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Morphometric characterization of a large scale rockslide, and probable seismogenic origin of landslides on the western flank of Central Precordillera, Argentina

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ABSTRACT

The distribution of late Pleistocene to Holocene rockslides in the western flank of the eastern mountain ranges of Central Precordillera (30° 40′–31° S), has been analyzed to determine the triggering mechanisms. The mode of failure was determined to be translational sliding. This paper presents the results of research on one of the Holocene rockslides located in the western flank of Sierra de La Dehesa, which is composed of stratified limestones of early Paleozoic age. In order to characterize this slide, high resolution satellite imagery interpretation was carried out, along with the recognition of the landslide detachment zones and landslide bodies with the aim of reconstructing the pre-slide topography. The model proposed for this slide is a translational or planar slide, as the mode of failure was along a broadly planar surface accompanied by shear or tensile fractures and joints. The estimated rock volume involved is 1.24 Mm^3. We compared rockslide occurrence patterns to slope, topography, lithology, geological structures, and seismicity records. After analysis of the spatial relationships among all the slides and the distribution of seismic epicenters, historical earthquakes and neighboring Quaternary faults as seismogenic sources, we hypothesize that these Quaternary rockslides in the Central Precordillera have been triggered by shallow seismicity associated with active faults.

1. Introduction

Cruden and Varnes (1996) defined the term 'landslide' as the gravitational mass downslope motions of rock, debris or soil, or as a translational movement of rock which occurs along a more or less planar or gently undulating surface (Varnes, 1978). The presence of these slides is frequent in mountain slopes or rock exposures where the slope angle is close or parallel to the dip of the rock. The movement is controlled by planar structural discontinuities, such as faults, joints and bedding. Rockslides are characterized by well-defined head scarps and flanks, a pronounced scar generally left with little or no debris, and usually a mass of debris that accumulates in the track or at the base. In general, the triggering mechanisms of this kind of slide are undercutting of the toe support by erosion, and earthquakes. Study of these features is important, as they may cause loss of life and property, damage natural resources, and hamper development projects such as road and communication lines.

Keefer (1984) studied 40 historical earthquakes worldwide and several hundred earthquakes from the United States to determine the characteristics, geologic environments, and hazards of landslides caused by seismic events. His study indicated that earthquakes as small as 4.0 in local magnitude (ML) can dislodge landslides from susceptible slopes, and those with large magnitude can generate many slope failures across wider areas. Sepúlveda et al. (2004, 2005a,b) has studied several topographical factors which can generate faults in rock slopes, one of the most important being seismic wave amplification. He found relationships between the slope size and shape with the dominant wavelength favoring topographical amplification and landslide generation.

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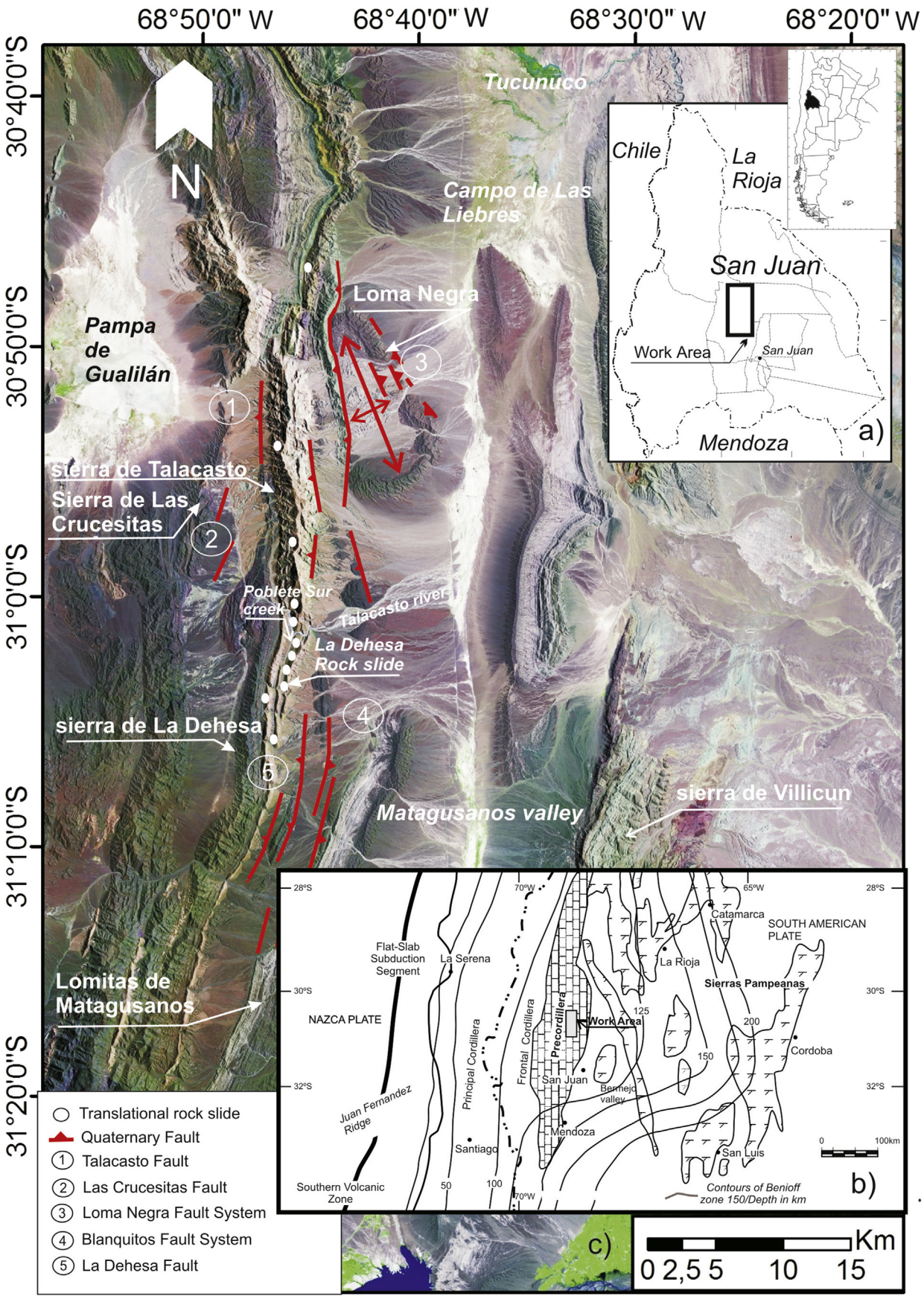

Fig. 1. a) San Juan Province and study area, b) Location of the Pampean flat-slab segment between 28° and 32° S with depth-contours of the oceanic slab (Modified from Ramos et al., 2002), c) Spatial distribution of rockslides inside the study area (white dots) and main neotectonic structures recognized in the study area.