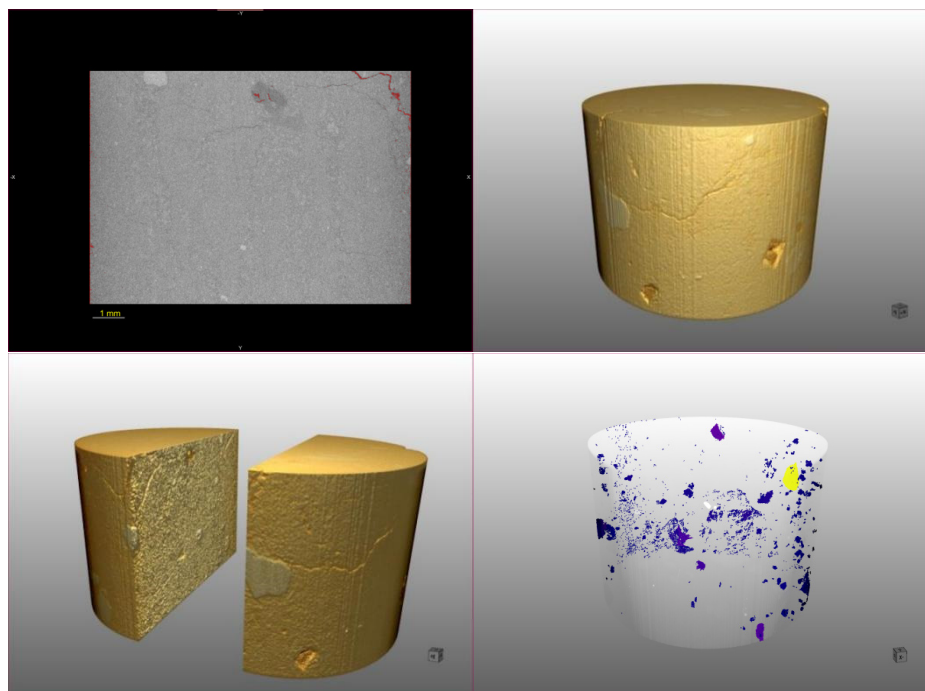
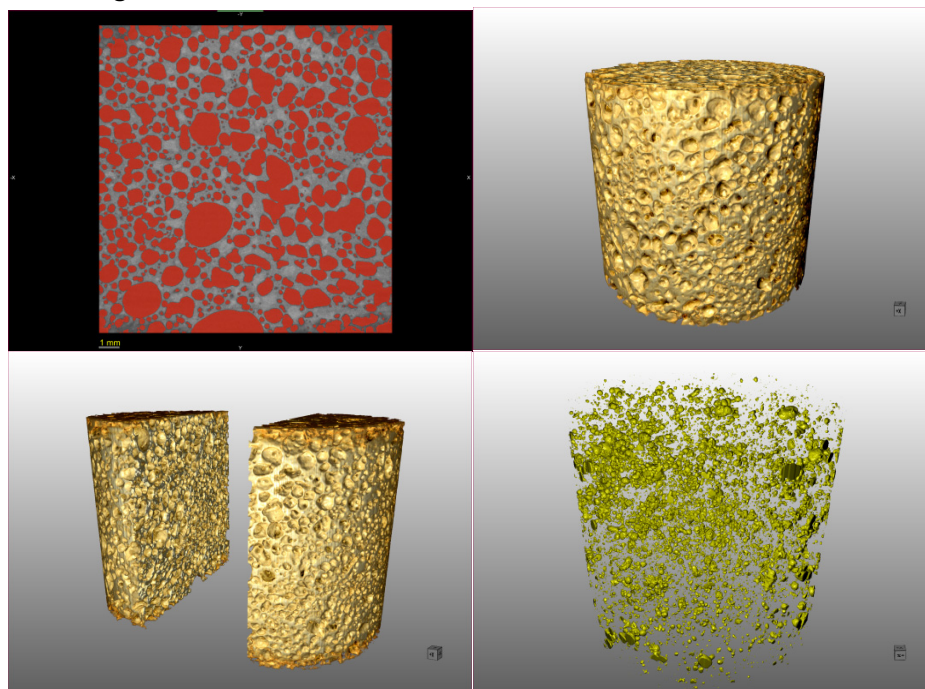


