

# Depositional environment and OSL chronology of the Homeb silt deposits, Kuiseb River, Namibia

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## Abstract

Previous studies suggest that the Homeb silts of the Kuiseb valley, Namibia (i) accumulated in a dune-dammed lake, (ii) are end-point deposits, (iii) represent an aggrading river bed, and (iv) are slackwater deposits. Thus, they have been used alternatively as evidence of past drier conditions or past wetter conditions. Lithostratigraphic analysis of two sediment sequences at Homeb indicates sedimentation by aggradation of the Kuiseb River triggered by a transition from an arid to humid climate. OSL ages for the sequences were obtained by the SAR protocol on aliquots of 9.6-mm and 4.0-mm diameter and on single grains. Four-millimeter aliquot minimum ages closely approximate the single-grain minimum ages and are younger than 9.6-mm aliquot minimum and central ages. Based on these results, the small-aliquot (4-mm) approach appears to provide ages comparable to those obtained by the more laborious and time-consuming single-grain method. Minimum ages indicate rapid deposition of the Homeb Silts in at least two episodes centered at ~15 ka and ~6 ka during climate transitions from arid to humid. Flash floods eroded the valley fills during slightly more arid conditions.

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## Introduction

The Homeb Silt Formation occurs in the canyon and valley sections of the Kuiseb River of Namibia, which forms, and to some extent determines, the northern boundary of the Namib Sand Sea (Ward, 1987). It is a regionally significant late Quaternary sedimentary unit of controversial origin and therefore of controversial paleoclimatic and paleohydrologic significance. It has been extensively studied for more than three decades by both Namibian and international scientists because the type locality at Homeb is easily accessible from the Gobabeb Research Station, now administered by the Desert Research Foundation of Namibia. Research on the Homeb silts has also influenced interpretation of relict fluvial sediments in the valleys of many west-flowing rivers, such as the Khumib

and Hoarusib draining to the Skeleton Coast (e.g., Eitel and Zöller, 1996; Eitel et al., 2001; Srivastava et al., 2004, 2005). Because they are the most thoroughly researched of the relict fluvial sediments in Namibia, additional information on the conditions that led to the deposition of the Homeb silts, together with a reliable chronology, would greatly facilitate interpretation of other fluvial deposits in the region and help to establish a reliable chronology for wet and dry climates in southwest Africa during the Quaternary.

The Kuiseb is a westerly flowing ephemeral river in southern Namibia. It is 420 km long and has a catchment of 15,500 km<sup>2</sup> (Jacobson et al., 1995). The headwaters of the Kuiseb are in the central Namibian Khomas Highlands reaching 2280 masl. This area has a mean annual rainfall of ~335 mm but only 5% of the catchment receives more than 300 mm/yr and only 52% more than 100 mm/yr (Jacobson et al., 1995). In its lower reaches near the coast, the river crosses the central Namib Desert where annual rainfall is <20 mm. The Kuiseb drainage system can be divided into four sections on the basis of catchment

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characteristics and valley morphology. There is (i) a headwater section in the Khomas Highlands plateau where incision has been minimal; (ii) a canyon section between the Khomas Highlands and Gobabeb superimposed into the calcrete-veneered Namib unconformity surface; (iii) a valley section, between Gobabeb and a few kilometers downstream of Swartbank, where the river is confined by rocky banks within a clearly defined shallow (<10 m deep) valley; and (iv) a delta section where the river braids into numerous undefined channels that spread over the coastal plain (Fig. 1; Marker, 1977).

Cosmogenic isotope dating indicates an episode of accelerated denudation in the central Namib Desert, with incision of deep canyons beginning around 2.8 Ma as a result of increasingly wet conditions in the region in response to Plio–Pleistocene global cooling (Van der Wateren and Dunai, 2001). Exposure ages of river-cut surfaces in the Kuiseb canyon show that the phase of canyon cutting terminated or slowed down significantly between 1.3 and 0.4 Ma.

The type locality of the Homeb Silt Formation is at Homeb, and deposits in this general area have been studied intensively (e.g., Marker, 1977; Ollier, 1977; Marker and Müller, 1978; Rust and Wienke, 1980; Vogel, 1982; Ward, 1987; Smith et al.,

1993; Heine and Heine, 2002), particularly in regard to sediment characteristics, mode of deposition, and age. The silts have been interpreted as: (i) dune-dammed lake sediments indicating arid conditions (Goudie, 1972; Rust and Wienke, 1980); (ii) river end-point deposits indicating arid conditions (Marker and Müller, 1978); (iii) floodplain deposits of an aggrading river indicating semiarid conditions (Ward, 1987; Smith et al., 1993 and references therein); and (iv) river flood slackwater deposits indicating wetter conditions and intense precipitation events in the headwaters (Heine and Heine, 2002).

In the present study, the lithofacies of the Homeb silts were reexamined and the sedimentological processes that resulted in their deposition reassessed. Our analysis adds to reports by Ward (1987) and Smith et al. (1993). We also provide new chronologic data including a comparison of the precision of the single-aliquot and single-grain OSL methods for dating fluvial sediments.

