

Knowledge resources for the seismic Interpretation course GEO272

The course uses the pedagogic principle of problem-based learning (PBL). This means that the students are themselves responsible for acquiring the necessary knowledge to fulfill the requirements set forward in the learning goals for the course and each case. Although the course supervisor will recommend reading to the students, the students must make sure that they have acquired the necessary knowledge. If in doubt, they should discuss this with the course supervisor.

E-LEARNING MODULES

The following e-learning modules give access to most of (but not all) the knowledge required in the course. Not everything in each module is relevant for the course and the students should avoid trying to go through everything in detail as this is far too extensive. Instead, they should focus on relevant parts necessary to fulfill the requirements set forward in the learning goals. Modules of specific interest are highlighted with bold title. Some of the modules have been published in [learningGEOSCIENCE](#). These modules require only Flash plugin and can be viewed from any computer with a broadband connection to the Internet.

1. [IPT-SIG4024-M] Seismic Key Examples (Required) – in course directory on shared drive

Author(s): Egil Tjøland

Producer(s): Camilla Hagelund

Abstract: The module presents the basic geophysical needed to understand acquisition of marine multichannel seismic data.

The module provides key 2D seismic lines from different structural and stratigraphic settings around the world.

Key words: Seismic data, seismic interpretation, tectonics, structural geology

2. [UiB-GFJ210-L3-M] Geophysical Principles (Required – overview) – Found on [learning GEOSCIENCE](#)

Author(s): Rolf Mjelde

Producer(s): Ståle Solbakken, Sølve M. Skogland

Abstract: The module presents the basic geophysical needed to understand acquisition of marine multichannel seismic data.

Key words: Seismic acquisition, multichannel data, reflection seismic data

3. [UiB-GFJ210-L3-M] Seismic Equipment (Required – overview) – Found on [learning GEOSCIENCE](#)

Author(s): Rolf Mjelde

Producer(s): Ståle Solbakken, Sølve M. Skogland

Abstract: Describe how the most important equipment used in marine multichannel seismic data acquisition work.

Key words: Seismic equipment, acquisition

4. [UiB-GFJ210-L3-M] Seismic Recording (Required – overview)– Found on [learning GEOSCIENCE](#)

Author(s): Rolf Mjelde

Producer(s): Ståle Solbakken, Sølve M. Skogland

Abstract: The module describes the most important aspects in recording of marine multichannel seismic data acquisition.

Key words: seismic, recording, acquisition

5. [UiB-GFJ210-L3-M] Processing (Required – overview) – Found on [learning GEOSCIENCE](#)

Author(s): Rolf Mjelde

Producer(s): Ståle Solbakken, Sølve M. Skogland

Abstract: The module describes the most important aspects in processing of marine multichannel seismic data.

Key words: seismic, processing, multichannel data

6. [IPT-SIG4024-M] Seismic Stratigraphy (Required) –in course directory on [shared drive](#)

Author(s): Egil Tjåland

Producer(s): Camilla Hagelund

Abstract: Recognition, mapping and interpretation of unconformities, seismic sequences and depositional sequences.

Key words: Seismic sequences, depositional sequence, unconformities, seismic facies

7. [UiB-GFJ213-L3-M] Gullfaks (Required) – Found on [learning GEOSCIENCE](#)

Author(s): Jonny Hesthammer

Producer(s): Petter S. Nielsen and Richard Kluge

Abstract: Gives a basic introduction to the Gullfaks Field (stratigraphy, production and structural geology).

Key words: Gullfaks, structural geology, stratigraphy

8. [UiB-GFJ213-L3-M] Closing the Gap (Optional) – Found on [learning GEOSCIENCE](#)

Author(s): Jonny Hesthammer

Producer(s): Petter S. Nielsen and Richard Kluge

Abstract: The ability to map small-scale faults from seismic surveys depends upon resolution, noise content and acquisition/processing procedure. In addition, the geoscientist must possess a sound understanding of plausible geometries consistent with analyses of well data. The comparison of two seismic datasets from the Gullveig structure, northern North Sea, demonstrates that the lateral resolution of the data is strongly dependent on the signal-to-noise ratio. By combining a theoretical approach with statistics from well analyses, exemplified by data from the Gullfaks Field, it is possible to enhance our understanding of the limits of fault resolution on 3D seismic data.

