Gravity & Magnetics Exploration Lexicon

Acquisition

Processing

Interpretation

Imaging

by

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PREFACE

Authors who write texts on exploration applications often declare their sincere desire to fill certain gaps in knowledge and experience. We are no exception to this rule, but our task is a little different—we are trying to fill a gap by organizing the terminology accumulated by theory and practice in the fields of gravity and magnetics. In the preparation of this Lexicon, we were motivated by the idea of making a book of gravity and magnetic definitions with supporting references, which would be helpful in everyday use for both specialists and non-specialists. We believe that this Lexicon will also contribute to better communication among gravity and magnetic specialists, as well as between two principal players in the exploration process: clients (exploration and production companies) and contractors/consultants (companies involved in acquisition, processing and interpretation of the gravity and magnetic data).

Many improvements and innovative developments have occurred in the fields of gravity and magnetic exploration during the last five to ten years. For this reason, even such an excellent reference as the latest (1997) edition of the Encyclopedic Dictionary of Exploration Geophysics by Robert E. Sheriff cannot embrace all the numerous terms that accompany these recent developments.

In compiling this Lexicon, we tried to keep the style of an "extended entry," wherein most definitions are provided with more or less detailed explanations given in a language that would be acceptable for potential field geophysicists, and clearly understandable by other professionals in the exploration business.

Here we have not invented terms of our own. All of them are taken from the original sources, sometimes almost directly and sometimes paraphrased, and we have attempted to provide a comprehensive reference list. Terms within definitions, indicated by italics, are themselves defined elsewhere in the Lexicon. For cross-reference purposes, most of the definitions are provided with other terms related to similar concepts.

There is inevitably a personal bias in the selection of entries. We tried our best to find such terms and definitions that represent both fundamentals and the latest developments in gravity and magnetic exploration. At the same time, we clearly realize that omissions are also inevitable. We apologize in advance for such omissions and ask that readers submit their suggestions for additional entries to be included in the next edition.

A few basic geological terms are also defined herein when they are particularly relevant, because the structural-geological interpretation is the final product of gravity and magnetic acquisition and processing.

We also understand that the scope of the task and continuing development of new techniques and concepts make this work an open-ended project, and there are always opportunities to improve some definitions as well as add more entries. We would greatly appreciate all corrections, remarks, and additions to this Lexicon and ask that you send them to the authors at the following address:

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A

Absolute Base – a regional Base Station where Absolute Gravity measurements are made. A.B. is a part of the national standardized network, which, in turn, is a part of the world-wide International Standardized Gravity Network. See also Temporary Base.

Absolute Gravity – the vertical acceleration due to the Earth's gravity field. The Earth's gravitational acceleration is often approximated as 9.8 m/sec^2 or 980,000 mGal. A.G. value for the gravity survey area is obtained from the local Base Station, which is tied to International Gravity Standarization Net. [34, 248]. See Gravity Acceleration.

Absolute Station – a term sometimes applied to the local gravity Base Station or gravity observatories measuring Absolute Gravity.

Acceleration of Gravity – see Gravity Acceleration.

Accuracy – a) an instrument characteristic that defines the highest deviation of obtained readings from the true measured value under normal conditions; b) an exploration method characteristic that defines the range of deviation of the target parameter estimate made by this method (such as space location of a fault, depth to the top of an ore body, or depth to the basement surface) from the true value established by drilling.

Aclinic Line – see Magnetic Equator.

Acquisition Footprint – See Corrugations.

Aerogravity – a method and instrumentation to collect and process measurements of the Earth's gravity field in a moving airborne vehicle (airplane, blimp or helicopter). Usually, data are collected in a grid pattern, composed of Traverse Lines and Control Lines, over a lease block in stable air conditions. Precise measurements are required for the aircraft X,Y,Z position to calculate the necessary corrections. Processing of A. data is based on two fundamental assumptions: 1) gravity signals of exploration interest dominate Noise in the long-wavelength spectrum range; and 2) noise is primarily restricted to the shorter wavelength spectrum range and can be removed by applying Low-Pass Filter. [37]. See also Aerogravity Corrections, Spectrum and Power Spectrum.

Aerogravity Corrections – corrections applied to the airborne gravity data to compensate for a) aircraft vertical motion (Vertical Acceleration Correction); b) aircraft course changes or turbulence (Horizontal Acceleration Correction); c) gravimeter platform velocity (Ëotvös Correction); d) aircraft elevation above sea level (Free-Air Correction); e) variation of the Earth's radius and the centrifugal force (Latitude Correction); f) Offleveling Errors. After correcting for aircraft-induced accelerations and standard gravitational effects, the applying Low-Pass Filter is the primary technique for removal of the residual noise from the obtained Free-Air Gravity. [37].

Aeromagnetic – a term applied to the Earth's magnetic field measurements made from an aircraft. [223]. See High Resolution AeroMagnetic (HRAM) Survey.

Aeromagnetic Gradiometer – an airborne three-sensor magnetometer array: two sensors are mounted on each wing tip extension, and one is mounted in a tail stinger of the aircraft to measure horizontal gradients. Also, two vertically separated sensors can be used to directly measure Vertical Gradient. A.G. can measure the total magnetic field using a tail sensor, as well as the diurnal-free (because of the subtraction in the process of calculation) horizontal and vertical gradients using the data from all sensors. A.G. data are compensated in the same manner as a single sensor magnetometer, both in real time and by post-flight processing. [46, 104, 112, 114, 155]. See also Fixed Wing Survey and Horizontal Aeromagnetic Gradiometer System.

Aeromagnetic Hydrocarbon Indicators – secondary magnetic effects that occur as a result of intra-sedimentary hydrocarbon seepage along faults and fracture systems. It is assumed that reducing zones may be formed above hydrocarbon accumulations with subsequent formation of diagenetic magnetite; its relatively high concentrations can produce low-amplitude, high-frequency magnetic anomalies detectable by the High Resolution Aeromagnetic (HRAM) Survey. See also Diagenetic Magnetic Anomaly and Chimney. [55, 61, 62, 110, 138, 150, 208, 209, 231].

Aeromagnetic Survey – a method and instrumentation to collect and process measurements of the Earth's magnetic field along the traverse and control (tie) lines using a specially equipped aircraft or helicopter. A.S. is the effective approach to the mapping of basin structures, lineaments, intra-sedimentary and intra-basement magnetized faults, basement surface, salt intrusions and sometimes reefs. A.S. also helps to focus the detailed 3-D seismic in a more cost-effective manner. See High Resolution Aeromagnetic Survey, Fixed Wing Survey, Helicopter Survey.

Aeromagnetic Survey Equipment – a set of acquisition, navigation, and processing equipment on board the survey aircraft and on the ground. Standard airborne A.S.E. set includes: a) high-sensitivity Magnetometer (usually, cesium or a similar type); b) Tri-Axial Fluxgate Magnetometer; c) Radar Altimeter; d) Barometric Altimeter; e) Differential GPS receiver and navigation system; f) video camera and video recorder; and g) computerized data acquisition system.The ground equipment for the Magnetic Base Station includes, usually, the same type of magnetometer as that on board the aircraft as well as a time synchronization interface with the ground GPS receiver. The ground GPS Base Station equipment is often identical to the GPS receiver and antenna on board the aircraft. Ground GPS data are used for post-flight differential correction to the recorded flight path.

Aeromagnetic Survey Specifications – a detailed description of the aeromagnetic survey parameters, which include: 1) scheduling (sequence and time duration); 2) survey area information (geographic location and extent, number of line km to be flown); 3) flight line spacing (both traverse and control/tie lines); 4) line direction (for example, E-W traverses and N-S ties or other, generally, orthogonal combination); 5) line length (minimum lengths are usually in the order of 5-10 km); 6) survey altitude ("constant altitude" or "drape" or "modified drape" at about 100-150 m above the ground level); 7) sampling interval (line interval between magnetometer readings in meters); 8) type of Base Station Magnetometer (usually, similar to the airborne system); 9) GPS system surveyed with the ground GPS base station, i.e., Differential GPS. [57, 78, 205].

Aeromagnetics – see Aeromagnetic Survey and High Resolution Aeromagnetic Survey.

AGL (Above Ground Level) – an airborne survey parameter that defines the altitude of a flight along the survey lines, i.e., the height above ground level. Sometimes AGL is referred to as Terrain Clearance.

AGRF – Australian Geomagnetic Reference Field. See International Geomagnetic Reference Field (IGRF).

Airborne Gravimetry – see Aerogravity.

Airborne Gravity Meter – a gravimeter mounted on a Stabilized Platform, upgraded for airborne use and equipped with fully digital Real-Time sensor and platform control systems. These systems are required to minimize non-linear responses of A.G.M. to aircraft motion and provide accurate measurements of the Earth's gravitational accelerations due to density contrasts related to geological formations and structures. See Horizontal Acceleration Correction, Vertical Acceleration Correction, Borehole Gravimeter and Shipboard Gravimeter.

Airborne Magnetometer – an instrument and supporting system used for measurements of the Earth Magnetic Field from an aircraft.[223]. Commonly, Cesium Magnetometer is used as A.M. in the high-resolution aeromagnetic (HRAM) surveys. See Magnetometer, Compensation Test, Figure of Merit and Real-Time Magnetic Compensation System.

Aircraft Signature – an aircraft-induced effect on the airborne magnetic measurements. Each aircraft has its own A.S. and, hence, the magnetic survey flown with two or more aircrafts will exhibit a level shift between data values recorded along the same survey lines flown by each aircraft. [187]. See Leveling.

Airy Hypothesis – an hypothesis of gravitational (isostatic) equilibrium between Crust and Mantle. It assumes a variable crust thickness below sea level, but a uniform Density of crust, “floating” on a liquid mantle substratum of a higher density, so that the thicker crust parts are topographically higher than the thinner ones. Mountainous areas have deep compensation “roots” extending to depths of about 50–60 km, while ocean basins have “antiroots” (as they are much shallower than mountains “roots”) at 6–10 km below the ocean bottom. Vening Meinesz Hypothesis assumes that some of the gravitational balance is also accommodated laterally (i.e., not only vertically) by surrounding region. The approximated radius of a region over which the compensation is distributed is about 200 km. [25, 54, 223, 238]. See also Pratt Hypothesis and Isostasy.

Algorithm – a step-by-step computer procedure for carrying out data processing operations. [223]. See also Data Enhancement.

Alias Filter – a filter applied before Gridding of the line data to remove the potential field components having spatial frequencies higher than Nyquist Frequency to avoid Aliasing. Low-pass option of Butterworth Filter is often used as A.F. Sometimes, A.F. is referred to as Anti-Aliasing Filter. See also Channel Filters.

Aliasing – a property of sampling data at discrete space intervals. When sampling is less than two samples per wavelength, the components having frequencies higher than Nyquist Frequency will produce the same artificial values (i.e., alias) as real lower frequencies from which they are indistinguishable. To avoid A., the frequencies above the Nyquist frequency must be removed before a spatial reconstruction of the data, i.e., before Gridding. Low-pass filtering (with Cutoff value equal to Grid Interval) is one of the most common procedures to prevent A. problems. [25, 223]. See also Alias Filter.

Altimeter – on-board instrument that measures and records the airborne survey flight height above the ground surface (AGL). Laser or radar altimeters are used to keep the aircraft constantly within the range of the planned height. [57, 78]. See also Barometric Altimeter and Radar Altimeter.

Altimeter-Derived Gravity – see Satellite Gravity.

Altimeter-Derived Terrain Model – a by-product of the airborne magnetic or gravity survey, representing surface (topographic) expression of the main geological domains in the survey area. See Altimeter, Barometric Altimeter and Radar Altimeter.

Altitude – a height of the survey aircraft flight above the Earth’s surface. See also AGL, Elevation and Sensel.

Amplitude – the maximum local departure of the potential field signal from the average value in the area. A. of the total intensity field is a composite feature that represents the sum of individual responses of magnetic/gravity causative bodies from various depths. See Causative Body.

Amplitude Anomaly – a local increase or decrease of the potential field Amplitude caused by changes in the subsurface distribution of susceptibility/density contrast values. As a rule, high A.A. is generated by magnetic or gravity Contact. In magnetic exploration, for example, the highest observed amplitude anomalies typically indicate lithologic boundaries (i.e., Susceptibility contrasts) of Igneous Rocks within the sedimentary section and upper Basement. Low amplitude anomalies usually indicate basement block structures (uplifts, horsts, etc.). Large regional amplitude anomalies (up to hundreds of “nT” and “mGal”) in the shelf and continental margin areas are caused mainly by the contact between oceanic and continental Crust. [23, 223]. See Density Contrast and Susceptibility Contrast.

Amplitude Envelope – see Analytic Signal Amplitude and Energy Envelope.

Amplitude Ratio Method – see Enhanced Analytic Signal Amplitude.

Amplitude Resolution – a quantitative estimate of the smallest Amplitude of the correlatable magnetic or gravity signal which can be objectively detected (i.e., resolved) using specific instrumentation, acquisition techniques and Noise suppressing algorithms. Present-day software tools are capable of extracting target signals that have much less amplitudes than the levels of background noise and Regular Noise. Generally, A.R. requirements are directly related to the geological target in the survey area: the smaller and shallower the target, the higher A.R. is required. See also Wavelength Resolution.

Amplitude Spectrum – the amplitude-versus-spatial frequency (wavenumber) relation of the Fourier transformed potential field data. A.S. is often referred to as Fourier Amplitude Spectrum. [9, 124, 164, 165, 166, 221, 223, 228]. See also Fourier Transform and Power Spectrum.

Analog Magnetic Depth Estimation – a group of graphical methods to estimate the depth to a magnetic source body, which are based on: a) construction of the profile of an isolated anomaly (this profile should be orthogonal to the anomaly's long axis); and b) determination of the various profile curve parameters, such as maximum slope, straight-slope distance, half-maximum distance, tangent points and others, which are then used in the depth estimation formulas. See Depth Rules.

Analytic Signal – a mathematical concept derived from the complex variable theory. Generally, A.S. is defined as a complex function whose real and imaginary parts are the Hilbert Transform of one another. For 2-D case, A.S. of a function "f(x)" can be presented as

$$A(x) = f(x) - j\ f_{Hi}(x),$$

where "f(x)" is the real or inphase component of A.S.; "j" – the imaginary number; "$f_{Hi}(x)$" – the imaginary component of A.S. which is often referred to as Quadrature. The real and imaginary components have the same Amplitude Spectrum but differ in phase by 90°. For the potential field, A.S. can be defined in terms of this field and its Hilbert transform:

$$A(x,y,z) = M(x,y,z) - j\ H\{M(x,y,z)\},$$

where "M(x,y,z)" is the magnitude of the field; "H{M(x,z)}" – the Hilbert transform of the field; "x", "y" and "z" – Cartesian Coordinates. For 2-D and 3-D potential field anomalies, the real and imaginary components of A.S. are given by the horizontal gradient(s) and vertical gradient, respectively.

For 2-D case, as

$$A(x,z) = dM(x,z)/dx - j\ dM(x,z)/dz\ ;$$

For 3-D case, as

$$A(x,y,z) = \underline{x}\ dM(x,y,z)/dx + \underline{y}\ dM(x,y,z)/dy + \underline{z}\ dM(x,y,z)/dz\ ,$$

where dM(x,y,z)/dx and dM(x,y,z)/dy are the horizontal gradients in the directions "x" and "y" respectively; dM(x,z)/dz is the vertical gradient (Vertical Derivative); "$\underline{x}$", "$\underline{y}$", "$\underline{z}$" are unit vectors. Since the real and imaginary components of A.S. are the Hilbert transform of each other, A.S. can be also defined in terms of Horizontal Derivative of the total field. For 2-D case, as

$$A(x,z) = dM(x,z)/dx - j\ H\{dM(x,z)/dx\}$$

For 3-D case, as

$$A(x,y,z) = dM(x,y,z)/dx + dM(x,y,z)/dy - j\ [H\{dM(x,y,z)/dx\} + H\{dM(x,y,z)/dy\}],$$

where "H{dM(x,y,z)/dx}" and "H{dM(x,y,z)/dy}" are the Hilbert transforms acting on "x" component and "y" component respectively. Correlating the A.S. amplitude maxima and computation of A.S. derivatives is used for delineating geologic boundaries in the subsurface. The amplitude characteristics of A.S. are used, under some simplifying conditions, to estimate the depth to the top surface of causative bodies. It should be noted that such depth estimates are strictly valid only for two-dimensional bodies (i.e., strike extent is assumed to be infinite and interference from adjacent anomalies is negligible). For 3-D case, the shape and absolute value of A.S. are dependent on the body's magnetization direction and the Earth's magnetic field direction, as well as on the depth below the observation level and the dip of a given boundary. Since A.S. parameters stem from computation of derivatives of potential fields, all noise effects (like gridding artifacts, line corrugations, random noise, etc.) will be enhanced, sometimes, significantly to obscure short-wavelength, low-amplitude anomalies of exploration interest. A.S. is also referred to as Simple Analytic Signal. [7, 103, 147, 152, 161, 164, 165, 166, 201, 214]. See Analytic Signal Amplitude, Analytic Signal Derivative, Enhanced Analytic Signal and Two-Dimensional (2-D) Body.

Analytic Signal Absolute Value – a square root of the sum of squared values of the vertical and two horizontal (in "x" and "y" directions) derivatives of the gravity or magnetic field:

$$*A(x,y,z)* = [(dM/dx)^2 + (dM/dy)^2 + (dM/dz)^2]^{1/2},$$

where "M" is the potential field anomaly. In case of isolated 2-D bodies, A.S.A.V. exhibits maxima over magnetization/density contrasts and, practically, independent of the direction of the ambient potential field. A.S.A.V. is invariant with respect to the coordinate system and, hence, the tracing of its maxima can be used for delineation of arbitrary striking geological boundaries. A.S.A.V. is also referred to as Analytic Signal Amplitude or Energy Envelope or Instantaneous Amplitude. [147, 152, 161, 214]. See also Analytic Signal.

Analytic Signal Amplitude – a component feature of the magnetic and gravity anomalies, which is defined as the square root of the sum of squared values of the vertical derivative and two horizontal derivatives (in "x" and "y" directions) of the potential field:

$$*A(x,y,z)* = [(dM/dx)^2 + (dM/dy)^2 + (dM/dz)^2]^{1/2} ,$$

where "M" is the potential field anomaly. A.S.A. is used to image geological discontinuities associated with magnetization/density contrasts such as faults (thin dikes or thin vertical sheets) and contacts (edges of causative bodies). In 2-D case of isolated magnetic anomaly, the shape of A.S.A. is independent of the Earth's magnetic field parameters (Inclination and Declination) as well as of the direction of magnetization, either induced or remanent. 2-D A.S.A. is a bell-shaped symmetric function that has its maximum directly over Thin Dike or vertical Magnetic Contact. The A.S.A. value becomes larger and its shape becomes narrower with the higher order of the calculated derivative of the analytic signal. For vertical 2-D Thick Dike, the locations of A.S.A. maxima are not directly over its both edges: the greater a depth to the top surface, the more an offset from side edges and vice versa – the shallower a depth, the closer maxima locations to the edges of a thick dike. For the most common 3-D cases, the A.S.A. maxima locations are always offsetting from the edges of Causative Body and the amount of offset is governed by several factors including depth to the top surface (the greater depth – the larger offset), interference from neighboring causative bodies, terrain effects (distortions by high-relief topography), magnetization direction and the Earth's magnetic field parameters, body's dip and others. However, A.S.A. is invariant with respect to the coordinate system and, for large-scale regional magnetic surveys or shallow depths of isolated causative bodies, the tracing of A.S.A. maxima is considered a useful method of delineating arbitrary striking geological boundaries in the subsurface. For 3-D case, A.S.A. is often referred to as Analytic Signal Absolute Value or Energy Envelope. [7, 103, 147, 152, 161, 164, 165, 166, 214]. See also Analytic Signal, Analytic Signal Derivative, Enhanced Analytic Signal and Two-Dimensional Body.

Analytic Signal Derivative – the analytic signal of the N-order Vertical Derivative of the potential field anomaly. The amplitude of A.S.D. of the N-order can be expressed equally in terms of the vertical or horizontal derivative of the potential field anomaly "M" (magnetic field or vertical component of gravity) as

$$*A_n(x,y)*= [(dM_z^n/dx)^2 + (dM_z^n/dy)^2 + (dM_z^n/dz)^2]^{1/2}$$

or

$$*A_n(x,y)* = [(dM_h{}^n/dx)^2 + (dM_h{}^n/dy)^2 + (dM_h{}^n/dz)^2]^{1/2},$$

where $M_z{}^n$ and $M_h{}^n$ are the N-order vertical and horizontal derivatives of the potential field anomaly "M". As the shape of 2-D A.S.D. amplitude function is independent of magnetization direction and source geometry, the location and depth of the magnetic source body can be estimated: maximum of A.S.D. amplitude function shows the location, while the width of this function is related to depth. A.S.D. provides highly efficient resolution of interfering anomalies from closely spaced sources and can be used for delineation of source edges and other geological boundaries in the subsurface. Prior to A.S.D. computation, the magnetic field should be reduced to the Pole. [52]. See Analytic Signal, Enhanced Analytic Signal, and Reduction-To-Pole.

Analytic Signal Filter – a processing algorithm that calculates three orthogonal gradients (horizontal "X", horizontal "Y" and vertical) of Total Magnetic Field to obtain Analytic Signal values which reach their maxima over corresponding source bodies, and, more often, over their edges, regardless of Remanent Magnetization. [230]. See Contact and Analytic Signal.

Analytic Signal Method – a method that includes a variety of processing techniques based on the concept of Analytic Signal. A.S.M. produces a particular type of gravity or magnetic anomaly enhancement maps used for delineation of maxima values of anomalous density or magnetization distributions in the subsurface. Extensions to this method include, as additional solved parameter, depth estimates. A.S.M. is also referred to as Total Gradient Method, because the absolute value the analytic signal equals to the absolute value of the total gradient, and the analytic signal of the magnetic or gravity anomalous field is calculated by taking the square root of the sum of square derivatives in all three directions ("X", "Y" and "Z"). See also Analytic Signal Amplitude, Analytic Signal Derivative and Enhanced Analytic Signal.

Annihilator – a non-zero rock magnetization or density distribution that does not result in detectable magnetic or gravity anomalies for a particular source geometry. [25].

Anomaly – a portion of magnetic or gravity data which is different in its Magnitude and/or Wavelength from the survey data in general and can be of exploration interest. A. can only be understood in the context of the regional or background field which has been defined for that particular case. In gravity measurements, A. is a difference between the observed (measured) value and a value predicted by some model, for example, Bouguer Anomaly or Free-Air Anomaly. [223]. See also Gravity Anomaly, Magnetic Anomaly and Regional Potential Field.

Anomaly Amplitude – the maximum local departure of a target signal (magnetic or gravity) from the level of a background Noise remaining after suppression of short-wavelenth, high-amplitude noise components and applying other signal enhancement procedures. Present-time processing algorithms are capable of extracting a low-amplitude target signal from background noise levels which are often much higher in amplitude than this signal. See also Amplitude Anomaly.

Anomaly Frequency – an estimation of the dominant Spatial Frequency in the magnetic or gravity anomaly. A.F. is a function of depth to Source Body: the shallower a source body, the higher A.F. See also Anomaly and Anomaly Wavelength.

Anomaly Offset – a specific pattern or trend of anomalies that differs from the adjacent or surrounding anomalies. See Anomaly.

Anomaly Relief – a difference between the highest and lowest magnitudes of the anomaly. See Anomaly and Magnitude.

Anomaly Resolution – a quantitative estimate of the smallest Anomaly Size which can be objectively identified on gravity or magnetic maps. [253]. See also Wavelength Resolution.

Anomaly Separation – a general definition of various processing methods of separating the gravity or magnetic effects of deep subsurface sources from shallow subsurface sources. See Regional-Residual Anomaly Separation.

Anomaly Size – a combination of Anomaly Amplitude and Anomaly Width or apparent Anomaly Wavelength, where the wavelength is estimated as about twice the anomaly width. [253]. See Anomaly.

Anomaly Wavelength – an estimation of the dominant spatial Wavelength in the anomaly calculated as the doubled horizontal distance from the peak value of anomaly to its trough on the map of the potential field data. A.W. is a function of depth to the magnetic or gravity Source Body: the deeper a source body, the longer A.W. See Anomaly and Anomaly Frequency.

Anomaly Width – a quantitative estimate of a specific Anomaly approximated as one-half of apparent Anomaly Wavelength. See also Anomaly Size.

Antenna Offset – a distance between the actual location of Gravimeter or Magnetometer and position of the navigation antenna. A.O. is used as a positioning correction factor applied to Channel recording “X” and “Y” coordinates during survey measurements. See Positioning and Global Positioning System (GPS).

Anti-Aliasing Filter – see Alias Filter.

Antiferromagnetics – magnetic rock materials (elements, compounds, etc.) in which the net magnetic moments of parallel and antiparallel subdomains almost cancel each other. The resultant Susceptibility is rather small. The most common example of A. is hematite. [25, 238].

Apparent Density – a) rock density calculated from gravity measurements in a borehole; b) rock density calculated from the residual gravity field under the following assumptions: 1) Earth’s surface is nearly flat; 2) rock Density varies horizontally, but not vertically (i.e., steeply dipping rocks); 3) residual anomalies are caused by source bodies within the uppermost part of the Earth’s crust. A.D. computations are used for the first-order mapping of geological boundaries hidden under the cover of relatively young unconsolidated sediments, glacier debris, and dense vegetation. [95, 108, 223]. See also Crust, Density Filter, Source Body and Terracing.

Apparent Susceptibility – magnetic Susceptibility of rocks calculated from the observed or residual magnetic field under the following assumptions: 1) rock magnetization is along the Earth’s magnetic field (i.e., Induced Magnetization); 2) source bodies have a rectangular shape and a size of Grid Cell with each Source Body centered at each grid point; 3) source bodies are approximated as Prism models of vertical dip and “infinite” depth extent. Aeromagnetic maps (grids) must be reduced to the pole and continued downward to the ground level. A.S. computations are used for the first-order (i.e., initial) mapping of geological boundaries hidden under the cover of relatively young unconsolidated sediments, glacier debris and dense vegetation. [108, 232]. See also Susceptibility Filter.

Artifacts – artificial (i.e., false) potential field anomalies originating from Aliasing, Spiking, Cultural Noise, Acquisition Footprint, Grid Merging as well as residual errors in Gridding, Leveling and other data processing operations.

Artificial Magnetic Anomalies – see Artifacts

Artificial Sun Illumination – a directional filtering method of Image Enhancement which is based on the visual selection among images obtained under various directions and angles of the sun illumination. Such images, color-scaled or gray-scaled, are often referred to as Shaded Relief, Sun Angle or Azimuth Images since they present high values of the potential field as “hills” and low values as “valleys”. A.S.I. is used to highlight subtle linear trends and feature areas on grids of potential field data. Such trends are interpreted as potential field responses of structural boundaries, regional faults or large-scale tectonic features. Using A.S.I. the interpreter has a choice of different sun azimuths (declinations) and sun elevations (inclinations) available in the software. Some software packages allow the sun position to be controlled by the mouse, and the image is updated in real time as the sun angle is changed.

ASL – a height above sea level. Elevation of the airborne survey area is usually specified in exploration reports in meters ASL (for example, 1000 m ASL) based on GPS, Barometric Altimeter, and Radar Altimeter data. See also AGL and Sensel.

Astatic Balance – a non-stationary (i.e., unstable) balance. A.B. is the basic operational principle of the most exploration gravimeters, where the gravity force on a unit or "proof" mass is balanced by a spring arrangement. When, due to a change in the gravity attraction, the imbalance occurs, a design-provided third force (two other forces are gravity and spring) intensifies the effect of this gravity change and increases Sensitivity of a gravimeter. [223].

Astatic Magnetometer – a magnetometer designed to measure Remanent Magnetization of rock samples. A.M. magnet system consists of two magnets of equal magnetic moments, rigidly mounted parallel to each other in the same horizontal plane with their poles opposed. The whole arrangement of magnets is suspended by a torsion fiber. The rock sample is placed below the magnet system in various orientations and the angular deflections of the magnets are measured. [238]. See also Astatic Balance.

Asthenosphere – a layer of the relative weakness below Lithosphere where isostatic adjustments are assumed to take place and Magma may be generated. A. begins about 100 km below the Earth's surface and extends to a depth of about 350 km. A. is thought to be involved in the plate-tectonic movements.[13, 223]. See Isostasy and Plate Tectonics.

Atlas Gravimeter – see Torsion Balance.

Atmospheric Gravity Correction – a correction which is required in using International Gravity Formula based on the WGS84 Reference Spheroid because the WGS84 Earth's Gravitational Constant includes the mass of the atmosphere:

$$\text{A.G.C.} = 0.87\ -0.118[(h/1000)1.047],$$

where "h" is the elevation above sea level.

Attenuation Rate – see Euler's Structural Index.

Automated Anomaly Axis Correlation – a grid-based procedure for tracking the axis of long linear and curvilinear anomalies. Axis of strong broad, and smooth anomalies of relatively deep origin are better correlated by Blakely-Simpson Method. Axis of "sharper" anomalies of a shallower origin, as well as those contaminated with Artifacts due to Terrain Clearance variations and Gridding oscillations are better correlated by Coherent Filtering. [8, 26, 80, 81, 94].

Automated Magnetic Data Interpretation – a general definition of various methods which can be applied to profile (line) or gridded magnetic data to calculate estimates of depth, location, dip, and susceptibility contrast of a source of the observed magnetic Anomaly. All methods assume certain elementary models whose calculated effects are accepted as the best fit with successive segments of profile data or windows of gridded data. See Automated Magnetic Depth Estimation.

Automated Magnetic Depth Estimation – a variety of techniques which analyze digital profiles or grids of the magnetic data to obtain estimates of causative bodies' depths using computer automated algorithms which free the user from specifying key portions (special points) of anomalies. The result is presented in the form of depth section (for line data) or map of depth estimates (for gridded data). A.M.D.E. includes such methods as Werner Deconvolution, 2-D Euler Deconvolution, 3-D Euler Deconvolution, Naudy Method, Phillips Method and

Analytic Signal Method. [47, 52, 107, 131, 152, 168, 169, 195, 207, 214, 224, 225, 226, 239, 242, 252].

Automatic Gain Control (AGC) – an image and/or data enhancement procedure that attempts to balance the amplitudes of anomalies of differing dominant wavelengths. AGC governing parameters are the sliding window size over which the gain is computed and the gain function that controls a relative amplification of signals (anomalies) and noise. The standard gain function is the inverse root-mean-square value computed within a sliding window. For varying wavelength (spatial frequency) anomalies, the choice of a window size predetermines a space range of anomalies that will be enhanced in the output. The best match for a specific datasheet is found by testing several combinations of gain functions and window sizes. AGC can be carried out either on profile (line) data or gridded data. Before applying AGC, it is recommended to remove the regional component of observed data (i.e., the average base level of data) by Detrending. [202].

Azimuth Images – a set of color-scale or gray-scale maps (images) that are "sun" illuminated from several different directions or azimuths simultaneously. See Artificial Sun Illumination.

Azimuthally Averaged Logarithmic Power Spectrum – see Radial Power Spectrum.

B

Banded Contour Map – a residual magnetic map where color (or gray-scale) bands are used instead of standard contour lines, and each color band represents the same magnitude values. The width of a contour band equals a preselected interval between mapped values. B.C.M. can be very helpful in delineation of faults and determining their upthrown/downthrown sides by the criterion of an abrupt color bandwidth change. [75]. See also Interruption Zones and Basement Fault Block Pattern.

Band-Pass Filter – a spectral domain filter that retains (passes) a pre-selected range of wavelengths or wavenumbers (spatial frequencies). Wavelengths between two specified Cutoff values will be retained. [99, 201, 223]. See Band-Pass Filtering.

Band-Pass Filtering – a procedure that enhances a pre-selected range of the potential field components, regional or residual, based on their wavelengths or wavenumbers (spatial frequencies). The wavelength of anomaly is partially dependent on the depth to the source and, hence, B.F. can be used to separate qualitatively the deeper sources from the shallower ones. [201, 223]. See also Energy Leakage.

Bandwidth – a range of spatial frequencies or wavelengths contained in a profile or grid of data; also the range of spatial frequencies over which a given filter is designed to operate in the pass or reject mode, or the range of frequencies containing significant energy for a given anomaly. [223, 257]. See Bandpass Filter and Wavelength.

Barometric Altimeter – an instrument to measure and record the elevation above sea level with common accuracy of about 0.3 m (1.0 ft). Corrections must be made for temporal and spatial variations caused by weather. Temperature and humidity corrections are also needed for precise ground elevations. [57].

Bartlett Filter – an edge-smoothing space domain grid and line filter which modifies the original data values (line curves or grid surface) within Rolloff Window to ensure their smooth transition to zero at the ends of survey lines or edges of a grid. B.F. is also referred to as Triangular Filter. [201].

Base Station – the reference magnetic or gravity observation station. In airborne magnetic surveys, it is used to monitor and record the Diurnal Variations (which should be removed from the observed magnetic data) and magnetic storms as well as provide GPS correction data. B.S. should be set up in the magnetically quiet area, away from power lines, pipelines, roads or other sources of noise. In gravity surveys, B.S. is used as a reference point to anchor geodetic survey data as well as to determine an instrumental Drift. The local gravity base stations are tied to the national gravity base stations with a known Absolute Gravity value to allow the merging of different survey datasets as well as correct application of Latitude Correction. See also International Standardized Gravity Network, Ground Magnetometer and Differential GPS and Magnetic Storm.

Base Station Magnetometer – see Ground Magnetometer.

Basement – a term used primarily in oil and gas exploration to refer to the crystalline rocks beneath the sedimentary section. Usually this term is synonymous with Crystalline Basement. However the term Economic Basement is used when metamorphic rocks exist which are of high enough grade that no hydrocarbons are expected within them. This may be different from Magnetic Basement, which is the top of the first continuously magnetic layer below the sedimentary section. As a rule, B. is composed of igneous and metamorphic rocks. In many regions, B. is of the Precambrian age but it also may be younger. Magnetic susceptibility of B. rocks is much higher than that of the sedimentary section, up to 100-1000 times and even more. In addition, heterogeneity of B. yields very high susceptibility contrasts. Because of all that, for magnetic exploration B. is the dominant regional subsurface structure that contributes to the total intensity of the magnetic field after applying IGRF Correction. [13, 18, 75, 76, 107, 210].

Basement Fault Block Pattern – an assemblage of Crystalline Basement blocks of varying shapes, sizes and often depths, separated by alignments of weakness zones, i.e., intra-basement faults. B.F.B.P. may exert a profound control on the structure and stratigraphy of the sedimentary section, both during and after the deposition of sediments. B.F.B.P. also controls the topography (i.e., surface relief) of the Crystalline Basement which, in turn, controls additionally the structure and stratigraphy of the sedimentary section through the mechanism of gravitational compaction. [74, 75, 76]. See also Banded Contour Map and Basement.

Basement Relief – a range of the basement surface depths in the survey area. The rough basement has a "high relief" and the flat basement has a "low relief". See also Anomaly Relief.

Bay – a transient magnetic disturbance with the period of about an hour. It originates outside the Earth and has the appearance of "a bay along the sea coast" on the geomagnetic field curve recorded at Base Station or other stationary point of measurements. [223].

BHGM – 1) borehole gravimeter model; 2) borehole gravity measurements using a remote-controlled gravimeter lowered into cased or uncased wells. The maximum achievable amplitude and wavelength resolution of BHGM is estimated as 0.002–0.005 mGal and 7–12 m. [36, 123]. See Borehole Gravity, Amplitude Resolution, and Wavelength Resolution.

BHGM Density – a rock density directly measured in a borehole (i.e., apparent Density) using a remote-controlled gravimeter lowered into a cased or uncased well. See BHGM.

Bi-Cubic Spline Method – a grid resampling method which involves two steps: 1) using the spline curves along the rows of the original grid to calculate interpolated values that will correspond to the columns in a new (resampled) grid; and 2) using the column values obtained in the first step to calculate a spline curve along each resampled column. B.-C.S.M. is very effective for resampling datasets with relatively small changes of values between adjacent grid cells and for smoothing noisy grids. See Resampling.

Bi-Directional Gridding – a gridding method that, at first, interpolates the data along the flight lines and then re-interpolates across the flight lines to create a rectangular Grid. Generally, B.G. enhances anomalous trends that are orthogonal to the direction of the flight lines. [126]. See Gridding and Minimum Curvature.

Big G – see Universal Gravitational Constant.

Bipole Map – a map that represents the line-by-line image of the traverse line data as the sequence of bar-graphs with their heights proportional to the amplitudes of horizontal derivatives computed along each traverse line. The polarity of bar graphs is depicted with a color: for example, red for positive values, blue for negative values. Each bar graph is plotted at the location of the computed value of a horizontal derivative. A wavelength-dependent Automatic Gain Control (AGC) filter is applied to control the dynamic range of horizontal derivatives so that both small- and large-amplitude anomalies could be displayed. Before applying a horizontal derivative operator, the traverse line data are filtered with a low-pass filter in order to suppress high-frequency noise. B.M. of the 1-st, 2-d, 3-d and 4-th horizontal derivatives can also be calculated. [163]. See Shaded Stacked Profiles.

Bird – a streamlined cylindrical housing (suspended from an aircraft by a cable) where the sensors are mounted in some airborne surveys. To eliminate magnetic effects of aircraft, B. is towered by cable at a distance of 50-100 m below and behind the aircraft. Fixed Wing Survey is commonly flown with sensors mounted in the aircraft tail stinger and (Gradiometry option) wings, while helicopters are more likely to tow B. [223, 238]. See also Fixed Wing Survey and Helicopter Survey.

Blackman Filter – an edge smoothing spectral domain filter that smoothes the grid data values at the edges of a grid to ensure their smooth transition to zero. B.F. is an alternative to Hanning Filter, Hamming Filter and Bartlett Filter. [201]. See Edge Smoothing Filters.

Blakely Test – an interactive calculation of the maximum values of the gridded magnetic or gravity data using Blakely-Simpson Method. See also Gridding.

Blakely-Simpson Method – an automated polynomial fitting method of locating maxima on contoured maps of the gridded gravity or magnetic data. The calculating algorithm compares each grid intersection with its eight nearest neighbors in four directions (along the row, column and both diagonals) to determine the presence of a maximum. This comparison is tested with the system of inequalities. For each satisfied inequality requirement, the horizontal location and magnitude of the particular maximum are found by interpolating a second-order polynomial through the trio of grid intersection points. B.-S.M. requires no assumptions about the sources except the direction of magnetization in the magnetic case. At the horizontal gradient maps, abrupt source edges and near-vertical contacts are more precisely delineated than non-vertical contacts. Along with other methods, B.-S.M. is used in Boundary Analysis. [26].

Borehole Gravimeter – a remote reading Gravimeter which can be lowered into a cased or uncased well. The difference between the gravity readings at two different true vertical depths gives Apparent Density value (See Borehole Gravity). The density computed is a bulk density value with its sourve coming mostly between the depth interval measured. Depending on the size of this interval, B. G. can detect effects of sources located tens to hundreds of feet/meters away from the well. [36, 223]. See also Airborne Gravity Meter and Shipboard Gravimeter.

Borehole Gravity – a method and instrumentation for gravity observations (measurements) with the gravimeter being lowered into a cased or uncased well with the purpose of direct rock density measurements. Two gravity measurements are needed to calculate the density of the interval between the measurement points:

$$p = 3.686 – 128.5\ )g /)h_1 = 3.686 – 39.18\ )g /)h_2 ;$$

where “p” is Apparent Density; in g / cm^3; “)g” is the gravity difference in mGal;“)h_1” is the depth difference in meters; “)h_2” is the depth difference in feet. Precise measurement of the vertical distance between stations is necessary to compute accurate densities over small intervals. Generally, borehole conditions have little effect on B.G. data. Maximum wellbore deviations should not exceed 15º. [211, 223]. See also BHGM.

Borehole Magnetics – a method and instrumentation to provide measurements of the magnetic properties of rocks in boreholes. B.M. acquisition system usually incorporates both Susceptibility and Total Magnetic Field measurements by using three orthogonally oriented fluxgate magnetometers. See Fluxgate Magnetometer, Magnetic Stratigraphy, and Magnetic Susceptibility Logging.

Bottom Gravity – a method and instrumentation to collect and process measurements of the Earth’s gravity field with Gravimeter being lowered on the sea bottom. A shipborne-type gravimeter is modified to fit inside a pressure case mounted on a self-balancing platform. B. G. provides high resolution of sourve bodies and detection of subtle anomalies which often cannot be detected by conventional sea surface measurements. See also TOWDOG.

Bott-Smith Method – a method of estimating a depth “H” to the source of the gravity anomaly:

$$H = 0.86 \text{ g-max/hoz-max},$$

where “g-max” is the maximum gravity value (i.e., peak of anomaly) and “hoz-max” is the maximum value of Horizontal Derivative. Coefficient 0.86 is applied for 3-D source bodies, and 0.65 is applied for 2-D bodies. B.-S.M. is also referred to as Smith Rule or Maximum Depth Rule. [27]. See Depth Rules.

Bouguer Anomaly – a) a local anomaly observed in Bouguer Gravity. B.A. represents the sum of gravity responses of all bodies that have densities deviating from the accepted correction model; b) more often, the value obtained after the known values of the gravity field at that location are removed, i.e. “B. A. = observed gravity-corrected Earth’s model”. These known values (Earth’s model) include: 1) latitude effect, i.e. Latitude Correction; 2) elevation effect which includes both free-air and Bouguer effects, i.e. Free-Air Correction and Bouguer Correction; and, usually, 3) terrain effects, i.e. Terrain Correction. The resulting B. A. gravity field is not the same as the gravity field which would have been observed at the datum elevation, because the shape of anomalies due to remaining density irregularities still are appropriate to the elevation of the point of measurement rather than to those of the datum elevation. [32, 34, 215, 223].

Bouguer Correction – a correction which is applied to the gravity data to eliminate the gravitational effect of the subsurface mass between the point of measurement (i.e. Station) and datum (usually, the sea level). B.C. formula can be presented as

$$B.C. = -0.04192\ Dh_1 = -0.01278\ Dh_2$$

where "D" is the assumed average rock density between the station and datum elevations or, in the case of stations below the datum elevation, the assumed density of rock that is missing between the station and datum in g/cm^3; "h_1" is the elevation above sea level (or datum) or thickness of Bouguer Slab in meters; "h_2" is of the same meaning as "h_1" but in feet. For land and airborne surveys, B.C. is always subtracted from the observed data. Two main assumptions are made here: 1) the elevation difference between points of measurements and Datum can be "filled-in" with a simple infinite slab (for this reason, B.C. sometimes is referred to as Slab Correction); 2) the "fill-in" has a reasonable density distribution. If the estimate of the correction density is wrong, it will result in either undercorrecting or overcorrecting of data and, thus, accentuate the topography. If proper average densities for rocks above sea level were used, there should be little or no correlation between Bouguer Gravity and topography. There are two B.C. types: a) Simple Bouguer Correction which involves making a slab correction based on the station elevation; b) Complete Bouguer Correction which involves making Terrain Correction as well as the slab correction. In marine (shipborne) gravity surveys, B.C. replaces the sea water with rock, and "D" in the preceeding formula is the difference in specific gravity of this Replacement Rock and that of the sea water and it is added to the observed data. [34, 54, 134, 137, 173, 215, 223, 234, 238]. See also Bullard B Correction, Free-Air Correction and Nettleton Test.

Bouguer Density – a density value for the infinite slab of a finite thickness (Bouguer Slab) that is used for the calculation of Bouguer Correction. Often, B.D. equals 2.67 g/cm^3. [19].

Bouguer Flat Plate – see Bouguer Slab.

Bouguer Gravity – the gravity field obtained after Free-Air Correction, Bouguer Correction, Theoretical Gravity Correction, and, usually, Terrain Correction have been applied to the observed (measured) gravity data. B.G. is often referred to as Simple Bouguer Field for the gravity field before applying the terrain correction and Complete Bouguer Field for the gravity field after applying the terrain correction. In concept, B.G. is the residual gravity field that is left after removal of all possible components of the Earth model to represent the effects of density inhomogeneities due to the local geology. In practice, gravity anomalies observed in B.G. are caused by lateral density contrasts within the sedimentary section and Basement (i.e., within Crust) and sub-crust of the Earth. If proper average densities for rocks above sea level were used in Bouguer Correction, there should be minimal correlation between B.G. and topography. Sometimes, such correlation is expected and unavoidable when density changes quickly. For land surveys above sea level, B.G. formula can be presented as

B.G. = "observed data" + "free-air correction" –

– "Bouguer correction" + "terrain correction" – "theoretical gravity correction."

[25, 34, 134, 173, 215]. See also Bouguer Anomaly and Bouguer Slab.

Bouguer Gravity Field – see Bouguer Gravity.

Bouguer Plate – see Bouguer Slab.

Bouguer Reduction – see Bouguer Correction

Bouguer Slab – an infinite length slab of a finite thickness and assumed density (often, 2.67 g/cm^3) between the point of measurement and Datum (usually, the sea level). B.S. is used in the calculation of Bouguer Correction. B.S. is also referred to as Bouguer Plate. [54, 223].

Bouguer Spherical Cap – the Earth's segment that includes all rocks above Datum (usually, the sea level) between the observation station and the arc distance along the curved Earth's surface out to 166.735 km. B.S.C. has the height "h" (observation station elevation) which is the same as the thickness of Bouguer Slab. The gravity effect of B.S.C. at its apex is

$$B.S.C. = 2pGrh,$$

where "G" is Universal Gravitational Constant; "h" is the station elevation; "r" is the assumed rock density (usually, 2.67 g/cm^3). The gravity effect of B.S.C. can also be expressed by the formula

$$B.S.C. = A + B,$$

where "A" is Flat-Plate Bouguer Factor; "B" is Bullard B Correction. [137, 234].

Boundary Analysis – a methodology that delineates and maps structural discontinuities associated with Density and Magnetization boundaries. Originally, B.A. was based mainly on Blakely-Simpson Method in application for horizontal gradient maps. At present, the concepts of Analytic Signal Derivative and Enhanced Analytic Signal as well as other techniques can also be used for the same purposes. [26, 52, 116].

Box Filter – a processing algorithm which calculates values for the interpolated cells in Grid using local averaging. B.F. tends to reduce a magnitude and size of grid anomalies.

Boxcar Filter – a theoretical approximation of the filter response curve presented by a rectangular window function which retains (passes) the range of data components within the window length and rejects all data components beyond the length of this window. [223]. See also Filter Cutoff and Filter Order.

Bulk Density – the weight of a rock material divided by its volume including the volume of a pore space. [33, 63]. See also Density.

Bull's Eye Effect – a result of Undersampling in the direction of a strike of the short-wavelength anomaly. B.E.E. appears in the form of a trend of small separated circular or elongated contours ("bull's eyes") on Contour Map or Color-Scaled Map. The source of this effect is the inability of gridding algorithms to interpolate data perfectly when Traverse Line spacing is longer than an extent of a short-wavelength anomaly. For example, the surface interpolated by Minimum Curvature algorithm in the absence of data point constrains is a circle in two dimensions. In Bi-directional Gridding anomalies perpendicular to traverse lines are usually well represented, while those at acute angles are also mapped as bull's eyes. Sometimes, B.E.E. is referred to as Pill Box Effect. [126].

Bullard B Correction – an adjustment to Bouguer Correction which accounts for the curvature of the Earth's surface. It is recommended that B.B.C. be applied to the data when Terrain Correction is calculated for radii greater than 100 km from the observation station. B.B.C. can also be defined as the difference between the gravity effects of Bouguer Spherical Cap and equally thick infinite flat plate (Bouguer Slab). [135, 136, 234].

Butterworth Filter – a spectral domain filter which retains (passes) one end of the data spectrum according to the specified cutoff (central) frequency or wavenumber. B.F. is characterized by a very flat amplitude response within the passband. There are low-pass and high-pass options available. The transition between the passed and rejected spectrum portions can be made steeper or smoother depending on the pre-selected degree of B.F. (the higher degree—the steeper transition and vice versa). B.F. is usually applied in Microleveling. Mathematically, B.F. can be presented as

$$F(k) = 1 / [1 + (k / k_c)^n],$$

where "k_c" is Central Wavenumber; "n" is a degree (order) of the Butterworth filter function. [67, 124, 201, 223]. See also Stabilized Downward Continuation.

C

Calculated Terrain – an airborne survey term to define the calculated Earth's surface topography. C.T. represents the difference between values recorded by the GPSZ channel (i.e. flight height above mean sea level) and those recorded by Radar Altimeter channel (i.e. flight height above the Earth's surface) . See also Digital Terrain Model.

Calculated Vertical Gradient – a vertical gradient of the magnetic or gravity not measured during the survey, but calculated by applying various algorithms. One of the most common methods is a three-step procedure: 1) space domain calculation of horizontal gradients in two orthogonal directions ("x" and "y") from the observed field; 2) transformation of calculated horizontal gradients into the spectral domain using Fourier Transform; 3) spectral domain calculation of the vertical gradient using Hilbert Transform. [2, 12, 94, 127, 154, 164, 165, 166, 177, 189]. See also Vertical Gradient, Measured Vertical Gradient and Analytic Signal.

Calibration – a gravity data reconstruction procedure used to convert the gravity field readings from counter (dial) units to milligals by applying the respective Interval Factor or Milligal Constant. See Milligal.

Calibration Factor – see Interval Factor and Milligal Constant.

Cartesian Coordinates – coordinates in which the position of a point in space is defined by its distances from an origin along three mutually orthogonal axes ("X", "Y" and "Z").

Cascaded Filtering – a sequential application of several filtering procedures, one after another, to a given dataset in order to ensure a consecutive enhancement of a pre-selected range of wavelength components of the potential field. In C.F., the output of each preceding step is the input for the next step. When filters are linear, the order in which they are cascaded does not affect the final result. Non-linear filters such as Horizontal Gradient must be cascaded in the same sequence to obtain the same result. [81, 124].

Causal Function – a function defined only for positive values of its argument, being zero otherwise. For such functions, their Fourier Transform has the property that the real and imaginary parts of the corresponding Analytic Signal are Hilbert Transform of each other. [83, 164, 165, 166].

Causal Spectrum – an amplitude spectrum obtained after Fourier Transform of the observed space-domain data and modified to meet requirements for the causal function: negative frequencies are changed to zero and amplitudes of positive frequencies are doubled. [164, 165, 166].

Causative Body – a theoretical approximation of a source which generates the potential field anomaly. Causative magnetic or gravity bodies are assumed to represent geological discontinuities within the sedimentary section and the basement and they are defined geometrically or geologically as thin sheets, dikes (faults), prisms, contacts (interfaces and faults), cylinders, etc. [83, 178]. See Gravity Modeling Shapes and Magnetic Modeling Shapes.

Cell – see Grid Cell.

Cell Size – a size of the regular spaced square cells that constitute Grid of the observed potential field data. C.S. is the same for all cells and commonly is about one-third of the traverse line spacing. See also Gridding, Control Lines and Traverse Lines.

Central Frequency – see Central Wavenumber.

Central Wavenumber – a user-selected parameter of the pass filter (high-pass or low-pass) which defines a wavenumber value where filter function is half its maximum value. C.W. is the equivalent of a cutoff wavenumber or frequency value for bandpass filters.

Cesium Magnetometer – an optically pumped magnetometer. Its sensor outputs Larmor Frequency which is proportional to the total magnetic field. This frequency signal is then measured by a magnetometer processor board. The achievable sensitivity is 0.001 nT. The total field intensity range is about 20,000-100,000 nT. For Cesium-133 isotope, Gyromagnetic Ratio is about 82 times higher than that of the common Proton Precession Magnetometer and it is the reason that C.M. has a higher sensitivity. [223]. See Optically Pumped Magnetometer.

Channel Filters – a group of the line-base filters designed for applying to the gravity and magnetic data, assigned to a separate Channel in the project Database, before Gridding. Standard set of C.F. includes High-Pass Filter, Band-Pass Filter, Low-Pass Filter, Median Filter, RTP Filter and some others. High-pass and low-pass filtering is usually performed by Butterworth Filter. Its low-pass option can be used as Alias Filter. Often, C.F. are referred to as Line Filters as they are applied to the data originating from measurements along survey lines.

