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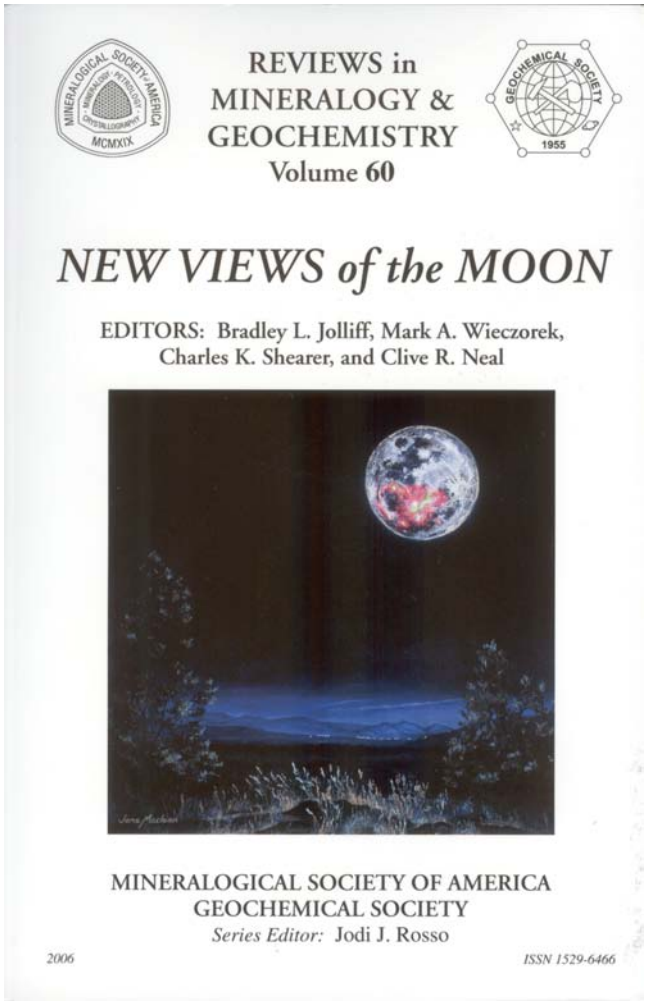
Book Review

New views of the Moon, edited by Bradley L. Jolliff, Mark A. Wieczorek, Charles K. Shearer, and Clive R. Neal. Mineralogical Society of America, 2006, 721 p., $45, paperback (ISBN 0-939-95072-3); $55, hardcover.



I haven't read all of this book and you probably won't either. But it is an invaluable companion that belongs on the desk of all lunar researchers. Although Ross Taylor has famously provided book-length summaries of our post-Apollo understanding of the Moon, there has not been a massive multi-author compendium since the *Lunar sourcebook* in 1991. This 721-page collection, with seven long articles and contributions by dozens of lunar scientists, is the post-post-Apollo view. It's also the new handy (3 lbs) place to start research on almost any lunar topic. The "new views" have sprung from the first modern remote sensing data about the Moon, which was provided by the Galileo flybys (1990, 1992), Clementine (1994), and Lunar Prospector (1998). These data, calibrated by Apollo samples and lunar meteorites, and the ideas springing from them, are the subject of this book.

The standard post-Apollo view of the Moon included concepts and terms such as mascon, magma ocean, 60 km crust, KREEP, anorthosite, heavy bombardment, regolith, agglutinates, Cayley, and the Europium anomaly. *New views* explains all of these, at least briefly, and then continues with in-depth discussions of the ideas that developed in the 1990s. Each chapter also ends with an exhaustive bibliography, and many have a list of unresolved questions. The chapters are so long (averaging 103 pages) that each could have a separate review, but here is a very brief one that provides a gloss of the main points.