Key words: seismic resolution, theoretical and practical resolution, Gullfaks and Gullveig

9. [UiB-GFJ213-L3-M] Seismic Attribute Analysis (Optional) – Found on [learning GEOSCIENCE](#)

Author(s): Jonny Hesthammer

Producer(s): Richard Kluge and Petter S. Nielsen

Abstract: Seismic attribute maps provide a useful tool in interpreting faults particularly those close to or below seismic resolution. Dip, relief, azimuth, and amplitude maps are most useful. One of the challenges is to distinguish between anomalies related to real geological features and to seismic noise: -both of which may occur as linear or curvi-linear, continuous features on the attribute maps. This challenge is solved by use of independent data as core data, dipmeter data, stratigraphic log correlation and forward modelling.

Key words: timedip map, azimuth map, amplitude map, relief map, Gullfaks

10. [UiB-GFJ213-L3-M] Use & Abuse of seismic data (Required – overview) – Found on [learning GEOSCIENCE](#)

Author(s): Jonny Hesthammer

Producer(s): Richard Kluge and Petter S. Nielsen

Abstract: The article shows with examples from the Gullveig and Gullfaks Field how seismic data can be misinterpreted due to the presence of noise and how well data can provide information needed to distinguish real features from noise.

Key words: Seismic data, noise, Gullfaks

11. [UiB-GFJ213-L3-M] Improving Seismic Data (Optional) – [Found on learning GEOSCIENCE](#)

Author(s): Jonny Hesthammer

Producer(s): Richard Kluge and Petter S. Nielsen

Abstract: Seismic data can be improved after final processing by applying simple techniques. One method is to combine several seismic surveys. In addition, the data set can commonly be further improved by applying dip filters and frequency filters. This requires a thorough understanding of the geology of the area. By combining and filtering seismic surveys from the Gullfaks Field, northern North Sea, an enhanced seismic interpretation could be carried out.

Key words: Gullfaks, combining, filtering, improving

12. [UiB-GFJ213-M] Combining Seismic Data (Optional) – [Found on learning GEOSCIENCE](#)

Author(s): Jonny Hesthammer

Producer(s): Katherine K. Gausland

Abstract: The learning experience discusses how it is possible to enhance seismic data quality (increase the signal to noise ratio) for structural interpretation by combining several seismic surveys. Such surveys are commonly available due to the focus on 4D seismic.

Key words: Gullfaks, combining seismic data, seismic surveys

13. [UiB-GFJ213-L3-M] Evaluation of the Timedip, Correlation and Coherence maps (Optional) – [Found on learning GEOSCIENCE](#)

Author(s): Jonny Hesthammer

Producer(s): Petter S. Nielsen and Richard Kluge

Abstract: Investigation of the timedip, correlation and coherence attribute maps from the Gullfaks Field demonstrates that in areas of poor data quality, the timedip map is best for structural interpretation. Although the coherence map can be developed without having any seismic interpretation, the method will reveal numerous (curvi-)linear features that may be misinterpreted as faults unless quality controlled against well data. Control against well data shows that it is very easy to overinterpret the seismic data based on surface and volume attributes.

Key words: seismic attribute maps, Gullfaks, timedip

TEXT BOOKS

There is no need to buy any books for the students. Relevant reading material will be made available during the course. The following text books give access to the knowledge required in the course. However, the students should avoid trying to read everything as this is far too extensive. Instead, they should focus on relevant parts necessary to fulfill the requirements set forward in the learning goals. The books are listed in recommended order.

1. **Hart, B., 2000: 3-D Seismic interpretation: A primer for geologists. SEPM Short Course No. 48., Tulsa.** This excellent short and concise (thus highly recommended) book contains the basics needed in order to understand the concepts of seismic interpretation. The students will be able to fulfill most requirements set forward in the learning goals by reading this book. However, for further reading, the students are encouraged to indulge in the books listed below. The book can be ordered from www.sepm.org. The book is available in digital format from one of the computers in the PBL-room.
2. **Brown, A.R., 1999: Interpretation of three-dimensional seismic data. AAPG Mem. 42, Oklahoma.** The book contains some very good chapters relevant for the seismic interpreter and it is recommended that the students scan the content for

relevant knowledge. The book is available in digital format from one of the computers in the PBL-room and the students can click on the link and from the index choose the chapters they want to read. Relevant chapters are:

Ch. 1: The whole chapter, p. 1-26

Ch. 2: Assessment of zero-phasesness

Ch. 3: Look through the whole chapter. Required reading is Interpretation procedures and Advantages and disadvantages of different displays.

Ch. 8: Classification of attributes

Ch. 10: The whole chapter on Depth conversion (not depth imaging), p. 421-434

Appendix A: The whole chapter, p. 489-494

ARTICLES

Articles are considered only as recommended reading and the students should be careful about what they read from each article. Many of the articles have a corresponding e-learning module that the student should go through instead of the more complicated article. Several of the articles are available in digital format from the course administration software. Use articles if there is a need for very specific knowledge not found elsewhere.

