A quest for the moon

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There has been a renewed interest in exploration of the moon in the past few years and a number of space missions are planned by various countries during this decade. The Indian Space Research Organization has also been discussing the possibility of an orbiter mission to the moon for remote sensing and has debated the scientific goals for such a mission in various fora such as the annual meeting of the Indian Academy of Sciences held at Lucknow.

The main motivation for the future missions is to resolve some of the problems regarding the formation and early stages of chemical evolution of the moon, which can be clearly defined now in view of the vast database on chemical, geological and chronological aspects that has become available as a result of thirty years of serious study of the samples of the moon and several orbiter missions. An attempt is made here to summarize the salient features of our current understanding of the moon so that scientific objectives of the future missions can be clearly formulated. Specifically, the desirability of a low altitude (100 km) lunar polar orbiter for simultaneous chemical, mineralogic and photogeologic mapping is discussed and some regions on the far side of the moon and polar regions are identified for a detailed study.

‘O moon! We should be able to know you through our intellect
You enlighten us through the right path’
Rgveda Part 1/91
(approximately 2000 years BC)

The intellectual quest for the moon began when man first learnt to comprehend nature and correlate celestial phenomena. This got a big boost when the Russian satellite Sputnik demonstrated in 1957 that man could enter the space around and beyond the earth. This was followed by a series of orbiting, landing and sample-return missions to the moon by the former Soviet Union and USA. The Surveyor landings (Figure 1) provided the first analysis of lunar samples, and Lunokhods and lunar rovers explored large areas of the moon. The Apollo manned missions by USA provided the opportunity for direct exploration of the moon by man. As a result of these missions, lunar samples from nine well-documented sites became available for study and the past three decades have seen an all-out effort to understand the origin and evolution of the moon based on their laboratory analyses. Much has been learnt about the astronomical, physical, chemical, isotopic, geological and chronological aspects of the moon, but new questions have emerged which demand fresh efforts to be resolved. In spite of the large database, the mystery of the origin of the moon remains unsolved. With the development of new technology, there is a renewed interest in lunar exploration in many countries. Here I attempt to trace the major advances in lunar science and present a case for new missions to the moon.

Lunar exploration and its scientific context

It has been over 30 years since Apollo 11 returned the first batch of lunar samples. A vast amount of data have since been obtained from the study of rocks and soils from Apollo and Luna sample collections and of nearly twenty lunar meteorites (collected from Antarctica) which presumably originated from the moon and fell on the earth after a brief journey through space. These studies provide many constraints on the original source material of the moon, its subsequent differentiation into crust and mantle and its cratering history. A calendar of events has been constructed based on isotopic dating of these rocks which represent different regions of the moon. Geophysical experiments conducted on the lunar surface and remote sensing from lunar orbiters and the earth have provided additional data sets. Based on these results, some internally consistent though complicated models of origin and evolution of the moon have been proposed.

In addition to the origin and evolution of the moon, there are several other aspects which are of scientific interest. The moon represents an important link in the series of bodies which formed as the dust and gas of the