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Avoiding Extraterrestrial Claim Jumping: Economic Development Policy for Space Exploration and Exploitation

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ABSTRACT

Any frontier exploration effort transitions eventually to an exploitation phase. Exploitation can be research or economic in nature. In either case, a regulatory framework is required to coordinate and govern any activity in the new realm. The Earth orbital regime has entered the exploitation phase with the advent of a permanent research facility in the form of the International Space Station (ISS) and increasing activity in the private sector. The lunar regime and perhaps near-Earth asteroids will be potentially entering the exploitation phase within the next two decades. A regulatory structure in the form of an international agreement using elements similar to the Antarctic Treaty and the Intergovernmental Agreement for the ISS may be used as an example of a potential regulatory structure for the exploitation of the extraterrestrial environment. Inevitably, economic development will follow the research phase if not specifically prohibited in any future treaties or agreements. To manage these activities, an organization similar to the World Trade Organization could form the basis of a management body for economic activities.

INTRODUCTION

"This mining outpost owned by an international conglomerate runs three shifts every 24 h, recovering unique materials from the soils and ships them to facilities where they are processed and delivered to industries that use them to generate the energy and manufacture the products that we use everyday. The only real differences between this site and any other remote mining facility are the long daylight periods and what seems like even longer nights. Days are, by most residents' accounts, easier to handle as the bright light makes it easier to move around. The high temperatures during the solar noon, however, sometimes cause cooling systems to overheat. The

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nights do have their awe-inspiring aspects, however, since the stars are too numerous to count and, when lights are left off and by looking closely, a miner can see colors in the dots of light not seen on earth. . .'' (an excerpt from the TerraLuna Mining Confederation brochure, welcoming visitors to the Mare Procellarum mining facility).

The above is obviously fiction, but someday, extraterrestrial mining will be an industry actively pursued by corporate entities once economic critical mass, or when reserves and demand reach the point of commercial interest, is achieved. Although it may be a decade or more away, as Harrison H. (Jack) Schmitt (2006) describes in his book *Return to the Moon*, the pressure for exploitation of assets, both mineralogical and potentially biological, on near-Earth bodies will ultimately be inevitable. As in recent low Earth orbit exploration projects, like the International Space Station (ISS) and numerous communications and resource monitoring satellites and systems, extra-terrestrial asset exploitation, when it occurs, will likely not be a single nation's effort but one of a transnational or truly international entity. The future business may be totally commercial or may be a hybrid government-commercial enterprise. In either case, political considerations that will be unavoidable will exist. An agreement between political entities will need to exist to allow the development of equitable relationships by the transnational economic entities and the protection of investment and production by regulation that will allow a legally clear and clean process for exploitation of future resources.

By negotiating the terms of an international agreement and the regulating structure now, an equitable and flexible framework may be developed under which any and all signatories will be involved in the governing process before economic and political pressures arise to make the task more difficult. What form could this agreement take and what might work effectively as a regulatory body in this new environment? This chapter will present a possible format for an international agreement using aspects of the successfully implemented agreements governing Antarctic operations and the ISS as a guideline for a space exploration and exploitation instrument and for proposing an international governing body using the Worl Trade Organization (WTO) as a model.

REGULATORY FRAMEWORK

Exploration and exploitation of the Moon and ultimately other celestial destinations may operate under several regulatory schemes: enterprise-only governance, where corporate policies regulate operations (essentially a laissez-faire environment); national legal frameworks, where corporations and other entities are regulated by the laws of their home country; or international agreement, where the interests of the participating nations will be merged to form a regulatory regime to ideally provide a stable economic climate for commercial activities. Each of these three points in the regulatory spectrum will be briefly reviewed to define potential strengths and shortcomings in each of the different approaches. An attempt will then be made to define an option providing the most palatable regime for the future enterprises that will risk extensive sums to form the future industries while recognizing the regulatory interests of the public sector.