Table S1. Pore Density and Specific Surface Area of the Five Substrates

Sample Name	Overall Pore Density (%)	Connected Pore Density (%)	Specific Surface Area (m^2/m^3)
Zeolite	0.1	0.01	0.213×10^6
Volcanic Rock	37.8	36.62	0.349×10^6
Gravel	<0.1	0.00	CT method not detectable
Magic Rack	18.7	16.67	0.137×10^6
Ceramic Pellets	44.9	39.56	0.131×10^6

**Figure S1.** Three-Dimensional Structural Characterization of Zeolite**Figure S2.** Three-Dimensional Structural Characterization of Volcanic Rock

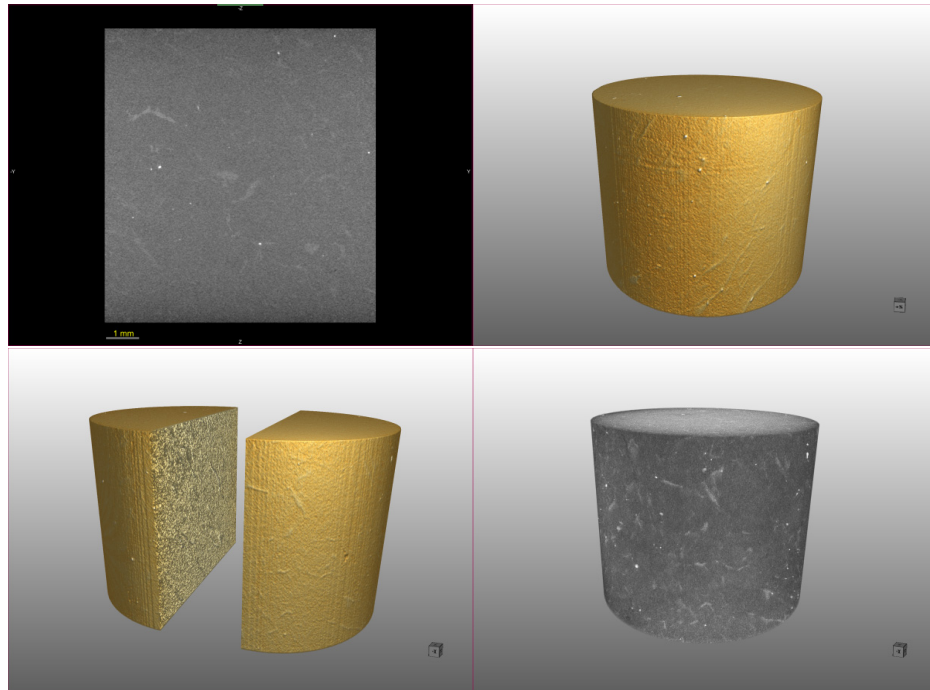


Figure S3. Three-Dimensional Structural Characterization of Gravel

