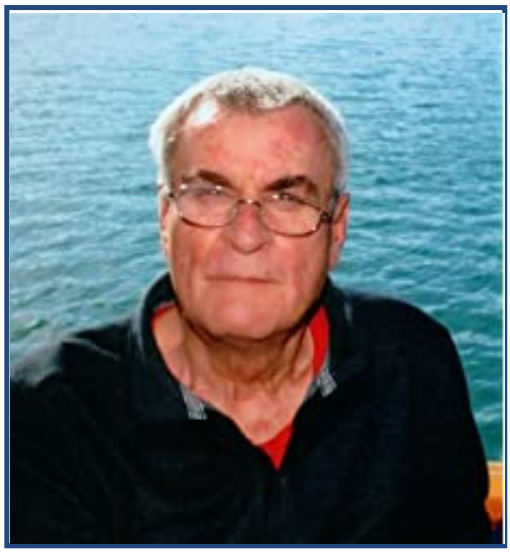

MARIUS ALBU

Promoţia:1965

Marius studied at the Institute of Petroleum, Gas and Geology in Bucharest, becoming an engineering geologist; worked in hydrogeology and mineral resources, getting his PhD in hydraulics at Bucharest University in 1975; was awarded the Romanian Academy Prize for mathematics in 1985. He wrote books in Romanian on mechanics, thermodynamics and geoprocesses. After settling in the UK, he worked as associate professor at Staffordshire University, consultant hydrogeologist at the Environment Agency, and has published several books since.

His passion for history and concern that Romanian historians did not recognise their country's Celtic roots lead to his work on Celtic Languages, stimulated by driving past a sign to Bala in north Wales. This has the same meaning in Romanian - the outlet from a lake and is clearly of Celtic origin.

Prin amabilitatea Domnului Prof.dr.ing Marius Albu se pune la dispoziţia cadrelor didactice şi a studenţilor, lucrarea:

“Overview of Geological Processes and Bases of Mathematical Geology”

Cei interesaţi vor contacta administraţia site-ului Facultãţii de Geologie şi Geofizicã pentru detalii.

Marius Andrei Albu and
Denis Melvin Nicolae
Enăchescu

Overview of Geological Processes and Bases of Mathematical Geology

Overview of Geological Processes and Bases of Mathematical Geology

Marius Andrei Albu and **Denis Melvin Nicolae Enăchescu**

In memory of two great Romanian academicians

Gheorghe Murgeanu |1901 - 84| and Caius Iacob |1912 - 92|

who encouraged the development of *mathematical geology*.*

*See pages 299-230 and 301 for further details.

«If people do not believe that mathematics is simple, it is only because they do not realize how complicated life is»
(J von Neumann |1903 - 57|).

Foreword

In the last fifty years, an unprecedented progress in sciences and technology has led to a better understanding of the universe, our galaxy, the solar system with its planets and satellites, including our distinctive planet and moon; but many processes taking place just beneath our feet remain often at a descriptive stage in spite of recognisable achievements not only in plate tectonics, but also in dynamical and structural geology, geomorphology, sedimentology, metamorphism, volcanology, geophysics, geochemistry, mineralogy, palaeontology, petroleum and gas geology, geo-thermodynamics, hydrogeology, geotechnology, geostatistics, and so on. Why has this delay in explaining geological processes happened? The answer can be found in the diversity of geological processes which are separately studied with no common mathematical basis.

An analytic approach of energy transfer in the Earth's crust implies:
1st, expertise at least in crustal (*i*) thermodynamics, (*ii*) electricity and magnetism, (*iii*) petrology, mineralogy, hydrogeology, petroleum and gas mechanics, (*iv*) gravity, (*v*) radioactivity, (*vi*) diffusion and/or dispersion, and (*vii*) chemistry;
2nd, ability to select local cases and models which, despite their restricted applicability, are essential for an initial rough evaluation and later calibration of numerical models;
3rd, discernment in identification of common characteristics and analogies between different kinds of geological processes that take place according to the well-established laws of conservation and transfer of energy, work-energy theorem, principles of coexisting or correlating processes including the superposition principle, and so on, which enable us to simplify, unify and eventually generalise variables, functions, laws, equations and solutions applicable to many processes;
4th, knowledge and comprehension to formulate a general equation applicable to several geological processes, specifically the thermal,

electrical, stereo- or rheo-mechanical, gravitational, radiative, diffusive or dispersive, and chemical ones;
5th, capability to use classical methods for solving partial differential equations (such as separation of variables, Laplace transform, Fourier transforms, Green's functions, finite difference and finite element methods) and numerical methods for simulation of other processes (such as Monte Carlo, stochastic differential equations, artificial neural network and genetic algorithm methods) for solving the general equation of geological processes;
6th, aptitude to identify or conceptualise plane-parallel, radial-cylindrical, radial-spherical, coexistent or correlative, as well as other processes with appropriate case-studies for solving their equations.

The forms and solutions of the general equation of geological processes have a wide applicability to many fields of the crustal investigation, such as: thermometry, metamorphism, volcanology, electrometry, thermoelectricity, geomechanics, seismology, isostasy, mechanics of fluids in porous or fissured rocks, gravimetry, radiometry, diffusivity or dispersivity, underground contamination or pollution, oxidation or reduction in soils/rocks, geochemistry, electrochemistry, and others.

As a result of over 40 years of experience in studying, analysing and deciphering various kinds of geological processes – including those related to transfer of heat, flow of fluids (water, petroleum, gas), transport of dissolved compounds, propagation of mechanical stress, transmission of radiation, spread of chemical reactions in the Earth's crust –, the present work includes: ♦ introductory notions of matter with its states/phases, energy with its forms, natural processes, laws, theorems and principles; ♦ the generalised equation of geological processes with its particular forms; ♦ analytical methods of solving partial differential equations not only for one kind of process, but also for coexisting geological processes of the same or different natures; as well as ♦ numerical methods for solving partial differential equations. All of these are exemplified by 35 case-studies of various processes with worked examples, 52 figures and 19 tables.