Multinational agreements, most commonly those driven by the political sector, commonly retain political risk in the form of common-heritage-of-mankind clauses that effectively impede development. In effect, the inclusion of commons language may be thought of as the distribution of any realized benefits to the broader community of humankind without regard to the participation of any community in the development of the enterprise. Benefits transferred to those who have not provided capital in one form or another in the form of investment (or skin in the game) in the enterprise is another way of describing this condition. This has been a major impediment to ratification of the United Nations Convention on the Law of the Sea (UNCLOS) Treaty by the United States primarily because of the lack of commercial protections for a return on investment and the lack of adequate protections on the intellectual property (IP) developed as part of any exploitation program. Unless an organization or country decides to proceed in an enterprise, ignoring these conditions on the assumption that they are ultimately unenforceable, the inclusion of the commons language in the Law of the Sea Treaty will still need to be addressed before any commercial activity may proceed.

A concept of shared risks, shared rewards exists in almost every commercial mining and/or extraction enterprise. Hydrocarbon exploration agreements routinely exist between regulatory agencies of the respective governments owning the license areas and industry partners that are commonly multinational in origin. This works well when the regulating agency (owning government) owns the rights and licensing authority to the resource area. What happens when that ownership is unresolved as in the

case of international waters for mineral extraction or in the case of resources in the space regime? Where does the regulatory authority come from and who delegates that authority to that entity?

Early stages of exploration leading to exploitation may conceivably be conducted unilaterally by any enterprise. However, in any completely open market space, ownership of the assets will eventually become a critical governance issue requiring regulation. As an example, as satellite telecommunications demand increased, the slots for satellite positioning in the geostationary orbit plane (GEO) became a critical asset issue. In response to the pressure of avoiding not only physical, but also radio frequency interference between GEO communication satellites, the International Telecommunication Union (ITU), originally formed in 1865 to provide a common set of rules for telegraphy across national borders, became empowered to organize and regulate the GEO slots as a member agency of the United Nations (International Telecommunication Union, 2010). Slots for GEO birds are now controlled by the ITU and issued to member countries, including those with little or no likelihood of establishing their own satellites in orbit. These assignments do not provide each country with satellite technology but, essentially, with real estate that gives each licensed country the opportunity to establish its own assets in the GEO belt or to sell or lease the rights to another entity. The advantage here is to allow the ultimate licensee the freedom and protections to invest in and exploit the asset, in this case, the communication capability that is the marketable product. This does not reduce the potential for misdeeds, such as intentional interference by a competing agent, but the ITU does form an avenue for a redress of grievances and potential regulatory action to correct the conflict. Without some form of regulation, as in this case where the ITU licenses and provides deconfliction for the GEO communication satellites, claims and counterclaims will generate the inevitable legal entanglements that may preclude the development of a viable industry. In the worst case, claim jumping by those nations and commercial interests uninhibited by a desire to seek cooperation is likely to lead to significant conflict once economic thresholds are reached.

Regulation at the state level may form a suitable legal environment should that nation own or manage the resource or real estate, as in the deep-water hydrocarbons exploration and production operations within what have classically been recognized as international waters but are now recognized as exclusive economic zones (EEZ). However, in the case of the Moon and other celestial bodies, any such ownership or territorial claim is specifically rejected within the Outer Space Treaty. However, where national jurisdiction is extended into the stateless regimes, then national-level regulations have characteristically covered operations. Examples are the national research stations in Antarctica (Figure 1) and those within the national assets of the ISS (Figure 2). In the case of the United States stations in Antarctica, United States law is extended for both civil and criminal matters. Aboard the ISS, United States law extends to the modules operated by the United States. However, in the case of the ISS, the United States legal extensions generally do not extend into the other key components of the station owned and operated by other countries. In this case, a separate supranational agreement was made between all participating parties to manage the joint efforts to build and operate the on-orbit laboratory. In the case of the Antarctic Treaty, where a similar international regime exists within an area where ownership is not expressed, the United States commercial interests have been limited by a legislative ban on capital activities by United States nationals. Other nations are not so burdened and will benefit disproportionately whenever the economic critical mass is reached for Antarctic mineral exploitation. This will be a separate form of political risk to avoid within the space regime.

