Report of
the External Review Committee

外部評価報告書

March 11, 2013

2013 年 3 月 11 日

Department of
Earth and Planetary Science
Graduate School of Science
The University of Tokyo

東京大学大学院
理学系研究科地球惑星科学専攻

Table of Contents

I. Outline of the External Review Committee

1. External Review Committee

FY 2012 External Review Committee for the Department of Earth and Planetary Science, Graduate School of Science, The University of Tokyo

2. Date and Place

The committee session was held on January 10 – 11, 2013 at the Department of Earth and Planetary Science, The University of Tokyo, Hongo, Tokyo. Prior reviews in writing were made via e-mails before January 10.

3. Committee Chair

Shun-ichiro Karato（Professor, Yale University）

4. Committee Members

Kimio Hanawa (Professor, Tohoku University)
Tadashi Mukai (Emeritus Professor, Kobe University)
Isao Koike (Emeritus Professor, Univ. Tokyo, now at University of the Ryukyus)
Hiroshi Kitazato（Research Director, JAMSTEC）

5. Members for review in writing

Atsuhiro Nishida（Emeritus Professor, JAXA）
Kelvin Richards（Professor, Univ. Hawaii）
Bruce Fegley（Professor, Washington Univ., St. Louis）
James Kasting（Professor, Penn State Univ.）
J. Casey Moore（Emeritus Professor, Univ. California, Santa Cruz）
Judith McKenzie（Emeritus Professor, ETH）

6. Schedule

Date	Time	Subject	Description	Duration	Attendees of the Department	Venue
						Science Building 1
Thursday, January 10	9:45	Assembly of members	Explanation of the schedule		Department Head (Ozawa)	Room 843
	10:00 - 10:50	Overview of the Department	Explanation & Qs and As	Presentation 30min., Qs and As 20min.	Department Head (Ozawa), Nagahara, Hibiya, Program Heads (Sugiura, Kimura), Chairman of Educational Committee (Kondo), Chairman of Accounting Committee (Tada), Hoshino, Endo, Sato	Room 710
	10:50 - 11:40	Atmospheric and Oceanic Science	Explanation & Qs and As	Presentation 30min., Qs and As 20min.	Speaker Hibiya: All the Group members	Room 710
	11:40 - 13:00	Lunch			Department Head (Ozawa), Tozuka, Amano, Ikoma, Iizuka, Tsuihiji	Ito International Research Center
	13:00 - 13:50	Space and Planetary Science	Explanation & Qs and As	Presentation 30min., Qs and As 20min.	Speaker Hoshino, Sugiura: All the Group members	Room 710
	13:50 - 14:40	Earth and Planetary System Science	Explanation & Qs and As	Presentation 30min., Qs and As 20min.	Speaker Kayane: All the Group members	Room 710
	14:40 - 15:10	Break				
	15:10 - 16:00	Solid Earth Science	Explanation & Qs and As	Presentation 30min., Qs and As 20min.	Speaker Kimura: All the Group members	Room 710
	16:00 - 16:50	Geosphere and Biosphere Science	Explanation & Qs and As	Presentation 30min., Qs and As 20min.	Speaker Murakami, Endo: All the Group members	Room 710
	16:00 - 17:20	Discussion with Graduate Students and PDs			10 Graduate Students & PDs, Department Head, and a few faculty members	Room 710
	18:00 - 20:00	Banquet			Department Head (Ozawa), Program Heads (Hoshino, Kimura), Hibiya, Sato, Koike, Iwagami, Yokoyama, Nagahara, Tada, Kayane, Geller, Murakami, Endo, Kogure	Matsumotoro
Friday, January 11	9:50	Assembly of members	Explanation of the schedule		Department Head (Ozawa)	Room 843
	10:00 - 11:50	External Review Committee	Discussion	External Review Committee members only		Room 843
	11:50 - 13:20	Lunch			Department Head (Ozawa), Miura, Yoshikawa, Takahashi, Ide, Suzuki	Capo Pellicano
	13:20 - 15:00	Qs and As	Follow-up Qs and As		Department Head (Ozawa), Nagahara, Hibiya, Program Heads (Sugiura, Kimura), Chairman of Educational Committee (Kayane), Chairman of Accounting Committee (Tada), Murakami, Endo, Hiyagon	Room 710
	15:00 - 16:00	External Review Committee	Reviewing discussion	External Review Committee members only		Room 843
	16:00 - 17:00	Reporting	Reporting on results		All the faculty members	Room 710

II. Report of the External Review Committee of the Department of Earth and Planetary Science, University of Tokyo, January 2013

This report summarizes the deliberations of the External Review Committee for the Department of Earth and Planetary Science, University of Tokyo held on 10th and 11th of January, 2013. Report of the educational and research activities of the Department was produced by the Department and distributed to us prior to the meeting of the Committee. The members of another Review Committee (prior review) were also requested to submit their comments to the above Report. We used their comments for reference but drafted our recommendations entirely based on our own viewpoint. Names of the Members, Schedule of the Meeting, and comments of the earlier Committee members are attached to this report. In the following, we report the review following the guideline provided by the chair of the department.

