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THE LA PUNTILLA - LA FALDA SHEAR ZONE, SIERRA DE UMANGO, WESTERN SIERRAS PAMPEANAS, ARGENTINA: AN EXAMPLE OF HIGH-TEMPERATURE LATERAL RAMP

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Introduction

In the Pampean flat-slab, Central Andes, crops out basement blocks (Sierras Pampeanas) uplifted and rotated in the Cenozoic times (Ramos et al., 2002). The Western Sierras Pampeanas (*sensu* Caminos, 1979) is characterized by Grenvillian Mesoproterozoic meta-igneous aged rocks and metasedimentary units metamorphosed in the Ordovician Famatinian Orogeny (Casquet et al., 2001; Varela et al., 2008 and 2011 and references therein) and it is considered the northern part of the Cuyania Terrane (e.g. Ramos et al., 1998, Porcher et al., 2004 and Vujovich et al., 2004). The Sierra de Umango is the westernmost Western Sierras Pampeanas, limited by Devonian sedimentary rocks of Precordillera on the western side, separated by tertiary rocks from the Sierra de Maz and Sierra del Espinal on the east, and with igneous and sedimentary rocks of Famatina System cropping out on the further east. It is composed of meta-igneous and metasedimentary rocks cropping out around the 29°S latitude and 68°30'W longitude, on the southwestern La Rioja Province, Argentina. Eight geological units were distinguished in the Sierra de Umango: i- the basement unit Juchi Orthogneiss of Mesoproterozoic age; ii- metasedimentary units Tambillo (where the PFSZ is included) and iii- Tambillito; iv- Ordovician syn-collisional El Peñon Granite; v- El Cordobés metamafic rocks Unit; vi- late-collisional Guandacolinos Granite and vii- post-collisional Cerro Veladero Granite; and viii- La Troya Marble (see Meira, 2010 and Varela et al., 2011 for

detailed descriptions). The PFSZ delineates a ~5 km wide stripe in the westernmost Tambillo Unit, determining the western boundary of the Umango basement rocks. A *Nappe* System associated to the Famatinian Collisional Event between the Cuyania Terrane and the proto-Andean margin of Gondwana characterizes the main structure of the Umango basement rocks, including the Juchi Orthogneiss *Klippen*. This report wishes to contribute to the understanding of the PFSZ kinematic and its geotectonic implications related to the collision of Cuyania Terrane against the proto-Andean margin of Gondwana.

Structural Evolution of the Sierra de Umango

The structural evolution of the Sierra de Umango revealed a polyphase tectonic history including an Ordovician collisional event, a Devonian compressional deformation, the Late Paleozoic and Mesozoic extensional faulting and sedimentation (Paganzo and Ischigualasto basins) and the compressional deformation of the Andean foreland during the Cenozoic. Five deformational phases were recognized in the Sierra de Umango (see Meira, 2010 and Meira et al., 2011 for further details), related to three diachronous tectonic events. The first three deformational phases are correlated to the development of a *Nappe* System and the PFSZ, associated to an oblique collisional event. A fourth deformational phase was described as open to close upright folds and discrete protomylonitic shear zones, correlated to the Chanica Tectonics. The fifth deformational

phase corresponds to open high angle plunging folds, associated to the Andean Cycle.

The La Puntilla-La Falda Shear Zone (PFSZ)

The PFSZ strikes NNE-NE and it is ~5 km wide and more than 38 km long. The alternating of kyanite and/or sillimanite-garnet-plagioclase-quartz-biotite mylonites/protomylonites, breccia marbles and amphibolitic boudins are the major lithologies, occurring minor porphyroclastic light gray mylonitic granites and dark gray ultramylonites. The protomylonitic to mylonitic foliation is correlated to the regional main foliation S2, typified essentially by lepidoblastic fine-grained biotite-rich bands, quartz ribbons and feldspar and garnet porphyroclasts. The post-S2 deformational phases modified the mylonitic structures, fundamentally expressed by upright open D4 folds.

An interesting mesoscopic feature in the PFSZ is the breccia-like structures involving the competence behavior of the marble layers and the host metapelitic rocks. The marble sheets seem to flow as a fluid, intruding and collecting fragments of the host metapelitic rocks that behaved as a competent layer.

Several evidences of crystal plastic flow can be observed in the microscopic scale. Deformation-induced twinning in plagioclase porphyroclasts, kink folds in tabular grains as kyanite and sillimanite, deformation lamellae and undulatory extinction in quartz grains are the most common evidences for ductile deformation. The mineralogical assemblages (sillimanite and/or kyanite, biotite, garnet, K feldspar, quartz, plagioclase and rutile in metagraywackes, and clinopyroxene, hornblende, quartz, plagioclase and opaques in metabasic rocks) indicate metamorphic conditions of upper amphibolite to granulite facies of medium- to high-pressure regime. Kinematic indicators (mainly garnet and plagioclase porphyroclasts) suggest top-to S sense-direction, corroborating with the idea of a right lateral shear zone that worked as a lateral ramp, facilitating the exhumation process of the *Nappe* System.

Nevertheless, low-temperature microstructures, such as bulging and subgrain rotation in quartz,

indicate a mylonitization in shallower crustal levels, post-S2 and metamorphic peak.

Discussion and Conclusions

Nappe Systems in the Western Sierras Pampeanas have been described in the Sierra de Pie de Palo by Ramos et al. (1996) and, more recently, detailed by van Staal et al. (2010), Mulcahy et al. (2011). These authors also cite the Ordovician collisional history to explain the *nappen* structures (van Staal et al., 2010) and the composite middle to lower crustal section (Mulcahy et al., 2011). Our observations and structural data lead us to similar interpretations, proposing an Ordovician oblique collision with continental wedge subduction followed by exhumation processes defined by the development of a *Nappe* System associated to a right lateral shear zone (PFSZ) that worked as a lateral ramp.

In the Sierra del Toro Negro area (north of Sierra de Umango) occurs, along the Bonete River section, the Jagüe Shear Zone - JSZ (Martino and Astini, 1998). There is cropping out Mesoproterozoic felsic to mafic orthogneisses and mylonites (Martina et al., 2005), minor calcitic to dolomitic marbles and para-amphibolites of Las Damas Marbles, named Rio Bonete Metamorphic Complex (Martina and Astini, 2009). The JSZ is thought to define the northern limit of Precordillera (or Cuyania) Terrane (Martina and Astini, 2009). Lithologically the JSZ and PFSZ are similar, both represent a very important geotectonic structure and their geographical locations are suggestive of a connection. For these reasons, we propose that these major structures might be connected.

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