Commercial activities in stateless or transnational areas have, in the past, been held as a common law (e.g., freedom of navigation on the open seas) or primarily treaty or protocol agreements. Examples of multinational regulatory agreements are the Antarctic Treaty, UNCLOS, and the Kyoto Protocol. The Kyoto Protocol will not be examined here because it is generally not related to regulating activities in stateless regions but focuses on the environmental conditions influenced by activities within sovereign nations. The Antarctic Treaty and the Law of the Sea Treaty, however, were each designed to provide an international framework for cooperation and regulation in the physical regions of Earth where no sovereign presence exists. They both either regulate or impact commercial activities and will be briefly summarized.

THE ANTARCTIC TREATY OF 1959 AMENDED IN 1991

Antarctica, as the last frontier of the 20th century, has been seen as a potential storehouse of minerals from hydrocarbons to metals. Numerous claims

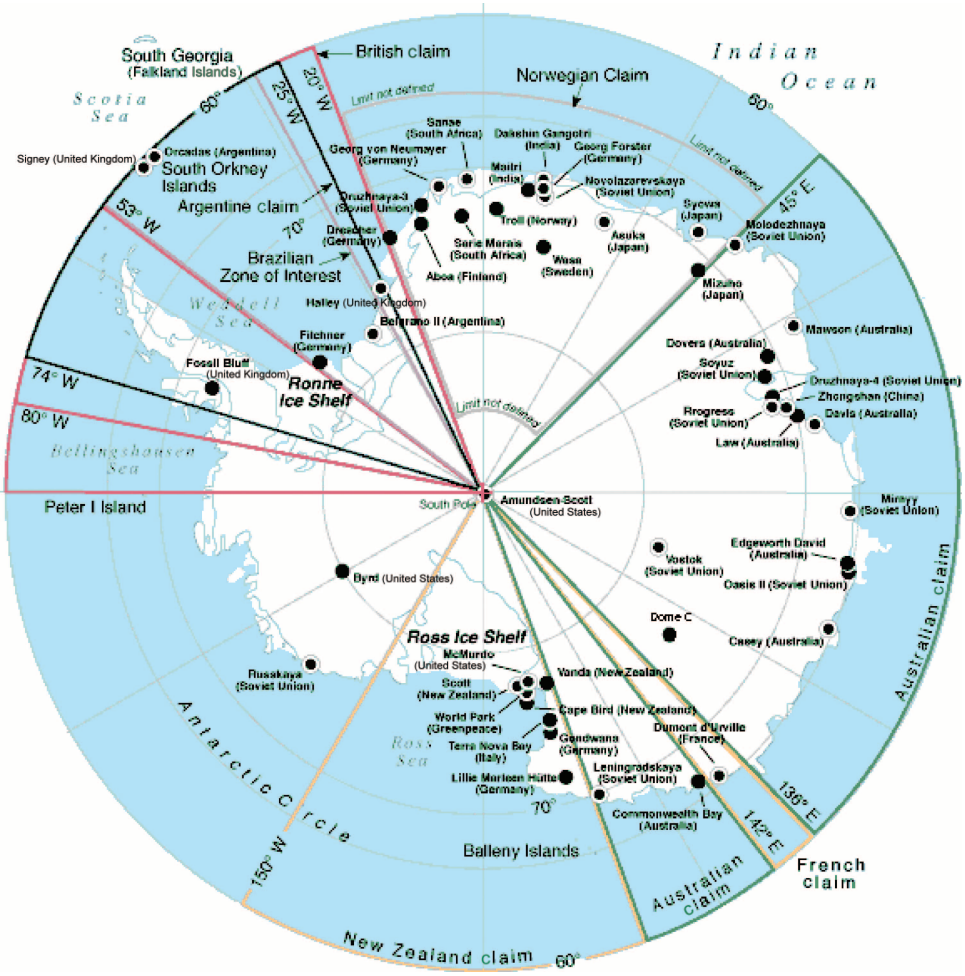

FIGURE 1. Antarctica, illustrating the locations of current and past stations and regions claimed by countries (credit: Central Intelligence Agency, 2009).

