

Heat, Helium, Hotspots, and Whole Mantle Convection

Meeting of Young Researchers in the Earth Sciences I

La Jolla CA; August 12 - 15, 2004

Second Circular

Buenos dias.

We are looking forward to meeting you in La Jolla this Fall and bring you the program of MYRES-I with syllabi of the keynote lectures. We have also listed travel information including maps that should get you to MYRES-I. If there aren't any last minute changes, you will hear from us only one more time before the meeting when we have the reading list and lecture notes available in mid July.

Jamie & Thorsten (June 14th, 2004)

Your responsibilities now

1. Book and pay for your own transportation to La Jolla, if you haven't done so already. We will reimburse you according to the details that were specified in your invitation email. The airport you want to fly into is SAN. *Please use American carriers, if your travel support comes from NSF, and keep boarding pass stubs and all other receipts.* From the airport, you want to use a shuttle service like www.cloud9shuttle.com or www.fivestarshuttle.com to get to the ERC dorms on the main UCSD campus (~\$20 one way), see map.
2. Pay the conference fee of \$80. US participants, please write a check to UC Regents (ref: "MYRES Conference" and send it to Caitlin Chu, Attn: MYRES Conference, Scripps Institution of Oceanography, IGPP-0225, UCSD, 9500 Gilman Drive, La Jolla CA92093-0025, USA (cvchu@ucsd.edu; (858) 534-4917). Others, please pay by credit card: fill out the attached form, and send it to the same address or fax it to ++1 (858)534-5332, Attn: Caitlin Chu. *The deadline for this is July 15th.*
3. Let us know if you need a formal letter of invitation for your visa application.
4. Send kellogg@ess.ucla.edu an email with a short abstract for a poster you may want to prepare (optional).

General information

Meeting location: La Jolla, CA, 15mi North of San Diego airport (SAN); <http://www.myres.org/myres1/>

Contact: Jamie Kellogg (kellogg@ess.ucla.edu; ++1-310-488-9676) and Thorsten Becker (twb@usc.edu; ++1-619-341-4595)

Housing location: Latin America Building, Eleanor Roosevelt College (ERC), UCSD, La Jolla, CA. <http://ercreslife.ucsd.edu/erctour1.htm> (see UCSD map)

Conference site: Hubbs Hall, Scripps Institution of Oceanography (SIO), La Jolla (see SIO map)

On-site transportation: It's a ~30 min walk from UCSD to SIO, and there will be a shuttle service in the mornings and evenings (see overview map)

Sponsors: main: National Science Foundation and European Science Foundation, site: Scripps Institution of Oceanography and IGPP

**Credit card authorization for conference
fee for MYRES-I meeting, UC San Diego,
La Jolla CA, August 12 – 15, 2004**

Please only use this form if credit card payment is the best option for you for transferring fund from abroad, because we have to pay a \$7 processing fee compared to personal checks. Send the filled out form (or checks made to “Regents UC Ref: MYRES meeting” to

Caitlin Chu, Attn: MYRES Conference, Scripps Institution of Oceanography, IGPP-0225, UCSD, 9500 Gilman Drive, La Jolla CA 92093-0225, USA (cvchu@ucsd.edu; (858) 534-4917).

You can also fax this form to ++1(858)534-5332, Attn: Caitlin Chu.

Your Name:

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I hereby authorize UCSD to charge my credit card as specified above for the amount of US\$80.

Place, date:

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MYRES-I Program

- *Wednesday, August 11, 2004*
 - evening: arrival (ERC dorms, UCSD campus)
 - 7pm: ice breaker (informal) (ERC dorms, UCSD campus)
- Thursday, August 12
 - 9am-6pm: full session (Hubbs Hall, SIO campus)
 - 6:30pm: Scripps sponsored dinner (Surfside, SIO campus)
- Friday, August 13
 - 9am - 5pm: full session (Hubbs Hall, SIO campus)
 - 5pm – 7pm: Tour of the Earth by D. Sandwell (VizCenter, SIO)
 - 8pm: informal poster session in dorm halls (ERC, UCSD campus)
- Saturday, August 14
 - 9am-6pm: full session (Hubbs Hall, SIO campus)
 - 8pm: informal poster session in dorm halls (ERC, UCSD campus)
- Sunday, August 15
 - 9am-6pm: full session (Hubbs Hall, SIO campus)
 - 7pm: Farewell dinner (Munk Lab, IGPP, SIO campus)
- *Monday, August 16*
 - morning: departure (ERC, UCSD campus)

