Hierarchical Human Guided Intelligent Stratigraphic Cross-correlation

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Abstract

Objectives/Scope: The identification of correlative stratigraphic markers between adjacent wells is critical for reservoir stratigraphic analysis and basin heterogeneity characterization. Deep learning is a sufficient method to extract the patterns from multiple sources of data. In this study, a workflow of intelligent stratigraphic auto-correlation from multiple wells is proposed to avoid the bias and subjectivity when this process is completed manually.

Methods, Procedures, Process: A three level hierarchical correlation workflow is proposed. Firstly, it is necessary to identify patterns from multiple wells. By using the artificial intelligence, all wells were grouped according to log curve similarities. Each group was defined as a spatial segmentation. The second step was to build a correlation across the segmentations. Based on existing regional stratigraphic knowledge, the macro-stratigraphic structure was constrained to all the wells and auto-correlation was undertaken. Completing micro-stratigraphic levels of correlation was the third step, and this can be done within the wells of each segment.

Results, Observations, Conclusions: The new proposed approach is tested with a synthetic dataset. The results show that the machine learning of pattern identification from all the wells play a key role for the final overall correlation results. The test shows that spatial segment is critical to provide a macro-spatial stratigraphic structure. This level of correlation is done in a deterministic way, and few stochastic correlations are introduced. The analysis provides an initial stratigraphic structure at the macro-level. More importantly, this spatial clustering or segmentation is guided by stratigraphic knowledge from geologists, which provide a way to integrate human knowledge with artificial intelligence. The quantitative similarity measurement of stratigraphic columns from multiple wells is another sensitive parameter for a successful correlation. In this test, it was found that the Jaccard distance is a best way to compare stratigraphic columns from each well. The results showed that using this hierarchical human guided automatic stratigraphic cross-correlation can obtain more geological realistic stratigraphic well correlation result.

Novel/Additive Information: The proposed hierarchical automatic stratigraphic correlation of adjacent well logs is an innovative way and provide a way to integrate human knowledge with artificial intelligence. The illustration with a synthetic dataset shows that correlations are similar to those produced by the geologist.