

# Caio Henrique Ciardelli

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## ACADEMIC FORMATION

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- **DOCTOR OF PHILOSOPHY IN GEOPHYSICS - INSTITUTE OF ASTRONOMY, GEOPHYSICS AND ATMOSPHERIC SCIENCES - IAG/USP**  
**Thesis Title:** Adjoint Tomography of South America based on 3D Spectral-element Seismic Wave Simulations  
**Advisor:** Marcelo Assumpção  
**Co-advisors:** Ebru Bozdağ and Suzan van der Lee  
**Funding Agency:** FAPESP  
March/2016 - July/2021
  - **BACHELOR OF SCIENCE IN GEOPHYSICS - INSTITUTE OF ASTRONOMY, GEOPHYSICS AND ATMOSPHERIC SCIENCES - IAG/USP**  
March/2011 - February/2016
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## STUDENT MONITOR AND/OR DIDACTIC EXPERIENCES

**Course/Subject:** Geophysics – Seismic I  
**Beginning:** 01/03/2014 **End:** 30/06/2014  
**Institution:** IAG - USP  
**Scholarship:** Voluntary

**Course:** Summer Course – Introduction to Seismology  
**Beginning:** 03/02/2014 **End:** 07/02/2014  
**Institution:** IAG - USP  
**Scholarship:** Voluntary

**Course:** Summer Course – Obspy: Python to Seismology  
**Beginning:** 10/02/2014 **End:** 14/02/2014  
**Institution:** IAG - USP  
**Scholarship:** Voluntary

**Course:** Summer Course – Introduction to Seismology  
**Beginning:** 02/02/2015 **End:** 06/02/2015  
**Institution:** IAG - USP  
**Scholarship:** Voluntary

**Course:** Summer Course – Surface Waves and Crustal Structure  
**Beginning:** 09/02/2015 **End:** 13/02/2015  
**Institution:** IAG - USP  
**Scholarship:** Voluntary

**Course/Subject:** Geophysics – Seismic I  
**Beginning:** 01/03/2015 **End:** 30/06/2015  
**Institution:** IAG - USP  
**Scholarship:** Voluntary

**Course:** I Python Boot Camp  
**Beginning:** 13/10/2015 **End:** 14/10/2015  
**Institution:** IAG - USP  
**Scholarship:** Voluntary

**Course:** Summer Course – Introduction to Seismology  
**Beginning:** 01/02/2016 **End:** 05/02/2016  
**Institution:** IAG - USP  
**Scholarship:** Voluntary

**Course:** Summer Course – Introduction to Seismology  
**Beginning:** 13/02/2017 **End:** 17/02/2017  
**Institution:** IAG - USP  
**Scholarship:** Voluntary

**Course:** Summer Course – Surface Waves and Crustal Structure  
**Beginning:** 20/02/2017 **End:** 24/02/2017  
**Institution:** IAG - USP  
**Scholarship:** Voluntary

**Course/Subject:** Geophysics – Seismic I  
**Beginning:** 01/03/2017 **End:** 30/06/2015  
**Institution:** IAG - USP  
**Scholarship:** Voluntary

**Course:** Summer Course – Introduction to Seismology  
**Beginning:** 28/01/2018 **End:** 02/02/2018  
**Institution:** IAG - USP  
**Scholarship:** Voluntary

**Course/Subject:** Geophysics – Seismic I (PAE Monitor)  
**Beginning:** 01/02/2018 **End:** 30/06/2018  
**Instituição:** IAG - USP  
**Scholarship:** CAPES

**Class (Seminar):** Fermat's principle, Ray theory and Fresnel zones.  
**Date:** 22/10/2018  
**Institution:** Colorado School of Mines

**Course/Subject:** Geophysics – Seismic I (PAE Monitor)  
**Beginning:** 01/02/2020 **End:** 30/06/2020  
**Instituição:** IAG - USP  
**Scholarship:** Voluntary

