

## Enhancing bio-remediation by controlling nutrient distribution area in contaminated soils

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Contamination by oil is not controlled by regulation, yet it would harm people's life and health. Oil is lighter than water, would stay over the water table or unsaturated zone above it. Therefore, in application of bio-remediation, nutrient injection needs to be carefully designed, because bypass flow or preferential flow would be dominant in natural soils where macropores were more the rule than exception. In this experiment, nutrient injection rate or degree of saturation was regulated where solute transport was controlled by convection and dispersion. Two injection rate, saturation and unsaturation, and structural differences, with and without macropores were prepared for volcanic ash soils with 5000 mg kg<sup>-1</sup> oil contamination. Outflow water quality was analyzed everyday by ion-chromatography, while biological activity was measured using FDA hydrolysis activity method. After the 30-day remediation experiment, soil columns were dismantled and residual oil concentration was measured by normal Hexane extraction method. The results showed that biological activity was effectively enhanced by macroporous structure with unsaturated flow. Macropore structure would allow oxygen intrusion and unsaturated flow condition allowed dispersion process over the entire soil body. The unsaturated injection control had another benefit that it allowed fewer nutrient leaks to ground water. Because bioremediation should avoid by-products after the process, the suggested technique offered low cost, effective and safe purification of contaminated soils.