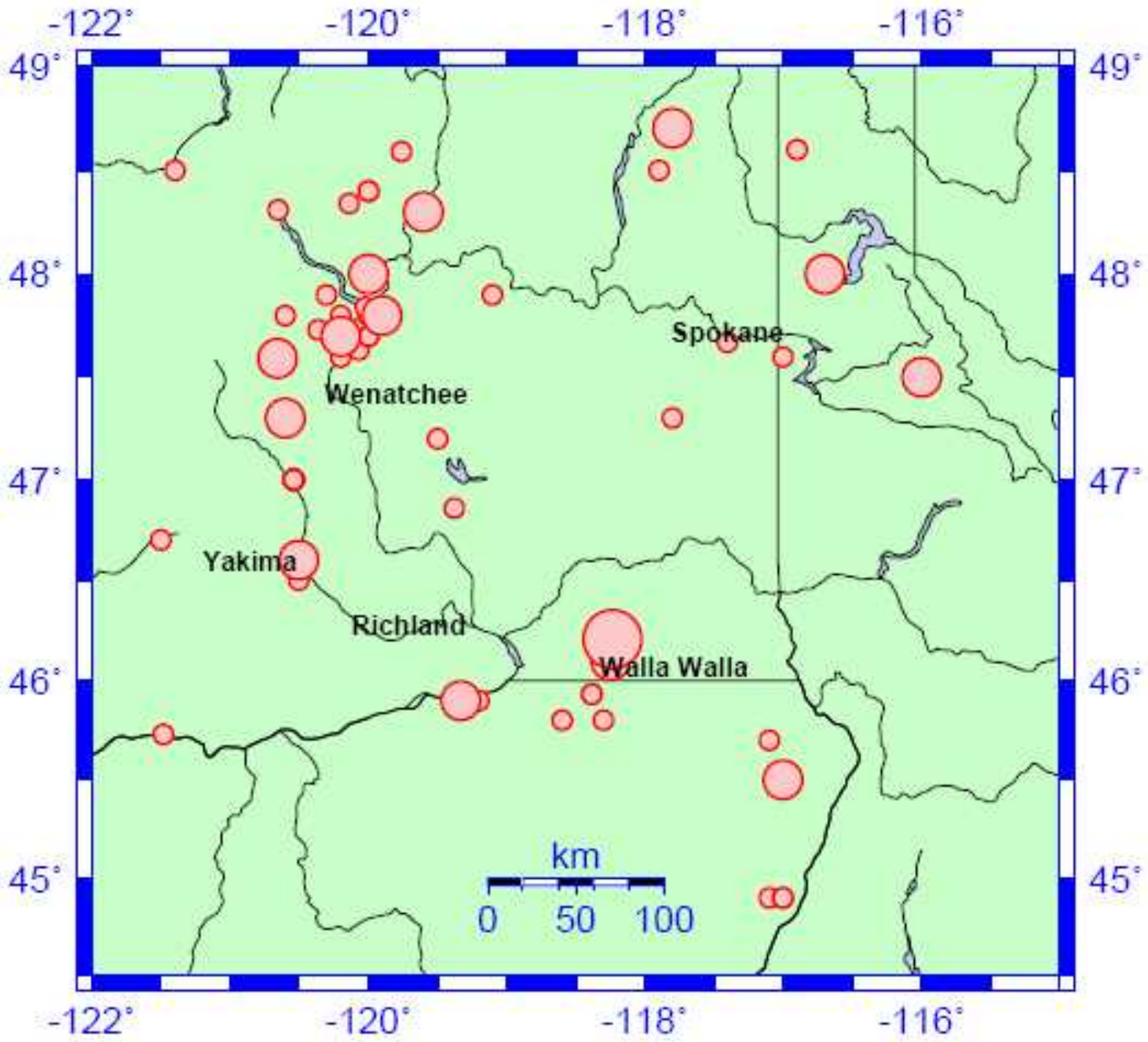
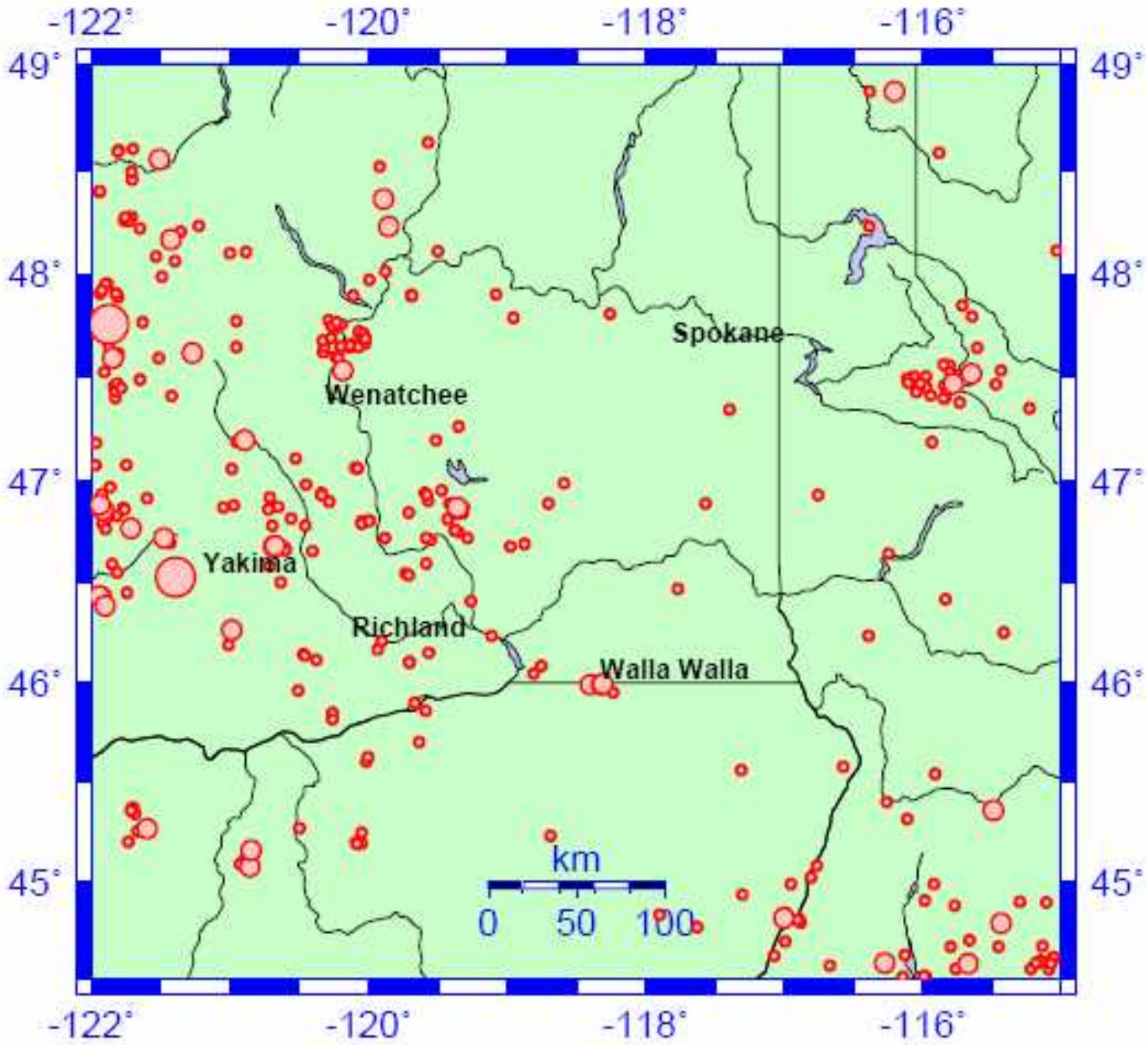

-122°
-120°
-118°
-116°
49°
48°
47°
46°
45°
Spokane
Wenatchee
Yakima
Richland
Walla Walla
km
0
50
100


-122°
-120°
-118°
-116°
49°
48°
47°
46°
45°
Spokane
Wenatchee
Yakima
Richland
Walla Walla
km
0
50
100

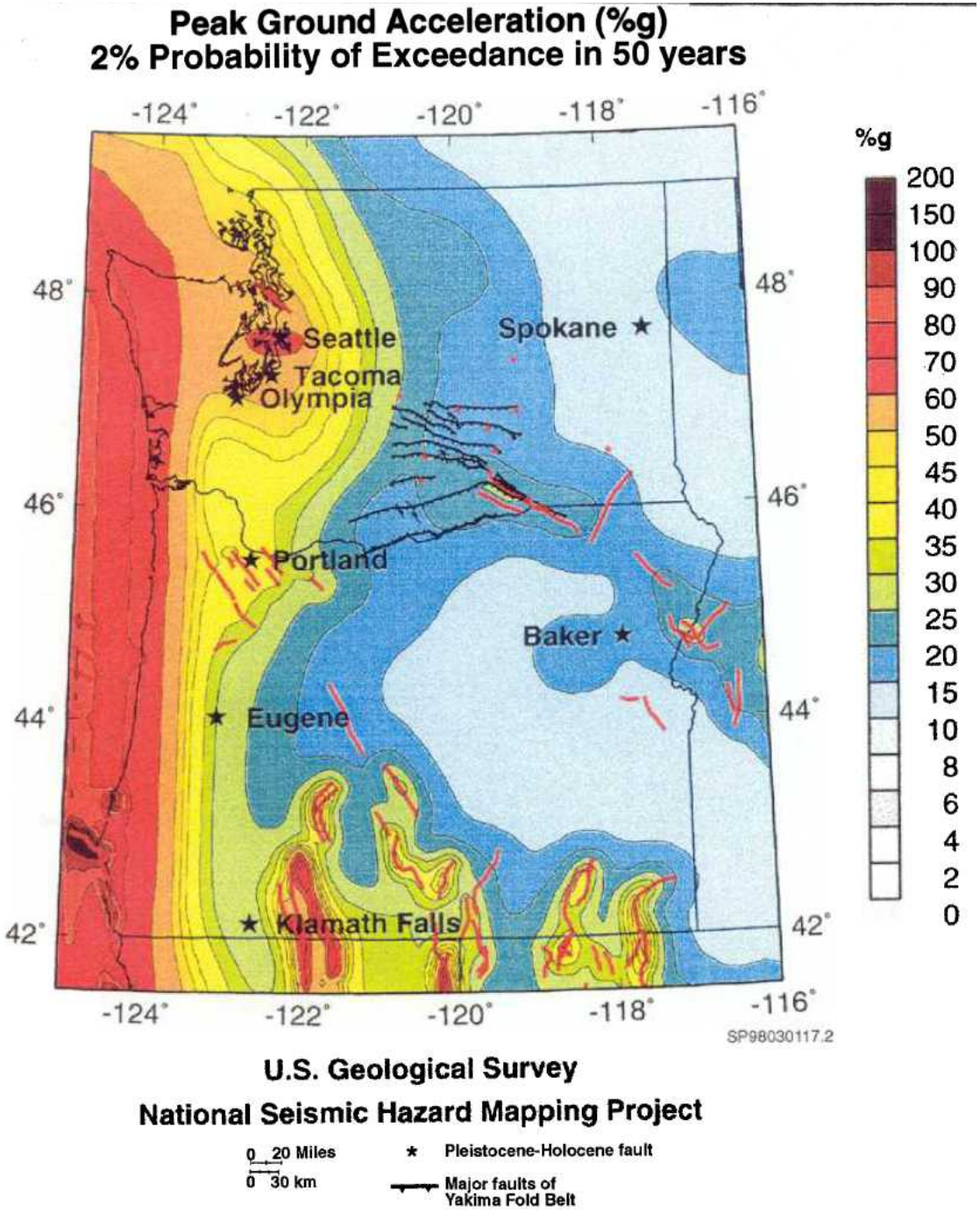


Figure 1. Faults of the Yakima Fold Belt Superimposed on USGS Hazard Map.

