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Application of Manufactured Products

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As table 3 shows, a wide range of useful products can, in principle, be manufactured from the following materials:

1. Lunar regolith or basalt
2. Regolith or rock beneficiated to concentrate plagioclase or other minerals
3. Iron, extracted from lunar soil or rocks by various means
4. Naturally occurring or easily obtained materials that have cementitious properties
5. Byproducts of the above products

TABLE 3. *Products Derived From Lunar Materials*

	Sintered regolith	Glass and ceramics	Cement	Metal
(a) Basic construction materials and their sources				
Beams	X	X	X	X
Plates, sheets	X	X	X	X
Transparent plates (windows)	–	X	–	–
Bricks, blocks	X	X	X	–
Pipes, tubes	–	X	X	X
Low-density materials (foams)	–	X	–	–
Fiber, wires, cables	–	X	–	X
Foils, reflective coatings	–	–	–	X
Hermetic seals (coatings)	–	X	X	X
Formed objects	–	X	–	X

TABLE 3 *(concluded)*.

	Sintered regolith	Glass and ceramics	Cement	Metal
(b) Applications and their parts, listed under their source materials				
Aerobraking heat shields		Low-density thermal protection material		Structural beams
Pressurized habitats	Radiation protection, insulation	Windows, seals	Internal structural plates (floors), beams	Pressure vessels, tanks
Photovoltaic arrays		Semiconductors	Foundation structure	Support structure, wires
Agricultural systems	Radiation protection, insulation	Windows, seals, high-pressure pipes	Structure, low-pressure pipes	Tanks, machine parts, wires

In addition to oxygen, which can be obtained by several processes, either from unbeneficiated regolith or by reduction of concentrated ilmenite, these materials make the simplest requirements of the lunar resource extraction system. A thorough analysis of the impact of these simplest products on the economics of space operations is not possible at this point. Research is necessary both to define optimum techniques and adapt them to space and to determine the probable market for the products so that the priority of various processes can be assessed.

However, as figures 14-17 show, we can envision simple to quite complex construction projects on the lunar surface even in the early stages of lunar operation. And the growth of an industry to make lunar products for use off the Moon is a possibility, though a more distant one.

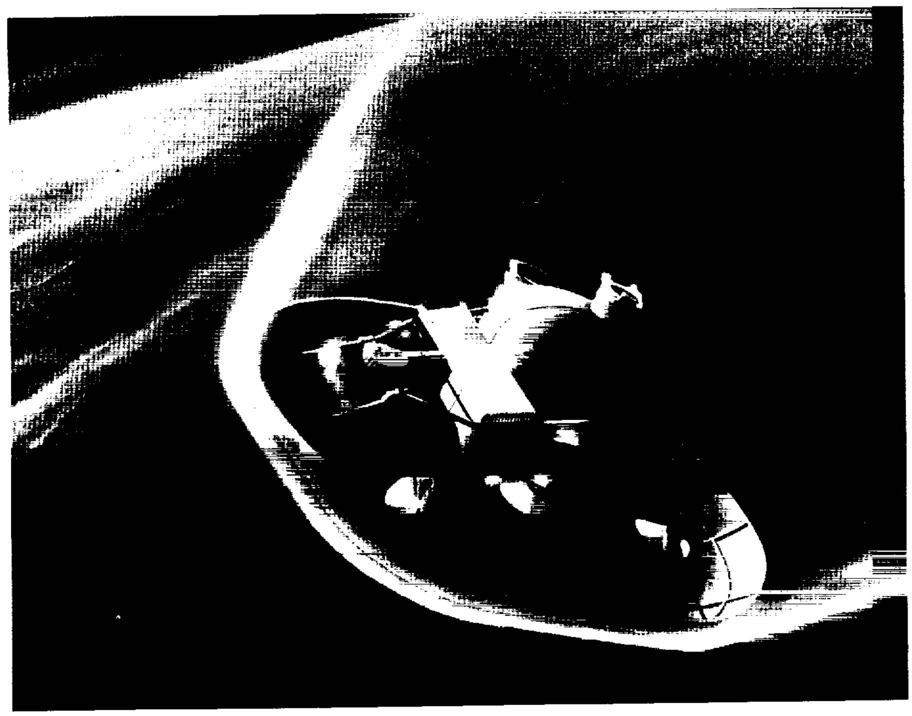
Figure 14

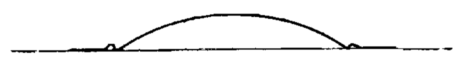
Aerobraking Heat Shields

When spacecraft, such as the Space Shuttle, enter the atmosphere of a planet at high velocity, the frictional heat must be dissipated and the interior of the spacecraft protected from high temperature. The thermal protection system of the Space Shuttle consists of reusable glass tiles, made out of silicon dioxide, which have very low thermal conductivity and remove the heat by radiation, conduction, and convection in the atmosphere. In contrast, the Apollo heat shield was an ablatable structure, the exterior of which melted and was sloughed off as the spacecraft reentered.