1. Review of Each Group in the Department

(1) Atmospheric and Ocean Science Group

The atmosphere and ocean form a mutually interacting system, and consequently, if we want to understand one, we need to understand another. One of the important themes in this area is to understand the actual features of climate change and to identify its mechanisms, and to explore the prediction of future climate change. This group consists of four sub-groups that have been studying above themes in various ways.

The group of atmospheric physics studies the influence of gravity waves on the atmospheric circulation in the boundary layer and in the stratosphere through observations, data analyses, and numerical modeling. Recently this group started PANSY (Antarctic Syowa MST/IS Radar Program), and in May 2012, they have begun routine observations on the three dimensional wind velocities in the lower and upper atmospheres as well as the plasma parameters in the ionosphere. This project is expected to contribute greatly to our understanding of atmosphere circulation by providing key observations.

The ocean dynamics group investigates the processes of turbulent diffusional mixing in the ocean, a problem that has been poorly understood. They conduct multifaceted approach including observations, data analysis, numerical modeling, and have mapped the intensity of turbulent flow, and proposed a mechanism of generation of turbulent flow called PSI (parametric subharmonic instabilities), and demonstrated that tidal current-induced mechanism of turbulence generation plays an essential role. This group is a clear leader in this area.

The climate dynamics group studied various modes of climate and their influence on short-term climate change. Particularly notable is the discovery of a new mode “El Niño Modoki” in addition to the previously known Indian Ocean dipole. This new mode was shown to affect the atmosphere differently from previously known modes, and this discovery attracted a strong attention from the scientists throughout the world.

The atmosphere-ocean materials science group collaborates with a group of Earth and Planetary system science and conducts aerosol measurements using airplanes. Such studies have made

important contributions to understand the influence of aerosol on the formation of clouds. This group is supposed to have a sub-group to study materials circulation in ocean, but this position is still open.

In summary, all four sub-groups in this group are world leaders in this area. However, currently there are only eight faculty members that may not be enough. As pointed out above, there is an open position in this group. It is critical to identify appropriate faculty member for this position and the reorganization of this group might be considered. It is recommended that faculty of this group conduct more collaborations with other scientists in this department as well as scientists in other institutions.

(2) Space and Planetary Science Group

This group contains three sub-groups, namely space-planet plasma group, planetary atmosphere group and terrestrial planets group. The former two groups study elementary processes, structure and dynamics of space and planetary atmospheres, and the third group studies the formation and evolution of planets, solar system through the analyses of meteorites and the data obtained by space exploration.

The plasma group investigates the processes of particle acceleration through theoretical modeling, and also studies the structures of magnetic field of the Sun. These are world-class contributions and they trained a number of graduate students. The planetary atmosphere group designed an infrared camera that was installed in the Venus exploration mission "Akatsuki". However, this mission was unable to get into the orbit and therefore the data has not been obtained. We hope that they will succeed in the next try.

The terrestrial planets group has made contributions to the early evolution of the solar system through the studies of meteorites. However, in comparison to the exciting research in this area such as the "Hayabusa" mission, the research activities in this sub-group are less than expected.

As pointed out in the previous external review, it is important for this sub-group to expand their studies to broader themes related to the formation and evolution of terrestrial planets. We understand that this has been made partly by hiring a few faculty members and scientists in Earth system science group. However, closer coordination among different groups will be needed to become a leading group in the studies and education in this area of science.

The directions of studies in this area include exploration of planetary magnetic fields (magnetospheres) and planetary atmospheres, direct observations of atmospheres of exo-planets, origin and evolution of exo-planets. This group at University of Tokyo is expected to be one of the leaders in this area, and to do this it is urgent to establish a world-class research group in which they train students and young scientists. It is important to make a major re-organization of this research group.

(3) Earth and Planetary System Science Group

It is well recognized that system science approach is effective and necessary in the study of Earth that is made of various sub-systems including atmosphere, hydrosphere, solid Earth and biosphere. This group in the University of Tokyo has an ambitious goal of conducting system

science style of research on not only Earth but also on other planets (planetary formation and evolution). The themes of studies in this group can be classified into five: (i) formation and evolution of planets, (ii) formation and evolution of habitable planets, (iii) dynamics of atmosphere, (iv) variation of the surface environment on Earth and (v) dynamics of Earth's surface system.

