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The Hindon Maar Complex: a high-resolution archive of Mid-Miocene climate variability

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The Hindon Maar Complex (HMC) is a complex of four sediment-filled maar craters located in East Otago on the South Island of New Zealand. Volcanic rocks associated with the craters have been dated to 14.6±0.1 Ma, which coincides with the end of the Mid-Miocene Climatic Optimum (MMCO), a period of unusual global warmth. Two of the Hindon Maar craters (HM1 and HM3) are infilled with mass-flow sediments from the early stage of maar formation overlain by ∼10 m of finely laminated, organic-rich, diatomaceous sediment. These deposits thus preserve an unusually high-resolution archive of palaeoclimatic and palaeoenvironmental information about mid-latitude terrestrial Southern Hemisphere conditions during the end of the MMCO. Here we present a detailed sedimentological and micropalaeontological study of cores from these two craters.

The lake sediment deposits in both craters are underlain by a series of mass-flow deposits which represent the later period of maar crater stabilisation after initial crater formation. The facies identified in these mass-flow deposits are similar in both craters, indicating a uniformity of volcanic and volcaniclastic processes despite the clear spatial separation between these structures. These mass-flow deposits pass rapidly upwards into organic-rich, laminated lake sediments, indicating the formation of relatively deep lakes with persistent anoxia at depth. Sediment in both deposits consists of biogenic silica (BSi), organic matter, and a minor component of minerogenic sediment derived from the surrounding schist country rock. Laminae form couplets of organic-rich and BSi-rich layers, indicating that they are most probably biogenic varves. Lamina counting suggests that the preserved sediment deposits represent 10,400 years (HM1) and 7,600 years (HM3) of continuous deposition. Analysis of changes in sediment composition and diatom species assemblage in both deposits indicate that the Hindon site was characterised by millennia-long periods of stable conditions bounded by relatively rapid climatic shifts, most likely involving changes in wind speed and temperature. Given the palaeolatitude and palaeotopography of the site, the most probable cause of these climatic shifts is changes in the latitude and intensity of the westerly winds.