Chinese and Russian language equivalents of the IAU Gazetteer of Planetary Nomenclature: an overview of planetary toponym localization methods

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Abstract

The Gazetteer of Planetary Nomenclature (GPN) is maintained by the International Astronomical Union Working Group for Planetary System Nomenclature. It contains the internationally approved forms of place names of planetary and lunar surface features. In the last decades, spacefaring and other nations have started to developed local standardized equivalents of the GPN. This initiated the development of transformation methods and created a need for auxiliary information on the names in the GPN that is not available from the database of the GPN. The creation of "localized" (local language) variants of the GPN in non-Roman scripts is an unavoidable necessity, but is also a cultural need. This paper investigates the localization methods into Chinese, Russian, and Hungarian: three nations with different scripts, and two that are spacefaring ones. The need for the creation of a localized GPN is related to the local importance of scientific papers published in the local language and the existence of locally developed and operated scientific planetary spacecrafts, but exceptions exist.

Keywords

Nomenclature, toponym, place name, history of planetary science, planetary cartography

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1 Introduction

In the second half of the 20th century, the need of naming planetary surface features moved from observer astronomers to planetary scientists in spacefaring nations that are capable to develop and operate planetary spacecrafts, and thus are able to discover new surface features. Planetary surface discoveries are mostly made by research teams that are involved in planning the science programs of spacecraft missions. However, in recent decades several groups emerged in various countries, which participate only in post-mission analysis or reanalysis of orbiter, lander and rover imagery. Despite the predominance of English language in today's scientific communications, there are planetary research results published in languages and scripts other than English and Roman (Latin), respectively. The Latin-based planetary nomenclature may be more or less transparent for the well educated Euro-American reader, but it is obscure for most young students in Europe and is as alien for the Russian or Chinese (or many other) readers, as alien Russian or Chinese is for the Euro-American readers.

Extraterrestrial bodies currently don't belong to any of the legal entities of Earth. This fact can be reflected in the system of planetary nomenclature: the use of a dead language, Latin, is one of the tools that makes it neutral. Whereas the International Astronomical Union's Gazetteer of Planetary Nomenclature (GPN) contains specifics (proper names) that originate from more than 300 ethnic/cultural groups or countries, its writing system matches that of only a part of the nations of Earth. In fact, all the three crewed spacefaring countries (the USA, China and Russia) use different writing systems. Instead of being international, the GPN should be considered "supra-national", giving all nations an equal right to use the names determined by IAU WGPSN in their respective languages and writing systems, while maintaining the standardized, single IAU forms in international communication.

Terrestrial geographical names are managed by National Names Authorities of which several have published their toponymic guidelines for map editors in English (UNGEGN 2012a).

The United Nations Group of Experts on Geographical Names (UNGEGN) coordinates international works on terrestrial toponyms, including various expert tasks related to the international standardization and romanization of geographical names (UNGEGN 2012b).

For the GPN, only international standards are determined, while the national variant are missing are their creation is not coordinated by any organization. One of the closest analogs to the GPN is the nomenclature of undersea feature names. A proportion of undersea features are located fully or partially outside territorial seas. International regulation and standardization of these names were initiated in 1987 by the International Hydrographic Organization and UNESCO's Intergovernmental Oceanographic Commission (IHO/IOC) (IHB 2008). Regulation methods of IHO/IOC in several aspects differ from that of IAU WGPSN but these may also be beneficial for the planetary science community. To name a few such differences: the IHO/IOC encourages the establishment of national boards; considers detailed historical information regarding the origin of names an important part of its gazetteer; its gazetteer publicly documents the name of the proposer of the particular place name; it provides guidelines on transliteration and includes rules on naming groups of features; and it accepts descriptive names. It is one of its basic rules that generic terms be in the language of the nation issuing the (map) product. Generic terms are published with detailed definition, including the term's and the definition's translation into six world languages (IHB 2008).

The authors of this paper all participated in efforts to transform the international standard forms in the GPN into their respective languages (Chinese, Russian and Hungarian). This process is also called localization: the creation of a local variant, in this case, the local *equivalent* of the GPN. We describe how Russia and China has localized the GPN. Whereas the Russian version has been under development since the 1960s, the Chinese variant has been created only in recent years, answering the needs connected to the successful Chinese Moon program. Methods of localization into Hungarian is discussed in detail in Hargitai et al. (2010).

1.1 Prehistory of the Gazetteer of Planetary Nomenclature

The need for named planetary surface features had been exclusive to astronomers in the past who actually observed the Moon and Mars by ground telescopes on Earth.

The basic concept behind the GPN descends from the maps of Riccioli, who combined and augmented the two preceding systems, invented by Langern (1645) and Hevelius (1647). Hevelius' map visualizations and both astronomer's nomenclatures were more Earth-like and contemporary (with names of his contemporaries: scientists, rulers and terrestrial geographical features), whereas Riccioli's map, supported by the visual representation of Grimaldi (Vertesi, 2007), was more alien with abstract names and names of ancient scientists and philosophers. The Italian Galilei, the German Kepler, the Dutch Langrenus, the Italian Riccioli and the Polish-German Hevelius in the 17th century all worked in Latin and naturally used Latin for their nomenclature: for personal and common names and also for the generic part. The mid-17th century marks the change from a pan-European use of Latin to national languages in printed publications. By the 19th century standard national dialects (or print-languages) were established (Anderson 1991). In the late 18th and the 19th century, the German Schröter (1791), and also Beer and Mädler (1837) wrote their scientific works in their mother language, German; and introduced true generic names in German (e.g., "Apenninische Gebirge"), but kept the original Latin forms for traditional names with false generics (Palus, Sinus, Lacus, Mare, Oceanus), respecting the traditions: Lunar nomenclature became bilingual.

Latin became old-fashioned by 19th century when the first maps of Mars were drawn and features were again named for contemporary scientists. The use of Latin was re-invented by the Italian Schiaparelli, who created Mars again with a 'classical-ancient' feel instead of a contemporary one by naming Martian albedo features for mythological beings and places. The American Lowell took this concept in developing his canal nomenclature.

During the 18-19th century, new names on the Moon were proposed in the language of the observer. The efforts of the standardization of the nomenclature were initiated by the work of English Blagg and Saunder in 1913 in which Blagg noted: "...Madler and Schmidt of course write such names [Familiar geographical names such as "Alps "] in German, and Neison in English. As th[is] list is written in English, I have given them in the English form." (Blagg and Saunder 1913). The first officially standardized IAU names (Blagg and Muller 1935) were also born in English and Latin. This marks a fundamental change in the naming *process*: from this time on, names are not assigned directly by the observers but selected and/or approved by members of the international scientific community: an international commission of a particular organization, namely, of IAU, which is the organization of astronomers. A basic principle of the commission's activity is that planetary features should be named only when a feature come into prominence, when "they have special scientific interest, and when the naming is useful to the planetary scientific and cartographic communities" (Shevchenko et al., 2009).

The center of gravity of lunar and planetary observations was in Germany in the 18th - early 19th century; it moved to France and England in the late 19th century and gradually to the USA in the late 19th-early 20th century. At the beginning of the space age the Soviet Union sent its first probes to observe the that far unseen hemisphere of the Moon. The acquisition of the first far side images by the Soviet Luna-3 marked the beginning of a new era for lunar nomenclature. Names were now designated in Russian language (and cyrillic script) and have been promptly translated (and not transcribed) into English and other languages in the popular and news press (Kenny, 1963). The official languages of IAU were English and French, and Russian became a standard language of international communications in the socialist countries. This colorful linguistic variety made IAU "restore" Latin as official standard of the planetary nomenclature.

Coinciding with the proposal and approval of the first Soviet names for the far side of the Moon, IAU have decided to standardize the nomenclature *in Latin* form in 1961 / 1964 (Sadler, 1962:234, Arthur, 1966). It was also decided that names (all personal names) should retain the original spelling. Latinization marks a major change in *the language* of the planetary nomenclature, especially concerning the generic elements. IAU has decided not only to use Latin

for the generic elements in place names but also latinized the specific elements of the names of Lunar mountains.

Criticism of the latinization decision is echoed until today: “English is the lingua franca of the scientific world, virtually no one knows Latin, so it makes no sense - except to a pompous bureaucrat on an international committee - to invent new terms that won't be understood” (Wood, 2007). Basically the same is expressed by Hartmann (2003): „For better or worse - probably worse – the mappers chose mostly Latin terms for topographic features, so the new Martian names can be opaque to modern readers”.

It is not surprising that Apollo astronauts and engineers at NASA Manned Spacecraft Center (MSC) used English variants of Lunar place names: “The target of Apollo 12 was known as the Ocean of Storms to the astronauts and MSC … The scientists called it Oceanus Procellarum” (Whitaker, 1993). Whitaker notes in the preface of his book on lunar exploration: “Names of lunar features are usually given [in this book] in the form most commonly employed by scientists. Hence, usually "the Apennines" rather than the international Latin "Montes Apenninus," but "Mare Fecunditatis" rather than the "Sea of Fertility" preferred by NASA and the astronauts (Whitaker, 1993).