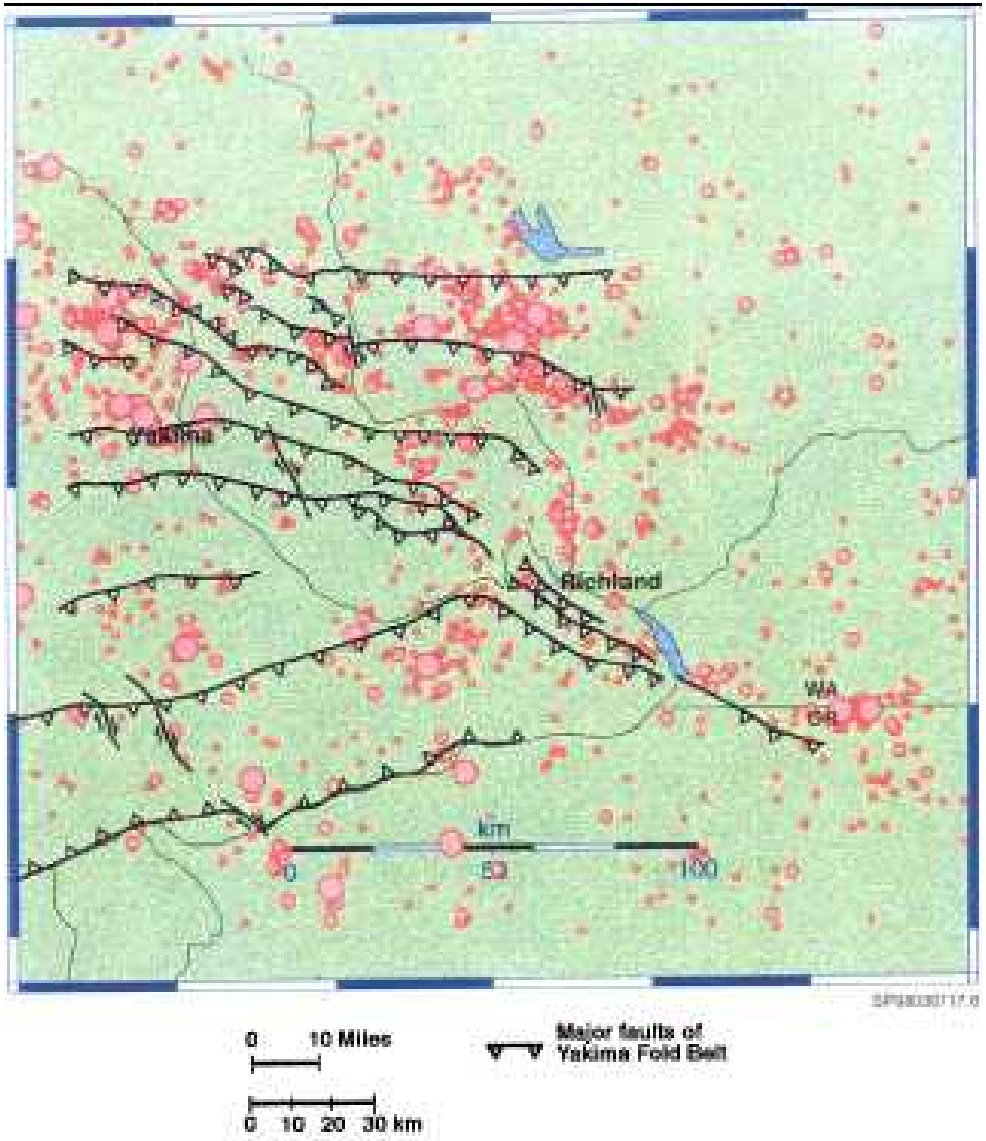
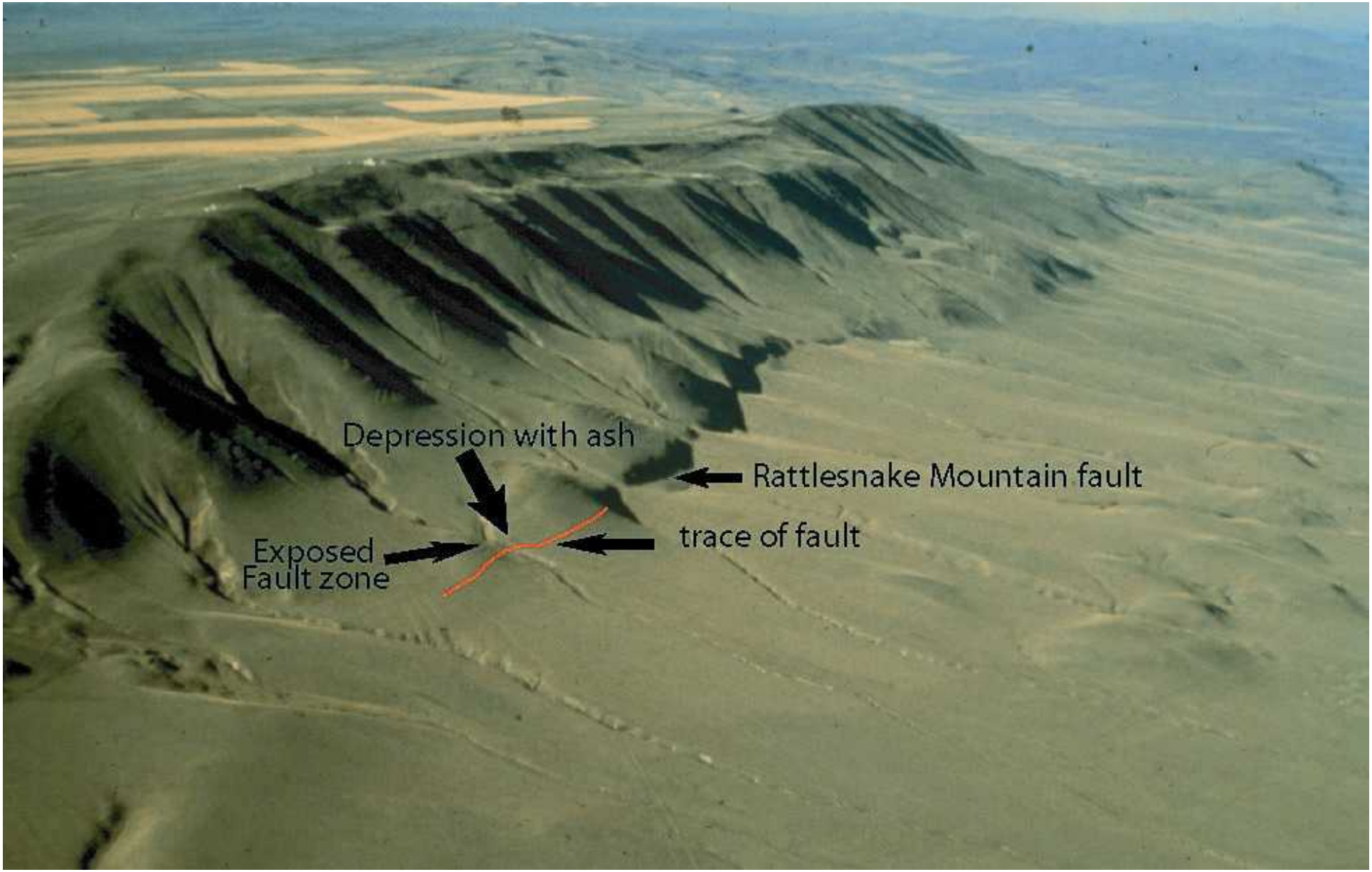
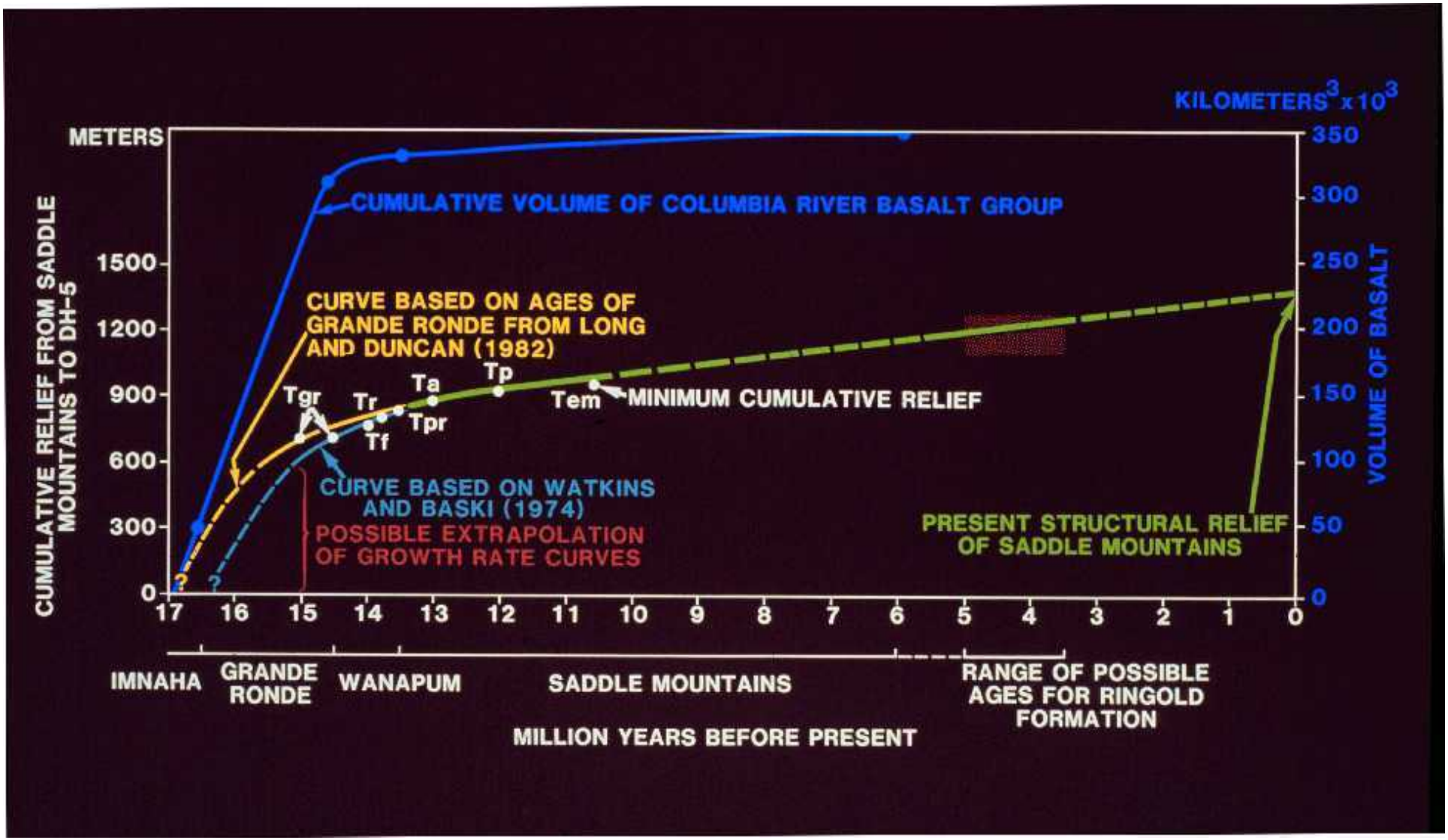
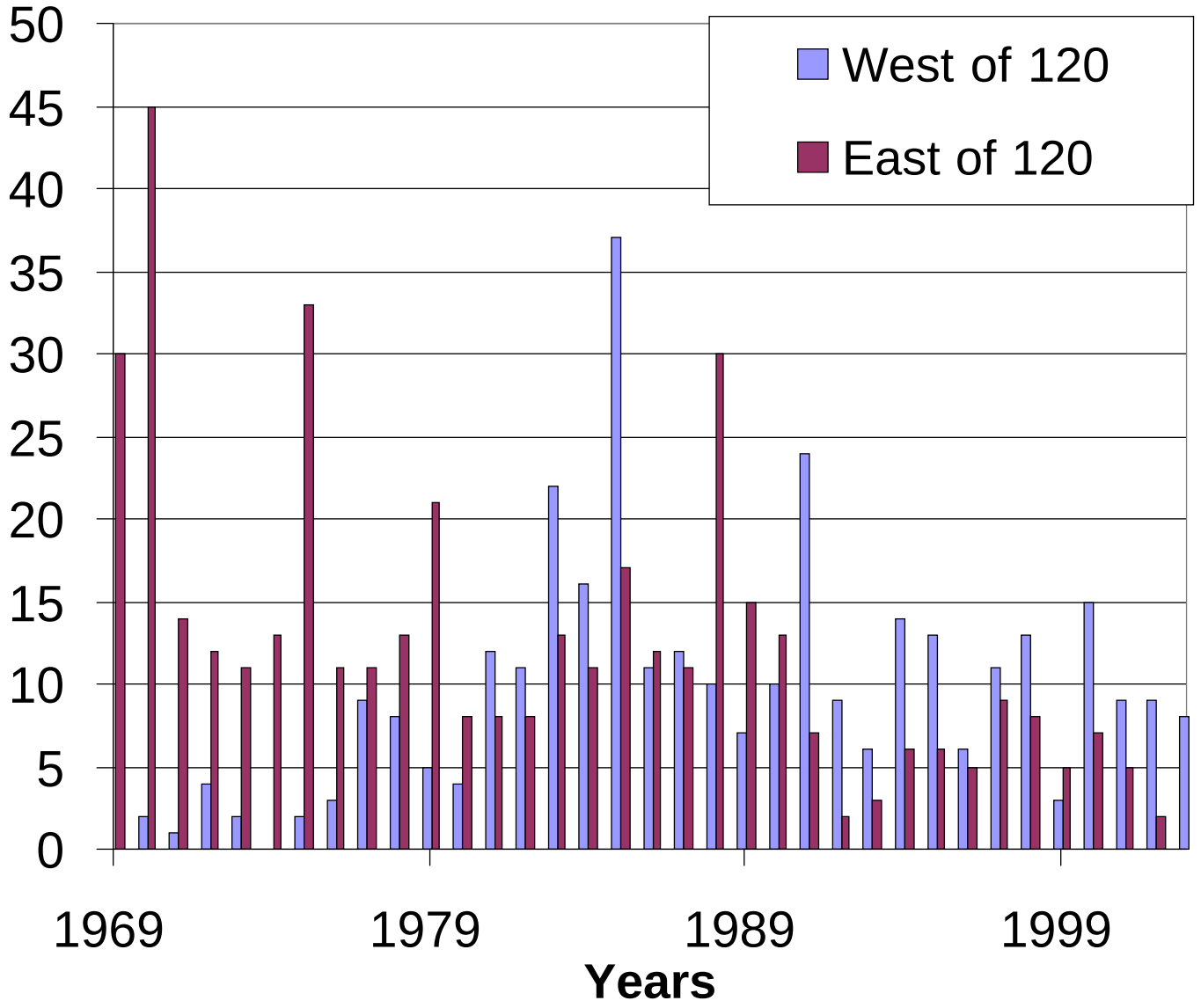


Figure 2. Faults in the Yakima Fold Belt and 1970-1998 Earthquake Locations.

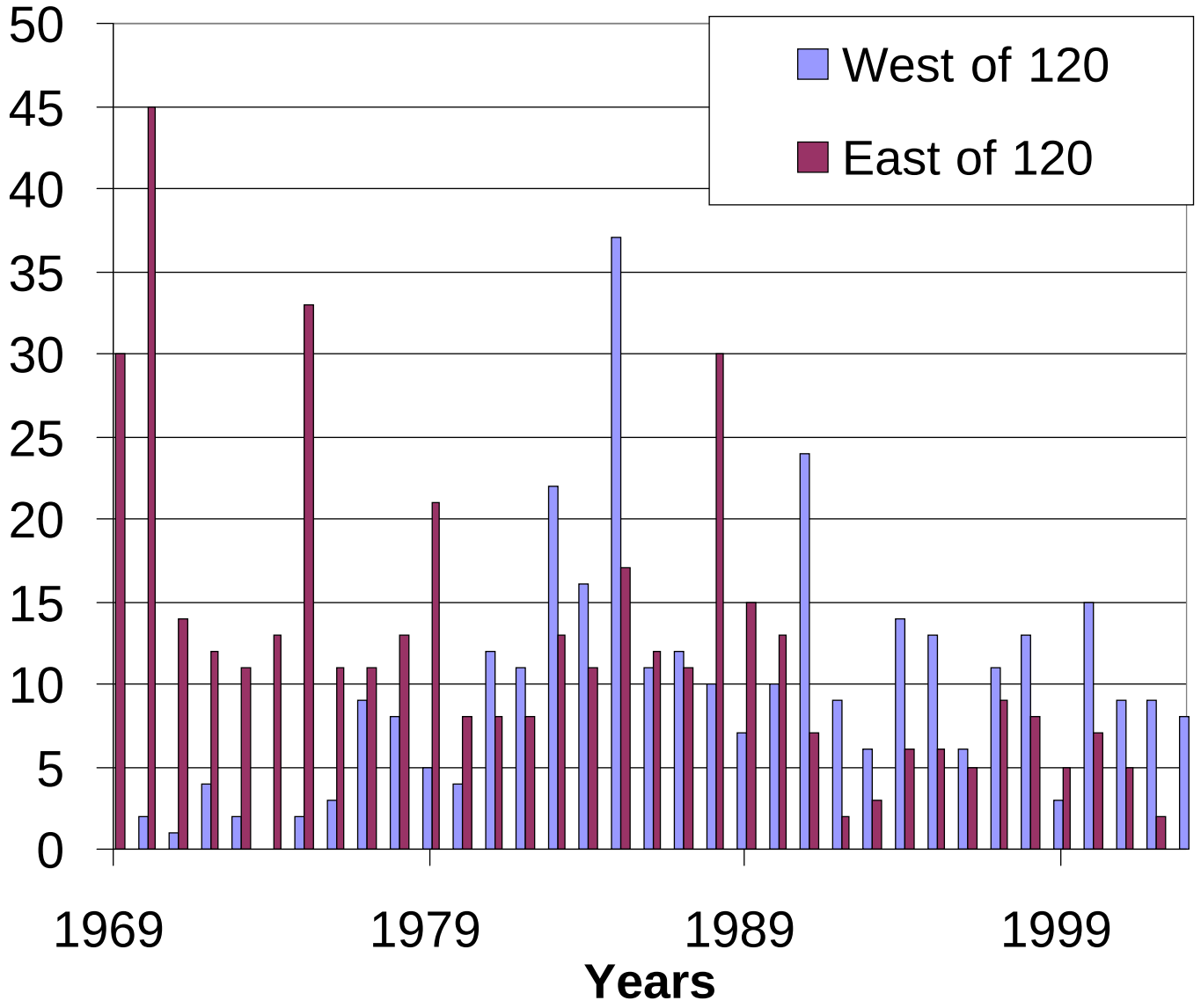

Depression with ash
Rattlesnake Mountain fault
trace of fault
Exposed
Fault zone


KILOMETERS^3 x 10^3
METERS
CUMULATIVE RELIEF FROM SADDLE MOUNTAINS TO DH-5
VOLUME OF BASALT
CUMULATIVE VOLUME OF COLUMBIA RIVER BASALT GROUP
CURVE BASED ON AGES OF GRANDE RONDE FROM LONG AND DUNCAN (1982)
Tgr
Tr
Ta
Tp
Tpr
Tf
Tem
MINIMUM CUMULATIVE RELIEF
CURVE BASED ON WATKINS AND BASKI (1974)
POSSIBLE EXTRAPOLATION OF GROWTH RATE CURVES
PRESENT STRUCTURAL RELIEF OF SADDLE MOUNTAINS
1500
1200
900
600
300
0
350
300
250
200
150
100
50
0
17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
IMNAHA
GRANDE RONDE
WANAPUM
SADDLE MOUNTAINS
RANGE OF POSSIBLE AGES FOR RINGOLD FORMATION
MILLION YEARS BEFORE PRESENT

