

## Further Evidence of Vegetational Change on Easter Island

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### Abstract

The palynology and radiocarbon dating of a further core from Easter Island (S. Pacific) is described. The date obtained confirm that the island was formerly covered in a forest of palms. Beginning at  $1630 \pm 130$  B.P., there was a decline of forest, accompanied by burning. By 400 B.P. the forest was totally destroyed. These dates are in accordance with archaeological evidence for the existence of a megalithic civilization on the island.

Key words: Easter Island, palynology, radiocarbon dating, archaeology, palm, charcoal.

### Introduction

Previous palynological work on Easter Island (FLENLEY and KING, 1984; KING and FLENLEY, 1989; FLENLEY *et al.*, 1991) has established that the present unforested state of the island is relatively recent, and that forest covered the island for most of the last 35,000 years. Deforestation occurred mostly between 1200 and 800 B.P., which is within the time of human occupation. Loss of forest was accompanied by charcoal deposition, so it was hypothesized that people had burnt off the forest to make way for agriculture.

Although there was evidence for this deforestation at all three of the crater swamps on the island, there remained some doubts as to the exact timing of the event, and about the nature of the forest before the onset of disturbance. These doubts related particularly to the large caldera of Rano Kau, the largest volcanic crater on the island. The inner slopes of this crater have the most favourable microclimate on the island, and might therefore have carried an unusual forest type. They might also have been cleared early in the colonization of the island. Previous analysis of core KAO 1, collected close to the foot of the inner slope, suggested a predominance of *Triumfetta semitriloba* immediately before clearance began at about 1200 B.P. (FLENLEY *et al.*, 1991). In order to find out whether this was typical, it was desirable to analyse a core collected well out into the middle of the swamp, away from the local influence of the

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inner crater slopes. Fortunately, such a core, KAO 2, had been collected in 1983 by the author, accompanied by Dr J.T. Teller and assisted by an Earthwatch team consisting of Ernest Igou, Sally Goodhue, Kathy Marine and Mike Symond.

### The Coring Site and the Core

Rano Kau (Fig.1) is a collapsed crater (caldera) at the south-western corner of Easter Island. It is about 2 km across and almost circular. The inner walls slope down at an angle of over  $30^\circ$  to a circular floating swamp, about 1 km in diameter, at an altitude of c.100 m. The swamp is a dangerous place, and one geologist has already lost his life in it. The floating vegetation mat is interrupted by numerous open water pools, and the mat itself is variable in thickness and strength, so that it will not everywhere permit walking. Nevertheless, with some difficulty we were able to reach a point, about 300 m from the eastern edge, where the mat was sufficiently strong to act as a raft for coring. Coring was carried out entirely with a D-section corer (JOWSEY, 1966), attached to extension rods of a lightweight type (LICHTWARDT, 1952). The resulting core was placed in 1 m plastic drainpipe sections, sliced longitudinally. These were wrapped in plastic sheet for transport to the laboratory.

The core obtained was in two parts. The upper 3.5 m was the floating mat. Below this there was a water gap down to 10.5 m where further core recovery began. This continued to 20.85 m depth, which was not the bottom of the deposit but simply the point at which the extension rods were all used up. The entire core consisted of very soft coarse

