Describing observed age-depth and C%-depth relationships in volcanic ash soils with a dynamic model of the carbon balance and bioturbation.

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A number of profiles in volcanic ash soils under forest and páramo vegetation in Northern Ecuador show a linear age-depth relationship and a varying (decreasing, increasing and decreasing again) C%-depth relationship. The micro-morphology of these profiles has been analyzed in detail and resulted in the identification of two different populations of soil organisms: one concentrating in the top 20 cm of the soil profile, and another at depths below 50 cm. Furthermore, old root-channels deeper in the profile suggest that the soil levels has been increasing over time. Increasing soil levels can be explained by the vast amounts of organic matter that accumulate in volcanic ash soils (the formation of organo-metallic or organo-mineral complexes in these soils resist microbial degradation). These observations have been used to build a dynamical 1D partial differential equation model describing the (radio-)carbon balance and the mixing processes due to faunal activity for these soils. Due to the increasing upper-level of the soil, the model has a dynamic grid and a shifting upper boundary condition. The model is calibrated with the observed age-depth and C%-depth relationships of two profiles and tested on two other profiles. The results suggest that the observed patterns can only be explained by a system whereby the two different soil organisms are separated by a zone of no mixing, and where the soil grows due to the mixing of C from litter into the soil profile.