Application of Data Reconstruction Techniques Based on Compressive Sensing in Onshore Acquisition*

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Abstract

In 2013, BGP conducted a 3D onshore seismic survey project in Liaohe Oilfield Company of PetroChina, which had lots of offset and skip shot points due to the limited surface conditions. In order to verify the effect of the data regularization approach, we first chose half of the shot points from the raw data in two ways: a) choosing every other SP regularly; b) extract half of the SPs randomly; and then the compressive sensing theory based data regularization algorithm was used to restore and reconstruct the incomplete seismic data. The comparison of the CMP gathers and PSTM sections demonstrates that the use of the data reconstruction algorithm can obtain a result similar to imaging quality of the raw data.

Application of data reconstruction techniques based on compressive sensing in onshore acquisition
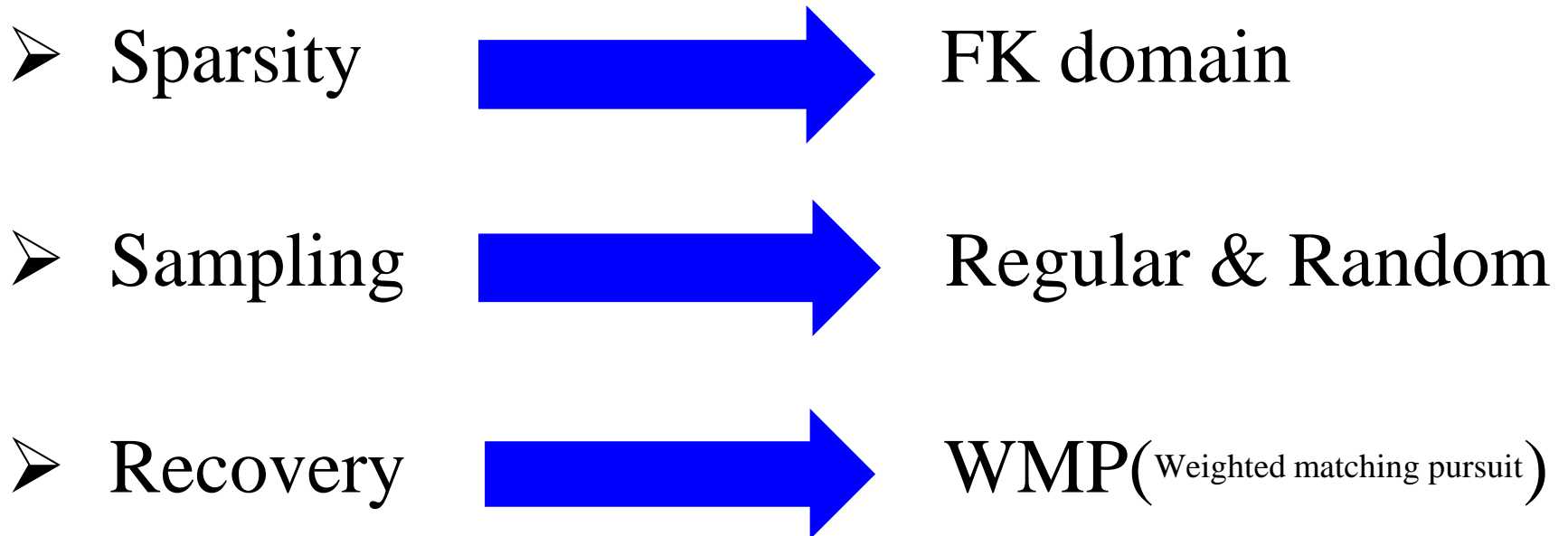
Yang Jinglei

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CONTENTS

Compressive sensing:

➢ Sparsity   ➡   FK domain

➢ Sampling   ➡   Regular & Random
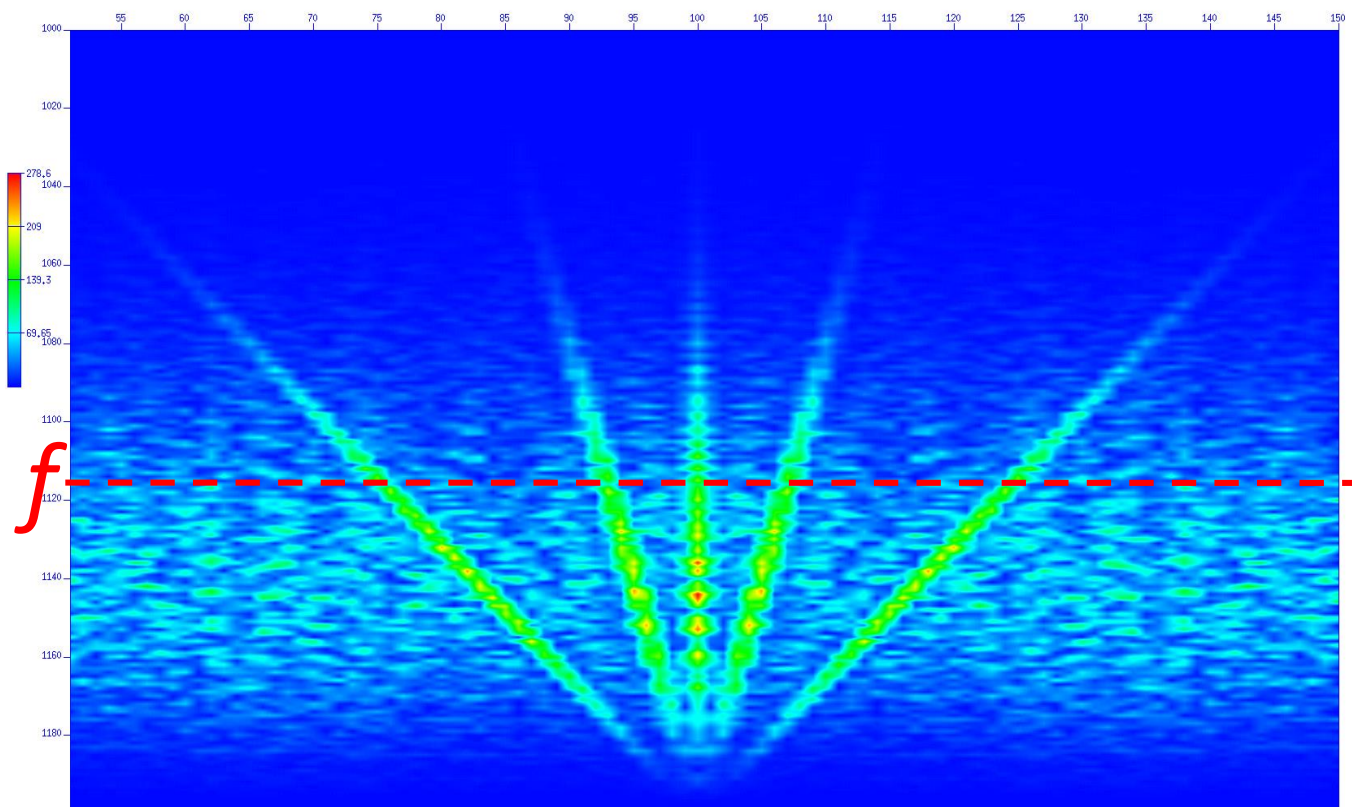
➢ Recovery   ➡   WMP(Weighted matching pursuit)

CONTENTS

1. **Introduction**

2. **Weighted matching pursuit**

3. **Field data application**

4. **Conclusions**

Matching Pursuit：

For each frequency, through many iterative steps, we can estimate the spectrum. But if the spatial alias are serious, the estimated spectrum may contain the noises. In order to avoid this problem, a weighted operator is introduced.

Weighted matching pursuit(WMP):

