Cooperative Institute for Dynamic Earth Research

2019 CIDER Summer Program

Bruce Buffett

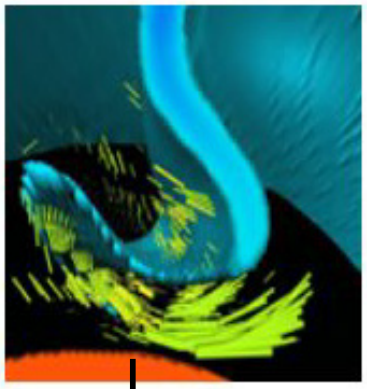
Univ. of California, Berkeley

Funded by CSEDI program (2004-2011), FESD (2012-2018), and CSEDI (2019-2020)

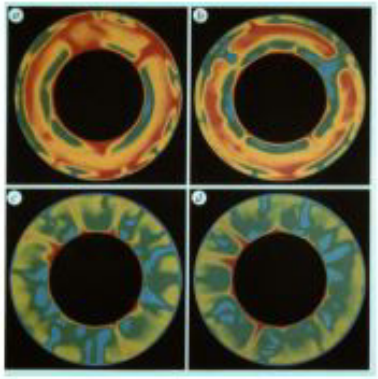
National Science Foundation
WHERE DISCOVERIES BEGIN

