Using Fragile Geologic Features to Inform Ground Motion Hazard

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Pacific Gas & Electric
20-second Summary

A surviving fragile geologic feature allows for:

- testing of ground motion hazard, and
- informs which branches of the logic tree are unrealistic.
• Calculate of a scale factor ($\alpha$) that adjusts mean hazard
• Governed by most fragile feature
• Conservatism added through probability of survival (e.g., 1% and 5%)
• Multiple features can only be considered if fragilities are similar
Mean Hazard Scaling

![Graph showing the relationship between probability of toppling and PGA (ground acceleration).]

- **Legend:**
  - `dre1`
  - `dre2`
  - `drw1`
  - `drw2`
  - `drw3`
  - `drw4`
  - `drw5`

- **Axes:**
  - Y-axis: `P(toppling|PGA=z)`
  - X-axis: `PGA (g)`

- **Scale:**
  - Y-axis: 0.0 to 1.0
  - X-axis: 10^-1 to 10^1

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Mean Hazard Scaling

\[ P(\text{survival}) = 0.01 \]

\[ \text{AFE (1/yr)} \]

\[ \text{PGA (g)} \]

- Blue: Mean
- Orange: dre1
- Green: dre2
- Red: drw1
- Purple: drw2
- Brown: drw3
- Pink: drw4
- Magenta: drw5
Mean Hazard Scaling

\[ P(\text{survival}) = 0.05 \]

\[
\begin{align*}
\text{PGA (g)} & \quad 10^{-1} & \quad 10^{0} & \quad 10^{1} \\
\text{AFE (1/yr)} & \quad 10^{-6} & \quad 10^{-5} & \quad 10^{-4} \quad 10^{-3} \quad 10^{-2}
\end{align*}
\]
Evaluation of Logic Tree Branches

• Consider the hazard associated with each branch of the logic tree
• Compute probability of survival of each branch
• PBR DWR1 - 22% of end branches are below 1% probability of survival
• Check fraction of realizations consistent with PBR survival at each node
## Logic Tree: Characteristic Magnitude

<table>
<thead>
<tr>
<th>Mean Mag.</th>
<th>Hosgri</th>
<th>Shoreline</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.2</td>
<td></td>
<td>0.2</td>
</tr>
<tr>
<td>6.4</td>
<td></td>
<td>0.6</td>
</tr>
<tr>
<td>6.6</td>
<td>0.05</td>
<td>0.2</td>
</tr>
<tr>
<td>6.8</td>
<td>0.15</td>
<td>0.2</td>
</tr>
<tr>
<td>7.0</td>
<td>0.30</td>
<td></td>
</tr>
<tr>
<td>7.2</td>
<td>0.30</td>
<td></td>
</tr>
<tr>
<td>7.4</td>
<td>0.15</td>
<td></td>
</tr>
<tr>
<td>7.6</td>
<td>0.05</td>
<td></td>
</tr>
</tbody>
</table>

![Graph showing fraction consistent with PBR for Hosgri and Shoreline Flt](image)

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## Logic Tree: Slip Rate

### Hosgri Shoreline Rate (mm/yr) Wt.

<table>
<thead>
<tr>
<th>Rate (mm/yr)</th>
<th>Wt.</th>
<th>Rate (mm/yr)</th>
<th>Wt.</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.6</td>
<td>0.10</td>
<td>0.020</td>
<td>0.10</td>
</tr>
<tr>
<td>1.0</td>
<td>0.24</td>
<td>0.027</td>
<td>0.24</td>
</tr>
<tr>
<td>1.7</td>
<td>0.32</td>
<td>0.040</td>
<td>0.32</td>
</tr>
<tr>
<td>2.3</td>
<td>0.24</td>
<td>0.060</td>
<td>0.24</td>
</tr>
<tr>
<td>3.1</td>
<td>0.10</td>
<td>0.110</td>
<td>0.10</td>
</tr>
</tbody>
</table>

### Graph

- **Hosgri fault**
- **Shoreline Fault**

**Fraction Consistent with PBR**

**Slip rate (mm/yr)**

- 0.02
- 0.027
- 0.04
- 0.06
- 0.11
• Fifty samples of a non-ergodic GMMs
• Equally weighted
• Alternative magnitude scaling, attenuation, etc.
Potential to Reduce Mean and Uncertainty

- Mean and 5\textsuperscript{th} to 95\textsuperscript{th} hazard
- Using PBRs has the potential to reduce the mean hazard and improve uncertainty
- 10,000-yr return period:
  Ref.: 1.0 g (0.45–1.8 g)
  Inf.: 0.7 g (0.40–1.0 g)