THE UNIVERSITY OF BRITISH COLUMBIA

AMPLIFICATION EFFECTS OF THIN SOFT SURFACE LAYERS: A STUDY FOR NBCC 2015

W.D. Liam Finn
The University of British Columbia, Vancouver, BC, Canada

Francisco Ruz
R y V Ingenieros, Santiago, Chile

CSRN – Tonji – UBC Symposium

August 19, 2013

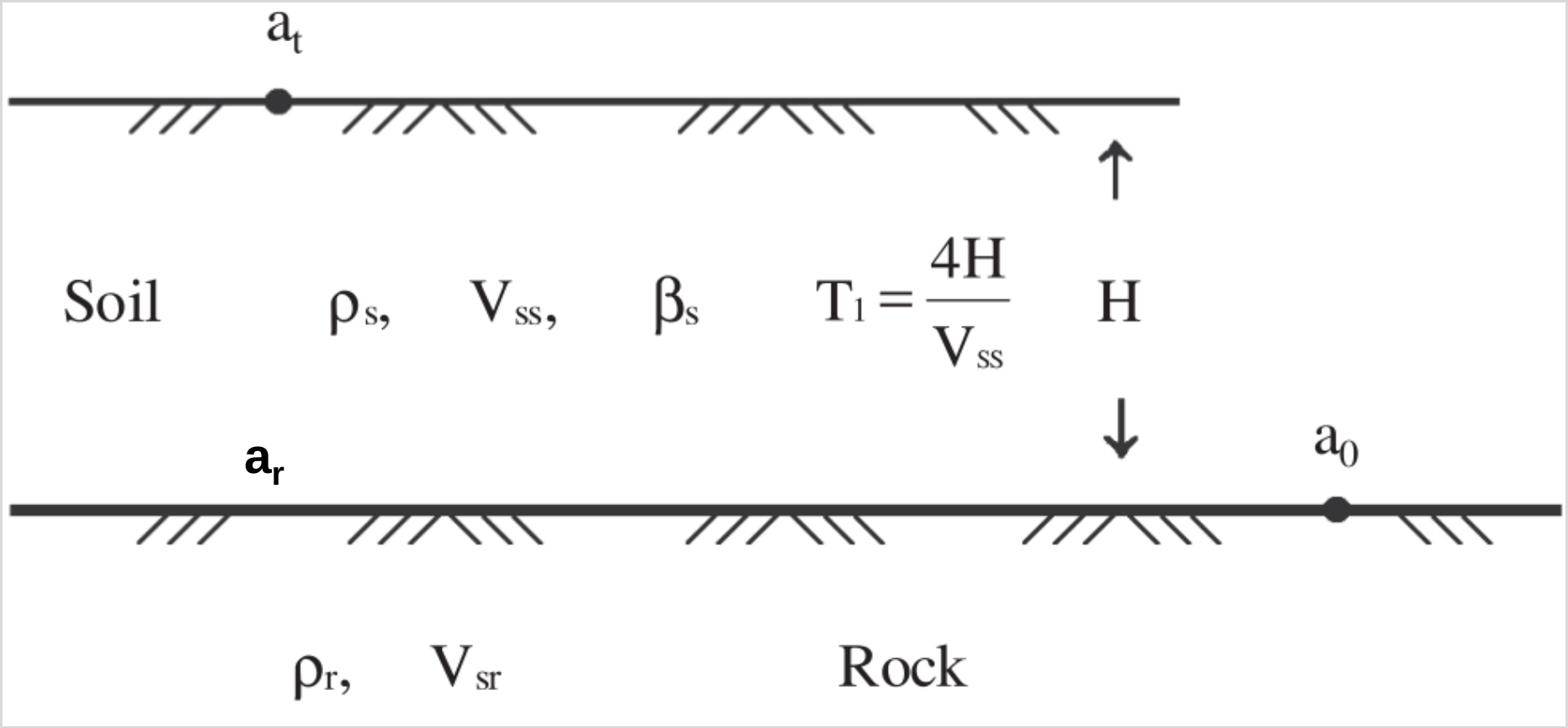
MOTIVATION FOR STUDY

- NBCC 2010 recommends that the classification of shallow surface layers less than 30m thick for amplification potential be based on the properties of the surface layer, in particular the average shear wave velocity, Vs.

- There was little data to support this recommendation. The extensive data from the 2011 Tohoku earthquake provides the opportunity to evaluate this recommendation

- Prior to NBCC 2010 there was no specific recommendation but practice was to base the classification on Vs30 even though this meant including thicknesses of rock or stiff soil to make up the 30m. There was one restriction the surface layer could not be classified higher than Site Class C (Vs30 in range 360m/s to 760m/s.

