

ASPECT OF LUNAR RESOURCES EXPLORATION

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ABSTRACT

Major purposes of the exploration and development of lunar resources are to assist the earth resources supply especially for the nuclear fusion energy, to supply energy and materials to construct the lunar and other planetary development base and the operation, and to supply energy and materials for properties for the space base and the industries. The reduction of energy cost of material extraction is required for the resource development. The integrated exploration method is proposed using the precise digital mapping by remote spectral sensors and the following in-situ measurement of elements, minerals, and the material characteristics by semi-automated rover vehicle investigation on near-mountainous regions of Lunar surface. The mission will be launched early soon in the next century[1].

The solar wind directly affects the lunar surface, so that some amounts of light elements concentrate or implanted in the surface materials, regolith for example. The lunar surface contains up to hundred ppm of hydrogen, nitrogen, carbon, and noble gases mostly in the lunar regolith[2]. Helium(He) concentrates in several ten's ppm with ³He, the isotope, which amount is about one-twentieth to two- thousandth of total He[2]. If the second stage of the nuclear fusion energy is available, ³He is the suitable source to obtain the nuclear fusion process. All the elements on the moon other than ³He may be costly to take and transport to the earth surface in the present technological phase.

Future space industries will need the cosmic resources. We will not be able to launch all the materials and the energy from the earth used for the space activities when the space industry develops for the communication networks, for the space factory to produce materials with micro gravity environment, for the observations of the outer space and of the earth, for the space sightseeing and so on. One of the important source of the space materials and the energy is from the Lunar resources.

To date, we supply all the energy and materials to keep the operation of satellites and the launching systems, the cost of which have been very expensive. We need much more energy and materials for space construction and maintenance when we need more space industries. We can supply the energy using solar battery cell in the space, though the costs of launching larger solar battery cell will increase more. In order to decrease the cost for the various space industries, we will need to develop the lunar surface where the gravity is about one-sixth lower than on the earth and very low atmospheric pressure.

The first step to develop the lunar resources, we need to bring much amount of materials and energy from the earth. After the construction of Moon base and the transportation pass, we can extract the lunar resources. Oxygen, hydrogen, nitrogen, carbon, and other light elements can be extracted from the regolith. Almost all the lunar materials are lack of water nor

hydrogen. Consequently we may extract the hydrogen using the similar process of helium. Oxygen can be extracted from the lunar silicate or oxide costly.

Metals and non-metal elements can also be extracted from regolith and rocks. On the earth, we usually extract metals from sulfide or oxide because of the cost of energy. The metal compounds have their bond energy so that we must consume the proper amount of energy to separate and concentrate the metals from the earth's materials. The energy cost to form the silicate minerals is generally very large, and the silicate minerals usually melt in higher temperature. Extraction of metals from the silicate minerals on the moon needs much amount of energy. The energy cost to form sulfide or oxide is relatively lower than silicate, and the melting or vaporized temperature is relatively lower. The concentration of sulfide and oxide are of the common resources on the earth but not common on the lunar surface.

The cost of energy to extract metals and compounds from the mixture of common materials on the moon will be too high to keep the lunar resource development as a beneficial industry. In order to decrease the energy cost, we need to search the significant concentration of materials with the low cost process to extract elements from them. Lunar surface is almost lack of air pressure that is sometimes favorable for the smelting process, though the heat conduction or cooling in lunar condition is another problem.

The lunar regolith and rocks can be available to build the lunar base or to use the lunar materials to construct or to maintain the large satellite base. This procedure is resemble to the construction process on the earth. The definite difference is the low gravity and low atmospheric pressure. We do not need to consider the large gravity loading or water problem. The problem is how to bind the materials to keep the appropriate strength. Melting the lunar materials is a possible answer that needs high energy and temperature. The binder material is another answer that needs the transportation cost of it from the earth. If the nuclear fusion energy is available on the lunar surface, the cost of energy can be low cost with benefit. The solar battery cell on the lunar surface can supply more effective electric energy than on the earth.

In order to obtain resources with lower cost, we first explore the unknown but significant lunar surface to get the detailed information of material distribution, surface structures, and material characteristics[3]. The lunar-base will be developed in the proper place to supply energy and materials to the space industry[4]. The technological development of low energy smelting and other process is needed. We may furthermore utilize the lunar base as the multipurpose observation and the relay stations for farther space development.

REFERENCES

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