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An interpreter's guide to understanding and working with seismic-derived acoustic impedance data

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You have just joined a new asset team or new company. You're handed an area to evaluate. The data include seismic, logs, and a cube of acoustic impedance. What do you do with the impedance data? How was it created? What unique information does it provide? What pitfalls and artifacts may be present? How do you interpret this data set on a workstation that is designed for seismic data? How do you report your results to management? Valid questions? Read on.

Inversion of seismic data into acoustic impedance (AI) is a rapidly growing field, due primarily to the ease and accuracy of interpretation of the impedance data. The term "inversion" has the potential for a great amount of confusion, as it is used to mean many different things within various branches of geoscience. The discussion in this paper will concentrate on the inversion of poststack seismic traces into acoustic impedance data. Even with this narrower scope, the plethora of programs on the market today makes the comparison of various inversion methodologies and the determination of the quality of your AI cube difficult at best.

This paper will provide a description of terminology and a basis for comparison of poststack acoustic impedance inversion products, as well as give the interpreter a methodology for quality control and interpretation of inverted data.

Benefits of impedance data. Acoustic impedance (AI) is the product of rock density and *P*-wave velocity. This means that AI is a rock property and not an interface property (e.g., seismic reflection data). As we will illustrate, this distinction is the power of AI. Acoustic impedance inversion is simply the transformation of seismic data into pseudoacoustic impedance logs at every trace. All information in the seismic data is retained.

Figure 1 shows an acoustic impedance model and its representation with two imaging techniques. The model is simply a low acoustic impedance wedge embedded in a high acoustic impedance background (Figure 1a). Figures 1b and 1c show zero-phase seismic representations of the model in standard wiggle trace and color density with wiggles overlain. Notice the tuning effects as the wedge thins and the side lobe interference within the wedge itself. Figure 1d shows the results from inverting the seismic data to AI. Tuning is diminished, and the false internal geometry is eliminated. The resulting inverted wedge is a more accurate spatial representation of the original model and provides absolute AI values (shown in color) that match the original model.

Another compelling reason for inverting seismic data is illustrated in Figure 2. A synthetic seismic data set (colored seismic with wiggles overlain) is shown in panel 2b. The synthetic seismic is created from the acoustic impedance model in panel 2d and the wavelet in panel 2a. The model contains three interfaces: 50 ms, 135 ms, and 230 ms. Note that each interface represents the same change in absolute AI units but in varying gradational degrees. The seismic data identify the sharp interface at 50 ms. They identify the top of the second interface at 135 ms, but it is not apparent that the interface is a gradational coarsening upward sequence because the seismic do not recognize the base of the event. The seismic fail to identify the most gradual interface at 230 ms. Compare the seismic response with that of the inverted traces in panel 2c. The inverted trace data can effectively model all these variations in rock properties because the inverted data utilize a complete frequency range of 0-80 Hz. To summarize some advantages of impedance data:

- A good quality impedance model contains more information than seismic data. It contains all the information in the seismic data without the complicating factors caused by wavelets and adds essential information from the log data. The AI volume is a result of the integration of data from several different sources, typically seismic, well log, and/or velocity. Indeed, building an impedance model is the most natural way to integrate data and provides a medium understood by geologists, geophysicists, petrophysicists, and engineers.
- Acoustic impedance is a rock property. It is the product of density and velocity, both of which can be directly measured by well logging. Seismic data is an interface property, a close approximation to the convolution of a wavelet with a reflection coefficient series, which reflects relative changes in acoustic impedance. AI is therefore the natural link between seismic data and well data.
- AI is closely related to lithology, porosity, pore fill, and other factors. It is common to find strong empirical relationships between acoustic impedance and one or more of these rock properties. AI models can provide the basis for the generation of 3-D facies models and 3-D petrophysical property models. These volume results can be ported directly into reservoir simulators for flow analysis.
- AI is a layer property. Seismic amplitudes are attributes of layer boundaries. As a layer property, acoustic impedance can make sequence stratigraphic analysis more straightforward. Wavelet side lobes are attenuated, eliminating some false stratigraphic-like effects as seen in Figures 1b and c.
- AI data support fast and accurate volume-based interpretation techniques, allowing for rapid delineation of target bodies.
- The AI concept is readily generalized to handle the inversion of angle or offset stack data to elastic impedance or elastic parameters. Elastic impedance captures AVO

information and, in conjunction with AI, improves interpretation power and the ability to discriminate lithology and fluids.

How frequency content affects interpretation. Seismic are band-limited, missing the highest and lowest frequencies. The band-limited nature of seismic data is often considered in terms of the high frequencies and the consequent lack of resolution. However, the low frequencies missing from the seismic data are extremely important if quantitative interpretation is required. This is illustrated in Figure 3 by a simple impedance layer model, inverted for three different frequency ranges: 10-80 Hz, 10-500 Hz, and 0-80 Hz. A modeled AI layer (well AI, in black) was used to derive a synthetic seismic data set utilizing a Ricker wavelet comprising the frequency range on the right. The synthetic seismic was subsequently inverted back to AI. The resulting inverted AI traces are red with the bandwidth of the inversion annotated on the right.

When the seismic data are inverted using a wavelet with frequencies of 10-80 Hz, (Figure 3a), the approximate thickness of the layer is accurately imaged, but the absolute impedance values and the interface shape are incorrect. When the wavelet frequency is increased to an extreme of 500 Hz (Figure 3b), the results are capable of resolving thinner beds but still do not accurately represent the model. However, when low-frequency information is included from additional sources, the inverted data best represent the model (Figure 3c). This demonstrates that low-frequency information is critical to a complete inversion result.