CIDER
Cooperative Institute for Dynamic Earth Research

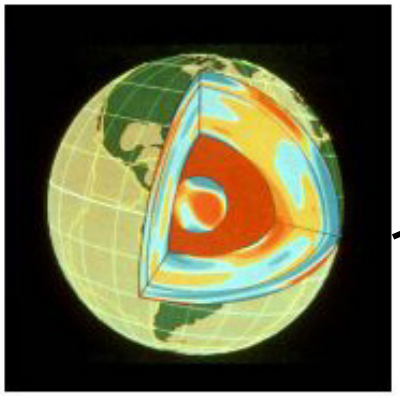
Chemistry and Mineral Physics,



Rheology and Material Properties,

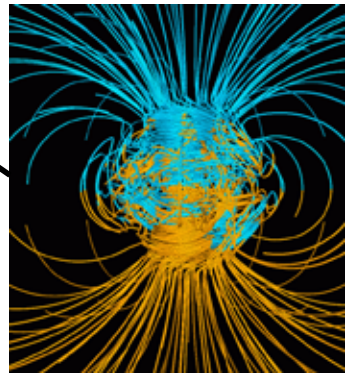


Geodynamics,

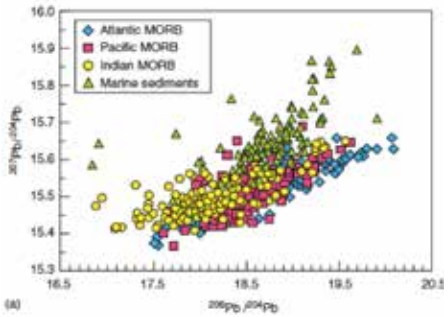


Seismology,

Understanding the Earth's interior structure, dynamics and evolution



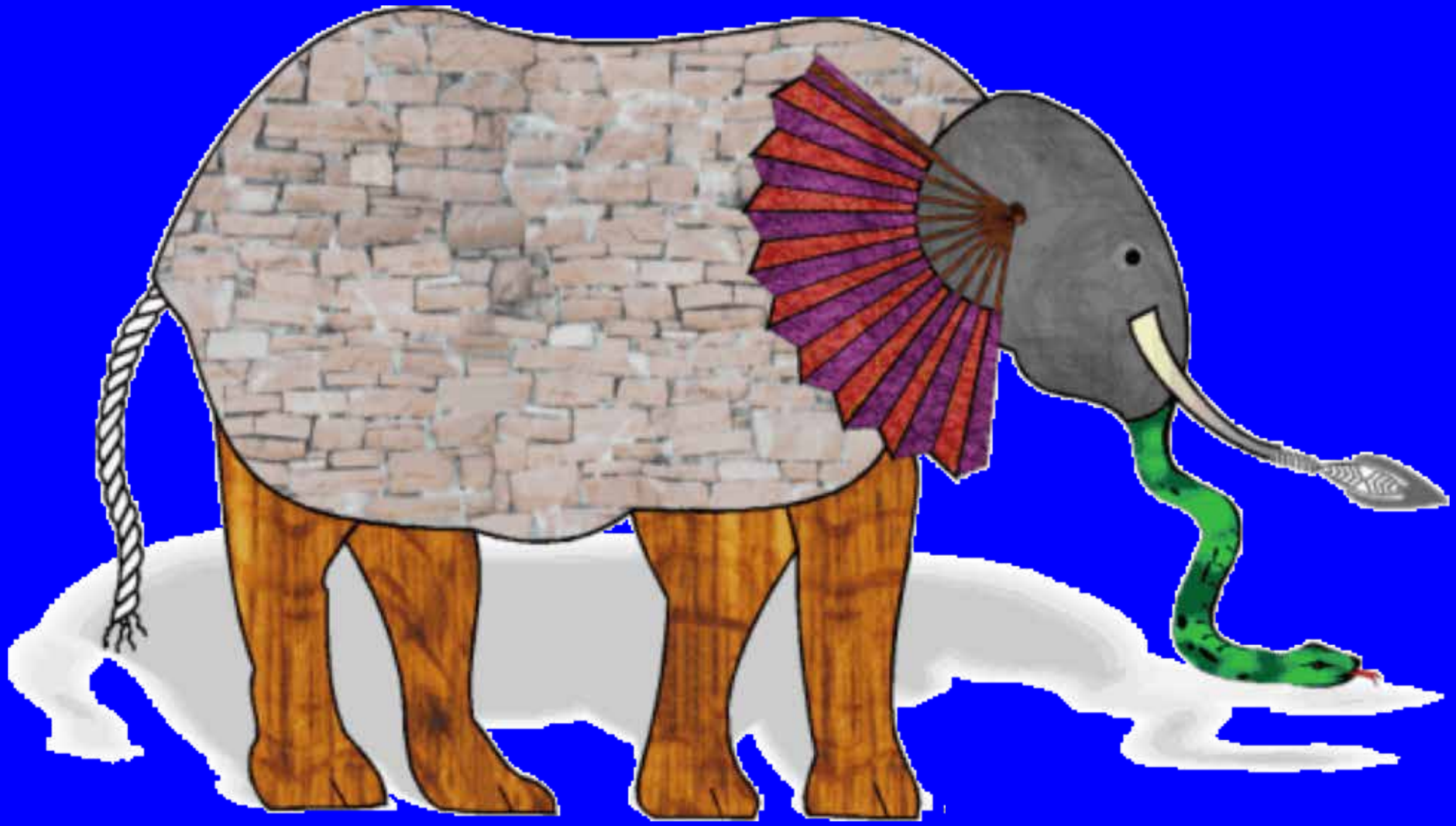
Geomagnetism



Geochemistry/cosmochemistry

Anchored in observations
at the Earth's surface
and remote sensing using satellites

Parable of the blind men and the elephant



Jason Hunt naturalchild.org

Recognizing the need for more effective communication and understanding between the different disciplines, CIDER's goal is to provide:

CIDER
Cooperative Institute for Dynamic Earth Research

- An intellectual framework for integrated multi-disciplinary research in the geosciences
- An essential complement to growing infrastructure for data gathering and distribution
- A cross-disciplinary educational environment to prepare the next generation of earth scientists

2002 – Visit KITP

Kavli Institute for Theoretical Physics

University of California, Santa Barbara

2003 – Marconi Center Community Workshop

- *To define the scope and format of CIDER*
- Resulted in proposal to NSF/CSEDI->
- co- funded 1st summer program with KITP (2004)
- Funded summer at KITP in 2006, 2008, 2010

2009 – Marconi Center Community Workshop

- To review past activities,
- To define the scope of CIDER-II
- -> "D" changed from "Deep" to "Dynamic"
- Resulted in:
  - proposal to FESD- 2011
- -> 5 years of funding with expanded scope.

