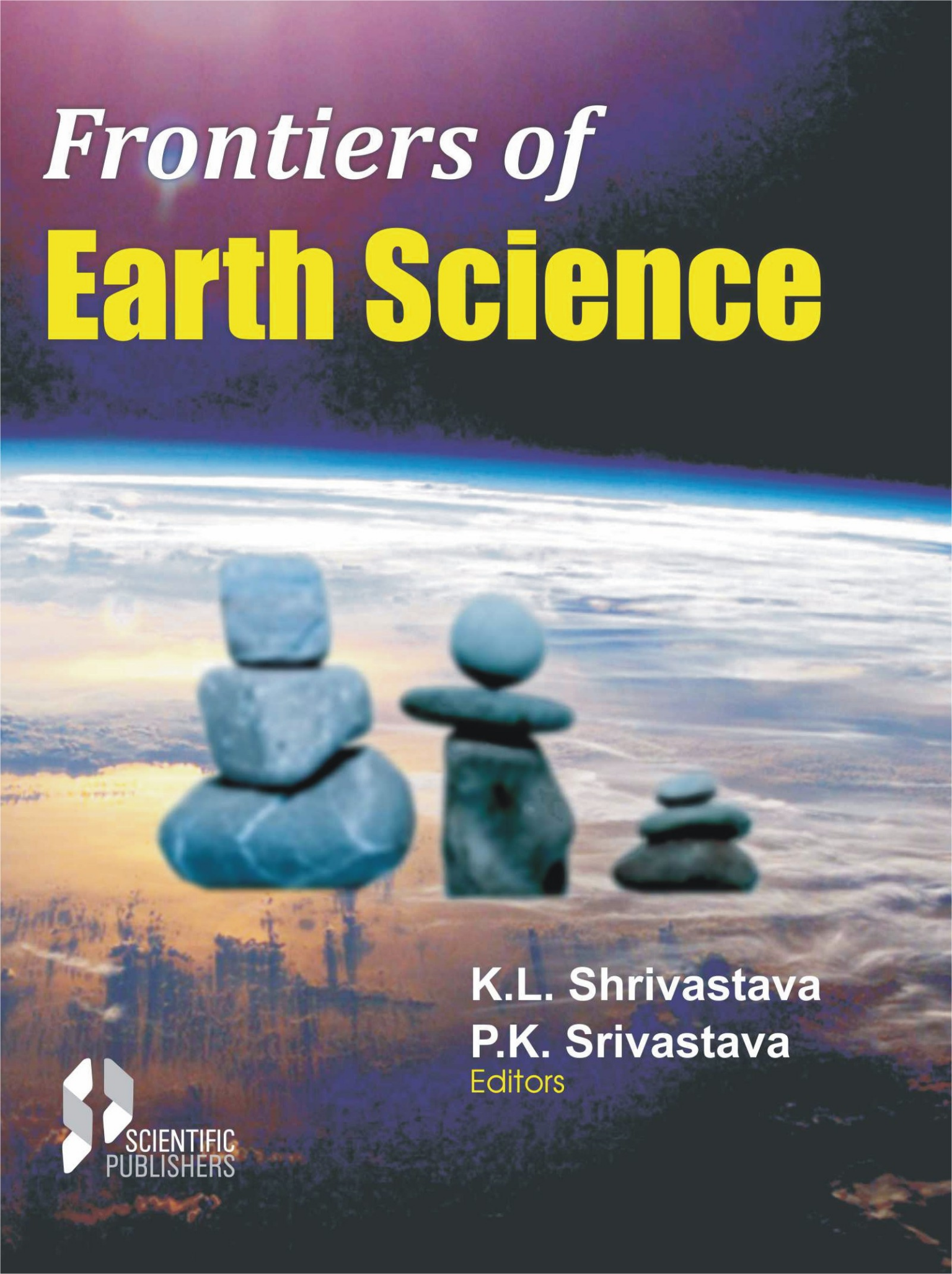
# Frontiers of Earth Science



K.L. Shrivastava
P.K. Srivastava
Editors

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## A Festschrif for Dr. Harsh Kumar Gupta

*Editors*

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# Preface

The Earth have supplied valuable and significant products to the human development since long and much before becoming an object of commercial exploitation and scientific curiosity. Present era has witnessed an information explosion and electrifying conceptual revolution in the field of Earth Science. Applications of computer-based data treatment and simulation practices now become greatly significant as they led to more quantitative definition of some of the theses. High speed computers allowed to numerically model Earth processes in a reasonable amount of time with increased accuracy. Seismic tomography of the Earth's mantle and increasing space missions have produce piles of data to study. The full emergence and advent of plate tectonic theory have revolutionalized the Earth Science. Numerous discoveries of 'live' genesis of ores and invensions of sofesticated geophysical and geochemical techniques have gave many logical explanations to unanswered questions related with the Earth.

