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Geomorphological evolution of the Tilcara alluvial fan (Jujuy Province, NW Argentina): Tectonic implications and palaeoenvironmental considerations

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ABSTRACT

The development and evolution of the Tilcara alluvial fan, in the Quebrada de Humahuaca (Andean Eastern Cordillera, NW Argentina), has been analysed by using geomorphological mapping techniques, sedimentological characterisation of the deposits and OSL chronological methods. It is a complex segmented alluvial fan made up of five evolutionary stages (units Qf1, Qf2, Qf3, Qf4 and Qf5) developed under arid climatic environments as well as compressive tectonic conditions. Segmentation processes, including aggradation/entrenchment cycles and changes in the location of the depositional lobe, are mainly controlled by climatic and/or tectonic changes as well as channel piracy processes in the drainage system. Alluvial fan deposits include debris flows, sheet flows and braided channel facies associated with high water discharge events in an arid environment. The best mean OSL age estimated for stage Qf2 is 84.5 ± 7 ka BP. In addition, a thrust fault affecting these deposits has been recognized and, as a consequence, the compressive tectonics must date from the Upper Pleistocene in this area of the Andean Eastern Cordillera.

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RESUMEN

Se han utilizado técnicas geomorfológicas (cartografía), sedimentológicas (análisis de facies) y cronológicas (dataciones de OSL) para analizar la evolución del abanico aluvial de Tilcara, en la Quebrada de Humahuaca (Cordillera Oriental Andina, NO Argentina). Se trata de un abanico complejo segmentado, en el que se han diferenciado cinco etapas constructivas (Qf1, Qf2, Qf3, Qf4 y Qf5) en un contexto de clima árido y de actividad tectónica compresiva. El encajamiento de las superficies de agradación y las modificaciones en la posición del lóbulo deposicional del abanico están controlados por cambios tectónicos y/o climáticos y procesos de captura en el drenaje del sistema. La etapa Qf2 tiene una edad media ponderada de 84, 5 ± 7 ka BP mediante OSL. Los depósitos incluyen facies de flujos de masas, flujos laminares y canales entrelazados acumulados en eventos de alta descarga hídrica bajo condiciones de aridez. Una falla inversa superpone el Terciario sobre estos depósitos lo que permite prolongar la tectónica compresiva hasta bien entrado el Pleistoceno superior en la Cordillera Oriental Andina.

1. Introduction

Quaternary alluvial fans are significant landforms within the Quebrada de Humahuaca landscape (Jujuy Province, NW Argentina) (Fig. 1). Their occurrence is related to the scarps defining the Quebrada and is associated with the sedimentary activity of the Río Grande tributary network under arid environmental conditions and in an active compressive tectonic context. Inside the Quebrada de Humahuaca several patterns of alluvial fan evolution (Bull, 1977; Silva et al., 1992; Harvey, 1997; Colombo et al., 2000) can be differentiated based on their morphostratigraphic features. Although the present-day alluvial fan activity, affecting routes, railways and villages, has been analysed by Chayle and Wayne (1995), Solís and Orozco (1996), very few detailed studies concerning geomorphological, sedimentological and chronological aspects of these Quaternary morphosedimentary units have been carried out (Azarevich et al., 1999).

