

Using geology to develop a better depth product in Central Green Canyon Roho

Lynn Anderson (CGG) discusses some of the techniques available to better understand a large Roho basin in the deep water Green Canyon area of the Gulf of Mexico

CGG's northern Green Canyon surveys cover a variety of basin types including silled basins, several Roho basins, and ramp basins. A new CGG 3D seismic survey imaged an unusual Roho basin that crosses the survey from north to south at the eastern side of the Phase A prestack depth area (Fig. 1).

Three phases of 3D seismic data were shot covering 207 blocks over a complex series of diapiric salt features and the intervening clastic-filled basins. Each basin has a unique growth, fill, and trapping history making the integration of a coherent regional picture quite challenging. Though early 3D coverage in the area was insufficient, the newer seismic data in conjunction with the depth processing is producing better results.

Nearly all deposition in the deep water Gulf of Mexico is controlled in one way or another by salt movement (Fig. 2). The different depocentres in Green Canyon are no exception.

Salt movement down slope towards the south created space in the north to be filled by sediments, as well as sills to dam the sediments in the south. Only a small amount of salt remains in the Green Canyon area, particularly when compared with the Sigsbee Escarpment to the south, but much more salt was present in the past.

This area appears to have had mass movements of the upper Miocene and Pliocene sediments on a major detachment surface (Fig. 3). The salt moved upward and basinward in a sheet and provided the lubricant for the basinward movement of the sediments. A variation of this type of feature has been described as a Roho by Rowan et al., 1999, Schuster, 1999, Diegel et al., and Peel et al., 1995

Rohos

Rohos are started when salt is fed upward to form a tongue (Fig. 4) that flows down dip forming a mass that is significantly longer than it is wide. Sediments are deposited at either side of the flow, keeping pace with the growing thickness of the salt tongue. After the salt is in place and the source is either exhausted or pinched off, continued movement of the salt creates a void. Sediments fill the void, from the shelf end, and prograde down dip with the help of growth faults. Salt remnants provide the lubricant where these faults merge into the basal detachment surface, at the

base of the Roho. The large Roho in Green Canyon has the correct geometry, dimensions, and lateral features of a Roho.

There is little evidence of the growth fault portion of the Roho in Green Canyon. North of the area, Karlo and Shoup, 1996, and Diegel et al., 1995 show a major Roho. This could be the shelf end of the Roho in Green Canyon. The portion of the Roho in Green Canyon would be the

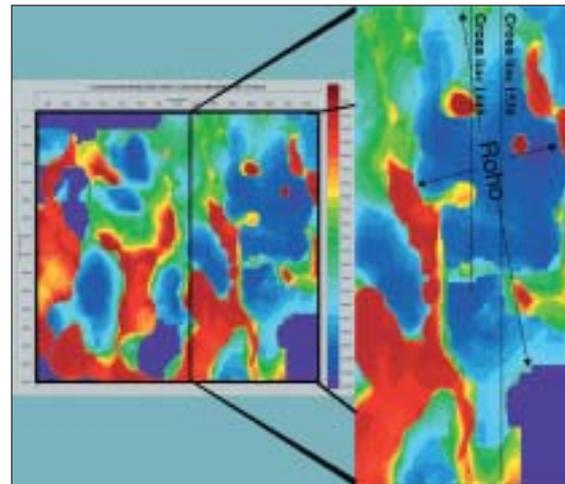


Figure 1 Phase 'A' top salt and detachment map in metres.

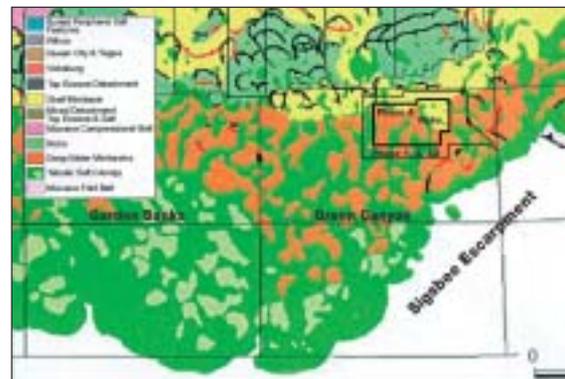


Figure 2 Gulf of Mexico principal structural provinces.

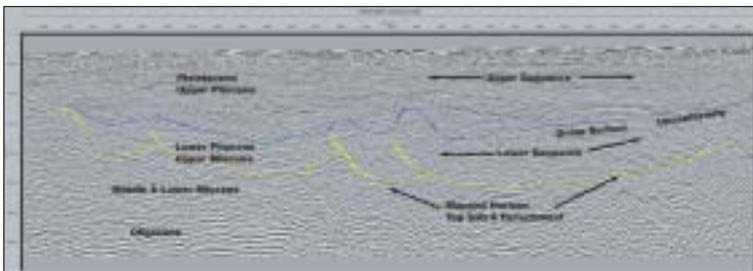


Figure 3 North-south seismic line 1530 down the length of the Roho in the eastern side of phase A showing a major onlap surface between the upper and lower sequences. See Fig. 1.

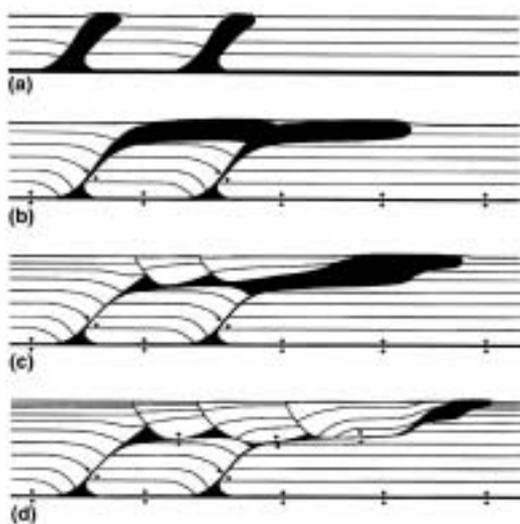


Figure 4 Rowan's evolution of a Roho.