The authors thank Harriet Nash for her help in the preparation of this book.

The authors

Abbreviations and Symbols

A	ampere unit of electrical current
$\forall$	universal quantifier; for all
A	proportionality constant; elementary area; spatial domain; space
A_n	subspace
A	coefficient
$a=\kappa/\sigma$	coefficient of transmissivity
a	generalised change in potential
AD	*Anno Domini*
ad hoc	(Latin meaning "to this") for this special purpose
B	factor of productivity
B	coefficient
b	thickness; height; depth
b	scalar
BC	Before Christ
C	coulomb unit of electric charge
$\mathbb{C}$	curved pass
C	constant; coefficient in general
C	chemical concentration
C	coefficient
$\mathcal{C}$	coefficient used for operational equation leading to a Green's function
$C_{\square}$, $C_{\blacksquare}$	coefficients
°C	Celsius unit of temperature
c	productivity of energy per unit capacity
$c=\Delta C$	finite difference of chemical concentration
c.	(Latin *circa*) about
cal	calorie unit of the amount of energy needed to rise one gram of water by one degree Celsius
card	cardinality of a set
cf.	(Latin *confer*) compare
const.	constant
cos	cosine
cosh	hyperbolic cosine
cot	cotangent
curl	curl operator
$c\cdot\sigma$	density of productivity
$c\cdot\sigma\cdot dV$	productivity: difference between input and output of energy in a volume V
D	diffusivity
D	diffusion/dispersion potential
D_H	depth in the mantle
Di	Dirichlet boundary conditions
$d=\Delta D$	finite difference of diffusion/dispersion potential
$d\boldsymbol{A}$	elementary surface $\hat{\boldsymbol{n}}dA$
d/dt	total derivative with respect to time
div	divergence operator
E	operator
E	energy; orbital energy
Ei	exponential integral function
Eq	equation
$EQ_{\alpha\beta}$	positive sum-function

ESA	European Space Agency
e	base of natural logarithms; number of order for the finite elements
$\mathscr{e}=\Delta V$	finite difference of electric potential
e.g.	(Latin *exempli gratia*) for example
erf	error function
erfc	complementary error function
etc.	(Latin *et cetera*) and so on
eV	electron volt
exp	exponential function
F	farad unit of capacitance
F	interaction-force magnitude; generalised force magnitude; function
F	force of reciprocal attraction between two bodies
$\mathcal{F}$	Fourier transform
$\mathcal{F}_s$	Fourier sine transform
$\mathcal{F}_s^{-1}$	inverse Fourier sine transform
$\boldsymbol{F}$	force vector
Fi	final conditions
Fo	Fourier boundary conditions
f	function
f^*	image function
$\boldsymbol{f}$	force density
$\boldsymbol{f}\cdot dV$	net force
Fig.	figure
G	function
G	gravitational constant
G	Gibbs free energy
$\mathcal{G}$	Green's function
$\mathcal{G}^\bullet$	transformed Green's function
g	local gravitational acceleration
g	gravitational potential (energy per unit mass)
$\mathscr{g}=\Delta g$	finite difference of gravitational potential
grad	gradient operator
H	henry unit of inductance
H	rate of radiogenic heat production per unit mass; functional in Ritz finite element method
$\hat{H}$	effective one-electron Hamiltonian
Hz	hertz unit of frequency
h	quantity equalling the operator $E\psi$ used in finite element method
h	rheomechanical (hydraulic) head, i.e. mechanical energy per unit weight
I	modified Bessel function of the first kind
i	$\sqrt{-1}$ = imaginary square root of -1; number of order; position on a distance increment $\lambda=\Delta x$, or inside an interval
In	initial conditions
i.e.	(Latin *id est*) that is
J	joule unit of energy
J	Bessel function of first kind
j	number of order; position on a distance increment $\lambda=\Delta x$
K	Kelvin unit of absolute temperature
K	modified Bessel function of the second kind

K	mean permeability
k	generalised coefficient of conductivity
kg	kilogram
km	kilometre
L	boundary
L	characteristic length scale; linear differential operator for a Green's function
$\mathcal{L}$	Laplace transform
$\mathcal{L}^{-1}$	inverse Laplace transform
l	width
ℓ	elementary interval of distance
LIGO	Laser Interferometer Gravitational-wave Observatory
lim	limit of a variable or function
ln	natural logarithm (to the base e)
log	decimal logarithm (to the base 10)
M	coefficient of function ψ
M	the Earth's mass
m	metre unit of length
m	parameter in a characteristic equation;
m	mass of a body
$\hat{\boldsymbol{m}}$	unit vector for linear velocity
N	newton unit of force
N	coefficient of the derivative of function ψ with respect to the normal to an equipotential surface
n	number of components
n	natural number; normal to an equipotential surface; number of order
n	positive integer
$\hat{\boldsymbol{n}}$	unit vector for angular velocity; position vector
NASA	National Aeronautics and Space Administration
Ne	Neumann boundary conditions
O	origin
$\mathcal{O}$	statistical error
P	number of phases in thermodynamic equilibrium
P_α	positive sum-function
p	complex variable used in Laplace transform
Pa	pascal unit of pressure
Q	conductive flux
q	entity (e.g. mass, charge); density of conductive flux
$\boldsymbol{q}$	generalised conductive flux of energy
$\mathbb{R}$	the set of real numbers
R	"sources" or "sinks" of the variable of interest χ, or radial distance from the centre
$\mathcal{R}$	function of cylinder radius
$\hat{R}$	solidification; isotherm speed
$\hat{\mathcal{R}}$	function of sphere radius
R_f	rate of flow
$R_{\alpha\beta}$	positive sum-function
$\boldsymbol{r}$	position; displacement vector
r	radiation potential
$\mathit{r}=\Delta r$	finite difference of the radiation potential r; radial distance from an

