I. Course Name: GEOL 6390 3D Seismic Exploration

II. Course Overview: In this course we will learn how to use principles of seismic stratigraphy, seismic geomorphology, structural geology, and rock physics to interpret seismic reflection data and associated attributes to delineate faults, fractures, folds, fluvial-deltaic complexes, turbidites, mass transport complexes, karst, and other structural and stratigraphic features of interest. This course is intended for graduate students in geophysics, geology, and petroleum engineering.

III. Course Objective: At the end of the course, the student will be able to identify major geologic features on 3D seismic data, to use 3D visualization to effectively communicate these features to others, to identify and interpret through seismic acquisition and processing artifacts, to generate simple seismic time/structure maps, and to generate and interpret simple attribute extraction maps. Along the way, the student will become adept in exploiting modern 3D data interpretation workstation software.

IV. Instructor: Kurt J. Marfurt
Room 872 Sarkeys Energy Building, OU campus
Email = kmarfurt@ou.edu

Lab Guru/TA: Ms
Email =

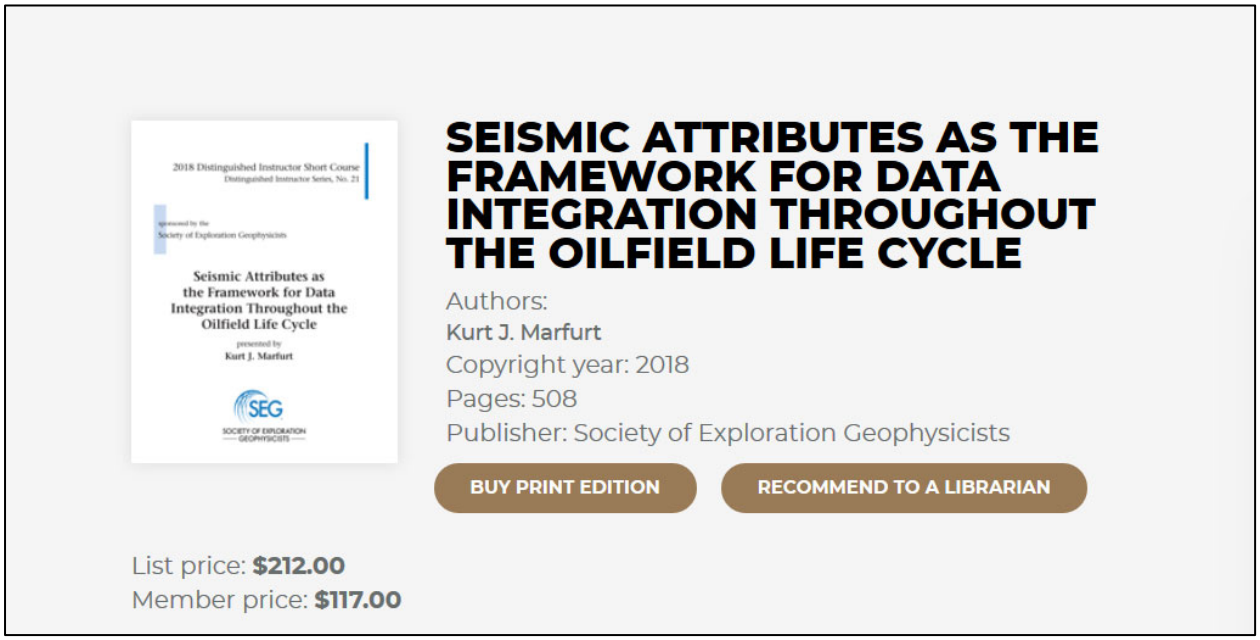
V. Times: (All lectures and labs will be remote)

Date	Time	Event
July 15	1:00-3:00	Lecture
July 15	3:00-5:00	Petrel Lab
July 15	5:00-6:00	Lecture
July 16	8:30-11:45	Lecture
July 16	11:45-1:00	Lunch
July 16	1:00-3:00	Petrel Lab
July 16	3:00-5:00	Lecture
July 22	1:00-2:40	Lecture
July 22	2:40-3:00	Practice Quiz
July 22	3:00-5:00	Petrel Lab
July 23	8:30-11:45	Lecture
July 23	11:45-1:00	Lunch
July 23	12:30-3:00	Petrel Lab
July 23	3:00-5:00	Lecture

