Earthquakes on Blasting Seismographs

by Wes Bender

Those of you who are recording your blasts with seismographs on the west coast stand a good chance of inadvertently recording an earthquake. After all, you're right in the middle of prime earthquake country. Mike Burneson recorded one a few years ago and I recorded one once while monitoring at the San Rafael rock quarry. Unfortunately, Mike doesn't have a record of his and I deleted mine, thinking it was a random false trigger. It wasn't until I read of the bay area earthquake the following day and noted the time, that I realized I had recorded one. Too late. It couldn't be retrieved.

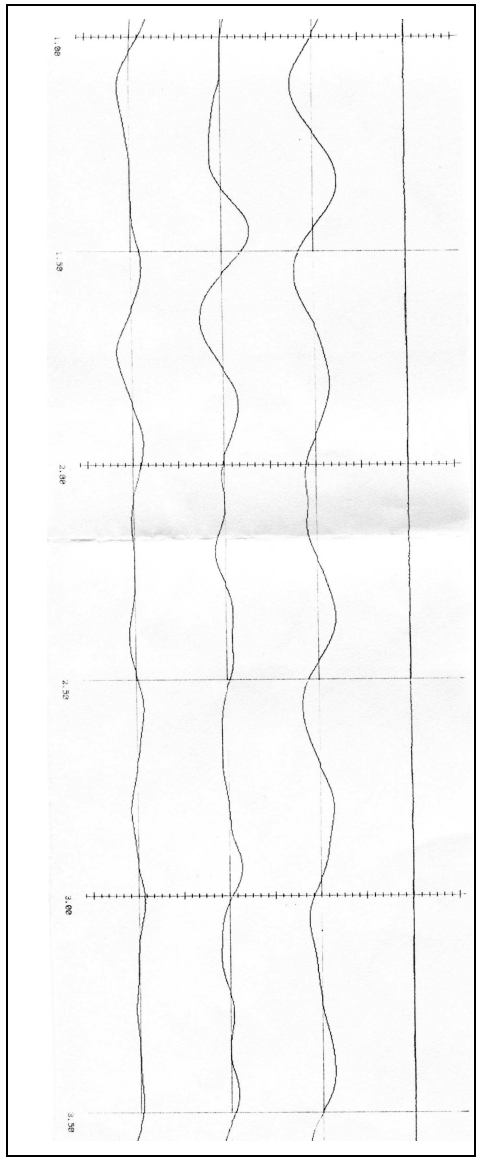
Our instruments are intended to record strong motion and aren't sensitive enough to capture distant earthquakes, although they will certainly be triggered by a strong enough local event. Usually, but not always, the body waves will slip through unnoticed, and the surface waves will be the ones to trigger your instrument.

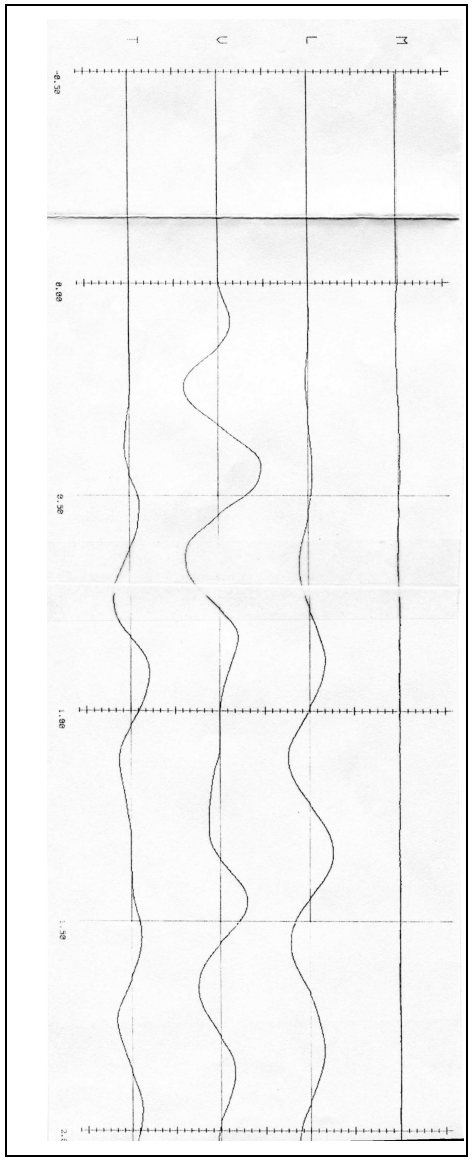
Interestingly, we have the following instance where an instrument was set out with the intent of capturing an earthquake, were one to occur, and it did. I had rented an instrument to Sig Schwartz, a noted geophysicist in Bethell, Washington. Sig only needed the instrument for a little over two weeks, but had rented it for a month. He called me after the job was done and wondered if it would be possible to connect a Mark Products L4-3D 1 Hertz geophone to the instrument. I told him it wouldn't harm the instrument and gave him the pin-outs for a substitute geophone cable. I also cautioned him that the velocity amplitudes displayed wouldn't be correct because a non-linear amplifier was being used to amplify the lower frequencies somewhat. (The output of the 5 Hz Geospace sensors that the instrument normally used required amplification at the lower frequencies to bring them into specification at 2 Hz.)

Sig fabricated a cable, tested the system and set the unit out to monitor. Almost on cue, a 4.4 magnitude earthquake occurred near Bremerton WA on June 18, 1989 and Sig captured it. Sig indicated to me that the epicenter (the point on the surface that is directly above the hypocenter) was at a distance of 31 nautical miles (~ 57.4 km). The USGS has since determined that the hypocenter was at a depth of 44 km.

Attempts to analyze the records are difficult because too many assumptions must be made. Were the sensors aligned N-S, E-W as might be expected? Were the individual channels connected to the geophone correctly? The epicenter would lie at an approximate azimuth of 240 degrees (clockwise from North) from the instrument. Were these body waves? Possibly, but probably not. If these are surface waves on the record, the first should be a Love Wave (motion transverse to the direction of the source), followed by Raleigh Waves (motion vertical and longitudinal from the source).

On the recording of the earthquake included on the next page, note the low frequencies and low accelerations (and the resulting high displacements) when compared to conventional blasts. That explains why an earthquake (with relatively low acceleration) can knock a house off its foundation, while your blast (with much higher acceleration levels) causes no damage.





INSTANTEL DS477 BLASTMATE

VIBRATION RECORD

Richter 4.4 31 mm
Mark Products L4-3D Geophone
1 hz
SDS

SERIAL #	560 V 3.1	
CLIENT	SD SCHWARZ	
	EXPERIMENTAL L4 3D	
LOCATION	SCHWARZ PATIO	
USER	SIG SCHWARZ	
TRIG SOURCE	geo	
TRIG LEVEL	0.02 in/s	
RECORD TIME	7.0 s	
NOTES		
TRIGGERED	vert. at 13:39:51	
	18 June 1989	

	TRAN	VERT	LONG	
PPV	0.454	1.006	0.562	in/s
FREQ	2	2	2	hz
TIME	906	431	1335	ms
ACCEL	0.02	0.03	0.02	g
PK DISP:				
1/4 WAVE	0.030	0.066	0.039	in
TOTAL	0.033	0.067	0.040	in

PVS	1.012 in/s at 431 ms
PSPL(RMS)	90 db
PSPL(MAX)	93 db