

Contents

Preface	v
SCIENCE CONCEPT 1: The Bombardment History of the Inner Solar System is Uniquely Revealed on the Moon	1
Science Goal 1a: Test the cataclysm hypothesis by determining the spacing in time of the creation of lunar basins	2
Science Goal 1b: Anchor the early Earth-Moon impact flux curve by determining the age of the oldest lunar basin (South Pole-Aitken Basin)	8
Science Goal 1c: Establish a precise absolute chronology	13
Science Goal 1d: Assess the recent impact flux	28
Science Goal 1e: Study the role of secondary impact craters on crater counts	45
SCIENCE CONCEPT 2: The Structure and Composition of the Lunar Interior Provide Fundamental Information on the Evolution of a Differentiated Planetary Body	47
Science Goal 2a: Determine the thickness of the lunar crust (upper and lower) and characterize its lateral variability on regional and global scales	61
Science Goal 2b: Characterize the chemical/physical stratification in the mantle, particularly the nature of the putative 500-km discontinuity and the composition of the lower mantle	77
Science Goal 2c: Determine the size, composition, and state (solid/liquid) of the core of the Moon	89
Science Goal 2d: Characterize the thermal state of the interior and elucidate the workings of the planetary heat engine	99
SCIENCE CONCEPT 3: Key Planetary Processes Are Manifested in the Diversity of Lunar Crustal Rocks	133
Science Goal 3a: Determine the extent and composition of the primary feldspathic crust, KREEP layer, and other products of planetary differentiation	152
Science Goal 3b: Inventory the variety, age, distribution, and origin of lunar rock types	172
Science Goal 3c: Determine the composition of the lower crust and bulk Moon	184
Science Goal 3d: Quantify the local and regional complexity of the current lunar crust	197
Science Goal 3e: Determine the vertical extent and structure of the megaregolith	210
SCIENCE CONCEPT 4: The Lunar Pole Are Special Environments That May Bear Witness to the Volatile Flux over the Latter Part of Solar System History	235
Science Goal 4a: Determine the compositional state (elemental, isotopic, mineralogic) and compositional distribution (lateral and depth) of the volatile component in lunar polar regions	256
Science Goal 4b: Determine the source(s) for lunar polar volatiles	262
Science Goal 4c: Understand the transport, retention, alteration, and loss processes that operate on volatile materials at permanently shaded lunar regions	265
Science Goal 4d: Understand the physical properties of the extremely cold (and possibly volatile rich) polar regolith	273

Science Goal 4e: Determine what the cold polar regolith reveals about the ancient solar environment	278
SCIENCE CONCEPT 5: Lunar Volcanism Provides a Window into the Thermal and Compositional Evolution of the Moon	293
Science Goal 5a: Determine the origin and variability of lunar basalts	296
Science Goal 5b: Determine the age of the youngest and oldest mare basalts	303
Science Goal 5c: Determine the compositional range and extent of lunar pyroclastic deposits	310
Science Goal 5d: Determine the flux of lunar volcanism and its evolution through space and time	318
SCIENCE CONCEPT 6: The Moon is an Accessible Laboratory For Studying the Impact Process on Planetary Scales	333
Science Goal 6a: Characterize the existence and extent of melt sheet differentiation	337
Science Goal 6b: Determine the structure of multi-ring impact basins	351
Science Goal 6c: Quantify the effects of planetary characteristics (composition, density, impact velocities) on crater formation and morphology	371
Science Goal 6d: Measure the extent of lateral and vertical mixing of local and ejecta material	391
SCIENCE CONCEPT 7: The Moon is a Natural Laboratory for Regolith Processes and Weathering on Anhydrous Airless Bodies	413
Science Goal 7a: Search for and characterize ancient regolith	419
Science Goal 7b: Determine physical properties of the regolith at diverse locations of expected human activity	428
Science Goal 7c: Understand regolith modification processes (including space weathering), particularly deposition of volatile materials	438
Science Goal 7d: Separate and study rare materials in the lunar regolith	450
FEASIBILITY ASSESSMENT OF ALL SCIENCE CONCEPTS WITHIN SOUTH POLE-AITKEN BASIN	477
Science Concept 1	477
Science Concept 2	492
Science Concept 3	499
Science Concept 4	510
Science Concept 5	519
Science Concept 6	536
Science Concept 7	560
Science Concept 8	562
Synopsis	563
References	566
Appendix	607