Use of statistical information to characterize sedimentary facies of alternating successions: an example using gamma rays and graphic logs

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Alternating successions consisting of monotonously rhythmic alternating beds occur in various depositional environments. Because quantitative data can be obtained from these alternating successions, they sometimes have been quantitatively analyzed sedimentary facies, in addition to traditional qualitative sedimentary facies analysis work conducted by geologists. Especially, well-log data of turbidite successions are frequently and quantitatively analyzed because turbidite successions can be important reservoirs for oil and gas (Rider and Kennedy, 2011). However, integration of well-log analysis data and traditional sedimentary facies analysis data from graphic logs is often not achieved because quantitative studies of sedimentary facies are rare. In this study, we examined common statistical indices that can be used to characterize sedimentary facies from well-log data and graphic logs collected on the same turbidite succession.
In regard to the well-log analyses, spectroscopy gamma ray (SGR) data were mainly used because they are the most sensitive parameter for lithofacies. The SGR data commonly have a poor resolution for individual beds because the vertical resolution is only 15 cm. Thus, graphic logs were interpreted for equal interval data corresponding to the SGR data. The lithology, ratio of sandstone to mudstone, and vertical grain size variation were used in the sedimentary facies indices to identify the lithofacies of turbidite successions. These parameters were grouped into clusters indicative of the different sedimentary facies through a cluster analysis technique.
Lithologies from SGR data were identified by the lamina identifying method proposed by Sasaki et al. (2015). Ratios of mudstone to sandstone in analysis windows were then estimated by using the identified lithology. Stratigraphic grain size variations were estimated by using differences in the SGR data of upper and lower parts in the analysis windows. In the case of graphic logs, ratios of mudstone to sandstone and stratigraphic grain size variations were estimated from the equal interval lithological data.
As a result of the cluster analysis, 12 clusters were derived. These clusters contained information about the lithology, ratio of mudstone to sandstone, and stratigraphic grain size variation. For example, the cluster information of sedimentary facies was useful for distinguishing between weathered sandstone or mudstone, sandy or muddy horizons, and upward fining or coarsening in the facies. We show the results for the identified sedimentary facies by considering the vertical transitions in these types of information.

References

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Keywords: sedimentary facies analysis, turbidite succession, gamma-ray log, cluster analysis

