



Course GEOS 6392 Fundamentals of Reflection Seismology
Professor George McMechan
Term Spring 2007
Meetings WT 2.210 tuesday 2:30-5:15

Professor's Contact Information

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General Course Information

Pre-requisites, Co-requisites, & other restrictions Prior functionality in a high level programming language such as C++ or Fortran is required.

Course Description

Theoretical and practical aspects of seismic reflection data acquisition and processing, with emphasis on wavefield characterization. Includes the wave equation, the convolutional model, coded sources, the array response, velocity estimation, statics, filtering, pre- and post-stack migration, and direct and indirect hydrocarbon indicators, VSPs, AVO, and 3-D processing. Includes an overview of the standard reflection processing sequence, and evaluation of alternatives.

Learning Outcomes

Assignments involve writing, testing and documentation of original computer programs.
To have a firm theoretical and practical understanding of the mathematical and physical basis of seismic reflection processing.
To be able to evaluate the strengths and weaknesses of alternative procedures. To interpret seismic data in terms of Earth structure and processes, and their implications for solving geophysical problems. To clearly and coherently communicate results of a scientific investigation. To demonstrate these abilities by using them in developing and testing the software in the assignments and in the assignment reports.

Required Texts & Materials

There is no text for this course. Readings are taken from the literature (see attached list).

Suggested Texts, Readings, &

Relevant references are:

- Materials** Yilmaz "Seismic Data Processing" (SEG 1987 or 2001)
Allen & Peddy "Amplitude Variation with Offset: Gulf
Coast Case Studies" (SEG, 1993)
Biondi "3-D Seismic Imaging" (SEG, 2006)
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Reference List, Spring 2007

- L limitations in standard processing
 - D datuming
 - S statics
 - V pre-stack velocity analysis
 - I pre-stack image conditions
 - C common-shot migrations
 - T 3-D implementations
 - P inversion
 - PR data processing
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- V Al-Yahya, K., 1989. Velocity analysis by iterative profile migration, *Geophysics*, 54, 718- 729.
- C Berkhout, A. J., Van Der Schoot, A. and Romijn, R., 1990. Seismic imaging by shot record migration: A case study, *Int. J. Imag. Sys. Tech.*, 2, 13-24.
- D Berryhill, J.R., 1984. Wave-equation datuming before stack: 54th Ann. Internat Mtg., Soc. Expl. Geophys., Expanded Abstracts, 397-399.
- CE Blacquiere, G., Duijndam, A.J.W. and Romijn, R. 1991. Efficient x-f depth migration of shot records: practical aspects, *First Break*, 9, 9-23.
- T Cabrera, J., Perkins, W., Hagen, T., Ratcliffe, W., and Lynn, W., 1992, 3-D prestack depth migration: Implementation and case history: 62nd Ann. Internat. Mtg., Soc., Expl. Geophys., Expanded Abstracts, 948-951.

- T* Chang, W. F. & McMechan, G. A. 1990. Three-dimensional acoustic prestack reverse-time migration, *Geophys. Prosp.*, 38, 737-755.
- I Chang, W. F. & McMechan, G. A., 1986. Reverse-time migration of offset vertical seismic profiling data using the excitation-time imaging condition, *Geophysics*, 51, 67-84.
- T Chang, H., van Dyke, J., Solano, M., McMechan, G.A., and Epili, D., 1998. 3-D pre-stack depth migration: from prototype to production in an MPP environment, *Geophysics*, 63, 546-556.
- NT+ Chen, H. W. and McMechan, G. A., 1992, Implicit static corrections in 3-D prestack depth migration of common source gather data, *J. Seis. Expl.*, 1, 207-214.
- S de Amorim, W.N., Hubral, P., and Tygel, M., 1987. Computing field statics with the help of seismic tomography: *Geophys. Prosp.*, 35, 907-919.
- C Deng, F., 2007, True amplitude prestack depth migration, *Geophysics*, preprint
- V Dunkin, J.W., and Levin, F.K., 1973. Effect of normal moveout on a seismic pulse, *Geophysics*, 38, 635-642.
- IE Esmersoy, C. & Oristaglio, M., 1988. Reverse-time wavefield extrapolation, imaging, and inversion, *Geophysics*, 53, 920-931.
- V Faye, J.P. & Jeannot, J.P., 1986. Prestack migration velocities from focusing depth analysis, 56th Ann. Internat. Mtg., Soc. Expl. Geophys., 438-440.
- VT Fei, W., 2006. 3-D common reflection point based seismic migration velocity analysis, *Geophysics*, 71, S161-S167.
- T French, W.S. 1990, Practical seismic imaging: The Leading Edge, 9, no. 8, 13-20.
- V Gardner, G.H.F., French, W.W., and Matzuk, T., 1974. Elements of migration and velocity analysis, *Geophysics*, 39, 811-825.

