
APPENDIX D. SUPPLEMENTAL FLAC3D RESULTS FOR BULKHEAD IN QUEENSTON AND MANITOULIN FORMATIONS

This appendix includes the plots with the results for bulkhead in Queenston and Manitoulin formations. The summary plots show yielded zones in the model, contours of the shear and the volumetric strains in the isometric view but also in the horizontal cross-sections 22.4 m above the middle of the seal, in the middle of the seal and 22.4 m below the middle of the seal. The results are shown at the characteristic times, including: (1) time after shaft excavation, (2) 100 years (pre-closure), (3) 200 years (post-closure), (4) 100,000 years and (5) 1,000,000 years. The included results are for: (1) time-dependent strength degradation, (2) time-dependent strength degradation and glacial load, and (3) time-dependent strength degradation, glacial load and pore pressure.

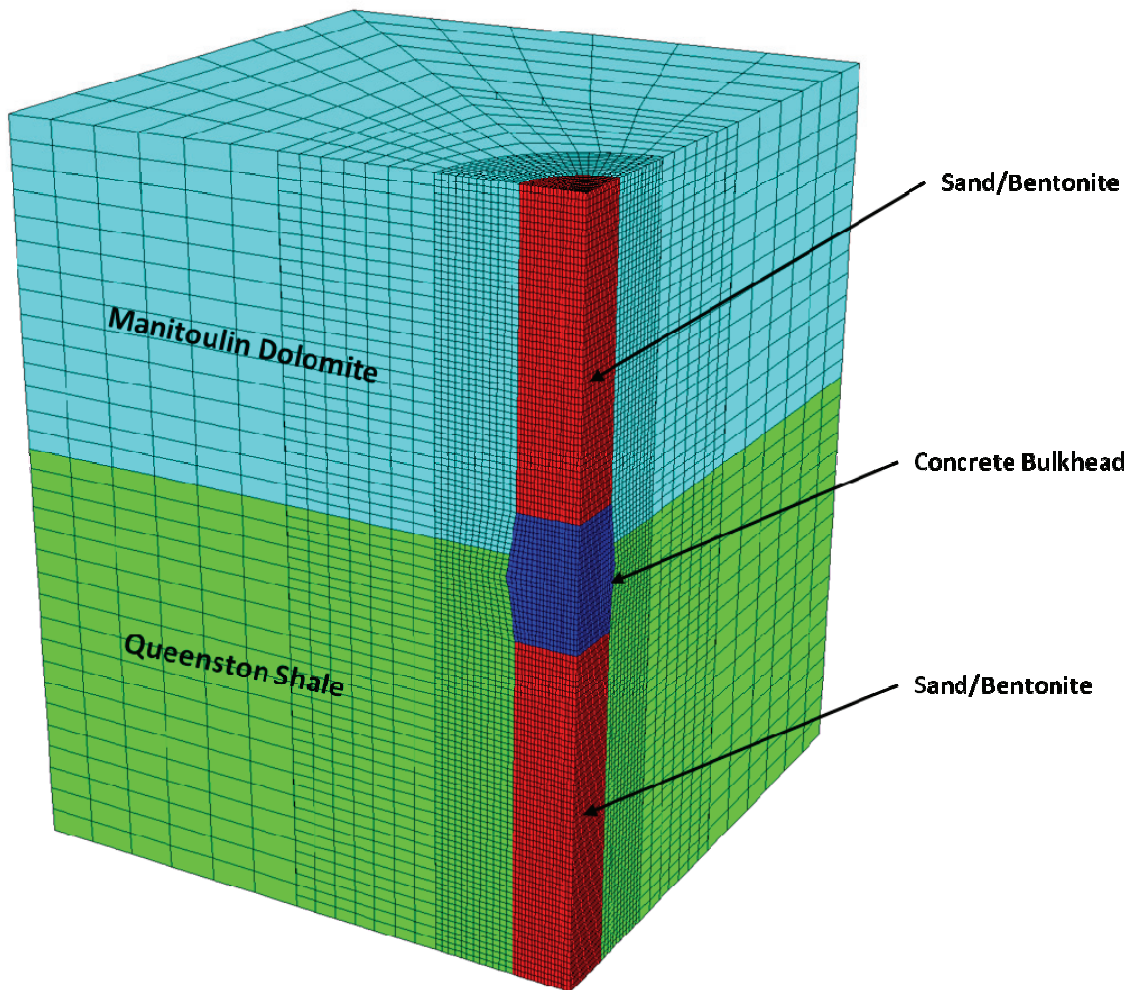


Figure D.1: Layout of Quarter-symmetrical FLAC3D Model of Over-excavated and Backfilled Main Shaft for Bulkhead in Queenston and Manitoulin Formations

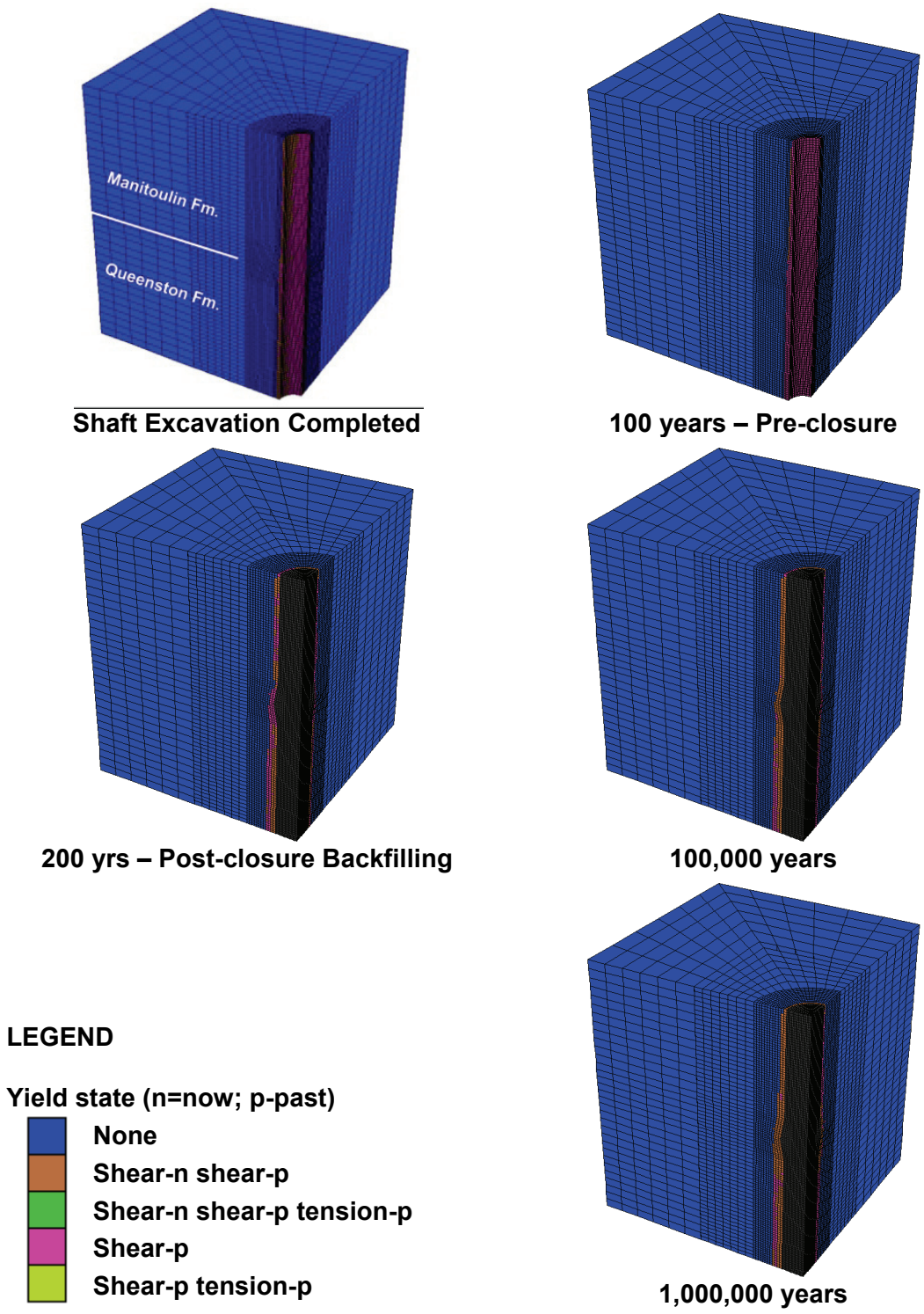


Figure D.2: Yield State – Concrete Bulkhead: Time-dependent Strength Degradation

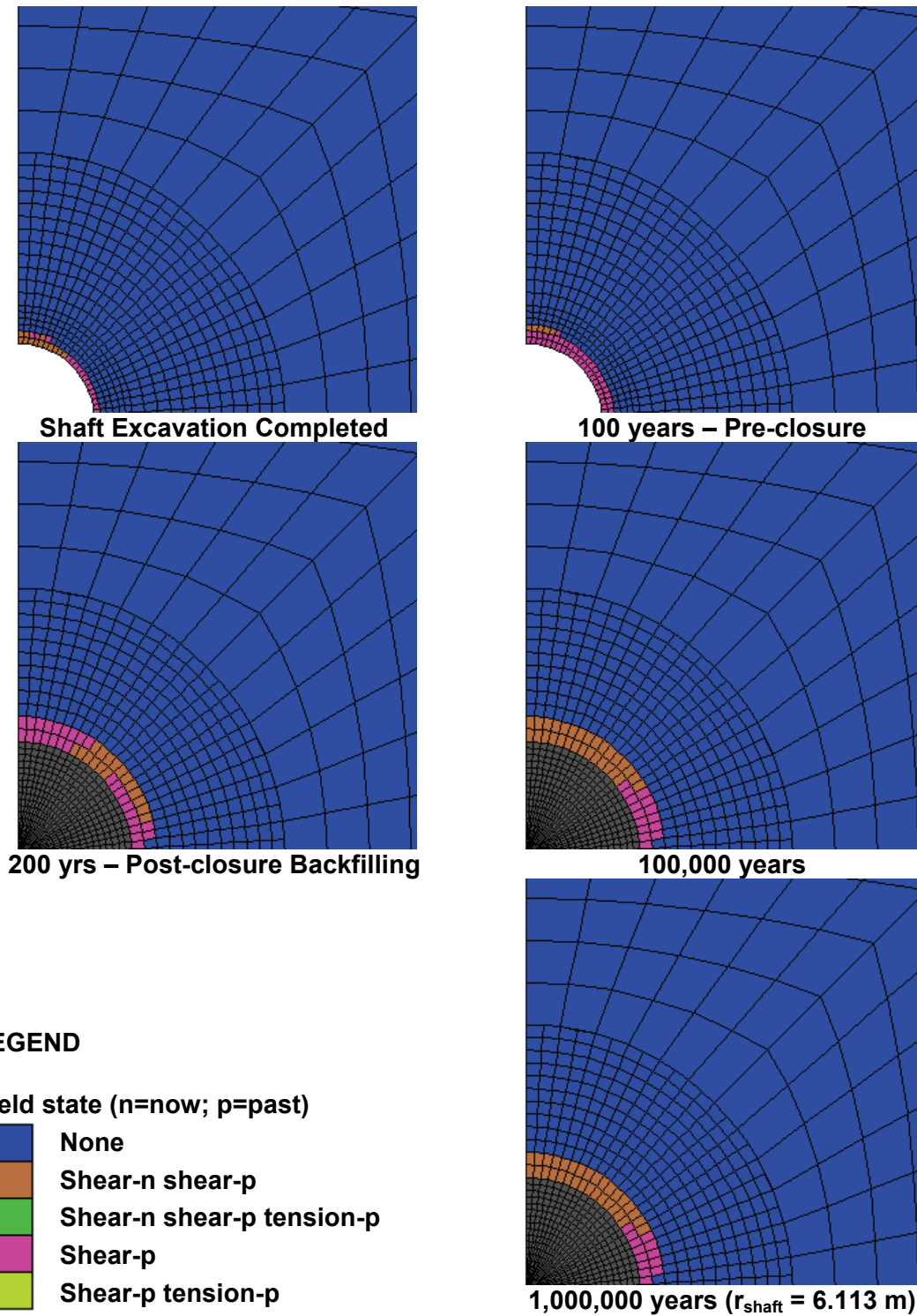


Figure D.3: Yield State – 22.4 m Above Concrete Bulkhead: Time-dependent Strength Degradation

