

APPENDIX E. SUPPLEMENTAL FLAC3D RESULTS FOR WATERSTOP BULKHEAD

This appendix includes the plots with the results for double bulkhead/waterstop. 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, and (2) time-dependent strength degradation and glacial load.

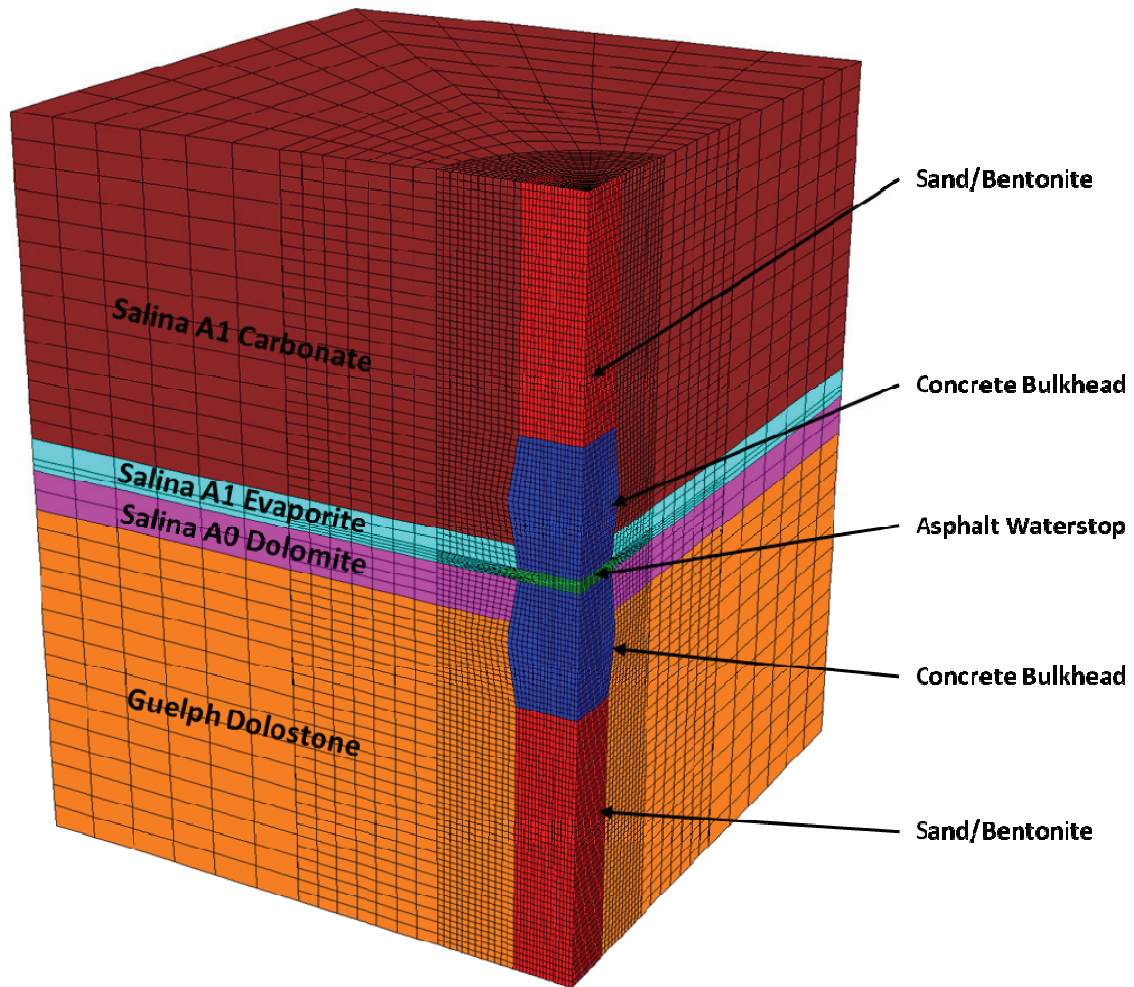


Figure E.1: Layout of Quarter-Symmetrical FLAC3D Model of Over-excavated and Backfilled Main Shaft for Double Bulkhead/Waterstop

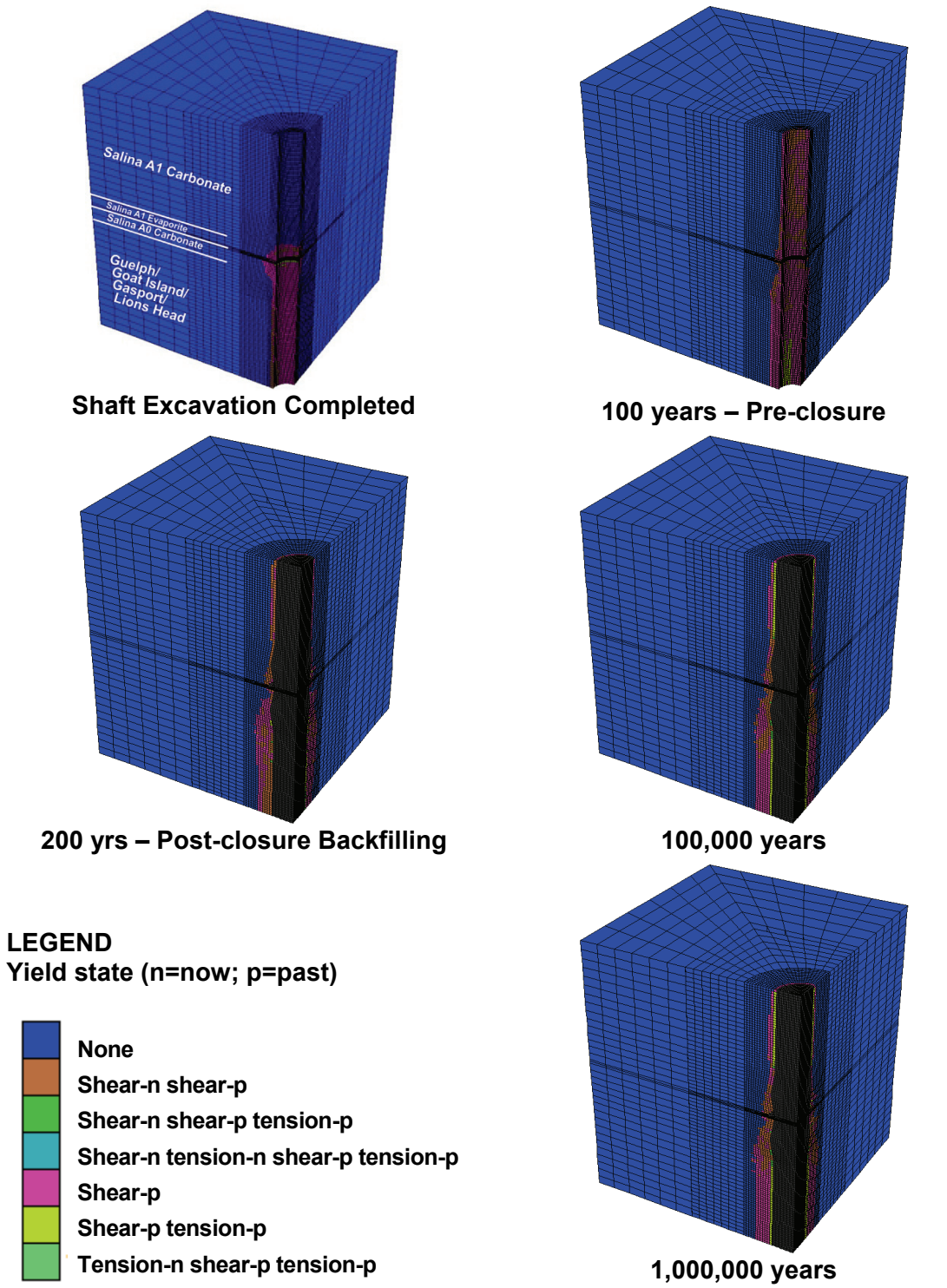


Figure E.2: Yield State – Waterstop: Time-dependent Strength Degradation

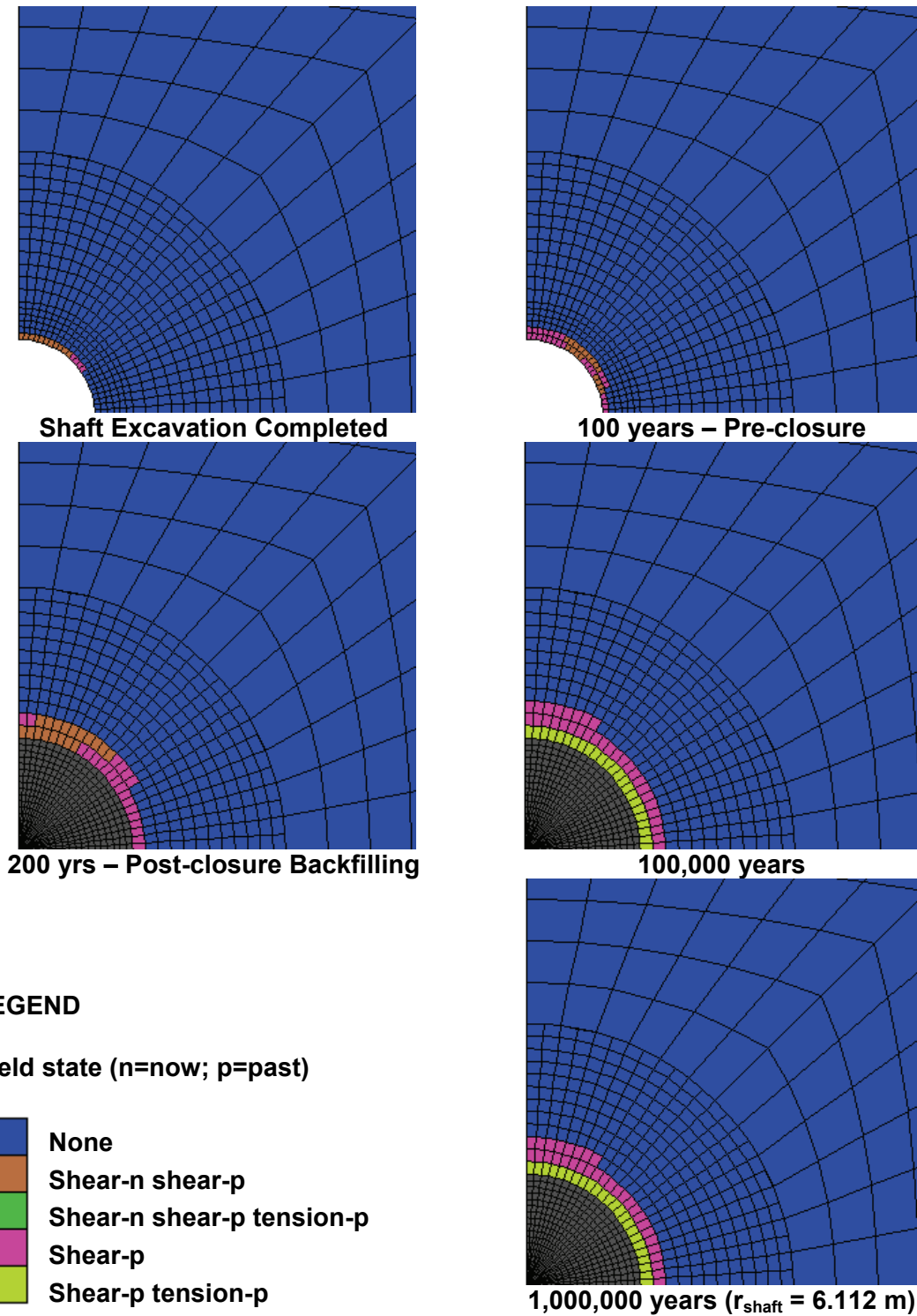


Figure E.3: Yield State – 22.4 m Above Waterstop: Time-dependent Strength Degradation

