Magnetic Electrokinetics: A Key to Monitoring Fluid Flow in Reservoirs

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It was theoretically demonstrated by Fitterman in 1979 that a magnetic field can be produced by fluid flow across rock contacts with different streaming potential coefficients, if specific geometries and pressures are involved. These geometries essentially imply vertical contacts for surface flown aeromagnetic surveys. Fitterman calculated that magnetic anomalies of over 1 nT, and possibly up to 10 nT, could be produced by such fluid flow. The pressures required to produce an observable magnetic anomaly are consistent with overpressures observed in many Australian sedimentary basins (e.g. Carnarvon and Perth basins). Middleton and others presented laboratory evidence in 2000 that oil and water moving in a layered granular medium could produce a magnetic field, albeit weak (ca. 0.005 nT) due to the small volumes of rock involved in the laboratory experiment.

Results presented show (1) that magnetic fields of about 0.1 nT can be produced in the laboratory, if sufficient pressures are involved in fluid flow through porous media, and (2) observed magnetic field disturbances of the order of 1 nT have been observed related to specific faults in a known oil field. Modeling based on these observations suggests that hydrodynamic movement of petroleum (in specific concentrations), and certain resistivity formation water, can produce observable magnetic fields. An hypothetical case history for a producing oil field is also modeled to have an observable magnetic anomaly.