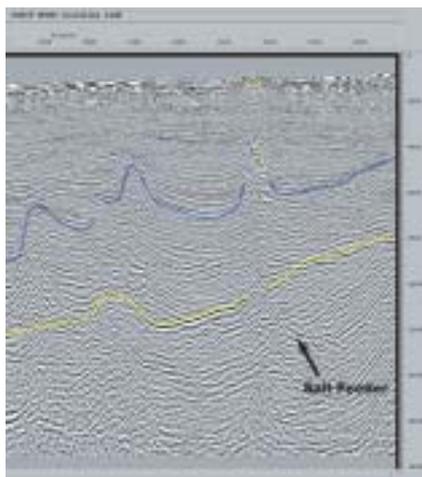


Figure 5 North-South seismic line 1440 showing salt feeder injected after the major movement along the detachment surface.

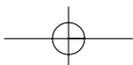
most basinward end of the Roho where most of the features are compressional. The eastern Phase A has two distinct sediment packages. The deeper section is complexly folded and thrust with the largest folds and thrusts in the deepest portion of the Roho (Fig. 3). The top of the lower sequence is eroded and the upper sequence onlaps this from south to north.

Throughout the evolution of this Roho, it is difficult to separate the mass movement of the sediments from salt evacuation along the detachment. There are several salt piercements within the Roho, but they seem to have been injected from depth after most of the movement occurred (Fig. 5). Though salt exerted its influence, major structures associated with the Roho must be attributed to mass sediment movement not diapirism.

Understanding the geometry and tectonics of this basin begins to put the shape of the salt and sediments into a clearer picture. The correct shape of the salt provides the input for the depth product, and the definition of the salt and sediment relationship can be presented to the clients to sell the data as well as give them an early start in their exploration efforts. The upper end of the Roho contains some of the listric faulting expected throughout the classic Roho, and Genesis Field is associated with this sort of faulting. The structure that traps Allegany Field was generated at the eastern edge of the Roho in response to the lateral movement of sediments.

The east-west anticline that sets up the Fronrunner Field, created by thrusting, and the turtle structure, inverted to form King Kong field in the south, was created in response to compression in the Roho. Fronrunner reservoir sediments at the base of the upper sequence pinch out as they onlap the unconformity on top of the lower sequence. Therefore, the reservoir should only be present in the southern end of the basin. This relationship only becomes evident when the entire Roho can be seen.

The excellent resolution and deep imaging in the prestack time migration of Green Canyon Phases I, II and III, and the highlighting of the salt in the depth migration of Phase A, have been the driving factors in making the analysis of this Roho possible. Definition of the salt and sub-detachment sediments in the depth imaging product has



been particularly definitive. The geologic analysis of these data sets has just begun. To define the total exploration package, the interrelationships between sediments, structures, and the evolution of the area must be analyzed as a whole.

References

Rowan, M. (2000) Practical salt tectonics: A short course emphasizing the geometry and evolution of salt structures and their impact on sedimentation and fluid flow.

Karlo, J. F. and Shoup, R. C. (1998) Tectonic provinces of the northern Gulf of Mexico, in Integration of geologic models for understanding risk in the Gulf of Mexico. *AAPG Hedberg Research Conference Proceedings*.



The CGG Alizé is currently shooting multi-client data in Green Canyon.

How CGG's multi-client work operates in the Gulf of Mexico

Seismic contractor CGG's multi-client library currently stands at over 90 000 km² of data, 90% of which is less than two years old. Regions covered include Africa, Norway and the North Sea but the current focus is on the very promising areas of the Gulf of Mexico and deep offshore Brazil which together now account for over 70 % of the company's total multi-client portfolio.

In the Gulf of Mexico, CGG's multi-client group for the Americas has emerged over the last five years as a significant player for 3D regional projects. According to Luc Schlumberger, vice president of CGG multi client surveys: 'The group's strategy is not to own the largest data library, but to develop new projects that are relevant and profitable. Before the first shot is acquired, each new project is subject to a strict evaluation process to meet critical guidelines. This ensures a mutually beneficial outcome for CGG and our clients.'

In 2003 the group will have delivered more than 540 OCS blocks (12 700 km²) of new high-quality products to the industry in CGG's core areas of Mississippi Canyon/Atwater Valley, Green Canyon and Garden Banks.

CGG says its Garden Banks survey is the first to have been acquired in a high resolution configuration utilizing

9000 m streamers and recording 13 seconds of data combined with a 25 m crossline interval in order to generate high-resolution imaging of the subsurface. The second half of Garden Banks will be delivered in January 2004 in advance of the next lease sale scheduled for August 2004. Interesting results have been obtained with surface-related and diffracted multiple techniques. In Green Canyon, CGG's flagship *Alizé* is currently shooting GC VI, also with six streamers of 9000 m.

Processing techniques used routinely include intensive de-noise and demultiple techniques, CGG's A+ fully anisotropic Kirchhoff Prestack Time Migration and high-density velocity analysis. 'What we call Time products are now the standard and the data produced by our deployment of longer digital streamers and our unparalleled processing sequence has met with an excellent response from our client community', says Luc Schlumberger.

Prestack Depth Migration (PDSM) projects in phases A and B of Green Canyon (see map of CGG's multi-client library in the Gulf of Mexico) illustrate CGG technology. Turning wave migration technology has been applied for the first time. With a 12 km aperture the turning wave processing allows salt bodies to be imaged along their steep flanks as well as under the overhangs at the edge of