

Physio-Chemical Characterization of Unsaturated Zone with Special Reference to Chemical Processes

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The unsaturated zone has a large degree of control over the transmission of water to aquifers, as well as to the land surface through overflow, plant uptake and to the atmosphere by evaporation. Key physical phenomena such as thermodynamic interactions, transport processes of various kinds, and chemical reactions occur in the unsaturated zone. The highly complex chemical reactions can be rebuilt by performing mass balance modelling with the soil-waters collected at different depths in the unsaturated zone. This modelling can lead to understanding of transport of contaminants to the groundwater. Chemical reactions that take place in the unsaturated zone were identified at an agricultural site in lower Palar River basin, Tamil Nadu, India. The measured physico-chemical parameters of the soil and soil water were used to identify the net geochemical reactions along the downward infiltration flow path, with the help of standard mass balance modelling software code. Inverse mass balance models prove that calcium carbonate precipitation, CO_2 out gassing, Ca/Na ion exchange, Ca/K reverse ion exchange and Mg/Na ion exchange are the dominant reaction in the unsaturated zone. The models however, suggest Ca/Na reverse ion exchange occurs between 1-2 and 5-6 feet, calcite dissolution between 3-5 feet, Ca/K ion exchange between 1-2 and 4-5 feet and may be due to the addition of external water to soil water in the unsaturated zone. Gypsum dissolution was very low throughout the 6 feet of unsaturated zone. Similar experimental techniques can be adopted to understand the chemical reactions during hydrocarbon migration through unsaturated zones. Knowledge of these chemical processes will lead to improved understanding of reactive transport through unsaturated zones.