Leon H. Charney
School of
Marine
Sciences
UNIVERSITY
OF HAIFA

Geophysical methods in the marine environment research – 2 credits

Course Number: 224.4007

Lecturer: Prof. Yizhaq Makovsky

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Course Type: Lecture

Course Level: MSc/ PhD

Prerequisites: The mathematical and physical background of a BSc degree. A basic understanding of the Earth is an advantage.

Course Description:

Because of the accessibility and visibility limitations, geophysical remote sensing methods play an important role in investigating the marine environment. Moreover, the search for marine resources and the need for geotechnical and environmental information as a base for offshore development and conservation require the use of geophysical methods. This course aims to provide basic intuitive familiarity with applied geophysical methods, their possible uses for the investigation of the marine environment, and the practical considerations related to using them effectively.

Topics:

1. Introduction to geophysics:
    - Applied geophysics – from acquisition to model.
    - Types of geophysical methods.
    - Geophysical non-uniqueness.
2. Gravity, the simplest example of a geophysical method:
    - The history of measuring gravity from Pythagoras to satellites.
    - The basic physics.
    - Understanding and approximating the gravitational field of the Earth (spherical, elliptical, and geoid approximations).
    - Estimating the geoid with satellites.
    - Measuring gravity – absolute vs. relative, measurement techniques and devices land to marine.
    - Marine / airborne surveying and data correction procedures to free air and Bouguer anomalies.
    - Density – the physical property measured by gravity, measuring density
    - The gravitational anomalies of buried bodies
    - Isostacy and compensation: isostatic and mechanical support models and examples, the elastic strength of the lithosphere, flexure and rebound in different environments and time-scales.

- Processing, mapping and displaying gravity (and other spatial data).
- Forward and inverse modeling – the case of gravity.
- Case examples of gravity based studies, particularly works related with Israel and the Eastern Mediterranean.

3. Geomagnetism and Paleomagnetism:

- The basics physics.
- The Earth's magnetic field, its controls and variations.
- Induced and remnant magnetization, magnetic types and properties of natural materials.
- Paleomagnetism at a brief.
- Magnetic anomalies of buried bodies at a brief.
- Measuring the magnetic field (space, land, airborne and marine based).
- Case examples of magnetic applications.

4. Seismic methods at a brief:

- Basic principles of waves at a brief – basic formulation, the need for Fourier Transform.
- Zero-offset data acquisition – wavefronts and rays, basic rules of propagation, the seismogram trace.
- The concepts of diffraction, migration and resolution.
- The concepts of multi-channel and CMP.
- The concepts of processing and imaging pitfalls.
- The concepts of elastic modulo and types of seismic waves.
- Seismic velocities of natural materials and their controls.
- Seismic and acoustic applications and acquisition methods and applications (from earthquake seismology through advanced exploration to hydrographic sonars).

5. Geo-electricity in the Marine Environment (optional depending on time):

- Types of geoelectric and geoelectromagnetic methods.
- The basic principle and application of Controlled Source Electromagnetics (CSEM).
- Innovative marine EM applications.

Learning Outcomes:

At the end of the course, students will be able to:

1. Phrase the objectives of a geophysical survey.
2. Knowledgeably discuss the geophysical method adequate to address their objectives.
3. Consider the level of resolution and uniqueness of the expected and obtained geophysical results.

Requirements: Attendance, Exam, Homework assignments.

Grading:

1. Attendance – 10%.
2. Homework assignments- 50%.
3. Exam – 40%.

Reading List:

1. E. J. W. Jones, 1999, Marine Geophysics, Wiley.
2. P. Kearey, M. Brooks, I. Hill, 2002, An Introduction to Geophysical Exploration, 3rd edition, Blackwell Publishing.
3. W. Lowrie, 2007, Fundamentals of Geophysics, Cambridge University QC806.L67 1997 (General Collection-14 days).
4. X. Lurton, 2002, An Introduction to Underwater Acoustics: Principles and Applications, Springer.
5. R.E. Sheriff and L.P. Geldart, 1995, Exploration Seismology, Cambridge.
6. W.M. Telford, L.P. Geldart, and R.E. Sheriff, 1990, Applied Geophysics, Cambridge.
7. MB Dobrin, CH Savit, 1988, Introduction to geophysical prospecting, McGraw Hill Book Co.
8. C.M.R. Fowler, 2005, The Solid Earth – An introduction to global geophysics, Cambridge.