Most inversion methods incorporate external information to reconstruct the missing frequencies outside the seismic bandwidth, producing broadband results. Different methods reconstruct the missing information in different ways and with varying degrees of success. Low-frequency information can be derived from log data, prestack depth, or time migration velocities, and/or a regional gradient. Because many of these data are very low frequency (0-2 Hz), processing that preserves low frequencies is advantageous. High-frequency information can be derived from well control or geostatistical analysis.

Figures 4-6 show the impact of converting from band-limited seis-

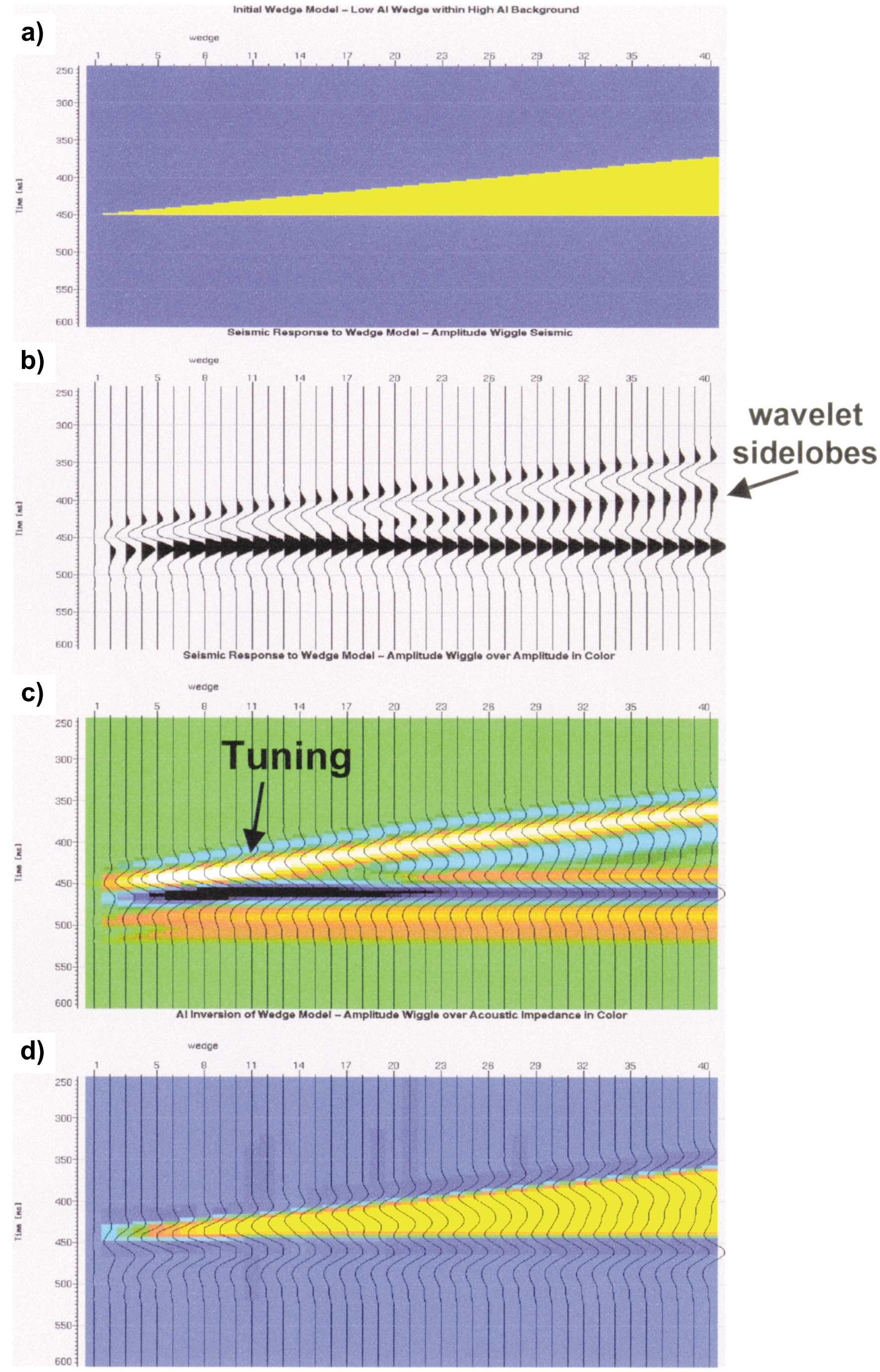

Figure 1. Some of the many advantages of acoustic impedance over seismic data are illustrated in this figure. (a) A simple model of a low-impedance wedge in a high-impedance background. (b) The synthetic seismic data generated by convolution of a Ricker wavelet with the reflection coefficients from this model are shown with the traditional wiggle trace and (c) as color amplitude with wiggles overlain. From the seismic data it would be simple, in this case, to interpret the general structure of the model. However, because of the effects of the side lobes of the wavelet and the effects of tuning, it is difficult to know whether there are any internal structure or lateral variations in the properties of the wedge. (d) The inversion of the seismic data. It is now a simple matter to interpret the boundaries of the wedge. It is also possible to examine the internal structure of the wedge in terms of absolute physical properties. Even though in the real world the situation is usually more complicated than this simple wedge, analogous interpretative advantages may be achieved through acoustic impedance inversion.