Chemical Remanent Magnetization – one of five main types of the remanent (residual) magnetization. C.R.M. originates from the rocks' exposure to the external magnetic field during chemical reactions which result in the changes in the shape and/or composition of magnetic grains. C.R.M. makes significant contribution to magnetization of sedimentary and metamorphic rocks. [33, 54, 238]. See also Detrital R.M., Isothermal R.M., Thermal R.M. and Viscous Remanent Magnetization.

Chessboard Method – a potential field continuation method. In this method, the potential field measured on the horizontal surface of the survey flight height (AGL) is continued to several horizontal surfaces spanning the elevation range of a desired "drape" surface. This 3-D volume of data resembles multiple tiers in 3-D chessboard. To evaluate the potential field on this "drape" surface, the vertical interpolation is used between the fields on the nearest bounding horizontal surfaces. C.M. is applied for level-to-drape, drape-to-level and drape-to-drape continuations. When C.M. is used for the parallel-surface continuation, it becomes identical to Simple Fourier Method. [196]. See Continuation Filtering and Equivalent Source Continuation.

Chimney – a vertical column of sediments over a hydrocarbon reservoir with a different mineralogy, magnetization and diagenetic alterations as compared to adjacent host rocks. C. origin is assumed to be related to Hydrocarbon Seepage. [6, 61, 62, 151].

Chopping Filter – a term that refers either to High-Pass (Low-Cut) Filter or High-Cut (Low-Pass) Filter.

Circular Convolution – a property of a convolving process in computation of the filtered data values in the Fourier (frequency) domain. As Fourier Transform assumes the discretely sampled data and filter operator to be periodic (even if they are not), the applying filter, like RTP Filter, at one edge of the gridded data convolves data not only at the side of this edge, but also data from the other side of the opposite edge, causing Wraparound Effect. [148]. See FIR RTP Filter and Linear Convolution.

Clarke Ellipsoid – the reference geodetic datum (Reference Ellipsoid) used in the most of the Western Hemisphere prior to the use of a satellite datum (such as WGS 1984). Often referred to as the Clarke 1866 ellipsoid. There is also a Clarke 1880 ellipsoid which is used in Africa. [223].

Clip Filter – a space-domain profile-based processing operator that nulls out any data points whose value lie outside the specified upper and lower bounds of C.F.

Coherence – a space measure of similarity (i.e., systematic phase relationship) between wavelengths at adjacent grid cells over extended distance on a map of the gridded potential field data. [8].

Coherence Map – a map of similarities and discontinuities in the gridded potential field data. High-resolution coherence algorithms are able to identify both low-intensity anomaly axes and subtle discontinuities associated with magnetized faults. [8].

Coherent Filtering – a procedure which is applied to the gridded potential field data in order to enhance the similarity among such map events as peaks, troughs and other coherent events. C.F. operators are based on computation of cross-correlation function maxima in windows of a user-specified length. As compared to conventional anomaly maxima computations, C.F. is less sensitive to local data oscillations caused by variations in Terrain Clearance of the survey aircraft and side effects of gridding algorithms providing, therefore, more stable (i.e., less noisy) mapping of coherent events. C.F. can also be used to map non-magnetic fault zones as zones of the least similarity (i.e., discontinuities in similarity). [8, 94]. See Coherence.

Coherent Noise – noise events which exhibit systematic (regular) phase and amplitude relations between adjacent observation lines or grid cells. C.N. includes Cultural Noise, Corrugations, gridding errors and others. C.N. is also referred to as Regular Noise. [219].

Color Bar – a display of the map or Grid values represented by user-defined range of different colors. [223].

Color Wheel – a full-circle (360º) distribution of colors in the "sun" illumination technique where each C.W. segment represents the direction of correlated map events like contact dip or fault strike. There is a "coned" C.W. where colors have a varying saturation from dark to light, and a "flat" C.W. where colors have a constant saturation. Sometimes, the use of a "coned" C.W. (also called Full Vector Sun Image) shows faults and other subtle map events that are not imaged with a "flat" C.W. See Artificial Sun Illumination.

Color-Coded Map – see Pseudocolor.

Color-Scaled Map – see Pseudocolor and Contour Map.

Combined Elevation Correction – see Elevation Correction.

Compensation Flight – see Figure-Of-Merit (FOM).

Compensation Test – one of On-Site Magnetometer Calibrations made by test measurements along at least four flight lines oriented in the direction of the survey lines with the following aircraft maneuvers: Pitch, Roll and Yaw with oscillating ± 5(10) degrees about the normal survey vector and flown at much higher altitude as compared to the planned survey flying. The purpose of C.T. is to derive a set of compensation coefficients to correct for the effects the aircraft has on magnetometer sensors. See also Figure-Of-Merit, Heading Test and Lag Test.

Compensator – an electronic device which is installed in aircraft to compensate magnetometer readings for the magnetic effects of the aircraft itself and its flight maneuvers, and different orientations with respect to the Earth's magnetic field vector. See also Real Time Magnetic Compensation System.

Complementary Filter – a spectral domain pass filter which is complementary to the previously applied pass filter. For example, C.F. of 2400 m low-pass filter is 2400 m high-pass filter. C.F. shows the components of data removed by the previous high-pass or low-pass filtering operation. Butterworth Filter is often used as C.F.

Complete Bouguer Correction – see Bouguer Correction.

Complete Bouguer Field – the gravity field obtained after applying Bouguer Correction and Terrain Correction to the observed gravity data. See also Simple Bouguer Field.

Complex Analytic Signal – see Analytic Signal.

Complex Attributes – three attributes of the analytic signal: 1) Instantaneous Amplitude (more often called Analytic Signal Absolute Value, Analytic Signal Amplitude or Energy Envelope); 2) Instantaneous Frequency; 3) Instantaneous Phase. The term "instantaneous" makes clear that these attributes are different from their spectral namesakes. As potential field data are spatial rather than temporal, the term “local” is often used instead of “instantaneous.” [94, 226, 236, 242]. See Analytic Signal.

Complex Gradient – a 2-D vector quantity corresponding to the resultant of the vertical and horizontal gradients. C.G. is computed to interpret anomalies produced by dikes using characteristic points of their anomalies as well as phase plots. [203].

Composite Forms – a number of generalized geometric forms (horizontal cylinders, thin and/or thick dikes, prisms, etc.) with different dimensions and different density/susceptibility values that simulate a presumed subsurface structure. C.F. are the basic ones for Inversion By Forward Modeling where the user adjusts dimensions and values of various component parts of a particular model until theoretical and observed gravity/magnetic curves fit. [54]. See also Gravity Model and Magnetic Model.

Composite Image – a grid data image which is obtained by overlaying one image, original or processed, with another dataset (line, point, polygon or grid) display. For example, the total magnetic field image overlaid with the point dataset of the 3-D Euler depth solutions or the total magnetic field contour lines as an overlay for the image of the filtered total magnetic field grid. See also Drape Image.

Compu-Drape™ – a processing technique that recalculates (“drapes”) the magnetic and gravity data to any reference surface (Digital Elevation Model, sea floor, estimated Basement, etc.) as well as drapes a loose Drape Survey to a tight drape and applies height corrections to minimize mis-ties. Trademark of Geosoft Inc. See Mis-Tie.

Constrained Regional Gravity Field – a quantitative estimate of the regional component of Bouguer Gravity calculated from control points where depth to the major Density Contrast is known from independent sources such as wells, seismic interpretation and Geologic Map of the area under study. [84]. See also Constrained Residual Gravity Field and Gravity Basement.

Constrained Residual Gravity Field – a quantitative estimate of the residual component of Bouguer Gravity calculated by subtracting Constrained Regional Gravity Field from the Bouguer gravity field. C.R.G.F. is assumed to represent the gravity effect caused by the major Density Contrast in the gravity survey area, referred to as Gravity Basement. [84]. See also Talwani Inverse Solution.

Contact – a boundary (often, a fault) between two blocks of differing susceptibility/density values or rock types. High-offsetting fault blocks can generate anomalies similar to those of C. See Analytic Signal and Analytic Signal Amplitude.

Continental Crust – See Crust.

Continental Margin – a part of the ocean (or sea) floor between the shoreline and a depth of about 4000 m below sea level. The Gulf of Mexico is an example of one of the world’s largest C.M. petroleum provinces. The combined effects of a large sedimentary thickness, salt tectonics, and oceanic-continental Crust relationships give rise to high-amplitude regional magnetic and gravity anomalies here. [13]. See also Continental Shelf.

Continental Shelf – a part of the ocean (or sea) floor between the shoreline and a depth of 200 m below sea level. C.S. is characterized by its very gentle slope of about 0.1°. By present, the largest discovered oil and gas reserves are concentrated within C.S. areas. [13]. See also Continental Margin.

Continuatio n – a data processing concept which is based on the potential field continuity, i.e. the observed gravity or magnetic field can be recomputed at an elevation higher (Upward Continuation) or lower (Downward Continuation) than that at which the potential field was measured. [223]. See also Continuation Filtering.

Continuation Concept – see Frequency–Depth Rule.

Continuation Filtering – a procedure to recompute the observed potential field at an elevation other than that at which the measurements were made. Upward or downward, this procedure is straightforward and stable as long as no sources exist between a selected level and the level of measurements. In the spectral domain, C.F. behaves like a low-pass filtering (Upward Continuation) or high-pass filtering (Downward Continuation). When used in the separation filtering, C.F. can accentuate a particular range of anomaly wavelengths representative of a given depth range, yielding a new picture of magnetic or gravity trends not readily apparent on the original unfiltered map. [42, 48, 59, 118, 184]. See Separation Filtering.

Continuation Filters – a group of the spectral domain grid or line dataset operators which process the data in such a way that, when reverse transformed from the spectral domain back to the original space domain, the processed data appear to have been collected at another level (upward or downward) as compared to the level of actual measurements. Depending on the quality of data and survey targets, C.F. can be used for either random noise suppression and separation applications (upward option) or short-wavelength components enhancement (downward option). [39, 42, 48, 118, 184, 196, 250]. See also Continuation Filtering and Separation Filtering.

Contour Map – a map of continuous lines (contours), connecting the same values of the observed gravity or magnetic field. Instead of contours, the map is often represented in the color spectrum shades where each shade corresponds to a particular range of the gravity or magnetic field values, from low to high. Such maps are called color-scaled or color-coded maps. See Pseudocolor.

Contrast Normalization Filter – a grid-based averaging operator whose resulting effect is similar to that of Automatic Gain Control. [230]. See also Histogram Equalization.

Control Lines – survey lines which are usually orthogonal or sometimes oblique to Traverse Lines and commonly flown with a larger spacing (three times and more) as compared to the traverse line spacing. C.L. are often referred to as Tie Lines and are intended to control line-to-line instrument variations in the process of measurements.

Convolution – a data filtering operation which changes the amplitude and wavelength content of the original sampled data. In the space domain, each input sample amplitude will be replaced by another amplitude scaled proportionally to Impulse Response of the convolution (filter) operator and the output will be the superposition of all scaled sample amplitudes that occur at the same space points within a length of the operator's sliding window. In the spectral domain (after Fourier Transform), the output will be presented by multiplying the amplitude spectra and adding the phase spectra of original sampled data and convolution operator. [223]. See also Deconvolution, Circular Convolution and Linear Convolution.

Convolution Grid Filter – a space domain filter which modifies a given grid through the processing each grid cell using a combination of values of its neighbors.

Coordinate Rotation Method – a method which re-projects, by coordinate rotation and re-gridding, the subparallel or fanning elongated short-wavelength anomalies caused, for example, by mafic dikes ("dike swarms") that lie on a single azimuth trend along the new coordinate axis. Re-projected anomalies along this trend can then be easily removed by Directional Filtering and data are re-gridded and projected back to their original condition. C.R.M. provides more selective and less disturbing removal of the various unwanted directional trends as compared to spatially invariant spectral domain directional filtering. [198]. C.R.M. is also referred to as Coordinate Transformation Method.

Coriolis Acceleration – The acceleration of a moving body (for example, a shipborne gravimeter platform) with respect to the Earth resulting from the rotation of the Earth. If body moves on the Earth's surface with the velocity "V", then C.A. formula can be represented as

$$C.A. = 2TV\sin N ,$$

where "T" is angular rotation of the Earth. "N" is the latitude. C.A. of a moving gravimeter is involved in

Eötvös Effect. [223].

Coriolis Effect – the horizontal component of the resultant vector in a vector addition of the gravimeter's platform velocity and the Earth's rotational velocity. The corresponding vertical component is Eötvös Effect. [13, 223, 238].

Correction of Magnetic Data – a compensation of the observed (recorded) magnetic data for a) irregular solar micropulsations and magnetic storms; b) regular diurnal and secular variations; c) instrument drift; d) flight elevation above ground surface (AGL); e) location ties (mis-ties) between traverse and control lines; f) the Earth's gradient field (based on the International Geomagnetic Reference Field – IGRF); g) local Inclination and Declination of the magnetic field (Reduction-to-the-Pole, i.e., RTP, or Reduction-to-Equator, i.e., RTE); h) Cultural Editing. Not all of these corrections are commonly applied and not necessarily in this order.

Corrugation Anomaly – an artificial anomaly arisen from residual errors in Leveling and Gridding of the survey line datasets. C.A. can be effectively removed by Directional Filtering if it meets the following criteria: a) relatively small dynamic range; b) quasi-symmetrical waveform; c) the shortest possible wavelength is orthogonal to Traverse Lines, and it is not longer than twice the traverse line spacing; d) the longest possible wavelength is along the traverse lines, and it is not shorter than twice the control line spacing. See Decorrugation.

Corrugations – small amplitude artificial anomalies (i.e., Artifacts) elongated along both traverse and control (tie) lines. C. represent the residual errors remaining after conventional Leveling and Gridding of the observed potential field data. C. are attenuated or removed in the process of Microleveling. Sometimes, C. are referred to as Acquisition Footprint or Striping. See also Corrugation Anomaly and Decorrugation.

Cosine Bell Filter – an edge smoothing spectral domain grid filter which converts the original grid edge data values into a "bell-shaped" cosine curves to ensure a smooth transition of these data to zero at the edges of a grid. [176]. See Edge Smoothing Filters.

Cosine Correction – a correction which is applied if a long axis of magnetic anomaly is not orthogonal to the orientation of magnetic profile. Magnetic depth estimates will be artificially deeper due to this skew and C.C. will compensate for this discrepancy by shallowing depth estimates.

Cosine Rolloff Filter – a spectral domain pass filter which retains long- or short-wavelength components of observed data using Taper with a smooth cosine curve in Rolloff Range. User specifies high and low frequency (short- and long-wavelength) cutoffs for the rolloff range and a degree of the cosine function: the higher degree – the steeper transition between passed and rejected portions of the data spectrum. Differing from the conventional pass filters, C.R.F. has strongly reduced or no Ringing effects. [230].

Cosine Taper Filter – see Cosine Rolloff Filter.

Crab – a steady Heading of the survey aircraft or ship at an angle to the selected course to compensate for a crosswind. [223]. See also Pitch, Roll and Yaw.

Creep – a gradually increasing deformation of a spring in the gravimeter sensing system as a result of a thermal expansion, elastic aging or excessive movement. [238, 255].

Critical Surface Concept – a concept that postulates a particular surface above which physical property contrasts (such as Density Contrast or Susceptibility Contrast) are either horizontally stratified or absent, or relative small, and below which these contrasts are large and reliably identified. C.S.C. considers physical property contrasts as invariants with depth and, therefore, effects of sources near and below the critical surface will predominate in the observed field. In magnetic explorations, the top of Crystalline Basement is the example of a critical surface. [45].

Crossing-Point Method – a method of calculating magnetic parameters of Dike and Contact (such as depth to top, effective dip angle, Susceptibility or Susceptibility Contrast) using the crossing points of Horizontal Derivative (“G_x”) and Vertical Derivative (“G_z”) profiles. Over dikes, profiles of “G_x” and “G_z” cross at two points. Over contacts, they cross at only one point. All sources (thin or thick dikes, contact) are assumed to have Induced Magnetization. Real data depth errors are estimated to be about 5-10 percent. [171]. See also Thick Dike, Thin Dike and Profile.

Crossovers – points of data measurements where the traverse and control (tie) lines cross each other. Crossover point values of the measured magnetic or gravity field are used in the process of Leveling. Most of the differences in airborne crossover values are due to problems with acquisition height.

Crust – the outermost layer of the Earth above Mantle. Mean density of C. is about 2.8 – 2.9 g/cu.cm. C. represents less than 0.1% of the Earth’s total volume. Continental C. is predominantly granitic and ranges in thickness from about 35 km up to 60 km. Oceanic C. is basaltic and about 5-10 km thick. [13, 223, 238].

Crustal Magnetic Field – the remaining magnetic field after removal of the external field effects (diurnal variations and other solar radiation activity) and the Earth’s main magnetic field (International Geomagnetic Reference Field – IGRF) from the observed data.

Cryogenic Magnetic Levitation – Magnetic Levitation under temperatures near absolute zero. C.M.L. is used in the design of high-sensitivity gravimeters. [36]. See Virtual Spring.

Cryogenic Magnetometer – a high-sensitive magnetometer which operates at the temperature of a liquid nitrogen. [223]. See Squid Magnometer.

Crystalline Basement – see Basement.

Cultural Magnetic Anomalies – see Cultural Noise.

Cultural Editing – the removal of artificial non-geologic magnetic effects generated by man-made objects (pipelines, wellheads, power lines, etc.) from the observed magnetic data. There are two basic approaches to C.E. : 1) automated Filtering , including a wavelet transform filter technique, and 2) manual peak selection controlled by the flight video records. C.E. is also referred to as Deculturing. [57,109, 139]. See also Cultural Noise, Cultural Suppression and Video Vewing.

Cultural Noise – non-geologic, usually short-wavelength (high-frequency), high-intensity anomalous components of the observed magnetic field generated by man-made objects: pipelines, wellheads/casings, large metal buildings and others. C.N. should be edited out of the original line dataset prior to Leveling. [57, 73, 109]. See Cultural Editing.

Cultural Suppression – a technique where a space variant filter such as a Naudy Filter is used to reduce sharp anomalies of cultural origin to an amplitude below a threshold value. [109].

Curie Point – the temperature at which magnetized rocks lose their ability to retain magnetic properties. C.P. of the most rocks is about 550^{o} C which is usually reached at depths of 30-40 km. C.P. is also referred to as Demagnetization Temperature. [223, 238].

Curvature – a reciprocal of the radius of a circular arc that can be best fitted to the portion of a line in the point’s immediate vicinity. C. defines the rate of change of the slope of a curve or surface. The second derivative of a function is a measure of the function’s curvature. See also Differential Curvature.

Curvature Correction – a correction which is applied to the observed gravity data to compensate (“bend”) Bouguer Slab in order to conform it to the shape of the Earth in a more reasonable way. Since this correction changes the Bouguer slab at considerable distances from the point of measurements, the corresponding C.C. values are generally small. [34, 135]. See Bullard B Correction.

Curvature of Gravity – a vector calculated from the gravity gradient data (such as the torsion-balance) indicating the shape of an equipotential surface. It points in the direction of the longer radius of curvature. [36 , 223].

Cutoff – a spatial frequency (wavenumber) or wavelength value which designates the effective operational range of a given filter. For example, 1200 m–4800 m Band-Pass Filter has a short-wavelength C. at 1200 m and a long-wavelength C. at 4800 m. See also Cutoff Wavelength and Cutoff Frequency.

Cutoff Frequency – a spectral domain filter parameter which controls the half-power or 30% amplitude point of the filter response curve in terms of Spatial Frequency (i.e., in cycles per grid or distance unit). See also Filter Cutoff.

Cutoff Wavelength – a wavelength filter parameter corresponding to Cutoff Frequency which controls the half-power or 30% amplitude point of the filter response curve in terms of Wavelength, i.e., it defines a wavelength value at which Wavelength Filter reaches 50% of its maximum response. See also Filter Cutoff.

Cutoff Wavelength Width – a wavelength interval within which the filter characteristic changes from its minimum response to its maximum response. The optimum C.W.W. to reduce Ringing and other side effects is recommended to be about one Octave. [257]. See also Cutoff Wavelength and Filter Order.

D

Data Conditioning – a general definition of preliminary processing operations applied to the observed data to prepare them for subsequent purpose-oriented computer processing and interpretation. D.C. includes Database Creation, Leveling, Line Resampling and/or Grid Resampling, Gridding, Microleveling, applying reductions and other operations (not necessarily in this order).

Data Enhancement – a sequence of selective procedures applied to the observed data to increase lateral resolution and relative amplitudes of short-wavelength (high-frequency) components of potential fields in order to highlight subtle features of exploration interest. There are two key factors which determine the effectiveness of D.E.: removal of regional long-wavelength high-amplitude components and suppression of regular and background noise. [59, 115, 216].

Data Extension – a procedure which is applied to the line or gridded data in order to create the extended regions at survey edges where values of the first or last original data point can be smoothly rolled off to zero. D.E. is used to ensure the most effective performance of Spatial Domain Filters, Hilbert Transform, Fourier Transform as well as to minimize Edge Effects. See also Taper.

Database Creation – a data storing procedure which organizes line oriented acquisition data (line datasets) in the standard order suitable for subsequent computer processing operations: Gridding, Microleveling, Filtering, etc.

Datum – a reference level to which the observed data are referred or corrected. All depth estimates, as well as the magnetic and gravity survey datasets, are referred to a specified D. Sea level is the most common D. Sometimes, it's called Reference Elevation. [223]. See Depth and Survey Datum.

Datum Transformation – a procedure to compute coordinates expressed in one Datum into another.

DC Level – a constant value of the gravity or magnetic field used as one of the input parameters in Inverse Modeling.

DC Power – the highest value in Power Spectrum of the observed potential field data assigned to zero value of Spatial Frequency or zero value of Wavenumber. Map Power Spectrum plots DC P. at the center of map, Radial Power Spectrum – at the left side of the spectrum graph.

De-Aliasing Filter – see Alias Filter.

Declination – a deviation of Geomagnetic Field vector from the true (geographic) North. D. can also be defined as the azimuth of Magnetic Meridian:

$$D. = \arcsin B_y / (B_x^2 + B^2_y)^{½},$$

where "B_x" and "B_y" are horizontal components of Geomagnetic Field Vector in directions "x" and "y" respectively. By convention, D. is positive to the east and negative to the west. D. generally ranges between –25º and +25º. [25]. See also Inclination.

Decomposition – a procedure to separate the observed gravity or magnetic field (usually presented as Grid or map) into its regional and residual parts. [223]. See also Residualizing.

Deconvolution – a signal enhancement procedure which helps to extract (resolve) original anomalies produced by causative bodies from the observed potential field created by their superposition and interference. The term of D. originates from the mathematical approximation of the observed potential field as Convolution of the sources' parameters with the basic function that describes the geometry of their subsurface distribution relative to the observation surface. Fundamental ambiguity in relationship between the potential field and its sources precludes any D.-based solutions without clearly specified assumptions about the particular model for the D. process. D. concept is the basis for automated estimation of magnetic source parameters such as depth, location, dip and susceptibility. D. has the same conceptual meaning as Inversion with the latter term being used in a more generalized sense. See Werner Deconvolution and Euler Deconvolution.

Decorrugation – a microleveling procedure that eliminates residual errors due to line– related noise (Corrugations) remaining after the standard Leveling and Gridding of the observed data. D. is based on Directional Filtering which is applied along the traverse and control lines in the space domain or in the frequency (wavenumber) domain. In space domain, Naudy Filter and Fuller Filter can be applied in a tandem. In frequency domain, Butterworth Filter and Directional Cosine Filter are often used. [230]. See also 1-D Directional Filtering and 2-D FFT Filtering.

Deculturing – see Cultural Editing.

Definitive Geomagnetic Reference Field (DGRF) – a predictive version of International Geomagnetic Reference Field (IGRF) on a 5-year epoch. DGRF is updated based on DGRF models that represent the official record of how the geomagnetic field has behaved in epochs. At present, nine DGRF models are in effect: DGRF 1945 through DGRF 1985, each representing a 5-year epoch since 1945. [25].

DEM – see Digital Elevation Model.

Demagnetization – the effect of magnetization distribution that results in reducing the magnetic moment "M" by a factor which varies with a shape of the magnetized body. Generally, this effect is small. D. can be significant in a massive pyrrhotite and in rocks containing more than 5–10% magnetite. [238].

Demagnetization Temperature – see Curie Point.

Density – the mass of a rock per unit volume. D. is usually expressed in grams per cubic centimeter (in cgs units) or kilograms per cubic meter (in mks units). [33, 63]. See Density Contrast.

Density Basement – See Gravity Basement.

Density Contrast – the difference in density of one rock mass relative to another. D.C can be either positive or negative. Gravity anomalies of exploration interest are caused by lateral density contrasts in the subsurface and they are analyzed and interpreted as lithologic and/or structural boundaries. For expample, local areas of relatively high values in Bouguer Gravity are usually interpreted as structural highs and vice versa. Maximum D.C. between different rocks (i.e., range of density values from the lowest to the highest) is approximately two. This as a very small range compared to that of magnetic Susceptibility (about 10^5). [63, 215]. See Density.

Density Factor – a value of rock density selected for calculating Elevation Correction. The most appropriate D.F. is the one that minimizes the correlation of the gravity values with appreciable topographic relief features. [223]. See Nettleton Test.

Density Filter – a grid-based Spectral Domain operator that calculates values of Apparent Density in the subsurface. See also Susceptibility Filter.

Density Model – a model of the geologic structure in which layers or bodies of given lithologies are replaced by specified bodies of assumed density distribution. See also Gravity Model.

Density-Depth Function – a relationship between changes in the rock Density and increasing Depth.

Density Profile – see Nettleton Test.

Depocenter – an area of the maximum deposition (i.e., laying down of a rock-forming material) in the sedimentary basin. On regional-scale gravity or magnetic maps, D. is represented as the gravity minima trend (zone) or the lowered intensity Total Magnetic Field area. [13, 141].

Depth – a vertical distance from the specified Datum (Earth's surface, sea level or derrick floor) to the top of the magnetic or gravity source body or structural surface like Basement.

Depth Controller – a ship borne magnetic survey device that maintains Fish at a pre-determined depth below sea level.

Depth Estimate Cosine Correction – see Cosine Correction.

Depth Estimate From Spectral Analysis – a calculation methodology which is based on the concept that for simple magnetic models the depth to magnetic source is related to a slope of the logarithm of Power Spectrum of the observed data. The minimum area, for which this power spectrum is computed, must be about 8-10 times the expected depth to magnetic source. For the total intensity magnetic field, depth estimate can be presented as

$$\underline{\text{depth} = \text{slope of the log power spectrum} / 4p},$$

where the slope value is defined as a ratio of the difference between two log power spectrum values to the difference between two corresponding Wavenumber values. For gradiometer data:

$$\underline{\text{depth} = 1 / 2pf_o},$$

where "f_o" is the frequency (wavenumber) of the log power spectrum maximum value. [48, 96, 169, 215, 228]. See also Radial Power Spectrum, Spectral Analysis and Spector-Grant Method.

Depth of Compensation – a term derived from the concept of Isostasy. It defines the theoretical depth level above which rocks are rigid and below which there is a slow movement of plastic rocks to adjust to changes in the overburden load. Lateral density variations below this level are assumed to disappear. Sometimes, it is taken as a top of Asthenosphere. [**25**, 223]. See also Hayford Modification.

Depth Rules – the rules which are used in the graphic methods of estimating the depth to the top of a source of the observed isolated anomaly. D.R. relate this depth to some measured features of the anomaly shape, such as horizontal distance between points on the side of anomaly where its slope is a half the maximum slope (Peters Half-Slope Method) or horizontal distance between points corresponding to the half amplitude and maximum amplitude (Half-Width Method) and others. D.R. are more successively applied to specific source shape approximations (such as dikes, point masses or horizontal line masses) and for isolated anomalies which appear to be not interfering with adjacent anomalies. The profile of the selected anomaly should be perpendicular to the contours of the potential field map (i.e., orthogonal to the anomaly trend). [53, 216, 223]. See also Hannel Method, "Quick-And-Dirty" Peters Method, Sokolov Method, Steenland-Vaquier Method, Tiburg Method.

Depth Slicing – a method that uses specifically designed filters in order to isolate anomaly contributions from source bodies in a certain qualitatively estimated depth range based on Power Spectrum and wavelength criteria. D.S. is more often referred to as Pseudo-Depth Slicing, as it only enhances particular parts of Power Spectrum frequency (wavelength) content of the data, rather than attempting to completely separate them and make a quantitative depth estimate. [18, 79, 175, 215]. See also Matched Filtering and Ensemble.

Depth-Slice Filtering – see Matched Filtering and Depth Slicing.

Derivative – a rate of change of the observed potential field in a particular direction ("x", "y" and "z"). The first D. represents the slope or gradient of the field in a specified direction. The second D. represents the slope or gradient of the first D., which is the curvature of the original potential field. In general, D. has the properly of discriminating against large-scale regional trends and accentuating mid-wavelength and short-wavelength (high wavenumber) anomalies of exploration interest as well as short-wavelength noise components of the observed gravity or magnetic field. See also Horizontal Derivative and Vertical Derivative.

Derivative Filtering – a spectral or space domain procedure which is based on applying Derivative Filters in order to enhance short-wavelength components of the observed data, accentuate subtle changes in the total intensity or filtered potential fields as well as reduce the effects of interference and superposition of anomalies generated by closely spaced sources. See Vertical Derivative, Second Vertical Derivative, Vertical Derivative Order and Horizontal Derivative.

Derivative Filters – a group of the spectral or space domain processing operators which calculate the derivatives of the observed potential field in the directions of "x", "y" and "z" coordinates. The effects of D.F. and Residual Wavelength Filter for appropriate wavelengths can be quite similar because both of them are constrained by Grid Spacing. See also Gradient Filter and Derivative Filtering.

Derivative Map – a map of one of the derivatives of the gravity or magnetic field, usually First Vertial Derivative and/or Second Vertical Derivative. [223]. See also Fractional Vertical Derivative, Horizontal Gradient and Total Gradient.

Despiking – a removal of spikes from the observed data (line or grid datasets) in order to improve the performance of filter operations both in space and spectral domains. See also Pre-Filter Transformation.

Despiking Filter – a filter that removes spikes (i.e., noise outbursts) from the line or gridded data, usually, by the use of Running Window averaging. Median Filter is often used as a simple D.F.

Detrending – a removal of overall trends in one (line dataset) or two (grid dataset) dimensions from the observed data before Fourier Transform. Usually D. is performed by Polynomial Fitting. Sometimes, when data exhibit no evident trends, D. is performed by subtracting the dataset mean (i.e. average) from all values in the dataset. [223].

Detrital Remanent Magnetization (DRM) – one of five main types of the remanent (residual) magnetization. D.R.M. originates in the rock material from exposure of its detritous component to an external magnetic field during a relatively slow settling of the fine-grain particles. Some clays have a strong magnetization of this type, but the magnitudes are generally too small to affect exploration interpretation. [33, 238]. See also Chemical R.M., Isothermal R.M., Thermal R.M. and Viscous Remanent Magnetization.

DGPS – see Differential Global Positioning System.

DGRF – see Definitive Geomagnetic Reference Field.

Diagenetic Magnetic Anomaly – a shallow low amplitude short-wavelength anomaly generated by relatively high concentrations of strongly magnetic diagenetic minerals (like diagenetic magnetite and/or pyrrhotite) which were formed as a result of diagenetic changes caused by various factors including hydrocarbon seepage. [55, 61, 110, 151]. See also Aeromagnetic Hydrocarbon Indicators and Syngenetic Magnetic Anomaly.

Diagenetic Magnetite – a strongly magnetic mineral formed as a replacement mineral or through a hydrothermal alteration. Often, D.M. is accumulated above hydrocarbon reservoirs. High concentrations of D.M. can generate a detectable Diagenetic Magnetic Anomaly. [55, 77]. See also Chimney, Magnetite and Syngenetic Magnetic Anomaly.

DiaMag[Ô] – a diamond and gold exploration helicopter-supported magnetic gradient acquisition system based on the use of UXO Detection technology. DiaMag[Ô] integrates high-accuracy DGPS positioning (1–5 m) with high magnetic Amplitude Resolution (0.001 nT) and 0.05 nT sensitivity. A fixed-boom multi-sensor transverse gradient array is mounted directly to the helicopter. High-speed sampling at 1 kHz (summed to 20 samples per second) from a slow-moving and low-flying helicopter provides sampling density of 1 ´ 12 m or higher.

Standard line spacing is 12 m. Trademark of Fugro Airborne Surveys. See Multi-Sensor Gradient Array.

Diamagnetics – magnetic rock materials having relatively small negative values of Susceptibility. The most common diamagnetic rocks are graphite, gypsum, marble, quartz and salt. The strongest diamagnetic anomalies are observed over large salt domes. [33, 223].

Differential Curvature – a gravity equipotential surface parameter which is the difference between the maximum curvature of a given surface and its minimum curvature (which is measured perpendicular to the direction in which the surface curves the most), multiplied by the gravity constant "G". D.C. is a measure of the curved shape of the gravity field surface in the vicinity of a gravity anomaly. Mathematically, D.C. can be presented as the horizontal gradient of a horizontal derivative component of the gravity field. [223].

Differential Global Positioning System (Differential GPS or DGPS) – a system which provides the most accurate continuous information on the current position in three dimensions based on signal received from the space satellites and GPS Base Station. The records from the GPS base station are used to differentially correct the GPS data for the moving platform to remove signal dither and correct for atmospheric effects. [181]. See also Global Positioning System (GPS).

Differential GPS – see Differential Global Positioning System.

Differential Upward Continuation Filtering – see Separation Filtering.

Differentiation – a term which sometimes is used to define the calculation of derivatives of the observed potential fields presented in the form of a map (grid). For example, double D. means calculation of Second Derivative.

Digital Elevation Model (DEM) – see Digital Terrain Model.

Digital Image Processing – a concept that is based on a computer-aided manipulation and transformation of the image data stored in a digital format in order to enhance the visual presentation of the objects of exploration interest. [132]. See also Pixel and Raster Grid.

Digital Terrain Model (DTM) – a digital topography model of the survey area which is used for the pre-programming of the aircraft drape flying and in the calculation of terrain corrections for gravity. D.T.M. also called Digital Elevation Model. See Drape Survey.

Dike – a tabular body of Igneous Rock in the form of a slab of a finite thickness which is longer in the vertical dimension than in the lateral dimension (i.e., as opposed to Sill) on its cross-section. D. may arise up to the Earth's surface cutting older rocks. D. is one of the basic geological sources of magnetic anomalies and model approximations in magnetic exploration. The response Magnetic Anomaly Amplitude and Magnetic Anomaly Wavelength of D. are controlled by its width and the depth to its top: the narrower and shallower D., the higher amplitude and the shorter wavelength of anomaly. Rectilinear geometry and above-average amplitudes of generated magnetic signals often make dikes easily recognizable on magnetic anomaly maps. [13, 140 , 223]. See Dike Model and Goussev Filter.

Dike Model – a model which is used to describe some linear features of the subsurface structure (like magnetized faults or block contacts), based on the assumption that corresponding causative bodies can be presented as wide/thick, narrow/thin, vertical or inclined dikes. See also Dike and Prism.

Dimension – a property which generally defines length, area and volume. For example, two-dimensional (2-D) modeling defines magnetic or gravity model in "x" and "y" dimensions. D. can also represent any basic quantity (distance, time, wavenumber, etc.) through which it becomes possible to define all other quantities. See Time-Lapse (4-D) Gravity Survey.

Dip – an angle that a stratum, or anomalous magnetic or density body, or fault plane makes with the horizontal plane.

D. is measured perpendicular to Strike and in the vertical plane. [13].

Dipole – see Magnetic Dipole.

Dipole Field – an approximation of the major component of Earth's Magnetic Field originating at the Earth's center. The intersections of axis of this dipole with the Earth's surface are Geomagnetic Poles. [223].

Directional Cosine Filter – a spectral domain grid filter which rejects or retains the components of the observed data oriented along the user-specified azimuth (angular direction). As compared to conventional directional filters, D.C.F. creates a smooth curve in Rolloff Range (i.e., from pass to reject ranges) to prevent short-wavelength (high-frequency) Ringing on the space domain images of the filtered data after Inverse Fourier Transform. D.C.F. is often used in Microleveling. [67].

Directional Filtering – a two-dimensional (2-D) procedure which is used to a) highlight structural trends on maps of the gridded data using Artificial Sun Illumination methods; b) pass, attenuate or suppress regular noise components oriented in a certain direction by the processing in the spectral domain. Spectral processing is based on the fact that directional features in the space domain have the equivalent presentation in the corresponding sector of the spectral domain and this sector's image on Map Power Spectrum is oriented orthogonally to the direction of given space features. [216, 240, 254]. See also 1-D Directional Filtering and 2-D FFT Filtering.

Directional Filters – a group of the spectral domain grid filters which pass, attenuate or reject components of the potential field oriented in a certain space direction. User specifies low-cutoff angle and high-cutoff angle (in degrees) for the low and high limits of the reject/pass range. D.F. may produce a short-wavelength (high-frequency) Ringing which appears on the image of the space domain data after Reverse Spectral Transform. [40, 240]. See Directional Cosine Filter, Strike Filter, Strike Balance Filter, Strike Wiener Filter.

Directional Spectral Analysis – a four-step procedure applied to the gridded magnetic or gravity data in order to determine from Power Spectrum what directions contain predominant portions of the total map energy to constitute linear anomalies associated with structural-tectonic trends. These steps include: 1) removal of the regional gradient from the observed data (Detrending); 2) 2-D Fourier Transform of the space domain data to the spectral domain with subsequent replacement of each spectral sample with the square of its magnitude to obtain a power spectrum for display; 3) determination of directions which contain predominant energy peaks; 4) directional (fan) filtering to separate selected lineaments associated with peaks in the power spectrum from other map features for independent examination. [240].

Discrete Fourier Transform – a version of the standard Fourier Transform for sampled data. D.F.T. can also be performed for the wavelets over a specified finite space interval so that equivalent spectral domain values are obtained for Dominant Wavenumber and its harmonics. [25, 44, 177, 201, 223]. See also Inverse Fourier Transform.

Display – a visual presentation of data on a screen of the workstation.

Distortion – an undesired change of the actual space waveforms of the potential field components caused by interference with and superposition of noise events.

Diurnal Correction – a correction applied to the observed magnetic data to compensate for Diurnal Variations due to solar radiation activity. D.C. involves the point-for-point subtraction of the diurnal values, recorded by Base Station, from the airborne magnetic values. Prior to D.C., the raw diurnal data is: a) "softly" filtered to remove high-frequency noise fluctuations; b) interpolated to match the airborne Sampling Interval; c) adjusted to ensure synchronization with airborne measurements. [187]. See also Ground Magnetometer.

Diurnal Drift – a level of Diurnal Variations recorded by Ground Magnetometer during the time of the airborne data acquisition. Using the GPS time as a synchronization parameter, the D.D. data are examined on a line-by-line basis in order to determine whether D.D., measured while each specific line was flown, exceeded the specified tolerances. Lines, for which D.D. did not meet the planned specification, are marked for re-flight. See Diurnal Variations.

Diurnal Variations – daily short-period temporal fluctuations of the external magnetic field due to the solar radiation activity. D.V. must be removed from the observed magnetic data prior to processing and interpretation. Ground Magnetometer records are used to decorrelate the external magnetic field signal from the airborne magnetometer's total magnetic field signal. D.V. are often referred to as Diurnals. See also Diurnal Drift.

Diurnals – see Diurnal Variations.

Domain – a mathematical set of values that define Dimension as the independent variable value and the corresponding values of a certain function as dependent variable values. For example, Space Domain defines the observed or processed potential field data as a set of values which vary depending on three geographic dimensions (i.e., independent variable values) of "x", "y" and "z". D. is also used with the meaning of the volume of a mineral with uniform (i.e. single direction with magnetic moments parallel) magnetization. [223]. See Spectral Domain and Magnetic Domain.

Dominant Frequency – a local or area average Spatial Frequency which is estimated by measuring the distances between successive peaks or troughs of the gridded or line potential field data. [223]. See also Harmonics.

Double Bouguer Correction – a two-step Bouguer Correction that is applied to the gravity measurements made by ocean-bottom gravimeters to compensate for: a) upward gravitational attraction of sea water above gravimeters; and b) the difference between sea water density and Replacement Rock density. For mine and borehole measurements, D.B.C. is referred to applying the Bouguer correction to the gravity readings obtained both above and below a target layer in a mine or at two different depths in a borehole. [223]. See also Replacement Density.

Double Differentiation – see Differentiation.

Downward Continuation – a procedure to recompute the observed potential field at the level which is lower than the level of actual measurements. Generally, D.C. is considered stable as long as no sources exist between a selected level and the level of measurements, i.e., it is assumed that the new level should always be selected above the Earth's surface. The most general formula of D.C. can be presented as

$$F(w) = e^{hw},$$

where "h" is the level of continuation in meters. D.C. enhances short-wavelength (high-frequency) components of the potential field which are generated by relatively shallower sources. In practice, noise can be greatly amplified also. To minimize this effect, D.C. is cascaded with a standard low-pass filter or other noise-suppressing procedures. [39, 94, 215, 223]. See also Stabilized Downward Continuation and Upward Continuation.

Drape Survey – an airborne survey flown as close as possible to a constant height (constant Ground Clearance) above the Earth's surface. D.S. is recommended in order to maximize the lateral resolution of short-wavelength anomalies of potential fields. As a rule, Digital Terrain Model is constructed with peaks as "anchor points" for the programmed flight surface that incorporates maximum slopes relating to the climb performance of the aircraft. Alternatively, the pilot flies using Radar Altimeter without a preplanned flight surface.

Draped Image – a composite image where one grid image, obtained in Pseudocolor, is overlaid (draped) on another grid image, obtained in a gray scale, or vice versa. See Composite Image.

Drift – a gravity instrument characteristic which defines a gradual change in the reference level in respect to which actual gravity measurements are made. D. takes place because gravimeter springs or torsion fibers are not perfectly elastic but subject to slow creep over long periods of time as a result of the thermal expansion, elastic aging or excessive movement. Often, D. is calculated as the linear approximation between Base Station observations recorded at the start and at the end of each Gravity Traverse. [223, 238, 255]. See also Drift Curves and Drift Correction.

Drift Correction – a time-varying correction applied to the observed gravity data to compensate for the gravimeter's drift using Drift Curves. D.C. can be presented as

$$D.C. = D\,(t_o - t_b),$$

where "D" is the gravimeter's Drift Rate, "t_b" is the base-in time, and "t_o" is the time of observation. Often, D.C. incorporates the correction for the Earth tides. [255]. See Drift and Time Variation Correction.

Drift Curves – a graphic presentation of repeated gravity measurements at the same observation station (Base Station) at intervals during the day. D.C. are obtained in order to calculate corrections to compensate for the gravimeter drift as a function of time. Adjustment of readings at other stations is made by taking differences from D.C. and using various available techniques. It is critical to record the time of a given measurement to relate it to D.C. See Drift Correction.

Drift Rate – a gravimeter instrument characteristic, which is calculated using Drift Curves. See Drift and Drift Correction.

DTM – see Digital Terrain Model.

Dynamic Gravity – a general definition of methods and instrumentation for measurements of the Earth's gravity field using a moving platform such as a ship or near-bottom towed pressure case (marine gravity survey) and aircraft or helicopter (airborne gravity survey). D.G. is opposed to Station Gravity. [253]. See Towed Deep Ocean Gravimeter and HeliGravÔ.

Dynamic Range – 1) a data parameter which defines the range of measured potential field values over the whole survey area or its local part. Usually, D.R. is defined as the ratio of the maximum measured amplitude to the minimum measured amplitude; 2) an instrument characteristic which defines the ratio of the maximum reading to the minimum reading (often, noise level) which can be recorded by and read from Gravimeter or Magnetometer without change of scale. [223].

E

Earth Tide Correction – a time-varying correction applied to the gravity survey data to compensate for Earth Tides. Often, E.T.C. is included as a part of Drift Correction and referred to as Tidal Correction. [223, 255].

Earth Tides – a time-varying response of the solid Earth's surface to the tidal influences of the moon and sun. E.T. can produce displacements up to about 10 cm and generate the anomaly of about 0.2 – 0.3 mGal. The magnitude of E.T. effects depends on a latitude and time; it is the greatest at low latitudes and has a strong periodic component with a period of about 12 hours. Over a short period of time (about 60 minutes), the tidal gravity variation is considered to be linear with time. [25, 223]. See Earth Tide Correction and Time Variant Correction.

Earth's Core – a central portion of the Earth, beginning at the depth of about 2900 km and probably consisting of metal (iron-nickel) substance. E.C. radius is about 3500 km. E.C. is divided into the outer core (depth interval from about 2900 km to 5000 km) that may be in the liquid state, and the inner core of about 1300 km in radius that may be in the solid state. [13, 223]. See also Core.

Earth's Gravity Field – a vector field of the gravitational acceleration (attraction) "g" of the mass "m" due to the presence of the Earth's mass "M":

$$g = F/m = -GM / R^2 ,$$

where "F" is Gravity Force; "G" is Universal Gravity Constant; "R" is the Earth's radius at the point of measurement. In gravity exploration, E.G.F. is often referred to as Gravity Acceleration. [25, 34, 54, 182, 238].

Earth's Magnetic Field – a vector field approximated as that of Magnetic Dipole originating at the Earth's center and defined by three parameters: 1) magnitude or Magnetic Field Strength expressed in nanoteslas (nT); 2) Inclination or dip expressed in degrees; 3) Declination or angle east of the geographic North direction expressed in degrees. E.M.F. varies over the Earth's surface and with time. For the airborne magnetic measurements, E.M.F. intensity (magnetic field strength) is inversely proportional to the square of distances above the sources. Measured differences in the magnetic field strength are related to the differences in subsurface distribution of magnetic sources. Since such variations reflect changes in geological structures, they can be used to interpret the geology of the subsurface. [25, 54, 223, 238]. See Earth's Magnetic Field Components.

Earth's Magnetic Field Components – three basic components that explain the origin and constitute the observed magnetic field of the Earth: 1) main field which is of the internal (core) origin and varies slowly over hundreds and thousands of years. The main field contributes the largest part to the magnitude of the Earth's magnetic field and varies in its values from 70,000 nT at the magnetic Poles to 25,000 nT at the magnetic Equator. Inclination of the main field is vertical at the magnetic Poles and horizontal at the magnetic Equator; 2) external field which originates outside the Earth and is characterized by rapid changes in time, partly cyclic and partly random. The external field is the cause of Diurnal Variations and Magnetic Storms which can strongly affect magnetic survey measurements. The variation of the external field can be about 1-2 nT for small diurnal variations up to 1000 nT and more for severe magnetic storms; 3) local field is the magnetic field which represents the result of interaction between the above two components and the local distribution of magnetic materials in the upper part of the Earth's crust. The local field is much smaller than the main field and considered as constant in time and location. The local field magnitude may vary from 0.1 to 100 nT over magnetically quiet deep sedimentary basins up to several thousand nT over highly magnetized crystalline basement rock outcrops, like some of the basic igneous rocks. [25, 54, 238]. See also Earth's Magnetic Field, Ionosphere, and Magnetosphere.

Earth's Magnetic Poles – see Geomagnetic Poles.

Easting – a component of a survey leg in the east direction. On maps and grids in Cartesian Coordinates, it may be expressed as an "X" value. [223]. See also Northing, False Easting and False Northing.

Economic Basement – see Basement.

ECF – see Elevation Correction Factor.

Edge Effect Anomaly – the region-scale free-air gravity anomaly comprised in its simplest form of a gravity "high" (which correlates with the outer shelf area and usually centers above the present-day shelf break) and a gravity "low" (which correlates with the continental slope sink and the oceanic crust rise areas). E.E.A. is the distinct geophysical feature of rifted continental margins and it is traditionally interpreted as the result of Juxtaposition of thick continental crust and thin oceanic crust, with contributing density contrasts of sea water, prograded sediments, continental and oceanic crusts, and Mantle. [245]. See also Crust, Density Contrast, Replacement Density and Free-Air Gravity.

Edge Effect Correction – a grid-based Spectral Domain procedure that eliminates high-intensity artificial anomalies near Grid edges and removes "waves" or "halo" around anomalies within the grid by: a) limiting anomalies that exceed a specified threshold value; and b) tapering grid data to zero at a specified distance near grid edges and, thus eliminating "stripes." See also Maximum Entropy Prediction.

Edge Effects – distortions of data which appear at the edges of grid images after applying filter operators or other grid or line data transformations. Assigning Taper or applying Data Extension and Edge Smoothing Filters allows to minimize E.E. [223, 251].

Edge Smoothing Filters – a group of the space domain and spectral domain filters which can be applied to line and grid datasets before their purpose-oriented processing in order to smooth the edges of data curves (line dataset) or surface (grid dataset) and ensure a smooth transition of data values to zero at the ends of lines and grid edges. E.S.F. minimize Edge Effects. [230].

Elevation – a vertical distance (height) from Mean Sea Level to a given point on the Earth's surface. Airborne survey area E. is calculated based on GPS, Barometric Altimeter and Radar Altimeter data. See also Altitude.

Elevation Correction – a correction applied to the observed gravity data to compensate for the difference between the elevation of the point of measurements and the reference elevation. E.C. is sometimes called Combined Elevation Correction as it represents the integrated result (i.e. the sum) of Free-Air Correction and Bouguer Correction:

$$E.C. = (0.3086 - 0.04192\ D)\ h_1 = (0.09406 - 0.01278\ D)\ h_2\ ;$$

where "D" is the assumed density in g/cm^3; "h_1" is the elevation of the point of measurement above survey Datum in meters, "h_2" is of the same meaning as "h_1" but in feet. [54, 223].

Elevation Correction Factor – a calculation parameter which is used to obtain Elevation Correction as the difference between elevation of the point of measurement and Reference Elevation multiplied by E.C.F. The E.C.F. formula is presented as

$$E.C.F. = (0.3086 - 0.04192D)\ mGal/m \quad or$$

$$E.C.F. = (0.09406 - 0.01278D)\ mGal/ft,$$

Where "D" is the assumed average density of Replacement Rock in g/cm^3. [223].

Ellipsoid – a 3-D shape for which every plane cross-section is an ellipse. Geoid is usually approximated as E. that rotates about one of its axes. [223].

Energy Envelope – the absolute value of Analytic Signal which is also called Amplitude Envelope or 3-D Analytic Signal Amplitude. E.E. is defined as a square root of the sum of squared vertical and two horizontal derivatives (in "x" and "y" directions) of the magnetic or gravity field. With certain assumptions, the depth to the magnetic source bodies can be estimated from the E.E. shape. Using E.E. images, the interpreter should take into consideration the following: a) E.E. magnitude and shape are dependent on the Earth's magnetic field parameters and E.E. maximum values are always offset from locations directly above magnetic contacts; b) over closely spaced or dipping magnetic contacts, E.E. calculations become non-linear and the result cannot be deconvolved into elementary bell-shaped functions assumed for a single contact; c) E.E. calculations are based on derivatives of the potential field anomalies and, hence, all kinds of noise events (gridding artifacts, line corrugations, random noise, etc.) will be significantly enhanced. [147, 214]. See also Analytic Signal Amplitude and Analytic Signal Absolute Value.

Energy Leakage – one of the inherent properties of the potential fields which reflects their fundamental ambiguity in respect to quantitative source depth interpretation. In data filtering, E.L. is represented by the spectral overlap of predominantly low frequency deep source anomalies with predominantly high frequency shallow source anomalies. By this reason, the filtered images of data (obtained after processing in Spectral Domain according to the energy of particular frequencies but irrespective to the depth of their origin) can be used only for approximate qualitative estimate of the source ensemble's depth, i.e., "relatively deeper" or "relatively shallower." [81, 82, 197]. E.L. is also referred to as Spectral Overlap.

Energy Rosette – see Map Power Spectrum.

