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Two-Retention-Point (2RP) Linear Model for Predicting the Soil-Gas Diffusivity in Unsaturated Undisturbed Volcanic Ash Soil

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Risk assessment and design of remediation methods at soil sites polluted with gaseous phase contaminant require an accurate description of the soil-gas diffusion coefficient (Dp) as governed by the typical large variations in soil air-filled porosity (e) within the soil vadose zone above the groundwater table. For undisturbed volcanic ash soils (Andisols), recent studies have shown that a linear model for Dp(e), taking into account inactive air-filled pore space, accurately described Dp across a wide range of soil moisture conditions from wet to completely dry. In this study, we developed a simpler and easier applicable yet still accurate linear Dp(e) model for undisturbed Andisols. The Dp(e) model slope and intercept (interpreted as a threshold soil-air content, eth) were calculated using only two points on the soil-water retention curve. The Dp values at the two retention points are predicted applying the classical Buckingham (1904) Dp(e) power-law model, e ˆ X, and assuming the same value of the pore connectivity factor (X = 2.3) at soil-water matric potentials of -100 cm H2O (near field capacity condition) and at -11600 cm H2O (near wilting point condition), in agreement with measured data. This linear Dp(e) prediction model performed better than the traditionally-used Millington and Quirk non-linear Dp(e) model, especially at dry soil conditions, when tested against several independent Andisol data sets from literature. When using the new Dp(e) model, only measurements of soil-air content at the two classical soil moisture conditions (field capacity and wilting point) are needed for a rapid assessment of the entire Dp (e) function.

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