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Late Quaternary paleosol–sediment-sequences and landscape evolution along the Andean piedmont, Bolivian Chaco

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Abstract

As part of the Bolivian Chaco, the Andean piedmont is situated in the transitional zone between the tropical-humid climate regime to the north (Amazonia) and the subtropical-semiarid regime to the south (Gran Chaco). In this zone, which is sensitive to climatic changes, late Quaternary landscape and climate history was reconstructed based on detailed sedimentological, pedological and geochemical analyses of paleosol–sediment-sequences along the Andean piedmont. The determination of characteristic lithofacies allowed correlation between the investigated profiles and their interpretation in terms of paleoenvironmental conditions, i.e. geomorphic stability (soil formation) or geomorphic activity (fluvial or fluvio–aeolian sedimentation, erosion, etc.). Coarse fluvial deposits (gravels, sands) form the base of the investigated profiles and have likely been deposited in a braided-river environment with low vegetation cover and intensive discharge events before and during the Last Glacial Maximum. Well-developed paleosols formed in the upper part of these sediments during the Lateglacial, documenting geomorphic stability (high vegetation cover) and wet conditions. Overlying palustrine sediments, dated to the Early Holocene, indicate a dramatic change in seasonality, i.e. increased winter precipitation and decreased summer precipitation. Subsequent erosion, followed by accumulation of fluvial and fluvio–aeolian sands, points to much drier conditions during the Mid-Holocene. Since ~2.9 cal ka BP soil formation indicates a return to geomorphic stability and wetter conditions (characteristic of the present day climate) interrupted by short arid intervals.

Keywords: Quaternary; Paleohydrology; Paleosol–sediment-sequences; Climate change; Piedmont; Chaco; Bolivia

1. Introduction

Over the last few decades tropical paleoclimatology has become more and more important for the understanding of the global climate system and its variability in the past. One research focus in tropical South America has traditionally been the Andean Altiplano and the Eastern Cordillera (Servant et al., 1981a; Seltzer, 1992; Clapperton, 1993; Argollo and Mourguiart, 2000; Mourguiart and Ledru, 2003; Servant and Servant-Vildary, 2003). However, significant contributions to the reconstruction of Late Quaternary landscape evolution also come from geomorphological research in the Amazonian lowlands (Räsänen et al., 1990; Latrubesse and Rancy, 1998; Latrubesse and Franzinelli, 2002; Latrubesse and Kalicki, 2002) and the aeolian and fluvial plains of northern Argentina and southern Brazil (Iriondo and Garcia, 1993; Iriondo, 1999; Stevaux,

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2000). In addition, palynological studies help to improve our understanding of the paleoenvironmental history of the Amazon basin and the adjacent lowlands (van der Hammen and Absy, 1994; Ledru et al., 1996, 1998; Behling, 1998; Colinvaux and Oliveira, 2000; van der Hammen and Hooghiemstra, 2000; Behling, 2002). All these investigations have provided evidence for a complex late Quaternary landscape evolution in tropical South America characterized by major geomorphic, hydrological and ecological changes.

The Eastern Bolivian lowlands lie at the transition between the tropical wet climate regime of the Amazon basin and the subtropical semi-arid climate regime of the Chaco. Paleoclimatic and especially hydrological changes should therefore be sensitively recorded in suitable archives and the landscape in general. Nevertheless, up to now only few studies have focused on the geomorphic and paleoenvironmental evolution of the Eastern Bolivian lowlands. The large-scale geomorphology of the Bolivian Chaco has, for example, been discussed in Werding (1977), Iriondo (1993) and May (2006). First chronological results from Late Pleistocene and Holocene sediments and groundwater were reported from the Paraguayan Chaco by Geyh et al. (1996), Kruck (1996) and Pasig (2005), whereas Servant et al. (1981b) investigated the Andean piedmont in Eastern Bolivia using paleosol–sediment-sequences. Mostly, these studies lack the chronological control that is necessary for more detailed paleoclimatic interpretation and regional comparison, but show evidence for important paleoenvironmental changes in the Bolivian Chaco.