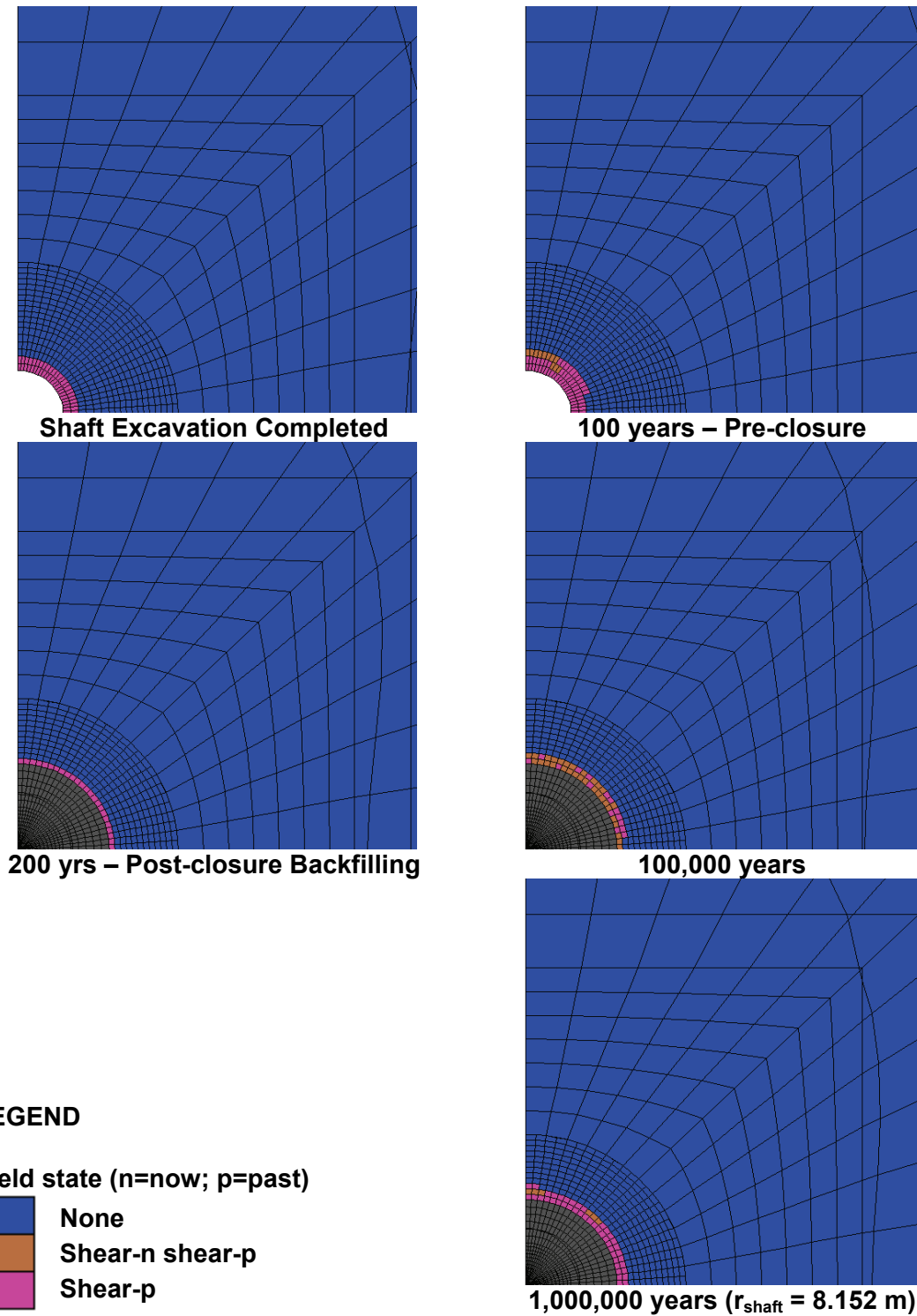


Figure E.4: Yield State – Middle of Waterstop: Time-dependent Strength Degradation

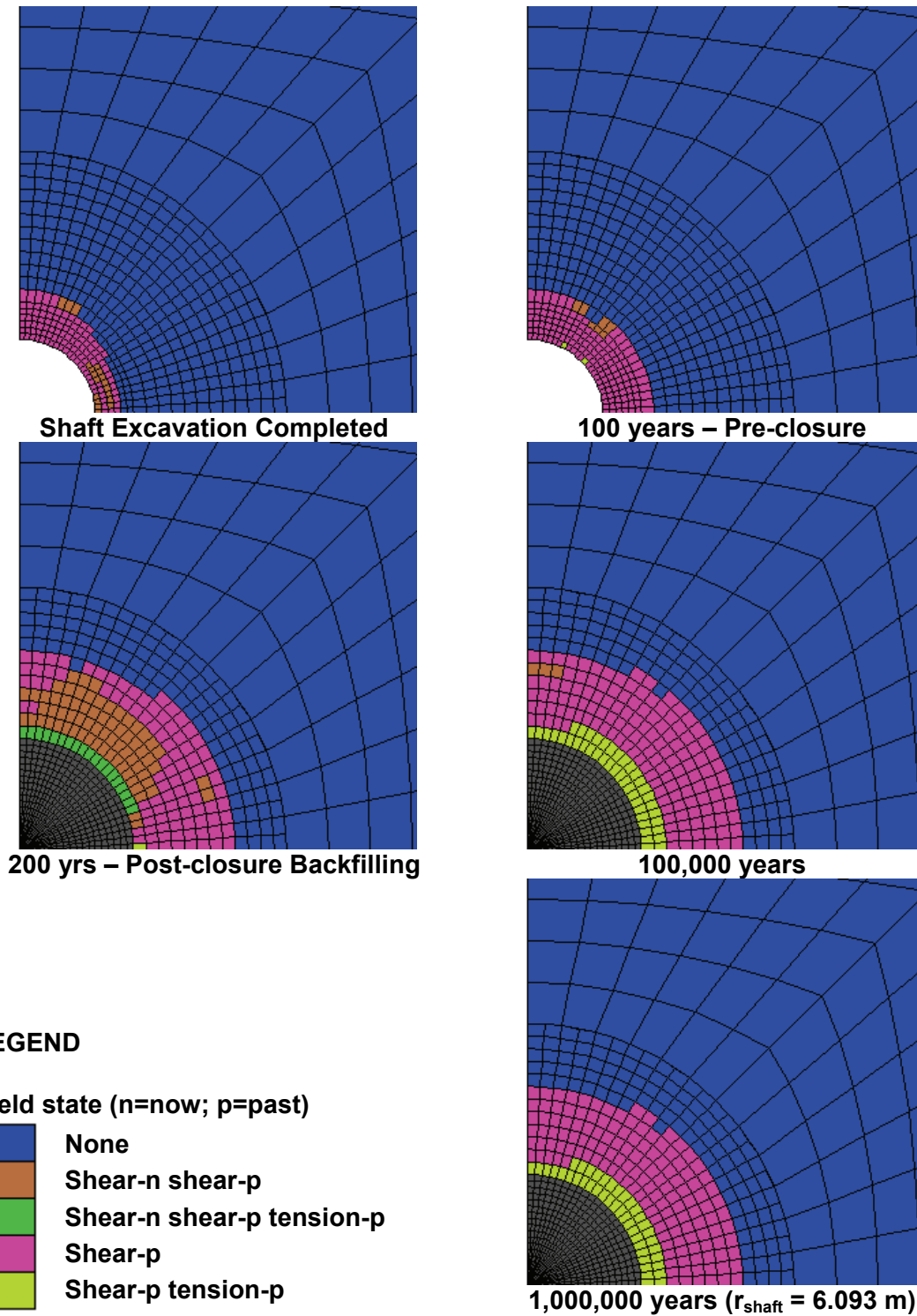


Figure E.5: Yield State – 22.4 m Below Waterstop: Time-dependent Strength Degradation

