Effect of Specific Surface, Mineralogy, and Pore-Fluid Chemistry on Fine-Grained Soil Classification Based on Plasticity and Electrical Sensitivity

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Abstract Macroscopic soil properties depend on fabrics of fines, which are largely controlled by electrical interactions due to mineralogy, variations in specific surface and pore-fluid chemistry. Traditional soil classification system has several limitations; ignored the pivotal influence of pore-fluid chemistry on fines behaviour, adopted rigid fines plasticity boundaries despite the broad spectrum, neglected fines thresholds for various (mechanical and hydraulic) properties, disregarded particle shape and size below 75 μm. These substantiates the need for improvement. Plasticity and electrical sensitivity were evaluated through fall cone penetrometer test for soil pastes prepared with three electrically differing permeant fluids viz, deionized water, 2 M brine, and kerosene. The result was used to categorize the clayey samples belonging to kaolinite (LKW-2, AMK-2, EPK-2), illite (YI, YI-2, MI-2), and bentonite (DB, DB-2), which shows that YI classifies as *intermediate plasticity* and *low electrical sensitivity*, LKW-2, AMK-2, EPK-2, YI-2 and MI-2 categorizes as *intermediate plasticity* and *intermediate electrical sensitivity* while DB and DB-2 groups as *high plasticity* and *high electrical sensitivity*. This highlights how interplay between mineralogy, changes in specific surface, and pore fluid chemistry can alter fines classification in ways the traditional systems did not envisage, thereby calling for a complementary application of both systems. Transition from one classification group to another occurs at critical specific surface value especially for Kaolinite and Illite while sensitivity to pore fluid chemistry appears the most conspicuous. Result of the study finds relevance in subsurface flow, sediment stability analyses, engineered flow systems like groundwater pollutant remediation, waste and barrier containment systems, hydrocarbon migration, and in non-particulate sorbent applications.

Keywords Fines · Specific surface · Mineralogy · Pore-fluid chemistry · Plasticity · Electrical sensitivity · Revised soil classification system

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