WMP assumes the valid signals are locally linear, so the τ-p spectrum of valid signals will correspond to strong energy in p direction. But the weak energy will correspond to noise.
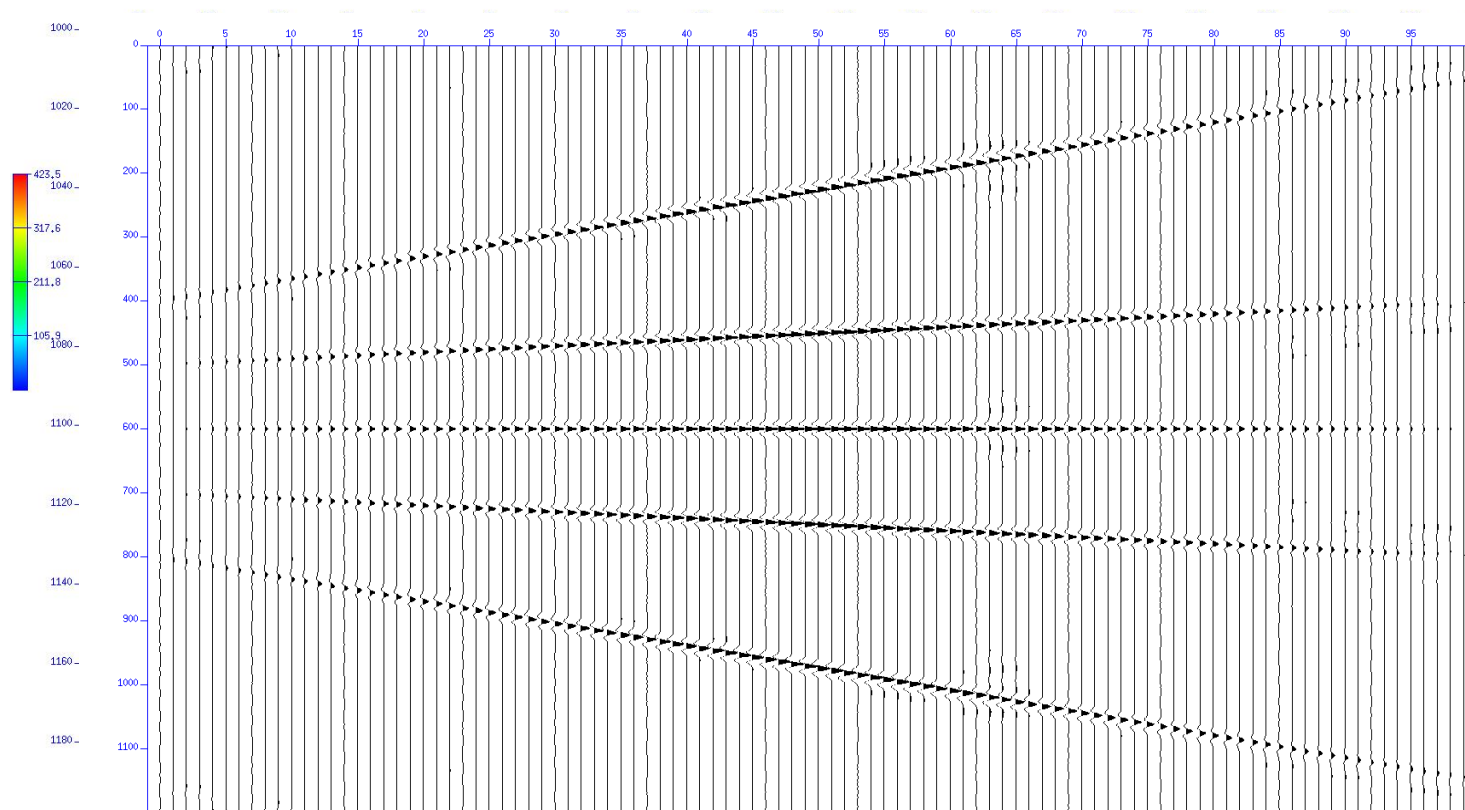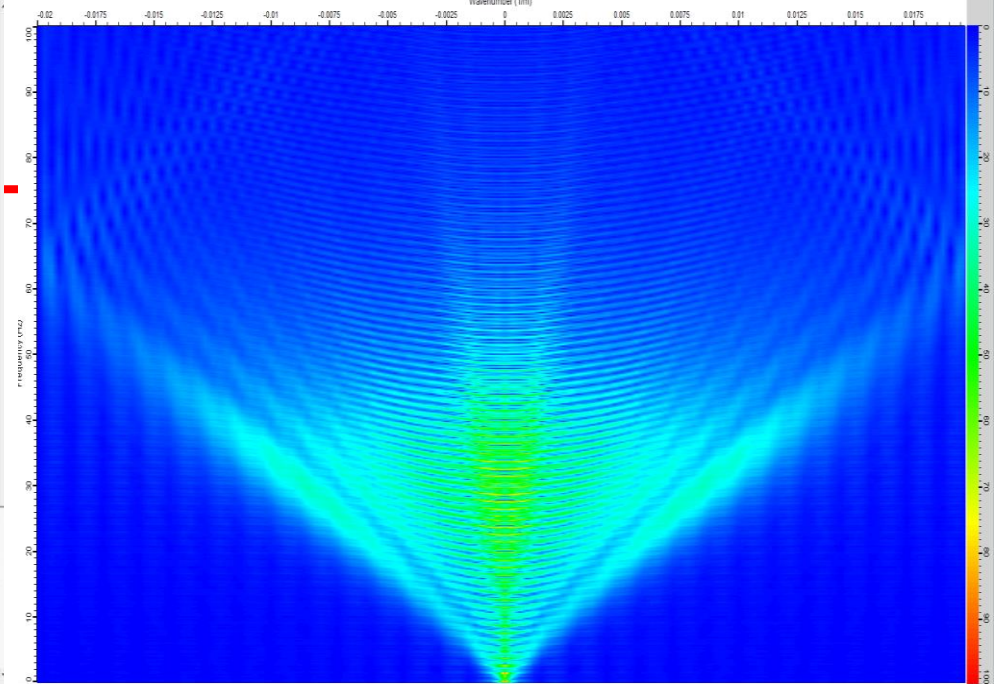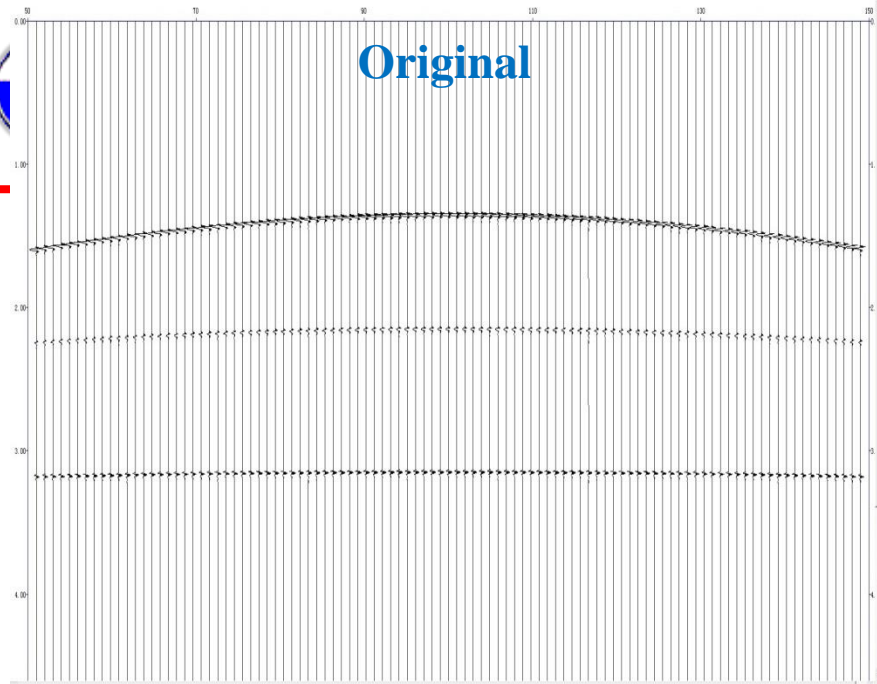