## **UNDERGRADUATE RESEARCH**

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**Project:** Andean Epicenters Determined using the BRASIS Seismic Network: Accuracy Analysis and Velocity Model Improvement

**Supervisor:** Prof. Marcelo Sousa de Assumpção

**Beginning:** 01/02/2013 **End:** 31/07/2013

**Funding agency:** CNPq - PIBIC

**Project:** Determination of the Montes Claros Seismogenic Fault Plane with P- and S- Phases Cross-correlation

**Supervisor:** Prof. Marcelo Sousa de Assumpção

**Beginning:** 01/08/2013 **End:** 31/01/2014

**Funding agency:** CNPq - PIBIC

**Project:** Determination of the Montes Claros Seismogenic Fault Plane with P- and S- Phases Cross-correlation

**Supervisor:** Prof. Marcelo Sousa de Assumpção

**Beginning:** 01/02/2014 **End:** 31/12/2015

**Funding agency:** FAPESP

## **SCIENTIFIC MEETINGS**

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**Event:** 21st Simpósio Internacional de Iniciação Científica da USP – SIICUSP

**Location:** USP de São Carlos, Brazil

**Beginning:** 22/10/2013 **End:** 24/10/2013

**Type of Presentation:** Poster

**Title:** Estudo da Orientação da Falha Sismogênica de Montes Claros com Correlação de fases P e S

**Authors:** Caio Ciardelli and Marcelo Assumpção

**Event:** IASPEI Regional Assembly Latin-American and Caribbean Seismological Commission - LACSC - 2014

**Location:** Bogotá, Colombia

**Beginning:** 23/07/2014 **End:** 25/07/2014

**Type of Presentation:** Poster

**Title:** Study of the Montes Claros Seismogenic Fault, in the São Francisco Craton, Brazil, with Correlation of P- and S- Phases

**Authors:** Caio Ciardelli, Marcelo Assumpção and Hans Agurto-Detzel

**Event:** XV Simpósio Nacional de Estudos Tectônicos

**Location:** Vitória - ES - Brazil

**Beginning:** 18/05/2015 **End:** 21/05/2015

**Type of Presentation:** Poster

**Title:** Relative Epicentral Location with Cross-correlation of Surface Waves: Application to Studies of Faulting Evolution in Four Brazilian Earthquake Sequences

**Authors:** Caio Ciardelli and Marcelo Assumpção

**Event:** Departmental Seminar

**Location:** IAG – USP, São Paulo, Brazil

**Date:** 21/05/2015

**Type of Presentation:** Video  
**Title:** Experiências de Estágios de Pesquisa no Exterior  
**Author:** Caio Ciardelli

**Event:** Departmental Seminar  
**Location:** IAG - USP, São Paulo, Brazil  
**Date:** 25/06/2015

**Type of Presentation:** Oral  
**Title:** Relative Epicentral Location with Cross-correlation of Surface Waves: Application to Studies of Faulting Evolution in Four Brazilian Earthquake Sequences  
**Authors:** Caio Ciardelli and Marcelo Assumpção

**Event:** IAG - Science Day;  
**Location:** IAG-USP, São Paulo, Brazil  
**Beginning:** 03/05/2016 **End:** 04/05/2016  
**Type of Presentation:** Oral  
**Title:** Tomografia de Forma de Onda Completa da América do Sul com Elementos Espectrais e Métodos Adjuntos

**Event:** Departmental Seminar  
**Location:** IAG - USP, São Paulo, Brazil  
**Date:** 16/06/2016  
**Type of Presentation:** Oral  
**Title:** Rupture-Length x Magnitude for Intraplate Earthquakes in Brazil using Cross-correlation of Regional Surface and Body Waves  
**Authors:** Caio Ciardelli, Marcelo Assumpção and Andreas Rietbrock

