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Advances in Experimental and Genetic Mineralogy

Special Publication to 50th Anniversary of DS Korzhinskii Institute of Experimental Mineralogy of the Russian Academy of Sciences

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Dmitriy S. Korzhinskii. First Director-Organizer of the Institute of Experimental Mineralogy

Preface

Researchers of the DS Korzhinskii Institute of Experimental Mineralogy (June 2019). *First row, from left* Vitaliy Chevychelov, Ekaterina Brichkina, Mariya Golunova, Alexey Kotelnikov, Yuriy Shapovalov, Oleg Safonov, Mikhail Zelenskiy, Anastasiya Kuzuyra, Vera Ermolaeva, Tatiana Setkova, Vladimir Balitskiy, Sergey Pivovarov. *Second row, from left* Aleksander Redkin, Yuriy Litvin, Nikolay Bezmen, Olga Shaposhnikova, Valentina Butvina, Tatiana Kovalskaya, Vera Devyatova, Anastasiya Kostyuk, Anna Spivak. *Third row, from left* Dmitriy Khanin, Konstantin Van, Valentina Korzhinskaya, Natalia Kotova, Paver Bukhtiyarov, Eduard Persikov, Kiril Shmulovich, Aleksander Simakin, Olga Karaseva. Galina Akhmedzhanova, Dmitriy Varlamov. *Back rows, from left* Galina Kashirtseva, Evgeniy Limanov, Liudmila Sipavina, Andrey Plyasunov, Natalia Suk, Nikolay Gorbachev, Evgeniy Osadchiy, Veniamin Polyakov, Pavel Gorbachev, Galina Bondarenko, Leonid Lakshtanov, Dilshad Sultanov, Tatiana Bublikova, Mikhail Voronin

This book *Advances in Experimental and Genetic Mineralogy* is devoted to 50th anniversary of the DS Korzhinskii Institute of Experimental Mineralogy of the Russian Academy of Sciences. This book has been prepared by the researchers of the institute and gives an indication of a variety of its present-day experimental and theoretical inquiries.

The Institute of Experimental Mineralogy has been organized at a period of August 1–October 1, 1969, in Chernogolovka town as a part of the Near-Moscow Scientific center of the USSR Academy of Sciences accordingly to the suggestion of academician Dmitry Sergeevich Korzhinskii who becomes the first director of the institute. D. S. Korzhinskii has made a basic contribution to working out the methods of physicochemical analyses for the metasomatic, metamorphic and magmatic processes under conditions of the Earth's crust and mantle. His pioneering investigations being directed onto the development of physicochemical methodology in studying and cognition of the basic regularities of the geologic processes date back to a beginning of the 1930s. In succeeding years, D. S. Korzhinskii and his disciples have actively developed this line of inquiry, and the results of their studies gained general recognition.

By the 1950–1960s, it dated a creation of the specialized laboratories for experimental studies of the deep-seated materials and processes under high pressure and high temperature in Moscow in the Institute of the Earth Physics (Prof. M. Volarovich), Institute of Geochemistry and Analytical Chemistry (Prof. N. Khitarov) and Institute of Geology of Ore Deposits, Petrography, Mineralogy and Geochemistry (Prof. I. Ostrovskiy) and in Novosibirsk in the Institute of Geology and Geophysics (Dr. I. Malinovskiy). At the end of 1960s, it has evolved the Laboratory of Experimental Mineralogy in the Institute of Solid State Physics (Prof. I. Ivanov) in the scientific center in Chernogolovka. Then in 1969, by the presentation of academician D. S. Korzhinskii, it has adopted a decision of reorganization of the laboratory into the Institute of Experimental Mineralogy for the fundamental experimental and theoretical studies in the fields of genetic mineralogy, physicochemical petrology and physical geochemistry. At the advent of the institute, it were taken into account the diversity and range of the magmatic, metamorphic, hydrothermal and ore-forming processes in the substance of the Earth's crust and mantle which have been going on at natural conditions over a wide range of temperature, pressure and reduction–oxidation potentials.

The disciples and colleagues of D. S. Korzhinskii become the first research workers and leaders of the scientific laboratories of the new institute. There are the well-known scientists Vilen Zharikov, Aleksey Marakushev, Leonid Perchuk, Ivan Ivanov, Georgiy Zaraiskiy, Ivan Nekrasov. Their theoretical and experimental searches were of considerable importance in the making the prospective themes of scientific researches by the institute collective. In the institute, it is worked out and brought into being the unique complex of hydrothermal, gas and solid-phase apparatus of high pressure and temperature. The research activity of the institute has focused onto the experimental studies of physicochemical properties of minerals and simplified and multicomponent mineral systems for the purpose of application of their results to the elaboration of physicochemical genetic models for the minerals, mineral assemblies and rocks, including the ore-bearing ones, at the deep-seated horizons of the Earth's crust and mantle.

The book *Advances in Experimental and Genetic Mineralogy* is originated by the scientists of the DS Korzhinskii Institute of Experimental Mineralogy (Russian Academy of Sciences) and reflects the present-day lines of experimental and theoretical studies. The book presents the fundamental experimental data and development of the experiment-based theoretical conclusions and physicochemical models for the natural hydrothermal, metasomatic, metamorphic, magmatic and ore-producing processes of the Earth's crust, upper mantle, transition zone and lower mantle. The topics discussed in the book concern the interaction of oil and aqueous fluids that is revealed by the methodology of aqueous-hydrocarbonic inclusions in synthetic quartz and applied to the natural evolution of the oil; the determination of solubility and interphase partitioning of trace and strategic elements and their components; and the experimental substantiation of physicochemical mechanisms for ultrabasic–basic evolution of the deep-mantle magmatic and diamond-forming systems. Experimental studies of physicochemical properties of supercritical water and hydrothermal fluids, viscosity of acidic ultramafic magmatic melts, peculiarities of metamorphism of basic rocks, kinetics of mineral nucleation in silicate melts and hydrothermal solutions, influence of the complex H_2O–CO_2–HCl fluids onto melting relations of the mantle–crust rocks have been marked with novel results and conclusions. The book is of interest for the Earth scientists, lecturers and students specialized in experimental and genetic mineralogy, petrology and geochemistry.

