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Overcoming the data constraints: a CoDa approach to grain size analysis of tidal–deltaic lihtofacies in the lower Ganges-Brahmaputra delta

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Grain size analysis remains a fundamental characteristic of environmental interpretation in coastal environments. Research over the past two decades on the Holocene sediments from the tide dominated west side of the lower Ganges delta has focussed on constraining the sedimentary environment through grain size distributions (GSD). The traditional analysis of GSDs has centred on the use of probability density function (PDF) approaches such as log-normal, log-hyperbolic, and log skew-Laplace functions. These approaches, while providing a heuristic for interpretation, do not acknowledge the compositional nature of grain size data, and may compromise outcomes in lithofacies interpretations. The use of PDF approaches in GSD analysis poses a series of challenges for the development of lithofacies models, such as equifinal distribution coefficients and obscuring the empirical data variability. In this study a methodological framework for characterising GSD is presented through the use of a compositional data analysis (CoDa) and multivariate statistical framework. The statistical methodology outlined in this study consists of employing a centred log-ratio (clr-) transformation on a closed GSD dataset. This is followed by principal components and cluster analysis (PCA and CA) by which lithofacies can be identified. The methodology is based on limiting the subjectivity of analysis of GSDs that generally characterises PDF approaches. The CoDa methodology removes challenges posed by constrained data with PCA extracting the maximum variance present, with this variance examined categorically through a series of cluster analyses.