Senior faculty members in this group have world-class reputation for their studies. A group of atmospheric chemistry is a world leader in the study of aerosol that is a key area in the climate studies. They developed their own new technique of measuring aerosol, conducted chemical analysis of black carbon, and developed a global model of aerosol. This is a world- leading group in this area. Two groups study paleo-environments. In one group they study coral reef that is sensitive to the environmental variation including global warming. They study ecological system using the system science approach, and this group is recognized as one of the world leaders. Another group studies paleo-oceanography of the Japan Sea, and investigates Quaternary evolution of environment including hydrology in the east Asia and variation in Asian Monsoon. Planetary science group has important contributions in the area of early evolution of the solar system with a focus on the combination of physical and chemical processes through experimental and theoretical approaches. Recently they expanded their studies to exo-planets. Another group in planetary science is a world leader in the study of formation and evolution of planetary atmospheres with the emphasis on the interaction between the magma ocean and the atmosphere. These senior members are well recognized in Japan and obtained a major funding from the government.

In summary, we recognize that individual members of this group conduct high quality cutting edge studies on exciting new subjects. Studies in this group have potential of developing new interdisciplinary fields. However, one limitation that we recognize is the fact that the collaboration among faculty members in this group has not been extensive. In particular, it is unclear to the review committee how this group has established their group as a leader to promote system science style of studies in collaboration with faculty members in other groups. This group has high potential for generating new areas of Earth and planetary science. In order to make the presence of this group as a unique resource in the department, department-wide discussions are essential to help grow this potentially important group.

(4) Solid Earth Science Group

Solid Earth science is historically a key area of Earth science including geology and solid Earth geophysics such as geodesy and seismology. University of Tokyo has been a world leader in many of these areas. As a result, University of Tokyo has research institutions such as Earthquake Research Institution where a large number of solid Earth scientists are located.

Currently, this group has three full professors, three associate professors and three assistant professors. Petrology group has made important contributions in the area of theoretical analyses of microstructures and composition of natural rocks as well as deformation of rocks. Studies in this group emphasize non-equilibrium aspects of this issue, and go beyond the classic equilibrium thermodynamics approach. In some cases, studies go beyond Earth and there is close collaboration between this group and Earth system science group to study the processes of planetary formation.

Tectonics group studies the tectonics of subduction zones through geological approach. This

group studies the structures of geological samples to understand the processes that occur in subduction zones. Particularly notable is their contribution to the understanding of the dynamics of accretionary prism in the Nankai trough through the analyses of structure of sediments collected by the deep sea drilling. Recently, this group also conducted a similar study in the Tohoku area where magnitude 9 earthquake occurred in March 2011. These studies play a key role in our understanding of the processes of earthquake generation and propagation in these environments. These studies also contribute to our understanding of evolution of island arcs. In collaboration with JAMSTEC, they use the advantage of Japan being located close to many subduction zones. This group is a world leader in this area of study.

Seismology group studies Earth structure from seismological records and the processes of earthquake generation. One of the focus points in this group has been to develop a new numerical method to interpret seismograms. The main emphasis has been technical aspects, but recently with some of the students from this group, they also started to pay attention to apply these methods to geodynamic problems. Also important is the study of "slow (low frequency)" earthquakes. A model developed by this group had a strong impact in understanding these new types of earthquakes.

In summary, individual faculty members in this group have important contributions to solid Earth sciences, but the contributions from this group as a whole is in short compared to what we expect as a world leader. What is missing is the integrated view to define new directions in the solid Earth science. Closer collaboration among faculty members in this group as well as the collaboration with scientists in other institutions, particularly those in the Earthquake Research Institute is recommended.

(5) Geosphere and Biosphere Science Group

Biogeosciences or geobiosphere sciences are the braches of science where origin and evolution of life on Earth and planets, and the impact of life on the evolution of environment are studied. This is a relatively new area in which rapid progress is being made in the 21st century. This area is recognized as one of the frontiers in the world scientific community. The review committee is pleased to note that the department of Earth and planetary science at the University of Tokyo identifies this area and plans to develop this area of science.

After the establishment of this group, efforts have been made to reconsider the pre-existing small groups and unify them. Two Professors who recently retired are the leaders in their respective areas. Well-known contributions from these professors include the study on paleo-biology in particular the study on ammonites, and the interdisciplinary ore petrology through the study on the behavior of high-temperature fluids and metal ore formation.

Currently active faculty members conduct broad range of studies including studies on paleo-surface environment through the studies on mineral formation in soil, studies on the molecular processes of fossilization of invertebrate animals. However, their studies are not well integrated and as a result, this group has not shown a leadership in this branch of science. Further effort is needed to make this group as a forerunner in this area.

The first step is to define a major goal as a group, and then coordinate research efforts through various related themes. These themes may include bio-mineralization, origin of life and early

evolution of life. It is important to use the opportunity of hiring new faculty members to establish new areas. Particularly important is to hire a faculty member in the area of bio-geochemistry. It is also important to collaborate with scientists in neighboring areas to establish a new community. Collaborations with scientists in other institutions including those in the overseas are critical.