The XVIth General Assembly of IAU in 1976 decided that „In general, individual names chosen should be … expressed in the language of origin. Transliteration and pronunciation for various alphabets should be given, but there will be no translation from one language to another” (Müller and Jappel, 1977). This is a key resolution that would have allowed easy localization into various scripts; and would make transcribed and transliterated variants equivalents; however, despite this resolution, neither transliteration nor pronunciation was determined for any of the names approved by IAU. (Transliteration is still mentioned in the current IAU rules, reference to pronunciation is left out.) In most cases, transliteration of the names is theoretically possible using the information provided in the GPN, however, the lack of any pronunciation guide places considerable difficulties and results in mistakes in localizations in which conversion is done by phonetic transcription. Since the GPN is truly international (it has 321 ethic/cultural groups or countries listed in 2012), no single expert may know the pronunciation of all names; this information should logically be provided by the proposer of the particular name. Another difficulty is that the GPN does not list the original *language* of a name, only the ethnic/cultural group of country. This makes any conversion problematic since orthography is language-dependent. Some European geographical place names are present in their English exonym form. Common nouns have no country of origin but has a language that is not listed.

The 1976 decision recommended to use the names of animals, birds (listed separately from “animals”) and minerals (Müller and Jappel, 1977) as name categories. Although birds were originally recommended for Mercury (Pike, 1976), these categories were not used until 2012, when mineral names appeared on asteroid Steins, in English language forms. It was probably not though through in 1976 that these are common nouns that have to be expressed in a particular language; which is necessarily biased and any localization of these names would be difficult. However, IAU did not set any rule on any recommended language for the use of common nouns in planetary nomenclature.

The decision on the latinization of the proper names of Lunar mountains may be regarded as an intention for a general, though unwritten principle to use neutral, „international” forms of the names of terrestrial features that span through several language-boundaries. Similarly, the Latin words used for the Lunar false generics may be treated as precedents of having common nouns in other worlds’ geographical names always in Latin language. This was not specifically said, though; and later IAU introduced the use of English variants of terrestrial geographical names that has no one single original form (e.g., Ionian, Danube, Egypt) and common nouns (e.g., gemstone names on asteroid Steins) or common nouns in English language that are found in geographical place names presumably selected for its meaning (e.g., “Peace Vallis”).

The Romanization methods used by IAU – at least, publicly - are not specified. This places difficulties in finding (“reverse engineering”) the original forms. Shingareva and Burba (1977) noticed that IAU has approved the Romanized forms of names of Soviet and Russian scientists

according to the rules of transcription into English language, and not according to the "Academic latinization", approved in 1925 by the Soviet Academy of Sciences. Romanization of planetary placenames employs only the letters of the English alphabet and thus is easiest to spell by the international community; but uses diacritical marks for names that are originally spelled in a Roman script.

1.2 Structure of the nomenclature

A planetary name is generally binominal: it consists of two elements, a specific part (e.g., Imbrium) and a generic part called "descriptor term" (e.g., Mare). Descriptor terms (table 1) are in Latin language. The specific parts are in the original language (for personal names, terrestrial geographical names and in some exceptional cases), or in Latin or in English. Some names (e.g., crater names) are composed of one element only, having no descriptor term (e.g., Tycho).

2 Methods of localization

Two principle methods are used to transform a toponym:

(1) **translation** (finding the equivalent denotative and connotative meaning in the other language's vocabulary), and

(2) **conversion** which includes

(2.1) *transcription*, which is a phonetic conversion between different languages, in which the sounds of a source language are recorded in terms of a specific target language and its particular script, normally without recourse to additional diacritics; and

(2.2) *Transliteration*, which is a conversion between different alphabetic scripts and syllabic scripts, in which each character or di-, tri- and tetragraph of the source script is represented in the target script in principle by one character or di-, tri-, or tetragraph, or a diacritic, or a combination of these. Transliteration, as distinct from transcription, aims at complete reversibility, and must be accompanied by a transliteration key (Kadmon, 2000).

Several of the planetary names are eponyms: named after a person. Two or more toponyms employed in reference to a single topographic feature are called allonyms. IAU recognizes only one single name and form for each feature: there are no official allonyms allowed. However, there are several informal or historic names that are allonyms of the same planetary feature.

3 Rationale for localization of the GPN

Until 1986, the only nations capable of developing successful planetary missions were the Soviet Union and the USA. Consequently, scientific discussions about lunar and planetary features were mostly carried out in English and Russian.

In the last two decades, planetary geology has become more international than ever: today research groups from at least about 30 countries publish their results in academic journals. Today there are six entities that have developed planetary research probes: the USA, Russia, China, Japan, India and the countries of ESA. Almost all aforementioned entities use completely different writing systems, into which localization is inevitable. Japan launched its probes to 1P/Halley in 1986. In 2005 it developed an English-Japanese nomenclature for Itokawa, an asteroid discovered by Japanese researchers and probe (Hayabusa). China launched its first Moon probe in 2007 and India in 2008. By 2012, the fraction of successful American (USA) planetary probes is about 56% of all successful missions, the Soviet Union /Russia has 26%, the ESA 9%, Japan 6%, China 2% *(Source of data: Wikipedia: List of Solar System Probes; List of Lunar Probes, 2012.)*

Collaborative international research requires a single standardized form of planetary place names (the IAU standard), while written and oral outreach may use planetary place names in the local language. It is a norm that spacefaring nations maintain academic journals on space science

in their own languages and writing systems that requires the development of a local variant of the IAU GPN.
Most ESA-member states use English for scientific publications; and they do not have any necessity to transform the IAU GPN because most of them use the Roman alphabet. However, Russian, Chinese and Japanese scientists and educators use their own scripts, therefore, when they refer to planetary features, they generally use their own writing system. Localization of the nomenclature is therefore necessary in these cases. ESA has 19 member states with similar scripts (except for Greece) but with different languages: localization here is not a necessity, only an option. IAU does not provide any guidelines for localization; and treats the official Roman forms as the single acceptable form for referring to any named planetary feature.

3.1 Planetary science publications

Whereas papers by American (USA) authors are the most numerous, Russian, Chinese and Japanese authors publish considerably less papers in international English language journals than what would be "expected" from their academic output; but they all maintain their own academic journals that are published in their own languages. The lack of international visibility is addressed by the publication a full English translated variants of many of these journals.
Solar System nomenclature is officially using Roman alphabet and Latin language that have no traditions in neither of the other crewed spacefaring nations. The implicite dominance of the Euro-American centered thought in making it an equivalent of 'international' is reflected by the fact that IAU is considering the Roman script nomenclature the only variant, not leaving open the option of having equivalents of the nomenclature in other scripts. A critical discourse analysis may still reveal a colonial thought: names from 'outside the dominant cultures' can be let into the system (similarly to the process in which Native Americans' geographical names got into the present map of the USA), but only after conversion into the Roman script; and the opposite direction is not considered an option.
Until recently, it was a problem of only Russians (who anyway developed their own system), but today it is also a problem of the Chinese and Japanese, who all maintain significant scientific literature in their own languages, that, for many European nations, had been given up for English in scientific publications.
Another trend that strengthens the thought of having local nomenclature variants is that more and more nations are involved in the planning of planetary missions and the analysis of planetary geological data. With the exception of a very few countries, planetary geological research is done in those countries (Fig. 2) where there is an active space industry or are cooperating in planetary space programs. Countries where no space industry is present seem to have no considerable interest in analyzing spacecraft data.
Scientific discussions about particular planetary surface features are carried out in more and more languages. Although most publications are in English, it may be unrealistic to suppose that Norwegian, Polish, French etc. scientists use English in their everyday conversations and domestic outreach activity in planetary geology.
To investigate the international and collaborative aspects of planetary science publication activities in recent decades, we have made a non-representative quantitative survey based on 312 papers published between 1971 and 2011 in international academic journals.[1]
In Icarus, the average number of countries that authors of a single paper are affiliated with has increased from 1.05 (1971) to 1.16 (1992) to 1.6 (2011). The number of papers with authors from a single country has decreased from 94% (1971) to 85% (1992) to 60% (2011). The maximum number of countries involved in a single paper made in international collaboration

[1] Issues and journals analysed: "1971": Icarus 14/3, 14/1, 15/2 (35 papers); "1992": Icarus 100/1, 100/2, 101/1 (56 papers); "2011": Icarus 211/1, 211/2, 220/1 (121 papers); Planetary and Space Science (PSS) 59/1, 59/11-12, 59/13 (46 papers); Journal of Geophysical Research-PLANETS (JGR) 114/Jan, 116/Jan, Mar, 117/Jan (54 papers)

has increased from 2 (1971) to 3 (1992) to 6 (2011). These data show that planetary science research has become more international, involving more countries and more scientists in a single research. The total number of countries (of the first author's affiliation) where planetary research was done has increased from 6 (1971) to 11 (1992) to 20 (2011) in the Icarus issues analyzed (29 countries in JGR, Icarus and PSS combined in 2011).
On one hand this shows that scientist involved in a single research may speak different languages and may publish their results in a variety of languages; on the other hand it shows the need for a single, common language (nomenclature and terminology). This common language is English, not only because the global language today is English, but also because a dominant part of planetary research is still carried out in the USA.
The fraction of American papers (the USA being the country of affiliation of the first author) of all papers published in the analyzed issues has decreased from 82.9% (1971) to 80.3% (1992) to 52.8% (2011) in Icarus (it is only 26.1% in the more international PSS [Earth Moon and Planets, although not analyzed here, is also known to be very international], and 79.6% in the more American oriented JGR in 2011). In 2011, 54.1% of all analyzed papers were USA-affiliated, followed by France (7.7%), Italy (5.4%), Germany, UK and Ukraine (all 4.5%), Japan (2.7%), Spain (2.2%), Canada (1.8%), Hungary and Mexico (1.3%) and 19 other countries below 1%. (Fig. 1.)

