Jorge Nicolas **Hayek**

PhD Geophysics · MSc Geophysics · BSc Geosciences · BSc Physics

Stavanger, Norway

✉ jorgenhayek@gmail.com   Nicolucas   jorgenhayek   0000-0002-0351-3368

Personal Summary

Highly motivated professional in Geosciences and Physics. Dedicated, curious and adaptable person, with a can-do personality. I have a strong interest in interdisciplinary work environments and innovative technologies applied to research in geophysics, geomechanics, and computational physics. Theoretical and practical knowledge on physics-based dynamic simulations and analysis of multiscale geophysical observational datasets.

Education

Ph.D. in Geophysics (Defended, awaiting degree conferral. Summa cum laude)   *Munich, Germany*

Ludwig-Maximilians-Universität   *Feb 2020 - Feb 2025*

- Thesis work: "Analysis and Extension of Earthquake Rupture Dynamics: A methodological exploration & links to global geodynamic studies", 2024. Supervised by Alice-Agnes Gabriel and Hans-Peter Bunge.

M.Sc. in Geophysics   *Munich, Germany*

Ludwig-Maximilians-Universität & Technische Universität München   *Oct 2017 - Aug 2019*

- Thesis work: "Mapping Dynamic Topography Evolution on Continental Scale using Observables from Chronostratigraphic Maps", 2019. Supervised by Hans-Peter Bunge.

B.Sc. in Physics   *Bogota, Colombia*

Universidad de Los Andes   *Jan 2011 - Mar 2016*

- Thesis work: "Plasmonic Excitation and T-MOKE effect", 2015. Supervised by Edgar J. Patiño.

B.Sc. in Geosciences   *Bogota, Colombia*

Universidad de Los Andes   *Jan 2011 - Mar 2015*

- Thesis work: "Determination of the 3D Melts Distribution in Deep Crustal Enclaves by Micro-XRF Analysis and Implications on Physical Crustal Anisotropy", 2014. Supervised by Fabio Ferri.

Work experience

Research assistant in Geophysics   *Munich, Germany*

Ludwig-Maximilians-Universität   *Feb 2020 – Present*

- **Earthquake Physics within the TEAR (ERC-funded) project:** Contributed to the development of a novel diffuse faulting approach; a spectral finite element (continuous Galerkin) method with a non-mesh aligned embedded diffusive discontinuity with the aim of understanding complex volumetric failure patterns observed in nature.
- Contributed to the rupture dynamic modeling and analysis of the 2021 Mw7.4 Maduo earthquake using geodetic data. The model uses the open-source software SeisSol, ran on the HPC system SuperMUC-NG from the LRZ.
- Contributed to the development of one-way linking long-term lithospheric deformation models to short-term earthquake rupture dynamic models.
- **Associated PhD student to the UPLIFT (DFG-funded) project:** Contributed to the development and analysis of proxy datasets for mantle flow induced past dynamic topography.
- Contributed to the development and analysis of first-order global stress field from an analytical asthenosphere flow representation.

Working Student   *Munich, Germany*

Allianz RE - A&S Cat Risk Management   *Aug 2019 – Jan 2020*

- Responsibilities: Data Enrichment. Generation of mosaics from hazard maps. Generation of convergence maps for flood risk assessment. Geolocalization analysis of geocoded building addresses.
- Achievements: Automated data enrichment processes and mosaic map building through Python scripts and ArcGIS. Bulk compilation and processing of test sets of portfolio building information, as well as validation against different geocoding services through Python scripts.

Research assistant in Geophysics (HiWi Job)
Munich, Germany

Ludwig-Maximilians-Universität
Jan 2018 – Jan 2019

- Use Specfem3DGlobe and the Symmetric multiprocessing system from the Geophysics department at LMU for calculating teleseismic synthetics and compare with the synthetics from a previous dynamic rupture model for Kaikoura 2016 and Sumatra 2004 events. In addition, prepare dynamic rupture simulations through different computing engines for educational purposes.
- Maintenance, QC, and expansion of the Seismological Ring Laser database and interface.

Junior Geologist
Bogota, Colombia

Meridian Consulting Ltda
June 2016 – July 2017

- Responsibilities: Support in data management for the geology projects of the company (Recompilation stage and generation of databases of E&P projects).
- Achievements: Collaborated with international work teams, generating database models for interpretation and acquisition of E&P data.