Fossen, H. and Hesthammer, J.

1998: "Structural geology of the Gullfaks Field, northern North Sea"; in Coward, M.P., Johnson, H. and Daltaban, T.S. (eds.) "Structural geology in reservoir characterization". Geological Society of London, Special Publications, **127**, 231-261.

The article gives an introduction to the Gullfaks area which also contains Gullveig, the field that is used in the three cases in the course.

Gabrielsen, R.H.

1986: "Structural elements in graben systems and their influence on hydrocarbon trap types"; in Spencer, A.M. et al. (eds.) "Habitat of hydrocarbons on the Norwegian Continental Shelf". Norwegian Petroleum Society, Graham and Trotman, London, 55-60.

The article explains the main structural style of the Viking Graben, including the Tampen area which is the focus of the three cases in the course.

Gabrielsen, R.H., Færseth, R.B., Steel, R.J., Idil, S., and Kløvjan, O.S.

1990: "Architectural styles of basin fill in the northern Viking Graben"; in Blundell, D.J. and Gibbs, A.D. (eds.) "Tectonic evolution of the North Sea rifts". Oxford, Clarendon Press, 158-179.

The article gives an overview of the architecture of the area relevant for the three cases in the course.

Hesthammer, J.

1998; "Evaluation of the timedip, correlation and coherence maps for structural interpretation of seismic data"; *First Break*, **16**, 151-167.

Seismic attribute maps have gained much focus over the last few years. As a result, the number of attribute maps that can be generated is increasing rapidly. However, not all attribute maps provide new information. The important thing is to realize that attribute maps can not reveal what is not in the data prior to attribute processing, but new artifacts may appear!

Hesthammer, J.

1999: "Improving seismic data for detailed structural interpretation"; *The Leading Edge*, **18**, 226-247.

This article explains how simple combination and filtering techniques carried out on the workstation can improve seismic quality for structural interpretation.

Hesthammer, J., and Fossen, H.

1997: "Seismic attribute analysis in structural interpretation of the Gullfaks Field, northern North Sea"; *Petroleum Geoscience* **3**, 13-26.

The article introduces the reader to the most useful seismic attribute maps for structural interpretation on a reservoir scale. The focus is on the timedip, relief, azimuth and amplitude maps.

Hesthammer, J., and Fossen, H.

1997: "The influence of noise in structural interpretation of seismic data"; *First Break* **15**, 209-215.

All seismic data contain abundant noise. The noise interferes with real data and the interpreter is faced with the challenge of separating real features from noise.

Hesthammer, J., and Løkkebø, S.M.

1997: "Combining seismic surveys to improve data quality"; *First Break* **15**, 103-115.

This article provides an in-depth explanation to some basic techniques for combining data from different seismic surveys.

Hesthammer, J., and Fossen, H.

in print: "From seismic to core data; an integrated approach to enhance reservoir characterisation"; in Ameen, M. (ed.) *Fracture & In-Situ Stress Characterization of Hydrocarbon Reservoirs*, Geol. Soc. Spec. Publ.

In this article, the authors show how different types of data can be integrated in order to obtain a fuller understanding of the characteristics of an area. Seismic data should always be quality controlled against well data whenever possible.

Hesthammer, J., Landrø, M., and Fossen, H.

2001: "Use and abuse of seismic data"; *Marine and Petroleum Geology*.

Seismic data are commonly misused and misinterpreted. There are many potential traps to be aware of. This is the focus of the present article.

Hesthammer, J., and Henden, J.O.

2000: "Closing the gap between theory and practice in seismic interpretation of small-scale faults"; *Petroleum Geoscience*, **6**, 107-111.

There are many misconceptions regarding seismic resolution. It is also important to be aware of the differences between theoretical and practical seismic resolution.

Simm, R., and White, R.

2002: "Phase, polarity and the interpreter's wavelet"; *First Break*, **20**, 277-281.

Every interpreter should know about phase and polarity of seismic data. However, this is not necessarily an easy task. This article gives an introduction to the concept and uncertainties related to the topic and is necessary reading for all seismic interpreters.

Tollefsen, S., Graue, E., and Svinddal, S.

1994: "Gullfaks development provides challenges"; *World Oil*, **94**, 45-54.

The article gives an introduction to the field development plans for the Gullfaks Field.

Vollset, J., and Doré, A.G.

1984: "A revised Triassic and Jurassic lithostratigraphic nomenclature for the Norwegian North Sea"; in Norwegian Petroleum Directorate, 53.

This article provides the basics for understanding the stratigraphy of the North Sea. However, the students will also find much of this information in some of the other articles listed above.