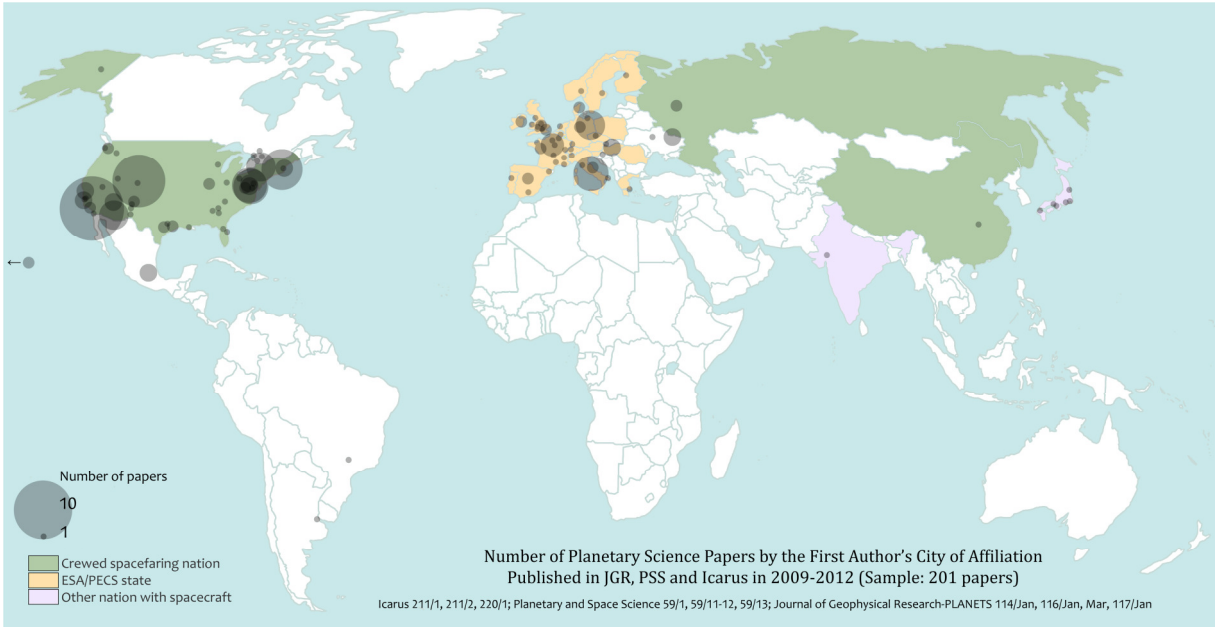

Fig. 1. Number of Planetary Science Papers by the First Author's City of Affiliation Published in JGR, PSS and Icarus in 2009-2012 (Sample: 201 articles, 10 issues)

However, interestingly, it is the other crewed spacefaring nations that do not appear in the map of Icarus, PSS and JGR: China and Russia is present only by 0.9% of all papers (2011) and this data was not very different in the past (In Icarus, in 1971: 0 Soviet/Chinese papers, in 1992: 1-1 papers (1.8%) from China and Russia). Their results are most probably published in their academic journals, in their languages. 'International' journals reflect mostly the output of American and ('Western') European scientists. Russian planetary scientists publish their results for example in the Russian language *Astronomicheskii Vestnik,* that is fully translated into English as *Solar System Research*. This academic journal is dedicated to publish from authors affiliated in an institution in Russia or the former Soviet Union. Chinese scientists may publish their results in Chinese, in the *Chinese Journal of Space Science* (published in English and/or Chinese), or the more general 中国科学 地球科学 [Earth Sciences], whose title's official Roman script equivalent is in Latin language (*Scientia Sinica Terrae).* This is originally published in Chinese but it also has a

translated edition (*Science China Earth Science*). Japan's planetary science papers are published in for example *Earth Planets Space* (in English) or in 遊・星・人 (*Planetary People)* (in Japanese).
The large number of academic and outreach content in planetary science requires a standardized planetary nomenclature with a single form for each feature in each language and script. In the followings we present two case studies, showing localization methods into two different scripts. Chinese GPN is being developed in these years; Russian GPN has the longest history in a script other then Roman.

4 The Chinese Gazetteer of Planetary Nomenclature

4.1 Needs and development of the localized GPN

The official names and terms of the GPN are obscure to most Chinese people, and they can hardly understand their cultural connotative meaning (e.g., Hargitai and Shingareva, 2011).. So it is particularly necessary to express planetary names within its own language and writing system. But so far, there hasn't been any normative planetary gazetteer in domestic China. As for planetary names used by the academic community, the media and the internet, they are entirely in chaos and unregulated; only a small part of planetary names are used widely and accepted generally. In academic exchange activities, different names of the same feature are used by different scientists, academics and amateur astronomers, causing ambiguities. In planetary maps, the publishers invent their own planetary nomenclature system according to certain principles which lack a systematic standard. For the general public, official planetary place names are perceived as strings of Roman characters without having any exact connotative meanings.

The success of China's Chang'E-1 lunar orbiter launched in 2007 raised not only the upsurge of the Moon and deepspace[2] research activities, but also aroused strong interest in Lunar and deepspace exploration. The popular media gave unprecedented extensive and in-depth reports on the Moon. All these activities inevitably involve the problem of how to handle Lunar feature names in Chinese. Making single, standardized, memorable and intelligible Chinese planetary names is not only important in regulating the use of Lunar feature names in the academic community, but also has profound and far-reaching influences on spreading scientific knowledge on the Moon among the general public.

The localization of planetary names is an ongoing work in domestic China. At its first stage, different groups and individuals tried to "chinesize" the most representative planetary names, but different versions were created, lacking inner relations, not fitting each other and containing only partial lists, so they were not suitable for the development of a generally accepted standard. Chief scientist of Chinese lunar exploration mission and academician Ouyang Ziyuan developed the first Lunar Gazetteer as the reference for all purposes as part of an introductory paper on Lunar science (Liu et al., 2005). Work on the Chinese standardization of Lunar feature names formally began in 2008, related to analysis of the Chang'E results, at the Moon and Deepspace Exploration Scientific Application Center of National Astronomical Observatory, Chinese Academy of Sciences. A set of localization principles were established after years' of research and discussion. Determination of all Lunar feature names has been completed in June 2010. These names have appeared in Moon Globe made from images and data from Chang'E-1 orbiter and in the Chang'E-1 Image Atlas of the Moon (Li, 2010), both publicized internationally (Fig. 2.).

[2] Note that in Chinese publications, Solar System research is referred to as "deepspace research".

