Paper 10

Application of high-resolution biostratigraphy in the Malay Basin

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High-resolution biostratigraphy is a technique that utilises bioevents of field-wide chronostratigraphic significance. The bioevents reflect the quantitative changes of microfossil assemblages, such as top increases, base increases, and acme events. They are the result of physical and chemical fluctuations in the oceanic water mass through time. Some of them are due to climatic fluctuations and ecological changes in the habitats of upland vegetation. Both marine- and terrestrially-derived microfossil assemblages record these changes in the accumulating sediments as bioevents, which can be interpreted and correlated throughout the field.

By carefully identifying and documenting bioevents, more candidates for correlateable datums can be defined, rather than relying on evolutionary appearance and extinction of certain taxa. This is illustrated in the hypothetical microfossil distribution (Fig. 1) where nine bioevents can be recognised as compared to only two from using a traditional evolutionary or extinction approach. When integrated with wireline logs and seismic data, such bioevents could provide a more accurate stratigraphic framework and allow detailed interpretation of depositional environments.

To illustrate the application of this technique, the results of a high-resolution biostratigraphic study in the JDA Area of the Malay Basin are presented (Fig. 2). The interval of interest consists of approximately 430 m of paralic sediments of Sequence III, II, I and 0. The sediments contain abundant terrestrially-derived palynomorphs, whereas benthic foraminifera and nannofossils are poorly represented.

Each recorded bioevent has enabled further refinement of the earlier regional broad age subdivisions. Three biozones PR13A, PR13B and PR14 of the PRSS Biozonation Scheme (1997)

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were recognised. These suggest that the age of the studied interval is Middle to Late Miocene. It can be observed that the tops of PR13A and PR13B zones closely coincide with middle Sequence II and lower part of Sequence 0, respectively, in all wells.

By integration of biostratigraphic data with wireline logs, depositional environments can be interpreted and correlated across the wells (Fig. 2). The correlation indicates that the three wells were always within the reach of brackish tidal influence. Development of biofacies seems to be related to eustatic sea level changes. Sequence III and II were interpreted to have been deposited in a predominantly lower estuarine environment, whereas the overlying Sequence I and 0 were deposited in a more distal location in a predominantly distal lower estuarine to shallow subtidal environment. This could have resulted from a widespread marine transgression at the base of Sequence I, marking an extensive drowning of the underlying sequences. A strong fluvial influx is thought to have occurred at the base of Sequence I which led to the establishment of a muddy shallow subtidal environment.

Integration with marine benthonic pulses and wireline logs has identified potential flooding surfaces, which could provide potential correlative datums across the study area. Eight possible marine flooding surfaces, and their correlative surfaces, were identified. Of particular importance are flooding surfaces FS2 and FS3, which are associated with widespread marine transgression over the study area.

From detailed paleoenvironmental interpretation, depositional facies within the lower coastal plain may be differentiated. This permits the recognition of different sand and shale facies from which reservoir compartmentalization could be assessed. Distal lower estuarine to shallow subtidal muddy sands associated with strong fluvial influx are more dominant in Sequence I and 0 as compared to those in the underlying sequences. Shale, associated with widespread marine transgression such as at the base of Sequence I, is likely to be laterally extensive and if preserved could form a potential overhead seal or barrier to reservoir fluid flow. The other potential barriers, are more distal shales such as shallow sub-tidal shale, which have a greater lateral extent than those in an estuarine system. In contrast, shales deposited in an estuarine system may be laterally less extensive, thus acting as less effective baffles to reservoir fluid flow. The results of the study may be used to optimise both exploration and development of oil fields in the area.