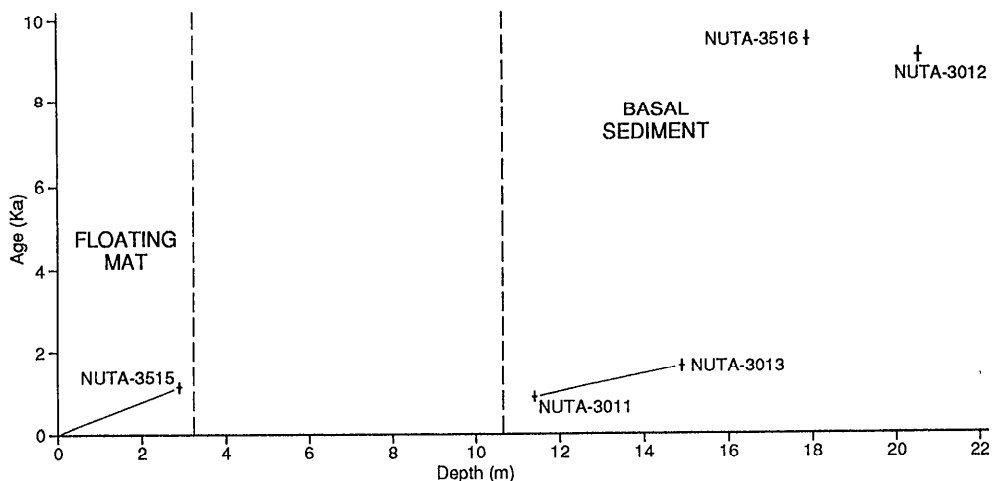


Fig.1 Plot of age against depth for radiocarbon dates from core KAO 2. Abscissa = length of core sample dated. Ordinate = age range (1 sigma).

organic detritus, most or all apparently derived from *Scirpus californicus*, with which the floating mat is almost exclusively vegetated today. Living rhizomes of this species were present in the uppermost metre.

Although it was not obvious in the field, inspection of the core in the laboratory in 1994 showed that the sediment below 20.70 m was darker and more consolidated than that above.

### Radiocarbon Dating

The core was radiocarbon dated in five places by the kind assistance of Prof. M. Umitsu of the Department of Geography, Nagoya University. The results are given in Table 1 and Fig.1. The results appear to show two inversions, and striking changes in sedimentation rate. The upper inversion, between the bottom of the floating mat and the upper part of the sediment below, was not unexpected. The drifting of younger material beneath floating mats is already well known (TAUBER, 1958). This is confirmed by the pollen stratigraphy described later.

The lower inversion is equally explicable. The lowest date of  $9130 \pm 170$  is not very surprising. It is just above the change from darker, more compacted sediment to lighter, less compacted sediment, which probably signals a change from slower accumulation in Late Pleistocene times to faster accumulation in the Holocene. The date above,  $9510 \pm 160$ , is therefore much too old. This is almost certainly due to contamination with older carbon and probably represents the inwash of old carbon from soils on the steep crater walls following initial disturbance by people. Contamination of dates from such a cause is well established (PENNINGTON *et al.*, 1976), and was found previously in the core from Rano Raraku (FLENLEY *et al.*, 1991). This date is therefore rejected.

For interpolation between dates, the accumulation rates indicated by solid lines on Fig.1 have been used. Dating outside this range is considered unreliable until further dates are obtained.

Table 1. Radiocarbon dates from core KAO 2

DEPTH	CODE NUMBER	DATE (ERROR 1 SIGMA)
2.85 – 2.95 m	NUTA – 3515	$1120 \pm 110$
11.35 – 11.45 m	NUTA – 3011	$890 \pm 110$
14.85 – 14.95 m	NUTA – 3013	$1630 \pm 130$
17.85 – 17.95 m	NUTA – 3516	$9510 \pm 160$
20.50 – 20.63 m	NUTA – 3012	$9130 \pm 170$

## Palynology

Palynological preparations were carried out every 0.5 m, or closer where necessary. Preparation used standard techniques (FAEGRI *et al.*, 1989), and samples were mounted in silicone oil (ANDERSON, 1960). Counting of pollen grains, spores and charcoal particles was done using an Olympus photomicroscope. Pollen and spores were counted until 200 individuals had been counted. Charcoal particles larger than 10  $\mu\text{m}$  were counted on two traverses of the pollen preparation. The results are shown in Fig.2. Because of large variations in numbers of fern spores, the pollen sum used was total dry land pollen.

