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Organic carbon content of the Green River oil shale from nuclear spectroscopy logs

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The total organic carbon content (TOC) of oil shale and gas shale is one of the most important parameters in defining reservoir potential. Inelastic and capture nuclear spectroscopy log data have been combined to produce elemental concentration logs of C, Si, Al, Fe, Ca, Ti, K, Na, S, and Gd in the AMSO CH-01 well which penetrates the Green River Formation in Colorado. The fraction of the inelastic gamma ray spectrum, or yield, due to carbon is converted to weight percent carbon using the inelastic silicon yield and the capture silicon weight percent log from the ECS elemental capture spectroscopy sonde. The total carbon log was then reduced by the inorganic carbon, due primarily to dolomite and ankerite, with some contribution from calcite, dawsonite and nahcolite. The inorganic carbon log was estimated from combinations of the calcium, magnesium, and sodium concentration logs from the ECS sonde. The TOC log is then the total carbon log minus the inorganic carbon log. For comparison with the chemical concentration logs, over 200 intervals of core from this well were sampled and 2-ft-long sections were homogenized to approximate the log vertical response. These core samples were analyzed for concentrations of 74 elements including carbon and the TOC content. Each of these samples was also analyzed for sample density and quantitative mineralogy by Dual Range Fourier Transform Infrared (DRFT-IR) spectroscopy. The agreement between the log and core values for total carbon, total inorganic carbon, and TOC is excellent. The TOC log can then be used to activate empirical relationships such as Fischer Assay oil shale grade from TOC.