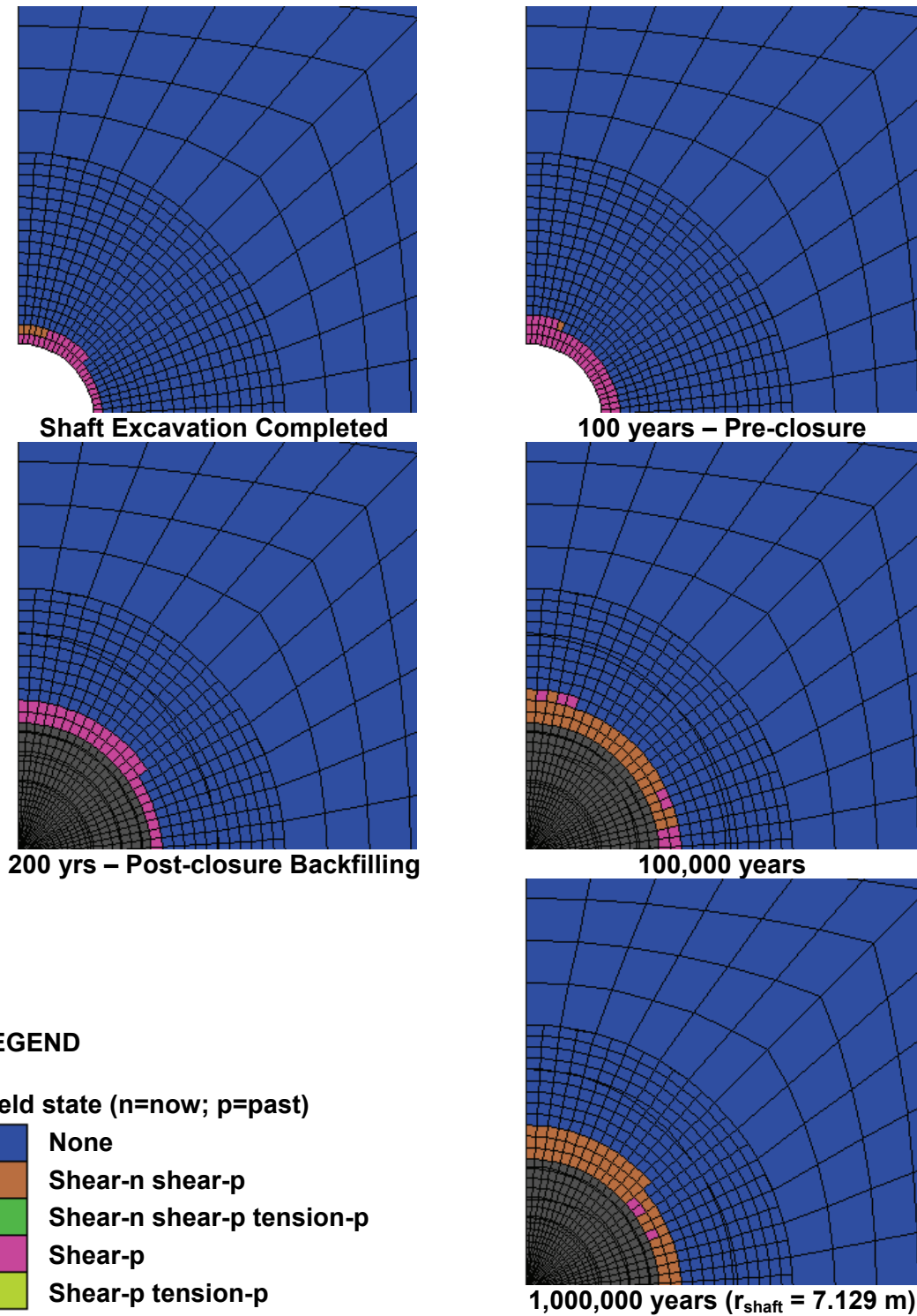


Figure D.4: Yield State – Middle Concrete Bulkhead: Time-dependent Strength Degradation

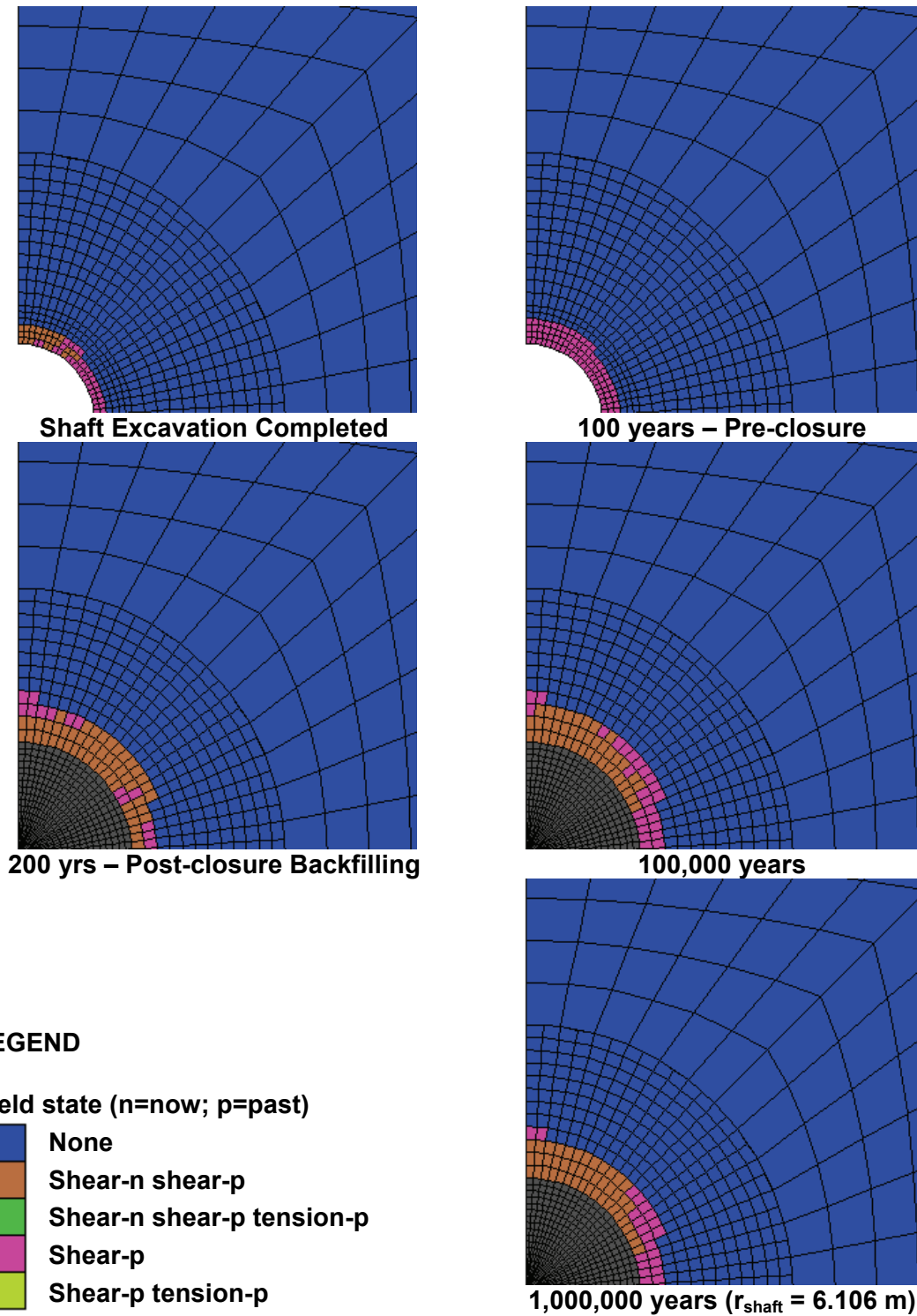


Figure D.5: Yield State – 22.4 m Below Concrete Bulkhead: Time-dependent Strength Degradation

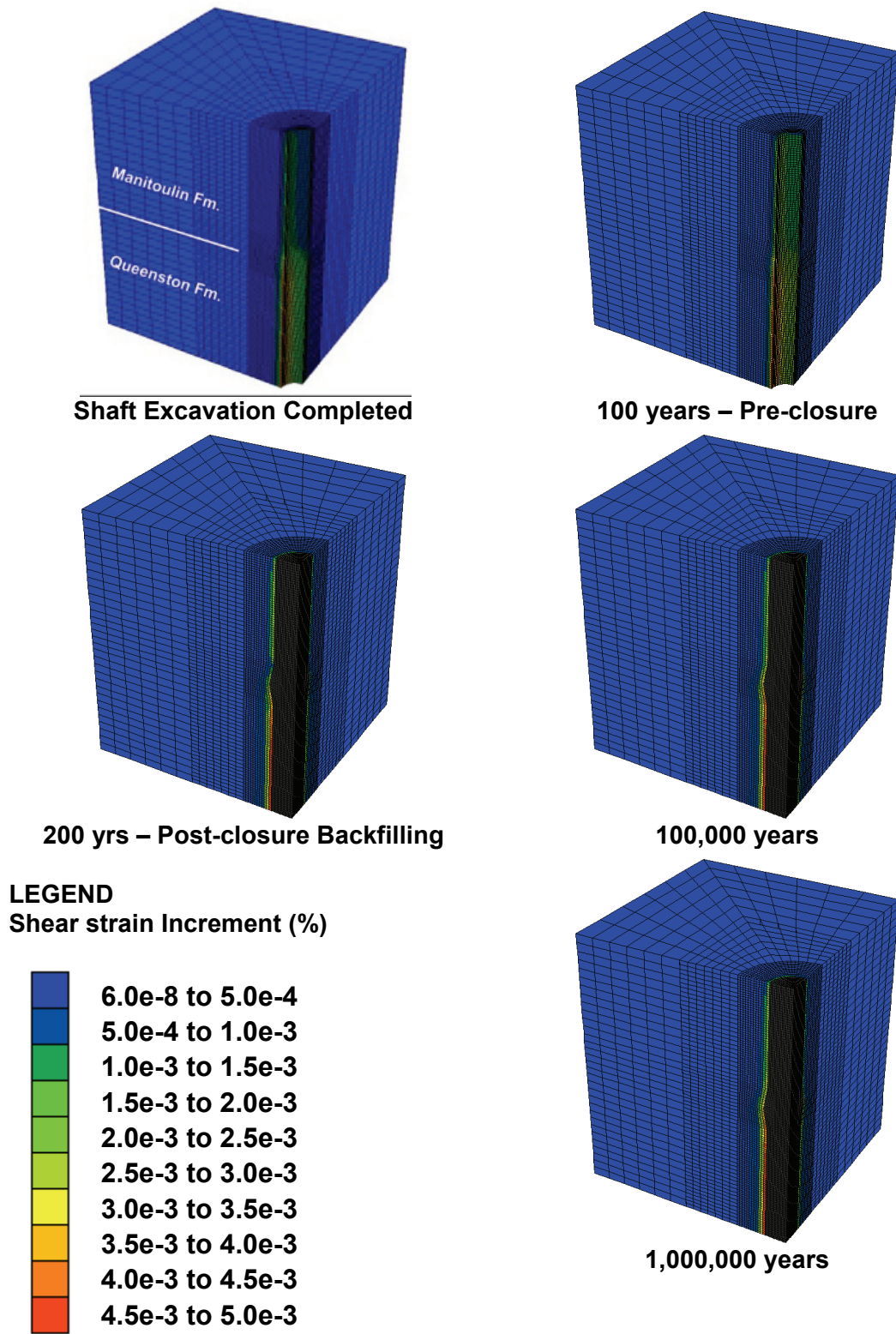


Figure D.6: Shear Strain – Concrete Bulkhead: Time-dependent Strength Degradation

