Site-Response Analysis

- When **not** to do it
- What approach to use for long period motions

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August 2011

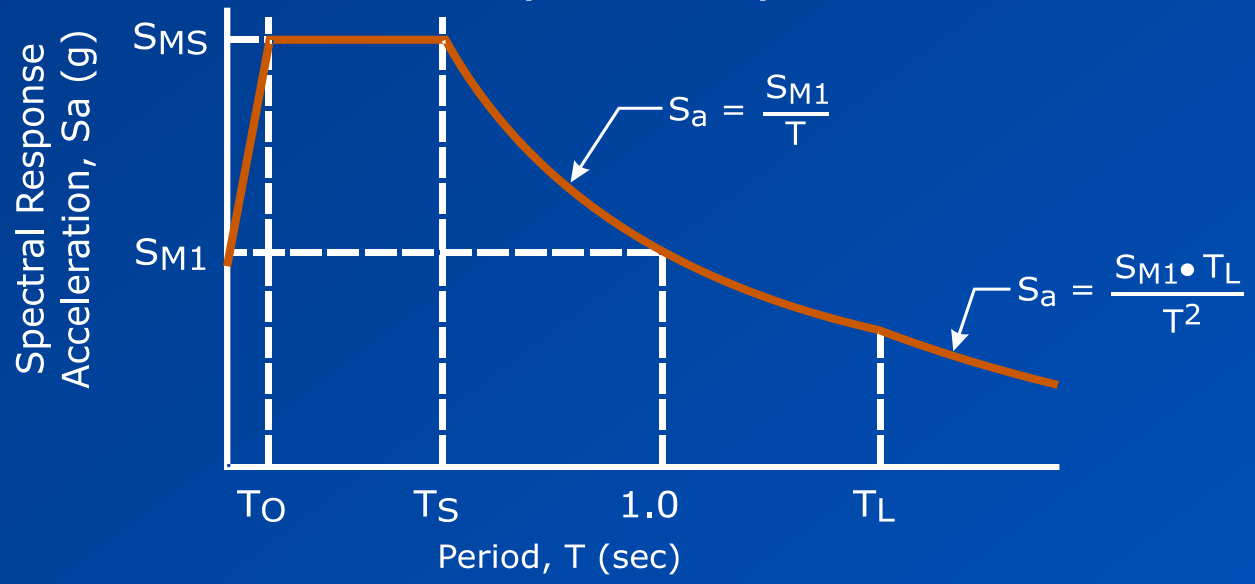
Two Seismic Hazard Analysis (SHA) Approaches in ASCE 7-05