- V Grau, G., and Lailly, P., 1993, Sequential migration aided tomography: an approach to imaging complex structures, *J. Appl. Geophys.*, 30, 75-87.
- V+ Grau, G., 1993, Seismic velocities in complex media: *J. Appl. Geophys.*, 29, 271-284.
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- PR Hu, L-Z., and McMechan, G.A., 1987, Wavefield transformations of vertical seismic profiles, *Geophysics*, 52, 307-321.
- C Hua, B., and McMechan, G.A., 2003, Parsimonious 2-D prestack Kirchhoff depth migration, *Geophysics*, 68, 1043-1051.
- I Jain, S. and Wren, A.E., 1980, Migration before stack - Procedure and significance, *Geophysics*, 45, 204-212.
- L* Kuhn, M. J., 1985, A look beyond the CMP concept, *First Break*, 3, No. 9, 17-21.
- I* Loewenthal, D. and Hu, L.Z., 1991, Two methods for computing imaging conditions for common-shot pre-stack migration, *Geophysics*, 56, 378-381.
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- DS McMechan, G.A. and Chen, H.W., 1990, Implicit static corrections in prestack migration of common-source data, *Geophysics*, 55, 757-760.

- C McMechan, G.A. and Sun, R., 1991, Depth filtering of first breaks and ground roll, *Geophysics*, 56, 390-396.
- L Mora, P., 1989. Inversion = migration + tomography, *Geophysics*, 54, 1575-1596.
- NI Rajasekaran, S., and McMechan, G.A., 1992, A new approach to prestack seismic processing, *Geophys. J. Int.* 121, 255-266.
- IE Reshef, M. and Kosloff, D., 1986, Migration of common-shot gathers, *Geophysics*, 51, 324-331.
- I+ Schultz, P. and Sherwood, J.W.C., 1980, Depth migration before stack, *Geophysics*, 45, 376-393.
- SV+ Stoffa, P.L., Diebold, J.B. and Buhl, P., 1982, Velocity analysis for wide aperture seismic data, *Geophys. Prosp.*, 30, 25-57.
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- T,PR Sun et al., 2004, Separating P- and S-waves in a prestack 3-D elastic seismogram by divergence and curl computations, *Geophysics*, 69, 286-297.
- L Taner, T., Cook, E.E. and Neidell, N.S. 1970, Limitations of the reflection seismic method; lessons from computer simulations, *Geophysics*, 35, 551-573.
- V Taner, T., Postma, R.W., Lu, L., and Baysal, E., 1991, Depth-migration velocity analysis, 61st Ann. Internat. Mtg., Soc. Expl. Geophys., Expanded Abstracts, 1218-1221.
- C Tarantola, A., 1984. Inversion of seismic reflection data in the acoustic approximation, *Geophysics*, 49, 1259-1266.
- T Xu, T., McMechan, G.A., and Sun, R., 1995. 3-D prestack full-wavefield inversion: *Geophysics*, 60, 1805-1818.
- V+ Versteeg, R., 1993, Sensitivity of prestack depth migration to the velocity model, *Geophysics*, 58, 873-882.

- S Wiggins, R.A., Lerner, K.L., and Wisecup, R.D., 1976. Residual statics as a general linear inverse problem, *Geophysics*, 41, 922-938.
- T,V Zhang, J., and McMechan, G.A., 1994. 3-D transmission tomography for imaging irregular salt bodies from wide-aperture data: *Geophysics*, 59, 1620-1630.

Assignments & Academic Calendar

[Topics, Reading Assignments, Due Dates, Exam Date

APPROXIMATE SCHEDULE OF TOPICS

- Jan 09 stress, strain, translation, deformation, rotation
- Jan 16 elastic moduli, elastic wave equation & solutions, wavenumber
- Jan 23 Snell's Law, impedance, reflection coefficients
- Jan 30 model parameterizations, convolutional model, apparent wavelets
- Feb 06 attenuation, transmission losses, matched filters, vibroseis
- Feb 13 reflection geometries, stacking diagram, S/N, array responses
(Assignment #1 due)
- Feb 20 seismic processing sequence, prediction error, statics
- Feb 27 consortium week: special topics in exploration seismology
(attend all consortium presentations)
- Mar 06 Spring Break
- Mar 13 Quiz # 1, 2-D vs 3-D
- Mar 20 NMO, velocity analysis
(Assignment #2 due)
- Mar 27 migration & velocity analysis
- Apr 03 impedance estimation