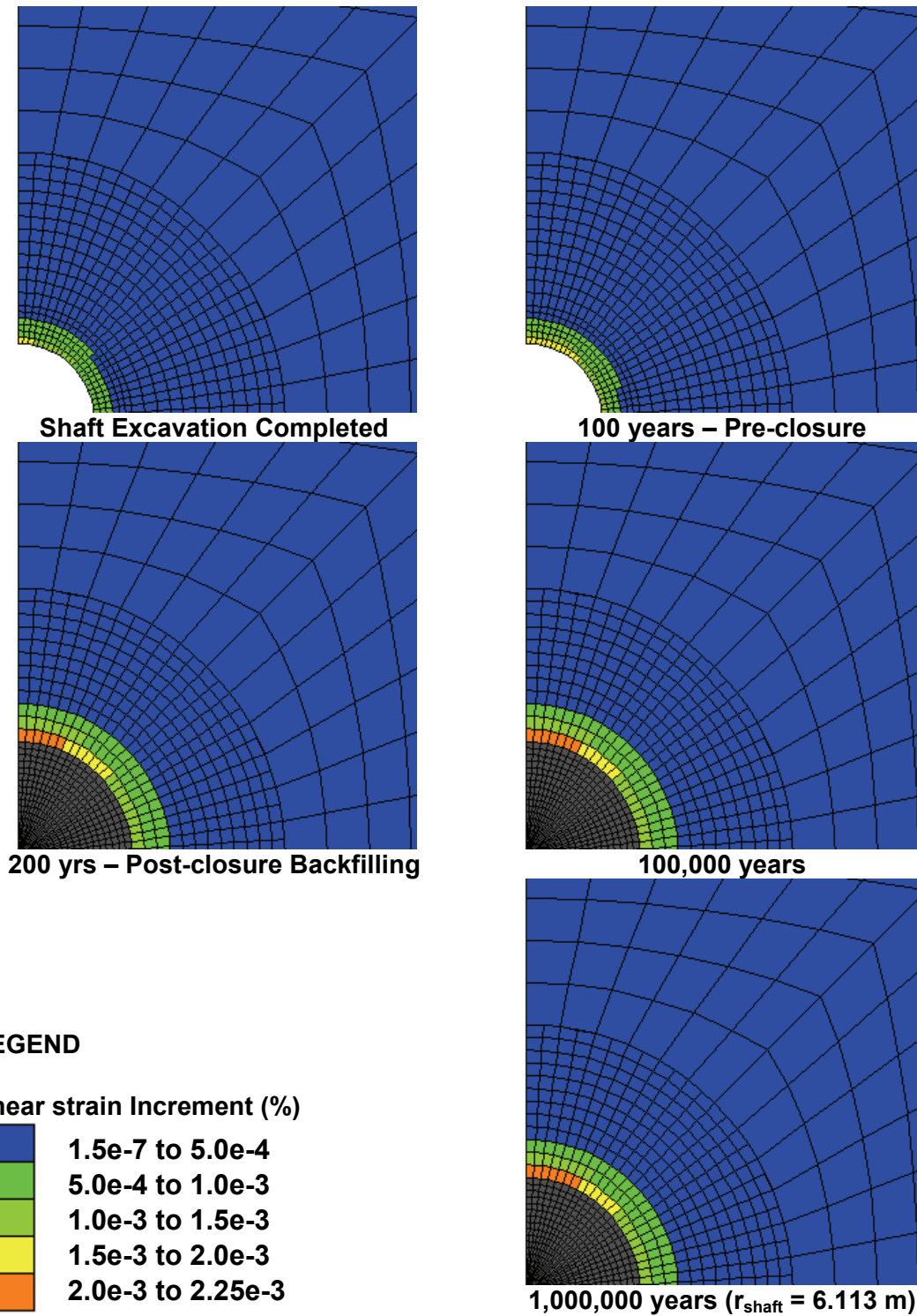


Figure D.7: Shear Strain – 22.4 m Above Concrete Bulkhead: Time-dependent Strength Degradation

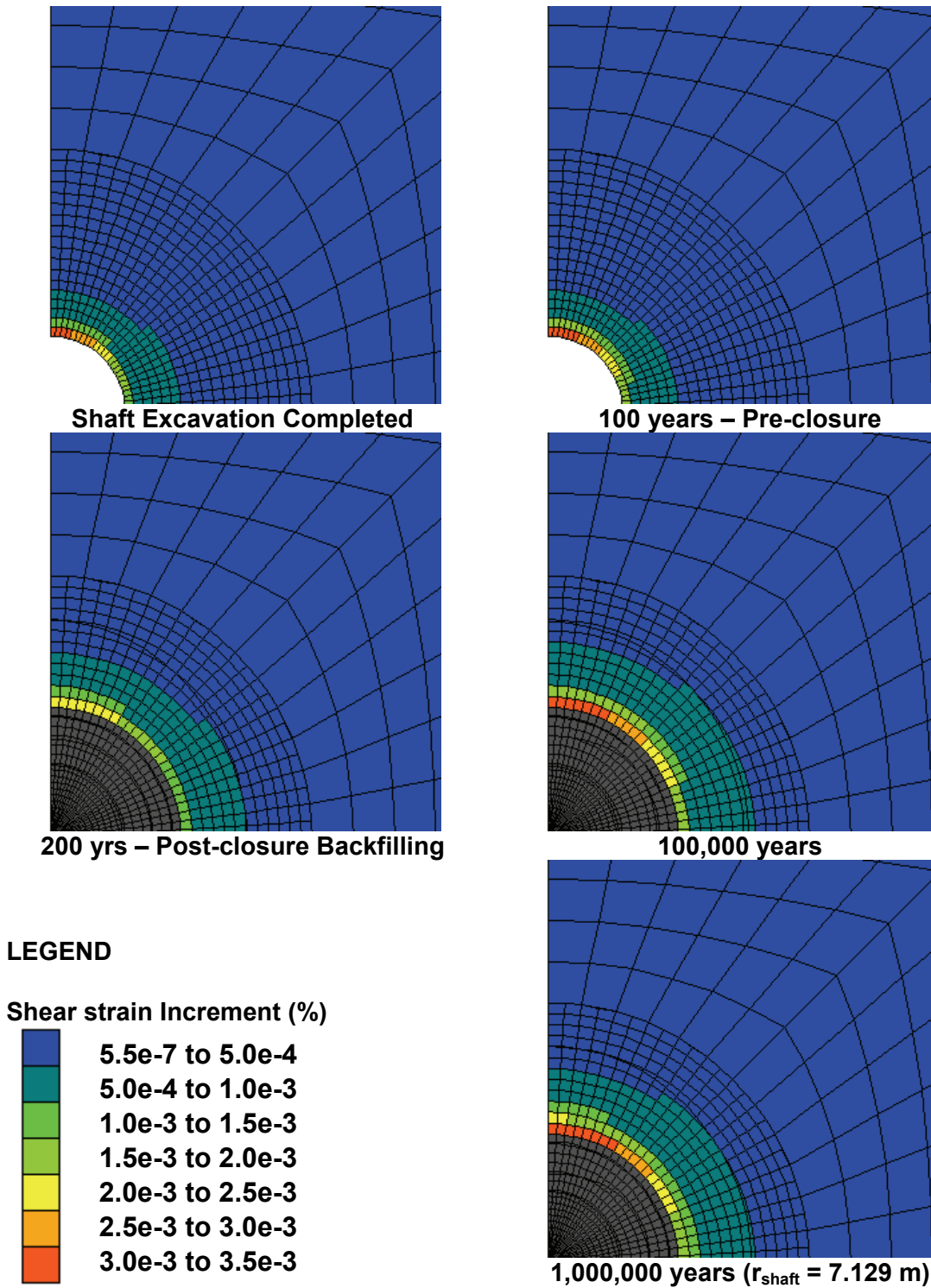


Figure D.8: Shear Strain – Middle Concrete Bulkhead: Time-dependent Strength Degradation

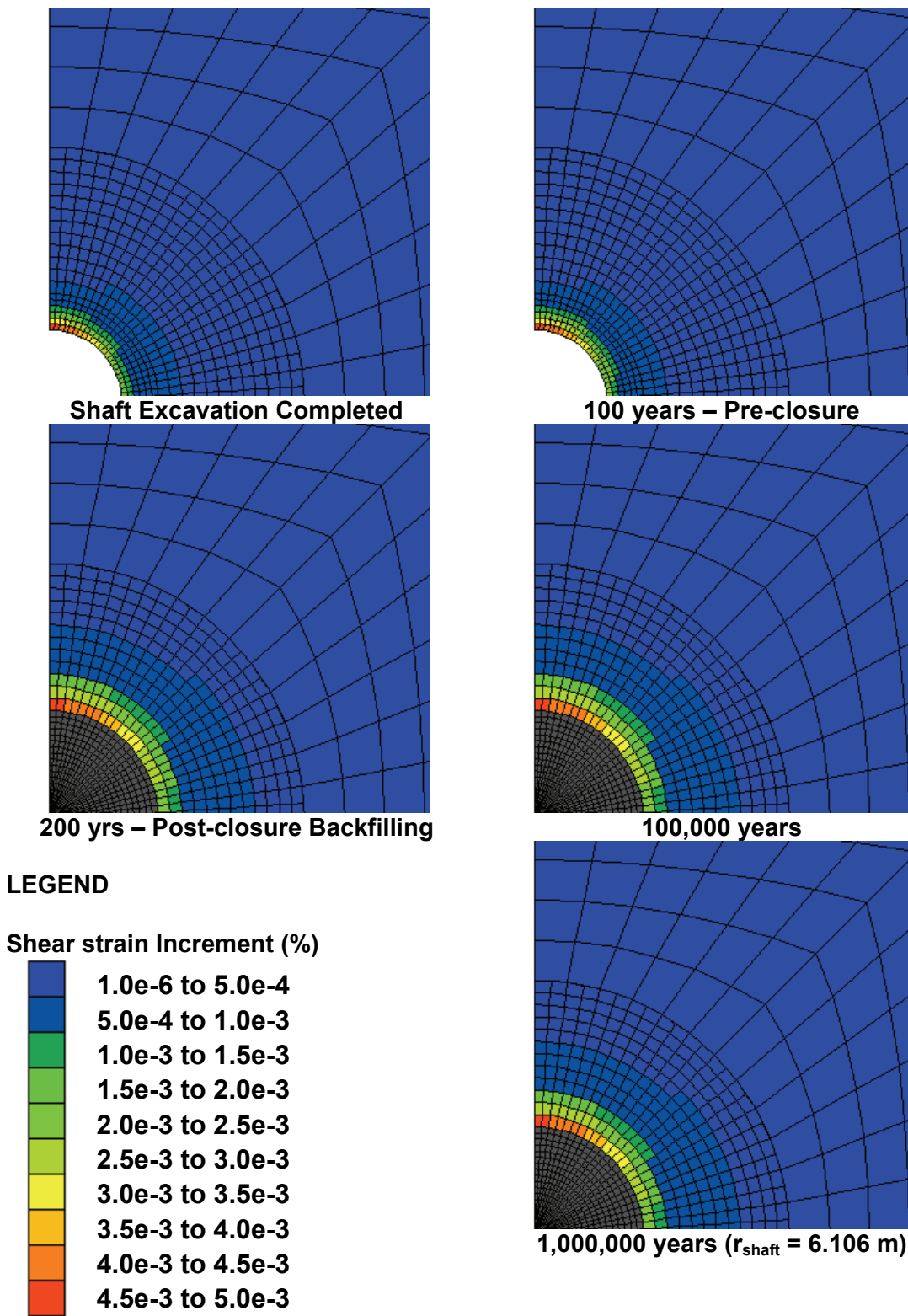


Figure D.9: Shear Strain – 22.4 m Below Concrete Bulkhead: Time-dependent Strength Degradation

