Enrique M. del Castillo

Office: 467 Snell Engineering Center, Northeastern University,
360 Huntington Avenue, Boston, MA 02115
E-mail: e.delcastillo@northeastern.edu
Personal webpage: https://emdc19.github.io/emdcwebsite/

ACADEMIC EMPLOYMENT

- July 2026-present. Tenure-track Assistant Professor in the Department of Civil and Environmental Engineering, **Northeastern University**.
- 2025-2026. Postdoctoral Research Associate at **Princeton University**. Working with Prof. Liuchi Li. Topic: Nonlinear mechanics and physics of dynamic fracture and crack steering in brittle solids.

EDUCATION

- 2025. Ph.D. in Civil Engineering, Geomechanics, **Stanford University**.
  GPA: 4.10/4.0. Dissertation title: Large Deformation Modeling of Dry and Saturated Geomaterials in Geotechnics and Tectonics using Smoothed Particle Hydrodynamics. Research advisor: Prof. Ronaldo I. Borja. Readers: Prof. Paul Segall, Prof. Christian Linder.
- 2021. M.S., Civil Engineering, Geomechanics, **Stanford University**. **GPA: 4.09/4.0**.
- 2019. A.B., Geosciences, **Princeton University**. Graduated with Highest Honors (Summa Cum Laude). Sigma Xi. **GPA: 3.876/4.0. Major GPA: 3.93/4.0**. Senior thesis title: Numerical and Field-data Evaluation of the Critical Taper Model for Orogenic Wedge Stability. Co-advisors: Prof. Allan Rubin and Prof. Blair Schoene.
  - Materials Science and Engineering Certificate (minor)
  - Geological Engineering Certificate (minor)
  - European Cultural Studies Certificate (minor)
  - Contemporary European Politics and Society Certificate (minor).

HONORS AND AWARDS

- 2024-2025 Siebel Scholars Award in Energy Science, Stanford Doerr School of Sustainability.
- 2020 NSF GRFP Fellowship: National Science Foundation Graduate Research Fellowship Program, Engineering - Civil Engineering Award Winner. Grant no. DGE - 1656518.
- 2019 SGF: Stanford Graduate Fellowship in Science & Engineering, Stanford University.
- 2019 EDGE: Enhancing Diversity in Graduate Education Fellowship, Stanford University.
- 2019 Princeton Institute for the Science and Technology of Materials (PRISM) Best Senior Thesis Award.
- 2019 Arthur F. Buddington Award for overall excellence in the Earth Sciences, Princeton University.
- 2018 NSF funded REU for Meeting the Grand Challenges in Engineering Fellow at the Pratt School of Engineering at Duke University. Advisor: Prof. Guglielmo Scovazzi.
  - Best REU student Research Poster Award 2018
- 2017 David E. Lumley Scholarship in Energy & Environmental Science-SEG Society of Exploration Geophysicists
- 2017 Princeton University Dean's Fund for Study Abroad Scholarship

- 2016 Dr. José Castillo Award, Mexican Cultural Center of Philadelphia (Top Mexican-American student in PA, NJ, and DE)
- 2016 Marvin and Jene Hewitt Scholarship-SEG Society of Exploration Geophysicists
- 2016 PEI Princeton Environmental Institute Summer Internship and Award
- 2015 Anadarko-SEG Society of Exploration Geophysicists Award
- 2015 Hispanic Scholarship Fund: Walt Disney Company-HSF Scholarship

PUBLICATIONS

[1] **E. M. del Castillo**, J. Geng, & E. Kuhl. (2026) A constitutive neural network-discovered transversely isotropic hyperelastic-damage model for shale rock. [In preparation].

[2] **E. M. del Castillo**. (2026) Conservative mass degradation: A physically consistent closure for dynamic phase-field fracture. [In preparation].

[3] **E. M. del Castillo** & L. Li. (2026) Near-tip mechanics of three-dimensional dynamic crack steering by localized out-of-plane constraints. [In preparation].