Research assistant in Physics: Condensed Matter Group
Bogota, Colombia

Universidad de Los Andes
Feb 2016 – June 2016

- Responsibilities: To conduct literature reviews, collect and analyze data acquired from plasmonic and magneto-optic characterization techniques applied to thin films of different materials. To support undergraduate and graduate students working on research projects (maintaining records on assignment completion).
- Achievements: I helped undergraduate and graduate students with their thesis work by developing scripts and processing their experimental data.

Junior Geologist
Bogota, Colombia

Geoconsult CS
July 2015 – Aug 2015

- Responsibilities: Quality control of vectorized electrical logs and logs metadata register into the database for the Agencia Nacional de Hidrocarburos – ANH, Colombia.
- Achievements: Designed and implemented scripts resulting in simplified faster organization of documents. Provided training to colleagues on how to implement the scripts.

Support Geoscientist
Bogota, Colombia

HPO Global Ventures Colombia – Hydrocarbon National Agency
Nov 2013 – Jan 2014

- Responsibilities: To provide technical support to seismic interpretation team, to load and QC seismic data in Petrel, to execute additional activities that required geoscience background under the supervision of experienced professionals.
- Achievements: I contributed to the generation of the final report and deliverables of the project.

Academic support and tutoring experience

Mathematics Tutor & Physics Tutor
Bogota, Colombia

Universidad de Los Andes
Semester: II-2013, I-2014, II-2014, I-2015, II-2015

- Responsibilities: To offer guidance to undergraduate students as a tutor at the university by helping with the understanding of problems from basic and intermediate-level courses concerning math and physics offered at Universidad de los Andes.

Paleontology Monitor
Bogota, Colombia

Universidad de Los Andes
Semester: II-2013

- Responsibilities: To provide support to the titular professor of the Paleontology class, regarding the grading of homework, classwork and evaluations. Assistant of Paleontology Laboratory, responsible for organizing and providing support to the students.
- Achievements: Increased the number of operating hours for the palaeontology laboratory.

Geosciences Laboratory Monitor
Bogota, Colombia

Universidad de Los Andes
Semester: I-2013

- Responsibilities: To support students as a laboratory assistant. Responsible for organizing and providing support to the students.

Publications

In preparation / Under review

- **Hayek, J.N.**, Stotz, I. L., Bunge, H.-P., and Carena, S. (under rev.). "First-order global stress patterns inferred from upper mantle flow models".
- Jourdon, A., **Hayek, J.N.**, May, D.A., and Gabriel, A.-A. (under rev.). "Coupling 3D geodynamics and dynamic earthquake rupture: fault geometry, rheology and stresses across timescales".
- Vilacís, B., Carena, S., **Hayek, J.N.**, Robl, G., Bunge, H.-P., Ma, J. (under rev.) "Comparative Analysis of Manual and Digital Approaches for Extracting Geological Hiatuses. A Case Study from China"
- Stotz, I.L., Vilacís, B., **Hayek, J.N.**, and Bunge, H.-P. (under rev.) "Continental rifting driven by asthenosphere flow and lithopshere weakening from flood basalts"