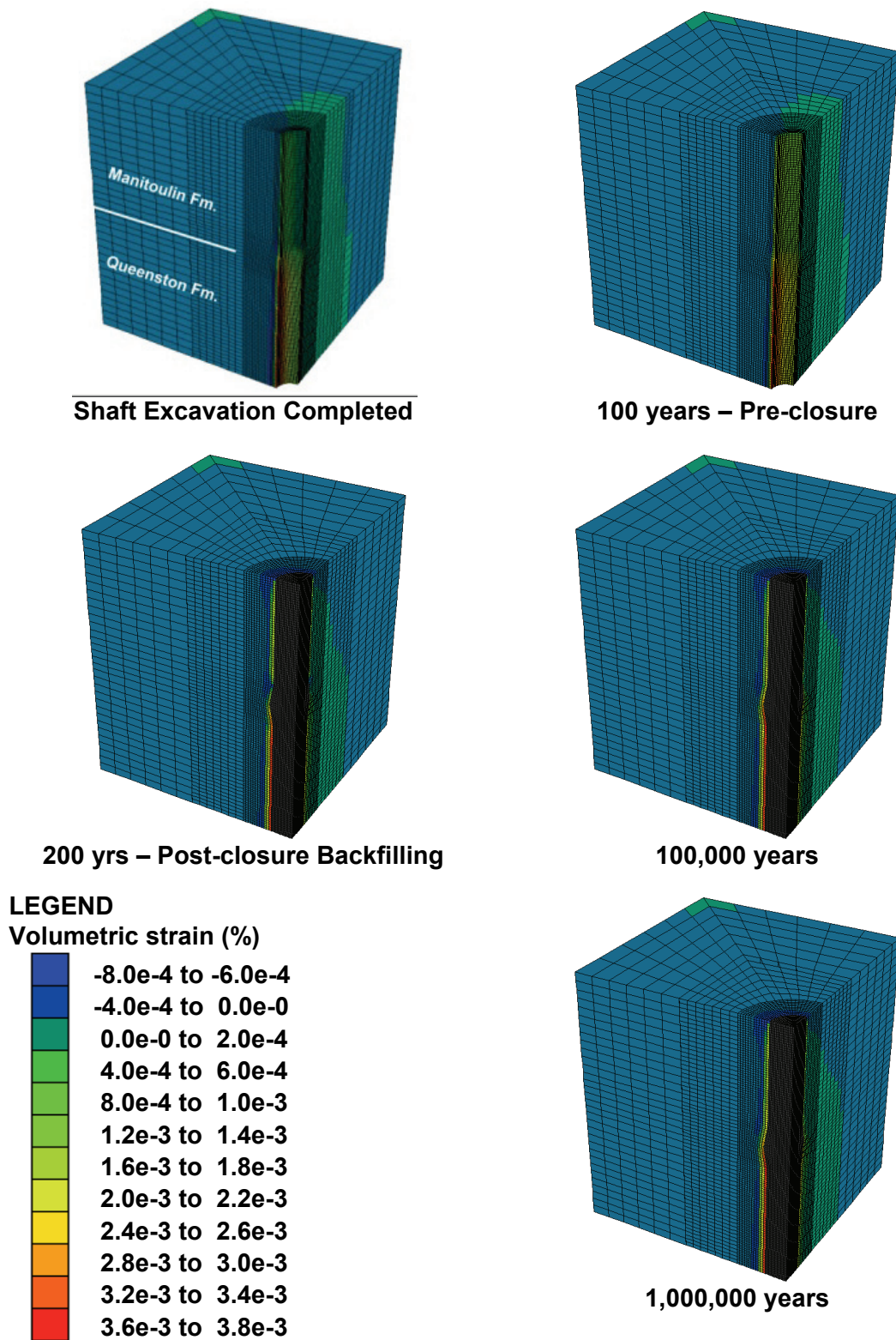


Figure D.10: Volumetric Strain – Concrete Bulkhead: Time-dependent Strength Degradation

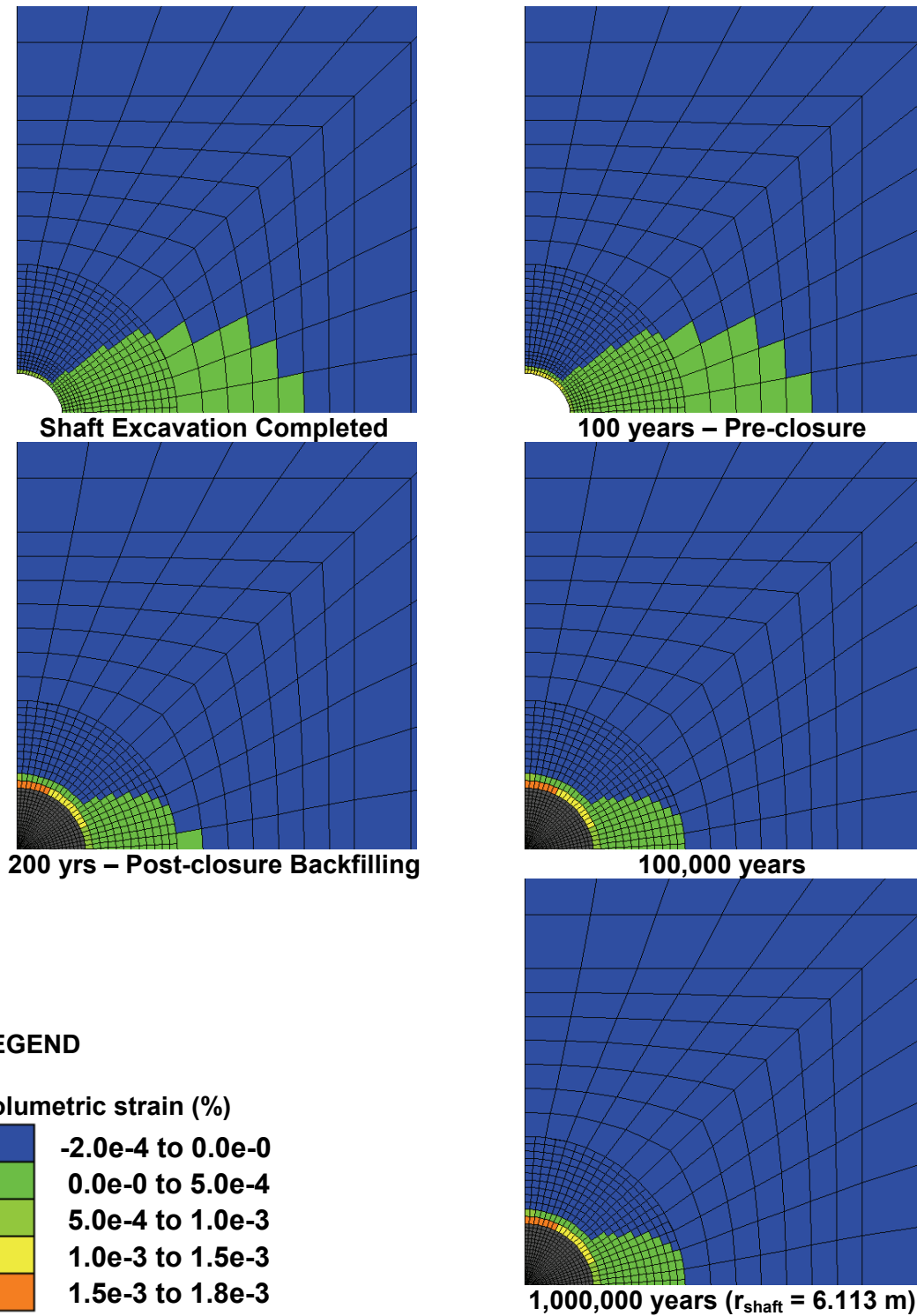


Figure D.11: Volumetric Strain – 22.4 m Above Concrete Bulkhead: Time-dependent Strength Degradation

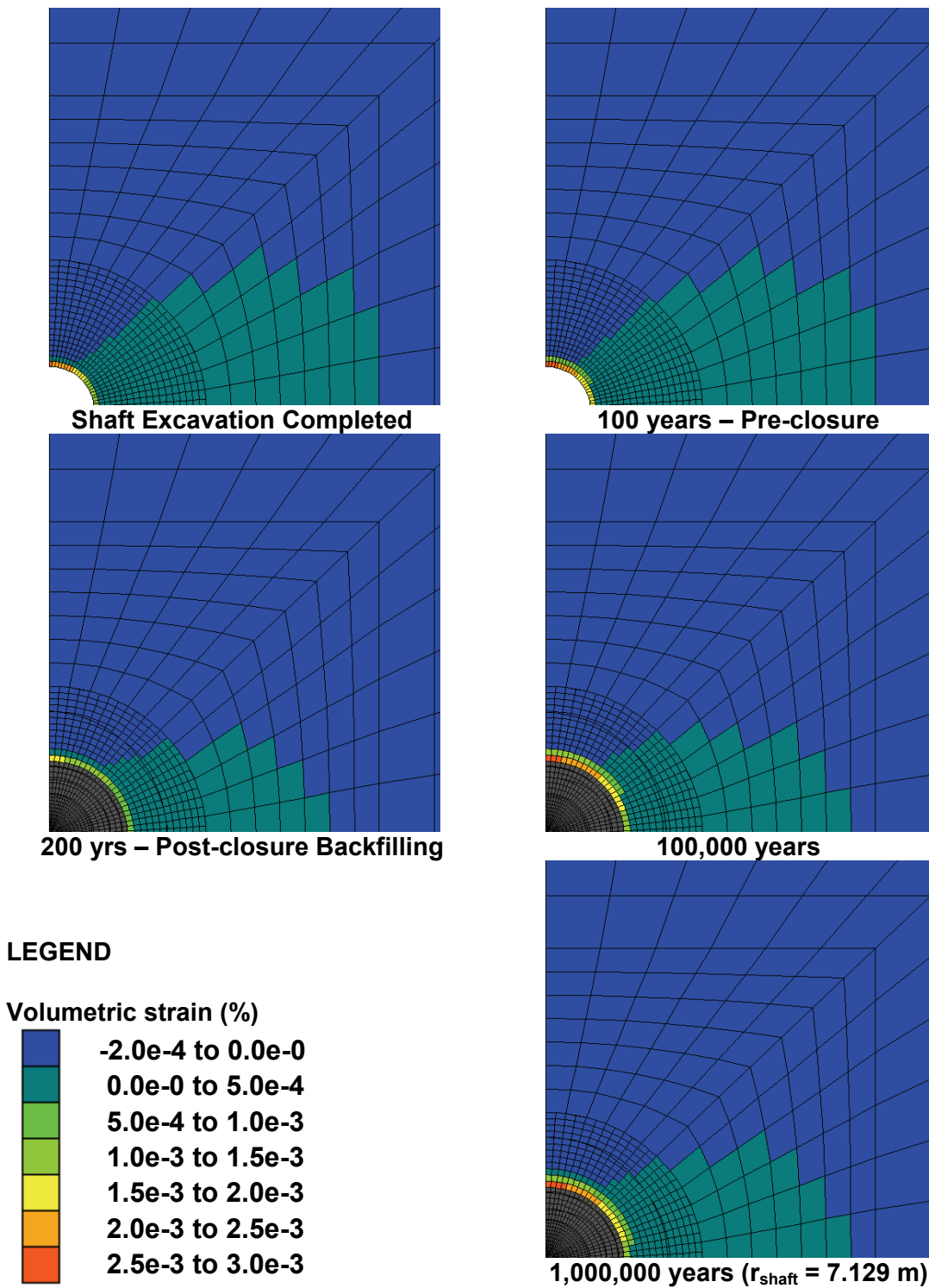


Figure D.12: Volumetric Strain – Middle Concrete Bulkhead: Time-dependent Strength Degradation