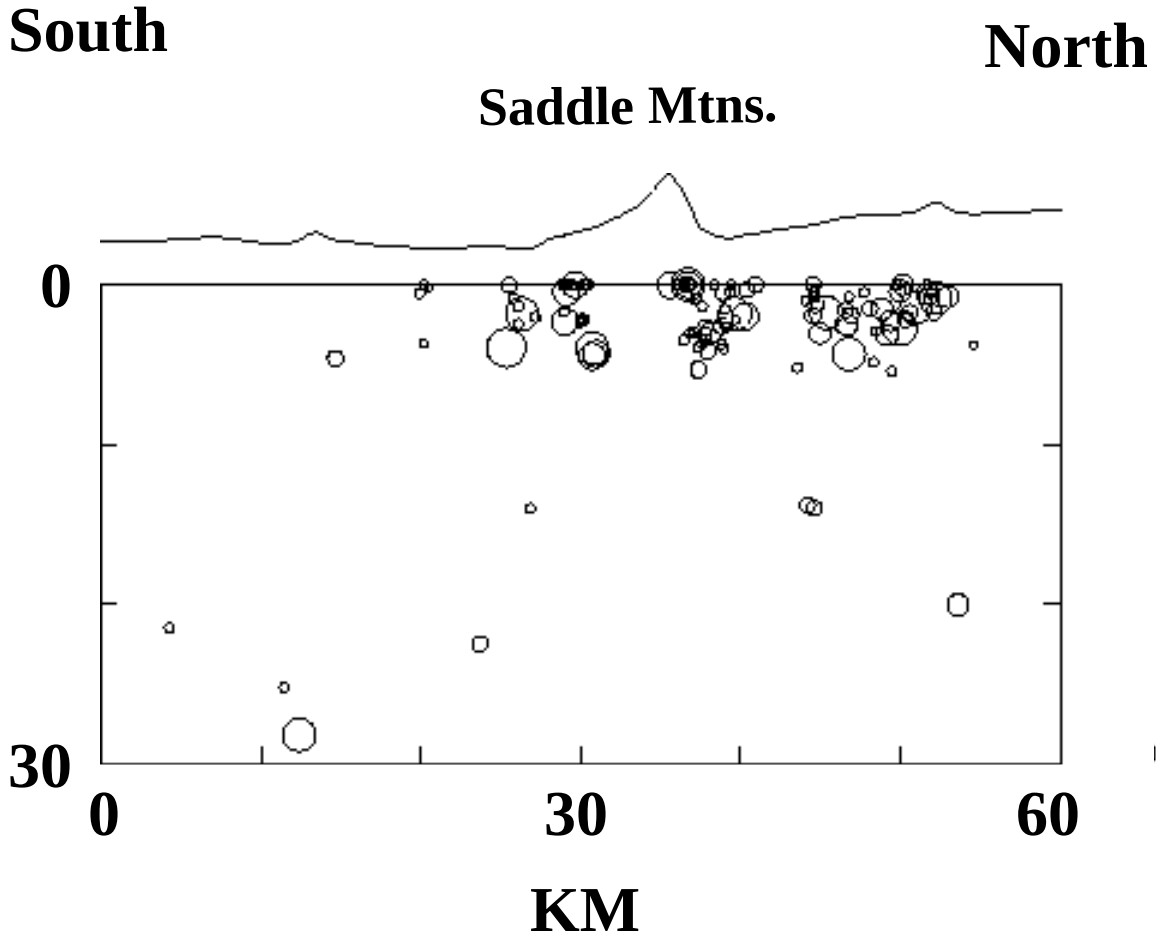
Annual Number of Events M > 2



Annual Number of Events M > 2



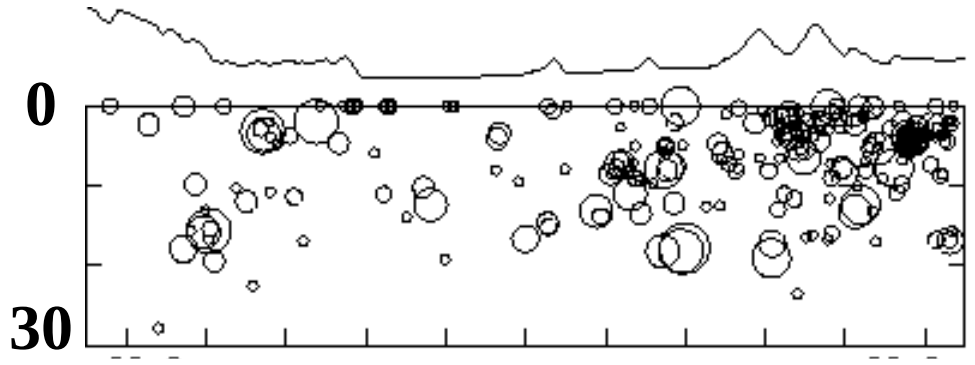
Shallow Swarm Earthquakes near Saddle Mountains