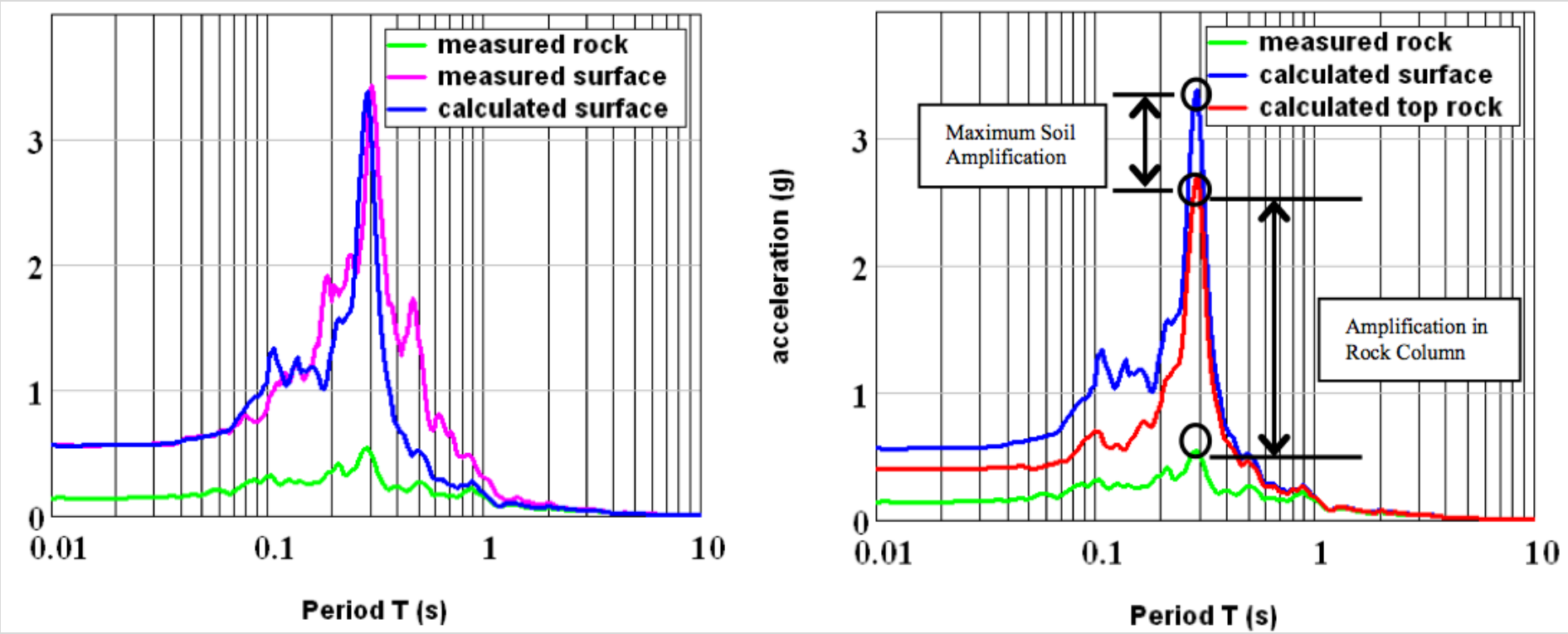
THEORETICAL BASIS OF AMPLIFICATION



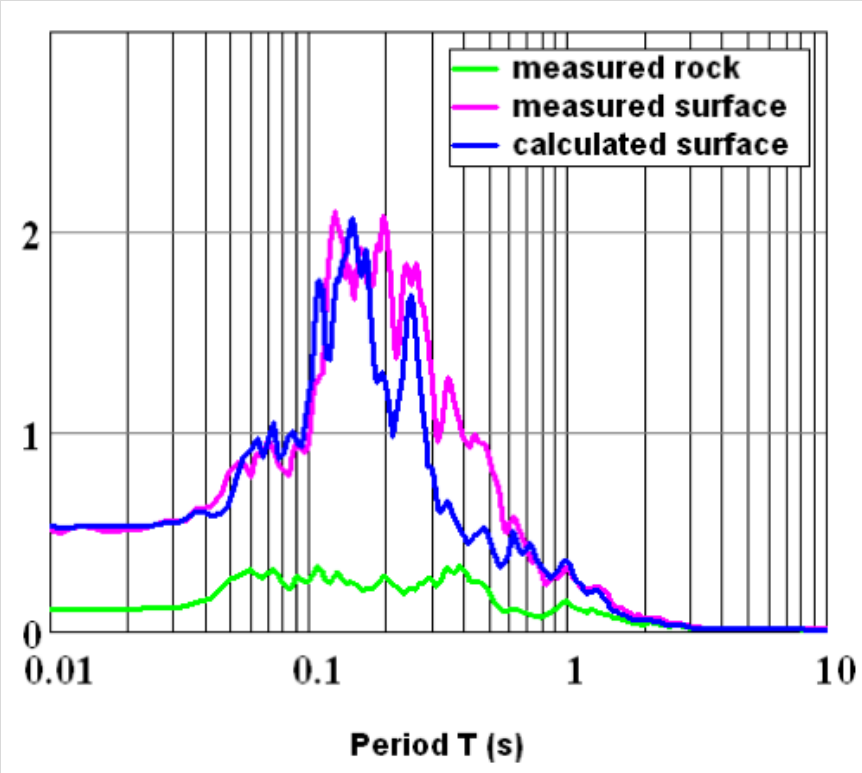
ANALYSES OF TOHOKU BOREHOLE SITES

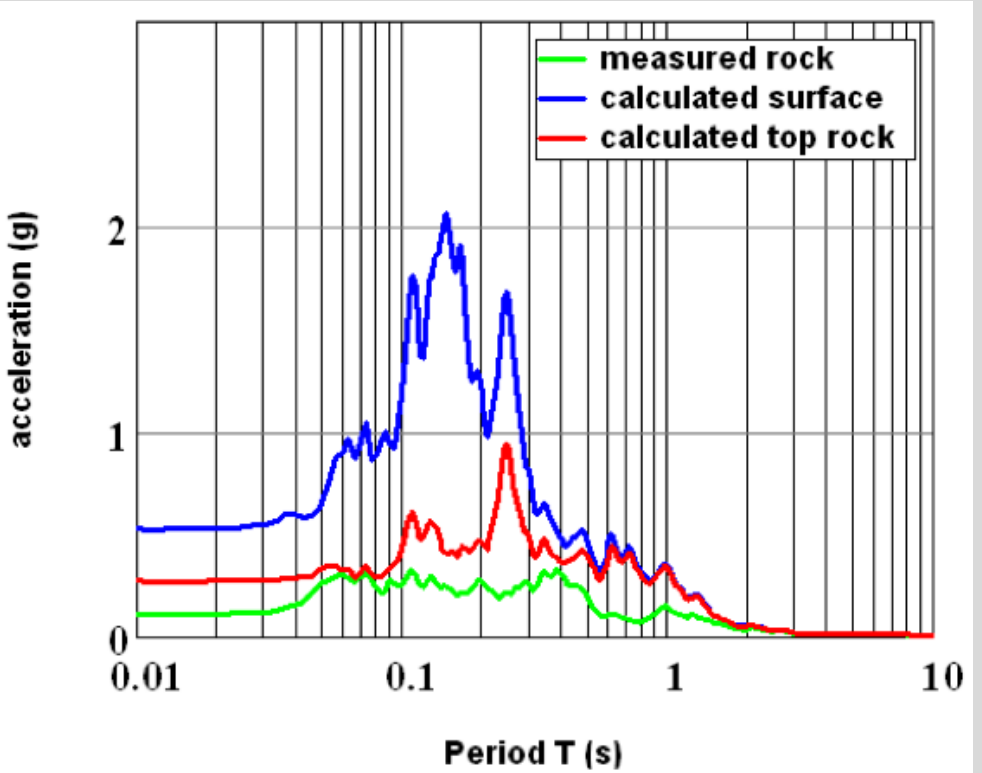
Site	Name	PGA Surface	PGA Top Rock	PGA Base Rock	Downhole depth (m)	H soil (m)	Vs30 (m/s)
1	MYGH04	0.70	0.41	0.12	100	4	850
2	MYGH12	0.53	0.31	0.16	102	6	748
3	IWTH27	0.75	0.38	0.11	100	4	670
4	IBRH16	0.51	0.28	0.12	300	12	626
5	FKSH09	0.43	0.25	0.10	200	10	585
6	TCGH13	0.56	0.41	0.14	140	4	584
7	IBRH18	0.45	0.29	0.16	507	15	559
8	FKSH17	0.28	0.18	0.07	100	6	544
9	FKSH10	1.08	0.48	0.18	200	16	487
10	IBRH15	0.60	0.25	0.10	90	5	450
11	SITH11	0.20	0.06	0.02	106	14	372
12	SITH06	0.23	0.10	0.06	200	50	369
13	FKSH19	0.61	0.31	0.13	100	18	360
14	FKSH18	0.58	0.19	0.10	100	30	307

