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Integrating Benthic Foraminiferal Data with geochemical records to trace shifts in Oxygenation and Methane Dynamics on the Chilean Margin

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The Chilean margin is a dynamic continental convergent boundary where possible presence of gas hydrates has been reported from ODP Site 1235, Leg 202, although their extent remains debatable. Earlier findings, based on changes in authigenic manganese ($_{xs}$Mn) and rhenium ($_{xs}$Re), show that stronger Antarctic Intermediate Water ventilation during the Last Glacial Maximum (LGM) greatly increased bottom-water oxygenation. Using this geochemical proxy data, we integrate our benthic foraminiferal assemblages and stable isotope values (δ^{13}C and δ^{18}O) to study possible methane emissions since the late Quaternary period. High oxygen levels during the LGM, indicated by high authigenic manganese ($_{xs}$Mn) and low rhenium ($_{xs}$Re) values, likely promoted methane oxidation and maintained hydrate stability. As the climate warmed, oxygen levels dropped - this change is recorded by decreasing $_{xs}$Mn and increasing $_{xs}$Re values, suggesting conditions that could trigger hydrate dissociation and methane release. Our foraminiferal dataset includes key species such as *Uvigerina peregrina*, *Nonionella auris*, *Globobulimina pacifica*, and *Fursenkoina bradyi*, along with variably abundant *Cassidulina carinata*, *Cassidulina teretis*, *Globocassidulina subglobosa*, and *Ehrenbergina pupa*. Shifts in these assemblages reflect changes in bottom-water redox conditions and environmental stress associated with methane emissions. Stable isotope analyses of benthic foraminiferal tests reveal lower δ^{13}C values in *Uvigerina peregrina*, which might indicate the intake of methane-derived carbon during possible seepage events, while heavier δ^{18}O values during warming phases support these episodes of methane release. Additionally, observed pyritization patterns in the tests offer further evidence of redox conditions linked to methane emissions. By combining existing geochemical records with new faunal and isotopic data, our integrated approach can provide a comprehensive view of how oxygenation shifts and methane dynamics might have interacted in the late Quaternary period.