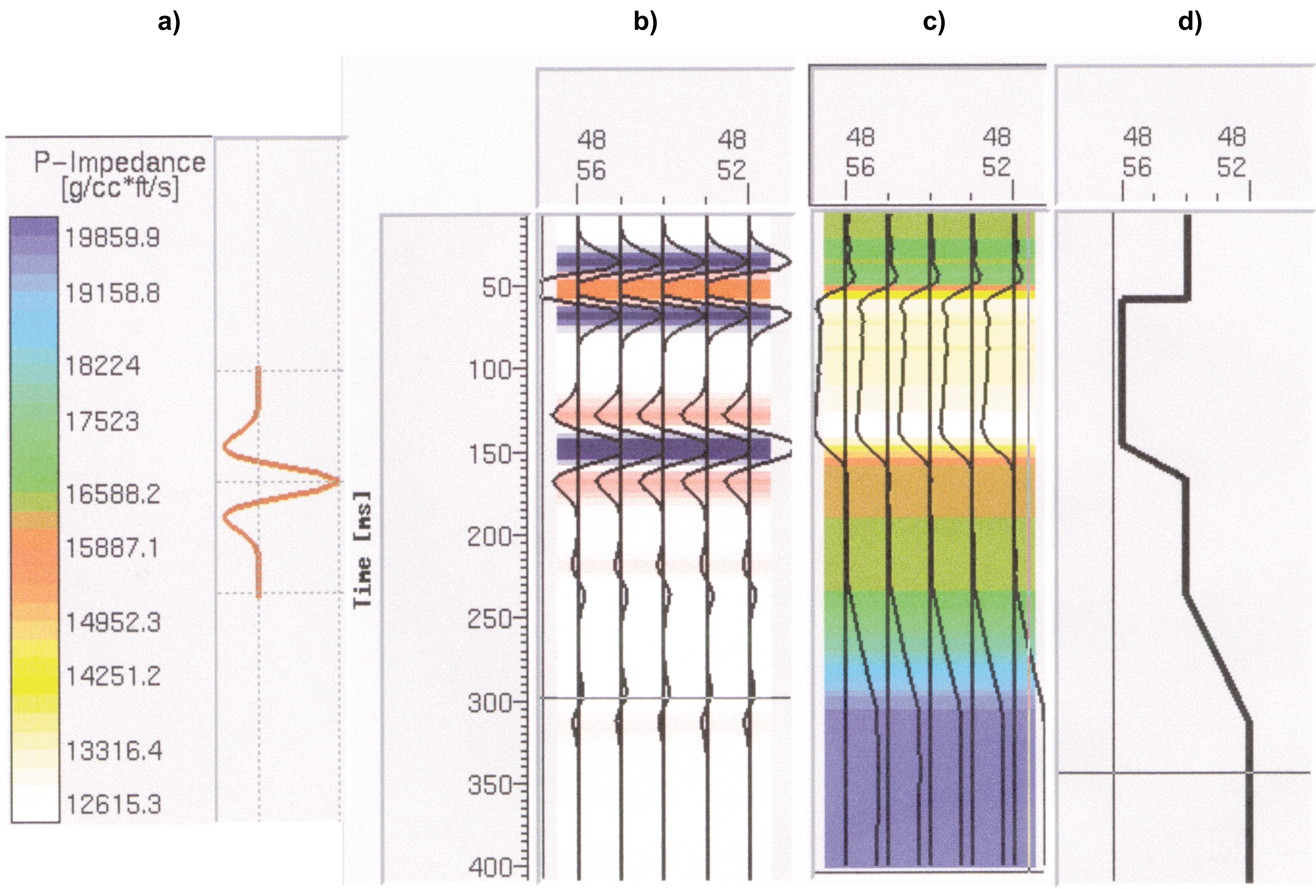

Figure 2. Impedance inversion models contain more information than seismic data because they have a broader frequency content. (b) Synthetic seismic data set based on the acoustic model in (d) and the wavelet in (a). There are three transitions—50 ms, 135 ms, and 230 ms. Each interface represents the same change in absolute AI units but in varying gradational degrees, representing varying dominant frequencies. The synthetic seismic identifies the sharp interface at the top 50 ms (80 Hz), sees the top of the event at 135 ms (15 Hz), but it is not clear that it is a gradational coarsening upward sequence and fails to recognize the most gradual interface at 230 ms (6 Hz). Compare the seismic responses to that of the inverted traces in (c). The inverted traces are shown in color with a black overlay. There is a significant difference in the properties of the rocks at 150 ms and 230 ms. These differences are not clear from the synthetic seismic data because the low-frequency information is missing. On the other hand the impedance inversion model contains this necessary information.

mic data to broadband impedance data. In this example, AI inversion was applied to assist in the interpretation of a "hidden" channel. In Figure 4, a seismic section is shown in wiggle trace format. The yellow event on the left and right of the section is interpreted based on well control and is a known unconformity. There are a number of ways that the yellow marker could be interpreted to tie between segments. The problem is resolved by looking at the acoustic impedance inversion result (Figure 5). Following the top of the high-impedance layer (red/yellow) leaves little ambiguity in the answer. A channel has been incised into the previously deposited high acoustic impedance layer. The completed interpretation has been transferred back to the seismic data in Figure 6. The interpretation from the seismic data alone is clearly problematic. The change in layer "hardness" allowed the inverted data to image the unconformity clearly.

Quality control of input data. The quality of the final inversion is a direct result of the quality of the input data. To objectively estimate the accuracy of an AI inversion cube, the interpreter must be familiar with the input data and what processes were applied to invert the data. A comprehensive inversion report is a powerful source of information but, if not available, some key items should be examined: seismic processing information, inversion algorithm, date and workflow, well spud details, and log processing. Depending on the inversion method, the data types may include poststack seismic data (full fold as well as angle stacks) well-log data, and a set of preliminary time or depth horizons.

Prior to inversion, examine the well logs for suitable relationships between measured impedance logs (calculated by dividing the density by the sonic log) and other desirable properties, such as porosity and fluid fill. Well logs should be converted to time and filtered to the approximate bandwidth of the seismic to determine if zones of interest are recognizable at the frequencies expected after inversion. All well logs should be edited for borehole effects, balanced and classified based on quality. Logs that do not tie the seismic should be investigated for problems in log, wavelet, or seismic data.