1. General Procedure – Ch. 11

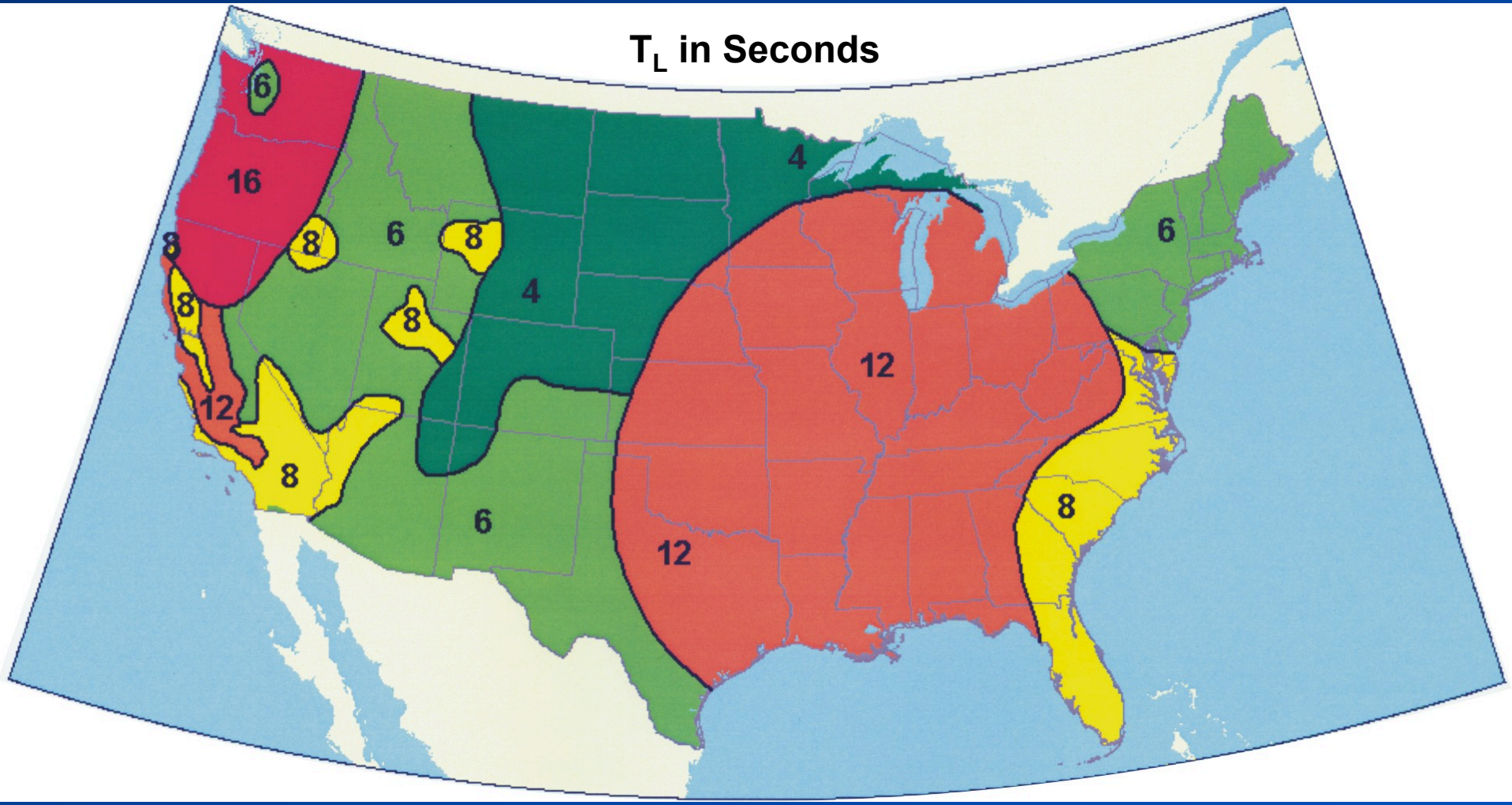
USGS MCE Maps & Site Coefficients

S_S, S_1, T_L $\qquad$ F_a, F_v

MCE Response Spectrum



T_L Map in ASCE 7



Two SHA Approaches (cont.) – Ch. 21

2. Site-Specific

- Probabilistic (PSHA)
- Deterministic (DSHA)

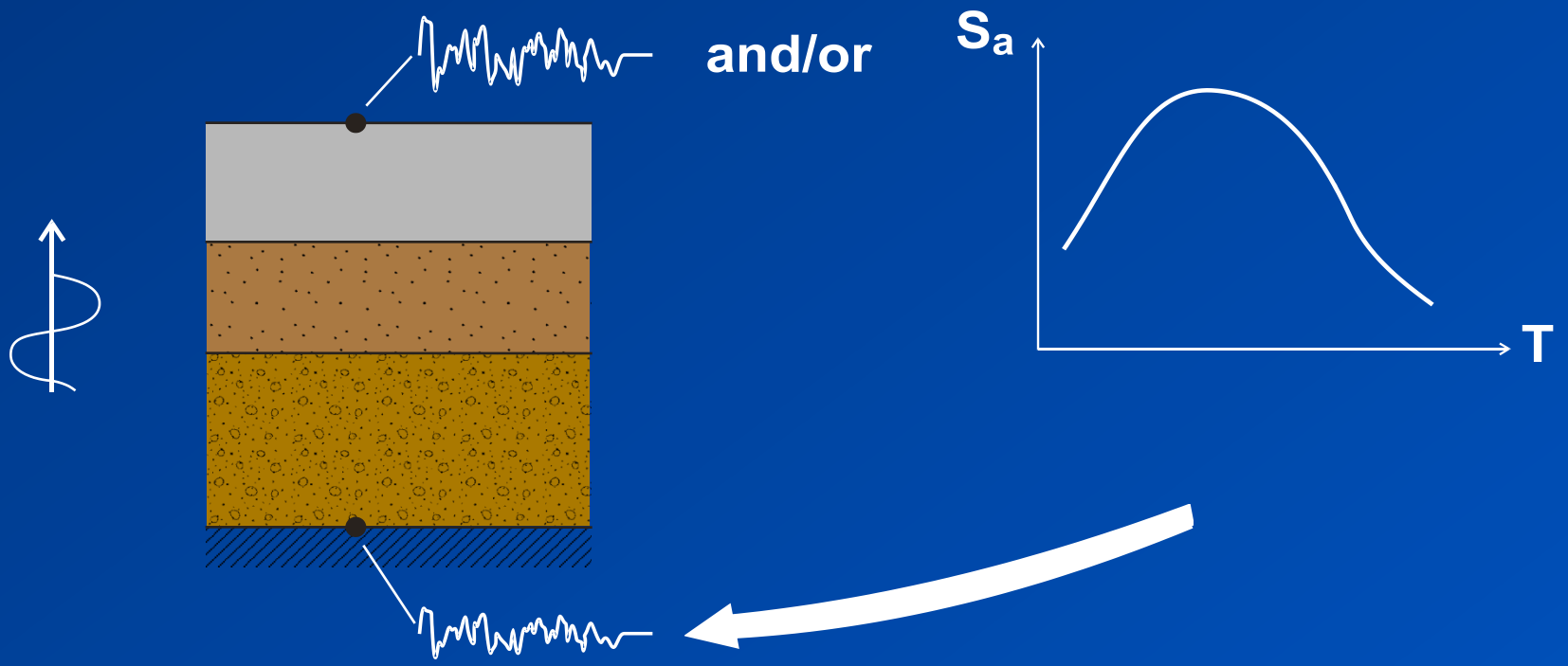
Preferred or Required for Important/Critical Structures