Earthquake Depth Distribution

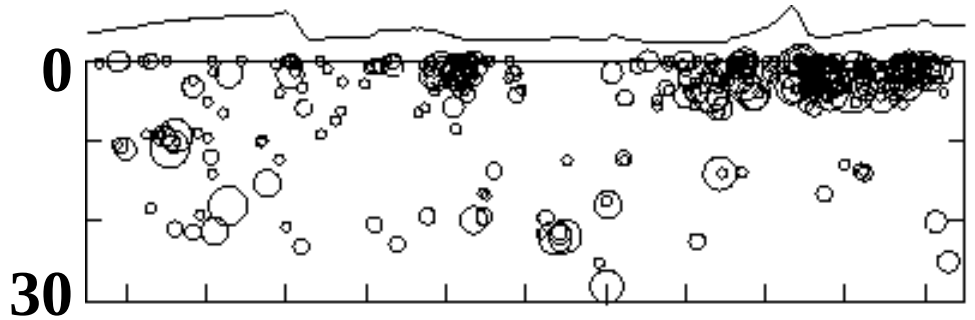
South **North**

120^0 - 121^0



46^0N **47^0N**

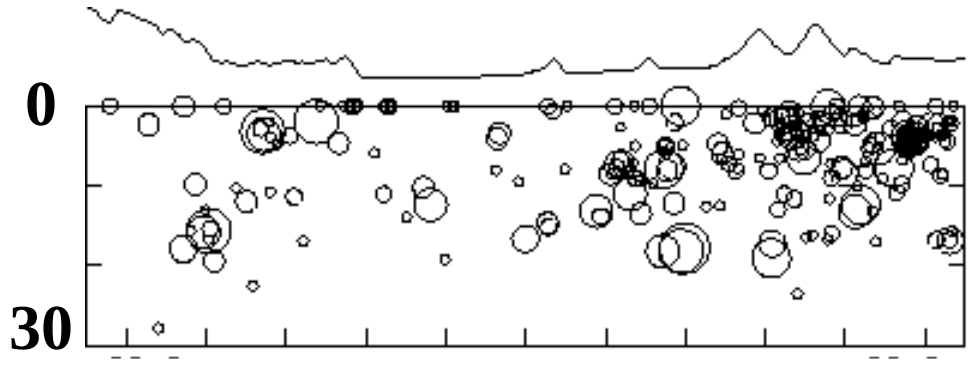
119^0 – 120^0



Earthquake Depth Distribution

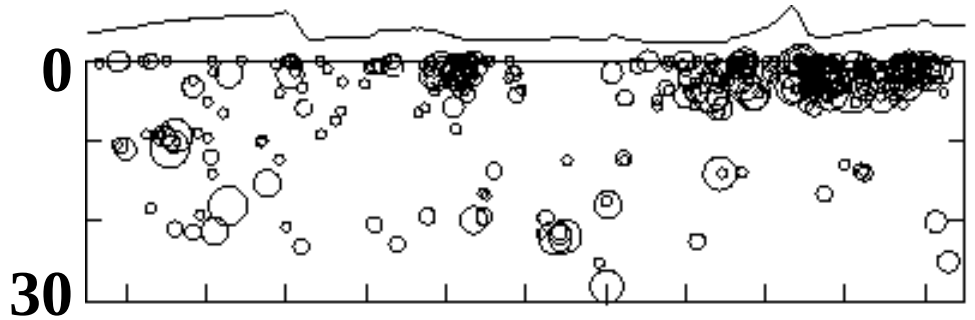
South **North**

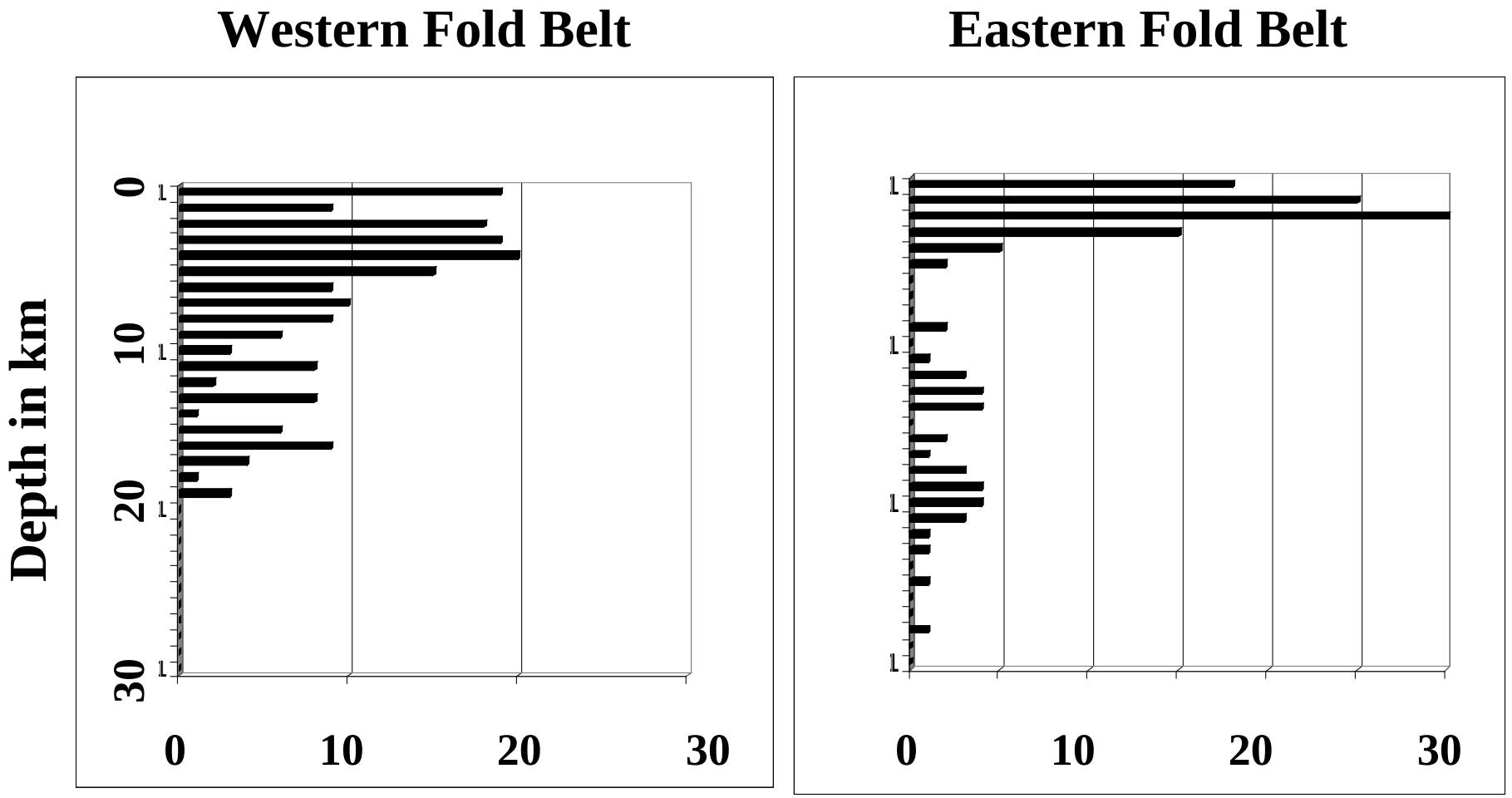
120^0 - 121^0



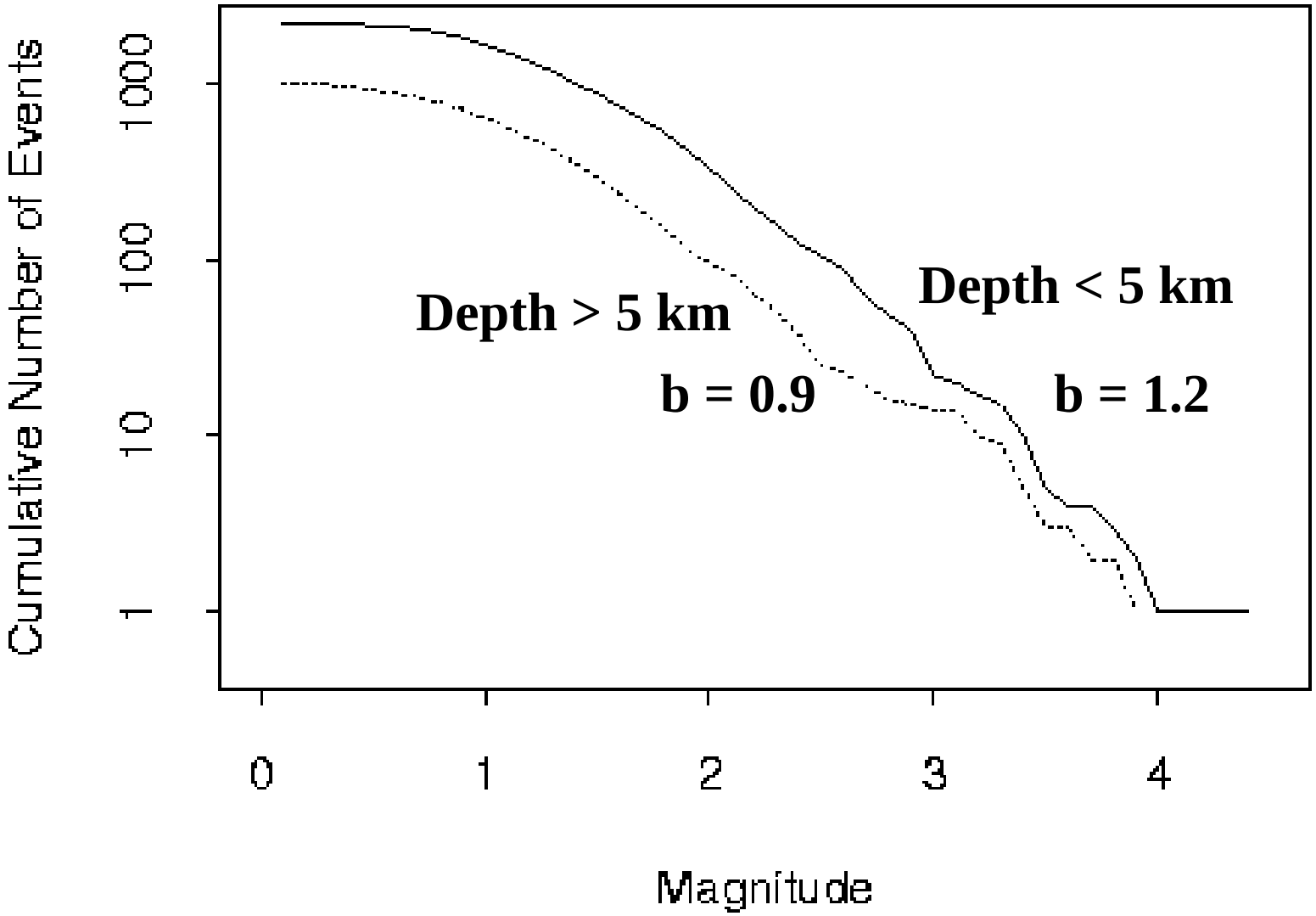
46^0N **47^0N**

119^0 – 120^0

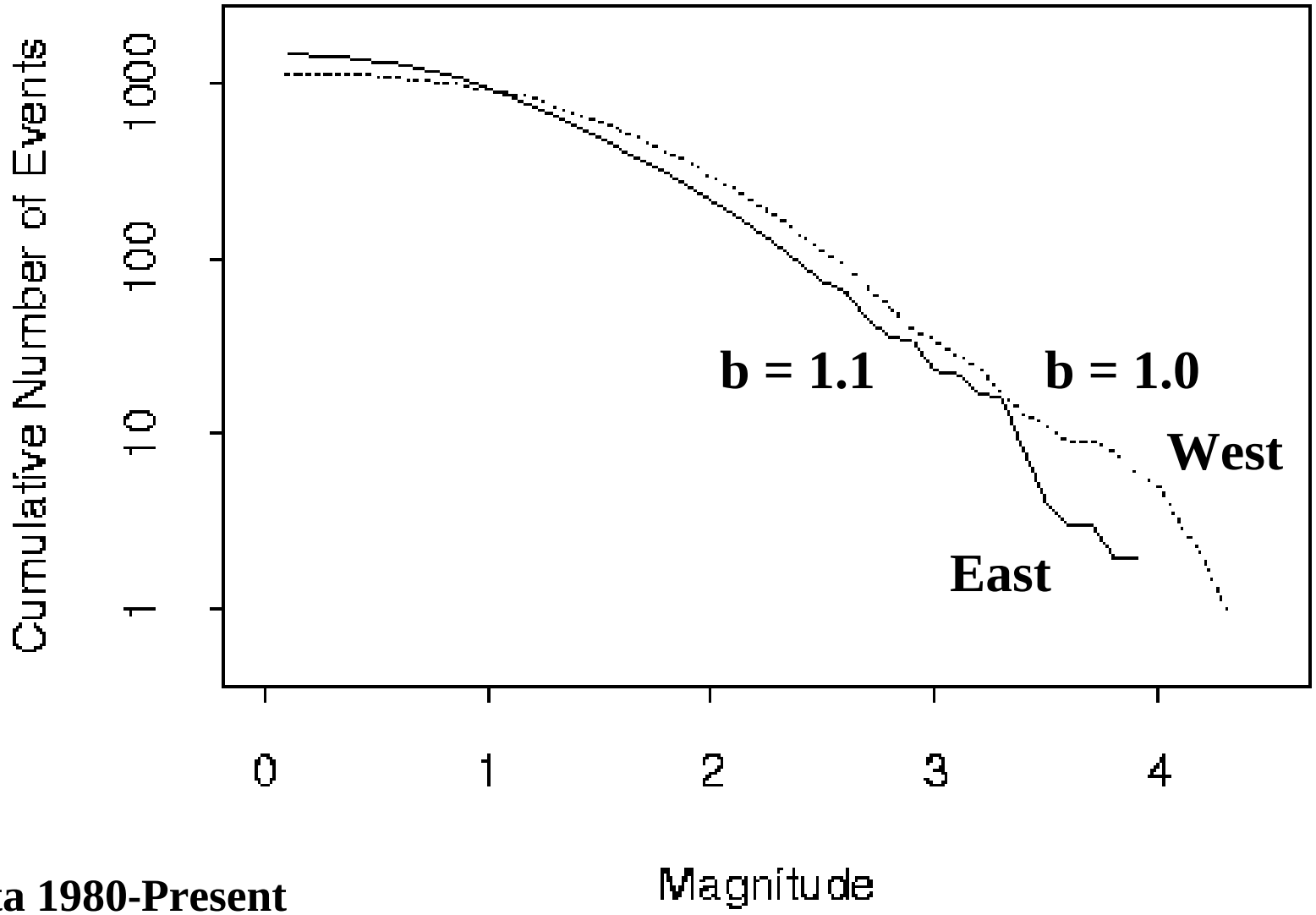



Western Fold Belt
Eastern Fold Belt
Depth in km
0
10
20
30
0
10
20
30
0
10
20
30
Number of Earthquakes per km

Earthquake Recurrence Shallow versus Deep

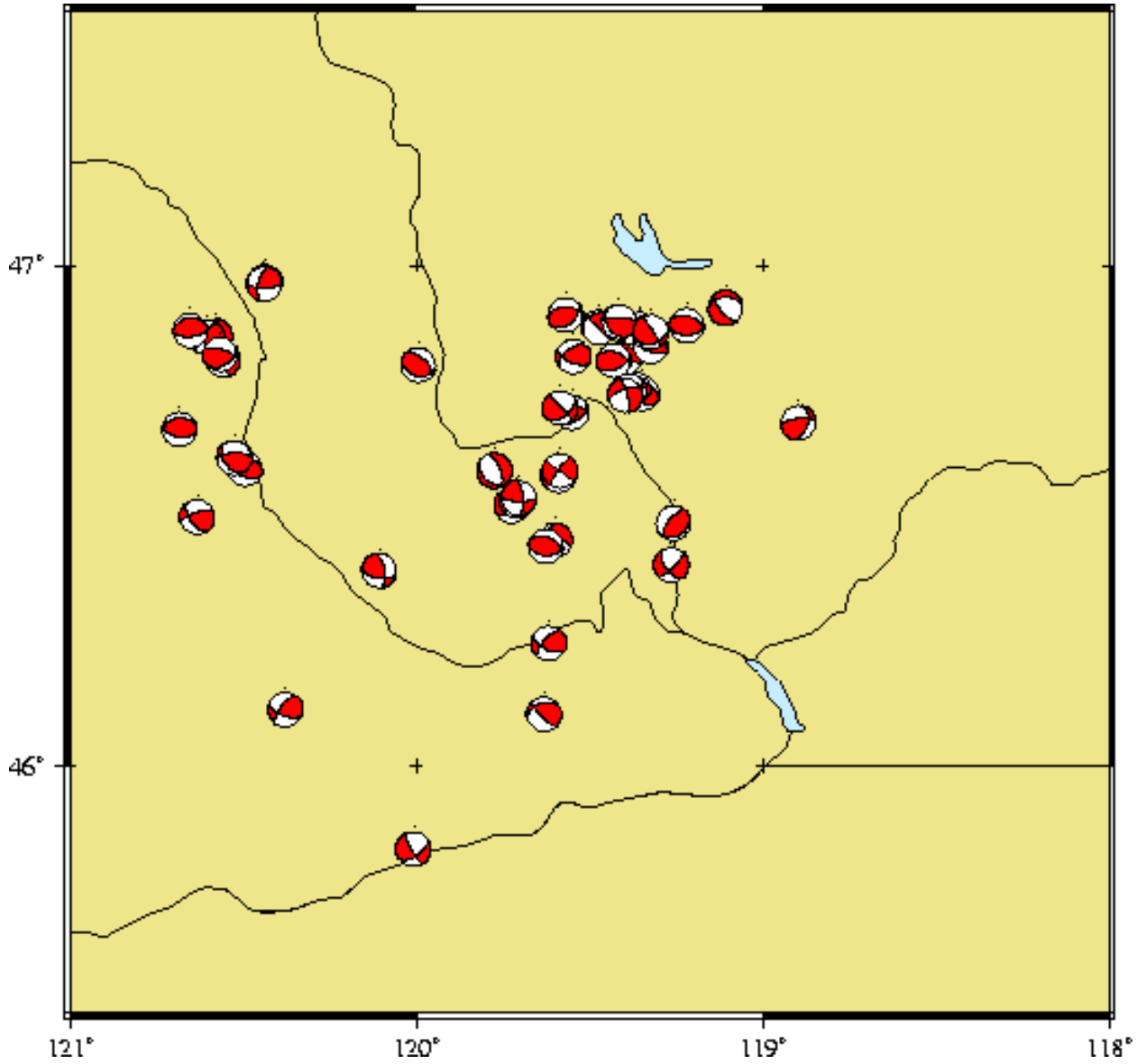


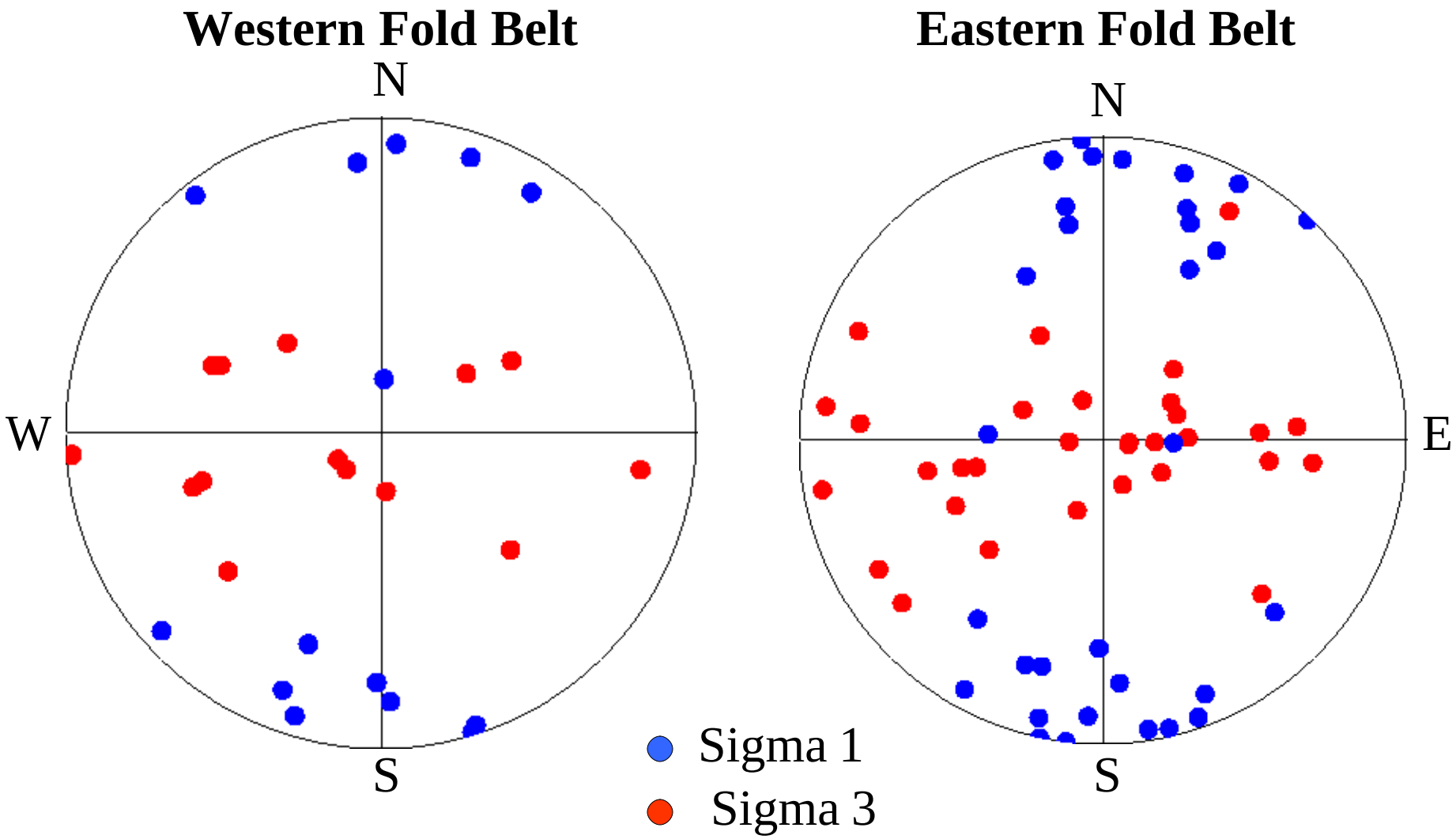
Earthquake Recurrence West versus East

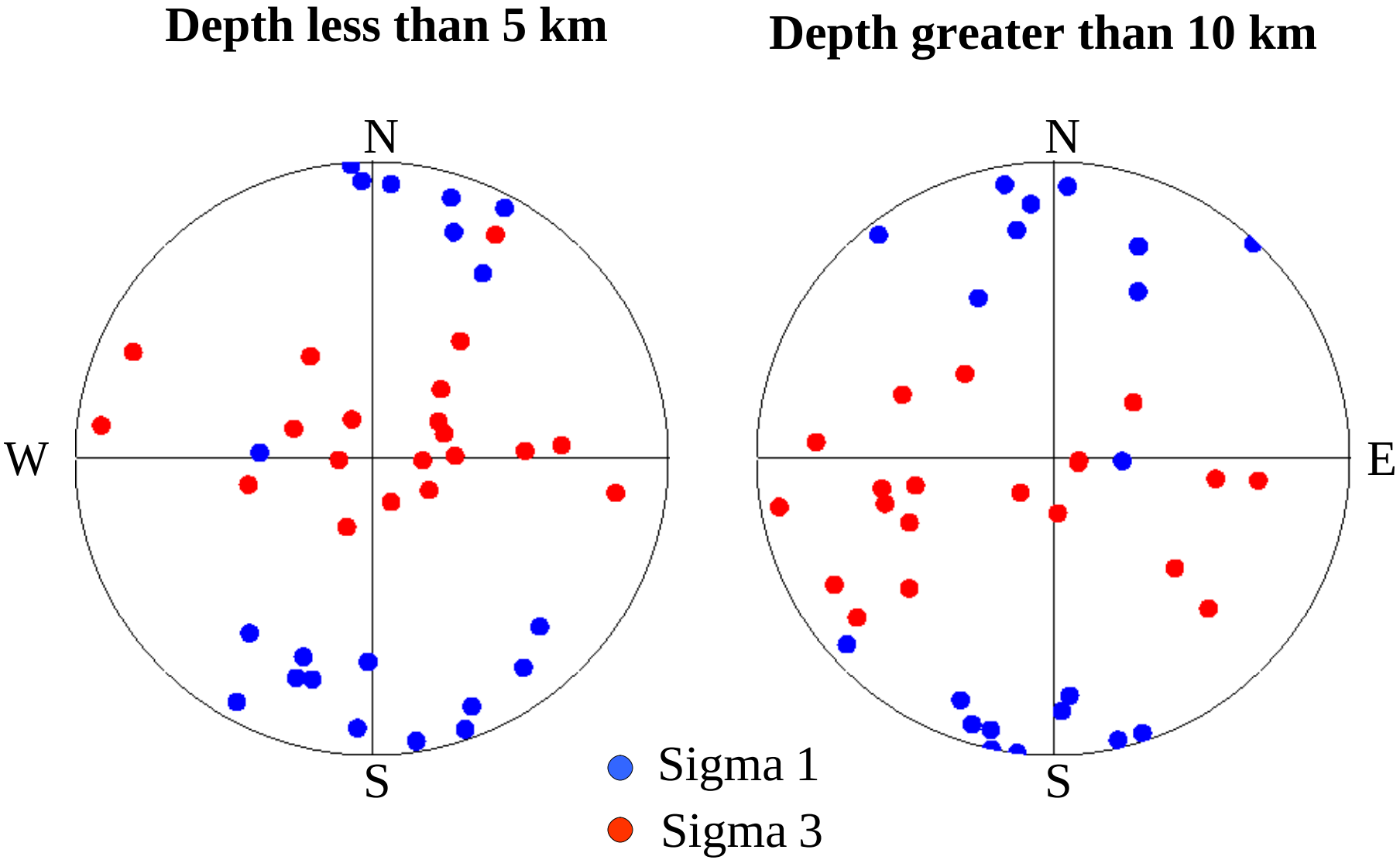


Data 1980-Present

Earthquake Focal Mechanisms in the Yakima Fold Belt




Western Fold Belt
N
W
S
Eastern Fold Belt
N
E
S
Sigma 1
Sigma 3


Depth less than 5 km
Depth greater than 10 km
N
W
S
N
E
S
Sigma 1
Sigma 3

Site-Specific Seismic Site Response Model for the Waste Treatment Plant, Hanford, Washington

