3), whereas dry density increases to 1.58 g/cm3 for DF deposits. The analysis of the grain-size distribution indicates that the percentages of the <2mm-sized grains are comparable: 90% for FHF and 80% for CHF but the values for DF deposits are much lower (53%). The proportion of <80$\mu$-sized grains in FHF and CHF deposits is 25% and 18%, respectively but once again this percentage is lower (7%) in DF deposits. Four additional tests were carried out: (1) the methylene blue test is strongly linked to the specific surface of the particles; (2) laboratory mechanical tests aim to measure the friction angle and the pseudo-elastic modulus while in situ dynamic penetration tests show also consistent contrasts between FHF-CHF and DF deposits. Both FHF and CHF lahar deposits are fine sand- and silt-rich deposits that lack clay particles. Two main results acquired from the field investigations and from the laboratory tests are the very low dry density (from 1.06 to 1.73 g/cm3) and the rather high friction angle found for lahar deposits (FHF and CHF). The low density is related to the large amount of pumice grains in both pumice-rich pyroclastic deposits and pumice-rich lahars, moreover lahar deposits often derive from pyroclastic deposits in the radial valleys draining the Misti volcano. These important geotechnical characteristics also contribute to the original dynamics of lahar flows and have to be properly introduced in flow modeling.