

Was the late Albian–Santonian too warm to support ephemeral polar ice sheets? ¹⁸O paleotemperature evidence from southern high latitudes

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Determining when and if polar ice sheets existed during the Cretaceous has many implications for models attempting to explain the record of sea level variations, patterns of atmospheric and oceanic circulation, and mechanisms of global heat transport. Direct evidence for glacial ice in Antarctica during the Cretaceous is non-existent, but reports of tillites and cobble to boulder-sized dropstones in South Australia suggest that glacial ice was present several times during the Valanginian through Aptian. Compilations of late Aptian–Maastrichtian foraminiferal $\delta^{18}\text{O}$ measurements are providing an increasingly complete history of mid–Late Cretaceous climates. The most dynamic and continuous archive of global paleotemperature shifts occurs in hemipelagic and pelagic chalk sequences deposited at southern high latitudes. A new compilation of $\delta^{18}\text{O}$ values from well preserved foraminifera from Falkland Plateau and Maud Rise (southern South Atlantic, 58–65°S paleolatitude) and Naturaliste Plateau (southern Indian Ocean, 60°S paleolatitude) is presented for the late Aptian–Maastrichtian using revised age–depth models for accurate correlation. The trend is similar to previous compilations showing decreasing $\delta^{18}\text{O}$ values for high latitude surface and intermediate water temperatures from the late Aptian–middle Cenomanian, minimum Turonian $\delta^{18}\text{O}$ values, and increasing Coniacian through Maastrichtian values. Paleotemperature calculations from the benthic and planktic $\delta^{18}\text{O}$ values (using standard assumptions for Cretaceous seawater) indicate that subpolar intermediate and surface waters averaged (1) 12° and 16°C, respectively during the middle Albian, (2) 19° and 28°C, respectively during the Turonian, (3) 12° and 14°C, respectively during the early Campanian, and (4) 6° and 8°C, respectively during the early Maastrichtian. Comparison with Paleogene foraminiferal $\delta^{18}\text{O}$ values from the same southern high latitude sites reveals that the late Albian and early Campanian were comparable to those recorded during the early–middle Eocene, and maximum temperatures during the Turonian thermal maximum were warmer by 10°C than the Paleocene–Eocene thermal maximum. Considering that the continental interior of Antarctica was probably bathed by a very warm ocean throughout the late Albian–early Campanian and the polar plateau was not likely to have been at an extraordinarily high elevation, we suggest that existence of even ephemeral continental ice sheets is highly unlikely from the late Albian through Santonian; before and after that interval, existence of Cretaceous ice sheets is unproven.