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The effect of encrustation on the trace element composition of Neogloboquadrinadutertrei, implications for reconstructing past sea water temperature

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Deep-dwelling planktonic foraminifera often develop a relatively thick calcite crust at the end of their lifecycle when reaching a certain temperature during descent in the water column. The composition of this layer considerably influences the whole test chemistry and therefore Mg/Ca-based reconstructions of past seawater temperature. Using laser ablation-ICP-MS we have determined intra- and intertest trace element variability in Neogloboquadrina dutertrei from sediment trap and core samples of modern and glacial age from the SW Indian Ocean. Trace element profiles confirm the presence of a low Mg/Ca, low Mn/Ca crust covering the chambers. The crust progressively thins towards the younger chambers while Mg content increases at the same time, indicating a tight biological control, independent of temperature, on crust formation. Both dissolution and conventional reductive cleaning methods cause selective preservation of the low-Mg crust, thereby biasing sedimentary temperature records towards lower and less realistic values. Data from core material indicate that the Holocene-Glacial change in whole-chamber Mg/Ca is solely due to changes in the composition of the crust. The primary calcite, which probably more truly reflects seawater conditions, shows no change in the median values. However, the primary calcite intertest variability in the Glacial is much higher. Mn/Ca and Sr/Ca in the primary crust show an increase in the glacial samples, likely reflecting the effects of enhanced wind-blown dust input and lower sea level, respectively. Importantly, such information can only be obtained when crustal and primary calcite can be separately analysed and the effects of compositional variability in the crust can be compensated. Similar mechanisms probably apply to other crust-forming foraminifera, thus highlighting the need to better understand crust formation and trace element incorporation for reliable reconstructions of past seawater conditions.