Summary

The Badin Concession is relatively mature with many small oil fields, which collectively account for about 50% of Pakistan’s current oil production. In total about 220 wells have been drilled in the area. The 3D seismic was shot with the dual purpose of helping in the development of the fields and to determine the remaining exploration potential. In 2000-2002, bp acquired a 3D survey over the Badin area using a non-orthogonal geometry and we demonstrate the improvement in data quality gained from the application of two recent advances in 3D processing; one at a pre-stack and one at a post-stack level:

- 3D velocity filtering to attenuate the linear noise, pre-stack (Meunier, 1999)
- 3D acquisition footprint attenuation, post-stack (Soubaras, 2002)

The 3D has helped significantly in our understanding of the structural styles of the basin. The size, distribution and shape of the structures are imaged much better when compared to the 2D data. This is helping bp in the planning for future exploration and development programs.

Introduction

The Badin-1 Petroleum Concession was granted in 1977 and the first discovery (Khaskeli field) was made in June 1981. Since then 54 fields have been discovered. The first 2D seismic was shot in 1977-78 and overall about 17,000 line km has been recorded. A number of smaller 3D seismic volumes have been recorded since 1996 covering individual fields.

Figure 1: 3D survey area [Each color represents area acquired as a single volume]
However, ~2700 sqkm 3D data have been acquired between 2000-2002 (Fig.1). This includes the 100 sqkm acquired over Mehran Concession.

Due to shear volume of this project, the processing parameters for a basic sequence were decided by using the first acquired volume. Two particular processes were used in the sequence that demonstrated significant uplift in the data quality. In particular, lateral continuity of events and fault imaging has improved markedly.

**3D Velocity Filtering**

It has been standard practice over many years to apply $f_k$ filtering to attenuate strong organized noise. In the absence of 3D velocity filtering software, 2D algorithms need to be applied to 2D subsets of 3D data. This process does not take full fold 3D geometry for 3D velocity filtering (Meunier, 1999).

In a 3D SP, when the receiver line interval is several times larger than the station interval, cross-line aliasing occurs at a wave number several times lower than the in-line aliasing wave number. Cross array 3D data sets can be decomposed into “cross-spreads”. A cross-spread is a single fold data volume with homogenous distribution in both directions (Vermeer, 1994).

During the acquisition of this volume, an attempt was made in the field to aid establishing the basic sequence in the processing center. Organized noise was removed by using the application of $f_k$ filter on shot and receiver domains. During the tests carried out in the processing center, the effect of 3D velocity filtering (in removing a cone in the FKxKy domain) was found to be much better in attenuating the organized noise (Fig. 2).

![Data w/o and with FK filter application](image)

**Figure 2: Data w/o and with FK filter application**
The improvement achieved at this early stage of processing was found to be very beneficial in picking the velocities and calculating the residual statics during the main processing of the data set. Furthermore, it gave added confidence early in the project that a robust processing sequence could be developed that would be applicable for processing the continuing acquisition of this large survey.

3D Acquisition Footprint Attenuation

Acquisition footprint can be defined as any pattern of noise that is highly correlated to the geometric distribution of sources and receivers on the earth’s surface. It appears on almost all 3D seismic data volumes to some degree. The causes of such footprints depend greatly on the details of the acquisition geometry and processing flow (Marfurt et al. 1998).

Acquisition footprints may look as patterns on the seismic time slices or RMS amplitude measurements over a window preventing the accurate mapping of amplitudes. These patterns may have an adverse effect on any subsequent special processing that could be undertaken. The inverted impedance volumes may carry undesirable stripping on the slices (Chopra & Larsen, 2000).

In the presence of strong 3D acquisition footprint it has been customary to use KxKy filter to attenuate these footprints. This filter requires the geometry of the acquisition; source and receiver line direction and line intervals. As the acquisition geometries become more complicated, such as 3D non-orthogonal acquisitions, the design of the filter by a deterministic method that is based on the acquisition geometry becomes more complicated. It was shown (Soubaras, 2002) that a procedure could be used to design a KxKy filter to attenuate the acquisition footprint of any acquisition geometry that uses as input the actual offset distribution of the stack traces. Processing artifacts unlike acquisition footprints are not periodic but can be attenuated in the KxKy domain by fan filter, just as a given velocity on a t-x data set can be attenuated by $f/k$ fan filter.

This survey was acquired by using non-orthogonal acquisition geometry. The technique developed by Soubaras was used in the processing the data to attenuate the 3D acquisition footprints. We will outline the methodology and show results from the processing (Fig. 3).

a. DMO Stack time slice @ 600ms
Conclusions

S/N ratio of the Badin data was improved significantly through the processing. The use of recent advances in 3D processing was contributed to the success of this data set. Considering the fact that this is a land survey (over a vast area) the overall quality of seismic data is much improved over previous vintage data.

Acknowledgements

The authors wish to thank bp and their co-ventures for their permission to publish their material and various CGG personnel for their participation in the project (in particular, J. Holden, M. McCluskey, J. Sinden).

References


