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Geomorphological study of the Cafayate dune field (Northwest Argentina) during the last millennium

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ABSTRACT

The Cafayate depression is a dry valley located in the Pre-Andean region of northwest Argentina. The area shows the development of a large dune field. Its significance has been established from geomorphological and mineralogical evidence, grain shape characteristics and chronological data (OSL dating, archaeological remains, and historical data). The dating results were between 1000–1100 AD to1740–1830 AD showing that the aeolian dynamics remained active during the last millennium. It was not possible to identify stabilised phases marked by ruptures or paleosol development. Nevertheless, other regional and local proxies from Northwest Argentina (archaeological, documentary, etc.) were used to complete the interpretative framework to propose the paleoenvironmental evolution of the area. In addition, human activity and land use must be considered as a complementary factor affecting aeolian dynamics during the most recent stage.

1. Introduction

Aeolian deposits are morphosedimentary records that can be used to produce valuable palaeoenvironmental reconstructions (Hesse, 2009; Iriondo et al., 2009; May, 2013; Thomas, 2013; among others) because sand dune dynamics are strongly influenced by short-term climatic fluctuations during the Late Pleistocene and Holocene (Muhs, 1985; Gaylord, 1990; Forman et al., 1992; Lancaster, 1997; Munyiwka, 2005; Hanson et al., 2009). Moreover, human action can trigger or accelerate aeolian processes during historical times (Levin and Ben-Dor, 2004; Wolfe et al., 2007). For instance, when vegetation cover is reduced below a threshold of ca. 30%, caused by environmental change, overgrazing and/or fire, sands are exposed sufficiently to allow aeolian mobilisation (Pye and Tsoar, 2009).

Aeolian accumulations (dunes and loess) cover large areas in Argentina, especially in the central regions of the country (Andean pediment, Pampean plains and the North Patagonian plateau) (Iriondo and Kröhling, 1996; Iriondo, 1990, 1999; Carignano, 1999; Muhs and Zárate, 2001; Tripaldi, 2002; Tripaldi and Forman; 2007; Tripaldi et al., 2010; Zárate and Tripaldi, 2012; among others). Most of the dunes are Upper Pleistocene (33–20 kyr) in age (Iriondo and Kröhling, 1996; Kröhling, 1999; Zárate, 2003). Furthermore, some dunes of the Pampean Region were reactivated heavily during the Holocene (Tripaldi and Forman, 2007; Forman et al., 2014) and even during the 20th century (Tripaldi et al., 2013).

However, dune accumulations in the Andean intermontane basins have received less attention. The dune field at Cafayate, located in the northern area of the Santa María valley (northwest Argentina), represents a unique opportunity for study, as it shows high levels of current activity of the aeolian deposits linked to land use change for agricultural purposes. Previous studies on the Cafayate dune field are scarce and mainly dealt with sedimentology and mineralogy for industrial applications (Cortelezzi et al., 1984).

The main objective of this paper is the geomorphological study of the Cafayate dune field. We present geomorphological mapping, aeolian deposit data (grain size, mineralogy, and grain surface microtextural analysis) together with palaeoenvironmental interpretation. Although 6 OSL ages were determined, it was not possible to obtain enough chronological and stratigraphical information to define accurate stages in

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the dune dynamics over time. Nevertheless complementary regional data are provided to give support to the main interpretation.

2. Regional setting

The Cafayate depression is located in the northern area of the Santa María valley in the Valles Calchaquíes in the province of Salta (Fig. 1). This is an elongated north–south trending graben, surrounded by the Northern Sierra Pampeanas. The east is bordered by the Cumbres Calchaquíes (La Hollada, 4177 m) and the west by the Sierra de Quilmes (Cerro Chuscho, 5468 m). Its northern area is wider and bordered by the Cerro El Zorrito (3224 m), where the Santa María and Calchaquí rivers meet. This is the starting point of the narrow canyon of the Las Conchas River that forms part of the basin of the River Juramento. The Santa María and Calchaquí rivers flow across the Cafayate depression and drain a large fluvial basin (19,760 km^2). This fluvial system receives abundant water discharge because of summer rains and snowmelt in the headwaters, while the rivers remain almost dry during winter.