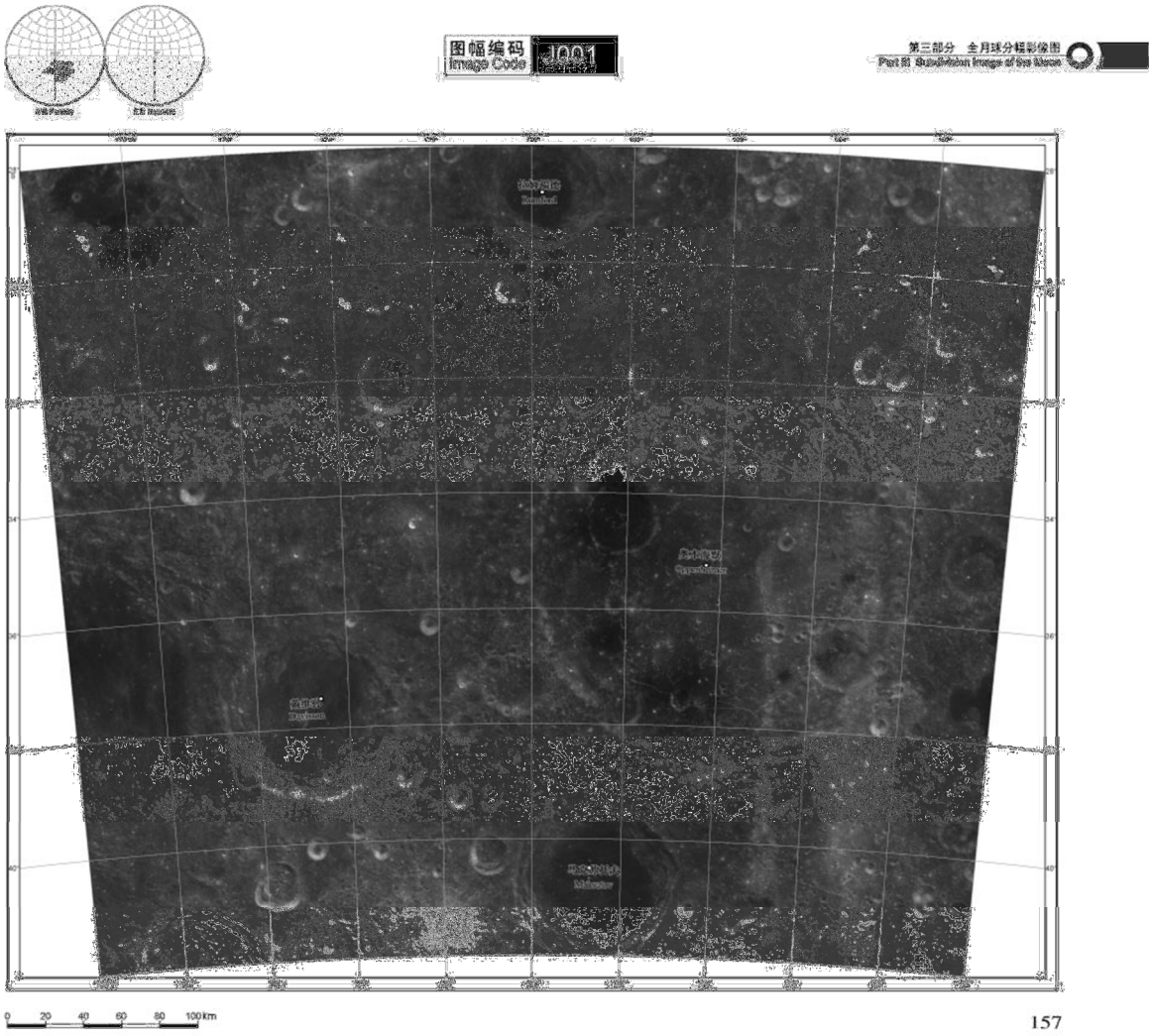

Fig. 2. Chinese feature names applied in The Chang'E-1 Image Atlas of the Moon (After Li, 2010)

4.2 Methods of localization

4.2.1 General orthographic rules

For foreign place names on the Earth, relevant administrative departments of China have established special supervision regulations, and orthographic rules (Ministry of Civil Affairs, 1999). This serves as a basis for regulating the localization of planetary names.

1. Standard planetary names are binominal.

2. Generic parts should be translated by its meaning, the applied word for the generic part should reflect the geographical nature of the named feature. Catena, for example, it is translated into "坑链" ['chain of craters'] by its semantic meaning, which reflects the geographical attributes of catena;

3. Specific parts should be translated by its pronunciation or by its meaning according to naming regulations;

4. Except for some idiomatic translations, Chinese orthographic rules of planetary names should base on the official language and standard pronunciation of its subordinate country; in countries that have more than two official languages, it should base on the language of the indicated language region by the name.

5. The orthographic rules of Chinese planetary names should be based on the pronunciation of mandarin, not dialect. Context-dependent polyphones, rare characters, and derogatory words should be avoided.

6. Commonly used names of translated planetary names according to the principle of conventionalization should be maintained, keeping the traditions.

4.2.2 Specific elements

4.2.2.1 General rules

Although only planetary names on the Moon has been localized so far, the rules established can also be applied to other planetary names. In the Lunar Gazetteer, its specific parts usually originated from three types of sources: 1) personal names; 2) place names on the Earth; 3) words that have specific meanings.

4.2.2.1.1 Personal names

Localization of foreign personal names mainly abides by three principles: (1) if possible, transcription, (2) "names follow their owners" (traditional transcription of some very famous person's name should not used for others with the same name.) (3) conventionalized. Personal names applied to Lunar features all clearly point to certain scientists, academics, artists, astronauts, etc. Some are related to famous people whose names have specific traditional localized forms that are different from present orthographic rules. These Chinese names usually apply conventionalized names that are extensively accepted. For example, Colombo, as common Italian name, is usually transcribed as "科隆博", but when it refers to the particular person who discovered the American continent, Cristoforo Colombo, we use its proprietary historical transformation "哥伦布".

Names with obvious national features may be spelled or pronunced differently from the variant used in the country/language of cultural origin. When their Chinese names are decided, it is needed to consider their origins. For example "Bailly" can be localized as "贝利" using its English pronunciation, but "巴伊" if its French pronunciation is considered.

In practice we cannot depend only on the existing technical regulations for transcribing foreign names to determine the single standard form. Except those names used frequently, many other names have different localized versions, so the authority of the source of localized names seems particularly important. In China, proper names and localization (translation) service office of Xinhua News Agency is the only comprehensive localization (translation) entity approved by the country. It supervises all translating of words issued internationally by the mainland. All foreign names that appear in newspapers, books or electronic media, such as personal names, place names, names of organizations etc., are supervised by this office. The dictionary edited by them (Guorong, 2007) is the preferred reference book for planetary name localization. In addition, authoritative encyclopedias such as the Encyclopedia Britannica (Xu and Hoiberg, 2007), the Encyclopedia of China (Zhou 2007, 2009) etc., are used as supplementary reference books when needed. Names not included in these books can be transcribed according to transcription charts.

The localization principle is determined for the person specifically referred to (from their name, nationality, dates of birth and death).

4.2.2.1.2 Terrestrial place names

Some Mons/Montes and Rupes on the Moon are named after terrestrial mountains and islands, so localization of these names can directly use transcribing techniques suitable for foreign place names, trying to be exact and normative, and continuing to use habitual Chinese names. In the actual process, the Foreign Place Name Translation Manual (Dingguo 1993) is usedas the chief reference book. If a name is included in these references, we translate directly, for example "Montes Alpes" is translated as "阿尔卑斯山脉", so its specific element "Alpes" is directly used as "阿尔卑斯". For place names not included, we confirm their names by the

transcription chart offered in Transformation Guidelines of Geographical Names from Foreign Languages into Chinese (Ministry of Civil Affairs, 1999), which is a national standard of the People's Republic of China.

4.2.2.1.3 Words with specific meanings

A significant part of Lunar feature names have specific meanings (e.g., maria names describe weather and other abstract conceptions, and landing sites names given by astronauts according to the feature's characteristics). *These lunar names are not only simple symbols or labels, behind them are the implications of cultural connotations, or the indication of the likely geographic entity they refer to.* To accurately express this information contained, we use free translation by its meaning. The meaning contained in the word can be extended, but cannot break its exact meaning. Translated names should try to be brief, graceful, less ambiguous, we should be faithful to the soul of the original name, and translated names should be easy to understand and be accepted. Translated names that have already been widely used and became conventionalized are kept unless they are obviously against their original meanings. Confirmation of these names indeed has certain randomness. The same place name may result in different Chinese forms, and there isn't clear standard to choose which one we should actually use. These Chinese place names without any technical regulations need to be carried out as mandatory standard.

4.2.2.2 Exceptions

Some of the Lunar feature names derived from personal names have different spellings in Latin, but would have similar transcribed forms in Chinese, because they are pronounced similarly. This would be against the general principle of the uniqueness of place names. To solve this problem, the initial of the particular person's first name is used followed by a dot character before the repetitive Chinese names to show the distinction. For example "Anderson" and "Andersson" are transcribed in Chinese both as "安德森". To distinguish them, we translate Anderson according to his full name John August Anderson as "J. 安德森", while Leif Erland Andersson into "L. 安德森".

Some of the personal names that are present in latinized form in the IAU GPN are not listed in authoritative reference books mentioned above, but their original forms. These persons are identified from their full name, date of birth, country, identity, etc., offered by IAU GPN. In these cases their original name is used as a basis of transcription instead of the pronunciation of the Latinized form. For example the name of the Arabic astronomer and mathematician Albategnius (Latinized form) is only listed as Al-Battānī (original form) in the authoritative referece books, so it is transcribed as "阿尔巴塔尼" according to pronunciation of Al-Battānī instead of that of Albategnius. This way Chinese readers can identify the person; whereas would the Latinized form be used, the readers may treat it as the name of another person.

There are few cases where the original meaning of the specific and that of the generic element is similar. For example in "Montes Cordillera", both elements mean „mountain range", in Latin and in Spanish, respectively. In this case, it is transcribed as "科迪勒拉" according to its pronunciation with transcription chart for Spanish included in reference books we used.

4.2.3 Generic elements ("descriptor terms")

4.2.3.1 General rules

Generic elements describe the morphology or albedo characteristic of a surface feature in Latin. A significant part of their translated names have been already used widely, have become standard translated terms and are used in the localization process. Those not widely used and/or having various translated versions, free translation was used: after studying images of its most representative examples and parameters of its formation, and considering various ways of translation, one concise generic term was chosen that can exactly summarize its topographic characteristics and can be easily understood and accepted by the public as a standard term.