ANALYSES OF TOHOKU BOREHOLE SITES

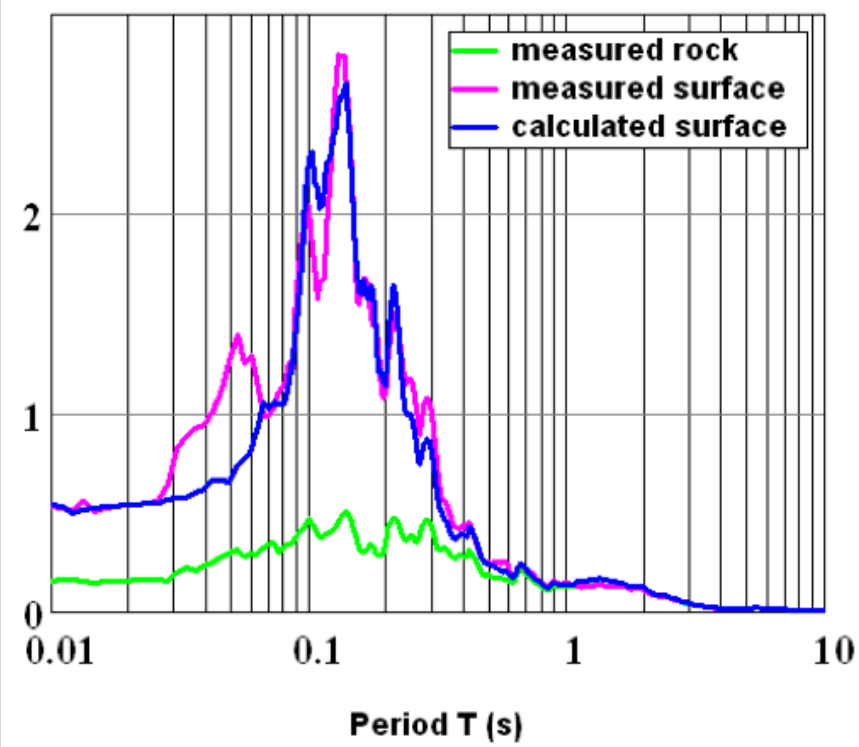


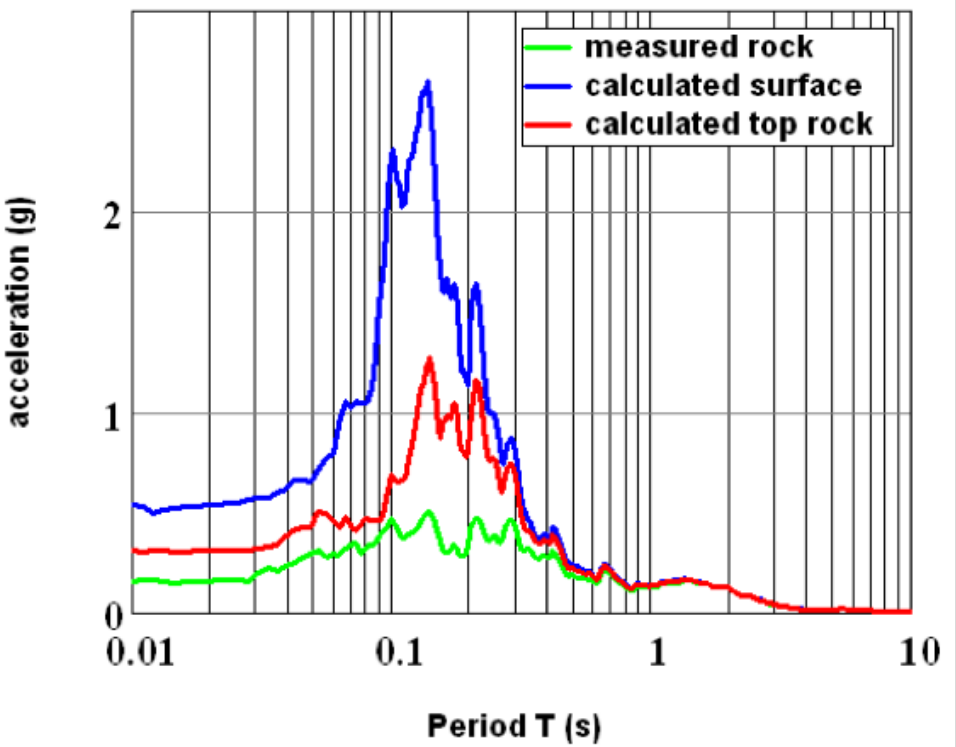
ANALYSES OF TOHOKU BOREHOLE SITES



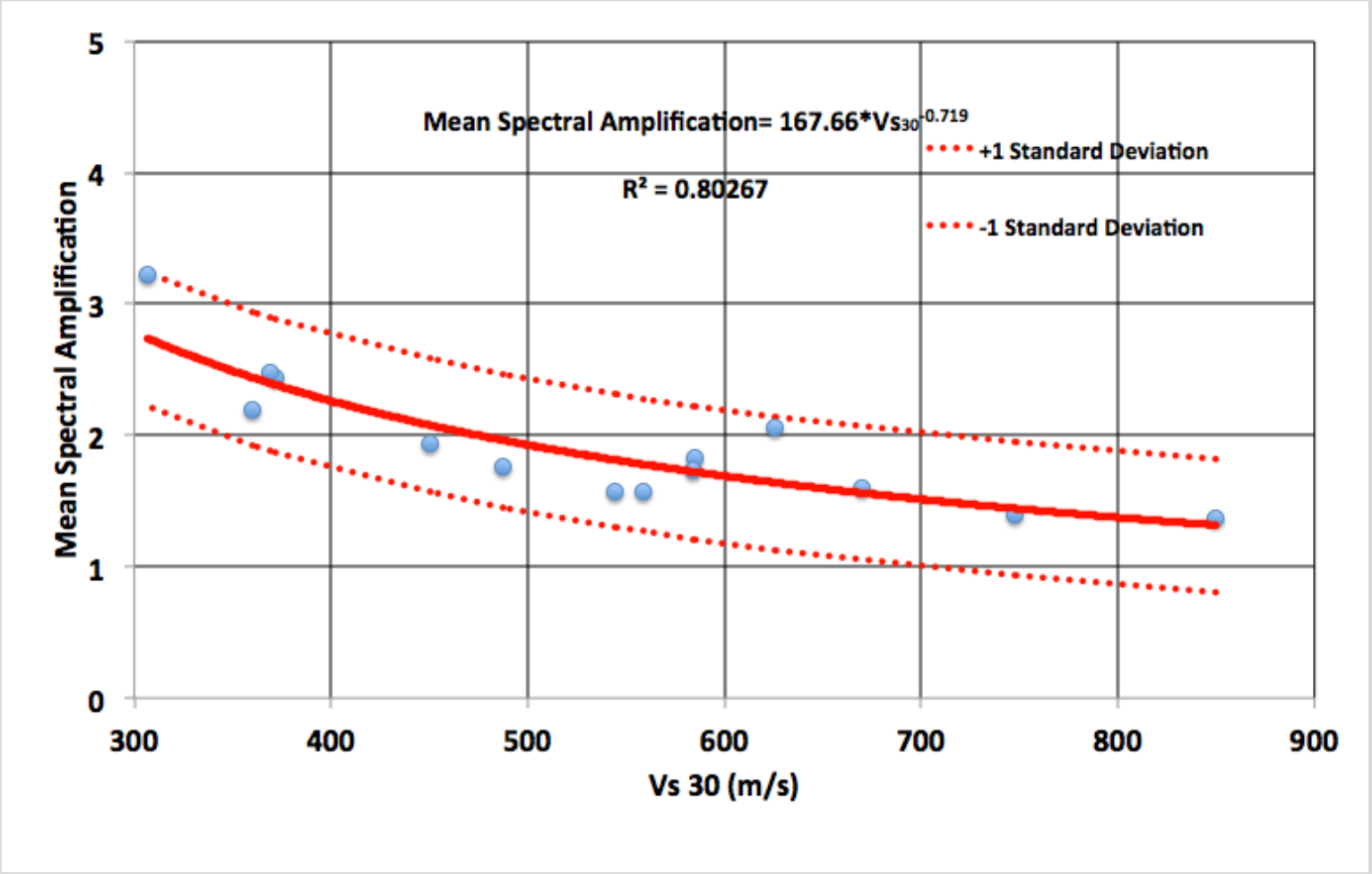


ANALYSES OF TOHOKU BOREHOLE SITES

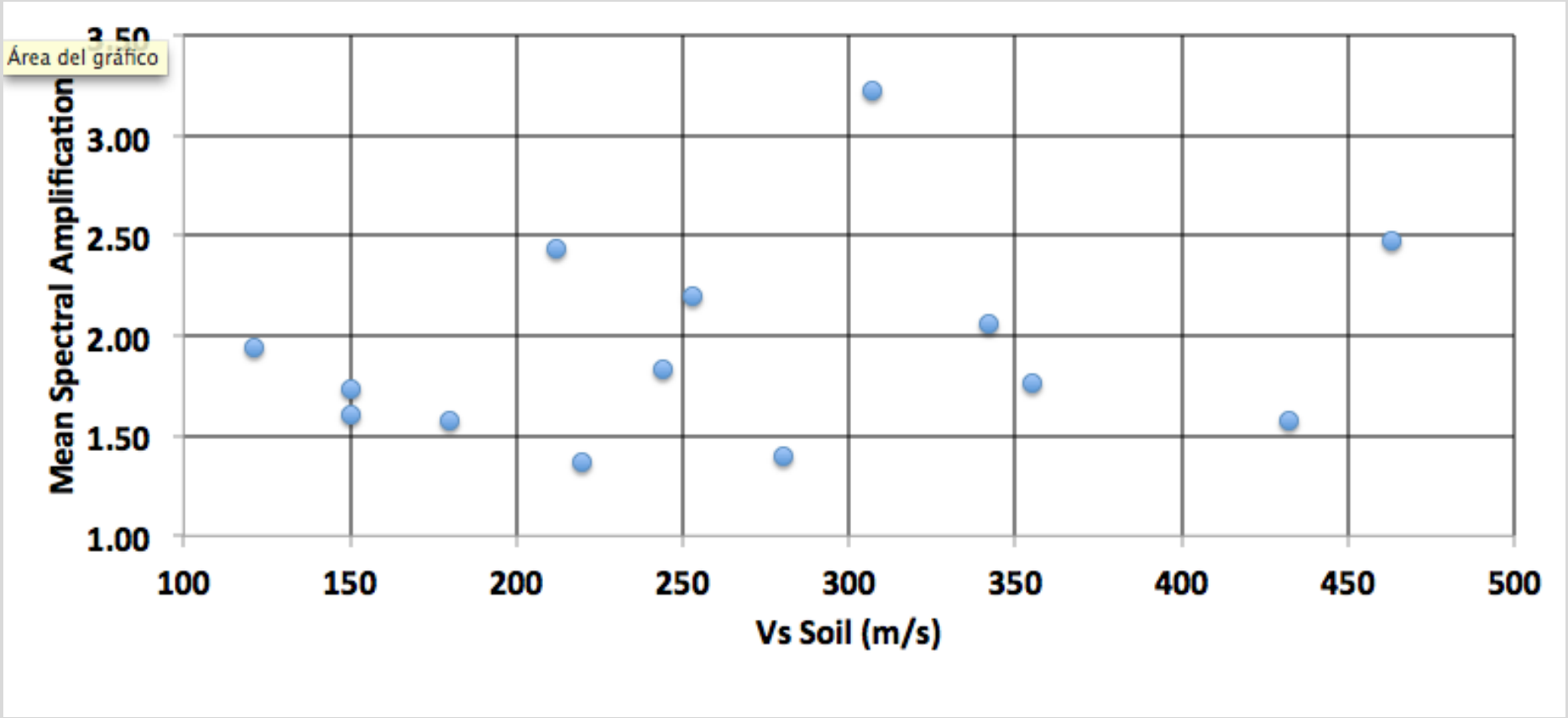