Daily program structure

7:30am-8:30am	breakfast (ERC college, UCSD)
9:00am – noon	two keynote lectures (SIO)
9am – 10:15am	lecture 1
10:15am – 10:45am	coffee
10:45am - noon	lecture 2
12:00 - 1:30pm	lunch (SIO)
1:30pm - 3:00pm	small group break-out discussion (SIO)
	<ul style="list-style-type: none">• focus on questions and create mini presentations for the FORUM• 2 days by discipline, 2 days mixed discipline• instructors act a facilitators and keep record of discussion• someone else from the group presents questions, synthesis to the FORUM
3:00 am- 5:00pm	THE FORUM (SIO)
	open floor discussion, ask questions, discussions
6pm-7pm	dinner ERC college (UCSD)
8pm-10pm	informal poster session (ERC, UCSD; only Aug 13 and 14)

Session order

Mantle Structure (Aug 12, 2004)

Frederik Simons (tomographic structure)

Wendy Panero (interpreting tomography)

Surface Observables (Aug 13)

Magali Billen (geoid & dynamic topography as constraints on mantle structure)

Cin-Ty Lee (geochemical constraints & long term picture on mantle structure)

Heat and Mass Flux (Aug 14)

Sujoy Mukhopadhyay (noble gas constraints)

Jie Li (boundary layers, heat & chemical exchange)

Boundary Layers (Aug 15)

Tine Thomas (imaging boundary layers)

Shijie Zhong (CMB heat flow, boundary layers, plumes flux)

Syllabi of lectures

Seismic Tomography: Art or Science

Frederik Simons

In the last two decades, seismologists have contributed detailed images of the wave speed variations in the Earth's interior. Those images have inspired, surprised, and often confused us. Just how are they made? This lecture will be part tutorial, exploring the methodology of seismic tomography in the larger context of scientific inverse problems. We will learn what seismology can tell us about the Earth - and what not. What we're looking for, and how to look at our results. On the way, we will learn what's hot, and what not, and not just when expressed in red and blue.

Interpreting Geophysical Data for Mantle Dynamics

Wendy Panero

The physical properties of earth materials as a function of pressure, temperature and composition are necessary for the interpretation of geophysical observations with respect to possible chemical variations between the upper and lower mantle as well as chemical and thermal lateral heterogeneities. I will discuss experimental and theoretical methods in mineral physics along with the way in which the data are interpreted and quantified. Examples will include the recent debate over the Mg_2SiO_4 to MgO and MgSiO_3 -perovskite phase boundary, the high-temperature equation of state of MgSiO_3 perovskite, and the influence of minor elements on material properties.

Heat in the Earth's Interior

Jie Li

This lecture will review constraints on the thermal structure and evolution of Earth's deep interior from experimental geochemistry and mineral physics. Topics to be covered include: (1) temperature at the core-mantle boundary and inner-core boundary based on melting point of iron, silicate perovskite, and magnesiowüstite; (2) current estimates on the heat sources in the Earth's interior, and constraints from experimental results on the light element(s) and potassium in the Earth's core; and (3) heat flow paradox (from a different perspective) and the age of inner core.

Inferring Mantle Dynamics and Viscosity Structure from Geophysical Surface Observables

Magali Billen

The surface observables of post-glacial rebound, geoid and dynamic topography have provided first order constraints on the radial viscosity structure of the mantle. Seismic imaging clearly shows significant lateral heterogeneity in the mantle related to temperature and/or composition in the mantle. Based on experimentally determined flow laws, this lateral heterogeneity may also represent strong lateral variations in viscosity. I will: (1) review some of the early research using surface observables to constrain viscosity structure; (2) discuss some of the inherited simplifying assumptions that need to be revisited in light of recent experimental results and current numerical modeling methods; (3) outline limitations in the sensitivity and resolving power of surface observations; and, (4), present a simple example of the effect of lateral variations in viscosity on surface observations. I aim to give an overview that provides the workshop participants with the background knowledge necessary to critically examine the ability of surface observations to distinguish between different models of mantle structure and dynamics.

