in the Farallon-SAM complex plate-transform-system at the orocline latitude can sustain an analogy with respect to the genesis of the Alaskan Orocline, implying that the Bolivian Orocline was developed where the continent-ocean plate transform system collapsed into subduction and the fore-arc was pushed into and beneath the continental plate, duplicating the crustal thickness in that segment of continent margin.
Since the north-south migration of the Aluk-Farallon-SAM triple junction is a diachronic process, then the growth of the southern and northern transform systems along southern South America is also a diachronic process.

## REFERENCES


- Aragón, E., D`Eramo, F., Castro, A., Pinotti, L., Brunelli, D., Rabbia, O., Rivalenti, G., Varela, R., Spackman, W., Demartis, M., L., Cavarozzi, C.E., Aguilera, Y., Mazzucchelli, M., Ribot, A., 2011. Tectono-magmatic response to major convergence changes in the north Patagonian suprasubduction system: The Paleogene subduction-transcurrent plate margin transition. Tectonophysics 509, 218-237.
- Beck Jr., M.E., Burmester, R.S., Cembrano, J., Drake, R., Garcia, A.R., Hervé, F., Munizaga, F., 2000. Paleomagnits of the North Patagonian batholith, southern Chile. An exercise in shape analysis. Tectonophysics 326: 185-202.
- Cornejo, P., Matthews, S., 2000. Relación entre magmatismo-tectónica y su implicancia en la formación de sistemas de pórfiros cupríferos, Yacimiento El Salvador, 3 Region, Chile. 9º Congreso Geológico Chileno, Actas 1: 184-188.
- Garcia, A.R., Beck Jr., M.E., Burmester, R.S., Munizaga, F., Hervé, F., 1988. Paleomagnetic Reconnaissance of the Region de los Lagos, southern Chile, and its tectonic implications. Revista Geológica de Chile 15 (1): 13-30.
- McQuarrie, N., 2002. Initial plate geometry, shortening variations, and evolution of the Bolivian Orocline. Geology 30: 867-870.
- Pankhurst, R.J., Weaver, S.D., Hervé, F., and Larrondo, P., 1999. Mesozoic-Cenozoic evolution of the North Patagonian Batholith in Aysén, Southern Chile. Journal of the Geological Society 156, 673-694.
- Rapela, C.W., Spalletti, L., Merodio J.C., Aragón E., 1987. Temporal evolution and spatial variation of the lower Tertiary Andean volcanism (40-42 30'S). Journal of South American Earth Sciences 1, 1-14.
- Somoza R., Ghidella M.E., 2005. Convergencia en el margen occidental de América del Sur durante el Cenozoico: subducción de las placas de Nazca, Farallón y Aluk. Revista de la Asociación Geológica Argentina 60 (4), 797-809.


## SPECTRAL EVIDENCE OF PALEOZOIC STRUCTURE IN THE WESTERN PRECORDILLERA, SAN JUAN (31°15'S), ARGENTINA 1-06


Juan P. Ariza[1,2*], Graciela I. Vujovich[2,3], Florencia L. Boedo[2,3], Myriam P. Martínez [1,2], Sofía B. Pérez[2] and Victor A. Ramos [2,3]

*(1) IGSV – UNSJ (Instituto Geofísico Sismológico Volponi – Universidad Nacional de San Juan).*
*(2) CONICET (Consejo Nacional de Investigaciones Científicas y Técnicas).*
*(3) IDEAN – UBA (Instituto de Estudios Andinos Don Pablo Groeber. Depto. Cs. Geológicas, FCEN, Univ. de Buenos Aires).*
** Presenting Author's email: jpariza@conicet.gov.ar.*


### Introduction

The western Precordillera (Baldis *et al.*, 1982) is located in the western central region of Argentina (Fig. 1). Geologically, it is characterized by the development of an Andean thin- skinned fold and thrust belt (Cristallini and Ramos 2000), where the internal structure of each thrust sheet shows evidence of several overlapping deformational phases (von Gosen, 1992; 1995). The stratigraphy of the western Precordillera in the area (Fig. 1) is represented by slope and deep marine siliciclastic facies (Don Polo, Alcaparrosa, Calingasta and El Codo formations) (Quartino *et al.*, 1971). These units are covered unconformably by both continental and marine neopaleozoic deposits (El Ratón and El Salto formations, respectively). The stratigraphic succession culminates with volcanosedimentary Triassic units (Barredo and Ramos, 2010) and Cenozoic continental units.