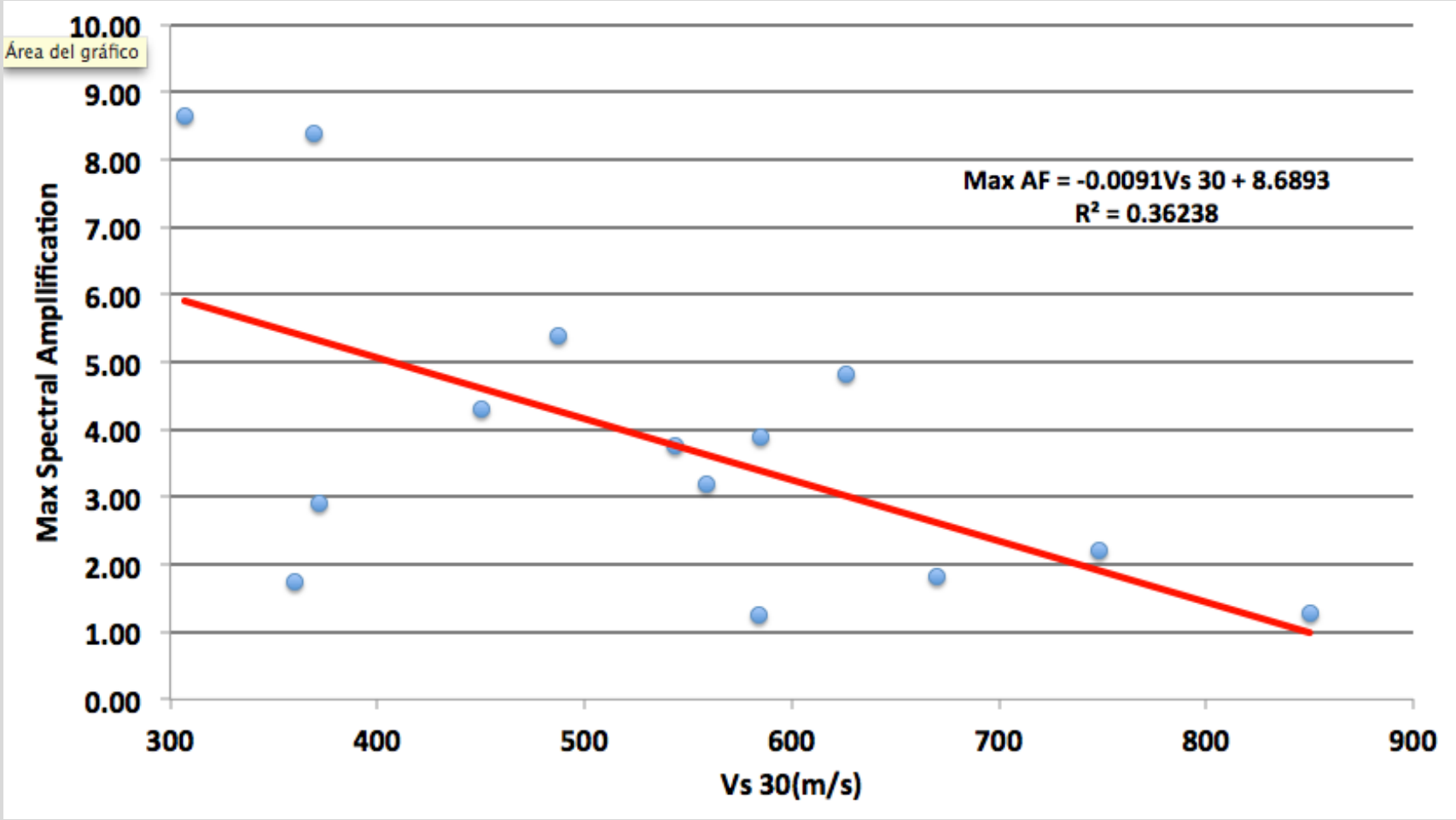
MEAN SPECTRAL AMPLIFICATION



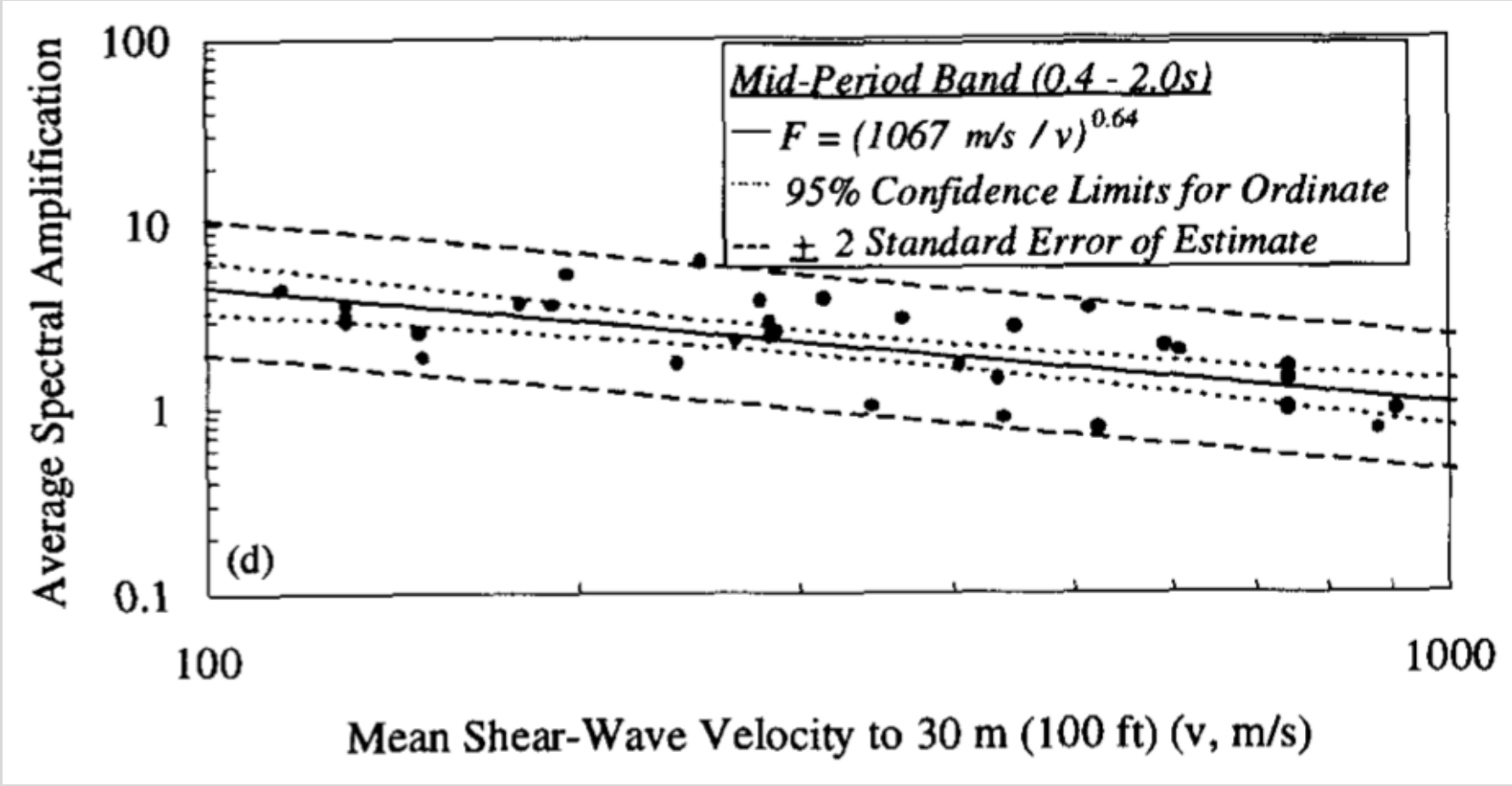
MEAN SPECTRAL AMPLIFICATION



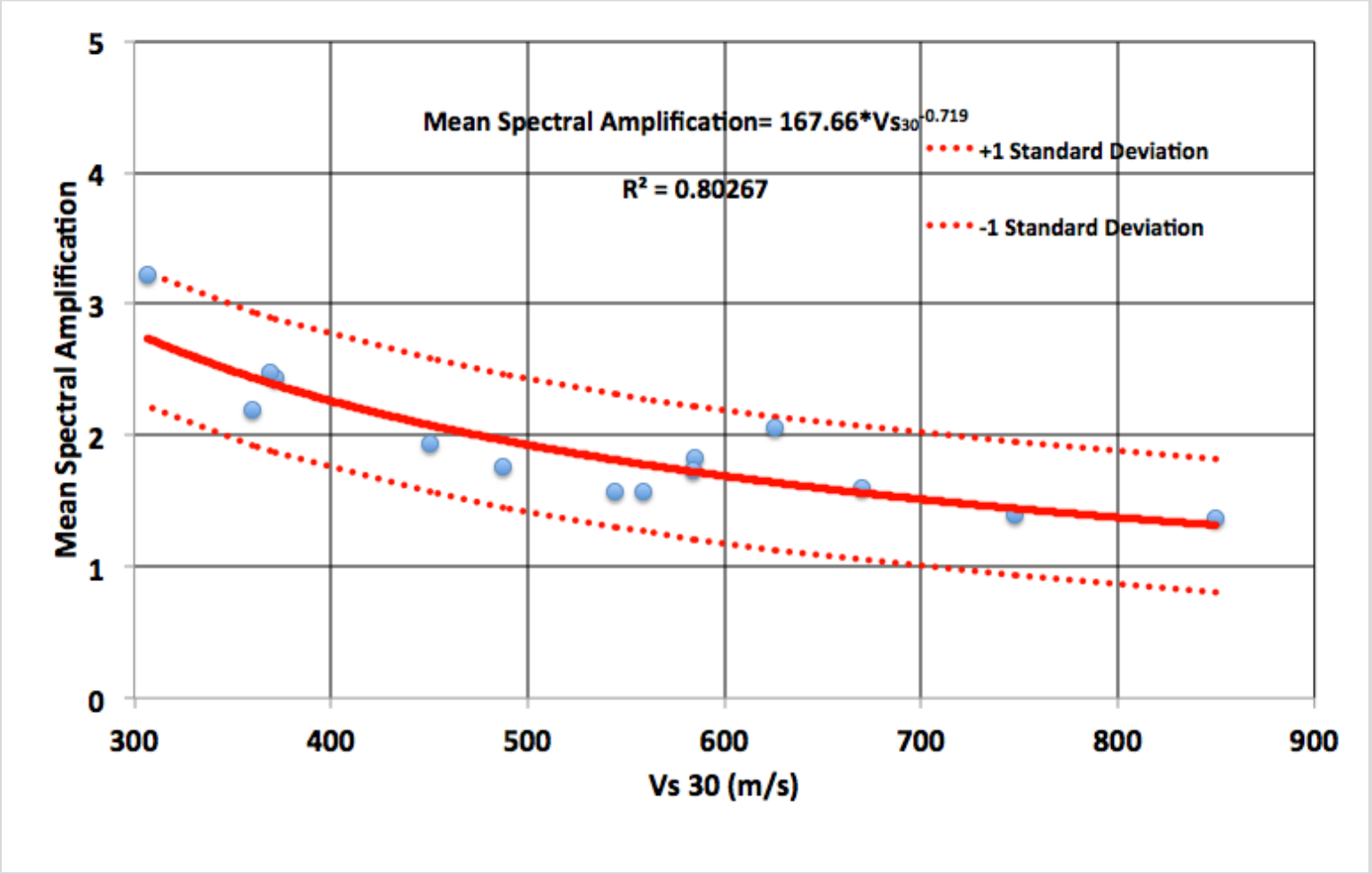
MAXIMUM SPECTRAL AMPLIFICATION



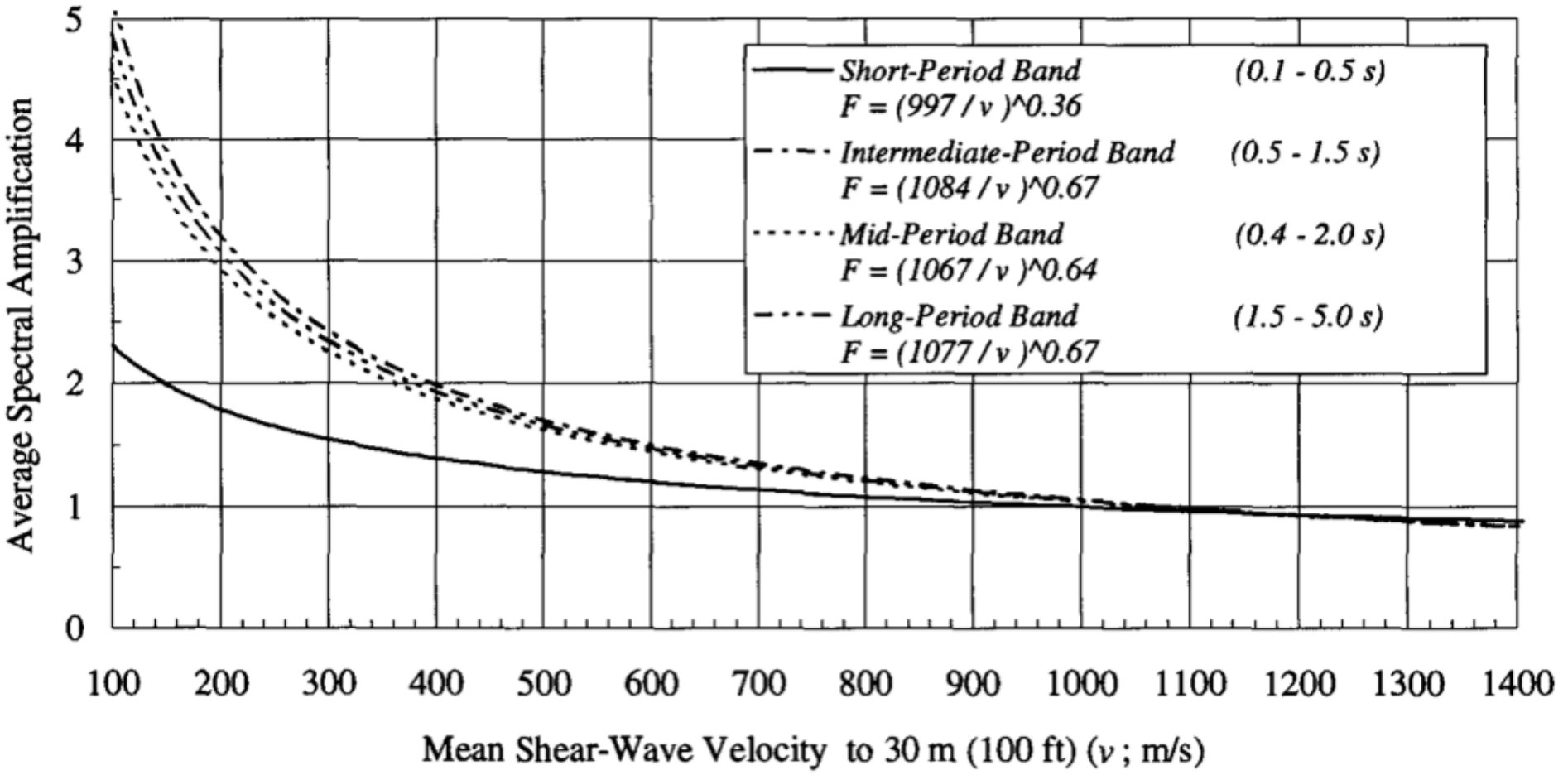
TYPICAL SCATTER OF FIELD RESPONSE DATA