Constraints on Mantle Structure and Composition from Geochemical Surface Observables

Cin-Ty Lee

The dynamic evolution of the Earth's interior is manifested by the geochemical differentiation of the Earth into various geochemical heterogeneities. Core-mantle segregation and partial melting at mid-ocean ridges, hotspots, and subduction zones are the dominant processes that lead to "unmixing" of the Earth while mantle convection serves to remix these heterogeneities back into the mantle. Therefore, the Earth is presently in a dynamic state of "mixing" and "unmixing". The goal of this presentation is to outline certain aspects of our current understanding of solid Earth geochemistry, how it bears on understanding the nature of the Earth's convective interior, and what, if any, fundamental questions remain. We will discuss the concepts of geochemical "reservoirs", "heterogeneity", and "observables" (e.g., lavas, xenoliths, and diamond inclusions) and their spatio-temporal evolution. I will review the salient geochemical features of continental crust, oceanic crust, and depleted mantle and proposed geochemical components (e.g., DMM, EM1, EM2, HIMU, SCLM, etc.) I will then compare and contrast the geochemical characteristics of ocean island basalts (OIBs) and mid-ocean ridge basalts (MORBs). Issues that arise include: How do the current datasets relate to the many models and cartoons that have been proposed for the chemical structure of the mantle? Are there new (geochemical) ways to refute some of these models, or are these models effectively untestable? Other current debates include the question if the mantle possesses a primordial stratification, could this be tested by short-lived lithophile radiogenic systems, such as by the ^{146}Sm - ^{142}Nd chronometer? Another knowledge gap is the water content and its variation in the mantle and all its sub-reservoirs as well as the problem of oxygen fugacity of the mantle.

Noble gas constraints on Mantle Convection

Sujoy Mukhopadhyay

The noble gases (He, Ne, Ar, Kr, and Xe) have provided valuable insights into mantle heterogeneities and into the nature of mantle convection. In particular, the noble gases have been used to argue for a primordial reservoir in the Earth's mantle. The existence of a primitive undepleted mantle is apparently at odds with geophysical evidences of slab subduction into the lower mantle and evidences from other geochemical tracers, such as Sr, Nd, and Os isotopic ratios. I will critically review and discuss the distribution of noble gas elemental and isotopic ratios in Mid Ocean Ridge Basalts (MORBs) and Ocean Island Basalts (OIBs). I will then address the geochemical histories of the sources that contribute to volcanism at MORBs and OIBs and the constraints noble gases place on mantle convection.

Boundary Layers of the Mantle - Seismological Constraints

Christine Thomas

This lecture will review how we can detect seismic boundaries in the mantle using seismic waves together with resolution issues. Discontinuities in the lowermost mantle (core-mantle boundary, D" layer) and the upper mantle (mantle transition zone) will be discussed. Different hypotheses as to the nature of the boundaries and their relation to mantle convection will be presented. Other boundary layers in the mid-mantle, and their absence, respectively, as well as lateral extent of known boundary layers will be examined.