When inverting, it is generally preferable to run a loosely constrained, trace-based inversion first. The inversion can then be used for a more thorough interpretation as shown in Figures 4-6. This initial inversion can be followed by a more tightly constrained or model-based inversion as the need arises to meet your particular project's interpretation objectives. With trace-based inversion, the process begins with the seismic data, possibly augmented with limited nonseismic data (trend data derived from velocities or wells). With model-based inversion, additional weight is given to the nonseismic data in addition to the seismic trace data. Nonseismic data do not necessarily need to be captured in the form of a model. For example, methods, which also use constraints or information about statistical distributions, are also considered model-based. This distinction into trace-based and model-based is important with regards to the QC of the results, as we will see in the next section.

Quality control of the acoustic impedance results. Numerous AI inversion algorithms are available throughout the industry. Regardless of the method used, certain quality controls should always be carried out. The main tests of inversion accuracy are the ties between the input well logs and the inversion result, and between the input seismic and the synthetic derived after the inversion. Which one of these two tests is most important as a quality check depends on whether the inversion is predominantly model-based or trace-based.

Volumes created with methods that are heavily driven by log-derived models should match at the well locations. If the logs do not tie, then they have been perturbed in the inversion process, indicating a problem in the log or seismic data or, more likely, the initial tie of the seismic to the well data. For these model-based inversions, the match between the seismic and the synthetic created from the inverted results serves as an important QC.

Trace-based inversion methods and those model-based methods that make limited use of well log or other nonseismic data rely heavily on the seismic data and should tie the seismic. Because the well data have limited use, the logs can be used as an independent QC. To make a valid comparison between log data and the inverted impedance, the log data should first be filtered to the range of the seismic frequencies.

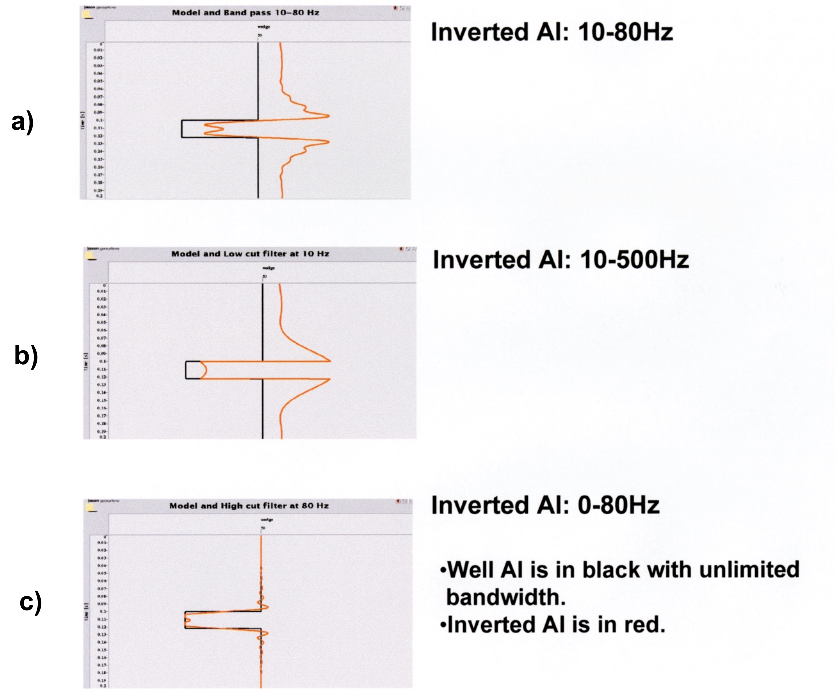

Figure 3. The band-limited nature of seismic data is often considered in terms of the high frequencies and consequent lack of resolution. However, the low frequencies missing from the seismic data are extremely important if quantitative interpretation is required. This is illustrated by filtering a simple impedance layer model to three different frequency ranges (a) 10-80 Hz, (b) 10-500 Hz, and (c) 0-80 Hz. The inclusion of the high frequencies (b) allows us to interpret the location of the layer boundaries more accurately, but it is the inclusion of the low frequencies (c) that allows us to obtain absolute values for use in the quantitative interpretation of the rock properties.

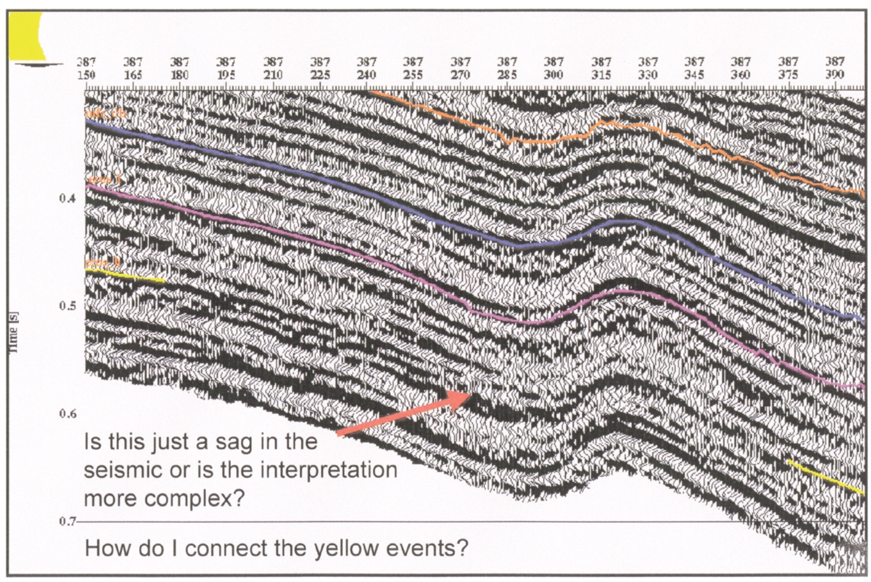

Figure 4. Interpretation is made easier by reference to the impedance inversion model. This is clearly demonstrated with this example of a "hidden" channel. A seismic section is shown in wiggle-trace format. The yellow event on the left and right is interpreted based on well control and is a known unconformity. A number of places exist where the yellow horizon could drop down onto a lower event in the attempt to tie the horizons. The correct answer appears to be a matter of interpretative judgment and knowledge of the regional play concepts.