The principal components of these heat shields are a supporting structure and the thermal protection material itself. If lunar material can be used to make heat shields (either reusable or ablatable), the cost of transporting such shields to the Moon can be avoided. This could significantly reduce the cost of transporting lunar products to Earth.

Artist: Doug McLeod

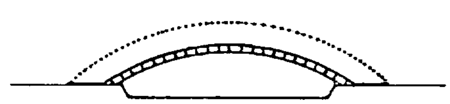




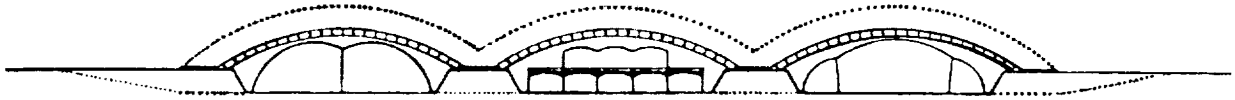
1. Inflated arch support form

2. Interlocking, molded regolith arch components laid over inflated form

3. Regolith pushed over arch, pneumatic support form removed, area underneath excavated where required by dragline scoop, and pressurized enclosures erected



4. Alternative pressurized enclosure using hermetic membrane applied to inner surface of shield



5. Interconnected arch shields with range of pressurized enclosures

Figure 15

Pressurized Habitats

The ability to construct hermetically sealed habitats from lunar materials could lead to rapid expansion of lunar capabilities. This illustration shows the construction of a dome-shaped structure using 2-meter-thick sintered regolith blocks, which serve as radiation shielding. (Each block has a mass that would weigh 15 metric tons on Earth, 2-1/2 metric tons on the Moon.) This structure would require an airtight seal, which might be provided by the application of a melted silicate glaze. Alternatively, lightweight organic seals could be brought from Earth. Internal structure—floors, walls, beams—could be made from metal, glass, or concrete.

Taken from Land 1985, p. 368.

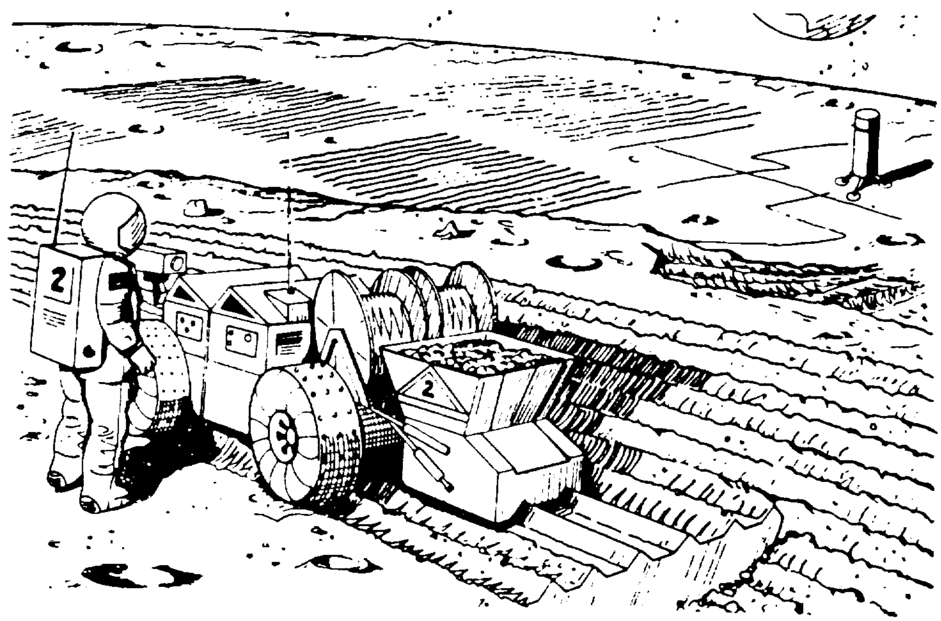


Figure 16

Lunar Photovoltaic Farms

A combination of items manufactured on the Moon might be used to produce a lunar power system. Photovoltaic semiconductor materials are deposited on prepared ridges in the lunar soil. Iron wires will carry the electricity to microwave transmitters. Microwave reflectors consisting of lunar ceramic and iron wires can beam the microwaves to space, even all the way to Earth. Thus, a relatively small lunar processing facility can rapidly develop substantial quantities of electricity using primarily indigenous materials.

