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Remote sensing analysis for fault-zones detection in the Central Andean Plateau (Catamarca, Argentina)

Anna Traforti (1), Matteo Massironi (1), Dario Zampieri (1), and Cristian Carli (2)

(1) Department of Geosciences, University of Padua, Via Gradenigo 6, 35131 Padova, Italy (anna.traforti@studenti.unipd.it),
(2) IAPS-INAF, Via Fosso del Cavaliere 100, 00133 Roma, Italy

Remote sensing techniques have been extensively used to detect the structural framework of investigated areas, which includes lineaments, fault zones and fracture patterns. The identification of these features is fundamental in exploration geology, as it allows the definition of suitable sites for the exploitation of different resources (e.g. ore mineral, hydrocarbon, geothermal energy and groundwater). Remote sensing techniques, typically adopted in fault identification, have been applied to assess the geological and structural framework of the Laguna Blanca area (26°35'S-66°49'W). This area represents a sector of the south-central Andes localized in the Argentina region of Catamarca, along the south-eastern margin of the Puna plateau. The study area is characterized by a Precambrian low-grade metamorphic basement intruded by Ordovician granitoids. These rocks are unconformably covered by a volcano-sedimentary sequence of Miocene age, followed by volcanic and volcaniclastic rocks of Upper Miocene to Plio-Pleistocene age. All these units are cut by two systems of major faults, locally characterized by 15-20 m wide damage zones. The detection of main tectonic lineaments in the study area was firstly carried out by classical procedures: image sharpening of Landsat 7 ETM+ images, directional filters applied to ASTER images, medium resolution Digital Elevation Models analysis (SRTM and ASTER GDEM) and hill shades interpretation. In addition, a new approach in fault zone identification, based on multispectral satellite images classification, has been tested in the Laguna Blanca area and in other sectors of south-central Andes. In this perspective, several prominent fault zones affecting basement and granitoid rocks have been sampled. The collected fault gouge samples have been analyzed with a Field-Pro spectrophotometer mounted on a goniometer. We acquired bidirectional reflectance spectra, from 0.35μm to 2.5μm with 1nm spectral sampling, of the sampled fault rocks. Subsequently, two different Spectral Angle Mapper (SAM) classifications were applied to ASTER images: the first one based on fault rock spectral signatures resampled at the ASTER sensor resolution; the second one based on spectral signatures retrieved from specific Region of Interest (ROI), which were directly derived from the ASTER image on the analyzed fault zones. The SAM classification based on the spectral signatures of fault rocks gave outstanding results since it was able to classify the analyzed fault zone, both in terms of length and width. Moreover, in some specific cases, this SAM classification identified not only the sampled fault zone, but also other prominent neighboring faults cutting the same host rock.

These results define the SAM supervised classification on ASTER images as a tool to identify prominent fault zones directly on the base of fault-rocks spectra.