The Latagualla mega-landslide, Tarapacá region, Northern Chile: an example of Cenozoic instability of the Andean arc of the Bolivian orocline

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The western part of the Andean arc in Northern Chile is constituted by four subparallel morpho-structural units, oriented ca. N-S, which are (from W to E): the Coastal Cordillera (1200-1500 m a.s.l.), the Central Depression (1000-1500 m a.s.l.), the Precordillera (ca. 3000 m a.s.l.) and the Western Cordillera (5000-6000 m a.s.l.). The western flank of the Precordillera, between $\sim$16°S in Peru and $\sim$21°S in Chile, is characterized by the presence of mega-landslides of several tens of cubical kilometers of removed material.

In southern Peru and northern Chile, the Precordillera is constituted by a succession of Cenozoic ignimbrites and lava flows interbedded with continental detritic deposits. These series are tilted some degrees towards the west and are very little deformed. The deformation is concentrated in a flexure that bounds the Precordillera and the Central Depression (Moquella Flexure), producing an uplift of the western edge of the Precordillera of the order of 2000 to 2500 m. This flexure was active from Lower Miocene. In this area, large magnitude earthquakes such as the shallow Aroma (24/07/2001, Mw=6.3) and the intraplate Tarapacá (13/06/2005, Mw=7.9) earthquakes are still registered. From 8 to 9 Ma B.P. climatic and/or tectonic changes produced an important incision of valleys of the order of 1000 m of depth, both in the edge of Precordillera and all the Central Depression, considering an exoreic drainage.

One of the large landslides along the western edge of the Precordillera is the Latagualla mega-landslide. It is located in the Tarapacá region, between the Latagualla and Suca ravines, just on the Moquella flexure. Its dimensions are 4 km long by 9 km wide, with a total volume of about 6.75 km^3. The landslide is constituted by two main rock masses. The first was displaced from east to west, with its front deformed in compression, showing a thrust-propagated anticlinal fold. The second rock mass is located between the first mass and the main scarp, and corresponds to a second episode of landsliding from the re-equilibrated scarp after the first event. Both masses are sepa-

rated by an alluvial plain. The age of the landslide has not been directly determined, but is former to the incision of the present day valleys. At that time, the erosion of the ravines was much shallower and the water table would have been much higher than now.

At the base of the landslide mass there is a thin clay layer in the contact between an ignimbrite and a detritic sedimentary formation. The clay layer was possibly originated by alteration during the emplacement of the ignimbrite over the sedimentary layers. We interpret this clay layer as a detachment level. Preliminary geotechnical analyses of the clay and slope stability analyses show that the rock mass may have failed during a strong earthquake with peak accelerations just over 1 g. These levels of accelerations have been found close to the epicentre in recent shallow earthquakes in Chile. Therefore, an ancient strong earthquake in the flexure, given favourable geomorphological conditions, may have induced the mega-landslide.