Geo-biosciences are new areas of study. To develop a new area, it is important to re-consider pre-existing areas, and make bold modifications to the existing research and educational structures

2. Review of the Department

(1) Structure of Studies in the Department

The research in this department is coordinated through five big groups. Among them four (atmospheric and ocean science, space and planetary sciences, geosphere and biosphere sciences, solid Earth sciences) are defined based on the research subjects. In contrast, the fifth group, Earth and planetary system science, is defined based on the approaches. As discussed in the previous sections, it is not clear if this group is functioning as effective as expected. Research subjects of different sub-groups in that group are so diverse that collaboration among members in that group seems not extensive. Rather, collaborations seem to be made mostly among the scientists whose research subjects are common. System science approach is important in most areas of Earth and planetary sciences, and it is time to re-consider the structure of groups particularly the role of Earth and planetary system science group.

One issue that was noted by the previous (2006) review committee as well as this review committee is the weakness of collaboration among different faculty members. In the previous external review, it was pointed out that this causes a difficulty in obtaining big funds. We agree that this is a weakness; the tendency of group funding in Japan can be considered as a weakness. We appreciate the importance of big projects in Earth and space science (e.g., space mission, ocean drilling), but the risk of a big project is that it is difficult to nurture creative minds through these big projects.

Perhaps more serious problem is that the vision of a scientist becomes narrow if communication (or collaboration) with scientists in other areas is lacking. Through discussions with scientists in other areas, a scientist will obtain hints on new areas or themes of research that is a key for the creative science. If isolated too much, science tends to become highly technical and it is difficult to maintain the leadership.

It was also pointed out in 2006 review that this department should strengthen geochemical aspects. There have been some efforts particularly in atmospheric chemistry, but the department needs to strengthen geochemistry in many other areas including bio-geoscience, planetary science and other areas.

(2) Education

In 2000, previously existing four departments (Geology, Mineralogy, Geophysics, and

Geography) have been merged to establish the department of Earth and Planetary Sciences. This merge was made based on the idea that modern Earth science is highly interdisciplinary and education must be made with a broad vision. In contrast to this view, the undergraduate education in this department is made based on two separate areas: “Earth and planetary physics” and “Earth and planetary environmental science”. The chair explained that this is to recruit good students. However, the committee does not fully agree with this, and believes that the better way to recruit good students is to advertise the excitement and importance of Earth and planetary science as a highly interdisciplinary science.

This Department has a number of adjunct faculty members from the Research Institutes and Centers in and outside the University of Tokyo. Their presence has been instrumental in expanding the area of research, but the role of faculty members in these institutions is limited in education. We recommend that they should contribute to teaching more including some undergraduate courses. In the same token, we recommend that the department should use the visiting lecturer system to teach a broad area of Earth and planetary science beyond what can be covered by the faculty members at this department.

Regarding the education in the graduate school, there is a need for providing a broad background. A graduate student is trained to become a scientist during his/her thesis studies. To become a scientist, one needs to learn some basic “tools (techniques)” (learn how to solve a problem) but one also needs to obtain a broad background. Broader knowledge learnt with a critical mind will help a student to identify a good problem. Earth science is unusually interdisciplinary, and the new developments in Earth science often occur through the interaction of different areas. In developing such a broad interdisciplinary curriculum, interdisciplinary collaboration among faculty members will be enhanced.

The committee also recognizes that a large fraction of students, even after PhD, may take a job in non-academic areas. The committee understands that career counseling for these students is provided at the department or at a broader level. It is important to maintain these activities.

Mentoring young faculty members (assistant professors, “Jokyo”) is important. These young faculty members will define the future of this department, but conducting research and education is a challenge for junior faculty members. The committee suggests that the department may introduce a mentoring system where, perhaps two mentors (selected from senior faculty members) are assigned to one junior faculty to help develop their career.

(3) Internationalization

There are only limited number of foreign (and women) faculty members and students in this department. More seriously, the number of foreign students in this department has been declining. We notice that these trends at this department are even worse than many other Universities in Japan or other departments at the University of Tokyo. This trend (less foreign students) is in contradiction to what the president of University of Tokyo emphasizes.

One practical reason is the fact that not many home-pages of faculty members are attractively prepared in English. In these days, a majority of students who apply for the graduate studies choose the institution based on the knowledge that they get from home-pages. Better home-pages will help

attracting more students from overseas.

Also, the faculty may teach some of the courses in English as they do in the department of chemistry.

Using OIYR, GCOE and other funds, a large number of graduate students and/or young scientists have been sent overseas for a short period (for meetings and/or short-term internship). This is highly successful and should be continued. However, longer-term activities in overseas (post-docs, faculty members in the over-sea institutions) are still highly limited.

(4) Organization and Administration

In terms of organization and administration, the personnel affair is by far the most critical. The most important issue for a leading institution is to attract and keep world-class scientists. In order to attract and retain first class scientists, it is essential to conduct fair decisions on the personnel affair including the selection of new faculty members and the promotion of existing members.

We notice that a few world-class faculty members left this department during the last a few years. This is a serious issue. It is essential to make appropriate promotion, and to maintain good research environment in order to attract top-notch faculty members.

