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C-isotope stratigraphy of plant-rich, non-marine sediments: towards an integrated record of mid-Cretaceous carbon cycling

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The Cretaceous is widely accepted as a 'Greenhouse world' - a climatic state that is primarily attributed to relatively high atmospheric pCO_2 levels. Carbon-isotope stratigraphy indicates that the carbon cycle was dynamic during the Cretaceous, suggesting that pCO_2 levels likely fluctuated significantly. Although there have been many proxy and model-based attempts to determine atmospheric pCO_2 concentrations during the Cretaceous, these have yielded varied results. Furthermore, very few studies have attempted to assess the response of pCO_2 to carbon-cycle perturbations, such as oceanic anoxic events. In order to do this, high-resolution proxy records of both pCO_2 and carbon-isotopes are required. We focus on Cretaceous-age sediments deposited in the Nuussuaq Basin of West Greenland that comprise organic-rich facies, including coals and leaf mats, siltstones and sandstones deposited in lacustrine and fluvial environments. Within these deposits an exceptionally preserved fossil flora provides an opportunity to constrain absolute pCO_2 values and trends during an interval of the mid-Cretaceous which witnessed significant carbon-isotopic excursions. This method uses leaf cuticle and the Stomatal Index technique, whereby the cellular preservation allows the ratio of epidermal cells to stomata to be ascertained and compared to a lab-grown, living equivalent calibration set. Additionally, a more comprehensive investigation of the West Greenland Cretaceous sedimentary and palaeobotanical record may provide new insights into the factors that influenced the radiation of flowering plants during the Albian–Cenomanian.

Here, we present the sedimentological and stratigraphic results from fieldwork in 2009 and new geochemical data (%TOC, $\%CaCO_3$, organic carbon isotopes) from bulk sediment samples and macrofossil wood pieces. The carbon-isotope data collected to date are consistent with organic matter predominantly sourced from non-marine C_3 vegetation and range from approximately -27 to -22‰: In the lower part of our composite section (Kome Formation) a positive carbon-isotope excursion of approximately 2.5‰ (wood) and 1‰ (bulk sediment) is present in both wood and bulk organic matter records. This isotopic excursion is consistent with an early Albian age based upon the limited existing micro and macrofloral evidence and through comparison to marine carbon isotope profiles. Identification of a carbon-cycle perturbation in the West Greenland record helps refine the stratigraphy of these sediments and provides us with a target stratigraphic interval on which to focus our ongoing efforts to generate stomatal index records.