

# Evidence of fire regimes in the Pleistocene of the California Islands

Andrew C. Scott<sup>1</sup>, Mark Hardiman<sup>2</sup>, Nicholas Pinter<sup>3</sup> and R. Scott Anderson<sup>4</sup>

1 Department of Earth Sciences, Royal Holloway University of London, Egham, Surrey, TW20 0EX, U.K.; a.scott@es.rhul.ac.uk

2 Department of Geography, Royal Holloway University of London, Egham, Surrey, TW20 0EX, U.K.; m.hardiman@rhul.ac.uk

3 Department of Geology, Southern Illinois University, Carbondale, Illinois 62901-4324, U.S.A.; npinter@geo.siu.edu

4 School of Earth Sciences and Environmental Sustainability, Northern Arizona University, Flagstaff, Arizona 86011, U.S.A.; Scott.Anderson@nau.edu

**Summary:** Charcoal has been recovered from a range of late Pleistocene sites both in Santa Cruz Island and Santa Rosa Island, belonging to the California Channel Islands. Sediments have been dated using radiocarbon measurements based on wood charcoal, fungal sclerotia, glassy carbon and fecal pellets and are given as calendar years BP. Charcoal assemblages from samples dating from 24,694 to 12,900 years are dominated by coniferous wood charcoal. Little angiosperm charcoal was recovered in any of the samples. Fungal sclerotia are frequent in a number of samples from a range of ages both on Santa Cruz and Santa Rosa. Fecal pellets are common in most samples and abundant in others. Some of the fecal pellets have hexagonal sides and are likely to represent termite frass. The sediments are fluvial in origin and the distribution of charcoal is irregular. The charcoal records a significant record of fire before the earliest documented human arrival on the islands and there is no evidence for a catastrophic fire triggered by a cometary impact at the onset of the younger Dryas, 12,900 cal years BP.

**Key words:** wildfire, charcoal, conifer, coprolites, human.

## INTRODUCTION

The California Channel Islands exposes Pleistocene sediments dating from around 24,000 years ago. These islands are significant as they record the first arrival of humans in to North America, around 15,000-13,000 cal BP (Pinter *et al.*, 2011). The sequence of sediments exposed in both Santa Cruz Island and Santa Rosa Island are fluvial in origin and the nature of the sedimentation changes through the sequence. In Santa Cruz Island some of the earliest Pleistocene sediments (16,000 cal BP) contain large coniferous trees and are associated with charcoal. In the Holocene sequence from Santa Rosa Island there is little charcoal reported and palynological data support a change in vegetation to one dominated by angiosperm dominated herbaceous vegetation (Anderson *et al.*, 2010). The climate dried and by 6900 cal BP grasslands are significant. In this paper we report on the charcoal assemblages recovered from the pre- Younger Dryas sequences on the islands.

## SEDIMENTOLOGY OF THE ARLINGTON CANYON SECTION, SANTA ROSA ISLAND

The sediments exposed on the Islands belonging to the late Pleistocene show significant variation. The sediments include fluvial channel sands and over-bank silts and muds. However, coarse fan sediments including extensive conglomerates occur sporadically through the sequence. Charcoal (Scott, 2010) occurs throughout the sequence both as scattered fragments, lenses and as thin discontinuous layers (Fig. 1). We have noted a change in sedimentation style as the climate dried and the vegetation switched from a forest-dominated system to one dominated by herbaceous plants and grasslands. In the lower part of

the sequences sediments are dominated by a range of muds, silts and sands that often contain charcoal.

However, plant compression fossils are generally absent and palynomorphs are often poorly preserved or absent. In the younger part of the sequences there are a number of prominent dark horizons. These do not contain any significant organic material, so their age is difficult to determine. They may represent paleosol horizons.