Site Response Analysis (SRA) – Ch. 21

Site-Specific Ground Motion

SRA

PSHA/DSHA



When not to do SRA

- Stiff soil sites

  i.e. Site Class C & D per ASCE 7

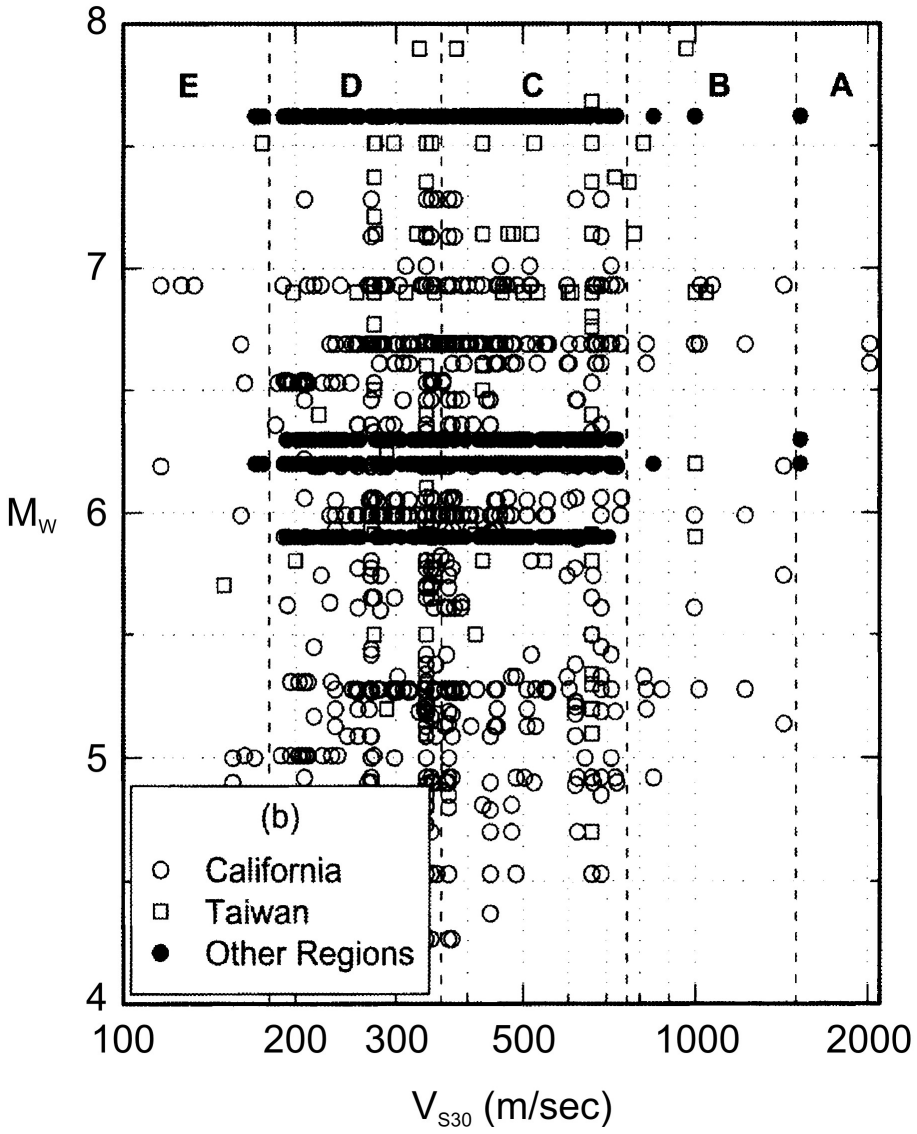
Recommendation

- Use F_a & F_v Site Coefficients in ASCE 7
- Use site term (V_{S30}) in GMPEs ➡ PSHA/DSHA

V_{S30} = ave. shear-wave velocity in upper 30m

(Direct Approach)

NGA Database – Chou & Youngs



Site Categories

A - Hard Rock

B - Rock

C - V. Stiff Soil

D - M. Stiff Soil

E - Soft Soil

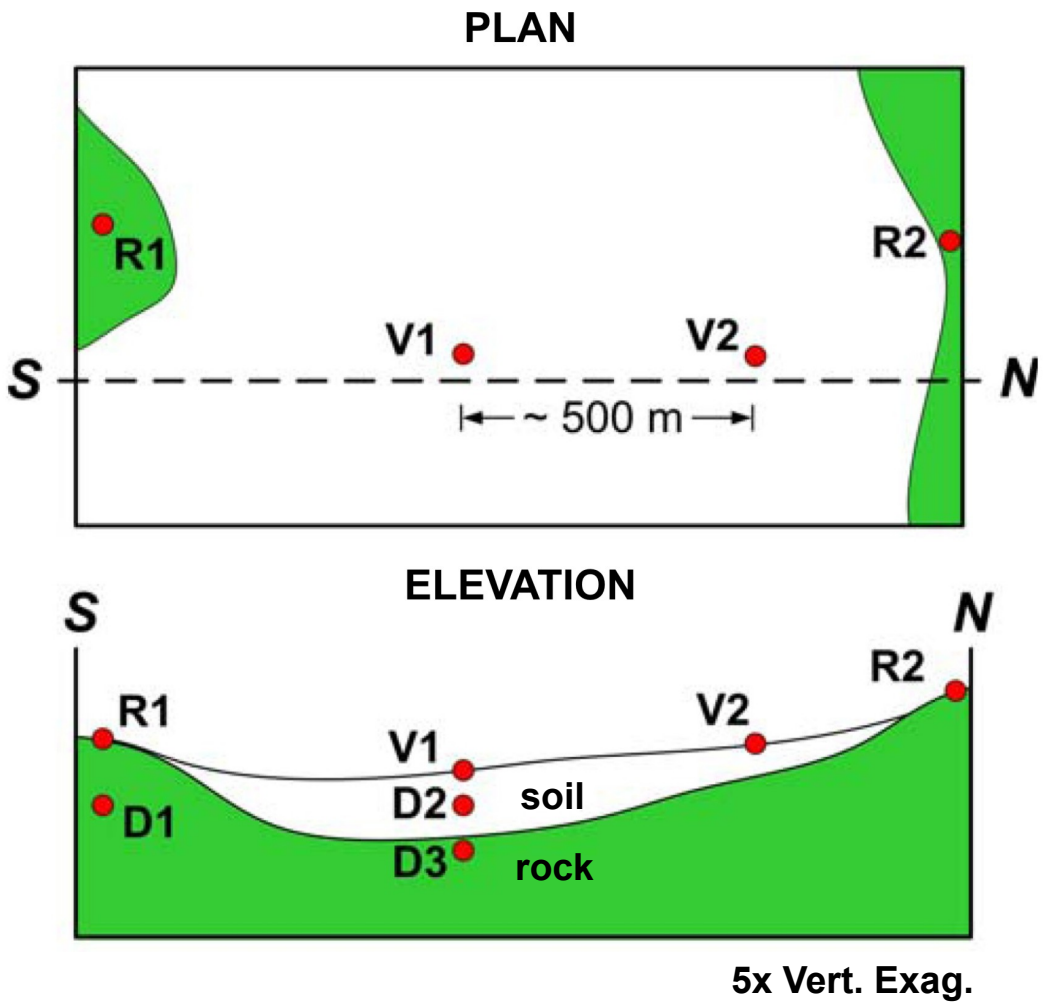
Turkey Flats Blind Prediction Experiment

