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Insight into the active seismotectonic settings of the broken foreland of the NW Argentine Andes

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After a severe Mw 5.8 earthquake on October 17, 2015 in El Galpón in the province of Salta NW Argentina, we installed a local seismological network around the estimated epicenter. The network covered an area characterized by inherited Cretaceous normal faults and neotectonic faults with unknown recurrence intervals, some of which may have been reactivated normal faults. The 13 three-component seismic stations recorded data continuously for 15 months.

The 2015 earthquake took place in the Santa Bárbara System of the Andean foreland at about 17km depth. This region is the easternmost morphostructural region of the central Andes. As a part of the broken foreland it is bounded to the north by the Subandes fold-and-thrust belt and the Sierras Pampeanas to the south; to the east lies the Chaco-Paraná basin.

The earthquake epicenter was located beneath the Metán basin. Its structural characteristics were previously interpreted based on analyses of several seismic reflection lines indicating the existance of a 4km deep depocenter (Iaffa et al., 2011a, 2011b, 2013). Furthermore, these authors suggested a multi-stage morphotectonic evolution with thick-skinned basement uplift and coeval thin-skinned deformation in the intermontane basins. The release of stresses associated with the foreland deformation can result in strong earthquakes, as the study area is known for recurrent and historical, destructive earthquakes. Besides the 2015 event, in 1908 and 1826 two earthquakes occurred in the northern and southern sectors of the network. All three events correspond to an estimated intensity VII (Mercalli scale). The strongest event in 1692 (magnitude 7 or intensity IX) destroyed the city of Esteco II, located in the center of the Metán basin, and damaged parts of the city of Salta. Destructive earthquakes and surface deformation are thus a hallmark of this part of the Andean foreland.

With state-of-the-art python packages (e.g. pyrocko, ObsPy), we used a semi-automatic approach to analyze the collected continuous data of our seismological network. On average, 4.5 events per day could be identified in the record. The resulting hypocenter locations consist of 3 different groups: 1.) local crustal earthquakes within the network, 2.) interplate activity, of regional distance in the slab of the Nazca-plate, and 3.) very deep earthquakes at about 600km depth to the east of the network. Our major interest focused on the first event class. Those crustal events are partly aftershock events of the El Galpón earthquake and a second earthquake close to the town of Rosario de la Frontera (September 5, 2015) in the south of the same fault. Further events can be considered as background seismicity of other faults within the study area. For some events macroseismic reports are available as ground truth. In addition, seismic lines from reflexion-seismic experiments, small-scale electric profiles and topographic breaks and scarps emphasize the nature of tectonic features and suggest ground rupturing events in the younger geological past. Thus, spatial location analyses and magnitude distribution in combination with other geological and geophysical information will help us understand the regional driving processes that determine the level of seismic hazard.