4.2.3.2 Exceptions

The Moon has an exceptional importance in Chinese culture. It is the subject of numerous well known myths, legends and also literary works by famous poets and writers.

Some of the generic terms are used differently for the Moon than they are for other planets. For example, *mare/maria* on other bodies (e.g., Titan) would be translated as "海" ('sea'), whereas on the Moon it is "月海" ('Lunar sea'), emphasizing Lunar attributes.

Craters are the most representative landform types on the Moon. The word crater is not part of the place names of craters, but it often appears in discussions on the lunar surface. There have been two different translations of the word crater: the widely used "环形山" ('circular mountain'), that focuses on its shape (or actually the shape of its rim; and is similar to Schröter's [1791] term ringgebirge ['ring mountain']) and "撞击坑" ('impact depression') that focuses on the cause of its formation. The first term contains the word "山" ('mountain') therefore it eventually means 'high land that tower above the earth', which is the opposite to the characteristic negative topography of a crater. On the other hand, the latter form specifically refers to its formation by impacting that is only one of the causes of crater formation, and cannot fully express the variety of their possible origins. Finally, the form "环形坑" ('circular depression') was chosen as a standard descriptor term for 'crater' that is non-genetic and characterizes their circular shape and negative topography.

4.2.3.3 Pluralization

Unlike western languages like English or Latin, Chinese nouns usually don't have singular and plural forms. Chinese usually use quantifiers like *crowd, group, pile* etc. to refer to plural meanings. Descriptor terms in the Gazetteer have different singular and plural forms that may have different connotation. Each descriptor term pairs (singular/plural) have one single Chinese equivalent that is chosen to exactly express its original meaning. In some cases, however, the different Latin forms (singular/plural) refer to landforms that are not only different in their number, but also in their fundamental structure, like in the case of mons/montes. In this case two different terms are used: mons is translated as "山" ('mountain with one peak') whereas montes is translated as "山脉" ('range of mountains').

4.2.4 Bilingual use

Displaying both Chinese and official IAU variants together can help the Chinese people to obtain direct perception of Lunar feature names and establish a link with official variants, and having the official IAU names can help obtaining more in depth information in English, so as to promote the development of scientific research.

4.3 Summary

In recent years, with the successful Lunar exploration project and the follow-up deepspace exploration planning, the public showed more and more strong desire for knowledge on the Moon and deepspace. The news media, websites etc. also promote our knowledge on the Moon and deepspace with unprecedented efforts. Launching the project on the Chinese standardization of the Lunar nomenclature conforms this tendency, creating a system of unambiguous names acceptable for both the public and professionals.

The significant difference between Chinese and western language systems makes the official Chinese planetary names difficult for the common people to understand. Although English in China already have a certain amount of mass base, in the peculiar planetary naming system, because of the particularity of official planetary names, and the comparatively large deviation between planetary science and the real life of the public, all these make most Chinese confused on the official planetary names. Connotative meanings of generic terms describing topography in Latin forms cannot be accurately understood by the people, and even by those with certain

professional knowledge. So the comprehensive "chinesization" of planetary names has significant influence on encouraging people to obtain knowledge about and research into the planetary disciplines. At present, a complete Chinese set of Lunar feature names are determined, and a set of operational rules in the process of localization of the Lunar place names have been established. Although present localization of planetary names is confined to the Moon, the set of rules established in the process of localization also applies to other planets. Along with the promotion of China's deepspace (Solar System) exploration activities, localization of planetary names will step by step be extended to Mars, Venus and other Solar System bodies.

5 The Russian Gazetteer of planetary nomenclature

5.1 Needs and development of the localized GPN

In the 19th-early 20th century, Lunar place names have been translated or transcribed into Russian, setting the basis for the future standardization of the nomenclature. In translations of Flammarion's popular works on the Moon and Mars (e.g., Flammarion, 1912), all names are translated, more or less similarly as today. Craters were called mountains or craters. Mountains named for terrestrial mountain ranges had the prefix 'Lunar' (e.g., Лунныя Аппенины – [lunniya appeniny] 'Lunar Appenines'), that is still a practice in popular literature.

Martian albedo features were shown in its original form with Roman letters inserted into the Cyrillic running text (e.g., Stovichek, 1925). Later, all albedo names have been fully translated (Pandorae Fretum → пролив Пандоры [proliv padory], 'Strait of Pandora') but original Latin forms were also shown (e.g., Bronshten, 1977).

The introduction of new lunar farside names required "the development of a single variation of their Russian spelling" (Shingareva and Burba, 1977) while keeping to the IAU variants in official documents (Shevchenko, 1984).

Works on the systematic localization of the Lunar nomenclature were initialized following the discoveries of the Soviet Luna-3 mission (1959) and have been continued extensively with subsequent successful Soviet Lunar missions. The Luna-3 mission provided the first photographs of the far side of the Moon. The Academy of Sciences of the USSR formed a special commission to suggest names for newly discovered features and submitted 18 names which were approved by IAU in 1961 (IAU, 1962) This probably also served as a stimulant for the re-examination of the IAU naming principles (Shingareva and Burba, 1977) and their re-latinization, since it was the first time that names of planetary features were proposed in original form in a script other than Roman.

Far side names were proposed by Yu. N. Lipsky et al. (1960, personal communication). Mare Moscoviense (Море Москвы [more moskvy]) was not traditional for the lunar nomenclature. However, IAU accepted the proposal aknowledging the historical achievement of first imaging the far side of the Moon. There were several proposed names that have been dropped since (Astronaut Bay, Montes Sovieticii, Sea of Dreams - the latter would have commemorated Luna 1 which was first named Мечта [mechta] (Dream) (IAU, 1962, Chikmachev and Shevechenko, 2001).

5.1.1 Major steps in the development of the Russian GPN

5.1.1.1 Moon

The first gazetteer showing Lunar names in both Cyrillic and Roman scripts appeared on the sheets of the first Complete Map of the Moon (Lipsky, 1967a; Lipsky, 1967b; Shingareva, 1967; Shevchenko, 1967). The proposed far side names were published in four lists, containing their Russian and official IAU forms, their coordinates and the size of the features. The gazetteer of all names on the Lunar far side was prepared and published in the next volume (Lavrova, 1975). The list included not only the Russian transcription of the names of the IAU GPN but also other, historic forms of the name of the same person. For example, for "Авицена (Ибн Сина), Абу Али. Ibn-Sina, Abu Ali (Avicenna)". The first gazetteer of all lunar feature names showing

both Cyrillic and Latin forms was published by Lipsky et al. (1977) and by Shingareva and Burba (1977).

Later, this series was continued under the auspices of GA Burba, who started this work at the Soviet Academy of Sciences and Vernadksy Institute (headed by AT Basilevsky at that time), with Russian and Latin nomenclature, data and schematic maps displaying the place names in Russian. The published volumes: Mars (Burba, 1981), Mercury (Burba, 1982), Galilean Satellites (Burba, 1984), Satellites of Saturn (Burba, 1986), Venus (Burba, 1988).

In 1987, a full list of Lunar craters with a diameter of more than 10 km (about 1400 names) with conversion of the names into the Russian language was given in the Morphological Catalog of the Craters of the Moon made at Sternberg State Astronomical Institute (SAI) of Moscow State University (MSU) by SG Pugacheva (Shevchenko et al., 1987). This Russian Gazetteer of Lunar Nomenclature was updated and made available online in 2010 (Pugacheva et al., 2010). This contains the Russian and Latin names (with and without diacritic marks) of 1933 named Lunar features, including data of their physical properties (diameter and selenographic coordinates) and information regarding the origin of their names (field of activity of scientists, their nationality, citizenship, date of birth and death) (Shevchenko et al., 1991).

5.1.1.2 Mars

The digital, online catalog of the named features of Mars was developed by SG Pugacheva (SAI MSU). Names of 1430 Martian objects are given in the catalog in Russian and Latin transcription. Each name is accompanied by detailed information on the origin of the name, areographical coordinates and morphological parameters, bibliographic data, and year of approval. This catalog was created from the following materials: G.A. Burba's catalog (396 names of craters and other objects), Z.F. Rodionova's catalog (459 names of craters) (Rodionova et al., 1987), and the manuscript of the list of names of relief features of Mars, made E.M. Kastorny (the State University, Kishinev, Moldova). In several cases these sources showed different forms for the same feature name; these have been corrected using the Encyclopedia of Ancient Myths and Cultures (Novikova and Buneeva, 2007), the Encyclopedia of World's Nations (Kurian et al., 2002), the Great Soviet Encyclopedia (Большая советская энциклопедия [bolshaya sovetskaya entsiklopediya] and directories of foreign names and names in the Russian text. This database is continuously updated.

