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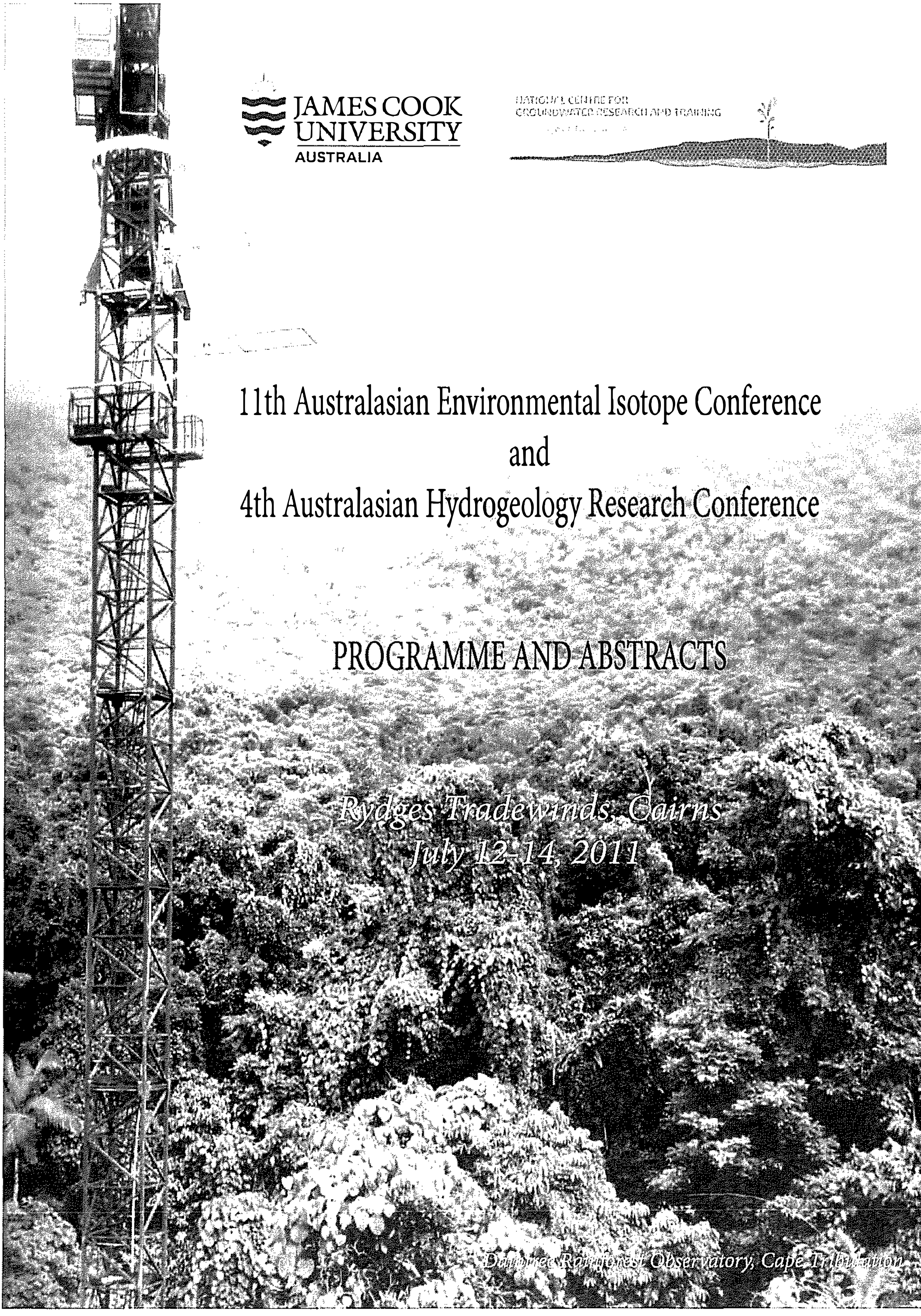
NATIONAL CENTRE FOR GROUNDWATER RESEARCH AND TRAINING



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PROGRAMME AND ABSTRACTS

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Explaining the imbalance in $\delta^{13}C$ between soil and biomass in fire-prone tropical savannas

Saiz, G [1], **Goodrick, I** [1], **Wurster, C** [1], **Nelson, P** [1], **Wynn, J** [2], **Bird, M** [1]

[1] James Cook University, Cairns, Australia

[2] University of South Florida, Tampa, Flroida, U.S.A.

Gustavo.saiz@jcu.edu.au

Currently, models of terrestrial ^{13}C discrimination indicate that about one quarter of the gross primary productivity (GPP - total carbon fixed as biomass by plants) by the terrestrial biosphere is attributable to tropical savanna/grassland plants that use the C_4 photosynthetic pathway. However, the fraction of C_4-derived biomass in soil organic carbon in savanna systems is much lower than these GPP estimates imply. Determining this imbalance has significant implications for correctly interpreting soil and palaeosol carbon isotope data, and for modelling studies that use variations in the atmospheric $\delta^{13}CO_2$ record to apportion sources and sinks of carbon. Here, we present preliminary results using hydrogen pyrolysis (HyPy) for quantifying the abundance and identifying the source of pyrogenic carbon (PC) in tropical savannas of North Queensland (Australia). We collected sediment from a series of micro-catchments covering the broadest possible range of C_3 and C_4 environments, and compared the abundances and stable isotope compositions of the total organic carbon (TOC) and pyrogenic carbon (PC) fractions.

Hydrogen pyrolysis (HyPy) can be used to quantify the production, fate and stable isotope composition of PC produced by vegetation burning. HyPy is pyrolysis (up to ~600°C) under high hydrogen pressures (>10 MPa) in the presence of a catalyst, and when applied to sediments, soils, or organic samples results in the reductive removal of labile organic matter. Therefore, this technique offers great potential to effectively isolate and quantify pyrogenic carbon in a rapid and cost effective manner. Moreover, comparison of the stable carbon isotope composition of PC with bulk carbon has the potential to discern if there is a dominant vegetation source contributing to burning.

The results indicate that the $\delta^{13}C$ value of PC in the sediments is up 6‰ higher than the $\delta^{13}C$ value of TOC. There is a larger difference when TOC abundances in the sediments are lowest. This suggests a significant component of C_4-derived PC is present in the sediments, even when the proportion of C_4 biomass in the catchment is relatively low. This in turn, provides evidence for the preferential combustion and transport of C_4-derived PC in tropical savannas. Savanna fires preferentially burn the grass understorey rather than large trees, leading to a bias toward the finer C_4–derived PC being exported from a fire and accumulated in the sedimentary record while large particles of C_3-derived PC are more likely to remain at the site of burning. Our preliminary data suggest that application of HyPy in environmental studies enables accurate quantification of an essential component of the terrestrial C cycle. Moreover, the use of HyPy also enables the reliable determination of the stable carbon isotope composition of PC, which will enable deeper understanding of the dynamic role of biomass burning in the global carbon cycle.