TECTONIC SETTING OF THE RIO COLCA VALLEY NETWORK

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INTRODUCTION

The Rio Colca, located in the Western Cordillera in southern Peru, creates one of the deepest valley in the Andes. Its down-cutting was completed between 9 and 3.8 Ma, but was followed by a refill owing to pyroclastic flows until 1.36 Ma and finally a re-incision (Thouret *et al.* 2007). Extreme V-shape morphology of the valley and its tremendous scale suggest that the incision was and still is controlled namely by climate and/or tectonic activity (Gonzales & Pfiffner, 2012), strictly connected with the still active subduction zone of the Nazca Plate beneath South American Plate, with the rate of convergence of about 9 cm/yr (Romanyuk, 2009).

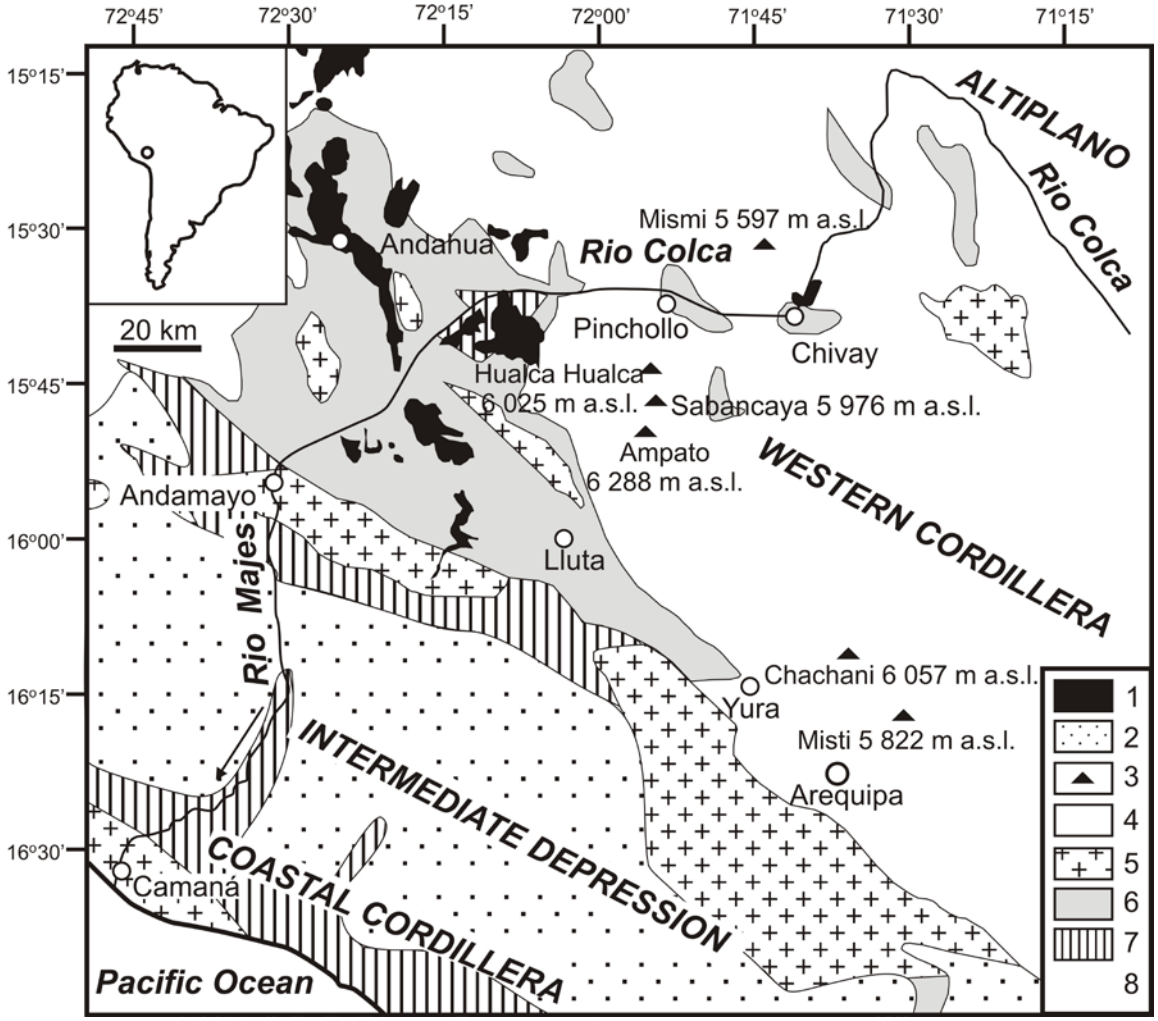

Fig. 1. Geological sketch map of the Rio Colca region (based on Paulo, 2008); 1 – volcanics of the Andahua Group (Quaternary), 2 – alluvial gravels (Pleistocene), 3 – stratovolcanoes of the Barroso Group (Pliocene-Quaternary), 4 – pyroclastic and lacustrine deposits, slopewash sediments (Neogene-Quaternary), 5 – plutons (Jurassic, Cretaceous, Palaeogene), 6 – sedimentary formations (Jurassic, Cretaceous), 7 – gneisses of the Arequipa massif (Proterozoic), 8 – main cities and villages.

THE RIO COLCA