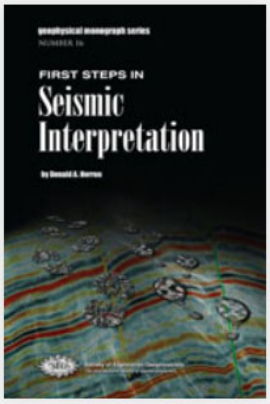
July 29	1:00-2:00	Lecture
July 29	2:00-3:00	Exam #1
July 29	3:00-5:00	Petrel Lab
July 30	8:30-11:45	Lecture
July 30	11:45-1:00	Lunch
July 30	12:30-3:00	Petrel Lab
July 30	3:00-5:00	Lecture
August 3	6:00-9:00	Exam #2

VI. Course Prerequisites: Basic senior level geology (physical geology, stratigraphy, and structural geology)

VII. Textbooks: The course will lean heavily on modern attributes as a tool to accelerate the delineation of tectonic, depositional, and diagenetic geologic features. I will therefore supply modern references. However, for those of you have $117 to spend, you may wish to consider the following up-to-date book that is written by a renowned author:



For those of you with no interpretation experience, you may wish to buy a copy of Don Herron's book that I have used in my undergraduate courses:



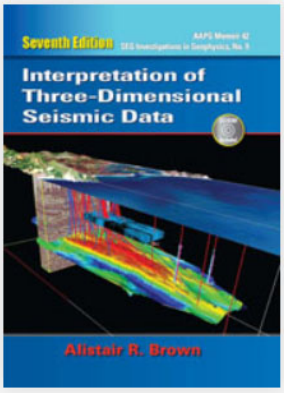
FIRST STEPS IN SEISMIC INTERPRETATION

Authors:
Donald A. Herron
Copyright year: 2011
Pages: 217
Publisher: Society of Exploration Geophysicists

BUY PRINT EDITION | RECOMMEND TO A LIBRARIAN

List price: **$75.00**
Member price: **$42.00**

Alistair Brown's book is a classic. You may be able to "borrow" it from an older colleague:



INTERPRETATION OF THREE-DIMENSIONAL SEISMIC DATA, SEVENTH EDITION

Authors:
Alistair R. Brown
Copyright year: 2011
Pages: 665
Publisher: Society of Exploration Geophysicists

BUY PRINT EDITION | RECOMMEND TO A LIBRARIAN

List price: **$97.00**
Member price: **$71.00**

I will also draw heavily on professional society journals:

1. The Society of Exploration Geophysicists (www.seg.org) and the American Association of Petroleum Geologists (www.aapg.org) jointly publish the peer-reviewed journal Interpretation that contains many excellent papers on methodologies, workflows, and case studies. I understand that the current editor is renowned for his wisdom and insight!

2. The Society of Exploration Geophysics publishes The Leading Edge (www.seg.org). TLE has excellent case studies and examples of best interpretation practices. The bulk of my

class lecture material will come from TLE. The SEG has a peer review journal called Geophysics. I will use draw some algorithmic material from this archived journal. The costs for students are minimal.

3. The European Association of Geoscientists and Engineers publishes First Break and Geophysical Prospecting. First Break is similar in readability and scope to TLE. Since the EAGE journals have only recently gone online, I draw less heavily upon them.

4. The American Association of Petroleum Geologists (www.aapg.org) publishes the AAPG Bulletin and the AAPG Explorer, both of which are available online. The Explorer is a monthly newspaper that has many good tips on seismic interpretation methodologies. Recent Explorer articles are online at no cost.

I have uploaded a subset of what I feel to be the more important readings. I do not expect you to read them all; however, I do expect you to look at all the figures and captions because I will take exam questions from some of these papers.

IX. Grading and Evaluation of Students: 2 Exams (30% each). Lab exercises - 40%.

X. Teaching Strategies – Lectures and Hands-on Application. The lectures and labs will go at different paces, with the labs reinforcing what we may have discussed in class. Like painting and sculpture, seismic interpretation is mostly self-taught.