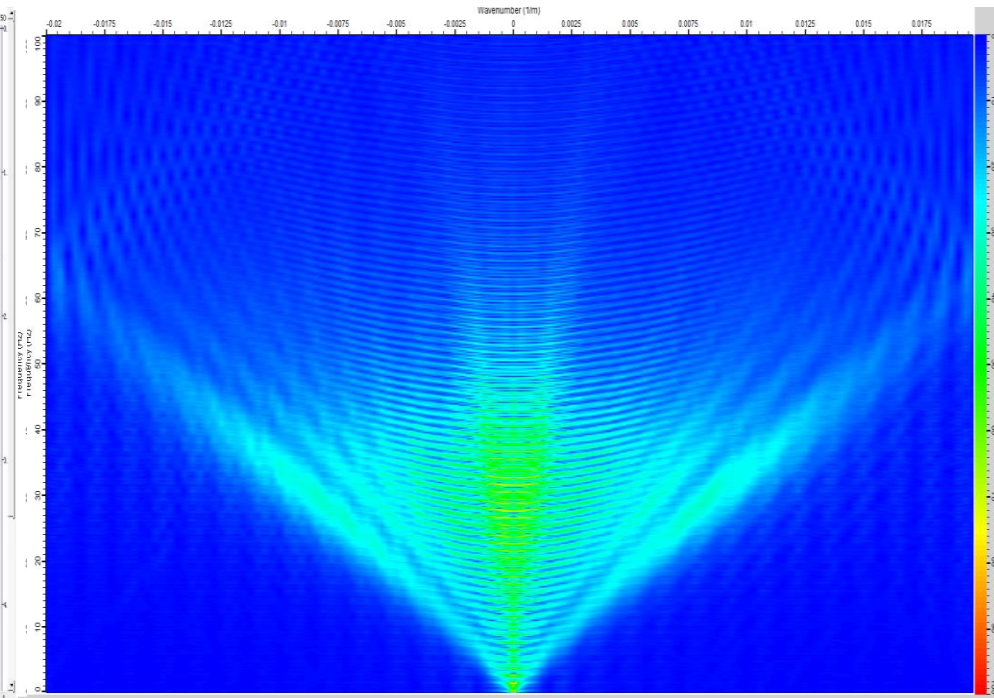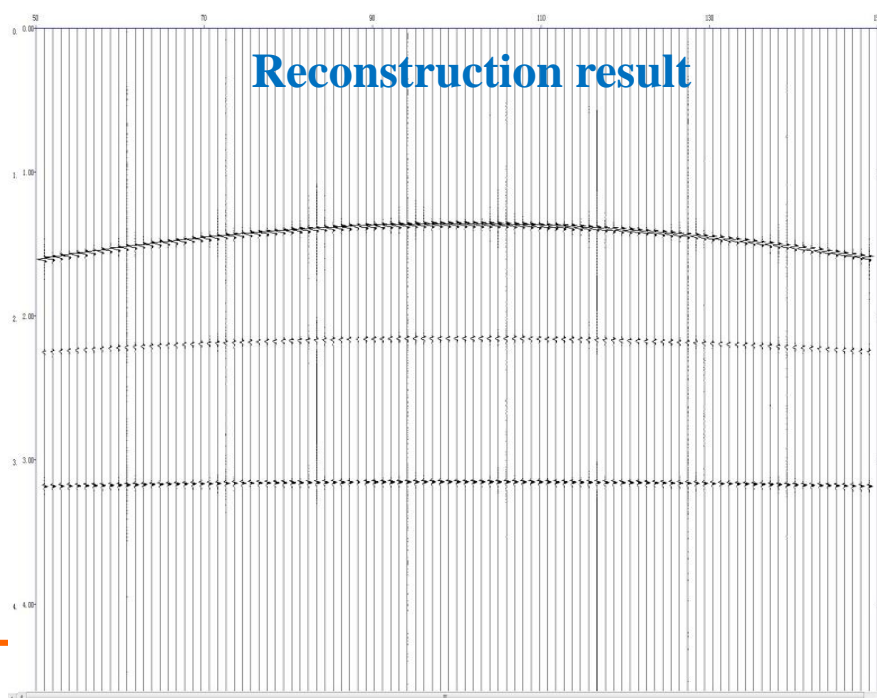
Original
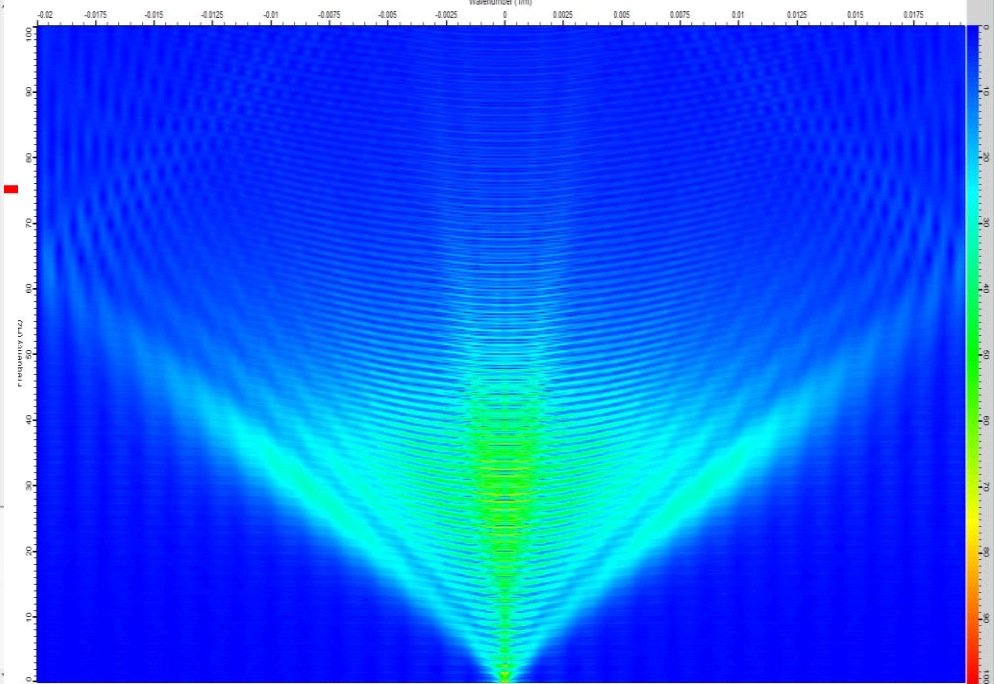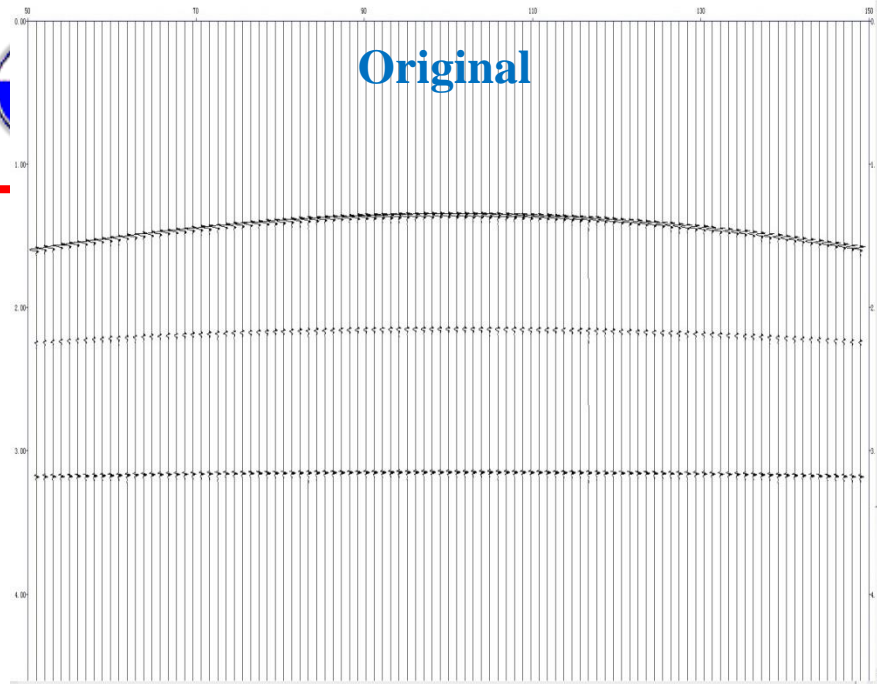
Reconstruction result
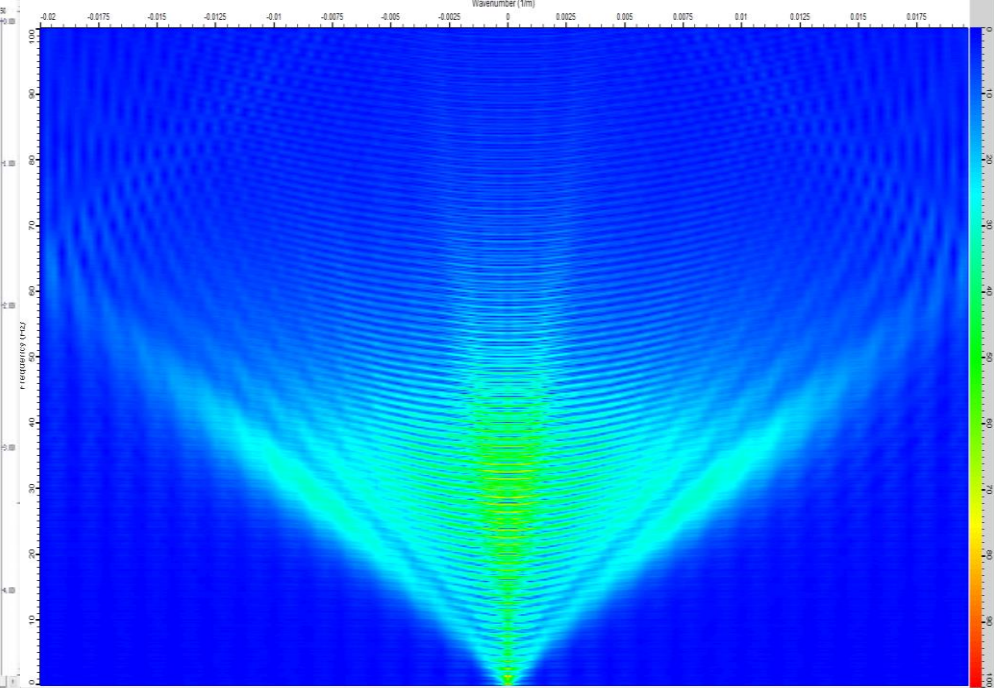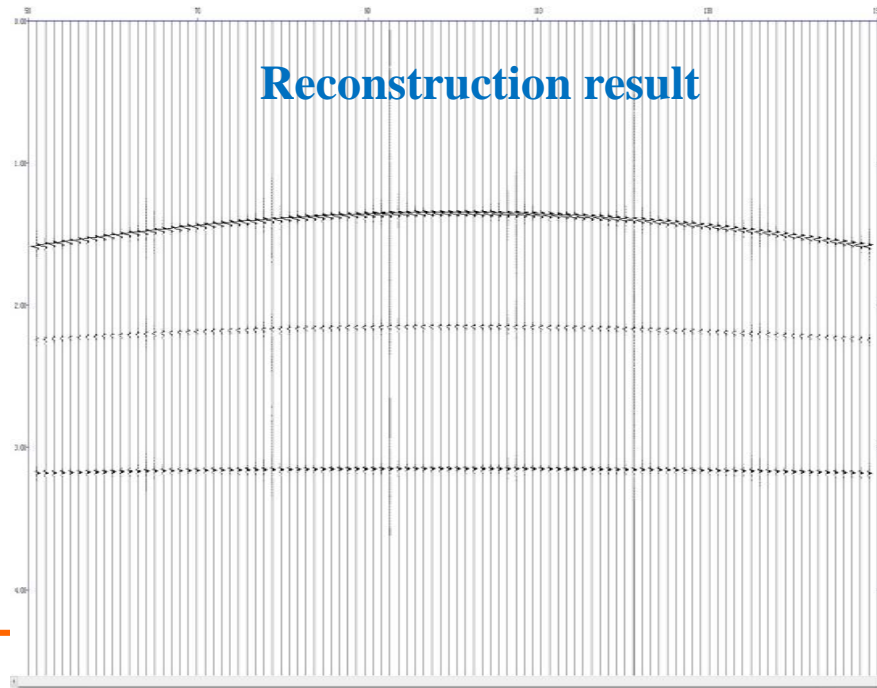
Original