The Rio Colca-Majes basin covers about 5,500 km^2 across the Western Cordillera in southern Peru. Its springs are situated at the elevation of over 4,500 m a.s.l. near the Abra Toroya pass (4,690 m a.s.l.), close to the Lagunillas Lake. For the first 100 km the Rio Colca flows in the NW direction across the Altiplano (Fig. 1). When meeting the Cordillera de Chila the river turns sharply towards the SW and later to the W. The deepest section known as the Colca Canyon starts at the elevation of about 3,050 m a.s.l. near villages Pinchollo and Madrigal and ends close to the Andamayo village below 1,000 m a.s.l. Firstly the river flows to the W, but between Cabanaconde and Huambo changes the direction and flows towards the SW (Fig. 1). On that section the Rio Colca cuts through folded Jurassic and Lower Cretaceous sedimentary rocks (mainly sandstones and shales of the Yura Group) and dioritic plutons of Late Cretaceous to Early Paleogene age (Klinck & Palacios, 1985; Caldas, 1993). In the uppermost part volcanics of the Miocene Tacaza and Pliocene-Pleistocene Barroso Group occur. Seaward of the orogenic front, the river changes its name to Majes–Camaná. It flows to the S, and finally, once again towards the SW, cutting folded and overthrust Mesozoic sediments, which are covered to the south by slightly folded Paleogene to Early Miocene Moquegua conglomerates, distal sand and sandstones.

