



3-D seismic acquisition in the Amazonian rain forest

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ABSTRACT

A 3-D survey was acquired in the Amazonian rain forest at São Mateus, in the Urucu province. The survey, shot at the end of 1998, achieved remarkable results in terms of turnaround, quality, safety and low impact in the environment. In this paper we review the main factors that led to these results.

INTRODUCTION

Exploration for hydrocarbons in the rain forest is one of the great challenges in 3-D seismic acquisition. As anywhere in the world, acquisition of seismic data is considered in terms of quality, cost and turnaround. However, the attempts to acquire seismic data on a routine basis are often challenged by the extremely hostile environment.

Petrobras has a long history of exploration in the Amazonian. For its seismic acquisition, Petrobras follows a strict bidding procedure that includes technical and financial evaluation of the competitors and public opening of the offers. In a highly competitive market CGG has been selected by Petrobras for several seismic contracts and since 1992 is the only seismic contractor working in the Amazonian forest with a versatile 2D/3D-heliportable crew.

The interest of Petrobras in the Urucu province resulted in the discovery of the Urucu field in 1986, among various other non-commercial shows. The São Mateus hydrocarbon history begun in 1996, when a 2-D seismic survey was shot in the area. The well, drilled by the end of 1997, showed promising results. To better image the producing levels, Petrobras decided to carry out a 3-D survey.

TURNAROUND

The history of the 3-D surveys shot by Petrobras in the Amazonian forest shows an impressive increase in turnaround. From the first survey, shot in 1988 at Urucu, to São Mateus shot in 1998, the productivity increased more than two fold.

In addition to the choice of optimized parameters, the crucial factor that enables to reach a high productivity is planning. Careful planning requires a close relationship between the client and the contractor in order to take advantage of all past experiences. For the São Mateus project, the pre-planning lead to:

- Program the fieldwork at the end of the dry season (September to December), in order to avoid large swampy and flooded areas and to facilitate the various river-crossings.
- Start surveying and lines opening four months before the first shot.
- Layout in advance the cables for river-crossings (on a particular swath the lines were crossed more than 50 times by the river Tefe). For the crossings, the crew used a cost-effective method that combined waterproof connectors and inner tubes to keep the Sercel station units floating.

QUALITY

Data acquisition adhered to strict quality rules, as Petrobras is starting a process aimed at earning the ISO 9001 certification for the whole E&P Division of the Amazonian District.

Topographic data of high quality was obtained using a dense grid of satellite control points. An essential point in the fast acquisition of reliable topographic data was the presence of highly qualified, senior surveyors, with an extensive experience both in 3-D acquisition and in operations in the Amazonian forest.

One of the challenges of the São Mateus survey was to succeed in crossing the river tefe without major loss in the fold coverage. Careful scouting coupled with the capacities of the pre-planning software achieved to optimize the number and position of the infill shots. With the infilled shots, and using the same offsets, the fold coverage that decreased to 20 due to river crossing could be recovered up to the target value of 40 fold.

Petrobras geophysicists performed routine quality controls (including instrumental and positioning QC) every day, in order to ensure an acceptable level of signal-to-noise ratio. A particular feature was the introduction of Petrobras proprietary program of static correction XTATICA in the contractor platform. After quality controls, the processed data were delivered in SPS and SEG Y formats to the Petrobras processing center in Belem. The preliminary processing of this recent survey already shows some valuable improvements in the quality of the section with respect to the previous 2-D survey.

SAFETY

In 1998, Petrobras earned the BS 8800 (Health) and the ISO 14001 (Safety and Environment) certifications for the E&P division of the Amazonian District. As the process began early in 1997, the procedures required for these certifications were implemented not only by the Petrobras operations, but also by the sub-contractors. The efforts towards safety in this hostile environment achieved an excellent record in 1998 for the seismic crew: a full year with no lost time injuries representing more than 1.000.000 man-hours. This record was obtained through a constant involvement of all the personnel and through the strict respect of all the safety procedures, particularly those involving the main risks: use of explosives, heliportable operations and chain sawing.

Special attention has been paid at São Mateus to address the main hazards related to the numerous river crossings. Strict hygiene rules were enforced in the camp to check the endemic cholera. Nevertheless, the rain forest environment reserves unpleasant surprises to the most careful planner. An epidemic of malaria in the São Mateus area nearly compromised the project. Compulsory measures prevented the malaria from spreading to the seismic crew.

ENVIRONMENT

The requirements of the procedures established through the ISO 14001 certifications of Petrobras and CGG were fully implemented in the field. The crew was regularly briefed. Selective collections of waste were organized and the non-biodegradable waste was treated at the Urucu facilities. Because combustible leakage and subsequent spillage can be a serious threat to the habitat, a detection process and a recuperation routine were also introduced.

In seismic operations, a major contribution to the preservation of the environment is the reduction of the cleared surface. Petrobras and CGG continuously evaluate the seismic parameters in order to reduce that surface. In this respect, the shooting geometry was chosen in order to divide by two the number of opened lines. The number of helipads used in operations is one more factor that contributes to the total cleared surface. The commitment to minimal impact on the environment in the Amazonian forest resulted in a decrease of the helipad density by a factor of three, from one helipad per 0,8 km² in 1988 to one per 2,4 km² in 1998. It has to be underlined that despite the logistical problems caused, the decrease in the number of helipads did not affect the overall turnaround, that increased by more than twice in the last decade.

CONCLUSIONS

A 3D land seismic survey is often a compromise between cost and quality with the respect of the environment as a strong constraint. The extremely hostile conditions that characterize the Amazonian rain forest add more challenges to the operations. The history of 3-D seismic acquisition in the area proves that the turnaround can be significantly increased and the cost decreased while minimizing at the same time the environmental impact. Careful planning, requiring a close cooperation between the client and the contractor, is an important factor of success. However, only qualified personnel with experience in the area and the dedication of the whole crew towards improving the standards can address the safety aspects

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