Boundary Layers of the mantle - dynamic constraints

Shijie Zhong

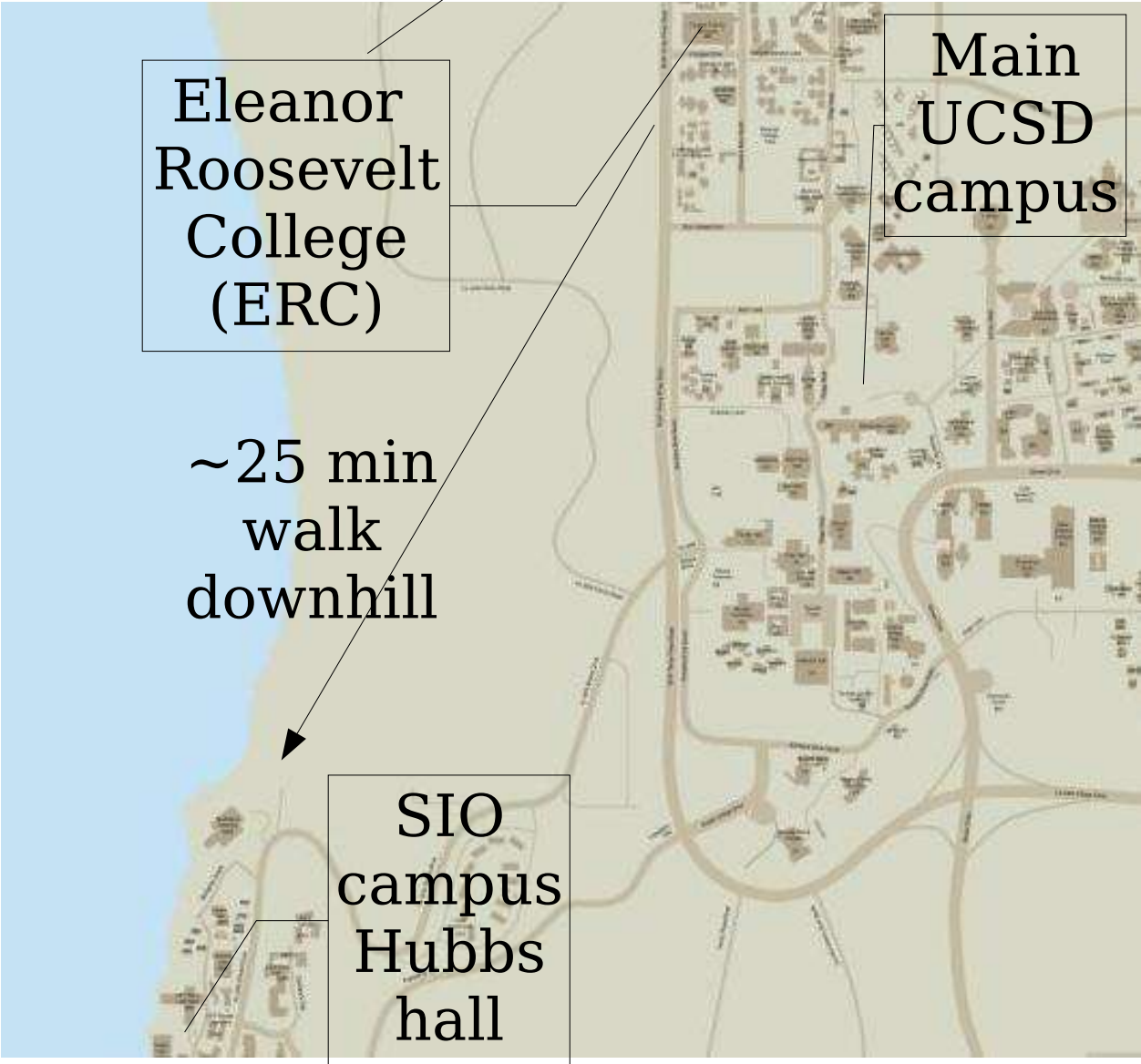
The dynamics of thermal boundary layers is an important part of mantle dynamics. Important physical processes in the mantle including subduction and mantle upwellings are all related to the boundary layer dynamics or instabilities. Although subduction, which results from the instability of the top boundary layer (i.e., lithosphere), is one of the most important processes in mantle dynamics, here we will focus on the dynamics of thermal boundary layer(s) in the deep mantle including the core-mantle boundary that may produce upwelling plumes. We will discuss: (1) the controls and consequences of such instabilities; (2) energy transfer associated with the upwelling plumes and its implications for the seafloor topographic anomalies and the core heat flux; and, (3), plumes in whole/layered mantle convection.