	axis; cylinder-radius
$\hat{r}$	sphere-radius
$r_\Diamond$	variable of the modified Bessel functions
Ra	Rayleigh number
Ra_H	Rayleigh number for the Earth's mantle
S	set of Markov chain states
S_α	negative sum-function
SI	International System of Units
s	second
s	space
$s=\Delta h$	drawdown = difference of rheomechanical (hydraulic) head
$\check{s}$	real part of a complex variable
sin	sine
$sinh$	hyperbolic sine
T	tesla unit of magnetic flux energy
T	temperature
$\mathcal{T}=\Delta T$	finite difference of temperature ΔT from the initial state
$\mathcal{T}(t)$	function of t
t	time
$t_\circ$	initial time
$t_\bullet$	final time
t	elementary interval of time
$t-\tau$	delay
$\boldsymbol{u}$	conductive velocity
u	variable $\omega^2/4t = r^2/(4a{\cdot}t)$ of the exponential integral function Ei
u	variable $4t/\omega^2 = 4a{\cdot}t/r^2$ of the function Φ
UK	United Kingdom
US	United States
USA	United States of America
V	volt unit of potential difference of electricity
V	volume
$V(t)$	volume variable in time
v	convective velocity; velocity field
v	linear speed
V	electric potential
viz.	(Latin *videlicet*) namely
W	watt unit of power
W	work done by a force and a torque
Wb	weber unit of magnetic flux
WW1	First World War
WW2	Second World War
w	position ≥ 0
$\mathcal{X}(x)$	function of x
x	distance perpendicular on yz-plane; co-ordinate; variable
Y	Bessel function of second kind
y	distance perpendicular on zx-plane; variable; co-ordinate
Z	function
Z^*	complex conjugate function Z
z	distance perpendicular on xy-plane; height; co-ordinate
α	thermal diffusivity; index symbol; integer number
β	thermal expansion coefficient; variable in Poison's integral formula; index symbol; integer number
Γ	number of degrees of freedom

Γ	Euler's gamma function
γ	Euler's constant
δ	Dirac delta function
$\varepsilon = \eta \cdot \sigma$	average density of energy
$\varepsilon \cdot dV$	net energy
ζ	constant; parameter; variable used in modified Bessel function of the second kind
η	potential (intensive quantity)
θ	rotational angle
ϑ	azimuth/latitude angle
κ	basic coefficient of conductivity
λ	coefficient of the local derivative of potential difference; displacement; finite distance increment such as Δx, Δy
μ	parameter; variable for the differential operator L
ν	delay index
ν_d	dynamic viscosity
ν_k	kinetic viscosity
Ξ_i	effect of change in a process coexisting but not interfering with other processes
ξ	variable; displacement in Fourier transform; element of a basis
$(\xi_1, \xi_2, \ldots)$	basis
ρ	density of matter
ρ_o	reference density
ρ_d	density of salt dissolved in water
σ	density of extensive quantity (capacity); storativity of a permeable layer (e.g. an aquifer)
$\sigma \cdot dV$	capacity (extensive quantity)
ς	storativity of a semipermeable layer (e.g. an aquitard)
τ	time t minus delay $(t-\tau)$; time increment; finite interval of time Δt
$\boldsymbol{\tau}$	torque (moment of a force)
υ	multiplying factor
Φ	function represented by an integral
ϕ	arbitrary function
φ	longitude angle
χ	variable of interest; difference of capacity density $\sigma_2 - \sigma_1$
Ψ	molecular orbital wave-function; function
Ψ^*	complex conjugate of molecular orbital wave-function; transformed of Ψ or of the other function
Ψ_i	effect of change in a process interfering with other processes
ψ	function representing the difference potential $\eta_2 - \eta_1$
ψ^*	Laplace transform of the function $\psi = \eta_2 - \eta_1$
$\psi^\bullet$	Fourier transform of the function $\psi = \eta_2 - \eta$
$\psi^\bullet{}_n$	proper function in generalised Fourier series
$\psi^\bullet{}_s$	Fourier sine transform
Ω	ohm unit of electrical resistance
Ω	boundary
ω	angular velocity; vorticity

ω	angular speed; real and positive variable in Laplace transform; or angular frequency variable in Fourier transform
d	differential
$\partial/\partial t$	local derivative (partial derivative with respect to time)
$\partial/\partial u$	partial derivative with respect to $u = x, y, z$
$\partial/\partial r$	partial derivative with respect to cylinder-radius
$\partial/\partial \hat{r}$	partial derivative with respect to sphere-radius
$\partial\psi/\partial t$	local derivative of potential difference
$\partial/\partial\theta$	local derivative with respect to rotational angle
$\lvert\ \rvert$	absolute value
$\lVert\ \rVert$	determinant
$+$	plus
-	minus
$\pm$	plus or minus
$\mp$	minus or plus
$\cdot$	multiply by
$\cdot$	dot product
$\times$	multiplication sign
$\times$	cross (vector) product
/	divide by
$\rightarrow$	approaches the limit; maps to, tends to
$\Longrightarrow$	implies
$\sqrt{}$	square root
Δ	finite difference; increment
$\sum$	sum, summation
$\prod$	product
π	$pi = 3.14159\ldots$
$\int$	integral

$!$	factorial
%	per cent, percentage or part per hundred
‰	part per thousand
$=$	is equal to
$\equiv$	is identically equal to
$\approx$	is approximately equal to
$>$	is greater than
$<$	is less than
$\geq$	is greater than or equal to
$\leq$	is less than or equal to
$\{\ \}$	set
$\langle\ \rangle$	scalar product
$\cup$	union, union of
$*$	Borel's convolution product
[1]	dimensionless
∞	infinity

Contents

Authors' biographical data

Marius Andrei Albu |1942 - |: Romanian-British engineering geologist, PhD in hydraulics, winner – together with Denis Melvin Nicolae Enăchescu – of the 1985 Gheorghe Lazăr Prize for mathematics awarded by the Romanian Academy; specialised in: hydrogeology, rheo-/stereo-mechanics, Earth's crust thermodynamics, diffusive/dispersive processes, land contamination, groundwater pollution, evaluation of mineral/thermal groundwater resources, use of geothermal energy, dewatering of mine-fields, modelling geological processes, Celtic place-names and words in central-eastern European languages, metaphysics, conversion of cosmic energy (including life energy), analysis of the pulsatory expanding universe whose dark-vacuum energy behaves as an underdamping oscillator, and mathematical geology based on the general equation of geological processes.