California Geological Survey

Objective

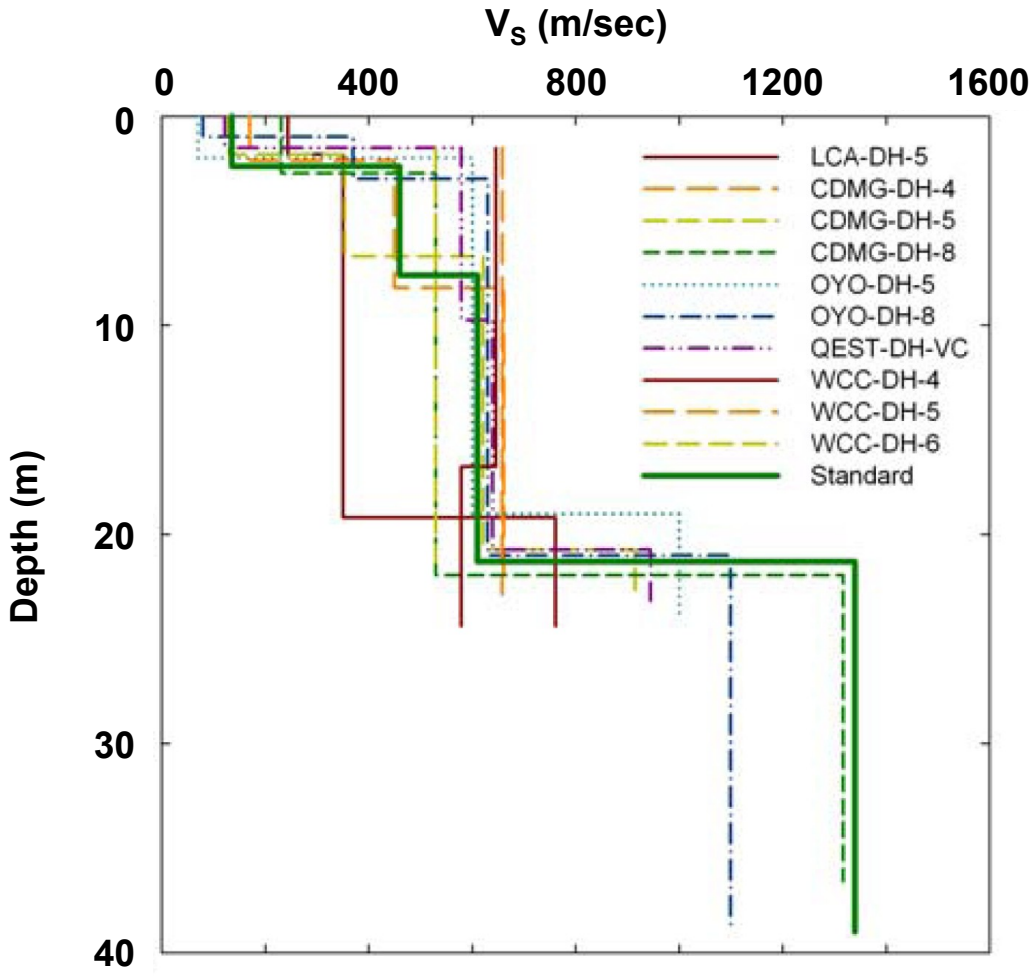
Predict soil motions given rock motions recorded during 2004 M6 Parkfield, CA EQ

Turkey Flats SM Instrumentation



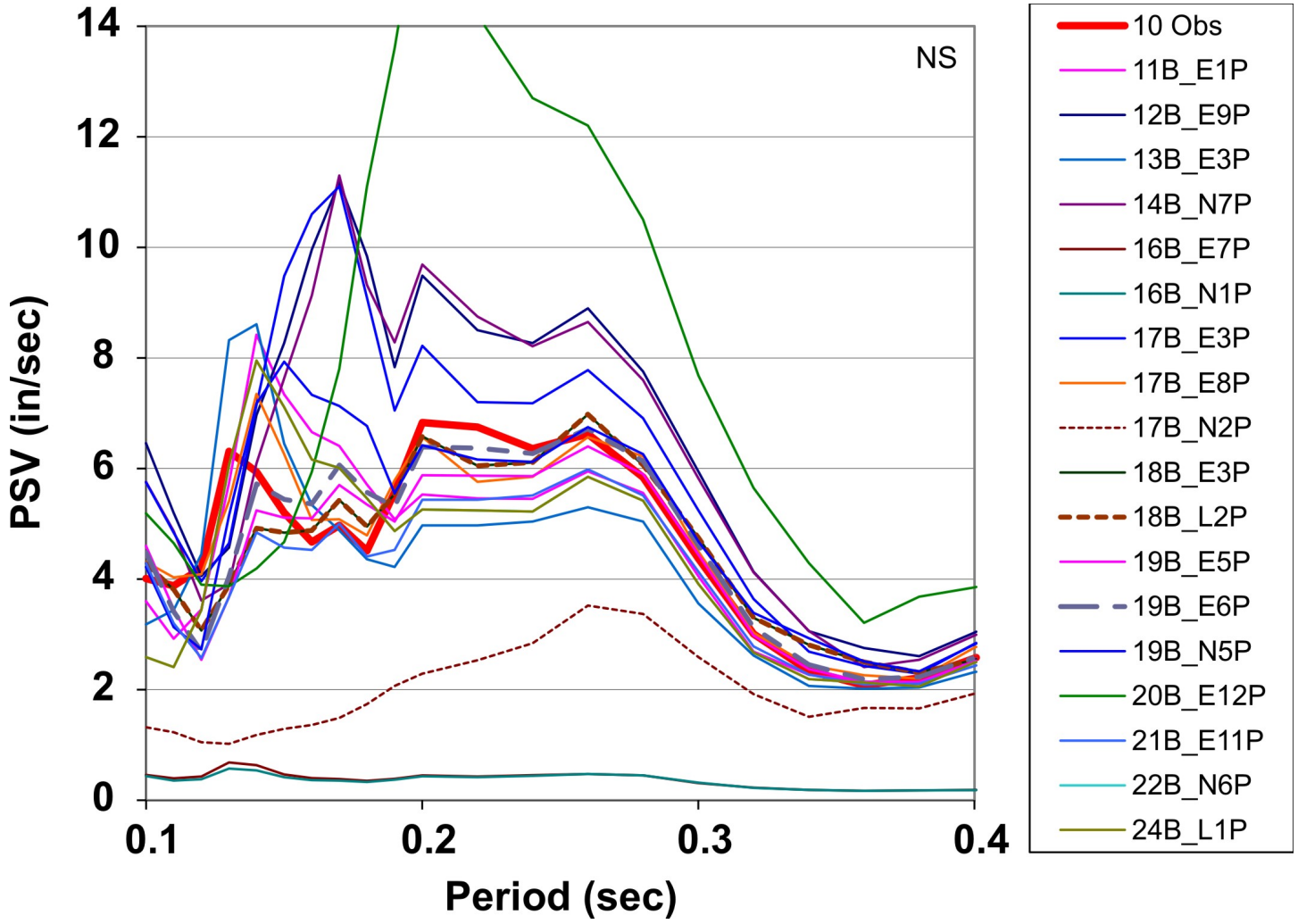
Kramer (2009)

