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Planning and Drilling Horizontal Wells in a Deep Water Environment, Campos Basin, Brazil

A.A.G. Meira (Petrobras S.A.), G.H. Schmitt (Petrobras S.A.), M.L. Moraes (Petrobras S.A.), R.O. Carvalho (Petrobras S.A.) & R. Beer* (Petrobras S.A.)

SUMMARY

Deep water environment is a challenging one to operate and most of the production projects rely on horizontal wells to be economically feasible. Optimizing the well placement of these horizontals demands an integrated approach including many different professionals and ultimate geosteering tools. Nowadays we observed a increment in the usage of images, both resistivity and nuclear, that provided reliable data to identify bed boundaries allowing reactive actions in geosteering. New generation deep resistivity devices indeed enlarge the drilling capabilities enabling a proactive geosteering, that means detect and identify bed boundaries before the bit crosses them. These new technologies require a sophisticated monitoring environment which is accomplished in the Decision Support Center. In this center all real time data are analyzed by the project team, to achieve the final goal of optimizing the wellbore trajectory in order to maximize the reservoir exposure and minimize the mechanical hazards like severe doglegs or others to ensure the best completion and productivity of the horizontal well. In this paper we present a typical workflow in designing and executing a horizontal well, This workflow will be illustrated through several field examples applying the most recent technologies currently available.

Deep water environment is a very challenging one to operate and most of the production projects rely on horizontal wells to be economically feasible. Optimizing the well placement of these horizontals demands an integrated approach including many different professionals and ultimate geosteering tools. Considering the later ones we observed a huge increment in the usage of images, both resistivity and nuclear, that provided reliable data to identify bed boundaries allowing reactive actions once the wells hit undesirable cap or bottom intervals. New generation deep resistivity devices indeed enlarge the drilling capabilities enabling a proactive geosteering, that means detect and identify bed boundaries before the bit crosses them. Having the ability to measure azimuthally these tools are able to map the direction of the oncoming strata and some of them can even map these boundaries over a short distance in the drilling direction. In 2009 Petrobras tested a recently developed resistivity tool that extends the measuring capability to 30-m or more from the well center, depending on the resistivity contrasts between the different strata. Due to this extended depth of investigation the tool identifies more than one resistivity contrast which can be correlated to different geological layers. This capability allows more confidence to the geosteering process. The complexity of all these technologies require a corresponded sophisticated monitoring environment which is accomplished in the Decision Support Center that was installed in the headquarter office. In this center all real time data are analyzed by the project team, involving the drilling operations team and the reservoir management team, to achieve the final goal of optimizing the wellbore trajectory in order to maximize the reservoir exposure and minimize the mechanical hazards like severe doglegs or others to ensure the best completion and productivity of the horizontal well.

In this paper we present a typical workflow in designing and executing a horizontal well, starting with the planning of the well trajectory based on a seismic interpreted model, the correlation with well log data obtained from nearby wells, and a geological model identifying all the important boundaries that should be traversed by the proposed well. All the available information is put together in order to obtain the most detailed model as possible. Using this refined model and the projected well trajectory the next step consists in model the most probable BHA tool responses, which will constitute the initial geosteering model. During the drilling phase this geosteering model is updated considering the real time data and all the decisions are taken based on this information. In addition, the data are also used to update the geological model that serves as input to the reservoir flow simulator model. This workflow will be illustrated through several field examples applying the most recent technologies currently available.