Recognition and Semi-Quantitative Evaluation of Biogenic Silica Contents in the Wolfcamp Formation of the Delaware Basin, Using Whole-Rock Elemental Data, and Comparison to Results from other North American Shale Resource Plays.

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Although there are many factors which contribute towards the successful targeting and completion of shale resource plays, one important factor is the contribution of biogenic silica to the silica or interpreted quartz content in the sediment. This paper demonstrates how whole rock inorganic geochemistry can be used to recognize intervals of shale sequences in which biogenic silica is a significant component and also provide a semi-quantitative assessment of the biogenic silica content.

The methodology relies on recognition of an elemental proxy for silt-sized terrigenous input into a basin. Typically, zirconium (Zr) is selected since it is not readily mobilized post-deposition in a typical oilfield setting and is not affected by redox fluctuations in the water column and at the sediment-water interface. Furthermore, Zr is typically present as silt-sized zircon grains, which will behave in a similar hydrodynamic manner to silt-sized quartz grains found in shale sequences. Therefore, in a shale that has only terrigenous-derived quartz, a zircon versus silica binary plot would display a positive linear association between the two variables. If, however, the amount of quartz increases without a corresponding increase in Zr content, the linear association will cease to exists, implying that silica is being deposited from a non-terrigenous source. In the type of depositional environments common to most organic-rich shale sequences, influxes of SiO_2 that are from a non-terrigenous source are best explained by the

presence of biogenic silica.

It is possible to provide a semi-quantitative estimate of the proportions of biogenic and detrital silica in a given sample by combining this approach with the sample's total silica content, which can be measured by X-ray diffraction or modeled directly from the elemental dataset.

While determination of the quartz content in a shale is simple, determination of the zircon content is challenging. However, using SiO_2 and Zr as proxies for quartz and zircon it is possible to quickly identify zones that have significant contributions of biogenic silica. By using elemental data, this methodology can be applied to a wide variety of sample types including core, side-wall core, and cuttings samples from both vertical and lateral wells. In this paper examples of this methodology are shown for the Wolfcamp Formation in the Delaware Basin and compared to other North American shale resource plays.