List of participants

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UCSD Upper campus map

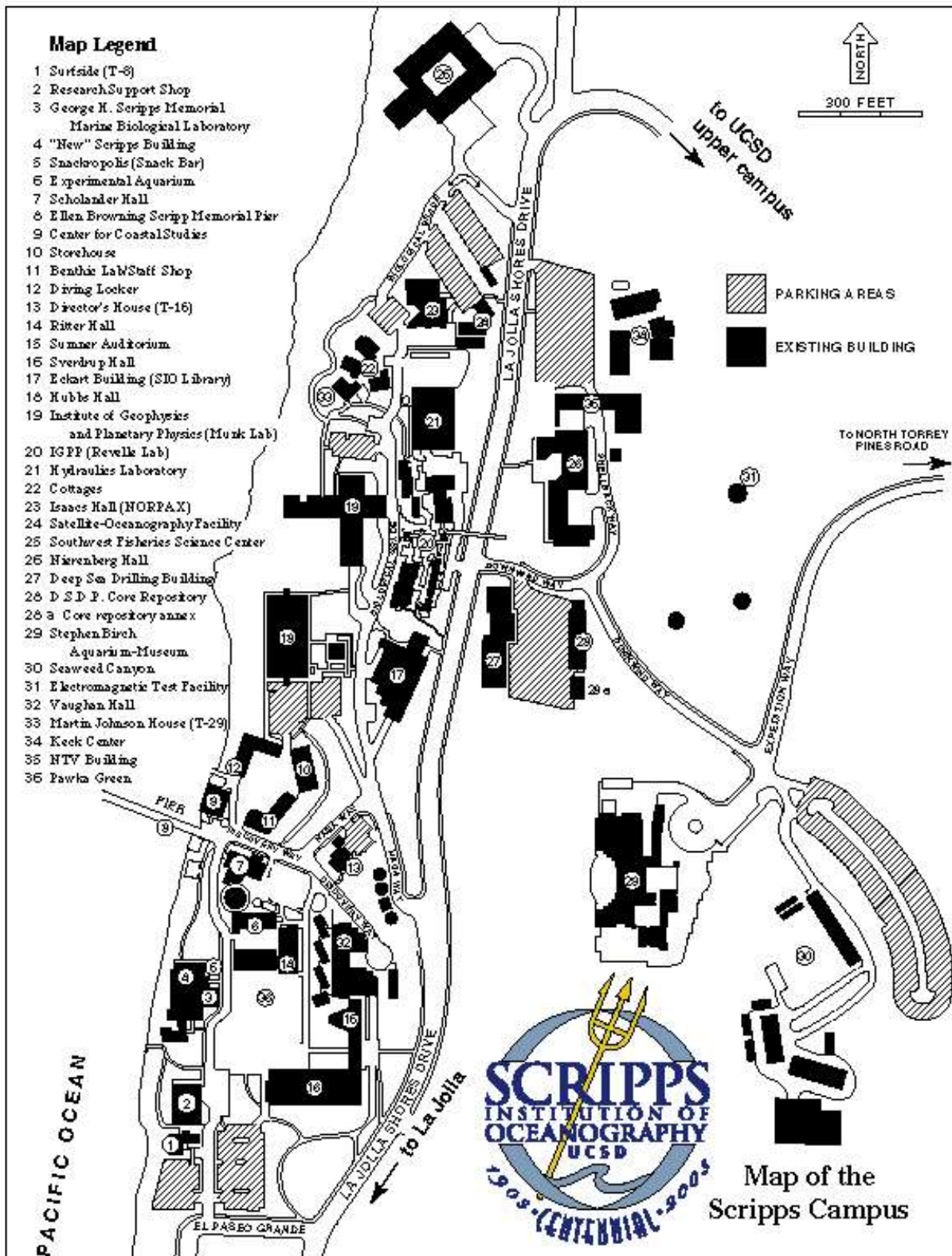
Dorm: ERC, Latin America



Map of the Scripps Campus (SIO, IGPP, meeting site)

Lectures: Hubbs Hall (#18), class rooms for breakout sessions:

library (#17) and in Munk Lab/IGPP (#19), good-bye dinner: Munk (#19), welcome reception: surfside (#1)



Maps to get to Scripps/UCSD from I-5 or SAN

DIRECTIONS FROM INTERSTATE 5 TO IGPP, SIO, UCSD AND HOTELS