V_S Survey at V1 Station

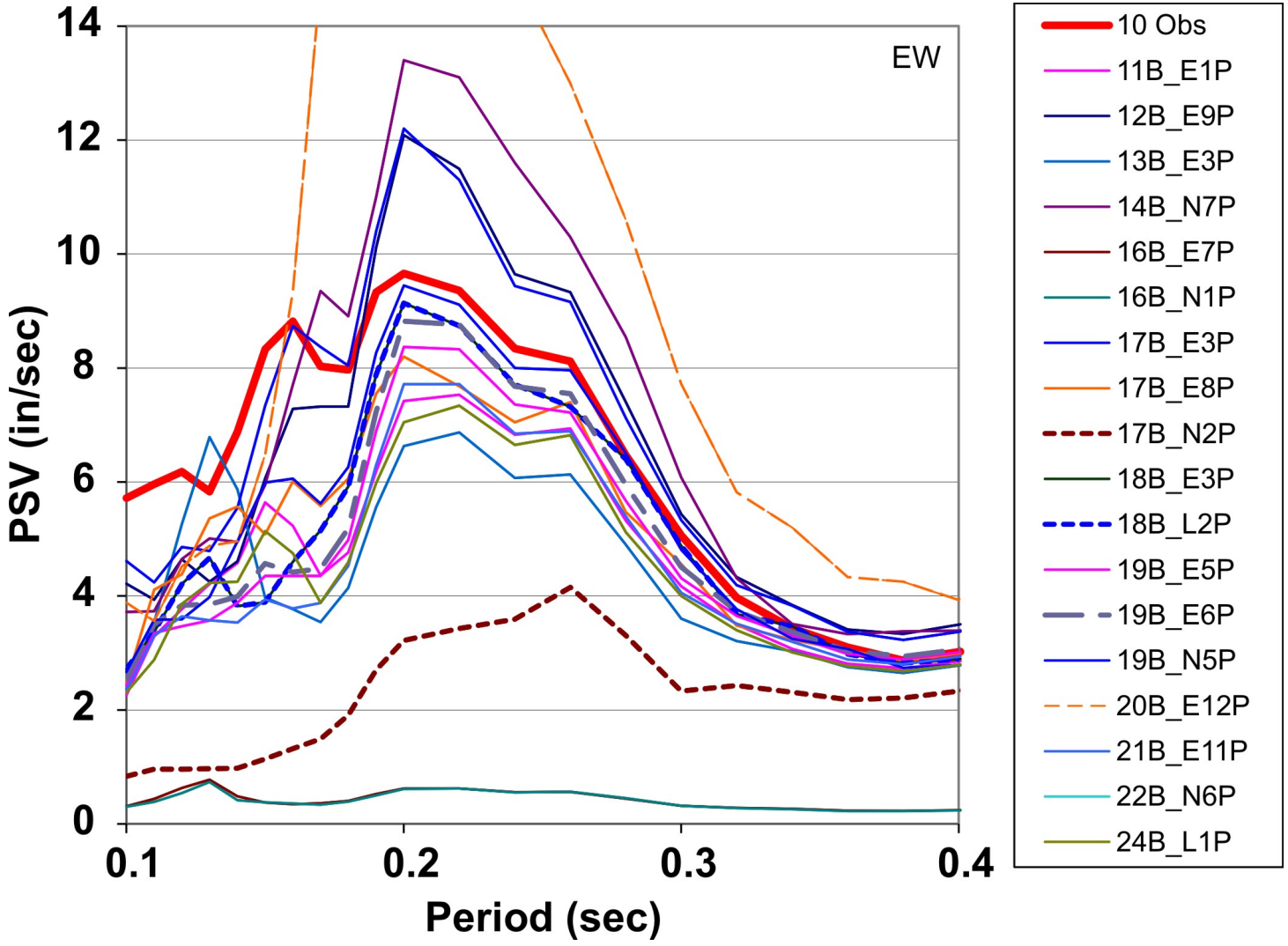


Kramer (2009)

