Chapter 23
Artificial Environments on Mars

Alexander A. Bolonkin
C&R, New York, USA

23.1 Introduction

This chapter has two independent sections, important to Mars resource utilization. Section 23.2 refers to inflatable domes for Mars as well as for Mars satellites. Section 23.3 is devoted to the proposed AB method of agriculture on Mars without added water (based on a closed-loop water cycle). Both sections are based on a common idea, i.e. the isolation of a limited area by a cheap transparent inflatable dome and creating more suitable conditions (in other words, micro-terraforming) inside this dome for humans and agriculture.

23.2 Inflatable Dome for Mars and Mars Satellites

23.2.1 Brief Description of Problem

This section is based on the previous paper (Bolonkin 2007d). The large-scale development of permanent human life on Mars requires two conditions: (i) all-sufficient space settlement and (ii) artificial life conditions close to those prevailing currently on the Earth. The first condition demands production of all main components needed for human life: food, oxidizer, and energy within the outer space and Solar System body colony. The second requisite condition is a large surface settlement having useful plants, flowers, water pool, walking and sport areas, etc. All these conditions may be realized within large 'greenhouses' (Bolonkin 2006a,b,c; Bolonkin and Cathcart 2006a,b,c,d) that will produce food, oxidizer and all needed conditions of “the good life”. Settlement will not be attractive to potential settlers unless free of privation.

In other words, future human lifestyles on Mars must be more comfortable than commonly projected now for humans to explore and properly exploit this planet. Human life there will be more comfortable if employing the author’s macro-project proposal - staying in Martian atmosphere without a special spacesuit (mass of current spacesuit reaches 180 kg, cost $22 millions) (Bolonkin 2006b,c, 2008; Bolonkin and Cathcart 2006c).
The current conditions in Mars are far from comfortable. For example, Mars does not have a terrestrial-like atmosphere, there is space radiation, etc. Especially during wintertime, Mars could provide only a meager and uncomfortable life-style for humans, showing low temperatures and strong winds.

### 23.2.2 Brief Information about Mars

Mars’ average distance from the Sun is roughly 230 million km (1.5 AU) and its orbital period is 687 (Earth) days. The solar day (or sol) on Mars is only slightly longer than an Earth day: 24 hours, 39 minutes, and 35.244 seconds. A Martian year is equal to 1.8809 Earth years, or 1 year, 320 days, and 18.2 hours. Mars's axial tilt is 25.19 degrees, which is similar to the axial tilt of the Earth (other details are given in Chap. 2).

Mars is a terrestrial planet with a thin atmosphere, having surface features reminiscent both of the impact craters of the Moon and the volcanoes, valleys, deserts and polar ice caps of Earth. It is the site of Olympus Mons, the highest known mountain in the Solar System, and of Valles Marineris, the largest canyon. In addition to its geographical features, Mars’ rotational period and seasonal cycles are likewise similar to those of Earth. Still, of all the planets in the Solar System other than Earth, Mars is the most likely to harbor liquid water, and perhaps life.

Although Mars has no intrinsic magnetic field, observations show that parts of the planet's crust have been magnetized and that alternating polarity reversals of its dipole field have occurred. Current models of the planet's interior imply a core region about 1,480 kilometres in radius, consisting primarily of iron with about 14–17% sulfur. Mars is also scarred by a number of impact craters: a total of 43,000 craters with a diameter of 5 km or greater have been found.

The red-orange appearance of the Martian surface is caused by iron(III) oxide, more commonly known as hematite, or rust. Based on orbital observations and the examination of the Martian meteorite collection, the surface of Mars appears to be composed primarily of basalt. Some evidence suggests that a portion of the Martian surface is more silica-rich than typical basalt, and may be similar to andesitic rocks on Earth; however, these observations may also be explained by silica glass. Much of the surface is deeply covered by a fine iron(III) oxide dust that has the consistency of talcum powder.

In June, 2008, the Phoenix Lander returned data showing Martian soil to be slightly alkaline and containing vital nutrients such as magnesium, sodium, potassium and chloride, all of which are necessary for living things to grow. Scientists compared the soil near Mars' north pole to that of backyard gardens on Earth, saying it could be suitable for plants such as asparagus. However, in August, 2008, the Phoenix Lander conducted simple chemistry experiments, mixing water from Earth with Martian soil in an attempt to test its pH, and discovered traces of the salt perchlorate. Its presence, if confirmed, would appear to make the soil more exotic than previously believed. Further testing is necessary to eliminate any possibility of the perchlorate readings being influenced by terrestrial sources which may have migrated from the spacecraft, either into samples or into the instrumentation.