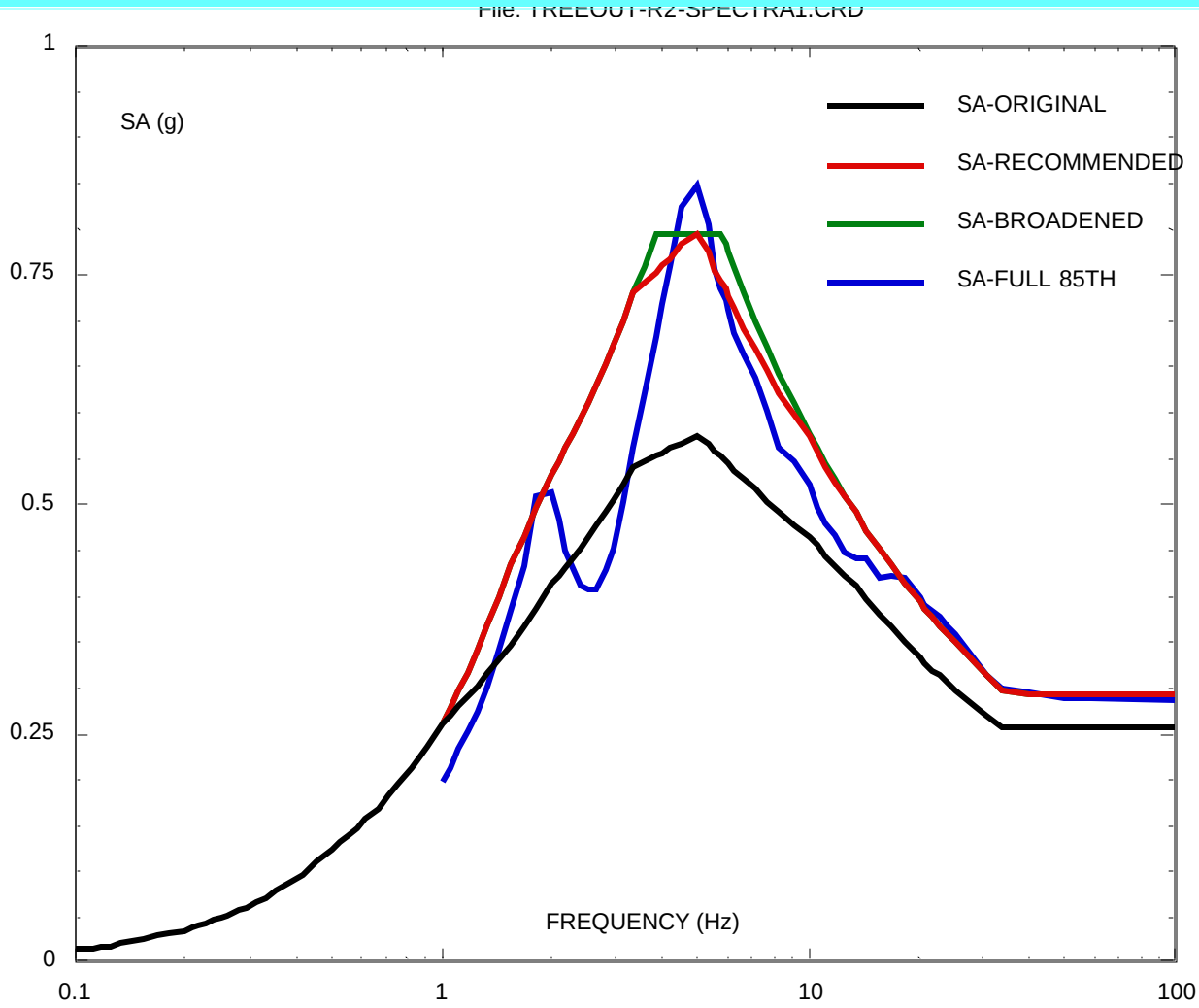
Ground Motion Team
PNNL: Alan Rohay, Steve Reidel
Bechtel: Richard Lee, Jim Cameron, Farhang Ostadan
Geomatrix: Bob Youngs
Pacific Engineering: Walt Silva
DOE/ORP: Lew Miller, Carl Costantino (consultant)

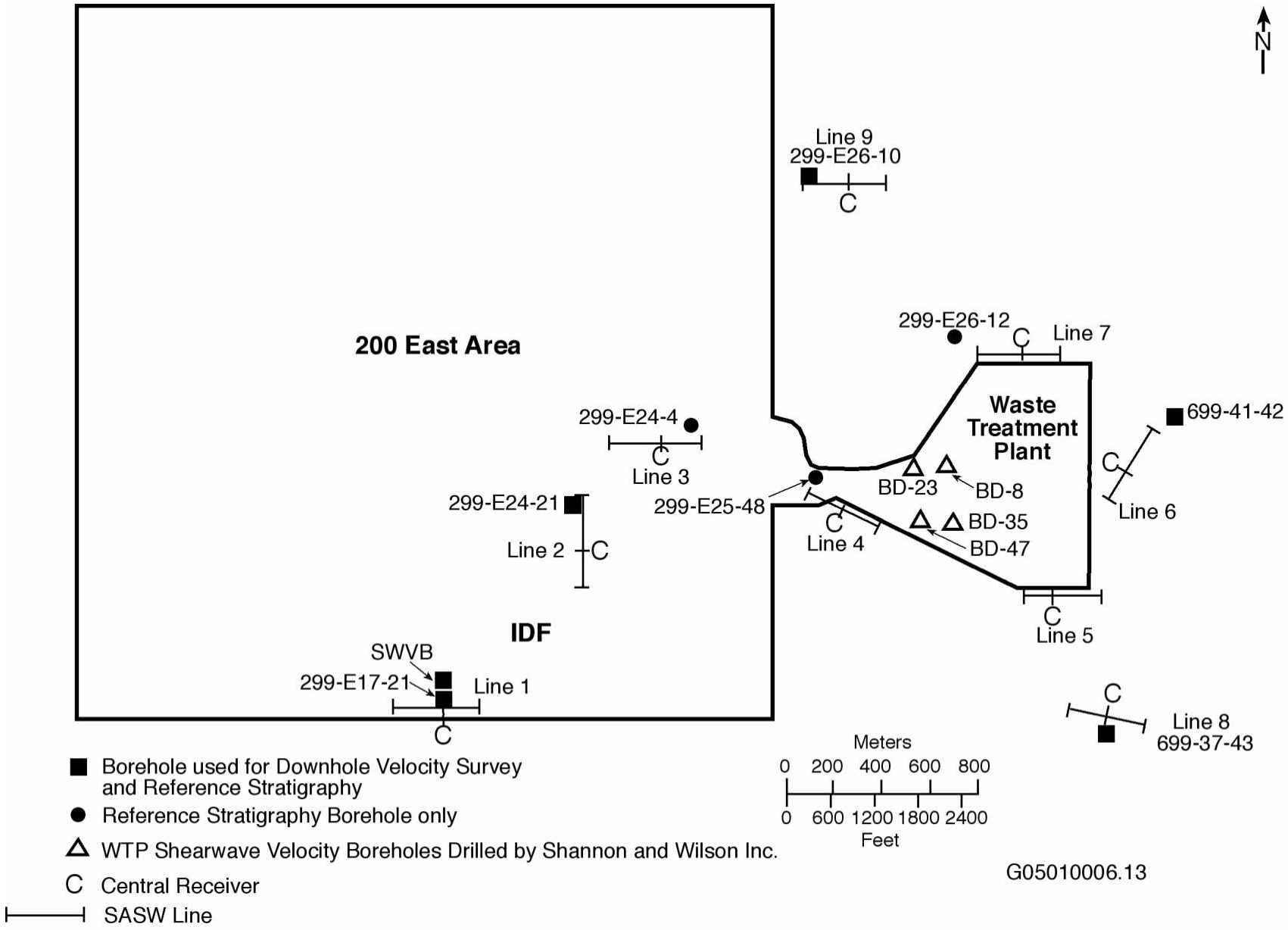
Subcontractors:
Northland Geophysics and Redpath Geophysical
GeoVision
University of Texas (Austin)
Fluor Daniel

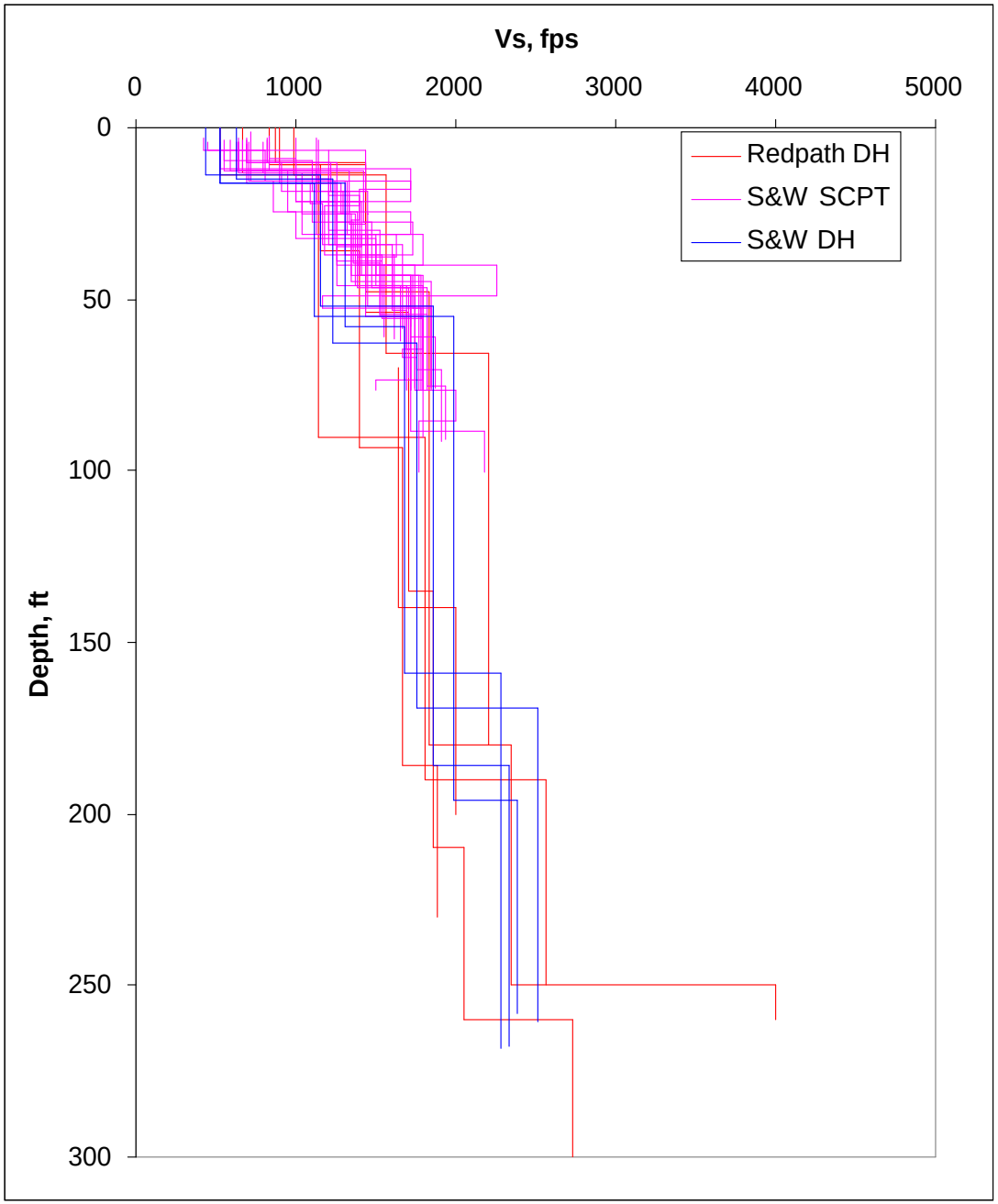
Approach for Ground Motion Assessment

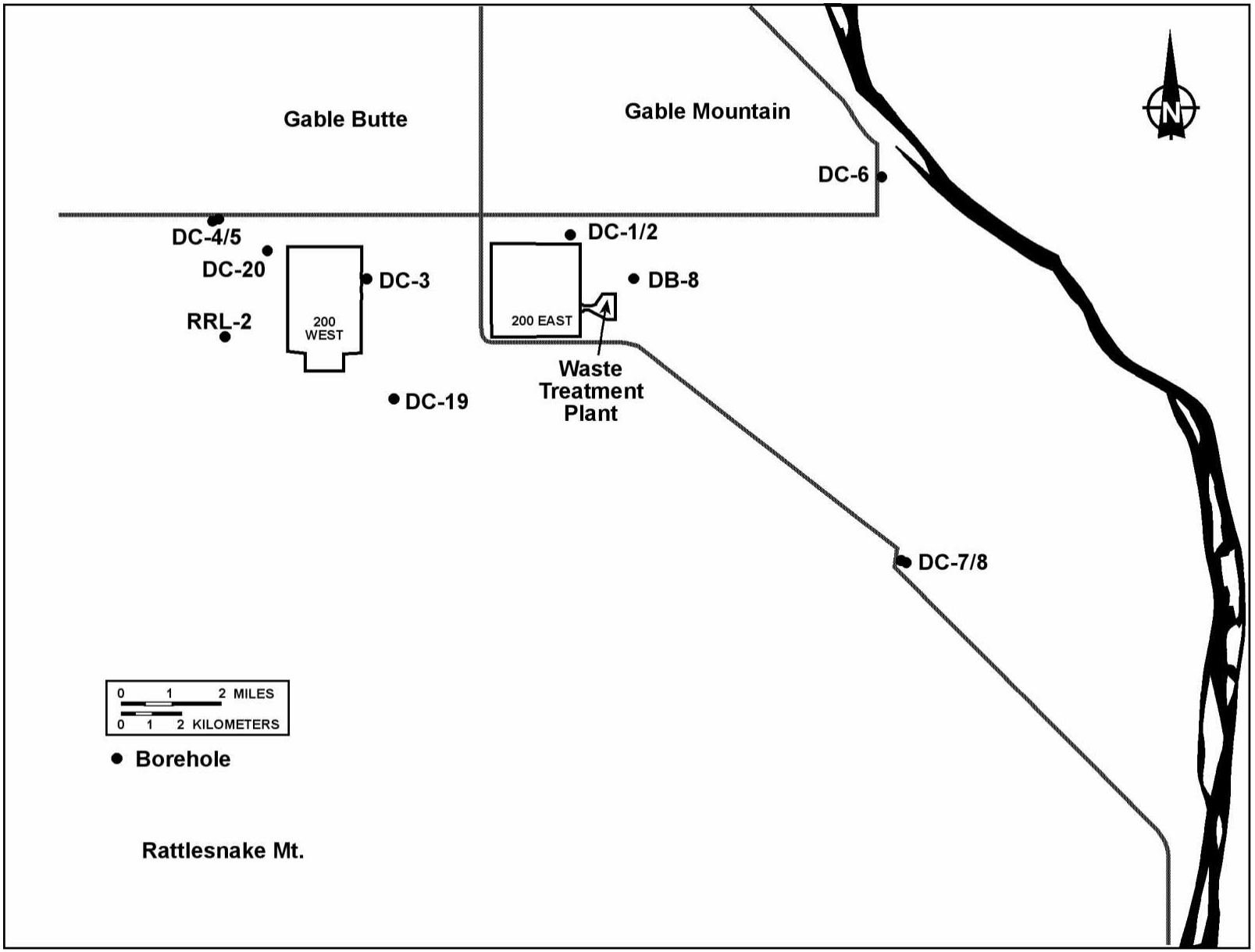
- 1996 PSHA based on empirical ground motion models for soil sites in California
- Evaluate the need for modification using relative site amplification studies
  - Compute response of soil profiles typical of California strong motion recording sites
  - Compute response of WTP site
  - Compare surface response spectra to assess need for adjustment of design spectra

