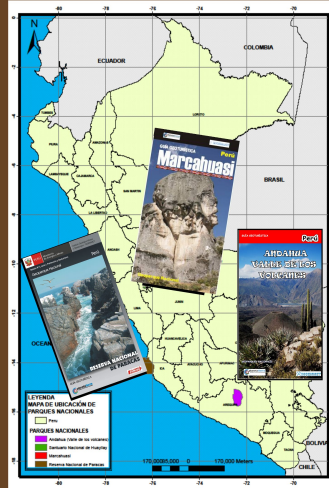
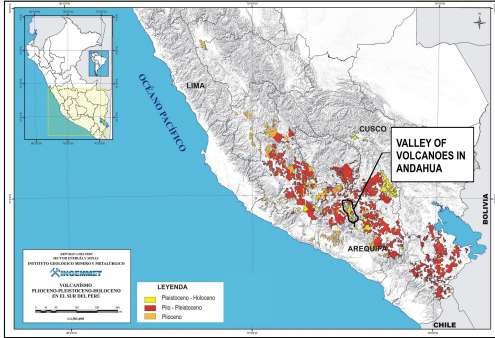


VALLEY OF VOLCANOES IN ANDAHUA, GEOPARK IN SOUTHERN PERU PROJECT

Por: Bilberto L. Zavala Carrón¹

¹ Instituto Geológico Minero y Metalúrgico, Lima, Perú. E-mail: bzavala@ingemmet.gob.pe

INTRODUCTION The list of the World Heritage Sites considers 26 areas in volcanic terrains. In Peruvian territory places of geologic interest and volcanic evolution, they are still not included as natural protected spaces. One of them, well known as "Andahua's Valley of Volcanoes", is located around five communities in Castilla Alto province (13000 inhabitants), to 135 km from Arequipa, the second most important in of Peru. The valley presents recent volcanic events, 2.8 Ma (Pliocene - Holocene), occupying their bottoms and slopes, the volcanic emissions and Strombolian lava type have caused a series of spectacular views, admired by own people and tourists. Strombolian eruptions, andesitic-basaltic lava flows, 24 ash cones overlap with alluvial fans, or over paleo-soils from Upper Pleistocene age, evoking relatively recent eruptions. These features of volcanic landscapes, natural and cultural people's values, customs and biodiversity, are a big reason to include and consider Andahua's Valley of Volcanoes this global list of Geoparks, for their protection, conservation and sustainable.



INGEMMET AND THE NATIONAL GEOPARK'S PROJECT
The Instituto Geológico Minero y Metalúrgico (INGEMMET) started in 2006 the studies in geological significance's areas to promote the establishment of Peruvian Geoparks. The goals of this researching called "Heritage and Geotourism" are the publications of geotourist's guides of "Forest Marcahuasi Rocks", integrating to the local community in its use and conservation management. The other guide called "Paracas National Reserve", located around Pisco province, which was affected by an earthquake of 7.9 Mw (in 2007). Where to part of the biodiversity, cultural heritage and customs, eight geotouristic routes were described with geological, tectonic features (with emphasis in earthquakes and tsunamis prevention), landforms, etc. And complemented by pre-Inca culture, wildlife and sports and economic activities developed in their environment.

Continuing with the diffusion of the geosciences, contribute to spatial planning and socio-economic improvement of the cities, in 2008 has been conducting studies in the "Andahua's Valley of Volcanoes". The proposal of this Geopark will allow unifying five districts of Arequipa with Colca and Cotahuasi Canyons, two of the most important national tourist destinations. We are very close to publish the third geotourist guide, which illustrated in a simple way its rich and varied geological heritage. We intend to resolve some concerns and meaning of landscapes, geologic history and customs of its people. To know, to value, to protect and to make a sustainable use of the valley of the volcanoes are some of the activities necessary to realize in the short term to achieve geocconservation heritage, awareness of Alto Castilla for proper tourism use.

THE VALLEY OF THE VOLCANOES OF ANDAHUA

Was recognized by first time in 1932 when the first aerial photos of the valley were obtained. Two years later, the National Geographic published an article about it. The first geological studies were published by the Geological Society of Peru (Hoempler, 1962), with significant field observations. In this study Hoempler refers to 36 small volcanic cones which he called "adventitious cones or ash volcanoes". Later, Caldas in 1973 performs the official mapping of the National Geological Map by INGEMMET which was published in 1994, which gives significant scope of the geomorphology, stratigraphy, tectonics and geological history of the area, highlighting an area of Barroso stratovolcanoes and basin or depression with the Andahua's volcanoes.