**Event:** IASPEI Regional Assembly Latin-American and Caribbean Seismological Commission - LACSC - 2016  
**Location:** San José, Costa Rica  
**Beginning:** 20/06/2016 **End:** 22/06/2016  
**Type of Presentation:** Oral  
**Title:** Rupture-Length x Magnitude for Intraplate Earthquakes in Brazil using Cross-Correlation of Regional Surface and Body Waves  
**Authors:** Caio Ciardelli, Marcelo Assumpção and Andreas Rietbrock

**Participation as Appraiser:** Worked in the XXI Undergraduate Research Symposium of the IAG and IGc and in the 24<sup>th</sup> SIICUSP;  
**Location:** IAG - USP, São Paulo, Brazil  
**Beginning:** 12/09/2016 **End:** 14/09/2016

**Event:** AGU Fall Meeting  
**Location:** San Francisco, USA  
**Beginning:** 12/12/2016 **End:** 16/12/2016  
**Type of Presentation:** Poster  
**Title:** Comparison of Velocity Models for South America through Seismic Wave Modeling of Ten Andean Earthquakes Recorded by the Brazilian Seismographic Network using the Spectral Element Method  
**Authors:** Caio Ciardelli and Marcelo Assumpção

**Participation as Appraiser:** Worked in the XXII Undergraduate Research Symposium of the IAG and IGc and in the 25<sup>th</sup> SIICUSP

**Location:** IAG - USP, São Paulo, Brazil

**Beginning:** 11/09/2017 **End:** 13/09/2017

**Event:** AGU Fall Meeting

**Location:** New Orleans, USA

**Beginning:** 11/12/2017 **End:** 15/12/2017

**Type of Presentation:** Poster

**Title:** Preliminary Results of the Full-waveform Tomography of South America and Surrounding Oceans using Spectral Elements and Adjoint Methods

**Authors:** Caio Ciardelli and Marcelo Assumpção

**Event:** Departmental Seminar

**Location:** IAG - USP, São Paulo, Brazil

**Date:** 02/08/2018

**Type of Presentation:** Oral

**Title:** Tomografia Adjunta na América do Sul com Elementos Espectrais

**Authors:** Caio Ciardelli and Marcelo Assumpção

**Event:** AGU Fall Meeting

**Location:** Washington, D.C., USA

**Beginning:** 10/12/2018 **End:** 14/12/2018

**Type of Presentation:** Poster

**Title:** Adjoint Tomography of South America based on 3D Spectral-Element Seismic Wave Simulations.

**Authors:** Caio Ciardelli and Marcelo Assumpção

**Event:** AGU Fall Meeting

**Location:** Washington, D.C., USA

**Beginning:** 10/12/2018 **End:** 14/12/2018

**Type of Presentation:** Poster

**Title:** Adjoint Tomography of South America based on 3D Spectral-Element Seismic Wave Simulations.

**Authors:** Caio Ciardelli and Marcelo Assumpção

**Participation as Appraiser:** Worked in the 27<sup>th</sup> SIICUSP

**Location:** IAG - USP, São Paulo, Brazil

**Beginning:** 23/09/2019 **End:** 27/09/2019

**Participation as Appraiser:** Worked in the second stage of the 27<sup>th</sup> SIICUSP

**Location:** Centro de Difusão Internacional - USP, São Paulo, Brazil

**Beginning:** 05/11/2019 **End:** 05/11/2019

**Event:** Departmental Seminar

**Location:** IAG - USP, São Paulo, Brazil

**Date:** 27/11/2019

**Type of Presentation:** Oral

**Title:** Interpolação e Expansão em Harmônicos Esféricos de Modelos de Tomografia Adjunta  
**Authors:** Caio Ciardelli