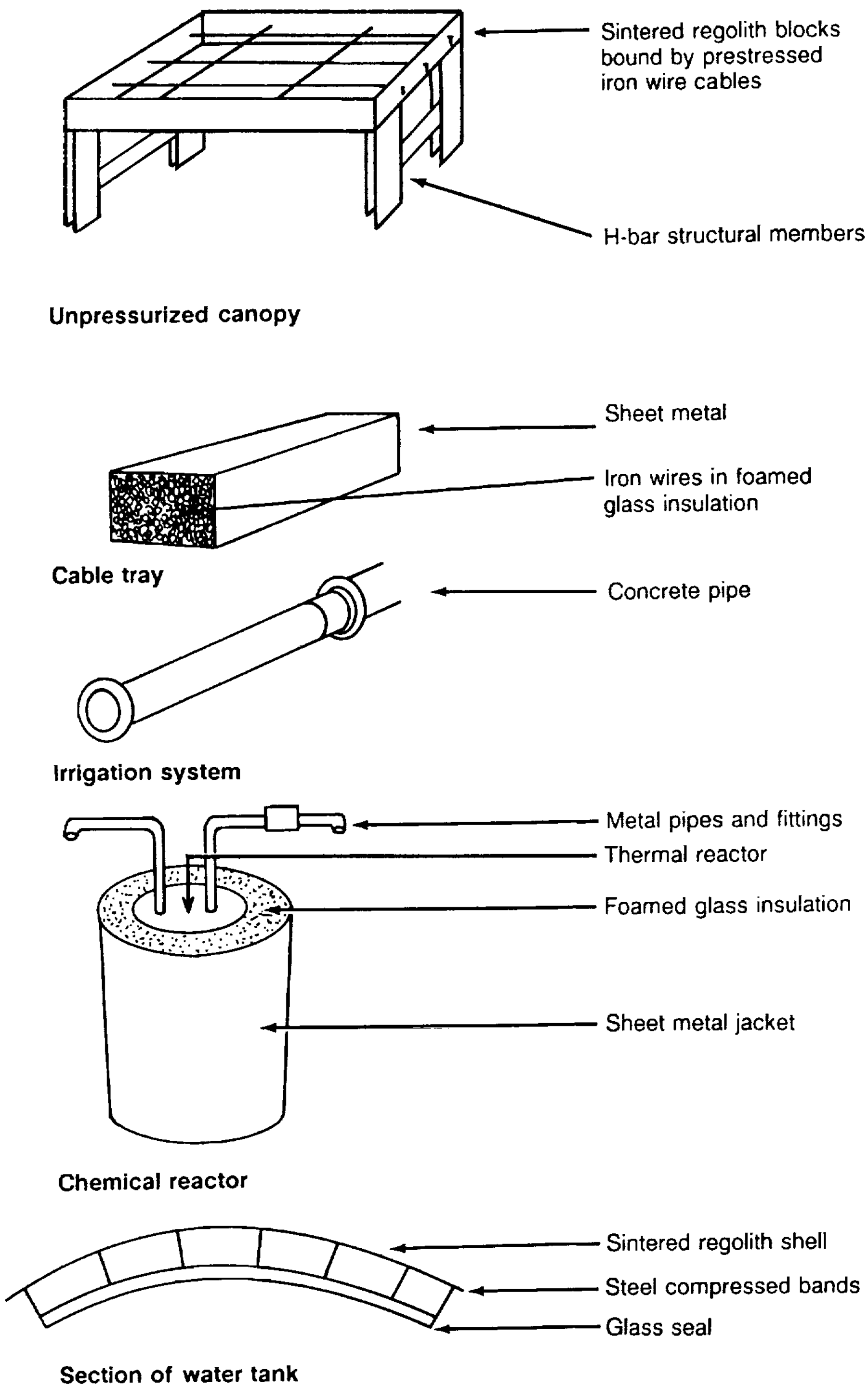


Figure 17

Agricultural Systems

Many applications of lunar materials could be found in a "home-grown" lunar agriculture facility. Structural members are similar to those for the habitat described in figure 15. Internal plumbing—tanks and pipes—could be made from glass, metal, or concrete. Plants may be grown in modified lunar soil. The lunar farm is also an essential component of the environmental control system for the lunar base, purifying air and water.

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