

Seismic Processing Steps

Process	Purpose	When Applied	Pitfalls	Cost (flops)
Data Reduction				
<i>Demultiplex</i>	Put data in trace sequential (SEG-Y,D) format, from multiplexed (SEG-A,B) field tapes. Label headers with geometry information.	First. Do in field if possible, as most engineering seismographs do.	Incorrect geometry, observer's reports, time breaks, sample rate, record length, etc.	10^9
<i>Gain Recovery</i>	Multiply data by binary gain codes from gain ranging.	Second, if needed.	Locating correct gain trace.	10^9
<i>Editing</i>	Remove bad records, misfired shots, open channels, noisy traces.	Third, and at other times during processing if needed. Best done in field during acquisition.	Must scrutinize plots of all of raw data.	10^9
<i>Summing (Vertical Stack)</i>	Reduce source and random noise by adding multiple impacts, shots, or sweeps at same location.	After editing. Often done during acquisition, irreversible.	Noisy or unbalanced shots. False triggers. Strong 60 Hz noise will sum to harmonics. Large moveup arrays attenuate steep dips and blur statics.	10^9
<i>Correlation</i>	Compress vibrator sweeps into small wavelets.	After summing to save computer time. Best after despiking and editing. Often done during acquisition, irreversible.	Incorrect sweeps, harmonics, spikes produce ghosts. Acts as a bandpass filter. Very expensive.	10^{11}
<i>Gain Function</i>	Remove effect of geometric spreading, amplifying deep events relative to shallow.	Last step in data reduction above.	Can destroy true amplitude information. Use a reversible function or save unequalized dataset.	10^7
Geometric Corrections				
<i>CMP Sort</i>	Arrange traces by common midpoint.	After data reduction but before velocity analysis or NMO correction.	Incorrect stacking diagram, crooked seismic lines. Uses little CPU time but very expensive in terms of storage media. Gathers no longer correspond to physical experiments.	10^7
<i>Elevation (Datum) Static</i>	Time correction for elevation differences.	Correct to at least a CMP-variable datum before NMO or velocity analysis. May correct to final datum after stack.	Assumed velocities above datum, long offsets.	10^4
<i>Uphole Static</i>	Time correction for lateral velocity variation in weathering layer.	Before NMO or velocity analysis.	Assumed depth of weathered layer; long offsets.	10^4
<i>Velocity Analysis</i>	Estimate V_{NMO} , $V_{interval}$	After determined time corrections and sorting, before final NMO and stacking or any migration.	Assumes zero dip, slow lateral velocity changes, strong reflectors at velocity changes, no multiples. Requires time-consuming human interaction.	10^9
<i>NMO Correction</i>	Correct time on offset traces to zero-offset time.	After sorting and statics, before stacking, part of velocity analysis.	Assumes zero dip, slow lateral velocity changes, no multiples, short offsets.	10^8
<i>Residual Static</i>	Correct any remaining time shifts to straighten out NMO-corrected events.	After NMO, before stacking.	Eliminates delay information useful for transmission tomography. Assumes only slow lateral velocity changes. Needs human interaction.	10^5

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Data Enhancement				
<i>Mute</i>	Zero out arrivals that are not primary P-wave reflections.	Before stacking and/or migration.	Arrival variations with midpoint must be catalogued through human interaction. Overly sharp clips cause artifacts in further processing.	10 ⁷
<i>Bandpass Filter</i>	Attenuate noise outside of reflection frequency band	Best before stack, NMO, or velocity analysis; can be after stack.	Often much noise in signal frequency band, or weak signals are filtered out. Alters true and relative amplitudes	10 ⁸
<i>Notch Filter</i>	Attenuate noise in narrow frequency band, such as 60 Hz AC power	Best before stack, NMO, or velocity analysis; can be after stack.	Too narrow a notch will cause artifacts. Destroys true amplitude and phase.	10 ⁸
<i>Deconvolve</i>	Compress source wavelet shape and duration, improve resolution, attenuate reverberations.	Best before stack, NMO, or velocity analysis, can be after stack	Can unwittingly remove evidence of real reflectors; will change true amplitude and phase.	10 ⁸
<i>2-D (F-K) Filter</i>	Spatial bandpass filter, attenuates or enhances arrivals based on dip, moveout, or apparent velocity.	Anytime after data reduction, depending on type of events.	Alters amplitudes. A good way to make data look like anything you might want, biasing interpretations.	10 ⁷⁻¹¹
<i>Stack</i>	Mimic zero-offset section, attenuate random and much coherent noise.	After sorting, velocity analysis, muting.	Attenuates dipping structures, accentuates lateral coherence. Depends on inferred velocities. Mislocates dipping structures.	10 ⁸
<i>Trace Equalize (AGC)</i>	Amplify weak events or traces relative to strong. Often best used just for display purposes.	Anytime, usually just before or after stack.	Lose amplitude information. Can end up enhancing noise.	10 ⁵⁻⁷
Imaging				
<i>Post-Stack Migrate</i>	Correctly position dipping events horizontally.	After stacking and usually equalization.	Depends on average and/or interval velocities. Cannot improve on steep or crossed dipping events that do not stack well.	10 ⁷
<i>Depth Conversion</i>	Correctly position events vertically.	After stack and usually migration.	Depth error proportional to average velocity error.	10 ⁴
<i>Pre-Stack Migrate</i>	Correctly position steeply-dipping and crossing reflectors. Invert for earth properties. NMO correction and stacking are a simplified migration that assumes zero dip.	Partial migration (dip moveout or DMO) can be done before NMO and stack. Full prestack migration done after data reduction and often after filtering, equalization, and deconvolution; no stacking. Usually applied only to good data from well-characterized areas.	Heavily dependent on velocity estimates and susceptible to gross errors when lateral velocity variations are not correctly accounted for. Extremely expensive.	10 ¹⁴
<i>Database Formation</i>	Organize 3-d seismic depth section to be interactively viewed by interpreter and related to geology, well measurements, other geophysical data, etc. in on-line environment.	Final result of processing. Interpreter should be able to change velocities based on supplemental data and see result on entire sequence of seismic processing interactively.	Interpreter could force data to meet his prejudices. Mis-ties and inconsistencies between seismic and other data must be accounted for.	10 ⁵⁻¹⁴