■ **Family, education and professional activity**

♦ *Father* Gheorghe Albu |1911 - 1974| civil engineer for construction of buildings, roads, bridges; *mother* Maria Albu |1912 - 2003| landholder and housewife; *brothers* Lucretiu Gheorghe Albu |1945 - 1975| aeronautical technician, and Lucian-Liviu Albu (1951 -) PhD in economics, professor of economic studies, director of the Institute for Economic Studies, minister of Labour and Social Protection, Romanian Academy Award "Petre S. Aurelian", member of the Romanian Academy; *son* Claudiu Albu (1970 -) PhD in civil engineering, Senior Civil Engineer at Sweco UK, Inspector of the National Agency for public auctions, Expert European Funds at the Consulting and Technical Assistance Company in Romania; *daughter* Ioana Adina Gauntlett (1979 -) geologist at the National Institute of Marine Geology and Geoecology in Romania, Max Factor - Procter & Gamble - Coty account manager and make-up artist in the UK, contribution with meaningful qu-speech examples to unveil Celtic words/names in eastern European languages;

♦ *Primary school* (1949 - 56), equivalent to Levels 1&2 and A Level;

♦ *Company of Geological Prospecting*, Team of Hydrogeology (1965 - 69), supervisor of groundwater pumping tests used to determine the hydraulic conductivity, transmissivity, storage, recharge and discharge of aquifers in

areas including Piteşti-Curtea de Argeş, Buzău and Râmnicu Sărat, south and south-west Romania;

♦ *Institute of Hydrotechnical Studies* (1969 - 70), researcher of flow in leaky aquifers beneath the Romanian Plain, a source of water supply for Bucharest; experiments with radionuclides tracers to determine the direction of groundwater flow and hydrogeological parameters at Timişeşti, a source of water supply for Iaşi city; and measurement of condensation in soil on the littoral area of Constanţa city;

♦ *Institute of Meteorology and Hydrology* (1970 - 72) in Bucharest, researcher of processing and interpreting data from hydrogeological network of wells for evaluation of groundwater resources, oscillation of water-level and storage capacity in aquifers;

♦ *Republican Commission of Geological Resources* (1972 - 81) in Bucharest, elaborator of norms for evaluation, classification and homologation of mineral and thermal water, mofettic carbon dioxide, and therapeutic mud;

♦ ***PhD in Hydraulics*** (1975) at the *University of Bucharest*, following the *Dissertation* «Study of Unsteady Gravitational Movement of Water in Porous Media» (Gravitational flow through porous media, Hydrodynamic field of gravitational flow, and Unconfined aquifers);

♦ ***Lecturer in Mechanics and Hydrogeology*** at the University of Bucharest (1975 - 83);

♦ *Ministry of Mine and Geology*, Department of Geology (1981 - 83), engineering geologist researching pollution of aquifers bounded by watercourses, numerical integration of the equation of diffusivity in aquifers, and convection of geothermal water;

♦ ***Gheorghe Lazăr Prize for Mathematics*** (1985) shared with the mathematician Denis Enăchescu, and awarded by the Romanian Academy for our mathematical work «Non-steady processes of energy redistribution in the terrestrial crust»;

♦ ***General Inspector for groundwater resources and mine dewatering*** (1983 - 91) at the *State Inspection of Geology and Mining* in the Romanian Ministry of Petroleum, Mines and Geology, responsible for optimisation of thermo-mineral water abstraction, evaluation of natural carbonated water resources, dewatering of mines, methodology for assessment of geothermal resources, conservation and protection of therapeutic mud and peat resources;

♦ *Agency of Mineral Water* (1991 - 92) in Bucharest, consultant for exploitation and protection of bottling mineral water;

♦ ***Lecturer for Management of mineral and thermal groundwater resources*** at the *University of Management* (1992 - 94) in Bucharest;

♦ ***Three-month stage for Hydrogeology in the UK*** (1993) at the *University College London*, Geology Department;

♦ ***Lecturer in Management and marketing of mineral resources*** and ***General hydraulics*** (1994 - 95) at the *University of Bucharest*, Faculty of Geology and Geophysics;

♦ ***PhD Advisor for Hydrogeology and Groundwater pollution***, as ***Senior researcher*** (1995 - 2004) in the team of Structural geology and basin analysis at *University of Bucharest*, supervising contractual studies for dewatering in the Rovinari and Motru coalfields, south-western Romania; optimisation of groundwater abstraction and remediation of water quality at Arad, west Romania, EU Phare programme; crush land remediation after salt extraction by dissolution at Govora, south of Carpathian Alps, EU Phare programme; technical advice for investigation, protection and remediation of the contaminated aquifers and the lake eutrophication in Romania; evaluation of aquifer vulnerability and drinking water resources for the National Territory Planning; risk assessment of uranium mine closure on the groundwater and surface water at Ciudanoviţa, south-west Romania; stabilisation of the sliding waste tip deposited after coal mining at Valea Mânastirii, near Motru, south-west Romania; and evaluation of pollution with petroliferous products at the Oil Terminal Constanţa, south-east Romania;