Reconstruction result

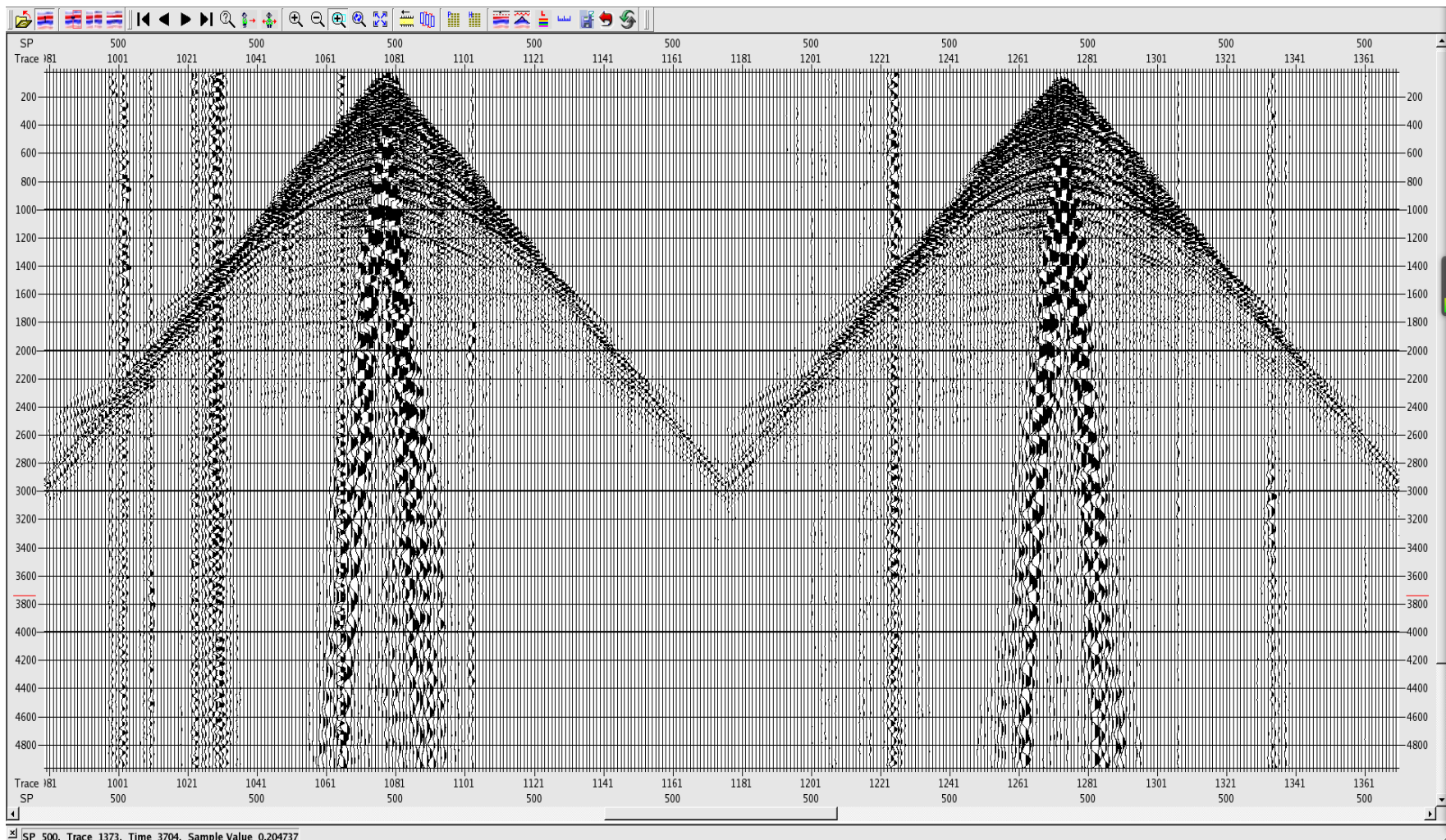# CONTENTS

Field data application

Original source point layout
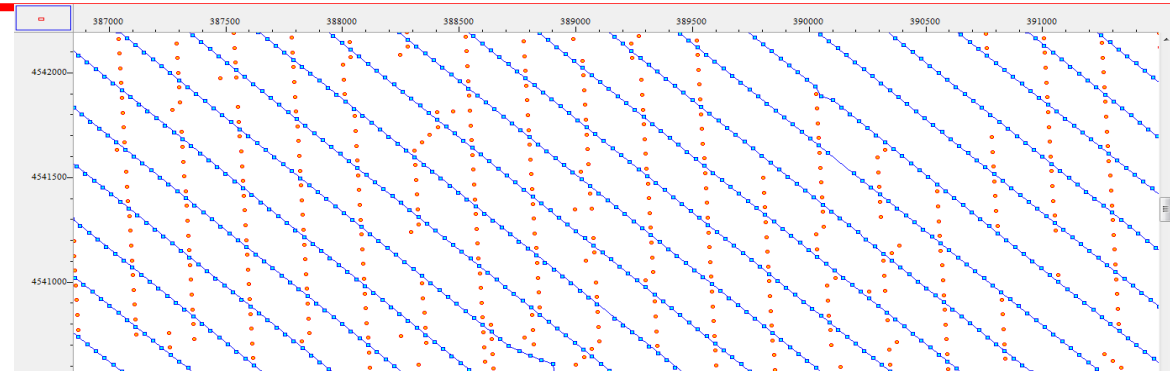
Field data application
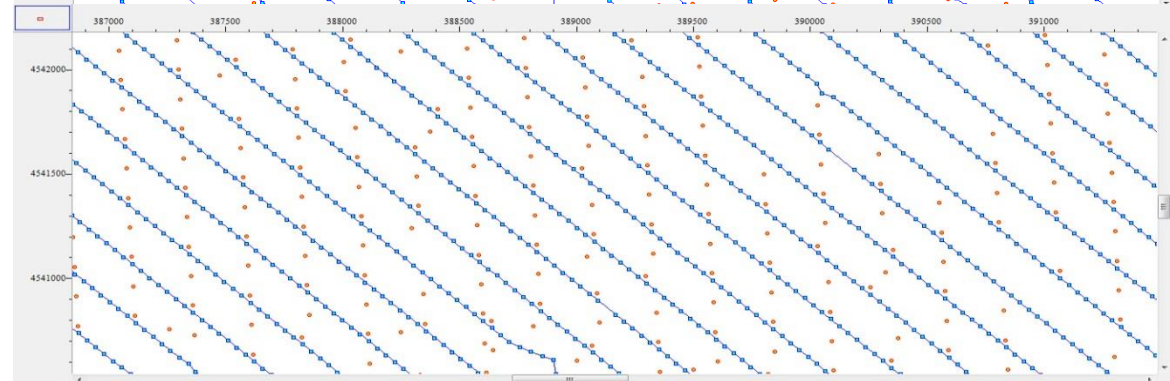
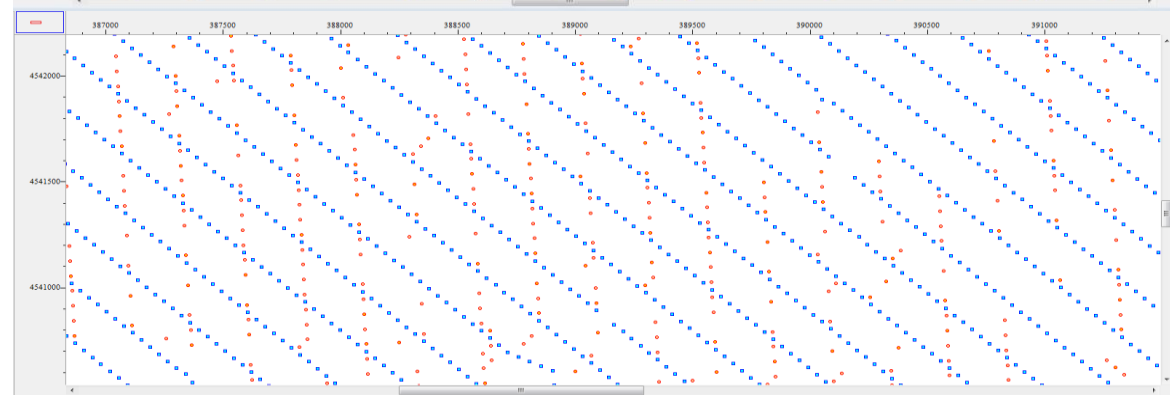**Original shot gathers**

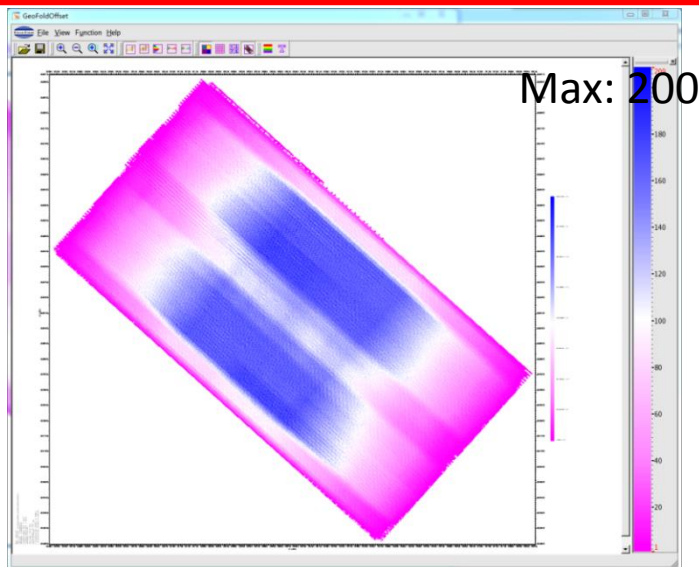# Field data application
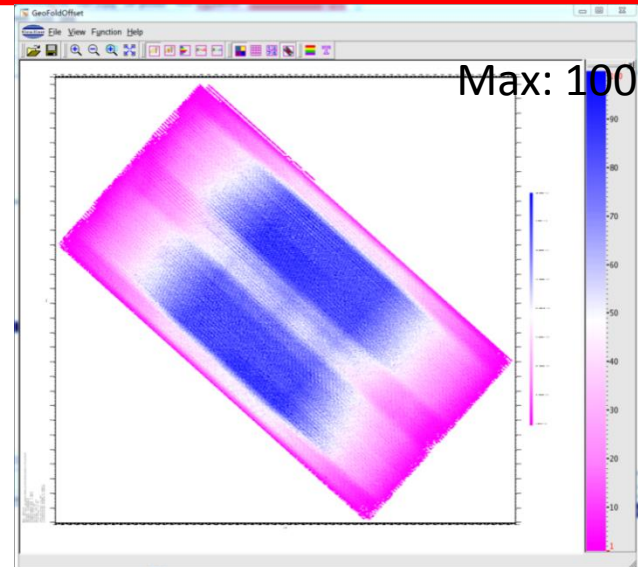
Original