Predicted NS Response Spectra at V1



Predicted EW Response Spectra at V1



Approach for Computing Long Period S_a

Use 3-D Numerical Models

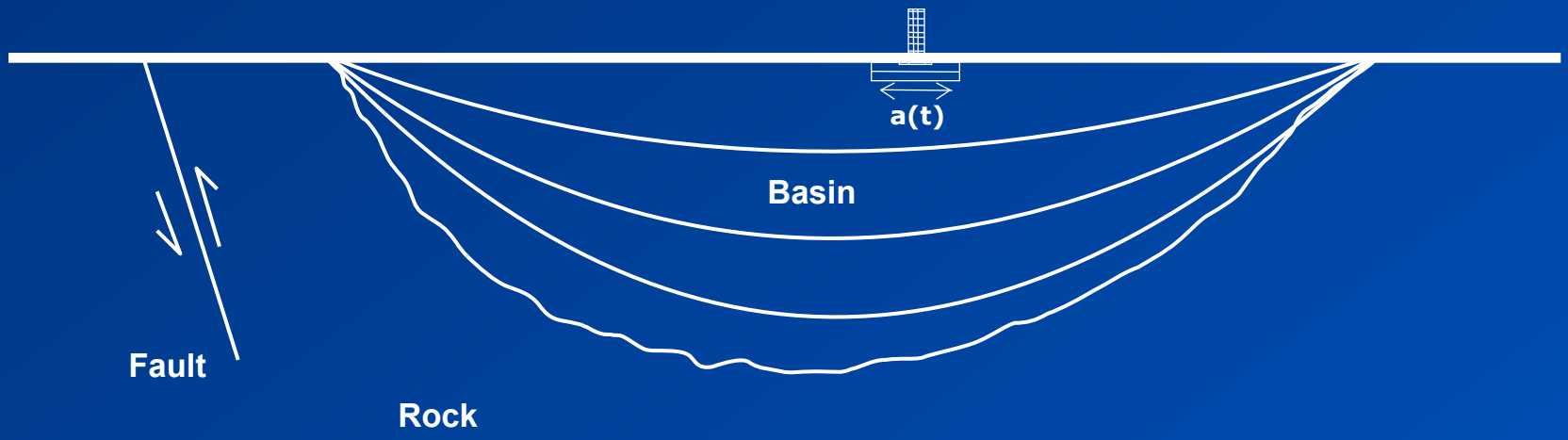
Application: Urban Areas

End Product

Long Period S_a Maps

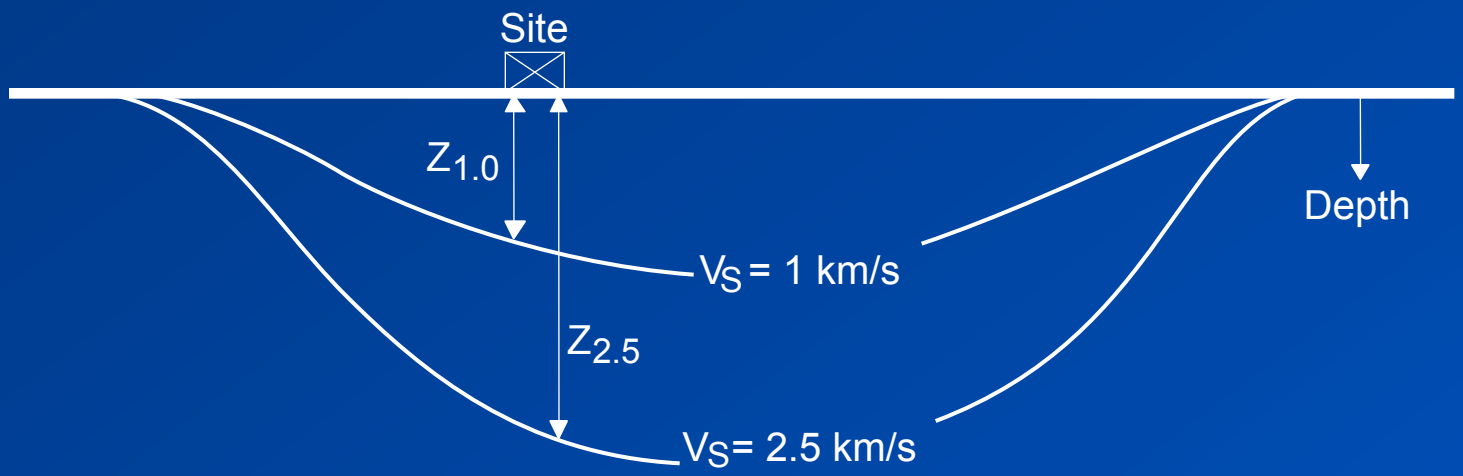
Next Generation Seismic Codes