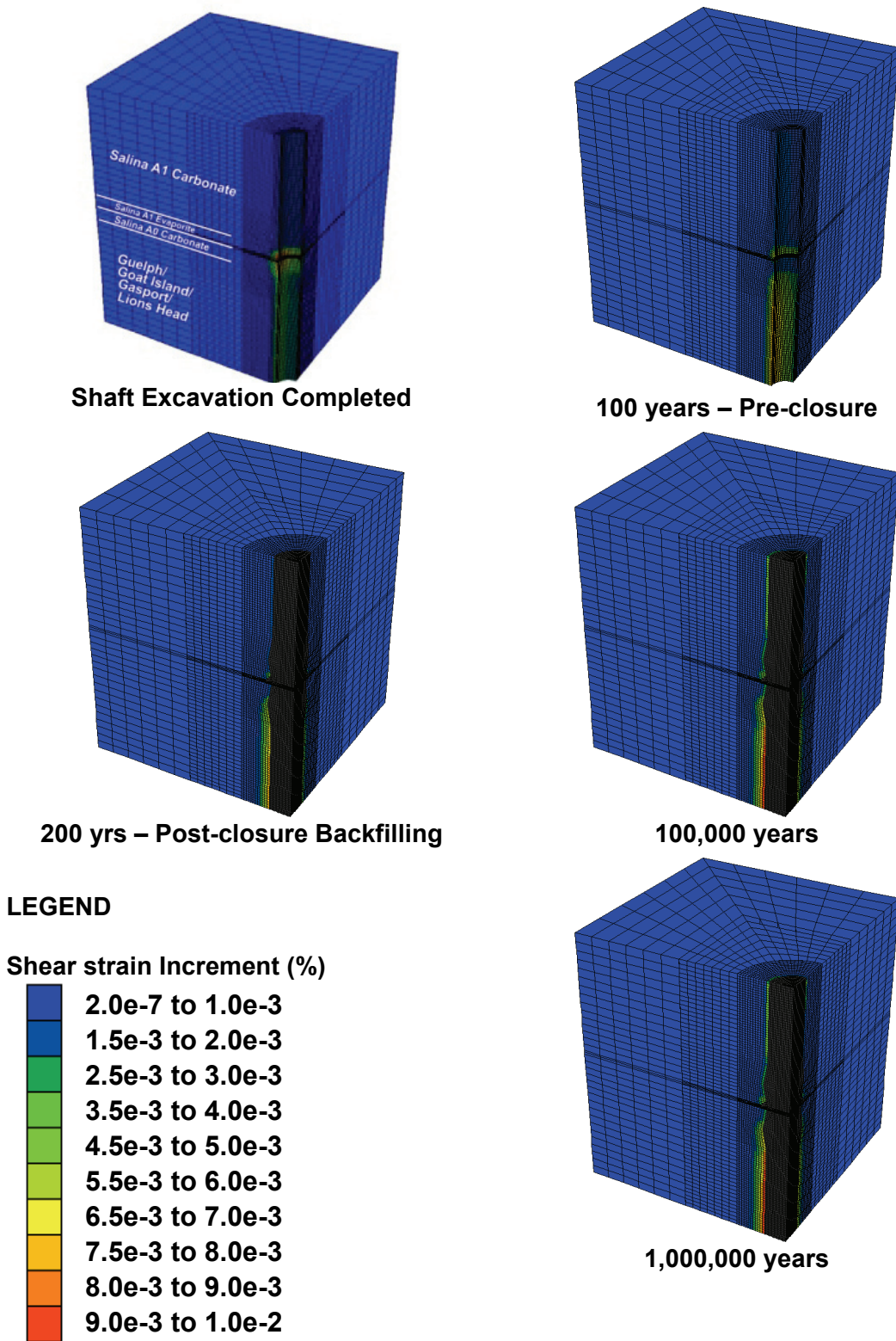


Figure E.6: Shear Strain – Waterstop: Time-dependent Strength Degradation

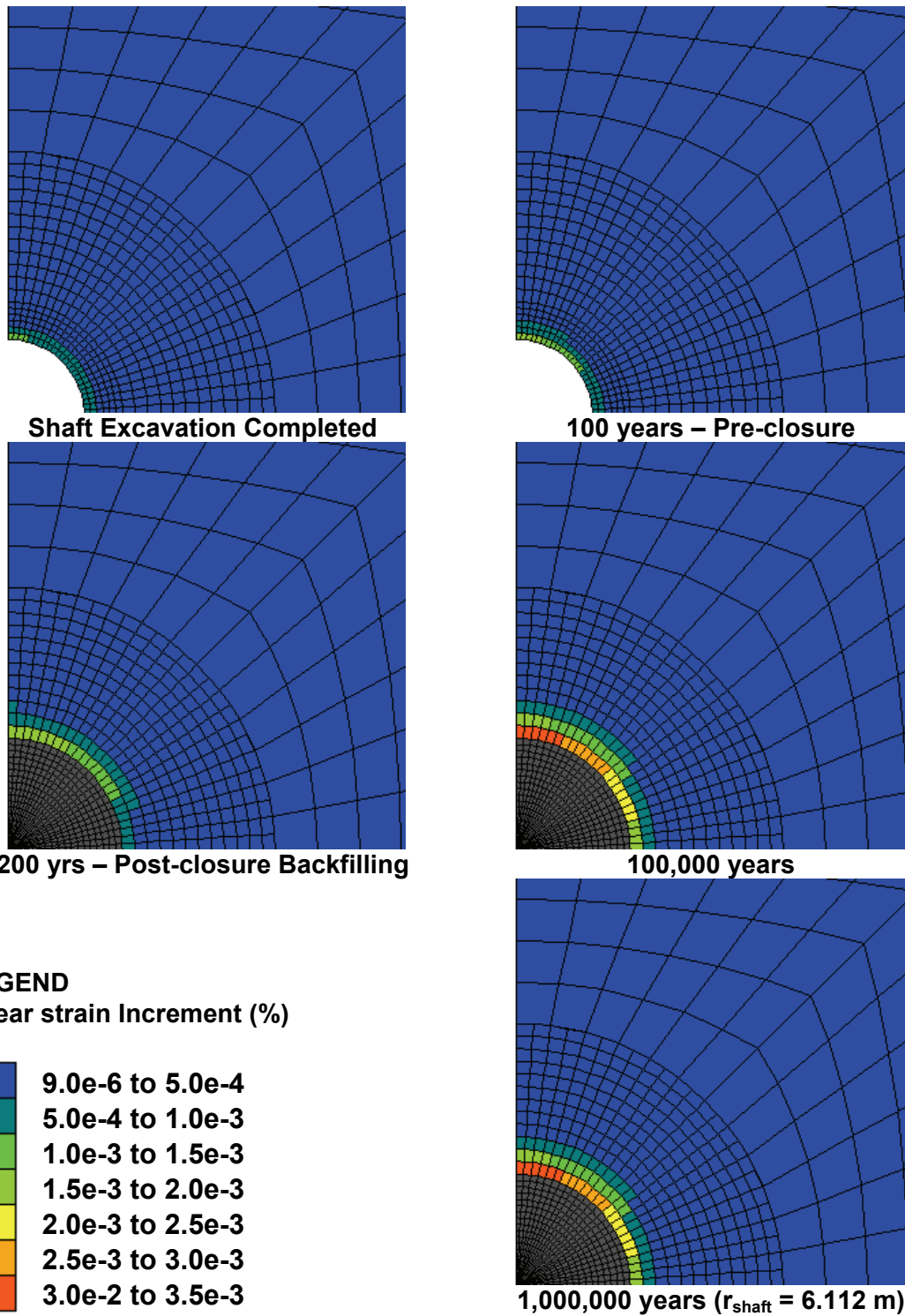


Figure E.7: Shear Strain – 22.4 m Above Waterstop: Time-dependent Strength Degradation

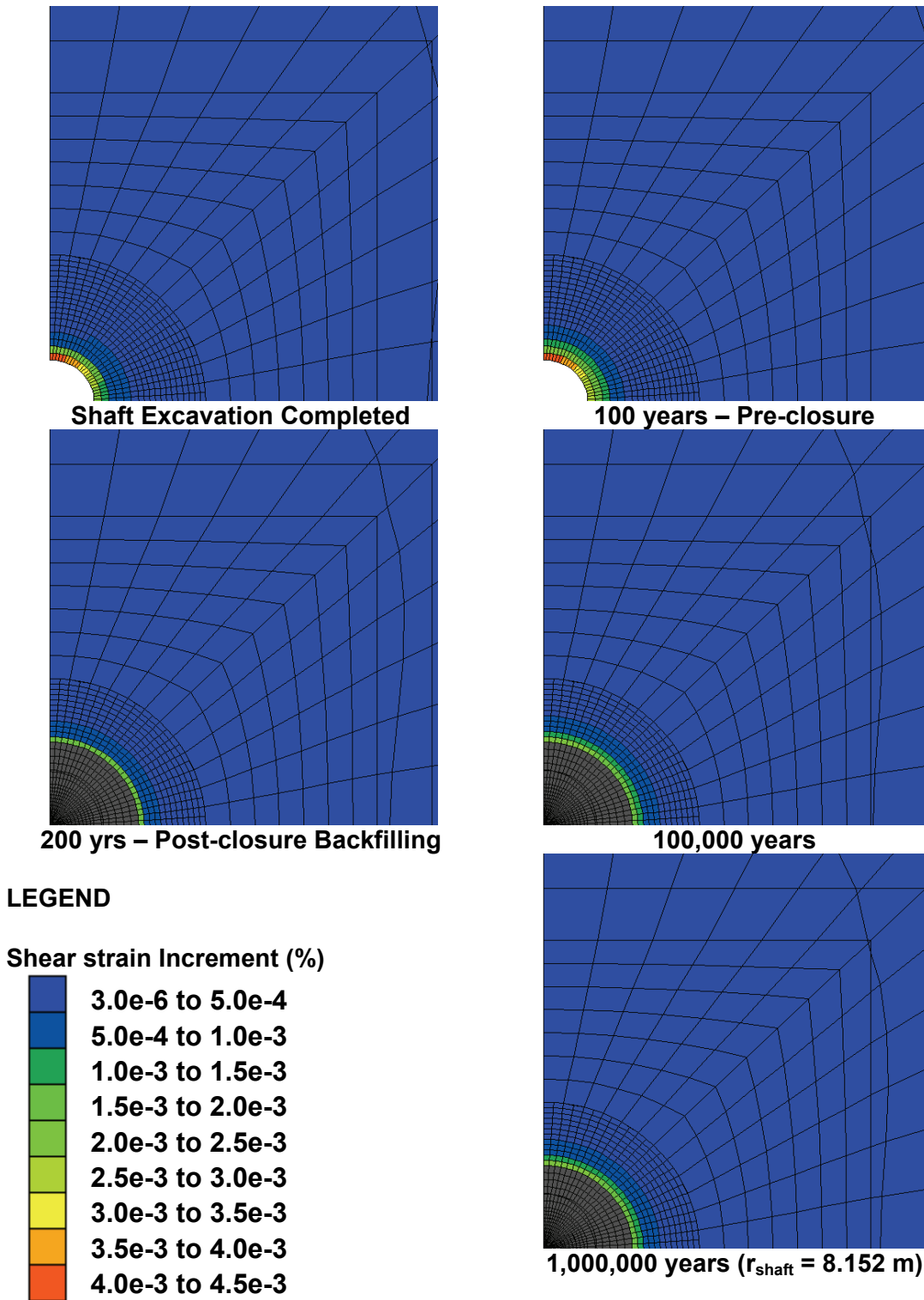


Figure E.8: Shear Strain – Middle of Waterstop: Time-dependent Strength Degradation

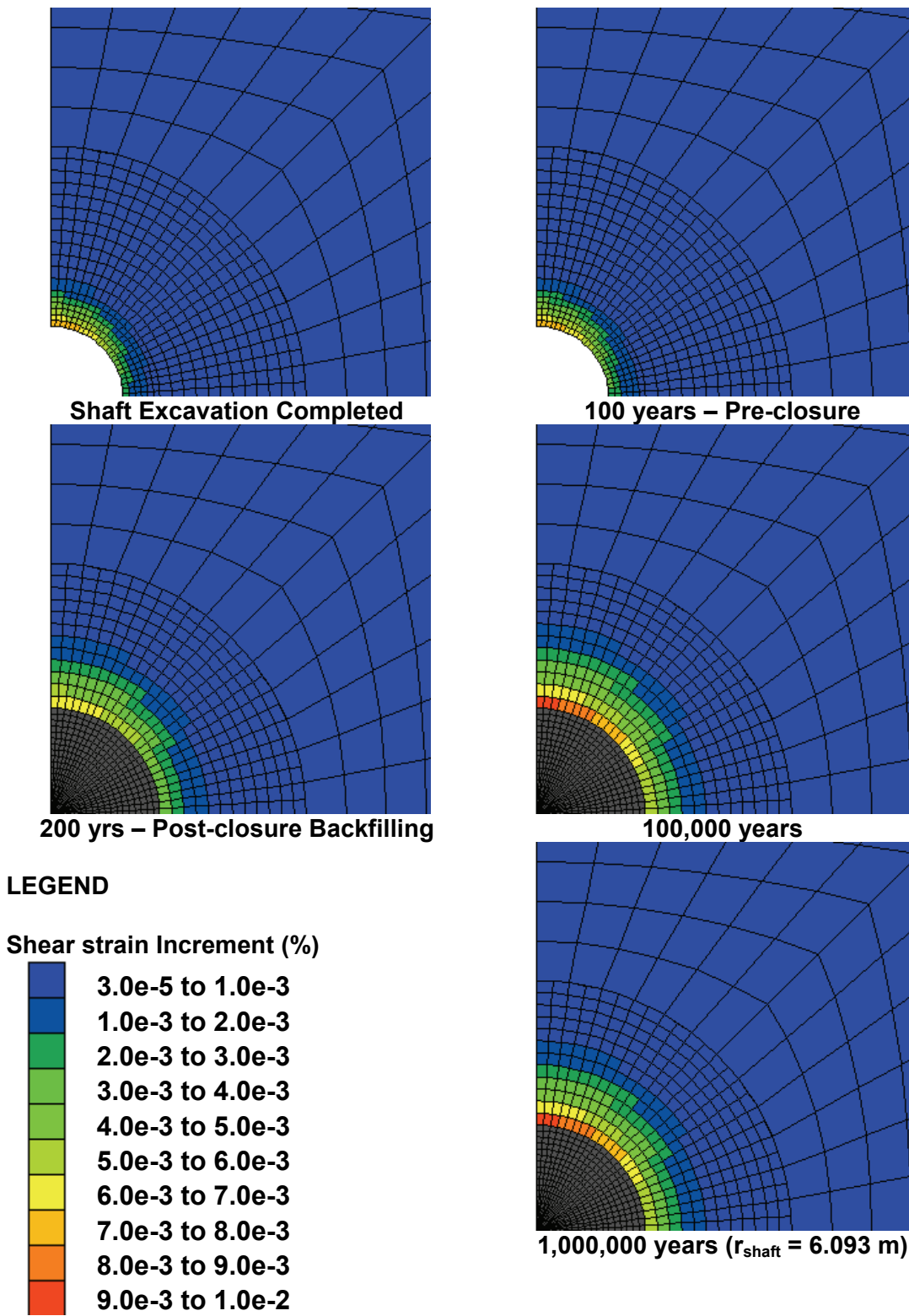


Figure E.9: Shear Strain – 22.4 m Below Waterstop: Time-dependent Strength Degradation

