ILP Task Force Proposal (2018-2022)
Lithospheric Seismicity and Tectonics in the Himalaya

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Keywords: Himalaya Seismogenic Zone (HSZ), Main Himalayan Thrust, Himalayan earthquakes, continent-continent collision

1. Introduction

The collision of the India and Eurasia plates at c. 55-60 Ma (e.g., Hu et al., 2015; or possibly as late as 20 Ma, van Hinsbergen et al., 2012) has created the Himalaya, the world's highest mountains and largest continental-continental collision. This convergent zone presents a significant earthquake hazard (e.g., Bilham et al., 2001, Sapkota et al., 2012), as demonstrated by the recent, devastating April 25, 2015 M=7.8 Gorkha earthquake and the following May 12, 2015 M=7.3 earthquake in Nepal (Adhikari et al., 2015). The relatively small Himalayan country of Bhutan also has a significant earthquake risk, despite the absence of record of a large earthquake since 1714 (Drukpa et al., 2006, Velasco et al., 2007, Hetenyi et al., 2016). Despite previous studies in the region, important questions remain, including distinguishing possible geometries of the Main Himalayan Thrust (MHT), the role of other regional faults, the crustal composition and role of fluids in faulting, and the details of the rupture process, including structural causes and locations of rupture segmentation both along-strike and down-dip.

We propose to establish a task force to study seismicity and tectonics in the Himalaya by partnering with researchers at the Department of Mines and Geology (DMG) in Nepal and the Department of Geology and Mines (DGM) in Bhutan. Investigators Karplus and Velasco currently have an active research project in Nepal studying the seismicity and tectonics of the Main Himalayan Thrust (with a Nepalese Ph.D. student and collaborators including Sapkota) and have been involved with recent projects studying seismicity and earthquake hazards in Bhutan (with a Bhutanese M.S. student and collaborators including Drukpa, Chief Seismologist at the DGM, who completed his M.S. at UTEP). This Task Force will facilitate collaborations between Nepal, Bhutan, the USA, and other global researchers to study Himalayan earthquakes and lithospheric structure of the Nepalese and Bhutanese Himalaya.

2. Objectives

We aim to follow up on existing projects studying seismicity, the Main Himalayan Thrust, and lithospheric structure in the Himalaya, with particular focus on the Himalaya in Nepal and Bhutan. We will build on existing collaborations to exchange ideas and work together to address key research questions and insights. Key research questions revolve around four themes:

Geometry of MHT: Distinguishing between different possible geometries of the Main Himalayan Thrust (MHT) and better understanding structural causes and locations of rupture segmentation both along-strike and down-dip are essential for assessing future Himalayan seismic hazards. Precise earthquake locations and source properties using existing seismic datasets will provide important insights into the geometry of the MHT.

Crustal Composition in the MHT Region: We will work towards creating detailed models of crustal *P*-wave, *S*-wave, and surface wave velocities using tomography. Using known relationships between velocity and crustal composition, we will determine the crustal composition beneath the Nepalese Himalaya and assess the presence and role of fluids in the crust, especially in the regions of active faulting.

Fault dynamics: Examining the spatiotemporal distribution of earthquakes (e.g., April 25, 2015 Gorkha earthquake aftershocks) and relation with past large earthquake rupture patches will also allow a better understanding of the rupture process at the MHT.

Broader geotectonic setting: We will explore the broader geotectonic setting of the Himalaya by bringing together local knowledge and datasets from Nepal and Bhutan with international knowledge and datasets to examine regional velocity structure, seismic anisotropy, Moho and LAB depths. We aim to integrate seismic datasets with other geophysical and geological datasets (e.g., magnetotellurics, gravity, surface mapping, deformation) to derive the best possible understanding to date of the tectonics of the Himalaya and southern Tibet in Nepal and Bhutan.

3. Outreach

As part of our active NSF grant investigating seismicity in Nepal, Sapkota and Karplus, together with collaborators John Nabelek of Oregon State Univ. and Simon Klemperer of Stanford Univ., co-organized a 4-day Seismic Data Processing short course in Kathmandu, Nepal. Almost 40 Nepalese seismologists and geologists from the DMG and Tribhuvan University attended the short course. Furthermore, UTEP funded 3 Bhutanese scientists to participate in the short course. The interactions between Bhutanese and Nepalese scientists managing their countries' respective seismic networks were fruitful, and participating scientists discussed future collaborations and studies involving both countries. This ILP Task Force will allow continued networking, collaboration, and capacity building involving young scientists from the USA (including Karplus), Nepal, and Bhutan.

4. Upgrades in Nepalese and Bhutanese seismic networks

Following the 2015 Gorkha earthquake, the Nepal Seismological Center (at the Department of Mines and Geology) has upgraded their local seismic network, originally installed in the 1980's. Over the past few years, Bhutan's Department of Geology and Mines has installed its first national seismic network. Members of our task force have

already been actively collaborating with each other to share scientific results from these networks as well as results from temporary networks.

5. Plans for ILP Task Force funds

We intend to use the ILP Task Force funds to allow young geoscientists at the DMG, DGM, and/ or universities in Nepal and Bhutan as well as young scientists in the U.S. to travel to international meetings with dedicated ILP-initiated sessions. These funds will also allow us to plan working groups or workshops involving Nepalese, Bhutanese, and international scientists to exchange knowledge and technical skills to make progress on the research objectives detailed above.

6. References

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Networks for Investigating Tectonic Deformation: Brittle Deformation and Evidence for Strike-Slip Faulting in Bhutan." *Seismological Research Letters* 78, no. 4 (July 1, 2007): 446–53. https://doi.org/10.1785/gssrl.78.4.446.