Revision of WTP Design Spectrum



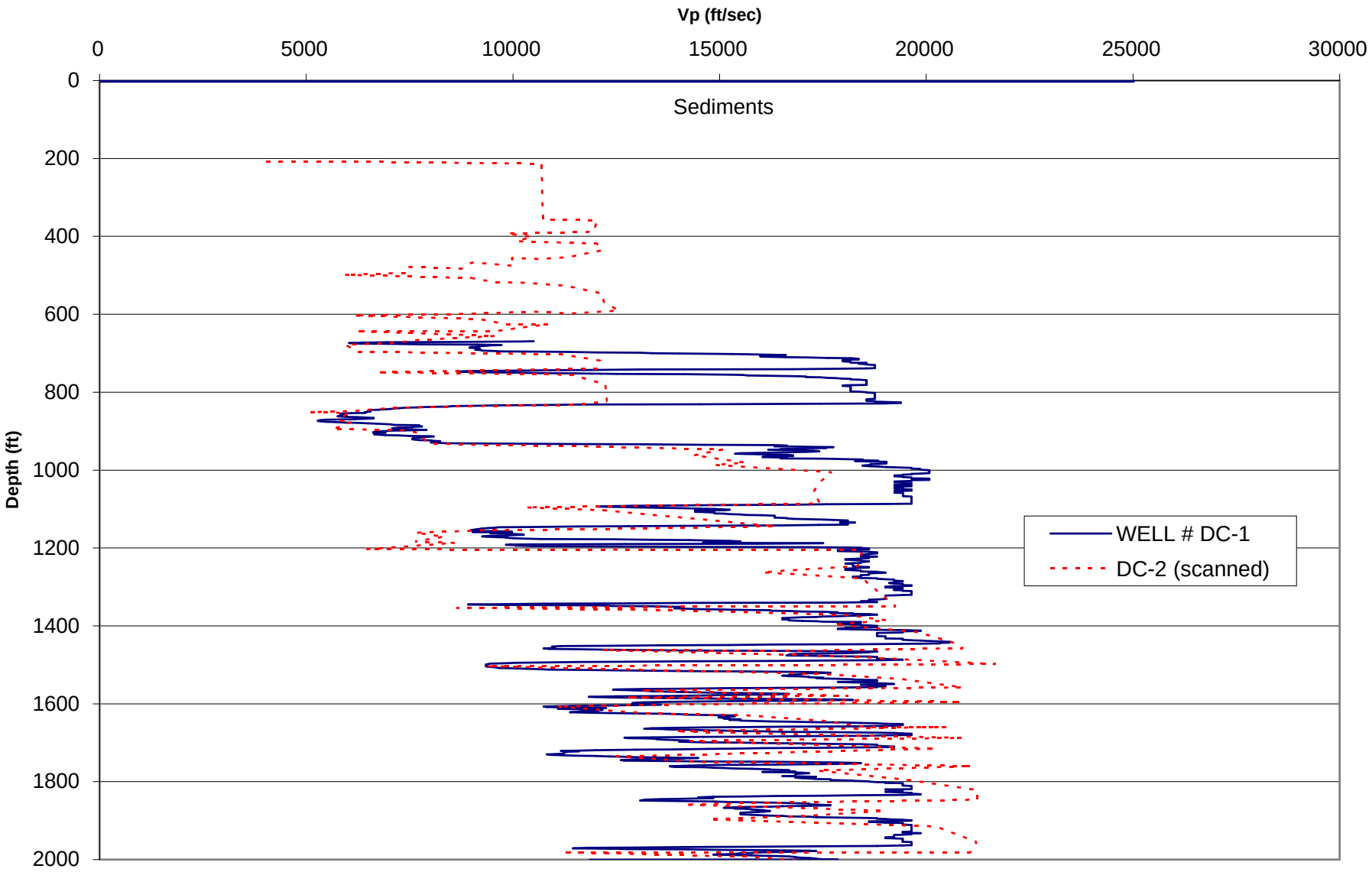

N
Line 9
299-E26-10
C
200 East Area
299-E26-12
C
Line 7
Waste
Treatment
Plant
699-41-42
299-E24-4
C
Line 3
BD-23
BD-8
C
Line 6
299-E24-21
299-E25-48
BD-35
BD-47
Line 2
C
C
Line 4
IDF
C
Line 5
SWVB
299-E17-21
Line 1
C
C
Line 8
699-37-43
Meters
0 200 400 600 800
0 600 1200 1800 2400
Feet
Borehole used for Downhole Velocity Survey and Reference Stratigraphy
Reference Stratigraphy Borehole only
WTP Shearwave Velocity Boreholes Drilled by Shannon and Wilson Inc.
C Central Receiver
SASW Line
G05010006.13

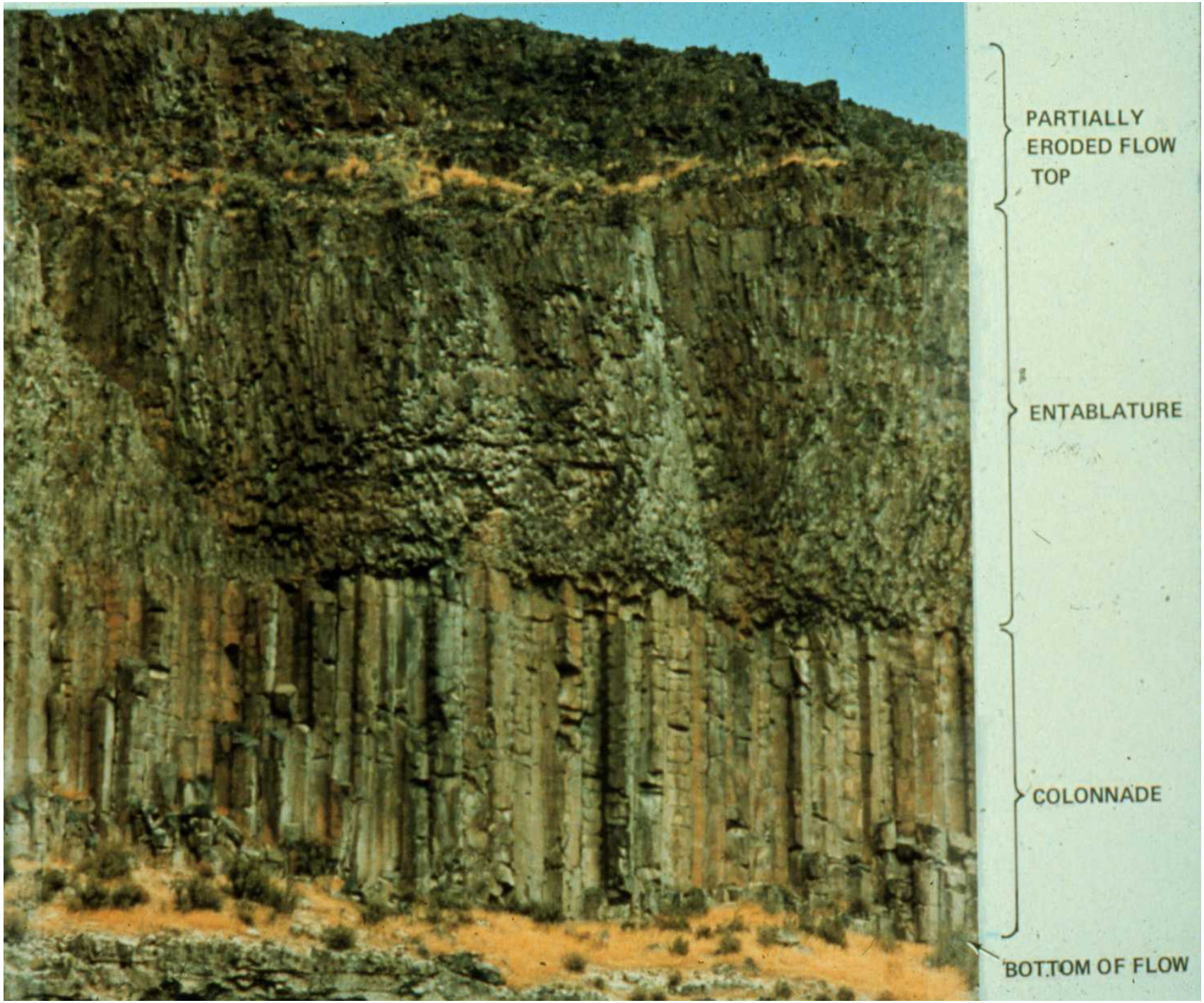

Vs, fps
0
1000
2000
3000
4000
5000
Depth, ft
0
50
100
150
200
250
300
Redpath DH
S&W SCPT
S&W DH

