Optimizing Magnetic Measurements on Drill Cuttings for Reservoir Characterization

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Abstract. Magnetic measurements on drill cuttings have recently been demonstrated to give good, independently validated, estimates of certain properties (such as mineral contents and permeability) of the rocks comprising the cuttings. Cuttings are a rapid, cheap alternative to core for providing useful petrophysical information for any drilled well. This paper details how magnetic measurements on drill cuttings can be optimized for estimating petrophysical parameters. We will demonstrate via a theoretical model how mass magnetic susceptibility is essentially independent of the porosity of dry drill cuttings samples. The total porosity of drill cuttings samples comprises two components: (i) the intrinsic matrix porosity of the individual rock cuttings, and (ii) the space between individual rock cuttings. By determining mass magnetic susceptibility, which merely requires an added step of weighing the sample compared to volume magnetic susceptibility, the total porosity will essentially not affect the results of dry cuttings. In contrast, volume magnetic susceptibility is more dependent on porosity. For example, high total porosity will reduce the magnetic susceptibility of paramagnetic cuttings (such as illite), and increase the magnetic susceptibility of diamagnetic cuttings (such as quartz and calcite).

The effect of different fluids in the pore space (which includes both the intrinsic rock matrix pore space plus the space between individual cuttings) on the magnetic susceptibility of drill cuttings has also been modelled. If the pore space merely contains air then the mass magnetic susceptibility measurements are essentially independent of the total porosity. Only at total porosities of over 90% (which are unlikely to be encountered) does the model predict slight changes in the mass magnetic susceptibility. However, if the pore space contains water then the mass magnetic susceptibility is more dependent on the total porosity. Washing and drying the cuttings prior to measurement is proposed to be an optimum approach. The modelling also explains some previous experimental results where wet cuttings gave slightly different magnetic susceptibility values compared to the identical dry cuttings. Furthermore, the effect of drilling mud additives and contaminants (if present) can also be modelled, and practical steps to remove their effects will be discussed.

In summary, drill cuttings provide a vast, largely untapped resource, and the magnetic measurements described above can be used to provide petrophysical information rapidly and cost effectively. These measurements can also easily be applied to the many vials of archived drill cuttings (that are rarely studied), thus potentially adding further insights into historical datasets.