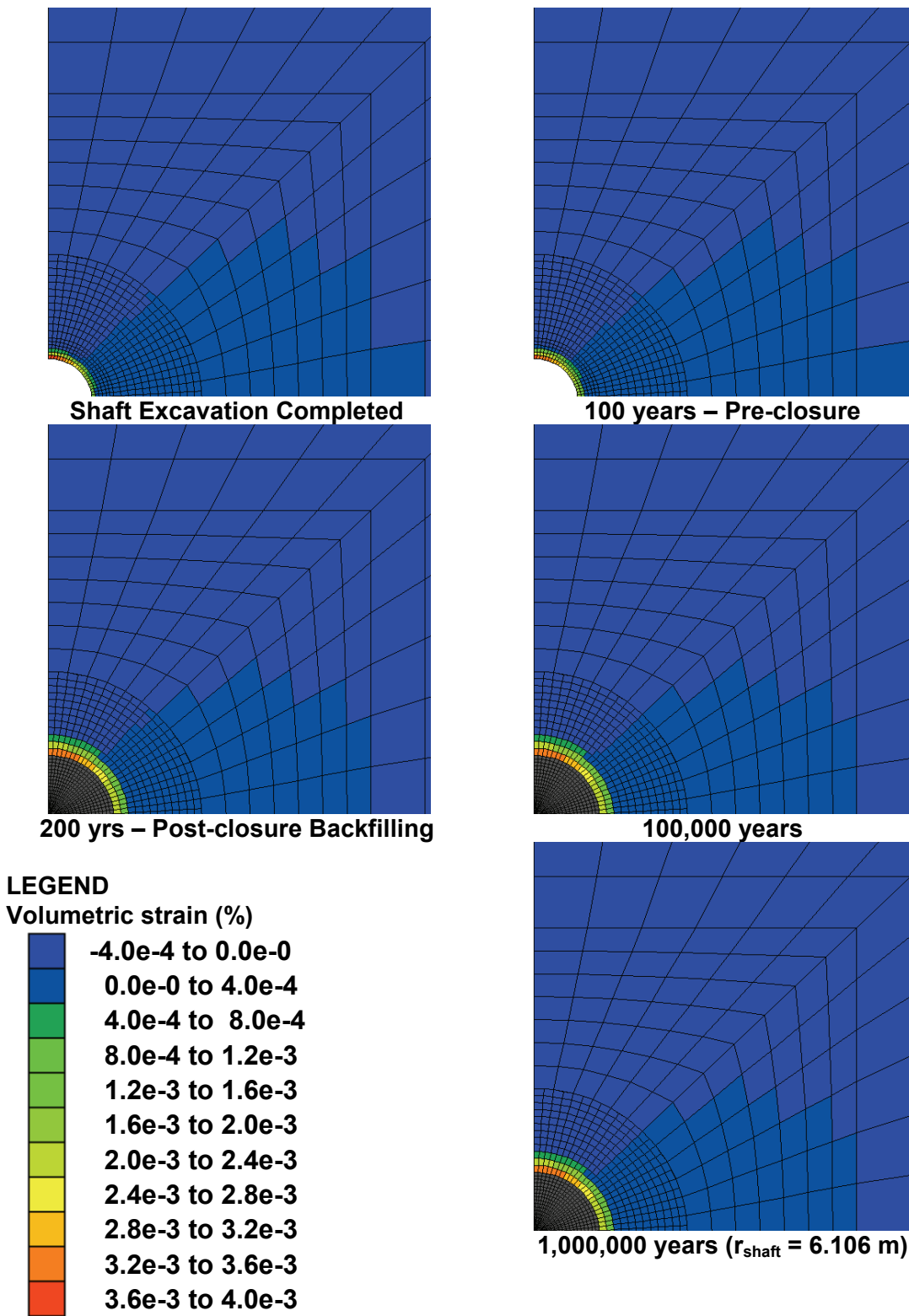


Figure D.13: Volumetric Strain – 22.4 m Below Concrete Bulkhead: Time-dependent Strength Degradation

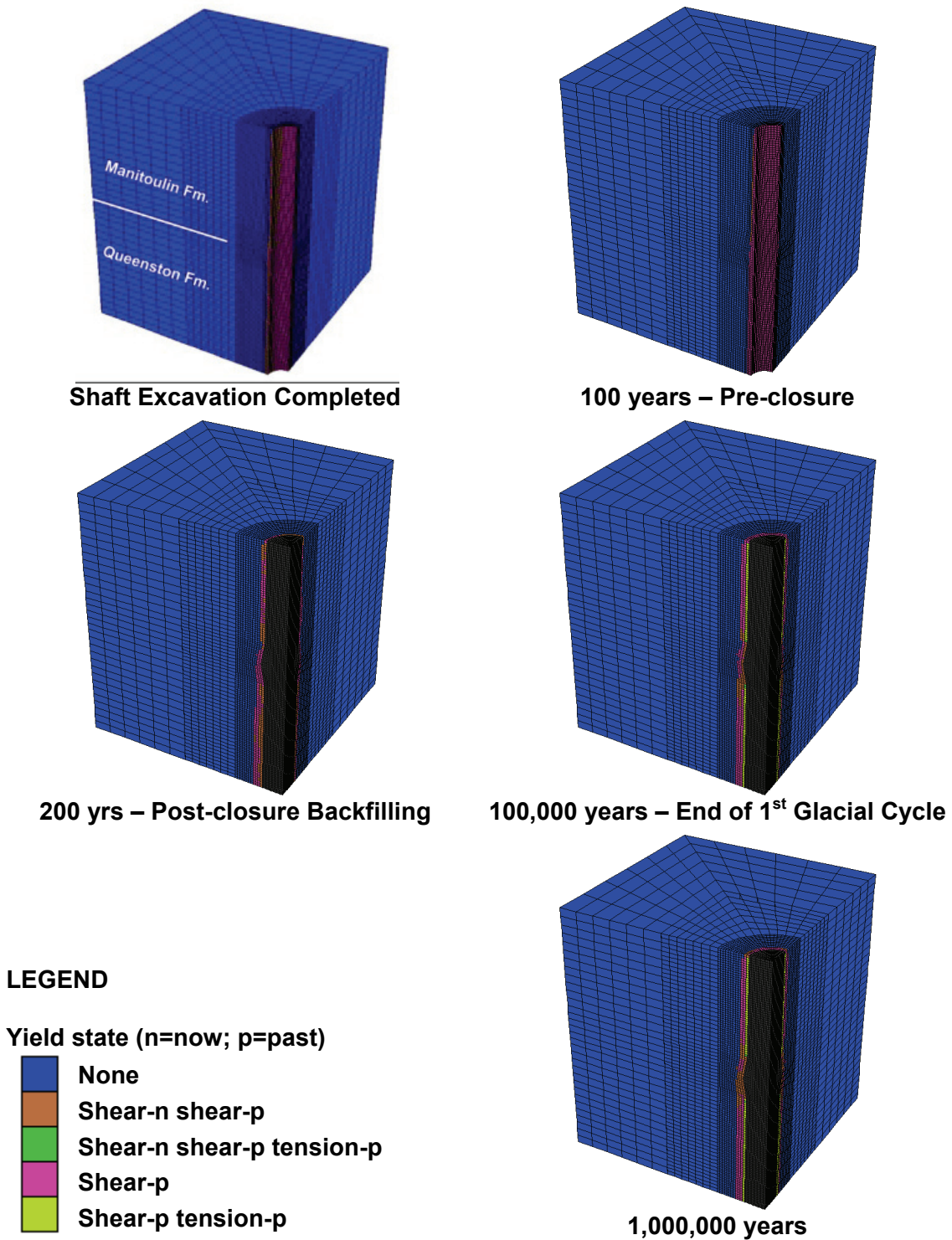


Figure D.14: Yield State – Concrete Bulkhead: Time-dependent Strength Degradation + Glacial Load

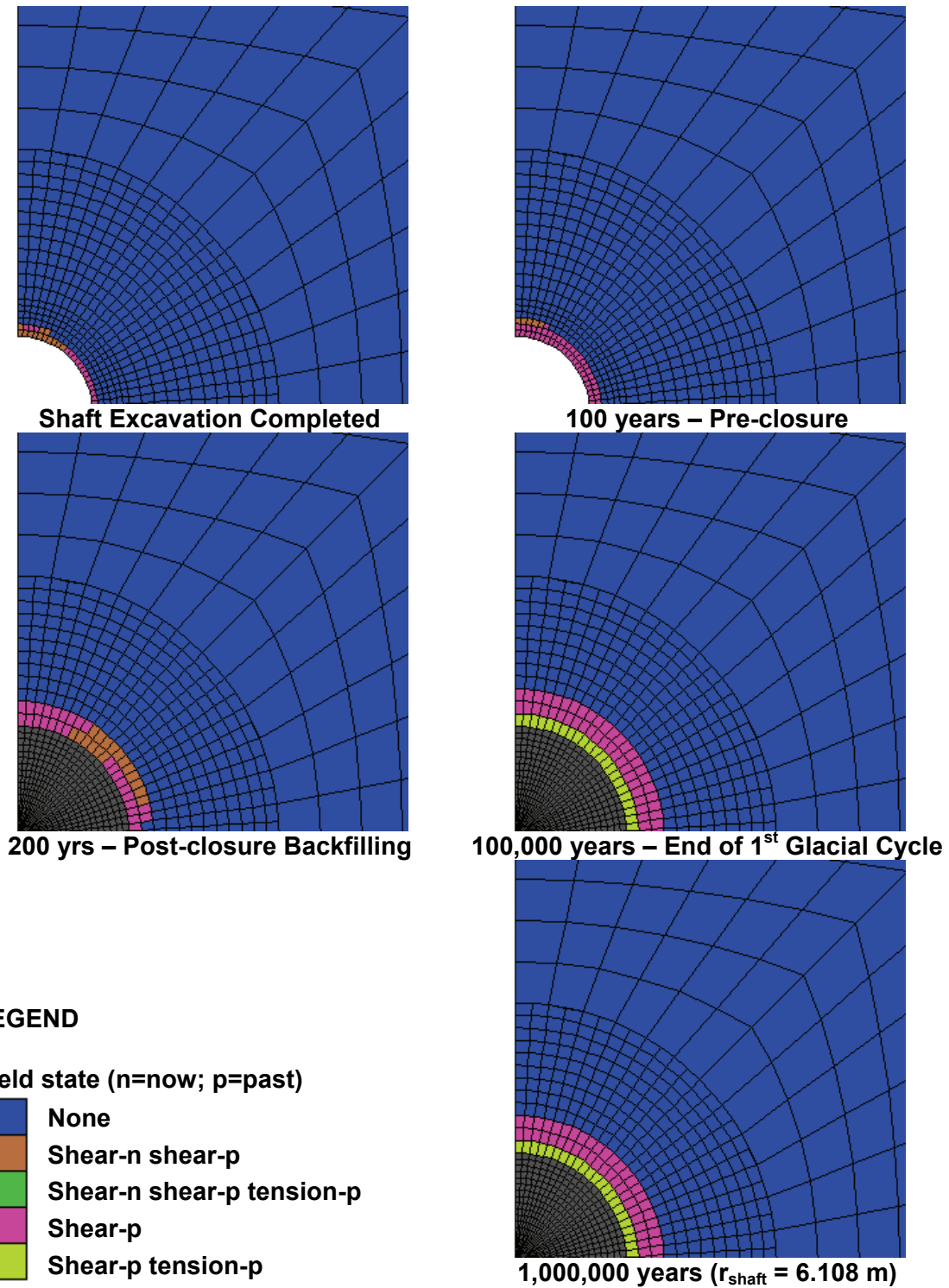


Figure D.15: Yield State – 22.4 m Above Concrete Bulkhead: Time-dependent Strength Degradation + Glacial Load

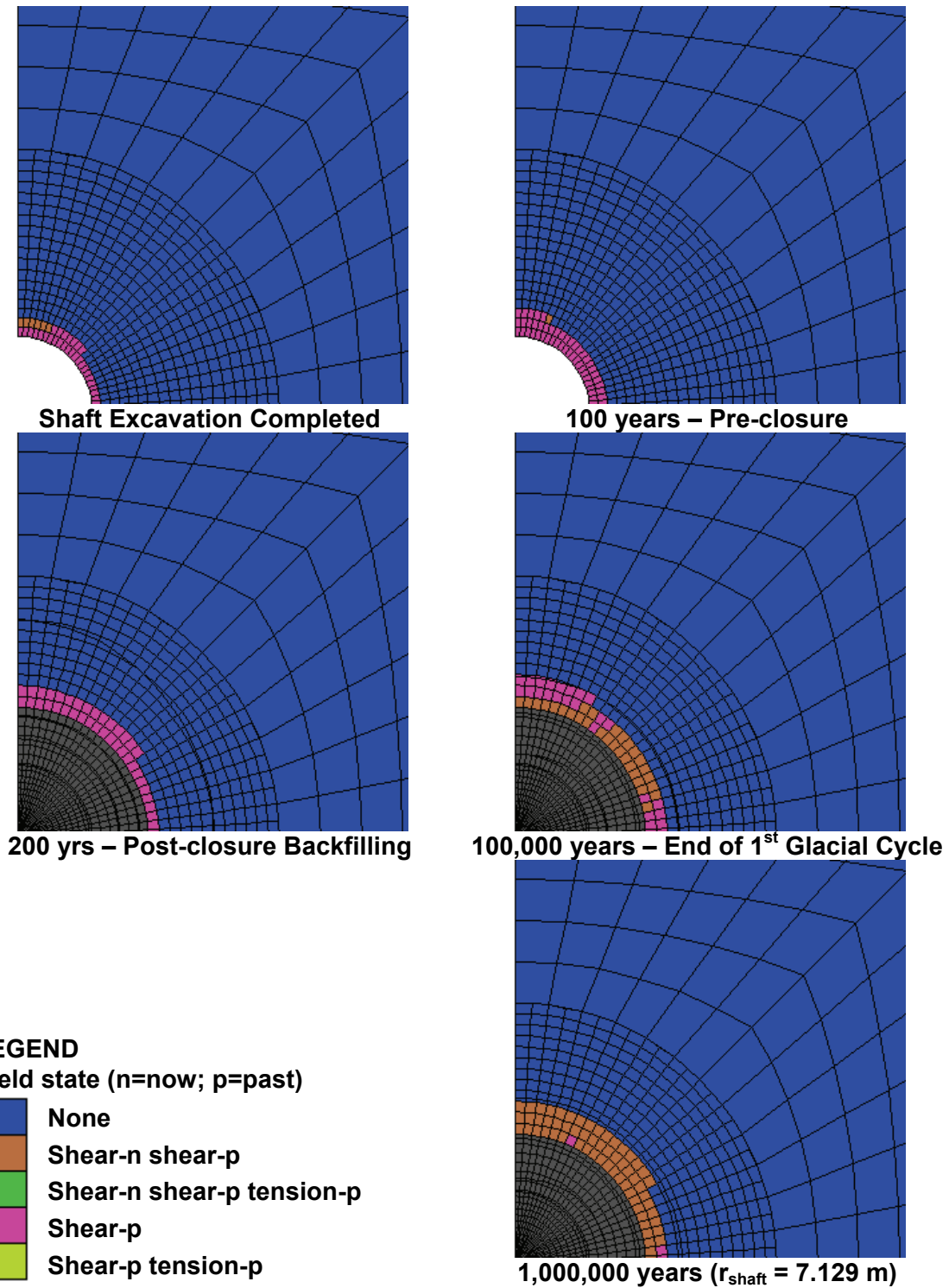


Figure D.16: Yield State – Middle Concrete Bulkhead: Time-dependent Strength Degradation + Glacial Load