The region has a complex geology (Galván, 1981). In the Sierra de Quilmes and north-eastern sector of Cumbres Calchaquíes, a Precambrian–Lower Cambrian geological basement comprising granitic and low-medium grade metamorphic rock outcrops (Rapela, 1976; Toselli et al., 1978) (Fig. 1). During the Upper Cretaceous–Miocene (Salfity and Marquillas, 1999; Bossi et al., 2001) a rifting stage favoured the formation of a graben filled with a sedimentary sequence of continental detrital and carbonate rocks of the Salta Group. These are overlain by detrital deposits from the Santa María Group (Pliocene) (Galván and Ruiz Huidobro, 1965; Galván, 1981). A compressive Pliocene phase affected this sedimentary sequence and developed north–south trending folds, as well as activating the marginal fault system of the Santa María graben.

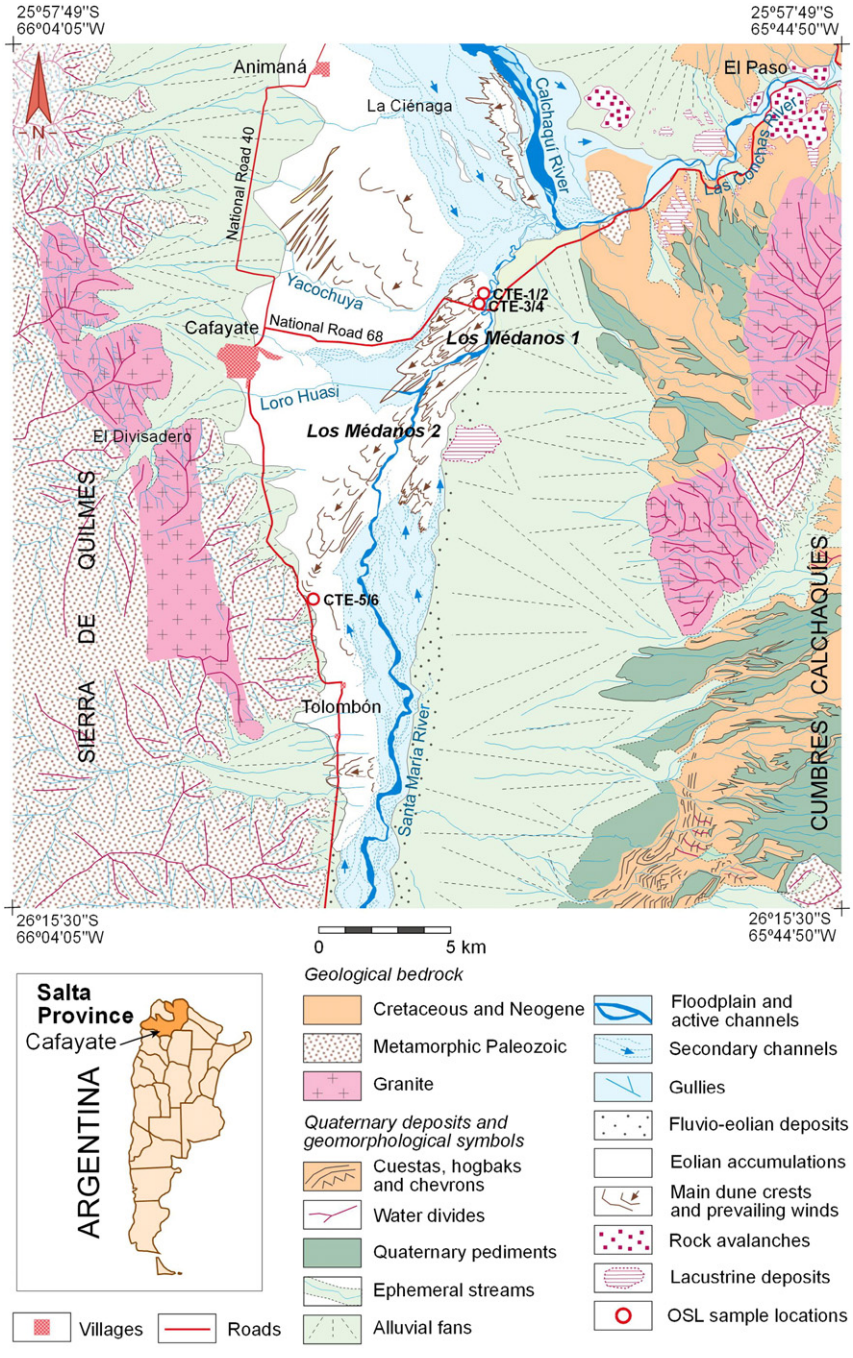

Fig. 1. Location and geomorphological maps of the Cafayate depression.