Here we present results from stratigraphical, grain size and geochemical analyses of paleosol–sediment-sequences that are exposed along the Andean piedmont. It has previously been emphasized that fluvial systems in tropical South America have a large potential for paleoclimate research (Baker, 2000; Latrubesse, 2003). Accordingly, our results are discussed in the context of the general landscape evolution of the Bolivian Chaco and the Eastern Bolivian lowlands. Thus, this study can contribute to the overall paleoclimate reconstruction of tropical and subtropical South America.

2. Regional setting

The investigated paleosol–sediment-sequences are situated along the proximal part of the piedmont

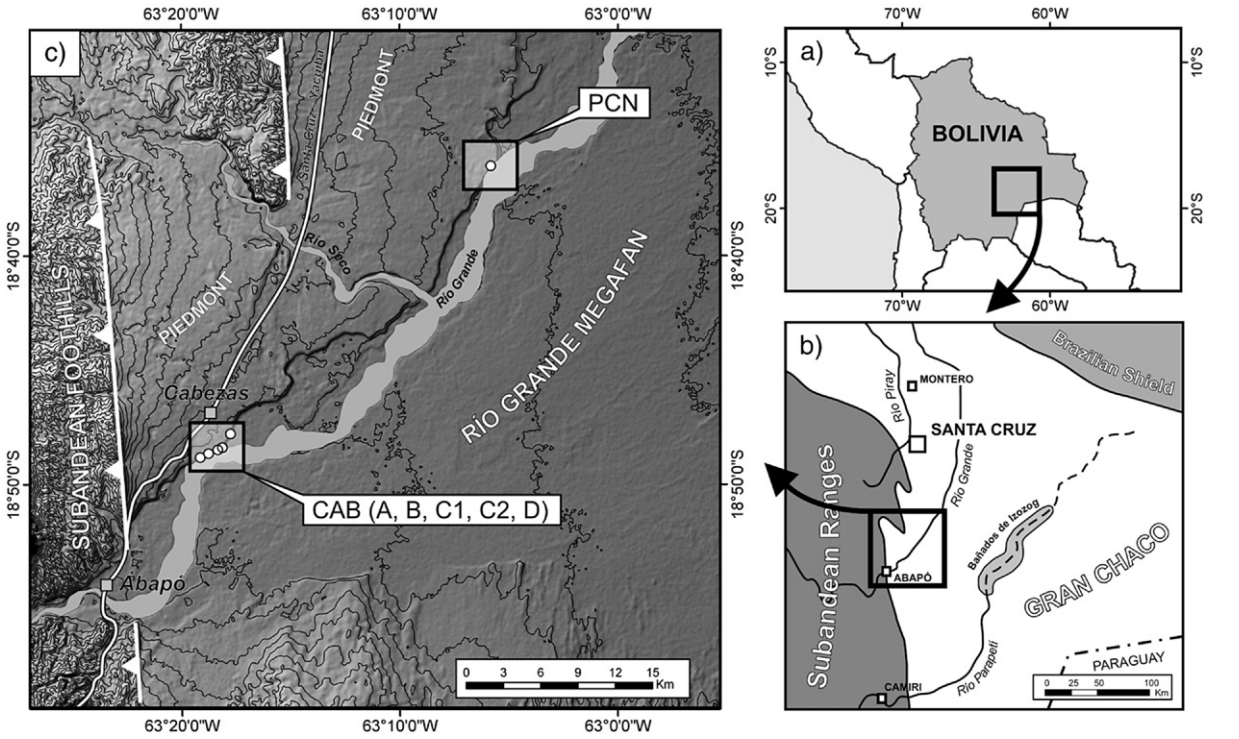

Fig. 1. Location and regional setting of the study area. a) Political boundaries of Bolivia, b) Eastern Bolivian lowlands and the Subandean Ranges, c) Location of the investigated paleosol–sediment-sequences along the piedmont terraces at the banks of the Río Grande (CAB = Cabezas, PCN = Pelícano).