to Antarctic territory have been made based on early sightings by mariners, extensions of national borders, and others but not because of habitation because no permanent human residents of Antarctica exist. Although no permanent residents exist, human presence claimed by the early pioneering exploration efforts on the continent could potentially bear on ownership claims on resources. During the heroic age of Antarctic exploration that occurred in the first two decades of the 20th century, exploration teams who landed on the Antarctic landmass briefly explored the environs and then departed without leaving a permanent station in place. These efforts were dominated by a small number of countries that could potentially make claims to significant regions of the continent based on an interpretation of the first use concept where ownership of a resource (e.g., water in Texas) is conferred by the first use of that resource, in this case, any activity requiring the use of indigenous materials. Following a gap of approximately 45 years, the second phase of exploration resulted in the placement of semipermanent to permanent bases on the continent by many of the countries sponsoring early efforts. The first permanent research presence was opened in the Antarctic during the 1959 International Geophysical Year. These first permanently occupied research stations have, over the last 50 years, grown to be a series of permanent stations on the continent where a broad range of investigations are conducted (Figure 1). From these bases, widespread, detailed exploration efforts have been quartered and launched.

With the lack of clarity regarding jurisdiction over future competing claims on potentially economic reserves of mineral resources, the international community recognized that some form of agreement was necessary to provide a regulatory framework to govern operations on the continent. The United States negotiated the Antarctic Treaty of 1959 with an original group of 12 signatories that contained all the major participants and claimants presently having or had activities in Antarctica. Subsequently, additional countries have signed on to the treaty, resulting in a total of 48 signatories

FIGURE 2. The International Space Station at an assembly complete in June 2011. From the Earth-nadir (lower part in the photograph) position, the components reflect the European Space Agency (ESA) Automated Transfer Vehicle cargo vehicle docked to the Russian Zvezda service module, the Zarya module, United States Node 1 Unity, United States laboratory Destiny, and United States Node 2 Harmony connecting the Japanese laboratory Kibo and the ESA laboratory Columbus. The space shuttle Atlantis is docked at the top of the image. Each of these modules are governed by agreements with the host countries and agencies (photo courtesy of National Aeronautics and Space Administration).

today (Scientific Committee on Antarctic Research, 2010).

Two basic levels of membership of the Antarctic Treaty are observed: full consultative parties, nations that are engaged in substantial scientific research activity, and nonconsultative parties, which, although not conducting any substantial research, agree to ratify and abide by the terms of the treaty. The 48 countries that have become parties to the Antarctic Treaty represent more than 80% of the population of the world, including, incidentally, all countries that currently have space-launch capability. The consultative parties are the 12 original signatories: Argentina, Australia, Belgium, Chile, France, Japan, New Zealand, Norway, South Africa, Russia, United Kingdom, and the United States, plus Brazil, Bulgaria, China, Ecuador, Finland, Germany, India, Italy, Netherlands, Poland, Peru, South Korea, Spain, Sweden, Ukraine, and Uruguay. The additional 20 nonconsultative parties are Austria, Belarus, Canada, Colombia, Cuba, Czech Republic, Denmark, Estonia, Greece, Guatemala, Hungary, North Korea, Monaco, Papua New Guinea, Portugal, Romania, Slovak Republic, Switzerland, Turkey, and Venezuela.

In general, this agreement has held any claims by nations in abeyance and restricted commercial exploitation on the continent and surrounding seas to preserve the region as a pristine research laboratory. Over the past five decades, international cooperation in Antarctica has resulted in groundbreaking research in the fields of biology, meteorology, atmospheric sciences, marine sciences, glaciology, chemistry, geology, geophysics, astronomy, climatology and, certainly, human behavior, to name just a few of the fields that have benefited from the presence of this unique terrestrial laboratory. Without this undisturbed terrain to work within, many of the research pursuits could not have been undertaken. Ultimately, however, as raw materials demand expands, economic considerations will result in exploration and exploitation efforts being undertaken in Antarctica and a new round of negotiations will be required to govern the efforts of the international compacts.

Within the 14 articles of the treaty, the following bear on the question of lunar exploration and exploitation:

- Article 1: Antarctica shall be used for peaceful purposes only.
- Article 4: All national claims are held static from the date of signature. No future activity of any country during the life of the treaty can affect the status quo on any rights or claims to territorial sovereignty.
- Article 10: Contracting parties shall ensure that no activity contrary to the treaty is carried out.
- Article 11: Any disputes between contracting parties shall be resolved by peaceful negotiation, in the last resort, by the International Court of Justice.

