SIO 182A: Environmental and Exploration Geophysics

Course Synopsis

Introduction

Overview of the course. Motivation; why do geophysics? Examples of fields in which exploration techniques are used.

Gravity

Force and potential (Newtons's law, acceleration, potential, gradient operators in various coordinate systems, potential due to an extended mass)

Gauss' Law (flux, derivation of Gauss' law using Gauss' theorem, demonstration that spherically symmetric masses are indistinguishable from point masses, use of Gauss' law to find gravity due to symmetric bodies)

Rock densities (relative density of rock types, effect of porosity and saturation, other factors affecting density, methods of estimating rock densities, Nafe-Drake relationship)

Gravity meters (absolute versus relative measurements, sensitivity of linear and non-linear meters, construction of LaCoste-Romberg meter, factors affecting meter measurements of g)

Earth's gravity (equipotential surfaces and the geoid, global gravity field, reference spheroid and the international gravity formula)

Gravity reductions (derivations of latitude correction, free-air correction, and Bouguer correction, Nettleton's method, tides, drift corrections, terrain corrections, regionals and residuals, methods for regional removal)

Interpretation (Excess mass calculation, forward modelling, depth rules)

There will be a weekday afternoon excursion during class to collect gravity data in the La Jolla region. These data will be worked up in class in order to study the depth and throw of the Rose Canyon Fault. Students will write and submit a report on this work.

Magnetic Methods

Introductory theory (current elements, H and B, units)

Magnetization (polarization, susceptibility, diamagnetism, paramagnetism, ferromagnetism, hysteresis and residual magnetism and coercive force, types of remnant magnetism)

Magnetic properties of rocks. Earth's magnetic field (coordinate systems, main field, origin of the field)

Basic theory (potential and field due to a dipole, extended bodies, Laplace and Poisson's equations)

Magnetometers (overview, fluxgate and PPM operation principles, optically pumped mags and SQUIDS)

Field operation (aeromagnetics and the effect of flight altitude, ground surveys)

Interpretation (effect of latitude, depth rules)

There will be a weekday afternoon excursion during class to collect magnetic data at Scripps beach. These data will *be worked up in class in order to study the depth and size of an object buried in the sand. Students will write and submit a report on this work.*

Electrical and Electromagnetic Methods

Introductory theory (Coulomb's law, field and potential, Ohm's law and current density, units)

Resistivity of rocks and minerals (metallic conduction, semiconduction, electrolytic conduction, factors affecting resistivity, measuring resistivity in the laboratory, anisotropy)

DC resistivity theory (theory for a point source, 4-electrode arrays, apparent resistivity, common arrays)

Resistivity sounding and profiling (the sounding curve, profiling curves, electrode effects)

Resistivity equipment (current circuit, potential circuit, electrodes, DC offsets, stacking)

Resistivity interpretation (curve matching, forward modeling, equivalence/suppression of layers, anisotropy)

Self-potential method

Induced polarization method (concept, membrane polarization, electrode polarization, time and frequency domain systems, chargeability, PFE, metal factor)

Electromagnetic methods (Earth response as part of source-receiver coupling, primary and secondary fields, skin depth, telluric, MT and AFMAG natural-source methods, VLF, phase and amplitude, and TEM controlled source systems, relation of the time and frequency domain systems through the Fourier transform, simple analysis of square wave)

There will be a weekend half-day excursion to collect electrical data in the San Diego River valley. These data will be worked up in class in order to study the depth to the water table and igneous basement. Students will write and submit a report on this work.