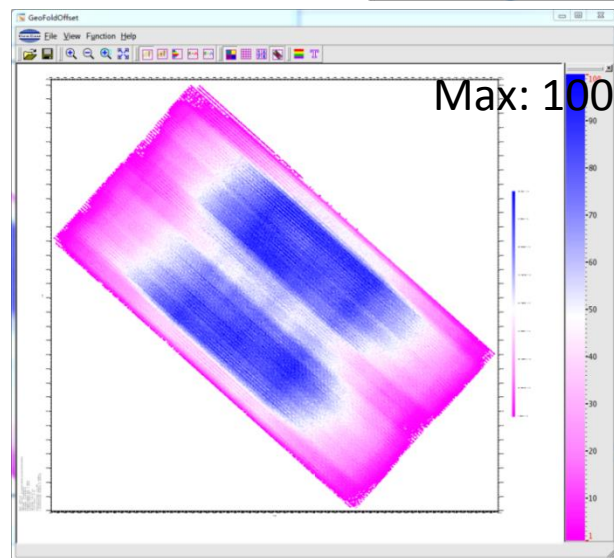Regular undersampling

Random undersampling

Zoom in partly

Field data application

Max: 200

Max: 100

**Regular
undersampling**

Original

**Fold
Comparison**

Max: 100

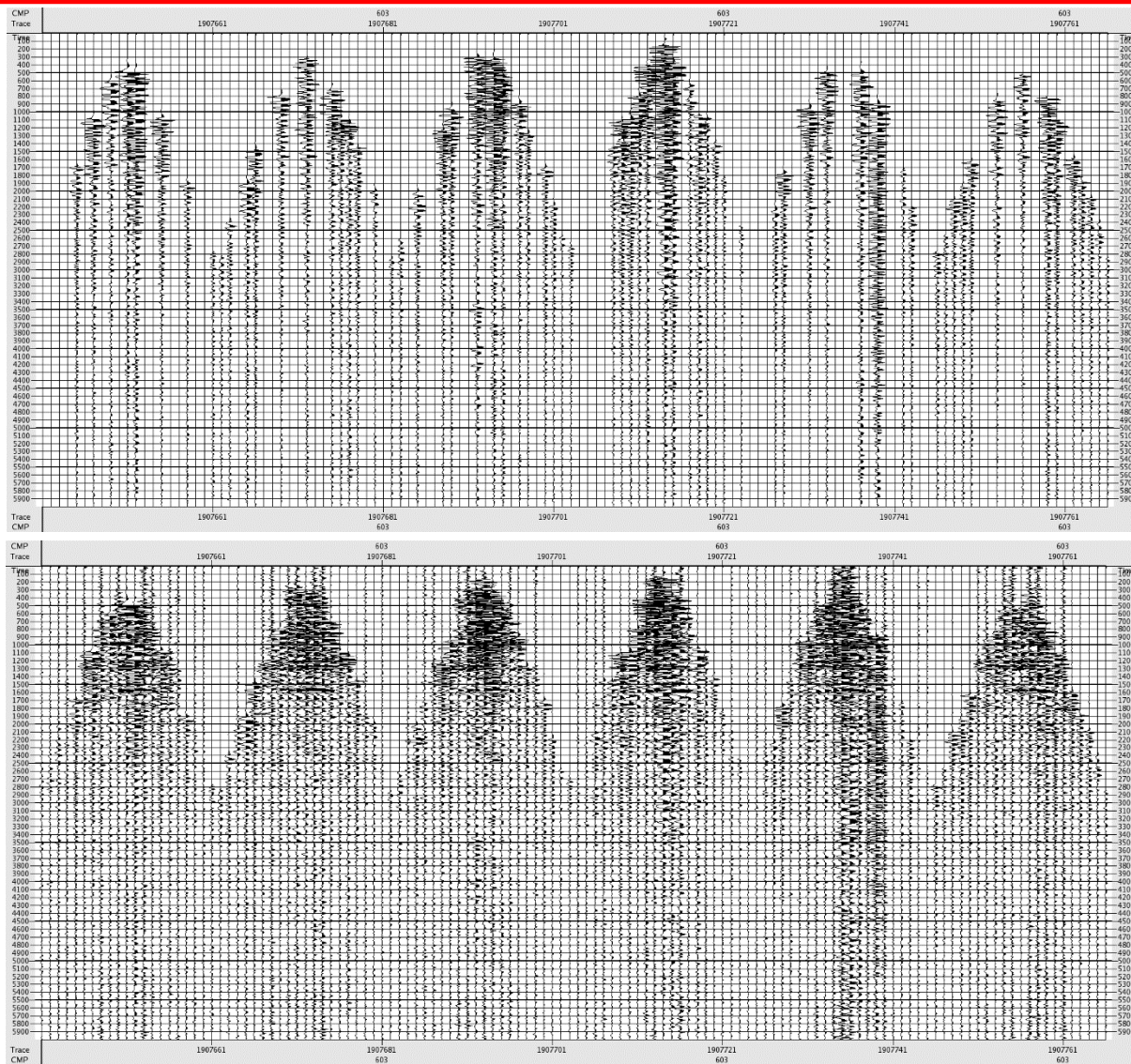**Random
undersampling**

Random undersampling, CMP gathers display before and after reconstruction
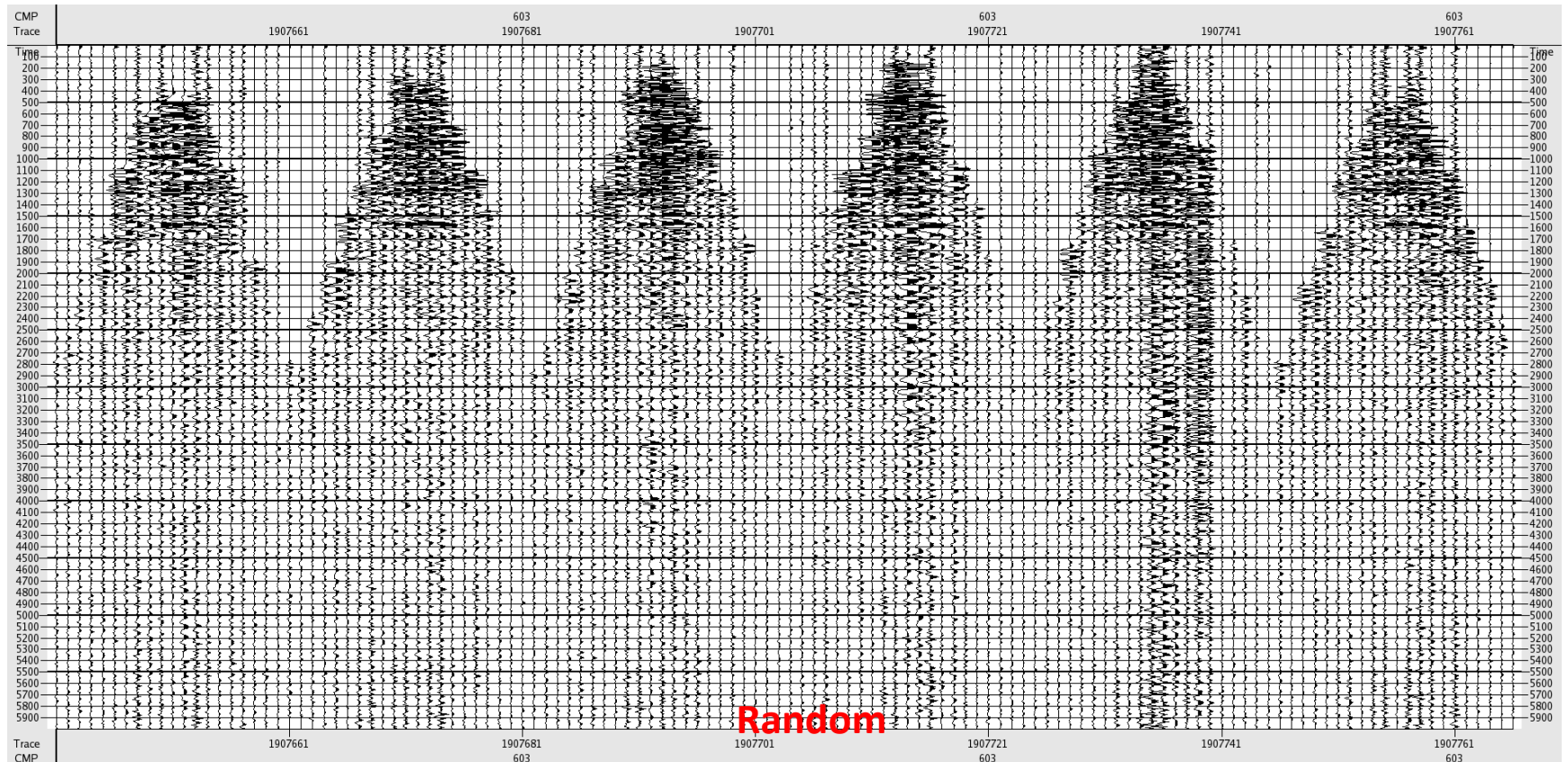
Field data application

Regular

undersampling,

CMP gathers

display before and

after reconstruction
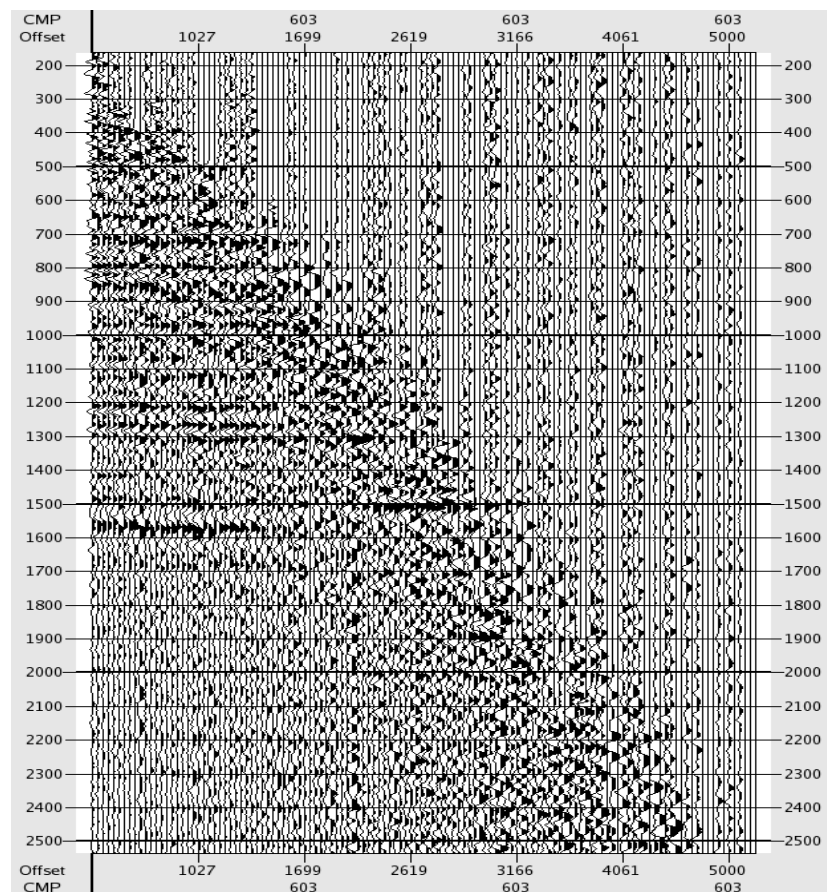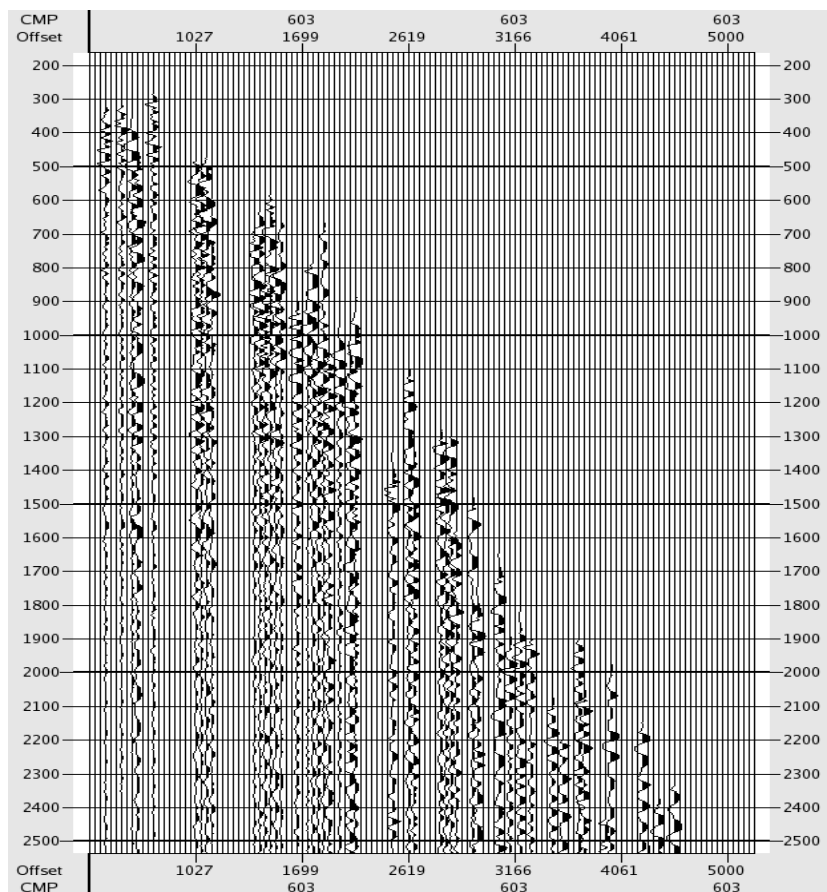
Field data application

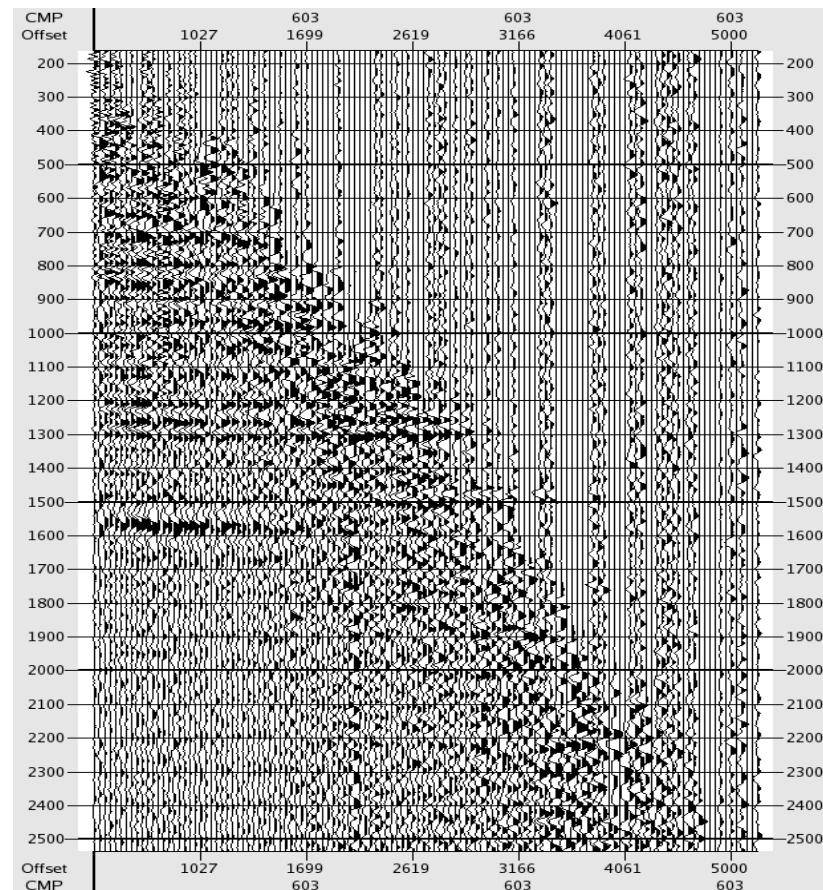**Comparison of the reconstruction results**

Field data application

Regular undersampling, CMP-offset gathers display before and after reconstruction