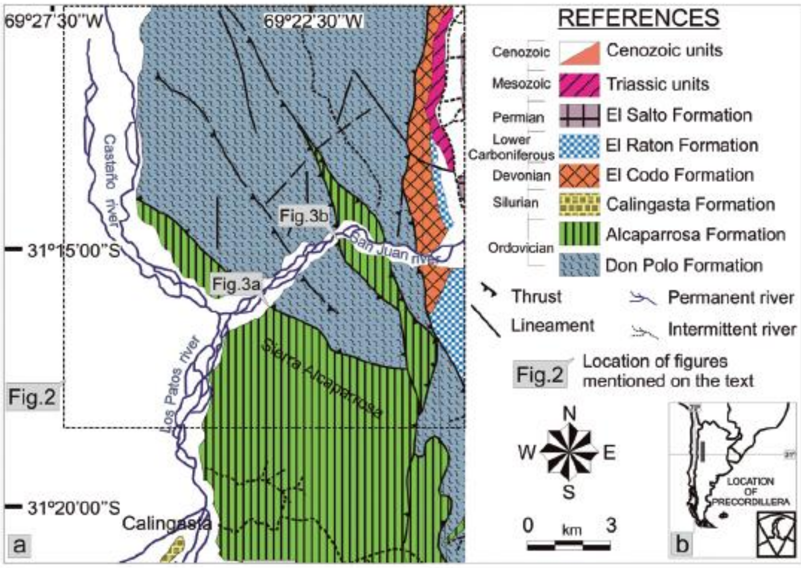


Fig. 1 - Figure 1: a) Geological map (based on Quartino *et al.,* 1971). Structural and stratigraphic framework of the western Precordillera at the study area. b) Location Map of the Precordillera Argentina in the South American context.

Based on different techniques of digital image processing (Sultan *et al*., 1986; 1987; Gad and Kusky, 2006) we have recognized the main structural features. The use of supervised classifications and mathematical operations among bands (5/7, 5/1, 5/4 * 3/4 and 7/5, 5/4, 3/1) show a robust structural framework of the study area.

## Methodology

Satellite data from Landsat 7 ETM + were acquired for this work from the website of the *Global Land Cover Facility* (http://glcf.umiacs.umd.edu) of to the University of Maryland and NASA *(National Aeronautics and Spatial Administration)*. The date of acquisition of the selected image (path: 232, row: 082) was December 3, 1999.

The software used for the processing of these images was ENVI 4.5, running on a PC platform. With this program, different techniques for the combination and classification of bands, band ratios and products were applied.

## Results

The digital image processing favored the spectral contrast among different lithological units. Based on this factor it was possible to highlight geometric features of structural lineaments and characterize geometrically

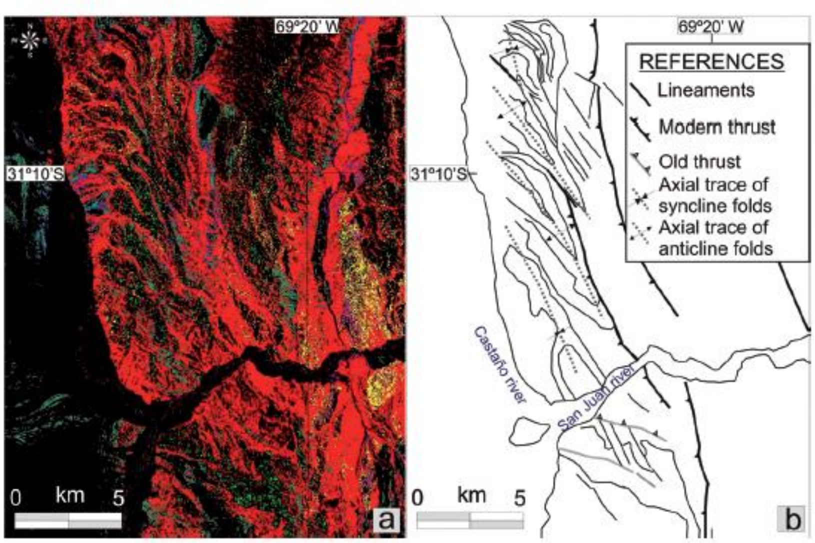


Fig. 2 - Structural Interpretation on a classified satellite image, from the study area (see location in Figure 1). a) Results of supervised classification (parallelepiped method). b) Reconstruction of fold geometries and thrust, from the image (a). The anticlines and synclines are asymetric. The axial traces of folds both syncline and anticline are oriented NW-SE. The axial planes of these folds are dipping toward NE. There are two systems of faulting: system faults Ia (represented by old thrusts) and system faults Ib (represented by modern thrusts).

both folds and faults at the surface.

