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Changes in carbon dioxide concentrations across the Cretaceous-Paleogene boundary revealed by first Southern Hemisphere (New Zealand) stomatal proxy-based pCO_2 reconstruction

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Carbon is acquired for photosynthesis from atmospheric CO_2 through microscopic pores on plant leaf surfaces called stomata, while water vapour and oxygen is lost simultaneously by diffusion. To preserve water, most plant species regulate the density of stomata – initiating fewer stomata when carbon is readily available in times of high pCO_2 and vice versa [1], [2].

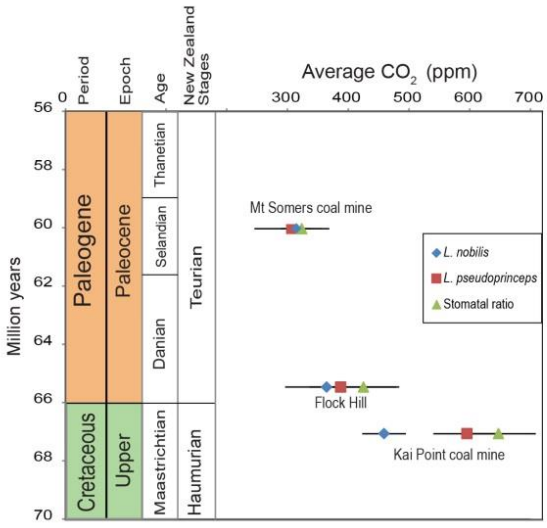

Fig. 1. Average stomatal proxy-based pCO_2 calibrated for each of the three stratigraphic levels across the New Zealand K–Pg boundary. Error bars show the standard deviation. Average pCO_2 decreases by ca. 45% from the end-Cretaceous to the mid-Paleocene.

The terrestrial stomatal proxy-based pCO_2 record presented here, using fossil Lauraceae leaves from South Island, New Zealand, is the first record spanning the latest Cretaceous to the mid- Paleocene (Maastrichtian–Selandian) from the Southern Hemisphere. 28 specimens of dispersed *Lauraceae* cuticles from the Taratu Formation were analyzed. These derive from three distinct stratigraphic intervals throughout the investigated succession; ten specimens from the Upper Cretaceous of Kaitangata coal field (Kai Point coal mine), ten from earliest Paleocene of Flock Hill and eight from mid-Paleocene of Mt Somers site.

We used the stomatal proxy method and two separate transfer functions, based principally on *Laurus nobilis* as the nearest living equivalent, to reconstruct three independent pCO_2 records. The records together indicate that pCO_2 decreased significantly (by ca. 45%) throughout this time interval, from ca. 570 ppm in the latest Cretaceous to ca. 310

ppm in the mid-Paleocene (Fig. 1). These results agree with the pCO_2 'background range' of previously published Late Cretaceous to Paleocene stomatal proxy records. The results presented here suggest that this transient spike was short-lived, requiring very high resolution to detect, but nonetheless that stomatal density worldwide was responding in a highly comparable manner to significant changes in pCO_2 during the Late Cretaceous and early Paleogene.

References:

[1] Steinthorsdottir M and Vajda V (2015) Gondwana Research 27: 932–939.

[2] Steinthorsdottir M et al. (2015) Climate of the Past 11: 4985–5019.