In all cases, a universal quality check of an acoustic impedance volume is to compare the inverted AI estimate to log data not used in the inversion. These wells may have been drilled later or intentionally not input to provide "blind" accuracy tests of the process. For such blind tests to be of value, wells used for this purpose should be properly tied with the seismic and corrected for borehole effects.

It is also important to ensure that the wavelet utilized in the inversion process matches the phase and frequency of the seismic data. If the results of an inversion do not tie the logs (assuming the logs are correctly time-converted and edited for borehole conditions), the wavelet may be incorrect. An inversion should be completed over a time target with a wavelet appropriate for that target. If the wavelet is extracted for a deep target and then applied in a shallow inversion, the frequency of the wavelet may be too low. This can result in "ringing" of the final AI inverted data. When the reverse is true and the wavelet frequency is too high, the results will appear smeared and of a lower frequency than the log data. Wavelets with an incorrect phase or amplitude spectrum can result in erroneous time shifts that can contain extra side lobes, which create false geologic events and result in mis-ties with the logs.

As we have seen, low-frequency reconstruction is critical to the final interpretation. But the input data available may be limited. If, for example, a survey area has only a few wells from which to derive the low frequencies, there may be variance away from the wells that is not captured by the low-frequency model. Additional information pertinent to low frequency content may be obtained by inclusion of stacking velocities or prestack time- or depth-migration velocities into the low-frequency model.

The final AI product should always be verified with a relative impedance result. A relative impedance data set is one where the data have` been filtered to remove the low frequencies. This volume is limited stratigraphically or structurally, as seen in Figure 2, but can be used to cross-check an anomaly. For example, if an anomaly such as a low AI target body is detected in the full bandwidth volume but no longer apparent on the band-limited data, then rethink this possible target. It may have been created from a poorly constructed low-frequency model.

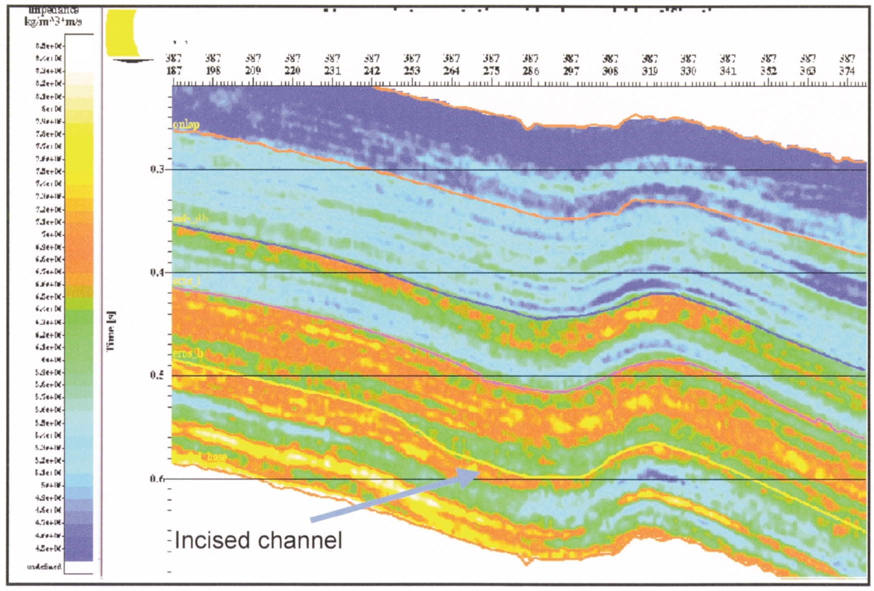

Figure 5. The interpretation problem is resolved by looking at the acoustic impedance inversion section. By following the top of the high impedance layer (red/yellow), there is no conflict between the geologic well picks. There is a low acoustic impedance channel that has subsequently been interpreted as an incised valley.

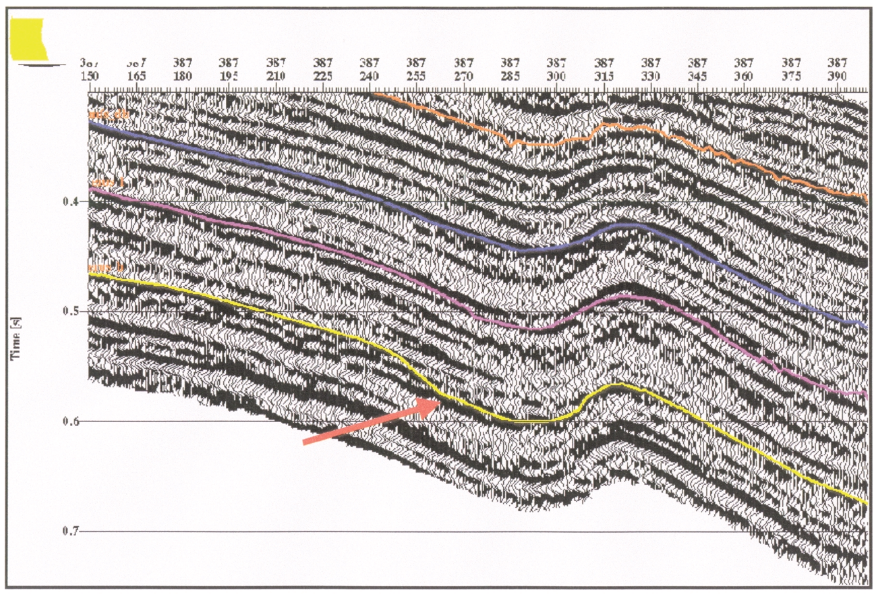

Figure 6. The completed interpretation from Figure 5 has been transferred back to the seismic data. The interpretation from the seismic data alone was clearly problematic. The change in layer impedances allowed the inverted data to image the unconformity clearly.