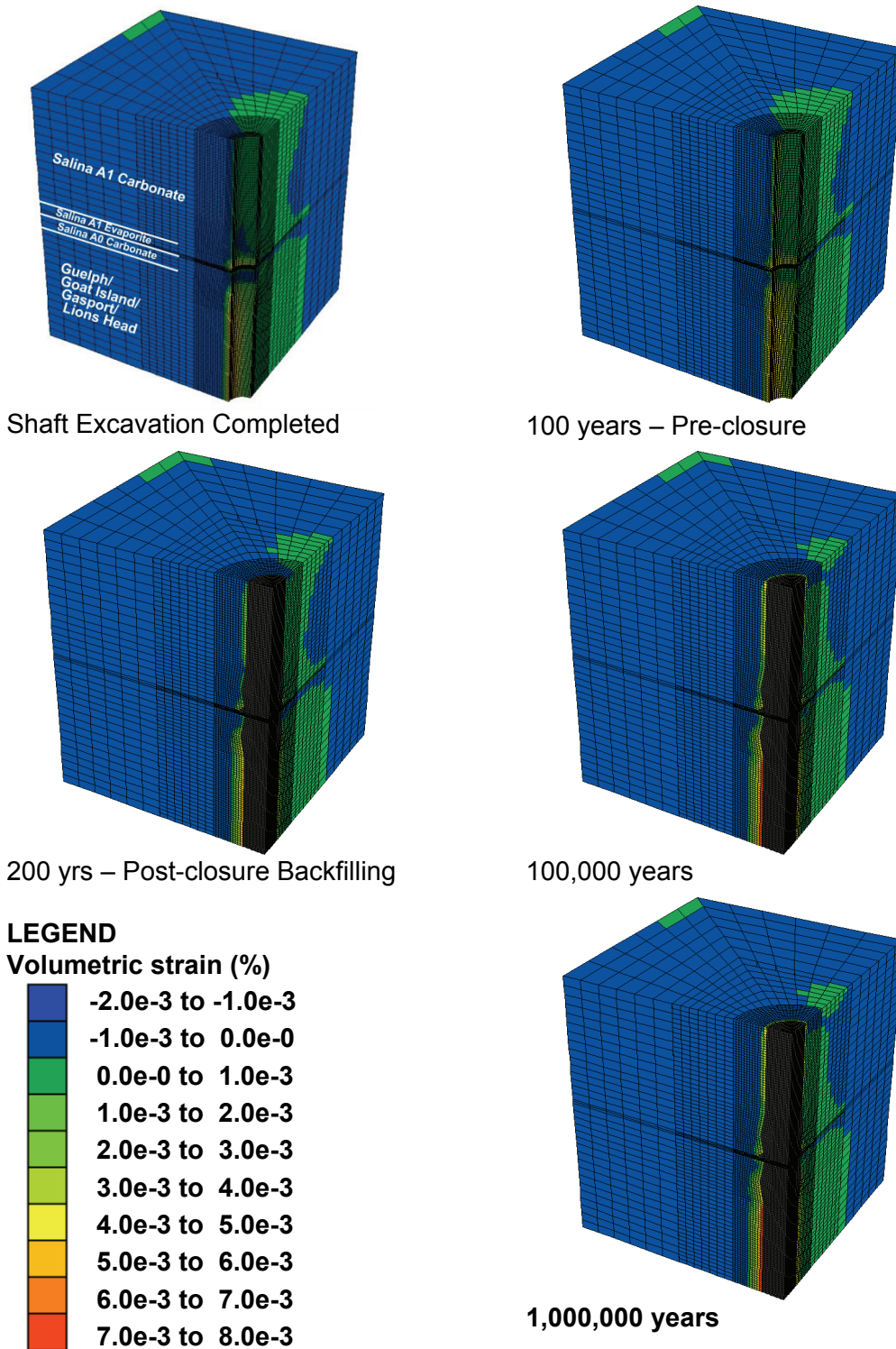


Figure E.10: Volumetric Strain – Waterstop: Time-dependent Strength Degradation

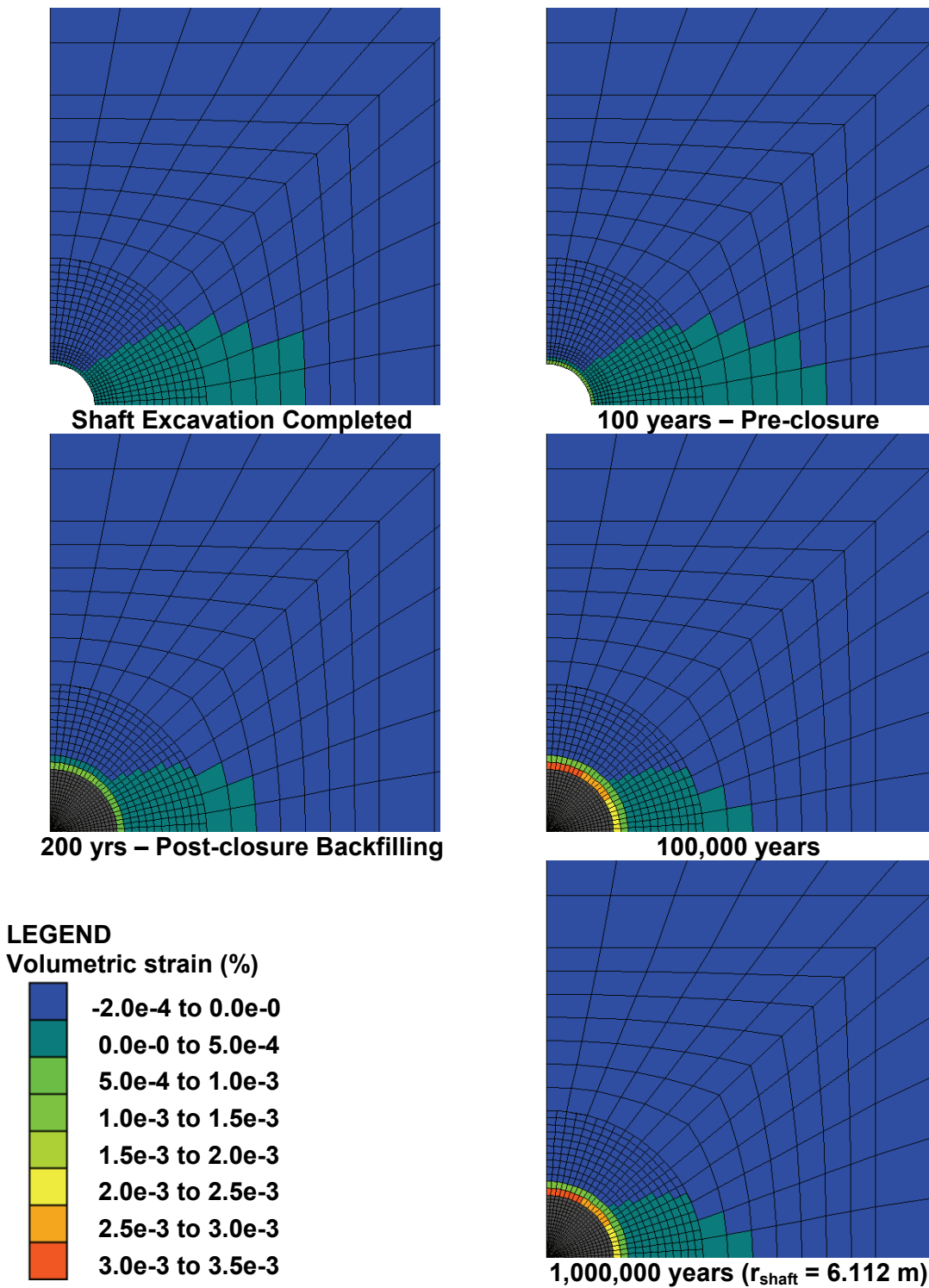


Figure E.11: Volumetric Strain – 22.4 m Above Waterstop: Time-dependent Strength Degradation

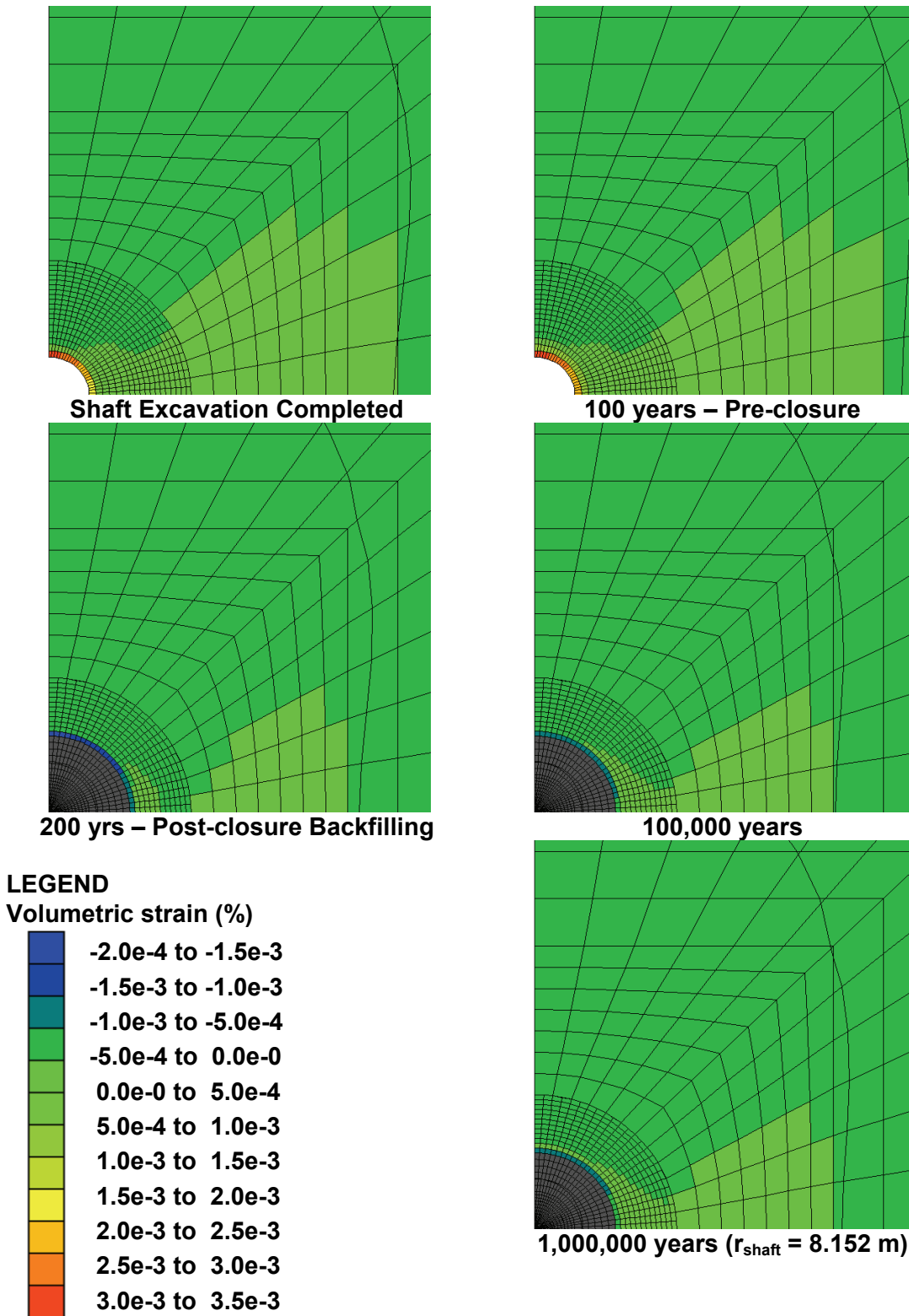


Figure E.12: Volumetric Strain – Middle of Waterstop: Time-dependent Strength Degradation

