Welcome to the plate boundary
The Hayward Fault

We are here

Hayward Fault

Memorial Stadium

with thanks to.....

Prof. Roland Burgmann and his group
particularly
Matt d’Alessio and Ingrid Johanson

http://earthquakes.berkeley.edu
Welcome to the plate boundary

Where is the fault?

Which way is this side moving?

Wallace Creek on the San Andreas fault in central California
Where is the fault on campus?

Hayward Fault

Hayward fault bounds East Bay hills.

Strawberry Creek is offset by fault.
The Hayward is a major fault.

Geologic evidence

- Offset: 335 m
- Age of Channel: ~32,000 years old
- Long-term Slip Rate: ~10 mm/year

10 mm/yr is 20% of the total Pacific-North American Plate Boundary (50 mm/yr).
Major Earthquake in 1868 (M7.0)

- Called "Great San Francisco Earthquake" 1868 - 1906
- Offset: 335 m
- Age of Channel: 32,000 years old
- Long-term Slip Rate: ~10 mm / year
- Slip in earthquake: ~2 m
- Number of EQs to offset Straw. Creek: ~170
- Earthquake rate: ~1 per 190 years

When was the last earthquake near Berkeley?

~300 years since EQ near Berkeley

EPS20: Earthquakes in your backyard – Prof. Richard Allen

http://earthquakes.berkeley.edu
No big earthquakes on Hayward since 1868

Plate motions cause strain to build up

1. Stress applied
2. Crust is deformed
3. Earthquake

► Earthquakes relieve strain
EPS20: Earthquakes in your backyard – Prof. Richard Allen

Looking for evidence of fault processes

Rose Street, Hayward, CA

What does the curb show?

1971

Steady progression
Not associated with an EQ
2.5 mm/yr?
**Different fault behaviors**

Locked vs. creeping faults

- LOCKED until the next earthquake...

- CREEPING along

**Memorial stadium**

Cut by the fault ...and creeping
Creeping and locked faults

Creeping faults

San Andreas Fault, Melendy Ranch
Central San Andreas Fault
Calaveras Fault, Hollister
**Spectrum of fault behavior**

*ASEISMIC* i.e. Creep
- Blocks constantly move
- Free Slipping

*SEISMIC*
- Earthquakes
- Stick-Slip

Even along creeping faults, the reality is somewhere in between.

---

**Both creeping and locked?**

- Creeping
- Locked Asperity
Creep relieves strain

→ makes earthquakes smaller

Hayward Fault

Surface movement is different

Locked vs. creeping faults

Long Term Buildup (Plate Tectonics) = Steady slip = Amount left for Earthquake

10 mm/yr = 2.5 mm/yr? = ???

Locked

Partially locked and partially creeping

Creeping
Measuring surface deformation

GPS at Nicholl Park, Richmond
- Precise to several mm
- Need several hours of data

Repeat measurements of benchmarks

1998
Lat: 37.93439377 °N
Lon: 122.34002635 °W
El: 14.145 m
Repeat measurements of benchmarks

1998
Lat: 37.93439377 °N
Lon: 122.34002635 °W
El: 14.145 m

2004
Lat: 37.93439322 °N
Lon: 122.34002390 °W
El: 14.130 m


Northward, Westward, and Down

(3-dimensional coordinate system)

VELOCITY = DISTANCE / TIME
The Burgmann group
Survey all over the place

Newark, CA

Hayward

North Berkeley

Kelly Grijalva

Frederique Rolandone, Eileen Evans & Isabelle Ryder

Dennise Templeton

Romain Jolivet

http://earthquakes.berkeley.edu
Including Memorial stadium

Hayward Fault

Creep across the stadium

Long term rate: 10 mm/yr
GPS creep rate: 4 mm/yr

STAC
STAB
STAA
STAD

N
100 m
10 mm yr⁻¹

http://earthquakes.berkeley.edu
Hayward Fault

Alessio et al., 2005

locked

20mm/yr

locked
Hayward Fault

Alessio et al., 2005

combination: locked + creeping

20mm/yr

http://earthquakes.berkeley.edu
Computer models
Mapping where the faults are creeping vs locked

Equations relate deformation to subsurface fault slip based on elasticity.

Input: Surface Deformation Measurements

Computer Model

Output: Fault Behavior (Where creeping)

Earthquake slip accumulation rates

<table>
<thead>
<tr>
<th>Condition</th>
<th>Formula</th>
<th>Distance (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>no creep</td>
<td>(long term - creep rate) * (time)</td>
<td>1.4</td>
</tr>
<tr>
<td>some creep</td>
<td>(10 mm/yr - 0.0 mm/yr) * (2009-1868)</td>
<td>1.1</td>
</tr>
<tr>
<td>more creep</td>
<td>(10 mm/yr - 7.0 mm/yr) * (2009-1868)</td>
<td>0.4</td>
</tr>
</tbody>
</table>