Random undersampling, CMP-offset gathers display before and after reconstruction

Field data application

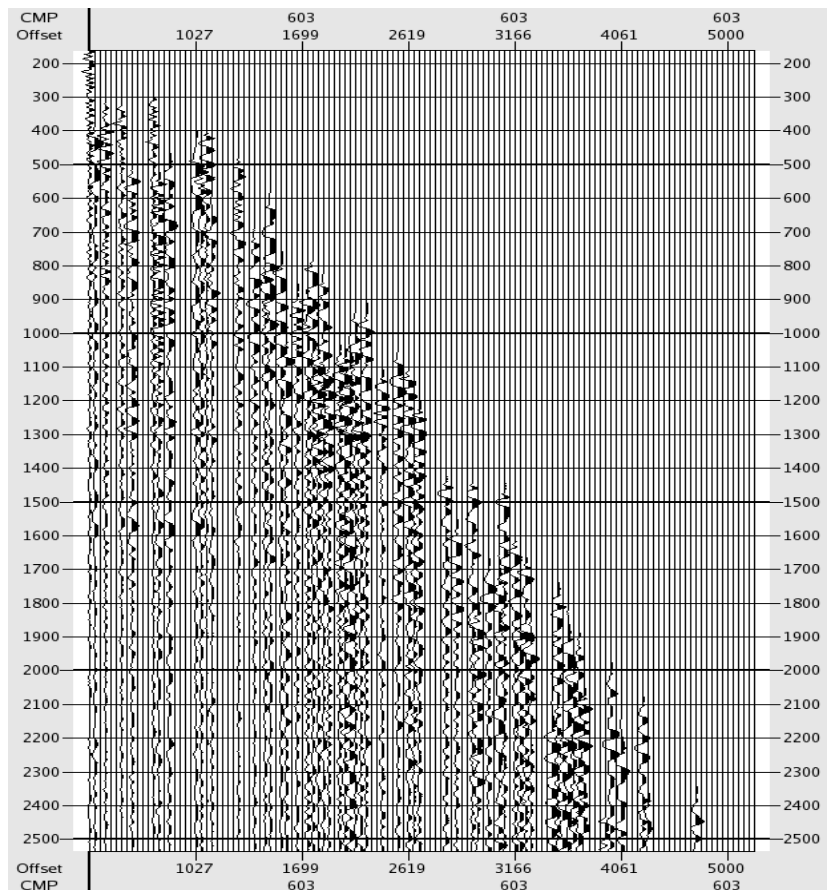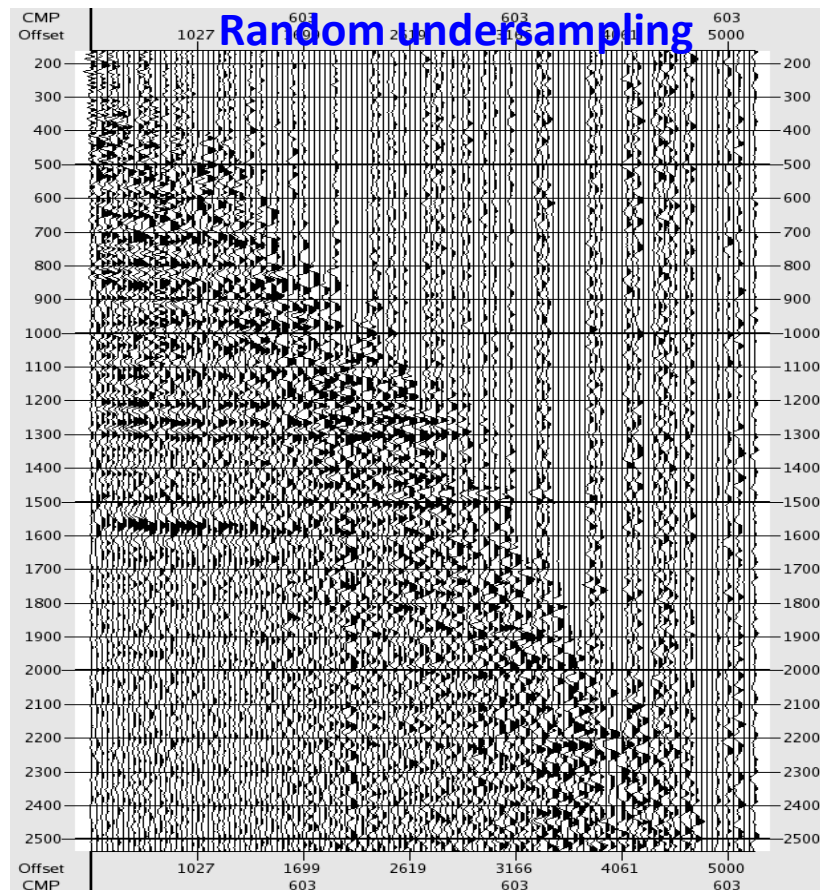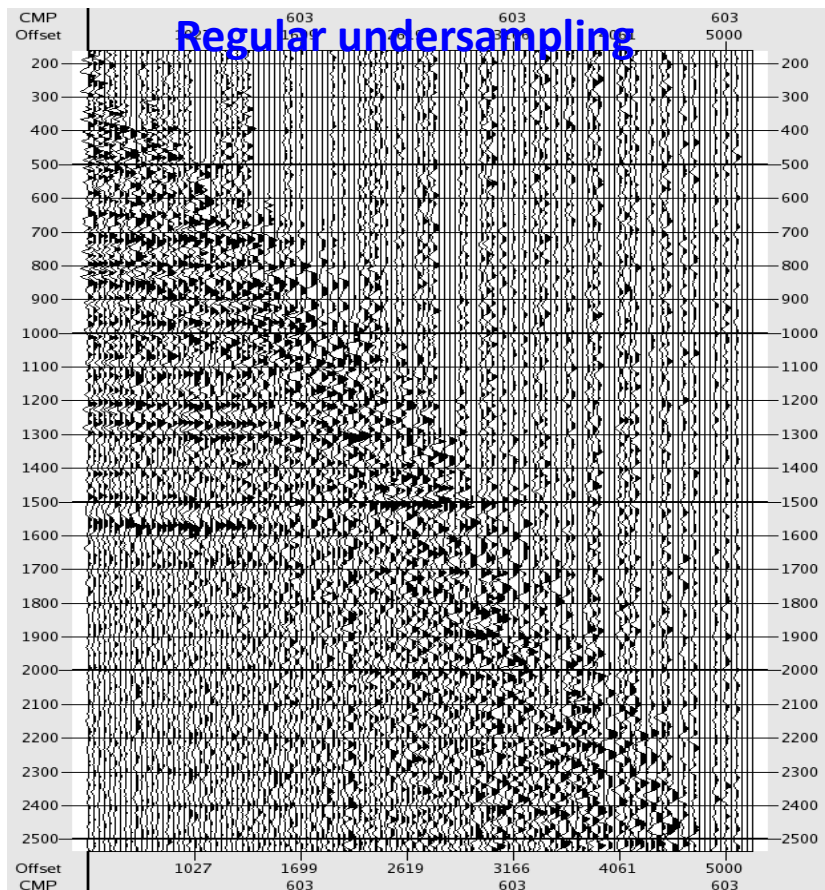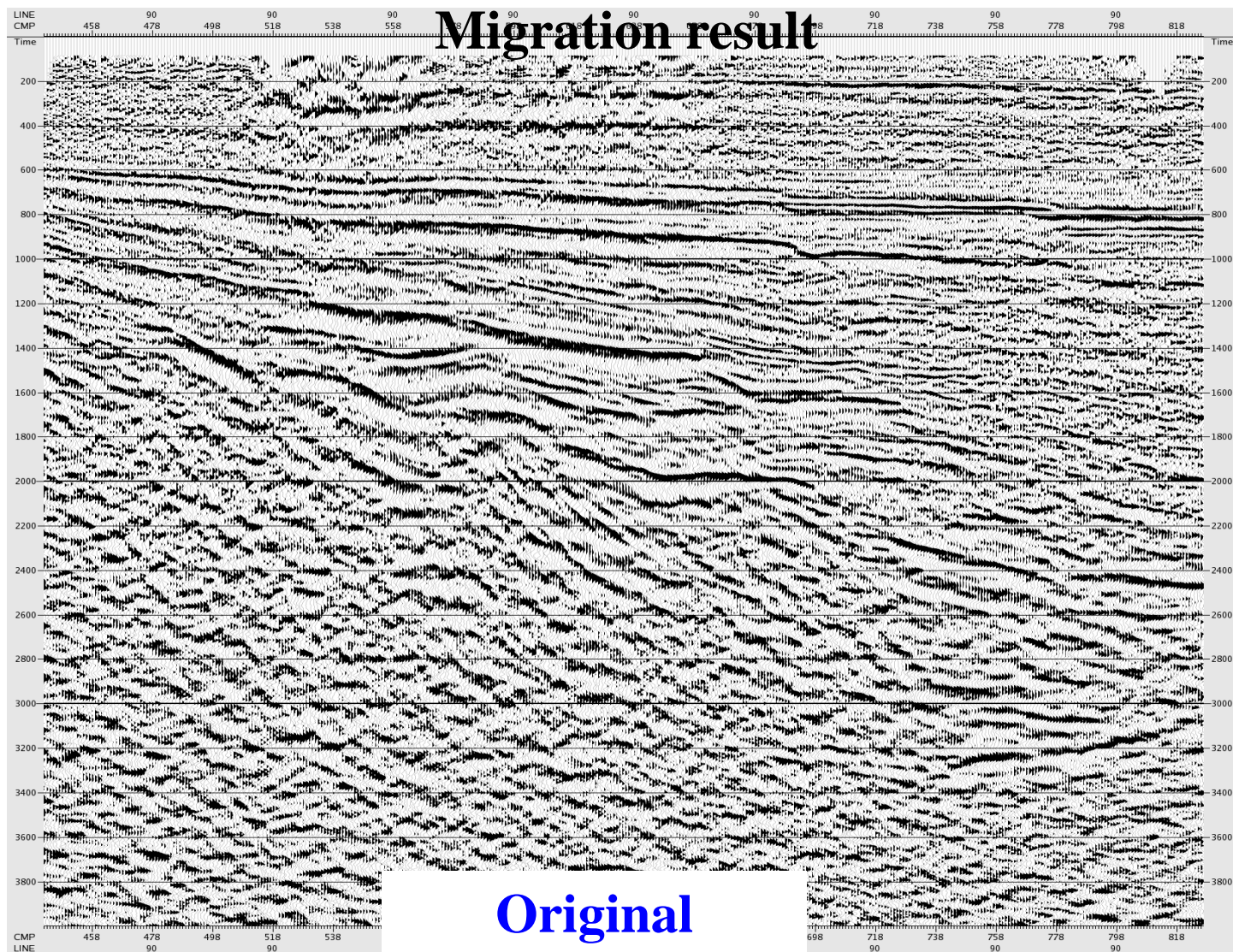Comparison of the reconstruction results
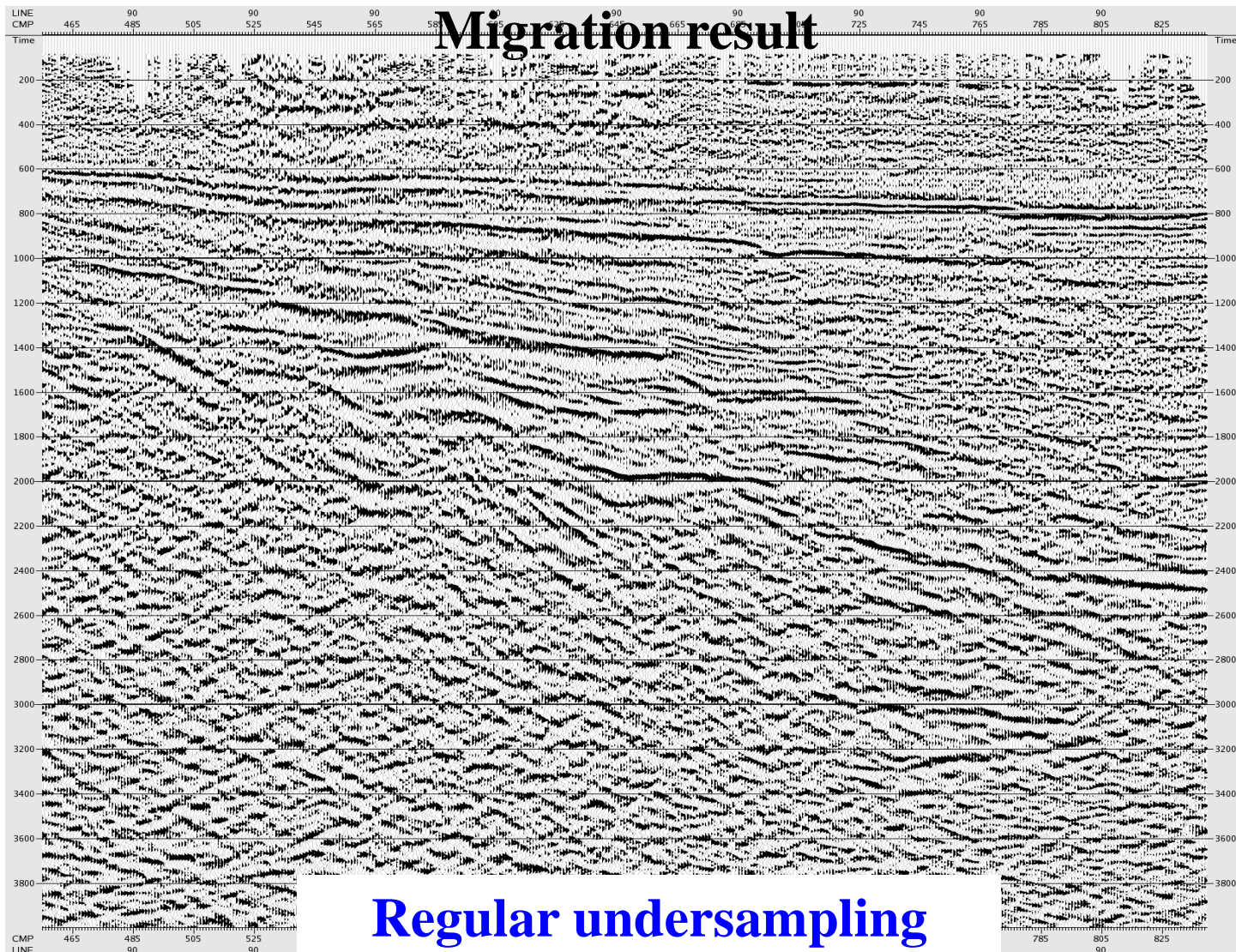
Field data application

