The Tswaing Impact Crater, South Africa: derivation of a long terrestrial rainfall record for the southern mid-latitudes

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Extended Abstract

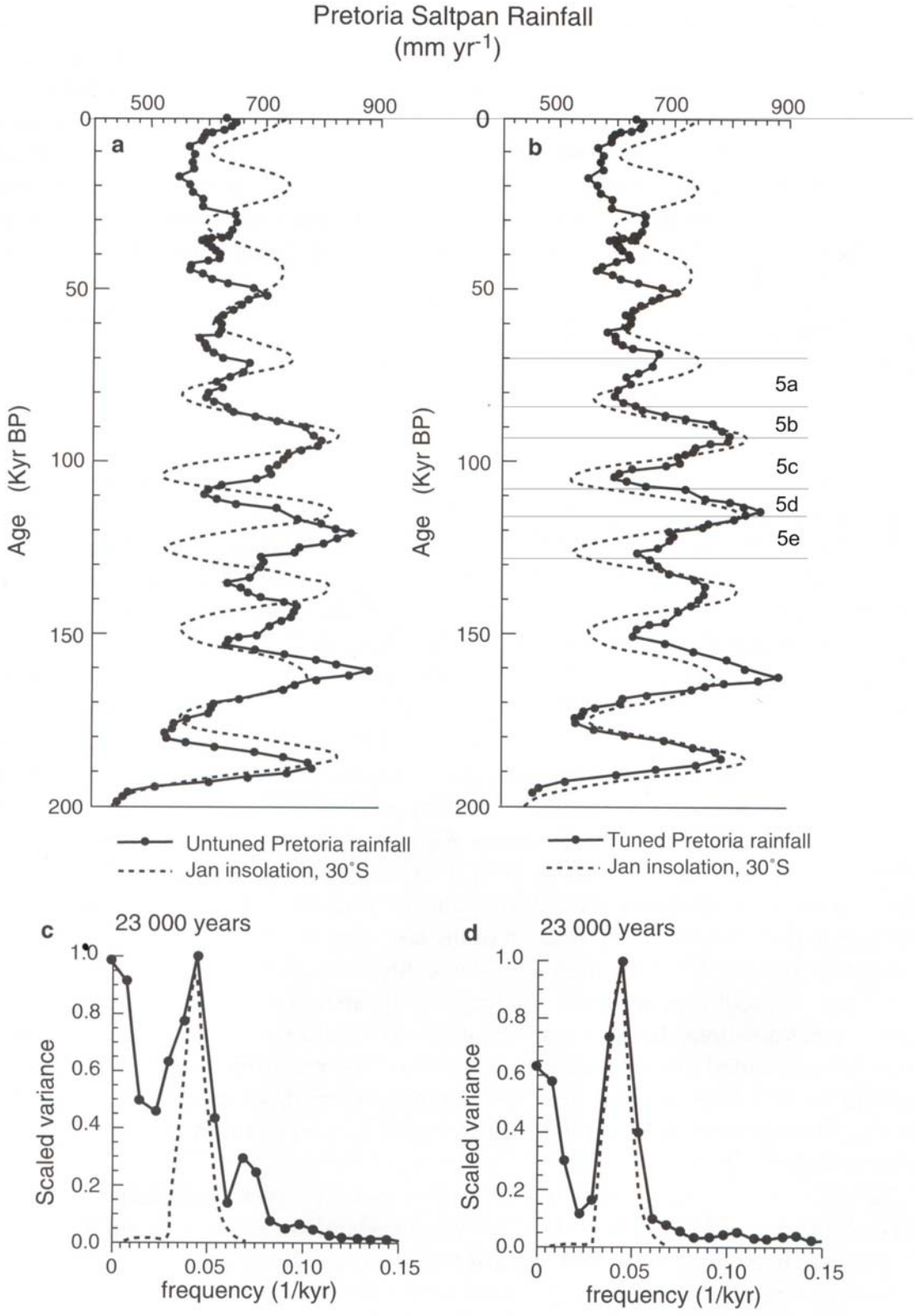
In the mid latitudes of southern Africa there is only one known terrestrial sequence that is characterized by continuous deposition over the last two glacial/interglacial cycles (i.e., extending back to MIS7).. This is the lacustrine infilling of the Tswaing impact crater (known previously as the Pretoria Saltpan) on the interior plateau of South Africa at 25°34'30"S, 28°04'59"E. It lies within the summer rainfall region of the subcontinent (mean annual precipitation 630 mm) at 1055 m elevation. The 90 m sedimentary infilling began to accumulate at around 200 kyr on the evidence of a basal fission track date on impact glass. Other age control is provided by calibrated radiocarbon dates spanning the last 43 kyr of the record. Large sections of the core are annually laminated, providing floating chronologies over some intervals, including the Middle/Upper Pleistocene transition.

The core includes a relatively complete diatom record, which is more strongly indicative of changes in water chemistry controlled by decreasing basin depth than of climate. Despite the measurable organic content of the sediments, the pollen record is disappointingly discontinuous. The clastic component of the sediments is derived from weathering and soil formation on the granitic walls of the crater. Since a close relationship was found to exist between mean annual precipitation (MAP) and the fine particle fraction (-20 μm) of pristine granitic soils across a southern African transect spanning MAP values of 440 – 1500 mm , a transfer function could be developed linking variations in the equivalent clastic fraction of the lake core to past rainfall. This proxy showed regular, well defined rainfall variations with a periodicity of about 23 kyr (Fig. A). Power spectral analysis confirmed this precessional signal. Fine tuning to the summer insolation curve permitted interpolation between the dated upper and lower parts of the sequence. In the process, ages based on mean sedimentation rates were adjusted by an average value of 3.3 kyr, with a maximum single adjustment of 8.8 kyr.

From Fig. A it is apparent that changes in inferred precipitation track precessional insolation changes almost perfectly between ~200 kyr and 60 kyr. After 60 kyr other forcings (probably thermohaline effects in the western Indian Ocean) appear to become dominant. The very close relationship between insolation and precipitation peaks evident in the earlier part of the Tswaing record permits the various substages within MIS 5 to be categorized clearly in terms of African rainfall in the subtropics of South Africa: 5a, c and e were predominantly dry hemi-cycles, while 5b and 5d were

predominantly wet. Maximum dryness tended to increase with the passage of MIS 5, from a value a little above present MAP in 5e to well below it in 5a. Interestingly, this trend coincided with a permanent change in the Tswaing lake: from a predominantly fresh water system it became irreversibly saline soon after 94 kyr. By contrast, during MIS 6 the lake was relatively deep and fresh, although the diatoms indicate some concentration between 140 kyr and the Eemian.

This record holds the potential for facilitating the interpretation of other, les continuous, proxy palaeoenvironmental data sets from the early hominid sites of South Africa.


Pretoria Saltpan Rainfall
(mm yr-1)
500
700
900
0
50
100
150
200
Age (Kyr BP)
a
b
5a
5b
5c
5d
5e
Untuned Pretoria rainfall
Jan insolation, 30°S
Tuned Pretoria rainfall
Jan insolation, 30°S
c
d
23 000 years
Scaled variance
frequency (1/kyr)
0.0
0.2
0.4
0.6
0.8
1.0
0.05
0.10
0.15