CARTOGRAPHIC MARS GIS

Tatyana V. Pletneva

Tatyana V. Pletneva
Moscow State University for Geodesy and Cartography
RF, 109469, Moscow, Perervinskiy bulvar, 27/1/61
Telephone number +7 926 141 18 94; e-mail: saturn1884@inbox.ru

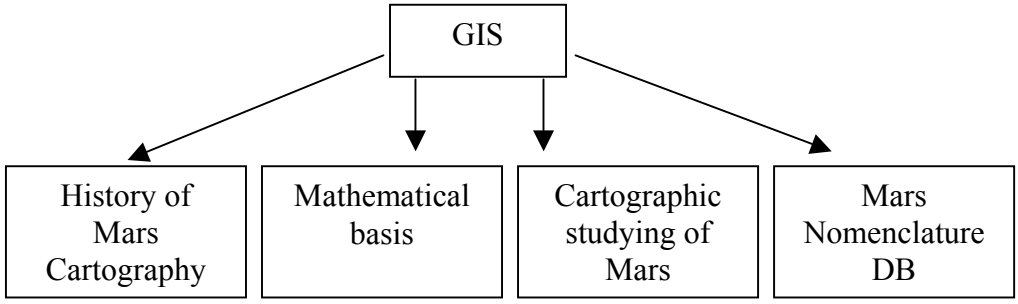
Abstract

The number of flights to celestial bodies with landing to their surface according already declared space programs, and with using for exploration planet artificial satellites will steadily increase. A produced set of maps should call in society interest to the "geography" of extraterrestrial territories. Especially it concerns to the planet Mars, the interest to which has considerably increased after Mars Pathfinder, Mars Global Surveyer, Mars Odyssey, and Mars Express missions in, resumption of organic substances searches and projects on delivery of a Mars soil to the Earth and on manned flight to Mars. That is why the Cartographic Mars GIS is the first one in the planned series of planetary GIS. The rationell structure of this GIS is considered. It will include several nodes such as mathematical basis, history of Mars cartography and especially the cartographic studying of the planet. Content of the last node will describe data base for all of the Mars maps with such characteristic as scale, method of compilation, the content according to map classification, editions, authors, place and year of printing, some inquiry data and the map image itself. The first version of this node is in preparing now. Cartographic Mars GIS will be very useful and important for exploration in different branches of comparative planetology, for education purposes, for planetary thematic mapping, for searching the landing sites and regions perspective for future investigations.

Introduction.

Scientists are very interested in studying celestial bodies using artificial satellites for their exploration. There have been many missions to Mars already. And number of flights is steadily increasing. Interestingly, the success rate of such missions to Mars has not been good with about fifty per cent failing. The USSR tried several times to get probes there, but the most part of them was failed. The European Space Agency's Mars Express and NASA's Mars Odyssey and Mars Global Surveyor missions are all ongoing and, of course, the Spirit and Opportunity Mars rovers have had their on-planet missions extended. Sojourner was the first rover landed on Mars in 1997. Anyway, there is a lot of information about Mars and its surface at the moment. Surely, it needs to be systemized. The Cartographic Mars GIS is a good way ordering all the information about Mars we have already got in this field and making it useful and convenient for other people. We are going to propose the following structure for this GIS:

1. History of Mars cartography.
2. Mathematical basis.
3. Cartographic studying of Mars.
4. Mars Nomenclature DB in two languages.



History of Mars cartography.

History of Mars Cartography will be represented in the first node of Mars GIS. For this purpose we'll preliminary allocate the historical periods: since the earliest days till the newest time.

Mars has been observed by many ancient cultures - we have no idea who was the first to notice it. Those who did it noticed a pale pink object that was only visible in the early morning just before dawn (and rather difficult to see at that). This object moved relative to the stars, got brighter over the next year and rose earlier and earlier. Then it abruptly stopped and reversed direction. At its brightest it was the third brightest object in the night sky (only Venus and the Moon were brighter), had an intense red color and was visible all night long. After moving the "wrong" direction for some 70 days or so, it stopped and reversed direction again. It gradually got dimmer, was only visible in the evening sky and set earlier and earlier. After another year it again was a pale pink object, this time only visible just after sunset. Shortly after that, it could not be seen at all. It remained hidden for about one hundred days when the cycle repeated again. Each cycle took a little over two years.

In the earliest days of Mars observation, all what was known about it was that it appeared to be a fiery red and followed a strange loop in the sky, unlike any other.

- **THE BABYLONIANS**
  The Babylonians studied astronomy as early as 400 BC, and developed advanced methods for predicting astronomical events such as eclipses. They made careful observations for their calendars and religious reasons, but never attempted to explain the phenomena they witnessed. The Babylonians called Mars Nergal - the great hero, the king of conflicts.