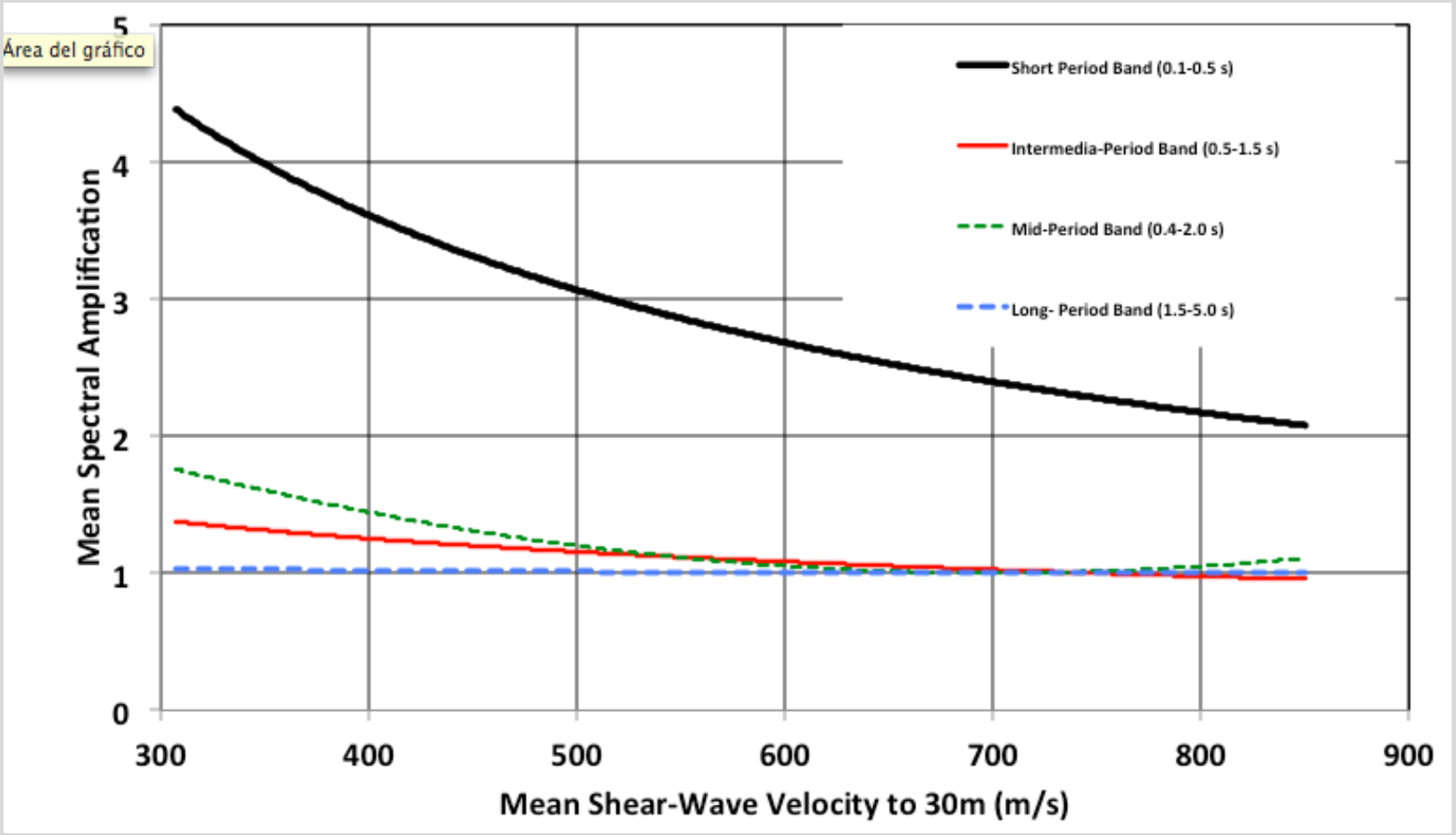
MEAN SPECTRAL AMPLIFICATION



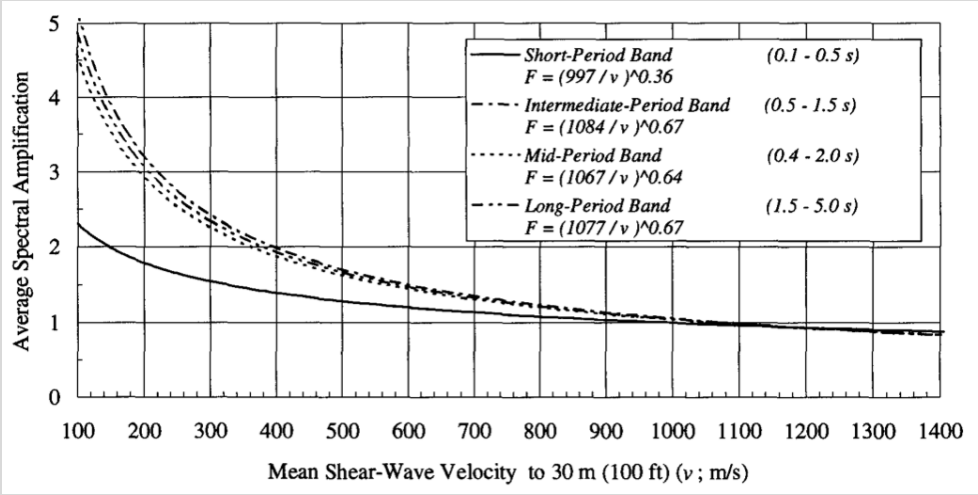
BORCHERDT (1994) AMPLIFICATION FACTORS

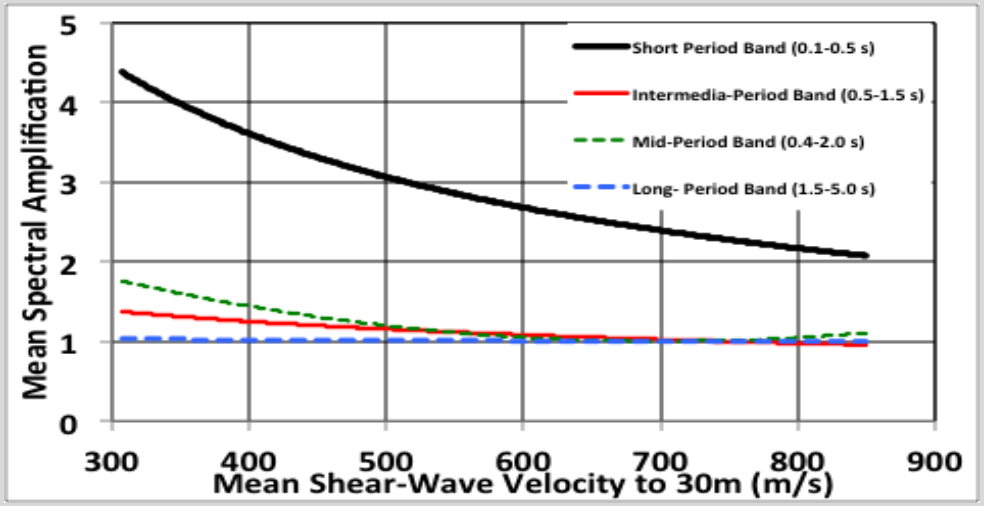


FINN-RUZ RESULTS

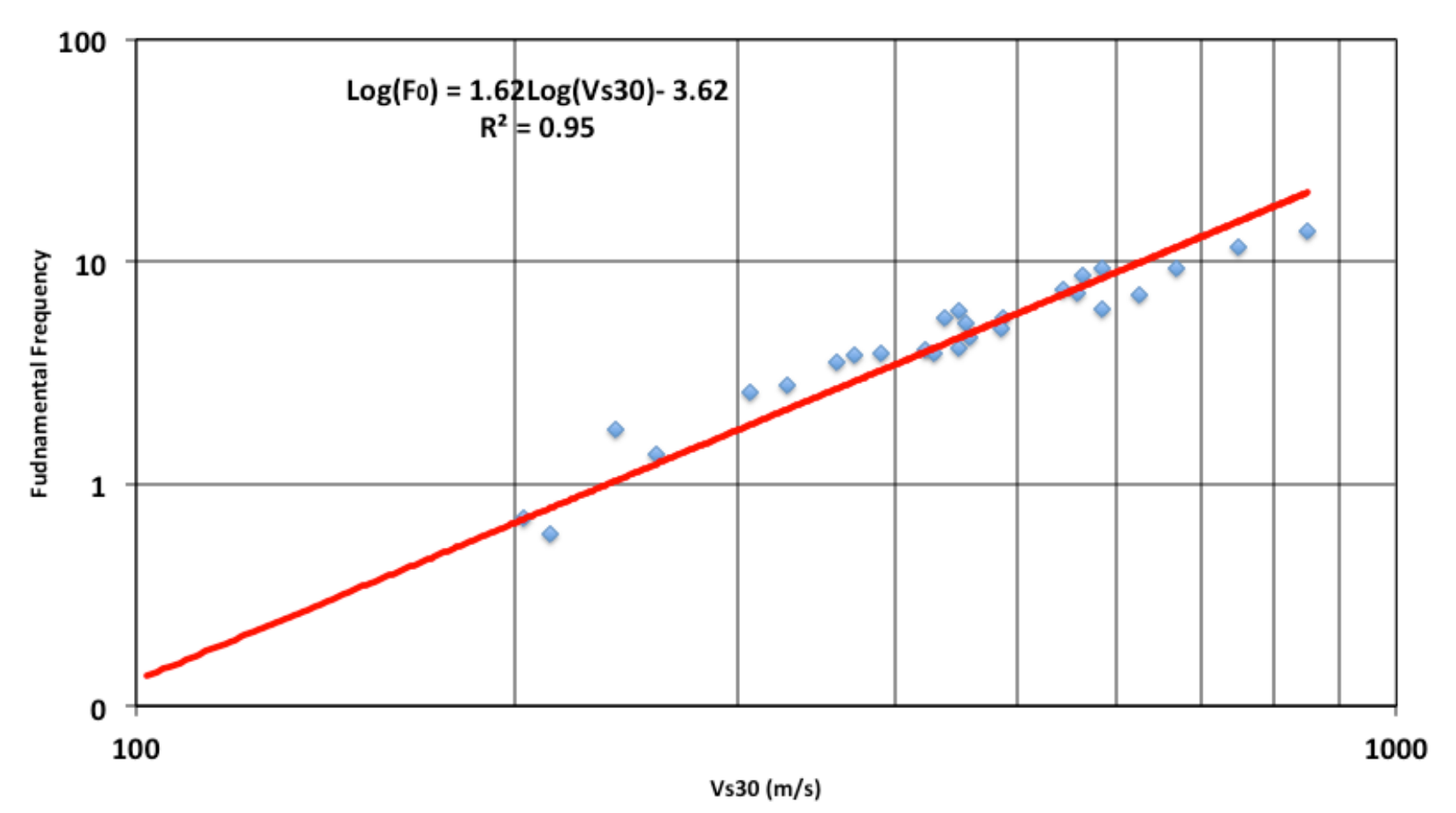


FOURIER SPECTRA AMPLIFICATION FACTORS

