



## The timing and cause of megafauna mass deaths at Lancefield Swamp, south-eastern Australia



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### ABSTRACT

Lancefield Swamp, south-eastern Australia, was one of the earliest sites to provoke interest in Pleistocene faunal extinctions in Sahul (Pleistocene Australia–New Guinea). The systematic investigation of the deposit in the early 1970s identified megafaunal remains dominated by the 100–200 kg kangaroo *Macropus giganteus titan*. Associated radiocarbon ages indicated that the species was extant until c.30,000 BP, suggesting significant overlap with human settlement of Sahul. This evidence was inconsistent with contemporary models of rapid human-driven extinctions. Instead, researchers inferred ecological tethering of fauna at Lancefield Swamp due to intense drought precipitated localised mass deaths, consistent with Late Pleistocene climatic variability. Later investigations in another part of the swamp, the Mayne Site, remote to the initial investigations, concluded that mass flow disturbed this area, and Electron Spin Resonance (ESR) analyses on megafauna teeth returned wide-ranging ages. To clarify site formation processes and dating of Lancefield Swamp, we excavated new test-pits next to previous trenches in the Classic and Mayne Sites. We compared absolute chronologies for sediments and teeth, sedimentology, palaeo-topography, taphonomy, and macropod age at death across the swamp. Luminescence dating of sediments and ESR analysis of teeth returned ages between c.80,000 and 45,000 years ago. We found no archaeological remains in the bone beds, and evidence of carnivore activity and fluvial action, in the form of reactivated spring flow. The latter disturbed limited parts of the site and substantial areas of the bone beds remained intact. The faunal assemblage is dominated by megafaunal adult *Macropus*, consistent with mass die-offs due to severe drought. Such droughts appear to have recurred over millennia during the climatic variability of Marine Isotope Stages 4 and 3. These events began tens of millennia before the first appearance of Aboriginal people in Sahul and only the very youngest fossil deposits could be coeval with the earliest human arrivals. Therefore, anthropogenic causes cannot be implicated in most if not all of mass deaths at the site. Climatic and environmental changes were the main factors in site formation and megafauna deaths at Lancefield Swamp.

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1. Introduction

In the contentious debate over the causes of Late Pleistocene megafaunal extinctions, understanding the contexts of megafauna deaths is critical. One of the richest fossil megafauna sites in Sahul (Pleistocene Australia-New Guinea) is Lancefield Swamp in south-eastern Australia, which contains discrete accumulations of bones (referred to as bone beds) of several thousand giant kangaroos and other extinct taxa (Fig. 1) (Gillespie et al., 1978; Van Huet, 1999; Van Huet et al., 1998). In the 1970s, radiocarbon samples collected

beneath one bone bed returned ages of  $26,600 \pm 650$  BP and  $25,200 \pm 800$  (uncalibrated) BP (~31–30 ka BP). These age estimates post-dated the arrival of humans in Sahul, as it was then understood, by several millennia (Bowler and Thorne, 1976). Current evidence places the first humans in Sahul around 50–45 ka BP (Summerhayes et al., 2010; Allen and O’Connell, 2014). Taphonomic and palaeo-ecological studies revealed that the megafauna perished at Lancefield as a result of prolonged drought or environmental stress (Gillespie et al., 1978), perhaps associated with the lead-up to the Last Glacial Maximum (LGM), 30–19 ka BP (Lambeck

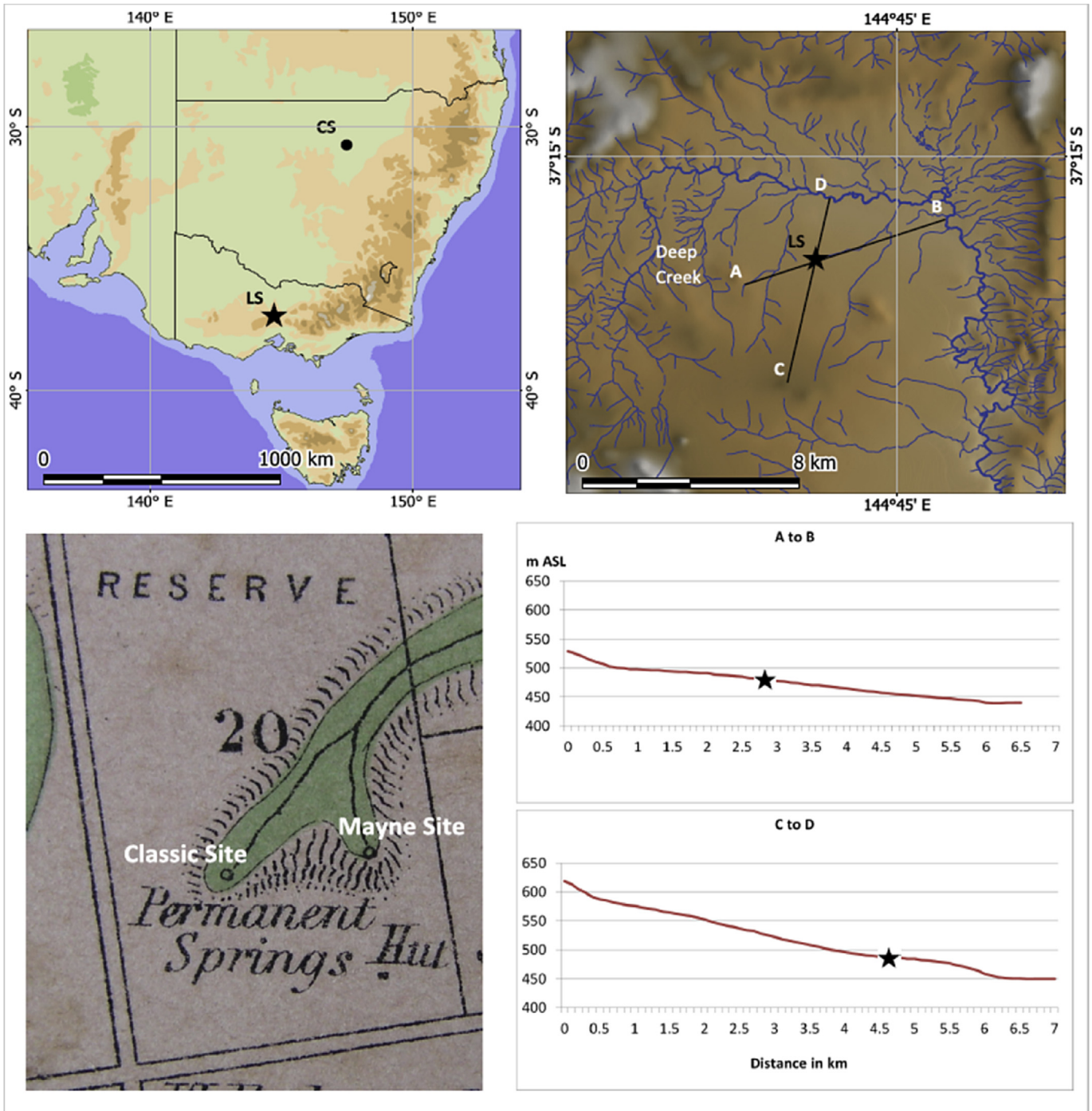


Fig. 1. Lancefield Swamp location. A: south-eastern Australia and places mentioned in the text (LS = Lancefield Swamp; CS = Cuddie Springs); B: local topography; C: excerpt from historic map (Geological Survey Office, Victoria c. 1861–7); D: profiles on transects shown in inset C, vertical scale exaggerated by x5.

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