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Quaternary International 148 (2006) 138–148

Chronology of a probable neotectonic Pleistocene rock avalanche, Cordon del Plata (Central Andes), Mendoza, Argentina

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Available online 19 January 2006

Abstract

Placetas Amarillas-1 rock avalanche located at 32°43′S–69°25′W was geomorphologically, stratigraphically and chronologically studied. This extraordinary event dammed a secondary gully causing the formation of a barrier-lake, indicated by relict lacustrine and diatomite deposits. Stratigraphically, its deposit is overlain by alluvial fans where three tephra layers are intercalated. Dating using Ar–Ar method of the middle ash level at 350 ± 80 ka determined a Middle Pleistocene or older age for this event. Furthermore, the younger age of Placetas Amarillas-2 is established by relative dating techniques such as soil development and rock varnish development. The ages established in this research indicate that Placetas Amarillas-1 may be temporally correlated with the Tigre Dormido rock avalanche, suggesting that the occurrence of these rock avalanches may be related to regional neotectonic activity. Nevertheless, climatic conditions are not underestimated as the Tigre Dormido event occurred before formation of an outwash terrace related to a glaciation of Early Middle Pleistocene age.

1. Introduction

Rock avalanches, known also as sturzstroms, are large, extremely rapid and often open-slope flows (Cruden and Varnes, 1996). Relatively large volumes and extremely high velocities associated with this kind of flow activity are often linked to a catastrophic impact. Historical examples included the Goldau slide of 1806 (volume 30–40 Mm^3, estimated velocity 70 m/s, 457 deaths); the Elm slide of 1881 (volume 11 Mm^3, estimated velocity 70 m/s, 115 deaths); and the Frank slide of 1903 (volume 30 Mm^3, estimated velocity 28 m/s, 70 deaths) (Heim, 1919, 1932; Abele, 1974; Cruden and Krahn, 1978; Hsü, 1978; Cruden and Hungr, 1986). The research community has a particular interest in the survey of these huge landslides, concerning probable causes, rupture mechanisms, velocities, magnitudes, volumes and probable relations with certain climatic conditions (Panizza, 1973; Abele, 1974; Hsü, 1975; Plafker and Ericksen, 1978; Voight and Pariseau, 1978; Adams, 1981; Záruba and Mencl, 1982; Keefer, 1984; Gonzalez Diez et al., 1996; Poschinger and Haas, 1997; Trauth and Strecker, 1999; Corsini et al., 2000; Hermanns et al., 2000, 2001; Trauth et al., 2000; Borgatti et al., 2001; Corsini et al., 2001).

As the study area is a seismic region, several landslides have been triggered by earthquakes with magnitudes higher than 3.5, and others are frequently related to intense rainstorms (Moreiras, 2003a, 2004a, 2005a,b). Even though debris flows and rockfalls are more common events, huge rock avalanches have affected the region (Salomón, 1979; Espizúa and Bengochea, 1991; Fauqué et al., 2000, 2001; Moreiras, 2003b, 2004b). These extraordinary events have usually dammed valleys and represent a potential hazard for this developing mountain area, where intense tourist activity exists. As well, the International road to Chile, an important traffic route, and the older International Transandino Railway pass through the area.

Although, these huge landslides have been geomorphologically studied, numerical dating of their deposits and assessment of their probable causes are still lacking. Establishing the chronology of these exceptional landslides is essential to understand their causes and relationship with

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1040-6182/$ - see front matter © 2005 Elsevier Ltd and INQUA. All rights reserved.
doi:10.1016/j.quaint.2005.11.009

past climatic conditions. Brundsen (1979) remarked that different hypothesis on the nature of rock avalanche movement mechanism have been proposed, unfortunately without complete satisfactory explanation; and lacking on precise triggering causes do not allow or enable realistic prediction of these threatening events. Present study enhances the knowledge of two extraordinary events identified in the study area. Chronology established for one of them, Placetas Amarillas-1 rock avalanche, allow temporal correlation with other rock avalanche studied previously, suggesting they may be sourced by the same triggering factor and at the same conditions. Probable triggering factor is analyzed regarding potential hazard evaluation.

2. Location of the study area

The study area is located in north-western Mendoza province at 32°43′S latitude and 69°25′W longitude. It comprises a 33 km^2 area along Placetas Amarillas. It is situated near La Quinta place, directly south of the Uspallata railway station (Fig. 1), access to the area is via International highway N° 7 to Chile, and then following unconsolidated road along La Quinta gully from the old Uspallata railway station. Tourist facilities and a small artificial dam have been built in La Quinta.

3. Geological/geographical setting

The study area comprises the Cordillera Frontal geological province, characterized with strong relief and very steep slopes. The highest elevations are: Colorado (4790 m.a.s.l.), Division (4603 m.a.s.l.), Burro (4293 m.a.s.l.), and Minero (3813 m.a.s.l.) peaks.

