CARTOGRAPHY FOR LUNAR EXPLORATION: 2008 STATUS AND MISSION PLANS

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Abstract:

The initial spacecraft exploration of the Moon in the 1960s–70s yielded extensive data, primarily in the form of film and television images, that were used to produce a large number of hardcopy maps by conventional techniques. A second era of exploration, beginning in the early 1990s, has produced digital data including global multispectral imagery and altimetry, from which a new generation of digital map products tied to a rapidly evolving global control network has been made. Efforts are also underway to scan the earlier hardcopy maps for online distribution and to digitize the film images themselves so that modern processing techniques can be used to make high-resolution digital terrain models (DTMs) and image mosaics consistent with the current global control. The pace of lunar exploration is about to accelerate dramatically, with as many as seven new missions planned for the current decade. These missions, of which the most important for cartography are SMART-1 (Europe), SELENE (recently renamed Kaguya, Japan), Chang'E-1 (China), Chandrayaan-1 (India), and Lunar Reconnaissance Orbiter (USA), will return a volume of data exceeding that of all previous lunar and planetary missions combined. Substantial advances in international standardization and cooperation, development of new and more efficient data processing methods, and resources for processing and archiving will all be needed if the next generation of missions are to fulfill their potential for high-precision mapping of the Moon in support of planned exploration and scientific investigation.

With the acquisition of these new datasets, lunar cartography is in a time of transition. Many types of cartographic products have been and are being generated from existing lunar data, extending from the paper maps of the 1960s and 70s to digital image mosaics and terrain models (DTMs) of the 90s and today. These products incorporate image data and information at many scales from missions such as Lunar Orbiter, Apollo, Galileo, Clementine, and Lunar Prospector. A global control network incorporating positional information from these data has recently been completed, but is already in need of updating. We now face a dazzling array of new missions to the Moon, many of which will produce torrents of new data, all of which will need to be registered into a common reference frame. Framing and scanner camera images, including multispectral and stereo data, hyperspectral images, synthetic aperture radar (SAR) images, and laser altimetry will all be collected, including, in most cases, multiple datasets of each type.

Cartographic products such as global mosaics and DTMs will have to be generated from a large portion of these datasets. With their laser altimeters, stereo, high-resolution, and multispectral cameras, and radar instruments, a deluge of new, high-accuracy, and complex datasets will be generated. All will need to be properly calibrated, pre-processed, co-registered, and (for images) mosaicked and/or stereoanalyzed to make DTMs for local, regional, and global areas. We stand at a crossroads where the needs are many: the need for greatly increased international cooperation; the need for new algorithms and software to handle such increasing complex and large datasets; the need for new data processing techniques to store, process, and archive such datasets; the need to administer the greatly increased efforts required to process such datasets; and the need for adequate funding to address all these concerns. A further requirement is the realization among all involved that as the reference frames improve and our knowledge of the data increases, multiple repeat processing of past and current datasets is required in order keep the datasets registered in a common system and properly calibrated, so that the data can be used together to address future scientific and exploration needs.

This is an exciting time of great promise for the exploration of the Moon, as this new "age of lunar reconnaissance" leads to further scientific exploration of the Moon and even new human missions, possibly by several nations. However, the cartographic community faces perhaps its greatest challenge ever in handling the new datasets that are and soon will be arriving, with an order of magnitude more complexity and several orders of magnitude more volume than for all previous extraterrestrial missions. Mapping an entire world at the resolution of 50 cm or better will not be an easy task!