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Determining oil shale porosity using borehole gravimetry

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Conventional logging methods fail to provide adequate results in measuring bulk properties in highly heterogeneous formations, such as vugular oil shale. Vugs in Colorado oil shale vary significantly in size, ranging from millimeters to several meters, whereas most logging tools reads just a few centimeters into the formation. Certain vugs are too large to be characterized by well logging, but too small for seismic methods. Hence, for this task one may consider using modern high-resolution potential field methods, and in particular, borehole gravimetry. Borehole gravimetry is a novel, even exotic method. In Shell it was used only a few times before and the Colorado oil shale survey is the first one that was done for vug characterization. The borehole gravimetric method is not new and has been in use for several decades under specific conditions; however, until recently, its use was significantly impeded by limited resolution and repeatability. Recently, a new generation of borehole gravimeters was developed and the interest in the method was renewed. The gravimetry method delivers bulk densities through measuring gravitational acceleration at various depths. The area of gravimetry sensing is on the order of 1000 ft away from the well bore. Hence, gravimetry densities are large-scale averages and are better representations of formation than those provided by traditional logging. Furthermore, with additional information, gravimetry bulk densities can be recomputed into porosities - the key reservoir parameter in vugular sections. A borehole gravimetry logging program was successfully run in 9 wells on Shell leases in Piceance Basin during 2008. The results of this work broadened knowledge of subsurface in the area and proved applicability of the method for future use.