5.1.1.3 Venus

Venus has a special place in the Soviet space research because several of its features and feature types were first seen in the radar imagery returned by Soviet missions. A gazetteer of selected names of Venusian features for map scale of 1:40 000 000 has been compiled at Vernadsky Institute by Burba (2005). At SAI MSU, a new, biscriptal map of Venus was produced, showing names in both Latin and Russian (Lazarev and Rodionova, 2011) (Fig. 3).

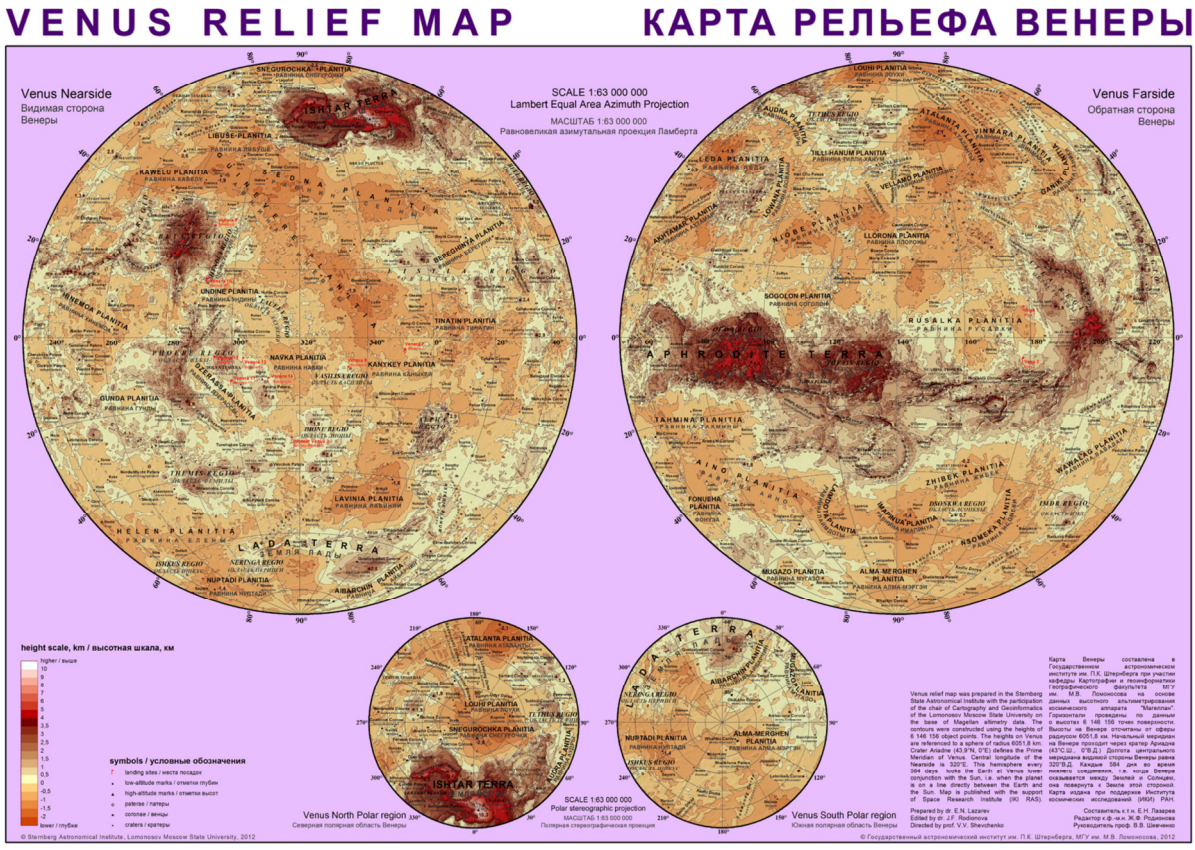

Fig. 3. Biscriptal map of Venus (scale 1:45000000) (Lazarev and Rodionova 2011)

5.1.2 **Current developments.** Further development of nomenclature databases are carried out by two research groups: one at SAI (lead by SG Pugacheva) and the other at the Moscow State University of Geodesy and Cartography (MIIGAiK) (lead by KB Shingareva). At MIIGAiK a planetary GIS "Mapping of extraterrestrial territories" with nomenclature database with Russian transcriptions is being produced, whose initial works were helped by N.B. Lavrova (librarian at SAI) (Shingareva et al. nd). MIIGAiK' Extraterrestrial Laboratory is the center of nomenclature-related works, including the preparations of proposals for new Lunar names (e.g., Lunokhod landing site names) and the creation of Russian language thematic maps. These display only the Russian version of the nomenclature (for example, on the map of Soviet missions to the Moon) (Baskakova, 2012).

5.2 Methods of localization

5.2.1 General orthographic rules

The transformation of names may follow two different directions:

(1) On Russian terrestrial maps, binominal names traditionally are in genitive case or adjective form and foreign names are usually translated, transcribed or a traditional Russian variant is used. This may or may not be followed in the planetary nomenclature. For example, the originally nominative case Aphrodite Terra is transformed in genitive case as земля Афродиты [zemlya afrodity] 'The Land of Aphrodite') (Lazarev and Rodionova, 2011). These forms may be more acceptable for the Russian reader.

(2) Names may also be in nominative case and transliterations of the IAU form (Table 1.). Today there is a tendency towards this form that better reflects the structure of IAU names, and makes name transformation reversible. Some authors use binominal place names mostly in nominative case, others in possessive; the question is not resolved.

To show an example: Baltis Vallis would become Балтийская долина [baltiyskaya dolina] in adjective form and д о л и н а ective form and come Б а л (Burba 2005) in nominative form.

5.2.2 Specific elements

5.2.2.1 General rules

According to Salishchev (1976), foreign place names can be spelled in the following forms: (1) local official, (2) phonetic (transcription), (3) transliteration, (4) traditional, or (5) translated. The Soviet cartographic practice is using "arbitrary phonetic and traditional forms". (Shingareva and Burba 1977). Few major exceptions from this are (1) names of maria and (2) when pronunciation is difficult to establish (e.g., in little-studied languages), transliteration is used.

Lunar **mountains** are named after terrestrial mountains; their Russian variants are similar to the spelling of these names on terrestrial geographical maps (Mont Blanc→ Монблан [monblan]).

Names of m**aria** are traditionally translated. Thus, the changes in the principles of the nomenclature by IAU (in particular, latinization) cannot be reflected in the Russian equivalents. For the Russian reader, the Russian variant's origin is much more transparent than for most readers who use Roman script.

False generic lunar names, both in near and far side, are fully translated: Mare Orientale →море Восточное [more vostochnoe] 'Eastern Sea'.

Names containing cardinal directions are fully translated: Planum Australe → плато Южное [plato yuzhnoe] 'Southern Plateau'.

Russian variants of **personal name-derived feature names** may use traditional Russian spelling of the person's name or, as suggested by Menzel and Minnart (Menzel et al., 1971), a transcription of the IAU spelling. Those names without a traditional spelling are usually phonetically transcribed. Names derived from terrestrial geographic names – especially those of mythological origin – usually use its traditional Russian variant (Apollo→ Аполлоон [apollon] or Hellas Planitia → равнина Эллада [ravnina ellada], Caucasus→ Кавказ [kavkaz])

The Russian spelling may be different from what would have resulted from using the rules of transliteration (e.g., traditional: Гартман [gartman], transliteration: Хартманн [hartmann] etc.). (Shingareva and Burba, 1977), so these conversions are irreversible.

5.2.2.2 Exceptions

Three Lunar far side catenae have unique Soviet/Russian names proposed by the academician V.P. Glushko that were never approved by IAU but are still used in Russian maps. Soviets named these features after (the acronyms of) Soviet research institutions which had a fundamental contribution to Soviet rocket industry, and Glushko wished to commemorate scientist who worked there and were killed by the Stalinist regime when the institutions were disbanded.

These are the only names in Russian planetary maps that are different in content from the IAU GPN and make the Russian nomenclature a variant, and not a perfect equivalent of the IAU GPN. This non-approved commemoration was unprecedented until 2012 when NASA started to consistently use a non-approved commemorative name (Mount Sharp) instead of an existing, approved name (Aeolis Mons) in its publications.

Montes Recti and Rupes Recta is traditionally fully translated: Прямой хребет [pryamoj hrebet] (Straight Range) and Прямая стена [pryamaya stena] (Straight Cliff) (in English: the Straight Wall). Vallis Alpes is interpreted as "Alpine Valley", thus translated as Альпийская долина [al'piyskaya dolina]. Similar translated forms appear in the vocabulary of many nations' amateur astronomers and are derived from their forms used since the late 19th-early 20th century. As already said, latinization of the Lunar place names hardly affected the Russian nomenclature.

5.2.3 Generic elements („descriptor terms")

5.2.3.1 General rules

Generic elements are fully translated, unless it is a newly invented term. Major mountain names, which on the Earth have no generic part, are also used without generic on the Moon.

