Abstract

This cumulative thesis reconstructs past changes in surface primary productivity and carbonate dissolution in the western South Atlantic Ocean, particularly the southernmost Brazilian continental margin, focusing on the Marine Isotope Stages 5 – 1. Comprising two published articles, one submitted manuscript, and this integrative text, this PhD thesis aims to contribute to our understanding of the mechanisms behind such variations and the dynamics of this area during the past interglacial-glacial cycle, as well as its potential role in carbon cycle processes.

The first article explores surface palaeoproductivity and benthic environmental conditions by analysing the sediment core SAT-048A, spanning 5 – 43 ka, from the continental slope of the southernmost Brazilian continental margin. Using micropalaeontological, geochemical, and sedimentological data, the study identifies a positive correlation between palaeoproductivity proxies and carbonate dissolution. It demonstrates that higher productivity and organic matter flux during glacial periods led to increased dissolution rates of planktonic foraminifera tests, driven primarily by productivity rather than by changes in the Atlantic Meridional Overturning Circulation.

The second manuscript examines the last interglacial-glacial cycle using core SIS-249, spanning 30 – 110 ka, also recovered from the continental slope of the southernmost Brazilian continental margin. It reconstructs past changes in sea surface productivity, stratification, and carbonate dissolution, suggesting a ~43 kyr cycle, likely related to the obliquity cycle. Enhanced productivity is attributed to glacial upwelling (due to a reduced stratification) of nutrient-rich waters and obliquity-paced continental fertilisation. The study highlights the role of organic matter bioavailability in driving calcium carbonate dissolution and suggests potential influences of corrosive Southern Component Water.

The submitted manuscript quantifies ecological and taphonomical signals in the test size variation of planktonic foraminifera from core SAT-048A. Notably, smaller sizes during periods of enhanced surface productivity, which is consequent with elevated carbonate dissolution. It provides a framework to understand the differential effect of dissolution on calcite tests which without proper identification can lead to underestimation of test sizes (by ~25±9%) and planktonic foraminifera fragmentation, potentially impacting foraminifera-based ecology and geochemical proxies.

The integrative text of this PhD thesis synthesises the abovementioned articles and manuscript, further discussing them in a global context, highlighting the strong connection between Antarctic system's dynamics and the southern hemisphere, as well as how they may respond to orbital cycles and regulate atmospheric CO_2 levels. Chapter 5 presents a detailed study on core SIS-203, discussing calcium carbonate dissolution over the 7 – 31 ka interval, which is planned to be submitted. This chapter investigates carbonate production, dilution, dissolution, and bottom current processes. Aided by new εNd analyses in foraminiferal coatings, it suggests a strong relationship between dissolution and changes in bottom water mass geometry at mid and deep waters. Altogether, this thesis suggests that past changes of carbonate dissolution in the study area are similar to modern patterns in the oceans, being related to metabolic CO_2 release in shallow waters and calcite solubility at greater depths.

This study highlighted some key gaps in our knowledge of the palaeoceanography of the western South Atlantic, and therefore future research should investigate more complete and longer temporal records in the southwestern Atlantic to fully understand the influence of orbital parameters and Antarctic's dynamics on biogeochemical processes (i.e., continental fertilisation due to enhanced southwesterly winds), exploring the role of the study area in global carbon cycling.