♦ ***Lecturer for the modules Hydrogeology*** and ***Petroleum geology - Basin analysis*** (1998 - 2001) at the *Staffordshire University*, School of Sciences, Geology Division, the UK;

♦ ***Consultant and adviser in the UK*** for 1st, *Beazer Strategic Land* and *Hinson Parry & Co* (1999) concerning residential development and nature reserve conservation at Newcastle-under-Lyme; and 2nd, *Wardell Armstrong* (1999 - 2002) in relation to its contracts of (*i*) site investigation at Derby and Cradley timber yards, interpreting borehole logs and pumping tests at Cheddleton Business Park south of Leek in west-central England, for Silverstone Trading Ltd, (*ii*) trial pitting, boreholes installing, soil and water sampling at Kigass, New Milton in Hampshire, south England, (*iii*) boreholes, soil and groundwater samples to assess any kind of contamination at Chesterton Hospital in Cambridge, south-east England, (*iv*) site work, log examination, soil and groundwater sampling at Loxhole Sawmill, near Dunster in Somerset, south-west England, (*v*) monitoring boreholes, permeability tests, and measurement of electrical conductivity at Kilnhurst Dredging Tip, south Yorkshire, north-central England, and (*vi*) investigation of contaminated land at Old Gas Works, in Kidsgrove, Staffordshire, west-central England);

♦ ***Hydrogeology consultant*** (2002 - 03) at the *Environment Agency* of England and Wales, Lichfield, the UK; interpreting data, evaluating hydrogeological parameters, mathematical modelling of aquifers and calculating their groundwater resources;

♦ ***Search for ancient Celtic roots*** (2003 - 10) in *western and eastern European languages* eastward of the so-called «Celtic fringe», by travelling in Wales, Cornwall, Scotland, Ireland and France, identifying place names or words of Celtic origin, and comparing them with similar place names and words which have the same meanings in other European languages, especially for those classified as "obscure or unknown etymologies";
♦ ***Water management consultant*** (2007) at *Severn Trent plc*, Birmingham headquarters, finalising a report on the mine drainage system of Dudley, UK, based on ten cost-benefit options for flooding and environmental protection in the West Midlands, England.
♦ ***Independent researcher*** (2010 - 18) at Birmingham, England, focusing on topics such as: (*i*) examination of conventional and non-conventional forms of energy; (*ii*) related courses of life, soul and mind; (*iii*) harmonisation of natural processes according to a time function; (*iv*) role played by communication in the evolution of organisms; (*v*) forms of cosmic energy – including life energy – and their conversion from uncondensed dark-vacuum energy into slightly condensed dark matter and tightly condensed ordinary matter; (*vi*) biographical displays; (*vii*) Zalmoxis as Pythagoras' disciple and Geto-Dacian god who believed in the immortality of soul after death and its transmigration taking place, mutatis mutandis, in a similar manner with the pulsatory course of cosmic-life energy conversion that has alternative periods of speeding up and slowing down during the universe's expansion; as well as (*viii*) unified view of geological processes leading to their general equation that, by its particular forms and solutions, is applicable to various kinds of processes taking place below the Earth's surface.

■ **Published articles and papers**

♦ ***Drenanţa in regimul apelor subterane*** 1970 "Leakage in the groundwater flow", *Hydrotechnics* 15/4, Bucharest;
♦ ***Interpretarea generală a curbelor denivelare-debit pentru foraje hidrogeologice*** 1970 "General interpretation of the drawdown-discharge curves for hydrogeological wells" (co-authors M Cristodulo and N Corlăţeanu), *Hydrotechnics* 15/4, Bucharest;
♦ ***Rezultate obţinute prin aplicarea pompărilor experimentale în regim transitoriu pentru determinarea parametrilor hidrogeologici din zona Buzău*** 1971 "Results from the application of the non-equilibrium pumping tests for determining the aquifer parameters in the Buzău area", *Geological Institute Reports* E/9, Bucharest;
♦ ***Despre precizia expresiilor analitice pentru nivelurile piezometrice ale apelor subterane*** 1971 "On the precision of analytical expressions for the piezometric levels of groundwaters", *Hydrotechnics* 16/5 Bucharest;
♦ ***Despre oscilaţiile nivelurilor apelor subterane*** 1971 "On the oscillations of the groundwater levels", *Hydrotechnics* 16/7, Bucharest;

