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A Robust Approach Towards Safe and Cost Effective Drilling in High Pressure Formations

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ABSTRACT

Formation overpressures often results in problems during drilling operations. High mud weights necessary to control the formation pressure impede drilling progress through low rate of penetration (ROP). Non-productive days, stuck pipe and, in some cases loss of wellbore, add operational cost and delays to the field development program. Therefore, accurate pre-drilling pore pressure prediction is crucial for over-pressured formations. The focus on this paper is a carbonate formation which varies in thickness and consists of two main lithology packages that include, (1) a lower, mainly tight, dolomite with thin shale beds and anhydrite and, (2) an upper predominantly anhydrite lithology. Explicit well data (e.g. mud weight) can be utilized to map overpressure areas via a deterministic approach. Deterministic mapping has reasonably high confidence when constrained with sufficient well data. On the other hand, with increasing distance from well control, confidence is reduced. Hence a major limitation of the well data map is the lack of predictability in undrilled areas. In order to improve predictability, a probabilistic approach utilizing Sequential Indicator Simulation (SIS) was employed. A set of multiple geological realizations built by sampling 80% of the drilling data was used to construct the risk-model. The confidence in these realizations was estimated by means of blind-tests using the remaining twenty percent of the data. The highest-rank models exhibits a reasonable match with the pattern of overpressure occurrence. Finally, seismic data has been utilized to predict seismic over-pressure map by classification of seismic waveform calibrated to well information. This map has been used as a spatial trend to improve inter-well pore pressure prediction. This integrated modeling approach substantially improved the predictability of high pressure zones from 15% (deterministic approach) to currently 70% (probabilistic approach followed in this work).