Enhanced Analytic Signal – the analytic signal derived from the Nth-order Vertical Derivative values of two horizontal gradients (in "x" and "y" directions) and one Vertical Gradient of the potential field anomaly. E.A.S. is defined as:

$$A_n(x,y) = \{d(d^{\,n}M/dz^{\,n})/dx\}\underline{x} + \{d(d^{\,n}M/dz^{\,n})/dy\}\underline{y} + i\{d(d^{\,n}M/dz^{\,n})/dz\}\underline{z},$$

where "M" is the potential field anomaly; "x", "y", "z" are unit vectors. The E.A.S. concept is the basis for interpretation of 3-D potential field anomalies with the purpose of high-resolution imaging of the geological boundaries such as Contact and Fault as well as for estimating the corresponding depth to each interpreted geological boundary. [116]. See Enhanced Analytic Signal Amplitude and Analytic Signal.

Enhanced Analytic Signal Amplitude – an amplitude of the enhanced analytic signal defined as:

$$| A_n(x,y)| = \{[d^n(M_x) / dz^n]^2 + [d^n(M_y) / dz^n]^2 + [d^n(M_z) / dz^n]^2\}^{1/2},$$

where "M" is the potential field anomaly; $M_x = dM/dx$; $M_y = dM/dy$; $M_z = dM/dz$.

For n =2, this equation corresponds to Enhanced Analytic Signal derived from Second Vertical Derivative, and, hence, the amplitude of this second-order enhanced analytic signal is defined as

$$|A_2(x,y)| = \{[d^2(M_x) / dx^2]^2 + [d^2(M_y) / dy^2]^2 + [d^2(M_z) / dz^2]\}^{½}$$

The outlines of geological boundaries can be determined by tracing the maxima of the calculated E.A.S.A. This technique provides significantly improved lateral resolution of anomalies and better visualization of geological boundaries when interference effects of closely spaced sources are considerable and other methods cannot provide reliable results. Under several simplifying assumptions, the corresponding depth to each detected geological boundary can be estimated from the amplitude ratio of the enhanced analytic signal and the simple (conventional) analytic signal:

$$\text{"depth"} = [2\ |A_0(x,y)|_{max} / |A_2(x,y)|_{max}]^{½},$$

where "$|A_0(x,y)|_{max}$" is the maximum value of the simple (conventional) Analytic Signal Amplitude (n = 0); "$|A_2(x,y)|_{max}$" is the maximum value of the second-order enhanced analytic signal amplitude (n = 2). [116].

Enhancement Operators – a general term for various Data Enhancement procedures. E.O. include Reduction-To-Pole, Filtering, Shadow Manipulation, calculation of First Vertical Derivative (1VD), Second Vertical Derivative (2VD), Horizontal Gradient, and others. [115]. See also FTG Technique and Magnetic Gradient Tensor.

Ensemble – a group of source bodies in a certain qualitatively estimated depth range. See Matched Filtering and Source Body.

Envelope – a long-wavelength curve which bounds a range of the specified quantities like amplitude ("amplitude envelope") or squared amplitude ("energy envelope").

Eötvös Correction – a correction which is applied to the observed gravity data to compensate for the velocity of the gravimeter movement during non-stop observations in shipborne and airborne surveys. E.C. can be presented as

$$E.C. = 7.503\ V\ \text{CosN}\ \text{Sin2} + V^2/R,$$

where "V" is the velocity of the observation platform (ship or aircraft) in knots; "N" is the latitude in degrees; "2" is the platform heading in degrees from the North; "R" is the radius of the Earth at this latitude in meters. The largest E.C. values will be obtained if the observation platform has a velocity component in the east-west direction. [25, 106, 223]. See Eötvös Effect.

Eötvös Effect – a motion-related effect defined as the vertical component of the resultant vector in a vector addition of the gravimeter's platform velocity and the Earth's rotational velocity. The corresponding horizontal component is Coriolis Effect. E.E. affects the centrifugal accelerational and, hence, the apparent gravitational attraction value. E.E. is one of the most important factors that limit the accuracy of the gravity data acquired on a moving platform in a shipborne or airborne survey with the use of conventional gravimeters. [25, 106, 223, 238]. See Eötvös Correction and Gravimeter.

Eötvös Unit (EU) – a standard unit which is used in the gravity gradient measurements. 1E4 = 10^{-6} mGal/cm = 0.1 mGal/km [223].

Equipotential Surface – an imaginary continuous surface which is everywhere perpendicular to the vector of the potential field. For example, mean sea level is E.S. for the gravity field. Any departures from a uniform density distribution below the Earth's surface (which generate gravity anomalies on this surface) will warp E.S. above. [223].

Equivalent Layer – a concept which is based on assumption that any observed gravity or magnetic field can be approximated by a single layer of many sources where distribution of density or magnetization produces the same gravity or magnetic field as the observed field. In magnetic exploration, once E.L. has been calculated, it can be used to recompute a field corresponding to this E.L. at other magnetic inclinations, on other observation surfaces or with arbitrary space grid intervals. E.L. concept can be used as a basis for more stable and accurate Reduction-to-Pole (RTP), elevation corrections and gridding algorithms as compared to traditional methods. For example, RTP with the use of E.L.-based algorithm does not suffer from the instability encountered with Fourier transform methods at low magnetic latitudes and, hence, RTP can be accurately achieved using the magnetic field originating near or at the magnetic Equator. Sometimes, E.L. is referred to as Equivalent Source. [25, 43, 49, 92, 183, 190, 196, 251]. See Equivalent Source Continuation.

Equivalent Source – see Equivalent Layer.

Equivalent Source Continuation – a three-dimensional method of the airborne data Gridding. Differing from the traditional gridding methods, E.S.I. requires the knowledge of the flight level (i.e., elevation above surface – AGL) at each data point in addition to its lateral location. E.S.I. enables data acquired at different flight levels to be brought to a common datum and eliminates gridding artifacts associated with these elevation differences. (Alternatively, data acquired on any flight surface can be calculated on any other flight surface). As a conceptual analog of Equivalent Layer, E.S.C. method can be used for applying Reduction-To-Pole to the magnetic data observed at low latitudes. E.S.C. is also referred to as Equivalent Source Interpolation. [100, 250].

Euler Deconvolution – a mathematical procedure (algorithm) which is applied to the line or gridded magnetic data to solve Euler's Homogeneity Equation for the source depths and locations. For 2-D (line data) case, E.D. uses the total field profile values to create a depth section along each survey line containing solutions for sources of a particular structural type (i.e., source geometry) defined by Euler's Structural Index. Each calculation is run for a wide variety of window lengths to obtain solutions for different depths. A valid depth pick is made once a certain minimum number of depth solutions falls within a pre-selected radius of a point. Vertical or near-vertical alignments of depth solutions may be interpreted as geologically meaningful features such as faults, filled-in with magnetic materials, or contacts across basement blocks of differing susceptibilities. Sometimes, E.D. is referred to as Euler Modeling because the process is based on the model approximation of a source geometry and is not, strictly speaking, a mathematical deconvolution. [10, 11, 14, 64, 107, 206, 207, 239]. See also 3-D Euler Deconvolution and Euler Method.

Euler Method – an automated inverse method applied to either profile (line) or gridded potential field data to obtain estimates of locations and depths for causative bodies of a particular structural type. E.M. based on the concept that anomalous magnetic or gravity fields of localized structures are homogeneous functions of the source coordinates and, therefore, satisfy Euler's Homogeneity Equation. This equation can be solved parametrically for the source locations and depths. Generally, E.M. results proved to be more effective in mapping structural boundaries such as faults and contacts (as trends of the Euler depth marks) rather than estimating the basement depth. [25, 206, 207, 215, 239]. See also Euler Deconvolution, 3-D Euler Deconvolution, and Euler's Structural Index.

Euler Modeling – see Euler Deconvolution.

Euler's Equation – see Euler's Homogeneity Equation.

Euler's Homogeneity Equation – a partial differential equation that constitutes the theoretical basis for the application of Euler Method. It can be presented as

$$(x - x_o)\, dT/dx + (y - y_o)\, dT/dy + (z - z_o)\, dT/dz = N(B - T),$$

where (x_o, y_o, z_o) is the position of a source whose magnetic or gravity total field "T" is detected at coordinates (x, y, z); "B" is the regional value of the total field; "N" is Euler's Structural Index. [25, 64, 107, 206, 207, 239].

Euler's Structural Index (SI) – a degree of homogeneity "N" interpreted physically as a measure of the rate of the potential field change with a distance (i.e., fall-off rate) for the particular model geometry. For example, magnetic field of a sphere (point dipole) falls off as the inverse cube (SI = 3); intrusive pipe (vertical line source) has an inverse square fall-off (SI = 2). Extended bodies are approximated as assemblages of dipoles with the following SI values: thin dike – 1.0 (sometimes, 2.0); contact – 0 (sometimes, 0.5); irregular sill – 1.0. Real data contain anomalies from sources with various SI values and therefore require solutions for a range of indices to make a proper selection of estimates. Generally, the Euler depth estimate for a given body will increase with increased SI. Results of modeling suggest that dominant structural trends can still be outlined despite a poor choice of SI. [11, 64, 107, 206, 207, 239]. See also Euler Deconvolution, Euler's Homogeneity Equation, and Euler Method.

Evaporites – sediments deposited from aqueous solutions as a result of extensive or total evaporation. Rock Salt and anhydrite are examples of E. Both are strongly non-magnetic (susceptibility is about – 0.01 in units of 10^3 SI), but significantly differ in their densities: 2.1 – 2.6 g/cm^3 (average 2.22 g/cm^3) for salt and 2.9 – 3.0 g/cm^3 (average 2.93 g/cm^3) for anhydrite. [13].

Exponential Taper Filtering – a pass filter method that retains a pre-selected part of the data wavelengths using a specifically designed exponential Taper in order to enhance the suppression of the ringing effects and increase the resolving power. There are high-pass and low-pass options available. E.T.F. can also be used as Stripping Filter. [42].

External Magnetic Field – the magnetic field produced as a result of interaction between the Earth's internal magnetic field and Solar Wind coupled with the Earth's rotation, tidal forces and thermal effects. [25]. See also Earth's Magnetic Field Components.

Extrusion – a flowout of molten Lava onto the Earth's surface. Highly magnetized Volcanic Rocks are formed after E. [13]. See also Intrusion and Magma.

Extrusive Rocks – igneous rocks that have been erupted onto the Earth's surface. E.R. include highly magnetized Lava flows, which can cover relatively large areas, and hence, form local Magnetic Basement. [13]. See also Extrusion.

F

Fabric – a spatial configuration of the dominant alignments or trends on the image of the gravity or magnetic anomalous fields. This term is often used to compare anomalous fields in adjacent terranes and tectonic provinces. Grain and Signature have similar meaning. See Tectonic Province, Terraine, and Trend.

False Easting – a constant longitudinal distance of 500 000 m, assigned to the central meridian in the UTM coordinate system to ensure positive values of “x” coordinate within the given UTM zone. See also False Northing and Universal Transverse Mercator (UTM).

False Northing – a constant latitudinal distance of 10 000 000 m, assigned to the Equator in the UTM coordinate system in the Southern Hemisphere to ensure positive values of “y” coordinate within the given UTM zone. In the Northern Hemisphere, F.N. value is zero. See also False Easting and Universal Transverse Mercator (UTM).

Fast Fourier Transform (FFT) – a computer algorithm which performs high-speed Fourier Transform. [124, 201, 223].

Fault Block – an intra-sedimentary or intra-basement structural unit bounded by faults, either completely or in part. [13]. See also Faults.

Fault Zone – a zone of fracturing or microfracturing which surrounds the fault plane. F.Z. may vary in width from centimeters to several hundreds of meters. [13]. See Faults and Magnetized Intra-sedimentary Fault.

Faulted Slab – one of the basic geometric shapes used for the model calculation of gravity or magnetic effects. F.S. is a horizontal slab of the uniform thickness terminated in a vertical plane along one side. The calculated effects are similar to those of faulted horizontal beds having anomalous density or susceptibility values. [54, 238]. See Gravity Model and Magnetic Model.

Faults – joints and fractures or surfaces which limit different blocks of strata in the sedimentary section and blocks of metamorphic or igneous rocks in the basement that have moved (or have not moved) relative to each other. F. play a key role in the crustal fluid migration balance. They can be an effective barrier to migration of water and hydrocarbons and can seal a hydrocarbon accumulation or divide it into separate pools preventing hydrolic communication. Alternatively, F. as zones of a finite width may be much more permeable than surrounding rocks and, hence, F. may drain away hydrocarbons from a source rock and empty a reservoir. As a rule, F. focus macroseepage: surface hydrocarbon indicators are commonly located on outcropping F. and water springs often are aligned on F. Similarly, ore deposits are sometimes located along major F. As a result of fluid migration, intra-sedimentary F. may be magnetized sufficiently to produce low-intensity short-wavelength magnetic anomalies. Such anomalies can be resolved and enhanced using HRAM methods. F. create weak zones within the basement and sedimentary section which are natural conduits for Intrusion of strongly magnetic igneous rocks. Such Intrusive Rocks or Magma infill of F. produce high-intensity short-wavelength and mid-wavelength magnetic anomalies which are easily detectable and identified using various processing methods. In magnetic processing and interpretation F. are often approximated by Thin Dike or Magnetic Contact models. [13, 81, 162, 203, 221]. See also Fault Block, Fault Zone and Magnetized Intra-sedimentary Fault.

Faye Anomaly – see Free Air Anomaly.

Faye Correction – see Free-air Correction.

Ferrimagnetics – minerals in which magnetic domains are divided into sub-regions that originally may be aligned in opposite to each other, but their net Magnetic Moment is non-zero in the absence of the external magnetic field. Magnetite, titanium, titanomagnetite, iron oxides, pyrrhotite, etc.—the great majority of magnetic minerals are F. [33, 238]. See also Ferromagnetics.

Ferromagnetics – a small group of elements (iron, cobalt and nickel) in which the atomic magnetic moments tend to align parallel to one another because of the exchange interaction energy. F. are easily susceptible to the external magnetic field and have very large positive values of Susceptibility, sometimes, up to 10^6 times larger than those of the usual rock materials. [33, 238]. See also Ferrimagnetics.

Ferry – an airborne survey term that defines the distance from the nearest airport facilities.

FFT – see Fast Fourier Transform.

Fiducials – reference points located at the equal spacing along the survey lines. Often these are equivalent to time in tenths of second.

Figure–Of–Merit (FOM) – a characteristic value derived from an airborne performance test flown in order to estimate the effectiveness of applied compensation of the magnetometer sensors for the static and dynamic components of the aircraft magnetic field. This test is usually flown at relatively high altitude in the survey area or over the area of a known low gradient field. The aircraft flies in each of the cardinal compass directions (east, west, north, south) and performs a specified Pitch, Roll and Yaw maneuver. Maximum deviation of the compensated response of magnetic sensors from the mean is measured for each of these 12 maneuvers. FOM is the sum (not an average) of all measured magnetic deviations resulting from all 12 maneuvers. Generally, FOM level of 1-2 nT is appropriate for the modern survey aircraft. Using on-board computer-based compensation systems, FOM of much less than 1 nT can be achieved. FOM is flown at the start of a survey and after every major change of an aircraft equipment. [57]. See also On-Site Magnetometer Calibrations and Real-Time Magnetic Compensation System.

Filter – a spectral domain grid-based operator or space domain line-based operator which modifies the amplitude and phase of a specified range of frequencies (wavenumbers) from Power Spectrum of a grid in the spectral domain or an interval along a pre-selected direction in the space domain. There is a great variety of filters (more than 50 different types are described in this book) designed with the purpose of enhancing certain data components which are thought to be of exploration interest, suppressing Noise and other unwanted components as well as improving the general presentation and processing properties of the observed data. See also Filtering.

Filter Cutoff – a filter parameter which defines the half-power (30% amplitude) point of the filter response in terms of Wavelength or Spatial Frequency (as reciprocal of wavelength). For example, a high-pass filter with 1200 m cutoff wavelength value will retain (pass) all wavelengths smaller than 1200 m (i.e., components which have higher spatial frequency values than the cutoff frequency) and reject all wavelengths larger than 1200 m (i.e., components which have lower spatial frequency values than the cutoff frequency). In accordance with the general theory of filtering, there is a transition zone between the retained and rejected wavelength ranges and F.C. defines the value point at which corresponding data components will be attenuated by a half of their maximum value. The length of this transition zone is determined by Filter Order. See also Rolloff Range.

Filter Order – a filter parameter which defines the filter falloff rate, i.e., the steepness of the filter response curve: the higher F.O., the faster the falloff. Higher orders of filter will approach the response of Boxcar Filter. At the same time, higher order filters may introduce strong Ringing into the filtered data. See Filter Cutoff and Rolloff Range.

Filter Size – a parameter that defines the total extent of Band-Pass Filter in “x” and “y” directions. For high-resolution application in terms of Wavelength Filtering, the optimally minimum F.S. to avoid strong Ringing and other side effects should be about 2.0 times the short-wavelength Cutoff value. F.S. can be expressed in meters, wavenumbers or grid units (i.e., cell size numbers). For example, if short-wavelength cutoff is 800 m, then the long-wavelength cutoff should be no less than 1600 m. [257].

Filtering – a space or spectral domain procedure used to separate anomalies by their wavelengths as well as enhance high-frequency (short-wavelength) residual components of the observed potential field by attenuating the dominant regional components and suppressing regular and random noise. F. is also used to resolve the interfering anomalies generated by closely spaced magnetic/gravity sources. Residual-Regional Anomaly Separation by F. is based on the assumption that a given geologic source's spectral power, presented in Radial Power Spectrum, is attenuated more rapidly at high spatial frequencies (short wavelengths) than low spatial frequencies (long wavelengths) as the source depth increases. [24, 223]. See also Energy Leakage and Filter.

Final Bouguer Gravity – a gravity field data obtained after applying Latitude Correction, Free-Air Correction. Bouguer Correction, Inner Zone Terrain Correction and Outer Zone Terrain Correction to the land gravity survey measurements. In order to make all data values positive, a constant value (100 mGals or more) is usually added to corrected data. F.B.G. can be calculated for several different assumed rock (Bouguer Slab) densities. See Bouguer Density.

Finite-Impulse-Response Reduction-To-Pole Filter – see FIR RTP Filter.

FIR RTP Filter – a finite-impulse-response reduction-to-the-pole filter. This filter is designed through modifying both the gridded magnetic data and conventional RTP Filter as follows: a) RTP filter grid operator with initial dimension "k H l" is windowed to the smaller dimension "m H n"; b) gridded magnetic data, assumed to have the same initial dimension "k H l", are padded with zero values to generate an extended grid with dimension equal to the summation of dimensions of the initial data grid and the windowed filter grid, i.e., "(k + m) H (l + n)"; c) the windowed filter grid is also padded with zeroes to generate an extended grid of the same dimension "(k + m) H (l + n)." Both extended data and filter grids are Fourier transformed and multiplied. The result is inverse Fourier transformed to produce the reduced-to-the-pole magnetic map and then trimmed back to the initial data extent. Above described filter design procedure prevents Circular Convolution and, hence, eliminates Wraparound Effect. The decreased filter size allows to attenuate both edge effects of data boundaries and noise effects. [148]. See Reduction-To-Pole (RTP) and Padding.

First Derivative – see Gradient.

First Derivative Map – usually, a map of First Vertical Derivative (1VD) of the gravity and magnetic field calculated after all proper corrections have been applied to the observed data. Being less resolving and much less enhancing Noise than Second Derivative Map, it tends to enhance mid- and short-wave length "residual" components and delineate areas of high Vertical Gradient values (i.e. fast decay of high frequencies) associated with anomalies of relatively shallow origin. See also First Horizontal Derivative.

First Horizontal Derivative (1HD) – see Horizontal Derivative.

First Vertical Derivative (1VD) – see Vertical Derivative.

First Vertical Gradient – see Vertical Derivative.

First Vertical Integral (FVI) – an approximation of the gravity field as calculated from the reduced-to-pole magnetic field using Poisson's Relation, i.e. F.V.I. represents Pseudogravity field. See Reduction-To-Pole (RTP)

Fish – a watertight housing where magnetometer sensors are mounted during shipborne magnetic surveys. To eliminate magnetic effects of a vessel, F. is towed at a distance of about 200-300 m behind the vessel, and it usually rides at the depth of 15-20 m below the sea surface.

Fixed Wing Survey – an airborne survey with the use of an aircraft. In the case of a magnetic survey, magnetometer sensors are mounted on the aircraft tail stinger and/or wings. See also Bird and Helicopter Survey.

Flat-Plate Bouguer Factor – the gravity effect of Bouguer Slab that is included in calculating Complete Bouguer Correction. [234].

Flattening Coefficient – see Polar Flattening.

Flight Lines – see Traverse Lines and Control Lines.

Fluxgate Magnetometer – a magnetometer which measures the axial component of the magnetic field induced on its coil. Properly oriented with the direction of a measured field, F.M. can provide the accuracy of about 0.2-1.0 nT, which is quite satisfactory for regional studies and basement depth approximations. [57, 223]. See also Proton Precession Magnetometer, Cesium Magnetometer and Tri-Axial Fluxgate Magnetometer.

Folding Frequency – see Nyquist Frequency.

Folding Wavenumber – see Nyquist Wavenumber.

Forward Modeling – a three-step procedure: 1) initial model of the ensemble of surfaces and bodies of contrasting densities or susceptibilities is constructed, based on available geological and geophysical data; 2) magnetic or gravity field produced by the initial model is calculated and compared with the observed field; and 3) initial model parameters are adjusted to improve the fit between the observed and calculated fields. This procedure is repeated until satisfactory fit is obtained. [25, 178, 209, 238].

Four-Dimensional (4-D) Gravity – see Time Lapse (4-D) Gravity Survey.

Fourier Amplitude Spectrum – see Amplitude Spectrum.

Fourier Analysis – a methodology that maps potential field data as functions of space into functions of their equivalent spatial frequencies (or wavenumbers). F.A. is based on the fact that any periodic function can be synthesized by an infinite sum of weighted sinusoids where the weights of these sinusoids are determined through the analysis of a given periodic function. [223]. See also Fourier Transform.

Fourier Domain – a frequency domain where the gravity and magnetic gridded data are presented after Fourier Transform as weighted sums of spatial frequencies generated by the ensembles of subsurface sources. The definition of F.D. is used with the same conceptual meaning as Frequency Domain and Spectral Domain. See also Space Domain.

Fourier Methods – various methods of the potential field data processing that are based on the use of Fast Fourier Transform (FFT) algorithms.

Fourier Power Spectrum – see Radial Power Spectrum.

Fourier Spectrum – see Radial Power Spectrum.

Fourier Transform – a mathematical operation that converts the gridded gravity and magnetic data from their original space domain to the equivalent frequency domain. After F.T. , gravity and magnetic grids (maps) can be analyzed for their wavelength content. F.T. represent the observed potential field as the synthesis of elementary sine/cosine waves of different frequencies, each having its own amplitude and phase. F.T. products such as “amplitude-versus-frequency” graph and “squared amplitude-versus-frequency” graph are referred to as Amplitude Spectrum and Power Spectrum respectively. In application to the gridded data, F.T. is also referred to as Two-Dimensional (2-D) Fourier Transform. [25, 44, 124, 201, 221, 223]. See also Fast Fourier Transform, Discrete Fourier Transform, Inverse Fourier Transform, Hartley Transform and Hilbert Transform.

Fractional Vertical Derivative – a vertical derivative (V.D.) which has a non-integer value of “N” – the order of vertical derivative. For example, the first V.D. (commonly referred to as Vertical Gradient) has N = 1, and the second V.D. has N = 2. Generally, F.V.D. allows one to choose a degree of data enhancement that will represent a balance between the enhancement of target short-wavelengths and avoidance of random noise amplifying. It often happens that a good result can be obtained with the first V.D., but the second V.D. result may be unusable because of a high-frequency noise being strongly amplified. In such cases, derivative computations with N = 1.5 will produce a result with a superior resolution to the first V.D., but they will not amplify high-frequency random noise as much as the second V.D. Fractional derivatives do not correspond to obviously measurable physical parameters, but they can provide additional details that assist visual (qualitative) interpretation of the potential field data. [94]. See also Vertical Derivative and Second Vertical Derivative.

Free-Air Anomaly – the gravity field anomaly at sea level after applying Free-Air Correction and Latitude Correction to the observed gravity data. Because of a direct dependence on the elevation, F.A.A. maps are very reflective of a topographic relief. Shipborne (marine) gravity measurements are presented and interpreted as F.A.A. datasets and maps. F.A.A. computation can be presented as

F.A.A. = "observed data" + "free-air correction" – "latitude correction" [25, 34, 54, 245]. See Gravity Corrections.

Free-Air Correction – a correction applied to the observed gravity data to compensate for the difference "Dh" in elevation of the observation point and the survey Datum (usually, sea level), i.e., it is a correction for the additional distance ("free-air" without any rock mass) of separation between the gravimeter and the Earth's center of mass. F.A.C. is based on Free-Air Gravity Gradient calculation, but in practice it is usually performed using a simplified linear formula:

$$F.A.C. = 0.3086\ Dh_1 = 0.09406\ Dh_2$$

where 0.3086 mGal/m (or 0.09406 mGal/ft) is the value of the normal Free-Air Gravity Gradient; "Dh_1" is in meters above the datum; "Dh_2" is in feet above the datum. If elevation is above the datum, F.A.C. is added to the observed data since "Dg" increases as separation distance decreases. This correction is also dependent on the latitude because a) the distance between observation point and the center of the Earth varies with the shape of the assumed ellipsoid; b) the value of acceleration due to the gravity attraction is different at each latitude. [25, 34, 182, 223, 238]. See also Latitude Correction, Bouguer Correction and Terrain Correction.

Free-Air Gravity – the gravity field at sea level after applying Free-Air Correction and Latitude Correction, but without correction for the density of a rock between sea level and the plane of measurements; i.e., without Bouguer Correction. Usually, F.-A.G. maps are obtained from the marine gravity survey data using on-board-the-ship gravimeters. [54, 223, 245]. See also Edge Effect Anomaly and Satellite Gravity.

Free-Air Gravity Field – see Free-Air Gravity.

Free-Air Gravity Gradient – a derivative of the acceleration "g" due to the gravity attraction with respect to elevation "h" of the observation point above the reference ellipsoid (i.e., sea level). F.-A.G.G. at a given latitude "N " and elevation "h" can be presented as

$$dgh/dh = 0.308768 - 0.000440 \sin^2 N - 0.0000001442\ h\ (mgal/m).$$

The most commonly used F-A.G.G. value is dg/dh = 0.3086 mGal/m, which was originally obtained using parameters of the 1930 International Gravity Formula and proved to be fairly acceptable after publishing the updated Geodetic Reference System in 1971. [211]. See Free-Air Correction and Theoretical Gravity Anomaly.

Free-Water Gradient – a correction parameter applied to gravity measurements obtained with the use of the Towed Deep Ocean Gravimeter (TOWDOG). F.W.G. is the free-air gradient ($(_a$ = 0.3086 mGal/m (or 0.09406 mGal/ft) modified by a water column:

$$(_w = (_a - 4BGD\ ,$$

where "G" is Newtonian Gravitation Constant and "D" is the water density. [256]. See TOWDOG.

Free-Water Gravity – a gravity anomaly which is obtained with the use of the Towed Deep Ocean Gravimeter (TOWDOG) and corrected for the free-water gradient, latitude effect, vertical acceleration, Ëotvös Effect and solid-earth tides. [256]. See Free-Water Gradient.

Frequency – a time-domain wavefield parameter that defines the number of wave cycles per second. In potential field data processing and interpretation, the space domain analog of F. is used, and it is referred to as Spatial Frequency or Wavenumber. [223].

Frequency Analysis – a methodology that is based on transforming the potential field data from original Space Domain into Frequency Domain using Fourier Transform. Any of the pass filters (high-, low-, band-pass, etc.) can then be applied to enhance certain residual components of exploration interest and suppress others that represent Noise or very deep-sourced regional components of the potential field. F.A. has the same meaning as Wavelength Analysis, but F.A. is traditionally used more often in exploration terminology. [174]. See also Filter, Filtering and Cascaded Filtering.

Frequency Content – a spectral domain characteristic that defines the dominant amplitude components of the observed and/or processed potential field data. This characteristic is widely used in both magnetic and gravity references because the space domain potential field data have their equivalent presentation in the spectral (frequency) domain through Fourier Transform and due to simple relation between Spatial Frequency and Wavelength: the higher frequency – the shorter wavelength. [223].

Frequency Domain – a domain where Spatial Frequency is an independent variable which defines Dimension of this domain transformed from distance values of meters (or km) to the spatial frequency (wavenumber) values of cycles per meter (or km). The dependent variables here are the magnitude and phase of each spatial frequency. Definition of F.D. is used with the same conceptual meaning as Fourier Domain and Spectral Domain. See also Space Domain.

Frequency-Depth Rule – a qualitative interpretation rule which is based on the physically plausible assumption that the higher frequency (shorter wavelength) components of the observed potential fields originate from the relatively shallower magnetic/gravity sources and the lower frequency components originate from the deeper sources. In magnetic interpretation it is also referred to as Continuation Concept as the magnetic anomalies become broader (i.e., exhibiting lower frequency content) as the distance between the source of anomaly and magnetometer sensor increases. For broad areas covering a wide range of depths, it is possible to separate the magnetic map into smaller areas of relatively shallow, intermediate and deep basement depths by identifying the areas of predominantly narrow, intermediate and broad anomalies. However, it is not only the source depth that determines the frequency content of anomalies, but the source width as well; often narrower anomalies result from a narrower source body of the same or even deeper depth. [75, 173].

FTG – see Full Tensor Gradient and Gravity Gradiometry.

FTG Technology – an exploration technology that is based on measuring Full Tensor Gradient (FTG), i.e., the gradient of the Earth's gravity vector field in three principal directions ("X", "Y", "Z"). Originally, it was developed for "Trident" submarines. Super-high Sensitivity provides opportunities to map very subtle Density changes in subsurface to assist in petroleum exploration at the prospect level, including processing and interpretation of 3-D seismic data in the areas of complex Salt and subsalt structures. At present, FTGT is used in marine (shipborne) gravity surveys.

Full Tensor Gradient – a nine-component Tensor which defines variations of three vector components of the Gradient (i.e., T_x, T_y, T_z) in three directions "x", "y" and "z", providing important directional information absent in observations of amplitudes of the potential field. The nine F.T.G. components can be presented as the following tensor matrix:

$$T_{i,j} = \begin{matrix} T_{xx} & T_{xy} & T_{xz} \\ T_{yx} & T_{yy} & T_{yz} \\ T_{zx} & T_{zy} & T_{zz} \end{matrix}$$

where $T_{yx} = T_{xy}$; $T_{zx} = T_{xz}$; $T_{zy} = T_{yz}$; $T_{zz} = T_{xx} + T_{yy}$. See Gravity Gradient Tensor and FTG Technology.

Full Vector Sun Image – a potential field map image obtained with the use of multiple "sun" illumination azimuths (up to 360º), simultaneously displayed with varying colors of a varying saturation from dark to light. The resulting cone of colors allows, for example, subtle changes in dip magnitude to modulate the darkness of the image while dip direction modulates the color. See also Color Wheel and Artificial Sun Illumination.

Fuller Filter – a moving average space domain convolution filter with a set of window coefficients, which detects high-frequency components of the observed data and retains (passes) or rejects it. The user specifies the window length (in data points or meters) for the convolution operator. The window length corresponds to the maximum width of anomalies to be identified as high-frequency components. F.F. is applied to line datasets or gridded data as one of the options in the process of Microleveling. [70]. See also Decorrugation.

G

G – see Universal Gravitational Constant

Gal – a unit of the gravity field acceleration (attraction) used in gravity measurements: 1 Gal = 1 cm/sec^2. The nominal value of the Earth's gravity field acceleration at the Earth's surface is 980 Gal. In gravity exploration, the unit of measurement is milliGal: 1 mGal = 10^{-3} Gal and, sometimes, microGal: 1 :Gal = 10^{-6} Gal. [25, 182, 223].

Gamma (g) – a unit of the magnetic field measurements. It defines the magnitude of the magnetic field vector represented by the number of lines of Magnetic Induction passing through a unit area perpendicular to the vector direction. Magnetic survey maps were often contoured in gammas. 1 gamma = 10^{-9} tesla = 10^{-5} gauss. The term of G. is now replaced in formal usage by the SI unit of nanotesla:

$$1 \text{ nanotesla} = 1 \text{ gamma} = 10^{-9} \text{ tesla}.$$

[25, 223]. See Nanotesla (nT).

Gardner's Equation – an empirically derived equation which describes the relationship between bulk densities and acoustic velocities of rocks:

$$D = 0.23\, V^{0.25},$$

where "V" is the interval velocity; "D" is Bulk Density. [72].

Gas Chimney – see Chimney.

Gate – see Window.

Gauss – the cgs-emu unit of Magnetic Induction (or flux density) "B". It is a measure of the number of magnetic lines of force per unit area.

$$1 \text{ gauss} = 10^5 \text{ gamma} = 10^{-4} \text{ tesla.}$$ [223].

Gauss Filter – a spectral domain grid-based pass filter that retains a low-frequency or high-frequency range of Power Spectrum using the smooth curve in Rolloff Range. The steepness of the G.F. curve is determined by the user-specified value of Standard Deviation for the power spectrum. G.F. is commonly used to attenuate high frequencies in order to stabilize the output. G.F. formula can be defined as:

$$F(w) = e^{\pm 0.5\left(\frac{w}{\sigma}\right)^2}$$

where "F" is the power spectrum standard deviation; "+" corresponds to a high-pass option; and "–" corresponds to a low-pass option. [230].

Gauss Theorem – a theorem that postulates the inherent non-uniqueness of the potential fields: if the field distribution is known only on a bounding surface, there are infinitely many equivalent source distributions inside the boundary that can produce the same observed field. In terms of the potential field Modeling, if there exists one model that reproduces the observed field, there are other models that will reproduce this field to the same degree of accuracy. [144]. See Inversion.

General Symmetric Filter – a spectral domain grid filter, which can be custom-designed as High-Pass Filter, Low-Pass Filter, or Band-Pass Filter. At first, Power Spectrum is divided into a set of segments of the user-specified length and a coefficient is assigned to each segment. Then, G.S.F. operator multiplies the data within the segment by its coefficient and processes the whole dataset in accordance with the coefficient value: 1 – pass the dataset as it is; 0 – reject the dataset; between 0 and 1 – reduce the dataset energy before passing it. [230].

Geodetic Datum – a reference level of Positioning which defines shape (i.e., specified Ellipsoid), size (as applicable regional extent), position with regard to the Earth's center, and coordinate axes' orientation (i.e., rotation of axes) of Reference Ellipsoid. Often, G.D. is referred to as Survey Datum. [223].

Geodetic Reference System 1967 (GRS67) – the Earth's shape approximation (i.e. Spheroid) adopted for the gravity data reduction purposes in 1967. It is based on Flattening Coefficient of 1/295.25, established by satellite measurements.[223]. See International Gravity Formula.

Geographic Coordinates – 3-D position (latitude, longitude, elevation), which is determined based on Reference Ellipsoid. A point on the Earth's surface may have more than one set of G.C. associated with it depending on Geodetic Datum.

Geoid – the equipotential surface of the Earth's gravity (i.e. surface to which the direction of gravity is everywhere perpendicular) that is the best fit for the mean sea level. On land G. is defined as the surface which the sea water would assume if it could reach its own level everywhere. [25 , 223].

Geoidal Undulation – the difference between Elevation (actual height above sea level) and ellipsoidal height at the point of measurement. [25]. See Reference Ellipsoid.

Geologic Map – a map of the Earth's surface where the distribution, nature and age relationships of various rock types, as well as the occurrence of related structural features, are shown. [13].

Geologic Stripping – an iterative modeling process that involves modeling, at first, the short-wavelength anomalies produced by shallow sources, and then the deeper and longer wavelength anomalies from sources at depths of exploration interest. After removal of the modeled residual anomalies at shallower depths, the longer wavelength anomalies will become much more apparent, helping to make necessary changes in the deeper portions of the geologic model. [117]. G.S. concept can also be implemented in Data Enhancement processing in order to remove both shallow and very deep gravity or magnetic effects of geologic origin, which obscure anomalies of exploration interest (such as those of sedimentary or Basement structures), and obtain enhanced anomaly field emphasizing the gravity or magnetic anomalies from the target depth level.

Geomagnetic Correction – see IGRF Correction.

Geomagnetic Field – the Earth's magnetic field that can be approximated by Magnetic Dipole at the Earth center. The intersections of the axis at this dipole with the Earth's surface are Geomagnetic Poles. The entire G.F. is composed of three basic components: core magnetic field, external magnetic field, and crustal magnetic field. Prior to processing and interpretation of magnetic data, the core (main) and external components are commonly removed. [25, 54 , 238]. See Earth's Magnetic Field Components, and I.G.R.F. Correction.

Geomagnetic Field Vector – a vector that defines the total intensity of Geomagnetic Field in terms of three orthogonal components in Cartesian Coordinates and two angles called Inclination and Declination. The absolute value (magnitude) of G.F.V. can be presented as:

$$T = (B_x^2 + B_y^2 + B_z^2)^{½},$$

where "B_x", "B_y" and "B_z" are orthogonal components in the directions "x", "y" and "z" respectively. Usually, the coordinate system for G.F.V. is oriented so that "x" increases to the North; "y" to the East, and "z" increases downward. [25]. See also Magnetic Meridian.

Geomagnetic Poles – magnetic poles that are the best fit for the dipolar nature of the Earth's magnetic field. G.P. represent the points of intersection of the axis of Magnetic Dipole (which approximates the main magnetic field of the Earth) with the Earth's surface. These points are referred to as the North magnetic pole and South magnetic pole. G.P. locations differ from those of the geographic poles of the Earth and they move with time. G.P. are also referred to as Earth's Magnetic Poles. [54, 238]. See Secular Variation.

Geomagnetic Reference Field – see International Geomagnetic Reference Field (IGRF).

Geomagnetic Reversals – changes in the polarity of the Earth's magnetic field which have occurred a number of times in the magnetic history of the Earth. [25]. See Sea Floor Spreading and Paleomagnetic Time Scale.

Geomagnetic Secular Variation – see Secular Variation.

Geometrics G-822 Magnetometer – see Optically Pumped Magnetometer.

Geospatial Imagery – a technique that allows to obtain images combining cultural information (pipelines, wellsites, roads, etc.) with color or black-and-white satellite-borne data.

Gibbs Phenomenon – an oscillatory effect in the form of short-wavelength artifacts which appear whenever data discontinuities are present (for example, at the ends of data grid). The same effect is observed around the cut-off frequency of all standard filters. By this reason, it is not recommended to apply narrow band-pass filters and high-order pass filters with steep transition from "pass" to "reject" frequency range. G.P. can be minimized using Edge Smoothing Filters and low-order pass filters. G.P. is often referred to as Ringing. [201, 223]. See also Rolloff Range.

Global Positioning System (GPS) – a system which provides the accurate continuous information on the position and velocity of a survey platform (aircraft or ship) in three dimensions based on signals received from a constellation of space satellites. [57, 181, 223]. See also Differential GPS and GPS Base Station.

GLONASS – Global Navigation Satellite System, the Russian equivalent of GPS.

Goussev Filter – a space domain line-based or grid-based operator that calculates a scalar difference between Total Gradient and Horizontal Gradient of magnetic data. This difference peaks above Thin Dike causative bodies (like magnetized faults or fracture zones) and faults with offsetted magnetized layers (like normal faults or strike-slip faults producing "flower" structures). It also suppresses irregular noise events. The best results are obtained when G.F. is cascaded with other data enhancement procedures, such as Separation Filtering, Band-Pass Filtering or Vertical Derivative calculations. [81]. See Magnetized Intra-sedimentary Fault.

GPS – see Global Positioning System.

GPS Base – see GPS Base Station.

GPS Base Station – a reference station equipped with a multi-channel receiver to monitor GPS satellite correction data. The records from this station are used to differentially correct the GPS data acquired in the aircraft. See also Global Positioning System (GPS) and Differential GPS (DGPS).

GPS Positioning – determining the location of a survey aircraft or survey ship using Global Positioning System (GPS) or Differential GPS (DGPS).

Gradient – a difference in the potential field values per unit of distance, usually between horizontally or vertically separated sensors. G. can also be defined as a rate of the potential field change with a distance along the given directions "x", "y" or "z". By results of measuring the horizontal G., the vertical G. of the potential field may be computed with varying degrees of accuracy. G. measurements have the advantage of removing non-geologic field signals such as those introduced by the normal accelerations of an aircraft in the gravity surveys or Diurnal Variations in the magnetic surveys. G. is also referred to as First Derivative. [171, 223, 238]. See Gradiometer, Gravity Gradient, Magnetic Gradient and Vertical Magnetic Gradiometry.

Gradient Depth Estimation – a 2-D method of estimating the depth of Causative Body with the use of Werner Deconvolution applied to Horizontal Derivative of the observed magnetic field (under assumption of Magnetic Contact model) or the vertical component of the Earth's gravity field (under assumption of Horizontal Cylinder model). [215].

Gradient Dip Estimation – a 2-D method of estimating Dip of magnetic or gravity Contact based on spatial relationship between the total and horizontal gradient maxima of the residual potential field. Total Gradient maxima is always located over the top of the contact irrespective to its dip. Horizontal Gradient maxima is always displaced down-dip (except for the vertical contact when it is coincident with the total gradient maxima). The following equation is used in G.D.E.:

$$A = B \text{ cotan } D,$$

where "A" is the horizontal distance between the total and horizontal gradient maxima; "B" is the depth to the top of a contact; and "D" is the dip of a contact. The horizontal derivatives are computed in Space Domain in two orthogonal directions ("x" and "y") and then Fourier transformed for input to Nabighian's Algorithm to compute Vertical Derivative. The derivatives are combined in the space domain after Inverse Fourier Transform to calculate a horizontal gradient and a total gradient. Maxima locations of calculated gradients are estimated by Blakely-Simpson Method. [103].

Gradient Filter – a space domain line data operator that calculates the slope of the total intensity field curve with respect to Fiducials. G.F. is commonly used to identify high-frequency noise components of the observed potential field data. [230].

Gradient Vector – a quantity that defines variations of three vector components of Gradient. See Vector and Full Gradient Tensor.

Gradiometer – a device or set of devices (gravimeters or magnetometers) to measure the value of the potential field in at least two different points in space at the same time to estimate Gradient of this field. The gradient value is the difference in field values per unit of distance between the sensors in a given direction. [46, 104, 112, 114, 142, 143, 223]. See also Magnetic Gradiometer Survey and Gravity Gradiometer Survey.

Gradiometry – a method and instrumentation to collect and process measurements of gradients of the Earth's gravitational or magnetic fields. See Gradient, Gradiometer, Gravity Gradiometer Survey, Magnetic Gradiometer Survey and Magnetic Gradiometry.

Grain – an arrangement of regular patterns on the image of gridded potential field data or its filtered map, which shows the dominating anomalous trends in the area. [223]. See also Structural Grain.

Graticule – a transparent template which is superposed over cross-sections of subsurface structures whose gravity effects are computed. [238].

Gravicline – a gravitationally-induced subsurface compaction structure, which is closely related to the crystalline basement fault-block surface. G. is favorable for forming oil and/or gas traps. [74, 76]. See Basement.

Gravimeter – an instrument for measuring small variations in gravitational attraction (vertical acceleration) of the Earth's gravity field. The gravity force on a unit mass in the measuring system of the exploration gravimeters is balanced by a spring arrangement. At each reading site (Gravity Station) the position of a unit mass is altered [223].

by a change in the gravitational attraction. Most gravimeters are of the unstable or Astatic Balance type. See Gravity Acceleration, Torsion Balance, Weight-On-Spring, Zero-Length Spring and Gravity Gradiometer.

Gravitational Acceleration – see Gravity Acceleration.

Gravitational Constant – see Universal Gravitational Constant.

Gravitational Field – see Gravity Field.

Gravity – the force of attraction between bodies because of their masses. G.is usually measured as Gravity Field or its gradients. [223]. See Newton's Law of Gravitation, Gradiometer and Gravimeter.

Gravitational Potential – see Gravity Potential.

Gravitational Potential – at a point in the gravity field, G.P. is defined as the energy required for the gravity force to move a unit mass from an arbitrary reference point (usually at an infinite distance) to the point in question. [25, 54, 223, 238]. See Gravity Field.

Gravity – the force of attraction between bodies because of their masses. G. is usually measured as Gravity Field or its gradients. [223]. See Newton's Law of Gravitation, Gradiometer and Gravimeter.

Gravity Acceleration – the acceleration (attraction) of the unit mass "m" (such as Proof Mass in the gravimeter) due to the presence of the Earth's mass "M", i.e., acceleration due to the Earth's gravity field:

$$g = \frac{F}{m} = \frac{-GM}{R^2}$$

where "F" is Gravity Force; "G" is Universal Gravitational Constant; "R" is the Earth's radius at the point of measurements. The unit of G.A. is 1 cm/sec^2 = 1 Gal. The nominal approximated value of G.A. at the Earth's surface is 980 000 mGal. In gravity exploration, the variations of a vector field of G.A. are measured and this vector field is called Gravity Field. Differences in the measured G.A. values are related to the differences in the subsurface mass distribution and considered to be representing the changes in geological structures. [25, 34, 54, 182, 238]. See Newton's Gravity Law and Gravity Anomaly.

Gravity Anomaly – a gravity signature of the geological interest generated by a lateral contrast in the subsurface distribution of rock densities. G.A. represents the departure of a corrected gravity value from the theoretical value of gravity at the latitude and longitude of the observation station, i.e., the difference between the observed gravity values and those of calculated from the Earth model. The type of anomaly depends on the corrections that have been applied to the observed data according to the model approximation (such as free-air G.A. or Bouguer G.A.). Positive G.A. trend indicates positive lateral density contrast and might be interpreted as structural high trend (uplift, horst, or other); negative G.A. trend indicates negative lateral density contrast and might be interpreted as a structural low trend (trough, graben, source rock Depocenter, or other). G.A. is always a composite quantity representing the sum of effects due to the superposition of anomalies from multiple sources at different depths. [25, 34, 54, 182, 186, 238]. See also Free-Air Anomaly, Bouguer Anomaly and Observed Gravity.

Gravity Anomaly Amplitude – a component feature of the Earth's gravity field governed by two factors related to the subsurface structure: 1) degree of a lateral density contrast: the greater contrast – the larger amplitude; 2) depth of a source of the gravity anomaly: the larger depth – the smaller amplitude. [215]. See also Gravity Anomaly and Gravity Anomaly Wavelength.

Gravity Anomaly Wavelength – a component feature of the gravity field governed by four factors related to the source of the gravity anomaly: source depth, source thickness and source lateral extent in "x" and "y" directions.

Density contrast has no effect on G.A.W. [215]. See also Gravity Anomaly and Gravity Anomaly Amplitude.

Gravity Base Station – see Base Station.

Gravity Basement – a term that is generally referred to a major Density Contrast interface in the gravity survey area. Anomalies, generated by density contrasts below this interface, are effectively lost in the background noise. Often, but not necessarily, G.B. corresponds to the density contrast between the whole sedimentary sequences and a top of the underlying crystalline (metamorphic) Basement. [84, 223]. See also Magnetic Basement.

Gravity Corrections – a series of corrections (or reductions) applied to Observed Gravity in order to isolate the anomalies caused by local density variations from all other Earth's Gravity Field components that contribute to values measured by Gravimeter. If G.C. have been properly applied (i.e. all components due to the motion and shape of a simple and virtually homogeneous Earth as well as other related effects have been removed from the observed data), then whatever remains would represent the anomalous gravity field due to local inhomogeneities that could be of exploration interest. The procedure of G.C. is also referred to as Gravity Reduction. [25, 34, 54, 182, 215, 238]. See Bouguer Correction, Free-Air Correction, Isostatic Correction, Terrain Correction and Theoretical Gravity Correction.

Gravity Curvature Correction – see Bullard B Correction.

Gravity Elevation – a height of Gravimeter sensor above sea level in the airborne gravity survey. See Aerogravity and Elevation.

Gravity Field – a vector field of the acceleration (attraction) which exists between bodies. G.F. is directly proportional to the values of bodies' masses and inversely proportional to the distance between them. In gravity exploration, G.F. is measured by the force "F" (also called Gravity Field Strength) exerted upon the unit ("proof") mass "m" in the gravimeter:

$$g = F/m,$$

where "g" is the Earth's gravity field (or gravitational acceleration) representing the vector sum of the attracting effects of all masses below the Earth's surface. Differences in gravitational acceleration "g", measured on or above the surface of the Earth, are related to differences in the subsurface mass distribution. Since such variations reflect changes in a geological structure, these measured differences can be used to interpret the geology of the subsurface. [25, 34, 54, 182, 215, 223, 238]. See Gravity Anomaly and Gravity Acceleration.

Gravity Field Strength – a measure of the gradient of Gravity Field. At a point in this field, G.F.S. is defined as force "F" that will be exerted upon a unit mass "m" if it is placed at the distance "r" from the center of mass "M" which is the source of the gravity field:

$$F = \frac{GMm}{r^2}$$

where "G" is Universal Gravitational Constant. G.F.S. is a vector directed toward the attracting mass "M". [54, 238]. See also Newton's Gravity Law.

Gravity Force – a vector force of gravitation between two masses "M_1" and "M_2" which is directly proportional to the product of these masses and inversely proportional to the square of the distance between their centers of masses. G.F. is directed along the line connecting the centers of these two masses and mathematically defined by Newton's Gravity Law. G.F. on the Earth's surface is the integrated effect of the Earth's mass attraction and the opposing centrifugal force caused by the Earth's rotation. [25, 54, 238]. See also Gravity Acceleration.

Gravity Gradient – the first derivative or spatial rate of change of the gravity field with respect to a particular direction. G.G. contains the directional information which is absent in observations of the gravity field amplitudes and it can be used to infer the structure of a source of the gravity anomaly. G.G. units are mGal/m and Ëotvös (E). "E" is equal to 10^{-6} mGal/cm or 0.1 mGal/km (i.e., 10E = 1 mGal/km). Generally, G.G. anomalies due to the sedimentary geological sources are in the range of about ± 200 E. As the gravity field is a vector, 3-D gravity gradient can be represented by a nine-component Tensor. [30, 31]. See Gravity Gradient Tensor, Ëotvös Unit, and FTG Technology.

Gravity Gradient Tensor – a nine-component vector that defines 3-D gravity gradient as three directional components "T_x", "T_y", "T_z" each varying in three directions "x", "y", and "z". See Gravity Gradient.

Gravity Gradiometer Survey – a gravity survey that provides measurements of the horizontal gradient and/or vertical gradient of the Earth's gravity field. See also Gravity Gradient and Gravity Gradient Tensor.

Gravity Gradiometer System – the gravity acquisition system, designed as an assemblage of horizontally and/or vertically separated gravimeters, to provide measurements of gradients of the Earth's gravitational field. The difference between the gravimeter readings represents the spatial rate of change of the observed gravity field (i.e., Gradient) along the direction in which gravimeters are separated. As compared to the conventional gravimeter systems, G.G.S. can ensure significantly higher accuracy of measurements on moving platforms (marine or airborne gravity surveys), because it is much less sensitive to both vertical accelerations of the moving platform and velocity-dependent effects due to the rotation of the Earth. [101]. See E`tv`s Effect and Gravity Gradiometry.

Gravity Gradiometry – a concept of 3-D measurements of the derivatives (gradients) of the Earth's gravitational field using an acquisition system with horizontally and vertically separated gravimeters. G.G. is based on measurement of all or some of nine components of Full Tensor Gradient (FTG): "T_{Xx}" represents the horizontal gradient in the "X" direction of the "x" horizontal component of Gravity Acceleration ("G_x"); "T_{Yy}" represents the horizontal gradient in the "Y" direction of the "y" horizontal component of the gravity acceleration ("G_y"); "T_{Zz}" represents the vertical gradient in the "Z" direction of the "z" vertical component of the gravity acceleration ("G_z"); "T_{Yz}" represents the horizontal gradient in the "Y" direction of the "z" vertical component of the gravity acceleration ("G_z"); "T_{Yx}" represents the horizontal gradient in the "Y" direction of the "x" horizontal component of the gravity acceleration ("G_x"), and so forth. The "z" vertical component of the gravity acceleration is the quantity measured by exploration gravimeters. All these gravity gradients provide much more precise and detailed information on the edges, shapes, and depths of dominant gravity anomalies. The present and future applications of G.G. include improved imaging of salt bodies, delineation of oil-water contacts, "time-lapse" monitoring of the oil field under deverlopment, and others. [15, 117]. See also Time-Lapse (4-D) Gravity Survey and Gravity Gradiometer System.