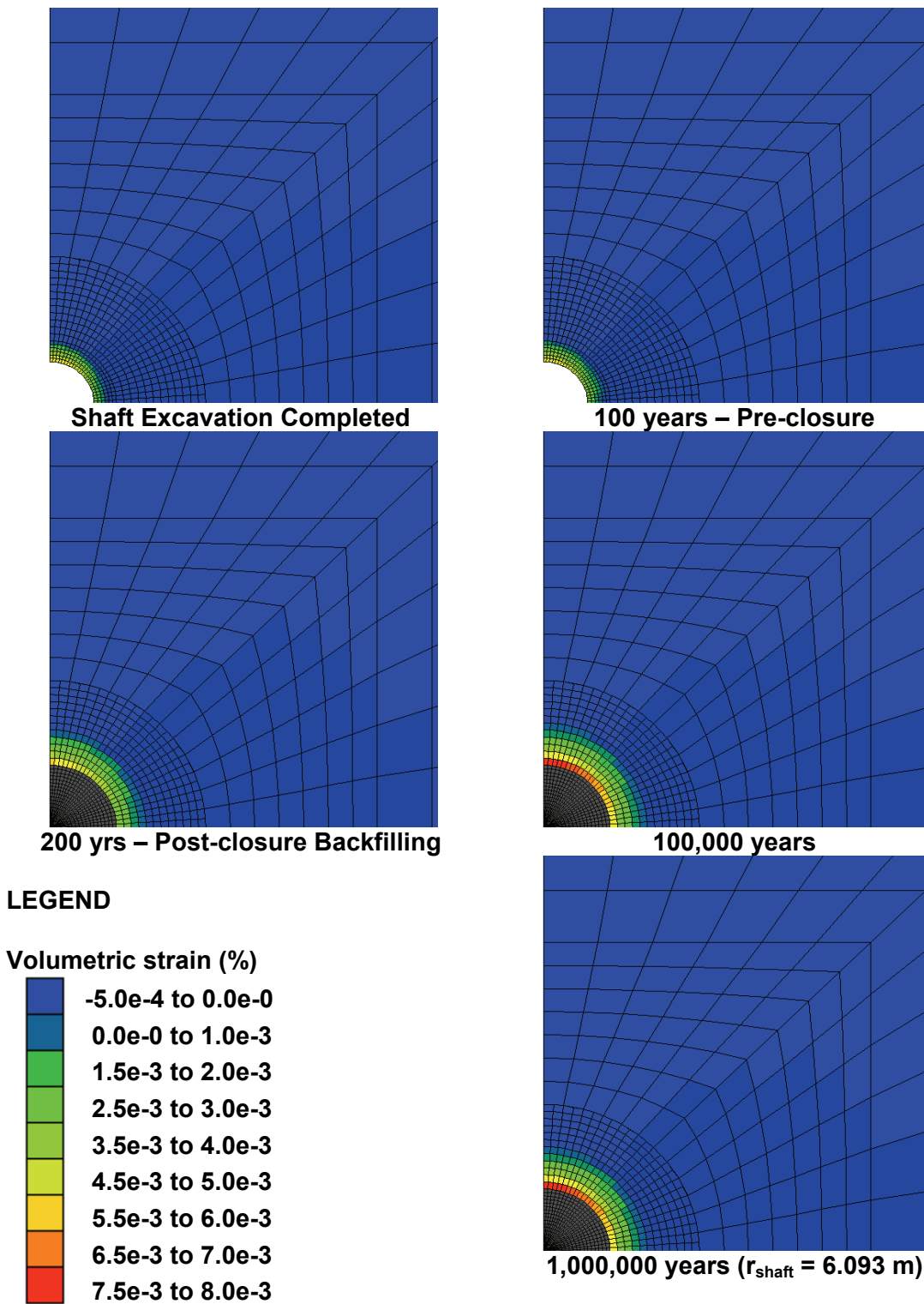


Figure E.13: Volumetric Strain – 22.4 m Below Waterstop: Time-dependent Strength Degradation

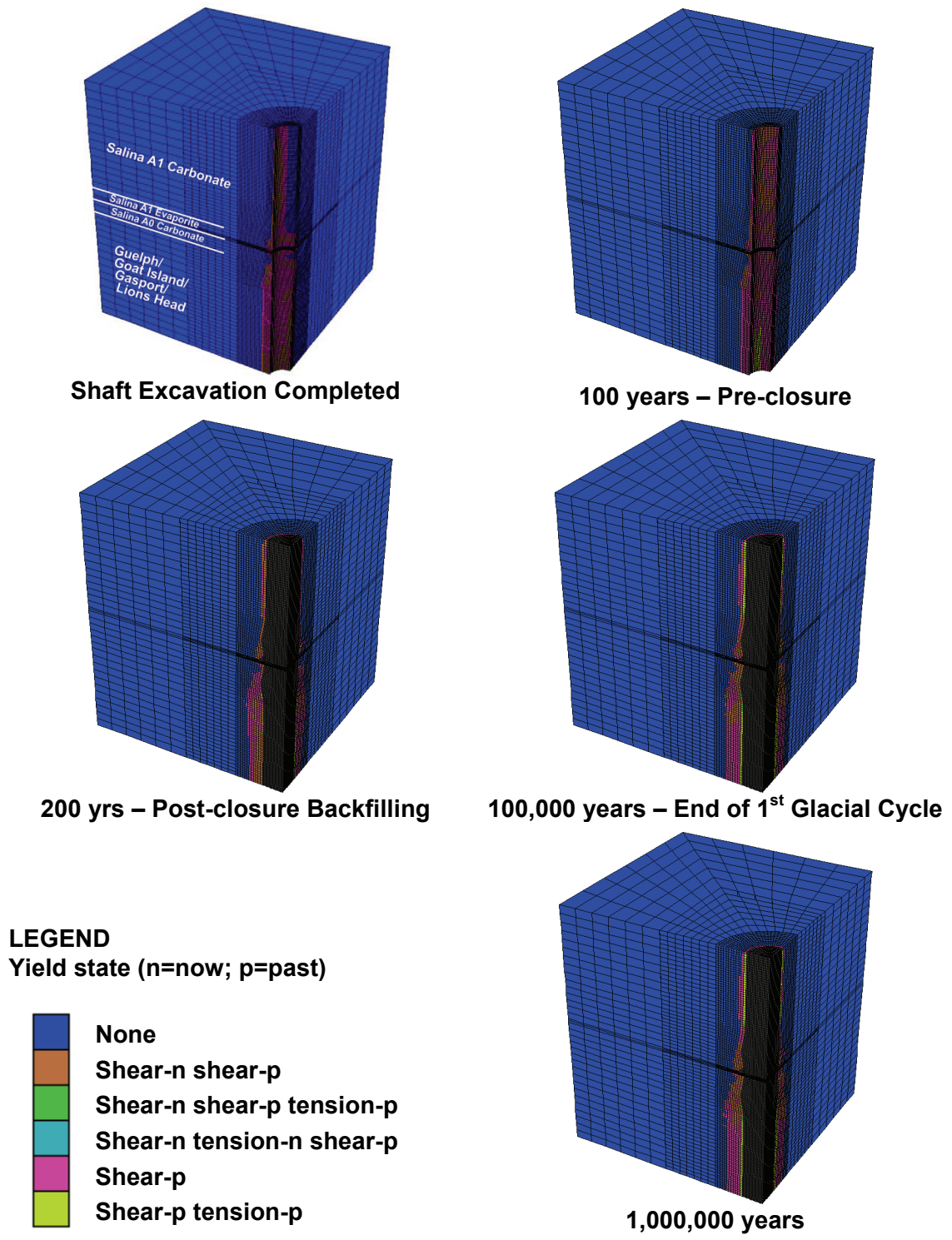


Figure E.14: Yield State – Waterstop: Time-dependent Strength Degradation + Glacial Load

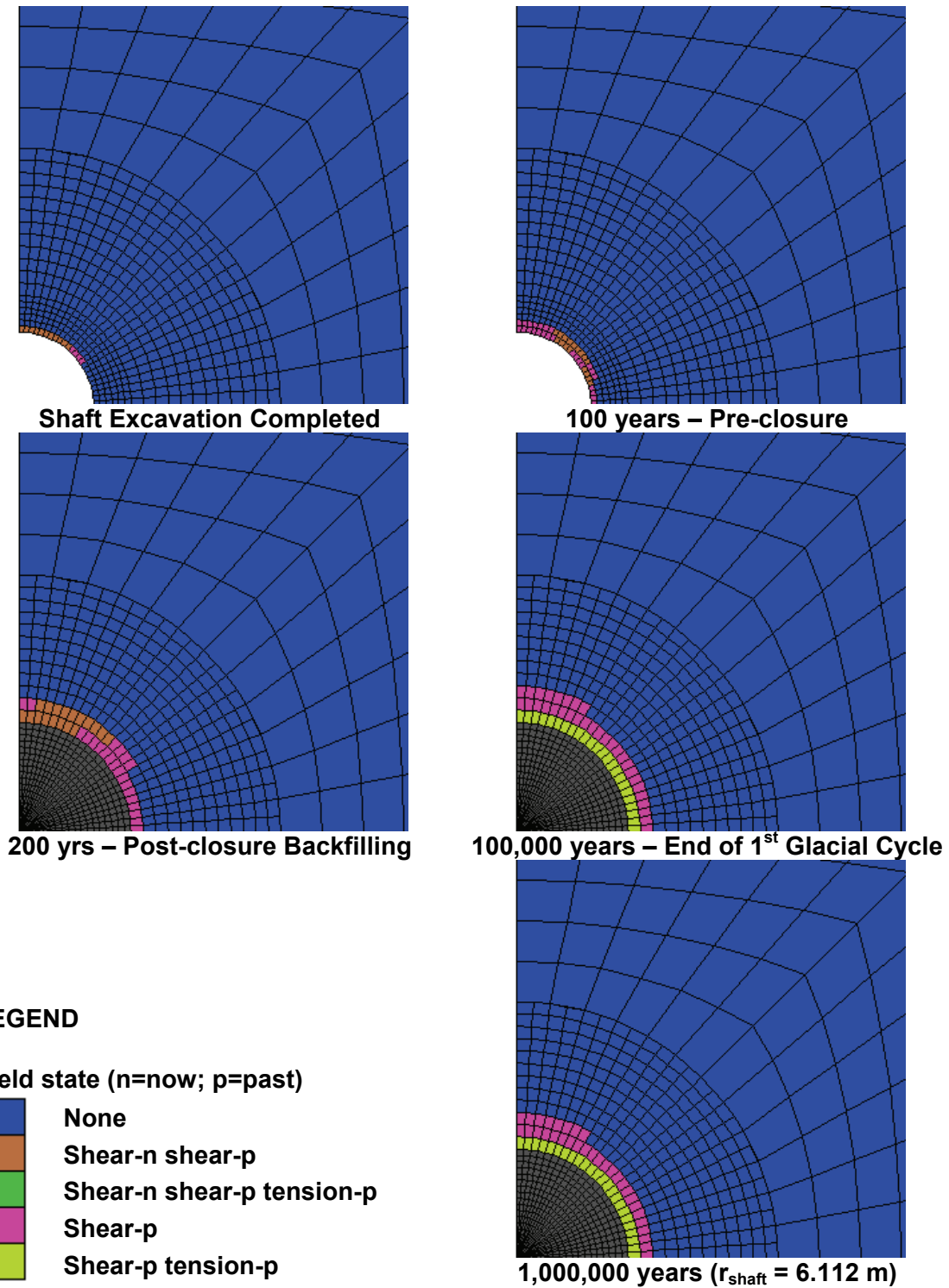


Figure E.15: Yield State – 22.4m Above Waterstop: Time-dependent Strength Degradation + Glacial Load

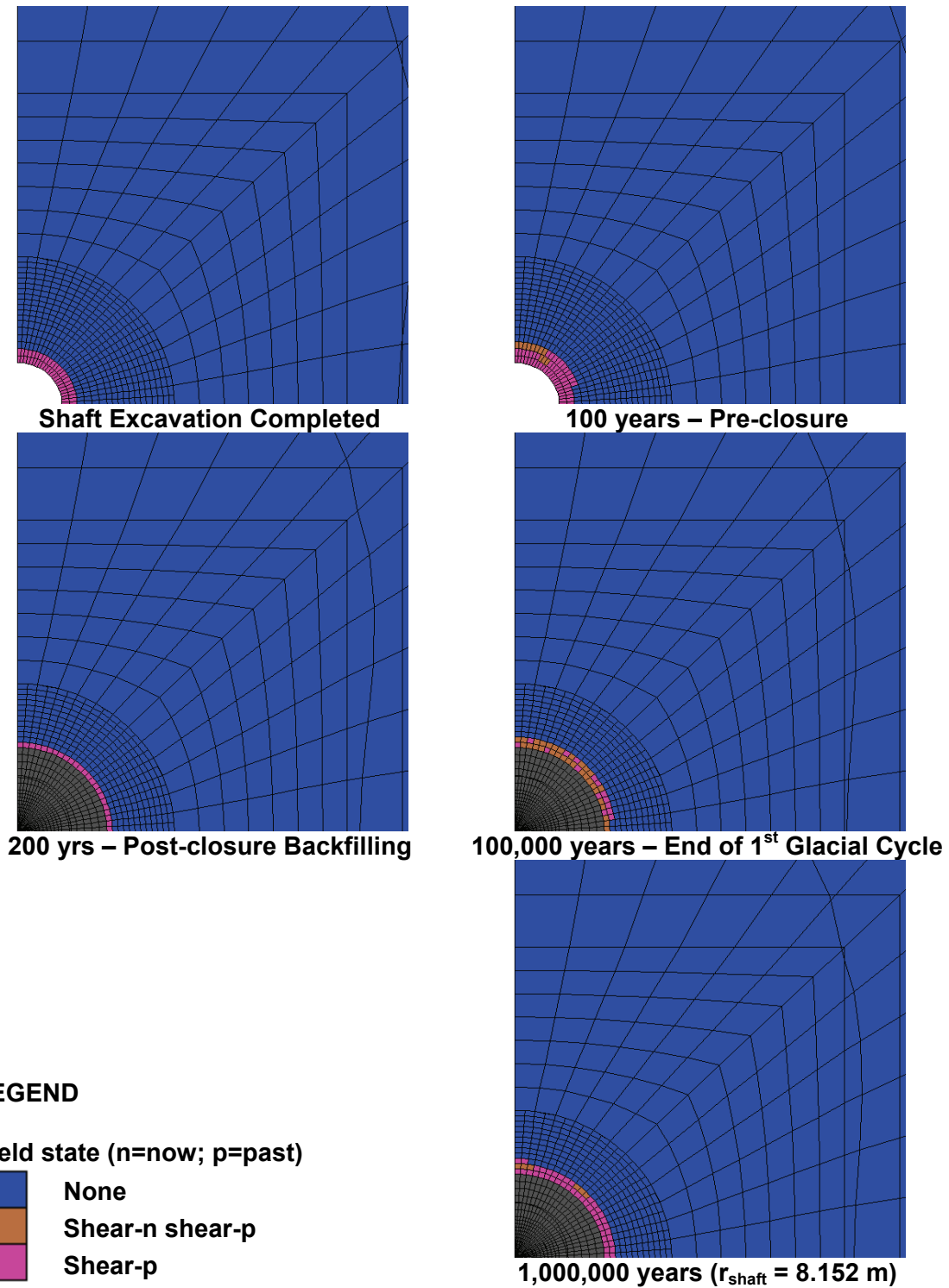


Figure E.16: Yield State – Middle of Waterstop: Time-dependent Strength Degradation + Glacial Load