### Study area and methodology

The Homeb Silt Formation is mostly preserved at the downstream end of the canyon section of the Kuiseb as isolated

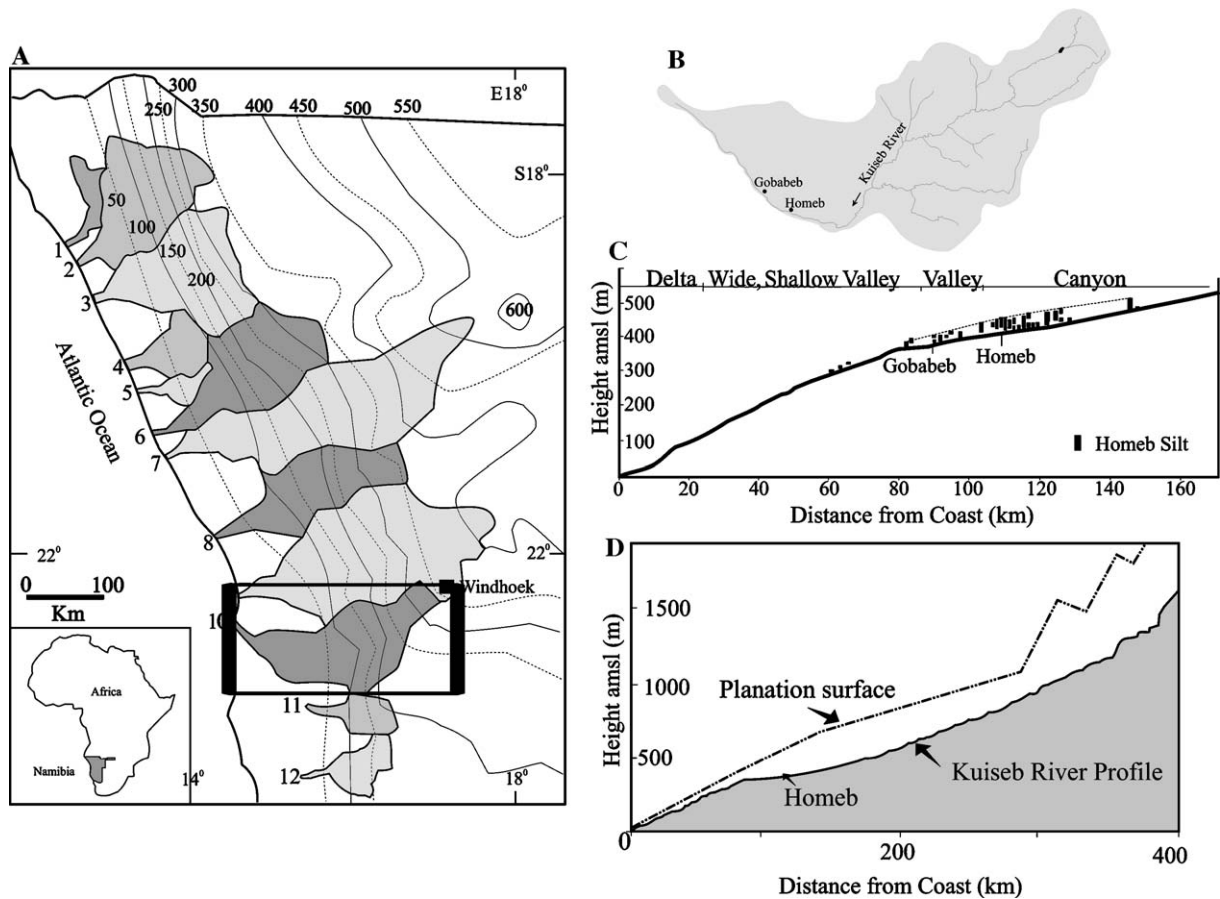


Figure 1. (A) Map showing the location of the Kuiseb catchment. Rainfall isohyets (mm) are shown in broken and continuous lines (after Jacobson et al., 1995). Drainage basins are: (1) Khumib, (2) Hoarusib, (3) Hoanib, (4) Uniab, (5) Koigab, (6) Huab, (7) Ugab, (8) Omaruru, (9) Swakop, (10) Kuiseb, (11) Tsondab, (12) Tsachab. (B) Map of the Kuiseb River basin showing the location of Homeb. (C) Profile along the thalweg of the Kuiseb River and the Namib unconformity surface from a DEM based on U.S. Geological Survey GTOPO30 and topographic map data. (D) Partial longitudinal profile of the Kuiseb River showing geomorphic divisions and the distribution of the Homeb silt deposits. The dotted line connecting the upper surfaces of the silt remnants indicates that after silt deposition, the river had a much steeper graded profile than today (A and B after Jacobson et al., 1995; C after Van der Wateren and Dunai, 2001; D after Ward, 1987).

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