Gravity Model – a density model of a given or assumed geological structure. The subsurface geology can be modeled by representing lithologic layers and separate bodies as equi-density layers and bodies formed by contrast model boundaries that may or may not correspond to actual geological boundaries and bodies. Assumed densities for a given G.M. need not be constant, they also may be a systematic function of a depth and/or lateral dimension. G.M. can be effectively used to constrain seismic velocity models for both pre-stack and post-stack depth migration in areas of complex geological structures where seismic imaging becomes difficult. [54, 215, 238]. See Model, Gravity-Seismic Velocity Modeling and Gravity Modeling Shapes.

Gravity Modeling Shapes – basic theoretical shapes (horizontal or vertical cylinder, vertical or horizontal sheet, infinite slab, faulted slab and others), which are considered as the most simple of the geometrical forms to be useful for the calculation of the gravity effects in Forward Modeling and for the matching of a computed model with the observed field in Inversion. [54, 238]. See Model.

Gravity Network Standardization – a general term that refers to various data adjustment procedures which allow placement of separate gravity survey datasets on a common Datum, using Absolute Gravity data from the local gravity Base Station. See also International Standardized Gravity Network.

Gravity Nose – see Nose.

Gravity Potential – a mathematical function that describes, through its derivatives, Gravity Field at any given space point. Quantitatively, G.P. can be defined as the amount of energy (work) required for Gravity Force to move a unit mass from the arbitrary reference point at an "infinite" distance to the point in question. G.P. is also called Newtonian Potential. [25, 54, 223 , 238].

Gravity Reduction – a multi-step procedure of applying latitude, free-air, Bouguer, terrain or other corrections to the gravity measurements. [223]. See Gravity Corrections and Observed Gravity.

Gravity Reference Field – a mathematical model of the Earth's gravity field defined by International Gravity Formula. It is based on three main simplifying assumptions: 1) the Earth is homogeneous in the lateral density distribution; 2) observations are made at sea level; 3) the observation point is not moving with respect to the Earth. G.R.F. is also referred to as Theoretical Gravity because it gives the theoretical value of the Earth's gravity field at any point on Reference Spheroid. G. R. F. provides the largest contribution to the measured gravity values and its removal is the starting point for all subsequent Gravity Corrections. [34, 54, 238].

Gravity Repeats – a quality control measure that defines the number of gravity observations repeated at the same Station during the day. R. can make up to 10% or more of the total number of the gravity survey observations. R. are used to calculate Standard Deviation of the survey measurements.

Gravity Standard – see International Standardized Gravity Network.

Gravity Station – a ground position at which Gravimeter is set up for making measurements of the gravity field.

Gravity Survey – ground, shipborne or airborne measurements of the Earth's gravity field and/or its gradients at various locations over the area of exploration interest. The objective is to associate variations of the measured values with distribution of density contrasts and, hence, of the rock types and subsurface structure. G.S. results are usually displayed as Bouguer Anomaly or Free-Air Anomaly maps. [223]. See Fixed Wing Survey, Helicopter Survey, FTG Technology and Satellite Gravity.

Gravity Survey Resolution – an amplitude and wavelength resolution of the gravity survey achievable with the use of specific instrumentation and observation techniques. A generalized table representing the range of present-day G.S.R. estimates is shown below. [36, 90, 123, 253].

Survey Type	Amplitude Resolution	Wavelength Resolution
Absolute gravity	*0.001-0.003 mGal*	*>1m*
Borehole	*0.002-0.005 mGal*	*7-12 m*
Microgravity	*0.004-0.010 mGal*	*1-10 m*
Ttime-lapse	*0.010-0.1 mGal*	*2-200 m*
Land	*0.015-0.1 mGal*	*100 – 200 m*
Water-bottom	*0.08-0.15 mGal*	*200-1000 m*
Shipborne	*0.2-1.0 mGal*	*500-2000 m*
Airborne	*1.0-3.0 mGal*	*2000-10000 m*
Satellite	*2.0-7.0 mGal*	*20000-30000 m*

See also Amplitude Resolution, Wavelength Resolution and Gravity Target Resolution.

Gravity Target Resolution – an amplitude and wavelength resolution of the gravity data required for objective identification of geological targets of exploration interest. A generalized table of G.T.R. for typical geological targets is shown below. [123, 253].

Target Type	Amplitude Resolution	Wavelength Resolution
Shallow hazard, foundation conditions, subsurface cavities	0.005-0.1 mGal	1-10 m
Stratigraphick traps, reservoir waterflooding, shallow gas pockets, weathering thickness, karst	0.05-0.10 mGal	100-200 m
Salt dome edges/base, caprock, 2D/3D prospect model	0.10-0.50 mGal	200 m-2000m
Anticlines, uplifts, deep salt dome flanks/overhang, faults	*0.2-2.0 mGal*	*500 m-4000 m*
Basin structures	0.5-5.0 mGal	1000m –2000m
Basin boundaries, plate tectonic structures, isostatic residuals	1.0 –10.0 mGal	2000m – 100000m

See also Gravity Survey Resolution, Amplitude Resolution and Wavelength Resolution.

Gravity Traverse – one cycle of the land gravity observations, which starts from the measurements recorded at Base Station, continues at the pre-planned stations in the survey area, and ends at the base station. In rough terrain or highly populated areas, G.T. observations are made at stations along the roads using four-wheel drive vehicles. Usually, there are several gravity traverses recorded during a working day. See Station.

Gravity Unit (g.u.) – a unit of the gravitational acceleration equal to 10^{-6} m/sec^2. Formerly, gravity units were widely used in gravity surveys, but now measurements in milliGals are more common. 1 milliGal = 10 gravity units. [223]. See Gal.

Gravity/Magnetic Topography – a term sometimes used to refer to Sun Angle Images of the potential field maps where high and low intensity coherent anomalies look like elevations (ridges) and troughs (valleys) at the topographic map. See also Artificial Sun Illumination.

Gravity-Controlled Seismic Statics – seismic static corrections calculated from the weathering layer model obtained from the land gravity measurements with Amplitude Resolution of 0.02 – 0.1 mGal and Wavelength Resolution of 100 – 200 m. [36, 123]. See also Gravity Target Resolution.

Gravity-Derived Static Corrections – see Gravity-Controlled Seismic Statics.

Gravity-Velocity Analysis – a methodology that is applied to obtain more precise and less expensive seismic velocity and depth migration data based on Gravity-Velocity Modeling. [5, 122].

Gravity-Velocity Modeling – a multi-step iterative procedure of refining and enhancing the seismic velocity model with the use of the high-resolution gravity data. G.-V.M. includes the following main operations: a) high-resolution gravity data is obtained in the area of seismic survey; b) seismic velocity data is used to create a density section (2-D case) or density volume (3-D case) based on Gardner's Equation and other density-velocity relationships as well as available velocity and density well logs; c) gravity field of the obtained density model is calculated; d) calculated gravity field of a model is compared with the observed gravity field; e) density model is refined with both Forward Modeling and Inversion methods in order to minimize the misfits between the calculated field of a refined model and the observed gravity field; f) revised subsurface structure model is reconverted into velocity domain to obtain an improved starting point velocity model for depth migration. If necessary, this iterative procedure and feed-back loop can be continued throughout the seismic migration and interpretation process. G.-V.M. proved to be very efficient in areas of the salt tectonic deformations. [5, 122]. See Salt Dome Gravity Anomaly.

Green's Equivalent Layer – a gravity concept stating that the Gravity Potential caused by a three-dimensional density distribution is identical to the gravitational potential caused by a surface (thin layer) density spread over any of its equipotential surfaces. [25, 183, 186]. See Equipotential Surface.

Grey-Scale Display Method – a data imaging method that involves the dividing of the whole range of grid cell values in the obtained grid into equal parts corresponding to the gray-scale values within a fixed range of the gray shades and assigning these gray shades to the grid cell values to produce Grey-Scale Map. See also Pseudocolor.

Grey-Scale Map – a potential field map image in which gray-color saturation from dark to light is modulated by the magnitude of the observed potential field: as a rule, the lowest values are the darkest and the highest ones are the brightest. See Grey-Scale Display Method.

GRF – see Gravity Reference Field.

GRF Leveling Correction – see IGRF Correction.

Grid – a standard presentation form of the potential field data where each data value is assigned to the center of one of the regular spaced square cells of the same size. The whole set of such cells constitutes a continuous 3-D surface. See also Gridding, Grid Cell and Grid Interval.

Grid Cell – one of the regular spaced and same size cells (usually, square by shape) which constitute Grid of the observed and/or processed potential field data. G.C. is often referred to as Cell. See also Gridding and Grid Interval.

Grid Expansion – a preprocessing operation that assigns Rolloff Window to the edges of gridded data to reduce edge effects and improve performance of filters after Fourier Transform. See also Grid Filling.

Grid Filling – a preprocessing operation that replaces grid gaps with values determined by interpolation from the valid grid points. See also Grid Expansion, Grid Gap and Maximum Entropy Prediction.

Grid Gap – an interval between data points that is larger than the selected Grid Interval. G.G. can be eliminated using interpolation procedures during Initial Gridding. See also Grid and Gridding.

Grid Interval – the distance between centers of the regular spaced square grid cells which represents Spatial Sampling of the gridded potential field data. G.I. is the basic parameter for Gridding and its value is usually limited to one third or, sometimes, one forth of Traverse Line spacing. G.I. is also referred to as Cell Size.

Grid Merging – the process of combining two geographically adjacent grids of the potential field data into the single integrated grid without changing original grid intervals. G.M. creates a smooth merge zone for closely spaced or, more often, overlapping grids so that data transition from one grid to another becomes gradual and invisible in the subsequent data imaging and processing of the whole area of these two grids. G.M. is also referred to as Grid Stitching. See Grid and Grid Interval.

Grid Resampling – a procedure that gives a new grid with a new Grid Interval and, if necessary, new location (origin) of grid cells. The new grid interval can be selected smaller or larger than that of the original grid. G.R. uses an interpolation process to calculate the potential field value for each new cell. See also Gridding.

Grid Residual Method – a method of enhancing the anomalies of a certain size on the gravity or magnetic map. G.R. is based on calculating the average of grid point values over a pre-selected area with the center at each grid point (like a perimeter of a circle of the user-specified radius) and then subtracting this average from corresponding center grid points. The remaining part represents the residual component of this grid. The size of enhanced anomalies depends on the extent of a selected area of averaging. Sometimes, the procedure is called Map Convolution. [223]. See Griffin Method.

Grid Smoothing – a method of Smoothing sharp irregularities in gravity or magnetic measurements caused by very shallow disturbances which are considered as Noise. Generally, G.S. is based on replacing the original grid point values with the calculated average of all values within a fixed small distance from each grid point. [223].

Grid Spacing – see Cell Size.

Grid Stitching – see Grid Merging.

Gridded Data – potential field data arranged in the form of a grid of the regular spaced square cells of the same size. Each potential field data value is assigned to the center of one of these cells. See Grid, Gridding, Grid Interval and Line Data.

Gridding – a spatial reconstruction of line or scattered data, i.e., a process of converting (or resampling) the observed potential field data recorded along the survey lines or at randomly distributed stations into a continuous set of regularly spaced (usually, square) cells each representing the potential field value assigned to the center of a cell. Grid Cell values derive from the original Line Data values or scatter Point Data values or, for cells located between data points, from the interpolated values of these data points. G. is a multi-step procedure which includes the following main operations: a) a mathematical surface is computed to represent the best fit with the observed data (Minimum Curvature or other algorithms are used); b) the obtained surface is sampled at the centers of cells; c) data values assigned to the centers of individual cells are smoothed to eliminate spikes. G. is always performed after Leveling of the original survey data. Applying Alias Filter to the line data is recommended before G. to prevent Grid contamination by Aliasing. [28, 43, 68, 100]. See also Equivalent Source Continuation and Station.

Griffin Method – a method of calculating the regional and residual gravity or magnetic fields from gridded data. G.M. calculates the average of grid points along the perimeter of a circle of the user-specified radius and assigns this average to the radius origin (centre of circle) as a regional value. The residual value is the difference between this average (i.e., regional value) and the observed value at the centre of a circle. The process is repeated for all points in Grid. Depending on the radius of averaging, the resulting grid is called, for example, 1.5 km radius regional (or residual) gravity. The magnitudes of regional and residual G.M. anomalies depend on the choice of radius: both very small and very large radii yield nearly the same anomalies as those of the original field and, hence, the optimum choise is between these two extremes. [88]. See also Gridding and Local Median Filter.

Ground Clearance – the height of an aircraft flight above the Earth's surface. Also abbreviated as AGL, i.e., above ground level. G.C. is often referred to as Terrain Clearance. See Drape Survey.

Ground Magnetic Intensity – the total intensity (Magnitude) of the Earth's magnetic field recorded by Ground Magnetometer at the survey Base Station. Profiles of G.M.I. are used for monitoring Diurnal Variations and period magnetic storms, as well as for applying Diurnal Correction to the observed magnetic data. See Magnetic Storm.

Ground Magnetometer – a magnetometer set up at Base Station for continuous operation throughout the data acquisition stage to monitor and record Diurnal Variations and periodic magnetic storms. As a rule, G.M. is similar to that of the airborne or surface (mining exploration) recording system. See Ground Magnetic Intensity.

Ground Truth – a general definition of the gravity or magnetic data obtained on the ground which are used as a) reference for estimating Accuracy and Resolution of new methods with a moving Observation Platform (such as aircraft, helicopter and satellite); b) control over variations of the external component of the Earth's magnetic field (such as Diurnals, Bay and Magnetic Storm). [223].

Ground Truth Gravity – land or marine (shipborne) gravity measurements which are used as a reference for estimating the accuracy and resolution of new methods of Dynamic Gravity, such as helicopter or satellite gravity surveys. [90, 253]. See also HGMS and HeliGravÔ.

GRS67 – see Geodetic Reference System 1967.

Gulf Gravimeter – see Weight-On-Spring.

Gulf Magnetometer – Fluxgate Magnetometer, where three mutually perpendicular fluxgate instruments and servomechanisms are used to minimize the magnetic field in two of these, thus maximizing the field intensity for the third. [223].

Gyromagnetic Ratio – the constant of proportionality that relates Larmor Signal to the intensity of the total magnetic field. G.R. is measured in units of Hz/nT and equals 2B/23.4868 Hz/nT for protons. See Cesium Magnetometer, Optically Pumped Magnetometer, Proton Precession Magnetometer, and Larmor Frequency.

Gyroscope – a heavy disk mounted so that its axis can turn freely in one or more directions. Once G. is set spinning rapidly, it will continue to rotate in the same plane regardless of the way the supporting frame is turned. Because of its property to resist a change in the direction of its axis, G. is used in servo systems to maintain the orientation of Stabilized Platform. See also Servo System.

H

Half-Maximum Method – see Tiburg Method.

Half-Slope Method – see Peters Half-Slope Method.

Half-Width Method – a graphic method of estimating the source's depth of an isolated gravity or magnetic anomaly. Depending on the assumed model, four options are available: 1) "depth to the gravity center of spherical mass" = 1.3 "half the horizontal distance across the peak at the level of a half the maximum amplitude"; 2) "depth to the gravity center of horizontal cylinder" = "half peak width" (i.e., half the horizontal distance across the peak at the level of half the maximum amplitude); 3) "depth to the center of spherical magnetic body" = 2.0 "half peak width" (i.e., half the horizontal distance across the peak at the level of a half the maximum amplitude; 4) "depth to the center of semifinite horizontal slab (fault anomaly)" = "half the horizontal distance between the points where anomaly is three-quarters and one-quarter its asymptotic amplitude". [53, 215, 223]. See Depth Rules.

Halo Effect – an outer short-wavelength curvilinear edge of the opposite sign adjacent to the filtered anomaly. H. E. represents the artificial opposite field curvature around the periphery of that anomaly due to convolution with a filter operator. H.E. usually appears on the grid data images after applying high-resolution band-pass or derivative filtering procedures to the observed potential field data. H.E. is the side effect of an increased lateral resolution, which at the same time makes enhanced residual anomalies better visible and, hence, better correlatable. [223].

Hammer Chart – see Terrain Chart.

Hamming Filter – an edge smoothing spectral domain grid filter that modifies grid surface values to ensure their smooth transition to zero at the edges of a grid. [99, 124, 201]. See Edge Smoothing Filters, Hanning Filter and Windowing.

Hannel Method – a graphic method used for estimating the source depth of an isolated magnetic anomaly. For the magnetic pole model, "depth = half horizontal distance at the level of $^1/_3$ maximum amplitude". [53]. See Depth Rules and Half-Width Method.

Hannel Rule – see Hannel Method.

Hanning Filter – an edge smoothing filter that can be applied as a space domain line filter or spectral domain grid filter. H.F. modifies line curve (line dataset) or grid surface (grid dataset) values to ensure their smooth transition to zero at the edges of lines or grid edges. [124, 201]. See Edge Smoothing Filters and Windowing.

Harmonic Function – a mathematical function that: a) satisfies Laplace's Equation; b) has continuous single-valued first derivatives; and c) has second derivatives. The function which is harmonic throughout a region "R" will have all maxima and minima on the boundary of "R" and none within "R" itself where H.F. value at any point is the average of values at neighboring points. [25].

Harmonics – spatial frequencies that are multiples of Dominant Frequency. For example, the fifth harmonic has a frequency five times that of the dominant value. H. are components of Fourier Transform. [223].

Hartley Gravimeter – see Weight-On-Spring.

Hartley Transform – a mathematical operation which is used to convert the observed Line Data from their original space domain to the equivalent spectral domain. [230]. See also Inverse Hartley Transform.

Hayford Modification – a modification of a concept of the gravitational (isostatic) equilibrium between Crust and Mantle. It assumes that the gravitational load of accumulated sediments is balanced in all sedimentary basins at a certain Depth of Compensation: the heavier sedimentary load (i.e., the larger thickness of sediments), the larger depth of compensation. [25, 223]. See also Airy Hypothesis, Pratt Hypothesis, and Isostasy.

Head Test – see Heading Error Test.

Heading – a direction of the survey aircraft or ship as indicated by the compass readings.

Heading Correction – one of the leveling corrections applied to the observed magnetic data to compensate for the measurement variations due to the aircraft's flight direction with respect to the Earth's magnetic field. [85].

Heading Error Test – one of On-Site Magnetometer Calibrations made by magnetic field test measurements along at least four flight lines, oriented in the direction of survey lines and flown above the area of a low gradient of the Earth's magnetic field. The heading variations are determined from comparison of readings obtained during the flight along these four lines. See also Figure-Of-Merit (FOM) and Heading Correction.

Heiskannen Modification – see Pratt Hypothesis.

Helicopter Gravity Measuring System – see HGMS.

Helicopter Magnetic Survey – helicopter-based magnetic measurements using a tail stinger mounted or towed high-sensitivity magnetometer. In rugged terrains, H.M.S. provides increased accuracy and data resolution due to a greater control on the flying height, flight path positioning and ability to fly very low level surveys with a close line spacing (less than 40-50 m), usually, for mineral exploration. See also Fixed Wing Survey.

Helicopter Survey – the airborne potential field measurements using a helicopter. H.S. can be conducted for both magnetic and gravity exploration. See also Fixed Wing Survey and HGMS.

Helicopter-Suspended Gravimeter – see HeliGravÔ.

HeliGravÔ – a helicopter-based gravity measuring system where the fully automatic gravimeter module is mounted in the self-leveling tripod assembly suspended on a tow cable. The gravimeter sensor itself is suspended in a dual-gimbal arrangement and leveled by servomotors controlled by signals from the gravimeter. When all tripod legs are on the ground, the ground-contact sensor generates a signal to the data-acquisition system and the self-leveling process commences, followed automatically by gravity measurements. The estimated Standard Deviation (SD) of gravity measurements is less than 25 microGal. Dual frequency Differential GPS provides relative Elevation measurements with SD less than 10 cm. Trademark of Scintrex Ltd. [220]. See also HGMS.

Herringbone Effect – an appearance of systematic deviations in contours or color-coded values on grid data images which is the result of the displacement of one or several survey lines from their correct positions or mis-leveling between survey lines. H.E. is better visible at the high gradient parts of the survey area. [223].

HGMS – a helicopter gravity measuring system. A basic set of HGMS instrumentation includes on-board stable-platform Gravimeter, laser or radar altimeter, GPS navigation system, video camera recorder, digital data processor and analog recording monitors. The achievable amplitude and wavelength resolution is estimated as 1-2 mGal and 1-3 km. [90]. See also HeliGravÔ.

High Resolution AeroGravity (HRAG) – airborne measurements of the Earth's gravitational field, which incorporate advanced technologies for recording three-component Positioning and velocities with the purpose-designed processing software to compute the aircraft accelerations to a precision that is equal to or exceeds the measuring Sensitivity of airborne gravity sensors. See Aerogravity and Aerogravity Corrections.

High Resolution AeroMagnetic (HRAM) Survey – a survey flown at low Terrain Clearance (80-150 m), with close line spacing (100–800 m), recorded at high sample rates (0.1-0.25 sec.), acquired with high-sensitivity magnetometers (0.001–0.005 nT), and using high-precision positioning systems (GPS or Differential GPS). HRAM survey can facilitate defining spatially complex geological structures and detecting subtle intra-sedimentary anomaly amplitudes. Sometimes, HRAM survey is referred to as Sedimentary AeroMagnetic (SAM) Survey. [57, 78, 155].

High-Cut (Low-Pass) Filter – a space or spectral domain filter that substantially attenuates or removes wavelength components smaller than Cutoff Wavelength and retains (passes) all wavelengths longer than the cutoff value. H.-C.F. is often used to suppress short wavelength (high-frequency) noise components of the potential field. It is also used as Alias Filter prior to resampling and Gridding. The corresponding Cutoff units (meters or km in the wavelength mode or cycles per grid unit in the spatial frequency mode) are specified depending on the software option available. [99, 201]. See Cutoff Frequency.

High-Pass (Low-Cut) Filter – a space or spectral domain filter that enhances wavelength components smaller than Cutoff Wavelength and removes or substantially attenuates wavelength components longer than this cutoff. H.-P.F. is sometimes used to suppress long-wavelength (low-frequency) regional components of the potential field. The corresponding Cutoff units (meters or km in the wavelength mode or cycles per grid unit in the spatial frequency mode) are specified depending on the software option available. [99, 201]. See Cutoff Frequency.

High-Pass Rolloff Filters – a group of spectral domain grid or line filters that retain (pass) the high-frequency range of Power Spectrum using a smooth curve in Rolloff Range to prevent Ringing. [230]. See also High-Pass (Low-Cut) Filter.

Hilbert Transform – a linear mathematical operation which is related to Fourier Transform. In 3-D case, H.T. is composed of two parts, with one part acting on the "x" component, and another part acting on the "y" component of the input signal. H.T. is used in the potential field data processing to: a) calculate Vertical Derivative of the potential field gridded data from Horizontal Derivative calculated in "x" and "y" directions; b) calculate the imaginary component of Analytic Signal from its real component (magnetic or gravity anomaly) which is then used to calculate Instantaneous Phase and Instantaneous Frequency. [68, 164, 165, 166, 201, 223, 236]. See also Hilbert Transform Filter and Three-Dimensional (3-D) Hilbert Transform Operator.

Hilbert Transform Filter – a space domain convolution filter which is applied in order to obtain the imaginary component of the observed potential field data from line datasets using a finite difference operator. For better results, Detrending is recommended before H.T.F. The filter result is combined with the real component of data to calculate Instantaneous Phase and Instantaneous Frequency. [68, 230, 236]. See also Analytic Signal and Quadrature.

Histogram Equalization – an image enhancement procedure to modify the color scale of the gridded data. The processing operator finds minimum and maximum values for grid contours and adjusts the color scale in such a way that the majority of color shades move into the range of the majority of data values. H.E. can enhance small anomalous zones of high or low values, which initially lie within a wide color range. [246].

Horizontal Acceleration Correction – a correction applied to the airborne gravity data to compensate for the stabilized platform tilt and corresponding gravimeter reading errors caused by the aircraft's horizontal accelerations. [37, 106, 233].

Horizontal Aeromagnetic Gradiometer System – an airborne observation system where each measurement includes the calculation of Gradient between the readings of the wingtip-mounted sensors and combines this information with the gradient between the wingtip sensors and a sensor mounted in the tail stinger of the aircraft. H.A.G.S. gives a measure of the full horizontal gradient (i.e., both in "x" and "y" directions) of the total magnetic field. [46, 104, 114, 153, 155].

The full horizontal gradient is very sensitive to short-wavelength magnetic anomalies. See also Magnetic Gradiometer.

Horizontal Component Filter – a spectral domain Line Data filter that retains (passes) the horizontal component of the measured magnetic field along the direction of a specified survey line. [230]. See also Vertical Component Filter.

Horizontal Cylinder – one of the basic geometrical shapes used for the model-approximated calculations of the gravity or magnetic effects. H.C. is an infinitely long cylinder of the radius "R" with a horizontal axis buried at a distance "Z" below the Earth's surface. Subsurface ridges or elongated anticlines generate gravity anomalies similar to those computed on the basis of this approximation. Magnetic effects are similar to those of Magnetic Basement uplifted areas of large extent as well as of magnetic intrusions along the strikes of regional faults. [54, 238].

Horizontal Derivative – a rate of a lateral change of the potential field calculated in "x" or "y" directions. The magnitude of the resultant of these two derivatives gives Horizontal Gradient of data. [25, 156]. See also Vertical Derivative.

Horizontal Geomagnetic Intensity – a magnitude of the horizontal component of Geomagnetic Field Vector at the point of measurement. H.G.I. can be defined as:

$$H = (B_x^2 + B_y^2)^{1/2}$$

where "B_x" and "B_y" are orthogonal components of the geomagnetic field vector in directions "x" and "y" respectively. [25]. See also Total Geomagnetic Intensity and Vertical Geomagnetic Intensity.

Horizontal Gradient – the absolute value of Horizontal Derivative. In the general form H.G. magnitude can be presented as

$$H.G. = [(dM/dx)^2 + (dM/dy)^2]^{1/2},$$

where M = M(x,y) is the potential field anomaly. H.G. is often calculated as a difference between adjacent grid values of the potential field. But this method generally enhances noise in data and, therefore, is not suitable for the subsequent calculation of the higher order horizontal derivatives. More robust calculation of H.G. can be made using a least-squares method, which fits a polynomial surface to the potential field data points in a particular window. H.G. value in any direction, assigned to the center of the window, can then be found from the coefficients of the fitting polynomial. H.G. reaches maximum wherever a strong slope (i.e., decrease or increase in data values) on the original gravity or magnetic data is present. This maximum will be located over a position where density or susceptibility of rocks are laterally changing the most quickly, such as over vertical contacts or source body edges. H.G. equals zero above Thin Dike. H.G. maxima will be displaced down-dip from tops of contacts in case of their non-vertical occurrence. Based on this phenomena, the spatial relationship between the horizontal and total gradient maxima can be used to infer magnetic or gravity contact location and Dip (see Gradient Dip Estimation). Analysis of the H.G. maps is known to be efficient for delineating both density and magnetization discontinuities in the exploration area. This analysis is often referred to as Boundary Analysis. [60, 98, 103, 104, 112, 142, 153, 189, 199, 238, 241]. See also Horizontal Gradient Vector (HGV) Method and Magnetic Horizontal Gradient Intensity.

Horizontal Gradient Intensity (HGI) – see Magnetic Horizontal Gradient Intensity.

Horizontal Gradient Magnetic Anomaly – a general term for maps (grids) showing calculated or measured Horizontal Gradient of the magnetic field, as a rule, after applying Reduction-To-Pole (RTP). Large horizontal gradient variations indicate the offsetting fault block boundaries and contacts between Basement blocks of contrasting Susceptibility values (boundaires between blocks of differing composition and/or lithology). Hence, the correlation of H.G.M.A. maxima can be useful for locating structural and compositional discontinuities. Low-pass filtered versions of H.G.M.A. are often used for delineation of Magnetic Terrane boundaries. See also Vertical Derivative Magnetic Anomaly, Boundary Analysis, and Contact.

Horizontal Gradient Vector (HGV) Method – an interpretation method based on obtaining HGV maps where Horizontal Gradient of the magnetic or gravity field is represented as an arrow whose orientation shows the direction of a gradient while the arrow length is proportional to the magnitude of a gradient. Arrows originate at grid nodes and point away from local maxima in the potential field. [60, 150]. See Horizontal Gradient.

Horizontal Intensity – see Horizontal Gradient.

HRAG – see High Resolution AeroGravity.

HRAM – see High Resolution Aeromagnetic Survey.

Hydrocarbon – any organic or non-organic compound (gaseous, liquid or solid), consisting of carbon and hydrogen. Crude oil and natural gas are complex mixtures of hydrocarbons with admixtures of other chemical components. [13].

Hydrocarbon Seepage – a migration of hydrocarbons within the sedimentary section along structural discontinuities, such as faults and fractures. It is assumed that H.S. may result in secondary magnetic effects, which (at least theoretically) are detectable by high-resolution magnetic surveys. [6, 55, 61, 62, 110, 138, 151, 208]. See also Chimney and Diagenetic Magnetic Anomaly.

Hysteresis Loop – a magnetization cycle graph which describes the relation between Magnetic Induction “B” and the magnetizing field “H” in ferromagnetic materials. H.L. clearly demonstrates the effect of Remanent Magnetization: when applied magnetizing field “H” declines to zero, the value of “B” is non-zero and the residual (remanent) magnetization is retained. [33, 223]. See also Magnetization and Induced Magnetization.

I

IGF – see International Gravity Formula.

IGSN Base Value – a value of Absolute Gravity measured at the local Base Station tied to International Gravity Standarization Net.

Igneous Rocks – rocks that solidified in the process of the molten Magma cooling either within the Earth (Intrusive Rocks) or after eruption onto the Earth's surface (Extrusive Rocks). I.R. constitute one of three main classes into which rocks are divided, the others are Metamorphic Rocks and Sedimentary Rocks. Magnetization of I.R. is the highest among all rock types. Estimates of Susceptibility values give the range of 0.5 – 100.0 with an average of 25 (in units of 10^3 SI). [13, 33, 238].

Igneous Rocks Density – the basic quantity that predetermines the gravity properties of igneous rocks. On average, I.R.D. values are higher than that of sedimentary rocks with considerable overlap. Generally, lavas have lower values compared to igneous Intrusive Rocks. Generalized table of the common I.R.D. values is shown below (in g/cm^3). [33, 238].

Rock Type	Range	Average
andesite	2.40 – 2.80	2.61
basalt	2.70 – 3.30	2.99
diabase	2.50 – 3.20	2.91
diorite	2.72 – 2.99	2.85
gabbro	2.70 – 3.50	3.03
granite	2.50 – 2.81	2.64
lava	2.80 – 3.00	2.90
peridotite	2.78 – 3.37	3.15
porphyry	2.60 – 2.89	2.70
Average of main types	**2.24 – 3.17**	**2.70**

Igneous Rocks Susceptibility – the basic quantity that predetermines the magnetic properties of igneous rocks. I.R.S. values are much higher (sometimes, 50-100 times and more) than those of Metamorphic Rocks and Sedimentary Rocks. Generalized table of the common I.R.S. values is shown below (in units of 10^3 SI). [33, 238].

Rock Type	Range	Average
andesite	–	160.0
basalt	0.2 – 175.0	70.0
diabase	1.0 – 160.0	55.0

diorite	0.6 – 120.0	85.0
dolerite	1.0 – 35.0	17.0
gabbro	1.0 –90.0	70.0
granite	0.0 – 50.0	2.5
peridotite	90.0 – 200.0	150.0
porphyry	0.3 – 200.0	60.0
Average of main types	0.25 – 92.0	22.5

S.I. susceptibility unit = 4p c.g.s. susceptibility unit. See also Metamorphic Rocks Susceptibility and Sedimentary Rocks Susceptibility.

IGRF – see International Geomagnetic Reference Field.

IGRF Correction – a time and space varying correction applied to the observed magnetic data to compensate for the Earth's main (core) magnetic field. Along with other magnetic field corrections, subtracting IGRF component from the measured magnetic field provides, in principle, the magnetic field of the crust, i.e., local magnetic field, which is usually of exploration interest. This correction is calculated using the formula that accounts for sensor's latitude, longitude and elevation, as well as year and day (sometimes also time), of the survey observations. State-of-the-art Leveling requires its application on the line (point-by-point) basis, i.e., it should be subtracted from values measured along the survey lines with the correction value corresponding to the time period of acquisition. IGRF Correction is considered as a part of the leveling process and often referred to as GFR Leveling Correction. [25, 238]. See Total Magnetic Field, Earth's Magnetic Field Components, and Crust.

Image Enhancement – a general term describing various processing methods used to highlight subtle trends and feature areas in images of the gridded potential field data. See Artificial Sun Illumination and Filtering. [223].

Improved Fourier Terrain Correction – a method that uses FFT-based algorithms for calculating the gravitational attraction of a layer with irregular top surface for application in Terrain Correction of marine gravity surveys in relatively shallow waters, as well as in land gravity surveys on observation surfaces with large-amplitude topographic variations. At each gravity station, the gravitational attraction is divided into two components: a local contribution from the rock material within a cylinder (R = 5-6 grid intervals) centered on the station and a regional contribution from the rock material outside the cylinder. The local contribution is calculated by direct integrating the gravity effects of vertical prisms within a cylinder. The regional contribution is calculated through a series of standard convolutions computed numerically by Fast Fourier Transform. [179, 180].

Improved Source Parameter Imaging (iSPI™) Method – an automated grid-based method of estimating and imaging the location and depth to the source of a magnetic anomaly using the first-order and second-order instantaneous ("local") wavenumbers of Analytic Signal. The first-order local wavenumber is defined as:

$$k_1 = d\,\{\tan^{-1}[(dM/dz)/(dM/dx)]\}/dx,$$

where M = M(x,z) is the magnitude of the anomalous magnetic field. The second-order local wavenumber is defined as:

$$k_2 = d\,\{\tan^{-1}[(d^2M/d^2z)/(d^2M/dzdx)\}/dx$$

After some simplification, these local wavenumbers can be presented as:

$$k_1 = (n_k + 1)h_k / (h^2_k + x^2) \text{ and } k_2 = (n_k + 2)h_k / (h^2_k + x^2),$$

where "n_k" is SPI Structural Index and "h_k" is the depth to the top of a model assumed. The first-order and second-order local wavenumbers are independent of the susceptibility contrast, the source dip, as well as Inclination, Declination and the magnitude of the Earth's magnetic field. They have an identical functional form for all three 2-D models accepted in the iSPI™ method (thin sheet, contact, horizontal cylinder) and they are symmetric about X = 0 taking their maximum value at this position which defines the source location. The model-independent Local Wavenumber is calculated from the difference between the second-order and the first-order local wavenumbers. The depth estimate ("local depth") is the inverse of the peak value of this difference (which is always equal to $1/h_k$ at X = 0) and it is also independent of the accepted model. I.S.P.I.M. assumes two-dimensional geology and negligible interference from nearby sources. As all analytic-signal-related computations, this method is very sensitive to Random Noise and requires high-quality acquisition, leveling, gridding, and filtering of the magnetic data. [226]. See also Source Parameter Imaging (SPI).

Impulse Response – an output of a convolution operator when the input is a unit impulse. I.R. of the filter operator is the basic characteristic to describe its performance and resulting changes of the filtered data.

Inclination – the dip (i.e., a vertical angle between the vector of geomagnetic field and the horizontal plane) of Geomagnetic Field:

$$I = \arctan B_z / (B_x^2 + B_y^2)^{½},$$

where "B_z" is the vertical component of the geomagnetic field vector; "B_x" and "B_y" are horizontal components of the geomagnetic field vector in directions "x" and "y" respectively. I. varies from –90° at the magnetic South Pole to 0° at the magnetic Equator and +90° at the magnetic North Pole. I. has the greatest effect on magnetic anomaly appearance: at both magnetic Poles, a source with a positive magnetic susceptibility contrast will generate a positive anomaly with small negative lobes (assuming that magnetization is induced); at the magnetic Equator, the same source, i.e., volume of rock with identical lateral magnetic susceptibility contrast, will generate a negative anomaly with small positives lobes. At I. = –45° in the southern hemisphere, this source will generate an anomaly with the positive lobe to the north, i.e., toward the Equator, from the source and the negative lobe to the south, i.e., toward the South Pole. At I. = +45° in the northern hemisphere, the same amplitude and wavelength anomaly will be generated but in the reversed order: the positive lobe is on the south side of the source toward the Equator, and the negative lobe is on the north side toward the North Pole. [25, 215, 238]. See also Declination and Magnetic Meridian.

Inclinometer – a surveying instrument used to measure terrain topography in the proximity to the gravity Station (usually in zones "B" and "C" of Hammer Chart). Gyroscopic or pendulous inclinometers are used for measuring Pitch and Roll of the survey aircraft or ship. [223]. See Gyroscope.

Indirect Gravity Effect – a gravity reduction phenomena, which arises from the fact that Station elevations usually refer to Geoid (or sea level), while International Gravity Formula refers to Reference Ellipsoid, and the two may not coincide.

Induced Magnetic Anomalies – crustal magnetic anomalies created by contrasting lateral concentrations of iron-rich rocks magnetized by the present geomagnetic field. See Induced Magnetization.

Induced Magnetization – a vector quantity that defines the rock magnetization in the direction of the present external field (i.e., Earth's magnetic field). I.M. magnitude is directly proportional to the strength of that field and the capacity of a rock substance to be magnetized, i.e., Susceptibility value. I.M. amounts to the lining up the originally random distributed magnetic dipoles within Magnetic Material of a given rock substance. By this reason, I.M. is sometimes referred to as Polarization. [25, 223, 238]. See also Remanent Magnetization.

Induction – the process by which a magnetizable rock becomes magnetized by the Earth's magnetic field. [223]. See Induced Magnetization and Remanent Magnetization.

In-Field Processing – a computer-aided Quality Control procedure which is applied to the observed potential field data at a survey location in order to identify and correct acquisition problems as well as check the acceptance level of diurnal variations (in magnetic survey). See also Post-Flight Quality Control.

Infinite Dike – see Tabular Body.

Infinite Slab – one of the basic geometrical shapes which is used for the model calculation of gravity/magnetic effects. I.S. is an infinite length horizontal slab of the thickness "L" which is equivalent to the case of Vertical Cylinder with its radius being very large compared with its height. [54, 238].

Infinitely Long – a term used in general approximations and Modeling meaning so long that the effects of the ends are negligible. [223].

Inflection-Tangent-Intersection Method – see Naudy Method.

Initial Gridding – a pre-gridding procedure that uses interpolation or extrapolation methods to calculate values for cells within grid gaps and for the edge regions of a grid. See Grid Gap.

Inner Terrain Correction – see Inner Zone Terrain Correction.

Inner Zone Terrain Correction – a correction applied to the gravity data to compensate for the deviation of the surface topography from flat Bouguer Slab approximation by using a Zone Chart, where the outermost radius equals 558 ft and the innermost radius equals 6.56 ft. See Terrain Correction and Outer Zone Terrain Correction.

Instantaneous Amplitude – an amplitude of Analytic Signal. Often I.A. is referred to as Analytic Signal Amplitude and Energy Envelope. [164, 165, 166, 214, 226, 236, 242].

Instantaneous Frequency – an attribute of Analytic Signal. For 2-D case, I.F. is defined as the rate of change of Instantaneous Phase with respect to "x" direction:

$$I.F. = d2(x) / dx$$

If the analytic signal is defined in terms of the horizontal and vertical derivatives of the total field, I.F. can be presented as

$$I.F. = \{d\tan^{-1} [(dM/dz)/(dM/dx)]/dx\} / 2B ,$$

where "M" is the magnitude of the potential field. I.F. is also referred to as Local Frequency. [226, 236, 242]. See also Instantaneous Frequency Image and Local Wavenumber.

Instantaneous Frequency Image – an image of the gridded potential field data obtained from the calculation of Instantaneous Frequency. I.F.I. has a high degree of variation and, hence, can effectively map character changes in potential field data for areas where the original total field intensity images have little apparent differences in terms of magnetic or gravity response. [94]. See also Instantaneous Phase Image.

Instantaneous Phase – a phase of Analytic Signal. For 2-D case, I.P. is defined as:

$$2 = \tan^{-1} [m * (x)/m(x)],$$

where "m * (x)" is the imaginary component of the analytic signal and "m(x)" is its real part, i.e., magnetic or gravity anomaly. I.P. values can vary between –180º and +180º. As compared to Energy Envelope, I.P.

calculations are less stable since they involve a division of real and imaginary components instead of the sum of their squares. [165, 226, 236, 242]. See also Instantaneous Frequency and Instantaneous Phase Image.

Instantaneous Phase Image – an image of the gridded potential field data obtained from the calculation of Instantaneous Phase. I.P.I. has the property of enhancing the continuity of the imaged features regardless of their amplitude values. In contrast to Automatic Gain Control technique, I.P.I. does not attenuate small anomalies on the flanks of large anomalies, and it is less susceptible to the enhancement of a random noise. Sometimes, I.P.I. can provide resolution superior to the resolution obtained using the vertical derivative imaging. [94]. See also Instantaneous Frequency Image.

Instrumentation Lag – an airborne magnetometer system parameter is determined during Lag Test by analyzing two sets of data flown in opposite directions over a known and well-defined magnetic anomaly such as, for example, a large river bridge. I.L. is defined as a time difference between location of selected anomaly from the positional (GPS) data and from the magnetometer data. I.L. can also be determined as one-half the time shift required to match the corresponding anomalous responses from data flown in opposite directions.

Intensity of Magnetization – see Magnetization.

Interference of Anomalies – a combined effect of sources located nearby or at close depth levels. The residual potential field anomaly always represents the vector sum of the interfering anomalies generated by individual sources. The observed potential field anomaly represents the vector sum of the superposition of anomalies generated by all subsurface sources. See also Superposition of Anomalies.

International Geomagnetic Reference Field (IGRF) – a time-varying magnetic field which represents the Earth's core component (i.e., the Earth's main magnetic field) of the observed magnetic data. IGRF is computed from data by the worldwide magnetic observatories and orbiting satellite-mounted magnetometers. It is updated every five years. Generally, after the magnetic survey has been completed, IGRF is subtracted from the observed data to obtain the crustal component of the magnetic field (i.e., the Earth's local magnetic field). The most precise way to correct for IGRF is to compute its values for each point in the survey, i.e., IGRF (x, y, z, t), and subtract proper values on a point-by-point basis. If the survey is completed within a short period of time (a few days), then computing IGRF as a grid may be adequate. The IGRF value can vary by 1-8 nT/month or more, depending on location. IGRF is sometimes referred to as Normal Magnetic Field. [25, 223, 238]. See also Earth's Magnetic Field Components and Definitive Geomagnetic Reference Field (DGRF).

International Gravity Formula (IGF) – a formula which defines the theoretical value of the Earth's gravity field at any point on Reference Spheroid assuming homogeneous Density distribution. The most recently published formula (1998) from the United States National Imagery and Mapping Agency (NIMA) is based on the WGS84 reference spheroid:

$$g = 978032.53359\ (1 + 0.00193185265241 \sin^2 f\ )\ /\ (1 - 0.00669437999014 \sin^2 f\ )^{0.5},$$

where "f" is the latitude in degrees and "g" is gravity in mGals. The application of this formula requires Athmospheric Gravity Correction because the WGS84 Earth's Gravitational Constant includes the mass of the atmosphere. I.G.F. accounts for three major phenomena that impact gravity measurements: 1) the Earth spins at different angular velocities at different latitudes and, hence, produces different outward accelerations resulting in gravity readings which differ from those obtained on a non-spinning Earth; 2) Earth has an ellipsoidal shape (i.e., all points on the surface are not equally distant from the center of the Earth's mass); 3) Earth's ellipsoidal bulges contain rocks (i.e., uneven mass distribution, due to the ellipsoidal shape as compared to a sphere, needs to be accounted for). Because of all these phenomena, the gravity acceleration (i.e., the Earth's gravity field) measurement values vary considerably from about 978 000 mGal at the Equator to about 983 000 mGal at the Poles (the gravitational attraction/acceleration is the highest at Poles as they are closest to the Earth's center of mass). [34]. Older versions of the I.G.F., which may have been used in the reduction of data sets, are:

1930: $g = 978049.0 \ (1 + 0.0052884 \sin^2 f - 0.0000059 \sin^2 2f)$ mGal

1967: $g = 978031.846 \ (1 + 0.005278895 \sin^2 f + 0.000023462 \sin^4 f)$ mGal

1987: $g = 978032.68 \ (1 + 0.00193185138639 \sin^2 f) / (1-0.00669437999013 \sin^2 f)^{0.5}$ mGal

International Gravity Standarization Net – the world-wide network of gravity base stations to provide reference measurements of the Earth's gravity field, using the same type gravity meters. [248]. See Base Station.

Interpretive Filters – a general definition of various conventional and specialized filters applied to the gridded or line-oriented data in order to enhance Target anomalies and provide data for subsequent interpretation. See also Filtering and Gridding.

Interruption Zones – the gravity or magnetic field map features defined as imaginary lines along which the observed or filtered anomalies are interrupted or terminated. I.Z. are often found to be associated with faults, basement block contacts and other geological lineaments. I.Z. are also referred to as Offset Zones. Sometimes, I.Z. are associated with wrench fault systems. [6, 75, 257].

Interval Factor – a gravimeter measurement range parameter (constant) that is applied to convert gravimeter readings from counter (dial) units within a pre-selected interval of Operating Range to milligals. I.F. is determined by the manufacturer during gravimeter calibration. See also Milligal Constant and Milligal.

Intra-basement Fault – see Magnetized Intra-basement Fault.

Intra-basement Magnetic Anomalies – magnetic signatures of the exploration interest generated by lateral contrasts in magnetic susceptibilities within Basement. Such contrasts are created, primarily, by contacts between different basement blocks and deep intrusions. As a rule, I.M.A. are represented by low-frequency and mid-frequency (long-wavelength and mid-wavelength) components of the observed magnetic field. As the basement becomes relatively shallower, the wavelength of I.M.A. becomes smaller. See Intrusion, Magnetic Contact, and Magma.

Intra-basement Magnetic Anomaly Sources – a model approximation of magnetic sources in the upper part of Basement. There are three main types of I.M.A.S.: 1) thin vertical sheet (sheet thickness is much less than the basement depth) or Thin Dike; 2) thick vertical sheet (sheet thickness is about the same as the basement depth) or Thick Dike; 3) vertical block with two magnetic contracts/interfaces (block width is more than the basement depth). [215]. See also Suprabasement Magnetic Anomaly Sources.

Intra-sedimentary Fault – see Magnetized Intra-sedimentary Fault.

Intra-sedimentary Magnetic Anomalies – magnetic signatures of the exploration interest generated by lateral contrasts in magnetic susceptibilities within the sedimentary section. Such contrasts are created primarily by magnetite-bearing formations, magnetized faults and/or localized fractured zones. In general, I.M.A. are represented by relatively high-frequency (short-wavelength) components of the observed magnetic field and have magnitudes which can be several orders smaller than those of the anomalies generated by sources in Basement. [1, 6, 51, 80, 191]. See Magnetized Intra-sedimentary Fault.

Intrusion – a) emplacement of Igneous Rocks in the pre-existing subsurface environment of Basement and/or sedimentary section as a result of the magmatic activity; b) emplacement of a diapiric salt plug or other sedimentary material in the pre-existing environment of the sedimentary section as a result of gravitational compaction and high-pressure subsurface structural deformations. [13]. See Intrusive Rocks and Magma.

Intrusive Rocks – masses of Igneous Rocks, or quite rarely Sedimentary Rocks, formed as a result of Intrusion.

Invariants – combinations of components of a measured quantity that are unchanging with respect to particular directions. I. of Gradient Vector can be used to infer the structure of a source of the observed potential field anomaly. See Full Tensor Gradient.

Inverse Filter – a residual-type Wavelength Filter that is complement to Regional Filter. I.F. is commonly referred to as Residual Wavelength Filter or High-Pass Filter.

Inverse Fourier Transform – a mathematical operation that converts gridded potential field data from the frequency (spectral) domain back to their original Space Domain. See Fourier Transform and Spectral Domain.

Inverse Hartley Transform – a mathematical operation that converts the line potential field data from the spectral domain back to their original space domain. See Hartley Transform.

Inverse Modeling – a technique that allows to compute 2-D or 3-D density or susceptibility geometric model of the subsurface geological structure that match the observed gravity or magnetic field. Because of the fundamental ambiguity of the relationship between the potential field and its sources, the output model geometry is always a non-unique solution unless it is constrained by independent geological and/or geophysical information. I.M. has the same conceptual meaning as Inversion and sometimes it is referred to as Inversion by Forward Modeling. [249]. See also Forward Modeling.

Inverse Wavelet Transform – a mathematical operation that recovers the original signal from its space-frequency representation and removes Coherent Noise components which have been identified during the "forward" wavelet transform. [65, 69]. See also Wavelet Transform.

Inversion – a methodology to obtain a Model derived from the observed data in order to describe the subsurface structure that is consistent with these data. Principal difficulty with I. of potential field data is their inherent non-uniqueness (see Gauss Theorem), which is also defined as the fundamental ambiguity of the relationship between the potential field and its sources. The non-uniqueness problem is commonly addressed by applying inversion algorithms which restrict consideration of possible solutions to parameters of one model or small set of pre-selected models which were defined on the basis of available geological and geophysical information. For example, seismic data can be used to estimate the limits of a shape, depth and lateral extent of Salt Dome and adjacent subsurface structures. Well logs provide information on lithology that is used for estimation of densities and susceptibilities of rocks. [31, 32, 86, 89, 144, 145, 223]. See Gravity-Velocity Modeling.

Inversion by Forward Modeling – see Inverse Modeling.

Inverted Gravity Signature – an image of the gravity field obtained with the use of the Shaded Relief technique, but, contrary to the standard visualization, the anomalous gravity peaks are inverted and shown as "valleys," while the anomalous gravity troughs are shown as "ridges." This visualization trick is considered to be useful for interpretation of the gravity data on continental margins where the regional gravity Signature tends (as in the Gulf of Mexico) to inversely reflect the interface between sedimentary cover and Basement. [141]. See also Continental Margin.

Ionosphere – the outer atmospheric zone surrounding the Earth at altitudes roughly between 50 km and 1500 km, where the interaction between Solar Wind and the Earth's internal magnetic field, coupled with the Earth's rotation and tidal effects, generates electrical currents, which in turn produce magnetic fields, called Magnetic Storm, with magnitudes of up to 1000 nT. [25].

Isoanomaly – a line which connects points of equal values on contour maps showing magnetic or gravity anomalies. [223].

Isoclinic Map – a contour map of the geomagnetic field that shows lines of the equal Inclination values over the Earth's surface. See also Isodynamic Map and Isogonic Map.

Isodynamic Map – a contour map that shows lines of the equal values of either the magnitude of the Earth's magnetic field, or its vertical or horizontal components respectively. See also Isogonic Map and Isoclinic Map. [25].

Isogal Map – a contour map of the gravity survey data which shows lines of equal values of the measured or processed gravity anomaly, usually in milliGals (mGal). For example, Bouguer anomaly contour map. See Gal.

Isogam Map – an older term describing a contour map of the magnetic survey data which shows lines of equal values of the total intensity of the magnetic field in gammas. See Gamma.

Isogonic Map – a contour map of the geomagnetic field that shows lines of the equal Declination values over the Earth's surface. See also Isoclinic Map and Isodynamic Map. [25].

Isomagnetic Charts – lines of equal values of Inclination, Declination, magnitude, horizontal/vertical intensity, and other Earth's magnetic field parameters. When plotted on maps, I.C. show the variations in Geomagnetic Field over the Earth's surface. [54, 238].