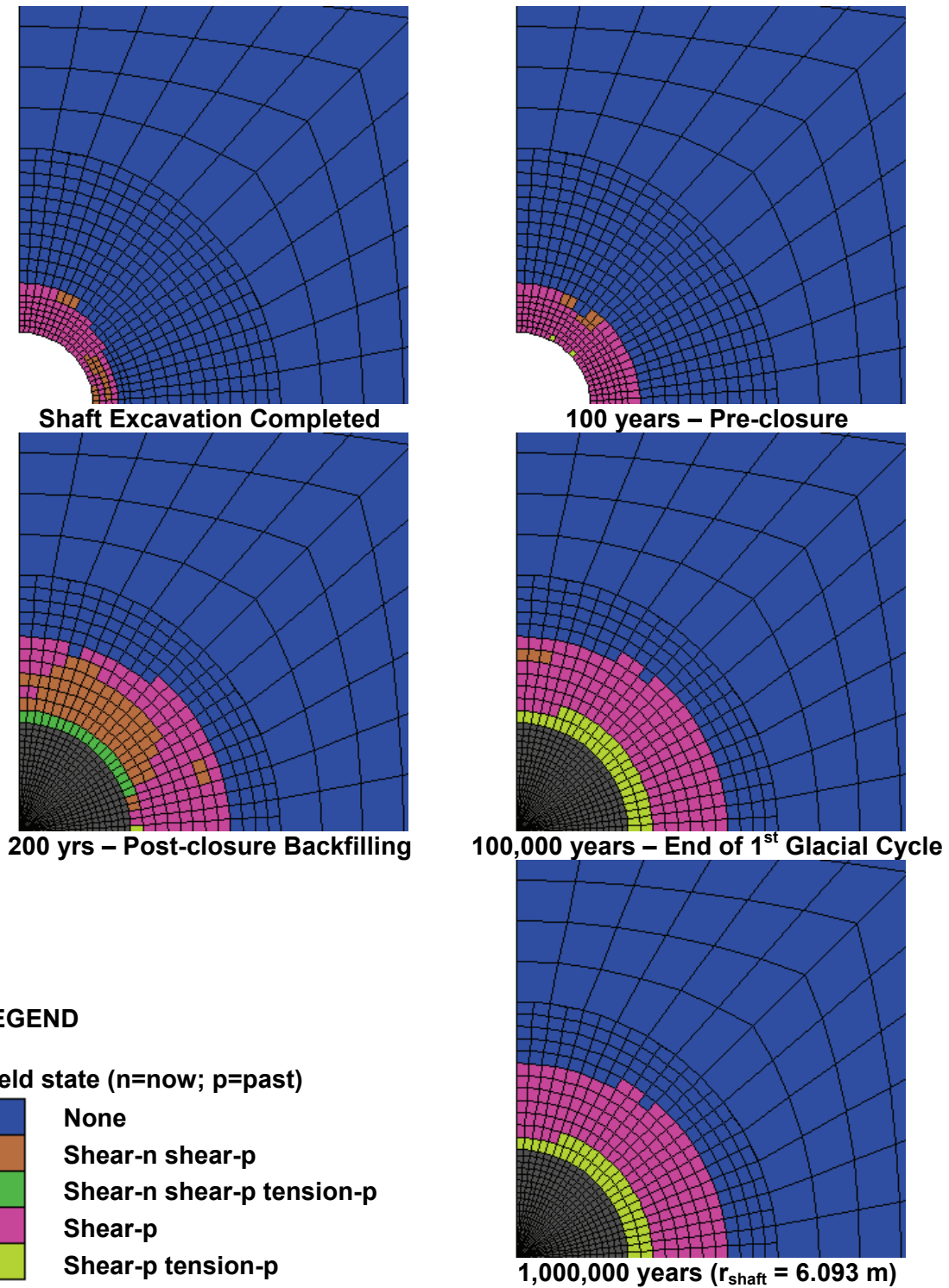


Figure E.17: Yield State – 22.4 m Below Waterstop: Time-dependent Strength Degradation + Glacial Load

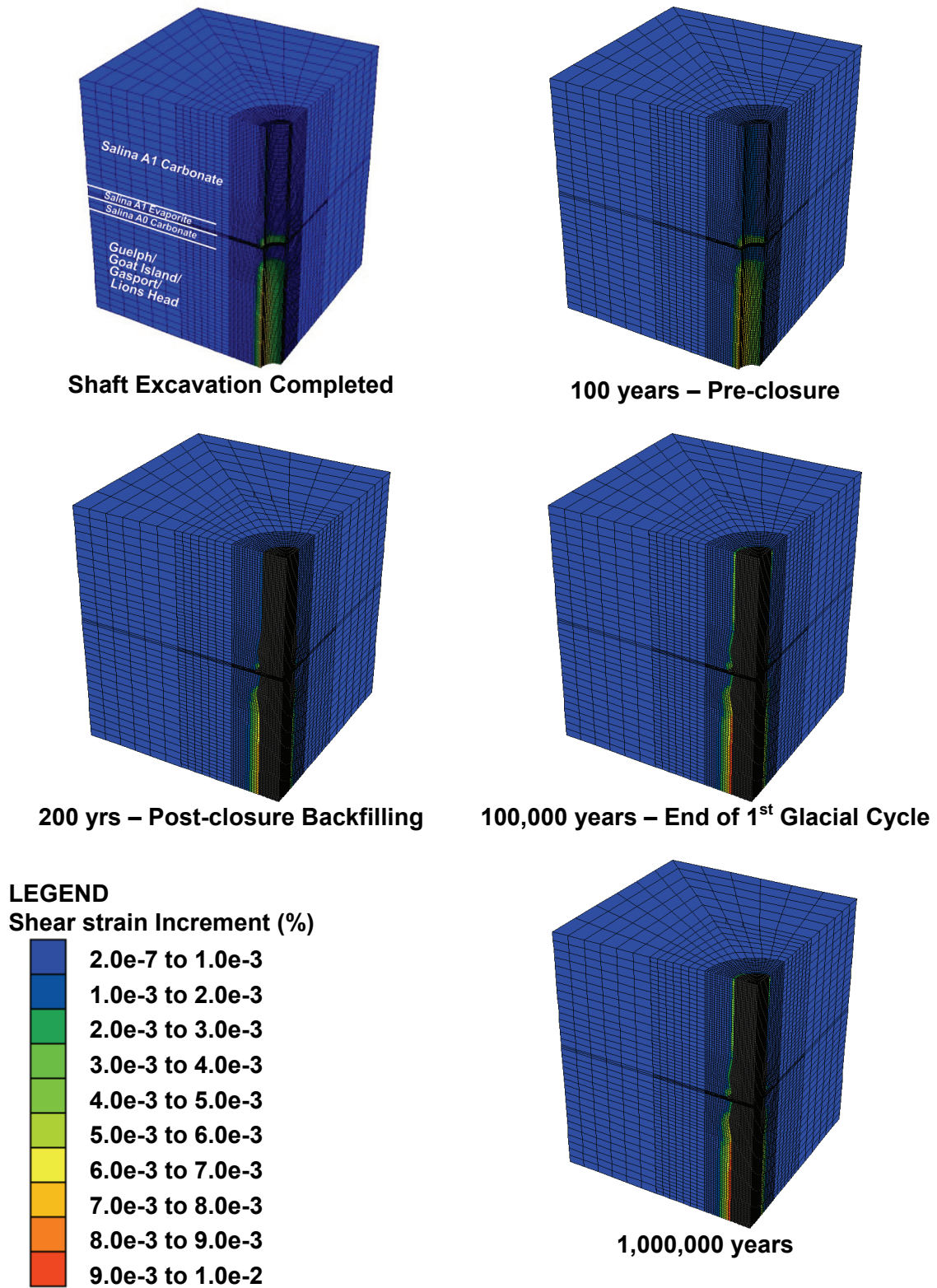


Figure E.18: Shear Strain – Waterstop: Time-dependent Strength Degradation + Glacial Load

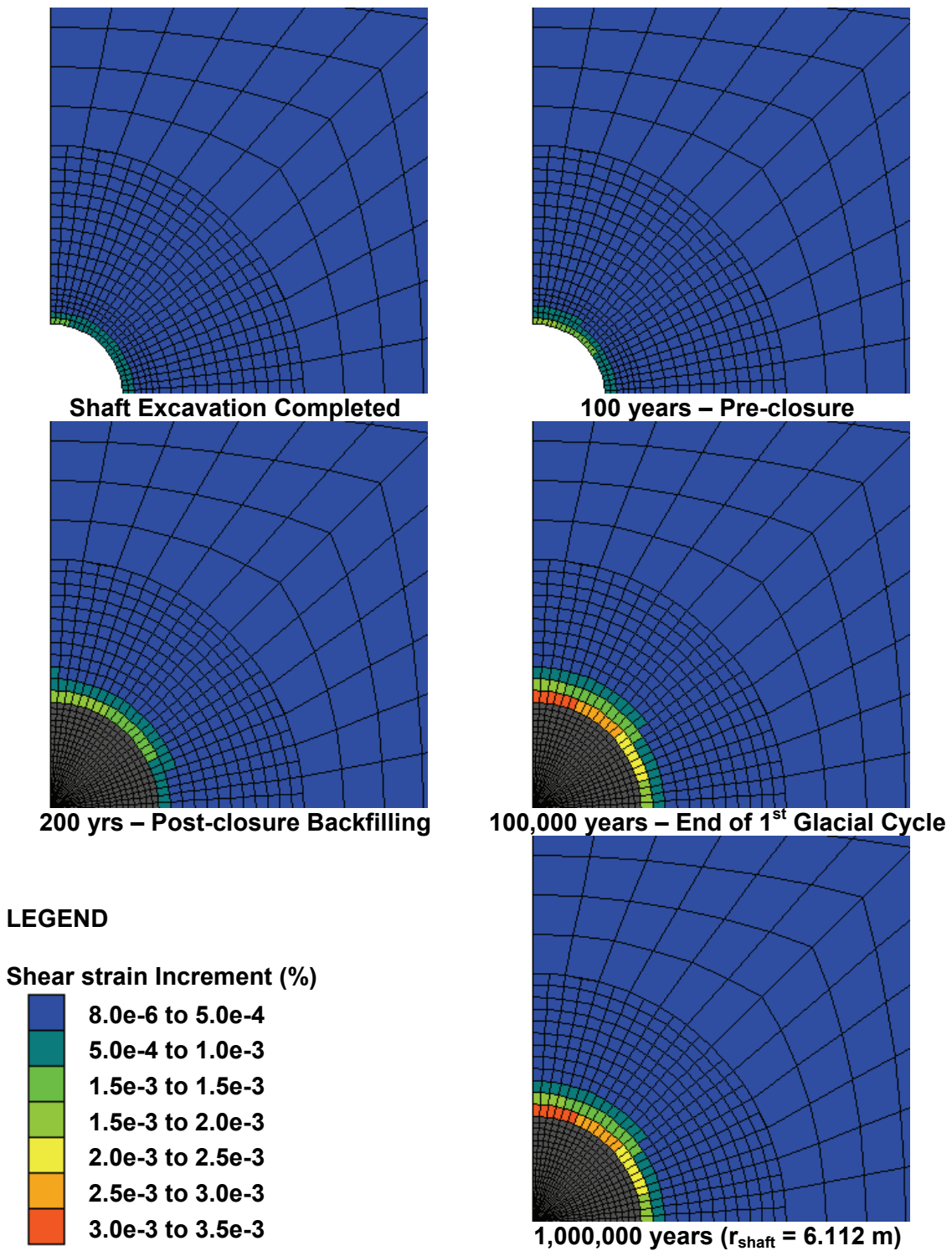


Figure E.19: Shear Strain – 22.4 m Above Waterstop: Time-dependent Strength Degradation + Glacial Load

