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A contribution to the understanding of late Pleistocene dune sand-paleosol-sequences in Fuerteventura (Canary Islands)

Dominik Faust [a,*], Yurena Yanes [b], Tobias Willkommen [a], Christopher Roettig [a], Daniel Richter [d,e], David Richter [a], Hans v. Suchodoletz [c], Ludwig Zöller [d]

[a] Lehrstuhl Physische Geographie, TU Dresden, Germany
[b] Department of Geology, University of Cincinnati, Cincinnati, OH 45221, USA
[c] Professur für Physische Geographie, Universität Leipzig, Germany
[d] LehrstuhlGeomorphologie, Universität Bayreuth, Germany
[e] Max-Planck Institute for Evolutionary Anthropology, Leipzig, Germany

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ABSTRACT

This paper describes dune sand-paleosol-sequences of four pits in Northern Fuerteventura (Canary Islands). The elaborated stratigraphy is reinforced with luminescence dating to provide a first chronological estimation. Apart from a Holocene colluvial layer, the sequence spans the period from ca. 50 ka to ca. 280 ka. Paleosols were formed during glacial times and point to a standstill in sand supply. The isotopic composition of terrestrial gastropod shells retrieved from soil horizons reflects fluctuations in humidity conditions during different edaphic phases. Because eolian sands were deposited during glacial times as well, it is inferred that soil development was simply caused by a decrease in sand supply independent of climate change. Our geomorphic, geochronological and isotopic results are discussed considering different perspectives of dune sand-paleosol intercalation and more broadly, soil-forming conditions in general.

1. Introduction

Dune sand-paleosol-sequences in lower latitudes are considered to reflect changes in the environmental conditions (Petit-Maire et al., 1986; Tripaldi and Forman, 2007; Fitzsimmons et al., 2009; Roskin et al., 2011). Traditionally, the interpretation of such changes is understood through the concept of geomorphic activity linked to dune sand accumulation vs. geomorphic stability characterized by soil formation (Rohdenburg, 1970), which suggests climate driven changes in geodynamics. However, more recently has been suggested that the change from sand deposition to soil formation in some cases is first of all a question of sand availability (Roskin et al., 2013). Moreover, not all brownish or reddish layers intercalated between dune sands are soils that were formed in situ, instead they can be soil sediments (Roskin et al., 2013; Faust et al., 2014). Thus, the interpretation of sand-paleosol sequences in terms of paleoenvironmental changes appears to be more complicated than formerly assumed. On the Canary Islands, the occurrence of kaolinite and the increase of Al-content in dune sand, interbedded soils and soil sediments can be attributed to the input of Saharan dust (locally called *calima*; Suchodoletz et al., 2009; Criado et al., 2011).

Previous stratigraphic and geochronological studies from the eastern Canary Islands mostly encompassed the period from the late MIS 3 until the Holocene (e.g. Meco and Pomel, 1985; Petit-Maire et al., 1986; Rognon et al., 1989; Damnati et al., 1996; Meco et al., 1997; Coello et al., 1999; Ortiz et al., 2006). This is due to the fact that most of these studies used radiocarbon dating of terrestrial gastropod shells to establish the chronology, an analytical method that only dates material younger than ~50,000 years and that furthermore appears to produce biased results in arid and semi-arid environments (Singhvi and Krbetschek, 1996). Hence, the reliability of already published ages has been debated over the last 10 years (e.g. Bouab and Lamothe, 1997; Meco et al., 2002, 2008; Suchodoletz et al., 2012; Faust et al., 2014). Meco et al. (2008), Damnati et al. (1996), Bouab and Lamothe (1997) and Ortiz et al. (2006) worked in two of the sand pits also investigated in this study (Melían and Costilla; see their Fig. 2) in northern Fuerteventura but used different dating methods (amino acid racemization, ^{14}C, U–Th, OSL and IRSL), whereas Bouab (2001) and Meco et al. (2008) present OSL ages from the Costilla profile (see their Fig. 8) that are comparable with the data presented in this study. Other previous studies (Bouab and Lamothe, 1997; Ortiz et al., 2006) proposed age models that differ notably from our own age results. Furthermore,

* Corresponding author.
E-mail address: dominik.faust@tu-dresden.de (D. Faust).

