Elements Of
3-D Seismology

Elements Of
3-D Seismology

Christopher L. Liner
Department of Geosciences
University of Tulsa

PennWell

All inquiries should be referred to PennWell Publishing
1421 South Sheridan/P.O. Box 1260
Tulsa, Oklahoma 74101

Cover Design by Matt Berkenbile
Book Layout by Geoff Harwood with Stormgrafx

Printed in the United States of America

1 2 3 4 5 04 03 02 01 00

CMP Fold

For a 3-D survey to yield good data quality, the target fold should be about one-half of the fold required to shoot good 2-D data in the area. This is a result of migration and dip moveout which result in more mixing of 3-D data than occurs in 2-D.

Some points on fold

1. High fold costs more at acquisition time
2. Low fold (< 10) 3-D has been successful
3. Lower fold with right bin size may be better than high fold with too large a bin

Spatial Aliasing

Spatial aliasing is an effect of trace spacing relative to frequency, velocity, and slope of a seismic event. With adequate trace spacing, the points along a seismic event are seen and processed as part of the continuous event. When trace spacing is too coarse, individual points do not seem to coalesce to a continuous event, which confuses not only the eye but processing programs as well. This can seriously degrade data quality and the ability to create a usable image.

Figure 7-6 shows one way of defining spatial aliasing. In this view spatial is based on trace-to-trace delay associated with a dipping reflector. Since the delay is related to trace spacing, the issue is really one of midpoint interval. This, in turn, is related to shot and receiver interval.

For 2-D data, midpoint spacing, M_i, shot interval, S_i, and receiver group interval, R_i, are related by

$$M_i = \frac{1}{2} Min(S_i, R_i) \tag{7.10}$$

To avoid spatial aliasing on the stack section we require

$$M_i < \frac{v_{int}}{4 f_{max} Sin\theta} \tag{7.11}$$

where v_{int} is the interval velocity near (or immediately above) the target, f_{max} is maximum signal frequency and θ is the physical dip angle of the reflecting bed. When interval velocity is not known, average velocity can be used. But this will give a bin size estimate that is smaller than required. The design condition is rightly based on maximum frequency, but the dominant frequency is often used. This means high frequency components risk being aliased.

Spatial aliasing is not difficult to recognize on real data, (Figure 7-7). The main problem with spatial aliasing is the detrimental effect it has on two very expensive processes: dip moveout and migration. Figures 7-8 and 7-9 give a migration example.

We note for design purposes that diffraction limbs (Figure 7-4) appear as $\theta = 90^\circ$ events. The *Sin*θ term is sometimes invoked to justify a non-square bin in 3-D shooting. However, this increases risk of spatially aliasing the data, so the safe design rule is to use $\theta = 90^\circ$. In this case, the midpoint spacing condition reduces to $M_i < \lambda_{dom}/4$. This agrees with the minimum bin size requirement, $\lambda_{dom}/4$, for a 3-D survey as discussed in chapter 14.

The unaliased midpoint interval grows with depth due to increasing velocity and decreasing frequency.

Some points on spatial aliasing

1. Safe direction is smaller
2. Will be different for shallow and deep targets
3. Use f_{max} and $\theta = 90^\circ$ for safest midpoint interval
4. Smaller midpoint interval costs more at acquisition time
5. Same equation for 2-D midpoint interval and 3-D bin size

Exercise 7.6. In an area with interval velocity of 2,600 m/s we want to record unaliased dips of 70° with a dominant frequency of 60 Hz. What midpoint interval is necessary?

DOCKET ALARM

Explore Litigation Insights

Docket Alarm provides insights to develop a more informed litigation strategy and the peace of mind of knowing you're on top of things.

Real-Time Litigation Alerts

Keep your litigation team up-to-date with **real-time alerts** and advanced team management tools built for the enterprise, all while greatly reducing PACER spend.

Our comprehensive service means we can handle Federal, State, and Administrative courts across the country.

Advanced Docket Research

With over 230 million records, Docket Alarm's cloud-native docket research platform finds what other services can't. Coverage includes Federal, State, plus PTAB, TTAB, ITC and NLRB decisions, all in one place.

Identify arguments that have been successful in the past with full text, pinpoint searching. Link to case law cited within any court document via Fastcase.

Analytics At Your Fingertips

Learn what happened the last time a particular judge, opposing counsel or company faced cases similar to yours.

Advanced out-of-the-box PTAB and TTAB analytics are always at your fingertips.

API

Docket Alarm offers a powerful API (application programming interface) to developers that want to integrate case filings into their apps.

LAW FIRMS

Build custom dashboards for your attorneys and clients with live data direct from the court.

Automate many repetitive legal tasks like conflict checks, document management, and marketing.

FINANCIAL INSTITUTIONS

Litigation and bankruptcy checks for companies and debtors.

E-DISCOVERY AND LEGAL VENDORS

Sync your system to PACER to automate legal marketing.

WHAT WILL YOU BUILD? | sales@docketalarm.com | 1-866-77-FASTCASE