The pollen diagram (Fig.2) may be considered in three zones. In zone 3, the dominant pollen is that of trees and shrubs, especially *Palmae*. A few other trees and shrubs are present, but herbs are virtually absent. Ferns are variable in abundance, with a large peak at c.19.25 m. The aquatic taxa *Cyperaceae* – *Scirpus* comp and *Polygonum* id *acuminatum* comp are present, but the latter appears only at 16.75 m and above.

In zone 2, the trees and shrubs undergo a sharp decline, although with a temporary recovery in the middle of the zone. Grasses rise to prominence in their place, and charcoal appears in significant quantities. Ferns are abundant throughout. The shrub *Sophora* is commoner than in zone 3. This zone is partially duplicated in the floating mat.

In zone 1, represented by the top metre, there are no trees and shrubs, and the *Gramineae* and ferns dominate completely. Charcoal is exceptionally abundant.

## Discussion

It seems clear that throughout zone 3 the island—or at least the Rano Kao crater—was completely dominated by palm forest. The fossil fruits of this palm, which appears to be extinct, have been found previously (DRANSFIELD *et al.*, 1984) and it has been named *Paschalococcus disperta* (DRANSFIELD in ZIZKA, 1991). It seems to have been similar to the Chilean wine palm, *Jubaea chilensis*. The variation in fern spores may indicate a climatic fluctuation, possibly an Early Holocene peak of moisture causing a peak of fern abundance. However, the exact temporal coverage of this zone is unclear, and there could well have been a hiatus in deposition. The arrival of *Polygonum*, which is a medicinal plant (HEYERDAHL, 1989) could indicate the arrival of people, but if so they were not yet active in this part of the island, unless the contaminated date indicates some early activity.

Zone 2 begins at a date of 1630  $\pm$  130 B.P. and strongly suggests a progressive decline of forest, accompanied by burning. The forest appears to have been replaced by grasses. The date of 1630  $\pm$  130 B.P. may therefore indicate the arrival of people on the island. When calibrated it indicates a date of 147 A.D. to 676 A.D. (95% confi-

