Appendix – Statistical Tables

Table A1. Three-way ANOVA for the Swelling Index (SI)

Factors: Treatment (static vs. cyclic), Matrix (dH_2O, sand, loam), Measurement Point (MP 0–10).

Effect	df	Sum of Squares	F-value	p-value	η^2
Treatment	1	1.56×10^{-6}	2.34×10^{-3}	0.962	0.00
Matrix	2	5.85×10^{3}	26.41	<0.001	0.45
MP	4	192.4	0.86	0.489	0.03
Treatment × Matrix	2	4.45×10^{-4}	3.99×10^{-3}	0.996	0.00
Treatment × MP	4	411.8	4.63	0.001	0.16
Matrix × MP	8	335.6	1.09	0.374	0.09
Treatment × Matrix × MP	8	406.5	1.33	0.182	0.11
Residual	108	12051.6	–	–	–

Table A2. Three-way ANOVA for T_{2WL} (^{1}H-NMR Relaxometry)

Factors: Treatment (static vs. cyclic), Matrix (dH_2O, sand, loam), Measurement Point (MP 0–10).

Effect	df	Sum of Squares	F-value	p-value	η^2
Treatment	1	1.12×10^{7}	1.52	0.220	0.05
Matrix	2	3.41×10^{10}	232.4	<0.001	0.78
MP	4	6.38×10^{9}	43.4	<0.001	0.15
Treatment × Matrix	2	1.89×10^{8}	2.57	0.079	0.01
Treatment × MP	4	4.37×10^{7}	0.30	0.878	0.00
Matrix × MP	8	1.01×10^{9}	6.89	<0.001	0.02
Treatment × Matrix × MP	8	4.85×10^{7}	0.33	0.959	0.00
Residual	108	1.58×10^{9}	–	–	–

Table A3. Three-way ANOVA for T_{2peak} (^{1}H-NMR Relaxometry)

Factors: Treatment (static vs. cyclic), Matrix (dH_2O, sand, loam), Measurement Point (MP 0–10).

Effect	df	Sum of Squares	F-value	p-value	η^2
Treatment	1	5.89×10^{6}	1.08	0.301	0.03
Matrix	2	1.76×10^{10}	162.6	<0.001	0.72
MP	4	2.67×10^{9}	61.7	<0.001	0.11
Treatment × Matrix	2	1.22×10^{8}	1.12	0.329	0.01
Treatment × MP	4	3.55×10^{7}	0.62	0.651	0.00
Matrix × MP	8	7.76×10^{8}	11.20	<0.001	0.03
Treatment × Matrix × MP	8	4.47×10^{7}	0.65	0.734	0.00
Residual	108	7.48×10^{8}	–	–	–

Table A4. Three-way ANOVA for τ_{max} (Rheology)

Factors: Treatment (static vs. cyclic), Matrix (dH_2O, sand, loam), Measurement Point (MP 0–10).

Effect	df	Sum of Squares	F-value	p-value	η^2
Treatment	1	2.51×10^{4}	0.38	0.540	0.01
Matrix	2	3.95×10^{6}	59.3	<0.001	0.61
MP	4	9.74×10^{5}	36.6	<0.001	0.15
Treatment × Matrix	2	3.01×10^{4}	0.45	0.642	0.00
Treatment × MP	4	1.55×10^{4}	0.58	0.678	0.00
Matrix × MP	8	5.42×10^{5}	10.1	<0.001	0.08
Treatment × Matrix × MP	8	3.29×10^{4}	0.61	0.763	0.01
Residual	108	7.19×10^{5}	–	–	–

Table A5. Three-way ANOVA for τ at tan δ = 1 (τ_{YP})

Factors: Treatment (static vs. cyclic), Matrix (dH_2O, sand, loam), Measurement Point (MP 0–10).