Isomagnetic Maps – contour maps representing various elements of Geomagnetic Field, such as contours of the equal field intensity (total intensity, vertical intensity, or horizontal intensity) or contours of equal Inclination and Declination. [25]. See Total Geomagnetic Intensity, Horizontal Geomagnetic Intensity and Vertical Geomagnetic Intensity.

Isoporic Map – a contour map of Secular Variation where contours represent constant rates of change of the total intensity of Geomagnetic Field, either in nanoteslas (nT) per year or in degrees per year. [25].

Isostasy – a concept of the gravitational balance of regional blocks of the Earth's crust which is based on the assumption that these blocks are "floating" on a more dense underlying layer of Asthenosphere or compensated at depth by lateral mass excesses and deficiencies. [25, 223, 238]. See Isostatic Compensation, Airy Hypothesis, and Pratt Hypothesis.

Isostatic Anomaly – a long-wavelength (low-frequency) anomaly of the gravity field at sea level after applying standard corrections to the observed data:

I.A. = "observed data" + "free-air correction" – "Bouguer correction" +

+ "terrain correction + "isostatic correction" – "theoretical gravity correction"

Positive I.A. indicates the absence of the regional isostatic compensation (i.e., undercompensation), and negative anomaly suggests regional overcompensation. Isostatic anomalies usually cover large areas, hundreds of kilometers or more in extent, and they can be interpreted to identify major tectonic and structural elements of the regional offshore petroleum systems such as Oceanic Crust and the transitional crust boundaries, rift-related lineaments, outlines of the primary depositional areas, etc. [25, 54, 223, 238]. See Isostasy, Isostatic Correction and Isostatic Residual Anomaly.

Isostatic Compensation – the phenomena of adjustment of Lithosphere to maintain the equilibrium (balance) among units of varying mass and density: the extra mass of carge topographic features is compensated at depth by lateral mass deficiencies, whereas large topographic depressions are matched at depth by lateral mass excesses. The density deficiency in ocean waters is compensated (balanced) by an excess of the rock mass densities under the ocean floor. [13 , 25 , 223 , 238]. See also Airy Hypothesis.

Isostatic Correction – a correction applied to the observed gravity data to compensate for lateral density and/or thickness variations between regional blocks of the Earth's crust. I.C. is based on a hypothesis that the gravitational effects of the continental rock masses extending above sea level are compensated by a deficiency of the density of rocks beneath those masses, while the effect of a density deficiency in ocean waters is compensated by an excess of density in the rock masses under the ocean floor. I.C. is based on the isostatic model which is made from elevation data and water depth data using zone charts. Geological structures of exploration interest are usually much smaller in extent than these regional blocks and corresponding isostatic anomalies. For this reason, I.C. is seldom applied to the exploration gravity data. [13 , 53, 223, 238]. See also Isostatic Anomaly.

Isostatic Equilibrium – see Isostasy.

Isostatic Residual Anomaly – an anomaly that the most closely represents lateral variations in density of the middle and upper Crust. Generally, I.R.A. can be defined as a sum of the anomalous effects due to variations in the crustal density and anomalous effects due to the deeper masses that support these crustal variations. [25]. See also Isostatic Anomaly and Isostatic Correction.

Isothermal Remanent Magnetization (IRM) – a type of the remanent magnetization which originates from the local short-time exposure to a high-intensity external magnetic field and represents the residual component that is left after the removal of that field. Lightning can produce I.R.M. over relatively small areas. [33, 238]. See also Chemical R.M., Detrital R.M., Thermal R.M. and Viscous Remanent Magnetization.

Iterative Fourier Equivalent Source Method – a potential field continuation method. In this method, an initial magnetization or density distribution is assigned to a horizontal plane located just below the level of measurements. The field of this magnetization/density distribution is calculated on the observation surface, using the Fourier technique, and subtracted from the observed field. The obtained residual field is converted into a residual magnetization/density distribution and added to the initial equivalent magnetization/ density distribution. The process is repeated until the residual field becomes sufficiently small or until the process starts to diverge. Convergence for the magnetic field is the fastest if the observed magnetic data are first reduced to the magnetic Pole. [196, 250].

Iterative Procedure – a procedure applied to data by successive steps, each based on results obtained from the preceding iteration. Cascaded Filtering, Forward Modeling and Inversion are examples of I.P.

ITI – see Inflection-Tangent-Intersection Method.

J

Jacobsen Filter – a Spectral Domain filter that enhances the residual components of the gravity or magnetic fields by calculating the difference between two Wiener Filter-based upward continuations or applying the modified Upward Continuation in accordance with a specified "pass-above" or "pass below" depth. J.F. is also referred to as Separation Filter. [48, 118].

Julian Date – a date of the magnetic or gravity survey observations, recorded by the digital acquisition system as a four-digit value, which represents Julian Day and the year of the survey. For example, the value of 3399 (or 9933) corresponds to February 2, 1999.

Julian Day – the day's ordinal number since January 1 of the current year. J.D. is used as standard input parameter for digital records of the magnetic or gravity acquistion data. See Julian Date.

Julians – a list of Julian days in the dataset of the gravity or magnetic observations. See Julian Day.

Juvenile – a term applied to water, gas or ore-forming fluids originating from Magma as opposed to fluids of the surface origin. J. fluids may significantly contribute to the magnetization of intra-sedimentary and intra-basement faults or fracture zones. J. water is also referred to as Plutonic Water. [13]. See Magnetized Intra-basement Fault and Magnetized Intra-sedimentary Fault.

Juxtaposition – side-by-side position of specified tectonic blocks, magnetic terranes and other subsurface structural elements identified on the basis of the potential field data interpretation. See Magnetic Terrane and Tectonic Province.

K

Keating Method – a method of locating the magnetic anomalies resembling the response of a modeled Kimberlite Pipe based on the pattern recognition technique. The model parameters of a vertically dipping cylinder are computed in a grid form and adjusted for the assumed depth, radius and length of a cylinder as well as for local Inclination, Declination and areal extent of the particular anomaly, The model grid is moved over Total Magnetic Intensity grid as Running Window. The correlation between modeled and observed data is computed at each grid node and anomalies with correlation coefficients that exceed a specific threshold (i.e. 75%) are retained for comparison to other exploration data. [125].

Kimberlite Pipe – a carrot- or mushroom-shaped, more or less vertical magmatic Intrusion body originating very deep in the Earth (about 150 km), which sometimes contains diamonds. K.P. is often only several hundred meters in diameter and buried under a cover of unconsolidated sediments. Because K.P. composition is dominated by Mafic Rock minerals, including Magnetite, its magnetic signature is often very distinctive. On Total Magnetic Intensity or, more clearly, on high-pass filtered magnetic maps, K.P. is often expressed as a “bright dot” – a local high-intensity circular-shaped anomaly. On a profile of the magnetic data displayed along a survey line, K.P. is presented as a short-wavelength, spike-like anomaly similar to that of Cultural Noise (wellhead, for example), hence, careful Cultural Editing is very important in K.P. exploration. In case of significant remanent magnetization, the magnetic anomaly caused by K.P. will be expressed as a “dim dot” – a local low-intensity (about 100 nT or less) circular-shaped anomaly. Generally, estimates of location and depth of K.P. are based on its model approximation as Monopole. [13, 125]. See also Magma.

Koefoed Method – a two-dimensional (2-D) method of estimating a depth to the source of the magnetic anomaly. K.M. is based on measuring horizontal distances between points on the chosen flank of the regionally corrected anomaly that represent one-half and three-quarter maximum slope values. Four measured distances (including the opposite side of the same flank inflection point) are used to generate a set of three depths: 1) for the contact; 2) thick plate (thickness-to-depth ratio is about 1:1); and 3) thin plate (thickness-to-depth ratio is about 1:10) assumed source geometries. K.M. also assumes that the strike length of a source body is at least four times its depth below sensor. See Depth Rules and Magnetic Contact.

Koenigsberger Ratio (Q) – a ratio of Remanent Magnetization to Induced Magnetization:

$$Q = \text{“remanent magnetization / induced magnetization”},$$

where the induced magnetization can be presented as the product of *Susceptibility* and the Earth’s magnetic field strength. [25, 113, 223].

L

Lag Correction – a correction applied to the airborne data to compensate for physical time delays due to the distance between sensors and GPS antenna and electronic delays due to the time taken to record the observed value in the data acquisition system. L.C. is determined during Lag Test and, as a rule, its typical value are about 0.3–0.6 sec. See also Instrumentation Lag.

Lag Test – one of On-Site Magnetometer Calibrations made by test measurements along two lines flown in opposite directions over the known surface magnetic feature. After data reduction and plotting, the lag value is determined as one-half the time shift required to match the corresponding anomalous responses. See also Compensation Test, Lag Correction and Parallax Correction.

Laplace Convolution – a heavy smoothing procedure which is sometimes applied after Initial Gridding in order to improve the condition of the gridded data for subsequent applying the minimum curvature smoothing operator. See Gridding.

Laplace Filter – a triangular-shaped line-based or grid-based convolution filter that calculates the curvatures in the observed data: high values indicate high curvatures, and zero values indicate inflection points. See also Second Vertical Derivative.

Laplace's Equation – a second-order differential equation which defines Potential Field at space points not occupied by its sources:

$$d^2U/d^2x^2 + d^2U/dy^2 + d^2U/dz^2 = 0,$$

where, "U" is the potential function and "x", "y", "z" are the rectangular coordinates. [25]. See also Potential.

Larmor Frequency – a frequency with which magnetic moments of atoms and nuclei precess about the direction of the externally applied steady magnetic field such as the Earth's magnetic field. L.M. is defined as

L.M. = (H/2B,

where "(" is Gyromagnetic Ratio, "H" is the Earth's magnetic field. For the value of the Earth's magnetic field 50000 nT, L.F. is 2100 Hz. [223]. See Cesium Magnetometer, Optically Pumped Magnetometer, and Proton Precession Magnetometer.

Larmor Signal – a signal generated by the proton-resonance or optically pumped magnetometer sensors, which is proportional to the intensity of an external magnetic field. Electronic console converts L.S. into values of the total magnetic intensity in nanoteslas (nT) using Gyromagnetic Ratio. See Cesium Magnetometer, Optically Pumped Magnetometer and Proton Precession Magnetometer.

Lateral Resolution – a resolution of the potential field data (observed or processed) in the horizontal direction, i.e., along "x" and "y" coordinates. Increased L.R. separates interfering anomalies generated by closely spaced sources. See also Lateral Separation.

Lateral Separation – a distinction between the potential field anomalies caused by closely spaced source bodies. Without L.S., determination of geological boundaries usually suffers from nearby sources interference that yields mislocations. Commonly, L.S. is performed by Filtering. Quite often, L.S. is used with the same conceptual meaning as Lateral Resolution. See also Enhanced Analytic Signal, Goussev Filter and Vertical Separation.

Latitude Correction – a correction applied to the observed gravity data to compensate for the increase of the gravitational acceleration (attraction) from the value of about 978000 mGal on the Equator to about 983000 mGal at the Poles due to a) variation of the Earth's radius because of Polar Flattening; b) variation of the centrifugal force (which opposes the gravitational acceleration) resulting from the Earth's rotation, as the distance to the Earth's axis varies with latitude. L.C. obtained by differentiating International Gravity Formula (often, based on GRS67) and can be defined as:

$$L.C. = 0.8108 \text{ Sin } 2N, \text{ (in mGal/km)}$$

or

$$L.C. = 1.3049 \text{ Sin } 2N, \text{ (in mGal/mile)}$$

where "N" is the reference latitude. L.C. value is multiplied by the N-S horizontal distance from the reference latitude and added, as we move towards the Equator, to the observed value at the point of measurement. At present, for the most exploration surveys, L.C. is not commonly calculated as separate value because it is assumed to be incorporated into the latest versions of International Gravity Formula. For Microgravity Survey applications, L.C. is defined as:

$$)g_L = "0.8108\ )S \text{ Sin2N},$$

where $)g_L$ is given in "microGals", ")S" is the north-south distance in meters between the observation point and Base Station, and "N" is the reference latitude of the base station. Here, L.C. is added to the measured value if the observation point is positioned south of the base station, and subtracted from the measured value if the observation point is positioned north of the base station. [34, 223, 238, 255]. Sometimes, L.C. is mentioned with the same conceptual meaning as Theoretical Gravity Correction.

Lava – a fluid igneous rock that flows out of a volcano and may cover large areas. This term is also applied to the same rock material solidified by cooling. [13]. See Extrusive Rocks, Igneous Rocks and Magnetic Basement.

Layer Filtering – see Separation Filtering.

Leveling – a procedure of adjusting the survey data so that they tie at line intersections. In aeromagnetic surveys, L. is a general term for a variety of procedures applied to the recorded magnetic data in order to correct for the following main distorting effects of the acquisition process: a) diurnal variations; b) positioning errors (primarily, the height of a flight along adjacent lines); c) mis-ties between traverse and control lines. In the ground gravity surveys, L. is usually applied to correct for mis-ties between survey lines. [85, 149, 172, 187, 223]. See also Decorrugation, Line Leveling and Microleveling.

Line-to-Line Noise – see Line Corrugations.

Line Corrugations – artificial anomalies elongated in the direction of the traverse and/or control (tie) lines. L.C. represent residual errors remaining after standard leveling of the observed potential field data. L.C. are removed by applying Microleveling techniques. See also Decorrugation.

Line Data – the potential field data measured along the survey lines and arranged in the form of the line point datasets. Consecutive line samples are assigned with consecutive Fiducials.

Line Direction – the orientation of the survey lines in respect to the geographic coordinates. See also Line Length and Line Spacing.

Line Filter Window – a line interval which includes a specified number of data points on either side of a target data point for which a new value is calculated by the process of Line Filtering.

Line Filtering – convolution procedure applied to the profiles of line datasets (i.e., to the data measured along acquisition lines) before Gridding to suppress narrow-band noise events such as Cultural Noise, leveling errors, or external magnetic field outbursts. See also Line Filter Window.

Line Filters – see Channel Filters.

Line Gridding – a method that makes a Grid (i.e., map) of the gravity of magnetic data obtained during measurements along pre-planned survey lines by creating the smoothest possible (i.e., Minimum Curvature) surface that fits all data values. See also Random Gridding and Bi-Directional Gridding.

Line Length – a survey parameter derived from the extent of the area planned for the mineral or petroleum exploration. For Fixed Wing Survey, the minimum L.L. is usually in the order of 8-10 km. See also Line Direction and Line Spacing.

Line Leveling – a multi-step procedure applied to the observed data to remove leveling errors between survey lines. At first, all intersection points between control and traverse lines are found and the mis-ties are determined. Then, the control lines are leveled to the traverse lines using a statistical approach. The mis-ties are calculated once more, this time using the statistically leveled tie lines as reference values. Finally, the traverse lines are leveled to the statistically leveled tie lines using the linear interpolation. See Leveling and Microleveling.

Line Power Spectrum – a power spectrum graph for the specified gate or segment of the survey line. L.P.S. is usually displayed before and after application of the spectral domain line filters. L.P.S. vertical axis represents energy (i.e., spectral power, which is equal to the square of amplitude); the horizontal axis represents wavenumber in cycles per km (sometimes, in cycles per meter) or in cycles per grid unit. See Power Spectrum.

Line Resampling – a data conditioning procedure that replaces the original line dataset with a new dataset where data are evenly distributed along the line without internal data gaps. Data gaps (null samples) are replaced in the process of L.R. by interpolated values. L.R. is applied in order to prepare the data for Line Filtering.

Line Spacing – a distance in meters between traverse or control lines of the survey. Distance between traverse lines is the most important parameter of the airborne survey. For mineral exploration, the traverse L.S. is derived mainly from the target size, such as an ore body or Kimberlite Pipe, and can be about 100-150 m or less. For petroleum exploration, the traverse L.S. is estimated as a function of the depth of a target interval which anomalies are expected to be resolved. Often, the basement depth is taken as the reference level for L.S. value estimates: the shallower Basement – the closer L.S. and vice versa. Generally, L.S. for traverse lines vary from 400-800 m up to 1600-2400 m; L.S. for control (tie) lines can vary from 1 to 20 times the traverse L.S., but 3-5 times value is the most common. [78, 205]. See also High Resolution Aeromagnetic (HRAM) Survey, Line Direction and Line Length.

Lineaments – linear topographic features of regional extent detected on airborne or satellite images as alignments of vegetation and soil color anomalies, topographic scarps, straight stream courses, and others. The vast majority of L. are considered to be true fractures or fracture zones (i.e., faults without relative vertical displacement of adjacent rock masses) that extend near vertically to great depths, including Basement. Often, L. act as conduits for migrating fluids (and, hence, can be magnetized enough for reliable detection by HRAM surveys), increase the permeability and porosity of penetrated lithological units, as well as create fractured reservoirs in structural and stratigraphic traps. [218]. See also Faults.

Linear Convolution – a mathematical operation that performs computation of filtered data values in Space Domain. In a single dimension, when the set of sampled non-periodic data “F(s)” is filtered by the operator “R(s)”, the result of filtering “P(s)” is obtained through (a) shifting a filter operator by one sample interval at a time; (b) multiplying the corresponding data and filter (Impulse Response) values; and (c) summing the product terms, i.e.,

$$P(s) = \sum^{s'} F(s')\, R(s - s'),$$

where “sN” is the number of data samples over the filter operator length. For periodic data, L.C. is accomplished by Padding both data and filter operator with zero values. L.C. eliminates Wraparound Effect. [148]. See also Circular Convolution and FIR RTP Filter.

Linear Filter – a) a space domain convolution filter, which action is pre-determined by its response to a spike or unit impulse. If continuous input function is considered as a succession of spikes, the L.F. response to this function could be obtained by integration using the principle of superposition. The order of applying two linear filters can be reversed without changing the outcome. Amplitudes of either the filter or the data can be scaled with the same results; b) an optimum-type filter designed from Power Spectrum of the observed data to remove anomalies caused by a pre-determined set of sources in a way similar to the older smoothing methods. [82, 167, 223]. See also Convolution and Wavelength Filter.

Lithosphere – the Earth's outermost layer of relative strength as compared to the underlying weak Asthenosphere. L. includes Crust and a part of the upper Mantle, and it is about 100 km in thickness. [13]. See Plate Tectonics.

Local Gravity – a residual component of the gravity field. Often, L.G. is Bouguer Gravity from which the estimated regional component has been subtracted [223].

Local Frequency – the same as Instantaneous Frequency. The term "local" is used to make clear that it is related to the potential field data, which are spatial rather than temporal. [226, 242]. See also Complex Attributes, Local Phase and Local Wavenumber.

Local Magnetic Anomalies – magnetic anomalies of Residual Magnetic Field generated by source (i.e. causative) bodies in the uppermost part of Crust. [223]. See Causative Body

Local Median Filter – a space domain filter applied to the gridded or line data to reduce the effects of irregular high-frequency noise components (spikes). L.M.F. moves a window of the specified length over the data and replaces the data at the middle (center) point with the median value of the data within the window. For line data, this window consists of a number of data points surrounding the "target" point. For gridded data this window represents a square configuration of several cells with the "target" cell in its center. L.M.F. is often referred to as Median Filter. [230].

Local Phase – the same as Instantaneous Phase. The term "local" is used to make clear that it is related to the potential field data, which are spatial rather than temporal. [226, 242]. See also Local Frequency and Local Wavenumber.

Local Regional Component – a spatial wavelength component of the observed potential field data which is larger than that of the dominant wavelengths of the target anomalies, but smaller than the spatial wavelengths on the order of the survey area extent. [255]. See also Regional Component.

Local Wavenumber – the space domain quantity "k" used instead of Local Frequency in the analysis of the magnetic field data in SPI Method:

$$k = d\,\{\tan^{-1}[(dM/dz)/(dM/dx)]\}/dx,$$

where "M" is the magnitude of the anomalous magnetic field. L.W. is also referred to as the first-order local wavenumber. [242]. See also Improved Source Parameter Imaging (iSPI) Method.

Local Wavenumber Method – see Source Parameter Imaging (SPI) Method and Improved Source Parameter (iSPI) Method.

Log-Energy Spectrum – see Power Spectrum.

Loop-Closure Correction – one of the data leveling corrections applied to the observed location data using an iterative procedure for repeated adjustments of "Z" values for each crossover and all acquisition lines to minimize overall misclosure for the crossovers' dataset and distribute the residual errors. Ground gravity data are often acquired in loops, so that stations measured at the beginning of the acquisition period are revisited at the end of the period. Among other things, this facilitates estimation of a temporal instrument drift. The technique also helps to locate survey “busts” in the data. [85, 149]. See Crossovers and Drift.

Low-Cut Filter – see High-Pass Filter.

Low-Pass Filter – see High-Cut Filter.

Low-Pass Rolloff Filters – a group of the spectral domain grid or line filters that retain (pass) the low-frequency range of Power Spectrum using a smooth curve in Rolloff Range to prevent Ringing after applying Reverse Spectral Transform. [230].

M

Mac Rule – a rule relating the depth of a source of magnetic anomaly to the width of its amplitude profile: "depth = ½ of the horizontal distance at the level of half the maximum amplitude". See also Half-Width Method and Depth Rules.

MaFIC (Magnetic Fault Interpretation Cube) – a 3-D data volume of the magnetic depth solutions obtained by Werner Deconvolution, Euler Deconvolution or other automated magnetic depth estimation methods and transformed into the standard SEG-Y format for interactive evaluation and interpretation using the seismic software. [212].

Magma – a molten igneous rock material ascended into Crust. [13] Often, M. is a primary source of water, gas and ore-forming fluids which contribute significantly to magnetization of faults and fracture zones. See Magma Chamber, Lava and Igneous Rocks.

Magma Chamber – a reservoir of Magma in the shallow part of Lithosphere at the range of depth from several kilometers to tens of kilometers where magma accumulates. From here, magma may intrude into the upper Basement and sedimentary section and/or extrude onto the Earth's surface through the system of faults that provide channels for the magma uprising. [13] See Extrusive Rocks and Intrusive Rocks.

Magmatism – a development and movement of Magma and its solidification to Igneous Rocks. See also Magma Chamber, Intrusion and Extrusion.

Magnetic Accelerometer – a high-precision Gravimeter designed on the basis of Magnetic Levitation. [36]. See Virtual Spring.

Magnetic Anomaly – the difference between the observed Earth's Magnetic Field and its theoretical or estimated components (such as IGRF, Diurnals, etc.). In magnetic exploration, M.A. is a magnetic signature of geological interest generated by lateral contrasts a) in magnetic susceptibilities of rocks (i.e., rock composition); b) in rock subsurface structure (horsts, grabens, faults with offsets, magmatic intrusions, and salt diapiric bodies). Flat-layered subsurface structures will be transparent to the magnetic methods if there is no lateral variation in magnetic susceptibility or magnetite content. The presence of a vertical contact (such as fault) can also produce a lateral susceptibility contrast and corresponding M.A. detectable by Magnetometer. Observed M.A. is always of a composite nature, representing the superposition and interference of anomalies from variously spaced sources. M.A. is positive when the field of a buried source reinforces the Earth's magnetic field, and it is negative when the source's field opposes the Earth's magnetic field (such as strong Remanent Magnetization) or has insignificant susceptibility value (such as salt diapiric bodies). Because of the great difference in Susceptibility values between sedimentary and metamorphic (basement) rocks, most of the anomalies observed at residual magnetic field maps stem from sources at or near the basement surface. [25, 54, 158, 173, 215, 223 , 238]. See also Anomaly, Magnetic Anomaly Amplitude, Magnetic Anomaly Wavelength, and Magnetic Anomaly Shape.

Magnetic Anomaly Amplitude – the relative change in the magnetic field intensity across the survey area governed primarily by two factors: 1) degree of a lateral magnetic susceptibility contrast (as a proportional scale factor: the greater contrast – the higher amplitude); 2) source body depth (as an inverse proportional factor: the deeper source – the smaller amplitude). [215]. See also Magnetic Anomaly Wavelength and Magnetic Anomaly Shape.

Magnetic Anomaly Shape – a component feature of the magnetic field governed by seven factors: 1) geometry of a source body; 2) susceptibility contrast created by a source body; 3) depth of a source body; 4) direction of the Earth's magnetic field at the location of a source body (i.e., Inclination and Declination); 5) direction and intensity of Remanent Magnetization of rocks forming a source body; 6) orientation of a source body with respect to the Earth's magnetic field; 7) azimuth of the observation line with respect to both source body and the Earth's magnetic field. [215]. See also Magnetic Anomaly Amplitude and Magnetic Anomaly Wavelength.

Magnetic Anomaly Wavelength – the dominant wavelength in the power spectrum of an observed magnetic anomaly. M.A.W. is governed primarily by four factors: 1) source depth; 2) source thickness; 3) source lateral extent in "x" direction; 4) source lateral extent in "y" direction. These factors cannot be perfectly separated and, hence, there is no proven technique for uniquely determining the depth of a magnetic source based on its dominant wavelength. M.A.W. provides important insight into source geometry: shallow sources generate short wavelength (high-frequency) anomalies, deeply buried sources generate long wavelength (low-frequency) anomalies. M.A.W. is not affected by changes in the lateral magnetic Susceptibility contrast. [215]. See also Magnetic Anomaly Amplitude and Magnetic Anomaly Shape.

Magnetic Base Station – see Base Station.

Magnetic Basement – an approximation in the magnetic exploration which defines the unconformity upon which the essentially non-magnetic sedimentary cover has been deposited. As a rule, M.B. is magnetically heterogeneous and featured with high values of Susceptibility Contrast. For this reason, M.B. is the major regional magnetic structure that constitutes the dominant component to the observed magnetic field after applying IGRF Correction. Sometimes, the relatively thick sequence of highly magnetic Volcanic Rocks may be considered as equivalent to M.B., because the magnetic effects of deeper source bodies are not resolvable. Quite often, but not necessarily, M.B. is coincident with Crystalline Basement. [173, 195, 215, 223,]. See also Crust, Mantle and Gravity Basement.

Magnetic Compensation System – on-board computerized system to compensate for the magnetic noise from both static and moving (dynamic) components of the survey aircraft. Compensation coefficients are derived from Figure-Of-Merit (FOM). [155]. See also Real-Time Magnetic Compensation System.

Magnetic Component Filter – a space domain line-based filter which resolves the observed magnetic field into its horizontal or vertical components. See also Horizontal Component Filter and Vertical Component Filter.

Magnetic Contact – a boundary or interface (usually Fault) between two basement blocks of contrasting magnetic susceptibilities or between the intrusive body and host rocks both in Basement and sedimentary section. M.C. position can be identified by zero values of Second Vertical Derivative or by maxima values of Horizontal Gradient, Analytic Signal Amplitude or Energy Envelope. Sometimes, M.C. is referred to as Source Edge. [26, 215, 238, 241].

Magnetic Corrections – a series of corrections applied to Observed Magnetics in order to isolate the anomalies caused by the rock Susceptibility variations (i.e., anomalies of exploration interest) from all other Earth's Magnetic Field Components, which contribute to values measured by Magnetometer. See also Correction of Magnetic Data.

Magnetic Dipole – a pair of infinitesimally separated Magnetic Poles of opposite signs. Volume of magnetic material is considered to be an assortment of continuously distributed magnetic dipoles. M.D. is a basic approximation of the magnetically polarized nature of rocks and bodies as well as the Earth as a whole. M.D. is also a model approximation in various inversion methods of location and depth estimates for relatively small isolated bodies. [25, 54, 119, 223, 238]. See Inversion.

Magnetic Domains – microscopically small regions of differently oriented Magnetization within rock grains or crystals. M.D. are magnetized to saturation and represent elementary components of magnetic materials (i.e., magnetized rocks). The creation, size, shape, orientation, and stability of M.D. depend on such physical factors as rock grain size, shape, mechanical conditions (presence of microcracks, inclusions, etc.), and surrounding temperature. Relatively weak external magnetic fields can orient M.D. with this field's present direction, creating Induced Magnetization of a rock material. The strong external magnetic field can align M.D. irreversibly, creating a permanent or, in terms of the geological history, Remanent Magnetization of a rock material. [33, 223].

Magnetic Elevation – a height of Magnetometer sensor (or sensors) above sea level in the airborne magnetic survey. See Elevation.

Magnetic Equator – the approximated line at the Earth's surface where the magnetic lines of force are horizontal and nearly orthogonal to this line. Sometimes, M.E. is called Aclinic Line. [25, 223, 238]. See also Magnetic Poles.

Magnetic Field – a vector field of Magnetic Dipole. Intensity of M.F. is inversely proportional to the distance from its source dipole. [25]. See also Earth's Magnetic Field.

Magnetic Field Logging – direct measurements of the Earth's magnetic field in boreholes. M.F.L. is also used for the vertical gradient measurements and estimates of the depth of isolated magnetic anomalies. [54, 238]. See also Magnetic Susceptibility Logging.

Magnetic Field of the Earth – see Earth's Magnetic Field and Earth's Magnetic Field Components.

Magnetic Field Strength – a measure of the gradient of Magnetic Field. At a point in this field, M.F.S. is mathematically defined as force "H" that will be exerted upon a small fictitious pole if it is placed at the distance "r" from another large and much stronger pole:

$$H = P/mr^2,$$

where "P" is the large pole strength, "m" is a medium constant called Permeability, which depends on the magnetic properties of the medium. [25, 54, 238].

Magnetic Flux Density – see Magnetic Induction.

Magnetic Force – a force "F" between two poles of strengths "P_1" and "P_2" separated by the distance "r":

$$F = P_1 P_2 /mr^2,$$

where "m" is a medium constant called Permeability, which depends on the magnetic properties of the medium where these poles are located. [54, 238].

Magnetic Gradient – a vector quantity describing the spatial rate of change of the magnetic field with respect to a particular direction:

$$M.G. = \underline{i}\, dM/dx + \underline{j}\, dM/dy + \underline{k}\, dM/dz,$$

where "M" is the magnitude of the magnetic field; "$\underline{i}$", "$\underline{j}$" and "$\underline{k}$" are unit vectors. [26, 46, 54, 142, 153, 199, 238]. See Horizontal Gradient, Vertical Gradient and Total Gradient.

Magnetic Gradient Tensor – a 3-D vector quantity that defines a spatial rate change of the three vector components of the observed magnetic field along three mutually orthogonal axes. M.G.T. can be measured by an array of vector magnetometers or by modified SQUID Magnetometer. In airborne applications, M.G.T. components can be derived from either horizontal or vertical magnetic field data obtained with the use of airborne gradiometers or calculated from the observed total magnetic field. M.G.T. is independent of the direction of the Earth's magnetic field. M.G.T. contour maps are capable of providing enhanced and more accurate delineation of the 3-D source body edges and can be used in Boundary Analysis. [170].

Magnetic Gradiometer Survey – a magnetic survey that provides measurements of the horizontal gradient and/or vertical gradient of the Earth's magnetic field. [46, 142]. See also Horizontal Aeromagnetic Gradiometer System and Vertical Magnetic Gradiometry.

Magnetic Gradiometer System – the magnetic acquisition system, designed as an assemblage of horizontally and/or vertically separated magnetometer sensors, to provide measurements of gradients of the Earth's magnetic field. The difference between M.G.S. sensor readings represents the spatial rate of change of the observed magnetic field (i.e., Gradient) along the direction in which sensors are separated. See also Horizontal Aeromagnetic Gradiometer System and Vertical Magnetic Gradiometry.

Magnetic Gradiometry – a method and instrumentation to collect and process measurements of the horizontal or vertical gradients of the Earth's magnetic field. As compared to conventional magnetometry (i.e., measurements of Total Geomagnetic Intensity), M.G. has three main advantages: 1) elimination of noise effects due to temporal changes in the Earth's magnetic field – Diurnals; 2) enhancement of signals due to relatively shallow magnetic sources over those due to deep-seated sources; 3) increased Lateral Resolution of closely spaced magnetic sources by observed gradient anomalies. [171]. See Magnetic Gradient and Magnetic Gradiometer Survey.

Magnetic Grain – coherent and, mostly, mid-frequency and high-frequency magnetic field features on the map of gridded data, which represents magnetic responses of major structural elements in subsurface.

Magnetic Horizontal Gradient Intensity (HGI) – the absolute value of Second Horizontal Derivative (2HD) of the residual magnetic field which is calculated as a difference between Total Magnetic Field and its long-wavelength component representing the regional magnetic effects of the crystalline Basement and deeper portions of Crust. [142, 143]. See also Horizontal Derivative and Regional-Residual Anomaly Separation.

Magnetic Indicators of Hydrocarbon Seepage – see Aeromagnetic Hydrocarbon Indicators.

Magnetic Inclination – see Inclination.

Magnetic Induction – a vector quantity designated by the symbol "B" which defines the total magnetic field including the field within a body. M.I. is the vector sum of the external and internal field strengths:

$$B = m_o (H + M) = m_o(1 + k) H = m_o H,$$

where "H" is Magnetic Field Strength (i.e., magnetizing field); "m" is a medium constant called Permeability; "m_o" is the permeability of free space; "k" is magnetic Susceptibility; "M" is Magnetization. The internal field is a body's own field generated by the poles induced upon the surface of a magnetic rock material when it is placed in the external (Earth's) field. In moderately magnetic materials, M.I. is directly proportional to the external field strength. SI unit of measure for "B" is tesla: 1 tesla = 10^4 gauss = 10^9 gamma = 10^9 nanotesla (nT). [25, 223, 238].

Magnetic Intensity – see Magnetic Field Strength.

Magnetic Latitude – the angle of Magnetic Inclination determined on a smoothed regional basis rather than locally at a point of measurement. [223].

Magnetic Levitation – a basic physical principle of operation of gravimeters with Virtual Spring design, where permanent magnet (proof) mass is maintained in suspended position ("levitates") in the electromagnetic field. The voltage value necessary to maintain the proof mass at the gravimeter's null point is proportional to Gravity Acceleration. [36].

Magnetic Marker – a sedimentary formation (bed) with a high concentration of Syngenetic Magnetite. Magnetic anomalies generated by M.M. can be used to map the sedimentary structures, including potential anticlinal reservoirs. [77]. See also Magnetite and Syngenetic Magnetic Anomaly.

Magnetic Material – a volume assortment of continuously distributed magnetic dipoles within a given rock substance.

Being exposed to any external magnetic field, M.M. becomes magnetized, and its originally random-oriented magnetic dipoles line up in the direction of the applied (external) magnetic field to produce a magnetic field of their own. See also Magnetic Dipole, Magnetic Domain, and Magnetization.

Magnetic Meridian – the vertical plane running through Geomagnetic Field Vector and indicating the direction of the horizontal component of Earth's Magnetic Field. [25, 223]. See also Declination and Inclination.

Magnetic Model – a susceptibility model of a given or assumed geological structure. Geology can be modeled by representing lithological blocks and bodies as equi-susceptibility model units (polygons) formed by contrast boundaries that may or may not correspond to the actual geologic blocks and bodies. Where high susceptibility contrasts exist in nature, M.M. may correspond closely to those geologic blocks and bodies. The condiuional criterion of such correspondence is the satisfactory fit of a model response with the observed magnetic field. See Forward Modeling and Inverse Modeling.

Magnetic Modeling Shapes – basic Causal Body shapes (like horizontal or vertical cylinder, point dipole, monopole or sphere, thin or thick dike, contact and others), which are considered as the most simple of the geometrical forms to be useful for the calculation of magnetic effects in Forward Modeling and for the matching of a computed model with the observed field in the process of Inversion.

Magnetic Moment – a vector parameter of Magnetic Dipole. For magnetic dipoles consisting of two poles of equal strength "P" and opposite signs that are separated by an infinitesimal distance "Dx", M.M. is defined as:

$$M.M. = PDx$$

M.M. direction is along the line connecting the poles and toward North-Seeking Pole. Continuous distribution of magnetic dipoles within a magnetized body results in a quantity defined as M.M. per unit volume and called Magnetization or Intensity of Magnetization. [223, 238].

Magnetic Nose – see Nose.

Magnetic Permeability – see Permeability.

Magnetic Polarization – an effect of the lining up the magnetic dipoles of Magnetic Material by induction due to the presence of the external magnetic field. M.P. is also referred to as Polarization, Magnetization or Intensity of Magnetization. [25, 33].

Magnetic Poles – two points near the opposite ends of a bar magnet toward which the magnetic lines of force are oriented and concentrated. M.P. always exist in pairs. See also Magnetic Dipole and Geomagnetic Poles. [25, 223].

Magnetic Potential – a mathematical function that describes, through its derivatives, Magnetic Field at any given space point. M.P. is a scalar quantity that defines the work to be done in moving a fictitious unit magnetic pole against the magnetic field from the "infinity" to the point in question. [25, 54, 238].

Magnetic Sensor Cable Length Correction – a correction applied to the marine magnetic data to compensate for the distance between the actual position of the magnetic sensor during survey measurements and the navigation point (as well as the position of the on-board gravimeter). M.S.C.L.C. is based on an interpolation procedure which artificially moves the magnetic sensor to the ship (i.e., navigation point) so that magnetic and gravity data can be correlated.

Magnetic Signal – a measured component of the observed magnetic field. M.S. at any observation point is the vector sum of contributions from all geologic source bodies (magnetic sources) that lie within some radius of that point. The radius at which the magnetic source no longer contributes to the total M.S. depends on the size, shape, depth of occurrence and Magnetization of the source body. See also Magnetic Anomaly. [140 , 215].

Magnetic Signature – a combination of a magnetic signal amplitude, Wavelength and response geometry as a distinctive constituent part of Magnetic Grain. Also called Magnetic Anomaly Shape. See also Magnetic Signal.

Magnetic Source Depth – depth to the source of magnetic anomaly, calculated with the use of Depth Rules, or, more often, a set of depth estimates for the near vertical (2-D case) or lateral (3-D case) alignment of sources (approximating heterogeneously magnetized fault or fracture zone or Contact), obtained by applying various Inversion techniques, such as Werner Deconvolution, Euler Deconvolution, Phillips Method, Naudy Method, SPIÔ Method, and others.

Magnetic Storm – short-period irregular fluctuations of the external magnetic field which are greater in magnitude, more irregular and of higher frequency than Diurnal Variations. M.S. occurs during the unusually high sun radiation activity and can have amplitudes of 50 nT to 200 nT and, sometimes, up to thousands of nT. M.S. duration is often several days. During M.S., the exploration magnetic survey should be suspended. [13, 25, 223].

Magnetic Stratigraphy – a method and instrumentation to identify Magnetization and stratigraphic parameters (such as Susceptibility values, thickness, age) of the sedimentary formations due to the presence of Magnetite or other magnetic minerals. M.S. is used for stratigraphic differentiation and cross-well correlation of the target formations based on direct measurements of magnetic susceptibility of rocks in boreholes. M.S. is often referred to as Magnetostratigraphy. [77]. See also Magnetic Marker and Magnetic Susceptibility Logging.

Magnetic Survey – ground, shipborne or airborne (Helicopter Survey or Fixed Wing Survey) measurements of the Earth's Magnetic Field and/or its gradients over the area of exploration interest. Deviations from Normal Magnetic Field as well as various Residual components are attributed to the subsurface distribution of rocks having different Susceptibility and related to geological structures. [223]. See also Satellite Magnetics.

Magnetic Survey Resolution – an amplitude and wavelength resolution, achievable with the use of specific instrumentation, acquisition techniques and noise-suppressing software tools. Present-day instrumentation and software capabilities can satisfy practically all requirements for Amplitude Resolution: magnetometers (most generally, Cesium Magnetometer) operate at a resolution up to 0.001–0.01 nT and a sampling rate 6–20 readings per second in the range of 20,000–100,000 nT; processing algorithms extract target signals from the background and regular noise levels of much higher amplitudes than those of a target signal. Hence, M.S.R. is mainly determined by Wavelength Resolution required for exploring the geological target in the survey area. The wavelength resolution of magnetic survey with the use of Moving Platform is defined as twice grid interval of the gridded data. The Grid Interval is usually selected as $^1/_3$ or ¼ of Line Spacing. Generally, the line spacing is estimated as a function of depth to the subsurface target interval: the shallower the target interval, the closer the line spacing. In mineral exploration (land and airborne surveys) with relatively shallow targets, the line spacing is primarily derived from the expected target size, i.e., the size of the ore body, Kimberlite Pipe, etc. In petroleum exploration (marine and airborne surveys), the target interval is often defined as the whole sedimentary section and the upper part of Basement. For this reason, most HRAM surveys are flown at low heights (120–150 m above the Earth's surface) with 400–800 m Traverse Lines spacing and 1200–2400 m Control Lines spacing. [20, 78, 123, 155]. See also Magnetic Target Resolution.

Magnetic Susceptibility – see Susceptibility.

Magnetic Susceptibility Logging (MSL) – measurements of rock susceptibility in boreholes with the purpose of improved stratigraphic differentiation and cross-well correlation. Both local and regional stratigraphic correlation is possible based on the differentiation of Sedimentary Rocks according to their measured magnetic Susceptibility. [22].

Magnetic Susceptibility Meter – a portable, high-sensitivity electronic device to measure Susceptibility values on rock outcrops, core samples and laboratory samples, with Accuracy of about 10^{-5} SI units (10^{-6} cgs units). Measured values are stored in M.S.M. digital memory. An installed microprocessor controls a display (digital or graphic-analog), auto-ranging and auto-calibration. As an option, M.S.M. has an interface to store magnetic susceptibility readings on a computer disk for subsequent processing and analysis.

Magnetic Target Resolution – an amplitude and wavelength resolution required for objective identification of anomalies caused by a geological target in the survey area. A generalized table of M.T.R. is shown below. [20, 78, 123].:

Target	Amplitude Resolution	Wavelength Resolution
Regional tectonic structure and basement	1.0 – 5.0 nT	20 km spacing 5 – 8 km grid
Basement structures, faults and lineaments, volcanics and salt	0.5 – 2.0 nT	2 – 5 km spacing 1 – 2 km grid
Detailed faulting, basement structure, salt edges, 2-D and 3-D modeling	0.1 – 0.5 nT	0.1 – 1.0 km spacing 0.05 – 0.25 km grid
Ore bodies, kimberlite pipes, etc.	0.005 – 0.1 nT	0.05 – 0.2 km spacing 0.025 – 0.05 km grid

See also Magnetic Survey Resolution.

Magnetic Terrane – an area of regional extent where the anomalous lineament pattern differs from that of surrounding or adjacent areas. Magnetic terranes are assumed to be limited by the ancient plate tectonic boundaries.

Magnetically Levitated Accelerometer – see Magnetic Accelerometer and Virtual Spring.

Magnetically Susceptible Intra-sedimentary Unit – a local zone of high magnetization within the sedimentary section. M.S.I.U. is often represented by volcanics (i.e., Volcanic Rocks), magmatic intrusions (such as sills, batholites, etc.) and, sometimes, by porous hydrothermal dolomites or extensively fractured rock formations with a history of repeated migration of highly mineralized fluids, which resulted in the occurrence of significant concentrations of strongly magnetic minerals like Magnetite. [51, 115, 191]. See also Magnetized Intra-sedimentary Fault and Plutonic Water.

Magnetically Transparent Fault – an intra-sedimentary or, sometimes, upper basement fault without Magma infill or the history of repeated fluid flows. M.T.F. may have a low magnetization which is not sufficient to generate magnetic anomaly detectable by HRAM surveys. Often, long M.T.F. can be detected using the criteria for Interruption Zones. A fault detected by seismic data can often be a M.T.F.

Magnetics Filters – a term used in some software packages to define processing operators that calculate and apply Reduction-To-Pole or Reduction-To-Equator to the observed magnetic data.

Magnetite – a strongly magnetic mineral (Fe_3O_4), which is a very common and widely distributed accessory mineral in rocks of all kinds. M. has the highest Susceptibility value among all rocks and minerals ranging from 1200 to 19,200 with the average of 6000 (in units of 10^3 SI). The volume content of M. in Sedimentary Rocks is the dominant parameter of their magnetic properties. There are four main types of M. defined based on its origin in the sedimentary section: 1) detrital M. deposited in sandstones; 2) diagenetic M. formed as a replacement mineral or through hydrothermal alteration; 3) M. formed as a part of the near surface weathering processes (i.e., place deposits in drainage systems or beach sands); and 4) M. formed in the medium-oxidation, low-pressure geologic environments of faults and fracture zones with a history of repeated vertical migration of highly mineralized fluids. Outcrops and unconformity truncations of the magnetite-bearing layers generate [1, 13, relatively intensive high-frequency (short wavelength) alignments on maps of the filtered magnetic data. 55, 61, 62, 77, 110, 231]. See also Magnetized Intra-sedimentary Fault.

Magnetization – a vector quantity that defines Magnetic Moment per unit volume. M. is a measure of a rock's ability to be magnetized by the Earth's magnetic field: originally random-oriented elementary dipoles within a rock body are lining up in the direction of the Earth's magnetic field creating a magnetic field of their own, i.e., induced magnetic field. The extent of this lining up is directly proportional to the strength of the Earth's field and/or any other applied magnetic field at the date of M.:

$$M = kH,$$

where, "H" is the magnetizing field (Magnetic Field Strength); "k" is the magnetic Susceptibility. Generally, rocks are magnetized by two mechanisms: 1) Remanent Magnetization, which may date from any time and may point in any direction; 2) Induced Magnetization, which points in the direction of the present Earth's magnetic field. As a result, M. of any rock is a vector sum of the two magnetization types – remanent M. and induced M. Sometimes, M. is referred to as Magnetic Polarization or Intensity of Magnetization. [25, 33, 38, 59, 93, 223, 238].

Magnetized Intra-basement Fault – an intra-basement fault filled with intrusions of strongly magnetic igneous rocks. Such faults generally give rise to relatively high-intensity, high-frequency and mid-frequency (short-wavelength and mid-wavelength) magnetic anomalies, which are reliably identified and mapped with HRAM survey data. In magnetic processing and interpretation, M.I.F. is approximated by either Thin Dike or Thick Dike models. [18, 20, 71, 215]. See also Fault, Intrusion, and Magnetized Intra-sedimentary Fault.

Magnetized Intra-sedimentary Fault – an intra-sedimentary fault with a history of the repeated vertical migration of highly mineralized fluids, which resulted in the occurrence of high concentrations of strongly magnetic minerals, like magnetite, along and around the fault plane. M.I.F. usually generates low-intensity, high-frequency (short-wavelength) magnetic anomalies, which can be identified with HRAM survey data after applying appropriately designed Cascaded Filtering. In magnetic processing and interpretation, M.I.F. is approximated by Thin Dike model. [1, 51, 81, 191, 192]. See also Fault and Magnetized Intra-basement Fault.

Magnetometer – an instrument for measuring the total intensity and other components of the Earth's magnetic field. In airborne and ground gradiometry surveys, the arrangements of magnetometer sensors are used to measure simultaneously Horizontal Gradient or Vertical Gradient as well as the total magnetic field. [25, 223]. See Cesium Magnetometer, Fluxgate Magnetometer, Optically Pumped Magnetometer and Proton Precession Magnetometer.

Magnetometer Calibrations – a set of tests of the airborne magnetometer readings performed by measuring: a) known magnetic field (pre-survey M.C.); b) effects of the aircraft and flight lines' orientation on magnetometer sensors (on-site M.C.). See also Heading Test and Figure-Of-Merit (FOM).

Magnetosphere – the Earth's outer zone of interaction between Solar Wind and the Earth's internal magnetic field. On the sunlit side M. is almost hemispherical, with the radius of about ten radii of the Earth under quiet conditions (it may be compressed to about six Earth's radii by Magnetic Storm). On the shadow side, M. may have a "tail" extent of more than a hundred Earth's radii. [13, 25, 223]. See also Ionosphere.

Magnetostratigraphy – see Magnetic Stratigraphy.

Magnitude – a measure of the anomaly or field intensity assigned to a quantity so that it may be compared with other similar anomalies or fields. Commonly, M. is considered as the reference equivalent of Amplitude. [215].

MagProbe™ – a profile-based automated inversion program of LCT Inc. that applies Werner Deconvolution, 2-D Euler Deconvolution and Phillips Method in a batch mode to obtain a cross-section of estimates of the magnetic sources' locations and depths ("magnetic depth section") along each of the magnetic survey lines. See also SPI Method and Improved SPI Method.

MagSlice Image – see Pseudo-Depth Slice.

Maneuver Noise – an aircraft motion-induced noise measured during Compensation Flight with Roll, Pitch and Yaw maneuvers.

Mantle – the Earth's subsurface interval between Crust and the Earth's core. M. density is estimated about 3.3–3.4 g/cm^3. M. is considered essentially non-magnetic, because temperatures at those depths exceed Curie Temperature. Below M. is Core. [13, 25, 223].

Map Convolution – see Grid Residual Method.

Map Filtering – applying variously designed two-dimensional filters to grids (maps) of the potential field data. The purpose of M.F. is the separation of anomalies of different sizes from each other to better define the anomalous trends, lineaments and other features that are not easily detectable or completely obscured on the original map. The most common M.F. is performed by wavelength filters applied either in Space Domain or Frequency Domain. See Lateral Separation, Vertical Separation and Wavelength Filter.

Map Power Spectrum – a presentation of Power Spectrum of the Fourier transformed gridded magnetic data as a function of direction. M.P.S. plots the highest magnetic energy of an infinitely small Wavenumber or Spatial Frequency (i.e., zero frequency) at the center descending out to some pre-selected value of Nyquist Frequency (often 0.5) at the edges; instead of the Nyquist fractions, wavenumbers may also be used as distance units. M.P.S. is imaged in order to estimate the quality of Leveling and Cultural Editing, monitor the effectiveness of applied filtering procedures, control Aliasing effects, and identify the strike of dominant structural trends. It should be noted that linear features on the spectral-domain M.P.S. are orthogonal to the linear space-domain features to which they correspond. Sometimes, M.P.S. is called Energy Rosette. See also Power Spectrum and Radial Power Spectrum.

Map Projection – a transfer of positions of the measurement points on the ellipsoidal surface of the Earth to corresponding points on a flat sheet, i.e., from spheroid (ellipsoid) points to the grid coordinates on a map. More than 250 different map projections are currently in use worldwide. See Universal Transverse Mercator (UTM).

Marine Gravimeter – see Shipboard Gravimeter.

Marine Magnetometer – see Overhauser-Effect Magnetometer.

Matched Filtering – a spectral domain grid-based separation-type filtering method which uses Power Spectrum parameters to design the filter operator. Provided there are distinct linear slopes in the spectrum image representing the effects of different depth source ensembles, these effects can be separated by M.F.: the Fourier transformed data are multiplied by the calculated transfer function "W" and then converted back to the original space domain by Inverse Fourier Transform. Matched filter transfer function "W(r)" is defined as:

$$W(r) = 1/\{1 + b/B[\exp(H - h)r]\},$$

where "h" is an average depth of the shallow source ensemble defined by the linear slope of the high-frequency part of the spectrum curve ; "H" is an average depth of the regional (i.e., deep seated) ensemble defined by the linear slope of the low-frequency part of the spectrum curve; "b" and "B" are the amplitude constants (energy axis intercepts by the high-frequency and low-frequency lines) for the shallow and deep source ensembles respectively; $r = (u^2 + v^2)^{1/2}$ where "u", "v" are Cartesian Coordinates. Parameters "b", "B", "h", and "H" are obtained from the power spectrum image. M.F. is also referred to as Spectral Matched Filtering or Depth Slice Filtering. [48]. See also Separation Filtering.

Maximum Depth Rule – see Bott-Smith Method.

Maximum Entropy Method – an interpolation method applied to the gridded potential field data to calculate missing values for gaps in Grid using an algorithm of linear preduction from segments of rows and columns in the original dataset.

Maximum Entropy Prediction (MEP) – a convolution method for interpolating the observed data within Grid as well as near grid edges. MEP calculates a data function with the same Spectrum as the original data, while reducing Ringing effects that might appear with traditional convolution methods. See also Maximum Entropy Method and Edge Effect Correction.

Mean Sea Level (MSL) – the average height of the sea surface for all stages of the sea tide over a 19-year period. MSL is often referred to as Sea Level. [13].

Measured Vertical Gradient – Vertical Gradient obtained during the magnetic survey with the use of two vertically separated magnetometer sensors on the same aircraft. M.V.G. value is obtained by subtracting the bottom sensor readings from the top sensor readings, and then dividing the result by the sensor separation distance. No diurnal correction of M.V.G. data is required, when acquired on a single aircraft. An alternative approach is to fly two surveys, both corrected for Diurnals, at different elevations. [155]. See also Calculated Vertical Gradient.