Modeling Regional Effects on Long Period Motions



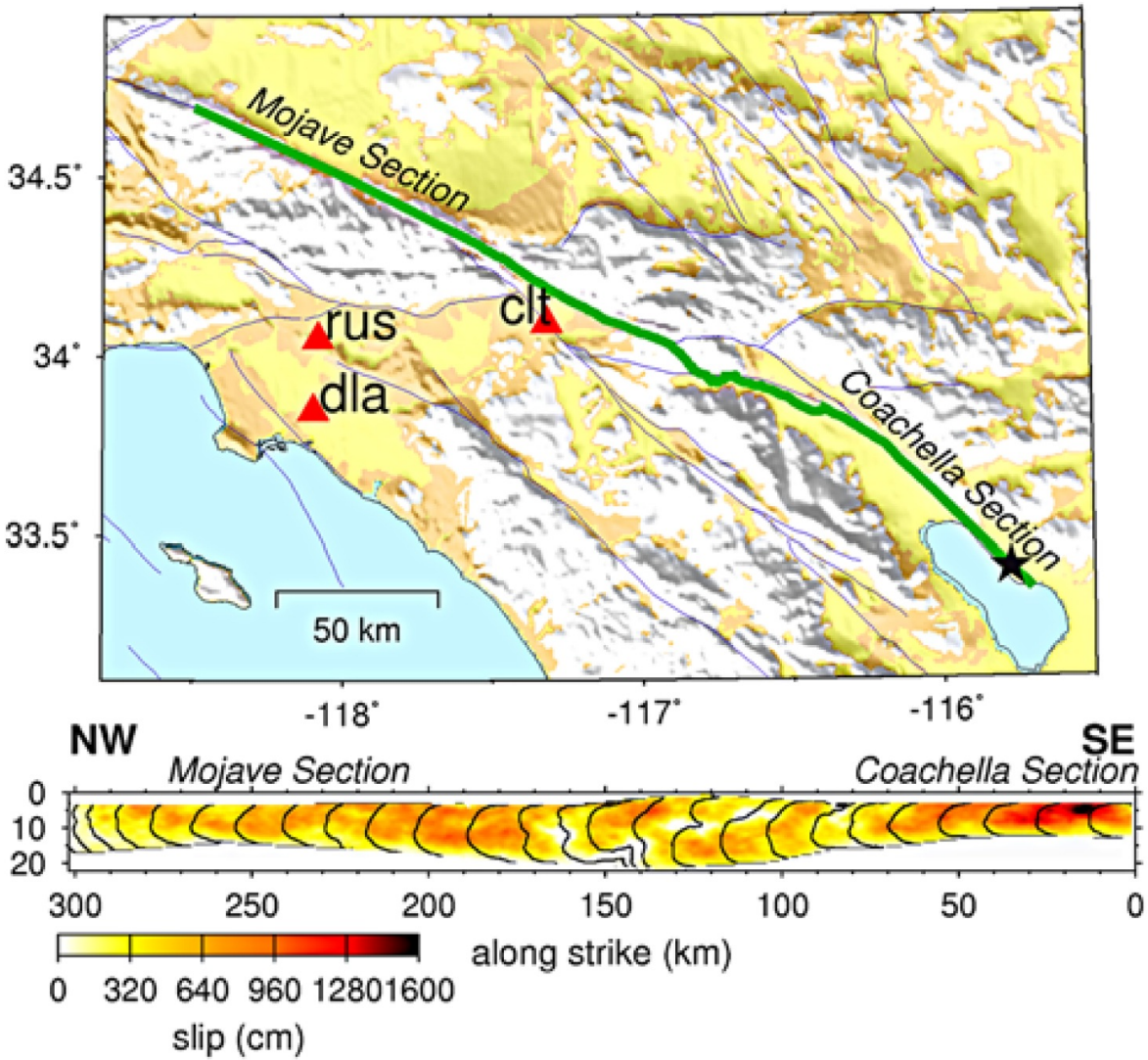
NGA Equations with Basin Depth Terms

- Abrahamson & Silva – Z1.0
- Campbell & Bozorgnia – Z2.5
- Chiou & Youngs – Z1.0



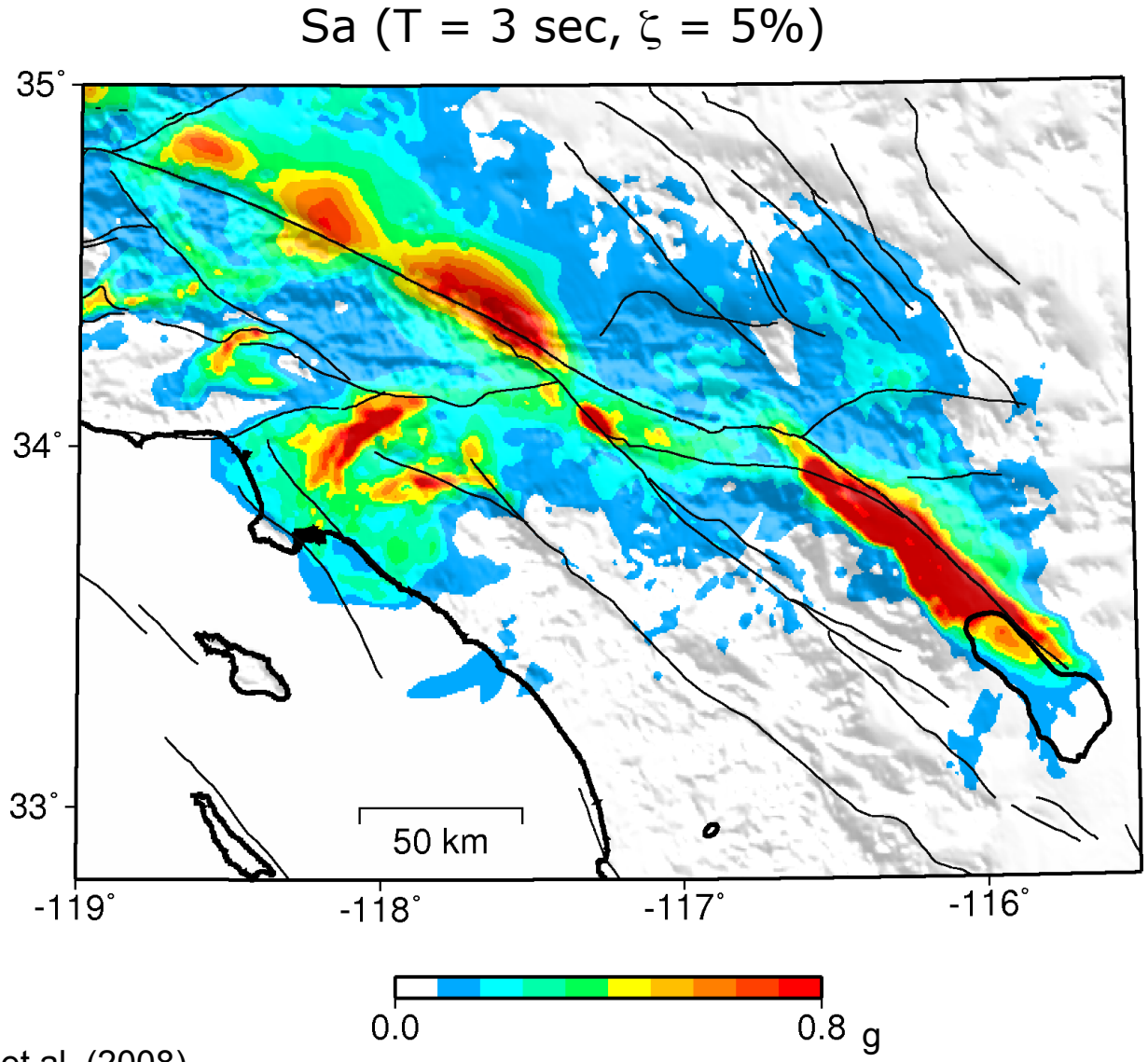
Basin Profile

M 7.8 San Andreas Earthquake Simulations



Graves et al. (2008)