[4] J. Geng, **E. M. del Castillo**, & R. I. Borja. (2026) Probabilistic tunnel collapse mechanism based on smoothed particle hydrodynamics and random field theory. [In preparation].

[5] **E. M. del Castillo** & L. Li. (2026) Crack steering in a homogeneous solid via out-of-plane constraints: A three-dimensional phase-field modeling study. *Extreme Mechanics Letters*. 88, 102517. https://doi.org/10.1016/j.eml.2026.102517.

[6] **E. M. del Castillo** & L. Li. (2026) Assessing variational phase-field fracture against LEFM predictions for crack-tip dynamics. *International Journal of Solids and Structures*. 340, 114199. https://doi.org/10.1016/j.ijsolstr.2026.114199.

[7] **E. M. del Castillo** & P. Segall. (2026) Large deformation, pressure-driven mechanistic modeling of the 2018 caldera collapse at the Kīlauea Volcano, HI. *Journal of Geophysical Research: Solid Earth*. 131(4), e2025JB032775. https://doi.org/10.1029/2025JB032775.

[8] **E. M. del Castillo**, R. I. Borja, & A. H. Fávero Neto. (2026) A Coupled u–p^w SPH Formulation for Hydromechanical Modeling of Retrogressive Landslides: Comparison with a Penalty-Based Approach. *International Journal for Numerical and Analytical Methods in Geomechanics*. 50(10), 4059-4089. https://doi.org/10.1002/nag.70322.

[9] **E. M. del Castillo**, & J. Geng. (2026) Evaluation of Retrogressive Slope Failure in Sensitive Clays under Undrained Conditions with Smoothed Particle Hydrodynamics. Geo-Congress 2026 Proceedings. 149–158. https://doi.org/10.1061/9780784486719.015.

[10] J. Geng, **E. M. del Castillo**, & R. I. Borja. (2026) Probabilistic Tunnel Collapse Mechanism Based on Smoothed Particle Hydrodynamics and Random Field Theory. Geo-Congress 2026 Proceedings. 208–217. https://doi.org/10.1061/9780784486719.021.

[11] **E. M. del Castillo**, J. Geng, & R. I. Borja. (2025) A nonlocal kernel-based continuum damage model for compaction band formation in porous sedimentary rock. *Computational Mechanics*. 75(6), 1745-1768. https://doi.org/10.1007/s00466-024-02540-x.

[12] **E. M. del Castillo**, A. H. Fávero Neto, & R. I. Borja. (2024) Fault rupture through stratified sand-clay deposits and engineered earth structures: a meshfree and critical-state modeling approach. *Acta Geotechnica*. 19, 7767–7798. https://doi.org/10.1007/s11440-024-02421-w.

[13] **E. M. del Castillo**, A. H. Fávero Neto, J. Geng, & R. I. Borja. (2024) An SPH framework for drained and undrained loading over large deformations. *International Journal for Numerical and Analytical Methods in Geomechanics*. 48(12), 3227–3257. https://doi.org/10.1002/nag.3790.

[14] **E. M. del Castillo**, B. Ferdowsi, A. Rubin, & B. Schoene. (2023) Strain localization patterns and thrust propagation in 3-D discrete element method (DEM) models of accretionary wedges. *Tectonics*. 42(8), e2022TC007707. https://doi.org/10.1029/2022TC007707.

[15] **E. M. del Castillo**, A. H. Fávero Neto, & R. I. Borja. (2023) Modeling Fault Rupture Through Layered Geomaterials with SPH. In: Pasternak, E., Dyskin, A. (eds) *Multiscale Processes of Instability, Deformation and Fracturing in Geomaterials*. IWBDG 2022. Springer Series in Geomechanics and Geoengineering. Springer, Cham. https://doi.org/10.1007/978-3-031-22213-9_16.

[16] **E. M. del Castillo**, A. H. Fávero Neto, & R. I. Borja. (2021) A continuum meshfree method for sandbox-style numerical modeling of accretionary and doubly vergent wedges. *Journal of Structural Geology*. 153, 104466. https://doi.org/10.1016/j.jsg.2021.104466.