Median Filter – see Local Median Filter.

MEP – see Maximum Entropy Prediction.

Merging – see Grid Merging.

Metamorphic Rocks – rocks which have derived from the pre-existing rocks by mineralogical, chemical and/or structural alterations in response to changes in temperature, pressure, shearing stress and chemical environment. Magnetization and density of M.R. is higher (sometimes, significantly) than that of Sedimentary Rocks. The average estimate of 61 types of M.R. gives the range of susceptibility values from 0 to 70 with the average of 4.2 (in units of 10^3 SI). [13, 33, 238]. See also Igneous Rocks.

Metamorphic Rocks Density – the basic quantity that predetermines the gravity properties of metamorphic rocks. Usually, M.R.D. values increase with the degree of metamorphism since this process fills pore spaces and recrystallizes the rock into a more dense form. Thus, metamorphosed sedimentary and igneous rocks have generally higher densities. M.R.D. variations are more diverse than that of sedimentary and igneous rocks because of their complicated geological history. [33, 238]. Generalized table of the common M.R.D. values is shown below (in g/cm^3)

Rock Type	Range	Average
amphibolite	2.90 – 3.04	2.96
gneiss	2.59 – 3.00	2.80
quartzite	2.50 – 2.70	2.60
schist	2.39 – 2.90	2.64
serpentine	2.40 – 3.10	2.78
slate	2.70 – 2.90	2.79

Metamorphic Rocks Susceptibility – the basic quantity that predetermines the magnetic properties of metamorphic rocks. M.R.S. values are usually low as compared to those of Igneous Rocks but significantly higher (in average, up to 10 times and more) than susceptibility values of Sedimentary Rocks. Generalized table of the common M.R.S. values is shown below (in units of 10^3 SI):

Rock Type	Range	Average
amphibolite	–	0.7
gneiss	0.1 – 25.0	–
quartzite	–	4.0
schist	0.3 – 3.0	1.4
serpentine	3.0 – 17.0	–
slate	0.0 – 35.0	6.0
Average of main types	0.0 – 70.0	4.2

S.I. susceptibility unit = 4B c.g.s. susceptibility unit. [33, 238]. See also Igneous Rocks Susceptibility and Sedimentary Rocks Susceptibility.

Microgravimetry – gravity measurements within the range of several dozens of microGals and less, i.e., about (5-100) 10^{-3} mGal. M. can be used for detection of subsurface cavities, investigations of foundation conditions, exploring stratigraphic traps, as well as waterflood surveillance at oil fields under development. [30, 32, 105, 255]. See also Time-Lapse (4-D) Gravity Survey and Earth Tides.

Microgravity Modeling – a) a method of Inversion, which is based on 4-D time-lapse gravity survey data and used to obtain a reservoir density model with the purpose of waterflood surveillance; b) a method of Forward Modeling, which is based on reservoir simulations and used to estimate the change in anomalies observed at the surface over periods of years after the water injection was initiated. [105]. See Time-Lapse (4-D) Gravity Survey.

Microgravity Survey – see Microgravimetry.

Microleveling – a) variety of profile or grid-based processing schemes which minimize very small (about 1nT or less) residual line-to-line level shifts in the magnetic data remaining after imperfect removal of the time-dependent diurnal variations, uncertainties in the altitude of the survey flight and gridding errors; b) term used to describe the process of making precise elevation surveys to measure temporal changes in elevation due to faulting, volcanic activity or petroleum reservoir depletion. [67, 160, 187]. See also Decorrugation and Leveling.

Microleveling Discontinuities – short wavelength local artificial anomalies of about a grid cell size which are the residual errors of extrapolation procedures applied during Microleveling. As a rule, M.D. can be effectively smoothed out by high-cut Line Filtering.

Microleveling Filters – a group of filters applied to assist in performing Microleveling. See Cascaded Filtering.

Micropulsations – a time-varying external components of the observed Earth's Magnetic Field having small amplitudes (usually, less than 10 nT) and frequency range from 0.01 to 3 Hz. M. with amplitudes up to tens of nanotesta result from interactions between Solar Wind and the Earth's magnetic field. [223]. See also Bay and Magnetic Storm.

MilliGal (mGal) – a unit of the gravity field acceleration used in the gravity exploration measurements. 1 mGal = 10^{-3} Gal = 10^{-3} cm/sec^2 = 10^{-5} m/sec^2. State-of-the-art gravimeters provide measurements with Accuracy of 0.01 [174, mGal or higher, which is a variation of less than one part in one hundred million of the total gravity field. 223]. See also Gal, Microgravimetry and Time-Lapse (4-D) Gravity Survey.

MilliGal Constant – a gravimeter instrument parameter used to convert gravimeter readings from counter (dial) units to milligals. M.C. is determined by the manufacturer during gravimeter calibration. See also Interval Factor and MilliGal.

Minettes – deeply sourced igneous intrusives that comprise dikes, sills and small extrusive vent complexes of Mafic Rocks. As a rule, M. have relatively high magnetization properties. M. are related to kimberlites, but they are not usually diamondiferous. See Kimberlite Pipe.

Minimizing Inversion – a methodology that divides the subsurface into a large number of fixed size cell of unknown susceptibility or density values. Inversion algorithm produces a single 3-D model by minimizing Objective Function, which approximates the subsurface structure based on available geological and geophysical information. The minimizing algorithm initiates the iterative process constrained by pre-selected misfit between Model Response and the observed data. The final 3-D model represents a spatially dependent distribution of density or susceptibility value in subsurface. [144]. See Inversion and Parametric Inversion.

Minimum Curvature – a gridding algorithm that computes the best fit surface passing through the observed data points by iteratively solving a set of difference equations to minimize the curvature of this surface. Original data values are used to control successive iterations and final surface construction. M.C. is also referred to as a method of the grid data smoothing. [28, 68]. See also Grid, Gridding, and Bidirectional Gridding.

Misclosure – see Mis-Tie.

Mis-Tie – a difference in data values obtained at identical points on intersections of Traverse Lines and Control Lines. Mis-ties are minimized in the process of Leveling. Remaining residual errors are eliminated by Decorrugation. See Crossovers.

Model – a conceptual approximation of the subsurface object or structure by one or an arrangement of simple geometric forms. Calculated effects from simple models help to develop better understanding of the observed magnetic or gravity fields. The concept of M. is based on the fact that, at depths comparable with horizontal dimensions of subsurface objects, the magnetic and gravity effects from bodies with irregular boundaries can be simulated by models with simple geometric forms. There are three main types of models: 1) 2-D (two-dimensional) M. meaning the “infinite” length in the strike direction; 2) 2.5-D (two-and-one-half dimensional) M. meaning each body is limited and symmetrical in the strike direction or 2.75-D (two-and-three-quarters) M. meaning the same as 2.5-D, but strike symmetry is not required; and 3) 3-D (three-dimensional) M. meaning all bodies are defined in three dimensions with the edges of the model space carried to “infinity.” Often, several different models give responses that match the observed gravity or magnetic field. However, much ambiguity can be eliminated by using available geological and geophysical data as model constraints. [215, 223]. See also Gauss Theorem, Inversion, Forward Modeling, Magnetic Modeling Shapes, and Gravity Modeling Shapes.

Model Response – a potential field calculated from the assumed distribution of densities or susceptibilities in subsurface. See Model and Forward Modeling.

Modified 2VD Filtering – a second vertical derivative (2VD) filter method which uses an additional Gauss Filter operator to attenuate wavenumber components of the observed potential field data which are close to Nyquist Wavenumber. The degree of attenuation in the wavenumber domain is controlled by the Gauss filter amplitude factor: the higher this factor, the more of the higher wavenumbers are attenuated. [48]. See Second Vertical Derivative.

Modulus – the positive square root of the sum of three squared spatial (in “x”, “y” and “z” directions) terms of a vector quantity. [223].

Monopole – a model approximation of Magnetic Dipole by such a dipole where one of its poles is "infinitely" away from another pole. Like many other approximations, magnetic M. does not exist in nature. Magnetic M. is used in estimates of location and depth of near vertical sources, e.g., cased wells and igneous rock intrusions like Kimberlite Pipe. [54, 125, 238]. See also Magnetic Body Shapes.

Motion Noise – unwanted airborne survey signals caused by Pitch, Roll and Yaw of the survey aircraft. See Motion Sensor.

Motion Sensor – an electronic device installed in aircraft to measure the aircraft's motions during a flight for Post Flight Quality Control data analysis. In airborne magnetic survey, a three-component Fluxgate Magnetometer is often used in the capacity of a M.S. See Motion Noise.

Moving Platform – a general definition of a ship, helicopter, fixed-wing aircraft, or orbiting satellite used as carriers in gravity or magnetic surveys. M.P. is also referred to as Observation Platform. See Stabilized Platform.

MSL – see a) Magnetic Susceptibility Logging and b) Mean Sea Level.

Multi-Sensor Gradient Array – a configuration of magnetometer sensors providing vertical, horizontal, and/or three-axis (XYZ) gradiometer measurements in, mostly, helicopter-supported surveys for ultra-detailed geological mapping (such as intrusive body zonation or alterations in the ore body), environmental, engineering, and military applications. See also DiaMagÔ.

N

N-km Regional (Residual) Gravity – a map of the regional or residual gravity field calculated using the data averaging radius of N-km. See Griffin Method.

Nabighian's Algorithm – a mathematical procedure that calculates Vertical Derivative of the residual potential field from its horizontal derivatives in "x" and "y" directions using the generalized Hilbert Transform. [164, 165, 166].

NAD 83 – the North American Datum 1983, which is the geocentric Ellipsoid accepted as the official frame of reference for all locations in North America. [223].

Nanotesla (nT) – a unit of Magnetic Flux Density stating the magnitude of the magnetic field vector represented by the number of lines of Magnetic Induction passing through a unit area perpendicular to the vector direction. Magnetic survey maps are now contoured in nanoteslas. 1 nT = 10^{-9} tesla = 10^{-5} gauss = 1 gamma. [215, 223 , 238]. See also Gamma.

Natural Remanent Magnetization – see Normal Remanent Magnetization.

Naudy Filter – a space domain line-based or grid-based filter which operates by detecting anomalies of wavelengths shorter than the defined window length, and then removing these anomalies by the extrapolation over them from the nearest adjacent data values. The user specifies the window length (in meters or data points) which corresponds to the maximum width of anomalies to be identified as high-frequency components. N.F. is commonly used for elimination of high-frequency noise as well as spikes in the process of Microleveling. [56]. See also Decorrugation.

Naudy Method – an automated profile-based depth estimation method wherein the anomaly type and location are indentified by cross-correlation of the observed magnetic profile with theoretical anomalies. Depth to a dike-like or plate-like source is then estimated from the relating source body's anomaly parameters such as half-width or others. N.M. option for manual calculations involves measuring the slope, amplitude and distance features of the magnetic anomaly profile and looking for the best fit of obtained values to theoretical values calculated for vertical dikes. In this case, it is referred to as Inflection-Tangent-Intersection (ITI) Method. [168, 223]. See also Depth Rules.

Nettleton Test – an evaluation of different values of the average rock density between Datum (usually, sea level) and Station elevation in order to select a "true" value (i.e. Density Factor) for Elevation Correction. After Theoretical Gravity Correction has been applied to the observed gravity data, a set of the gravity profiles is constructed over a prominent topographic feature in the survey area. Generally, profiles with accepted lower density values (as compared to the "true" density) have a curtain similarity with topography (undercorrection case); profiles with accepted higher density values have a mirror-like, i.e. inverted similarity with topography (overcorrection case). The profile with a "true" density value has a very little or no correlation with topography.

Neural Network – a general definition of the processing algorithms whose operational principles are similar to those of the brain's nervous systems. Following the "training" with series of input values (patterns) and corresponding output values (definition of patterns), the N.N. algorithm is able to recognize the patterns through the generation of specific logical rules based on associative memory. Along with pattern recognition, classification and statistical evaluation of data, N.N. algorithms can be used effectively in the modeling of complicated geological structures. [188, 215].

Newton's Gravitational Constant – see Universal Gravitational Constant.

Newton's Gravity Law – see Newton's Law of Gravitation.

Newton's Law of Gravitation – the expression of the force of gravitation, which is the basis for the gravity measurements. N.L.G. states that the force "F" between two masses "M_1" and "M_2" is directly proportional to the product of these masses and inversely proportional to the square of the distance "R" between the centers of masses:

$$F = -GM_1M_2/R^2,$$

where "G" is Universal Gravitational Constant and the minus sign indicates that this force is always attractive. The force "F" is a vector directed toward the attracting mass. [25, 223, 238].

Newtonian Potential – see Gravity Potential

Noise – any unwanted, usually, high-frequency (short-wavelength) components of the observed data. N. often appears due to more or less random inhomogeneities in the surface and near-surface distribution of density or magnetic materials as well as a result of regular processing errors, such as aliased Gridding and poor Leveling, and effects of a cultural (man-made) nature such as pipelines, wellheads, power lines etc. Sven Treitel made the observation that "there is no such thing as noise, it really is only uncorrelated data." [219]. See also Aliasing.

Noise Grid – a resulting Microleveling error grid, containing elongated anomalies (line Corrugations) and obtained after applying Directional Filters to the standard leveled magnetic grids. N.G. is subtracted from original grid to get a microleveled, corrugation-free grid. See One-Dimensional (1-D) Directional Filtering and Two-Dimensional (2-D) Directional Filtering.

Non-Dipole Field – the portion of the Earth's magnetic field not representable by Magnetic Dipole approximation.

Non-Magnetized Fault – see Magnetically Transparent Fault.

Non-Stationary Filtering – a filtering with the use of a filter operator whose impulse response varies in a controlled fashion over the area of data processing. See also Stationary Filtering.

Non-Stationary Transform – a transform procedure that decomposes input signal (for example, gridded potential field data) on a grid of both space and wavenumber. N.-S.T. is an alternative to the conventional Fourier Transform, which decomposes input signal only in a single dimension of frequency (wavenumber). Wavelet Transform is an example of N.-S.T.

Normal Gravity – see Normal Gravity Field.

Normal Gravity Field – an approximation of the Earth's gravity field at Mean Sea Level based on International Gravity Formula. [25, 211, 238]. See Latitude Correction.

Normal Magnetic Field – a smooth large-scale component of the observed Earth's magnetic field that represents its main (core) component and is free of anomalies of exploration interest. N.M.F. is often referred to as International Geomagnetic Reference Field or IGRF. [223]. See Earth's Magnetic Field Components.

Normal Remanent Magnetization (NRM) – a general term of the residual magnetization (R.M.) of rocks which basically includes five main types: Chemical R.M., Detrital R.M., Isothermal R.M., Thermal R.M. and Viscous R.M. Often, N.R.M. is referred to as Natural Remanent Magnetization. [33, 238].

Normalized Map Power Spectrum – a map power spectrum after applying the radial sweep normalization which suppresses radial variations in the power spectrum and enhances its directional trends. See Map Power Spectrum.

Northing – a component of the survey leg in the north direction from an east-west reference line, usually, the Equator. On maps and grids in Cartesian Coordinates, it may be expressed as an "Y" value. See also Easting, False Easting and False Northing.

North-Seeking Pole – a positive pole of Magnetic Dipole which is attracted towards the Earth's north magnetic pole. See also South-Seeking Pole. [238].

Nose – a gravity or magnetic anomaly for which contours do not close, i.e. Gravity Nose or Magnetic Nose. [223].

Nuclear-Precession Magnetometer – see Proton Precession Magnetometer.

Nyquist Fraction – a unit parameter often used in displays of Radial Power Spectrum and Map Power Spectrum. This parameter defines decimal fractions of Nyquist Frequency, from 0 to 1, to describe spectral characteristics of the observed or filtered potential field data.

Nyquist Frequency – a data sampling parameter which is equal to a half of Sampling Frequency (S.F.) which is the reciprocal of Grid Interval (G.I.):

$$N.F. = S.F./2 = 1/2\ G.I.$$

For gridded data sampled as one data point per Grid Cell and in accordance with the Nyquist theorem, N.F. defines the highest frequency (shortest wavelength) which can be indentified (resolved) with a selected grid cell size, i.e., grid interval. All wavelengths shorter than the selected grid interval (i.e., spatial frequency components of the potential field which are higher than N.F.) cannot be identified as there is no data between grid cell centers, and they may be aliased. Sometimes N.F. is referred to as Folding Frequency. [223]. See also Aliasing, Nyquist Theorem, Nyquist Wavenumber and Nyquist Wavelength.

Nyquist Theorem – see Sampling Theorem.

Nyquist Wavelength – a data sampling parameter used with the same meaning as Nyquist Frequency, because of the conceptual analogy between Frequency as a time-domain characteristic and Wavelength as a space-domain characteristic. Generally, N.W. is defined as a quantity equal to two times Sampling Interval. Similarly, for the gridded data it equals two times Grid Interval (G.I.):

$$N.W. = 2\ G.I.$$

Wavelengths smaller than this threshold are indistinguishable and may be aliased. Aliasing can be reduced if N.W. is decreased, i.e., sampling interval is made smaller. [25]. See also Nyquist Frequency and Nyquist Wavenumber.

Nyquist Wavenumber – a sampling quantity used in Discrete Fourier Transform and defined as a half of Sampling Wavenumber:

N.W. = B /)x,

where "Dx" is Sampling Interval. Sometimes, N.W. is referred to as Folding Wavenumber. [25]. See also Nyquist Wavelength and Nyquist Frequency.

O

Objective Function – a 3-D integral function which, being minimized, produces a 3-D model of the subsurface structure as a result of Minimizing Inversion. Mathematically, O.F. can be defined by a sum of integrals combining the initial (i.e., reference) model approximation parameters with spatially dependent weighting functions and their corresponding coefficients that affect the relative importance of different model components. O.F. has the flexibility of constructing various models and incorporating into Inversion process of additional information other then gravity or magnetic data. [144]. See also Parametric Inversion.

Observation Platform – see Moving Platform.

Observed Gravity – the Earth's gravity field attraction (acceleration) value measured at any point on or above the Earth's surface. O.G. is the sum of various components that contribute to the measured value (the name of a corresponding correction for each component is shown in parenthesis):

O.G. = attraction of Reference Ellipsoid (Theoretical Gravity Correction)

+ effect of elevation above or below sea level (Free-Air Correction)

+ effect of mass between sea level and level of observation (Bouguer Correction)

+ effect of mass above and/or below observation point (Terrain Correction)

+ time-dependent variation (Tidal Correction) + effect of moving

observation platform in marine and airborne surveys (Ëotvös Correction)

+ effect of masses that support topographic loads (Isostatic Correction)

+ effect of Crust density variations (i.e., effect of local and regional geological structures).

The purpose of Gravity Corrections is to isolate the last component in this formula. The gravity acceleration due to the Earth's mass is about 9.8 m/sec^2 (980 Gal), whereas the crustal density variations are about 10^{-3} m/sec^2 (100 mGal) or less, i.e., the gravity anomalies of exploration interest are less than 0.01% of O.G. [25].

Observed Magnetics – the sum or integrated effect of the following components, which contribute to the value measured at any point on or above the Earth's surface: 1) Earth's main (core) magnetic field; 2) Earth's local (regional and residual) magnetic field; 3) irregular solar radiation energy pulsations (Magnetic Storms); 4) regular fluctuations of the Earth's external magnetic field due to solar radiation activity (Diurnal Variations); 5) man-made effects (Cultural Noise). The purpose of Magnetic Corrections is to isolate the second component, i.e., local magnetic field. The Earth's main magnetic field varies from 70,000 nT at magnetic Poles to 25,000 nT at magnetic Equator, whereas local magnetic field varies from 0.1 to 100 nT over magnetically quiet, deep sedimentary basins up to several thousand nT over highly magnetized crystalline basement outcrops, i.e., the magnetic anomalies of exploration interest, in average, are less than 2–10% of the Earth's main (core) magnetic field, which is the dominant component of O.M. [54, 238]. See Earth's Magnetic Field Components.

Oceanic Crust – see Crust.

Octave – an interval between two Spatial Frequency or Wavelength values having a ratio of two (i.e., 1200 m and 2400 m in wavelength values). O. is used to define filter response parameters. [223]. See Cutoff Wavelength

Width.

Offleveling Errors – the airborne gravity measurement errors that result from high-amplitude horizontal accelerations of the survey aircraft due to course changes or turbulence, which drive the gravimeter gyro-stabilized platform offlevel. [37]. See also Aerogravity Corrections and Stabilized Platform.

Offset Zones – see Interruption Zones.

One-Dimensional (1-D) Directional Filtering – a space-domain Microleveling technique which is based on the use of 1-D directional filters applied to the standard leveled magnetic grid. At first, the original grid is low-pass filtered in the traverse-line direction with a wavelength Cutoff value greater than the tie-line spacing. Then, this grid is high-pass filtered with a wavelength (cut-off value) 2 to 4 times the traverse-line spacing in the direction of the control lines. The obtained raw leveling error grid containing the elongated anomalies ("line corrugation") is subtracted from the original grid to obtain the final 1-D directional filtered grid. [67]. See also Two-Dimensional (2-D) Directional Filtering.

One-Dimensional Fast Fourier Transform (1-D FFT) Filters – a group of Fourier Domain filters that are applied to the line (i.e., one-dimensional) gravity or magnetic data. These filters are also referred to as Channel Filters or Line Filters. See also Two-Dimensional Fast Fourier Transform (2-D FFT) Filters.

One-Dimensional Fast Fourier Transform (1-D FFT) – a mathematical procedure that converts the line (profile) gravity or magnetic data from their original Space Domain into the equivalent Frequency Domain. After 1-D FFT, gravity and magnetic profiles can be analyzed for their frequency (wavelength) content. See also Fourier Transform.

On-Site Magnetometer Calibrations – a set of tests of the airborne magnetometer readings made prior to the commencement of routine survey flying and whenever the configuration of aircraft and/or magnetometer system was altered. The following tests are usually made: Compensation Test, Lag Test and Heading Error Test. These tests are also referred to as Pre-Survey Magnetometer Calibrations. [58]. See also Figure-Of-Merit (FOM).

Operating Range – an instrument characteristic that defines a difference between the largest and the smallest possible measurement values.

Optically Pumped Magnetometer – a cesium-vapor or rubidium-vapor Magnetometer that measures the Earth's magnetic field using the nuclear magnetic resonance between the frequency of precessing atoms in vapor cells, excited by the monochromatic polarized light, and the transverse radio-frequency field at Larmor Frequency. The achievable accuracy is up to 0.001 gamma and far exceeds the requirements of the contemporary exploration efforts. [57, 223]. See also Cesium Magnetometer, Fluxgate Magnetometer and Proton Precession Magnetometer.

Optimum Filtering – a filter procedure which pre-supposes the knowledge of a desired output (for example, such as a level of irregular noise to be suppressed) and involves the application of individually designed filters for each processing problem. See Wiener Filter.

Outer Terrain Correction – see Outer Zone Terrain Correction.

Outer Zone Terrain Correction – a correction applied to the gravity data to compensate for the deviation of the surface topography from flat Bouguer Slab approximation by using a Zone Chart where the outermost radius equals 21,826 ft (7270 m) and the innermost radius equals 558 ft (186 m). See Terrain Correction and Inner Zone Terrain Correction.

Overhauser-Effect Magnetometer – a high-sensitivity magnetometer of a proton-precession type. The proton nuclei are aligned with and precess about the Earth's magnetic field by interaction with free electrons which are brought to a resonance through the excitation by a VHF field. The frequency of a proton nuclei precession (i.e. Larmor Frequency) is measured to determine the value of the Earth's magnetic field. O.-E.M. is used in the marine magnetic surveys, often, combined with the seismic acquisition system. In this case, O.-E.M. is towed behind a seismic tail buoy to provide operation in the magnetically quiet zone. Also referred to as Marine Magnetometer and Tail-Buoy Magnetometer. See also Proton Precession Magnetometer.

Overhead Point – a Sun Angle Image parameter which defines the center of the image shown in the display window. See also Sun Declination and Sun Inclination.

P

Padding – an extension of discretely sampled data with zero values in order to accomplish Linear Convolution in computation of filtered data values and eliminate Wraparound Effect. [148]. See FIR RTP Filter.

Paleomagnetism – the history of the Earth's magnetic field as recorded in the magnetic properties of rocks. Paleomagnetic studies indicate that the Earth's magnetic field has varied in its magnitude and has reversed its polarity several times in the geological past. [223, 238]. See Remanent Magnetization.

Parallax Correction – one of the leveling corrections which is applied to airborne data to compensate for relatively small errors in the recorded geographical location of the readings due to a horizontal distance separating aircraft and a cable-towed sensor unit called a Bird. P.C. is also used to describe the time delay that may exist between the time a navigation position is recorded and the time the corresponding geophysical measurement is recorded. [85]. See Lag Test.

Paramagnetics – weakly magnetized rock materials. Paramagnetism is due to the electron spin of unpaired electrons that creates magnetic moments. Susceptibility in P. is positive and small. Magnetic effect is weak, only a few nanoteslas added to the magnetic field observed at the Earth's surface. [33, 223]. See also Ferrimagnetics, Ferromagnetics, and Diamagnetics.

Parametric Inversion – a methodology where parameters of a few geometrically simple bodies are sought and corresponding values are found by solving overdetermined problems (i.e., number of applied equations is more than number of unknowns). P.I. requires the initial estimate of input geometrical parameters and limits of Susceptibility or Density allowed. The problem of non-uniqueness is addressed by the restrictive nature of the inversion algorithm, which considers only a small set of pre-specified models and their solutions. [144]. See also Inversion and Minimizing Inversion.

Parzen Filter – an edge smoothing space-domain filter which is used to smooth edges of line datasets (line curves) by superimposing a weighted polynomial function on original point values to ensure their smooth transition to zero at the ends of lines. P.F. is also referred to as Parzen Window. [124, 223]. See Edge Smoothing Filters.

Parzen Window – see Parzen Filter.

Pass Filters – a group of the spectral domain grid-based or line-based filters which retain (i.e., pass) a pre-selected range of frequencies (wavenumbers). See High-Pass Filter and Low-Pass Filter.

Permeability – a magnetic medium proportionality constant. Its value depends on the properties of a medium where magnetic poles are situated. P. is defined as the ratio of Magnetic Induction ("B") to the inducing Magnetic Field Strength ("H"):

$$\mu = B / \mu_o H,$$

where "μ_o" is the permeability of free space. P. has the value of "1" in vacuum, and practically "1" in the air. [33, 238]. See also Permeability-Susceptibility Relation.

Permeability-Susceptibility Relation – a relation between the magnetic permeability "μ" and magnetic susceptibility "k" defined as

$$\mu = 1 + 4B\,k \text{ (cgm system)} \quad \text{or} \quad \mu = 1 + k \text{ (SI system)}$$

[54, 223]. See also Permeability and Susceptibility.

Peters Half-Slope Method – a graphic method used for the isolated magnetic anomaly source depth estimation. It requires the determination of several curve parameters on the profile of a magnetic anomaly: maximum slope, half-maximum slope, tangent points, and a distance between them. Estimation of depth also requires the knowledge of a structural index, i.e., Peters Index:

"depth" = "Peters Length / Peters Index"

The horizontal location of the obtained depth pick is the south tangent point in the northern hemisphere and the north tangent point in the southern hemisphere. [53, 193]. See also Depth Rules and "Quick-And-Dirty" Peters Method.

Peters Index – a structural index used in Peters Half-Slope Method of the magnetic anomaly source depth estimates. P.I. value is based on a given assumption about the source geometry. The following indices are commonly applied: vertical thin sheet = 0.8–1.0; horizontal thin sheet = 1.0; thick sheet = 1.6; wide body (block) = 1.8–2.0; single interface (contact) = 1.8–2.0; plug-like body = 1.8; default option (dike model) = 1.6. [193, 215]. See also Peters Length.

Peters Length – an isolated magnetic anomaly profile parameter used in Peters Half-Slope Method. P.L. can be determined using the following steps: 1) determine the maximum slope of the anomaly profile; 2) calculate ½ the maximum slope and draw a corresponding line ("half-slope line"); 3) with two triangles to keep the line parallel, project the obtained "half-slope line" onto the anomaly profile to find two tangent points in the lower and upper parts of the anomaly profile; the horizontal distance between these two tangent points is P.L. [215]. See also Peters Index.

Phase – a spatial waveform parameter that represents an angular measure of difference between a reference point on the observation surface and a specific point on a wave. See Instantaneous Phase and Wavelength. [223].

Phillips Method – an automated method of the magnetic source depth estimation using the autocorrelation function of the magnetic anomaly profile and the basic model approximation as vertical Thin Dike (thin sheet) or Magnetic Contact. P.M. employs the maximum-entropy algorithm to calculate the first few lags of the autocorrelation function in a short window. The depth to a dipping sheet source can be computed from these lags and their differences. Two-dimensional (2-D) Magnetic Basement surface is constructed by laminating together a large number of very thin vertical or near vertical dikes of infinite extent in "y" and "z" directions. The magnetic anomaly profile (observed at the surface z = 0) is assumed to be a superposition of anomalies produced by each thin dike. [194, 195]. See also Euler Method and Werner Method.

Pill Box Effect – see Bull's Eye Effect.

Pitch – a rising-and-falling motion of the survey aircraft or ship about a horizontal axis perpendicular to the selected course. See also Crab, Roll and Yaw.

Pixel – a picture element in the form of an individual cell in the two-dimensional grid that represents a digital image. Spatially, each P. corresponds to a certain area on the potential field map. See Raster Grid. [223].

Plate – a) sheet-like magnetic source body approximation with a limited vertical dimension. P. thickness may range from 0.1 to 1.0 times its depth-to-top. Magnetic anomaly of P. is similar to that of a set of dipoles; b) large, torsionally rigid segment of the Earth's Lithosphere, which may be assumed to move horizontally, being carried by slow convection currents in the underlying Asthenosphere. [13, 121, 215, 223, 238] See Plate Tectonics and Magnetic Modeling Shapes.

Plate Tectonics – a concept of global tectonics that describes the Earth's Lithosphere as divided into variously shaped, torsionally rigid, slowly moving plates of a regional extent which are carried along by slow convection currents in Asthenosphere. At present, plates interact with one another at their boundaries, causing structural-tectonic deformations and seismic activity. Along mid-oceanic ridges plates are moving away from each other, and a new Crust is being created by the convective uprising of Magma. [13, 33, 223]. See also Plate and Sea Floor Spreading.

Pluton – a big intra-basement or, sometimes, intra-sedimentary igneous rock body. Magnetic anomalies generated by large uniformly magnetized masses of plutons represent one of the main regional components of the observed magnetic field and often transect regional Magnetic Grain patterns .[13, [140]. See Igneous Rocks and Magma.

Plutonic Rocks – igneous rocks formed at considerable depths by crystallization of Magma. Generally, P.R. are strongly magnetic, unless they are granites with little or no mafic minerals. [13]. See Igneous Rocks and Pluton.

Plutonic Water – water derived from the crystallization of Magma. P.W. may significantly contribute to magnetization of the intra-basement faults and, probably, intra-sedimentary faults. [13]. See Pluton and Plutonic Rocks.

Point-Like Anomalies – short-wavelength single maxima magnetic anomalies generated mostly by cultural effects such as wellhead casings, grain elevators, dams, etc. Sometines, P.-L.A. may represent localized sources of geological significance like magnetite-bearing minettes and similar intrusions. [140]. See also Intrusion and Kimberlite Pipe.

Poisson's Relation – a relation between the magnetic and gravity potentials of the same Causative Body when both density and magnetic dipole moment are constant; the magnetic potential is directly proportional to the derivative of the gravity potential in the direction of assumed magnetization. When magnetization is vertical, P.R. can be presented as:

$$dM / dz = k\, dg_z / dz,$$

where "dM/dz" is the vertical component of the magnetic field; "dg_z / dz" is the vertical component of the gravity field (i.e., Vertical Gravity); "k" is the combined constant: "k = n/GD" where "n" is the magnetic moment per unit volume (i.e., Intensity of Magnetization), "G" is Universal Gravitational Constant, "D" is the assumed rock density. P.R. is used to make the pseudogravity maps from the observed magnetic data. [9, 223]. See Pseudogravity.

Polar Flattening – the Earth's shape parameter, which is the difference between the equatorial and polar radii divided by the equatorial radius. P.F. value is about 1/298.257. P.F. is also referred to as Flattening Coefficient. [25, 238].

Polarization – see Magnetic Polarization.

Pole Reduced Magnetics – a total magnetic field of the Earth (i.e., Total Magnetic Intensity – TMI) in the survey area after applying Reduction-To-Pole (RTP), usually, to the leveled and gridded magnetic data. See Grid, Gridding and Leveling.

Polynomial Fitting – an analytical method to separate a long wavelength regional component from an observed shorter wavelength anomaly. The regional component of the potential field is fitted by a polynomial surface of low orders, which is then subtracted from the observed potential field to obtain an estimate of the residual component. See Residual-Regional Anomaly Separation.

Positioning – determining the actual location of a measurement platform, survey ship or aircraft in the process of measurements with respect to the geodetic coordinates. See Global Positioning System (GPS) and Differential GPS. [223]. See also Survey Positioning and Positioning Accuracy.

Positioning Accuracy – the accuracy of determining the location of a measurement platform, survey ship or aircraft in the process of measurements with respect to the geodetic coordinates. Depending on the positioning system applied, P.A. may vary from 50-100m to 2-5m or less. See also Positioning.

Post-Flight Quality Control – a set of QC checks to verify the accuracy of the parameters of airborne survey flown and their agreement with the planned survey specifications. Usually, P.-F.Q.C. for aeromagnetic surveys comprises four main steps: 1) flight path reconstruction to ensure the lines were flown within allowable tolerances; 2) videotape flight path checking to confirm the cultural noise sources' locations; 3) visual examination of the diurnal profiles obtained at Base Station; 4) noise level checking to confirm acceptance values. [58]. See also Diurnals, Cultural Noise and On-Site Magnetometer Calibrations.

Potential – a mathematical function that describes Potential Field at any given space point. P. at a point in Gravity Field is the amount of energy (work) required to move a unit mass from a point at an "infinite" distance to the given point. Similarly, P. at a point in Magnetic Field is the amount of energy required to move a fictitious unit pole from "infinity" to the given point. [25, 54, 223, 238].

Potential Field – a space varying field that obeys a differential equation known as Laplace's Equation, which describes P.F. at any given space point through derivatives of Potential. Gravity and magnetic fields are vector potential fields. Most exploration gravity surveys utilize the vertical component of the gravity field, while the most exploration magnetic surveys utilize the scalar total intensity of the magnetic field. The observed gravity or magnetic P.F. may be described as the additive combination of deep and shallow subsurface source distributions. In the most general approximation, P.F. can be presented as the sum of the regional and residual gravity or magnetic fields. [25, 54, 238]. See Regional Potential Field and Residual Potential Field.

Potential Field Anomaly – a composite magnetic or gravity anomaly which represents the sum of effects from all source bodies in subsurface: the interference of anomalies caused by closely spaced source bodies and superposition of anomalies caused by source bodies at significantly different depth levels. Generally, each anomaly on the gravity or magnetic map contains a whole spectrum of wavelengths (spatial frequencies or wavenumbers) instead of just one. [25, 173, 178, 238]. See also Gravity Anomaly, Magnetic Anomaly and Energy Leakage.

Potential Field Map – a map of composite magnetic or gravity anomalies representing the additive combination of the gravity or magnetic effects of deep and shallow subsurface source distributions.

Potential Field Tilt – a concept for determining a location of the potential field sources based on the ratio of Vertical Derivative to Horizontal Gradient (the latter should be calculated in both "x" and "y" directions). The vertical gradient is positive over a source and has zero value over its edges, while the horizontal gradient peaks over edges and is zero over the center of a source. This concept can be effectively used for identifying the presence of subtle magnetic and gravity anomalies as well as for deducing the location of the magnetic or gravity source body edges and anomaly peak values through calculating the potential field parameter called Potential Field Tilt Angle. [159].

Potential Field Tilt Angle – a parameter defined in terms of the ratio of Vertical Derivative to Horizontal Gradient (the latter should be calculated in both "x" and "y" directions):

$$\text{P.F.T.A.} = \tan^{-1}(\text{vertical derivative / horizontal gradient})$$

P.F.T.A. values are always in the range from –90º to +90º. P.F.T.A. has large positive values over a source, passes through zero at or near the edge of a vertical sided source body, and it is negative outside the source region. P.F.T.A. has the property of being relatively insensitive to the depth of a source body and resolves anomalies from both shallow and deep sources equally well, therefore, allowing identification of the presence of subtle sources, which are often swamped in the stronger responses of larger and more intensive sources. In practice, a grid of tilt angles, calculated at each point on the potential field grid, can be obtained. This P.F.T.A. grid is then color-coded to define positive and negative tilt angle values. The result of this process is a map that delineates horizontal locations of both shallow and deep sources. [159]. See Potential Field Tilt.

Power Spectral Density – see Radial Power Spectrum.

Power Spectrum – the square of Amplitude Spectrum of the gravity and magnetic data, i.e., squared amplitude-versus-wavenumber relation. The energy (power) of the observed data components is presented in the logarithmic scale, wavenumbers - in cycles per km (meter) or, sometimes, in the decimal fractions of Nyquist Frequency. P.S. provides the slope and intercept parameters for the design of Matched Filtering operator. It is assumed that the decay of the P.S. curve can be approximated by three or four linear slopes (gradients) corresponding to the clearly separated depth ensembles of magnetic sources. Power spectra, which do not exhibit distinct linear slopes (i.e., non-linear power spectra), cannot be interpreted in this way. P.S. of the area is a statistical estimate representing the area averages. It means that the analysis of the calculated spectra covering, for example, more than one tectono-magnetic Terrane may produce averages not present in either terrane. P.S. is also referred to as the Log-Power Spectrum, Log-Energy Spectrum, Radial Power Spectrum (in case of gridded magnetic data) or Power-Density Spectrum. [25, 228]. See also Map Power Spectrum and Spector-Grant Method..

Pratt Hypothesis – an hypothesis of gravitational (isostatic) equilibrium between Crust and Mantle. It assumes a uniform crust thickness below sea level (i.e., no mountain "roots" as in Airy Hypothesis), but laterally variable crust Density so that areas of a lower density rise above sea level higher than areas of a higher density. In the most general approximation, the relationship among densities of regional crust blocks can be presented as

$$F_1 < F_2 < F_3$$

where "F_1" is the crust density of a mountainous region; "F_2" is the crust density of a flat Earth's region; and "F_3" is the crust density below ocean basins. Heiskanen Modification of P.H. combines lateral variations of the crust density with variable crust thickness (about $^2/_3$ of the topographic high is compensated by mountain "roots") and also assumes a gradual increase of density with depth. [25, 54, 223, 238]. See also Isostasy.

Precision – an instrument characteristic that defines the repeatability of readings and estimated as the mean deviation of a set of readings from their average value. See also Accuracy and Sensitivity. [223].

Predictive Filter – a processing operator (algorithm) which fills gaps in the gridded data remaining after applying standard Gridding and interpolation procedures.

Preferential Continuation – a spectral domain anomaly enhancement procedure designed on the basis of Optimum Filtering and Equivalent Layer concepts for the downward and upward continuation of the potential field data. Differing from the standard upward and downward continuation operators, P.C. operator selectively (or preferentially) enhances a certain range of spatial frequencies in Amplitude Spectrum. Downward P.C. can enhance deep-source (long wavelength) components of the potential field without overamplifying shallow-source (short wavelength) components. Upward P.C. effectively attenuates shallow-source and very shallow-source (i.e., short wavelength) components while minimally attenuating deep-source (long wavelength) components, as it often happens after applying the standard upward continuation. [184]. See also Downward Continuation and Upward Continuation.

Pre-Filter Transformation – a set of supplementary procedures applied to the line or grid datasets in order to improve the performance of filter operations both in space and spectral domains. P.-F.T. includes Detrending, Despiking, Data Extension, edge smoothing, filling data gaps, etc. [230].

Pre-Survey Magnetometer Calibrations – see On-Site Magnetometer Calibrations.

Prism – a model source body approximation defined as a parallelepiped of semi-infinite length in the vertical dimension, i.e., its depth-to-bottom distance is at least four times its depth-to-top distance. Magnetic anomaly caused by P. is similar to that of a magnetic Monopole or line of poles. Two-dimensional P. (semi-infinite vertically and normal to the plane of view) is sometimes referred to as Dike model. [215]. See Magnetic Modeling Shapes.

Profile – see Profile Graph.

Profile Graph – a) cross-section of the gridded data defined by a segmented path or straight-line direction that the user traces over Grid; b) cross-section of the potential field anomaly along the survey line.

Proof Mass – a suspended weight in the gravimeter sensing system. Position of the P.M. is altered by a change in the gravitational attraction (acceleration). See Gravity Acceleration, Torsion Balance, Weight-On-Spring and Zero-Length Spring.

Proton Precession Magnetometer – a magnetometer which determines the value of the Earth's magnetic field by, first, polarizing water with a high proton (hydrogen nuclei) content and, then, measuring the precession of hydrogen nuclei (protons) when the polarizing field is removed. The frequency of the precession is proportional to the intensity of the Earth's magnetic field and called Larmor Frequency. The achievable accuracy is up to 0.1 gamma. No orientation is necessary, i.e., P.P.M. sensor arrangement is omni-directional. However, Sampling Rate is limited by how often the polarization cycle can be applied. P.P.M. is also called Proton-Resonance Magnetometer. [57, 223]. See Cesium Magnetometer, Fluxgate Magnetometer and Optically Pumped Magnetometer.

Proton Resonance Magnetometer – see Proton Precession Magnetometer.

Pseudo-Anomaly – see Artifact.

Pseudocolor – a method of mapping the observed and/or filtered data as a color-coded (color-scaled) grid where each color spectrum shade corresponds to a particular range of the cell values in the obtained grid, from low to high. P. is often referred to as Color-Coded Map, Color-Scaled Map or Pseudocolor Map. See also Color Wheel and Grey-Scale Map.

Pseudocolor Map – see Pseudocolor.

Pseudo-Depth Slice – a grid image of the magnetic field data obtained after applying Matched Filtering to the observed or reduced-to-pole data. Each P.-D.S. highlights a particular range of spatial frequencies (wavelengths) corresponding to a quantitatively estimated depth in the subsurface. Fundamental ambiguity of the relationship between a potential field and its sources precludes reliable qualitative estimates of this kind. Sometimes, P.-D.S. image is referred to as MagSlice Image. [18, 48, 175]. See also Spatial Frequency and Pseudo-Depth Slicing (PDS).

Pseudo-Depth Slicing (PDS) – a spectral domain filtering method applied to the observed total magnetic intensity grids or reduced-to-pole (RTP) magnetic field grids. PDS produces a set of grid images (slices) highlighting the particular ranges of the spatial frequency (wavelength) content generated by the magnetic source bodies at different depths in the subsurface. PDS is based on the theory of Matched Filtering and designed from the analysis of the radial power spectra. It is assumed that magnetic sources are ensembles of semi-infinite vertical prisms occurring at the same or close depths. This assumption allows to approximate Radial Power Spectrum curve by straight-line segments (slopes) each representing magnetic sources at a particular depth and this depth corresponds to a particular slope of the curve. The final space domain pseudo-depth slices are obtained by Inverse Fourier Transform of the filtered spectral domain data. [18, 48, 79, 175, 215]. See also Prism, Pseudo-Depth Slice and Spector-Grant Method.

Pseudogravity – a concept that is based on approximation of the gravity field by observed magnetic field. P. requires the conversion of Susceptibility values to Density values and can be defined mathematically as the vertical integral of the reduced-to-pole total magnetic field data. P. calculations are based on Poisson's Relation. [9, 25]. See also Pseudogravity Transform and Pseudomagnetics.

Pseudogravity Filter – see Pseudogravity Transform.

Pseudogravity Transform – a procedure to calculate an approximation of the gravity field from the observed magnetic field. P.T. is a linear filtering procedure, usually applied in Fourier Domain, that transforms the magnetic anomaly over magnetization distribution “M(x,y,z)” into the corresponding gravity anomaly that would be observed if the density “D ” satisfies the requirement defined as:

$$D (x,y,z) = kM(x,y,z),$$

where “k” is a constant. It should be remembered that anomalies produced by P.T. are not real gravity anomalies, but transformed magnetic anomalies, and the obtained map is measured in units of “nT/km”. P.T. enhances relatively lower Spatial Frequency components and attenuates high-frequency effects of the surface cultural features. In some cases, P.T. – based map can accentuate the areal extent of magnetically anomalous relatively shallow zones. Detrending with the use of a higher order (third or fourth) polynomials is recommended before P.T. [25]. See also Pseudogravity and Pseudomagnetics.

Pseudomagnetics – an approximation of the magnetic field derived from the observed gravity field. P. is based on Poisson’s Relation: the magnetic potential is directly proportional to the derivative of the gravity potential in the direction of assumed magnetization. Because the magnetization variability of rocks is usually much more complex than the density variability, in practice it is far more common to calculate Pseudogravity rather than P. [25].

Pseudosusceptibility – a ratio between Total Magnetization and the Earth’s magnetic field. This term is often used in mining exploration. [17].

Q

Quadrature – the imaginary component of Analytic Signal which has the same Amplitude Spectrum as the real component but differs in phase by 90º. For 2-D profile data or 3-D gridded data, Q. can be calculated using Hilbert Transform. For 3-D data, Q. is sometimes estimated by subtracting the grid data (as the real component) from the calculated 3-D analytic signal. [94, 236] See also Quadrature Image and Three-Dimensional (3-D) Analytic Signal.

Quadrature Image – an image of the gridded potential field data which is obtained from the calculation of Quadrature. Since Q.I. incorporates a 90º phase shift of the original data, the single peak anomalies on the standard image will appear as combinations of peaks and troughs on Q.I. This doubling of the number of anomalous features often contributes to the higher resolution of the subsurface discontinuities. Position of the magnetic sources is assumed to be approximately aligned with the crossovers from the positive to the negative parts of Q.I. anomalies for near-vertical magnetic sources with strikes orthogonal to the traverse survey lines. [94]. See also Quadrature.

Quality Control (QC) – the in-field and in-office processing of the recorded measurements in order to identify and, if possible, correct data acquisition problems. [58]. See also Post-Flight Quality Control.

“Quick-And-Dirty” Peters Method – a simplified version of Peters Half-Slope Method of the magnetic source depth estimate using map data without the need to plot the magnetic anomaly profile. It includes the following steps: 1) determine the distance between map contour lines at the area of the maximum gradient of the selected anomaly; 2) locate the points on either side of the gradient area where the distance between contour lines is twice that of the maximum gradient – these points correspond to the Peters half-slope points; 3) measure the obtained half-slope distance (i.e., Peters Length) and divide it by 1.6 to determine the depth (if the survey is airborne, subtract the flight elevation from the determined depth value to get the actual depth below the Earth’s surface). [215]. See also Depth Rules.

R

Radar Altimeter – an instrument which is installed on board the aircraft to measure and record the flight height above the Earth's surface (AGL) with the common accuracy of about 0.15 m (0.5 ft). [57]. See also Barometric Altimeter.

Radar Altimetry – see Satellite Altimetry.

Radar Imagery – a method and instrumentation to measure and map the Earth's surface relief by the radar installed on board the aircraft or orbiting satellite. [223]. See Radar Altimeter.

Radial Frequency – unit of reference on the Radial Power Spectrum curve or the filter amplitude response curve. R.F. is presented in cycles per meter or in cycles per km or, sometimes, in cycles per grid unit.

Radial Power Spectrum – a logarithmic plot of the Fourier transformed gridded magnetic data representing a logarithm of a power (i.e., square of an amplitude) versus Wavenumber relationship. R.P.S. is derived from the normalized Map Power Spectrum by integrating each Radial Frequency component over all 360º azimuths, i.e. R.P.S. represents the average spectral content in Grid over all directions. Instead of wavenumbers in cycles per km or meter, the horizontal axis can represent values of Nyquist Fraction. It is common for the lower wavenumbers to have a higher energy. This phenomenon gives R.P.S. curves the characteristic descending shape. Generally, R.P.S. curve can be divided into two main portions: 1) steeply declining energy (amplitude) portion at low wavenumbers which represents sources that are deep and/or very broad; 2) more gently declining portion at the higher wavenumbers which represents sources that are comparatively shallow and more localized. Based on this relation, linear segments on R.P.S. (usually, not more than three or four) are interpreted for depths of the dominant ensembles of source bodies in the survey area. R.P.S. is also referred to as Radially Averaged Power Spectrum or Fourier Spectrum. [25, 48, 228]. See also Spectrum, Spector-Grant Method and Power Spectrum.

Radially Averaged Power Spectrum – see Radial Power Spectrum.

Random Gridding – a process of converting the observed magnetic or gravity data, recorded at randomly distributed observation stations, into Grid (map) by creating the smoothest possible (Minimum Curvature) surface composed of a continuous set of regularly spaced cells, each representing the interpolated or original data value assigned to the center of a cell. See also Line Gridding, Grid Cell, and Station.

Random Noise – unwanted high-frequency (short-wavelength) components of the potential field data which does not exhibit correlation between the survey lines or distant cells of the gridded data. R.N. is generated by occasionally (i.e., randomly) distributed near-surface sources. R.N. is also referred to as White Noise. [219]. See also Coherent Noise.

Range – an instrument characteristic which defines the extent of actually measured values within their lowest and largest limits established for measurements, like Operating Range and Temperature Range. See also Accuracy and Resolution.

RAPS – see Radially Averaged Power Spectrum.

Raster Grid – an image grid in which data is arranged as a set of horizontal rows ("lines") and vertical columns ("samples"). Individual cells that constitute R.G. are called pixels. Digital Image Processing concept is based on the use of R.G. See Pixel.

Raw Gravity – the gravity field measurements obtained at the gravity stations. R.G. represents the gravity field values before applying the Bouguer, free-air, latitude and other corrections. R.G. is also called as "measured gravity" or “observed gravity”.

Raw Gravity & Magnetics – measured gravity or magnetic values at any point on or above the Earth’s surface after applying instrumentation corrections. See also Drift, Diurnal Variations, On-Site Magnetometer Calibrations.

Reading Resolution – an analogue instrument (gravimeter or magnetometer) accuracy characteristic which defines the smallest change of a measured value detectable by the human eye. See also Resolution.

Real-Time – a term that is applied to data processing systems to describe their capability to process and/or record data instantly, i.e., at the same time and at the same rate as those at which these data are detected.

Real-Time DGPS – a survey positioning system which computes the real-time location of the survey platform as instant as Differential GPS data is collected. See also Global Positioning System (GPS).

Real-Time Gravity – measurements of the Earth’s gravity field using digital recording systems and computer-aided Real-Time processing of the measured gravity values. For land surveys, R.-T.G. includes the following sequential steps: 1) entering gravity observations; 2) entering local terrain data (from parallel measurements); 3) entering GPS coordinates; 4) merging with the regional terrain data; 5) applying Gravity Corrections to the observed data; 6) calculating Bouguer Gravity; 7) mapping.

Real-Time Magnetic Compensation System – a computerized system which allows to compensate the magnetometer sensors for the effects of the aircraft maneuvers (Pitch, Roll, Yaw) as well as for residual airframe magnetism on board the aircraft in real time using the fluxgate sensors. Magnetometer compensation can also be post-processed based on the information recorded during the survey flight. See also Post-Flight Quality Control.

Real-Time Shaded Relief – an interactive imaging technique that allows creation of Shaded Relief images of gridded data using a light source (“sun”), controlled by the cursor position. The zenith angle (i.e., “sun” height above surface) and the azimuth (i.e., direction of “sun” illumination) are changed by movements of a cursor and, hence, map shading effects can be observed in Real-Time. See also Gridding.

Real-Time Video – a time-synchronous color video recording of the ground surface below the aircraft in the progress of survey measurements. R.-T.V. is required to identify non-geologic cultural anomalies which must be edited out of the dataset prior to Microleveling and subsequent processing of the magnetic data. In older airborne surveys, R.-T.V. was used as a positioning aid in lieu of DGPS. See also Cultural Editing and Video Viewing.

Reduction Density – an average rock Density above sea level, which is used in calculation of Bouguer Correction. See also Replacement Density.