♦ ***Contribuţii la estimarea capacităţii de înmagazinare a apei în medii poroase*** 1971 "Contributions to the assessment of the water storage capacity in porous media", *Hydrotechnics* 16/8, Bucharest;
♦ ***Hydrogeological researches in the Prahova-Teleajen alluvial fan*** 1971 (co-authors E Avramescu and G Tomescu), *Meteorology and Hydrology* volume 1, Bucharest;
♦ ***Analysis of the groundwater flow by means of radionuclides for the assessment of hydrogeological parameters*** 1971 (co-author NP Botezatu), *Meteorology and Hydrology* volume 1, Bucharest;
♦ ***Some considerations regarding the appraisal of naturally occurring groundwater resources of unconfined aquifers*** 1971 *Meteorology and Hydrology* volume 2, Bucharest;
♦ ***Consideraţii asupra evaluării resurselor de ape subterane în acvifere cu nivel liber*** 1972 "Considerations on the assessment of groundwater resources in unconfined aquifers", *Hydrotechnics* 17/4, Bucharest;
♦ ***Aspecte privind evaluarea rezervelor de ape minerale*** 1976 "Aspects on the assessment of the mineral resources" (co-author A Hînculov), *Geological Institute Reports* E/12, Bucharest;
♦ ***Evaluarea resurselor de ape minerale carbogazoase*** 1976 "The assessment of natural carbonated groundwater resources", *Hydrotechnics* 21/1, and *Mines, Petrol and Gas* 27/3, Bucharest;
♦ ***Despre simularea evoluţiei sistemelor hidro-termominerale*** 1981 "On the simulation of the evolution of the hydro-thermo-mineral systems" (co-author DMN Enăchescu), *Studies and Researches of Geology, Geophysics, Geography* volume 19, Bucharest;
♦ ***Contaminarea unui acvifer mărginit de un canal sau râu poluat*** 1982 "The propagation of pollution in an aquifer bounded by a watercourse", *Hydrotechnics* 27/5, Bucharest;
♦ ***Integrarea numerică a ecuaţiilor de diffuzivitate orizontală pentru acviferele termominerale*** 1982 "The numerical integration of the horizontal diffusivity equations for the thermo-mineral aquifers" (co-author DMN Enăchescu), *Mathematical Studies and Researches* 34/2 Bucharest;
♦ ***Hydro-thermo-convection dans un aquifère horizontal rechargée par l'eau plus chaude ou plus froide que le long d'un plan de discontinuité*** 1982 "Hydro-thermo-convection in a horizontal aquifer recharged by water warmer or cooler than it along a plane of discontinuity" (co-author R Cădere), *Bureau de Recherches Géologique et Minière* volume 45 Orléan-La Source, France;
♦ ***Unele consideraţii privind optimizarea exploatării apelor termominerale*** 1984 "Some considerations regarding the optimisation of thermo-mineral water abstration" (co-author I Drăghici), and ♦ ***Asupra evaluării resurselor de ape termominerale carbogazoase in condiţii de conservarea acviferelor***

1984 "On the assessment of natural carbonated water resources in the conditions of hydro-mineral aquifer conservation" (co-author C Radu), both in proceedings of *Technical and Economic Studies* E/14, Bucharest;

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♦ ***Groundwater supply of Slatina city endangered by contamination from the river Olt, Romania*** 1997 (co-authors I Dinu, V Moldoveanu and H Nash), *Congress on Groundwater in the Urban Environment*: Problems, Processes and Management Nottingham, UK;

♦ ***Risk assessment of groundwater contamination from the south-eastern Bucharest landfill*** 1997 (co-authors VD Mocanu and VD Mirca), *Congress on Groundwater in the Urban Environment*: Problems, Processes and Management (1997) Nottingham, UK;

♦ ***Study for the assessment, mitigation and protection of water and soil resources in the Prahova and Teleajen area*** 1998 (co-author I Dinu), volume *Mare chiama mare Antartide – Sorrento alla ricerca della vita* Cultural Association of Cypraea, Italy;

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♦ ***Aplicaţii şi Probleme de Hidrogeologie*** 1983 "Applications and Problems of Hydrogeology" (co-authors G Alexandru, F Zamfirescu and D Scrădeanu), *University of Bucharest* [15 chapters, 22 subchapters, 245 pages];

♦ ***Termodinamica Crustei Terestre*** 1984 "Thermodynamics of the Terrestrial Crust", *Technical Publishing House* Bucharest [7 chapters, 45 subchapters, 351 pages];

♦ ***Procese Nestaţionare de Redistribuire a Energiei în Crusta Terestră*** 1985 "Non-steady Processes of Energy Redistribution in the Terrestrial

Crust" (co-author DMN Enăchescu), *Technical Publishing House* Bucharest [6 chapters, 21 subchapters, 323 pages];

♦ ***Energia Geotermică*** 1987 "Geothermal Energy", *Technical Publishing House* Bucharest [10 chapters, 32 subchapters, 142 pages];

♦ ***Cărbunii în Actualitate şi in Perspectivă*** 1989 "The Coals in Present and in Expectation", or "World Resources of Coals" (co-authors A Guran, LL Albu, C Rădulescu, DMN Enăchescu and M Palcu), *Technical Publishing House* Bucharest [10 chapters, 30 subchapters, 249 pages];

♦ ***Management şi Marketing în Geologie*** 1996 "Management and Marketing in Geology" (co-author I Popa), *University of Bucharest* [12 chapters, 60 subchapters, 5 annexes, 136 pages];

♦ ***Mecanica Fluidelor pentru Ingineria Geologică*** 1997 "The Mechanics of Fluids for Engineering Geology" (co-author C Pene), *University of Bucharest* [12 chapters, 61 subchapters, 26 annexes, 266 pages];

♦ ***Mineral and Thermal Groundwater Resources*** (1997) (co-authors H Nash and D Banks), *Chapman & Hall* London, UK [16 chapters, 93 subchapters, 8 case studies, 447 pages] ISBN 0-412-61040-X

♦ ***Analogies between Celtic and Eastern Languages*** 2006 *Editura Cartea Universitară* Bucharest [4 chapters, 7 subchapters, 201 pages] ISBN 973-731-399-2;

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♦ ***Conventional and Non-Conventional Forms of Energy*** 2013 *united p.c. publisher* European Union [7 chapters, 26 subchapters, 398 pages] ISBN 978-3-8543-8222-5;

♦ ***Integrated Course of Life, Soul and Mind*** 2014 *united p.c. publisher* European Union [9 chapters, 27 subchapters, 302 pages] ISBN 978-3-7103-1012-6;

♦ ***Time, the Harmonizer of All Things*** 2014 *Charleston*, SC USA [28 chapters, 26 case studies, 466 pages] ISBN 978-1-4960-4351-1;

♦ ***Evolution Propelling through Communication*** 2014 *Charleston*, SC USA [7 chapters, 21 subchapters, 253 pages] ISBN 978-1-4996-6051-7;

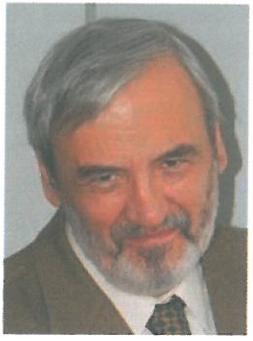
♦ ***Cosmic Conversion of Energy and Meaning of Time*** (2014) *united p.c. publisher* European Union [17 chapters, 312 pages] ISBN 978-3-7103-2071-2;