As the review committee understands from the materials that we obtained, it seems that each five group possesses a certain number of faculty positions (a certain fixed number of faculty positions are allocated to each group). The review committee considers that the number of faculty positions for each group should not be fixed. The number of faculty positions for each group must be flexible, and the distribution of faculty members among different groups should be discussed by all faculty members. These discussions naturally lead to a discussion on the future direction of Earth and planetary sciences. We understand that these discussions, i.e., the discussions on the future directions have been held. These discussions must include the discussion on the distribution of faculty members including new hires and re-distribution of existing faculty members.

The committee also noticed that about 80 % of the faculty members are the graduates of University of Tokyo. This could stagnate the research activities. Similarly, the number of women faculty members is small. Faculty search must be made openly to attract best candidates throughout the country and the world.

In the critical discussions such as personnel affairs or the discussions on the future direction of the department, the chair should take a leadership. In order to secure the leadership of a chair, the role of the chair and his/her term should be re-considered. We understand that the term of the chair was changed from one year to two years. We consider that two years may still be too short. A chair may appoint a committee on important issues (e.g., new hire, promotion of a current faculty) and let the committee discuss a particular issue. To help the chair, it will be helpful to form an advisory committee made of members from each group. Also it is important to allocate discretionary funds for a chair to help his/her activities.

The review committee got an impression that mutual interaction among various sub-groups is not active at this department. We suggest that a weekly seminar series where hot issues on various branches of Earth and planetary science are discussed by the top scientists throughout the country (possible from other countries). All graduate students and scientists should attend such seminars. We

understand that young members of this department are already organizing interdisciplinary seminars. We strongly support these activities.

During the last several years, the financial support from Japanese government has declined dramatically. Particularly serious is the reduction of support for technical personnel. This is serious in research areas where the operation and/or maintenance of large-scale equipment is critical. Efforts are needed to support technical personnel through internal and/or external funding.

III. 2013 年 1 月東京大学地球惑星科学専攻外部評価委員会報告書

今回の評価は 2006 年に続くものである。その当時、指摘された問題への対応や、その後に起こった、大学での研究や教育に対する政府など外部からの援助の変化、この学問分野の進展、学生の社会進出の仕方の変化などをふまえて、東大地球惑星科学専攻科の研究、教育活動を外部から評価し、今後の研究教育活動の発展の助けになることを目的にして行われた。

東京大学での外部評価委員会は、2013 年 1 月 10 日、11 日に開催された。 評価委員会に先立って、５名の各評価委員と６名のメール評価委員には小澤専攻長から研究、教育に関する詳細な資料が送られた。この資料には各研究者の研究成果、研究資金の獲得状況のみならず、学生の分布、卒業後の進路の追跡結果なども含まれている。また、評価の当日には、専攻長からの全体的な説明に続き、５つの各グループの代表者から研究教育内容の説明がなされた。また、評価の第１日の午後には、評価委員からの要請により、大学院生と若手研究者と評価委員との対話の機会も持たれた。

以下の報告はこの評価委員会での検討に基づいて提出された５名の評価委員の報告と、別にメールで送られた６名のメール評価委員からの報告に基づいて作成された。

以下では、専攻長から送られてきた「審査評価項目」に従って、（１）各研究グループの研究内容の評価、（２）専攻全体の研究体制、（３）学部と大学院の教育、（４）国際性、（５）組織と運営、（６）社会貢献という６点にわたって評価結果をまとめる。

1. 各研究グループの研究内容の評価

(1) 大気海洋科学講座

大気と海洋は相互作用系を成しており、一方の深い理解のためには他方への十分な理解をも必要としている。この分野の重要課題は、気候の変化と変動の実態把握とそのメカニズムの同定、さらにそれらに基づく数値モデルを用いた将来予測の可能性の追求である。大学院理学系研究科地球惑星科学の本分野は４グループからなり，上記の課題にそれぞれの側面から研究をすすめてきた。

大気物理学グループでは、大気境界層から成層圏に至る領域で、重力波が大気循環に及ぼす影響を、観測、データ解析、数値モデル実験から研究を進めてきた。近年は南極昭和基地大気レーダー計画(PANSY)を進め、2012 年 5 月に対流圏、成層圏定常観測の開始に至った。今後のデータの蓄積によるこの分野の飛躍的発展が大いに期待できる。

海洋力学グループは、この分野で最も実態把握が遅れている海洋中の乱流拡散混合について、現場観測とともに理論、数値シミュレーション手法を用いて精力的に研究を進め、乱流強度のマッピングと PSI と称される乱流発生メカニズムを提唱し、潮汐流による乱流発生が本質的であることを実証した。これら一連の研究は世界のフロントランナーである。

気候力学グループは、この間気候モードの抽出とその世界の短期気候変動への影響について精力的に研究を進めた。とりわけ既に発見されていたインド洋ダイポールモードに加え、「エルニーニョもどき」モードを発見し、エルニーニョとは異なる大気応答を出現さ