THE GEOLOGY OF ANDAHUA-ORCOPAMPA IN ELEVEN EPISODES

The local geological history of the valley dates back 150 million years in the Upper Jurassic, which was occupied by a shallow to deep sea, and repeated situations of rising and sinking in the mountain range with marine and continental sedimentation. Intense volcanic activity occurred in the Oligocene-Miocene, and the last extension of the Andean volcanism, Andahua (Pliocene-Holocene) marked the beginning of a new geo-volcanological process in the Andes. Geodiversity in rocks, stratus, fossils, geological structures and landforms allow reconstructing this puzzle. Which is summarized in eleven episodes: 1) A sea in the Middle Jurassic, 2) Coastal marine sediments of the Jurassic-Early Cretaceous, 3) Lifting and removal of the seas in the Early Cretaceous, 4) Flooding in the Upper Cretaceous, 5) Gradual withdrawal Cretaceous sea (shallow sea), 6) Moving of the Peruvian Andes, 7) First phase of intense volcanic, 8) Tectonic movement again; 9) Plio-Quaternary volcanic phase, 10) Quaternary glaciation, 11) The present landscape and the formation of the valley of the volcanoes of Andahua.

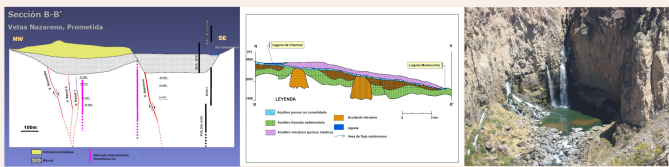
GEOMORPHOLOGICAL EVOLUTION LANDSCAPE AND MAIN UNITS

It is possible to differentiate a river valley to glaciofluvial, with recent deposits of lava flows overlies alluvial sediments and dam areas in several stretches of the river, bounded by steep to moderate slopes of mountains and some sedimentary hills with structural control. Sequences of ignimbrites, lavas and domes, lavas, crown the higher elevations. Locally differing cinder cones, lava flows and pahoeoha AA, alluvial fans and terraces, canyons and waterfalls, lakes formed by the damming of the valley (Pumajallo, Chachas and Mamacocha). In the northwest, the Sora's Valley, is filled by lava flows, showing extensive volcanic plateaus, some volcanic centers. The southern part has a large deposit of old alluvium, and over this is located a town called Ayo. Systems pre-Inca terraces near the town were affected by landslides and the emplacement of Andahua's lavas. In the eastern part we can see glacial landscapes (moraines and lakes) and on the western part there are hanging valleys in U shaped and ancient glacial cirques. In summary, the geomorphic units that dominate the Geopark are volcanic, fluvial, denudacionales, gravitational and glacial/ periglacial.

VOLCANIC ROCKS: MINERAL DEPOSITS AND GROUNDWATER

Orcopampa mining auriferous and polymetallic district: In Orcopampa veins of gold and silver are hosted in the volcanic rocks, with calco-alkaline composition, in the Geopark. It is part of a major regional epithermal mineralization belt of precious metals, which includes several mines (Arcata, Shila, Caylloma, Ares, Paula and the latest Poracota) at the head of the valley of volcanoes of Sora. Epithermal veins of gold and silver are hosted in a sequence of early Miocene volcanic rocks that overlie Mesozoic limestones (Arcuquina formation), shales (Murco formation) and quartz sandstone of the Yura Group, which are exploited from middle of last century.

Groundwater resources: Volcanic rocks, as lava flows, and sedimentary rocks, as limestone and sandstone, with important structural features, located in the Andahua's valley have important hydrogeological characteristics as porosity and permeability. These characteristics allow to the water that came from the precipitations and the surface runoff goes into de underground and finds a reservoir bed rock or aquifer rocks. Then this groundwater is discharged by fractures or faults, that is evidenced in several manifestations, there are 25 cold springs and 1 hot spring. The characteristic source in Andahua's Geopark is called "resurgence", where the springs of Sanquilyay and Mamacocha (from Chachas to Mamacocha) have flow rate higher than 8 m³/s. The Huancarama hot spring has a temperature of 54,3 °C, the hot spring are linked to deep faults where the temperature of water increases as a result of geothermal gradient



Geodiversity and volcanic landscape in the "Andahua's Valley of Volcanoes": 1. Ash fall, 2. Pliocene lava flow, 3. Jechapita volcano, 4. Andahua at the foot of the twin volcanoes, 5. Volcanoes Chicayoc and typical vegetation of cactus, 6. Chicayoc Grande volcano, 7 y 8. Fields of lava and monogenetic volcanoes, sedimentary bedrock in the background.