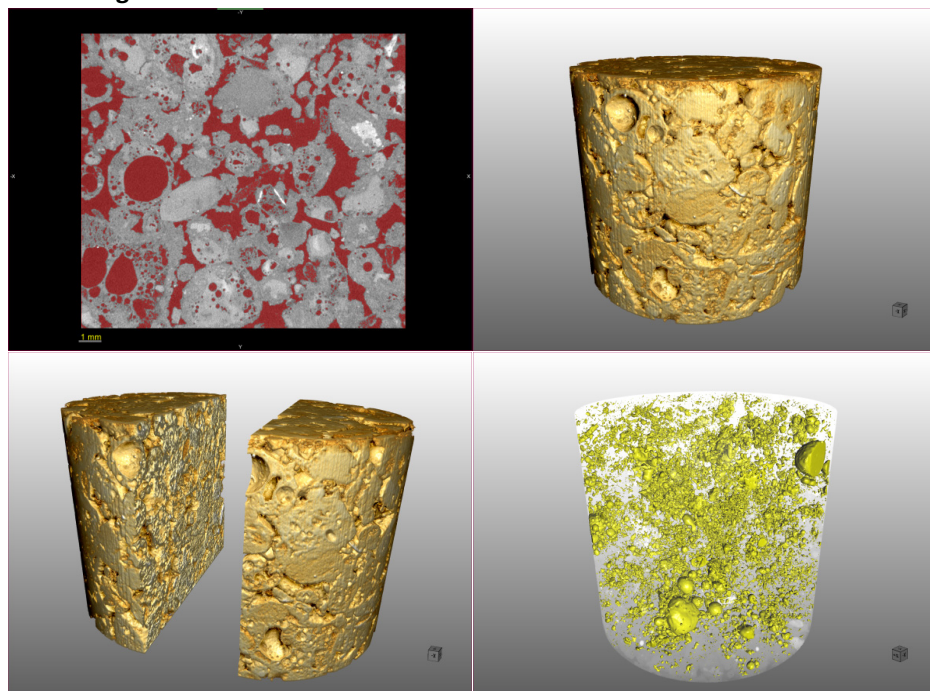
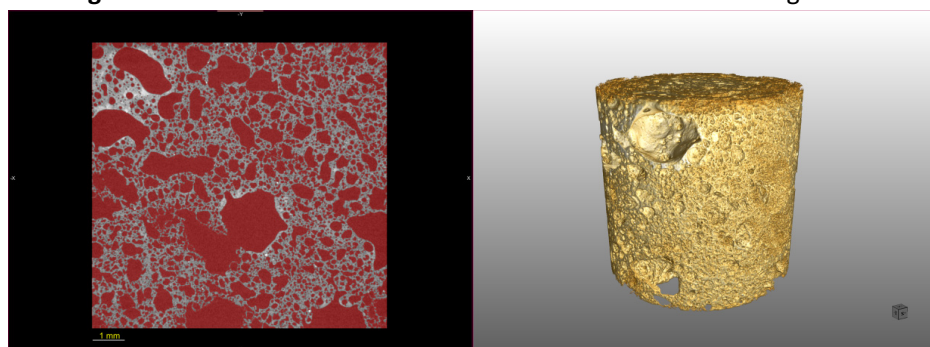
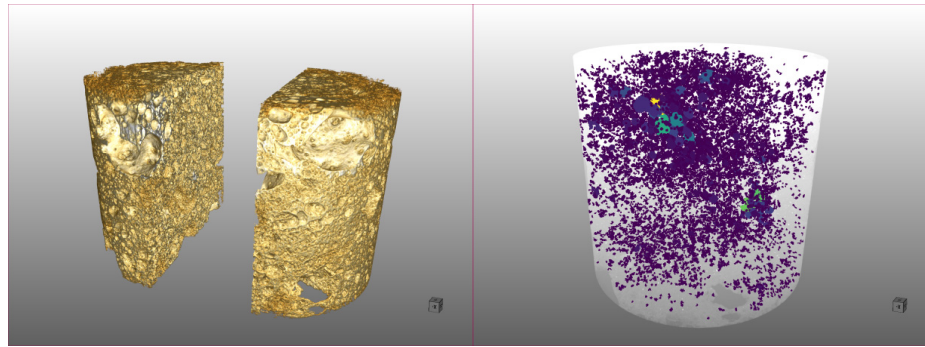


Figure S4. Three-Dimensional Structural Characterization of Magic Rack





FigureS5. Three-Dimensional Structural Characterization of Ceramic Pellet

Table S2. Sequence Statistics Table for Each Sample

Sample Name	Sequence Count	Base Pair Count	Average Sequence Length
Zeolite	45406	17061205	375.75
Volcanic Rock	57761	21723549	376.09
Gravel	46029	17318548	376.25
Magic Rack	47855	17978112	375.68
Ceramic Pellet	59191	22268374	376.21