♦ ***Steps on a Stretch between Hell and Heaven*** 2015 *Charleston*, SC, USA [16 chapters, 452 pages] ISBN 978-1-5195-5441-3;

♦ ***Background and Framework of Energy-based Cosmology*** 2016 *Charleston*, SC, USA [4 chapters, 16 subchapters, 281 pages];

♦ ***Zalmoxis and His Legacy*** 2017 Middleton, DE USA [7 chapters, 35 subchapters, 307 pages] ISBN 978-1-9757-3499-2;

♦ ***Overview of Geological Processes and Bases of Mathematical Geology*** 2019 (co-author DMN Enăchescu), independently published, USA [8 chapters, 41 subchapters, 332 pages], ISBN 978-1-0726-6593-9.



Denis Melvin Nicolae Enăchescu |1952 - |: Romanian professor of Artificial Intelligence and Data Mining at the University of Bucharest, Faculty of Mathematics and Computer Science, Department of Computer Science.

♦ His expertise covers: Numerical Methods, especially Monte Carlo methods with applications in simulation geothermal aquifers; Data Mining methods, especially factorial methods, cluster and discriminant analysis; Artificial Intelligence, neuronal networks and support vector machines for supervised and unsupervised statistical learning; Biostatistics, especially statistical methods for bioavailability and bioequivalence.

♦ Dr. Enăchescu has worked for 39 years in the University of Bucharest and 42 years in the field of informatics, teaching 29 distinct courses, of which 12 were new; three of these courses have also been offered at the universities of Paris and Padua. He initiated and coordinated a master's course in Artificial Intelligence (since 2008) and a interdisciplinary master's course in Biostatistics in collaboration with the University of Medicine and Pharmacy "Carol Davila", Faculty of Pharmacy (since 2006).

♦ As PhD supervisor for Artificial Intelligence - IA and Data Mining-DM, at the Doctoral School of Computer Science of the University of Bucharest (since 2009), he coordinated six doctoral theses awarded at least "very good" qualification. He has been member of numerous committees for the award of doctorates, degrees and diplomas in computer science in Romania and France.

♦ Professor Enăchescu contributed to the creation and development of a School of Artificial Intelligence and Data Mining in the Department of Computer Science of the Faculty of Mathematics and Computer Science. The school is now made up of 8 professors, of whom 5 are former students / PhD students of the professor.

♦ Dr. Enăchescu contributes to the international visibility of the University of Bucharest by teaching (since 2011) AI courses for foreign post-doctoral students (Brazil);

♦ Professor Enăchescu has carried out scientific research activity by participating as a member / director in 6 international grants, 22 national

grants and over 50 contracts with industry won by international / national competition;

♦ The scientific contribution of Dr. Enăchescu includes over 80 articles in national and international journals and proceedings (mostly as the sole author) and 20 chapters in books, of which 16 were published outside Romania;

♦ The professional prestige he enjoys is illustrated by the large number of citations (in recent years, over 70), the award of the Gheorghe Lazar Prize of the Mathematics Section of the Romanian Academy (1985), election as member of the most prestigious international statistical institute, The International Institute of Statistics (ISI) (1995), appointment on the international committee for management of two COST projects, membership in several editorial boards of international journals and scientific committees of international conferences, in doctoral commissions of foreign universities and evaluator expert in national grant competitions. He has lectured as guest professor / invited speaker at over 14 universities outside Romania and over 20 international conferences;

♦ Professor Enăchescu was actively involved in different institutional services: member of the faculty council (2004-2017); Deputy Dean of the Faculty of Mathematics and Computer Science (2008-2015) for computer science research and curricula; member of the Board of the Computer Science Department (2009-2017); Senate member of the University of Bucharest (2011-2015); member of the National Council for the Recognition of University Degrees, Diplomas and Certificates, CNATDCU (2014-2016).

■**Education and professional activity**

Bachelor in mathematics, specializing in computer science at the University of Bucharest (1971-1975) and PhD in mathematics at the same university (1976-1980).

From 1992 to 1992 analyst-programmer and researcher at the Computer Centre of the University of Bucharest involved in applied research contracts.

From 1992-2017 lecturer, associate professor and professor at the University of Bucharest, Faculty of Mathematics and Computer Science delivering courses and seminars at bachelor, master and doctoral level.

From 2009 to present, member of the Doctoral School of Computer Science of the University of Bucharest.

■ **Published articles and papers**

Since 1975, he has published more than **80 scientific papers.** Some relevant titles are:

♦ ***Monte Carlo methods for solving a class of partial differential equations with variable coefficients*** 1975 Bull. Math. Soc. Sci. Math. RSR, 19 (67);

♦ ***A generalization of the Monte Carlo method for solving a linear algebraic equation system*** 1976 Bull. Math. Soc. Sci. Math. RSR, 20 (69);
♦ ***Statistical methods for parabolic equations*** 1980 Preprint Series in Mathematics, *47, INCREST*, Bucharest;
♦ ***Stabilirea condiţiilor de alimentare a zăcămintelor geotermale din judeţul Bihor*** 1980 (co-authors: MA Albu, G Paal), "Determination of the intake conditions of the geothermal aquifers in Bihor County" Tehnical Report, *Institutul de Învăţământ Superior Oradea*, Oradea;
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♦ ***Despre simularea evoluţiei sistemelor hidro-termominerale*** 1981 "On the simulation of the evolution of the hydro-thermo-mineral systems" (co-author MA Albu), *Studies and Researches of Geology, Geophysics, Geography* volume 19, Bucharest;
♦ ***Monte Carlo techniques in finite element method*** 1982 communication: *The 3rd Pannonian Symp. of Math. Stat., Visegrad*, Hungary;
♦ ***Integrarea numerică a ecuaţiilor de diffuzivitate orizontală pentru acviferele termominerale*** 1982 "The numerical integration of the horizontal diffusivity equations for the thermo-mineral aquifers" (co-author MA Albu), *Mathematical Studies and Researches* 34/2 Bucharest;
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♦ ***Despre metodologia de procesare and interpretare a datelor pentru evaluarea resurselor disponibile de ape geotermale şi pentru optimizarea exploatării lor*** 1986 "On the methodology of processing and interpreting data for the assessment of available geothermal water resources and for the optimization of their development" (co-authors MA Albu and G Paál), *Studies and Researches of Geology, Geophysics, Geography* volume 24, Romanian Academy Bucharest;
♦ ***Despre simularea acviferelor minerale and termale in cursul cxploatării*** 1986 "On the simulation of mineral and thermal aquifer behaviour during abstraction" (co-author DMN Enăchescu), both in proceedings of the

