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Geosteering of High-angle Wells Using Heavy-mineral Analysis: The Clair Field, West of Shetland, U.K.

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ABSTRACT

Conventionally, a combination of biostratigraphy, logging-while-drilling (LWD) data, and routine cuttings description is used to monitor continually the geology encountered during drilling of high-angle wells. However, the biostratigraphic component of the geosteering tool kit cannot be used if there is insufficient diversity of microfossils in the sequence to be drilled. In such circumstances, alternative, less conventional geosteering methods can be used. This paper presents the application of one such approach, heavy-mineral analysis (HMA), in monitoring high-angle wells in the Clair field, west of Shetland, U.K. The reservoir sequence in the Clair field comprises Devonian-Carboniferous nonmarine fluvial and eolian sandstones that lack a continuous, diverse suite of palynomorphs. Consequently, there is no high-resolution biostratigraphic framework for reservoir correlation. By contrast, heavy minerals occur throughout the sequence and therefore offer a potential for correlation and discrimination of different sandstone units.

During appraisal of the Clair field in 1996 and 1997, high-angle wells targeted Clair Unit V, a unit approximately 50 m thick with the best overall reservoir quality. The overlying Unit VI has poor reservoir quality, and therefore it was important that the wells avoided drilling through significant lengths of this unit. The reservoir quality of the underlying Unit IV is poorer than in Unit V but is better than in Unit VI. Therefore, drilling of Unit IV sandstones could be tolerated but ideally would be avoided.

Prior to the application of real-time HMA at well site, it was necessary to establish whether the method would provide adequate, repeatable distinction among units IV, V, and VI. This was assessed first using core material from the "reference" well 206/8-8. On the basis of variations in a number of key parameters, two major events were observed. One of these corresponds closely to the V–VI boundary, and the other lies within the top part of

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Unit IV, approximately 20 m below the IV–V boundary. These promising results were tested further by analysing two uncored sequences, which established that these events occur elsewhere in the field and that they can be identified by analysis of cuttings samples. It was therefore considered that HMA provided sufficient resolution for the method to be applied at the well site as part of the geosteering tool kit. The stratigraphic implications of the HMA data are illustrated by reference to the two wells (206/8-10Z and 206/8-11Z) where the method has been used to date.