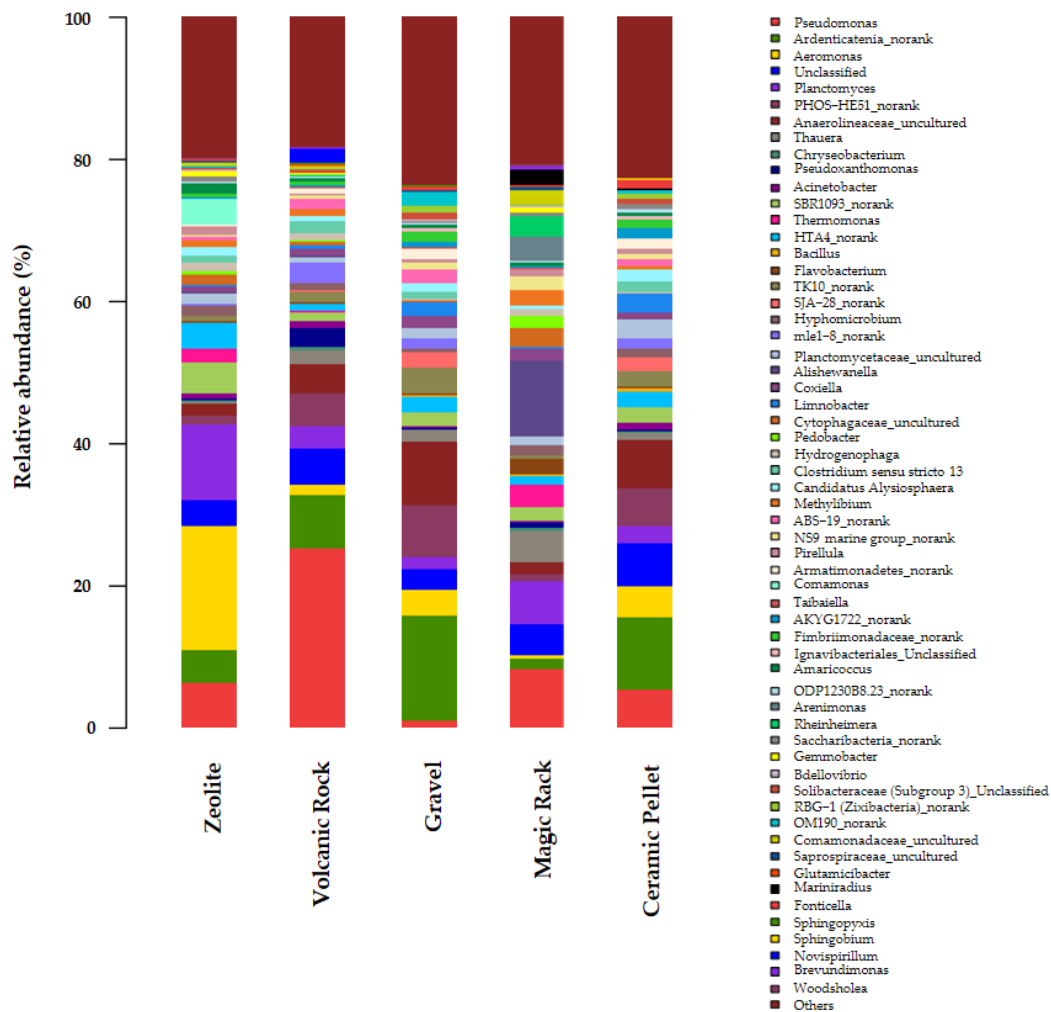


Figure S6. Species Relative Abundance Chart

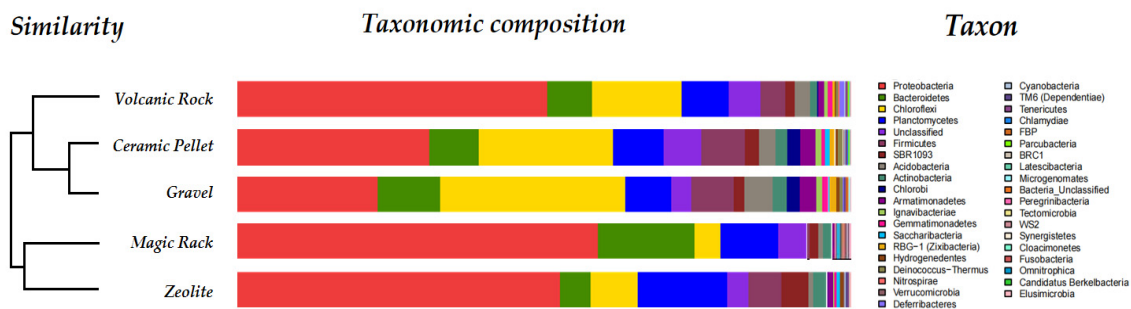


Figure S7. Phylogenetic Tree Diagram of Samples

