Significance of Sedimentological and Ichnological Relationships between Various Substrate Types in an Intertidal Marine Environment

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Summary

Studying trace genesis and resultant burrow architecture, density and depth in relation to various physico-chemical conditions that are present at the time of firmground colonization is important to aid in furthering our understanding of similar biogenically generated structures in the rock record (Gingras et al., 2001). Paleoecological information concerning *Glossifungites* Ichnofacies suites is just as important as the potential sequence stratigraphic value that they may hold (Gingras et al., 2001). This study aims to assess the sedimentological, ichnological and potential stratigraphic relationships between associated softground, stiffground, firmground and woodground substrate occurrences in a modern, wave-dominated, tidally-influenced, intertidal marine environment in relation to select analogous ancient outcrop examples.

The exhumed compact peaty-clay and silty-sand firmgrounds studied are thought to comprise two separate, but related, *Glossifungites* Ichnofacies assemblages. Localized *Teredolites* Ichnofacies assemblages are demarcated by sporadic woodground appearances within the peaty-clay firmground. The peaty-clay firmground is characterized by large diameter *Thalassinoides*-, *Psilonichnus*-, and *Gastrochaenolites*-like traces; and smaller diameter *Skolithos*-, *Arenicolites*-, *Diplocraterion*-, *Rhizocorallium*-, and *Polykladichnus*-like traces. *Gastrochaenolites*-like traces are only found within the peaty-clay firmground. Woodground associated with the peaty-clay firmground consists of multiple small traces including *Skolithos*-, *Arenicolites*-, *Caulostrepsis*-, *Meandropolydora*-, and *Trypanites*-like traces; with a few select larger traces such as *Teredolites*-, *Thalassinoides*- and *Psilonichnus*-like traces. *Teredolites*-, *Trypanites*-, and *Caulostrepsis*-like traces are exclusive to the woodground assemblage. The silty-sand firmground was observed to include large diameter *Thalassinoides*- and *Psilonichnus*-like traces; in addition to smaller diameter *Arenicolites*-, *Skolithos*-, and *Polykladichnus*-like traces. The peaty-clay firmground consists of a surface of compact peaty or organic rich clay gradationally transitioning into silty sand below. Firmness tests conducted on this surface yielded an average firmness of 1.65 x 10^6 Pa. The silty-sand firmground, in contrast, consists of dominantly fine grained sand with approximately 15% silt and clay. The average firmness of the silty-sand firmground was 2.08 x 10^6 Pa, higher than that of the peaty-clay firmground surface.

Traces within the modern silty sand to clay stiffgrounds consist of traces akin to *Thalassinoides*, *Skolithos*, *Arenicolites*, *Meandropolydora*, and *Rhizocorallium*, with *Thalassinoides*-like traces being the

only large trace type present. A variety of grain sizes were observed within the modern stiffgrounds and, depending on location, either fine sand, silty sand, silt or clay was dominant. Due to the large variability in sediment texture and consistency, the overall average firmness across the modern stiffgrounds fluctuated greatly, with an overall average firmness value calculated to be 4.53×10^5 Pa.

Sediment comprising the modern surficial softground veneer displayed an array of traces such as *Gordia*-like, *Diplichnites*-like, *Protichnites*-like and *Olivellites*-like surface traces; small, vertical traces akin to lined and unlined *Skolithos*, *Arenicolites*, and *Polykladichnus*; small, horizontal traces akin to *Rhizocorallium*, *Planolites*, *Gyrolithes*, and *Palaeophycus*; large, open *Thalassinoides*- and *Psilonichnus*-like traces; *Piscichnus*-like feeding traces; and finally, sediment disruption navichnia and potential cryptic bioturbation features. The mainly fine- to lower medium-grained sand of the softground veneer had the largest fluctuations in firmness measurements and the lowest firmness values overall, due to the sediment having, qualitatively, the highest water content and was the least compacted. The overall average firmness value calculated for this highly variable sediment was 1.73×10^5 Pa.

Variability between substrate trace assemblages appears, most likely, to be related to differences in sediment texture and absolute firmness of the substrates. The presence of a surficial softground veneer and slight differences in elevation with respect to tide level are also thought to lead to trace assemblage variability. The lateral extent of modern intertidal bay margin firmground and associated woodground deposits observed may have significant stratigraphic value, even if variability exists within the deposit. Assessment of exhumed firmground and associated woodground animal-sediment relationships within modern substrates, as well as ancient analogue counterparts, is vital in furthering our understanding of various paleoenvironmental systems in the rock record.

References

Gingras, M.K., Pemberton, S.G., Saunders, T., 2001. Bathymetry, sediment texture, and substrate cohesiveness; their impact on modern *Glossifungites* trace assemblages at Willapa Bay, Washington. Palaeogeography, Palaeoclimatology, Palaeoecology 169, 1-21.