Chernogolovka, Russia

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Contents

Abbreviations

Ab	Albite $NaAlSi_3O_8$
Alm	Almandine $Fe_3Al_2Si_3O_{12}$
An	Anorthite $CaAl_2Si_2O_8$
Ancl	Anorthoclase $(Na, K)AlSi_3O_8$
And	Andalusite Al_2SiO_5
Brd	Bridgmanite $MgSiO_3$
CaPrv	Ca-perovskite $CaSiO_3$
Carb, Carb*	Assembly of several carbonates
Chr	Chromite $FeCr_2O_4$
Coe	Coesite SiO_2
Cpx	Clinopyroxene $(Ca, Na)(Mg, Fe)(Si, Al)_2O_6$; $[(Di{\cdot}Hd{\cdot}Jd)_{ss}]$
Crn	Corundum Al_2O_3
D	Diamond C
Di	Diopside $CaMgSi_2O_6$
Dol	Dolomite $CaMg(CO_3)_2$
En	Enstatite $MgSiO_3$
Fa	Fayalite Fe_2SiO_4
FBrd	Ferrobridgmanite $(Mg, Fe)SiO_3$
Fo	Forsterite Mg_2SiO_4
FPer	Ferropericlase (Mg, Fe)O
FRwd	Ferroringwoodite $(Mg, Fe)_2SiO_4$
Fs	Ferrosilite $FeSiO_3$
Gros	Grossularite $Ca_3Al_2Si_3O_{12}$
Grt	Garnet $(Mg, Fe, Ca)_3(Al,Cr)_2Si_3O_{12}$; $[(Prp{\cdot}Alm{\cdot}Gros)_{ss}]$
Hd	Hedenbergite $CaFeSi_2O_6$
Jd	Jadeite $NaAlSi_2O_6$
Kfs	K-feldspar $KAlSi_3O_8$
Ky	Kyanite Al_2SiO_5
L	Liquid, melt
Ma	Mathiasite $(K, Ba, Sr)(Zr, Fe)(Mg, Fe)_2(Ti,Cr,Fe)_{18}O_{38}$

Mcl	Microlite $NaCaTa_2O_6F$
Mgs	Magnesite $MgCO_3$
Mic	Microcline $KAlSi_3O_8$
MWus	Magnesiowustite (Fe, Mg)O
Ol	Olivine $(Mg, Fe)_2SiO_4$; $[(Fo{\cdot}Fa)_{ss}]$
Olg	Oligoclase $(Na, Ca)(Si, Al)_4O_8$
Omph	Omphacite, Jd-rich clinopyroxene
Opx	Orthopyroxene $(Mg, Fe)SiO_3$; $[(En{\cdot}Fs)_{ss}]$
Par	Paragonite $NaAl_3Si_3O_{10}(OH)_2$
Pchl	Pyrochlore $(Ca, Na)_2(Nb, Ta)_2O_6(O, OH, F)$
Per	Periclase MgO
Pf	Pyrophyllite $Al_2Si_4O_{10}(OH)_2$
Phl	Phlogopite $KMg_3AlSi_3O_{10}(F,OH)_2$
Pl	Plagioclase $(NaAlSi_3O_8{\cdot}CaAl_2Si_2O_8)_{ss}$; $(Ab{\cdot}An)_{ss}$
Pri	Priderite $(K, Ba)(Ti, Fe, Mn)_8O_{16}$
Prp	Pyrope $Mg_3Al_2Si_3O_{12}$
Qz	Quartz SiO_2
Rwd	Ringwoodite Mg_2SiO_4
Srp	Serpentine $(Mg, Fe, Ni, Al, Zn, Mn)_{2–3}Si_2O_5(OH)_4$
Sti	Stishovite SiO_2
Tnt	Tantalite $(Mn, Fe)(Nb, Ta)_2O_6$
Wds	Wadsleyite Mg_2SiO_4
Wol	Wollastonite $CaSiO_3$
Wus	Wustite FeO
Yim	Yimendite $K(Cr, Ti, Mg, Fe, Al)_{12}O_{19}$

Physical Symbols

A_{Kr}	The Krichevskii parameter
f_1^*	The pure water fugacity
f_2	The fugacity of a solute
$G^o(g)$	The Gibbs energy of a compound in the ideal gas state
G_2^∞	The Gibbs energy of a compound in the state of the standard aqueous solution
K_D	The vapor–liquid distribution constant
k_H	Henry's constant
m	Molality (a number of moles of a substance in 1000 g of water)
$N_w \approx 55.508$	The number of moles of H_2O in 1 kg of water
P_1^*	Pressure of saturated water vapor
T_c	The critical temperature of pure water

Greek Symbols

ρ_c	The critical density of pure water
$\rho_1^*(L)$	The pure water density along the liquid side of the saturation vapor–liquid curve
ϕ_1^*	The fugacity coefficient of pure water
ϕ_2^∞	The fugacity coefficient of a solute at infinite dilution in water