Peer-Reviewed

- Vilacís, B., Brown, H., Bunge, H.-P., Carena, S., **Hayek, J.N.**, Stotz, I.L., Wang, Z.R., and Friedrich, A.M. (2024). "Dynamic topography and the planform of mantle convection since the Jurassic inferred from Global Continental Hiatus Maps". *Proc. R. Soc. A*. 480:20240311. DOI: 10.1098/rspa.2024.0311.
- Stotz, I.L., Carena, S., Vilacís, B., **Hayek, J.N.**, and Bunge, H.-P. (2024). "Kerguelen plume drives the Eocene directional change in Australia plate motion". *Lithosphere*. DOI: 10.2113/2024/lithosphere_2023_289
- **Hayek, J.N.**, Marchandon, M., Li, D., Pousse-Beltran, L., Hollingsworth, J., Li, T., and Gabriel, A.-A. (2024). "Non-typical supershear rupture: fault heterogeneity and segmentation govern unilateral supershear and cascading multi-fault rupture in the 2021 M_w7.4 Maduo Earthquake". *Geophysical Research Letters*. DOI: 10.1029/2024GL110128
- **Hayek, J.N.**, May, D.A., Pranger, C., and Gabriel, A.-A. (2023). *Geophysical Research Letters*. "A diffuse interface method for earthquake rupture dynamics based on a phase-field model". *Journal of Geophysical Research: Solid Earth*, 128, e2023JB027143. DOI: 10.1029/2023JB027143.
- Bunge, H.-P., Horbach, A., Colli, L., Ghelichkhan, S., Vilacís, B., and **Hayek, J.N.** (2023). "Geodynamic Data Assimilation: Techniques and Observables to Construct and Constrain Time-Dependent Earth Models". In A. Ismail-Zadeh, F. Castelli, D. Jones, and S. Sanchez (Eds.), *Applications of Data Assimilation and Inverse Problems in the Earth Sciences* (Special Publications of the International Union of Geodesy and Geophysics, pp. 311-325). Cambridge University Press. DOI: 10.1017/9781009180412.021
- Wang, Z.R., Stotz, I.L., Bunge, H.-P., Vilacís, B., **Hayek, J.N.**, Ghelichkhan, S. and Lebedev, S., (2023). "Cenozoic upper mantle flow history of the Atlantic realm based on Couette/Poiseuille models: Towards paleo-mantle-flowgraphy". *Physics of the Earth and Planetary Interiors*, 340, p.107045. DOI: 10.1016/j.pepi.2023.107045.
- Stotz, I.L., Vilacís, B., **Hayek, J.N.**, Carena, S. and Bunge, H.-P., (2023). "Plume driven plate motion changes: New insights from the South Atlantic realm". *Journal of South American Earth Sciences*, 124, p.104257. DOI: 10.1016/j.jsames.2023.104257
- Vilacís B., **Hayek, J.N.**, Stotz I.L., Bunge H.-P., Friedrich A.M., Carena S. and Clark S. (2022). "Evidence for active upper mantle flow in the Atlantic and Indo-Australian realms since the Upper Jurassic from hiatus maps and spreading rate changes". *Proc. R. Soc. A*. 478:20210764. DOI: 10.1098/rspa.2021.0764.
- Stotz, I.L., Vilacís, B., **Hayek, J.N.**, Bunge, H.-P., and Friedrich, A. M. (2021). "Yellowstone plume drives Neogene North American plate motion change". *Geophysical Research Letters*, 48, e2021GL095079. DOI: 10.1029/2021GL095079.
- **Hayek, J.N.**, Vilacís B., Bunge H.-P., Friedrich A.M., Carena S., and Vibe Y. (2020). "Continent-scale Hiatus Maps for the Atlantic Realm and Australia since the Upper Jurassic and links to mantle flow induced dynamic topography". *Proc. R. Soc. A*. 476:20200390. DOI: 10.1098/rspa.2020.0390. Correction (2021) *Proc. R. Soc. A*. 477:20210437. DOI: 10.1098/rspa.2021.0437.
- Fabio, F., Acosta-Vigil, A., Perez, C.A., **Hayek, J.N.** (2018). "Mapping the distribution of melt during anatexis at the source area of crustal granites by synchrotron Micro-XRF". *American Mineralogist.*, 103(11), 1719-1733. DOI: 10.2138/am-2018-6290.
- **Hayek, J.N.**, Herreño-Fierro, C.A., and Patiño, E.J. (2016). "Enhancement of the transversal magnetic optic Kerr effect: Lock-in vs. hysteresis method". *Rev. Sci. Instrum.* 87, 103113 ; DOI: 10.1063/1.4966250.