Interpreting impedance. The first thing you will notice about your full bandwidth AI data is that all the values are positive. These positive values pose a problem when attempting to analyze the results on a traditional seismic interpretation workstation designed for the positive and negative values found in seismic data. A solution to this problem is to subtract a constant value from the AI data in order to visualize the data on the workstation. This is often easier than attempting to "fool" the workstations by editing the colors. Some workstations have implemented impedance color bars in order to handle AI data. Another solution is to load a filtered "relative impedance" data set, which contains positive and negative values that allow for seismic type tracking.

The problem with the traditional workstation approach is that AI data are being treated as though they were seismic. Once it is understood that inverted AI data represent a true rock property, it becomes much easier to extend our methods of interpretation beyond traditional 2-D or 2.5-D interpretation methods. In fact, impedance data make true 3-D interpretation not only possible but also the technique of choice.

With a known relationship between AI and a desirable lithologic parameter such as porosity or sand/shale fraction, the entire AI volume can be examined and targets of interest may be quickly extracted from the inverted data by capturing the top, bottom, and areal extent of the target body. Variations of the lithologic property within these "geobodies" are known and can be included in volumetric calculations. Generally, this type of analysis is done in several steps, as shown in Figures 7-9 and outlined below.

- Using log data, establish a relationship between AI and known rock properties within specific target zones and within the frequency range of the inverted data set. Figure 7 shows a crossplot of AI, gamma ray, and resistivity. Samples with high resistivity (colored dots) and low gamma ray are shown to contain low AI. This establishes that, in this case, low AI is diagnostic of hydrocarbon-bearing sands.
- Limit the lateral and vertical range of the AI volume to the zone of interest, either by defining a time or depth range around a horizon, or by focusing around a specific lithologic unit. Apply the AI-to-rock-property relationship established in the first step (Figure 7) to the target zone. All data values that do not satisfy the desired range of values are made transparent, leaving only those points of interest as shown in Figure 8.
- Apply an economic threshold to the data shown in Figure 8 as well as a determination of the connectivity between bodies. Figure 9 shows a set of color-coded "geobodies." Each color consists of cells in communication with each other. Output can include the top, base, and thickness horizons as well as the actual property values within the bodies.
- Because the final analysis is truly 3-D, rock-property variations within the volume are included in calculations of porosity, volumetrics, net pay, and any other log property that can be related to AI. Traditional thickness and structure maps (in depth or time) are also a by-product of this process but can be computed and mapped in minutes rather than months.
- The individual "geobodies" can be

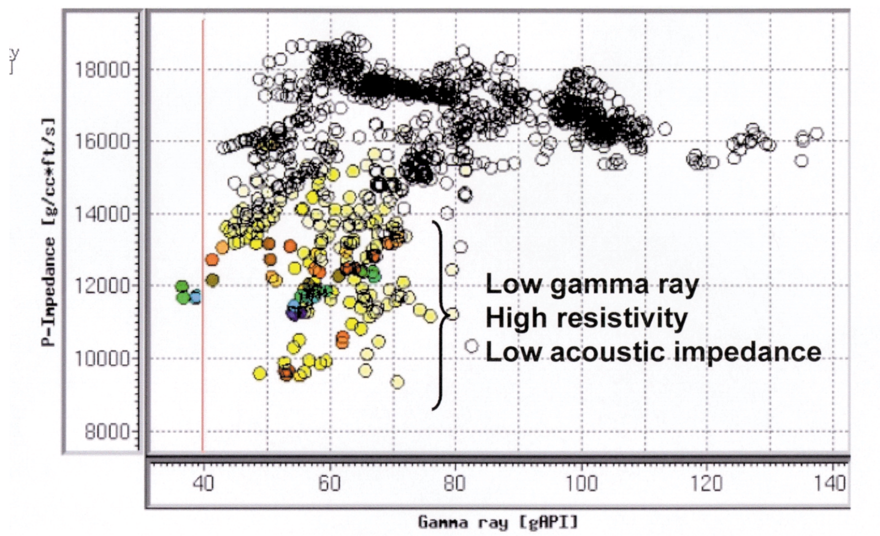

Figure 7. Acoustic impedance volumes can be interpreted differently than seismic data. Once it is understood that inverted AI data represent a true layer rock property, it becomes much easier to extend methods of interpretation beyond traditional 2-D or 2.5-D interpretation methods. In fact, impedance data make true 3-D volume interpretation not only possible but also the technique of choice. Figure 7 illustrates a process showing a faster, more straightforward method of volume analysis. The figure shows a crossplot of AI, gamma ray, and resistivity. Samples with high resistivity (colored dots) and low gamma ray are shown to contain low AI. Crossplot analysis establishes a relationship between AI and known rock properties within specific target zones. In this case the hydrocarbon bearing reservoir sands fall below the indicated threshold. This threshold can be applied to volume data in order to isolate areas of potential hydrocarbon accumulation.

