Alejandro Cardona

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I. EDUCATION

Ph.D.	2020	Energy Resources and Petroleum Engineering	KAUST, Saudi Arabia
M.S.	2016	Earth Sciences and Engineering	KAUST, Saudi Arabia
B.S.	2015	Petroleum Engineering	UNAL, Colombia

II. EMPLOYMENT

2022-present	Research Associate	UT Austin, USA
2020-2022	Postdoctoral Fellow	UT Austin, USA
2015-2020	Graduate Research Assistant	KAUST, Saudi Arabia
2014	Geomechanics Intern	Equion Energia, Colombia

III. PUBLICATIONS

ARTICLES IN REFEREED JOURNALS

Published

Cardona A., Liu Q., and Santamarina J.C. (2023), The capillary pressure vs. saturation curve in a fractured rock mass: fracture and matrix contributions, *Scientific Reports*, v. 13, 12044, doi: 10.1038/s41598-023-38737-y

Cardona A. and Santamarina J.C. (2023), Immiscible fluid displacement in fractured media: A dual porosity microfluidics study, *International Journal of Rock Mechanics and Mining Sciences*, v. 170, 105555, doi:10.1016/j.ijrmms.2023.105555

Cardona A., Bhandari A., and Heidari M. and Flemings P.B. (2023). The viscoplastic behavior of natural hydrate bearing sediments under uniaxial strain compression (K_0 loading), *Journal of Geophysical Research: Solid* Earth, v. 128, e2023JB026976, doi:10.1029/2023JB026976

Cardona A. and Santamarina J.C. (2023), A Convenient Device to Measure the Permeability of Intact Rock (Heterogeneity and Anisotropy), *Geotechnical Testing Journal*, v. 46 (5), doi:10.1520/GTJ20220112

Cardona A., Finkbeiner T. and Santamarina J.C. (2021), Natural Rock Fractures: From Aperture to Fluid Flow, *Rock Mechanics and Rock Engineering*, v. 54, p 5827-5844, doi:10.1007/s00603-021-02565-1

Cardona A. and Santamarina J.C. (2020), Carbonate rocks: Matrix permeability estimation, *AAPG Bulletin*, v.104 (1), p 131-144 doi:10.1306/05021917345

Under review (PDF available on request)

Bhandari A., **Cardona A.**, Flemings P.B, Germaine J. T. Geomechanical behavior of sandy silts from Green Canyon 955 hydrate reservoir - Deepwater Gulf of Mexico, *Marine and Petroleum Geology (submitted on Nov-6-2023)*

Rodriguez-Florez X., Barbosa A., Guimarães L., **Cardona A.** and Finkbeiner T. Impact of carbonate content, rock texture, and roughness on fracture transmissivity and acid-etching patterns in carbonate rocks, *Rock Mechanics and Rock Engineering (submitted on Sep-29-2023)*

In preparation (PDF available on request)

You K., Thomas C., Savage A., Murphy Z., O'Connell J., **Cardona A.** and Flemings P.B, Dissolved Methane Diffusion Drives Hydrate-Bearing Pressure Core Degradation During Long-Term Storage in Water *(to be submitted to Energy & Fuels)*

Cardona A., You K. and Flemings P.B, Relative permeability of hydrate-bearing sediments: the critical role of hydrate dissolution *(to be submitted to Geophysical Research Letters)*

Cardona A., Finkbeiner T. and Santamarina J.C, Numerical Study of Fractured Reservoirs: Hydromechanical Analysis of the Permeability Tensor *(to be submitted to Rock Mechanics and Rock Engineering)*

Terzariol M. and **Cardona A.**, Methane Hydrate-Bearing Sediments Morphology: Spatial Variability, Physical Properties and Implications *(to be submitted to Geophysical Research Letters)*