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Fig. 1. Location of the studied sand pits.

recent chronological data by Gutiérrez-Elorza et al. (2013) from the same quarries show "OSL" ages that must be regarded as questionable due to the lack of any methodic or stratigraphic documentation (see also comments by Faust et al., 2014).

Suchodoletz et al. (2008, 2012, 2013) presented OSL, IRSL and ESR ages of hillwash sediments (locally called Vega sediments) that were dammed up by volcanoes, and of dune sediments from the Mala Dune complex (Suchodoletz et al., 2013) that are all located on Lanzarote Island. These studies stressed the difficulties in establishing a robust chronology of Quaternary eolian deposits and paleosols from the eastern Canary Islands due to the rarity of suitable material for luminescence dating.

In this study we present new comprehensive geomorphological, stratigraphic and paleoenvironmental data reinforced with new IRSL dates covering the last ca. 250 ka from four large sand pits in northern Fuerteventura (Fig. 1), two of which have never been studied by previously published work. Based on new multi-proxy data this investigation aims to build up a composite stratigraphy and should help to clarify the chronological frame of four important Quaternary eolian deposits from Fuerteventura. A robust and improved

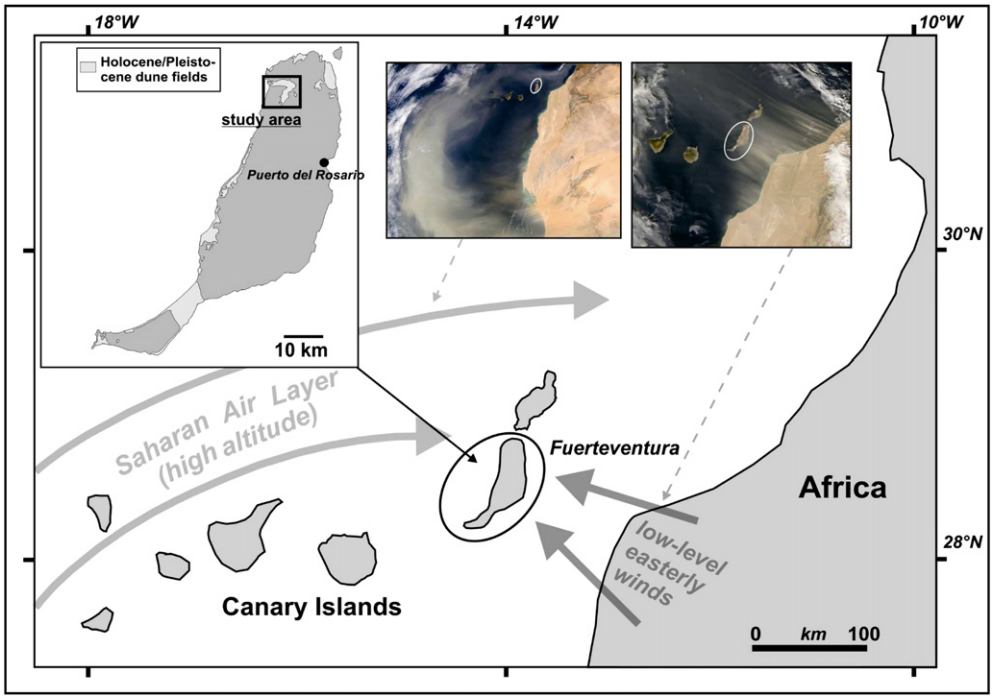

Fig. 2. Location of Fuerteventura off the coast of NW-Africa with indication of dune fields (adapted after Rothe, 1996). Main dust-bringing winds (Saharan Air Layer and low-level dust loaded eastern winds) are shown with arrows, and further illustrated by appropriate satellite-images where Fuerteventura is indicated with white ellipses (source: NASA, 1997).