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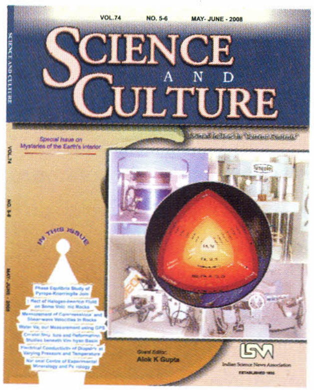
EDITORIAL

EXPERIMENTAL PETROLOGICAL STUDIES OF ROCK SYSTEMS



Geophysical measurements on seismic velocities inside the earth together with measurements of elastic properties and high pressure-temperature simulation of both upper and lower mantle conditions, provide us strongest constraints on the structure of the Earth's deep interior. Measurement of thermodynamic properties of mantle minerals, their phase relations, determination of rheological properties and elastic constants of different rock types under variable pressure-temperature conditions provides us deep insight into the physico-chemical condition of the interior of the earth.

This particular volume emphasizes on modern experimental approaches to solve geophysical problems related to the Earth's internal structure. It is sincerely hoped that publication of this issue should draw the attention of most Indian geologists, who have confined themselves so far to traditional field studies. Whereas it is improtant to learn from our field observations, many vexing earth science problems, it is equally important to test our hypothesis by conducting experimetns in the laboratory.

The first paper in this issue by R. Chopra, M. M. Dwivedi and A. K. Gupta deals with pressure – temperature stability and thermodynamic properties of gamets crystallizing under mantle P-T conditions. Pyrope gamet is stable in the upper mantle, but careful studies on diamond-bearing kimberlites show that these pyropes contain significant amount of Cr^{3+} in the form of knorringite molecule in solid solution. The investigation by Rajeev Chopra and others, not only provide data on enthalpy, entropy and free energy of formation of chromium-bearing gamets but also provides us important data on the P-T stability of knorringite-rich gamet in the mantle.

The second paper by M. M. Dwivedi and A. K. Gupta deals with determination of electrical conductivity of diopsidic pyroxene under 4 and 7 GPa at variable P-T conditions. They demonstrate that at 4 and 7 GPa (equivalent to mantle depths of 125 and 220 km. and temperatures between 773 and 1273 K), the conductivity (log σ) of diopside varies between – 3.64 to –2.48 (S/m). They measured conductivity of diopside between 1 MHz to 100 KHz. using a Hioki LCR-Z meter. They have shown that conductivity of diopside increases exponentially with increase of temperature at a given pressure, and this increase is related to the to the water content of diopside (.001 H/Si).

The third paper by A. Rai and others discusses about laboratory measurements of compressional (V_p) and shear wave velocities (E_s) in the laboratory. Knowledge of these wave velocities can provide us important information about the bulk physical properties and composition of the subsurface rocks. We measured the wave velocities from Rewa limestone belonging to Vindhyan basin. Measurement of wave velocities was conducted at variable pressures and temperatures under controlled laboratory conditions. We note that at 400°C and 5 Kb, compressional wave velocities vary between 5.1 and 5.7 km / sec. whereas that of the shear wave velocities (Vs) ranges between 2.8 and 3.2 km/sec.

In the fourth paper A. Rai and others describe the method of calculating precipitable water vapour in the atmosphere, using a Global Positioning System (GPS) and meteorological sensor, installed near Allahabad. It is observed that the water vapour content changes from 70 to 115 kg/m^2 during 206 and 355 day of the year 2007.

In the next paper, Rai and his colleagues discuss about the crustal structure and deformation characteristics beneath the Vindhyan sedimentary basin. Broad-band earthquake records from seismic station (Allahabad) located at the northen edge of the Vindhyan basin have been analysed to determine the crustal shear-wave velocity structure, average crustal thickness and Vp/Vs values.

It is observed that the average crustal thickness in this region is about 47 km and the Vp/Vs/ value is about 1.765. The detailed shear-wave velocity structure, determined by joint inversion of receiver functions and surface-wave dispersion data, suggest a multi-layered seismic structure with crust-mantle boundary at a depthof 46 ± 1 km. Analysis of the seismic shear-phases originating at the coremantle boundary (SKS), recorded at various broad-band seismic stations located in the Indian subcontinent, suggest a complicated deformation pattern as established by an anisotropic pattern. The fast-axis direction of polarization of the SKS phases are generally consistent with the plate motion direction, except for Allahabad, which indicates almost E-W directed deformation pattern, possibly related to the formation of the Vindhyan basin.

In the final paper M. M. Dwivedi and others describe about their phase equilibria study on the joins leucite-akermanite-albite and leucite-akermanite-albite$_{50}$ anorthite$_{50}$ of the system nepheline-leucite-CaO-MgO-SiO_2 under atmospheric and 10 kbar. These joins were studied to explore the cause of melilite-plagioclase incompatibility observed in ultrapotassic mafic and ultramafic volcanic rocks. Two starting compositions namely lecucite$_5$ akermanite$_{58}$ (albite$_{50}$ anorthite$_{50}$)$_{37}$ and $Lc_{20}Ak_{50}(Ab_{50}An_{50})_{30}$ equilibrated at 1000^{0}C and under atmospheric pressure show the presence of leucite$_{ss}$, plagioclase/temary feldspar, melilite, diopside$_{ss}$, nepheline$_{ss}$ and wollastonite$_{ss}$ in X-ray diffractograms. When these compositions were crystallized under 1 kb [P(H_2O) = P(Total)] at 750^{0}C in presence of an aqueous vapur containing 0.5 or 0.1 M HCl, it was observed that melilite completely disappeared. In presence of the albite component associated with plagioclase, akermanite reacted to produce diopside$_{ss}$ containing Tchermak molecule, nepheline$_{ss}$, leucite$_{ss}$ and wollastonite$_{ss}$. These phases coexisted with melilite. If the starting materials contained more akermanite, with respect to albite, melilite still persisted but in presence of aqueous vapour containing HCl (0.5 molar solutions), melilite disappeared as it was dissolved in aqueous solution as chlorite complex. Excess silica reacted with feldspathoids to form feldspar, which in turn entered into the feldspar structure. ❐

Alok K. Gupta
(Guest Editor)

Prof. Alok K. Gupta has been a professor at the University of Allahabad since 1985 and founded the Department of Earth and Planetary Sciences at this university. He is also the Founder-Director of National Centre for Experimental Mineralogy and Petrology at Allahabad. He was graduated from Calcutta University and did his Ph.D. degree from University of Pittsburgh, USA. He has been awarded *Shanti Swarup Bhatnagar Award, Rhode Memorial Award* and many others. He is a fellow of the Indian National Science Academy (INSA), Indian Academy of Sciences, Bangalore and National Academy of Sciences, Allahabad. He is currently the Vice-President of INSA. His area research is experimental mineralogy and petrology.

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