[17] **E. M. del Castillo**, A. H. Fávero Neto, & R. I. Borja. (2021) Fault propagation and surface rupture in geologic materials with a meshfree continuum method. *Acta Geotechnica*. 16(8), 2463–2486. https://doi.org/10.1007/s11440-021-01233-6.

[18] G. Scovazzi, O. Colomés, N. Abboud, M. Veveakis, **E. M. del Castillo**, D. Valiveti, & H. Huang. (2021) A blended transient/quasistatic Lagrangian framework for salt tectonics simulations with stabilized tetrahedral finite elements. *International Journal for Numerical Methods in Engineering*. 122(14), 3489–3524. https://doi.org/10.1002/nme.6671.

CONFERENCES AND ABSTRACTS

[1] L. Li & **Enrique M. del Castillo**. (2026) Steering (in-plane) cracks via out-of-plane constraints: A 3D computational phase-field study. Society of Engineering Science (SES) Annual Technical Meeting 2026. Purdue University in West Lafayette, Indiana.

[2] **E. M. del Castillo**. (2026) Computational Meshfree Modeling of Fluid-Saturated Granular Flows and Slides. 22nd Annual Northeastern Granular Materials Workshop, June 2026. (Oral presentation).

[3] **E. M. del Castillo** & L. Li. (2026) Modeling noninvasive crack propagation control in homogeneous materials using the phase-field method. Princeton Materials Institute Symposium, April 2026. (Poster).

[4] **E. M. del Castillo** & J. Geng. (2026) Evaluation of Retrogressive Slope Failure in Sensitive Clays under Undrained Conditions with Smoothed Particle Hydrodynamics. ASCE Geo-Congress 2026, Salt Lake City, UT. (Oral presentation).

[5] J. Geng, **E. M. del Castillo**, & R. I. Borja. (2026) Probabilistic Tunnel Collapse Mechanism Based on Smoothed Particle Hydrodynamics and Random Field Theory. ASCE Geo-Congress 2026, Salt Lake City, UT. (Poster).

[6] P. Segall, T. Wang, J. A. Crozier, M. V. Matthews, K. R. Anderson, & **E. M. del Castillo**. (2025) "Insights into Caldera Collapse Mechanics and Outstanding Questions from the 2018 Kīlauea Event." IAVCEI 2025 Scientific Assembly, Geneva, Switzerland. (Poster).

[7] **E. M. del Castillo**. "A Smoothed Particle Hydrodynamics-Based Poromechanics Framework for Large Deformation Analysis." Blume Earthquake Engineering Center 50th Anniversary, Stanford, USA. (Poster).

[8] P. Segall, T. Wang, J. A. Crozier, K. R Anderson, M. V. Matthews, & **Enrique M. del Castillo**. (2025) "Insights into Caldera Collapse Mechanics and Outstanding Questions from the 2018 Kīlauea Event." AGU Chapman Conference on Caldera-Forming Eruptions at Basaltic Volcanoes: Insights and Puzzles from Kīlauea and Beyond, Hilo, HI. (Oral presentation).

[9] **E. M. del Castillo** & R. I. Borja. (2024) "Modeling large deformation soil loading and failure under undrained conditions using a meshfree approach." EMI/PMC 2024 Conference, Engineering Mechanics Institute Conference and Probabilistic Mechanics & Reliability Conference in Chicago, Illinois. (Oral presentation).

[10] **E. M. del Castillo** & R. I. Borja. (2023) "Fault Rupture Orientation under Diverse Loading Conditions in SPH Simulations." Complas 2023, XVII International Conference on Computational Plasticity in Barcelona, Spain. (Oral presentation).

[11] **E. M. del Castillo**. (2023) "Fault rupture through layered sand-clay deposits: a meshfree modeling approach." PEER 2023 Annual Meeting, Pacific Earthquake Engineering Research Center at UC Berkeley. (Lightning talk and poster).

[12] **E. M. del Castillo**. "Fault Propagation and Surface Rupture in Geologic Materials with a Meshfree Method." Blume Earthquake Engineering Center and SURI Affiliates & Alumni Meeting, Stanford, USA. (Poster).