Symposium organized by *Institute of Studies for Communal Works* Sinaia, Romania;

♦ ***Pharmacokinetics of progesterone in postmenopausal women. 1. Pharmacokinetics following intravaginal administration*** 1998(co-authors C Mircioiu, A Perju, E Griu, G Calin, A Neagu), European Jour. of Drug Metabolism and Pharmacokinetics, 23 (3) pp. 391-396

♦ ***Estimation of Pr(Y<X) in the case of the Luceno Distribution*** 2002 (co-author C Enăchescu), Rev. Roumaine de Math.Pure et Appl., 47, 2, pp.171-177;

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♦ ***Learning Vector Quantization for Breast Cancer Prediction*** 2005 (co-author C Enăchescu), Proceedings 12th Portuguese Conference on Artificial Intelligence Celebrating 20 Years of AI in Portugal, Covilha, Portugal, 5-8 December 2005, Eds. Bento C., Cardoso A., Dias G., p.177-180, ISBN: 0-7803-9366-X;

♦ ***Approximating the distribution of a randomly weighted sum of random variables using kernel and neural network method***s" 2006 (co-author R Vernic), Math. Reports, vol.8(58), no.1, 37-47;

♦ ***A new approach for outlying records in bioequivalence trials*** 2009 (co-author C Enăchescu), In: Selected papers of "The XIIIth International Conference-Applied Stochastic Models and Data Analysis", L Sakalauskas et al. (eds.), Vilnius, Lithuania, pp. 250-257, *VGTU Press "Technika"*, ISBN 978-9955-28-463-5;

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♦ ***A supervised learning process to elicit fraud cases in online auction sites*** 2011 (co-author C Almendra) 13th International Symposium on Symbolic and Numeric Algorithms for Scientific Computing (SYNASC), pp. 168-174;

♦ ***A fraudster in a haystack: Crafting a classifier for non-delivery fraud prediction at online auction sites*** 2012 (co-author C Almendra), 14th International Symposium on Symbolic and Numeric Algorithms for Scientific Computing (SYNASC), pp. 233-239.

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♦ ***Cărbunii în Actualitate şi in Perspectivă*** 1989 "The Coals in Present and in Expectation", or "World Resources of Coals" (co-authors MA Albu, A Guran, LL Albu, C Rădulescu, and M Palcu), *Technical Publishing House* Bucharest [10 chapters, 30 subchapters, 249 pages];

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♦ ***An Iterative Algorithm for Learning by Support Vector Machine*** 1999 (co-author C.Enăchescu) Applied Stochastic Models and Data Analysis - Quantitative Methods in Business and Industry Society, eds. H Bacelar-Nicolau, E Costa Nicolau, J Janssen, pp. 293-99, *Instituto Nacional de Estatistica*, Portugal;

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♦ ***Aplicații numerice de statistică în farmacie și în studiile clinice. Metode computerizate*** 2008 "Numerical Statistical Applications in Pharmacy and Clinical Studies. Computerized Methods", (co-authors C.Mircioiu, C.Enăchescu, R.C.Sandulovici), vol II, *Ed. Universitara "Carol Davila"*, ISBN 978-973-708-222-0;

♦ ***Autoregressive systems with double-exponentially distributed noise*** 2009 (co-author C.Enăchescu) in "Systems Theory Modeling, Analysis and Control", eds. A.El Jai et al., Fes, Morocco, pp.433-440, *Presses Universitaires de Perpignan*, ISBN 978-2-35412-043-6;

♦ ***A new approach for outlying records in bioequivalence trials*** 2009 (co-author C.Enăchescu) in Selected papers of "The XIIIth International Conference-Applied Stochastic Models and Data Analysis", eds. L. Sakalauskas et al. pp. 250-257, *VGTU Press "Technika"*,Vilnius, Lithuania;

♦ ***Data Mining. Metode și Aplicații*** 2009 "Data Mining. Methods and Applications", *Ed. Acad. Române*, Bucharest, 280 pages, ISBN 978-973-27-1798-1;

♦ ***Overview of Geological Processes and Bases of Mathematical Geology*** 2019 (co-author MA Albu), independently published, USA [8 chapters, 41 subchapters, 332 pages], ISBN 978-1-0726-6593-9.

Printed in Great Britain
by Amazon

As a result of over 40 years of experience in studying, analysing and deciphering various kinds of geological processes – including those related to transfer of heat, flow of fluids (water, petroleum, gas), transport of dissolved compounds, propagation of mechanical stress, transmission of radiation, spread of chemical reactions in the Earth's crust –, the present work includes: ♦ introductory notions of matter with its states/phases, energy with its forms, natural processes, laws, theorems and principles; ♦ the generalised equation of geological processes with its particular forms; ♦ analytical methods of solving partial differential equations not only for one kind of process, but also for coexisting geological processes of the same or different natures; as well as ♦ numerical methods for solving partial differential equations.

ISBN 9781072665939