Available online at www.sciencedirect.com

SCIENCE DIRECT®

Geomorphology 65 (2005) 321–336

GEOMORPHOLOGY

www.elsevier.com/locate/geomorph

A large landslide on the urban fringe of metropolitan Phoenix, Arizona

John Douglass[a,*], Ronald I. Dorn[a], Brian Gootee[b]

[a]*Department of Geography, Arizona State University, Tempe AZ 85287, USA*
[b]*Department of Geological Sciences, Arizona State University, Tempe AZ 85287, USA*

Received 17 May 2004; received in revised form 28 August 2004; accepted 28 September 2004
Available online 23 November 2004

Abstract

A granitic rock avalanche, one of the largest Quaternary landslides in Arizona outside the Grand Canyon with a volume of approximately 5.25 M m^3 and a width a little under 0.5 km, ran ~1 km from the eastern McDowell Mountains. With lateral levees and pressure ridges, the rock avalanche deposit displays many features found on classic sturzstroms. Failure occurred along a major joint plane paralleling the slope with a dip of 44°, when a major base level lowering event in the Salt River system would have undermined the base of the failed slope, and probably during a period of more moisture than normally available in the present-day arid climate. Failure at the subsurface weathering front highlights the importance of the dramatic permeability change between grussified regolith and relatively fresh bedrock. Rock varnish microlaminations (VMLs) dating, in concert with other geomorphic evidence, suggests that the rock avalanche deposit is slightly older than ~500 ka. The rock vanish results also have important implications for sampling strategies designed to use cosmogenic nuclide to date Quaternary landslide deposits. Discovery of a large landslide in close proximity to the extending urban fringe of metropolitan Phoenix argues for a more careful analysis of landslide hazards in the region, especially where rapid development excavates bedrock at the base of steep mountain slopes and where the subsurface weathering front is near the surface.

Keywords: Central Arizona; Cosmogenic nuclide; Dating; Geomorphology; Natural hazard; Urban growth

1. Introduction

Urban growth in arid regions often faces natural hazards very different from those in wetter climates (Schick et al., 1999; Arrowsmith, 2001; Gupta et al., 2002). Commonly addressed hazards include flooding along larger streams (Greenbaum et al., 1998; Graf, 2000), flash flooding on smaller drainages (Holle and Bennett, 1997), and ground subsidence (Hoffmann et al., 1998). Mapping efforts help define those locales likely to experience future growth under such natural hazards (Christenson et al., 1978–1979; Schick et al., 1999).

* Corresponding author. Fax: +1 480 965 8313.
E-mail address: johndouglass@hotmail.com (J. Douglass).

0169-555X/$ - see front matter © 2004 Elsevier B.V. All rights reserved.
doi:10.1016/j.geomorph.2004.09.022

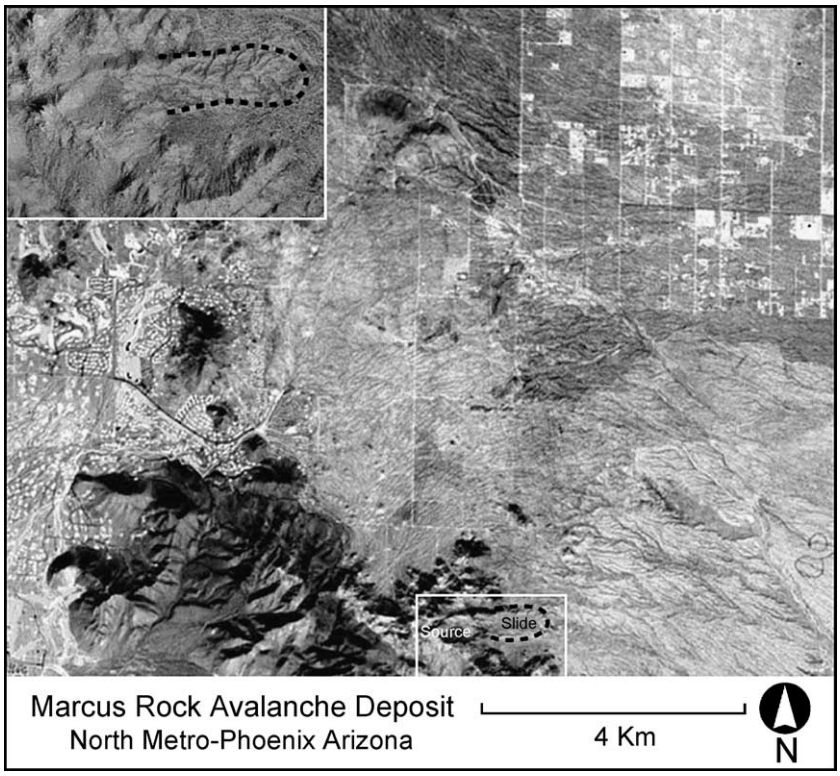

Fig. 1. Location of the Marcus rock avalanche deposit with respect to growth in Scottsdale, AZ. Note how the development is starting to emerge next to very steep slopes on the eastern side of the McDowell Mountains, even though the landslide itself rests in a land preserve.

Staggering urban expansion in metropolitan Phoenix takes place both gradually and by leapfrogging—jumping tens of kilometers from the former outer edge—often to create communities in aesthetic settings in and among steep mountainous terrain. Building at the foot of mountainous areas offers better vistas with commensurately higher property values (Alexander, 1989). Mountains and landsliding, however, go hand-in-hand—even in arid regions (Selby, 1993; Yarnold, 1993). As surprising as it sounds, large landslides do sometimes host suburbanization (Smith, 2001), with people living in locales known to have large-volume landslides with long runouts (Kilburn and Pasuto, 2003). Landsliding, however, remains a largely underappreciated hazard in metropolitan Arizona, despite explicit notations to historic rockfall events (Péwé, 1989) and efforts to understand landsliding at a regional level in Arizona (Welsch and Péwé, 1979; Realmuto, 1985; Welty et al., 1988; Arrowsmith, 2003).

The McDowell Mountains in central Arizona, immediately NE of the city of Phoenix, offer scenic vistas and development potential. The 1970s brought scrutiny to assess potential environmental hazards for future development on the western flank, and numerous small landslides were identified (Christenson et al., 1978–1979). A quarter century later, Scottsdale continues development on the granite piedmont with thin soils on the north end of the McDowell Mountains (Stefanov, 2000)—with the latest growth snaking southward on the eastern flank (Fig. 1). Fountain Hills continues slow growth northwards on the eastern side from the south. Between these extending cities rests a previously unrecognized rock avalanche deposit (Fig. 2) in a land preserve, large enough to be classified a small sturzstrom (Hsü, 1975).

This paper presents one of the largest Quaternary landslides reported in Arizona outside of the Grand Canyon (Savage et al., 2002), a deposit we informally named the Marcus rock avalanche in honor of former