Lectures:

Date	Lecture	Topic
July 15-16	Lecture 01a	Introduction
July 15-16	Lecture 01c	Impedance, reflection coefficients, and the convolutional model
July 15-16	Lecture 02	Color display and 3D visualization
July 15-16	Lecture 03	Spectral content and limits to vertical resolution
July 15-16	Lecture 04	Direct hydrocarbon indicators
July 15-16	Lecture 05	Complex trace, horizon, and formation attributes
July 15-16	Lecture 06	Geometric attributes that map reflector dip and configuration
July 22-23		Practice quiz
July 22-23	Lecture 07	Geometric attributes that map continuity and texture
July 22-23	Lecture 08	Spectral decomposition and thin-bed tuning
July 22-23	Lecture 09	Seismic expression of tectonic deformation
Jul 29-30	Exam #1	On basic interpretation workflows (e.g., interpreting faults, horizons, stratal slices, from labs) and volumetric attributes
Jul 29-30	Lecture 10	Seismic expression of clastic depositional systems
Jul 29-30	Lecture 11	Seismic expression of carbonate depositional systems.
Jul 29-30	Lecture 12	Shallow marine features and potential drilling hazards
Jul 29-30	Lecture 15	Impact of acquisition of seismic interpretation
Jul 29-30	Lecture 16	Post-stack data conditioning
By Aug 6	Lab Grades	Meet with TA to go over the rubric checklist
Aug 3 6-9PM	Exam #2	On seismic expression of structure and stratigraphy; on seismic data quality issues

Lectures 15 and 16 are voiced over if we run out of time.

Labs:

Seismic interpretation is heavily self-taught – you recognize faults and different stratigraphic features on the data by trying to map them. I expect you to learn effective workflows and tricks from your fellow participants that I, as your instructor, have not seen. For these reasons, you will spend much more time working on the labs than listening to lectures. You will also develop skills that are useful in the workplace. The labs are heavily loaded towards week 1 so that you do not fall behind. Lab 4 is long. It is perfectly OK to run ahead with the labs, depending on your other work, school, or personal commitments.

Lab Report Products (40 points)

All images should be provided with a legible color bar, histogram, scale bar, and North arrow.

========== week 1 ==========

Lab 1. Data loading, 3D visualization, and color bars (0 points)

- No images required

Lab 2. Instantaneous (complex) attributes (3 points)

- One vertical image of instantaneous frequency plotted against an inverted rainbow colorbar modulated by (corendered with) envelope plotted against a monochrome gray colorbar.
- One image using instantaneous frequency plotted against an inverted rainbow colorbar corendered with seismic amplitude using a binary black-white color bar.
- Interpretations of geologic features seen on both – using the attributes! For help on attributes read Taner et al., 1979

Lab 3. Interpreting faults (3 points)

- An image of the three faults in the SE corner of the survey

Lab 4. Interpreting horizons in Petrel (7 points)

- An image of your tied 10-by10-line grid of manually picked Magenta horizon

========== week 2 ==========

Lab 5. Generating surfaces in Petrel (6 points)

- An image of your 3D autotracked Magenta horizon (i.e., the dense picks)
- An image of your Magenta surface (i.e., the cleaned-up surface using B-splines)
- Images of your dip magnitude (dip angle in Petrel) and dip azimuth maps computed from the Magenta Surface

Lab 6. Horizon slices, phantom horizons, stratal slices, and isochrons (6 points)

- An image of your isochron map between the Magenta and Carbonate horizons
- A horizon slice along the Magenta horizon of instantaneous frequency
- A stratal slice 50% of way between the Magenta and Carbonate horizon through the variance volume

Lab 7. Computing structural dip magnitude and dip azimuth (4 points)

- A time slice through corendered dip azimuth (as the base layer against a cyclical color bar), dip magnitude (against a monochrome gray color bar), and variance (against a monochrome black color bar)

- A vertical slice through the corendered dip azimuth (as the base layer against a cyclical color bar), dip magnitude (against a monochrome gray color bar), and seismic amplitude (against a binary black-white color bar)

========== week 3 ==========

Lab 8. Computing variance, chaos, and other edge-sensitive attributes (3 points)

- Pick a time slice that shows some turbidites or other stratigraphic features of interest and provide three images that show the differences between variance, chaos, and amplitude contrast, noting why you like one better than the other two

Lab 9. Computing spectral components (3 points)

- Pick the same time slice as shown in the previous exercise and corender three spectral MAGNITUDE components of interest using RGB blending

Lab 10. Structure-oriented filtering (5 points)

- Provide the following images on a vertical slice of your choice. Plot all images at the same amplitude scale:
    - The original amplitude data
    - The structure-oriented filtered data using two cascaded 3x3 trace filters
    - The structure-oriented filtered data using a single 5x5 trace filter
    - The difference (rejected “noise”) when using the cascaded 3x3 filters
    - The difference (rejected “noise”) when using the larger 5x5 filter

========== end ==========