**Event:** AGU Fall Meeting

**Location:** São Francisco, USA

**Beginning:** 09/12/2019 **End:** 13/12/2019

**Type of Presentation:** Poster

**Title:** Adjoint Tomography of South America based on 3D Spectral-Element Seismic Wave Simulations

**Authors:** Caio Ciardelli, Suzan van der Lee, Ebru Bozdağ and Marcelo Assumpção

**Event:** Virtual Tomography: Full-Waveform Methods and Application

**Location:** None (virtual event)

**Beginning:** 06/04/2021 **End:** 06/04/2021

**Type of Presentation:** Oral

**Title:** Adjoint Tomography of South America based on 3D Spectral-Element Seismic Wave Simulations

**Authors:** Caio Ciardelli, Marcelo Assumpção, Suzan van der Lee, and Ebru Bozdağ

**Event:** SSA 2021 Annual Meeting Day

**Location:** None (virtual event)

**Beginning:** 19/04/2021 **End:** 19/04/2021

**Type of Presentation:** Oral

**Title:** Adjoint Tomography of South America and Geometry of the Nazca Slab

**Authors:** Caio Ciardelli, Marcelo Assumpção, Suzan van der Lee, and Ebru Bozdağ

**Event:** AGU Fall Meeting

**Location:** New Orleans, USA

**Beginning:** 13/12/2021 **End:** 17/12/2021

**Type of Presentation:** Poster

**Title:** SphGLLTools: A toolbox for visualization of large seismic model files based on 3D spectral-element meshes

**Authors:** Caio Ciardelli, Ebru Bozdağ, Daniel Peter, and Suzan van der Lee

**Event:** AGU Fall Meeting

**Location:** New Orleans, USA

**Beginning:** 13/12/2021 **End:** 17/12/2021

**Type of Presentation:** Poster

**Title:** Effects of the subducting Nazca Plate on South American upper-mantle dynamics

**Authors:** Caio Ciardelli, Marcelo Assumpção, Ebru Bozdağ, and Suzan van der Lee

**Event:** AGU Fall Meeting

**Location:** New Orleans, USA

**Beginning:** 13/12/2021 **End:** 17/12/2021

**Type of Presentation:** Oral

**Title:** Upper Mantle Anisotropy from Global Adjoint Tomography

**Authors:** Ebru Bozdağ, Ridvan Orsvuran, Caio Ciardelli, Daniel Peter, and Yinzhi Wang

**Event:** AGU Fall Meeting

**Location:** New Orleans, USA

**Beginning:** 13/12/2021 **End:** 17/12/2021

**Type of Presentation:** Poster

**Title:** Investigating trade-offs in anelastic full-waveform inversions for regional- to global-scale models

**Authors:** Ridvan Orsvuran, Daniel Peter, Caio Ciardelli, Ebru Bozdağ, Federica Magnoni, Angela Stallone, and Emanuele Casarotti

## **PUBLICATIONS**

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**Title:** Sensitivity kernels in seismic wave propagation: a simplified explanation for the banana-doughnut paradox

**Authors:** Caio Ciardelli

**Journal:** European Journal of Physics

**Volume:** 43

**Year:** 2022

**Pages:** 045802

**DOI:** <https://doi.org/10.1088/1361-6404/ac6a8e>

**Title:** Adjoint Waveform Tomography of South America

**Authors:** Caio Ciardelli, Marcelo Assumpção, Ebru Bozdağ, and Suzan van der Lee

**Journal:** JGR Solid Earth

**Volume:** 127

**Year:** 2022

**Pages:** e2021JB022575

**DOI:** <https://doi.org/10.1029/2021JB022575>

**Title:** SphGLLTools: A toolbox for visualization of large seismic model files based on 3D spectral-element meshes

**Authors:** Caio Ciardelli, Ebru Bozdağ, Daniel Peter, and Suzan van der Lee

**Journal:** Computer & Geosciences

**Volume:** 159

**Year:** 2021

**Pages:** 105007

**DOI:** <https://doi.org/10.1016/j.cageo.2021.105007>

**Title:** The exponentiated phase measurement, and objective-function hybridization for adjoint waveform tomography

**Authors:** Yanhua O Yuan, Ebru Bozdağ, Caio Ciardelli, Fuchun Gao, F J Simons

**Journal:** Geophysical Journal International

**Volume:** 221

**Year:** 2020

**Pages:** 1145-1164

**DOI:** <https://doi.org/10.1093/gji/ggaa063>

**Title:** Seismic Velocities Distribution in a 3D Mantle: Implications for InSight Measurements

**Authors:** Plesa, A., Bozdağ, E., Rivoldini, A., Knapmeyer, M., Mclennan, S., Padovan, S., Tosi, N., Breuer, D., Peter, D., Stähler, S., Wiczeorek, M., Driel, M., Khan, A., Spohn, T., Ciardelli, C., and King, S