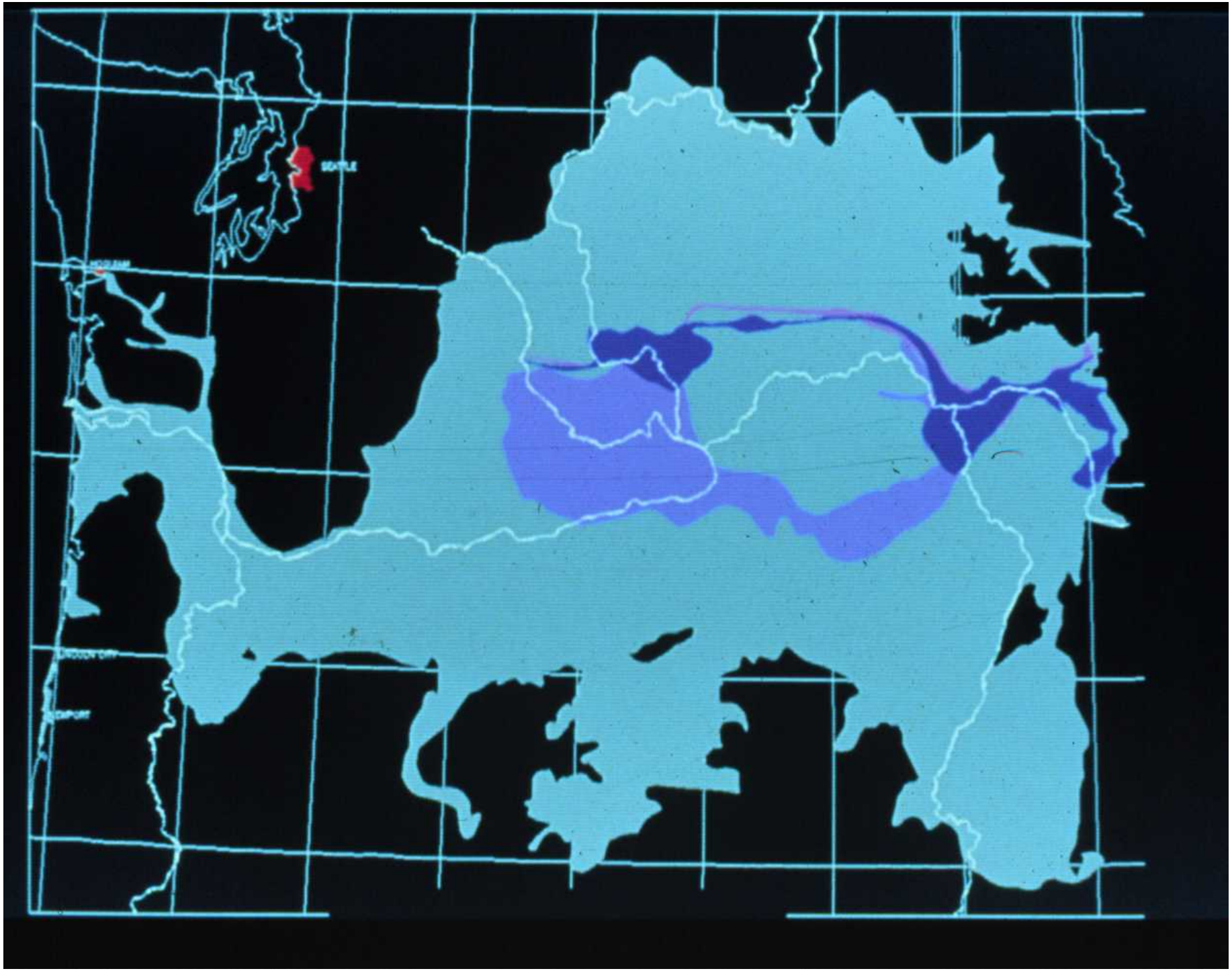


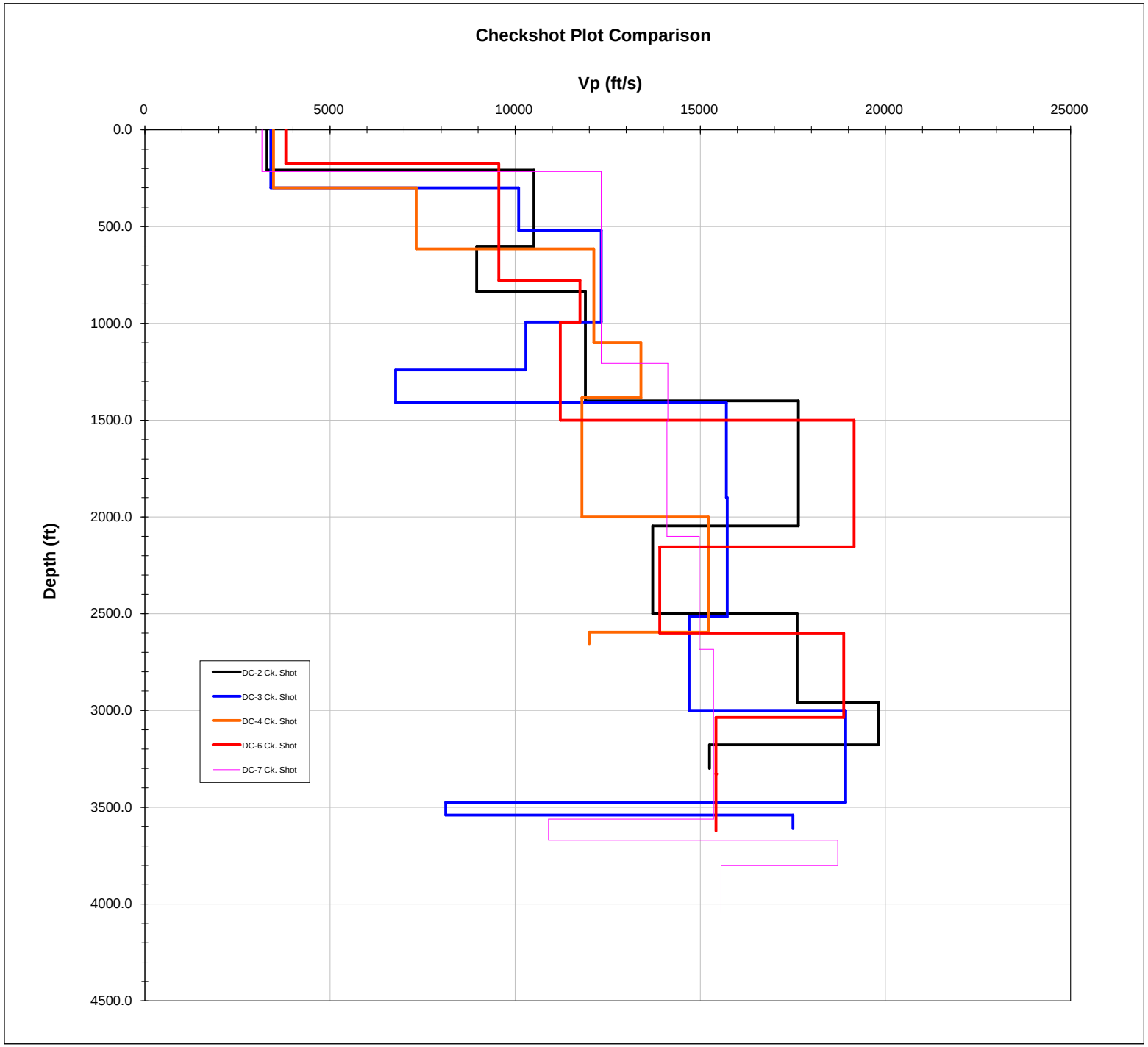
G05010006.14

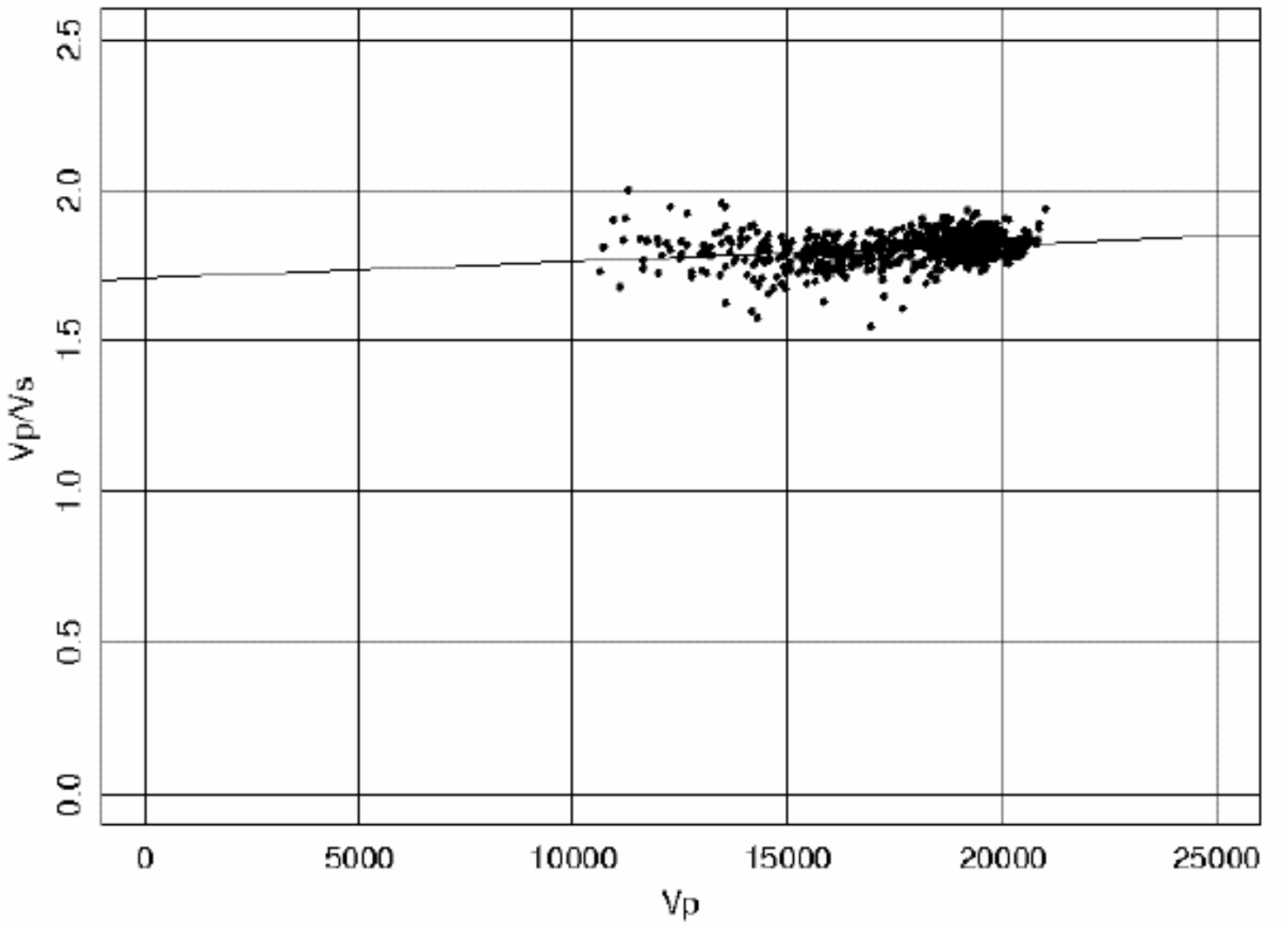
Comparison of Sonic Logs for DC-1 and DC-2