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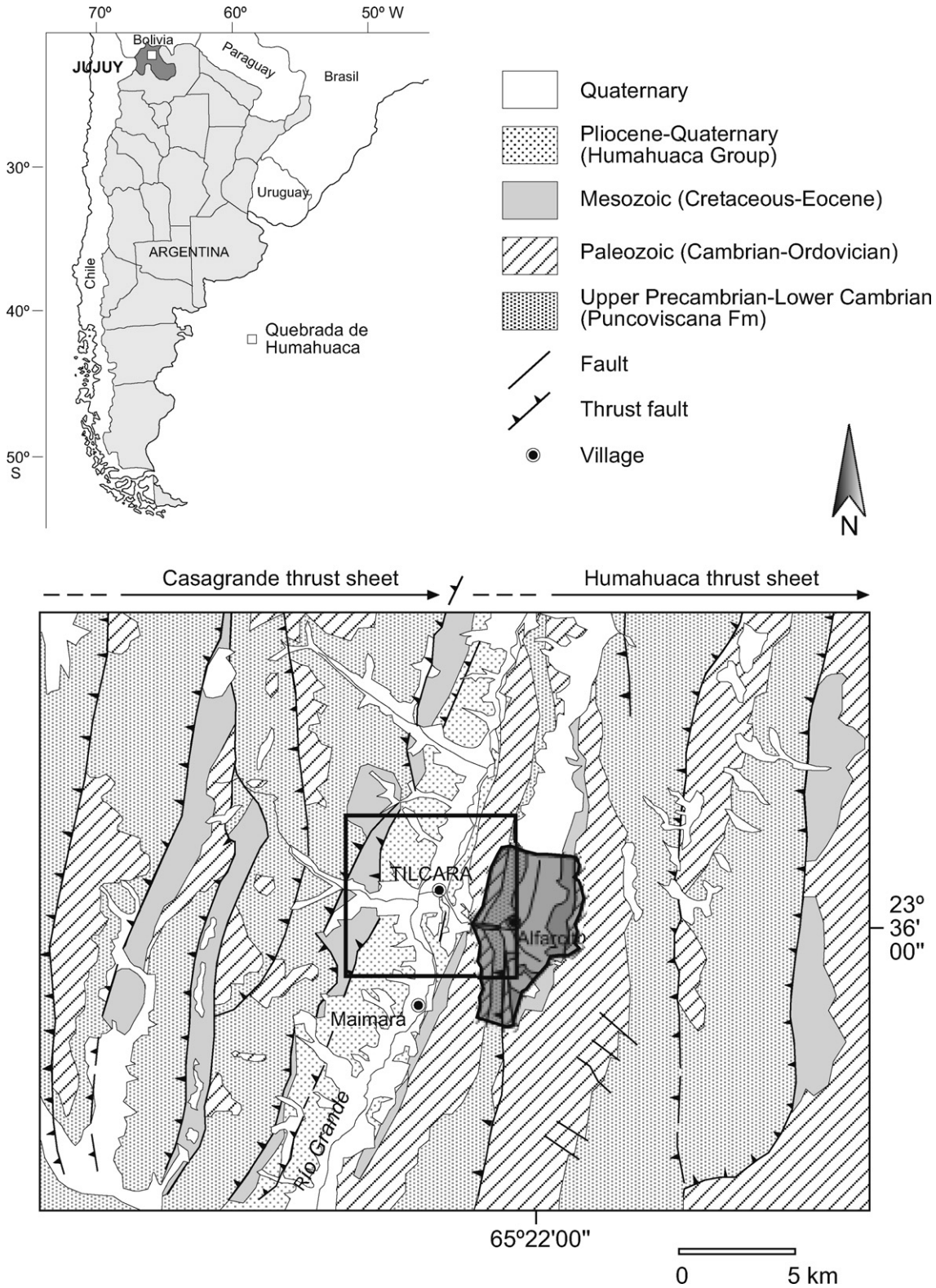

Fig. 1. Location of the study area and geological setting (after Rodríguez-Fenández et al., 1999).

The Huasamayo River, a tributary of the Río Grande, has built one of the most interesting alluvial fans in the Quebrada de Humahuaca, located at latitude 23–24°S near Tilcara village. Besides the geomorphological and applied interest, this alluvial fan shows spectacular features of compressive tectonic activity during Quaternary times (Salfity et al., 1984; Marret et al., 1994; Rodríguez-Fenández et al., 1999).

The main objectives of this work deal with the study of the geomorphological evolution of the Tilcara fan, the analysis of the sedimentological characteristics of the deposits and the determination of the alluvial fan age by using OSL (Optically Stimulated Luminescence) techniques. In addition, these chronological data are very useful to determine both the palaeoenvironmental and