PLIO-QUATERNARY SEDIMENTARY AND TECTONIC EVOLUTION OF THE CENTRAL INTER-ANDEAN VALLEY IN ECUADOR

Diego VILLAGÓMEZ [1], Arturo EGÜEZ [2], Wilfried WINKLER [3], Richard SPIKINGS [4]

[1] Departamento de Geología, EPN. Ap. 17-1-2759. Quito, Ecuador (fravil@uio.satnet.net)

[2] Instituto Geofísico, EPN Ap. 17-1-2759. Quito, Ecuador (geofisico@accessinter.net)

[3] Geological Institute, ETH-Zürich, Sonneggstrasse 5, 8092 Zürich, Switzerland (winkler@erdw.ethz.ch)

[4] Section Sciences de la Terre, Université de Genève, 1211 Genève, Switzerland (spikings@terre.unige.ch)

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INTRODUCTION

The Inter-Andean Valley (IAV) is an elongated geomorphic depression (about 2000 m), which is situated between the Cordillera Occidental and Real in northern Ecuador. It is approximately a 25km wide and 300km long NNE oriented tectonic structure and extends from latitude 2°S to the Colombian border in the north (~ 1°N). The IAV exhibits intensive Quaternary volcanic activity and active faults are widespread, dense population centers exist in the valley. Therefore, it is important to understand the geodynamics of this region, in order to assess the seismic and volcanic hazard in the area.

The present study focuses on the Central IAV between latitude 0°02'30"N and 0°12'30"S with an emphasis on the Quito uplift structures. We carried out a detailed facies and structural mapping of the Quito-San Antonio-Guayllabamba area in order to derive a new geodynamic model for the region. Several radiometric datings are available in literature (Olade 1980, Barberi et al. 1988, Geotermia Italiana 1989, Lavenu et al 1992, 1996). However, these represent mostly data from volcanic edifices, which were correlated into the basin fill series. Further radiometric dating ($^{40}Ar/^{39}Ar$) of six samples of the basin fill is in progress.

MORPHOSTRUCTURAL FEATURES ON THE CENTRAL IAV

The Central IAV is bounded by the Calacalí-Pallatanga Fault in the W, and the Peltetec Fault in the E. The most prominent geologic feature in the Central IAV is the so-called 'Quito active fault system', which forms a key part in the tectonic evolution of the region. The morphological expression of this system is defined by a set of three ridges that, although they have a common N to NNE orientation, they are not connected with each other. From north to south, the ridges **a**re called: Calderón-Catequilla ridge (**CCR**), Batán-La Bota ridge

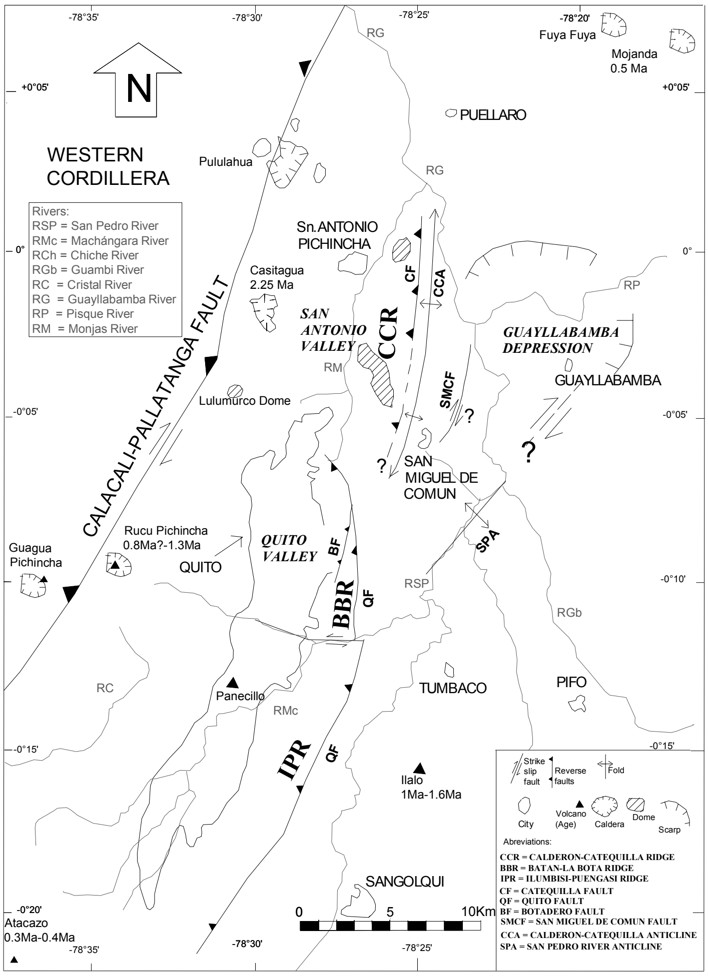

Fig 1: Actual tectonic scheme of the Central IAV.

(**BBR**) and Ilumbisí-Puengasí ridge (**IPR**) (Fig. 1). These ridges divide the younger Central IAV in three sub-basins (Quito, San Antonio and Guayllabamba) and are important controls in the sedimentation pattern (see below). Previous work (Ego et al. 1996, Alvarado 1996) considered the ridges as fold structures associated with a blind reverse fault dipping to the west. Detailed studies in the two northern ridges show a more complicated tectonic evolution in time. The morphological, tectonic, and stratigraphic evidences suggest that the northern **CCR** correspond to a double plunging fold, associated with an active thrust fault (Catequilla Fault), which began to work earlier than the other structures. In contrast, the **BBR** and **IPR** are active 'flexure-and-thrust' structures, which represent a different and younger fault segment. This southern segment, called the Quito Fault, was active during recent times and is composed of a set of smaller active faults (e.g. the recently mapped Botadero fault, Fig. 1). All these faults form the 'Quito active fault system'.