CHAPTERS IN BOOKS

Santamarina J.C., Park J., Terzariol M., **Cardona A.**, Castro G., Cha W., Garcia A., Hakiki F., Lyu C., Salva-Ramírez M., Shen Y., Sun Z., Chong S.H. (2019), Soil Properties: Physics Inspired, Data Driven, *in: Lu N., Mitchell J. (eds) Geotechnical Fundamentals for Addressing New World Challenges*, Springer Series in Geomechanics and Geoengineering, Springer, doi:10.1007/978-3-030-06249-1_3

PEER-REVIEWED CONFERENCE ARTICLES

Cardona A., Finkbeiner T. and Santamarina J.C. (2020), Numerical Study of Fractured Reservoirs: Hydromechanical Analysis of the Permeability Tensor. *4th Naturally Fractured Reservoir Workshop*, Ras Al Khaimah, UAE.

Araujo, E., Alzate, G., Arbelaez, A., **Cardona, A.**, Pena, S., Naranjo, A. (2014), Analytical Prediction Model of Sand Production Integrating Geomechanics for Open Hole and Cased Hole – Perforated Wells. *Conference Paper SPE 171107-MS. SPE Heavy and Extra Heavy Oil Conference: Latin America*, Medellin, Colombia, 24-26 September. doi:10.2118/171107-ms

TECHNICAL REPORTS

Price, A., Flemings, P., Thomas, C., **Cardona, A.**, Murphy, Z., Garcia, A., Savage, A., Houghton, J., and Pettigrew T. (2021), GOM2 Pressure Coring Tool with Ball Valve (PCTB) Land Test III Report.

Cardona A., Finkbeiner T., Santamarina J.C. (2019), Hydromechanical Response of Fractured Carbonates, Saudi Aramco - Final Deliverable.

THESES

Cardona A. (2020), Fluid Transport in Fractured Carbonate Rocks, PhD Dissertation, KAUST. doi: 10.25781/KAUST-8A4ZQ

Cardona A. (2014), Software Construction to Generate Mechanical Earth Models from Well Logs, Engineering Thesis, UNAL (Universidad Nacional de Colombia), Colombia (in Spanish).

IV. INVITED SEMINAR TALKS

01/ 2023 Energy Geotechnology: Understanding Geo-Material Behavior
South Dakota School of Mines & Technology

11/2022 Methane Hydrates at the University of Texas: Expeditions & Geo-material Behavior
UTIG 50th Anniversary, The University of Texas at Austin (link)

09/2022 Energy Geotechnology: Flow & Geomechanics
National Energy Technology Laboratory (NETL)

06/2022 Hydrate-bearing sediments: K_0 Loading and Creep
KAUST

09/2021 Flow Phenomena in Geomaterials: Unraveling Processes and Behavior
UTIG, The University of Texas at Austin (link)

V. HONORS AND AWARDS

03/2022 GRC Travel Award, *Natural Gas Hydrate Systems GRC 2022*
12/2016 Commencement speaker candidate, *KAUST*
2015-2020 KAUST Graduate Fellowship, *KAUST*
01/2015 WEP Annual Poster Competition, *KAUST*
09/2013 1st Place in Petro Cup SPE, *XV Colombian Congress of Oil and Gas*

VI. FIELD EXPERIENCE

08/2023 UT-GOM2-2: Gulf of Mexico Deepwater Hydrates Expedition - Dockside
Physical Properties Specialist (2 weeks), Salt Lake City, UT, USA

08/2023 UT-GOM2-2: Gulf of Mexico Deepwater Hydrate Expedition - Offshore
Downhole & Pressure Core Specialist (1 month), Gulf of Mexico, USA

04/2021 Pressure Coring Tool with Ball Valve Land Test III
Pressure Core Specialist (1 week), Catoosa, OK

02/2020 Naturally Fractured Reservoirs Field Trip, EAGE Workshop
On-site geoscientist (2 days), Northern Emirates Mountains

11/2017 Carbonate Analogues Field Trip, KAUST
On-site geoscientist t (2 days), Abu Dhabi

