Preface

The International Conference on Exploration and Utilization of the Moon (ICEUM-6) was held during 22nd–26th November 2004 at Darbar Hall, Udaipur, Rajasthan, under the aegis of the International Lunar Exploration Working Group (ILEWG).

The series of International Lunar Conferences began with the first conference at Beatenberg (Switzerland) in 1994 and was followed by biannual gatherings at Kyoto (Japan – 1996), Moscow (Russia – 1998), Noordwijk (The Netherlands – 2000) and Hawaii (USA – 2002). The Udaipur Conference was the sixth in this series. The next conference is proposed to be held in Toronto, Canada in September 2005, followed by a larger conference in China during July 2006, after the COSPAR Beijing assembly.

The Udaipur conference was organized at a time when there was a renewed interest in the exploration of the Moon and a large number of lunar missions were being planned. This new era started with the SMART-1 mission of European Space Agency (ESA) which attained a lunar orbit on 15th November 2004, just before the conference, exhibiting the success of the Ion Propulsion System. This mission is expected to be followed by Lunar-A and SELENE by Japan, Chandrayaan-1 by India, Chang'E by China and the Lunar Reconnaissance Orbiter (LRO) by USA during the next few years. There will thus be a continuous presence on the Moon till the end of this decade, and possibly a permanent presence during the next decade, offering excellent opportunities for international collaboration. The ILEWG endeavours to optimize the scientific and technical outcome of these various missions by facilitating international collaboration and by debating priorities, problems and strategies.

The conference was inaugurated by His Excellency Dr. A P J Abdul Kalam, President of India, who set the agenda of the conference with his illuminating talk on "International partnership in Lunar Missions". There was an overwhelming response to this conference from about 200 participants from 17 countries including Australia, Canada, China, Europe (Belgium, Germany, France, Italy, The Netherlands, Sweden, Switzerland and others), Russia, UK and USA who attended the conference and presented over 100 papers. The participants included representatives of various international space programs, scientists and engineers, astronomers, business people and entrepreneurs, educators, professionals and enthusiasts – all seeking to develop global understanding, strategies, initiatives and enterprises leading to a permanent human habitat on our Moon, within a decade. The conference thus enabled an excellent opportunity for international cooperation.

The main themes of the Udaipur Conference encompassed all scientific aspects of the Moon – robotics, engineering, space flight dynamics, navigation and control, lunar exploration programs of various International Space Agencies (ESA, ISRO, Russia, NASA, JAXA and China), first results from ESA's SMART-1 mission, programs of future lunar exploration (Lunar-A, SELENE, Chandrayaan-1 and Chang'E missions and development for lunar bases) and next generation science and technology missions to the Moon. A program, specifically for young lunar explorers, and reviews and results from previous missions such as Clementine and Lunar Prospector were also included.

In addition, round table discussions on science questions and priorities, international collaboration and Moon–Mars roadmap and technology and resource utilization were held at the end of the conference. On 26th November, 2004, a joint declaration approved by all the participants, known as the **Udaipur Declaration** was issued. Relevant excerpts from the Udaipur Declaration are reproduced below:

"A new lunar decade has begun. SMART-1 technology opens the fleet of new missions being flown to the Moon. Plans for CHANDRAYAAN-1 are timely, scientifically relevant, building infrastructure for future exploration. Additional complementary missions of exceptional value include SELENE, LUNAR-A, CHANG'E and LUNAR RECONNAISSANCE ORBITER.

We acknowledge that fundamental science questions about the Moon remain to be addressed, not only to understand the early history of the Earth/Moon system and its current environment, but also to acquire knowledge for the next steps

of exploration and human utilization. Of prime importance is the formation and evolution of the terrestrial planets, including the origin of the Moon. Also vital is the impact history at 1 AU, including the absolute timing of early events such as the giant basins. A major unknown is the internal structure of the Moon, both its geophysical and compositional properties. The Moon is a natural laboratory for studying its interaction with the space environment, together with the products resulting in the polar deposits.

Recognizing that any lunar exploration program must later include advanced orbital instruments as well as *in situ* analyses from several surface stations and targeted sample return, we urge a broad and open discussion and coordination for the selection of landing sites to optimize the science return and benefit for exploration.

We believe that exploration and utilization of the Moon will bring global benefits to human kind as well as serve national needs, and we recommend an international plan for its implementation. The participants endorsed the ILEWG stepwise approach, starting with a joint science analysis from on-going precursor missions (SMART-1, Lunar-A, SELENE, Chang'E, Chandrayaan-1, Lunar Reconnaissance Orbiter), continuing with lunar landers, and cooperating into an international lunar robotic village before 2014, evolving technologies for man-tended missions and preparing the ground for an effective, affordable human lunar exploration and permanent presence by 2024. We encourage space agencies to coordinate and integrate their plans in a robust international Moon–Mars roadmap in coordination with the ILEWG roadmap, where partners can identify their contribution for an effective implementation using their skills.

As we move forward with mission implementation, we urge space agencies to study and coordinate international lunar infrastructures and assets, such as telecommunication, navigation, logistics, lunar internet, towards an effective lunar exploration. We specifically recommend coordination of international efforts for the establishment of 'standards' to facilitate lunar exploitation and settlement – e.g., use of the metric system, well-characterized lunar soil simulants, common data formats and instrument interfaces; frequency, and power. We also urge the establishment of a standard lunar geodetic network, and recommend that the 'Moon Treaty' be revisited, refined, and revised as necessary in the light of the present-day impetus for expeditions, both robotic and human, to the Moon by several nations.

We believe missions to the Moon have an enormous potential to inspire both the young as well as their parents because the Moon is visible to all and is within our reach to visit. Herewith we encourage young scientists of different fields and nations to join this activity and work together in realizing lunar exploration goals."

I would like to thank Dr S R Shetye, Editor, *Journal of Earth System Science*, who kindly agreed to publish the Proceedings of the Udaipur Conference and Dr D Shankar and Ms Hema Wesley for careful editing of the manuscripts. The present volume contains 29 papers accepted for publication after a review process. These papers include topics such as origin and early evolution of the Moon, orbital dynamics, science on the Moon, results of Clementine mission, new missions to the Moon, e.g., Lunar-A, SELENE, Chandrayaan-1, Chang'E and Telerobotic explorations of the Moon.

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and

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