Terrigenous Clay in Coastal Habitats:
Effects on Sediment Oxygenation

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Introduction

Climate change models predict an increase in the frequency of extreme rainfall events. This is of particular concern where vegetation removal and coastal urbanisation lead to large scale mobilisation of soil, and where steep topography supports rapid transport of suspended soil into coastal waters. The suspended soil will eventually settle, smothering the seafloor and its organisms. The effects of such a deposition on seafloor ecosystem functioning are not well understood.

We conducted a laboratory experiment to investigate how mm-thin deposits of terrigenous clay affect the distribution and consumption of oxygen in subtidal soft sediment. We considered two variables: the thickness of the clay deposit (quantity) and the number of resuspensions the clay had undergone before deposition (quality).

This image was provided by the GERS Lab from the University of Puerto Rico at Mayaguez

Figure 1. Satellite photograph of the Añasco River plume, Puerto Rico. Large quantities of suspended terrigenous clay are supplied to coastal waters.

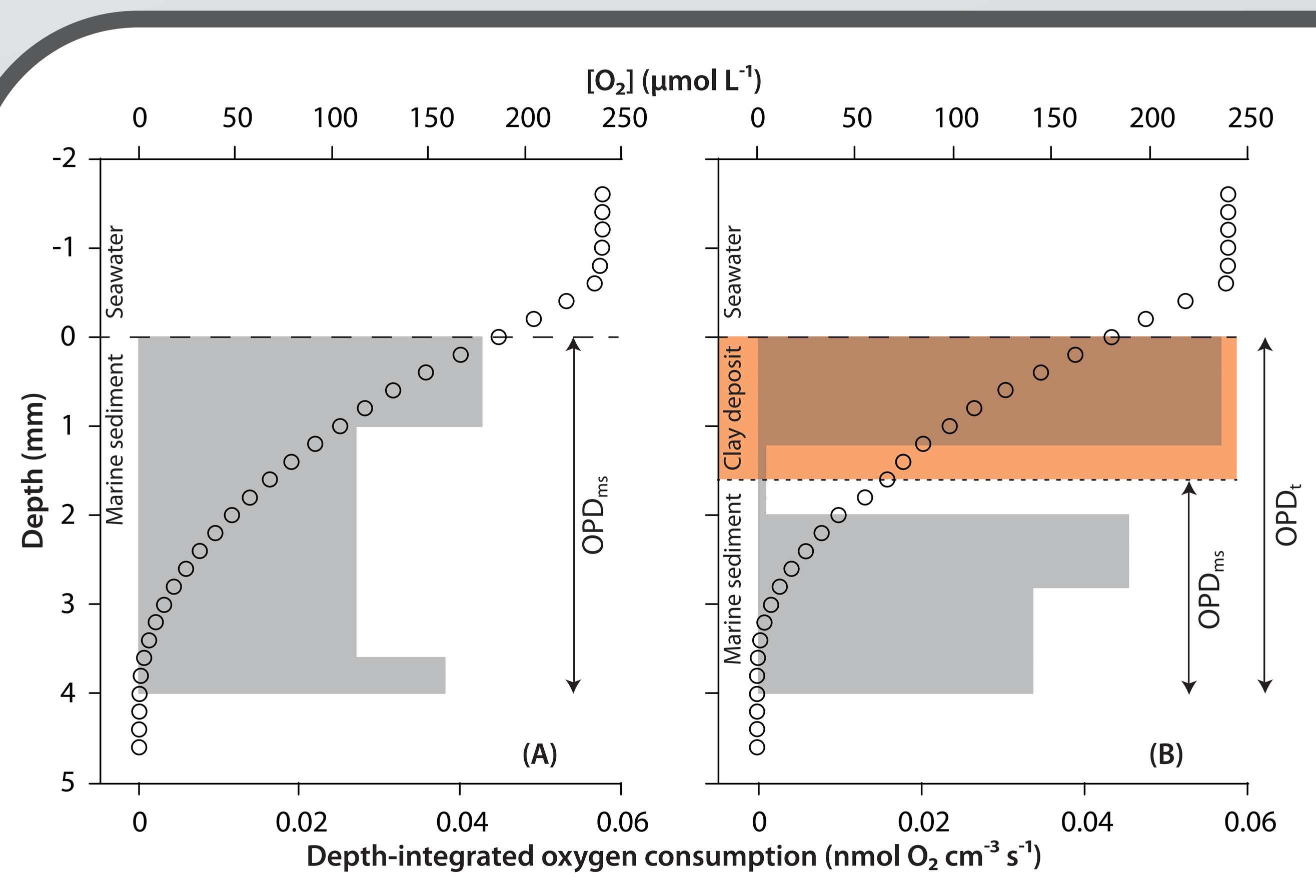

Figure 2. Two O_2 microprofiles measured in **(A)** a control core and **(B)** a core treated with clay. Grey bars indicate the depth profile of the sediment O_2 consumption.

Methods

- Sampling
  12 cores of subtidal mud collected with acrylic tubes at 15 m water depth off the coast of New Zealand.
- Two treatments
  Addition of terrigenous clay suspensions to 9 cores, 3 cores left untreated
  - Quality: 2, 3, and 6 suspension-deposition cycles prior to deposition of clay
  - Quantity: clay deposit thicknesses between 1 and 6 mm
- Three variables
  - Oxygen penetration depth including clay deposit (OPD_t)
  - Oxygen penetration depth excluding clay deposit (OPD_{ms})
  - Depth-integrated oxygen consumption (*R*)

Findings

Treatment of the clay with 3, 6, and 9 suspension–deposition cycles did not significantly change the effect of the deposit on OPD_t, OPD_{ms}, or *R*. This result is at variance with an earlier study by Cummings et al. 2009. This variance is likely due to our laboratory modified treatment as opposed to an in situ modification used by Cummings et al.