07/2014 Well Floreña AP-13 drilling operation, Equion Energia
Wellbore stability engineer (1 week), Colombian Foothills

VII. RESEARCH METHODS

A. EXPERIMENTAL DEVICES – DESIGN, CONSTRUCTION, OPERATION

(contributed in initiating/developing experimental hardware for laboratories)

- Triaxial cell for hydrate-bearing sediments at in-situ fluid pressure
- Torsional shear and radial flow for pre-fractured specimens
- Matrix permeameter for unjacketed rock specimens
- Micromodel fabrication using soft lithography with pressure and optical instrumentation
- Bench-scale 2D flow sandbox model with optical measurements

B. SCIENTIFIC INSTRUMENTS - OPERATION

Rock and soil mechanics, petrophysics, complex fluids

- Manipulation and testing of natural hydrate-bearing sediments under pressure and temperature
- High Pressure High Temperature: Core Flooding, Triaxial System, Contact Angle and Interfacial Tension
- Mercury Intrusion Porosimetry (MICP), Helium porosimetry
- Surface Roughness by Interferometry

Material characterization, imaging, and nanofabrication

- Analytical chemistry. Gas Sorption Specific Surface (Micromeritics ASAP 2420), Mercury Porosimeter (Micromeritics AutoPore IV)
- Imaging and Characterization. X-Ray Diffractometer (Rigaki Miniflex), X-Ray Computer Tomography (Tescan XRE), Nuclear Magnetic Resonance (Oxford Instruments, 12 MHz), Scanning Electron Microscopy SEM (Quanta 600 at KAUST Corelab), White Light Interferometer (Nanovea ST400 and Nanovea JR25)
- Nanofabrication. Mask Maker (Heidelberg μPG501), Mask Aligner (EVG 6200), Plasma Cleaner (Plasma Etch PE-50)

C. ANALYTICAL AND NUMERICAL TOOLS

Software development

- Pore-scale modeling: invasion percolation, fracture flow, fracture digital analogues
- Digital image correlation: strain analysis, fluid invasion fronts (micro&bench scale)
- Element-based models: coupled thermo-hydro-chemo-mechanical processes
- Programming languages: Python, Matlab, Mathcad, Mathematica, Fortran
- Numerical tools: finite differences, finite elements

Commercial software - operation

- High Performance Computing (HPC): Texas Advanced Computer Center (TACC)
- Laboratory software: Solidworks, AutoCAD, LabView, ImageJ
- FEM/DEM/Visualization Software: COMSOL, LIGGGHTS, Paraview
- Petroleum and geological engineering software: GMI-Suite, Fracman, CMG, Eclipse, Petrel, Interactive Petrophysics, Techlog, Matlab Reservoir Simulation Tool MRST

VIII. TEACHING AND ADVISING

Teaching Assistantships

Experimental Methods for Research & Digital Signal Processing, *Summer 2020*, KAUST
Rock Mechanics for Energy Geo-Engineering, *Fall 2019*, KAUST
Well logging, *Spring and Fall 2013*, UNAL

Undergraduate Research Students

At University of Texas at Austin

Camila Van Der Maal (2023)	Resedimentation in clay-rich materials
Colton Hayden (2022)	Strain-rate effects in salt-sand mixtures

IX. CONFERENCE ABSTRACTS

Cardona A., Fang Y., You K., and Flemings P.B (2023), Relative Permeability of Hydrate-Bearing Sediments: The Critical Role of Hydrate Dissolution, *AGU 2023,* San Francisco

Terzariol M**.** and **Cardona A.** (2023), Pore Habit of Natural Hydrate-Bearing Sediments: Learnings from GHASS2 Cruise, *AGU 2023,* San Francisco.

Cardona A., Bhandari A.R., and Flemings P.B. (2022), Creep and stress relaxation behavior of hydrate-bearing sediments: implications for stresses during production and geological sedimentation, *AGU 2022*, Chicago, IL.