M 7.8 San Andreas Earthquake Simulations



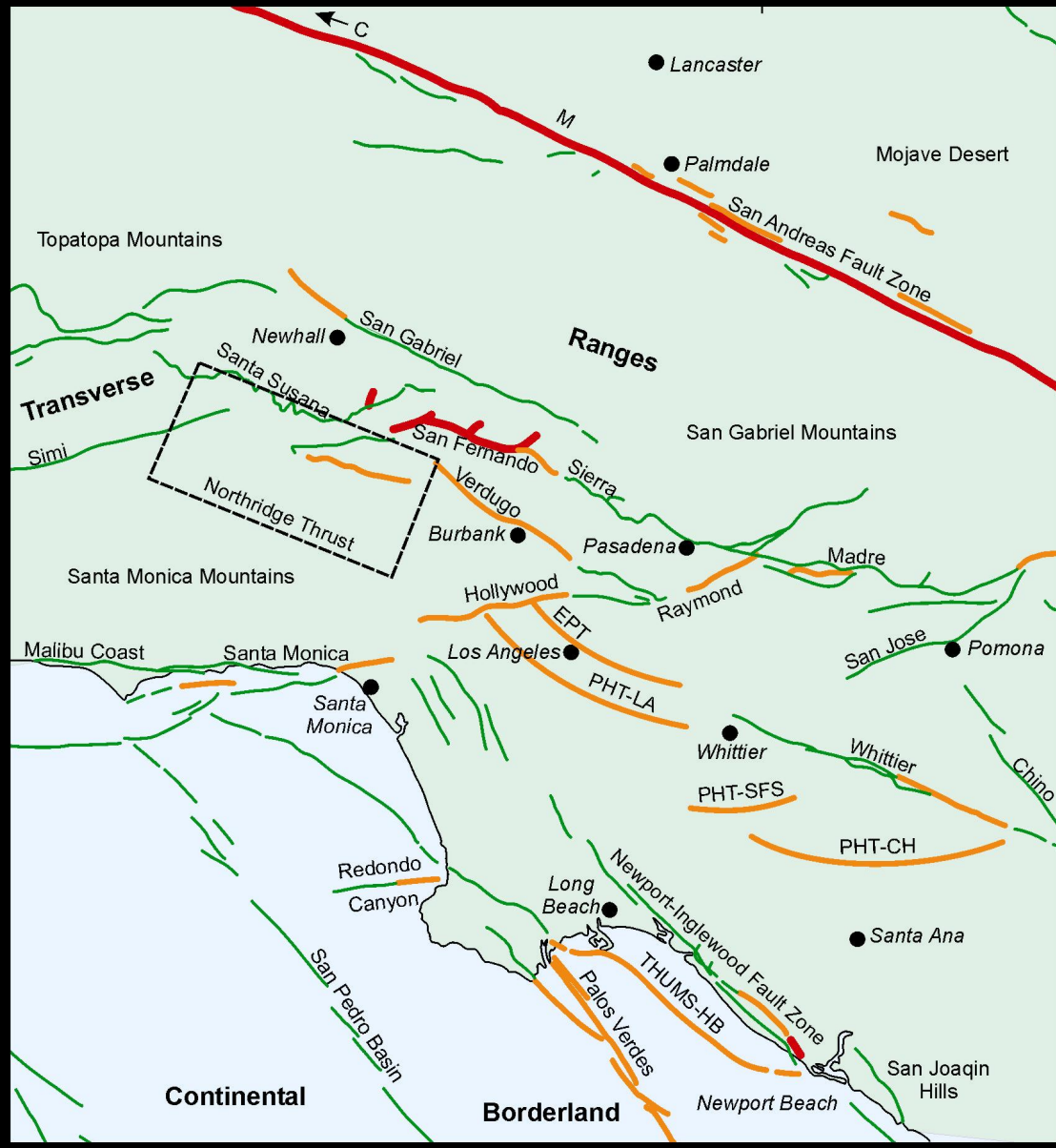
Graves et al. (2008)

Recommendation

- Conduct pilot study for L.A. Basin
- Objective - Generate Long-Period Ground-Motion Maps per PSHA/DSHA Procedures in Ch. 21, ASCE 7-10
- Substitute Simulations for GMPEs

Approach

1. Identify faults
2. Perform simulations
   - ↓
   - 3-comp. accelerograms
   - ↓
   - response spectra, $S_a(T)$
   - ↓
   - median $S_a(T)$
3. Select σ_{ln}
4. Proceed with PSHA/DSHA



PSHA for Fault i, Magnitude j

Simulated $S_a(T)$ ➡ $P_i\ (S_a > A\ I\ M_j)$

V_{ij} = Rate/yr of M_j on Fault i

$V_{ij} \cdot P_i\ (S_a \geq A\ I\ M_j)$

Rate/yr of $S_a \geq A$ for Fault i & M_j

Total Ground-Motion Hazard

$$\sum_{\text{all Mj}} V_{ij} \cdot P_i(S_a \geq A \mid M_j)$$

$$\sum_{\text{all faults}} \sum_{\text{all Mj}} V_{ij} \cdot P_i(S_a \geq A \mid M_j)$$

Total Rate/yr of $S_a \geq A$

L.A. Pilot Study End Poducts

Contour Maps of $S_a(T)$

for

Selected T in ~3 ≤ T ≤ 10 sec range

Comparison of Maps

Simulation-Based Maps

vs

Empirical-Based Maps
using NGA eqns

Direction for Developing
Long Period S_a Maps
in
ASCE-7