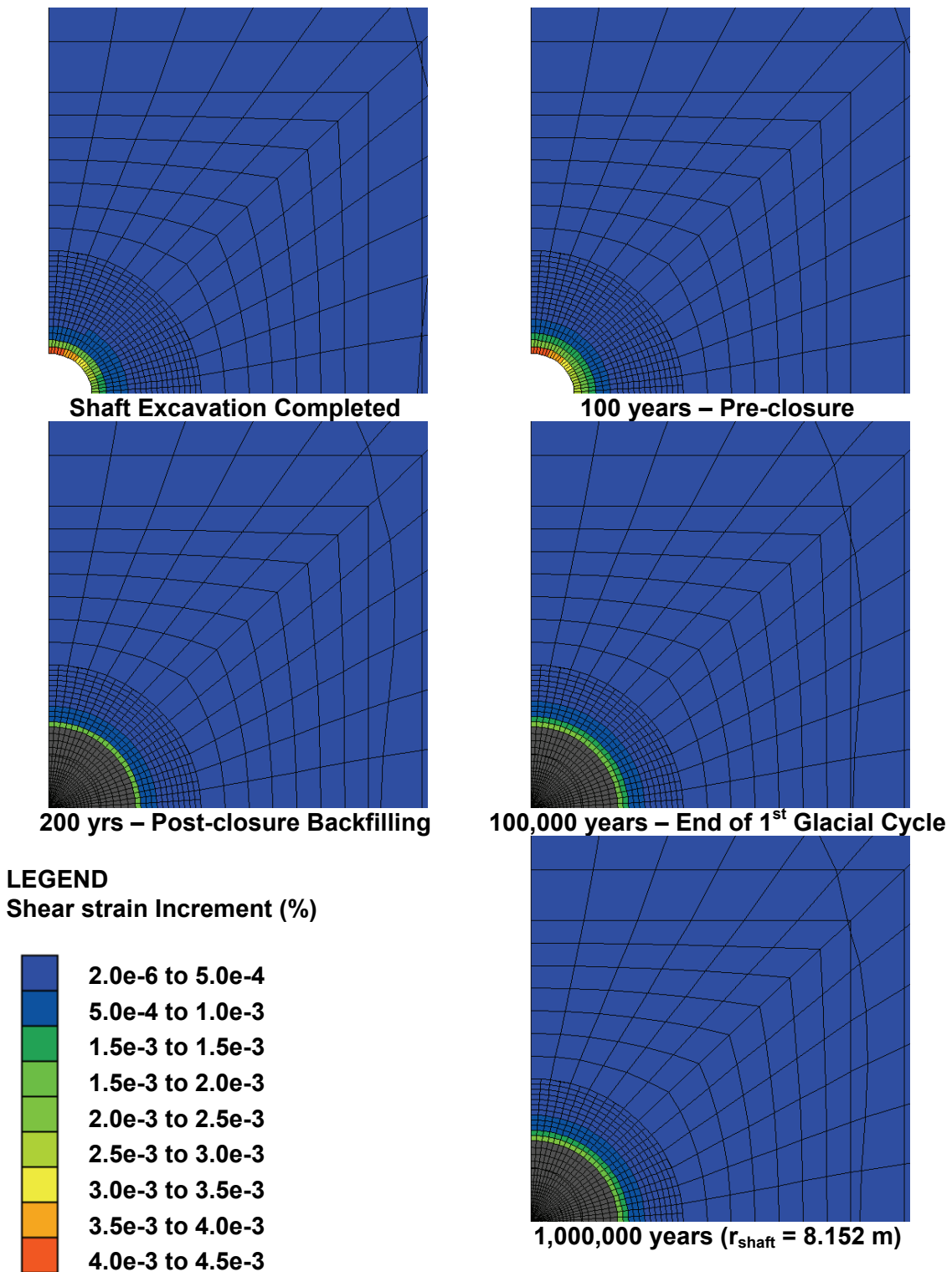


Figure E.20: Shear Strain – Middle of Waterstop: Time-dependent Strength Degradation + Glacial Load

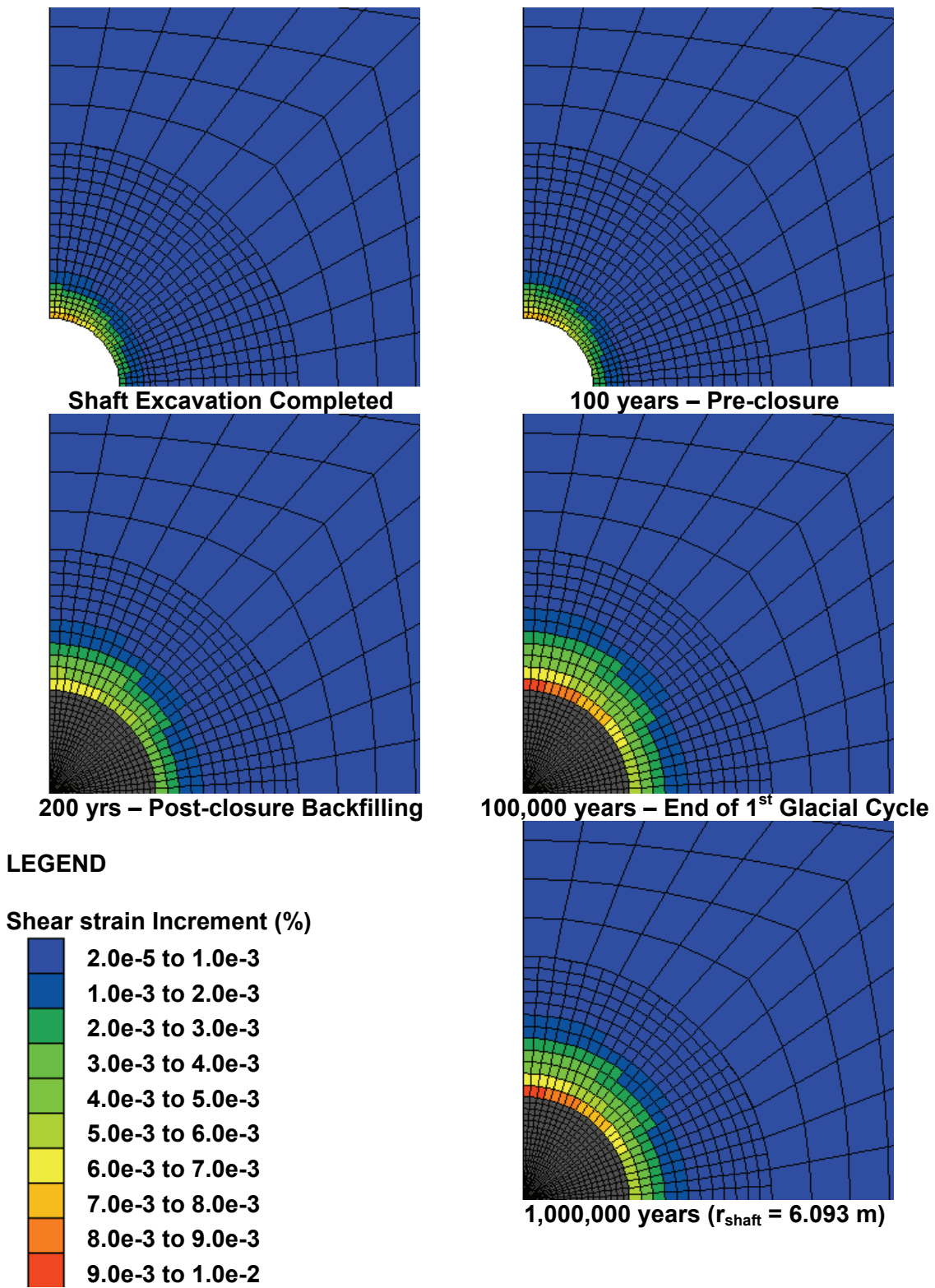


Figure E.21: Shear Strain – 22.4 m Below Waterstop: Time-dependent Strength Degradation + Glacial Load

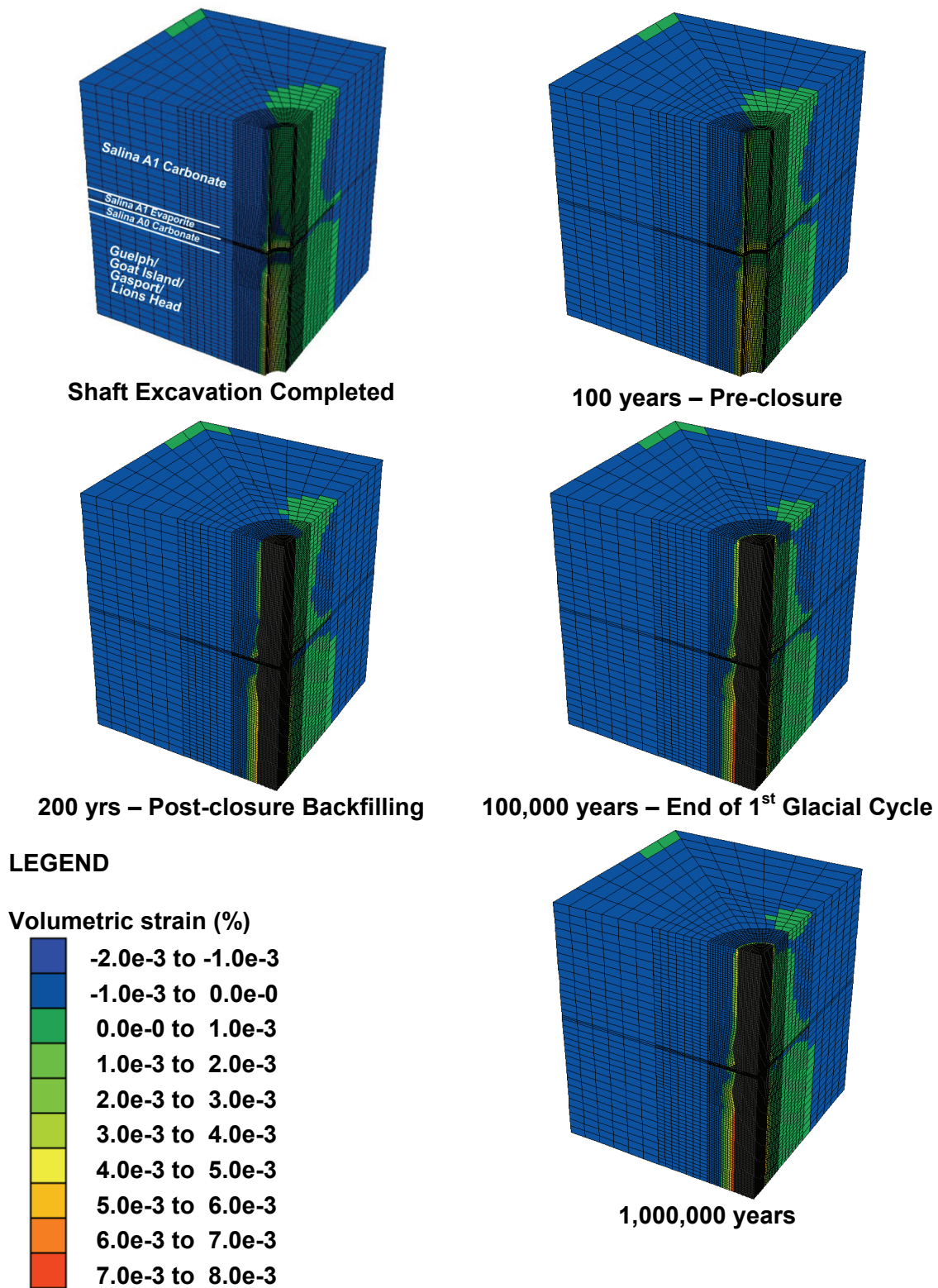


Figure E.22: Volumetric Strain – Waterstop: Time-dependent Strength Degradation + Glacial Load