Cardona A., Rasmussen C., Shionalyn K., Gase A., Boddupalli B., Greenbaum J. S., Buhl D., Morrison S., Reyes A., Soderlund K.M, and Van Avendonk H.J. (2022), Developing a Code of Conduct at The University of Texas at Austin, Institute for Geophysics (UTIG) - Alternative Approaches, Measures of Success, and Open Questions, *AGU 2022*, Chicago, IL.

Flemings P.B., Fang Y., You K., and **Cardona A.** (2022), The Water Relative Permeability Behavior of Hydrate-bearing Sediment, *AGU 2022*, Chicago, IL.

Shionalyn K., Rasmussen C., Buhl D., **Cardona A.**, Morrison S., Reyes A., Soderlund K.M, and Van Avendonk H.J. (2022), Working from the ground up-initiating a new code of conduct for improved inclusion, *AGU 2022*, Chicago, IL.

Terzariol M. and **Cardona A.** (2022), Natural Hydrate-Bearing Sediments: Pore Habit, *GDR 2022 - Hydrates*, Paris.

Rodriguez-Florez X., Finkbeiner T., Guimarães L., Barbosa, A., and **Cardona A.** (2022), Natural fracture flow - mechanical and chemical degradation effects on carbonates, *ARMA International Geomechanics Symposium IGS*, Abu Dhabi, UAE.

Cardona A., Fang Y., and Flemings P.B. (2022), Methane hydrate-bearing sediments: in-situ state of stress, *Natural Gas Hydrate Systems: Gordon Research Conference 2022* (*cancelled)*, Oxnard, CA.

Cardona A., Fang Y., O'Connell J., and Flemings P.B. (2021), Validation of hydro-geomechanical properties in high pressure triaxial device for hydrate-bearing core analysis, *AGU 2021*, New Orleans, LA. doi: 10.1002/essoar.10508543.1

Liu, Q., **Cardona, A.** and Santamarina J.C. (2020), Capillarity vs. Saturation in Fracture-Matrix Systems, *InterPore*, online format.

Cardona A., Finkbeiner T., and Santamarina J.C. (2020), Numerical Study of Fractured Reservoirs: Hydromechanical Analysis of the Permeability Tensor, *4th EAGE Workshop on Naturally Fractured Reservoirs*, United Arab Emirates.

Cardona A., Finkbeiner T., and Santamarina J.C. (2020), The Hydro-Mechanical Response of a Single Carbonate Fracture, *International Petroleum Technology Conference*, Saudi Arabia.
Cardona A., and Santamarina J.C. (2018), Matrix Permeability in Carbonate Rocks, *KAUST Research Conference: Recovery of Difficult Hydrocarbons*, Saudi Arabia.

X. RESEARCH PROJECTS AND CONSULTING

Supercomputing Allocations

- Impact of viscoelastic inclusions on the geomechanical behavior of sediments, (2022-2023)
  Source: Texas Advanced Computer Center (TACC), 500 node-hours
  Role: Principal Investigator

XI. SERVICE

Professional contributions

Reviewer of Journal and Conference Articles

- Geomechanics and Geophysics for Geo-Energy and Geo-Resources
- Acta Geotechnica
- Energy & Fuels
- AGU: Geophysical Research Letters, Journal of Geophysical Research: Solid Earth
- Rock Mechanics and Rock Engineering
- ARMA Symposium, American Rock Mechanics Association

Organizer of Conferences, Workshops, or Sessions

- Co-convener, Session on Gas hydrates in Earth's subsurface, *AGU 2023.* Dec 2023.
- Organizer, Pressure core monthly discussion (UT Austin, JAIST, USGS, NETL), *Virtual*, Jan 2022 - Dec 2022
- Co-organizer, Athenaeum on Dissolution and Precipitation: Implications for Energy Geo-Engineering, *KAUST*, Feb 2016

Membership in Professional Organizations

- Society of Petroleum Engineers (SPE)
- American Geophysical Union (AGU)
- The International Society for Porous Media (Interpore)
- American Association of Petroleum Geologists (AAPG)
- European Association of Petroleum Geoscientists (EAGE)