せることを見いだし、世界中の注目を集めた。

大気海洋物質科学グループでは、地球惑星システム科学講座と連携して、航空機によるエアロゾル現場観測を行い、雲形成に与える影響を研究している。本グループは海洋の物質循環も対象にすることになっているが、現在担当教員はいない。

以上概観してきたように、４グループから成る大気海洋科学分野は、この間、世界最先端の研究業績を挙げていると評価される。しかしながら、現在特任教員を含めて８名と、必ずしも十分な研究者が配置されている分野ではない。その意味で、空席となっているポストを埋める今後の人事はきわめて重要なものであり、また、グループの再編、見直しも考慮すべきであろう。何れにしても少ない教員であるので、専攻内、外との共同研究を推進、強化し、研究水準の維持と成果の量的確保を図るべきと思われる。

(2) 宇宙惑星科学講座

惑星、惑星圏、太陽圏、宇宙空間の各領域における素過程、構造、ダイナミックスの特殊性、共通性、領域間の相互作用の解明を目指す「宇宙惑星プラズマ」と「惑星大気」のグループに加えて、隕石などの分析と惑星探査データなどに基づいて太陽系の形成、進化や、小天体の起源の解明をめざす「固体惑星」グループが、この講座を構成して、教育、研究活動を行っている。

「プラズマ」グループは理論シミュレーション研究において、磁気圏内部の粒子加速機構の解明、太陽表面磁場の構造解析等において世界的業績を挙げ、大学院生の育成にも成果を挙げている。「大気」グループは、惑星の光学探査を目指して金星探査計画（あかつき）の搭載赤外線カメラを開発したが、当初の金星軌道突入に失敗したために、予期したデータは得られていない。今後の金星周回軌道への再突入に期待したい。「固体」グループは、隕石を用いた太陽系最初期の物質進化に関する研究で一定の成果を挙げているが、始原物質の回収計画（スターダストやはやぶさ計画）がこの分野の最先端を走っている現状から見て、物足りなさを感じる。

前回の外部評価で指摘された、より広い固体惑星研究への進出が必要であるという指摘は、地球惑星システム科学講座への関連分野のスタッフ導入で一応の成果が期待されるが、世界最先端の研究と教育の拠点になるためには、よりいっそうの改革が必要であろう。

この講座が目指す研究課題の世界的な流れは、惑星磁気圏、大気圏の探査実施、系外惑星大気の直接観測の実現、系外惑星の起源と進化の基礎理論構築に向かっている。当専攻は世界の流れを先導する役割を期待されており、そのための若手人材の養成、研究拠点への基盤整備が急がれる。思い切ったグループの再編が必要であろう。

(3) 地球惑星システム科学講座

大気圏、水圏、固体圏、生命圏から構成される地球、特に地球の表層圏を研究するときにシステム科学的なアプローチが有効でありかつ必要であることは、この分野の研究者の共通理解となっている。地球惑星システム科学分野は太陽系を含む惑星系にもこの考え方を拡張して研究を行うことを目指した、挑戦的な研究分野ということが出来る。当分野

の研究内容は、惑星系の形成、進化、生命居住可能惑星（ハビタブル惑星）の形成、進化、地球大気システムの変動、地球表層環境システムの動態、地球表層システムの変動の５つに分けられる。

この研究分野に属するシニアの教員は各分野で国際的にも研究業績を高く評価される研究を行っている。ひとつのグループは、気候変動の大きな不確定要因であるエアロゾルに観測方法の開発から始まって、ブラックカーボンなどの組成分析、全地球規模でのモデル作成など幅広くインパクトのある業績を挙げ、この分野の世界に於ける代表的な研究グループになっている。また、他のグループでは、海洋の生態系において温暖化影響に敏感な珊瑚礁を研究対象として生態系のフェーズシフトをシステム科学的なアプローチで解析しこの分野をリードしている。さらに日本海での古海洋学的な研究から東アジアの水環境とアジアモンスーンの変遷まで第４紀における環境変遷を幅広い視点から優れた研究を行っているグループもある。また、惑星科学グループでは、惑星の初期形成過程における物理過程と化学過程の相互作用に関する実験的、理論的研究で顕著な業績があり、さらに系外惑星の一般的な形成理論まで研究を拡大している。惑星科学の理論的な側面では、地球型惑星の形成時におけるマグマオーシャンと大気との相互作用に関する研究、大気、海洋の進化に関しても世界的な業績を挙げている。

さらに、これらのシニアな教員は大型研究費である科学研究費新学術領域研究の代表者、同基盤研究Ｓの代表者としても国内的にも評価されている。

以上のように、当該大講座の教員のそれぞれは優れた業績を挙げており、また将来性があり先端的な研究目標を持っていると評価できる。特に、境界領域を切り開く研究課題の多いのがこの大講座の特徴と思われる。一方、この大講座は、極めて幅広い分野の教員から構成されているため、大講座を構成する４名の教授はそれぞれの分野のリーダーとして活躍している一方で、研究課題として重なる部分が少ないように思われる。もちろん、講座内外の准教授、助教との共同研究は多いが、システム科学的なアプローチを共通項としての講座としての求心力は他の講座に比べて弱いと感じる。この講座がユニークな実績のある分野として地球惑星科学でどう成長していくかは、講座の構成員のみならず専攻全体としての意識改革が必要と思われる。