SEDIMENTARY AND TECTONIC EVOLUTION OF THE CENTRAL IAV.

The opening of the IAV presumably started first in the north (Chota Basin) during the late Miocene (Winkler et al., Spikings et al., this volume). Preliminary stratigraphic data suggest that the Central IAV opened during the late Pliocene. The aperture was mainly driven by major strike slip movements along the Calacali-Pallatanga Fault at the western margin of the basin. The basement of the Central IAV consists of rocks of the Pallatanga Unit (late Cretaceous) to the west, and andesitic lavas and breccias of the lower **Pisque Fm.** to the east. The oldest basin fill deposits, which unconformably cover the basement rocks, show an important supply of rock material derived from the Cordillera Occidental. The basin fill series can be divided in two main sequences (Fig. 2) separated by a major unconformity. The lower sequence, the **Pisque** and **San Miguel Fms.** were deposited in a dominantly E-W extensional regime from late Pliocene to early Pleistocene. The upper sequence **(Guayllabamba, Chiche, Machángara, Mojanda, Cangahua Fms.)** was deposited mainly during the middle Pleistocene-Holocene and was related to important volcanic activity in the area and an inversion in the stress regime to E-W compression.

The lower part of the **PISQUE Fm.** (Fig 2) is mainly composed of andesitic lavas and breccias, which are unconformably topped by tuffs and lahars. The upper part of the formation consists of eastward prograding alluvial fan system sediments and braided river deposits, which indicate enhanced subsidence of the Central IAV and uplift in the Cordillera Occidental. After this, a large lake developed in the NE part of the Central IAV, which received high amounts of detrital volcaniclastic material from the W (fluvial and deltaic facies). These volcaniclastic sediments correspond to the **SAN MIGUEL Fm.** Abundant tuff layers in the lacustrine deposits document the syn-eruptive character of the San Miguel Fm. The progradation of the deltas towards the center of the basin suggests that it must have subsided rapidly with respect to the western margin. Many syn-sedimentary and post-sedimentary deformation features imply that the Pisque Fm. and San Miguel Fm. were deposited in an E-W oriented extensional regime, which corroborates with the observations of Tibaldi and Ferrari (1992) and Samaniego et al (1994).

Subsequently, an important change to intense tectonic activity and volcanism along the remaining lacustrine basin margin produced the unconformably deposition of the **GUAYLLABAMBA Fm**. of middle Pleistocene age. In the lake deposits several intrusions occurred (Catequilla and Pacpo domes). The formation consists of primary volcanic deposits in the south and west, and lahar deposits towards the lake in the northeast. When the lahars entered the lake, they deformed the unconsolidated sediments of the San Miguel Fm. by developing giant slumps. In the west, the top of the Guayllabamba Fm. consists of alluvial fan system sediments that record the uplift of the CCR. The inversion of the stress regime to E-W compression occurred sometime during the Guayllabamba Fm. deposition. A relatively quiescent period followed with the deposition of the **CHICHE Fm**., which is characterized by lacustrine and fluvial deposits interbedded with lahars (Fig. 2). Facies analysis reveals that many different source regions contributed to the Chiche Fm. Compressive deformation was then revived in the area at the end of the deposition of the Chiche Fm. (~0.5 Ma, Lavenu 1996), in particular with the start of the activity of the reverse Quito fault. This fault has risen the Quito sub-basin with respect to the rest of the Valley, and formed the BBR and IPR structures. Quito is a type of piggyback basin and a main trap of the products derived from the Pichincha and Atacazo volcanic complexes. The correlative deposits correspond to the **MACHÁNGARA Fm.,** which consist at the base of primary volcanic deposits and lahars. At the top it consists of fluvial sediments. The succession of these two well defined facies, the primary volcanic and the epiclastic ones, mark the westward retreat of the Pichincha volcanic complex (Alvarado, 1996). The Máchangara Fm. shows progressive unconformity geometries along the BBR and IPR structures, due to the activity of the Quito fault. Coeval with the Machángara Fm., in the north the **MOJANDA Fm.** with volcanics and volcanoclastic products of the Mojanda volcanic complex was deposited.

During the late Pleistocene the deposition of the tuffs of the **CANGAHUA Fm**. took place, which are widely distributed in the entire Inter-Andean Valley. Towards the end of the Pleistocene, the conspicuous Guayllabamba depression began to form due to the interaction of the Quito Fault System and a NE trending inherited fault (Samaniego et al, 1994). (See Fig. 1). This depression is a pull-apart basin that contains large blocks that have collapsed towards the center of the basin. Finally, during the Holocene the San Antonio sub-basin was filled with pyroclastic products of the Pululahua volcano, and the Quito sub-basin filled with local lacustrine deposits (so-called La Carolina deposits).

CONCLUSIONS

The opening of the Central IAV occurred on an E-W extensional stress regime sometime in the late Pliocene or early Pleistocene. During this time a major basin developed which was a dumpsite for lacustrine, fluvial, alluvial, lahar and other volcanic deposits. Later, during the middle Pleistocene, the tectonic regime was inverted to E-W oriented compression, which was probably driven by major dextral displacement along the western border faults (e.g. Calacalí-Pallatanga Fault) of the IAV. This compression produced a set of ridges, and the major basin was split into three sub-basins, which then developed individually. The formation of the ridges was not simultaneous, and they played an important role in the sedimentation of the sub-basins. The ridges are the morphological expression of thrust propagation towards the east. Uplift of the ridges is still active today as documented by seismicity (Calahorrano, 2001) and the abundance of landslides and creeps along their oversteepened slopes.

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