2016 – Marconi Center Community Workshop

- To review CIDER accomplishments
- To define the scope of CIDER beyond 2017 and start planning for future funding model

CIDER Summer Programs

- *At KITP, U.C. Santa Barbara*

  - 2004 : "Relating seismological and geochemical heterogeneity in the earth' s mantle"
  - 2006: "The earth's transition zone"
  - 2008: "Boundary layers in the Earth"
  - 2010: "Fluids and volatiles in the Earth's mantle and core"
  - 2012: "Deep time: how the early Earth became the modern world"
  - 2014: "Dynamics of planetary interiors"
  - *2016: "Flow in the deep Earth"*
  - *2018: "Relating seismological and geochemical heterogeneity in the earth's mantle"*
  - *2020: "Earth's evolution as an inhabited world"*

CIDER Summer Programs

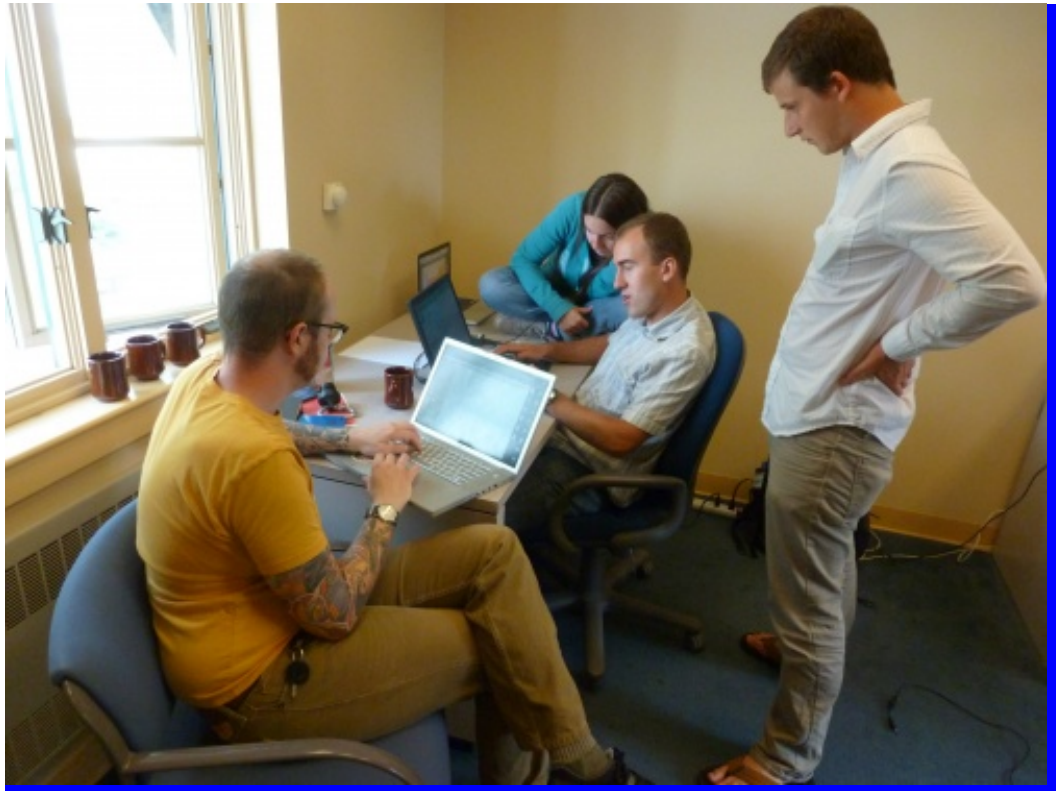
- *At UC Berkeley*
  - 2011: "Dynamics of mountain building"
  - 2013: ""From mantle to crust: continental formation and destruction"
  - 2015: "Solid Earth and climate"
  - *2017: "Subduction zone structure and dynamics"*
  - *2019: "Volcanoes"*

CIDER 2004, KITP

CIDER 2008, KITP

CIDER 2010, KITP

CIDER 2011, Berkeley



CIDER "Burnman group" in action,
Summer 2012

CIDER poster session
Summer 2014

New activities starting in 2012 (FESD):

- Post or pre -AGU CIDER workshops:
  - 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018

- Support for research projects initiated during summer program

- Support for "working groups" :
  - Reference Earth Model (led by V. Lekic)
  - Attenuation (led by D. Wiens)
  - Geoneutrinos (led by W. McDonough)
  - Geomagnetic prediction (led by D. Lathrop)
  - Dynamic topography (led by S. Zhong)

CIDER
Cooperative Institute for Dynamic Earth Research

CIDER wiki

- *Open to the public* (www.deep-earth.org)
  - Summer program lecture slides and video-recording
    - CIDER Lecture Collection
  - Reports of Working Groups
  - Other Activities
    - CIDER publications, presentations, proposals
    - Wiki-topic pages
      - E.g. "Seismic Reference Earth Models"
      - "Dynamic topography" …
- *Open only to CIDER participants*
    - Student Research Group pages