**Meeting:** AGU 2020 Fall Meeting  
**Year:** 2020  
**Type:** Proceedings  
**DOI:** <https://doi.org/10.1002/essoar.10504918.1>

**Title:** Rupture lengths of intraplate earthquakes in Brazil determined by relative location of aftershocks: Evidence for depth dependence of stress drops  
**Authors:** Caio Ciardelli and Marcelo Assumpção  
**Journal:** Journal of South American Earth Sciences  
**Volume:** 89  
**Year:** 2019  
**Pages:** 246-258  
**DOI:** <https://doi.org/10.1016/j.jsames.2018.11.017>

**Title:** The tailings dam failure of 5 November 2015 in SE Brazil and its preceding seismic sequence  
**Authors:** Hans Agurto-Detzel, Marcelo Bianchi, Marcelo Assumpção, Martin Schimmel, Bruno Col-laço, Caio Ciardelli, José Roberto Barbosa and Jackson Calhau  
**Journal:** Geophysical Research Letters  
**Volume:** 43  
**Year:** 2016  
**Pages:** 4929-4936  
**DOI:** <https://doi.org/10.1002/2016GL069257>

**Title:** The 2012–2013 Montes Claros earthquake series in the São Francisco Craton, Brazil: new evidence for non-uniform intraplate stresses in mid-plate South America  
**Authors:** Hans Agurto-Detzel, Marcelo Assumpção, Caio Ciardelli, Diogo Farrapo Albuquerque, Lucas V. Barros and George S. L. França  
**Journal:** Geophysical Journal International  
**Volume:** 200  
**Year:** 2015  
**Pages:** 216 - 226  
**Type:** Scientific Journal  
**DOI:** <https://doi.org/10.1093/gji/ggu333>

**Title:** Study of the Montes Claros Seismogenic Fault, in the Sao Francisco Craton, Brazil, with Corre-lation of P- and S- Phases  
**Authors:** Caio Ciardelli, Marcelo Assumpção and Hans Agurto-Detzel  
**Volume (Special Issue):** 18  
**Journal:** Earth Sciences Research Journal  
**Year:** 2014  
**Pages:** 100 - 101  
**Type:** Proceedings

**Title:** Relative Epicentral Location with Cross-correlation of Surface Waves: Application to Studies of Faulting Evolution in Four Brazilian Earthquake Sequences  
**Authors:** Caio Ciardelli and Marcelo Assumpção  
**URL:** <http://www.inscricoes.fmb.unesp.br/upload/trabalhos/201533182316.pdf>  
**Type:** Symposium Abstract XVSNET



**Title:** Estudo da Orientação da Falha Sismogênica de Montes Claros com Correlação de Fases P e S

**Authors:** Caio Ciardelli e Marcelo Assumpção

**URL:** <https://uspdigital.usp.br/siicusp/cdOnlineTrabalhoVisualizarResumo?numeroInscricaoTrabalho=791&numeroEdicao=21>

**Type:** Symposium Abstract - 21<sup>st</sup> SIICUSP

## **RESEARCH INTERNSHIP**

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**University:** University of Liverpool