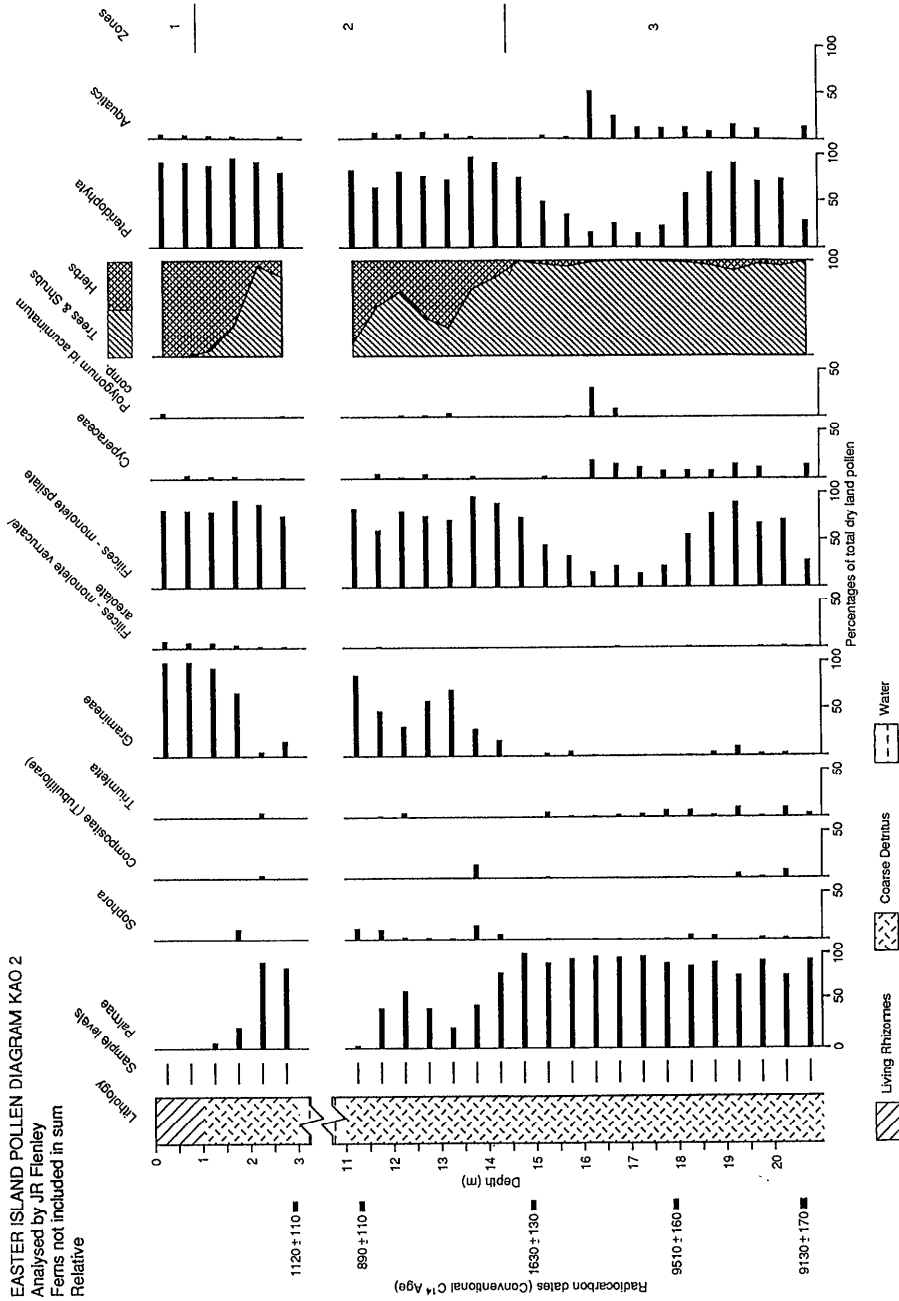


Fig.2 Pollen diagram from core KAO 2. Only selected pollen types are shown.

dence), which may be compared with the date of c.400 A.D. previously accepted for human arrival. A date of  $1630 \pm 130$  B.P. is considerably earlier than the date of c.1200 B.P. for the start of forest clearance obtained from core KAO 1 (FLENLEY *et al.*, 1991). This is precisely what would be expected. KAO 1 was close to the crater wall and showed what was happening nearby. KAO 2 is more central and gives an overall view, which is much more likely to pick up the earliest clearance.

Zone 1 represents the final treeless state of the island, and by interpolation between the date of  $1120 \pm 110$  and the present surface, this zone began about 400 B.P., i.e. about A.D. 1550. This may be compared with the already treeless state of the island when it was first visited by Europeans in 1722 A.D. (BAHN and FLENLEY, 1992). The date of becoming treeless indicated by KAO 1 was c.550 B.P. (A.D.1400) (FLENLEY *et al.*, 1991). Again, it appears that the central core (KAO 2) has picked up the more generalized record (i.e. disappearance of trees from the whole crater), while the local record picked up a more local event.

The new data add something to the debate as to whether the Easter Island civilization collapsed because of lack of forest resources (BAHN and FLENLEY, 1992). The start of forest decline is now associated more exactly with the start of the archaeological record. The date of final forest demise is now closer to the date of 1680 A.D. which is the supposed date for the final crash of the civilization. What seems likely is that the loss of resources provided the background conditions which meant that any other perturbation of the environment (such as the major drought hypothesized by MCCALL (1993)) could trigger off the major collapse which apparently occurred. The new data also suggest that the *Triumfetta* peak found in core KAO 1 represents a local abundance of this tree on the nearby crater wall, since the peak is almost absent in core KAO 2. In other words, the inner crater walls did indeed bear an unusual forest type, as hypothesized in the introduction.

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