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Specific surface area of porous rocks: an integrated approach by combination of BET and Micro-CT imaging

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The specific surface area is an essential petrophysical parameter to characterize natural reservoirs by means of (e.g.) complex electrical properties, fluid dynamics and chemical reactions between pore fluids and matrix minerals. This parameter is affected by different types of sample features, such as micro fractures, pore space cementation and by the existence of various clay minerals (e.g. ilite, kaolinite, smectite, etc.). Therefore, a detailed description of the mineral composition is of great importance. To get access to this rock specific composition, classical BET-experiments in combination with high resolution micro-CT imaging on different types of sandstone have been fulfilled.

The specific surface area of natural rocks is formed by the total surface of all pores within a sample. In general, the specific surface is related to the mass (Sm) of the sample, or to its volume (Spor). Classically, this parameter is determined by using the "BET-Method" (after Brunauer, Emmet and Teller, 1938) via physisorption. Typically, N2 is used as adsorbate but also other types of gas (e.g. CO_2 or Kr) could be utilized. The amount of adsorbed gas and the size of the gas molecules are well known so that the specific surface area of the sample can be calculated therefrom.

High resolution micro-CT provides fast, nondestructive and three dimensional reconstructions of rock samples, including detailed information about the structural behavior of the pore space and of the mineral phases. The results do not only depend on the density of the samples but also on the X-ray parameters used. To interpret the results of the BET measurements the findings of micro-CT investigations are combined. 3D imaging provides direct information about the different mineral phases which influence the size of the specific surface area. Furthermore, micro-CT measurements allow the deduction of this petrophysical parameter. For this case study, three different types of sandstone are used: First, Flechtingen sandstone, a typical middle permian rock, heavily cemented and with low porosity. Second, Bentheimer sandstone (lower cretaceous), characterized by low degree of cementation and with high porosity and permeability. Last, Oberkirchen Sandstone (lower cretaceous), ranging in between the Bentheimer and Flechtingen sandstone. The preliminary results of this study are promising and may possibly be used for an easy and fast way of clay mineral identification.