Migration result

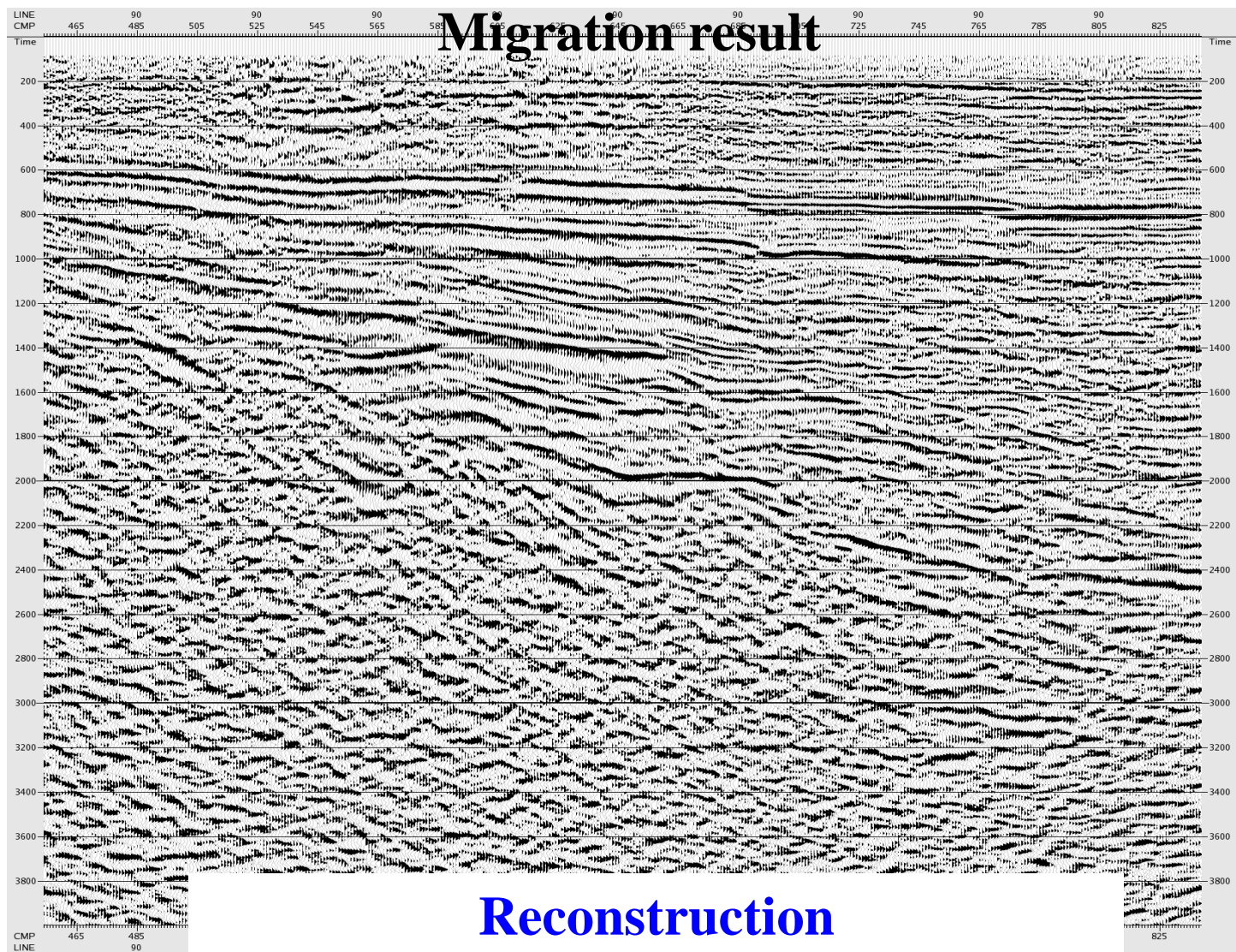Original

Migration result

Regular undersampling

Field data application

Migration result

Reconstruction

Field data application

Migration result

Random undersampling

Field data application

Migration result

Reconstruction

Field data application

Original

Regular undersampling and reconstruction

Random undersampling and reconstruction

Field data application
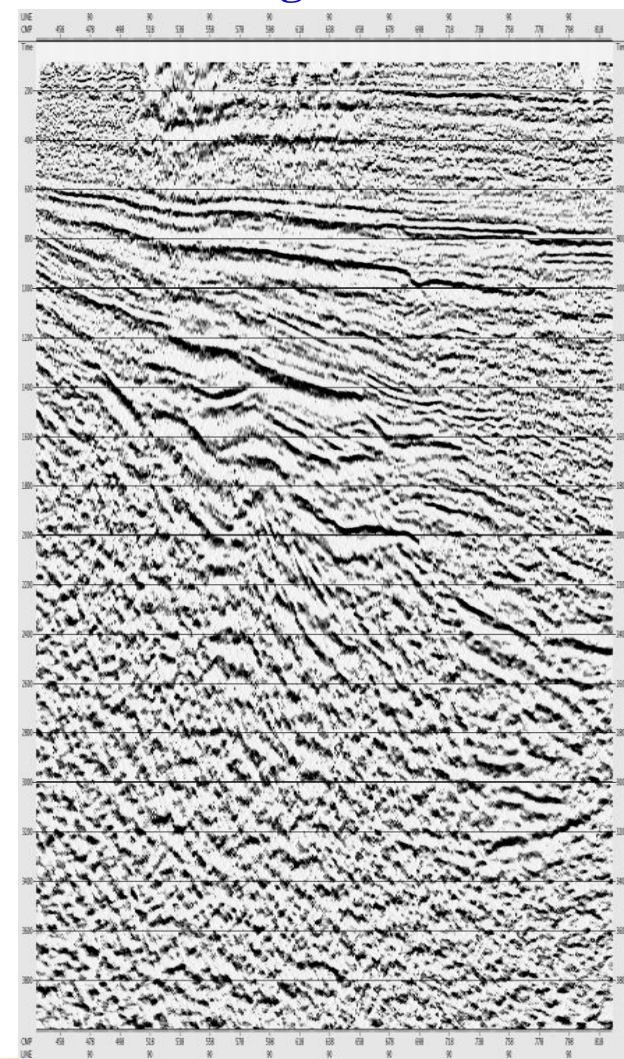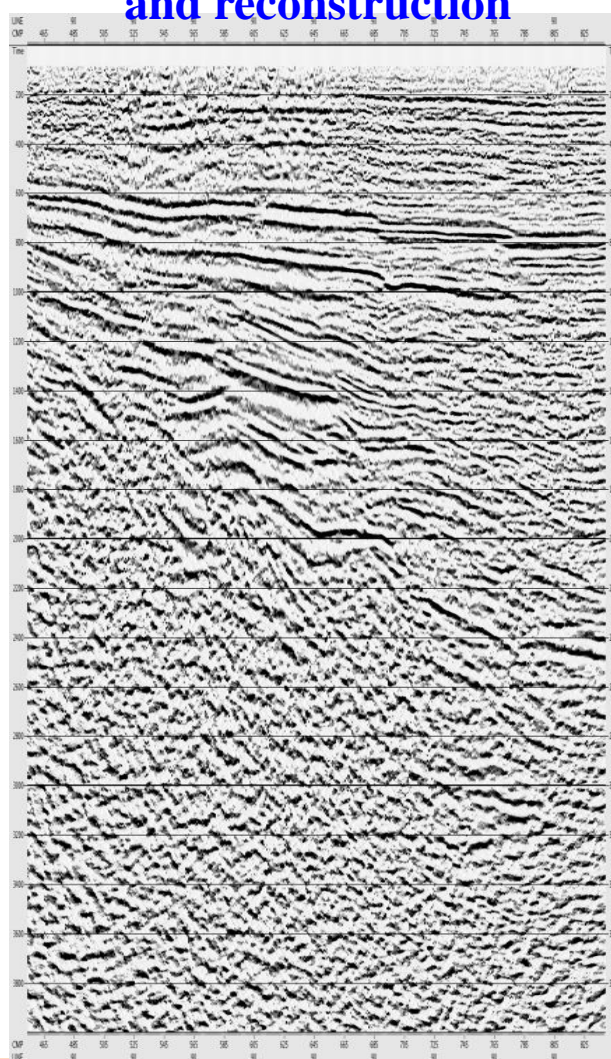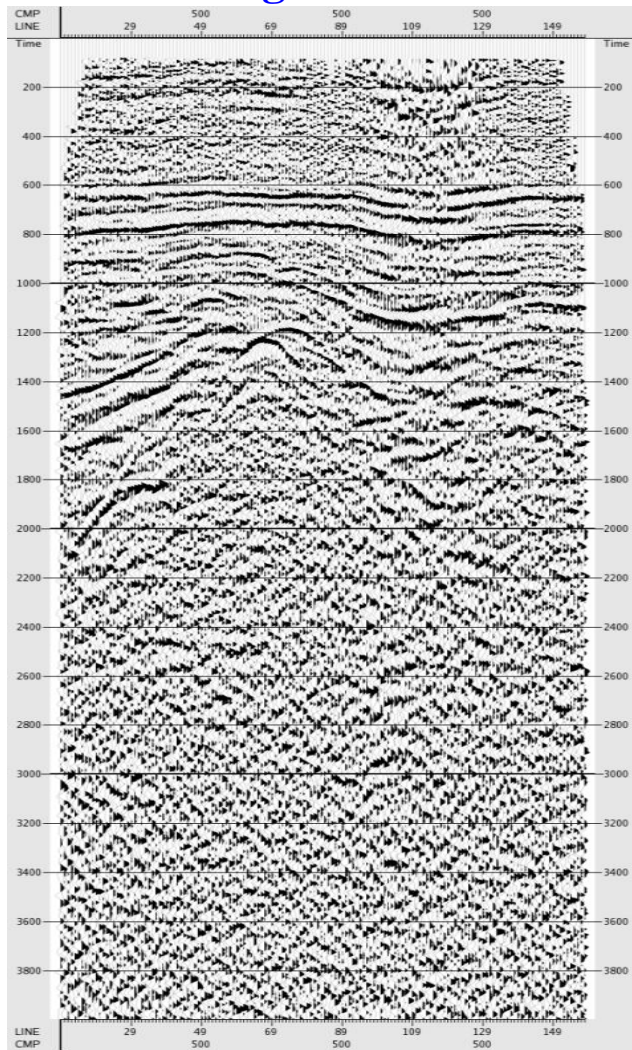