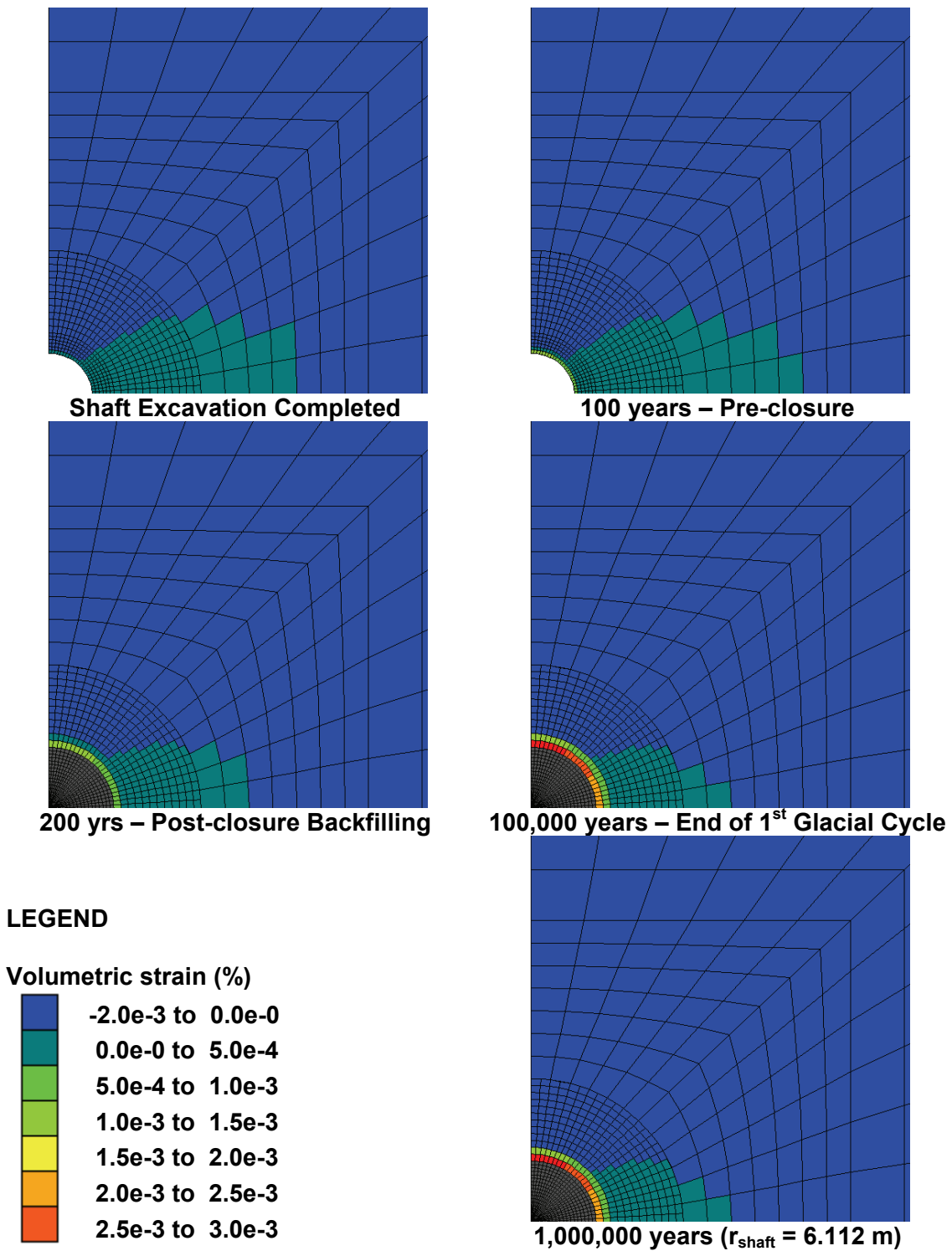


Figure E.23: Volumetric Strain – 22.4 m Above Waterstop: Time-dependent Strength Degradation + Glacial Load

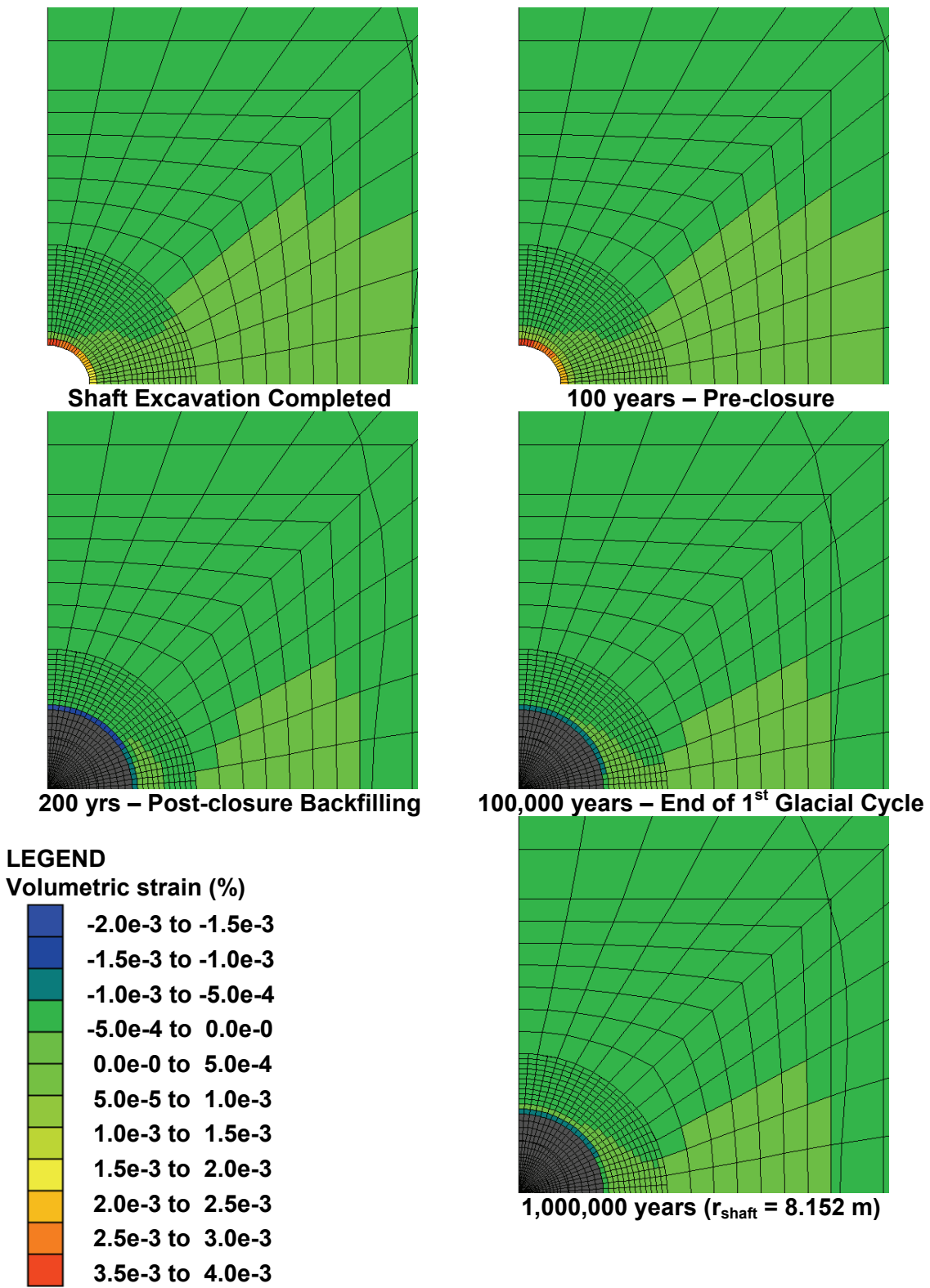


Figure E.24: Volumetric Strain – Middle of Waterstop: Time-dependent Strength Degradation + Glacial Load

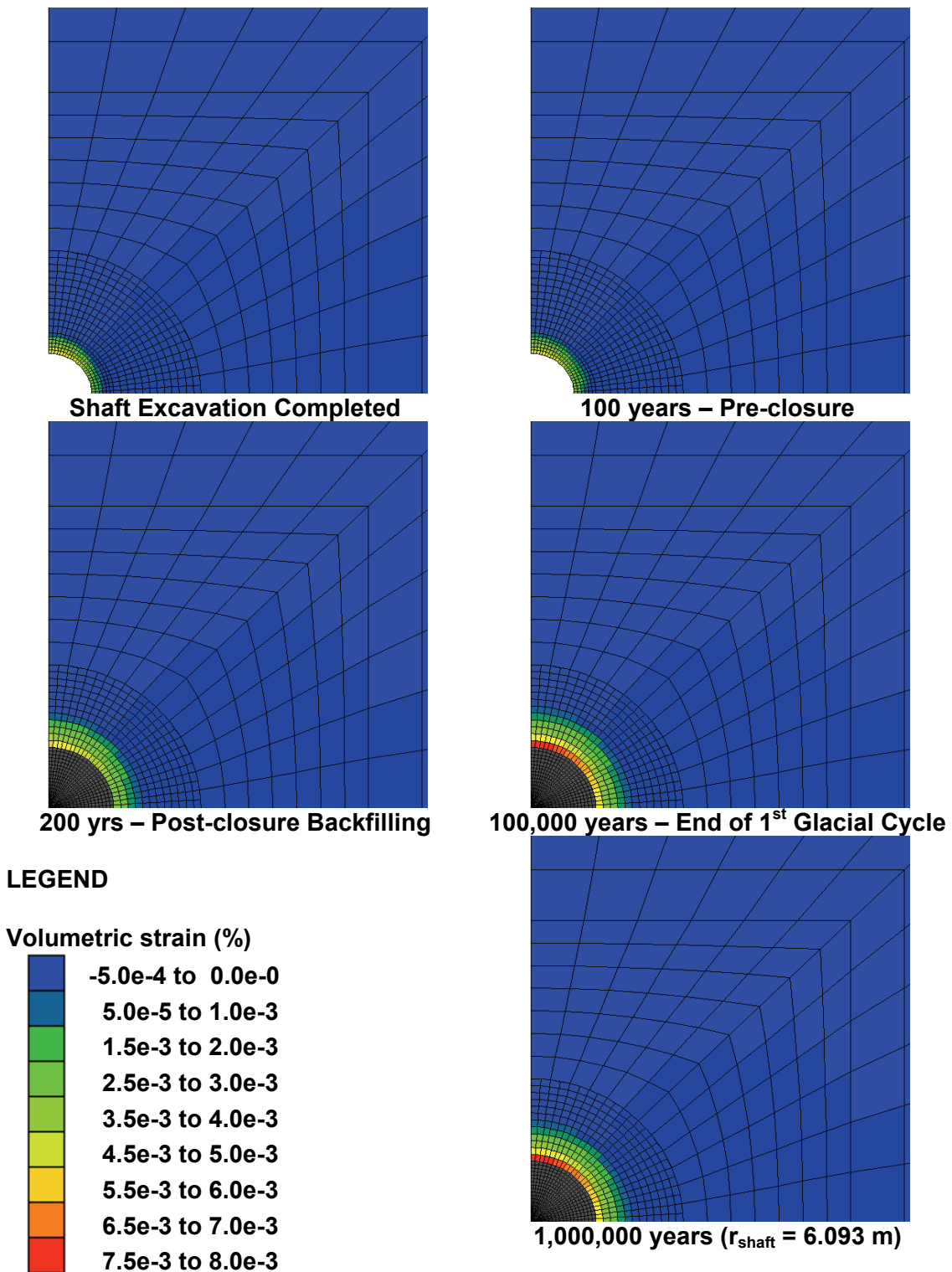


Figure E.25: Volumetric Strain – 22.4 m Below Waterstop: Time-dependent Strength Degradation + Glacial Load