Enrique M. del Castillo

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I am a Ph.D. candidate at Stanford University in the Geomechanics program within the Department of Civil and Environmental Engineering. My research interests lie in understanding the mechanics and physics of granular and porous media found in nature such as soil, rock, ice, and snow, or in industrial processes using both computational and experimental methods, as well as across spatial scales, focusing on interdisciplinary problems between geomechanics, geotechnics, and geophysics. I wish to leverage my knowledge of computational mechanics and data-driven modeling to help understand and mitigate risks to the built environment posed by natural hazards and climate change, particularly by pushing the envelope of traditional mechanistic engineering modeling and accounting for large material deformations and the post-failure behavior of structures, in turn helping to improve critical infrastructure resilience. To this end, my doctoral research has brought me to meshfree methods where I developed computer codes for smoothed particle hydrodynamics (SPH) and the discrete element method (DEM) for tackling diverse problems ranging from the performance and failure of embankment dams and levees under fault-rupture and seismic loading, to explaining the formation of mountain ranges looking at the development of faults and strain localization zones.

EDUCATION

- 2019-Present. **Stanford University**. Ph.D. candidate in the Department of Civil Engineering, Geomechanics. **Current GPA: 4.10/4.0**. Research advisor: Prof. Ronaldo I. Borja.
- 2019-2021. M.S., Civil Engineering: Geomechanics, **Stanford University**
- 2015-2019. 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**. Thesis title: Numerical and Field-data Evaluation of the Critical Taper Model for Orogenic Wedge Stability.
  - Materials Science and Engineering Certificate (minor)
  - Geological Engineering Certificate (minor)
  - European Cultural Studies Certificate (minor)
  - Contemporary European Politics and Society Certificate (minor).

CURRENT AND PRIOR ACADEMIC DISTINCTIONS

- 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
  - 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. (2024) A constitutive neural network discovered transversely isotropic hyperelastic model for shale rock. [In preparation]

[2] **E. M. del Castillo**, J. Geng, R. I. Borja. (2024) A nonlocal kernel-based continuum damage model for compaction band formation in porous sedimentary rock. *Computational Mechanics*. [Under review].

[3] **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*. [Under review]

[4] **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*. [Accepted].

[5] **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.

[6] **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.

[7] **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.

[8] **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.

[9] 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.

CONFERENCES AND ABSTRACTS

[1] EMI/PMC 2024 Conference, Engineering Mechanics Institute Conference and Probabilistic Mechanics & Reliability Conference in Chicago, Illinois. Oral presentation title: "Modeling large deformation soil loading and failure under undrained conditions using a meshfree approach."

[2] Complas 2023, XVII International Conference on Computational Plasticity in Barcelona, Spain. Oral presentation title: "Fault Rupture Orientation under Diverse Loading Conditions in SPH Simulations."

[3] PEER 2023 Annual Meeting, Pacific Earthquake Engineering Research Center at UC Berkeley. Lightning talk and poster title: "Fault rupture through layered sand-clay deposits: a meshfree modeling approach."

[4] IWBDG 2022, 12th International Workshops on Bifurcation and Degradation in Geomaterials in Perth, Australia. Oral presentation title: "Modeling Fault Rupture Through Layered Geomaterials with SPH."

[5] AGU 2021 Fall Meeting (American Geophysical Union). Oral presentation title: "A Novel Meshfree Approach for Numerical Sandbox-style Modeling of Fold-and-Thrust Belts". In the T51B: Fold-and-Thrust Belts and Associated Basins: Evolution and Dynamics at All Spatiotemporal Scales section.

[6] EMI 2021 Conference (Engineering Mechanics Institute of the American Society of Civil Engineers - ASCE). Oral presentation title: "Shear Banding, Fault Propagation, and Tectonic Modeling with a Meshfree Continuum Method."

PROFESSIONAL ACTIVITIES

- Reviewer for leading technical journals including 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.
- Teaching Assistant, Stanford University, Graduate courses (CEE 315 Plasticity Modeling and Computation) Spring 2023.

ONGOING RESEARCH PROJECTS

1. 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-triggered events such as fault rupture deformation or soil liquefaction. Dissertation topic, under advisor Prof. Ronaldo I. Borja (Dept. of Civil and Environmental Engineering Stanford University).
2. 2024-Present. Understanding the pressure-driven caldera collapse mechanism during the 2018 Kīlauea eruption using smoothed particle hydrodynamics numerical simulations and geodetic field data, with Prof. Paul Segall (Dept. of Geophysics Stanford University).
3. 2023-Present. Modeling tunnel face and alcove collapse in coal mine tunnels using smoothed particle hydrodynamics, with Jung Geng (Dept. of Civil and Environmental Engineering Stanford University), and Dr. Souheil Ezzedine (Lawrence Livermore Natl. Laboratory).
4. 2024-Present. Developing constitutive neural networks for automatically discovering a transversely isotropic hyperelastic model for shale rock, with Prof. Ellen Kuhl (Dept. of Mechanical Engineering Stanford University).

PAST RESEARCH AND INTERNSHIPS

- 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).
- 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.
- 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.

EXTRACURRICULAR ACTIVITIES AND INTERESTS

- Society of Hispanic Professional Engineers (SHPE), Princeton Undergraduate Geosciences Society (PUGS), Princeton Club Soccer, Club Tennis.
- Play chess and classical guitar.

RELEVANT SKILLS

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