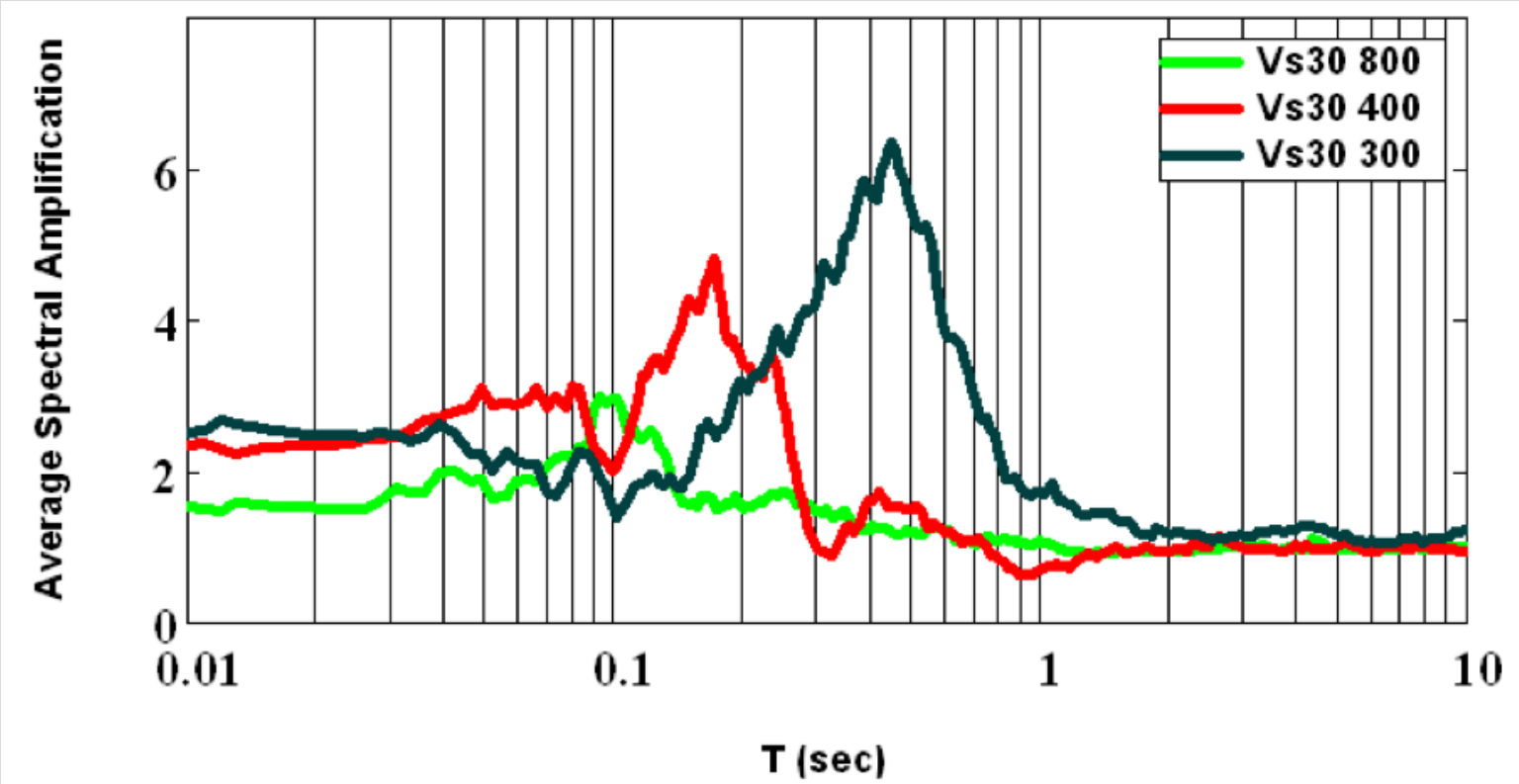




FUNDAMENTAL SITE FREQUENCY VS MEAN SHEAR WAVE VELOCITY (Vs30)



REGIONAL SITE AMPLIFICATION FACTORS



CONCLUDING REMRKS

- Average shear wave velocity in a soft surface layer significantly less than 30m thick is not a reliable indicator of amplification potential.

- A strong correlation was found between Vs30 and average amplification factors for the thin, soft surface layers.

- Very strong correlation between the period of the surface layer and Vs30. Ghofani et al (2012) found a similar correlation with the entire borehole period.

- For the Tohoku borehole sites, the average Fourier amplification factors in the short period range T = 0.1- 0.5s are much higher than the longer period amplification factors in contrast to the findings by Borcherdt (1994) for Loma Prieta data which were recorded on much thicker deposits.