Reduction Filters – a general definition of the data processing operators which perform Reduction-to-Pole (RTP) or Reduction-to-Equator (RTE). In the RTP case, R.F. are applied to the observed magnetic data to correct for Inclination (I) of the Earth’s magnetic field as well as for Declination (D). Magnetic anomalies within an inclined source field show phase distortions which are removed by R.F. After RTP the survey data will be the same as it was measured at the Pole (i.e., I = 90º, D = 0°). RTE is a complementary filtering to RTP procedure which transforms the observed Earth’s magnetic field to the inclination of 0º (instead of 90º as in the RTP case). Sometimes, R.F. are referred to as Magnetics Filters.

Reduction-To-Equator (RTE) – a data processing method of recalculating the Earth’s magnetic field from its observed Inclination (“I”) and Declination (“D”) to that of the magnetic Equator where “I” = 0º while “D” varies from 0º to ±25º. As a rule, RTE is not used in magnetic exploration data processing. In the same manner as RTP, this procedure tends to center the anomalies over respective sources, but the shapes of the anomalies may become artificially stretched in the east-west direction relative to the horizontal dimensions of sources. [25, 121]. See also Reduction-To-Pole (RTP).

Reduction-To-Pole (RTP) – a data processing method of recalculating the Earth’s magnetic field from its observed Inclination (“I”) and Declination (“D”) to that of the North or South magnetic Pole (i.e., I = ±90º, D = 0º). RTP transforms originally dipolar magnetic anomalies to the monopolar anomalies centered exactly over their source bodies, i.e., it is a phase shift procedure which changes both the position and the amplitude of the anomaly peaks, making them sharper and, hence, better resolved laterally. Physically, RTP removes the assymetry of magnetic anomalies due to a non-vertical direction of the Earth's magnetic field and locates anomalies above their source bodies. No significant Remanent Magnetization is assumed here. In areas where this assumption is not satisfied, the anomalies after RTP may become smeared with a slight loss in resolution. Below the latitudes of about 15-20º, it is recommended to adjust only the phase, not the amplitudes of the observed magnetic data, as the RTP calculation can be unstable at these latitudes. Sometimes, such RTP errors may appear as narrow anomalies elongated in parallel to the local Declination of the Earth's magnetic field. [25, 91, 102, 121, 223]. See also Reduction-to-Equator (RTE).

Reference Body – a source body (i.e., Causative Body) imported into the gravity or magnetic Model as the initial approximation of the anomaly source. R.B. parameters are obtained from available geological and geophysical information.

Reference Elevation – see Datum.

Reference Ellipsoid – a) 3-D mathematical surface of Survey Positioning which the best represents the Earth's shape for that specific project survey area. b) Reference Spheroid. See also Positioning and Reference Spheroid.

Reference Spheroid – a mathematical model of the Earth's shape adopted for the gravity data corrections. R.S. is related to Mean Sea Level with excess land masses removed and ocean deeps filled, i.e. there are no undulations in the Earth's surface. R.S. is the equipotential surface: the gravity force is everywhere normal to this surface. The theoretical value of the total gravitational attraction of R.S. (Theoretical Gravity) at any point on R.S. is given by International Gravity Formula. One of the latest approximations of R.S., established by satellite measurements, is WGS84. [25, 54, 238]. See also Geoid.

Reference Upward Continued Distance – a distance at which Bouguer Gravity is upward continued in the process of Variable Datum Gravity Inversion. [84].

Regional – see Regional Component.

Regional Component – a term which is used to describe the wavelength components of the observed gravity or magnetic field data which are greater in length than the dominant wavelength of an average observed anomaly or on the order of and greater than the survey area extent, i.e. R.C. is generated by large-scale variations of Susceptibility or Density in deep subsurface. R.C. can be estimated graphically, by surface fitting, by Gridding methods, by filtering in Fourier Domain and by other methods. [223, 255]. See also Local Regional Component.

Regional Gravity Field – a long wavelength component of the gravity field usually attributed to the density variations which are located deeper than the general exploration interest, e.g., the gravity field component due to the crustal density variations or undulations of the crust/mantle interface. Subjective R.G.F. can be designed and subtracted from the original field to enhance the residual gravity anomalies of a primary interest. [25, 157, 223]. See Crust, Mantle and Residual Gravity Field.

Regional Magnetic Field – a long wavelength component of the total magnetic field representing major tectonic features such as basins, regional uplifts, troughs and fault zones. R.M.F. is attributed to Susceptibility variations at depth levels which are usually considered to be associated with intermediate and deep parts of Crystalline Basement. A subjective R.M.F. can be designed and subtracted from the original total field to enhance the residual anomalies of shallow basement levels and intra-sedimentary section. [47, 115, 157, 238]. See also Residual Magnetic Field.

Regional Map – a map where residual (i.e., short-wavelength) components of the observed potential field are removed by Filtering or other methods of Residual-Regional Anomaly Separation. See Residual Map.

Regional Potential Field – the most generalized definition of a portion of the observed gravity or magnetic field caused by deep subsurface source distributions, i.e. Susceptibility or Density variations within or below Basement. [25, 157]. See Regional Gravity Field and Regional Magnetic Field.

Regional Wavelength Filter – a filter that retains (passes) long wavelength components of the observed potential field, and rejects all wavelengths smaller than the user-specified Cutoff Wavelength. Conceptually, R.W.F. is the equivalent of Low-Pass Filter. [257]. See Residual Wavelength Filter.

Regional–Residual Anomaly Separation – a separation of the long-wavelength large amplitude smoothly varying regional anomalies, typically caused by deep-seated sources in Magnetic Basement, from the short-wavelength low amplitude sharply varying anomalies associated with shallower sources in the upper portion of the magnetic basement and within the sedimentary section. There are six basic methods of R.-R.A.S. applied correspondingly in the gravity and magnetic exploration: 1) graphical method, in which the regional component (regional trend) is drawn manually on the plotted magnetic or gravity anomaly profile along the survey line and then the difference between the observed and regional curves is calculated ; 2) polynomial method, where the regional magnetic or gravity field is estimated by the N-order polynomial and then subtracted from the observed data; 3) spectral domain filtering method, which is based on a filter-assisted separation between wavenumbers as reciprocals of the long (regional) and short (residual) wavelength components of the observed magnetic or gravity field and it is performed by Bandpass Filtering, Highpass Filtering, Lowpass Filtering, Matched Filtering, Separation Filtering and others; 4) stripping method, in which the field of an approximated regional geological model (i.e., an ensemble of magnetic or gravity sources) is calculated and subtracted from the observed data; 5) upward continuation method, where the regional magnetic or gravity field is approximated by Upward Continuation and then subtracted from the observed data; and 6) Wavelet Analysis, based on decomposition of the potential field into constituent Wavelet components with subsequent separation into portions of a frequency spectrum over selected space domain windows. [42, 48, 82, 97, 118, 184, 186]. See also Data Enhancement and Filtering.

Regolith – an assemblage of the fragmental and unconsolidated rock material, whether residual or transported, that forms the surface of the land and overlies the unweathered bedrock. R. contains both detrital magnetic minerals accumulated from the weathered bedrock and secondary magnetic minerals originating from the chemical changes during the weathering processes. Magnetic effects of these shallow magnetic minerals are often observed as random magnetic spikes having vague areal concentration. Such spikes are usually regarded as Noise, which obscures short-wavelength, low-amplitude, intra-sedimentary magnetic anomalies. [50, 94]. See also Regolith Enhancement.

Regolith Enhancement – a processing technique which extracts the magnetic effects of Regolith from the observed HRAM data and processes the resulting anomalies in such a way that coherent mappings of the magnetic regolith units are obtained. In some cases, R.E. can significantly contribute to the improved resolution of the HRAM data by eliminating the calculated magnetic effects of Regolith. [50, 94].

Regular Noise – see Coherent Noise.

Remanence – see Remanent Magnetism.

Remanent Magnetism – a phenomenon of the rock magnetization remaining after removal of the magnetic field which caused this magnetization. [223].

Remanent Magnetization – the permanent magnetization that remains regardless of an external magnetic field. Magnetic dipoles in rocks are able to maintain this orientation even in the presence of a new inducing magnetic field. There are several types of R.M.: Chemical R.M., Detrital R.M., Isothermal R.M., Thermal R.M., Viscous R.M. and others. R.M. can often be ignored in exploration problems except in cases where Extrusive Rocks are present. R.M. is also referred to as Residual Magnetization. [25, 33, 61, 213]. See Induced Magnetization.

Repeats – see Gravity Repeats.

Replacement Density – a density used in calculating Bouguer Correction to the gravity data obtained during the marine gravity survey with on-board gravimeters. R.D. is the difference in Replacement Rock density and that of sea water. [223].

Replacement Rock – a hypothetic rock used to replace sea water in calculating Bouguer Correction to the gravity data obtained during the marine gravity survey. R.R. density is assumed as Bouguer Density. [223].

Resampling – see Grid Resampling.

Residual – a difference between the observed data and its Regional Component, i.e. the remaining part of the observed data after the effects of large-scale (long-wavelength) variations have been removed.[223].

Residual Gravity Field – a short wavelength component of Bouguer Gravity attributed to density contrasts within the high density Basement and/or the lower density overburden (i.e., sedimentary section). Anomalies in the residual gravity field are usually of the exploration interest. R.G.F. is obtained as a result of the variously performed attenuation and/or removal of the long wavelength regional components from the Bouguer gravity field. See First Residual Gravity and Regional Gravity Field.

Residual Magnetic Field – a short and mid-wavelength components of the total magnetic field. R.M.F. is usually attributed to Susceptibility contrasts within the shallower portion of Magnetic Basement and lower value susceptibility distributions of the sedimentary section. R.M.F. anomalies are usually of exploration interest. Generally, residual magnetic fields are obtained through calculation of a difference between the total magnetic field (as a rule, after RTE or RTP applied) and either polynomial approximation of the regional magnetic field or upward continuation(s) of the total magnetic field. See also Regional Magnetic Field and Residual-Regional Anomaly Separation.

Residual Magnetization – see Remanent Magnetization.

Residual Map – a map where regional (i.e., long-wavelength) components of the observed potential field are removed by Filtering or other methods of Residual-Regional Anomaly Separation. Generally, it is assumed that R.M. contains predominantly shallow source effects which represent local anomalies. It should be taken into consideration that the remaining short-wavelength components of a bigger and deeper regional anomalies (that are expected to be filtered out) may be of significant amplitudes and mistakenly identified as shallow local anomalies. See Regional Map and Energy Leakage.

Residual Potential Field – the most generalized definition of a portion of the observed magnetic or gravity field caused by relatively shallow subsurface source distributions, which are usually the main target of magnetic and gravity exploration. See Residual Gravity Field and Residual Magnetic Field.

Residual Wavelength Filter – a filter which retains (passes) short wavelength components of the observed potential field and rejects all wavelengths longer than Cutoff Wavelength. R.W.F. is the equivalent of High-Pass Filter. [257]. See also Regional Wavelength Filter and Residual Map.

Residualizing – 1) methodology that attempts to estimate the regional (i.e. large-scale) effects and isolate local (i.e. residual) anomalies of exploration interest by subtracting these regional effects. R. is not unique. The regional variations can be estimated graphically, by gridding methods, by surface fitting , by filtering in Fourier Domain and by other methods; 2) a process of determining what is not accounted for a particular model: the effect of a model is calculated and subtracted from the observed data and the remaining portion is assumed to be a residual component. [223]. See Observed Gravity, Gravity Corrections, Residual Gravity Field and Residual Magnetic Field.

Residual-Regional Analysis – a methodology that separates anomaly patterns of the kind one is looking for from the remaining portion of the observed potential field based on the use of Filtering, upward or downward continuation, calculation of derivatives and other data processing methods. See Regional-Residual Anomaly Separation.

Resolution – a) the ability to separate laterally and vertically interfering potential field anomalies produced by closely spaced sources; b) an instrument (gravimeter or magnetometer) characteristic which defines the smallest detectable change of the measured potential field value. [223]. See also Lateral Resolution and Reading Resolution.

Resultant Gradient – a vector sum of the first-order derivatives in three orthogonal directions calculated for the magnetic or gravity anomaly modified by a filter which is designed on the basis of an assumed source geometry. The shape of the obtained R.G. function is used for estimating location and depth of 3-D Causative Body. [222].

Reverse Spectral Transform – a processing procedure which converts the data from the spectral domain back to their original space domain using Inverse Fourier Transform. See also Spectral Domain and Space Domain.

Rift – a) long relatively narrow regional trough bounded by normal faults; b) graben of regional extent associated with the wrench tectonics of a pull-apart zone and, often, with volcanism and igneous rock intrusions. [13]. See also Intrusion.

Ringing – see Gibbs' Phenomenon.

Roll – a side-to-side rotational motion of the survey aircraft or ship about the horizontal axis of the selected course. See also Crab, Pitch and Yaw.

Rolloff Ramp – see Rolloff Range.

Rolloff Range – a tapering range of a filter over which the values of the passed (or rejected) space or spectral domain data gradually decrease to their zero values. See also Taper.

Rolloff Region – see Rolloff Window.

Rolloff Window – an extended region at each end of the line or a grid where the values of the first or last original data points are rolled-off to zero value. R.W. is created in order to improve the performance of Line Filtering before Fourier Transform to prevent loss of data as well as the creation of artifacts ("edge effects") at the line or grid ends. R.W. is also called Rolloff Region or Taper.

RTE – see Reduction-To-Equator.

RTP – see Reduction-To-Pole.

RTP Analytic Signal – Analytic Signal of the magnetic anomalous field calculated after applying Reduction-To-Pole (RTP). Usually, RTP A.S. is calculated by taking the square root of the sum of squared derivatives in all three directions ("X", "Y", "Z"). See also Analytic Signal Method.

RTP Anomaly – a general term for maps (grids) showing the anomalous magnetic field in the survey area after all pertinent corrections and Reduction-To-Pole (RTP). Usually, such maps are presented in several versions: regional, residual, band-pass filtered, depth sliced, vertical or horizontal derivatives, etc. See also Grid, Total Magnetic Field, RTP Regional Anomaly, and RTP Residual Anomaly.

RTP Filter – a convolution filter that performs Reduction-to-Pole for the gridded magnetic data. This filter ensures phase shifts of magnetic anomalies to remove their skew caused by a non-vertical direction of the Earth's magnetic field. The maxima of magnetic anomalies on the RTP-filtered maps are located directly above causative bodies. Phase shifts increase with decrease in latitude. [148]. See also Causative Body, Convolution and FIR RTP Filter.

RTP Regional Anomaly – a regional component of Total Magnetic Field after applying Reduction-To-Pole (RTP) to the gridded magnetic data. RTP R.A. field is dominated by deep-seated magnetic source bodies and structures. See Regional-Residual Anomaly Separation, RTP Anomaly and RTP Residual Anomaly.

RTP Residual Anomaly – a residual component of Total Magnetic Field after applying Reduction-To-Pole (RTP) to the gridded magnetic data. RTP R.A. field is dominated by magnetic effects caused by relatively shallow and local subsurface features, such as Magnetic Basement structures and intra-sedimentary magnetized Faults. See RTP Anomaly and RTP Regional Anomaly.

Rubidium-Vapor Magnetometer – see Optically Pumped Magnetometer.

Running Window – a line-based or grid-based operator of a specified length (i.e. “window”) whose position moves one sample value or grid value at a time. [223]. See Smoothing.

S

Salt – a general term for naturally occurring halite and other saline minerals deposited from aqueous solutions as a result of extensive or total evaporation. S. has a relatively low density (2.1 – 2.6 g/cm^3 with the average of 2.22 g/cm^3), high plasticity and featured with regional occurrence. Because of these properties, S. is often squeezed out from the depth level of its origin under the pressure of the overlaying sediments. This process results in the deformation of overlaying sedimentary strata and creation of diapiric and/or piercement structures like salt anticline or Salt Dome. S. is strongly non-magnetic (Susceptibility value is about –0.01 in units of 10^3 SI) and, being accumulated in domes or lenses, produces intense negative anomalies of Total Magnetic Field. Salt dissolution, which is often controlled by deeper faults, causes collapse of the overlying sediments. [13, 238). See also Evaporites, and Salt Dome Gravity Anomaly.

Salt Dome – a general term for a diapiric or piercement structure with a columnar salt plug at its core, a cap rock of anhydrite and upturned, complexly faulted sedimentary formations adjacent to the salt plug. [13]. See Salt.

Salt Dome Gravity Anomaly – a large negative Anomaly on the gravity profile or local closed minima zone on the gravity map. Often, the uppermost part of a salt dome (i.e., salt cap rock composed of Anhydrite) has a higher Density than that of the surrounding Sedimentary Rocks at the same depth. Thick salt cap rock (50–100 m and more) can create lateral Density Contrast and, hence, give rise to a small positive anomaly within the large negative S.D.G.A. Sometimes, gas chimney anomalies may look like shallow S.D.G.A. [117, 174]. See also Chimney.

Salt Residual – a residual gravity map obtained after the calculated effects of Salt Dome model have been subtracted from the original (Bouguer or free-air) gravity map [223]. See Salt Dome Gravity Anomaly.

Salt Wall – similar to Salt Dome, but very elongated in one dimension. S.W. is usually associated with Fault or fracture zone of a regional extent.

SAM Survey – see Sedimentary AeroMagnetic Survey.

Sampling – discrete measurements of data at fixed space or time intervals, usually, along the survey lines. See also Sampling Interval, Spatial Sampling and Sampling Theorem.

Sampling Density – a ground magnetic or gravity survey parameter that defines the number of magnetic or gravity points of observation (stations) per square kilometer. See Station.

Sampling Frequency – the number of samples (data points) per unit of distance (or time) in a given direction “x” or “y”, i.e., “1 / Dx(y)” samples per unit distance. For the gridded data (i.e., one sample per grid cell), “Dx(y)” is equal to Grid Interval and, hence, S.F. is the reciprocal of the selected grid interval. See also Gridding.

Sampling Interval – a) distance between two successive measurement points (instrument readings), usually along the survey line. For aeromagnetic surveys, S.I. is derived from the magnetometer Sampling Rate, which is about 8-10 readings per second, and the aircraft ground speed defined in meters per second; b) distance between the cell centers of the gridded potential field data, i.e., Grid Interval. See also Cell and Sampling.

Sampling Rate – an instrument characteristic that defines the minimum time interval between successive readings (measurements). See also Sampling Interval. [223].

Sampling Theorem – a theorem which postulates that no information contained in the observed data is lost by a regular sampling, provided that Sampling Frequency is greater than twice the highest frequency component in the waveform being sampled. In other words, there must be more than two samples per cycle for the highest

Spatial Frequency component of the data. S.T. is also referred to as Nyquist Theorem. [25, 223].

Sampling Wavenumber – the period of Discrete Fourier Transform defined as

$$k_S = 2B / Dx$$

where "Dx" is the sampling interval, i.e., Grid Interval for the gridded data. See also Gridding and Sampling.

Satellite Altimetry – a method and instrumentation to collect and process measurements of the Earth's surface topography in orbiting satellites. S.A. over ocean basins provides data for Satellite Gravity as measurements of the sea surface reveal undulations of the geoid and, hence, permit to map the related gravity anomalies. In gravity applications, the satellite altimeter uses a pulse-limited radar to measure the altitude of the satellite above the sea surface. High-accuracy global tracking of the satellite orbit and orbit dynamic calculations provide an independent measurement of the satellite's position and height above the Earth's Ellipsoid. The height of the sea surface (i.e., Geoid height) is calculated as the difference between these two measurements, minus corrections for the radar signal propagation. The major source of S.A. errors in exploration in marine areas is the roughness of the sea surface due to waves (about 1-6 m). The achievable accuracy of S.A. over ocean basins is estimated as 10-20 mm. [223 , 253].

Satellite-Derived Gravity – see Satellite Gravity.

Satellite Gravity – a method, instrumentation and software tools to calculate gravity anomalies (i.e., Free-Air Gravity) over ocean basins from Satellite Altimetry data. S.G. is based on the fact that Earth's Gravity Field in marine areas is related to the equipotential shape of the sea surface, called Geoid, which can be measured by radar altimeters aboard orbiting satellites. These measurements are converted into the gravity anomalous field using various transform techniques. The resolving capacity of S.G. is estimated at 3–7 mGal and 20–30 km in width. S.G. is also referred to as Satellite-Derived Gravity or Altimeter-Derived Gravity. [87, 253].

Satellite Magnetic Anomalies – super long-wavelength (about 400-500 km and more) anomalies representing cumulative magnetic effects within and across neighboring large-scale tectonic provinces in Lithosphere as well as localized effects of regionally extensive magnetic ore deposits (like the Kursk iron formation in Russia). As satellites measure the Earth's magnetic field far away from anomaly sources, the satellite-borne magnetic data usually are not suitable for determining 3-D source body geometry. [204]. See Satellite Magnetics, Source Body and Tectonic Province.

Satellite Magnetics – a method and instrumentation to collect and process measurements of Earth's Magnetic Field in orbiting satellites, usually at the elevation of about 400 km and more above sea level. Cesium Magnetometer, Rubidium-Vapor Magnetotemeter and, sometimes, Fluxgate Magnetometer are used for making S.M. measurements. The resolving capacity (i.e., Resolution) of S.M. does not exceed 1-2 nanotesla. [204]. See Nanotesla and Satellite Magnetic Anomalies.

Scale Factor – a map projection parameter that defines the coefficient of deviation of the real Earth's surface from the map plane with respect to the UTM central meridian and a map scale.

Scatter Point Data – a set of potential field (usually gravity) measurements obtained at observation stations, which are irregularly distributed over the study area.

Schuler Frequency – a reciprocal of Schuler Period.

Schuler Period – a gyroscope-based mechanical system parameter that defines the period (or precession rate) of gyroscopes in Servo System, and equals 84 minutes. S.P. value is determined by the ratio of the Earth's radius to Gravity Acceleration and presented as:

$$S.P. = 2p\,(R/g)^{1/2},$$

where "R" is the Earth's radius and "g" is the gravity acceleration. [25, 223].

Scintrex CS-2 Magnetometer – see Optically Pumped Magnetometer.

Sea Bottom Gravity – see Bottom Gravity.

Sea Floor Spreading – a part of the Plate Tectonics concept that postulates the creation of a new oceanic Crust and moving away (spreading) of this new crust material by the convective uprising of Magma along the mid-oceanic ridges. S.F.S. half rates are typically about 1-10 cm per year. [13, 223].

Sea Level – see Mean Sea Level.

Sea Tides – sea level movements governed by the gravitational pull which is exerted on the Earth by the Sun and Moon. Due to the closer distance of separation between the Moon and the Earth relative to that of the Sun and the Earth, S.T. are dominated by the Moon's influence. See also Earth Tides.

Second-Derivative Map – usually, a map of Second Vertical Derivative of the gravity or magnetic field calculated after all proper corrections have been applied to the observed data. S.D.M. tends to enhance and increase Resolution of short-wavelength local anomalies (i.e. "residual" components of the measured field) and suppress the long wavelength "regional" components. Ambient Noise is also strongly enhanced [223]. See Second Horizontal Derivative and First-Derivative Map.

Second Horizontal Derivative (2HD) – a horizontal derivative of First Horizontal Derivative (1HD) or rate of change of a horizontal derivative component of the potential field. 2HD magnetic profiles calculated along observation lines can enhance high-frequency components of anomalies associated with boundaries between regional structures like fold belts or depressions. Large negative values of 2HD can occur when magnetic sources exhibit a strong Remanent Magnetization. 2HD of the upward-continued gravity profile is used to obtain values of location, dip and vertical extent of the truncated horizontal plate model in Zero-Crossover Method. Sometimes, 2HD is referred to as Differential Curvature or Second Horizontal Difference. [39, 163].

Second Horizontal Difference – see Second Horizontal Derivative.

Second Vertical Derivative (2VD) – a rate of change of the vertical component of the gravity field or rate of change (the slope) of First Vertical Derivative of the magnetic field. 2VD is a measure of the curvature of the potential field: positive values indicate the increasing Vertical Gradient and negative values indicate the decreasing vertical gradient of the potential field. 2VD enhances the mid-frequency and, especially, high-frequency components of the observed data much more effectively than the first vertical derivative and, therefore, it is used to resolve (separate) the interfering anomalies from closely spaced magnetic or gravity sources. 2VD also amplifies any noise. For this reason, 2VD calculation is often cascaded with a conventional Low-Pass Filter or Upward Continuation to suppress or attenuate high-frequency components of noise. Sometimes, 2VD can be used to delineate source body edges: its zero crossings can mark the outlines of a thick body. [25, 39, 59, 201]. See also Vertical Derivative, Fractional Derivative and Modified Second Vertical Derivative.

Second Vertical Gradient – see Second Vertical Derivative (2VD).

Secular Variation – regional long-period (sometimes, up to hundreds of years), cyclic variation in the Earth's magnetic field Inclination and Declination, which are presumably caused by changes in convection currents in the Earth's core and the rotation speed of the Earth. For example, Geomagnetic Poles precess around the geographic poles with a period of about 7000 years. S.V. can be displayed by a contour map called Isoporic Map. Often, S.V. are referred to as Geomagnetic Secular Variation. [25].

Sedimentary AeroMagnetic (SAM) Survey – see High-Resolution AeroMagnetic (HRAM) Survey.

Sedimentary Rocks – layered rocks originating from the consolidation of sediments, e.g., clastic rocks such as sandstones; chemical rocks such as carbonates; and salt or organic rocks such as coal. Magnetization of S.R. is much less (10-1000 times) than that of Igneous Rocks and Metamorphic Rocks. S.R. very rarely show any appreciable Remanent Magnetization which can be observed in exploration survey. See Sedimentary Rocks Density and Sedimentary Rocks Susceptibility. [13, 33, 238].

Sedimentary Rocks Density – the basic quantity that predetermines the gravity properties of sedimentary rocks. On average, S.R.D. is lower than that of Igneous Rocks and Metamorphic Rocks. In general, S.R.D. varies with composition from the lowest for conglomerates to the highest for dolomites with considerable overlap in the range values. Wide range of S.R.D. values is due primarily to porosity variations, pore fluids content as well as age and depth below surface. Typical Density Contrast between adjacent sedimentary formations is rarely more than 0.25-0.30 g/cm^3. Generalized table of common S.R.D. values is shown below (in g/cm^3) [33, 238]:

Rock Type	Range	Average (wet)
alluvium	1.96 – 2.00	1.98
clay	1.63 – 2.60	2.21
dolomite	2.28 – 2.90	2.70
gravel	1.70 – 2.40	2.00
limestone	1.93 – 2.90	2.55
sand	1.70 – 2.30	2.00
sandstone	1.61 – 2.76	2.35
silt	1.80 – 2.20	1.93
shale	1.77 – 3.20	2.40

Sedimentary Rocks Susceptibility – the basic quantity that predetermines the magnetic properties of sedimentary rocks. S.R.S. values are usually very low as compared to those of Igneous Rocks or Metamorphic Rocks, and generally related to the volume content of Magnetite. Generalized table of the common S.R.S. values is shown below (in units of 10^3 SI):

Rock Type	Range	Average
clay	0.0 – 0.3	0.2
dolomite	0.0 – 0.9	0.1
limestone	0.0 – 3.0	0.3
mudstone	0.0 – 1.0	0.5
sandstone	0.0 – 100.0	0.4
shale	0.01 – 15.0	0.6
Average of main types	0.0 – 18.0	0.9

S.I. susceptibility unit = 4B c.g.s. susceptibility unit. [33, 238]. See also Igneous Rocks Susceptibility and Metamorphic Rocks Susceptibility.

Sensel – a graph (profile) of the aircraft height ("sensor elevation") above the Earth's surface during the flight along a specified survey line. S. is obtained from the Radar Altimeter data. See also AGL.

Sensitivity – an instrument characteristic that defines a degree of response to changes in the measured values. High-sensitivity gravimeters and magnetometers can measure very small variations in the potential field magnitudes. See also Accuracy.

Sensor – an electronic device that detects a change in the magnetic or gravity field and turns it into a signal which can be measured and recorded.

Sensor Compensation – an instrument correction applied to the airborne magnetic measurements to compensate for the static and dynamic magnetic components of the survey aircraft. [57]. See also Figure-Of-Merit (FOM) and Compensation System.

Separation – see Regional-Residual Anomaly Separation.

Separation Filter – see Jacobsen Filter and Separation Filtering.

Separation Filtering – a filtering procedure that attempts to separate the residual and regional components of the potential field. S.F. is based on either applying Upward Continuation of the observed field or calculating the difference between two upward continuations. Generally, the objective of S.F. is to determine the residual field due to sources: 1) mainly above a pre-selected depth level; 2) mainly below a pre-selected depth level; 3) mainly between two pre-selected depth levels. Fundamental ambiguity of the relationship between a potential field and its sources precludes total and complete separation of the regional and residual components. There will always be some Spectral Leakage. The effectiveness of S.F. depends entirely on the differences in wavenumber contents of the potential fields to be separated. [39, 48, 97, 118, 167]. See also Energy Leakage, Sounding Filtering and Strip Filtering.

Servo System – an electronically controlled system used in stabilized instrument platforms to keep them as close as possible to horizontal level during airborne or marine gravity surveys. S.S. is coupled with Gyroscope and activated by signals from accelerometers to obtain the necessary amount of correction to immediately restore the horizontal level of Stabilized Platform. See also Schuler Period.

Shaded Relief – see Artificial Sun Illumination.

Shaded Stacked Profiles – the line-by-line ("stacked") image of the processed traverse line data for the whole airborne magnetic survey area. Commonly, S.S.P. represent the calculated profiles of the second horizontal derivative (called Second Horizontal Difference-2HD) along each of the traverse lines. Positive 2HD values are shaded for better visualization of the data trends. The square-root function is applied to the absolute value of the computed 2HD so that both small and large amplitude features can be displayed without being obliterated by the larger amplitudes on adjacent traverse lines. Before applying the 2HD operator, it is necessary to filter the traverse line data with Low-Pass Filter in order to suppress high-frequency noise. S.S.P. image can effectively delineate anomalies generated by normally magnetized thin dikes as well as the edges of thick bodies. [163]. See also Bipole Map.

Shadow Manipulation – an image enhancement procedure for selecting the optimal Sun Declination and Sun Inclination to highlight the image features of exploration interest. [115]. See also Artificial Sun Illumination.

Shadowed Total Field – an image of the total field (magnetic or gravity) obtained with the use of Artificial Sun Illumination imaging techniques. [115].

Shadowgram – a term which is sometimes used to define Shaded Relief or Artificial Sun Illumination image of the observed or processed potential field data. Depending on the azimuth of the "sun" position, S. may be referred to as the western S., the southeastern S., the northern S. and so on.

Shape Factor – see Structural Index.

Sharpe Gravimeter – see Torsion Balance.

Sheet – a thin tabular model approximation which is used in estimates of location and depth of the magnetized faults or magnetite-bearing sedimentary formations. See Magnetic Body Shapes and Magnetite.

Shifting of Magnetic Anomalies – see Reduction-To-Pole (RTP) and Reduction-To-Equator (RTE).

Shipboard Gravimeter – an instrument and supporting system for measuring Earth's Gravity Field (i.e. the field of Gravity Acceleration) from a moving ship. The supporting system includes Stabilized Platform and provides the insulation of S.G. from many accelerations to which the ship is subject and corrects the data for the effects of measuring in Real-Time mode, i.e. while moving. [223]. See also Airborne Gravity Meter and Borehole Gravimeter.

SI – International System of Units.

Signature – a general term for intensity of observed anomalies and dominant amomalous alignments on images of the gravity and magnetic fields (i.e., gravity S. and magnetic S.). Fabric and Grain have similar meaning. See also Inverted Gravity Signature.

Sill – a tabular interlayer intrusion of Igneous Rocks which is longer in the lateral dimension than in the vertical dimension (i.e., as opposed to Dike). S. always parallels the planar structure of surrounding rocks. [13].

Similarity Theorem – a theorem of Fourier Transform. For the one-dimensional case, S.T. states that if a function "f(x)" (where "x" is in spatial/wavenumber units) has its Fourier transform "F(u)" (where "u" is in spectral/wavenumber units), then another function "f(ax)" will have the Fourier transform "F(u/a) / *a*". S.T. is the basis for designing filters with the same or similar filter response characteristics for different wavelengths. [257].

Simple Analytic Signal – see Analytic Signal.

Simple Bouguer Correction – see Bouguer Correction.

Simple Bouguer Field – a gravity field obtained after applying Bouguer Correction to the observed gravity data, but before applying Terrain Correction.

Simple Fourier Method – a potential field continuation method. S.F.M. is based on the fact that the Fourier transform F(u,v,0) of a potential field measured on a horizontal plane at z = 0, can be converted into the Fourier transform of the same field measured on the plane z = h by a simple multiplication:

$$F(u,v,h) = F(u,v,0)\ \exp[h(u^2 + v^2)^{1/2}]$$

If "h" is negative the operation is Upward Continuation; if "h" is positive the operation is Downward Continuation. This technique assumes there are no sources in the region between the old and new levels of continuation. [196]. See also Fourier Transform.

Skewness – a horizontal displacement of the maxima of magnetic anomalies with respect to their sources. S. results from the fact that the directions of the magnetization and geomagnetic field are not usually vertical. See Reduction-To-Pole (RTP).

Sky Map – a circle in Sun Angle Image display window which emulates the "sky" above the image viewed from the "space". The center of S.M. corresponds to Overhead Point. Trough testing different locations within S.M., the user selects the optimum position of the “sun” to “illuminate” the image. See also Artificial Sun Illumination.

Slab Correction – see Bouguer Correction.

Slope Analysis – a methodology that obtains magnetic and gravity source depth estimates from the profile parameters of observed anomalies, such as maximum slope, half-maximum slope, three-quarter maximum slope, straight-slope distance, half-maximum distance, tangent points and others. See Depth Rules.

Smith Rule – see Bott-Smith Method.

Smoothing – a line-based or grid-based procedure of averaging adjacent values in order to filter out (i.e. suppress) very high frequencies and spikes generated by Noise. Usually, S. accomplished by use of Running Window [223]. See also Grid Smoothing and Local Median Filter.

Sokolov Method – a graphic method of estimating a depth to the top of a source of the isolated magnetic anomaly: “Depth” = “horizontal distance between points of intersection of the maximum-slope-line with a regional line (i.e., an asymptotic line for both ends of anomaly profile) and with a line which is parallel to a regional line and tangent to the maximum value of anomaly profile”. [223, 227]. See also Depth Rules.

Solar Wind – a stream of charged plasma emitted by the sun. Complex interaction between the Earth’s internal magnetic field and S.W., coupled with the Earth’s rotation, tidal forces and thermal effects, produces External Magnetic Field. Transient magnetic disturbances on the curve of the measured Earth’s Magnetic Field are often correlated with S.W. variations [25, 223]. See Bay and Diurnals.

Sounding Filtering – an anomaly separation procedure which amplifies the components of the gravity or magnetic field originating mainly from the depth85 interval between two pre-selected depth levels. Fundamental ambiguity of the potential field sources predetermines only qualitative separation of this kind, i.e., it is impossible to extract the anomaly and/or potential field components from the quantitatively defined depth interval based only on spectral content. S.F. result is obtained by calculating the difference between two upward continuations of the observed potential field. [118]. See also Separation Filtering.

Source Body – see Causative Body.

Source Edge – see Magnetic Contact.

Source Parameter Imaging (SPI™) Method – an automated grid-based method of computing and imaging the instantaneous (“local”) magnetic source body parameters developed by CGG-Geoterrex, such as contact positions, depth, dip and susceptibility contrast. Estimates of these parameters are obtained from the calculated Complex Attributes of the analytic signal. All estimates assume: a) either 2-D sloping Magnetic Contact model or 2-D dipping thin-sheet model; b) there is no interference from adjacent anomalies; c) there is no Remanent Magnetization assumed in the dip and/or susceptibility contrast computations. The estimate of the local depth is obtained from Local Wavenumber and considered to be independent of the magnetic Inclination, Declination, dip, strike and any remanent magnetization. Contact positions are determined from the maxima of the local wavenumber. Four separate color-coded images can be obtained for each of the above four source body parameters. [242]. See also Improved SPI (iSPI™) Method, Analytic Signal and Pseudocolor.

South-Seeking Pole – a negative pole of Magnetic Dipole, which is attracted towards the Earth’s south magnetic pole. [238]. See also North-Seeking Pole.

Space Domain – a domain where a mathematical function describes the relationship between the distance coordinates “x”, “y” and “z” as independent variables and some quantity (milliGals, gammas, density, susceptibility, etc) as the dependent variable. In S.D., the potential field data are presented by their observed or processed values at locations which correspond to the geographic distances in three directions (“x”, “y”, “z”). See also Domain and

Spectral Domain.

Space Domain Filters – a general definition of filters which process both line and grid datasets using mainly convolution operators in the space domain. S.D.F. include the following filter types: Fuller Filter, Gradient Filters, Local Median Filter, Naudy Filter, and others. See also Spectral Domain Filters.

Space-Frequency Localization – the analysis of a portion the frequency spectrum of the potential field signal over a pre-selected space domain window. [35]. See Spectrum and Wavelet Transform.

Spatial Aliasing – an aliasing which appears as a result of Spatial Sampling. Generally, S.A. occurs when the spatial sampling interval is chosen too large compared to the short wavelengths contained in the observed data. These wavelengths will then be aliased and their energy will be folded back onto longer wavelengths when Inverse Fourier Transform is applied. To avoid S.A., the data should be high-cut filtered back to Nyquist Frequency associated with the selected Sampling Interval prior to Gridding. In other words, one should expect to meet Aliasing effects when the potential field components have more waves per unit of distance or per grid unit in a given direction "x" or "y" than Nyquist Wavelength for a given survey. [223].

Spatial Filters – a group of processing operators which enhance certain pre-selected Space Domain components of the observed gravity or magnetic fields (assumed to be of exploration interest) by removing or attenuating the other components. A large class of data transformations can be considered as S.F., including regional-residual separation, first and second vertical derivative computation, upward and downward continuation, and others. [108]. See also Space Domain Filters and Spectral Domain Filters.

Spatial Frequency – a number of wave cycles per unit of distance or per grid unit in a given direction "x" or "y". S.F. is also referred to as Wavenumber. [223]. See also Grid.

Spatial Resolution – see Wavelength Resolution.

Spatial Sampling – discrete measurements of the data at separate regular or irregular spaced locations (stations) over the survey area. S.S. may involve Spatial Aliasing problems. [223]. See also Sampling and Station.

Spector-Grant Method – a magnetic source depth estimation method which is based on the use of the data Power Spectrum and assumes a statistical model of Causative Body as an ensemble of blocks or vertical prisms. The power spectrum is examined and linear slopes ("gradients") of the log power curve are identified. The average ensemble depth "h" is defined as:

$$h = \text{"gradient"} / 4B$$

Sometimes, only two or three source ensembles with different slopes ("gradients") can be identified. Non-linear spectra, which do not exhibit distinct linear slopes of the spectral curve, cannot be correctly interpreted. [48, 228]. See also Depth Estimate From Spectral Analysis.

Spectral Analysis – the examination of the Fourier domain spectra of the magnetic and gravity data with the purpose of identifying characteristic slope breaks on the plot of a power spectrum logarithm as a function of wavenumber (i.e., Radial Power Spectrum) and examining the noise characteristics of data using both the radial power spectrum and Map Power Spectrum. These slope breaks correspond to source ensembles of different depths and/or lateral extents. S.A. is performed for either gridded data or individual line profiles. S.A. results are used in preliminary estimates of the depth to magnetic source ensembles, the effect of Deculturing and in designing standard data filters as well as matched filters. [48, 83, 169, 228]. See also Power Spectrum, Radial Power Spectrum, Map Power Spectrum and Matched Filtering.

Spectral Depth Estimation – a method of estimating the depth of ensembles of source bodies based on the calculated Radial Power Spectrum of the observed potential field. S.D.E. is also referred to as Depth Estimate From Spectral Analysis. [48, 96, 228]. See Spector-Grant Method and Pseudo-Depth Slicing.

Spectral Domain – a domain in which frequencies and azimuth directions (along which frequencies gradually increase) are independent variables, while amplitudes of the data components are dependent variables. The observed data are presented in S.D. by their equivalent spatial frequencies (wavenumbers) with corresponding amplitudes after applying Fourier Transform to the gridded data or Hartley Transform to the line data. In S.D. both line and gridded data are processed in regard to their energy (i.e., square of amplitude) at each frequency rather than their field intensity value at the corresponding space position. Certain ranges of frequencies (wavenumbers) can be removed or attenuated, as well as certain wavelengths that are oriented in a particular direction. S.D. is often referred to as Fourier Domain. See also Domain, Space Domain and Wavenumber.

Spectral Domain Filters – a general definition of filters which process both line and gridded data according to their "energy" at each frequency (wavenumber) rather than their space point values. S.D.F. include the following filter types: Bandpass Filters, Continuation Filters, Derivative Filters, Directional Filters, Magnetic Component Filters, Pass Filters, and others. Inverse Fourier Transform for the gridded data or Inverse Hartley Transform for line data are used to return data back to the space domain to locate features that have been enhanced using S.D.F. See also Space Domain Filters.

Spectral Filtering – a directional filtering procedure based on calculation of Map Power Spectrum. [240, 254]. See also Directional Filtering.

Spectral Leakage – see Energy Leakage.

Spectral Matched Filtering – see Matched Filtering.

Spectral Overlap – see Energy Leakage.

Spectral Slope Method – see Spector-Grant Method.

Spectral Transform – a transformation of the observed data from their original space domain to the equivalent frequency (wavenumber) domain. See Fourier Transform, Space Domain and Frequency Domain.

Spectrum – the amplitude characteristic of data components as a function of their respective wavenumbers (spatial frequencies). S. of the gridded data is calculated using Fast Fourier Transform (FFT). S. is the basic characteristic of the data which provides information on the main trends in the area and wavelengths involved as well as guides the computer processing in order to enhance the components of the exploration interest. S. constitutes Frequency Domain. [223, 228]. See also Spectrum Calculation, Spectral Analysis, Spatial Frequency and Wavenumber.

Spectrum Calculation – a multi-step procedure that generally includes the following processing operations (not necessarily all of them): a) Detrending, i.e., removal of the long wavelength trends and biases from the observed data; b) transformation of the residual field to the wavenumber domain using Fast Fourier Transform; c) applying a sliding window function; d) assigning the tapers for the grid ends or lines ends; e) expansion to square dimensions of the power (energy) components. S.C. can be performed in 1-D (one dimension) for line datasets and in 2-D for gridded data. See also Spectral Analysis, Spectrum and Power Spectrum.

Spherical Cap – see Bouguer Spherical Cap.

Spheroid – an approximation of the Earth's shape by an ellipse of revolution. S. is symmetrical through its center, and also symmetrical about the axis of rotation. See Reference Spheroid. [25].

SPIÔ Method – see Source Parameter Imaging(SPI™) Method.

SPI Structural Index – a model parameter which is used in Improved Source Parameter Imaging (iSPI™) Method to discriminate between depth estimates of basic models. SPI S.I. is defined as

$$N = [\, k_1 /(k_2 - k_1)] - 1,$$

where "k_1" and "k_2" are the first-order and the second-order local wavenumbers, respectively. For three SPI basic models, "N" gives the following integer values: 0 –magnetic contact (fault); 1 – thin sheet; 2 – horizontal cylinder. [226, 242]. See also Local Wavenumber.

Spike – an irregular noise outburst. See Noise.

Spike Filter – see Despiking Filter.

Spiking – a term that is sometimes used to define the procedure of calculating the higher order derivatives of the original function, i.e., potential field or its horizontal and/or vertical derivatives. Due to the inherent noise, S. can yield Artifacts and only geological constraints can filter them out. S. can also be achieved through some versions of Downward Continuation but this procedure, as a rule, results in strong amplification of irregular noise. See Noise.

Spline – a polynomial operator that creates a continuous curve by interpolation between discrete data values obtained at fixed points. S.–based functions are used in the gridding algorithms. See Gridding. [223].

Spring Balance – a sensor type in some Gravimeter models (like BHGM) where the weight of a hinged beam with Proof Mass on its free end is balanced by the tension of a spring. As Gravity Acceleration changes, the spring tension (calibrated in the gravity units of measurement) also changes and, hence, allows to measure the gravity field change.

SQUID Magnetometer – a high-sensitive magnetometer equipped with "superconducting quantum interference device (SQUID)" sensors. Its very low electronic noise level allows to detect subtle magnetic field changes using a superconducting loop. SQUID M. is capable of measuring the magnetic fields on the order of 10^{-5} nanotesla (nT) and used for high-precision measurements of the Tensor components of the magnetic field as well as in paleomagnetic studies of sedimentary rocks. [170, 223]. See Magnetic Gradient Tensor and Cryogenic Magnetometer.

Stabilized Downward Continuation – a data enhancement procedure which combines the traditional Downward Continuation with a high-cut filtering technique using Butterworth Filter in order to provide the option of stripping high frequencies which cause instability in the downward continuation process from the magnetic data. The general formula of S.D.C. process can be presented as:

$$F(w) = e^{\,hWs},$$

where "h" is the continuation distance; $Ws = W(1 / (1 + W/W_c)^n$; $W = (u^2 + v^2)^{1/2}$ "W_c" is the median wavenumber; "n" is the exponent order; "u" and "v" are angular frequency coordinates. S.D.C. enhances deep magnetic anomalies covered by the shallow magnetic material. In some situations, the continuation distance required to enhance deeper magnetic sources may be below the top of shallow magnetic sources and, hence, the continued field cannot be considered as a theoretically true magnetic field. Nevertheless, it may be indicative of valuable qualitative information that is not obvious in the original magnetic field contaminated with the effects of shallow magnetic sources. [94].

Stabilized Platform – a platform on which gravimeters are mounted during airborne and marine gravity surveys. S.P. keeps a nearly horizontal level despite tilts of the platform support because it is mounted on gimbals and controlled by Servo System on each gimbal axis. Generally, S.P. behaves like a damped long-period pendulum. When subjected to horizontal accelerations, S.P. may tilt resulting in gravimeter reading errors. The amount of tilt depends on the ratio of the period of the horizontal motion to that of the platform. The tilt is considered negligible if this ratio is less than 0.1. [223]. See also Horizontal Acceleration Correction, Vertical Acceleration Correction and Schuler Period.

Stacking – a procedure of averaging over repeated measurements at the same observation stations. Often, S. can reduce Random Noise (i.e., the noise that is uncorrelated) and provide a relative enhancement of correlated signals. [219].

Standard Deviation (S.D.) – a statistical parameter which represents an estimate of the accuracy of measurements, i.e., deviation of readings from their true value under normal conditions or the deviation of the potential field data values from the dataset mean value for the whole area after Detrending. Generally, S.D. is defined as

$$S.D. = [(1/n)S(x_i - x_m)^2]^{1/2},$$

where n is a number of readings or points in the dataset; x_i is the reading value or the observed value after detrending; x_m is the reading mean or the dataset mean. See also Accuracy and Variance.

Station – a ground position at which Gravimeter or Magnetometer is set up for making measurements of the gravity or magnetic field. [223]. See Station Spacing.

Station Gravity – a general definition of methods and instrumentation for ground (conventional or Microgravity Survey) and underwater (sea bottom gravity survey) measurements of the Earth's gravity field at pre-planned gravity stations (i.e., ground or sea bottom positions at which Gravimeter is set up for measurements) over an area of exploration interest. S.G. is opposed to Dynamic Gravity. [253].

Station Spacing – a distance between two consecutive points of the gravity or magnetic field measurements along the survey line. S.P. should not be more than ½ the lateral extent of the smallest wavelength anomaly which is expected to be resolved with a planned survey design. See Station.

Stationary Filtering – a filtering procedure with the use of a filter operator which is the same (i.e., constant) all over the area of data processing. See also Non-Stationary Filtering.

Steenland-Vacquier Method – see Vacquier Straight Slope Method.

Stopband – see Cutoff.

Straight Slope Index – a structural index used in Vacquier Straight Slope Method of magnetic anomaly depth estimation. S.S.I. value is based on the source geometry assumption. The following indices are commonly applied: vertical thin sheet – 1.9; horizontal thin sheet – 1.7; thick sheet – 1.4; plug-like body – 1.3; wide body (block) – 1.2; single interface (contact) – 1.2; default option -1.5. [215].

Straight Slope Method – see Vacquier Straight Slope Method.

Strakhov Filter – a linear filter that gives a best least-squares fit of a smoothed spectral estimate to the actual spectrum of the observed data over the whole frequency range while suppressing Random Noise components by a pre-selected amount. S.F. concept can be applied for Regional–Residual Anomaly Separation. [82, 118, 167]. See also Separation Filtering.

Streaks – see Corrugations.

Strike – a space direction taken by a structural surface (fault plane or tabular intrusive body) as it intersects the horizontal plane. S. is always perpendicular to Dip. [13].

Strike Balance Filter – a spectral domain grid-based filter that is applied to suppress Corrugations estimated from Map Power Spectrum. Any frequency bin in the map power spectrum whose radially normalized power is greater than a pre-selected amplitude ratio balance limit can be set to this limit. See also Strike Wiener Filter.

Strike Filter – a spectral domain grid directional filter designed to pass or attenuate the components of the observed potential field along a pre-determined directional angle or azimuth, i.e., Strike. In the reject option, S.F. zeros out the Fourier domain segment ("pie-slice") which corresponds to the specified space-domain trends irrespective to their wavelengths. S.F. can be used to remove the dominant Structural Grain from the gridded data so that subtle features may be seen at different azimuths. See also Directional Filtering.

Strike Wiener Filter – an optimum-type spectral domain grid-based filter that is applied to suppress high-amplitude short-wavelength noise falling within a narrow azimuth range. S.W.F. design is based on assumption that Map Power Spectrum can be divided into two main segments: a noise-free segment where power spectrum represents only the signal "$S^2(r)$" and a noise segment (noise fan) where power spectrum represents both signal and noise "$S^2(r) + N^2(r)$". The optimum S.W.F., designed to suppress the noise, is defined as:

$$W(r) = S^2(r) / (S^2(r) + N^2(r))$$

In S.W.F. design, the user should define the maximum wavelength limit to be used with this filter. See also Strike Balance Filter.

Striping – see Corrugations.

Stripping Filtering – a separation filter procedure which amplifies regional components of the potential field based on calculating the consecutive upward continuations. S.F. represents the potential field data after the "removal" ("stripping") of more and more of the crust overburden. [42, 97, 118]. See also Separation Filtering.

Structural Grain – alignments or trends that represent dominant structural features (for example, interpreted faults and associated horsts or grabens) at the specified subsurface level. See also Grain.

Structural Index – see Euler's Structural Index and SPI Structural Index.

Structural Model (2-D or 2.5-D) – a model that is calculated to compare a magnetic or gravity response of an assumed geological structure, approximated by a density or susceptibility model, with the actual magnetic or gravity field. Each specific S.M. may or may not correspond to the actual geological structure. For 2-D modeling, the density and susceptibility models and their responses are assumed to be two-dimensional and semi-infinite. For 2.5-D modeling, the third dimension "y" ("in" and "out" of the plane of a profile) is approximated by one or more given distances providing a quasi-3-D model. [215]. See also Model, Gravity Model and Magnetic Model.

Subsurface – an exploration term meaning the space below the Earth's surface, in particular, Crust.

Sun Angle Image – a gray-scale or color-coded image that creates the illusion of the sun shining from a chosen angle and highlighting the patterns of variously illuminated areas. [115]. See Artificial Sun Illumination.

Sun Declination – a display parameter of Sun Angle Image which defines the azimuth of the straight line from Overhead Point to the sun location. For example, S.D. = 0º means that sun is at the North from the overhead point; S.D. = 90º means that sun is at the East; S.D. = –90º means that sun is at the West; S.D. = 180º means that sun is at the South. [115]. See also Sun Inclination.

Sun Inclination – a display parameter of Sun Angle Image which defines the angle of the sun between the horizon and Overhead Point, i.e., sun elevation. For example, S.I. = 0º means that sun is on the horizon. S.I. = 90º means that sun is at the overhead point. [115]. See also Sun Declination.

Sunshaded Image – an image of the magnetic or gravity map with artificial "illumination" under pre-selected "sun" azimuth and elevation. S.I. is also referred to as Sun Angle Image or Shadowed Image. [115]. See Artificial Sun Illumination.

