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CHANCES OF GEOTOURISM DEVELOPMENT IN THE COLCA AND THE VOLCANOES OF ANDAGUA GEOPARK (PERU)

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ABSTRACT

The areas of the Colca Canyon and the Valley of the Volcanoes, located in the Arequipa region in the Central Andes, southern Peru, are distinguished for their unique geodiversity in the whole planet scale [10]. Currently, the INGEMMET Institute has submitted a proposal to designate the area as a geopark belonging to the UNESCO network [13]. The designation of the Colca and the Volcanoes of Andagua Geopark brings new opportunities to develop tourism. Inventory of geosites includes numerous geomorphological, geodynamic, volcanic, structural, tectonic, hydrogeological, sedimentological, palaeontological, stratigraphic, and palaeogeographical sites. Indication of accessibility of those sites will be an important stage of tourism development. The paper uses the results of research of the Polish Scientific Expedition to Peru, which since 2003 has been conducting extensive geological and environmental studies to document the values of the area. On the basis of spatial analyses, the conditions and limitations of making the geological sites accessible have been evaluated in regard to nature protection. It was a serious challenge to define the boundaries of usage of different environmental resources. Apart from the tourist industry, there are also other activities in the area, such as mining, agriculture, hydrotechnical and energy investments on a supra-local scale. It is an urgent matter to define the rules of coexistence of different economic entities within the area of the future geopark.

Keywords: geosites, geodiversity, volcanoes, Colca Canyon, Peru

INTRODUCTION

Features that guarantee attractiveness of the area for geotourism are as follows: unique landscapes, active geological processes, valuable ecosystems, preserved cultural heritage and possibilities for recreation or doing sport. The features are enhanced, developed and protected in most of the famous geoparks through educational and scientific activities carried out by the parks. Geoparks teach also a great lesson of the life of humans and their socio-economic activities in agreement with the principles of sustainable development.

There are only 2 geoparks belonging to UNESCO Global Geoparks (Brazil - Araripe, Uruguay - Grutas de Palacio) which are located in South America. Two Geopark

projects from Mexico (Comarca Minera and Mixteca Alta) are waiting for approval and the Colca and the Volcanoes of Andagua Geopark (Fig.1) has been formally applying for being put on the list since 2016 [13]. Geological structure of South America is distinguished for its great potential of geodiversity and it is expected that further geopark projects from Chile, Ecuador, Colombia, and others will be launched soon [1]. 17 out of the 119 geoparks of the network can be regarded as geoparks in volcanic areas (Unesco.org.com 2017). They occupy a distinguished position on the international scene.

Tourism development in the Colca Canyon area causes a growing problem for preserving valuable environmental resources including geodiversity [2, 3, 5]. Activities of investors in that branch of industry are carried out without taking into account environmental conditions and lead to the loss of basic values, thus decreasing or even drastically reducing attractiveness of tourism [9]. Designation of a geopark involves interest, cooperation and consent of the local community. The educational aspect is of particular importance in that case. The park is designated not only to enable recognition of the phenomena and the processes that lead to formation of the relief, but above all to build awareness of necessity to protect non-renewable resources. Making environmental values available to a wide range of tourists brings with them not only economic benefits but also the danger of loss of the values. Determining the limits of access and protection of particularly sensitive values is a task for scientific centres and for the state geological service.

INVENTORY AND VALORIZATION OF GEOSITES

The INGEMMET Institute carried out inventory and valorization of geosites in the area to provide documentation for the project the Colca and the Volcanoes of Andagua Geopark. 119 sites (Fig.1) were identified and divided into 8 thematic groups [12, 13]: geomorphology, hydrogeology, volcanology, neotectonics, geodynamics, palaeontology, stratigraphy and structural geology. The sites were also qualified for future use by division into the following functions: tourist, educational and scientific. Apart from the above-mentioned groups, a thematic group of mineral deposits and mining was added to the list increasing it by 5 geosites. The new sites were added to the following groups: geomorphology (1), volcanology (1), structural geology (3). Approximate areas of the future park may be ascribed to particular thematic groups. The sites from the groups: geomorphology, hydrogeology, neotectonics, geodynamics and stratigraphy are concentrated in the Valley and in the Colca Canyon. Most of the volcanic sites are located in the Valley of the Volcanoes, the other sites are located on both sides of the Colca Canyon and they are connected with stratovolcanoes [3]. The groups: structural geology, palaeontology and stratigraphy are generally scattered, although, most of them are located in the Colca Valley.