Conference contributions

- EGU General Assembly 2024: Hayek, J.N., Stotz, I.L., Bunge, H.-P., Carena, S., and Ghelichkhan, S.: "First-order global stress patterns inferred from hierarchies of upper mantle flow models", EGU24-16807.
- EGU General Assembly 2024: Bunge, H.-P., Stotz, I.L., Hayek, J.N., Vilacís, B., Brown, H., Freissler, R., Schuberth, B., Carena, S., and Friedrich, A.: "Closed loop experiments in global geodynamic earth models", EGU24-21895.
- EGU General Assembly 2024: Jourdon, A., Hayek, J.N., May, D., and Gabriel, A.-A.: "One-way linking of 3D long-term geodynamic models and short-term earthquake dynamic rupture models", EGU24-19294.
- EGU General Assembly 2024: Stotz, I.L., Vilacís, B., Hayek, J.N., Carena, S., Friedrich, A., and Bunge, H.-P.: "The Influence of Mantle Plumes on Plate Tectonics", EGU24-17341
- EGU General Assembly 2024: Vilacís, B., Brown, H., Carena, S., Bunge, H.-P., Hayek, J.N., Stotz, I.L., and Friedrich, A.M.: "Global continental hiatus surfaces as a proxy for tracking dynamic topography since the Upper Jurassic", EGU24-12118.
- EGU General Assembly 2024: Wang, Z.R., Stotz, I.L., Bunge, H.-P., Vilacís, B., Hayek, J.N., Ghelichkhan, S., and Lebedev, S.: "Cenozoic asthenospheric flow history in the Atlantic realm: Insights from Couette/Poiseuille flow models", EGU24-2321.
- AGU Fall Meeting 2023: Hayek, J.N., May, D.A., Pranger, C., Gabriel, A.-A.: "A diffuse interface method for earthquake rupture dynamics based on a phase-field model", S21E-0334.
- AGU Fall Meeting 2023: Jourdon, A., Hayek, J.N., May, D.A., and Gabriel, A.-A.: "One-way Linking of 3D Long-term Geodynamic Models and Short-term Earthquake Dynamic Rupture Models", S11C-0279.
- AGU Fall Meeting 2023: Vilacís, B., Hayek, J.N., Stotz, I.L., Bunge, H.-P., Friedrich, A.M., Carena, S., and Clark, S.: "Upper-mantle flow in the Indo-Atlantic Realm since the Upper Jurassic: Insights from continent-scale hiatus surfaces and oceanic spreading rate variations", DI31A-05.
- EGU General Assembly 2023: Vilacís, B., Hayek, J.N., Stotz, I.L., Bunge, H.-P., Friedrich, A.M., Carena, S., and Clark, S.R.: "Pressure-driven upper-mantle flow in the Indo-Atlantic Realm since the Upper Jurassic inferred from continent-scale hiatus surfaces and oceanic spreading rate variations", EGU23-2575.
- EGU General Assembly 2023: Stotz, I.L., Carena, S., Vílacis, B., Bunge, H.P. and Hayek, J.N.: "Plume driven plate tectonics: new insights from the Australia/Antarctica separation", EGU23-12268.
- AGU Fall Meeting 2022: Hayek, J.N., Li, D., Marchandon, M., Gabriel, A.-A., Pousse Beltran, L., and Hollingsworth, J.: "Unraveling the Dynamic Complexity of the 2021 Mw7.4 Maduo Earthquake", S23A-05.
- SEDI 2022: Vilacís, B., Hayek, J.N., Bunge, H.-P., Friedrich, A.M., Carena, S., and Clark, S.: "Tracing active upper mantle flow using continental-scale hiatus surfaces and spreading rates in the Atlantic and Indo-Australian Realms since the Upper Jurassic"
- SEDI 2022: Wang, Z., Bunge, H.-P., Stotz, I., Vilacís, B., Hayek, J.N.. "Asthenospheric flow estimates in the Atlantic realm based on Poiseuille/Couette flow models"
- EGU General Assembly 2022: Vilacís, B., Hayek, J.N., Bunge, H.-P., Friedrich, A.M., and Carena, S.: "Tracing upper mantle flow patterns through continent-scale hiatus surfaces in the Indo-Atlantic Realms since the Upper Jurassic"
- EGU General Assembly 2022: Stotz, I., Vilacís, B., Hayek, J.N., Bunge, H.-P., and Friedrich, A.M. "Plume push force: a relevant driver of plate tectonics that can be constrained by horizontal and vertical plate motions"
- EGU General Assembly 2022: Wang, Z., Bunge, H.-P., Stotz, I., Vilacís, B., Hayek, J.N., Friedrich, A.M. "Asthenospheric flow estimates in the Atlantic realm based on Poiseuille/Couette flow models"
- EGU General Assembly 2022: Hayek, J.N., May, D.A., Pranger, C., Gabriel, A.-A.: "Diffuse thick fault representation in 2D SEM for earthquake dynamic rupture simulations", EGU22-12539.
- AGU Fall Meeting 2021: Hayek, J.N., May, D.A., Pranger, C., Gabriel, A.-A.: "Mesh-independent diffuse fault modelling in 2D SEM for dynamic rupture simulations", S45D-0329.
- EGU General Assembly 2021: Hayek, J.N., May, D.A., Pranger, C., Gabriel, A.-A. "Non-planar dynamic rupture modelling across diffuse, deforming fault zones using a spectral finite element method with a non-mesh aligned embedded diffuse discontinuity", EGU21-15686.
- Goldschmit 2021: Vilacís, B., Hayek, J.N., Bunge, H.-P., Friedrich, A.M., Carena, S., Stotz, I.L.: "Geodynamic interpretations of continent-scale hiatus maps in the Atlantic Realm"
- AGU Fall Meeting 2020: C. Uphoff, D. Li, J.N. Hayek, C. Pranger, D May, A.-A. Gabriel, "Methods for simulating earthquake sequences and rupture dynamics in diffuse fault zones", S067-06.
- EGU General Assembly 2020: Vilacís, B., Hayek, J.N., Bunge, H.-P., Friedrich, A.M., and Carena, S.: "Hiatus Mapping at a Continental Scale for Cretaceous and Cenozoic time"
- EGU General Assembly 2020: Hayek, J.N., Li, D., May, D.A., and Gabriel, A.-A.: "Modeling earthquake rupture dynamics across diffuse deforming fault zones", EGU2020-20600.