Original

Regular undersampling and reconstruction

Random undersampling and reconstruction

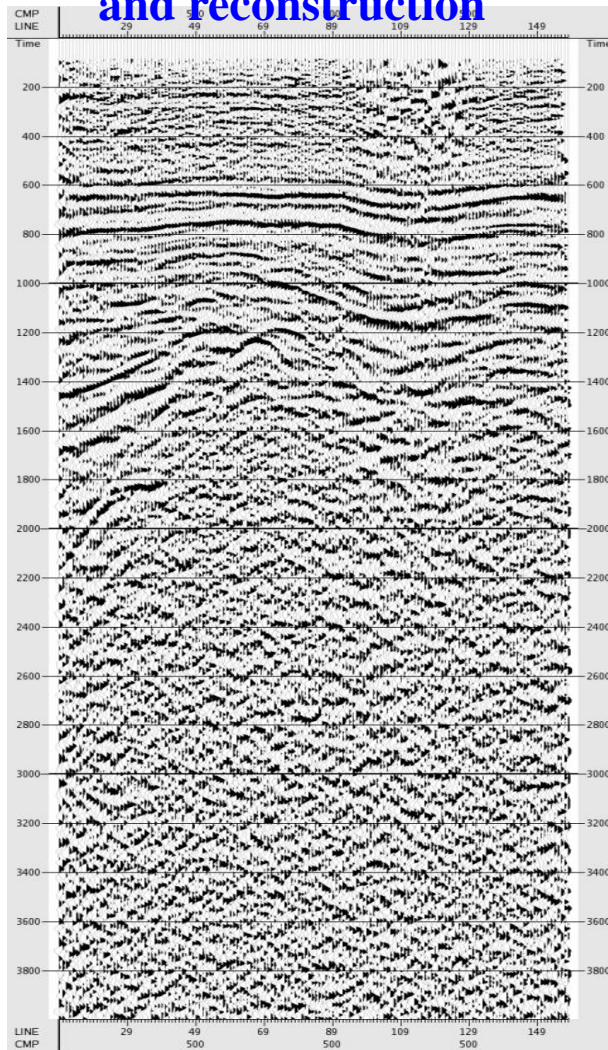# Field data application

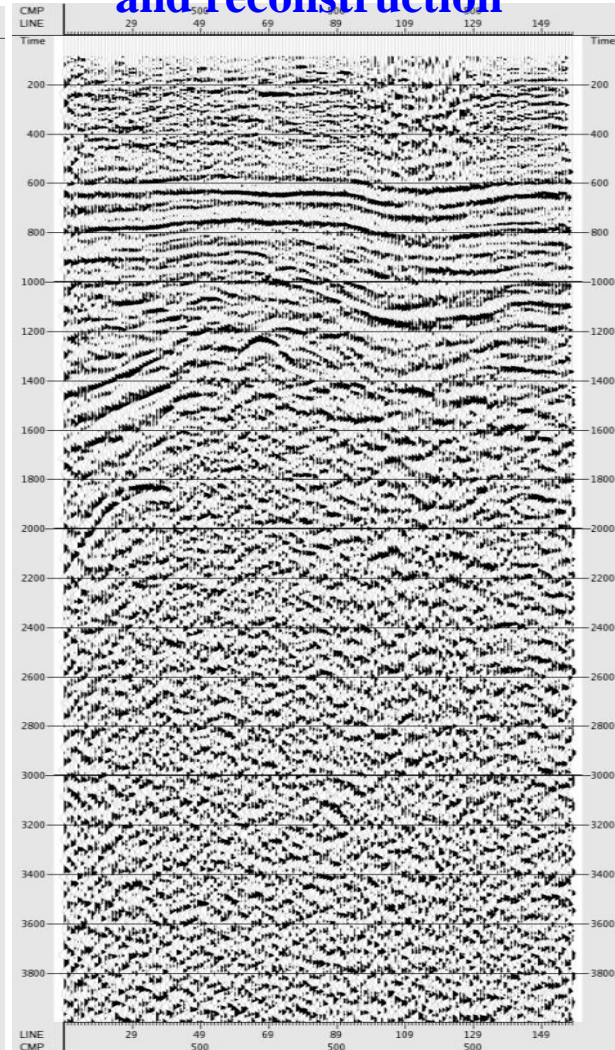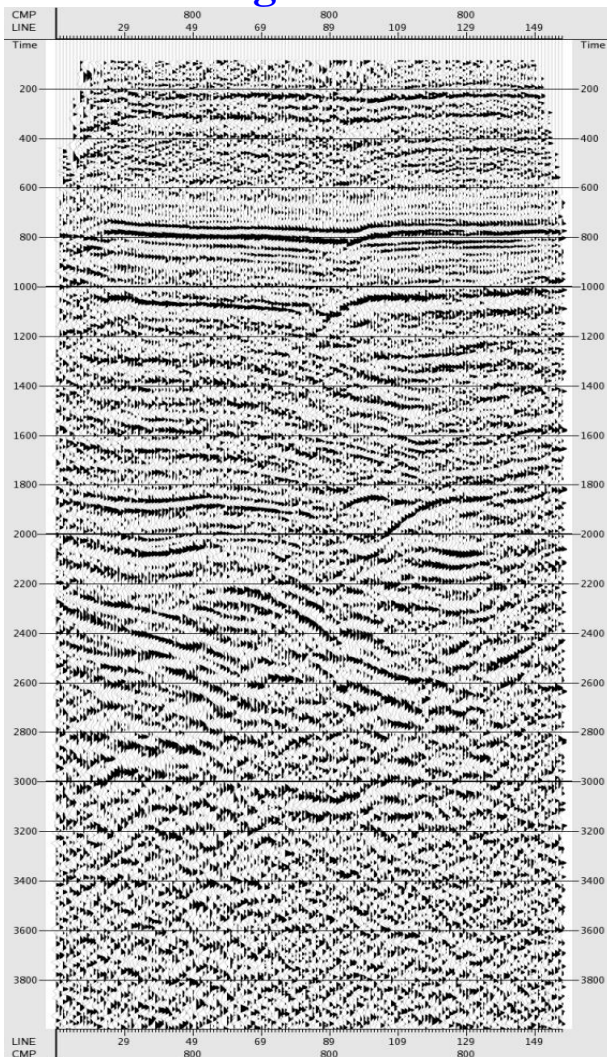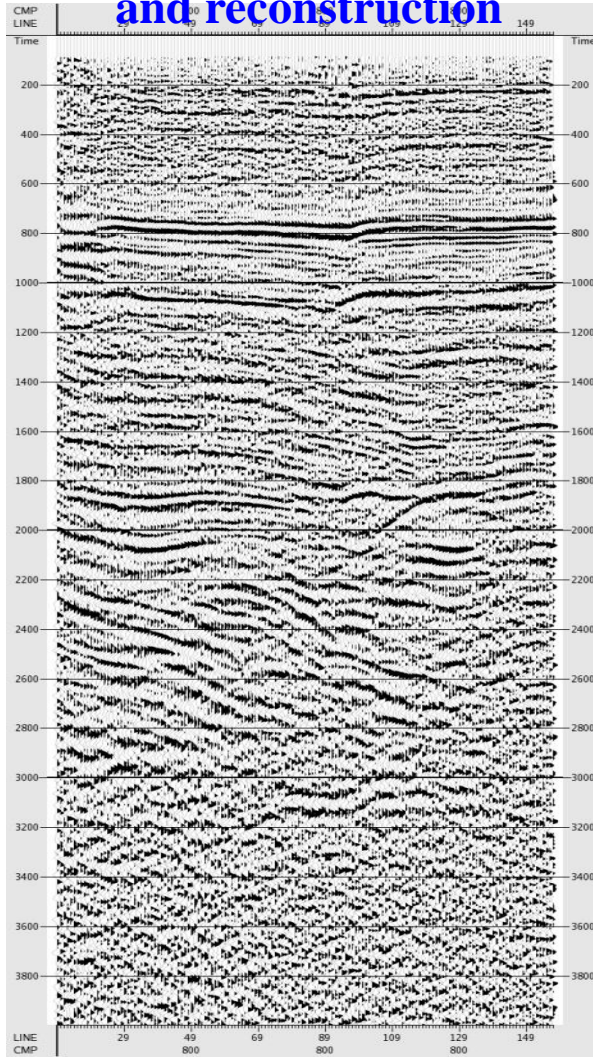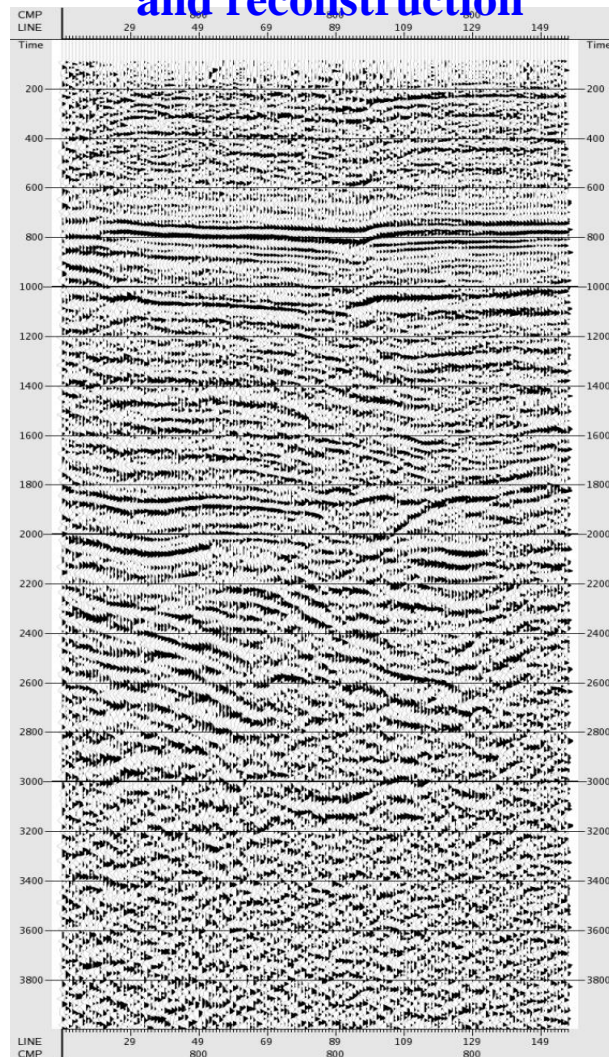
Original

Regular undersampling and reconstruction

Random undersampling and reconstruction

CONTENTS

Conclusions

1.	The comparative analysis to the CMP gather results shows that sampling randomly can convert the noises mixed with true frequencies into incoherent random noises easy to be eliminated, hence its reconstruction result is better than that of the regular way.

2.	The migration results indicates that lack of shots or traces will cause the irregular distribution of seismic traces in the image gather, and then reduce the image quality of migration section, especially in the shallow layer. Although the number of shot points is cut in half, we got a migration section quality similar to the raw data through data reconstruction, which further demonstrates that the algorithm is effective for data reconstruction. For the seismic survey, the purpose of acquisition can be achieved through sparse acquisition and reconstruction processing.

Thanks !