CIDER
Cooperative Institute for Dynamic Earth Research

CIDER Summer Program Products

- Research groups formed during the summer program continue to function after the end of the summer program (AGU posters, publications)

- More generally, new collaborations lead to publications and/or proposals

- Networking among participants.
  - Post-doc and faculty positions

From 2013 Summer Program:

RESEARCH ARTICLE
10.1002/2015GC005943

G-Cubed 2015

Characterization and Petrological Constraints of the Midlithospheric Discontinuity

Erika Rader[1], Erica Emry[2], Nicholas Schmerr[3], Daniel Frost[4], Cheng Cheng[5], Julie Menard[1], Chun-Quan Yu[6], and Dennis Geist[7]

From 2014 Summer Program:

RESEARCH LETTER
10.1002/2016GL068560

GRL. , 2016

Primordial metallic melt in the deep mantle

Zhou Zhang[1], Susannah M. Dorfman[2,3], Jabrane Labidi[4], Shuai Zhang[5], Mingming Li[6,7], Michael Manga[5], Lars Stixrude[8], William F. McDonough[9], and Quentin Williams[10]

From 2016 Summer Program:

RESEARCH ARTICLE
10.1029/2018GC007534

G-Cubed 2018

Multidisciplinary Constraints on the Abundance of Diamond and Eclogite in the Cratonic Lithosphere

Joshua M. Garber[1,2], Satish Maurya[3,4], Jean-Alexis Hernandez[5], Megan S. Duncan[6,7], Li Zeng[8], Hongluo L. Zhang[9], Ulrich Faul[10], Catherine McCammon[11], Jean-Paul Montagner[3], Louis Moresi[12], Barbara A. Romanowicz[4,13], Roberta L. Rudnick[1], and Lars Stixrude[14]

From 2017 Summer Program

https://doi.org/10.1038/s41467-019-09113-0 OPEN

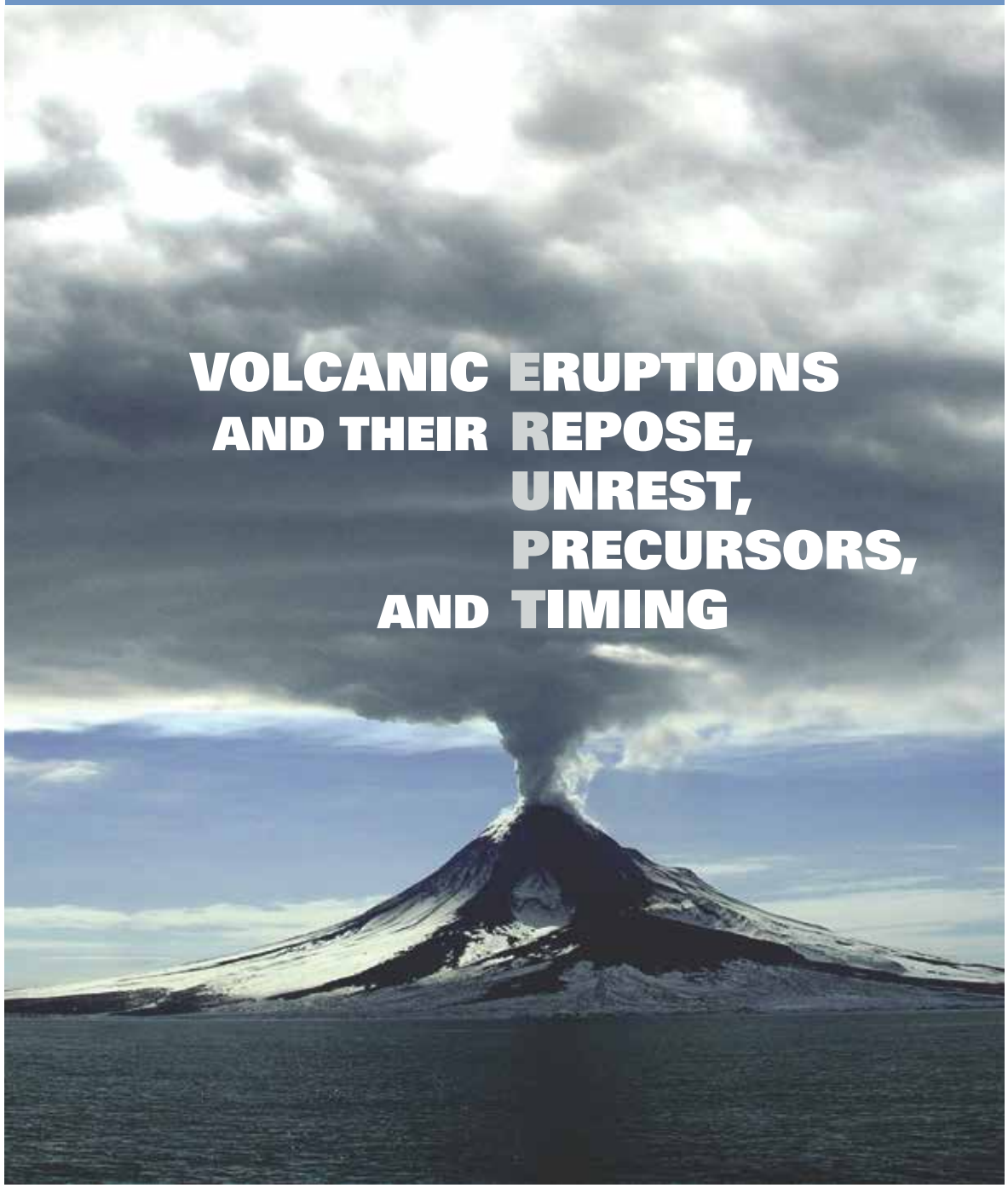
The causes of spatiotemporal variations in erupted fluxes and compositions along a volcanic arc