The 'Frontiers of Earth Science' is an upshot of recent and revolutionary scientific and academic race of discoveries and evolution of new concepts in the discipline of the Earth Science. The Indian Science Congress Symposium in Earth Science, hence, provided an opportunity so this pre-conference volume is in hand. This pre-conference volume is first volume ever in the history of any section of the Indian Science Congress, now running in its one hundred and second year.

The purpose of the present edited volume is to produce and assembled orderly these newely emerging researches in the field of Earth Science. Also to emphasize the many areas in which problems still exists with a view to encourage and contribute further research. The volume 'Frontiers of Earth Science', incorporates selectively invited sixty papers from distinguished earth scientists. It has seven sections on Mineral deposits; Climate Change and Environment; Remote Sensing; Stratigraphy and Palaeobiology; Petrology; Groundwater, and Seismology and Tectonics. We the editors feel that it would not find it truly rewarding unless the book delivered the desired goods to the specialized readers. In a work of this nature, errors of omission and commissions are inevitable,

although every care has been taken from our end. We would unhesitantingly own responsibility for the same. We hope, wish and pray that the volume should delivered the desired goods to the specialized readers of Industry and academia.

**K.L. SHRIVASTAVA**
**P.K. SRIVASTAVA**

1st Nov 2014
Jodhpur

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**P.K. SRIVASTAVA**

1st Nov 2014
Jodhpur

# Dr Harsh K. Gupta :
## An Appreciation

Dr Harsh Gupta, born on June 28, 1942; obtained his BSc (Hons), MSc and AISM from the Indian School of Mines and PhD from the University of Roorkee. He was Director, Centre for Earth Science Studies, Trivandrum (1982-87) and Leader of the 3rd Indian Scientific Expedition to Antarctica (1983-84), which established a permanent base for India. He was Vice-Chancellor, Cochin University of Science & Technology (1987-90); Adviser, Department of Science and Technology, Government of India (1990-92); Director, National Geophysical Research Institute, Hyderabad (1992- 2001); and Secretary to the Government of India, Department of Ocean Development (now Ministry of Earth Sciences, 2001-05). He was an Adjunct Professor at the University of Texas at Dallas (1978-2001) and Visiting Professor to the Universities of Hamburg and Paris Sud. He has also been a Visiting Scientist to US Geological Survey and Adviser/Consultant to UNESCO, ICSU, IAEA and the Commonwealth Science Council. Dr Gupta is currently Raja Ramanna Fellow at the National Geophysical Research Institute, Hyderabad and Member of Atomic Energy Regulatory Board of India..

Dr Gupta specialized in Earth Sciences and their application to address problems of continents and oceans. He is globally known for his work on artificial water reservoir-triggered earthquakes for developing criteria to discriminate them from normal earthquakes. He has also developed procedures to estimate potential of occurrence of reservoir- triggered earthquakes at a given site. In the recent years, he has contributed to understanding the genesis of stable continental region earthquakes. Dr Gupta carried out detailed investigations of regional crustal structure of the Bay of Bengal and Arabian Sea using the state-of-the-art surface-wave dispersion techniques.

Dr. Gupta has Provided the first geophysical evidence for an enormously thick crust (65-70 km) below the Tibet Plateau and Himalayan region in 1967, found to be accurate as confirmed by detailed field seismic surveys conducted in 1980s. Over the past 40 years, through detailed studies of earthquake focal mechanism, surface wave attenuation and other related work, threw much light on the geodynamic processes responsible for the high elevation of Tibet Plateau and tectonics of the Himalaya and nearby region. Pioneered investigations of artificial reservoir induced earthquakes and developed criteria to discriminate reservoir induced earthquakes from normal earthquakes. These criteria are now internationally applied. Also developed procedures to estimate potential of occurrence of reservoir induced earthquakes at a given site. He discovered that reservoir induced earthquakes of