The Antarctic Treaty currently in force restricts the activities of the signatories to research only during the period that the treaty is in force. Although economic exploitation is prohibited for the term of the original and extended terms of the treaty, ultimately, it will prove to be impossible to expect the moratorium on economic exploitation to remain indefinitely, so a revised commercial form of the treaty will have to be negotiated. An early attempt to regulate Antarctic mineral resources in 1988 was unsuccessful (Secretariat of the Antarctic Treaty, 2010).

UNITED NATIONS CONVENTION ON THE LAW OF THE SEA

The UNCLOS established an International Seabed Authority to govern activities in the pelagic regions

outside of national EEZ. In addition to codifying the generally accepted principals of freedom of navigation, the UNCLOS also contains regulations governing economic exploitation activities (United Nations, 2011). Although many countries have ratified the agreement, the United States and other major industrial countries have not ratified the agreement because of onerous regulatory requirements on the distribution of benefits and the protection of intellectual property. These requirements, or conditions, include a requirement to deliver proceeds of output to nonparticipating countries under the common-heritage-of-mankind principle and no protections on IP covering the techniques and technologies were used. With these two conditions, a free market enterprise would be facing an uncertain economic environment and, with no protection for proprietary tools and techniques, would abruptly lose any industrial advantage. This uncertainty, coupled with the high entry costs to exploit the deep-marine minerals, has, to date, inhibited the formation of an industry to mine the deep ocean. In effect, provisions of the law delivered benefits (output) from any enterprise risking the significant capital outlays to nonparticipating parties (nations) that had no skin in the game.

Obviously, a hybrid solution needs to be reached where the economic interests of any commercial enterprise are recognized, protected, and regulated within an international legal framework.

LEGAL FRAMEWORK GOVERNING OUTER SPACE ACTIVITIES

Although a significant body of space law currently exists, it has primarily been focused on the near-Earth regime, with little that could be described as comprehensively governing potential mineral or biological exploitation in the extraterrestrial regime. Those few efforts extending beyond the Earth orbital environs have been well summarized by Schmitt (2006) and can be found in their entirety in the United Nations Office for Outer Space Affairs document, publication ST/SPACE/51 (United Nations, 2009), and will only briefly be discussed here. They are as follows:

1) Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and other Celestial Bodies of 1967 (commonly known as the Outer Space Treaty);
2) Agreement on the Rescue of Astronauts, the Return of Astronauts, and the Return of Objects Launched into Outer Space of 1968 (commonly known as the Rescue Agreement);
3) The Convention on International Liability for Damage Caused by Space Objects of 1972 (commonly known as the Liability Convention);
4) Convention on Registration of Objects Launched into Outer Space of 1975 (commonly known as the Registration Convention); and
5) Agreement Governing the Activities of States on the Moon and other Celestial Bodies of 1979 (commonly known as the Moon Agreement).

Of these agreements, only two of them directly, or mostly, refer to or apply governing conditions on the activities of governments and, by extension, commercial entities, those being the Outer Space Treaty of 1967 and the Moon Agreement of 1979.

The founding document in space law is the Outer Space Treaty of 1967 where several provisions define the functions and responsibilities of nations and nongovernmental entities in the exploration and exploitation of the outer space environment. Article 1 states that ''the exploration and use of outer space, the Moon, and other celestial bodies will be carried out for the benefit and in the interests of all countries, irrespective of their degree of economic or scientific development, and shall be the province of all mankind'' (United Nations, 2002, p. 4). Commercial activities in Earth orbit have demonstrated that this does not limit economic activities, nor impose undue restrictions on asset and capital protection and distributions. Article 2 dictates that outer space, including other celestial bodies, is not subject to claims of sovereignty, thereby limiting property ownership by any state. Activities will be conducted in the interest of peace and international cooperation, according to Article 3. In Article 6, each country is deemed to be responsible for its national activities in outer space regardless of whether they are conducted by governmental or nongovernmental agencies. The treaty further provides under Article 6 that the appropriate state, or the government of that country, is required to authorize and maintain continuing supervision of the activities of nongovernmental entities, generally understood to include private and commercial entities. When activities are international, then responsibilities and supervisory authority are shared by the participating state parties and the organization itself (see the Intergovernmental Agreement [IGA] governing ISS operations).