- **THE EGYPTIANS**
  The Egyptians were the first to notice that the stars seem "fixed" and that the sun moves relative to the stars. They also noticed five bight objects in the sky (Mercury, Mars, Venus, Jupiter, and Saturn) that seemed to move in a similar manner. They called Mars Har Decher - the Red One.

- **THE GREEKS AND ROMANS**
  Greeks called the planet Ares after their god of war, while the Romans called it Mars. Its sign is thought to be the shield and sword of Mars.

The 1500s

The Danish astronomer, Tycho Brahe (1546 - 1601) made surprisingly accurate calculations of Mars position 200 years before the telescope was invented. In 1576, Brahe set up an observatory in Hven, an island near Copenhagen where he studied the stars for 20 years. Using keen eyesight and large instruments, he calculated the position of Mars to within four minutes of arc.

The 1600s (the first telescope has been used)

Johannes Kepler (1571 - 1630), a student of Tycho Brahe, publishes *Astronomia Nova* (New Astronomy), which contain his first two laws of planetary motion. Kepler's first law assumes that Mars has an elliptical orbit, which was a revolutionary idea at the time. Until then, the classical belief held that a circle was perfect, and therefore all orbits must be circular.

The 1700s (era of the telescope)

- **1704**
  Giancomo Moraldi observes "white spots" at the poles, and discovers that the southern cap is not centered on the rotational pole.

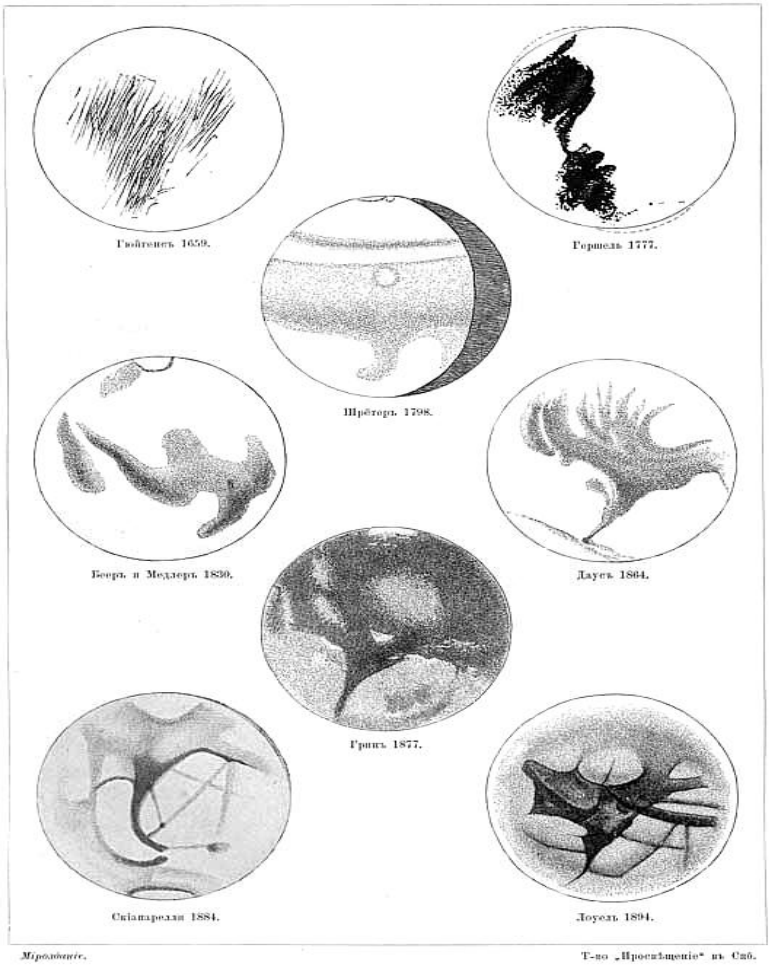
- **1719**
  Moraldi wonders if the "white spots" are ice caps.

- **1777-1783**
  Sir William Herschel (1738 - 1822), the British Astronomer Royal, studied Mars with telescopes he built himself. Herschel believed that all the planets were inhabited and that there were even intelligent beings living in a cool area under the surface of the sun.

- **1784**
  In Herschel's paper, entitled *On the remarkable appearances at the polar regions on the planet Mars, the inclination of its axis, the position of its poles, and its spheroid figure; with a few hints relating to its real diameter and atmosphere.*, which declares the axial tilt to be 30 degrees. (The actual current value is 25.19 degrees.) Herscel also mistakenly assumed that the dark areas on Mars were oceans, and the lighter regions land. When two faint stars passed very close to Mars with no affect to their brightness, Herschel correctly assumed that Mars had a tenuous atmosphere. He speculated that Martian inhabitants "probably enjoy a situation similar to our own."

The steadfast attention of scientific community and pseudo-scientific public has been involved in Mars in XIX century by opening of Italian astronomer Skiaparelli. The strange linear structures represented a uniform network were discovered by him during the telescope observations. According to the nomenclature of objects names developed by him for Mars surface, he has named them "channels" (1879). Later the seasonal changes were noted on Mars (and, in particular, spring thawing of a southern polar cap and also periodic storms).