Apr 10 direct detection of hydrocarbons, AVO

Apr 17 resolution, borehole seismology, recent developments
(Assignment #3 due)

Apr 24 Quiz # 2

SCHEDULE

Exam dates and times	First Class	Jan 09
	Assignment #1 due	Feb 06
	Spring break	Mar 06
	Quiz #1	Mar 13
	Assignment #2 due	Mar 20
	Assignment #3 due	Apr 17
	Quiz # 2	Apr 24
	(covers readings & lectures since Quiz 1)	

Course Policies

Grading (credit) Criteria	Marks will be distributed as follows:	
	Quiz # 1	20
	Quiz # 2	20
	Assignments (20 each)	60
	Total	100

Make-up Exams	Only for legitimate non-academic reasons
Extra Credit	none
Late Work	THERE WILL BE A PENALTY OF ONE MARK PER DAY FOR LATE ASSIGNMENTS
Special Assignments	none
Class Attendance	Expected, but not mandatory (at student's risk of not understanding and not having an opportunity to ask questions for clarification in class)
Classroom Citizenship	Civil interaction is expected
Field Trip Policies	No field trips
Student Conduct and Discipline	<p>The University of Texas System and The University of Texas at Dallas have rules and regulations for the orderly and efficient conduct of their business. It is the responsibility of each student and each student organization to be knowledgeable about the rules and regulations which govern student conduct and activities. General information on student conduct and discipline is contained in the UTD publication, <i>A to Z Guide</i>, which is provided to all registered students each academic year.</p> <p>The University of Texas at Dallas administers student discipline within the procedures of recognized and established due process. Procedures are defined and described in the <i>Rules and Regulations, Series 50000, Board of Regents, The University of Texas System</i>, and in Title V, Rules on Student Services and Activities of the university's <i>Handbook of Operating Procedures</i>. Copies of these rules and regulations are available to students in the Office of the Dean of Students, where staff members are available to assist students in interpreting the rules and regulations (SU 1.602, 972/883-6391).</p> <p>A student at the university neither loses the rights nor escapes the responsibilities of citizenship. He or she is expected to obey federal, state, and local laws as well as the Regents' Rules, university regulations, and administrative rules. Students are subject to discipline for violating the standards of conduct whether such conduct takes place on or off campus, or whether civil or criminal penalties are also imposed for such conduct.</p>
Academic Integrity	<p>The faculty expects from its students a high level of responsibility and academic honesty. Because the value of an academic degree depends upon the absolute integrity of the work done by the student for that degree, it is imperative that a student demonstrate a high standard of individual honor in his or her scholastic work.</p> <p>Scholastic dishonesty includes, but is not limited to, statements, acts or omissions related to applications for enrollment or the award of a degree, and/or the submission as one's own work or material that is not one's own. As a general rule, scholastic dishonesty involves one of the following acts: cheating, plagiarism, collusion and/or</p>

	<p>falsifying academic records. Students suspected of academic dishonesty are subject to disciplinary proceedings.</p> <p>Plagiarism, especially from the web, from portions of papers for other classes, and from any other source is unacceptable and will be dealt with under the university's policy on plagiarism (see general catalog for details). This course will use the resources of turnitin.com, which searches the web for possible plagiarism and is over 90% effective.</p>
<p>Email Use</p>	<p>The University of Texas at Dallas recognizes the value and efficiency of communication between faculty/staff and students through electronic mail. At the same time, email raises some issues concerning security and the identity of each individual in an email exchange. The university encourages all official student email correspondence be sent only to a student's U.T. Dallas email address and that faculty and staff consider email from students official only if it originates from a UTD student account. This allows the university to maintain a high degree of confidence in the identity of all individual corresponding and the security of the transmitted information. UTD furnishes each student with a free email account that is to be used in all communication with university personnel. The Department of Information Resources at U.T. Dallas provides a method for students to have their U.T. Dallas mail forwarded to other accounts.</p>
<p>Withdrawal from Class</p>	<p>The administration of this institution has set deadlines for withdrawal of any college-level courses. These dates and times are published in that semester's course catalog. Administration procedures must be followed. It is the student's responsibility to handle withdrawal requirements from any class. In other words, I cannot drop or withdraw any student. You must do the proper paperwork to ensure that you will not receive a final grade of "F" in a course if you choose not to attend the class once you are enrolled.</p>
<p>Student Grievance Procedures</p>	<p>Procedures for student grievances are found in Title V, Rules on Student Services and Activities, of the university's <i>Handbook of Operating Procedures</i>.</p> <p>In attempting to resolve any student grievance regarding grades, evaluations, or other fulfillments of academic responsibility, it is the obligation of the student first to make a serious effort to resolve the matter with the instructor, supervisor, administrator, or committee with whom the grievance originates (hereafter called "the respondent"). Individual faculty members retain primary responsibility for assigning grades and evaluations. If the matter cannot be resolved at that level, the grievance must be submitted in writing to the respondent with a copy of the respondent's School Dean. If the matter is not resolved by the written response provided by the respondent, the student may submit a written appeal to the School Dean. If the grievance is not resolved by the School Dean's decision, the student may make a written appeal to the Dean of Graduate or Undergraduate Education, and the dean will appoint and convene an Academic Appeals Panel. The decision of the Academic Appeals Panel is final. The results of the academic appeals process will be distributed to all involved parties.</p>