Volcanic sites are distinguished because of their number and also because of their scientific and education values. A significant number of them (31) are concentrated in the Valley of the Volcanoes. The remaining (19) are located along the Colca Canyon and the Colca Valley (Fig.1). The large number of objects increases the possibility of observation of intermediate forms, partly transformed by geological processes, and creates excellent conditions for preparation of educational pathways providing

information on the subject of volcanology, increasing tourist availability and conducting scientific research.

There is a high concentration of proposed sites in several locations. They form natural centres of exceptional geological structure, which is evidenced by the sites belonging to various subject groups. They include the areas of Maca-Lari, Huambo, Ayo and Andagua. In the vicinity of Maca and Lari, five sites belonging to the group of geodynamics have been identified, there is also one geomorphological site, one belonging to a volcanic group and one belonging to a stratigraphic one in the area. Around Huambo there are two sites in each of the following groups: structural geology, stratigraphy, mineral deposits and mining and one site related to the subject of volcanology and one to geomorphology. In the area where the Valley of the Volcano enters the Colca Canyon, in the immediate vicinity of Ayo, there have been indicated two sites in each of the following groups: hydrogeology, structural geology and one in the group of geomorphology and neotectonics. The Andagua area is a *locus typicus* for the Andahua Group volcanoes and therefore there are as many as seven volcanic groups there (Fig.2). Apart from that, there are also three ones related to the neotectonics group and one to the hydrogeological one. Another group of sites can be found a few kilometres south of Andagua, at the level of the Chachas Lagoon. They are four sites related to volcanology, two to neotectonics and one to hydrogeology.