Chapter 1, by Hiesinger and Head, is an overview of lunar geoscience that could profitably be published as an 80-page stand-alone introduction to the Moon. It briskly reviews origin, petrology, structure, geologic processes, and landing sites, and, as a good opening chapter should, sets a framework for what follows. The next chapter is 137 pages on lunar surface materials and interactions with their space environment. Lucey and 17 co-authors (it finally struck me that I was probably asked to review the book because I am one of the few lunar scientists who is not a co-author) describe the regolith and lunar minerals and rocks, and how remote sensing probes them. This chapter is especially good at explaining the implications of data, and thus would serve as an excellent textbook.

Wieczorek and 15 co-authors use their 143 pages for an in-depth examination of what we think the lunar interior is like and why. They explain that the magma ocean concept provides the framework for understanding the lunar interior, and then systematically work through petrologic and geophysical modeling to arrive at a thinner and more complex crust and upper mantle than in the post-Apollo view. But it is clear than many uncertainties remain for topics such as the thicknesses of mare lava and the crust. This chapter is probably the best single source about the states of the various components of the lunar interior—my copy now has underlinings everywhere.

Sixteen scientists led by Shearer composed the monograph that is chapter 4, which discusses the thermal and magmatic evolution of the Moon. The giant impact and

magma ocean hypotheses are the starting points, and many models are considered. As with the previous chapter, the great increase in data from Apollo to Prospector has led to a more sophisticated general understanding of the complexity of the processes, but the uncertainties are still great.

The chapter on the cratering history of the Moon is unique in not having Hartmann or Neukum as a co-author. Nonetheless, Stöffler and five colleagues review the morphologic, formational, and chronologic aspects of impact craters. They argue for an age of 3.77 Gyr for the formation of the Imbrium basin, rejecting the more common 3.85 Gyr age; the chapter was not updated to consider the 3.91 Gyr age derived in 2004 from the Sayh al Uhaymir meteorite. The following chapter by Duke and three others summarizes the well-known reasons for establishing a human outpost on the Moon, how to get there, and what in situ resources could be mined.

New views about the Moon are scattered through every chapter, but the last one brings together in one place the new ideas as identified by Taylor, Pieters, and MacPherson. One of the most important is that most Apollo sites were highly contaminated with Imbrium ejecta, skewing our post-Apollo understanding of crustal composition. Lunar meteorites and Ti and Fe mapping from Clementine have been critical in deciphering a more representative highlands composition. Related to this is the recognition that the Moon does not have just two terrains—highlands and maria—but two additional ones: Procellarum KREEP Terrain and SPA Terrains. The moon has more variety than Apollo sampling led us to believe. This chapter ends with strong documentation that scientific understanding of planets and moons requires data collections from both remote sensing instruments and humans on the ground.

But what about the book as a tool? It is new views but not necessarily up-to-date ones. The book took four years to be edited and produced, which is reflected in the otherwise monumental collection of references. There are 95 pages of references, but a tiny sample suggests only about 25% are more recent than 1999; many are from the 1970s. Such an information-packed tome needs an excellent index and this one is pretty good, but it needs a complete lunar place name index; for example, it includes Pluto but not Plato. This is such a massive reference that it will be used frequently to look up a fact or a line of reasoning; an online version of the book would be the best way to optimize retrieval of the vast amount of information it contains. This finally occurred for the *Lunar sourcebook*, but hopefully it will not take 15 years for the online version of *New views* to appear. An online version would have another benefit: it would be easier to read. The tight binding makes reading awkward—it won't stay flat and nearly requires two hands to hold it open. What's more, the very narrow margins allow more text to be crammed in, but don't leave room for penciled-in notes. What good is a reference if you can't annotate it? And it should have been better bound; this is one of those books that you know will end up with a stout rubber band holding all the pages together. Spend the extra $10 for the hardback edition.

These shortcomings aside, this book will be invaluable to the new generation of geoscientists from various countries who will analyze the terabytes of data from SMART-1, and especially the Chinese, Indian, perhaps British, and even American lunar probes that will fly in 2007 and beyond, opening the second phase of space exploration, fifty long years after the beginning of the first.

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