

Testing the Value of Rebound Hardness in Estimating Petrophysical and Rock Mechanical Properties from Core and Wireline Logs: Examples From the “Mississippian Limestone”/STACK Play (U.S.) and the Vaca Muerta Formation (Argentina)

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9.29.2020 - 10.1.2020 – AAPG Annual Convention and Exhibition 2020, Online/Virtual

Abstract

Rebound hardness (RHN) has become a widely applied rock mechanical parameter in the petroleum industry due to the low-cost, easy-to-perform testing procedures. However, the RHN data is often under-utilized from a lack of detailed integration with reservoir properties. Targeting the unconventional “Mississippian Limestone”/STACK play in north-central Oklahoma, USA, and outcrops of the Vaca Muerta Formation in Argentina, this study tests the value of RHN in reservoir characterization and production design by evaluating the statistical relationship between RHN and petrophysical and rock mechanical properties. RHN can be a valuable parameter in assisting petrophysical rock typing and sample selection for laboratory tests of rock properties. Using the “Mississippian Limestone”/STACK cores and the Vaca Muerta plug samples, 2D crossplots between the collected RHN data and the associated rock data (mineralogy, porosity, sonic velocity, elastic parameters) show correlative trends, indicating RHN may help estimate these properties in a more time- and cost-efficient and sample-conservative way than conventional laboratory analysis. All the correlations show clusters by facies groups, confirming the value of RHN for rock typing and the

importance of a detailed, core-based facies description in this workflow. As revealed by multivariate analysis, different rock parameters (mineralogy, porosity, sonic velocity) show variable levels of significance in affecting RHN in different facies grouping schemes, indicating that RHN is likely resultant from the interaction of multiple rock properties, which can explain the scatter observed in the 2D correlations. No distinct pattern is observed when correlating RHN with general wireline log data from the “Mississippian Limestone” wells. The scatter in 2D correlation and the lack of pattern in wireline log data may be related to the scale difference between wireline log, core, and RHN data, and to the heterogeneity of rock properties across a variety of scales. In this sense, RHN exhibits an overall limited value in precisely predicting rock properties using 2D cross-plots for these complex mixed carbonate-siliciclastic rocks. On the other hand, forward regression analysis indicates that RHN can potentially assist in the prediction of certain rock properties, indicating the potential value of RHN in modeling these properties from a multivariate perspective.