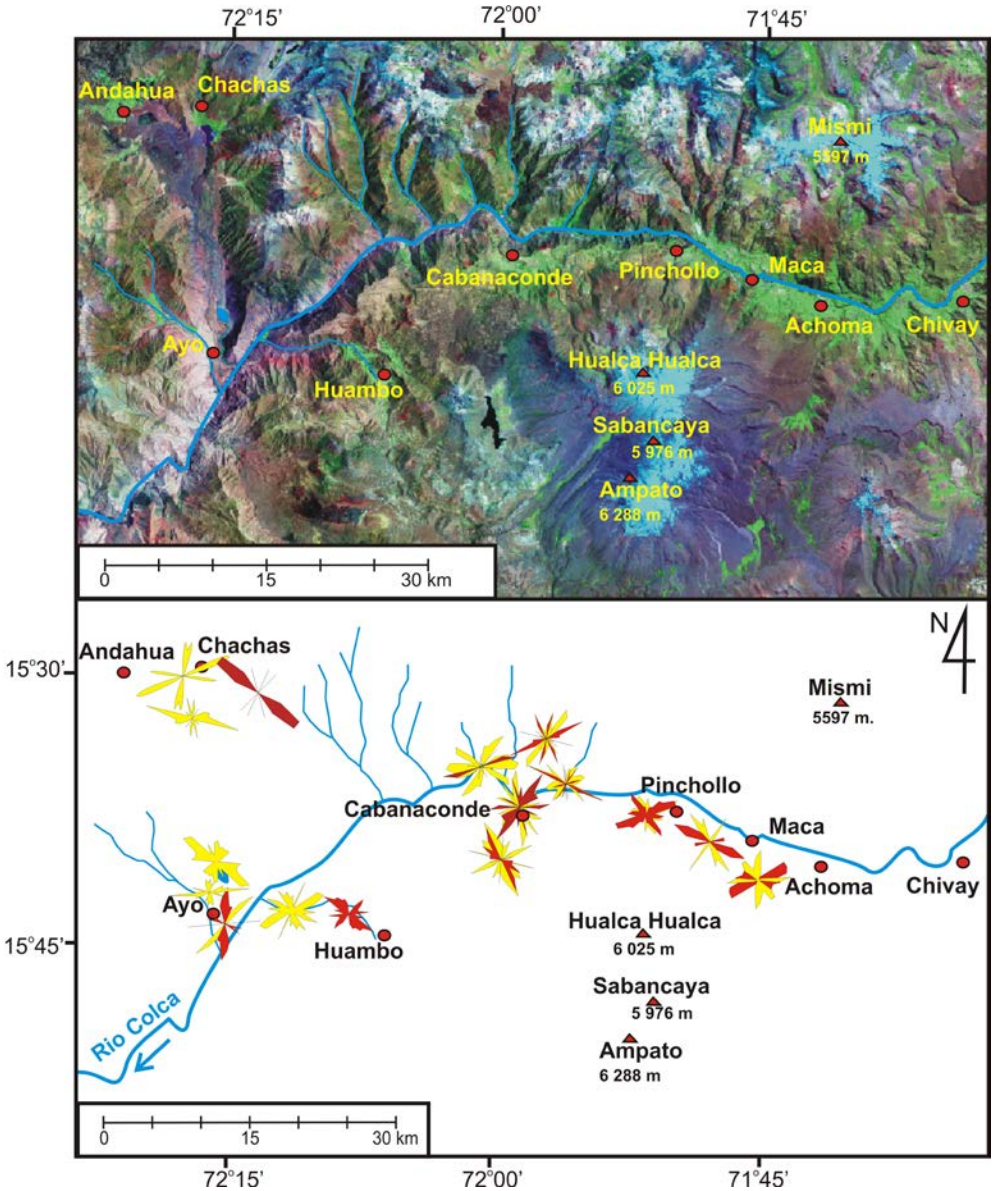

Fig. 2. Orientation of faults (red) and joints (yellow) within chosen outcrops in the area of the Rio Colca based on satellite image (LANDSAT 7).

In this paper only the central section of the Rio Colca between Chivay and Andamayo has been characterized (Fig. 2). It is divided into two segments: the uppermost part, between Chivay and Pinchollo, where the Rio Colca forms a wide asymmetric valley and lower section beneath Pinchollo, where the Rio Colca creates the famous so-called Colca Canyon.

TECTONIC SETTING

The course of the Rio Colca, either where the river forms a wide valley or within the Colca Canyon, strictly refers to the geological structure (e.g. Żaba & Małolepszy, 2008). Cutting through the Cenozoic volcanic rocks (e.g. the valley between Chivay and Pinchollo or the Canyon in the area of Cabanaconde) the general course of the Rio Colca (WNW-ESE, W-E) reflects the orientation of the main faults stated within these complexes (Fig. 2; Żaba & Małolepszy, 2008). Local variations are caused by dislocations oriented NNE-SSW (especially in the area of Chivay) and NW-SE, NNW-SSE, WSW-ENE, used by the tributaries of the Rio Colca, e.g. Rio Picomayo, Rio Pina, Rio Chocacahua, Quebrada Huayuray, Quebrada Sahuayto, Quebrada Shutone, etc. Changes in lithology appear only as subordinate factor influencing the development of the river system.

Although within the Mesozoic sedimentary rocks in the region of the Huambo village the course of the Colca Canyon is determined strongly by the discontinuous structures (Fig. 2), the setting of the Rio Huambo network (left-bank tributary of the Rio Colca) is determined by the combination of fold and fault features. The very common straightforward sections of the river oriented NW-SE are parallel to the widespread fold structures, trending NW-SE and plunging gently towards the SE. For instance, synclinal valley (Fig. 3) or parallel to the bedding planes valley were observed (Żaba *at al.* 2009). Usually shorter transverse or oblique segments of the Rio Huambo valley are correlated with the orientation of stated faults and fractures.