A Permo-Triassic volcanic complex (Choiyoi Group) crops out in the region, composed of pyroclastic material, lavas, subvolcanic and intrusive rocks. The Tambillos and Horcajo Formations can be distinguished. The former is mainly constituted by volcanites, rhyolitic lavas and lacustrine sediments (Cortés, 1985). The latter corresponds

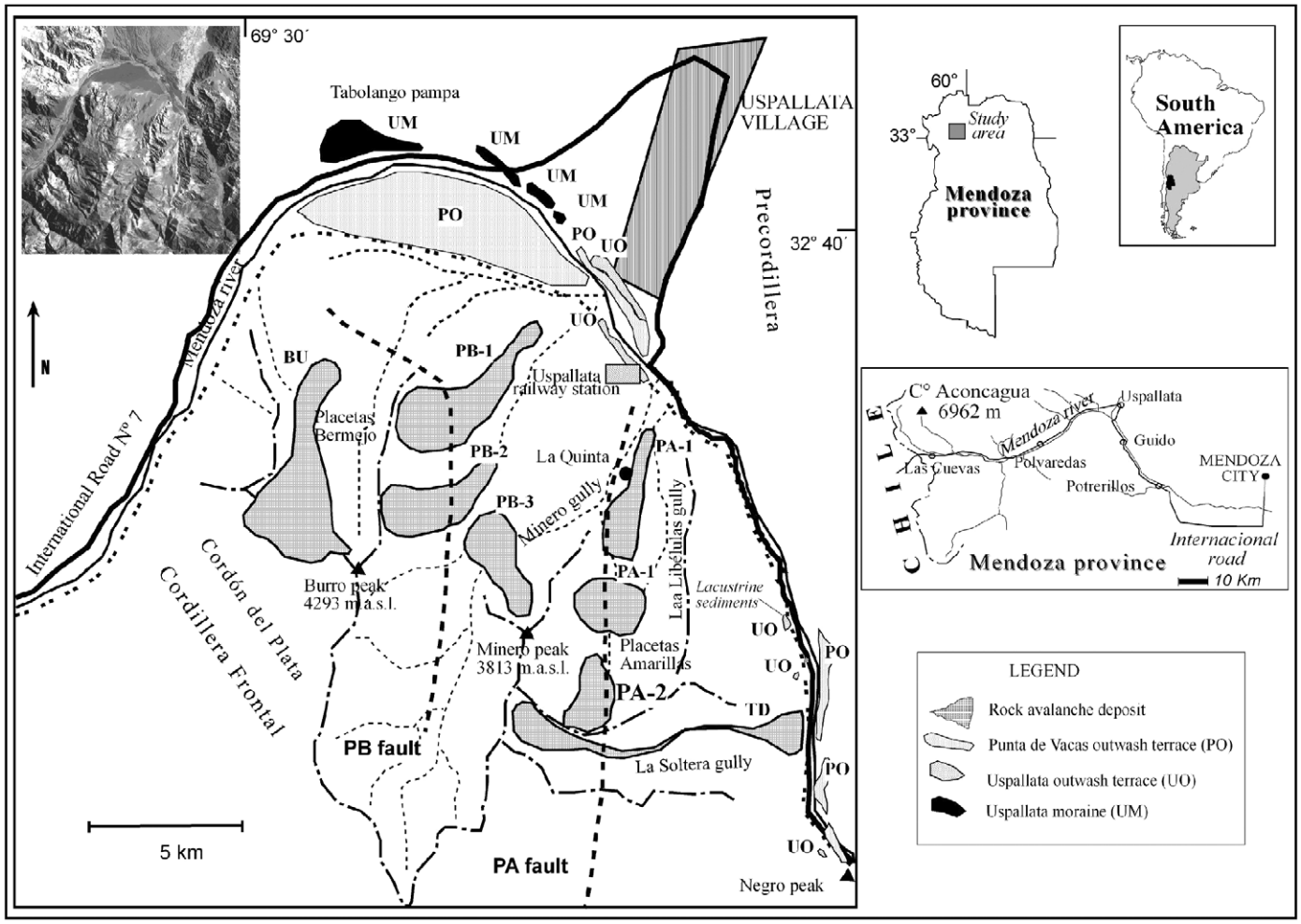

Fig. 1. Location of study area, where six huge landslides are identified: (a) Tigre Dormido (TD); (b) Placetas Amarillas 1 (PA-1); (c) Placetas Amarillas 2 (PA-2), c-Piedras Blancas 1 (PB-1); (d) Piedras Blancas 2 (PB-2); (e) Piedras Blancas 3 (PB-3), and (f) Burro (BU) (after Fauqué et al., 2000, 2001). Pleistocene drifts identified in the area are the Uspallata terminal moraine (UM), Uspallata outwash (UO), and Punta de Vacas outwash (PO) (after Espizúa, 1993; Moreiras, 2003, 2004b). Placetas Amarillas fault (PA) and Piedras Blancas fault (PB) are represented.