(4) 固体地球科学講座

この分野は地球物理学、地質学という地球科学の根幹のひとつを担う伝統的な分野であり、東京大学はこの分野の日本及び世界の指導的役割を果たしてきた輝かしい歴史を持っている。その輝かしい歴史の遺産の一つとして、世界でも類をみない地震研究所があり（物性研究所にも１部門固体地球に関連した部門があった)、世界的にみても多数の研究者を抱えた大きな部門である。

外部評価のために送られてきた資料に基づくと現在３人の教授、３人の准教授、３人の助教がこの部門に所属している。

岩石グループでは岩石の組成や微細構造の理論的解析、岩石変形の研究でユニークな業績をあげている。特に、今までの平衡熱力学の枠を出て、非平衡、つまり、ダイナミクスに関連した研究に意欲的に取り組んでいる。この手法を惑星形成期の蒸発、固化過程に

も応用して、他の大講座（地球惑星システム科学）の研究者と協力した研究成果も挙げられている。

テクトニクスグループでは、とくに沈み込み帯の研究を地質学的方法、すなわち、実際に採集した岩石資料の構造を解析して明らかにする研究を行ってきた。とりわけ重要な研究は南海トラフや東北沖での深海掘削による海底堆積物構造の研究であり、沈み込み帯で起こる地震のメカニズムを理解する上で、また島弧の形成過程を理解する上で非常に重要な研究である。このグループは JAMSTEC などとの連携した研究で指導的な立場で広汎な活動を行っており、日本のおかれた地質学的環境を利点にし、世界をリードする先端的な研究をしている。

地震学グループでは理論地震学を専門にした研究を行い、とくに地震波の記録を詳しく解釈する理論的方法の開発に力を入れてきた。その研究では技術的な側面が強調されてきたが、最近、この研究室から輩出した若手研究者によって、このような方法の地球ダイナミクスへの応用もなされるようになった。またこのグループでは、低周波地震など最近日本で発見された興味深い現象の解釈で世界的な業績を挙げている。

このように、この部門では個々の研究者はそれなりに重要な業績を挙げているが、講座全体として見た場合、世界をリードすることが期待されている東京大学の地球惑星科学専攻の１部門としてはやや不足する点は否めない。特に、痛感するのは地球惑星科学としての将来の方向を示すようなリーダーシップの不足である。固体地球科学では色々な分野を総合し新しい地球（惑星）観を建設する作業が重要であるが、異分野間の研究者が連携して大きな仮説を出し、それを検証していこうという動きは書類で見る限りあまり見られなかった。また、多くの研究者を擁する地震研究所との教育や研究でのより密接な連帯関係も必要であろう。

(5) 地球生命圏科学講座

地球生命科学（Biogeosciences）あるいは地球生命圏科学（Geo-biosphere Sciences）は、地球惑星における生命の起源と進化、そして、地球と生命の相互作用に基づく環境変遷を議論、解明する研究分野である。２１世紀に入って急激に成長を遂げている。欧米の科学者コミュニティでは、地球惑星科学の将来性ある分野として認知され、市民権を得ている。東京大学大学院理学系研究科地球惑星科学専攻が、この分野を研究の柱の一つとして立て、推進しようとしていることは大いに評価する。

地球生命圏科学大講座が、発足後、既存の関連小分野の見直しと統合を目指し努力されていることについて、まずは敬意を表する。昨年、停年退職した、あるいは本年度に停年退職する教授は、いずれも、それぞれの分野を牽引し実績をあげている。たとえば、アンモナイトを中心とするパレオバイオロジーの研究や、地殻内高温流体の挙動と金属鉱床形成に関連して地下圏微生物研究を含めた学際的な研究などがその例として挙げられる。また、土壌形成時の鉱物形成の実験的検討から、太古代における地球表層環境を論じた研究も重要である。他にも無脊椎動物が石灰化する分子機構の研究や、それに基づいた生物進化の議論なども興味深い。それぞれの教員はユニークな研究を行っており、いずれも高い研究ポテンシャルがあることを認める。しかし、そのポテンシャルが新しい研究分野に

向いた動きになっているかどうかという視点で見ると、お互いが独立しており、統合された成果につながっていない。今後、幾つかの工夫が必要である。

まず、大講座全体に共通する目標を立て、それに向けていくつかのテーマで研究することが必要であろう。例えば、生鉱物化作用、生命の起源と初期生命進化等のテーマがある。また、これから予定されているいくつかの人事を新分野形成の機会とする必要があるだろう。とりわけ、分野の共通言語になりうる生物地球化学に関する研究者の導入が鍵である。また、分野形成に必要な近隣分野との積極的な連携を目指すこともコミュニティ形成という視点から重要である。その際は、東京大学の内に閉じることなく、分野を先導する国内外の大学あるいは研究機関との積極的な交流を考えるべきであろう。