5.2.3.2 Exceptions

Both farrum and tholus are translated as 'dome' (купол [kupol]) by Burba (2005), because "they both are morphologically similar to dome-shaped hills, except that farrum has a flat top and steeper slopes". However, farrum/farra is translated as фарра/фарры[farra/farry] in other Russian gazetteers. Small Lunar Mons (sing.) are translated as пик [pik] (peak, summit of a mountain) which is different from the singular form of mountains (Mons) (гора [gora]) used on other planets (Shingarevae et al., nd; Pugacheva et al., 2010).

5.2.5 Summary

The essential Russian contribution to the planetary nomenclature has begun as a result of reception of the first images of far side of the Moon (1959). The Russian proposals of names always made on an international basis. The first list of lunar names of craters contained names of scientists from the different countries: China – 1, England - 1, Germany - 1, Italy - 1, France - 3, USSR/Russia - 6, the USA - 1. The first system of names on the far side of the Moon have been accepted by the international scientific community and established a precedent for further proposals.

7 Conclusions

Does localization "worth" the effort? In a survey, maps of Mars have been shown to Hungarian high school students in two variants: Latin and Hungarian. Students were asked to describe the landscape using the maps. The language of nomenclature did change the perception of the surface features. Transparent descriptor terms helped to interpret features which nature was hard to decipher from its visual representation, whereas the nature of features with opaque descriptors had to be interpreted, sometimes erroneously, based solely on their visual representation (Hargitai, 2012a).

Planetary nomenclature is a basic tool in identifying places and communicating about them. Nations gaining entry into the group of nations with active planetary missions have and presumably will have the intention to use the GPN in their languages, for domestic communication. In addition to the officially approved forms, several nations have already developed the localized equivalents of planetary feature names. This is an absolute necessity for nations using a non-Roman writing system and an option for those that use Roman letters. These place names are not 'informal', different variants of the names in the IAU GPN, but their corresponding equivalents resulted from translation or conversion into other scripts or languages. It is common in all localization methods that descriptor terms are made transparent, while the specifics may remain treated as labels, decoupled from what they were named after (a practice in Hungarian); or may be localized by keeping the name transparent and adapting a familiar spelling of what they were named after (a practice in Chinese and Russian). The most problematic names are those that were already in use in the particular target language prior to their latinization by IAU. The USA and ESA members use English in their scientific publications while the local language remains the primary language in the other spacefaring countries with lunar and planetary probes (Russia, China, Japan) in domestic scientific discussions.

Table 1. **Descriptor terms in selected languages**
[–] show new loan words

IAU descriptor term (sing, plur) [English meaning of Latin or Greek term	**Russian term** [English meaning of Russian term] [1] Burba (2005) 2 Pugacheva (2010)	**Chinese** [English meaning of Chinese term] For multiple variants: variant for the Moon / other planets*	**Current and previous English description(s)** [1] IAU (2011) [2] Moon: Whitaker and Andersson (1982) [3] Moon: Wilhelms (1987) [4] Venus: Burba (1990) [5] IAU (1962) [6] Titan: Owen et al. (2005) [7] Mars: de Vaucouleurs et al. (1975)	**Possible geologic nature of the features named (interpretations)**
arcus, arcūs [arc]	дуга, дуги [arc]	弧地 [arc-shaped landform]	[1] Arc-shaped feature	cryocaldera (?)
astrum, astra [star]	астра, астры [–]	放射地形 [radial-pattern landform]	[1] Radial-patterned features on Venus	Proposed for novae (stellate fracture centers on Venus) by AT Basilevsky in 2000. The category was approved but no feature was named with a new term
catena, catenae [chain]	цепочка, цепочки [chain]; [2]цепочки кратеров [crater chain]	坑链 [chain of craters]	[1] Chain of craters [2] Chain: chain of distinct craters [7] Crater chain, a chain or line of craters	chain of primary impact craters (Callisto), chain of secondary craters (Moon), chain of volcanic calderas (Io), chain of pit craters (Mars)
cavus, cavi [hole]	котловина, котловины [depression, basin]	洼陷地形 [depression landform]	[1] Hollows, irregular steep-sided depressions usually in arrays or clusters	aeolian-subglacial depression (Mars)
chaos, chaoses [unordered state of cosmos before creation]	хаос, хаосы [chaos]	混沌地形 [chaos landform]	[1] Distinctive area of broken terrain	cryotectonic-cryovolcanic terrain (Europa), complex collapsed terrain, source region of outflow channels (Mars), erosional terrain (Mars)
chasma, chasmata [deep scarp]	каньон, каньоны [canyon]	大峡谷 [canyon]	[1] A deep, elongated, steep-sided depression [4] Canyons [7] Canyon. An elongated, steep-sided depression	rift (Venus), compression-extensional graben (Tethys), aeolian-fluvial valley (Mars), tectonic-fluvial valley (Mars)
collis, colles [hill]	холм, холмы [hill]	矮丘 [small hill]	[1] Small hills or knobs [4] Small hills	fields of knobs made by differential erosion or erosion of crater interior (Mars), rootless cones (V, M)
corona, coronae [corona, wreath]	венец, венцы / овоиды [crown / ovoid]	冠状地形 [corona-shaped landform]	[1] Ovoid-shaped feature [4] Large circular features	Introduced after Venera-15 and 16 results. cryovolcanic complex (Miranda), volcanotectonic complex (Venus).
dorsum, dorsa [back (of a body)]	гряда, гряды [ridge]	山脊 [ridge]	[1] Ridge [3] Dorsum: mare ridge [3] Dorsa: network or	ridge belt, warp (Venus), wrinkle ridges(Moon),

			group of ridges [2] Mare ridge, wrinkle ridge : narrow ridge, mostly in mare [4] Ridges [7] Ridge(s). Irregular, elongate prominence	erosional ridge; sedimentary wrinkle ridge, esker (Mars)
facula, faculae [small torch]	факула, факулы [–]	光斑 [bright spot]	[1] Bright spot	tectonic structure; cryovolcano (?) (Titan), palimpsest crater (Gan., Call), mountain (Amalthea)
farrum, farra [a kind of food for cattle]	фарра, фарры [–] [1]купол, купола (Venus).	薄片结构 [pancake-like structure]	[1] Pancake-like structure, or a row of such structures	steep sided volcanic domes (Venus)
flexus, flexūs [bend]	извилина, извилины [bend]	弯脊 [curving ridge]	[1] A very low curvilinear ridge with a scalloped pattern	tensile cracks (Europa)
fluctus, fluctūs [wave]	поток, потоки [flow, stream]	流动地形 [flow landform]	[1] Flow terrain [4] Flows	lava flow (Mars, Venus), cryolava flow (?) (Titan)
flumen, flumina [river]	канал, каналы [channel, watercourse]	河道 [watercourse]	[6][1] Channel on Titan that might carry liquid	fluvial channel (Titan)
fossa, fossae [trench, moat]	борозда, борозды [furrow, trench]	月沟/槽沟* [trench on the moon]/[trench,groove]	[1] Long, narrow depression [4] Furrows [7] Ditches. Long, narrow, shallow depression. They generally occur in groups and are straight or curved.	tectonic subparallel grabens; aeolian valleys and yardangs; tectonic-fluvial system (Mars) Radial grabens connected to stress build-up (Mars, Mercury)
insula, insulae [island]	остров, острова [island]	岛屿 [island]	[1] Island (islands), an isolated land area (or group of such areas) surrounded by, or nearly surrounded by, a liquid area (sea or lake).	island (Titan)
labes, labēs [landslide]	оползень, оползни [landslide]	滑坡 [landslide]	[1] Landslide [4] 'tongue', landslide	landslide deposits (Mars)
labyrinthus, labyrinthi [labyrinth]	лабиринт, лабиринты [labyrinth, maze]	迷宫地形 [labyrinth landform]	[1] Complex of intersecting valleys or ridges. [7] Valley complex. Complex, intersecting valleys	graben network (Mars), polygonal troughs (Mars)
lacus, [lacūs] [lake]	озеро, (озера) [lake]	月湖/湖* [lake on the moon]/[lake]	[2] small mare [1] "Lake" or small plain;	lava filled impact crater (Moon), dark dust covered terrain (Mars)
lacus, [lacūs] on Titan	озеро, (озера) [lake]	湖 [lake]	[6][1] on Titan, a "lake" or small, dark plain with discrete, sharp boundaries	lake of liquid methane (Titan)
lenticula, lenticulae [small lentil]	лентикула, лентикулы [–]	暗点 [dark spot]	[1] Small dark spots on Europa	micro-chaos (Europa)
linea, lineae [line]	линия, линии [line]	线状地形 [linear landform]	[1] A dark or bright elongate marking, may be curved or straight [4] Lines	extensional, compressional or strike-slipfaults (Europa), ridge belt (Venus), rift zone (Venus)
lingula, lingulae [small tongue]	лингула, лингулы [–]	舌形高原 [tongue-	[1] Extension of plateau having rounded lobate	peninsular lobe (Mars)