Effect	df	Sum of Squares	F-value	p-value	η^2
Treatment	1	1.77×10^4	0.41	0.524	0.01
Matrix	2	2.61×10^6	60.3	<0.001	0.58
MP	4	7.86×10^5	36.2	<0.001	0.17
Treatment × Matrix	2	2.11×10^4	0.49	0.615	0.01
Treatment × MP	4	2.41×10^4	0.55	0.699	0.01
Matrix × MP	8	3.41×10^5	7.85	<0.001	0.08
Treatment × Matrix × MP	8	2.85×10^4	0.65	0.731	0.01
Residual	108	6.19×10^5	–	–	–

Table A6. Three-way ANOVA for γ at tan δ = 1 (γ_{YP})

Factors: Treatment (static vs. cyclic), Matrix (dH_2O, sand, loam), Measurement Point (MP 0–10).

Effect	df	Sum of Squares	F-value	p-value	η^2
Treatment	1	0.37	0.41	0.523	0.01
Matrix	2	87.54	60.2	<0.001	0.56
MP	4	23.86	8.22	<0.001	0.15
Treatment × Matrix	2	0.73	0.46	0.631	0.00
Treatment × MP	4	1.56	0.54	0.703	0.01
Matrix × MP	8	9.47	6.52	<0.001	0.08
Treatment × Matrix × MP	8	1.04	0.71	0.689	0.01
Residual	108	19.62	–	–	–

Table A7. Three-way ANOVA for CH_2

Factors: Treatment (static vs. cyclic), Matrix (dH_2O, sand, loam), Measurement Point (MP 0–10).

Effect	df	Sum of Squares	F-value	p-value	η^2
Treatment	1	0.0014	0.06	0.805	0.00
Matrix	2	0.0953	2.11	0.128	0.05
MP	6	0.0311	0.23	0.968	0.01
Treatment × Matrix	2	0.0110	0.12	0.890	0.00
Treatment × MP	6	0.0197	0.15	0.989	0.00
Matrix × MP	12	0.1281	0.47	0.920	0.06
Treatment × Matrix × MP	12	0.0791	0.29	0.991	0.04
Residual	72	1.9655	–	–	–

Table A8. Three-way ANOVA for OH

Factors: Treatment (static vs. cyclic), Matrix (dH_2O, sand, loam), Measurement Point (MP 0–10).

Effect	df	Sum of Squares	F-value	p-value	η^2
Treatment	1	0.0002	0.08	0.782	0.00
Matrix	2	0.0024	0.51	0.603	0.01
MP	6	0.0027	0.19	0.973	0.01
Treatment × Matrix	2	0.0044	0.46	0.633	0.01
Treatment × MP	6	0.0043	0.30	0.936	0.01
Matrix × MP	12	0.0305	1.06	0.404	0.08
Treatment × Matrix × MP	12	0.0206	0.72	0.736	0.06
Residual	72	0.8283	–	–	–

Table A9. Three-way ANOVA for carbonyl/carboxyl

Factors: Treatment (static vs. cyclic), Matrix (dH_2O, sand, loam), Measurement Point (MP 0–10).

Effect	df	Sum of Squares	F-value	p-value	η^2
Treatment	1	0.0049	0.17	0.683	0.00
Matrix	2	0.2319	3.92	0.024	0.09
MP	6	0.2785	1.57	0.167	0.13
Treatment × Matrix	2	0.0912	1.54	0.221	0.04
Treatment × MP	6	0.0686	0.39	0.885	0.03
Matrix × MP	12	0.2852	0.96	0.495	0.13
Treatment × Matrix × MP	12	0.2622	0.88	0.575	0.12
Residual	72	2.1326	–	–	–

Table A10. Three-way ANOVA for SiO/Al-O-Si

Factors: Treatment (static vs. cyclic), Matrix (dH_2O, sand, loam), Measurement Point (MP 0–10).

Effect	df	Sum of Squares	F-value	p-value	η^2
Treatment	1	0.0005	0.01	0.920	0.00
Matrix	2	0.4434	8.44	<0.001	0.17
MP	6	0.0474	0.30	0.933	0.02
Treatment × Matrix	2	0.0426	0.81	0.449	0.02
Treatment × MP	6	0.0515	0.33	0.917	0.02
Matrix × MP	12	0.2875	1.02	0.435	0.11
Treatment × Matrix × MP	12	0.2037	0.72	0.740	0.08
Residual	72	1.8877	–	–	–