	<p>Copies of these rules and regulations are available to students in the Office of the Dean of Students, where staff members are available to assist students in interpreting the rules and regulations.</p>
<p>Incomplete Grades</p>	<p>As per university policy, incomplete grades will be granted only for work unavoidably missed at the semester's end and only if 70% of the course work has been completed. An incomplete grade must be resolved within eight (8) weeks from the first day of the subsequent long semester. If the required work to complete the course and to remove the incomplete grade is not submitted by the specified deadline, the incomplete grade is changed automatically to a grade of F.</p>
<p>Disability Services</p>	<p>The goal of Disability Services is to provide students with disabilities educational opportunities equal to those of their non-disabled peers. Disability Services is located in room 1.610 in the Student Union. Office hours are Monday and Thursday, 8:30 a.m. to 6:30 p.m.; Tuesday and Wednesday, 8:30 a.m. to 7:30 p.m.; and Friday, 8:30 a.m. to 5:30 p.m.</p> <p>The contact information for the Office of Disability Services is: The University of Texas at Dallas, SU 22 PO Box 830688 Richardson, Texas 75083-0688 (972) 883-2098 (voice or TTY)</p> <p>Essentially, the law requires that colleges and universities make those reasonable adjustments necessary to eliminate discrimination on the basis of disability. For example, it may be necessary to remove classroom prohibitions against tape recorders or animals (in the case of dog guides) for students who are blind. Occasionally an assignment requirement may be substituted (for example, a research paper versus an oral presentation for a student who is hearing impaired). Classes enrolled students with mobility impairments may have to be rescheduled in accessible facilities. The college or university may need to provide special services such as registration, note-taking, or mobility assistance.</p> <p>It is the student's responsibility to notify his or her professors of the need for such an accommodation. Disability Services provides students with letters to present to faculty members to verify that the student has a disability and needs accommodations. Individuals requiring special accommodation should contact the professor after class or during office hours.</p>
<p>Religious Holy Days</p>	<p>The University of Texas at Dallas will excuse a student from class or other required activities for the travel to and observance of a religious holy day for a religion whose places of worship are exempt from property tax under Section 11.20, Tax Code, Texas Code Annotated.</p>

	<p>The student is encouraged to notify the instructor or activity sponsor as soon as possible regarding the absence, preferably in advance of the assignment. The student, so excused, will be allowed to take the exam or complete the assignment within a reasonable time after the absence: a period equal to the length of the absence, up to a maximum of one week. A student who notifies the instructor and completes any missed exam or assignment may not be penalized for the absence. A student who fails to complete the exam or assignment within the prescribed period may receive a failing grade for that exam or assignment.</p> <p>If a student or an instructor disagrees about the nature of the absence [i.e., for the purpose of observing a religious holy day] or if there is similar disagreement about whether the student has been given a reasonable time to complete any missed assignments or examinations, either the student or the instructor may request a ruling from the chief executive officer of the institution, or his or her designee. The chief executive officer or designee must take into account the legislative intent of TEC 51.911(b), and the student and instructor will abide by the decision of the chief executive officer or designee.</p>
<p>Off-Campus Instruction and Course Activities</p>	<p>Off-campus, out-of-state, and foreign instruction and activities are subject to state law and University policies and procedures regarding travel and risk-related activities. Information regarding these rules and regulations may be found at http://www.utdallas.edu/BusinessAffairs/Travel_Risk_Activities.htm. Additional information is available from the office of the school dean.</p>

These descriptions and timelines are subject to change at the discretion of the Professor.