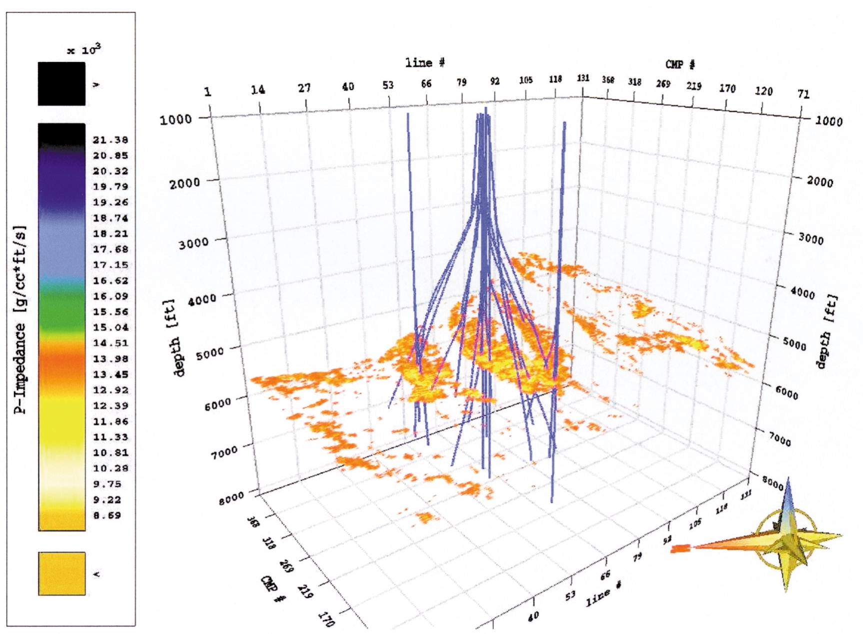

Figure 8. The acoustic impedance-to-rock-property threshold established in Figure 7 is applied to a target horizon slice or layer. All data values that do not satisfy the desired range of values are made transparent, leaving only those points of interest visible on the screen. This isolates only the target reservoir or target rock property.

converted to depth and ported directly into a reservoir flow simulator, along with AI-derived reservoir properties such as porosity.

All the above interpretative advantages apply to the inversion of angle-stack data into elastic impedance (EI). Discrimination of lithology and fluid content is further enhanced when comparing AI (near angle) and EI (mid- or far-angle) data.

Methods of inverting seismic data. There is no single best method for inverting all data. After defining the scope of the project, analyze the available data, determine project objectives, consider the desired turnaround time, and then select the most suitable method for inversion. Some of the following points should be considered:

- An exploration project with huge volumes of data and little well control calls for application of quite a different method than a development project with extensive well control and a narrower production target.
- Through log analysis, determine if the survey area has a unique relationship between AI and your hydrocarbon target. Determine the thickness of the target section. Do you need to image events thinner than the seismic can resolve? Do you need to run an inversion on an angle stack data set in order to better image the target or better discriminate between lithology and fluids?

The earliest methodologies developed for AI inversion were based on recursive or trace integration algorithms (RTI methods). These are truly trace-based, because the seismic trace is the sole input. They are also the simplest and most limited algorithms. For these algorithms to produce meaningful results, the wavelet embedded in the seismic must be zero phase and flat. RTI methods are simple and fast. However, they produce results only within the seismic data bandwidth and, because the embedded wavelet is not removed, tuning and wavelet side-lobe effects are not reduced. As a result, the advantages they offer relative to interpreting seismic data are limited.

Why are there so many inversion methods available, given the seemingly simple process of transforming data from the seismic reflection domain to the acoustic impedance domain? The fundamental reason is that when removing a wavelet from a seismic trace to arrive at an appropriate reflection coefficient series, there are many answers; i.e., the solution is not unique. To address this mathematical limitation, most modern inversion methods constrain the answer in some way and therefore produce broadband results that generally succeed in correctly inverting the seismic within the seismic bandwidth. How the constraints and the frequency reconstruction issues are handled determines the fundamental differences between algorithms. In other words, all methods except RTI are to some degree model-based and differ in how they leverage nonseismic information. Most model-based inversion algorithms available today can be divided into the following categories:

Layer-based or blocky inversion. These algorithms model the earth as layer blocks described by acoustic impedance and time. This blocky model is broadband. The link to the seismic is through the convolutional model, which can incorporate any wavelet. Nonuniqueness is countered by restricting the number of layers relative to the number of seismic samples. When the layers become thinner than the seismic resolution, the answer becomes nonunique, which is countered by stabilizing to an initial model.

Sparse spike inversion (SSI). In these algorithms, the reflection coefficient series underlying the acoustic impedance is assumed sparse; i.e., the seismic trace data can be modeled with fewer reflection coefficients than seismic trace data samples. A sparse spike series is also broadband. In these methods the link to the seismic is also through the convolutional model which can incorporate any wavelet. Nonuniqueness is countered by applying the sparsity criterion. To provide further control on reconstructing frequencies outside the seis-