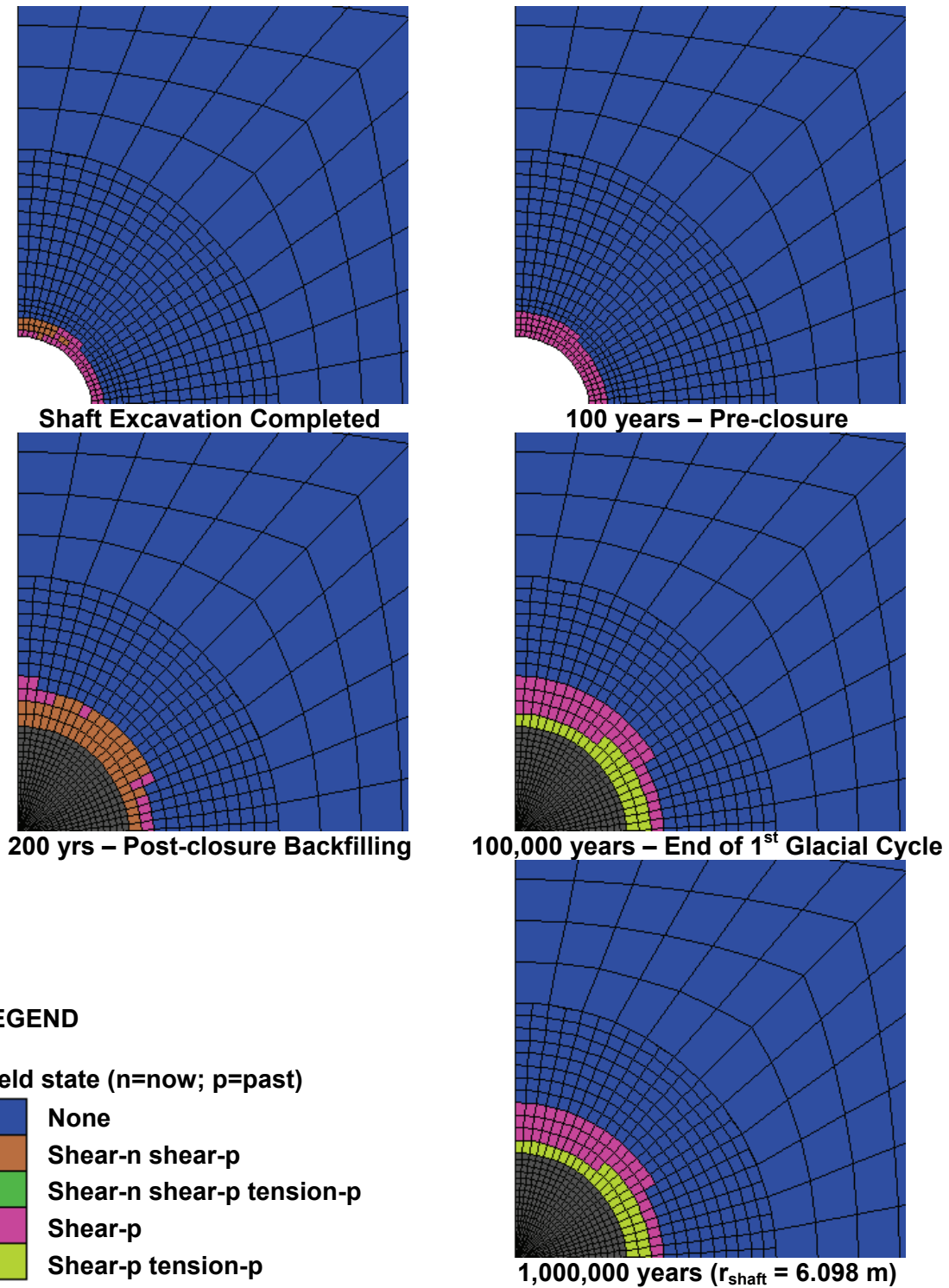


Figure D.17: Yield State – 22.4 m Below Concrete Bulkhead: Time-dependent Strength Degradation + Glacial Load

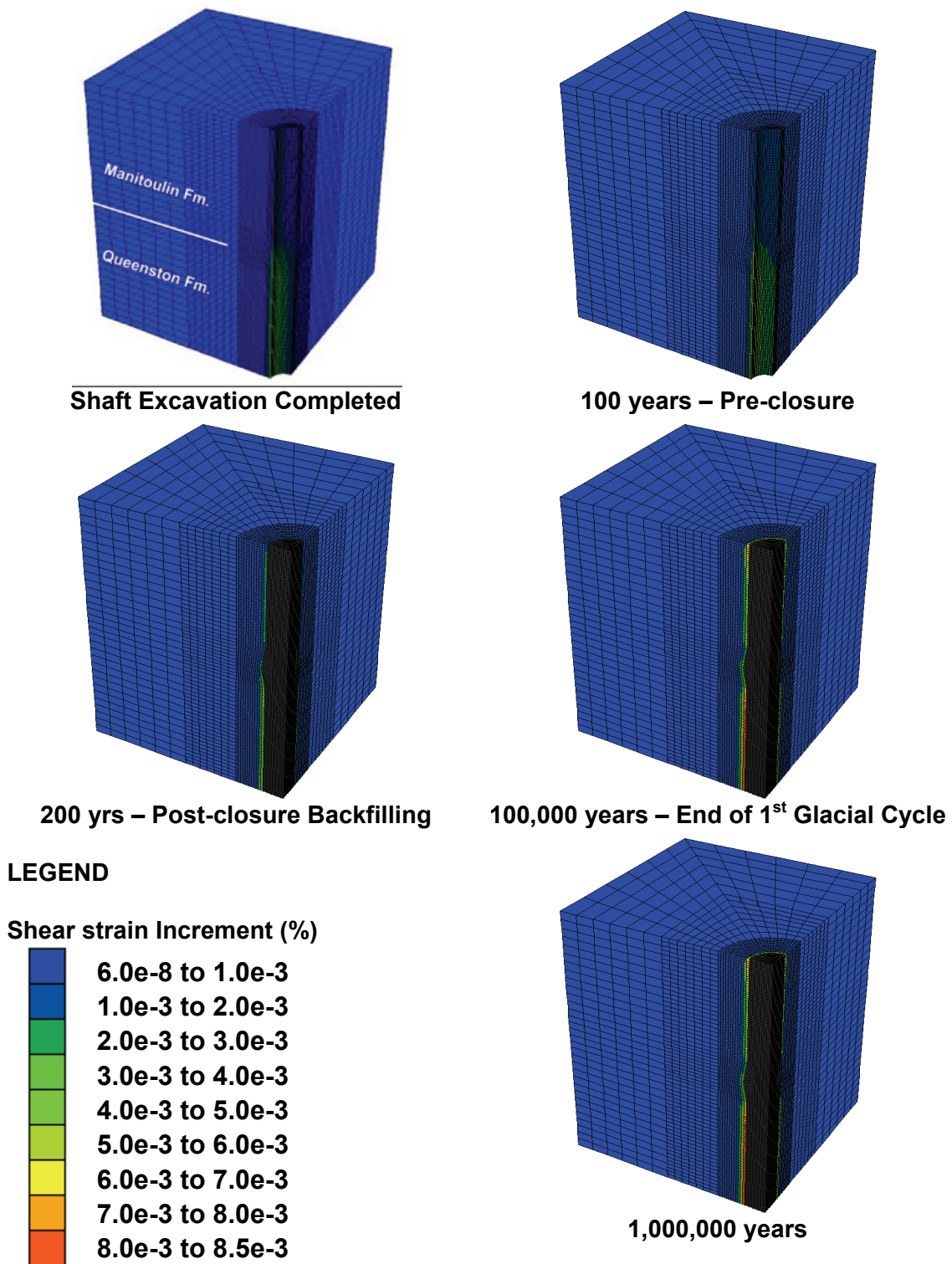


Figure D.18: Shear Strain – Concrete Bulkhead: Time-dependent Strength Degradation + Glacial Load

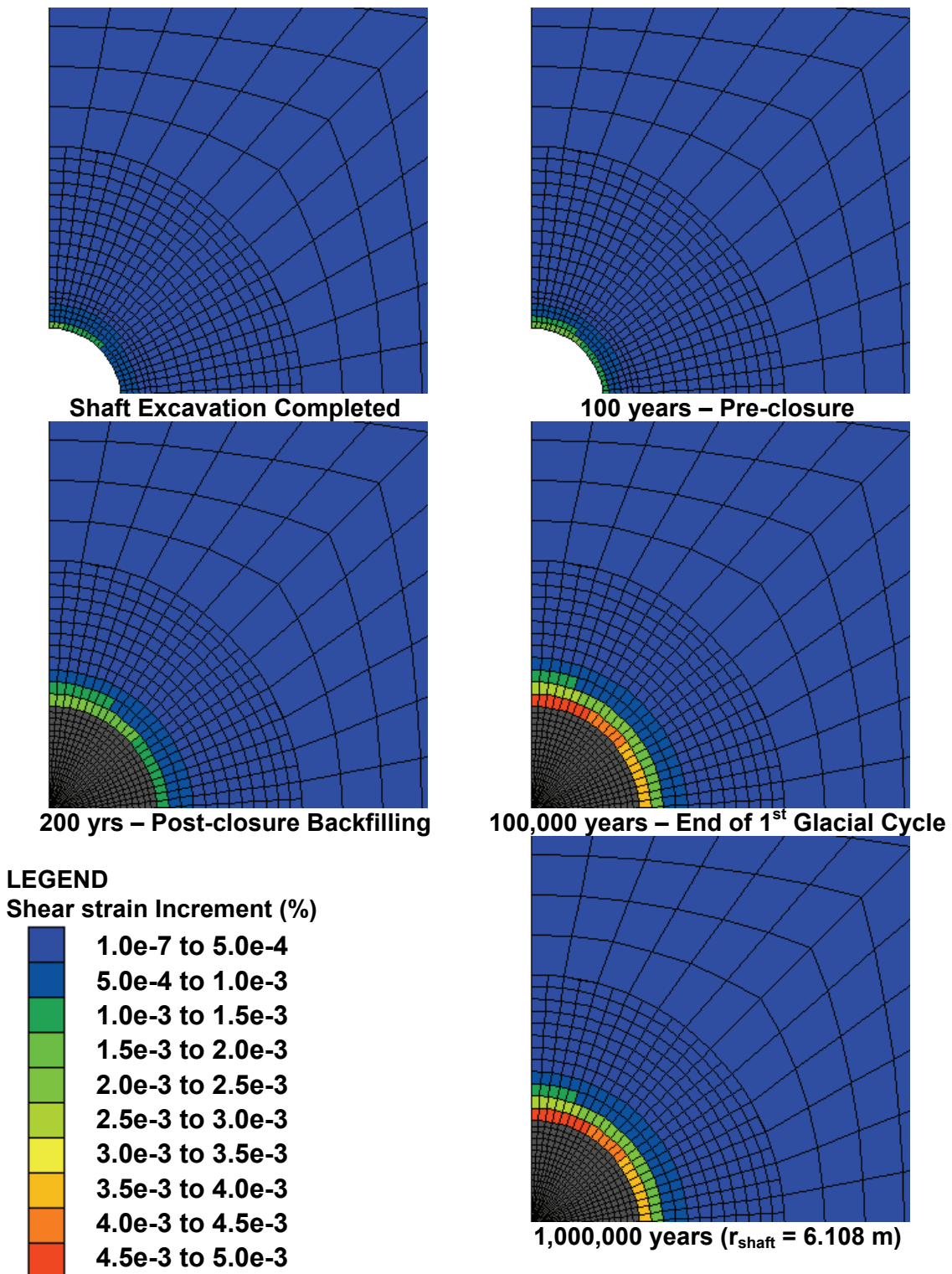


Figure D.19: Shear Strain – 22.4 m Above Concrete Bulkhead: Time-dependent Strength Degradation + Glacial Load