[13] **E. M. del Castillo**, A. H. Fávero Neto, & R. I. Borja. (2022) "Modeling Fault Rupture Through Layered Geomaterials with SPH." IWBDG 2022, 12th International Workshop on Bifurcation and Degradation in Geomaterials in Perth, Australia. (Oral presentation).

[14] **E. M. del Castillo**, A. H. Fávero Neto, & R. I. Borja. (2021) "A Novel Meshfree Approach for Numerical Sandbox-style Modeling of Fold-and-Thrust Belts". AGU 2021 Fall Meeting (American Geophysical Union). In the T51B: Fold-and-Thrust Belts and Associated Basins: Evolution and Dynamics at All Spatiotemporal Scales section. (Oral presentation).

[15] **E. M. del Castillo**, A. H. Fávero Neto, & R. I. Borja. (2021) "Shear Banding, Fault Propagation, and Tectonic Modeling with a Meshfree Continuum Method." EMI 2021 Conference (Engineering Mechanics Institute of the American Society of Civil Engineers-ASCE). (Oral presentation).

INVITED TALKS

- Department Seminar, Department of Civil and Environmental Engineering, Princeton University, June 2026. Talk title: "From Localization to Catastrophic Collapse: Computational Approaches for Failure in Complex Materials."
- SMatCH Soft Materials Seminar, Department of Mechanical and Aerospace Engineering, Princeton University, March 2026. Talk title: "Crack steering in homogeneous materials via lateral constraints: a three-dimensional phase-field modeling study."
- Department Seminar, Department of Civil, Construction and Environmental Engineering, University of Alabama, January 2025. Talk title: "A meshfree hydromechanical approach to large deformation modeling of natural hazards involving localized geomaterial failure."
- Distinguished Seminar Series, Department of Civil and Environmental Engineering, Northeastern University. January 2025. 'Talk title: "Meshfree hydromechanical modeling of large-deformation natural hazards involving localized geomaterial failure."

RESEARCH INTERESTS

Localization and failure in geological and granular materials, numerical modeling of tectonic processes, accretionary wedges, fault rupture and propagation, fracture, Discrete Element Method, compaction bands, mechanics of geomaterials (soil, rock, ice, and snow) and other granular materials, mechanistically-grounded data-driven modeling, Smoothed Particle Hydrodynamics, landslides and debris flows, seismic loading and soil liquefaction, and infrastructure resilience in the wake of geologic hazards.

ONGOING RESEARCH PROJECTS

1. 2026-Present. Phase-field modeling of mode-II shear cracks. Extending variational phase-field fracture methods to robustly capture the dynamics of mode-II shear cracks and dynamic shear rupture without requiring crack paths to be known a priori or explicitly track crack topology.
2. 2026-Present. Understanding the micromechanical origins of fault-system development and earthquake processes in subduction zones, particularly in relation to proto-thrusts and other localization precursors and the formation of splay faults from a granular-mechanics perspective.
3. 2026-Present. Developing and testing (both computationally and experimentally) a novel approach for crack steering in materials and structural elements based on simple kinematic constraints that is noninvasive and can be applied to currently deployed infrastructure. Future work targets integration of this approach with architected material systems to help increase fracture toughness in engineered structures. Collaboration with Prof. Liuchi Li (Dept. of Civil and Environmental Engineering, Princeton University).