magnitude ≥ 5 are generally preceded by a couple of M ≥ 4 earthquakes. Completed a detailed study in 1986 of earthquake swarms and quiescence that precede major earthquakes in the northeast India region and concluded that major earthquakes are preceded by well-defined swarms and quiescence. Also made a medium term forecast of a 8± ½ magnitude earthquake to occur in area bound by 21°N and 25 ½ ° N, and 93°E and 96°E with a focal depth of 100 ± 40 km before the end of 1990. This has come true. Completed 'stress pattern' for the Himalayan and the Andaman-Nicobar Region as inferred from earthquake focal mechanism. Dr Gupta has carried out detailed studies of Latur earthquake, one of the deadliest stable continental region earthquakes, and shown that fluids existing at shallow crustal depths played an important role in the genesis of Latur earthquake. Dr. Gupta has developed the concept of spectral magnitudes and showed its application in learning about characteristics of seismic sources using broadband recordings. One latest application has been in characterizing the nuclear explosion. Dr. Gupta made a successful short-term forecast in May 2006; of an M 4 earthquake in the Koyna region in India. The forecast made in May 16 and communicated to Current Science & Geological Society of India said "On the basis of the data available from 7 seismic stations operating in the Koyna region, we have identified a nucleation, which started on May 12th, 2006. This may lead to the occurrence of an M~4 earthquake in the next 15 days. This shallow earthquake (focal depth less than 8 km) will occur within a radius of 10 km centered at 17.1° N,73.8°E. On the basis of our previous experience of studying nucleation-preceding earthquakes in the Koyna region, we expect this earthquake to occur over the next 15 days time (till 31st May, 2006), with a 50% probability". An earthquake of M 4.2 occurred on May 21st, 2006 with in specified parameters.

Dr Harsh Gupta has been very deeply involved with investigations related to oceans. Early in his career during 1964-65 he participated in the India Ocean Expedition Programme where joint expeditions were undertaken in the Arabian Sea by the German research vessel Meteor and Indian research vessel Kistna. In 1968 he carried out very detailed investigations of regional crustal structure of the Bay of Bengal and Arabian Sea using the state-of-the-art surface wave dispersion techniques. Later, as the Director, Centre for Earth Science Studies (1982-87), Trivandrum, he pioneered efforts to generate wave atlas of the west coast of India. Detailed work on placer deposits on the west coast was also carried out.

He was the Leader of the 3rd Indian Scientific Expedition to Antarctica (1983-84) which established a permanent base for India in a record time. This station fulfilled a very urgent scientific requirement of the country.

In the recent years, at the National Geophysical Research Institute, he initiated a very detailed work on Gas Hydrates in the Exclusive Economic Zone of India. Sponsored by the Gas Authority of India Limited, a comprehensive report has been prepared under his leadership entitled "Gas Hydrate Exploration along the Continental Margins of India – Evaluation of Available Geophysical and Geological Data". Another landmark work has been the analysis of 80,000 line km of single channel seismic data in the Indian Exclusive Economic Zone to identify locations where bottom simulating reflectors occur. This has been extremely helpful in identifying zones of gas hydrate occurrences.

One of the major requirements in Antarctica has been the setting up of a permanent seismic station as well as permanent GPS station. Under Dr Gupta's stewardship these two major objectives were achieved during 1996-97 and 1997-98. India now boasts of one of the best state-of-the-art GPS station and a digital seismic data acquisition system in Antarctica.

At the Department of Ocean Development, he has implemented several new programmes, such as, scientific work necessary for submitting India's claims on Legal Continental Shelf where India may gain 1.5 million sq. km of additional ocean area over and above the 2 million sq. km Exclusive Economic Zone (EEZ); detailed bathymetry surveys in the entire EEZ of India; building of an Indo-Russian Gas Hydrate Centre at Chennai; acquisition of new research vessels; and latest being putting India on the global map by designing an Early Warning System for Oceanogenic Hazards (Tsunami and Storm Surges) for India, as well as successful commissioning of a 1 million litre per day Low Temperature Thermal Desalination Plant at Kavaratti, Lakshadweep Islands.

Dr. Gupta has authored four books. (1) Gupta, H.K. and B.K. Rastogi (1976). "Dams and Earthquakes", Elsevier Scientific Publishing Company, Amsterdam, 229 p. (Translated into Russian in 1979 and Chinese in 1980). (2) Gupta, H.K. (1980). "Geothermal Resources: An Energy Alternative". Elsevier Scientific Publishing Company, Amsterdam, 227 p. (3) Gupta, H.K. (1992). "Reservoir Induced Earthquakes", Elsevier Scientific Publishing Company, Amsterdam, 364 p. (4) Gupta, H.K. and Sukanta Roy (2006). "Geothermal Energy: An Alternative Resource for the 21st Century", Elsevier Scientific Publishing Company, Amsterdam, 306 p.

He has published over 150 papers in scientific journals of international repute. To include SCIENCE/NATURE (5), BULLETIN OF SEISMOLOGICAL SOCIETY OF AMERICA (25), TECTONOPHYSICS (12), OTHER INTERNATIONAL JOURNALS (39), and INDIAN JOURNALS (57).

He has edited volumes of Tectonophysics (3), I.G.U. (2), A.G.U. (1), Current Science (2), Inter Union Commission on Geodynamics (1), Department of Ocean Development (GOI) (1), Physics of the Earth and Planetary Interior (1), Geological Society of India (3), Pure & Applied Geophysics (1), INSA Proceedings (2).

