ART OF LANDING SITE CARTOGRAPHY. H.I. Hargitai[1] [1]Eötvös Loránd University, Cosmic Materials Space Research Group, Budapest 1117 Pázmány Péter st 1/a Hungary hargitai@emc.elte.hu

Introduction: Planetary cartography is or should be a science, technique and art, similar to the traditional view on cartography in general [e.g. 3]. The technique part in planetary cartography is data acquisition and instrumentation. The science part is the quantitative and qualitative post-mission analysis of data acquired; and the pre-mission and real time cartographic support of planetary and lunar missions. In this paper we give examples of scientific maps and of outreach maps of landing sites.

Cartography for science: The scientific visualization of a landing site and its surrounding terrain can either serve the needs of a landing site selection process or can be a post-or pre-activity analysis a the rover's achieved or planned work, in spatial context. During such process, the following major issues are addressed: (1) scientific goals: location and properties of structures that are ideal for scientific analysis (2) Engineering constraints: location and properties of surface structures and other features that should be avoided [1, 4]. Landing site and rover traverse maps resulted from scientific analysis of multiple parameters are very often spectacular 3D visualizations of the surface at high resolution, but only the science and technique aspects of cartography are fully utilized here; colors and shapes etc. are chosen to be clear and informative. But the art concept plays no role here.

The art perspective of landing site maps: There is a thin dividing line between maps and other representations of spatial phenomena. Art here is understood not as marginal elements on a scientific map, not decorations, but essential part of the map itself, map design, as integral part of the product, from typeface to color scheme selection. When maps are designed to be easy-to-understood, generalization of the reality – inevitably: interpretation of the unimaginable complexity of reality – is necessary. But from which point can we say that a map is not a map anymore because it is oversimplified or essential elements are missing? Non-maps range from non-controlled automatically created photo mosaics to artistic paintings based on a cartographically projected image or photograph. However, in everyday use, especially in elementary schools in which measurements on a map are not considered, and especially in the case of planetary maps, which depict an alien landscape, it is more important that the image shown in the map be understandable and attractive. Attractiveness does not necessarily include clarity. Landscapes – surfaces – of extraterrestrial bodies are hard to interpret based on our terrestrial experiences. Comparative planetology, itself also limited, is only a viable choice if the photo reader is similarly familiar in terrestrial airborne or satellite imagery and spacecraft data. Students are typically unfamiliar in terrestrial space photography; they are mostly shown cartographic products in their Atlases. On a spacecraft photo or photo mosaic, there are no landmarks, the scales are hard to "feel", features are unknown. In terrestrial maps, there are various features that help navigation and identification of scales: such are hydrology in physical geographic maps or man-made real objects (roads) or imagined features (country borders) in political maps. None of these are present on other bodies. What can be mapped then? Which elements can be generalized? Craters? Valleys? Automated topographical maps provide relatively little help in understanding the surface – craters and some volcanoes are identifiable but other landforms are not necessarily. Photomaps provide the same enigmatic view of planetary surfaces. Photomaps do not provide interpretations, and are non-narrative. At large scales, valleys and even boulders are visible, but the context is missing: is it a lava flow or a fluvial valley? Are we looking at a volcanic lava field or a floodplain? These questions are difficult to answer for even planetary scientists sometimes, but for K-12 education, identification of regional and global features may be of higher importance. What is the Martian or Lunar equivalent of the terrestrial continent-ocean dichotomy? We have to narrate, to interpret the visual data in order to make it *visible* for the human mind.

Landing sites, as we have seen, may be selected primary to meet engineering constraints. Even though these spots may be not the most interesting places on a body, regardless of their scientific importance, these sites are unquestionably the most important hot spots on planetary surfaces for us humans. Those places where humans walked, or where our devices were or are operating, keep record of our physical or tele-presence.

For K-12 education the following two end members of cartographic scales may have the highest importance: (1) global scale features and feature types are important to be made identifiable, and (2) local scale, historically selected sites (landing sites) which are the best known planetary surfaces and where surface images are also available. These may stimulate the children's imagination the best.