Superconducting Gravity Meter – see Virtual Spring.

Superposition of Anomalies – a concept that defines the composite nature of the observed potential field anomalies: they represent the vector sum of individual effects of the ensemble of sources in the subsurface featured with their specific depths, lateral and vertical extents and density/susceptibility contrasts. [25].

Supra-basement Magnetic Anomaly Sources – a general assumption about the nature of magnetic sources in the upper portion of Basement related to its topographic (relief) prominence rising above the average level of basement. There are two main types of S.M.A.S.: 1) fault-uplifted portion of a large block approximated by a thin horizontal sheet, i.e., fault throw is much less than the basement top depth; 2) large step (interface) in the basement block structure, i.e., fault throw is much larger than the basement top depth. [215]. See also Intra-basement Magnetic Anomaly Sources.

Surface Anomaly – a short-wavelength magnetic or gravity anomaly generated by variations of Density or Susceptibility at or near the Earth's surface. Such anomalies often produce spikes and usually are considered as Noise.[223]. See also Regolith and Regolith Enhancement.

Surface Elevation – a general term for a map (Grid) showing the topographic relief in the survey area. S.E. is also referred to as Terrain Elevation.

Surface Fitting – see Trend Surface Analysis.

Surface-Ship Gravimeter – see Shipboard Gravimeter.

Survey Altitude – an airborne survey parameter that defines the flight height above ground level, i.e., AGL. HRAM surveys are usually flown as Drape Survey with the typical flight height about 100-150 m AGL. Before the advent of GPS, the altitude of airborne surveys was often defined as a constant barometric altitude. Safety and Aviation Authority Regulations are the major factors to be considered in planning S.A. [57, 205].

Survey Channel – an instrument channel where airborne data (line datasets) are continuously recorded, usually, in a binary format. There are several separate channels for the recording of observed magnetic/gravity data, altitude measurements, GPS data, latitude and longitude, diurnals, fiducials, real time and other survey data. They can be added with channels containing pre-processed data: for example, in the aeromagnetic survey such channels are dc-mag channel (diurnal-corrected data), lev-mag channel (standard leveled data), edit-mag channel (culture-edited data), finlev-mag channel (leveled and culture-edited data).

Survey Datum – see Geodetic Datum.

Survey Positioning – determining the location of the survey area with respect to Reference Ellipsoid. See also Positioning and Survey Datum.

Susceptibility – a magnetic property of rocks defining the degree to which the rock may be magnetized by an external (usually the Earth's) magnetic field. For each specific rock type, S. is the proportionality constant "k" in the relationship between Intensity of Magnetization ("I") and the external Magnetic Field Strength ("H"):

$$I = kH$$

S. value is directly proportional to the volume percentage of highly magnetized minerals, like Magnetite, contained in a rock rather than a bulk rock property only. S. is a dimensionless unit, expressed in SI or cgs units (micro-cgs, i.e., cgs H 10^{-6}). The general range of S. values is about 10^5. [25, 158, 215, 223, 238]. See also Susceptibility Contrast and Koenigsberger Ratio.

Susceptibility Contrast – the magnetic susceptibility difference between two adjacent rocks or geologic bodies. The degree of lateral S.C. primarily controls the amplitude of the magnetic anomaly. Theoretically, maximum S.C.

[215,

between different rocks can be as high as 2000 (for example, peridotite dike within dolomite stratum). 238]. See also Susceptibility.

Susceptibility Filter – a grid-based Spectral Domain operator (algorithm) that calculates values of Apparent Susceptibility in the subsurface. See also Density Filter.

Susceptibility Log – the depth-versus-susceptibility curve obtained from the direct measurements of the magnetic Susceptibility of rocks in the borehole. Anomalous susceptibility values indicate the presence of magnetic minerals such as magnetite, pyrrhotite, etc. S.L. is not affected by mud resistivity, must be run in uncased boreholes, and can be run in dry boreholes. [22]. See also Magnetic Susceptibility Logging.

SVD – see Second Vertical Derivative.

Swarm – a group of sub-parallel tabular igneous rock bodies (usually, dikes) which can sometimes be correlated over hundreds of miles as intense short-wavelength elongated anomalies at the magnetic field maps. [198]. See Dike and Igneous Rocks.

Synergistic Correlation – an integrated interpretation of different data types (aeromagnetic, seismic, airborne radar, and satellite radar) in order to delineate anomalies of exploration interest, which may not have been recognized in case of separate interpretation of each data type. Gravity, radiometry, well control, and surface geology data can also be integrated into the S.C. process to facilitate structural interpretation and evaluation of hydrocarbon and mineral prospects. [6, 18, 29, 111, 130, 132, 157, 200, 252].

Syngenetic Magnetic Anomaly – a low amplitude short-wavelength anomaly generated by relatively high concentrations of Syngenetic Magnetite in the sedimentary formations. Syngenetic magnetic anomalies can be used to detect and map potential anticlinal reservoirs as well as stratigraphic traps in the areas of incised paleotopography. [77].

Syngenetic Magnetite – a strongly magnetic mineral laid down contemporaneously with its sedimentary host formation at the time of deposition. S.M. can be derived directly from a magmatic source. Certain types of conglomerates, sandstones, tuffs, glacial till, "black sands" in stream channels, and other areas of incised topography can contain high concentrations of S.M. and, therefore, generate a detectable Syngenetic Magnetic Anomaly. [77]. See also Magnetite and Diamagnetic Magnetite.

T

Tabular Body – a model approximation in the gravity and magnetic field calculations. T.B. is a body of finite thickness with one edge nearly horizontal but other edges “infinitely” remote from the point of measurements. T.B. width (i.e. orthogonal lateral extent) is assumed to be more than 50 times its thickness. Also called Infinite Dike [223]. See Thick Dike and Thin Dike.

Tail-Buoy Magnetometer – see Overhauser-Effect Magnetometer.

Talwani Inverse Solution – a result of the gravity Inversion that determines a subsurface mass distribution causing the residual gravity field. In 3-D case, a grid of rectangular prisms of the same lateral extent and various depths is used to approximate the shapes and depths of causative bodies. Such inversion of the residual gravity assumes: a) a model of two homogeneous layers without large scale lateral Density Contrast; and b) an interface formed by these two layers is the primary source of a density contrast generating the residual gravity field. T.I.S. is obtained through an iterative process that includes the calculation and summation of the gravity effects of all prisms. The difference between the iteratively calculated and actual residual gravity values is used to adjust the depths of prisms. As an option, the prisms can have their tops fixed at the pre-selected Datum, while their bases are adjusted. The iterative process is continued until Standard Deviation of the difference is less than a specified value. The inversion algorithm can incorporate a density contrast function that defines the decrease of a density contrast with depth. [84]. See also Causative Body, Prism and Talwani Method.

Talwani Method – a method of calculating the gravity anomaly caused by 2-D or 3-D source body of an arbitrary shape. In 3-D, the source body at first is represented by contours. Then each contour is replaced by a horizontal irregular N-sided polygonal lamina (i.e., very thin layer). The gravity anomaly caused by each lamina can be determined at any external point. By interpolation between contours combined with a numerical integration, the gravity anomaly of a given 3-D source body can be calculated to a high degree of precision. The possibility that density varies with depth can be easily incorporated into the calculation of anomaly by assigning a separate density value to each contour. [235]. See also Gravity Model, Forward Modeling and Inverse Modeling.

Taper – a space-domain or frequency-domain interval (window) assigned to the filter cutoff value or specified at the end of a line or grid, where the data gradually decrease to their zero values. T. is used to prevent Ringing and the loss of data at the line and/or grid ends. See also Gibbs’ Phenomenon and Data Extension.

Target – a geological object of exploration interest (ore body, Faults, Basement and sedimentary structures, salt domes, etc.) at which the gravity or magnetic survey is aimed. [223].

Tare – a sudden jump in the gravity meter readings, i.e. an instrumental error. The jump may be a) temporaty, when readings go up or down but eventually come back to the baseline; b) permanent, when readings show a permanent baseline shift. Large tares (about 50 microGal and larger) are assumed to be caused by movement (slippage) at the measuring spring hooks. Most tares are less than 10 microGal and they are caused by temporal variations of Proof Mass resulting from contamination and migration of dust, lubricating oil and other volatiles inside the sensor compartment. [4].

Tectonic Province – a large region characterized by its tectonic style and development, i.e., major structural or deformational features (basins, uplifts, troughs and fault zones), their relations, origin and historical evolution. [13].

Temperature Coefficient – a gravity instrument characteristic that defines a change in the measurement values caused by temperature changes. T.C. unit of measure is microGal per ºC. See Gal.

Temperature Range – an instrument characteristic that defines the lowest and the highest temperatures acceptable for making measurements. See also Temperature Coefficient.

Template – a transparent overlay for calculating the gravity effects such as Terrain Correction, Isostatic Correction or, sometimes, residual components of the measured field. [223]. See Residualizing and Zone Chart.

Temporary Base – a local Base Station that is set up temporarily in the area of the gravity survey to provide reference measurements of the gravity field. T.B. is tied to Absolute Base.

Tensor – a mathematical entity (commonly, vector) represented by components that vary in a special way depending on the choice of a coordinate system. [223]. See Full Tensor Gradient, Magnetic Gradient Tensor, Gravity Gradient Tensor and FTG Technology.

Terracing – a line-based iterative method that transforms smoothly varying continuous gravity or magnetic field profiles into a stepped (terraced) function composed of steeply dipping or flat segments. The obtained terraced function simulates Density or Magnetizations distributions, which have discontinuous first vertical derivatives (i.e., abrupt boundaries), and can be transformed into a geologic-map-like image. T. detects local segments (domains) of relatively homogeneous physical properties and various lateral extent. These domains are compared to independently identified geological features within Crystalline Basement or other critical surface, and a basement bulk susceptibility map or other physical property map can be constructed. [45]. See also Critical Surface Concept.

Terracing Inversion – see Terracing.

Terrain Chart – a template used for the calculation of Terrain Correction. T.C. is a set of concentric circles and radial lines that form sectors whose areas increase with the distance from the center. T.C. is placed over the digital topographic map with the center of circles at the gravity station. The average elevation in a single compartment is estimated from the map contours within it and, then, it is subtracted from the station elevation value. T.C. is also referred to as Hammer Chart or Zone Chart. [238].

Terrain Clearance – see AGL.

Terrain Correction – a correction applied to the gravity data to compensate for the effects of local topographic features when the whole area (terrain) cannot be approximated by Bouguer Slab, as not all the surroundings are at the same elevation as an observation point. Generally, T.C. is applied when Bouguer Correction did not account for: a) the absence of mass below an observation point (i.e., Station); b) the absence of mass below and the presence of mass above an observation point; c) the presence of mass above an observation point. Since these effects are close to the point of measurements, T.C. can be important in high relief areas. For land and underwater stations, T.C. is always added whether the feature is a hill or valley. For sea surface stations over relatively deep water, it may be negative. T.C. is made by dividing the topography into compartments or radial segment zones and totaling the individual effects at each station. [25, 34, 134, 137, 179, 180, 215, 223, 234]. See also Terrain Chart, Inner Zone Terrain Correction and Outer Zone Terrain Correction.

Terrain Elevation – see Surface Elevation.

Terrane – a fault-bounded area of the regional extent whose geologic and tectonic history differs from that of the surrounding areas. [223]. Magnetic terranes can be delineated using the calculated maps of Horizontal Gradient (often, low-pass filtered) as it reaches its maximum value above the boundaries (i.e. contacts) between large rock masses of differing magnetic properties. See Magnetic Contact.

Tesla – a unit of measure for Magnetic Induction (Magnetic Flux Density) or simply magnetic field in the International System of Units (SI). 1 tesla = 10^4 gauss (in cgs units) = 10^9 gamma = 10^9 nanotesla (nT). The magnetic field maps are contoured, mostly, in nanoteslas and, sometimes, in gammas (1 gamma = 1 nT). [223].

Thalen Method – a graphic method which is used for the isolated magnetic anomaly source depth estimation. <u>"Depth"</u>

= <u>"horizontal distance between maximum amplitude of selected anomaly and its minimum amplitude H 0.7"</u>. The minimum amplitude here is the maximum negative value in the trough adjacent to the positive peak on the profile of this anomaly. [53]. See also Depth Rules.

Theoretical Gravity – a mathematical model of the Earth's gravity field. T.G. is also referred to as Gravity Reference Field. The formula, which specifies the computation of T.G., is known as International Gravity Formula (IGF). [34].

Theoretical Gravity Correction – a correction applied to the observed gravity data to compensate for the theoretical value of the Earth's gravity field at the latitude of the gravity Station. This theoretical value is defined by International Gravity Formula. [25, 34, 134, 215]. See also Reference Spheroid.

Theoretical Latitude Correction – same as Theoretical Gravity Correction.

Thermal Remanent Magnetization (TRM) – one of five main types of the remanent (residual) magnetization. T.R.M. originates from the cooling of rock material below its Curie Point in the presence of the external magnetic field. The remanence of this type is particularly stable and makes the largest contribution to magnetization of the igneous and metamorphic rocks. [33, 238]. See also Chemical Remanent Magnetization, Detrital Remanent Magnetization, Isothermal Remanent Magnetization, and Viscous Remanent Magnetization.

Thick Dike – a model approximation for the magnetic sources of an igneous rock body whose width is about the same as the depth to its top. [203, 215]. See also Thin Dike and Two-Contact Block.

Thin Dike – a model approximation for the magnetic sources of an igneous rock body or magnetized fault or fracture zone, whose width is much less than the depth to its top. [54, 203, 215, 238]. See also Thick Dike and Magnetized Intra-Sedimentary Fault.

Thin Sheet – see Thin Dike.

Three-Dimensional (3-D) Analytic Signal – a 3-D generalization of the 2-D analytic signal. Defining "$\underline{x}$", "$\underline{y}$" and "$\underline{z}$" as unit vectors in "x", "y" and "z" directions allows the 3-D analytic signal of the potential field anomaly "M" to be presented as

$$A(x,y) = \underline{x}dM/dx + \underline{y}dM/dy - \underline{z}dM/dz$$

Here, its real part "$\underline{x}dM/dx + \underline{y}dM/dy$" (i.e., Horizontal Derivative) and imaginary part "$\underline{z}dM/dz$" (i.e., Vertical Derivative) constitute Hilbert Transform Pair. Definitions of Energy Envelope, Instantaneous Phase and Instantaneous Frequency follow the similar definitions for the profile 2-D case. [103, 147, 152, 161, 166, 214]. See also Analytic Signal.

Three-Dimensional (3-D) Bouguer Correction – a multi-step correction procedure that results in the construction of a 3-D Gravity Model of the area topography. This process effectively combines Simple Bouguer Correction and Terrain Correction into one precise model-based correction. [34].

Three-Dimensional (3-D) Euler Deconvolution – a grid-based automated method of the magnetic data interpretation for the source depths and locations using Euler's Homogeneity Equation. The method employs horizontal and vertical gradients, either measured or calculated (typically, using the Fourier methods). The obtained grid is sampled using a moving square window the size of which is selected big enough to contain the gradient and field values from sources of interest, but small enough to minimize the effects from adjacent sources. For each point in the selected window, one Euler's equation may be written, so the window provides an overdetermined equation set which may be solved for a source position ("x_o", "y_o", "z_o") and the regional value "B" in accordance with the Euler's homogeneity equation. Here, it is also necessary to assume Euler's Structural Index value. For each structural index, a map of depth solutions can be plotted. The method is quite effective in the delineation of structural trends such as basement faults (often, despite a poor choice of a structural index) and estimates of their depths. The method cannot yield any dip information. Observed data need not be reduced to the Pole and Remanent Magnetization seems to be a non-interfering factor. The gravity anomalies of some geologic features also obey the Euler's homogeneity equation and, hence, this method can also provide useful information on faults and near-vertical contacts where the density contrasts exist. [206, 207]. See also Euler Deconvolution (2-D).

Three-Dimensional (3-D) Gravity – see Gravity Gradiometry.

Three-Dimensional (3-D) Hilbert Transform Operator – a frequency domain operator applied to calculate Vertical Derivative, when horizontal derivatives in two orthogonal directions "x" and "y" are available. [214]. See also Hilbert Transform and Hilbert Transform Pair.

Three-Dimensional (3-D) Inversion – a methodology that produces a geophysically interpretable 3-D model of the subsurface structure based on the observed potential field data. [144, 145]. See Inversion.

Three-Dimensional (3-D) Model – a network or grid of values which model subsurface geological boundaries or blocks and bodies represented as 3-D surfaces and bodies of Density contrast in Gravity Model or 3-D blocks and bodies of Susceptibility contrast in Magnetic Model.

Three-Dimensional (3-D) Susceptibility Inversion – method of inverting the observed magnetic data to recover 3-D susceptibility model. Model solutions are obtained based on minimizing a general Objective Function and pre-selected misfit between Model Response and the observed data. [144]. See Minimizing Inversion.

Tiburg Method – a graphic method used for the isolated magnetic anomaly source depth estimation. "Depth to magnetic pole" = "2/3 the horizontal distance between points at the level of half maximum anomaly amplitude". T.M. is also referred to as Half-Maximum Method or Tiburg Rule. [53, 223]. See also Depth Rules.

Tiburg Rule – see Tiburg Method.

Tidal Correction – see Earth Tide Correction.

Tidal Effect – a distortion of the Earth's surface (up to about 10 cm) due to attraction of the sun and moon. T.E. results in the gravity measurement variations which should be corrected. Correction for T. E. are made by means of tables or included in Drift Correction. [223]. See Earth Tide Correction.

Tie – an observation repeated at one of previously observed points in order to check for Drift, error, etc. or to establish relationship of two datasets. [223]. See also Gravity Repeats.

Tie Lines – see Control Lines.

Tilt – see Potential Field Tilt and Potential Field Tilt Angle.

Time Variation Correction – a correction that is applied to the observed gravity data to compensate for the Earth's tides and instrument drift. T.V.C. is determined by the repeated measurements at the gravity base station, assuming that the gravity values at all stations within the survey area vary in the same manner as at Base Station. See Drift, Earth's Tides, Earth Tide Correction and Drift Correction.

Time-Lapse (4-D) Gravity Survey – a gravity survey repeatedly performed at the same stations in the area of the oil field under development: at first, prior to the fluid injection (to obtain baseline data) and, then, over a period of years later with the purpose of the waterflood surveillance. Differences in the gravity anomaly, associated with the change in a fluid volume and fluid distribution, can be obtained. T.-L.G.S. requires the use of Global Positioning System (GPS) and a microGal-precision gravimeter. The gravity signal of interest is derived from the observed gravity data corrected, along with standard corrections, for instrument Drift, Earth's Tides and [105].

elevation. See also Microgravity Modeling.

TMI – see Total Magnetic Intensity.

Topographic Correction – see Terrain Correction.

Torsion Balance – a) an instrument for measuring gradients of the observed gravity field using the arrangement where two equal "proof" masses at opposite ends of a horizontal beam are suspended by a very fine torsion wire. The attracting (i.e. gravity) forces on these masses differ and, hence, produce a torque which can be measured by counter balancing with a known torque (such as balancing or null screw); b) a physical principle of operation of some gravimeters. The T-shaped moving system is horizontally supported by fine torsion fibers (wires) attached to the cross-bar with a weight on the end of a cross-arm. The torque due to the gravity field acting on the weight is balanced by the torsion of these elastic supports. The balancing or null screw, operating on the moving system through a spring and mechanical linkage, is adjusted at each reading. Differences in the gravity field values are proportional to differences in the position (dial reading) of the null screw when the system is balanced. The Atlas, Worden, World-Wide, Sharpe, and some other gravimeters are of this type. Sometimes, T.B. is referred to as Torsion Fiber. [174, 223]. See also Zero-Length Spring and Weight-On-Spring.

Torsion Fiber – see Torsion Balance.

Total Bouguer Correction – see Complete Bouguer Correction.

Total Geomagnetic Intensity – a magnitude of the Geomagnetic Field Vector at the point of measurement. T.G.I., measured at fixed points over the survey area and corrected for IGRF, solar pulsations, diurnal variations and several other effects, is called Total Magnetic Intensity (TMI) or Total Magnetic Field. [25]. See also Horizontal Geomagnetic Intensity and Vertical Geomagnetic Intensity.

Total Gradient – a vector sum of three potential field gradients: two horizontal gradients in "x" and "y" directions and Vertical Gradient. In the general form, T.G. magnitude (Modulus) can be presented as

$$T.G. = [(dM/dx)^2 + (dM/dy)^2 + (dM/dz)^2]^{1/2}$$

where M = M(x,y,z) is the potential field anomaly. T.G. is always positive over Causative Body. T.G. maxima are centered directly above vertical thin dikes and contacts between two blocks of contrasting susceptibilities or densities. Over thick dikes, T.G. has two maxima equidistant from a local minimum, which is directly above the center of a thick dike. [171]. In the case of a dipping dike or contact, T.G. maxima are usually shifted updip. Based on this phenomena, the spatial relationship between the total and horizontal gradient maxima can be used to infer the location and dip of the magnetic or gravity Contact as well as location of a magnetized fault (see Gradient Dip Estimation and Goussev Filter). Modulus of T.G. equals to Analytic Signal Absolute Value (which is often called Energy Envelope) and for this reason Total Gradient Method is also referred to as Analytic Signal Method. See Thick Dike and Thin Dike.

Total Gradient Method – see Total Gradient and Analytic Signal Method.

Total Intensity – a term which is usually refers to Total Magnetic Intensity as opposed to the Earth's magnetic field components in the vertical (Vertical Gradient) and horizontal (Horizontal Gradient) directions.[223].

Total Magnetic Field – the resulting magnetic field after applying the following some or all corrections to the observed magnetic data (not necessarily in this order): a) removal of the Earth's main (core) magnetic field based on International Geomagnetic Reference Field – IGRF model appropriate for the date of the survey;
b) compensation for the solar radiation energy, i.e., irregular solar pulsations; c) compensation for the regular diurnal variations; d) instrument drift compensation; e) flight elevation compensation; f) Leveling, i.e., Mis-Tie elimination; g) Cultural Editing. As a rule, T.M.F. is assumed to represent the gridded magnetic data after basic corrections, but before Reduction-To-Pole (RTP) or Reduction-To-Equator (RTE). Often, T.M.F. is referred to

[25, 53, 238].

as Total Magnetic Intensity. See Diurnals, RTP Anomaly, and Total Magnetic Field WRTP.

Total Magnetic Field Anomaly – an anomaly of the observed magnetic field after Magnetic Corrections and before applying filters or other processing operations. See Anomaly.

Total Magnetic Field Measurements – measurements of the magnitude of the Earth's magnetic field without regard to its vector direction, using standard total-field magnetometer (as compared to measurements of components of the total field in the vertical or horizontal directions using Gradiometer). [25].

Total Magnetic Field WRTP – Total Magnetic Field after applying Wiener Noise Filter and Reduction-To-Pole (RTP).

Total Magnetic Intensity (TMI) – see Total Magnetic Field.

Total Magnetization – see Total Polarization.

Total Polarization – a vector sum of Remanent Magnetization and Induced Magnetization. In general, T.P. may be different from the direction of the Earth's magnetic field. T.P. is used with the same meaning as Magnetization. T.P. vector is defined by three parameters: 1) Pseudosusceptibility; 2) magnetic azimuth (often, the same as the present Earth's magnetic field); and 3) magnetic Inclination or dip (for ore body anomalies, it is usually significantly different from the inclination of the present Earth's magnetic field). [17].

TOWDOG – a towed deep ocean gravity meter. The instrument consists of a marine gravimeter modified to fit inside a pressure case that is mounted on a platform designed for towing stability. The gravity sensor unit (sensor package) is tethered to a ship and towed just above the sea floor, providing much higher resolution of anomalous masses as compared to conventional sea surface measurements. [256].

Towed Bird System – an airborne magnetic survey system wherein the Magnetometer is mounted in a streamlined cylindrical housing, which is towed by cable below and behind the aircraft. See Bird.

Towed Deep Ocean Gravimeter – see TOWDOG.

Transform – a mathematical operation that provides the same information content in different domains. For example, Fourier Transform maps space domain potential field data to their equivalent frequency (wavenumber) Domain. [223].

Transverse Mercator – see Universal Transverse Mercator (UTM).

Traverse – see Gravity Traverse.

Traverse Lines – survey lines along which magnetic or gravity data are recorded. In HRAM survey, T.L. are flown at close spacing (100-800 m depending on the depth to exploration targets), preferably, orthogonal to the regional geologic strike with the mean ground clearance of 90-120 m. [78, 205] See also Control Lines.

Trend – a general term for direction of dominant alignments on structural and tectonic maps and on images of the anomalous gravity or magnetic fields. [223]. See also Grain, Fabric, and Signature.

Trend Analysis – see Trend Surface Analysis.

Trend Replacing – a restoration of the overall data trend (overall slope) removed from the observed potential field data by Detrending.

Trend Surface Analysis – a grid-based methodology for Residual-Regional Anomaly Separation and identifying trends and dominant wavelengths in the residual and regional components of the observed field. Generally, T.S.A. is based on the fitting Bouguer Gravity or magnetic field (often, after RTP applied) with a polynomial surface of

st

the pre-determined order, from the 1 through N-th. The resulting polynomial fit is assumed to be an N-th order polynomial approximation of the regional component of the potential field. By subtracting the N-th order polynomial surface from the original potential field, the user obtains the residual component of this field. Also called Surface Fitting. [223].

Triangular Filter – see Bartlett Filter.

Tri-Axial Fluxgate Magnetometer – a three-directional Fluxgate Magnetometer which is installed on board the aircraft to monitor magnetic effects caused by the aircraft's maneuvers (Pitch, Roll, Yaw) during the flight along survey lines. T.-A.F.M. data are used as input to Real-Time Magnetic Compensation System. See also Aeromagnetic Survey Equipment.

Trimming – a grid-based procedure generally used to cut away Edge Effects at the grid ends to provide a better image of the processed data. T. can also be used to select the specified region within the original grid and cut away the rest of the grid keeping this region for the subsequent detailed processing.

Tripod Correction – a correction applied to Observed Gravity values to compensate for the height of the instrument tripod. T.C. can be presented as

$$T.C. = h \times dg/dz,$$

where "*dg/dz*" is the vertical gradient of gravity (0.30861 mgal/m) and "*h*" is the height of a tripod.

Two-and-Half (2.5) Dimensional Body – a magnetic or gravity source body which is limited in the strike direction, but its strike length is significantly larger than a length in any other direction. See also Two-Dimensional (2-D) Body.

Two-Contact Block – a model approximation of the potential field source with two separate susceptibility or density vertical contacts (interfaces) and "infinite" depth extent. The width of T.-C.B. is much larger than the depth to its top. See also Contact.

Two-Dimensional (2-D) – a term of general approximations and Modeling meaning that under given assumptions there is no variation in one of three dimensions or directions: "X", "Y" and "Z". [223].

Two-Dimensional (2-D) Body – a magnetic or gravity source body which is unlimited in the strike direction, i.e. it has an "infinite" length meaning that it is so long that the effects of the ends are negligible. In practice of Modeling, this length should be at least 15 or, preferably, 20 times larger than a length in any other direction. See Two-and-Half (2.5) Dimensional Body and Strike.

Two-Dimensional (2-D) Euler Deconvolution – see Euler Deconvolution.

Two-Dimensional (2-D) Directional Filtering – a frequency domain Microleveling technique based on use of 2-D directional filters and Fast Fourier Transform (FFT) applied to the standard leveled magnetic grids. Before filtering, the removal of the first order trends, as well as expansion to square grid dimensions, is required. The modified grid is filtered in two directions to construct the leveling error pass notch using: 1) high-pass Butterworth Filter in the direction of the control lines and a cutoff set 2-4 times the traverse line spacing to pass the unchanged spatial frequencies of an order of these line spacing; 2) Directional Cosine Filter along the traverse lines to pass only the wavelengths of an order of the control line spacing in this direction. Finally, the resulting error grid containing elongated anomalies (line corrugations) is subtracted from the original grid to obtain a new grid filtered in two directions. [67]. See also One-Dimensional (1-D) Directional Filtering.

Two-Dimensional Fast Fourier Transform (2-D FFT) Filters – a group of Fourier Domain filters that are applied to the gridded (i.e., two-dimensional) magnetic and gravity data. See also One-Dimensional Fast Fourier Transform (1-D FFT) Filters, Grid, and Gridding

Two-Dimensional (2-D) Fourier Transform – see Fourier Transform.

U

Undersampling – a term applied to the measurements of the gravity or magnetic field at regular space intervals which are longer than the size of anomalies striking at acute angles to the traverse survey lines. In case of U., the interpolation between discrete data points in the direction of a strike of a short-wavelength anomaly by gridding algorithms will result in appearance of a trend of small separated circular or elongated contours (bull's eyes) instead of more or less continuous trend of this anomaly. [126]. See also Bull's Eye Effect.

Universal Gravitational Constant (G) – a force of the gravity attraction between two small uniform spheres, each of the mass equals to 1 gram and placed so that their centers are 1cm apart. The latest reference [41] define this value as

$$G = (6.67259 \pm 0.00085)\ 10^{-8}\ \text{cm}^{3}\ \text{gm}^{-1}\text{sec}^{-2}\ \text{(in cgs units)}$$

or

$$G = (6.67259 \pm 0.00085)\ 10^{-11}\ \text{m}^{3}\ \text{kg}^{-1}\ \text{sec}^{-2}\ \text{(in SI units)}$$

U.G.C. is also referred to as Newtonian Gravitational Constant and Big G. See Newton's Law of Gravitation.

Universal Transverse Mercator (UTM) – a global coordinate system based on a standard rectangular map grid. It is used to determine "x" and "y" coordinates in meters for each specific location in reference to the Equator (positive "y" values increase toward the North from the Equator, and negative "y" values increase toward the South from the Equator), and one of 60 central meridians within 60 meridianal zones, each 6° of longitude wide, covering the Earth's surface (positive "x" values increase toward the East from the given central meridian, and negative "x" values increase toward the West from the given central meridian). UTM zones are numbered from west to east. Zone 1 has the central meridian of 177ºW longitude. Zone 31 has the central meridian of 3ºE longitude. Each central meriduan is assigned the False Easting value of 500 000 m. The Equator is assigned the False Northing value of 0 in the Northern Hemisphere and 10 000 000 m in the Southern Hemisphere. [223]. See also False Easting and False Northing.

Upward Continuation – a procedure to recompute the potential field data at an elevation higher than that at which the potential field was observed. In the frequency domain, U.C. behaves like a smoothing Low-Pass Filter. Commonly, U.C. is used to attenuate near-surface noise, tie the aeromagnetic surveys flown at different altitudes and calculate a residual component of the potential field (as a difference between the observed field and the upward continued field). The general formula of U.C. can be presented as

$$F(w) = 1/e^{hw},$$

where "h" is the level of upward continuation in meters. The property of attenuating the gravity or magnetic effects of small-scale topographic and near-surface density or susceptibility variations allows to use U.C. in designing cascaded filters. [97, 118, 156, 184, 196, 215, 223]. See also Downward Continuation and Preferential Continuation.

Upward Continuation Residual – a residual gravity or magnetic field obtained after subtracting the upward continued field from the original field. See Residual and Upward Continuation.

UTM – see Universal Transverse Mercator.

UXO Detection – unexploded ordinance detection. A new military technology adapted to the diamond and gold exploration as well as ultra-detailed mapping of very subtle magnetic property differences (such as intrusive/ore body zonation/alteration), monitoring buried pipelines, and other high-precision applications.

UXO acquisition system features DGPS navigation, ultra-high Amplitude Resolution (0.001 nT), high-speed summed sampling (up to 20 summed samples per second), multi-sensor high-sensitivity gradient measurements at randomly distributed or regular-oriented points of observation using low-flying and slow-moving helicopters. See DiaMagÔ.

V

Vacquier Straight Slope Method – a graphic method used for the isolated magnetic anomaly depth estimation. It is applied to the dike or vertical prism models and based on determination of a straight slope segment on the profile of a magnetic anomaly and its projection to the "x" direction (straight slope distance). Estimation of depth requires the knowledge of a structural index (straight slope index):

"depth" = "straight slope distance" H "straight slope index"

V.S.S.M. is also referred to as Steenland-Vacquier Method. [53, 215]. See also Analog Magnetic Depth Estimation and Straight Slope Index.

Variable Datum Gravity Inversion – a 3-D gravity Inversion that incorporates Upward Continuation of Bouguer Gravity to an arbitrary level from Mean Sea Level in order to ensure the interpretation of the gravity-detectable structures of exploration interest that are above the mean sea level, especially in the areas where the topographic relief changes drastically. [84]. See also Reference Upward Continued Distance.

Variance – a statistical accuracy estimate parameter which is the square of Standard Deviation. See Accuracy.

Vector – a quantity defined by both Magnitude and direction. V. is usually shown as an arrow pointing in a certain direction and the arrow length is proportional to the magnitude of V. [223].

Vector Magnetics – a methodology based on three-component magnetic field measurements to examine three orthogonal elements of the magnetic field "M":

$$F = \underline{i}Mx + \underline{j}My + \underline{k}Mz ,$$

where "$\underline{i}$", "$\underline{j}$" and "$\underline{k}$" are unit vectors.

Vening Meinesz Hypothesis – see Airy Hypothesis.

Vertical Acceleration Correction – a correction that is applied to the airborne gravity data to compensate for Stabilized Platform vertical acceleration due the aircraft motion. V.A.C. is calculated based on GPS data for three component (x, y, z) aircraft position and velocity data using various processing software. [37]. See also Horizontal Acceleration Correction.

Vertical Component Filter – a spectral domain line-based filter which retains (passes) the vertical component of the measured magnetic field. [230]. See also Horizontal Component Filter.

Vertical Cylinder – one of the basic geometrical shapes which is used for the model calculation of the gravity and magnetic effects. V.C. is a cylinder of the radius "R" and height "L" with its top buried at a distance "Z" from the Earth's surface. This shape is often convenient for computing the gravity and magnetic model anomalies from salt domes, volcanic plugs, and isolated magnetic intrusions. See Gravity Modeling Shapes and Magnetic Modeling Shapes.

Vertical Derivative – a rate of a space change of the potential field in the vertical ("Z") direction. V.D. is also referred to as First Vertical Derivative. For magnetic data V.D. usually does not represent an actual survey-measured quantity (except for special vertical gradient surveys) and calculated as a point approximation of the magnetic field's rate of change in the vertical direction using the Hilbert transform properties of potential fields. V.D. enhances the shallower (short-wavelength) anomalies and attenuates the longer wavelength regional components of the potential field. V.D. has its zero values over the vertical edges of thick source bodies, positive values over positive anomalies, and negative values over negative anomalies. V.D. calculation is generally a spectral domain procedure, and it is often cascaded with conventional low-pass filtering or Upward

Continuation in order to suppress high-frequency noise components. [25, 52, 59, 166, 214, 222]. See also Vertical Gradient, Second Vertical Derivative (2VD) and Analytic Signal Derivative.

Vertical Derivative Magnetic Anomaly – a general term for maps (grids) showing the calculated Vertical Derivative of the magnetic field, as a rule, after applying Reduction-To-Pole (RTP) to the gridded magnetic data. V.D.M.A. emphasizes magnetic effects caused by relatively shallow and local subsurface features, such as Magnetic Basement structures and intra-sedimentary magnetized Faults. The zero contour of V.D.M.A. map outlines the boundaries of offsetting fault blocks and blocks of contrasting Susceptibility values in the upper part of magnetic basement and, hence, this data can be used in studies of the tectonic elements. V.D.M.A. lines of discontinuity often indicate the presence of cross-cutting faults or shear zones. See also Horizontal Gradient Magnetic Anomaly and Grid.

Vertical Derivative Order – a parameter ("n") which establishes the degree of enhancement of high-frequency (short-wavelength) components of the potential field data during Vertical Derivative computation: the higher orders of vertical derivatives enhance the high-frequency content to the greater extent than the lower orders of derivatives. For example, Second Vertical Derivative (n = 2) provides much better resolution of data through a greater high-frequency content enhancement than First Vertical Derivative (n = 1). [94]. See also Fractional Vertical Derivative.

Vertical Geomagnetic Intensity – a magnitude of the vertical component of Geomagnetic Field Vector at the point of measurement. [25]. See also Total Geomagnetic Intensity and Horizontal Geomagnetic Intensity.

Vertical Gradient – the absolute value of Vertical Derivative. V.G. is known to be efficient in enhancement of relatively shallow short-wavelength potential field anomalies associated, for example, with magnetized faults or density-contrast faults. V.G. has its peak value over the top of the vertical Thin Dike and two peaks over Thick Dike, which are centered at equal distances from the thick dike axis. V.G. maxima can be offset from the tops of thin dikes in case of their non-vertical occurrence. [2, 12, 127, 154, 171, 177, 189, 203]. See also Measured Vertical Gradient, Vertical Derivative and Analytic Signal Derivative.

Vertical Gravity – a derivative of Gravity Potential in the direction of the vertical axis, i.e., vertical component of the Earth's gravity field. This is the quantity measured by gravimeters. [25, 238]. See Gravimeter and Gravity Force.

Vertical Integration – a grid-based Spectral Domain procedure (filter) that calculates the vertical integral of the observed potential field data after applying Fourier Transform. See also Vertical Derivative and First Vertical Integral.

Vertical Magnetic Gradiometry – direct measurements of Vertical Derivative of the magnetic field using a recording system with two vertically separated magnetometer sensors. V.M.G. has the following benefits: a) minimization of the diurnal effects, particularly, in high magnetic latitudes; b) suppression of the regional gradients of the Earth's magnetic field; c) enhanced lateral resolution of anomalies generated by closely spaced sources. Areas with low intensity of target magnetic signals may require an increased vertical separation of sensors. With the instrument sensitivity of 1 nT, the vertical separation of sensors about 1.0–1.5 m is considered sufficient for stable measurements. The general formula of V.M.G. can be presented as

$$dF/dz = (F_2 - F_1)/Dz,$$

where "dF/dz" is the vertical derivative; "F_1" and "F_2" are sensor readings; "Dz" is a sensor separation distance. [155].

Vertical Separation – a separation of the potential field anomalies caused by source bodies located at different depths. Without V.S., determination of source parameters (depth, lateral extent, etc) suffers from distant sources superposition that yields mislocations. Commonly, V.S. is performed by Upward Continuation and Filtering.

Because of the fundamental ambiguity in relationship between the potential field and its sources, V.S. can produce a reliable qualitative (not quantitative) result on condition that distinctly different depth levels of sources are present. See Matched Filtering and Lateral Separation.

Vertical Sheet – one of the basic geometrical shapes used for the model calculation of the gravity and magnetic effects. V.S. is equivalent to the vertical set of many horizontal cylinders having their radii much smaller as compared to the depth of their horizontal axes from the Earth's surface. V.S. (or Thin Dike) is the most common approximation of faults. [238]. See Gravity Modeling Shapes and Magnetic Modeling Shapes.

Video Viewing – a procedure which is a part of the Cultural Editing process. Line profiles of the acquired aeromagnetic data are visually reviewed in order to detect high-frequency anomalies (spikes) and check them against cultural objects, such as houses, farms, power lines, wellheads, roads, etc. recorded by the on-board video camera during the flight. All identified non-geological anomalies are then removed by the digital editing. [57].

Virtual Spring – a gravity meter design which is based on the use of Magnetic Levitation. The V.S. design provides direct electronic measurements of Gravity Field by measuring the voltage necessary to maintain the permanent magnet mass in magnetic levitation at the null point. The value of this voltage is proportional to Gravity Acceleration at the point of measurement. For this reason, the instrument based on this concept is called Magnetically Levitated Accelerometer or simply Magnetic Accelerometer. The same basic concept is used in Cryogenic Magnetic Levitation devices operating at near absolute zero temperatures. The physical property of superconductivity is used in the design of the very high-precision (0.0008-0.0015 mGal) Superconducting Gravity Meter, which is now in use at some gravity observatories measuring Absolute Gravity. [36].

Viscous Remanent Magnetization (VRM) – a residual magnetization produced by a long exposure to an external magnetic field. VRM acquisition rates vary widely according to the mineralogy and grain size of the rock. VRM is an important consideration in paleomagnetic studies, but can be neglected in exploration scale projects. [33, 238]. See also Chemical R.M., Detrital R.M., Isothermal R.M. and Thermal Remanent Magnetization.

Voice – a discrete portion of a signal derived by Wavelet Transform Filtering. See also Wavelet Transform (WT).

Volcanic Rocks – finely crystalline and, as a rule, strongly magnetic Igneous Rocks originating from the volcanic action at or near the Earth's surface and which were ejected explosively or extruded as Lava. Thick layer of V.R. covering a large area may create Magnetic Basement in the subsurface. [13]. See Extrusive Rocks.

W

Wavelength – a distance between successive repetitions of the waveform, from one peak to the next peak, measured perpendicular to the wavefront. In gravity and magnetic exploration, depth to the source of observed anomaly is related to the horizontal distance of the slope (i.e., about half-wavelength) of this anomaly. Generally, long W. is related to a deep source, and short W. is related to a relatively shallow source. [23, 223]. See Magnetic Anomaly Wavelength and Gravity Anomaly Wavelength.

Wavelength Analysis – a methodology which is based on transformation of the observed potential field data from the original Space Domain to the equivalent Frequency Domain using Fourier Transform. After transformation, low-pass or band-pass or high-pass filters can be constructed to analyze a wavelength (or equivalent frequency) content of the gravity or magnetic anomalies. The wavelength-filtered maps are usually compared with the input (unfiltered) data for combined examination in order to get a better spatial understanding of the relationship between relatively deep/broad/thick sources and relatively shallow/narrow/thin sources. [257]. See Wavenumber.

Wavelength Filter – a space domain or spectral domain filter that separates anomalies of different horizontal extent by passing or rejecting a certain wavelength range from the mapped potential field data. Originally, W.F. was developed as Linear Filter for application in the space domain. Modern software packages offer conceptually equivalent and more effective anomaly separation option based on filtering in the spectral (frequency) domain where the user makes a choice of filter parameters either in wavenumber or grid units (grid intervals) or wavelength values. [257]. See also Anomaly Wavelength.

Wavelength Resolution – a quantitative estimate of the smallest Wavelength where the noise and target signal levels are equal. W.R. is limited by Sampling Interval and by wavelength filtering applied to suppress Noise and enhance target signal. In the case of Station data, W.R. is twice Station Spacing. In the case of data obtained with the use of a moving platform (marine, airborne and satellite surveys), it is the noise-suppressing filter parameters that determine W.R. [253]. See also Anomaly Resolution.

Wavelet – a waveform component consisting of only a few wave cycles and having a short length. According to the Fourier synthesis concept, each W. is the result of superposition of many harmonic waves of different frequencies and amplitudes. In its turn, the superposition of short-length wavelets constitutes the longer wavelength components of the observed potential field. [223]. See Wavelet Transform and Fourier Analysis.

Wavelet Analysis – see Wavelet Transform.

Wavelet Decomposition – see Wavelet Transform.

Wavelet Transform (WT) – a space and spectral analysis technique that complements traditional Fourier methods. W.T. views any potential field signal as a combination of finite length wavelets. W.T. decomposes input signals into constituent wavelet components with the subsequent analysis of a portion of their frequency spectrum over a selected space domain window. Based on results of the multi-window test, lateral resolution of the potential field data can be significantly improved. W.T. can also be used for Regional-Residual Anomaly Separation. Aliasing in the transform domain is a problem that should be properly addressed when using this technique. W.T. is also referred to as Wavelet Analysis, Space-Frequency Localization or Wavelet Decomposition. [35, 65, 69]. See Wavelet.

Wavelet Transform Filtering – a two-step procedure which is based on high-resolution decomposition by Wavelet Transform: 1) data decomposition into different resolution levels; 2) signal reconstruction by Inverse Wavelet Transform while discarding unwanted noise components of the transform.

Wavenumber – a spatial frequency (i.e., space domain analog of the time domain frequency) or the number of wave cycles per unit of distance or per grid unit in a given direction “x” or “y”. W. is a reciprocal of Wavelength:

“wavenumber” = “1 / wavelength”

See Spatial Frequency and Local Wavenumber.

Wavenumber Filter – a general term of a filter from a group of Spectral Domain Filters which have their Cutoff values defined in wavenumber units and operate based on the concept of discrimination against certain wavenumbers relative to others. W.F. is the equivalent of Wavelength Filter. See Wavenumber.

Weighted Euler Deconvolution – a technique that weights the Euler’s homogeneity equations (which are solved for the source body depth estimates using 3-D Euler Deconvolution of gridded gravity data) by an error function proportional to a) Accuracy of the gravity station measurements, i.e., the larger errors, the smaller weight; b) distance between a grid point and the nearest Station, i.e., the larger distance, the smaller weight. Erroneous depth estimates resulting from low accuracy measurements and the gridded field’s Aliasing due to irregular station distribution or large spacing between regular survey lines can be rejected. [128]. See Euler Deconvolution and Euler’s Homogeneity Equation.

Weight-On-Spring – a basic physical principle of operation of some gravimeters. The change of a length of the spring with a weight attached to its end is proportional to the change of the gravity field. High-accuracy optical systems, with multiple reflections or others, are required to make changes of the order of one part in a million or less apparent and measurable. The Gulf and Hartley gravimeters are of this type. [174]. See also Zero-Length Spring and Torsion Balance.

Werner Deconvolution – an automated magnetic source parameter estimation procedure (algorithm) based on the analysis of 2-D profiles of the magnetic anomalies from source bodies approximated by Thin Dike or Magnetic Contact model geometries. The Werner’s equation expresses the total magnetic intensity anomaly of a thin dike and the first horizontal derivative anomaly of a contact in terms of six parameters to fit Window with at least seven points from the anomalous profile. The window is moved along the profile to generate solutions (coordinates “x” and “z” of the top of a dike, or contact as well as Susceptibility and dip values) for each anomaly. The process is usually run for 15-20 different window sizes to look for progressively deeper solutions. The final result is the depth section of solutions along each survey line. Using line data sampled every 7-10 meters, W.D. provides high-resolution information which is superior to that of the gridded data because: a) grid represents the potential field data sampled according to Cell Size, i.e., each 50-250 meters; and b) field curvature data crucial to resolution and depth analysis is often distorted in the process of Gridding. [25, 66, 120, 129, 131, 153, 215]. Sometimes, W. D. is referred to as Werner Filtering. See also Werner Method, 2-D Euler Deconvolution, and 3-D Euler Deconvolution.

Werner Depth Estimation – see Werner Deconvolution.

Werner Filtering – see Werner Deconvolution.

Werner Method – a 2-D (i.e., profile-based) potential data interpretation method that was originally developed for magnetic data and based on two assumptions: 1) distribution of magnetic sources in subsurface can be described by ensembles of variously dipping, differently magnetized dikes occurring at different depths and striking orthogonally to the line of measurements; 2) interference from a neighboring anomaly or regional anomaly can be expressed as a simple polynomial added to the residual anomaly of interest. Basically, W.M. separates the magnetic field contributed by a particular Dike (or thin sheet) under study from the interference of both neighboring and distant dikes (thin sheets). W.M. can be extended to models other than dikes (or thin sheets) as well as applied to the gravity data. For example, Magnetic Contact model and Horizontal Cylinder model apply W.M. for Horizontal Derivative of the magnetic field and the vertical component of the gravity field respectively to obtain estimates of the source depth and other parameters. [129, 215]. See Werner Deconvolution.

Werner Profile Analysis – see Werner Deconvolution.

WGS84 – one of the latest versions of Reference Spheroid.

White Noise – see Random Noise.

Wiener Filter – see Wiener Noise Filter.

Wiener Noise Filter – an optimum-type low-pass data stabilizing filter. Generally W.N.F. is used to suppress any geophysically meaningless high-frequency noise (Random Noise) before applying Reduction-To-Pole or Reduction-To-Equator. Basic principles of a more general Wiener filter, as an optimum-type filter, are used in developing anomaly separation methods, reduction-to-the-pole techniques and Equivalent Layer concept. [91, 92, 102, 118, 183, 186].

Window – a portion of the line dataset or grid dataset chosen as a basis for designing the data processing or inversion operators or other considerations. Also called Gate [223]. See also Running Window and Werner Deconvolution.

Windowing – a grid edge smoothing procedure which is applied before Fourier Transform and calculation of Power Spectrum to prevent the loss of data at grid edges and minimize Edge Effects. [240]. See also Rolloff Window.

Worden Gravimeter – see Torsion Balance.

Wraparound Effect – an undesirable edge effect caused by Circular Convolution, which occurs when conventional RTP Filter is applied in the Fourier (frequency) domain. W.E. enhances artificial edge anomalies that could be misinterpreted as real structural trends. To eliminate W.E. and minimize noise and other edge effects, the applying FIR RTP Filter is recommended. [148]. See Fourier Domain, Linear Convolution and Padding.

Y

Yaw – a turn from a straight course or rotational motion of the survey aircraft about a vertical axis during the flight. See also Crab, Pitch and Roll.

Z

Zero-Crossover Method – a profile-based method of estimating the gravity source body parameters using the truncated horizontal plate model approximation. Z.-C.M. is applied to the gravity profile which is perpendicular to the upper edge of this model. This gravity profile is upward continued over several constant intervals and profiles of Second Horizontal Derivative (2HD) are calculated at each elevation. Differences in the lateral offset of the zero-crossover points of 2HD of successively upward continued gravity profiles are used to estimate dip, vertical extent and location of the model boundary. Application of this method requires that distance to the upper surface of the model (i.e., geological body) is known. Tests indicate that the best results are obtained when both the length of gravity profile and the finite-strike length of a model are at least three times the maximum depth extent of the model. [156]. See also Upward Continuation.

Zero-Error Normalization – a data processing operator (LCT ZENÔ algorithm) for adjusting closely spaced gravity and magnetic datasets. Z.-E.N. provides a 3-D line adjustment for each survey line to derive a minimum warp surface that retains the high-frequency signals, supported by surrounding neighbor control points, while suppressing apparent line-oriented noise events (which have no surrounding support) and resolving the low-amplitude, intermediate to long-wavelength level offsets between survey lines.

Zero-Length Spring – a basic physical principle of operation of some gravimeters. The distance between points of a quartz spring attachment is designed in such a manner that a projection of the stress-strain curve passes through zero spring length for zero strain. In other words, without a mass load the spring will have no extension. Gravimeters with a spring of this type can be made very sensitive to strain (gravity) forces with theoretically infinite period and linear deflection of a suspended weight proportionally to the gravity field. Z.-L.S. suspension supports a weight on the end of a horizontal beam in the LaCoste & Romberg gravimeters. [36, 174]. See also Torsion Balance and Weight-on-Spring.

Zero-Phase Meter Gravity – the gravity data after applying a “soft” phase-only-inverse filter to the gravity field records in order to align all data to a zero phase time lag. Z.-P.M.G. is the basis for subsequent gravity reduction (correction) procedures. See Bouguer Gravity and Free-Air Gravity.

Zone Chart – a template used for applying Terrain Correction or Isostatic Correction to the gravity data. Each zone within Z.C. is represented by a circular ring divided by radial lines into compartments of arbitrary azimuth. The smallest applicable zone (“B”) is bounded by the inner radius of 6.56 ft and the outer radius of 54.6 ft, and divided into four compartments. The largest zone (“M”) is bounded by the inner radius of 48,365 ft and the outer radius of 71,996 ft, and divided into 16 compartments. In gravity exploration Z.C. is commonly subdivided into the inner zone (with radii varying from 6.56 ft to 558 ft) and the outer zone (with radii varying from 558 ft to 21,826 ft), where the surface topography is corrected by using the zone charts constructed on the same principle as above, but with different scales. In practice, Z.C. is laid over the topographic map of the exploration area with Z.C. centered at the gravity Station being corrected. The differences in average elevation in each zone and the station elevation are tabulated. The sign of this difference is ignored as the correction is always positive, regardless of whether zones are higher or lower than the station elevation. Z.C. is also referred to as Hammer Chart or Terrain Chart. [223, 238]. See also Inner Zone Terrain Correction and Outer Zone Terrain Correction.

Zooming – an interactive display option which magnifies the selected region of a display (zoom-in) for better viewing or decreases it (zoom-out) back to the original view. [223].

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