Characterisation of Beach rocks in natural and *in vitro* biomineralization conditions

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Biogeochemical processes have long been found to play an important role in the formation of natural structures including microbialites, corals, and beach rocks. Microbial-mineral interactions along with abiogenic processes have been found to play a crucial role during the formation of these geological structures. In this study, we made an attempt to undertake a comprehensive approach to characterise mineralogical, morphological, microbial and nanomechanical properties of natural beach rocks and investigate similar properties for mineral cements formed under *in vitro* conditions via biogenic and abiogenic routes. Morphological, mineralogical and chemical characterisation of the natural samples revealed the presence of iron hydroxides and oxides in the form of magnetite, hematite, goethite and nontronite along with iron silicates which were clearly cementing the sand grains. Microbial imprints and associations were also noticed in a few sections. Under biogenically enriched laboratory conditions, significant precipitation of similar biominerals was recorded wherein bacterial cells serving as nucleation sites for ferruginous crystals was seen. Magnetite, hematite, hydromagnesite and aragonite were recorded to be the predominant minerals during *in vitro* studies. Tremendous variations in microbial community structure were recorded at Phylum, Class as well as species level compared to native beach rocks with dominance of Halophilic and Iron reducing microbes. In case of abiogenic sets, much lower mineral precipitation was recorded signifying the role of microbial associations in precipitation of natural minerals. The nanomechanical properties of the natural cements were higher compared to *in vitro* biocement. This study has shown evidences that atleast part of mineral precipitation in beach rocks is most likely biogenic and phylogenetic lineage plays important role in affecting mineralogical and nanomechanical properties.