Rock-Eval analysis as an efficient technique to determine carbonate content in shale source rocks

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Content of carbonates is an important factor to consider in source rock evaluation, especially for unconventional hydrocarbon resources development. Traditionally, the content of carbonates in rock samples has been determined via weight loss after acid digestion and/or acidimetry analysis. These wet-chemistry based approaches are labour-intensive and produce chemical wastes, thus are not environmentally friendly. In comparison, X-ray powder diffraction (XRD) analysis as a non-destructive method is now being widely used in laboratories to quantitatively determine the mineralogical composition of rock samples including quartz, clays and carbonates, but the method is costly and time consuming.

Various thermal analytical techniques have also been developed to measure the quantity of carbonates via the detection of CO_2 released during different temperature range of step-wise pyrolysis treatment of powdered rock samples. One of the most widely accepted in the oil industry is the Rock-Eval 6 or other similar thermal analysis that produces a parameter MinC(%) as a proxy of carbonate content. Although Rock-Eval results for characterizing the quantity and quality of organic matter in sedimentary rocks such as TOC, Tmax, S1, S2, S3 values have been extensively used by petroleum geologists and engineers for hydrocarbon resources characterization and assessment, the MinC(%) parameter has often not been utilized as a measurement of the carbonate content. In this study, we have collected both Rock-Eval 6 and XRD data on hundreds of potential source rock samples from Ordovician, Devonian, Triassic, Cretaceous and Tertiary shale strata in Canadian sedimentary basins. Data analysis showed that the MinC(%) from Rock-Eval 6 analysis has an excellent positive linear relationship (R^2>0.9) with the sum of the calcite, dolomite and siderite from XRD analysis. As the number of Rock-Eval 6 analysis on shale and tight reservoir samples has been growing exponentially during the last decade or so due to the increased industrial and academic interest in shale gas and tight oil, the MinC(%) values are considered to be cost-effective and provide quality estimates of the total carbonate contents in petroleum source and reservoir intervals.