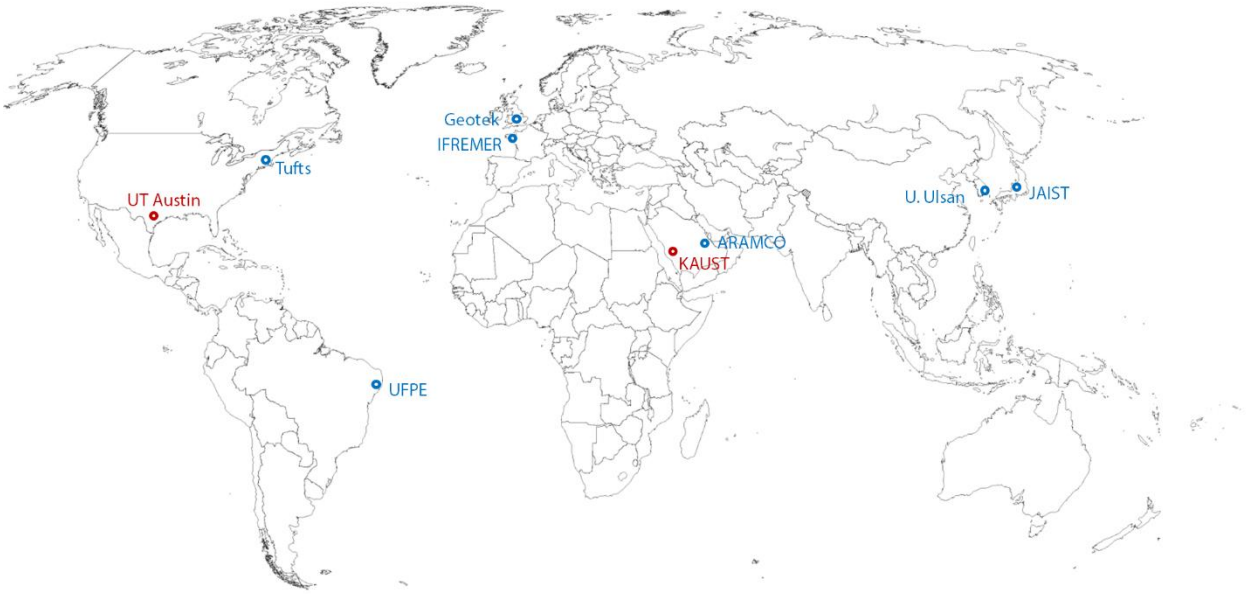
Campus contributions

At UT Austin

- Co-organizer, GeoFORCE K-12 outreach program, July 2022

- Postdoctoral representative, UTIG Diversity, Equity, Inclusion and Accessibility (DEIA) Committee, August 2022 - Present

XII. CLOSE COLLABORATORS



Advisors

- Peter B. Flemings, UT Austin (Postdoctoral Advisor)
- J. Carlos Santamarina, KAUST (PhD Advisor)

Current Collaborators at UT Austin

- Nicolas Espinoza - creep of geomaterials
- Athma R. Bhandari - experimental geomechanics
- Mahdi Heidari - creep of geomaterials
- Kehua You – hydrates dissolution and flow in porous media

Active collaborations with academics outside UT Austin

- Thomas Finkbeiner, KAUST - geomechanics
- John Germaine, Tufts - experimental geomechanics
- Qi Liu, KAUST - complex fluids
- Jun Yoneda, JAIST - pressure cores
- Marco Terzariol, IFREMER - hydrate-bearing sediments
- Hosung Shin, U. Ulsan - fractured rocks
- Leonardo do Nascimento Guimarães, UFPE - fractured rocks

Industrial Collaborations

- Peter Schultheiss, Geotek - pressure cores
- Yaser Alzayer, ARAMCO - fractured rocks