The **OPD_{ms}** decreased linearly with increasing thickness of the clay deposit (Fig. 3A). That is, the oxic–anoxic boundary at which reduced endproducts of the anaerobic microbial degradation of organic matter oxidise with O_2 shifted upwards. When the clay deposit reached a thickness >4.1 ± 0.8 mm, this oxidation occurred within the clay deposit.

OPD_t decreased up to a deposit thickness of ~3.5 mm (Fig. 3B) because the OPD_{ms} decreased faster than the clay layer thickness increased.

Thicker clay deposits (>3.5 mm) increased the OPD_t because they gradually increased the distance between O_2 sink (sediment) and source (seawater).

We are currently investigating how these clay-induced changes in the sediment O_2 distribution and consumption affect key seafloor functions: inorganic nutrient cycling, benthic primary production, and recruitment.

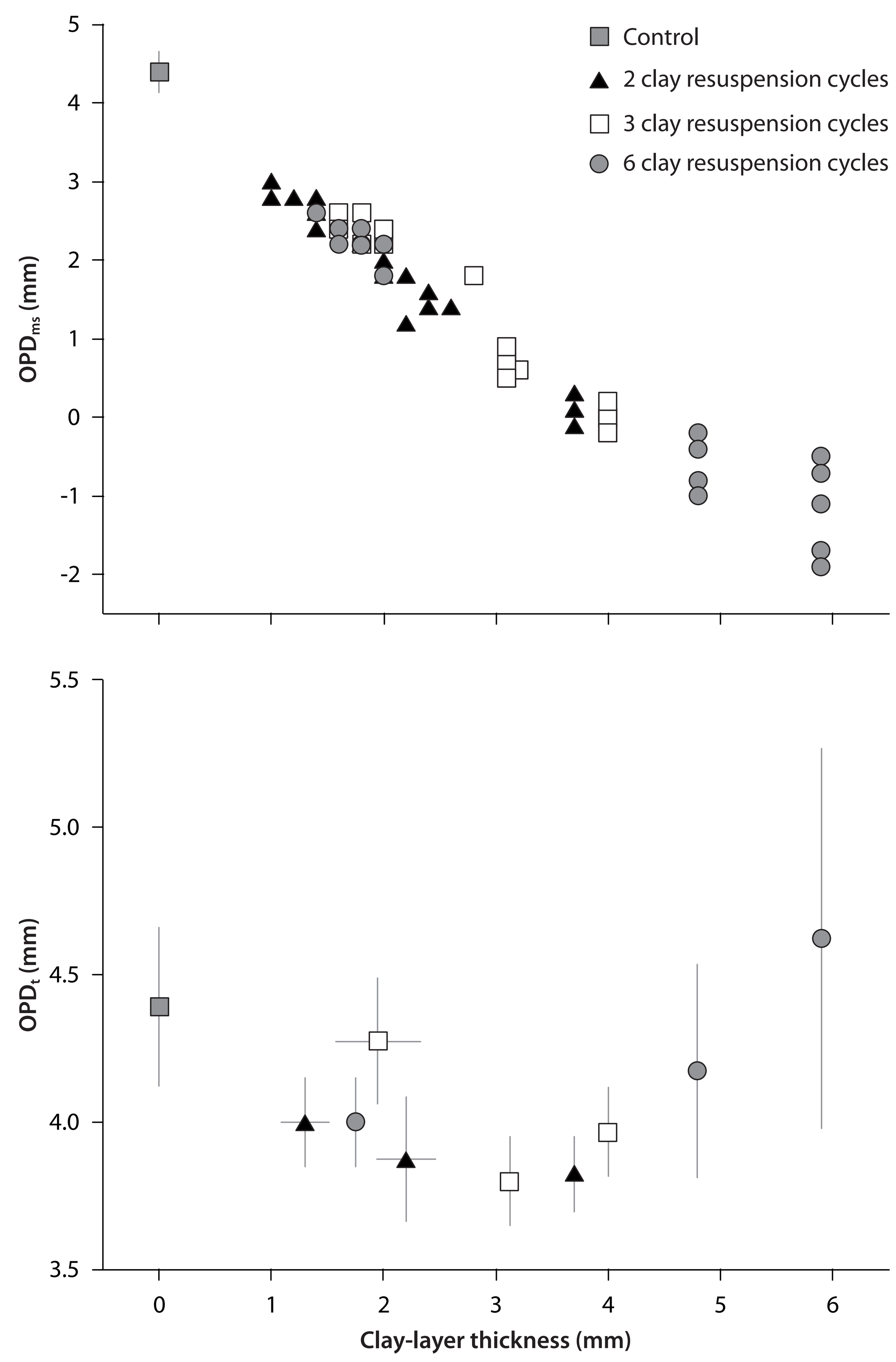

Figure 3. Scatter plots showing the effect of the thickness of the clay deposit on **(A)** the penetration of O_2 into the marine sediment (OPD_{ms}), and **(B)** the overall penetration of O_2 including the clay deposit (OPD_t). Negative values in **(A)** indicate that the oxic–anoxic boundary is located in the clay deposit.

Reference

Cummings V, Vopel K, Thrush S (2009) Terrigenous deposits in coastal marine habitats: influences on sediment geochemistry and behaviour of post-settlement bivalves. Marine Ecology Progress Series 383:173–185

Acknowledgements

The Faculty of Health and Environmental Science of Auckland University of Technology funded this research through a Research Summer Studentship. The Earth and Oceanic Sciences Research Institute, AUT, provided field support.