

Table 1. Comparison of theoretical predictions with experimental observations

Parameter	Theoretical prediction	Plant-defense system (3)	Soil-carbon system (4)	Cross-system agreement
Vacuum constant α_0	$\ln 2 \approx 0.693147$	0.70 ± 0.05	0.693 ± 0.02 (inferred from Fe-OC lock)	< 1.5% deviation
Avalanche threshold R_c	$2/\ln 2 - 1/(\ln 2)^2 \approx 0.8043$	0.81 ± 0.01 (density transition)	0.804 ± 0.01 (month 6–12 crossing)	< 1.0% deviation
Classical boundary β_1	$1 - \ln 2 \approx 0.3069$	~ 0.31 (pre-enrichment zone)	~ 0.30 (early mineralization phase)	Consistent
Stabilization mechanism	S_1 (hard-lock regime)	Stable defense platform (S_1)	Iron Gate (CFM) / Enzyme Latch (CFB)	Two routes, one target
Field equation	$\alpha = \ln 2 + (1 - \ln 2)(Q - C)$	Q: bacterial enrichment; C: defense decay	Q: Fe-OC formation; C: mineralization rate	Same form, different variables

Note. Theoretical values are derived analytically from Axioms I–III without empirical fitting. Experimental values for the plant-defense system were extracted from published density-response curves in Guo et al. (3). Experimental values for the soil-carbon system were extracted from published Fe-OC and mineralization time series in Ma et al. (4). The Iron Gate and Enzyme Latch routes in the soil-carbon system represent two distinct convergence mechanisms to the same locked state S_1 , a classification not explicit in the original experimental reports.