Article 8 governs the ownership, jurisdiction, and control over any space object launched under the auspices of any state and that object remains the property of that state regardless of location. In summary, the Outer Space Treaty would limit ownership of any real property in space but does not preclude commercial activities. Furthermore, any equipment launched by any state (or international organization) remains the property of the state or organization whether in space, on the Moon, or on any other celestial body.

The Agreement Governing the Activities of States on the Moon and Other Celestial Bodies of 1979, or the Moon Agreement, attempted to explicitly legislate any exploratory and exploitation activities of space-faring nations. Only 11 countries have ratified the Moon Agreement: Austria, Australia, Belgium, Chile, Kazakhstan, Mexico, Morocco, Netherlands, Pakistan, Philippines, and Uruguay. Five other countries have signed but not ratified the treaty: France, Guatemala, India, Peru, and Romania. None of the major space powers have been party to this agreement primarily because of its ambiguity regarding potential future activities, commercial ownership of recovered resources, and regulation of operations. Similar to the Outer Space Treaty, the Moon Agreement in Article 4 states that the use of celestial bodies ''shall be carried out for the benefit and in the interest of all countries, irrespective of the degree of economic or scientific development'' and that ''due regard shall be paid to the interest of present and future generations as well as to the need to promote higher standards of living'' (United Nations, 2002, p. 28). In Article 11, paragraphs 1 and 5, the Agreement further states that ''the Moon and its natural resources are the common heritage of mankind'' and any exploitation of resources shall be governed by an ''international regime'' (United Nations, 2002, p. 31–32). In paragraph 7 (d), the ''special needs'' of the developing countries shall be given ''special consideration,'' with the interests of the parties having contributed directly or indirectly in the exploration of the Moon. As Jack Schmitt points out in chapter 12 of *Return to the Moon* (2006), this echoes the redistribution language of the Law of the Sea Convention of 1982. In its current form, this agreement suffers from an apparent political objective of global distribution of any potential output without regard to the corresponding expenditure of effort or capital by the national or commercial sponsor of the future commercial enterprise. It will likely remain unratified by the major space powers because any future economic development must result in economic reward to the developers, whether they are national, international, or commercial entities. Without major changes, this document will never suffice as a governing document for future extraterrestrial activities.

THE INTERNATIONAL SPACE STATION FRAMEWORK

The ISS (Figure 2) is governed by the Agreement among the Government of Canada, Governments of the Member States of the European Space Agency, the Government of Japan, the Government of the Russian Federation, and the Government of the United States of America Concerning the Cooperation on the Civil International Space Station (National Aeronautics and Space Administration, 1998), more popularly known as the ISS IGA. The original agreement was signed in 1988 and the current agreement was signed in 1998 by the 14 countries participating in the construction and operation of the ISS: United States, Canada, Japan, Russia, and the member states of the European Space Agency (ESA)—Belgium, Denmark, France, Germany, Italy, Netherlands, Norway, Spain, Sweden, and Switzerland (Moenter, 1999). In addition, Memoranda of Understanding between the participating space agencies exist: National Aeronautics and Space Administration, Canadian Space Agency, Russian Space Agency (Roscosmos), ESA, and the Japan Aerospace Exploration Agency. The ownership of operations is governed by the assignment of utilization rights based on their respective shares of investment in the ISS facility. To simplify the technical and financial balancing, no exchanges of funds occur. Utilization rights and accommodations are bartered between the parties by the use of multilateral agreements. Negotiations among the partners do not occur at the governmental level but, characteristically, at the agency level.

One important factor in the ISS agreements not addressed in the previous treaties is the protection of IP. In the ISS agreement structure, intellectual property is protected based on the ownership of the laboratory element in which the invention occurred (Article 21 of the IGA). In other words, if an invention were to occur in the United States laboratory, the country of invention would be the United States. However, patents on the invention can be filed in any country; this condition is only to define the location of the invention for which IP protections may be asserted. However, inventors must have contractual

arrangements with their respective agencies to support these assertions and to delineate the future exploitation rights for any inventions.