**Departament:** Department of Earth, Ocean and Ecological Sciences

**Project:** Determination of Accurate Earthquake Locations to Study Earthquake Fault Geometry

**Supervisor:** Prof. Andreas Rietbrock

**Funding agency:** FAPESP

**Beginning:** 15/08/2014 **End:** 14/12/2014

**University:** Colorado School of Mines

**Departament:** Department of Geophysics

**Project:** Adjoint Tomography of South America based on 3D Spectral-Element Seismic Wave Simulations

**Supervisor:** Prof. Ebru Bozdağ

**Funding agency:** FAPESP

**Beginning:** 16/08/2018 **End:** 14/02/2019

**University:** Northwestern University

**Departament:** Department of Earth and Planetary Sciences

**Project:** Adjoint Tomography of South America based on 3D Spectral-Element Seismic Wave Simulations

**Supervisor:** Prof. Suzan van der Lee

**Funding agency:** FAPESP

**Beginning:** 01/03/2019 **End:** 15/08/2019

## **UNIVERSITY EXTENSION COURSES**

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**Course:** Introduction to Seismology

**Institution:** IAG - USP

**Beginning:** 28/01/2013 **End:** 01/02/2013

**Duration:** 20h

**Course:** Seismic Reflection Interpretation

**Institution:** IAG - USP

**Beginning:** 20/07/2015 **End:** 24/07/2015

**Duration:** 35h

**Course:** XSEDE HPC Big Data Workshop

**Institution:** Northwestern University

**Beginning:** 06/08/2019 **End:** 07/08/2019

**Duration:** 12h

## **TRAINING COURSES**

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**Course:** Crash Course of Relative Epicentral Location with Surface Waves Cross-correlation  
**Institution:** Observatório Sismológico – UnB, Distrito Federal, Brazil  
**Date:** 06/12/2015  
**Duration:** 4h  
**Remuneration:** Voluntary  
**Course leader:** Caio Ciardelli

**Course:** Introduction to GNU/Linux  
**Institution:** IAG/USP - IAG Jr. Course  
**Beginning:** 25/07/2016 **End:** 29/07/2016  
**Remuneration:** Voluntary  
**Course leaders:** Caio Ciardelli and Israel Dragone  
**Obs:** The course was taught for two classes of 20 hours each, totaling 40 hours.

**Course:** Introduction to GNU/Linux  
**Institution:** IAG/USP – Winter School  
**Beginning:** 24/07/2017 **End:** 28/07/2017  
**Remuneration:** Voluntary  
**Course leaders:** Caio Ciardelli and Israel Dragone  
**Obs:** The course was taught for two classes of 20 hours each, totaling 40 hours.

### **EXTRACURRICULAR COURSES**

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**Course:** Assembly and maintenance - Hardware  
**Institution:** Microlins - Formação Profissional  
**Beginning:** 14/11/2007 **End:** 25/08/2008  
**Duration:** 44h

### **NON-REGISTERED COMPUTER CODES**

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1. Correlate: A Waveform Cross-correlation Program, 2015.
2. MasterLoc: A Master Event Location Program, 2015.
3. InvLoc: A Master Event Location Program Using Body and Surface Waves, 2015.
4. Sac2Nordic: Create the Input file for the Hypocenter Program, 2015.
5. Vector: A Program for Vectorization of Ancient Seismograms.,2015.
6. AdjTomo1D: 1D Adjoint Tomography Code, 2018.
7. SphGLLTools: a toolbox for visualization, processing, sharing, and spherical harmonics analysis of tomographic models defined on GLL meshes, 2021.
8. PyWinEPAdjoint: a set of scripts for carrying out time-window selection and computing exponentiated phase adjoint sources for full-waveform inversion, 2021.

## **COMPLEMENTARY ACTIVITIES**

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### **Exhibitions in Fairs and Events of Scientific Divulcation:**

- Virada Científica – 2015;
- 19ª Feira do Estudante Expo CIEE– 2016;
- Visita Monitorada IAG/USP – 2016;
- Semana de Ciência de Tecnologia – 2017;

### **Others:**

Made the image for the book cover of “Geocronologia e Evolução Tectônica do Continente Sul Americano: a Contribuição de Umberto Giuseppe Cordani”, released on 10/15/2020.