C.B. Till[1], A.J.R. Kent[2], G.A. Abers[3], H.A. Janiszewski[4,5], J.B. Gaherty[4] & B.W. Pitcher[2,6]

Nature Comm., 2019

The National Academies of
SCIENCES • ENGINEERING • MEDICINE

REPORT



VOLCANIC ERUPTIONS AND THEIR REPOSE, UNREST, PRECURSORS, AND TIMING

Summary of the ERUPT report Grand Challenges

- Forecast the onset, size, duration and hazard of eruptions by integrating observations with quantitative models of magma dynamics
- Quantify the life cycles of volcanoes globally and overcome our current biased understanding
- Develop a coordinated volcano science community to maximize scientific returns from any volcanic event

5. Strengthening volcano science

Requirements for an effective volcano science community

- Support for interdisciplinary collaboration and training, which is essential to making discoveries and integrating models and measurements
- Shared community infrastructure, which is necessary for state-of-the-art modeling, analytical facilities, monitoring and field experiments
- Databases that preserve and facilitate open exchange of information and hence enable exploration of the life cycle of volcanoes and improve forecasting
- New technology and instruments that permit new detection, measurements and sampling, including previously inaccessible parts of ongoing eruptions
- A coordinated response by the research community to eruptions globally to overcome observational bias
- Observatory-academic partnerships, which will accelerate the translation of basic science to applications and monitoring

6. Grand challenges in volcano science

3. Develop a coordinated volcano science community to maximize scientific returns from *any* volcanic event

The research community needs to be prepared to monitor and respond to eruptions globally

Requires multidisciplinary research, USGS-academic partnerships, training networks

Logistics

- Lectures:
  - Recording
  - Microphones
  - Lecturers post lecture ppt/pdfs on the wiki
    - https:/seismo.berkeley.edu/wiki_cider/2019_Summer_Program_Agenda
    - Assistance from Dan Frost
    - Login:CIDER.2019
    - Password:summer2019
- Poster Sessions
  - Wed. June 19th : A-Mi
  - Wed. June 26th: Mu-Z
- Wear badges at all times
- Lunch cards
- The University of California indoors AND outdoors is non-smoking sampus
- Group dinners (Wednesdays on campus, volunteers)
- Group photo (Tuesday during morning coffee break)
- Reimbursements (students and post-docs by June 28, senior participants by July 7)

Sarna-Wojcicki et al., *Geosphere* (2011)

Clear Lake volcanic field

Late-Pliocene to early Holocene

~100 km^3 since 2.1 Ma

Mean interval between eruptions is 1800 years (USGS)

Basalt to rhyolite

Supports world's largest geothermal facility ("The Geysers")