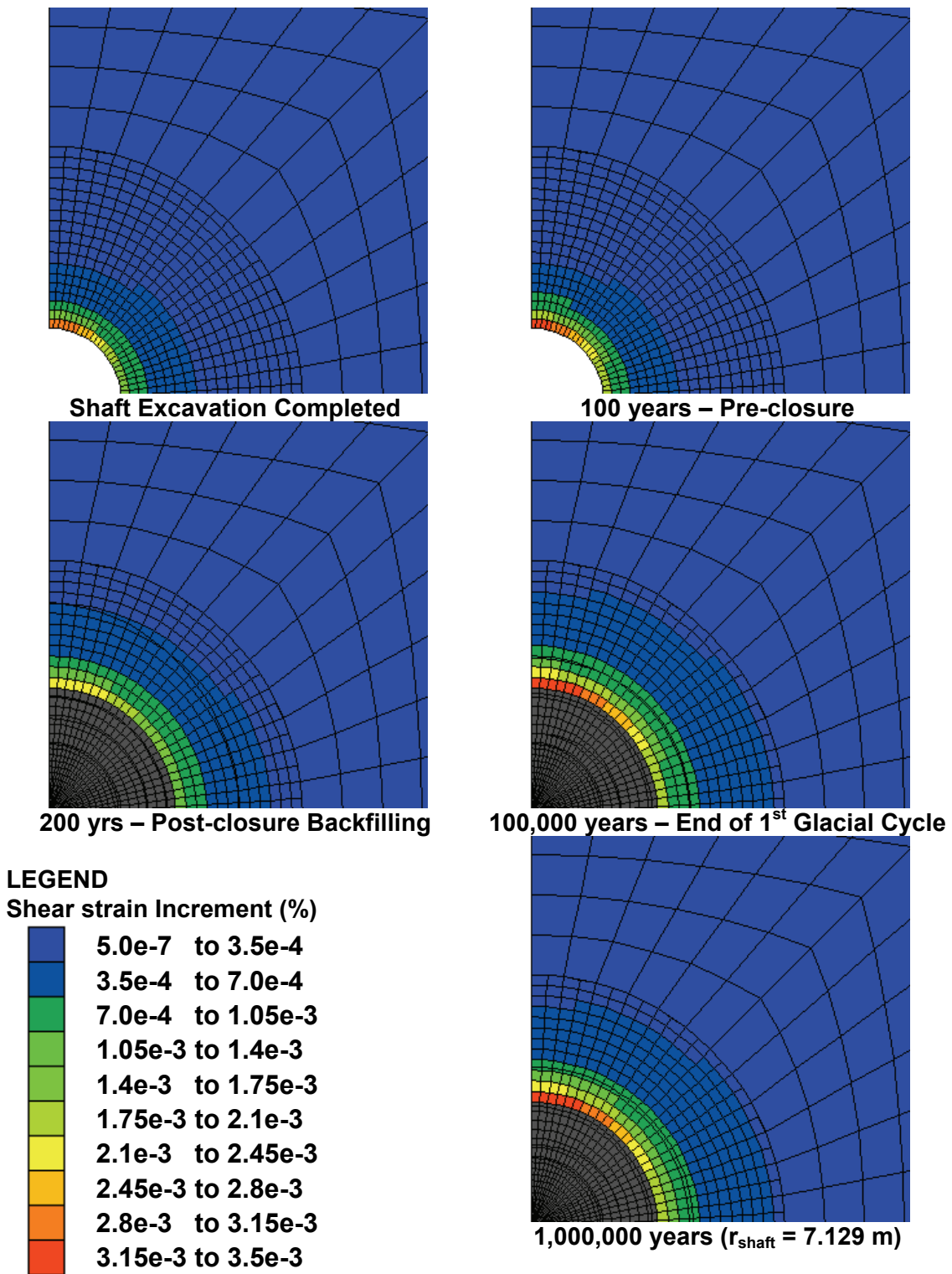


Figure D.20: Shear Strain – Middle Concrete Bulkhead: Time-dependent Strength Degradation + Glacial Load

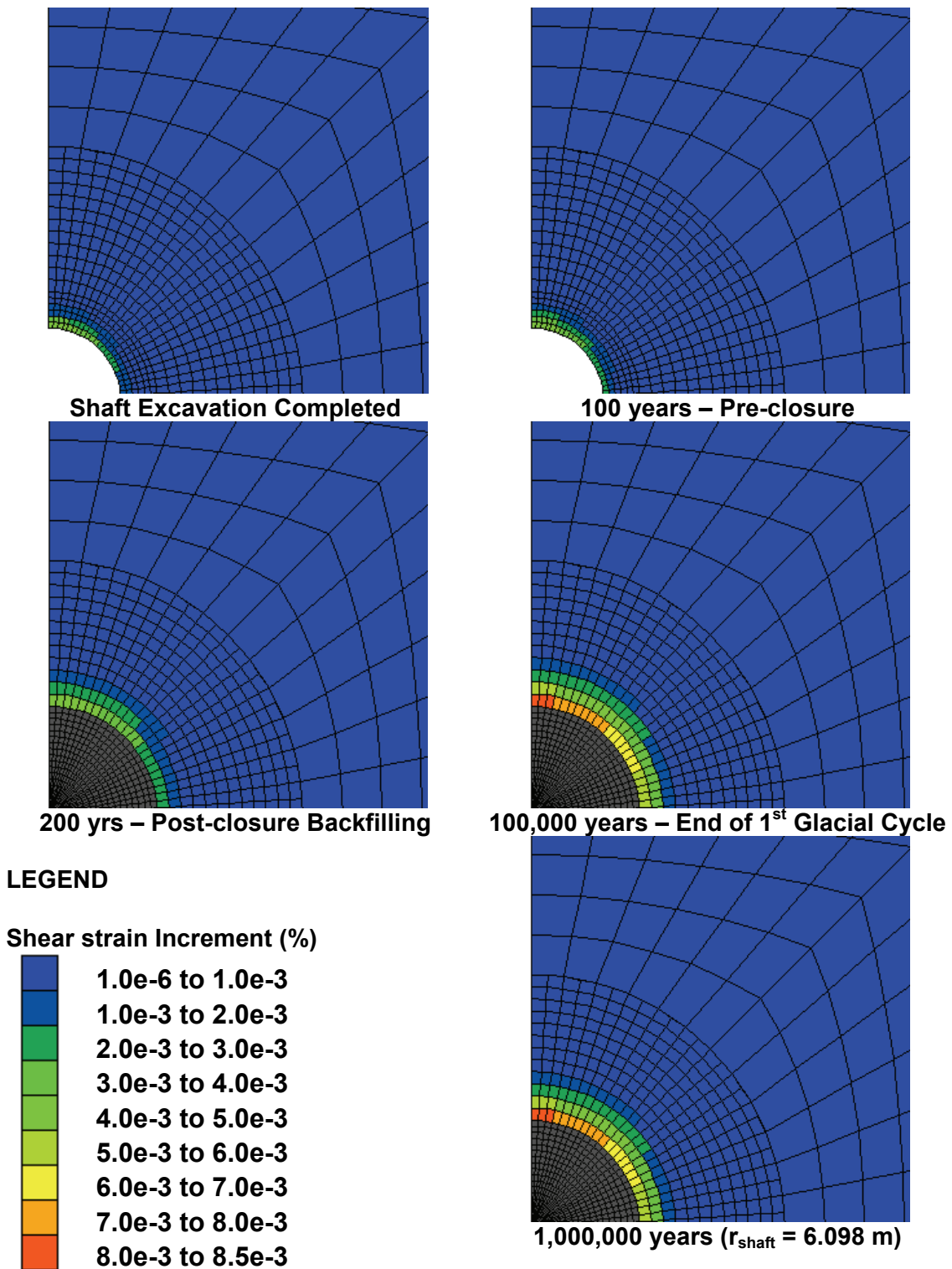


Figure D.21: Shear Strain – 22.4 m Below Concrete Bulkhead: Time-dependent Strength Degradation + Glacial Load

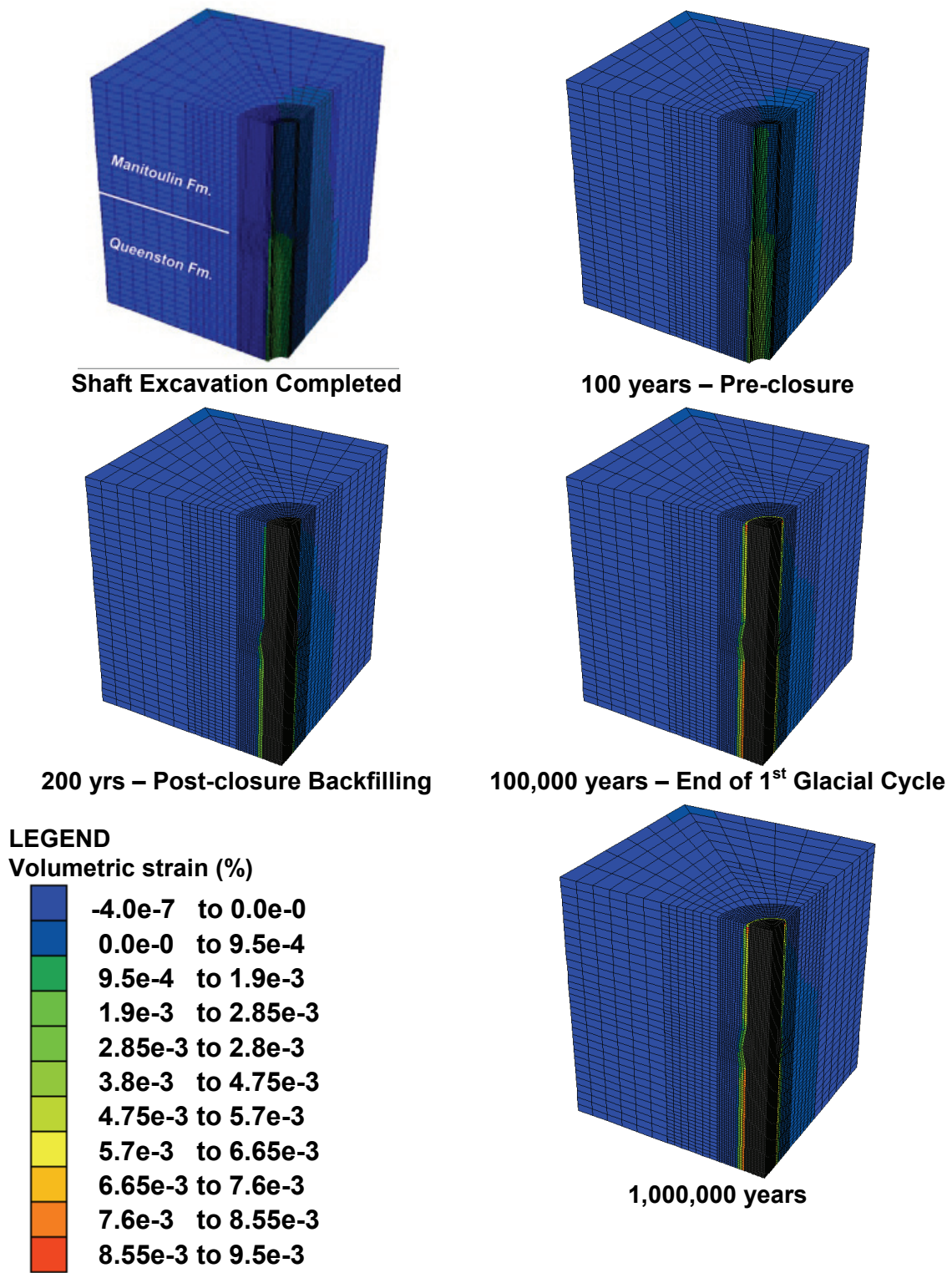


Figure D.22: Volumetric Strain – Concrete Bulkhead: Time-dependent Strength Degradation + Glacial Load

