The "Bright Spots" in this month's issue covers a broad spectrum of topics in the May-June issue of GEOPHYSICS — an integrated application of seismic reflection/refraction/HTEM data, fracture parameter inversion in the Marcellus Shale, an application of dynamic warping to seismic-to-well-log ties, and a clever method of extracting density from the amplitudes of converted-wave data.

These are only the warm-up. The three final papers mentioned below discuss methods for avoiding the single-scattering assumption that is inherent in all conventional seismic-migration methods, based on an inverse-scattering inversion theory founded on the Marchenko equation.

Reiser et al. discuss "Constraining helicopter electromagnetic models of the Okavango Delta with seismic-refraction and seismic-reflection data." In this case study, the authors use high-quality seismic-reflection and seismic-refraction data to obtain a simple three-layer model of the Okavango Delta to constrain the inversion of HTEM data.

In another important case study, Far et al. present "Fracture parameter inversion for Marcellus Shale." The authors invert P-wave amplitude versus offset and amplitude (AVOAz) data to solve for fracture parameters of the Marcellus Shale.

Moving from case studies to improved data interpretation, Herrera and van der Baan, in "A semiautomatic method to tie well logs to seismic data," seek to replace the visual pattern-recognition step in well-log-to-seismic ties with a constrained dynamic warping technique as an aid to the interpreter. The algorithm determines the appropriate amount of local stretching and squeezing to produce the highest correlation between the original well data and the resulting synthetic seismogram. The technique is an aid but still requires interpreter supervision.

In "S-zero stack: A converted wave processing to extract subsurface density information," Zou notices that it is possible to decouple density contrast from shear-velocity contrast for P-wave angles of incidence greater than 30°, with the maximum separation occurring at about 60°. By applying a special stacking technique, the author creates a processing method that can yield density contrast for such wide-offset PS mode-converted data.

Taking a multidisciplinary approach, Witsker et al. explore the possibility of linking reservoir engineering and 4D seismic by "Using a pseudo-steady-state flow equation and 4D seismic traveltime shifts for estimation of pressure and saturation changes." The authors create an inversion scheme that combines a reservoir-engineering flow equation for pore-pressure prediction with the rock-physics models of Hertz-Mindlin and Gassmann to discriminate pressure and saturation effects from 4D time shifts. Synthetic and field data examples (CO_2 sequestration) are presented.

The next three papers are related and deal with seismic migration in the presence of internal multiples.

Broggini et al. present "Data-driven wavefield focusing and imaging with multidimensional deconvolution: Numerical examples for reflection data with internal multiples." The authors apply their "data-driven wavefield focusing" technique, which employs the virtual-source method, combined with reciprocity, to generate upward-traveling and downward-traveling Green's functions at every point in the medium. Through an iterative technique, the method allows the proper imagining of internal multiples. The technique is data driven but depends on the same type of model that would be used for conventional migration.

Wapenaar et al. introduce the theory of "Marchenko imaging." The authors presents a 3D version of a 1D inverse-scattering method developed in the 1950s by Marchenko and by Gelfand and Levitan, which is based on Sturm-Liouville theory. The 3D version is an iterative scheme that introduces "focusing functions" that might be related to upward- and downward-traveling Green's functions. The effect is that the reflection response can be used to estimate the upward- and downward-traveling fields at all points in the medium. The authors claim that the Marchenko approach is an improvement over the interferometric virtual-source method as applied in the "data-driven wavefield focusing" method discussed in the previous paper.

Behura et al. present an application of the Marchenko theory to the problem of migrating seismic data containing internal multiples in "Autofocus imaging: Image reconstruction based on inverse scattering theory," by which the authors mean the 3D extension of the Marchenko equation presented in the previously discussed paper. Effectively, the autofocus method is an iterative seismic-imaging technique that not only produces an accurate image of the subsurface but also handles internal multiples correctly. The authors present a numerical comparison of autofocus imaging of the Sigsbee model data with traditional RTM imaging (Figure 1), showing fewer artifacts in the autofocus image.

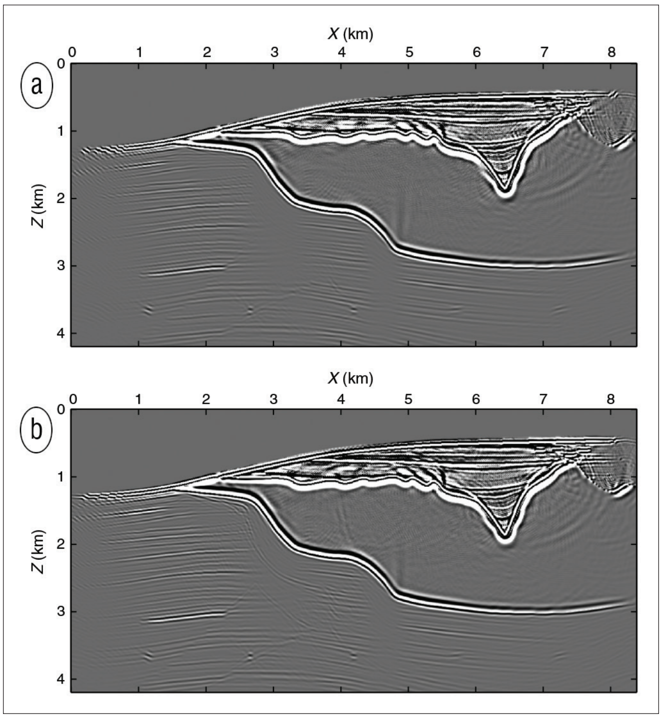

Figure 1. (Figure 5 of Behura et al.) Images of the Sigsbee model obtained from (a) autofocus imaging and (b) RTM. The autofocus image is generated with 20 iterations. The crosscorrelation imaging condition is used for generating both images.