4. 2025-Present. Comprehending the role and importance of distributed, non-localized inelastic deformation in the caldera collapse during the 2018 Kīlauea eruption intercalating smoothed particle hydrodynamics numerical simulations with in-situ imaging and geodetic field data. Collaboration with Prof. Paul Segall (Dept. of Geophysics Stanford University).
5. 2025-Present. Work on developing new and improving existing remedies such as the mass degradation approach for the dynamic variational phase field method to eliminate nonphysical damage widening, excess dissipation, tip-blunting and the crack speed cap all inherent to the method, while retaining its variational structure.
6. 2024-Present. Developing constitutive neural networks for automatically discovering a transversely isotropic hyperelastic-damage model for shale rock, with Prof. Ellen Kuhl (Dept. of Mechanical Engineering, Stanford University) and Dr. Jun Geng (Dept. of Civil and Environmental Engineering Stanford University). Future work focuses on accounting for viscoelasticity and ultimately viscoelastoplasticity in addition to anisotropic damage.
7. 2022-Present. Developing fully-coupled hydromechanical formulations for the smoothed particle hydrodynamics method, designed for post-failure and large deformation modeling of fluid saturated geomaterials involving a diverse set of applications including debris and mud flows, landslides, embankment and levee stability and failure, as well as earthquake-induced soil liquefaction. Collaboration with Prof. Alomir Fávero Neto (Dept. of Civil and Environmental Engineering, Bucknell University) and Prof. Ronaldo I. Borja (Dept. of Civil and Environmental Engineering, Stanford University). Current working focused on modeling tailings dam collapses under static liquefaction using SPH with critical state soil models appropriate for mine tailings, such as the NorSand or CASM models.
8. 2025-Present. Surrogate modeling of granular flows and landslides, including estimating impact forces on baffles and barriers by way of graph neural networks. In collaboration with Prof. Alomir Fávero Neto (Dept. of Civil and Environmental Engineering, Bucknell University) and Daniel Zhou (Stanford University).
9. 2024-Present. Modeling tunnel face and alcove collapse in coal mine tunnels using smoothed particle hydrodynamics, with Dr. Jun Geng (Dept. of Civil and Environmental Engineering Stanford University), and Dr. Souheil Ezzedine (Lawrence Livermore Natl. Laboratory).

PROFESSIONAL ACTIVITIES, SERVICE, AND OUTREACH

- Reviewer for leading technical journals including *Acta Geotechnica*, *Computers and Geotechnics*, *Geomechanics for Energy and the Environment*, the *International Journal for Numerical and Analytical Methods in Geomechanics*, the *European Journal of Environmental and Civil Engineering*, the *KSCE Journal of Civil Engineering*, and the *Springer Series in Geomechanics and Geoengineering* "Multiscale Processes of Instability, Deformation and Fracturing in Geomaterials."
- Member of the American Society of Civil Engineers and the American Geophysical Union.
- EDGE: Enhancing Diversity in Graduate Education member and peer mentor at Stanford University. Participate in discussions and activities focused on the graduate experiences of new students from diverse and marginalized backgrounds.
- Graduate student mentor and event organizer at Stanford Engineering Research Introductions Organization SERIO seeking to support and augment the participation of underrepresented undergraduate students in graduate-level STEM education.
- Earthquake Engineering Research Institute (EERI) Stanford University Chapter Peer mentor. Mentored two first year Masters students in the Structural Engineering and Mechanics and Computation (SEM) program regarding their academic interests and career goals.

TEACHING EXPERIENCE

- Assistant Professor, Northeastern University, Undergraduate course, CIVE 2340: Geotechnical Engineering. Spring 2027.

  - Focuses on the formation, composition, and classification of soil for engineering purposes; soil-water phase relations; water in soil; seepage; stresses in soil; consolidation theory; strength properties of soils; and the basics of geoenvironmental engineering.

- Teaching Assistant, Stanford University, Graduate course (PhD level), CEE 315: Plasticity Modeling and Computation. Spring 2023.
  - Held biweekly office hours, graded the class problem sets, conducted additional tutorials augmenting and further explaining class material, and helped students design their final projects, implementing different constitutive models at the stress point level. Office hours consisted of first working on additional example problems and then opening the floor to questions.
  - Student reviews: In the question "overall, how effective was the instruction you received from this instructor?" out of 7 respondents (12 students total) I scored the highest "extremely effective" as the median score. Students also commented that I was "very helpful in the homework and the project," "Enrique was good at helping with the homework," and that as an instructor my teaching demonstrated the following characteristics, "knowledge on the subject," "quick and effective feedback," and "patience."