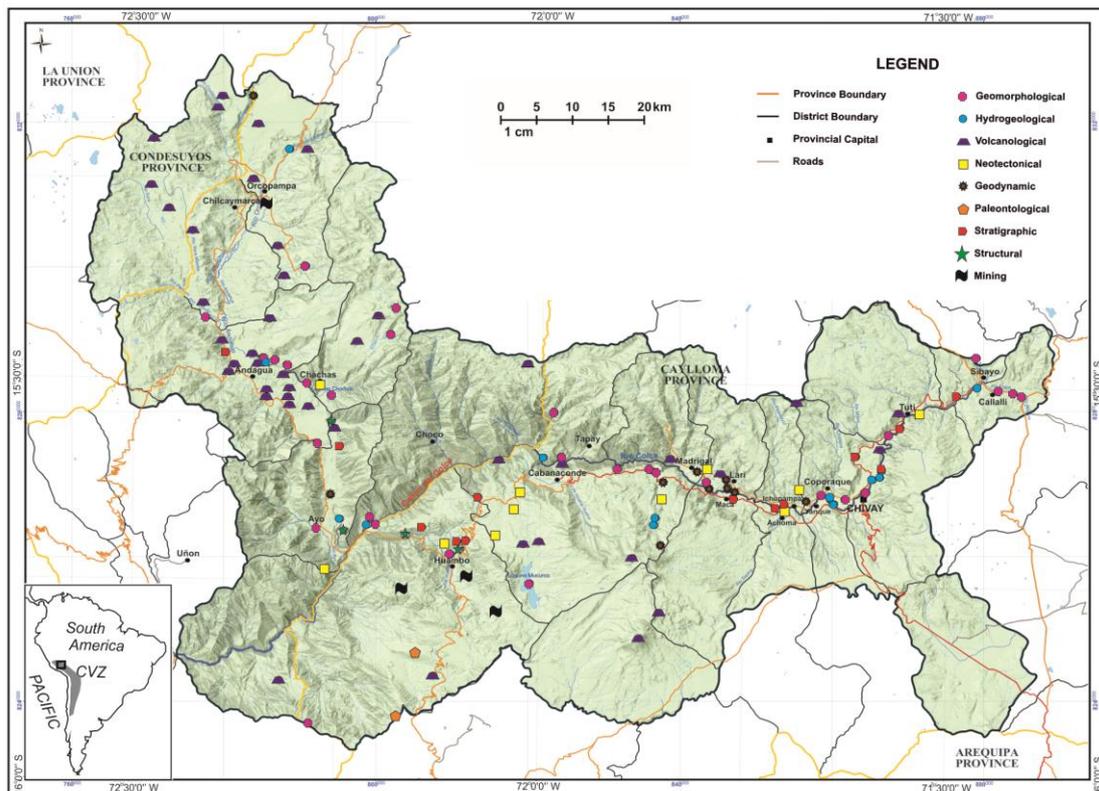


Fig.1. Map of project Geopark Colca and Volcanoes the Andagua with geosities [13, modified].

There is a bus connection from Arequipa via Viraco or Caylloma to Andagua (currently about 16 hours long journey). A road from Ayo is being under construction at present. It will cross the Colca Canyon and significantly shorten the journey through Huambo to Arequipa. There are several small hostels of different standard of accommodation in Andagua and a simple meal can be ordered in a small restaurant in the town.

Using the existing dirt roads running along the Valley of the Volcanoes, it is easy to get close to the described forms.

EDUCATIONAL POTENTIAL

The middle part of the Valley of the Volcanoes located between the Jenchaña-Niñamama fault line in the north and the lava dome area near Sucna is a true pearl in terms of tourism and educational attractiveness [3]. There are 9 geosites there which represent such volcanic forms as: lava domes, pyroclastic cones, block lavas, aa lavas, furrows in lava flows. It is also possible to observe there a perfect cone Jechapita and a less regular one Chilcayoc Chico broken by the lava flowing out of it. Lava flows, which pile up, change courses of rivers and dam them. Fissure vents filled with sulphur, flow structures, massive lava flows, scoria, lapilli and volcanic ash can be observed in exposures [4].

Stratovolcanoes complex Hualca Hulaca – Sabancaya – Ampto, which are a much larger from centres of Andagua Group also have educational and scientific potential. Activity which occurred there can be observed mainly in the form of lava effusion accompanied by explosions that left ash cover around the volcano and sediments of pyroclastic flows damaged by erosion [8]. Ashes from the eruption column of the Sabancaya Volcano melted a part of the ice cap and exposed a large part of the top of Ampato. In 1995, archaeologist J. Reinhard accompanied by M. Zarate discovered a place of sacrifice on the north-western slope and a juvenile girl frozen in ice. The girl, commonly called Juanita, was sacrificed by Incas in the 15th century.

Among the sites associated with active morphological processes, the Maca-Lari region in the Colca Valley deserves special attention. The dominant feature is the Maca Landslide, which covers an area of over 2.5 km². On the surface of the landslide, a system of crossing escarpments, horsts and grabens can be observed. The course of the forms refers generally to a set of faults occurring in the older substratum. At its bottom, landslide dam lakes can be found [14]. Within the tongues of those landslides sets of rejuvenated slopes, secondary crevices and ox-bow lakes occur [7]. Renovation of the landslide took place during the 1991 earthquake. Colluvial assemblages and diatomites can be found in the exposures.

The remarkably visible geological structure of the Huambo area, especially the path to Canco along the Huambo Valley, provides an excellent lesson showing how flowing water makes use of the tectonic structures and facies changes. The river Huambo flows many times contrary to the general inclination of the terrain, changing direction when following the encountered geological structures, such as a fold axis, a fault with a breccia zone, a fracture zone, or intra-layer surfaces [15].