In the ISS environment, there will be little in the way of resources to exploit. The primary output of ISS research activities is in the form of intellectual services. However, the ISS offers a business model for an international construct where access to the resources, in this case, the laboratories and crew time to deliver experimental results, is linked with the respective shares of investment of the parties. Although real estate, per se, does not exist on the ISS, the owning parties, for example, Japan for the Kibo module, hold jurisdiction over that environment. This could be an important distinction for future resource facilities on the Moon or other celestial bodies in the future.

Opportunities exist in commercial research in methods, materials, and processes aboard the ISS. The ISS will likely never become a manufacturing facility but follow-on vehicles may certainly be deployed to provide micro-g environments for the manufacture of materials that would be impossible to manufacture on Earth. Once high-value commodities are manufactured in space, the concept of ownership will be further cemented.

MODEL AGREEMENT FOR RESOURCE EXPLORATION AND MINING IN OUTER SPACE

In *Return to the Moon* (2006), Jack Schmitt (Figure 3) discusses the limitations to the existing multinational agreements including the Moon Treaty, UNCLOS, and Antarctic Treaty. He concludes that none of the current treaties or conventions would suitably address the commercial interests in future lunar prospecting. He proposes a private enterprise approach to this effort along the lines of existing consortia operating in the Earth orbital regime. However, to operate on the Moon and, eventually, Mars without a clear regulatory structure would form a significant limitation to capital investment in the form of political risk and no clear title to assets extracted. To avoid this limitation, a structure similar to the IGA governing ISS operations would allow commercial enterprises the regulatory structure to move forward. In terms of the facilities on the Moon and the ownership of the IP driving the techniques and tools, these would be protected under the principles outlined in the existing Outer Space Treaty and the ISS IGA. If a business model where a multinational consortium operates the facilities, the ISS IGA at the government level and Memoranda of Understanding (MOUs) at the agency and contractor level can be used to provide a management structure for the enterprise. Moreover, if the consortium was built with the participation of numerous governments, a cost-balancing scheme similar to the principles outlined in the ISS multilateral agreements would balance investment against return in the same way that ISS research facilities and crew time are allocated today. This is not very different from what Schmitt has proposed as consortia along the lines of Inmarsat and Intelsat but it does have the advantage of tying national, agency, and contractor functions and interests together.

FIGURE 3. Astronaut Harrison (Jack) Schmitt, Apollo 17, on the surface of the Moon in the Taurus-Littrow region during the heroic age of lunar exploration (photo courtesy of National Aeronautics and Space Administration).

The initial start-up expenses for any research station or resource exploration and/or extraction operation will likely be very large and risky to avoid government or, likely, international sponsorship of the construction and operation of the facilities. In this, it would be similar to ISS where no real claims to real estate exist but output from the station has real value. Contractors pay to have their payloads operated on the ISS but they retain the commercial and IP rights to their experiments. Oversight and operations are defined in the IGA and MOU documents, whereas the cost balancing and contract management are handled at the agency level. Distribution of the proceeds, once an economic opportunity is realized, would still need to be addressed.

Once this economic potential is recognized, the entanglements of redistribution economics seen in the UNCLOS and the Moon Treaty will need to be addressed. One option, similar to existing petroleum exploitation agreements within EEZ, would be an investment-weighted royalty system. In this instance, the commercial entities pay a percentage of the proceeds, in kind or in currency, into a reserve account. Distributions from this account will be delivered to the participating countries based on their investment factor. One way of determining the investment factor would be to calculate the total extraterrestrial investment made by the enterprise, whether national or commercial, and measure that against the total investment in the project. If the enterprise operated via governmental organizations or agencies, then a further weighting could be applied to balance rich-versus-poor national investments. In this way, the investment factor could be further weighted by determining a ratio of investment against the gross domestic product of that nation.

To address potential disagreements, no suitable judicial organization that would act as an arbiter between the parties currently exists. In the UNCLOS, a separate International Seabed Authority is charged with regulating operations, managing resources, and settling disputes via a tribunal process. The ITU, which handles satellite orbit assignments and manages the radio frequency spectrum, does not have a strong judicial arm and state-supported jamming of other satellites occurs with little recrimination or punitive actions. Without a strong judicial framework, any extraction or resource development activity will face potential conflicts between competing entities. An organization with regulatory as well as judicial authorities will be needed to manage resource allocation (e.g., mining leases) and to provide a strong judicial component to act in resolving disagreements. The World Trade Organization (WTO) may provide a model for such an organization.