- Teaching Assistant, Stanford University, Graduate course (Master's level), CEE 281: Mechanics and Finite Elements. Winter 2025.
  - Taught the class when professor was traveling, held biweekly office hours, graded the class problem sets, conducted additional classes to help students with their computing assignments, implementation of 2D FEM code to solve Poisson's equation over a unit square, as well as more involved 2D BVPs including fluid seepage around a pile, and cantilever beam bending considering different element types in the incompressible limit, and how to avoid volumetric locking.
  - Student reviews: In the question "overall, how effective was the instruction you received from this instructor?" out of 9 respondents (13 students total) I scored the "very effective" as the median score. In the question "How much did you learn from this instructor?" I scored "A lot" as the median score.

PAST RESEARCH, INTERNSHIPS AND WORK EXPERIENCE

- 2018-19: As an undergraduate Geosciences student at Princeton University, I performed 3-D numerical simulations of accretionary wedges using the discrete element method for my senior thesis advised by Prof. Blair Schoene, Prof. Allan Rubin, and Dr. Behrooz Ferdowsi (now Prof. at U. of Houston). This research resulted in publication [14] above.
- Summer 2018: REU intern for Meeting the Grand Challenges in Engineering at Duke University, supervised by Prof. Guglielmo Scovazzi (Dept. of Civil Engineering). Studied salt tectonics and modeled salt diapirism using the finite element method. This work resulted in paper [18] above.
- Summer 2017: Under the supervision of Prof. Blair Schoene, Dept. of Geosciences, Princeton University, I helped to analyze crystal size distributions in pumice clasts to characterize the temporal nature of the volcanic super-eruption that occurred in the Bishop Tuff, California.
- Summer and Fall 2016, Spring 2017: Lab Assistant at Maloof Lab and Grinder Lab, Dept. of Geosciences, Princeton University. Assisted in the reconstruction process of Cloudina, one of the earliest biomineralizer organisms, using destructive tomography methods.
  1. Trained in the operation of the FEI Quanta 200 FEG Environmental-Scanning Electron Microscope (SEM) and in element mapping.
  2. Trained in the operation of an Isotope Ratio Mass Spectrometer.
  3. Trained in the operation of a Camsizer machine to sieve and characterize different sand grain sizes.

RELEVANT FIELD WORK

- At Stanford University:
  - Spring 2022 GEOPHYS 214 Tectonics Field Trip (Prof. Simon Klemperer) to Crater Lake, Mt. Lassen, Lava Beds Natl. Monument, Hat Creek, and Klamath Lake Fault Zones.
- At Princeton University:
  - Fall 2017 Field Trip GEO 373 (Prof. Blair Schoene) to the Diligencia Basin near the Salton Sea CA, as part of my Structural Geology Class. Spent a week creating a geological map of the area dominated by a large plunging inclined syncline.
  - Spring 2017 Field Trip GEO 372 (Prof. Blair Schoene) to Marble Canyon Death Valley CA, Bishop Tuff CA, and the Searchlight Pluton NV, as part of my Metamorphic and Igneous Petrology Class.
  - Summer 2016 Trip to the Forteau Formation of southern Labrador, Canada with the Maloof Group with the objective of temporally constraining Archaeocyath patch reefs from the Cambrian.
  - Fall 2015 Field Trip FRS 135, Dune du Pilat SW France, Zumaia Spain (carbonate turbidites). Studied sand dune formation and aeolian transport processes at the Dune du Pilat.

RELEVANT SKILLS

- C++, Python, MATLAB, Paraview, LaTeX, ArcGIS, ANSYS, PLAXIS, MPI, OpenMP, Excel.
- Languages Spoken: English (Native), Spanish (Native), Portuguese (Fluent), Italian (conversational), French (basic, reading).

EXTRACURRICULAR ACTIVITIES AND INTERESTS

- Society of Hispanic Professional Engineers (SHPE)
- Princeton Undergraduate Geosciences Society (PUGS)
- Princeton Club Soccer, Club Tennis.

PERSONAL DATA

- Birthplace: Arlington, TX, (prior to college, lived in State College, PA).
- Other interests: Playing chess and classical guitar, reading about historical and contemporary international events.