What Did They Do on the Moon?
A Proposal for an International Atlas of Lunar Exploration

Philip J. Stooke
Department of Geography
University of Western Ontario
London, Ontario, Canada N6A 5C2

Introduction. The exploration of the Moon by spacecraft began in 1959 with the impact of Luna 2 and the first photography of the far side by Luna 3. On the fortieth anniversary of these pioneering flights it is appropriate to look back at the history of lunar exploration. What was accomplished by missions which succeeded? What was attempted by missions which failed? What dreams were fulfilled, and what others never came to fruition? I propose the creation of an International Atlas of Lunar Exploration to tell this story in cartographic form. It would provide a detailed record of the subject, capable of serving as a foundation for future scholarship in the planetary sciences and in space history.

Justification. Consider a few simple questions, such as might be asked by anybody with an interest in space exploration. Where did Surveyor 1 land? What did Luna 12 accomplish? Where would the Apollo 13 astronauts have walked if they had landed? What experiments were performed by the Lunokhod 2 rover? These questions can be answered superficially by means of readily available resources: Surveyor 1 landed in the Flamsteed region of Oceanus Procellarum, Luna 12 took photographs from lunar orbit, and so on. These are not complete answers, however. Where exactly is the Surveyor 1 landing site relative to individual hills and craters? What features were observed at the landing site? Which parts of the Moon did Luna 12 photograph? What did the images show? No single existing resource compiles this information in detail.

To answer these questions fully, a more thorough presentation of results is required. It is not enough to know that a spacecraft landed near a particular named feature, or even that it landed at a specific latitude and longitude. The location can only be portrayed precisely and usefully in a series of nested maps of increasing scale, maps which bridge the gap between regional overviews and very large scale charts of the lander's surroundings. At the site itself, what activities were undertaken? This question can also be answered cartographically, by showing plans of trenches dug by a sampler arm, the route of a rover, the locations of compositional or mechanical properties experiments, and so on. For orbital missions, the extent of photography or other observations can be plotted on maps, and photomosaics or other presentations of data can be compiled to portray results. In the case of Luna 12, for instance, the very limited western sources available for this mission include only two small frames of high resolution photography without any context information to identify the targets.

Sources of Information. Most of the information needed to answer these questions already exists in obscure technical reports on individual missions. The proposed atlas would gather this material from both Russian and American reports in one convenient and accessible reference work. Extensive use would be made of existing maps and photomosaics, both to reduce preparation time and cost and with the important secondary goal of illustrating the history of lunar cartography in this period. Relatively few new maps would have to be drawn. Many new products would be based primarily on spacecraft images rather than drawn maps, which will also reduce costs and help illustrate the primary data products of the principal lunar missions. Thus, the Surveyor 1 landing site might be located on Lunar Orbiter images, and the Lunar Prospector impact site on Clementine images. Therefore spacecraft images will also be an important resource.

The resources indicated above are technical reports, existing maps and image data. All should be readily available. Both Russian and U.S. technical reports on all missions should be easy to locate, particularly with involvement by participants from both countries. Similarly, all necessary maps are readily available. U.S. mission images can be obtained via the Planetary Data System or through the network of Regional Planetary Image Facilities. Russian images of the Moon would probably be available in hardcopy, and interesting mapping projects such as the preparation of mosaics from scanned prints of these images might be undertaken as part of the preparation of the atlas. An additional benefit of that procedure would be that the images would become available in digital format for new scientific and cartographic uses. Similarly, some Surveyor mission composites of many images might be scanned and reprojected to a panorama format for presentation in the atlas.

Editorship. A project of this magnitude and international scope requires a highly qualified editorial board including experts in the field drawn from several institutions. It will be particularly important to involve a prominent editor from Russia in order to facilitate access to materials from institutions in that country and to be sure its pioneering role is fully reflected in the atlas. The need for access to U.S. maps and image data sets dictates the involvement of the U.S. Geological Survey or a scholar with close ties to that agency. I would anticipate a three-person editorial board including representation from the U.S. and Russia, with additional editorial assistance where appropriate for individual sections of the atlas.

Scope

Successfully flown missions alone do not tell the full story of lunar exploration. Some flights fail and others do not proceed beyond the planning stage, but possible targets or surface activities can be portrayed. Additional sections of the atlas could present telescopic maps and contemporary thematic data sets (magnetic fields, elemental distributions, lineaments, transient lunar phenomena etc.) to place Space Age exploration in its historical and scientific context.

Example

The illustration on the following page portrays NASA's Ranger 9 mission of 1965 in very condensed form. Actual and alternative targets are shown in Figure 1. Figures 2 to 5 show the impact point in increasing detail. The criterion for scale selection is that the major features in each map should be discernable in the previous map. The sequence ends with a post-mission photograph from Apollo 16 showing the crater formed by the impact of Ranger 9. In the atlas, each map might occupy half a larger format page, revealing much more detail. There may be at least one more step in the sequence, between Figures 2 and 3, as well as a diagram of the trajectory of Ranger 9 showing flight events such as course corrections. At least one map might be replaced with a mosaic of Ranger images to illustrate the nature of the data obtained, and the text would be expanded beyond the brief captions shown here. Nevertheless, this set of maps and similar coverage of all other missions and proposals would record our first steps off Earth in unprecedented detail. Publication might be targeted for 2007 or 2009, the fiftieth anniversaries of Sputnik 1 and Luna 3 respectively. Following this first step, a similar volume devoted to Mars might follow in about 2019 (the fiftieth anniversary of Apollo 1), by which time several sample collection missions may have been completed and plans for human expeditions may be well developed.