THE WORLD TRADE ORGANIZATION MODEL

The WTO consists of 153 member states encompassing more than 97% of the world population. The primary function of the WTO is to define the international legal and commercial ground rules that regulate trading policies between nations. It also provides a forum for dispute resolution between member states (World Trade Organization, 2011). In this, it is more relevant to future efforts at mining lunar resources, resource exploitation of asteroids, and, ultimately, any potential Mars activities than the ITU model. In addition, the WTO has recognized the importance of protecting IP rights and has expanded the functions of the Agreement on Trade-Related Aspects of Intellectual Property Rights attached to the Marrakesh Agreement Establishing the World Trade Organization signed in 1994.

The members of the WTO operate within an agreed legal framework where disputes are reviewed within a multilateral system and findings, when necessary, are issued to resolve the dispute. The WTO also manages the tariff conditions between countries so that it acts as an arbiter within the marketplace as well. Furthermore, in the case of developing countries, the WTO provides technical cooperation and technical training, which meets the needs of expanding the opportunities and participation in the future enterprises by the nontraditional, if you will, countries.

CONCLUSION

Future economic development of the lunar, and eventually Martian, resources will someday be inevitable (Figure 4). Currently, a significant regulatory need that is not being addressed with current laws, treaties, or organizations is observed. The Antarctic Treaty can be used as an analog for developing an agreement outlining the functions and responsibilities of parties engaged in the second, or research,

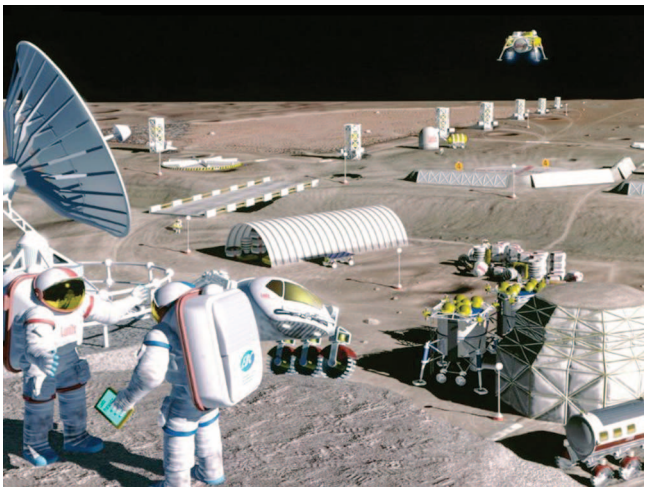

FIGURE 4. Conceptual lunar mining facility where jurisdiction and ownership of produced resources will be defined by the future space exploitation policy modeled on the International Space Station (ISS) Intergovernmental Agreement and Memoranda of Understanding between the participating parties (courtesy of National Aeronautics and Space Administration and artist Alan Smith).

phase of lunar exploration where the scientific objectives will hold primacy, but it is not a perfect extension to the third, or exploitation, phase. Eventually, resource development on the Moon and elsewhere in the solar system will require an expansion of the regulatory regime to meet the demands of the commercial sector. With no clear ownership of the lands holding these resources, a new regulatory and judicial body will be required to support exploration and exploitation operations. The ISS IGA model may offer a legal framework where the states negotiate the terms of agreement for the programs, identify the requirements, and forge agreements within the MOU process. Resource allocation and investment balancing are then accomplished at a multilateral agency (or company) level. To manage the resource environment and to resolve the inevitable conflicts, an agency modeled on the WTO may provide a set of both rules and techniques to manage this new supranational regime. The WTO model would also provide a means to resolve disputes with mandatory actions and recommendations binding to all parties. Finally, the Space WTO model entity would enforce the fiscal rules outlined in the IGA regarding participation rights and allocations of resources so that the political risk of redistribution economics that plague the UNCLOS and Moon agreements will not impede the extraterrestrial mining operations of the future.

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