In the study area at least two structural systems of different nature, judging by their features, were identified (Fig. 2). These systems may be arranged as follows: *I - Fault systems: System Ia* - represented by faults that are preferentially northwest–trending and vergence toward SW (Fig. 3); System Ib – represented by thrusts that truncate the previous structures and are mainly north-trending (Fig. 2). These structures are widely extended along this direction and its vergence is toward E (Fig. 3). *II - Fold System:* This system is characterized by the development of asymmetric folds which the orientations of the axial traces are approximately NW and dipping toward NE (Fig. 2). There is an increase of bed thickness from a minimum value in the limbs, to a maximum in the area of the hinges of the folds, indicating nonparallel folding. This system fold is developed on lower Paleozoic rocks from the study area.

## Conclusions

This paper shows the potential application of the satellite image processing techniques to solve geologic-structural problems. Based on the previous geological knowledge of the area and the corresponding field

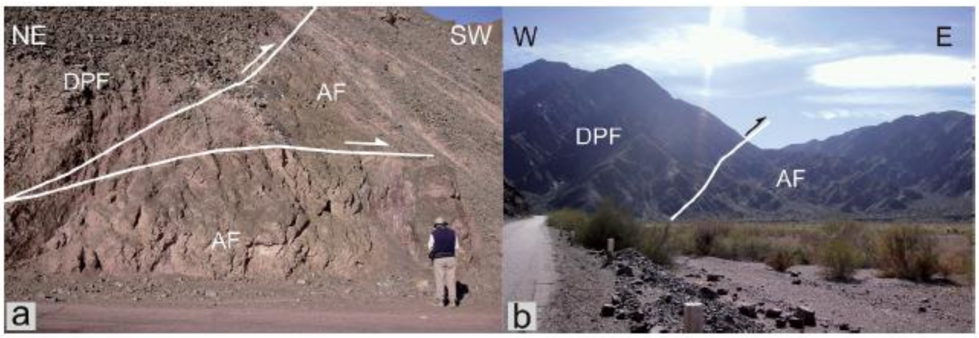


Fig. 3 - Image of the fault systems (see location in Figure 1) a) Fault corresponding to system Ia. This fault is oriented NW-SE with vergence southwestward. b) Fault corresponding to system Ib. This fault is oriented N-S with east vergence. DPF: Don Polo Formation; AF: Alcaparrosa Formation.

controls it is possible to identify two main structural systems: I) fault systems, II) fold systems. On the basis of genetic, temporal, and spatial features, we have could differentiate each group of structures.

The results obtained from the application of remote sensing techniques for areas that have undergone a complex structural evolution, such as the Argentine western Precordillera, are an excellent approximation tool, prior to performing a detailed structural study.

## REFERENCES


- Baldis, B., Beresi M., Bordonaro, O., & Vaca A. (1982). Síntesis evolutiva de la Precordillera Argentina. 5º Congreso Latinoamericano de Geología, Argentina. Actas 4, 399-445.
- Cristallini, E., & Ramos, V. (2000). Thick-skinned and thin-skinned thrusting in the La Ramada fold and thrust belt: crustal evolution of the High Andes of San Juan, Argentina (32°SL). Tectonophysics 317, 205–235.
- Gad, S., & Kusky, T. (2006). Lithological mapping in the Eastern Desert of Egypt, the Barramiya area, using Landsat thematic mapper (TM). Journal of African Earth Sciences 44: 196–202.
- Sultan, M., Arvidson, R.E., & Sturchio, N.C. (1986). Mapping of serpentinitesin the Eastern Desert of Egypt using Landsat Thematic Mapperdata. Geology 14, 995–999.
- Sultan, M., Arvidson, R.E., Sturchio, N.C., & Guinnes, E.A. (1987). Lithologic mapping in arid regions with Landsat TM data: Meatiqdome, Egypt. Geological Society of America Bulletin 99, 748–762.
- von Gosen, W. (1992). Structural evolution of the Argentine Precordillera. Journal of Structural Geology 14, 643–667.
- von Gosen,W. (1995). Polyphase structural evolution of the southwestern Argentine Precordillera. Journal of South American Earth Sciences 8, 377–404.