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(A) PROFESSIONAL PREPARATION

Dartmouth College, NH Earth Sciences B.A., Mathematics B.A., Physics Minor 2004
Stanford University, CA Geophysics M.S. 2010, Ph.D. 2012
University of Southampton, Southampton, UK Geophysics postdoctoral institution, 2012 to 2014

(B) APPOINTMENTS

January 2015-present Assistant Professor, University of Texas at El Paso, TX
2012-2014 Postdoctoral Research Fellow, University of Southampton, UK
2006-2012 Ph.D. Student, Stanford University, CA
2008 Geophysics intern, Schlumberger Western Geophysical, TX
2004-2006 Geologist, Platte River Associates, Inc., CO
2001-2004 Geophysics intern, Cold Regions Research and Engineering Laboratory, NH

(C) SELECTED PUBLICATIONS

Ringler, A.T., Anthony, R.E., **Karplus, M.S.**, Holland, A.A., Wilson, D.C. (2018), Laboratory Tests of Three Z-Land Fairfield Nodal 5-Hz, 3-Component Sensors, *Seis. Res. Lett.*

Wu, S.-M., Ward, K.M., Farrell, J., Lin, F.-C., **Karplus, M.S.**, Smith, R.B. (2017), Anatomy of Old Faithful from Subsurface Seismic Imaging of the Yellowstone Upper Geyser Basin, *Geophys. Res. Lett.,* 44, doi: 10.1002/2017GL075255.

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(D) SERVICE

Co-organized Seismic Data Processing Short Course in Kathmandu (Jan. 2018), Guest editor for special focus section of *Seismological Research Letters* (2017-2018), Instructor for IRIS USARRAY short course for graduate students (summers 2016, 2017), Earth Science Day public outreach (2014, 2016, 2017).

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(a) Professional Preparation

Ph.D. (Geophysics), University of California, Santa Cruz, 1993
B. S. (Applied Geophysics), University of California, Los Angeles, 1988

(b) Appointments

2017-present, State Seismologist, Railroad Commission of Texas
2008-present, Professor, Dept. of Geosciences, University of Texas at El Paso
2016-2017, Special Assistant to the Provost, Director of Interdisciplinary Initiatives
2012-2013, Interim Assoc. Dean for Research and Faculty Development, College of Science, University of Texas at El Paso
2012-2013, Interim Director, Computational Science Program, University of Texas at El Paso
2008-2011, Chair, Dept. of Geosciences, University of Texas at El Paso
2002-2008, Associate Professor, University of Texas at El Paso
1997-2002, Technical Staff Member, Los Alamos National Laboratory
1999-2002, Team and Task Leader, Los Alamos National Laboratory
1993-1997, Staff Geophysicist, Science Applications International Corporation
1994-1995, Internet Consultant, Velasco Consulting Services
1993, Postdoctoral Researcher, Institute of Geophysics and Planetary Physics, Lawrence Livermore National Laboratory

(c) Products

Publications Related to Proposed Research

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Curriculum Vitae

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(1) Education

Phd Geophysics, Université de Montpellier, France, 2017
MS Geological Sciences (Geophysics), University of Texas at El Paso, Texas, USA, 2002
BS Geological Sciences (Honors), Jadavpur University, Calcutta, India

(2) Work Experience

2012-present: Chief Seismologist, Earthquake & Geophysics Division, Department of Geology and Mines, Thimphu, Bhutan

2009-2012: National Project Manager for the project on "Reducing Climate Change -Induced Risks and Vulnerabilities from Glacier Lake Outburst Floods (GLOF) in the Punakha-Wangdue and Chamkhar Valleys" funded by Global Environment Facility (GEF), UNDP, Austrian Development Cooperation, WWF Bhutan and RGoB: Total Fund: US$ 7.6 million.

2002-2009: Executive Geologist, Department of Geology and Mines, Ministry of Economic Affairs, Thimphu, Bhutan

(3) Selected Publications

Drukpa, D., Gautier, S., Cattin, R., Namgay, K., & Le Moigne, N. (2017). Impact of nearsurface fault geometry on secular slip rate assessment derived from uplifted river terraces:Implications for convergence accommodation across the frontal thrust in southern central Bhutan. Geophysical Journal International.

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(A) PROFESSIONAL PREPARATION

Ph.D. – Earthquake Geology: Surface rupture of 1934 Bihar-Nepal earthquake: implications for Seismic Hazard in Nepal Himalaya (Research Advisor: Paul Tapponnier) Magistère – IPGP Paris 2011

Post graduate Centre for Space Science Technology Education in Asia Pasific (CSSTE-AP) from Indian Institute of Remote Sensing Dehradun India –1999 with Gold Medal

Master in Geology from Tribhuwan University in Geology on 1994 with first Class.

(B) APPOINTMENTS

1995-2006 Seismologist in National Seismological Centre of Department of Mines and Geology

2007-2011 PhD in IPGP Paris on quantification of seismic hazard in Nepal Himalaya in parallel as a Chief of National Seismological Centre Nepal as a Senior Seismologist

2006-2014 Chief of National Seismological Centre, Department of Mines and Geology2014 onward Deputy Director General of DMG as Head of Geoscience Division

(C) SELECTED PUBLICATIONS

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(D) SERVICE

Co-organized Seismic Data Processing Short Course in Kathmandu (Jan. 2018), Guest editor for special volume Earth Planets Space focusing 2015 Gorkha Earthquakes. Nepalese Counterparts in collaborative projects HiCLIMB, NAMASTE HiMNT etc.