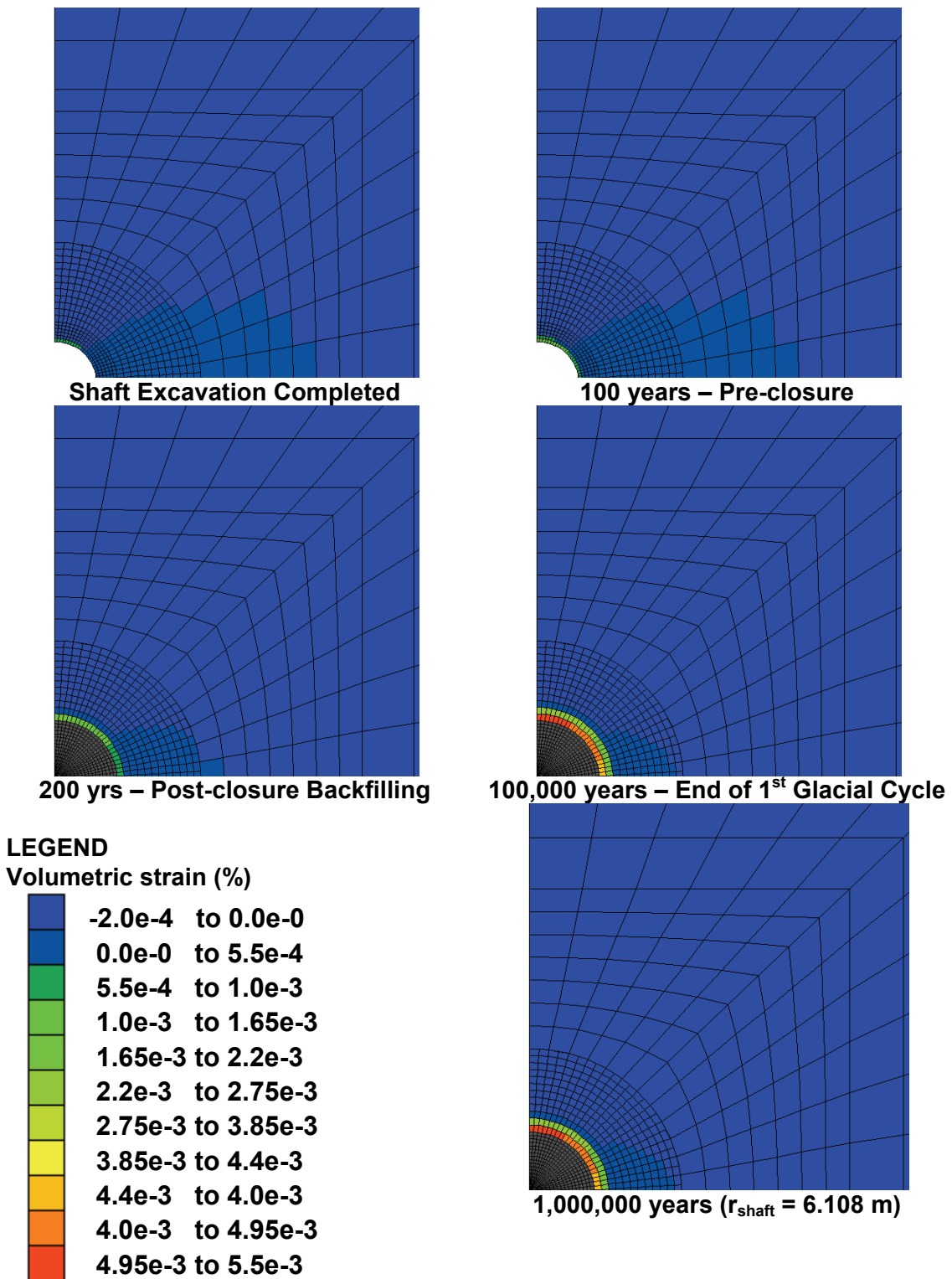


Figure D.23: Volumetric Strain – 22.4 m Above Concrete Bulkhead: Time-dependent Strength Degradation + Glacial Load

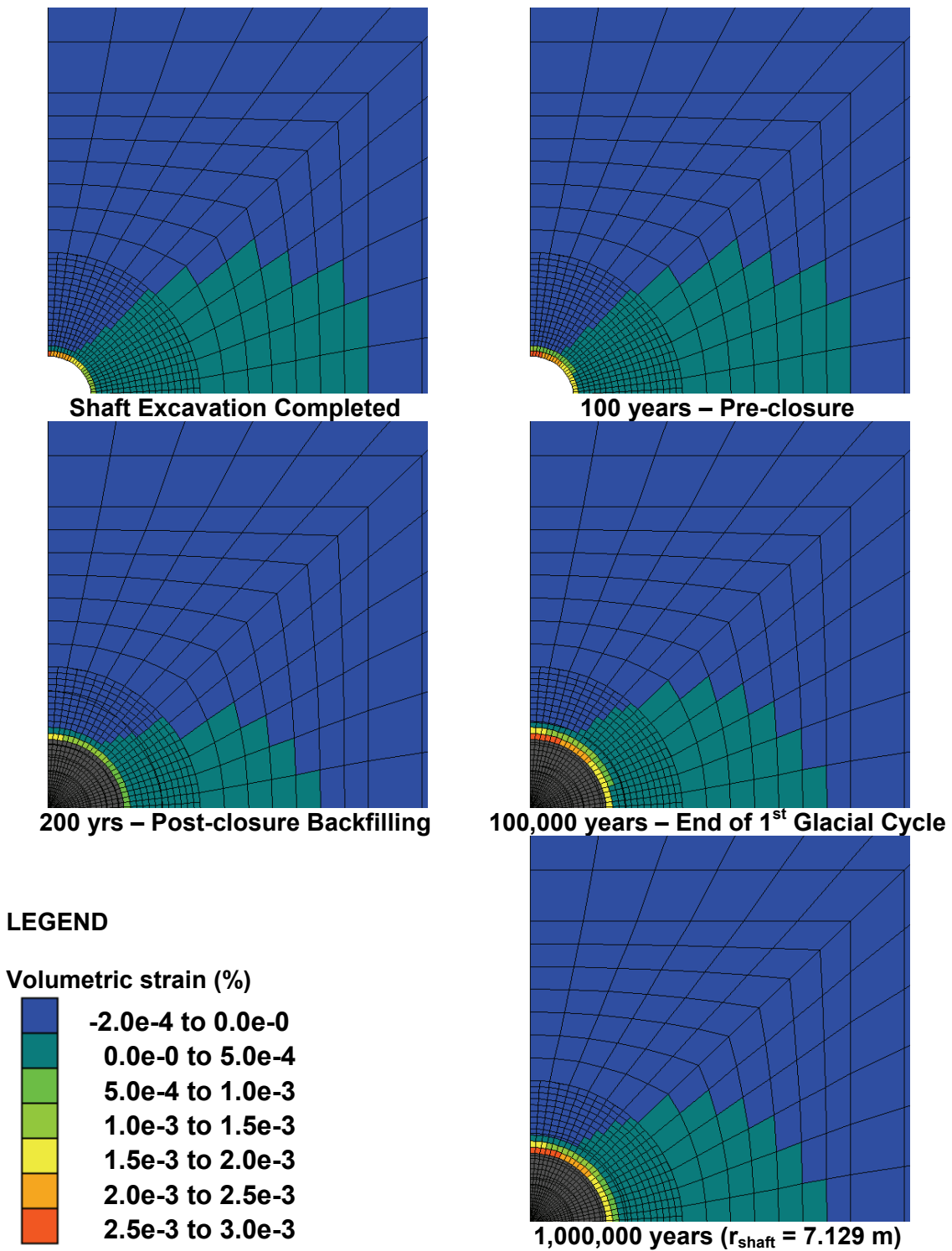


Figure D.24: Volumetric Strain – Middle Concrete Bulkhead: Time-dependent Strength Degradation + Glacial Load

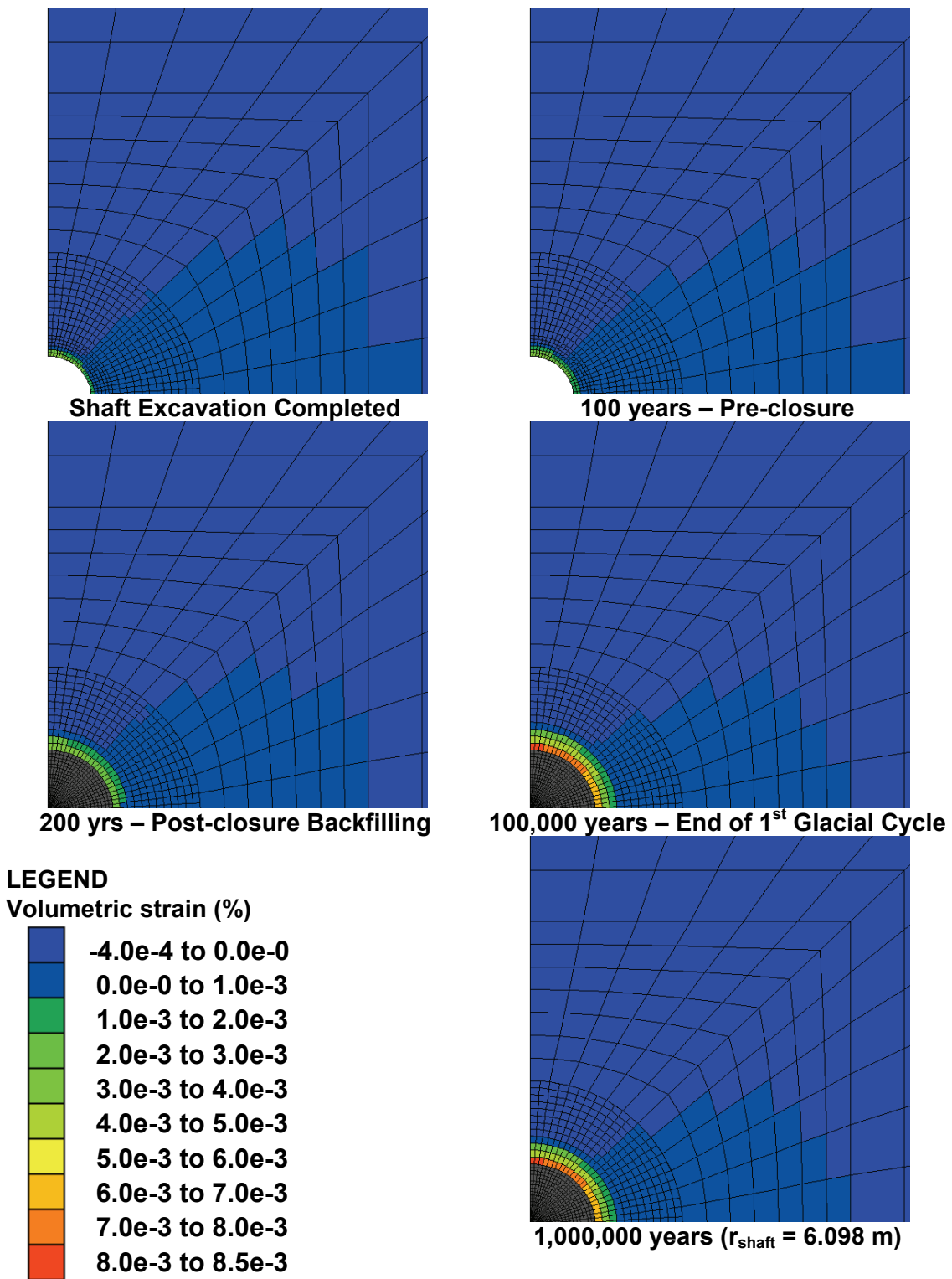


Figure D.25: Volumetric Strain – 22.4 m Below Concrete Bulkhead: Time-dependent Strength Degradation + Glacial Load