As Secretary, Department of Ocean Developmetnt, Dr Gupta implemented several new programmes, such as, scientific work necessary for submitting India's claims on Legal Continental Shelf; detailed bathymetry surveys in the entire EEZ of India; building an Indo-Russian Gas Hydrate Centre at Chennai; designing an Early Warning System for oceanogenic hazards (Tsunami and Storm Surges) for India, as well as successful commissioning of a 1 MLD low temperature thermal desalination plant at Kavaratti, Lakshadweep islands. Dr Gupta has revolutionized application of earth sciences by significantly contributing to water resource finding, rainwater harvesting and water pollution related studies as well as ways and means of assessing and safeguarding against earthquake hazards. He is the President of the Geological Society of India, a Member of the CSPR/ICSU as well as ICSU Planning Group on natural and human-induced hazards and disasters; Vice President of IUGG; Founder President of Asian Seismological Commission; and has been Councilor of IUGS; Bureau member of IASPEI and ILP. He was the General President of the Indian Science Congress (2007).

Dr Gupta has been involved from a very young age in senior administrative positions of institution building. He built Centre for Earth Science Studies at Trivandrum from a scratch. This included development of a whole campus in a short time of two years (1984-86). He also had the responsibility of building Indian Scientific Station in Antarctica which he did with distinction and completed all the tasks in a record time of one Antarctic summer (1983-84). In his capacity as Vice-

Chancellor of Cochin University of Science and Technology (at the age of 45 years he was the youngest Vice-Chancellor in the country), among several things, he created DRDO – Cochin University of Science & Technology, Computer Centre equipped with the then latest available computers for joint research projects. He also hosted the Science Congress in January 1990, the first Science Congress in Kerala, which, people still remember as one of the best conducted Science Congress meetings. At DST, during his stay of two years (1990-92) he initiated many new programmes including consolidating DST inputs on IGBP projects.

During 1992-2001, Dr Gupta was the Director at the National Geophysical Research Institute (NGRI), Hyderabad. NGRI has risen to the position of one of the top few CSIR laboratories. From a meager rupees one crore external cash flow during 1993-94, it has grown to 11 crores during 1996-97 and the same level is maintained since then. NGRI won the prestigious Technology Prize for Business Development and Technology Marketing during 1997. At NGRI, Dr Gupta has revolutionized application of earth sciences to the basic needs of the country. This has included delineation of Mesozoic sediments (which could be petroliferous) under Deccan Trap cover, and a new chapter has been opened in looking for Gas Hydrates in offshore region of India. NGRI has also significantly contributed in water resource finding, rain water harvesting and water pollution related studies as well as ways and means of assessing and safeguarding against earthquake hazards.

Dr Gupta received the SS Bhatnagar Prize (1983), USSR Academy of Sciences' "100 Years of International Geophysics" Memorial Medal (1985), National Mineral Award (1991), the Indian Geophysical Union Millennium Award (2000), Indian Society of Applied Geochemists Millennium Award (2000), Jawaharlal Nehru Birth Centenary visiting Fellowship (2003) and Professor K Naha Memorial Award (2004) of INSA, National Mineral Award for Excellence (2002), Padma Shri by Government of India (2006), Nayudamma Memorial Gold Medal Award (2008), National Award in Ocean Science & Technology (2008) and the Waldo E Smith Medal Award of the American Geophysical Union (2008). He is a Fellow of National Academy of Sciences (India), Allahabad.

Dr Gupta has been very active internationally. He is currently a Bureau Member of the International Union of Geodesy and Geophysics (IUGG), and Member of the Committee on Scientific Planning and Review of ICSU. Earlier he has been Councillor of the International Union of Geological Sciences (IUGS); the Chairman of the Steering Committee of Global Seismic Hazard Assessment Programme (a UN initiative); Chairman of IASPEI/UNESCO/ICL Working Group on Seismology and Related Sciences in Africa, as well as Bureau Member and Chairman of several Committees of the International Lithosphere Programme. He was the Founder President of Asian Seismological Commission. Dr. Gupta is currently a Member of the CSPR/ICSU as well as Member, ICSU Planning Group on Natural and Human-induced Hazards and Disasters. He has convened several international symposia at IUGG, IASPEI and IGU Assemblies. During January 1998, he convened a Chapman Conference on “Stable Continental Region Earthquakes” at NGRI, Hyderabad, this being the first Chapman Conference ever held in Asia.

It is matter of great honour for India to have a scholar of distinction like Dr. Harsh K. Gupta, who has given a new scientific and administrative directions for this country to grow. The scientists of this great nation, specially Earth Scientists, and those who have contributed to this volume, by joining hands with we, the editors, wish from the core of their hearts, all the best to Dr. Harsh Kumar Gupta for his future.

**K.L. Shrivastava**

**P.K. Srivastava**

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