Abandoned mining excavations of rock, chemical raw materials and metal ores also offer an interesting proposal. The largest and the most interesting seems to be the

mining complex of polymetallic mine called Madrigal. Abandoned drifts, where exposures of ore bearing veins can be found, waste rock heaps, waste dumps, fragments of processing and technological structures should be secured and made available for tourists. There are also interesting sites near Huambo, including excavations of travertine and rock salt [9]. In future, buildings and structures of the Au-Ag Orcopampa mine should be adapted for tourism.

GEOTURISM DEVELOPMENT

The Colca Canyon, which forms a natural cross-section through the crust, has excellent and unique, in the world, values for development of geotourism [10, 11]. There is a continuous increase of the number of tourists visiting the Colca Canyon every year. In 2014, the Canyon was visited by about 185,000 people. This is a great opportunity for development of the local economy [5, 6]. For many years, there has been an increase in the number of facilities and services in the tourist industry such as: hotels, organisation of leisure and sightseeing, tourist centres, thermal pools, museums. Unfortunately, the development of the branch has a negative impact on the environment (Fig.3) [5, 6].

Covering the area by the geopark boundaries will continue to draw crowds of tourists. However, the number of people interested in the knowledge about our planet will increase among them. To follow this direction, it is proposed to make a number of didactic paths or thematic trails. Apart from the presentation of problems related to earth sciences, information on bio and geodiversity conservation needs to be included in the educational offer.



Fig.2. Landscape in Valley of the Volcanoes, view from Jenchaña volcano.

Preparation of educational programs for local communities and investors on the sustainable economic development will be an important stage of the project. Ecological awareness of the inhabitants of the future geopark should be definitely increased. Their way of living and economic activity is to provide tourists with an example of life in harmony with nature and respect for its resources. Scientific research centres in cooperation with local government should propose such forms of tourism development that will not exert negative impact on the environment of the geopark. For example, construction of a communication infrastructure that increases accessibility for tourist and development of the area can provoke growth of mass movements (Fig.3). Hotel and catering services should take into consideration the needs of water and sewage management and also waste management.



Fig.3. An unsuccessful attempt to build a road on the slopes the Colca Canyon, near Cabanaconde.

Revitalization and tourist development of the mining areas where ores, rock and chemical raw materials were extracted is a separate problem. Depletion of resources and termination of exploitation should be preceded by the post-exploitation study in relation to tourism. A chance to visit a gold or silver mine is an excellent opportunity to see mining buildings and excavations, but also to create a park of old equipment, a mineralogical exhibition or to organise a fun competition in prospecting and mining for gold. Such attractions greatly increase the potential offer of leisure and recreation activities. They also have an important educational message which states that exploitation of minerals resources is at the expense of the environment, post-mining development is the return of the costs.

A serious problem with the availability of water is another difficulty encountered when setting up a camp in that part of the Andes. Limited consumption of water may precipitate occurrence of the altitude sickness. Furthermore, protected species such as

vicuna, guanaco and puma can be found on the slopes of the volcano. Frequent presence of large groups of tourists can be a serious threat and may interfere with that unique ecosystem.

CONCLUSION

The designation of the Colca and the Volcanoes of Andagua Geopark, which is an applicant for the UNESCO Global Geoparks network, is a long-awaited event. Conservationists, geologists, planners and geotourism specialists have for some time been drawing attention to the unique qualities of the Colca Canyon and the Valley of the Volcanoes.

The area has outstanding features which enable to present forces of nature, both of creative and destructive character. Various fields of business: agriculture, mining and tourism guarantee a wide range of geotouristic and educational attractions. The Colca and the Volcanoes of Andagua Geopark can offer a real-life lesson among dormant volcanoes and deep in the canyon, using and respecting the resources of our planet.

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