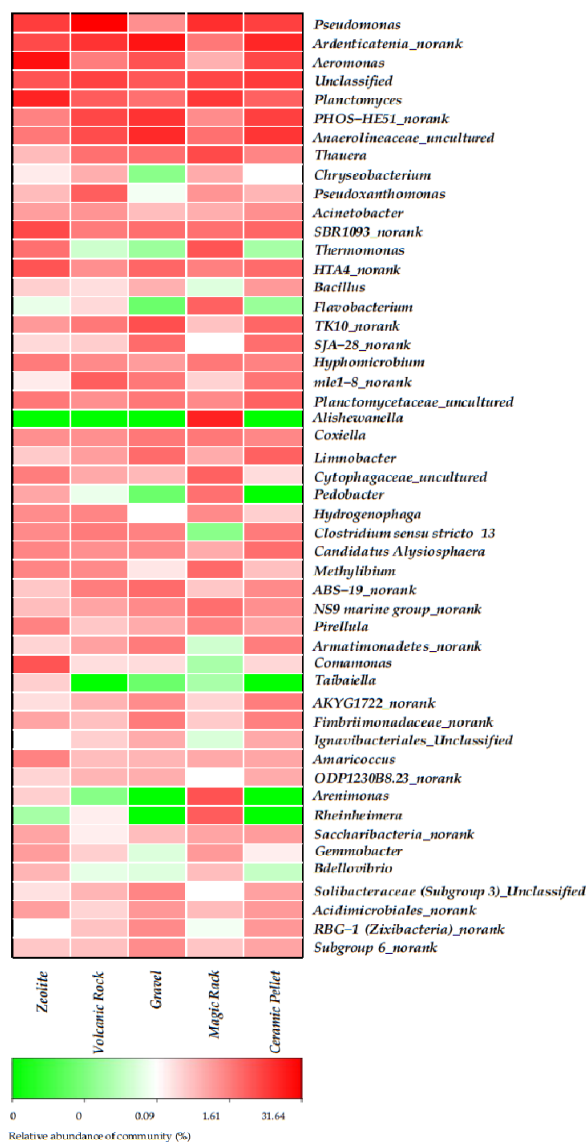


Figure S8. Heatmap Diagram of Samples

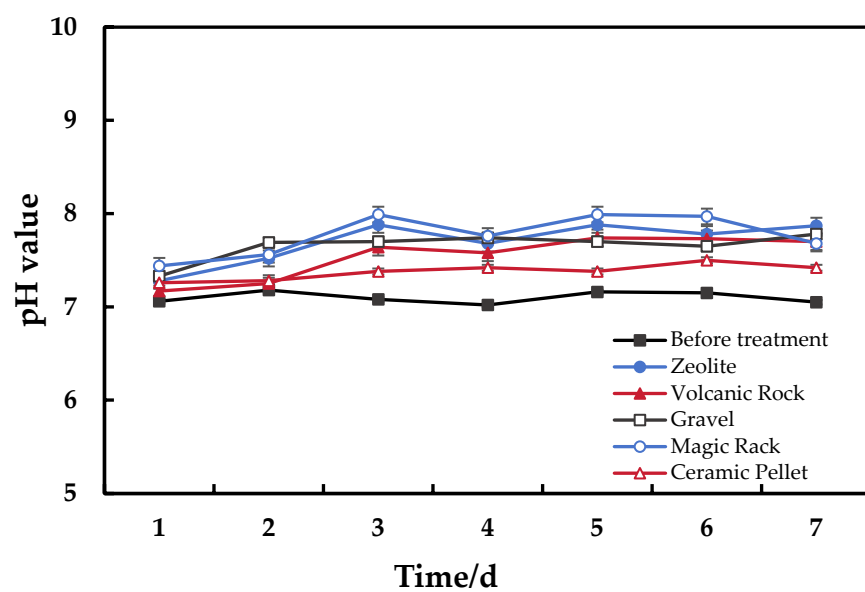


Figure S9. Effect of Substrate-Microorganism System on pH Reduction in Water