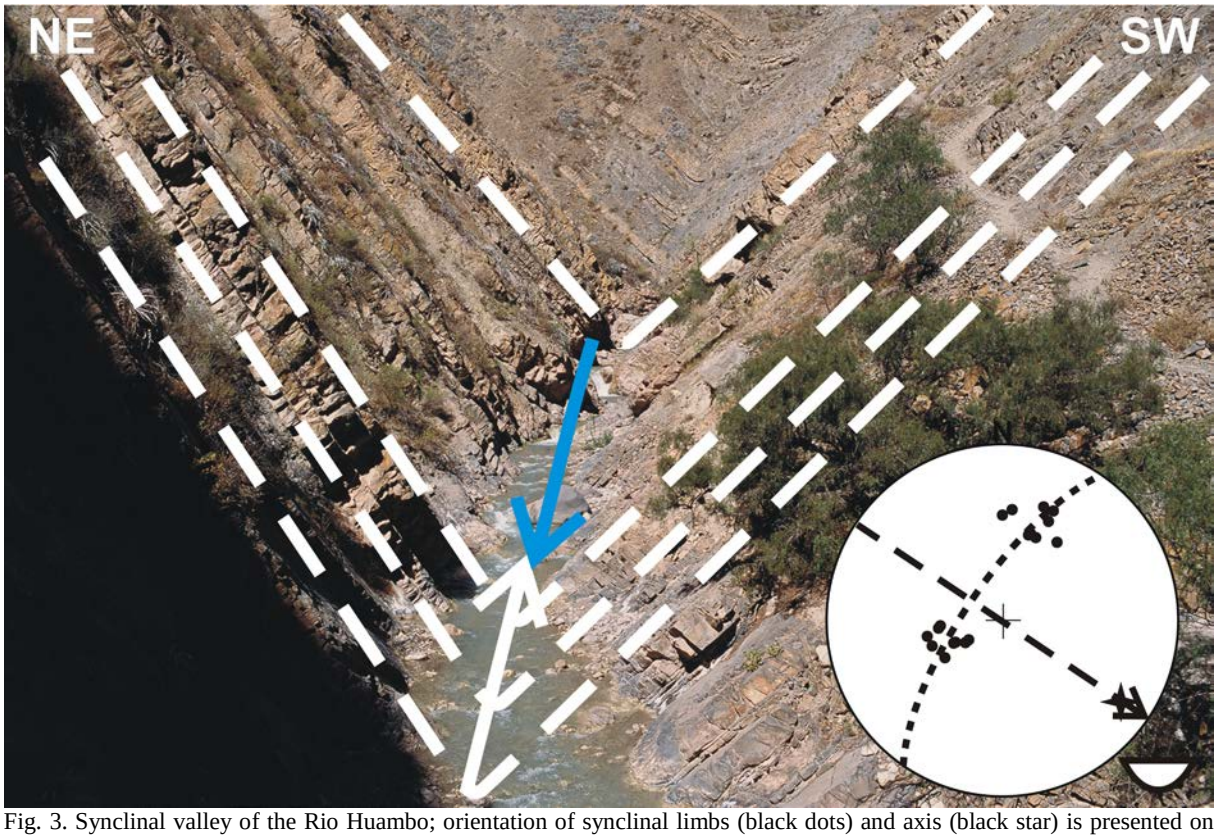

Fig. 3. Synclinal valley of the Rio Huambo; orientation of synclinal limbs (black dots) and axis (black star) is presented on the tectonic diagram in lower right corner, blue arrow – direction of the river flow, white arrow – orientation of the synclinal axis.

CONCLUSIONS

The development of the Rio Colca network is undoubtedly determined by geological features, both lithology, as well as continuous and discontinuous tectonic structures. Faults and changes in lithology are the main agents responsible for the river direction in areas build of volcanic or magmatic rocks, like the Rio Colca valley between Chivay and Pinchollo or the Colca Canyon near Cabanaconde. When cutting through sedimentary rocks the combination of faults network and fold structures determine the river orientation.

ACKNOWLEDGMENTS

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