Courses

2022	**The mechanics of earthquakes and aseismic slip**, Joint ETH-EPFL PhD summer school, Zurich	*July 18 - 21*
2021	**Introduction to C++**, Online, offered by the Leibniz Supercomputing Centre	*May 3 - 6*
2021	**CIG Developers Workshop**, Online at CIG	*February 23 - 6*
2020	**ChEESE Advanced Training on HPC for Computational Seismology**, Online at HLRS, University Stuttgart	*October 21 - 23*
2020	**Introduction to Pointers and Memory Management in C/C++**, Coursera, online, offered by Coursera Project Network	
2020	**Test-Driven Development Overview**, Coursera, online, offered by LearnQuest	
2020	**Writing, Running, and Fixing Code in C**, Coursera, online, offered by Duke University	
2020	**Introduction to PETSc Training**, online at Texas Advanced Computing Center TACC	*February 6*
2020	**SCEC Dynamic Rupture Group Ingredients Workshop on Fault Friction**, Online offered by Southern California Earthquake Center	*Jan 8*
2020	**SCEC Workshop on Advancing Simulations of Sequences of Earthquake and Aseismic Slip (SEAS)**, Online offered by Southern California Earthquake Center	*Jan 9*
2018	**Fundamentals of Deep Learning for Computer Vision**, Nvidia - Leibniz Supercomputing Centre. Yu Wang.	*September 12*
2016	**X-Ray Diffraction and Rietveld analysis**, Universität Bremen - Universidad Nacional de Colombia. Eric Macke.	*September 9 - 12*
2016	**Reservoir Geomechanics**, Stanford University Distance Learning. Mark D. Zoback.	*March 28 – May 24*
2014	**Sequence stratigraphy**, Oklahoma University – Universidad de los Andes. Roger M. Slatt.	*July 10 - 20*
2014	**Seismic fracture Characterization: Concepts and practical applications**, Enru Liu. ACGGP & EAGE, Bogota, Colombia.	*June 6*
2013	**Petroleum Industry in the Next Decade**, Paul Weimer. AAPG, Cartagena, Colombia.	*September 7 – 8*

Other Skills

Hands-on experience with programming, data processing, and visualization tools

- Python (e.g., data analysis, postprocessing, visualization, augmenting LLMs with RAG), MatLab, C (e.g., diffuse fault implementation - se2dr), C++.
- Software & Tools: SeisSol, SimModeler, Paraview, COMSOL, Petrel, ImageJ, Blender, ArcGIS (ArcPy), GPlates (pyGPlates).
- Dev Tools: VS Code, Jupyter Notebooks, Git, HPC systems (e.g., SuperMUC-NG, local university clusters).

Languages

- Spanish (native), English (fluent), German (basic).

Organizations and Associations

- Member of the Earthquake Physics group led by Alice-Agnes Gabriel at Ludwig-Maximilians-Universität
- Member of the Global Geodynamics group led by Hans-Peter Bunge at Ludwig-Maximilians-Universität
- Former member of the Student Chapters of Optics (GOA), Materials (CEMUniandes) and geothermal energy (GRC Uniandes) at Universidad de los Andes.
- Society of Exploratory Geophysicists (SEG).
- American Association of Petroleum Geologists (AAPG).
- Asociación Colombiana de Geólogos y Geofísicos del Petróleo (ACGGP).