Future goals: maps made by graphic artists – from automated products to hand-made maps: Virtual planetary maps made of actual automatically derived topographical data are still too complex. In order to make it interpretable at K-12 school level, it requires simplification and generalization. Its nomenclature should be in the mother tongue of the pupils, and using the vocabulary they understand, and its visual appearance should only show the very basic features on the planet or moon, as very small scale global maps on Earth show continents and oceans, deserts and forests, mountain chains and main cities in a very simple way. It may not be possible to create such visualizations by using any automated process. Such map can be produced by professional graphic artists, cartographers and planetary scientists together. The end product can be simple, visually attractive and still scientifically accurate maps that are the planetary equivalents of well known very small scale global cartographic visualizations of the Earth. Such a map, published online or in print, should use simple symbols, non-scalable labels and show only the major types of landforms and other surface features on planetary bodies, to give a general overview of the basic surface properties of a planetary body. To give more background details, it could use „points of interest" with auxiliary images and text, that can provide additional information on the features displayed. [2] To make it more children-friendly, imagined characters can be invented, who would "narrate" the map content as if it were a fairy tale and this character could be used as a personalization of the given planetary body similar to those invented by the character designer Simon Basher [6]. Such maps are being produced with the support of ICA Commission on Planetary Cartography [2].

Common experiences in spatial dimensions: We have common spatial experiences up to the size of a sports stadium [5], but for much larger areas our experiences are different: we live in different settlements, urban or rural areas and the cities we know to navigate in are different: landmarks may not be helpful in putting landing sites into spatial context. In this case we propose two possible ways to produce useful maps: either a *localized (fixed) visualization* or a *freely relocatable* map layer of the landing site. In the latter case the user would have to place the landing site map layer over their living area, which they are familiar with. Both small and large distances will be easily perceived, starting from "home". This map would be a highly personalized, interactive map that is designed to be understood by only one or very few people, but for them, the experience it offers would be truly personal, tied to their personal living space .

Using the principles of the artistic and scientific requirements, we have created a traverse map of the Curiosity rover (Fig. 1). As this map was shown to an audience in Budapest, we used the downtown map of Budapest, Hungary, as base map.

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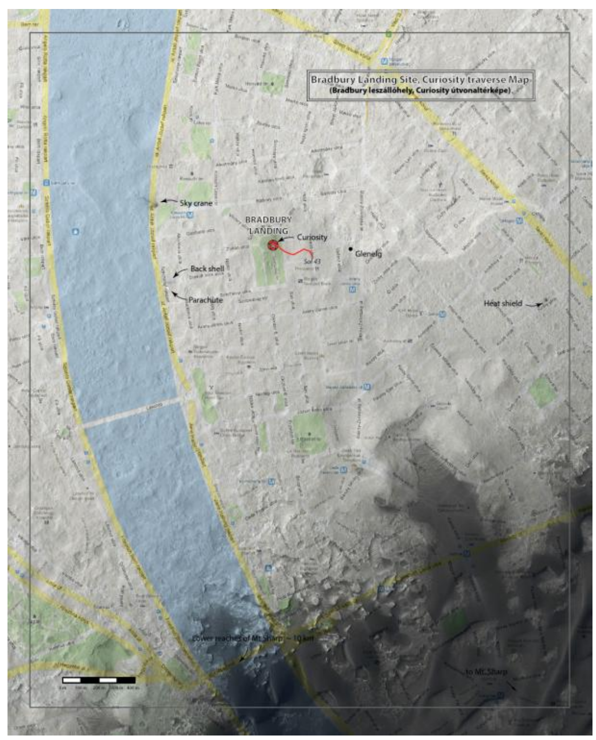

Fig.1. This map puts the Curiosity landing site on Mars into spatial context on the Earth (Oct. 2012). Landforms (dunes) in the south makes Martian landscape more transparent. (Map by Merk, Zs., Hargitai, H).