Ranger 9 United States March 21, 1965

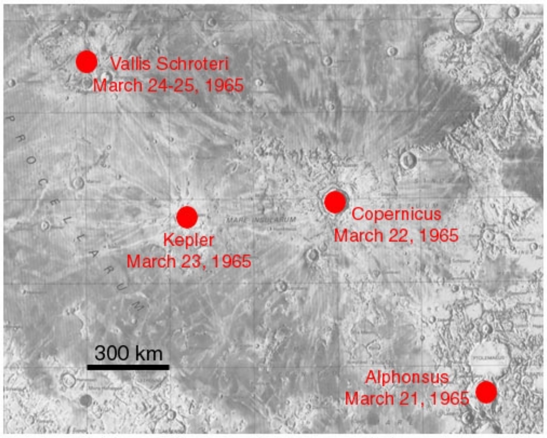

Figure 1. Potential targets for Ranger 9. In order to ensure adequate lighting, different targets were designated for each of the indicated launch dates.

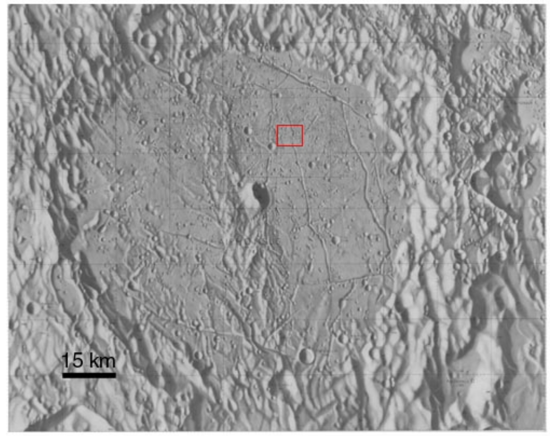

Figure 2. Ranger 9 was targeted for the floor of the crater Alphonsus, which was suspected to be a site of past and possibly continuing volcanic activity. The red box shows the location of Figure 3.

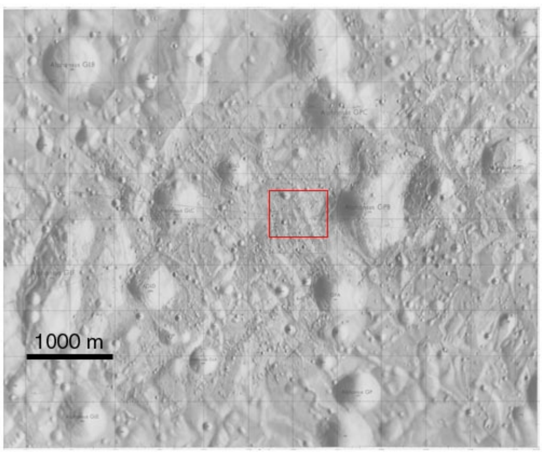

Figure 3. The impact area was just to the west of a valley, believed to be a fracture in the crater floor. Images showed that the valley consisted of a chain of pits. The red box shows the location of Figure 4.

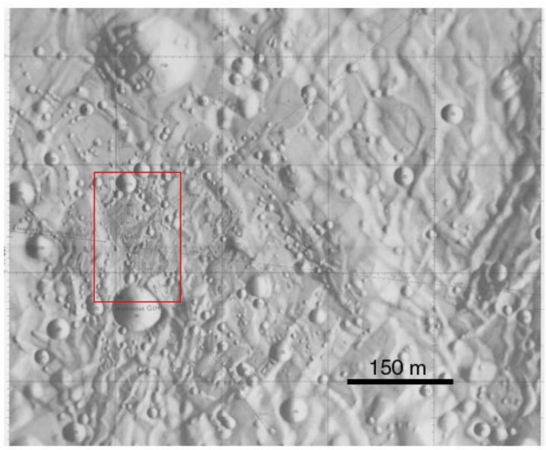

Figure 4. The impact site lies in the red box, which is shown in more detail in Figure 5.

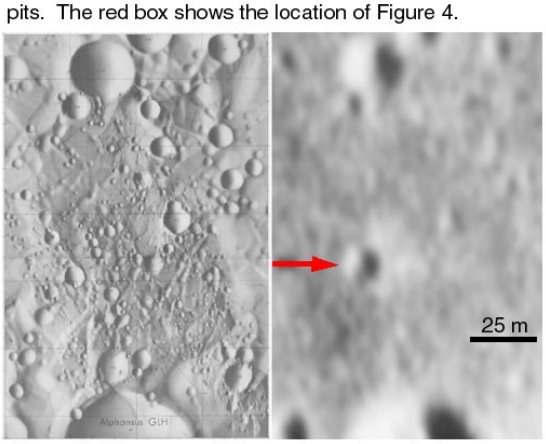

Figure 5. The map at left was drawn from the last few Ranger 9 images. At right is an image from the Apollo 16 panoramic camera. Ranger 9 approached from the left. Its impact crater (red arrow) has bright ejecta to its right.

Image sources:

Figure 1. U.S. Geological Survey map I-2276, 1992.

Figure 2. U.S. Air Force Aeronautical Chart and Information Center (ACIC) map RLC 14, 1966.

Figure 3. ACIC map RLC 16, 1966.

Figure 4. ACIC map RLC 17, 1966.

Figure 5. ACIC map RLC 17, 1966, and Apollo 16 panoramic camera frame 4658, 1972 (reprojected to the same scale and geometry as the map).