## CHARCOAL OCCURRENCE AND IDENTITY

Charcoal occurs abundantly in many parts of the sedimentary sequence. Most of the samples were dominated by wood charcoal and are of coniferous origin (Fig. 2b). While many samples predominantly contain only charred wood fragments some also include uncharred wood fragments (Fig. 2a). Reflectance microscopy on the charcoal fragments give low reading, usually less than 2% Ro. This implies temperatures of less than 500 °C and may indicate predominantly surface fires. Many of the samples also contain both fungal sclerotia (Scott *et al.*, 2010) and arthropod fecal pellets (Scott *et al.*, 2010) (Fig. 2c, d). Such pellets may be abundant and dominate assemblages. In some cases coprolite assemblages contain charred, partially charred and uncharred specimens (Fig. 2a).

## IMPLICATIONS FOR WILDFIRE INTERPRETATION

Dating of the oldest charcoal, associated with large coniferous trees suggests that wildfire was a natural part of the ecosystem before the arrival of humans on the islands. There is evidence of regular small surface

fires with a limited amount of post-fire erosion and deposition through the sequence. We do not find evidence of 'mass wasting' following intensive fires at the 12,900 horizon as claimed by other authors (e.g. Kennett *et al.*, 2008) as part of their Younger Dryas impact theory (Firestone *et al.*, 2007). Quantification of charcoal as claimed by other authors in these sediments is difficult as many of the sediments contain pebbles from fan deposits so successive samples are not comparable. This is also made difficult because of the intermittent occurrence of the charcoal. While it is possible to imagine that there is an increase in fire through the early part of the sequence it is not possible to determine if this is human or naturally caused.



FIGURE 1. Sediments exposed along Arlington Canyon, Santa Rosa Island. Charcoal occurs as discontinuous layers as well as on the cross-set of sandy units and scattered in the sediments

## CONCLUSIONS

Fire was an important element of the ecosystem on the islands from at least 24,000 cal BP. Fires were dominated by surface fires through coniferous woodland as evidenced by the common occurrence of conifer wood charcoal that has been exposed to low temperatures. There is also evidence that at least some litter was charred, transported and deposited into the river systems from the common occurrence of fungal sclerotia, but particularly from termite frass. Fire systems changed as the vegetation changed and little wood charcoal is found after 12,900 cal BP at the beginning of the Younger Dryas. We see no evidence for the occurrence of a cometary impact at 12,900 cal BP (see Pinter *et al.*, 2011 for a review of this issue).

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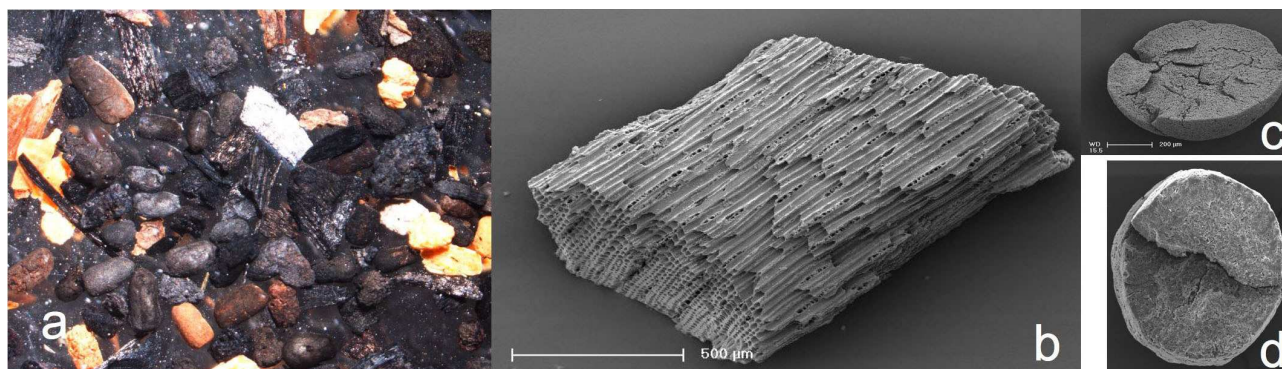


FIGURE 2. Examples of charcoal from the late Pleistocene of the California Channel Islands. a. Typical charcoal assemblage with charred and uncharred wood and fecal pellets, Arlington Canyon. b. SEM of charred conifer wood, Santa Cruz Island. c. SEM of Broken fungal sclerotium, Santa Cruz Island. d. SEM of section through charred termite pellet, Santa Rosa Island.