		likeplateau]	or tongue-like boundaries	
macula, maculae [dark spot]	макула, макулы [–]	暗斑 [dark spot]	[1] Dark spot, may be irregular	remains of the polar cap (Triton), relaxed cryolava dome (Europa, Titan)
mare, maria [sea]	море, моря [sea]	月海/海* [sea on the moon]/[sea]	[2] Dark, smooth plains [1] "Sea"; large circular plain; [5] Large dark area	lava filled impact basin or terrain (Moon), bright dust-free or dark sand-covered terrain (Mars)
mare, maria [on Titan]	море, моря [sea]	海 [sea]	[1] on Titan, large expanses of dark materials thought to be liquid hydrocarbons	liquid methane lake (Titan)
mensa, mensae [table; plateau]	столовая гора, столовые горы [table mountain, mesa]	台地 [mesa]	[1] A flat-topped prominence with cliff-like edges [7] Mesas. Flat topped prominence with cliff-like edges	flat topped tectonic block (Io), outliers (Mars), layered depositd (Mars), ice plateau (Mars)
mons, montes [mountain]	гора, горы [mountain/-s] but: [2]пик (mountain peak), горы (mountains)	山,山脉 [mountain; plur:mountain range]	[1] Mountain [3] Mons: mountain [3] Montes: mountain range or group of peaks [2] High massifs, generally forming arcuate ranges [5] Mountain-like chains [7] Mountains. A large topographic prominence or chain of elevations.	corona–nova (Venus), horst (Io), remains of circumbasin structures (Moon, Mars, Mercury), shield volcano (Mars, Venus), subglacial volcano (Mars), fold mountain (Venus), hills (Mars)
oceanus, [oceani] [global sea]	океан, (океаны) [ocean]	洋 [ocean]	[1] A very large dark area on the moon	lava filled terrain (Moon). Only one named example in the Solar System.
palus, [paludes] [swamp]	болото, болота [swamp]	月沼/沼泽* [swamp on the moon]/[swamp]	[2] small mare [1] "Swamp"; small plain	mixed terrain of mare and terra (Moon), albedo feature (Mars)
patera , paterae [flat cup]	патера, патеры [–]	扇形坑 [scalloped depression]	[1] An irregular crater, or a complex one with scalloped edges [4] Shallow, complex edge craters [7] Irregular crater or a complex one with scalloped edges	caldera (Io, V), cryocaldera (Triton), shield volcano (Mars, V), ash shields (Mars), corona (Mars, V), arachnoid (Venus)
planitia, [planitiae] [plains, plateau]	равнина, равнины [plain]	平原 [plain]	[1] Low plain [4] Plains [7] Plain. Smooth, low areas.	landing site (Moon), uncratered terrain (Enceladus), lava filled basin (Mercury), impact basin (Me, Mars), sediment covered plains (Mars), volcanic plains (V, Mars), cryolava plains (Triton)
planum, [plana] [plains, plain (smooth) surface]	плато, плато [plateau]	高原 [plateau]	[1] Plateau or high plain [4] Plateau [7] Plateau. Smooth elevated area	volcanic plains (Mars, V),cryolava plains (Triton), uplifted volcanic plains (Mars) uplifted plateau (Venus), aeolian sediment (Mars), dune covered polar layered deposit (Mars), dome of the polar ice cap (Mars), uplifted layered plains

				block (Io)
promontorium, promontoria [pro+mons]	мыс, мысы [cape]	海角 [cape]	[1] "Cape"; headland [2] Promontory: Mountains partly enclosed by mare [5] Isolated peaks	lobe of highland material (Moon)
regio, regiones [direction, area on the sky]	область, области [area, region]	区域 [region]	[1] A large area marked by reflectivity or color distinctions from adjacent areas, or a broad geographic region [4] Regions	albedo feature (Mars, Europa, Ganymede), eroded crater (Ida), volcano (Venus), sulfur snow field (Io), tessera plateau (Venus), boulder (Itokawa), diapirs of cantaloupe terrain (Triton), volcanic plateau (Venus)
reticulum, reticula [small net]	полигон, полигоны [polygon]	网状地形 [netlike landform]	[1] reticular (netlike) pattern on Venus	not in use, suggested for ???
rima, rimae (only on the Moon) [fissure, opening]	борозда / трещины [furrow / cracks]	月溪 [rivulet on the moon]	[1] Fissure [3] Rima: rille [3] Rimae: network or group of rilles [2] Rille, narrow, elongate depression (sinuous, arcuate or straigh) [5] Rifts (translated from French rainures) NB: English equivalent is rille (as in German 'groove') and not rill (as in English 'stream')	lava channel (Moon), straight or arcuate rille (graben) (Moon)
rupes, rupēs [rock, cliff]	уступ, уступы [shelf, step, escarpment]	峭壁 [escarpment]	[1] Scarp [2] Scarp: Fault in mare or high arcuate scarp in terra [4] Scarps	fault (H, Me, V, M), thrust fault (Me, M), strike-slip fault (Venus), basal scarp, crater rim, polar scarp (Mars), rift (Miranda)
scopulus, scopuli [rock, cliff]	ступень, ступени [step, stair, escarpment]	断崖 [irregular escarpment]	[1] Lobate or irregular scarp	thrust fault (Mars), wrinkle ridges (Mars), ice sublimation/ sedimentation trench (Mars)
serpens, serpentes [serpent]				paleovalley modified by differential erosion and cementation
sinus, sinūs [bay, curved line]	залив, заливы [bay]	月湾/湾* [bay on the moon]/[bay]	[2] small mare [1] "Bay"; small plain	dark sand covered terrain (Mars), lava flooded crater or highland area (Moon)
sulcus, sulci [groove]	рытвина, рытвины [hollow, pitfall]	褶状沟系 [wrinkled groove system]	[1] Subparallel furrows and ridges	grooved terrain - horst and graben and domino faulting (Ganymede), cryovolcano (Miranda), strike-slip fault (Enceladus), aureole deposits (Mars), compression fault (Triton)
solitudo [solitude, featureless land]	пустыня, пустыни [desert, wilderness]	荒原 [wilderness]	[1] (part of Albedo Features category)	dark albedo feature (Mercury)
terra, terrae [continent, soil, earth]	земля, (Земли) [land, earth, ground]	高地 [high land]	[1] Extensive land mass; [2] highlands, uplands, continents: rugged, relatively bright terrain Note: on the Moon there used to be terrae	densely cratered terrain (Mars), rift zone plateau / large tessera (Mars, Venus), bright albedo feature (Iapetus)

			as named features, but today the term is used as a general reference to cratered lunar highlands. In this sense [2] there is no sharp distinction between an individual terra and terrae. Note 2: [2] 'terrestrial' refers to planet Earth. [4] Continents	
tessera, tesserae [mosaic tile, four]	тессера, тессеры [–]	镶嵌地块 [mosaic tile]	[1] Tile-like, polygonal terrain [4] Tile-like features	Introduced after Venera-15 and 16 results. tessera: deformed plateau (Venus), ribbon tessera (Venus).
tholus, tholi [dome, circular building]	купол, купола [dome]	山丘 [small domical mountain]	[1] Small domical mountain or hill [4] Domes [7] Hill. Isolated domical small mountain or hill	pancake volcano (Venus, Io), steep sided dome (Io, Mars), shield volcano, ash cone (Mars), festoon flow (Venus)
[unda], undae [wave]	волна, волны [wave]	浪蚀地形 [wave-cut landform]	[1] Dunes [4] Ripple-like, dune-like features	dune field (Mars, Venus)
vallis, valles [valley]	долина, долины [valley]	月谷/峡谷* [valley on the moon]/[valley]	[1] Valley [2] Valley: wide, elongate depression, commonly consisting of inconspicuous craters (!) [5] Valley [7] Valley. A sinuous channel, many with tributaries.	Rift graben (Mars, Moon), sapping valley, outflow channel, polygenetic channel, (Mars), overlapping impact craters (Moon, Mercury), lava channel, canali (Moon, Venus), graben (Ariel, Mercury) plural: valley network (Mars)
vastitas, vastitates [featureless plains]	великая равнина, великие равнины or ваститас [great plain]	辽原 [extensive plain]	[1] Extensive plain [7] Extensive plain. The vast northern circumpolar plain.	deposit covered plains (Mars). Only one named example in the Solar System.
virga, virgae [ray, band, streak]	полоса, полосы [streak, band]	条纹 [streak]	[1] A streak or stripe of color	dark linear albedo feature (Titan)
–				
– [albedo: whiteness]	[альбедо]		[1] Albedo Feature: Geographic area distinguished by amount of reflected light	
– [crater: chalice, cup]	[кратер]	环形坑 [circular depression]	[1] Crater: A circular depression [2] crater: circular or subcircular depression generally bounded by a raised rim [5] Craters, rings and walled plains	smaller (approx. < 300 km) impact crater
–			[1] Satellite crater	
–			[1] Plume: Cryo-volcanic features on Triton	cryovolcano/geyser eruption fallout (Triton)
–			[1] Eruptive Center: Active volcanic centers on Io	active volcano (Io)
–			[1] Large ringed feature [6] Ringed feature: "cryptic ringed feature"	relaxed impact crater, palimpsest (Callisto, Ganymede, Europa)

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