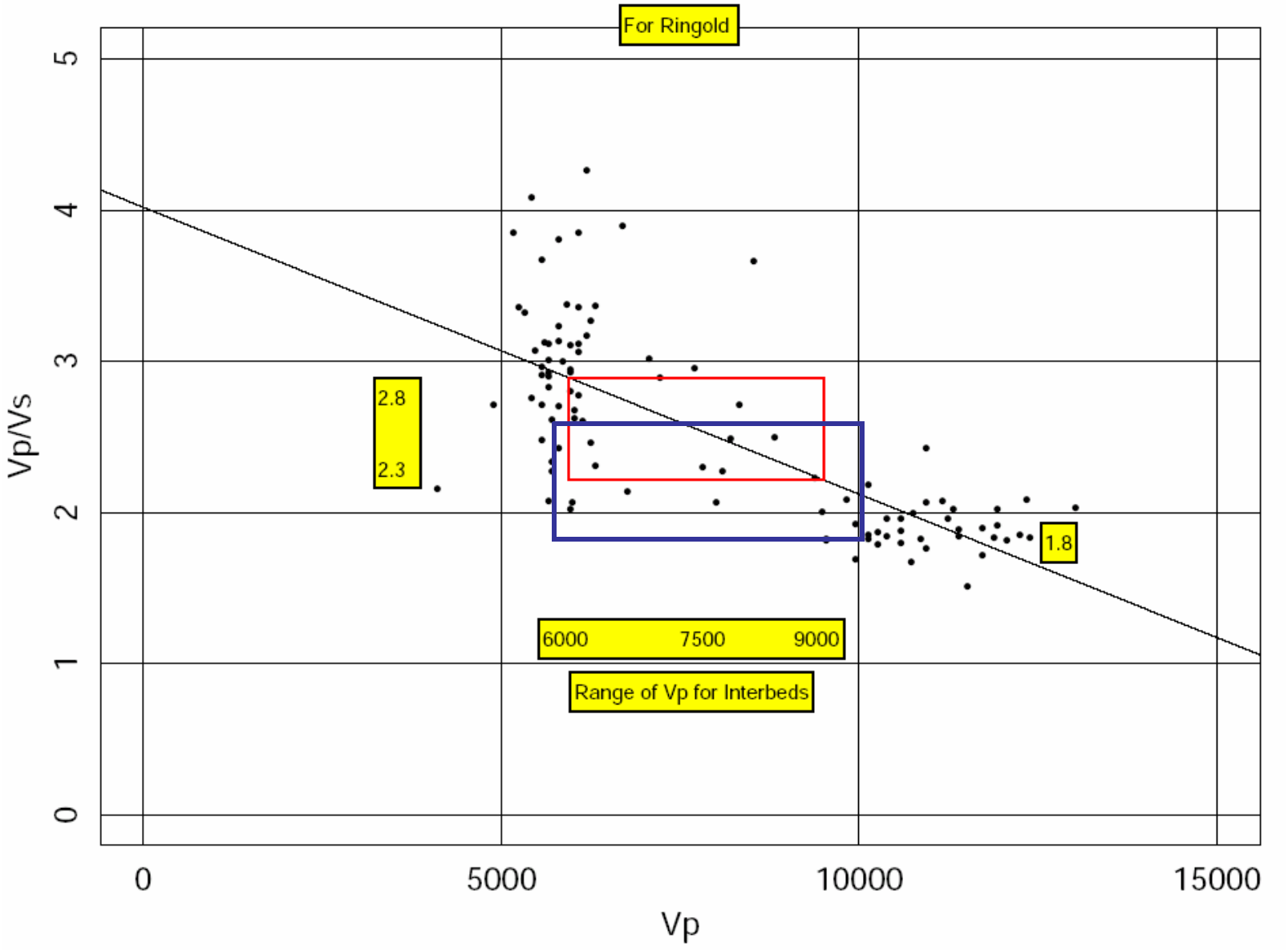


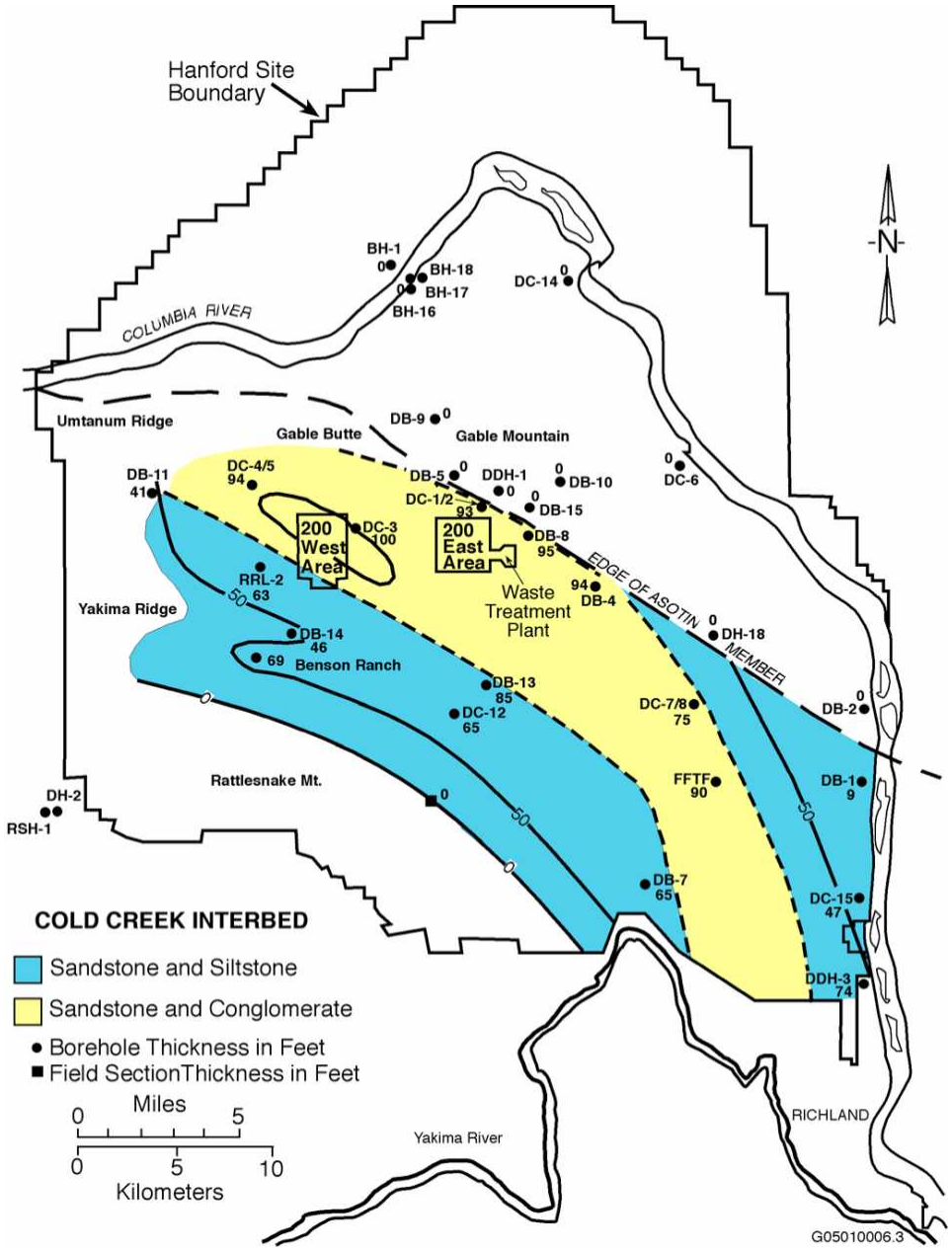

PARTIALLY
ERODED FLOW
TOP
ENTABLATURE
COLONNADE
BOTTOM OF FLOW

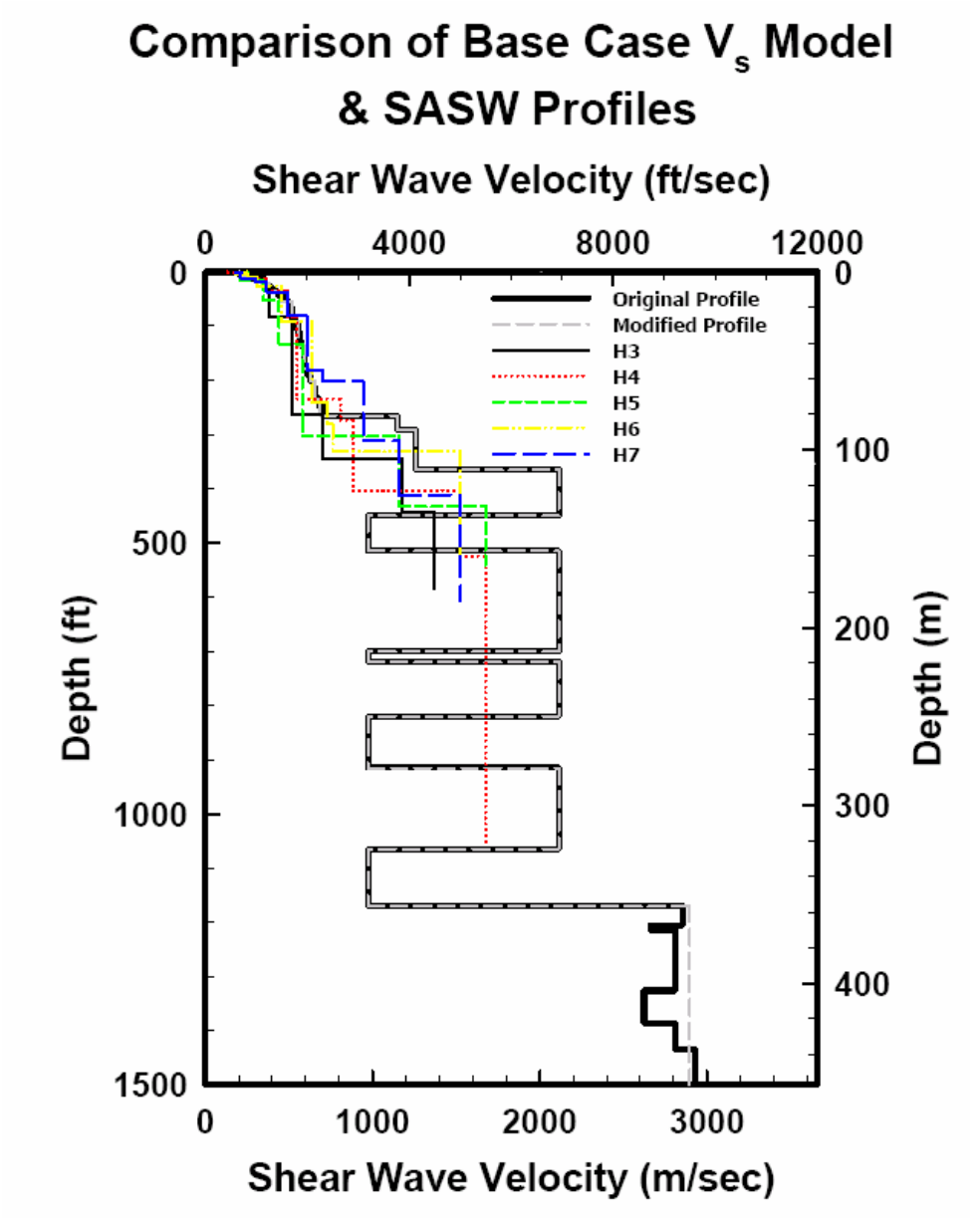

SEATTLE

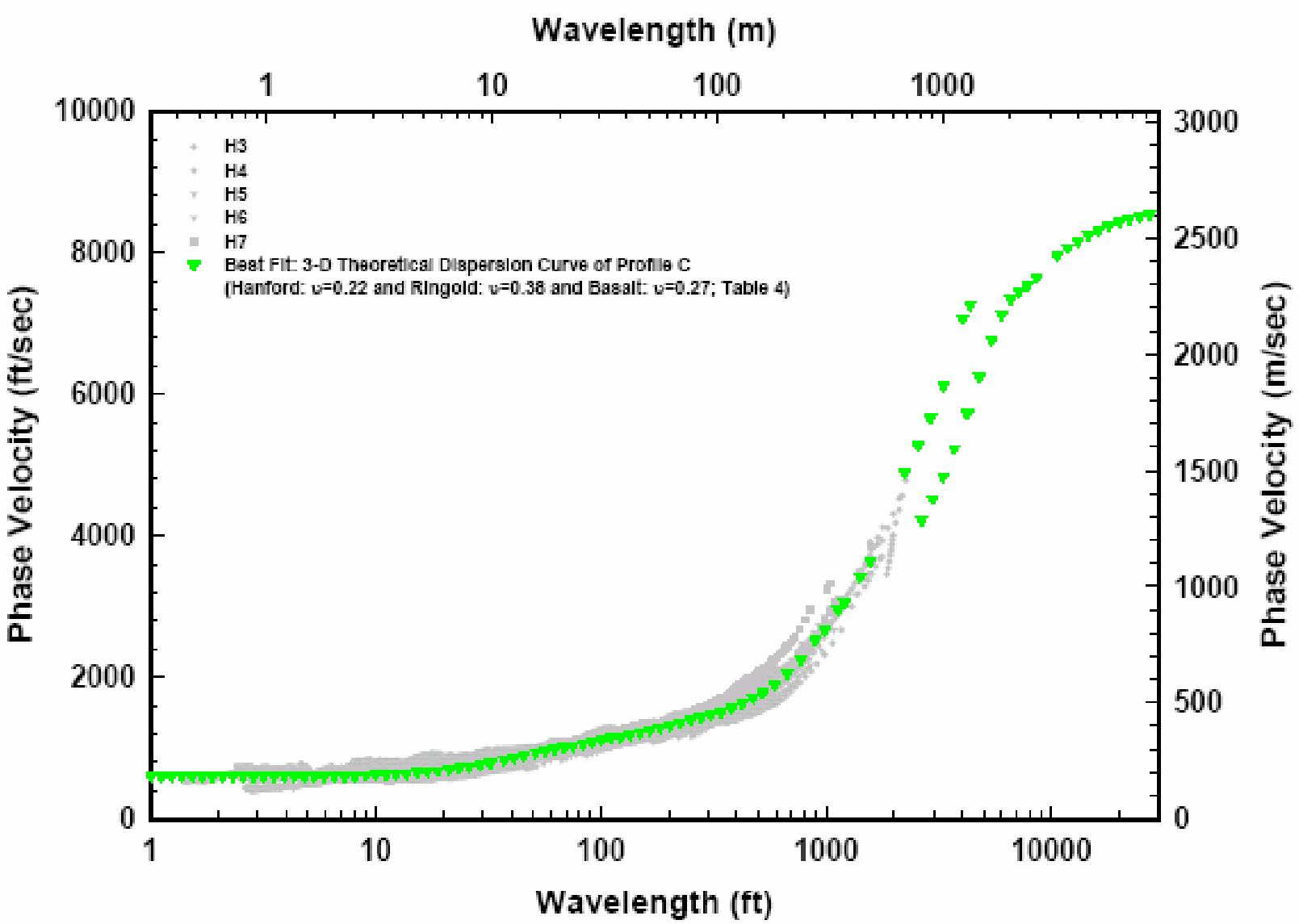

Checkshot Plot Comparison
Vp (ft/s)
0
5000
10000
15000
20000
25000
Depth (ft)
0.0
500.0
1000.0
1500.0
2000.0
2500.0
3000.0
3500.0
4000.0
4500.0
DC-2 Ck. Shot
DC-3 Ck. Shot
DC-4 Ck. Shot
DC-6 Ck. Shot
DC-7 Ck. Shot


Vp/Vs
0.0
0.5
1.0
1.5
2.0
2.5
0
5000
10000
15000
20000
25000
Vp

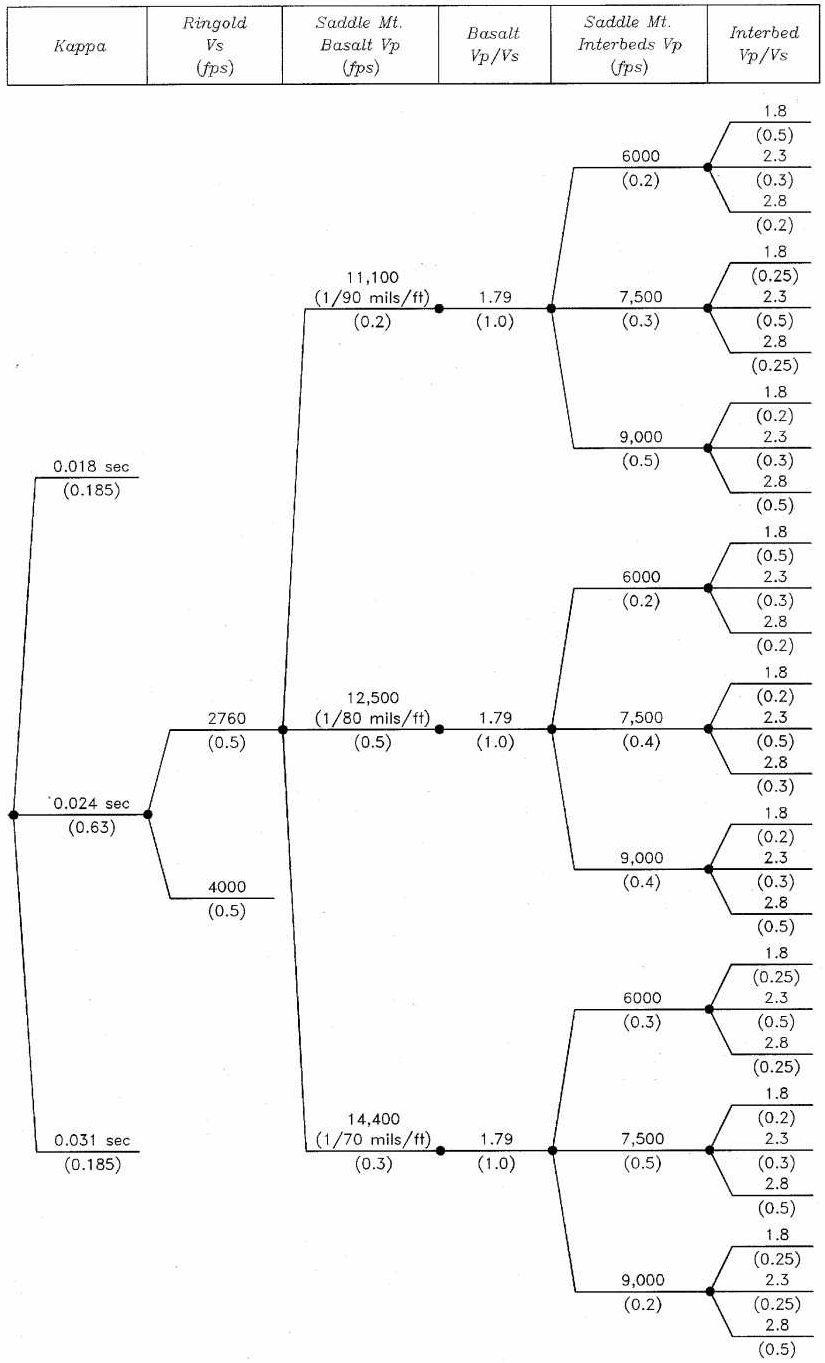

For Ringold
Vp/Vs
Vp
0
1
2
3
4
5
0
5000
10000
15000
2.8
2.3
1.8
6000
7500
9000
Range of Vp for Interbeds


Hanford Site Boundary
COLUMBIA RIVER
Umtanum Ridge
Gable Butte
Gable Mountain
Yakima Ridge
Rattlesnake Mt.
Yakima River
RICHLAND
200 West Area
200 East Area
Waste Treatment Plant
EDGE OF ASOTIN MEMBER
Benson Ranch
BH-1 0
BH-18 0
BH-17 0
BH-16
DC-14 0
DB-9 0
DB-11 41
DC-4/5 94
DB-5 0
DDH-1 0
DB-10 0
DC-6 0
DC-1/2 93
DB-15 0
DC-3 100
DB-8 95
RRL-2 63
DB-4 94
DH-18 0
DB-14 46
69
DB-13 85
DC-12 65
DC-7/8 75
DB-2 0
FFTF 90
DB-1 9
DH-2
RSH-1
DB-7 65
DC-15 47
DDH-3 74
50
0
COLD CREEK INTERBED
Sandstone and Siltstone
Sandstone and Conglomerate
Borehole Thickness in Feet
Field SectionThickness in Feet
Miles 0 5
Kilometers 0 5 10
N
G05010006.3

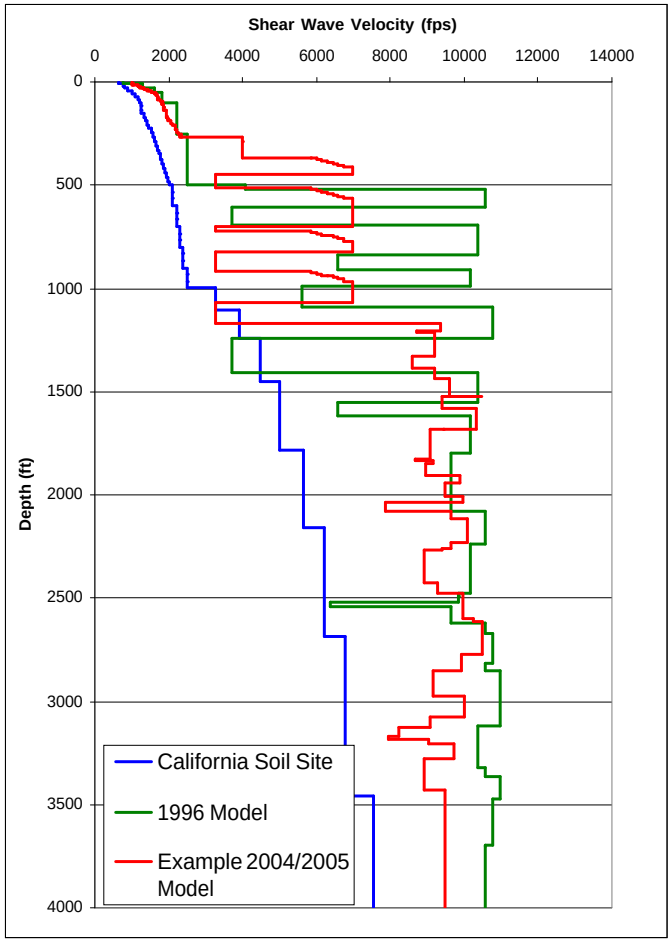

Comparison of Base Case V_s Model & SASW Profiles
Shear Wave Velocity (ft/sec)
0
4000
8000
12000
Original Profile
Modified Profile
H3
H4
H5
H6
H7
Depth (ft)
0
500
1000
1500
Depth (m)
0
100
200
300
400
0
1000
2000
3000
Shear Wave Velocity (m/sec)


Wavelength (m)
1
10
100
1000
10000
8000
6000
4000
2000
0
Phase Velocity (ft/sec)
3000
2500
2000
1500
1000
500
0
Phase Velocity (m/sec)
H3
H4
H5
H6
H7
Best Fit: 3-D Theoretical Dispersion Curve of Profile C
(Hanford: υ=0.22 and Ringold: υ=0.38 and Basalt: υ=0.27; Table 4)
1
10
100
1000
10000
Wavelength (ft)

LOGIC DIAGRAM DESCRIBED RANGE OF VELOCITY ESTIMATES

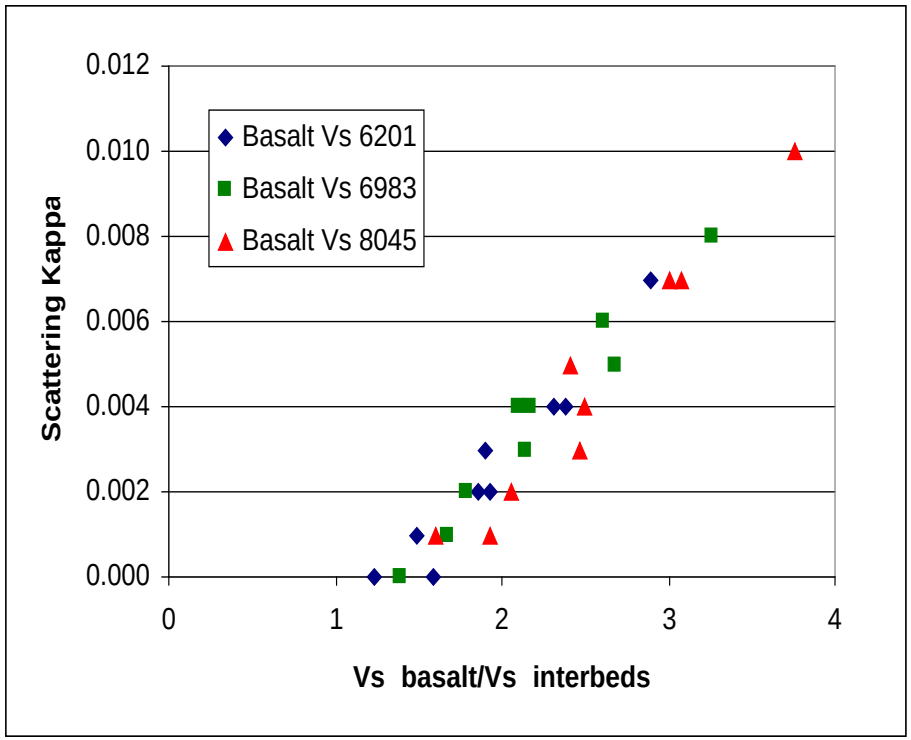


Changes in Velocity Profile (top kilometer)



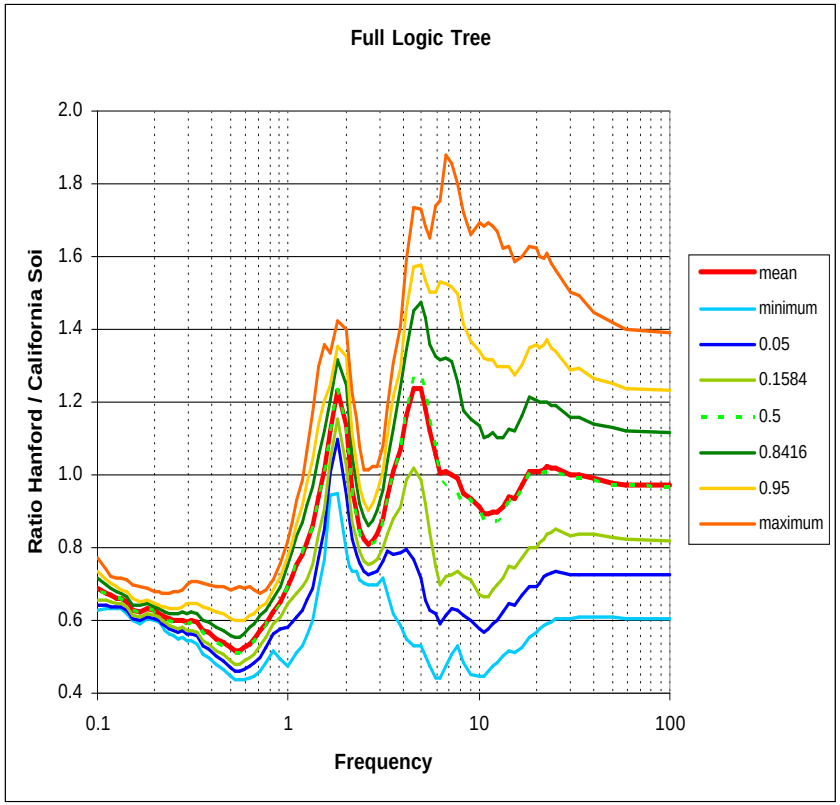
- Soil depth changed from 500 to 365 ft
- Vs in first basalt sequence (Saddle Mountains) changed from >10,000 fps to 6,000 to 9,000 fps

Damping in Top 1 km of Basalt Depth Range 365 to 3,300 ft



- Total damping defined by ground motion parameter kappa.
- Overall kappa set at three alternative values – 0.018, 0.024, and 0.031 sec
- Scattering kappa due to velocity contrast removed
- Damping in basalt/ interbed sequence and remaining intact basalts defined by remaining kappa
- Individual layer Q defined to be proportional to velocity

Distribution of Results



- Largest contributor to uncertainty is the interbed velocity uncertainty
- Second largest is uncertainty in kappa
- Uncertainty in basalt velocity, Ringold velocity and dynamic property curves have minor contributions

Revision of WTP Design Spectrum

FIGURE 1
RECOMMENDED BROADED DRS
File: TREEOUT-R2-SPECTRA1.CRD