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Coalbed methane reservoir characterization using magnetic susceptibility

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This research describes a study of the dependence of the magnetic susceptibility (MS) and permeability as a new approach for coalbed methane (CBM) reservoir characterization. Experimental measurements were undertaken in coal cores from Kazakhstan (Karaganda Basin). The well sections containing coal are the area of high interest where regular deposition of sandstone, shale and coal is observed.

The MS measurements were made by the core logging sensor with the sensitive area of the probe providing volume magnetic susceptibility values. Permeability has been determined by air permeameter. Both magnetic susceptibility and permeability have been measured at the same points. The obtained values of permeability and magnetic susceptibility exhibit the predicted pattern of deposition of reservoir rocks. Coal reservoirs generally is spaced between shale layers with extremely high MS values and highly low permeability. Sandstone with shale interlayers tends to be a transition area between shale and coal. Such tendency appears within several sections. The experimental results showed a strong correspondence between measured magnetic susceptibility and permeability of coal core samples. Therefore, inverse proportionality between magnetic susceptibility and permeability is observed. Generally, the high values of magnetic susceptibility correspond to low permeability, likewise the low diamagnetic MS values comply with high permeability of production zones. In a point of fact, linear proportionality appears as well due to fractures. In this case, permeability must be recalculated in relation to degree of fracturing. Magnetic susceptibility results could sometimes be affected by small content of ferrimagnetic minerals that resulted in high MS values. However, MS data demonstrated good correlations with permeability.

The application of magnetic susceptibility values for coalbed methane reservoir characterization could be a non-destructive and rapid method potentially used in both laboratory and field conditions.