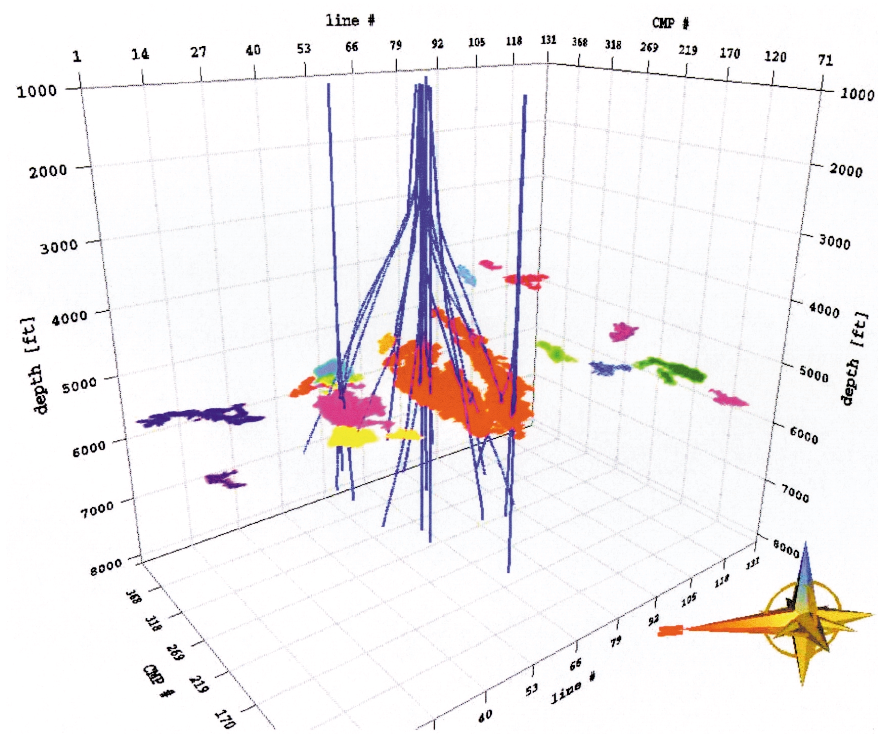

Figure 9. An economic threshold is applied to the data shown in Figure 8 by setting a minimum number of connected cells as well as determining how the cells are connected within the bodies. This analysis results in "geobodies" that are color-coded by size and communication to one another. The results allow the interpreter to remove all bodies below an economic threshold. Output can include the top, base, and thickness horizons as well as the actual property values within the bodies. This produces traditional thickness and structure maps (in depth or time), but now they are computed and mapped in days rather than months. Because the final analysis is truly 3-D, rock-property variations within the volume can be included in further calculations of porosity, volumetrics, net pay, and any log property that can be related to AI.

mic data bandwidth, modern sparse spike algorithms can also use model data for stabilization and/or constraint.

Least-squares inversion. These methods are similar to SSI, except a sparsity criterion is not used. As a result, least-squares inversions do not attempt to broaden the spectrum for the higher frequencies. The focus in these methods is on including an initial model and stabilizing to this initial model to cover the low-frequency component of the spectrum.

Layer-based or blocky, sparse spike, and least squares inversion all produce broadband results by virtue of the nature of the method itself, or by providing control relative to an initial geologic model. They are all limited in their ability to reconstruct the high frequencies. Except for RTI, all these methods succeed, to some level, in backing out the wavelet and reducing tuning effects. Also, the more modern of these methods allow varying degrees of control on the use of external information. In this way some of these methods can smoothly cover the spectrum from trace-based to model-based, making them applicable to a range of interpretation projects.

New methods are also becoming available. These methods take inversion to the next level by greatly extending the use of nonseismic information to get broadband results. We discuss two examples of these advanced methods.

Methods based on 3-D geologic log models: Modern computers allow for the construction of complex 3-D geologic models using a parametric approach. One example utilizes a model based on input logs, lateral distribution of log weights, time structure maps, and velocity corrections to control geologic layer thickness. This model utilizes seismic, where log information is sparse, to update the lateral distribution of log weights. Such a method produces a high-resolution, broadband output. Because the initial geologic model is heavily utilized (strongly model-based), successful application requires multiple wells with excellent fit to the seismic and good control on the geologic model.

Geostatistical inversion: This inversion algorithm combines geostatistical data analysis and modeling with seismic inversion. In geostatistical analysis, the spatial statistics of the data are generated. Geostatistical modeling simulates data at grid points starting from known control points, typically well logs. Geostatistical modeling preserves the spatial statistics of the data but does not guarantee that any simulations are consistent with seismic data. In geostatistical inversion, the simulation algorithm is modified to simultaneously honor both the well bore and the seismic data while producing estimates of reservoir parameters between wells. Geostatistical inversion provides a powerful way to bring in information from outside the seismic bandwidth, utilizing both well control and geologic control on the spatial distribution of acoustic impedance.

The future of inversion. AI inversion provides the most straightforward conversion from seismic reflection data to layer rock-property data, providing a wide range of interpretive benefits. However, AI inversion is only a stepping stone into the realm of seismic-derived rock-property data. There are many new exciting areas of development to investigate. The first is the inversion of angle or offset partial stack data to leverage AVO information. Several approaches are feasible, including methods that invert angle- or offset-stacked data to elastic impedance. Interpretation of elastic impedance has added benefits to acoustic impedance interpretation. The possibility to combine AI and EI data, enabled by a new generation of multicube volume interpretation methods, creates powerful possibilities for enhanced interpretation and discrimination of lithology and fluids. As a next step, simultaneous inversion of multiple angle or offset stacks is now feasible. This leads to estimates of various combinations of elastic parameters such as *P*-wave and *S*-wave sonic, V_P/V_S, density, and Lame parameters. Joint interpretation of these parameters maximizes use of the available seismic data for interpretation and for enhanced lithology and fluid discrimination.

Conclusions. AI, being a lithologic property rather than an interface property, can be used for direct geologic interpretation. Impedance data sets have many advantages over seismic. Tuning is diminished and resolution is increased; sequence stratigraphic analysis is simpler because the data are now in layers, rather than interfaces; and wavelet side lobes are removed, eliminating the risk of false geologic structures. Direct hydrocarbon indicators are commonly more apparent in impedance than in seismic, and rock types are easily discernible. Crossplots of various log properties can identify relationships, such as AI to porosity and AI to lithology, which may be directly applied to the inverted volume or detected geobodies. The bottom line is that, through the use of acoustic impedance data or related inversion products, a prospect derived from your new exploration area or a development or production well proposal can be more accurately and efficiently evaluated and risked by the geologist, geophysicist, and engineer. LE

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