Sketches of Mars making by astronomers in XVII – XIX centuries



SYRTIS MAJOR НА МАРСѢ,
по наблюденіямъ трехъ столѣтій.

The new and newest periods will be represented in the first node of Mars GIS as well.

Mathematical basis.

The second node of Cartographic GIS Mars is mathematical basis.
Here we are going to study three subnodes such as:

1) reference - surface

The physical surface of Mars has the complex form.
Ellipsoid on which surface materials of astronomical and geodetic works both topographical shootings and which most full corresponds to a surface of a geoid on corresponding territories of Mars are displayed, refers to a reference-ellipsoid. These surfaces are also called as reference - surfaces.
To display on a plane a physical surface of Mars and other real surfaces, it is necessary to pass from these surfaces to mathematical. As such surfaces accept surfaces of a sphere or ellipsoid - rotations.

2) system of coordinates

When processing planetary images it is necessary to transform image coordinates to planetocentric coordinates or back. Also at photometric studies it is necessary to calculate photometric conditions (geometry) of observation for each point on the planet surface. Often at realization of such transformations it is supposed that the planet image is in orthographic projection. But it is true only if ratio of the planet size to distance to it (i.e. the angular size of the planet) is negligible for accuracy of the task being solved. Otherwise it is necessary to suppose that the planet image is in the perspective projection (this is especially appreciable at the observations from the board of space vehicles approaching with planets and asteroids).

3) classification of projections

At studying cartographical projections parameters used reference - ellipsoid, initial geodetic dates and parameters about Mars, received by results of astronomical works, and also on materials of space sounding recognize, are known.

4) scale (large-scale, middle-scale, small-scale maps)

5) multi – sheet division

6) configuration of maps (hemispheres, multi – sheet division, maps of regions, areas and sites).

Cartographic studying of Mars.

The third node of Cartographic GIS Mars is cartographic studying of Mars.
Content of the third node will describe data base for all of the Mars maps with such characteristic as:

1) scale,
2) method of compilation,
3) the content according to map classification,
4) editions, authors, place and year of printing,
5) some inquiry data,
6) the map image itself.

Mars Nomenclature DB in two languages.

The last node includes the nomenclature DB in two languages.
The concept of the planetary nomenclature includes classification of objects in aggregate with the list of their names. On a surface of a planet a number of forms of a relief (craters, valleys, ledges, etc), which could not be distinguished at supervision in a telescope has been revealed. These features of a relief of Mars not always keep within details of albedo, observable with the Earth. Last years the new system of the Mars nomenclature has led to occurrence the new names for details of albedo and also for details of the relief. Work under the name of details of Mars relief of has been undertaken and proceeds by the International Astronomical Union (IAU) at the moment. The first list of the names was accepted by the XV General Assembly of the International Astronomical Union (also called as the IAU) (Sydney, 1973). A short example of Mars Nomenclature in Latin and Russian has been applied below.

№	Классификация деталей рельефа		Определение
	Латинский термин	Русский термин	
1	Catena (Catenae)	Цепочка (цепочки)	Цепочка или линия кратеров
2	Cavus (Cavi)	Котловина (котловины)	Крутосклонная депрессия неправильной в плане формы.
3	Chaos	Хаос	Характерный район разрушенного рельефа
4	Chasma (Chasmata)	Каньон (каньоны)	Глубокая, крутосклонная линейная депрессия
5	Crater	Кратер	Депрессия круглой формы
6	Dorsum (Dorsa)	Гряда (гряды)	Линейная возвышенность неправильной в плане формы
7	Fossa (Fossae)	Борозда (борозды)	Длинная, узкая, неглубокая депрессия
8	Labyrinthus (Labyrinthi)	Лабиринт (лабиринты)	Комплекс пересекающихся долин
9	Mensa (Mensae)	Столовая гора (столовые горы)	Плосковершинные возвышенности с обрывистыми краями
10	Mons (Montes)	Гора (горы)	Крупная возвышенность рельефа или цепь возвышенностей

Conclusion.

Why are people so interested in Mars? Mars is seen as the one planet that might provide a somewhat comfortable habitat for human colonization (perhaps with a long program of terraforming). The "canali" seen by astronomer Percival Lowell in the late 1800s turned out, unfortunately, to be a trick of perception rather than great irrigation works contracted by the red planet's imagined inhabitants. NASA are planning to send a manned mission to Mars but that could be decades away. There are still many unsolved issues but gradually they will be solved. Cartographic Mars GIS will be very useful and important for exploration in other branches of comparative planetology, for education purposes, for planetary thematic mapping, for searching the landing sites and regions perspective for future investigations.

Literature:

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Some information: Pletneva Tatyana Vladimirovna, a student of Moscow State University for Geodesy and Cartography; Faculty of Applied Cosmonautics; the 9th semester.