地球生命科学は、伸張著しい研究分野である。新分野の創成には既存分野の大規模な見直しが必要であり、大胆な改革を行うことを期待する。

2. 専攻全体の評価

(1) 専攻全体の研究体制

専攻全体の研究体制の問題の殆どは運営と組織の問題でありそちらで幾つかの問題を指摘したのでその節を参照していただきたい。

研究体制としては５つの大講座制（大気海洋科学、宇宙惑星科学、地球生命圏科学、固体地球科学、地球惑星システム科学）がとられている。このうち、最初の４つは自然な、研究対象によった分類であるが、最後の地球惑星システム科学講座は、研究手法で特徴つけられた講座という点でユニークである。しかし、実際に地球惑星システム講座に属している教員の研究内容を見ると、この研究体制のあり方がうまく機能しているかどうか、必ずしも明らかではない。この講座には、惑星科学、環境科学等に属する研究者が所属しているが、研究対象はこれらの分野間で大きく異なるため、システム科学に属する教員間では相互の連携が薄いように見える。むしろ、実際の連携は、研究対象の近い他の分野（例えば大気海洋や固体地球）の教員となされているようである。システム科学的な研究手法は、上記の４部門のどの研究でも用いられるものである。方法によって定義された大講座が存在意義のあるものなのかは検討されるべきであろう。

分野によって多少の違いはあるのであるが、東京大学の本専攻の研究者に共通する問題点の一つとして、連携の薄さが指摘されている。特に前回の評価でもこの点が指摘され、そのため、大きな予算を獲得しにくくなっていることが弱点として挙げられる。しかし、逆に、日本では、研究者集団として獲得する研究費が多額になっており、この点はむしろ研究を弱体化している側面もある。研究には色々な性格のものがあり、宇宙探査など、巨額の研究費が必要で集団的な研究方法が不可欠の分野も地球惑星科学には多い。しかし、この集団を強調した研究方法では、個人の独創的な発想による研究が育ちにくいという欠陥もある。

異なった分野の研究者の連携の薄さが問題になるもう一つの側面は、異分野の研究者との接触を欠くことにより研究者の視野が狭まり、研究成果に発展性が欠けていくことで

ある。色々な研究分野との交流があれば個々の研究者は新しい刺激を受け、独創的な発想が自然に湧いてくるであろうが、あまりに孤立した研究者の場合、研究が技術化し小粒になりがちである。

また、2006 年の外部評価でも指摘されたことであるが、化学関係の研究者層が薄いという問題は依然として存在している。大気化学の分野では強化が有効に行われたが、固体地球惑星科学、生命科学関係ではまだ層が薄い。このような分野では同位体等を使った強力な手法が物質移動過程の追跡や、時間軸の導入に世界的に使われている。この分野の研究者の採用を考慮する必要があろう。

(2) 学部と大学院の教育

2000 年に、それ以前、別々の専攻として存在していた地球物理学、地質学、鉱物学、地理学専攻が統合されたのは、これらの個別の学問が相互に関連しており、総合的な視点がこの学問分野でより重要になってきているという認識に基づいていたはずである。それにもかかわらず、学部の教育が地球惑星物理学科と地球惑星環境科学の二つに分かれているのは、学科統合の目的に反するもので、適切ではないであろう。その理由として「進振り（進学振り分け）」対策であるとの説明を受けたが、より優秀な学生をこの学科でとるための方策は、総合科学としての地球惑星科学の魅力を学生に伝えることであろう。

また、東京大学では地震研究所、大気海洋研究所などの附置研究所に多数の教員が存在するのが強みであるが、彼らは主に大学院での教育に参加している。学部レベルでの教育でも附置研究所との連携をさらに進めるべきであろう。また、これと関連したことであるが、非常勤講師制度等を使い、他大学の教員等に依頼して東大の本専攻だけではカバーしきれない広い範囲の教育を行うことも検討すべきであろう。

大学院レベルでの教育に関しては、学生に学問の広がりを教える体制が不足しているように思う。個々の学生は大学院で、ある専門の分野（テーマ）を研究するのであるが、そのためには、幾つかの基礎的な「技術」の取得の他にテーマに関連した、広い共通の背景となる知識を得る必要がある。このような共通基盤となる事柄の教育を行う体制（カリキュラム）をより良く整備すべきであろう。地球科学は異常と言ってもいいほど学際的な学問分野であり、異分野間の交流で新しい学問が発展していくことが多い。そのような分野の将来を担う人材を生み出すには幅の広い教育を行う必要があろう。そのような教育体制を整える過程で、異分野間の教員の連携関係も深まることが期待でき、新しい研究の発展にも繋がるであろう。また、大学院卒業生の進路が多様化している現実に対応する上でも幅広い教育がなされねばならないであろう。

若い教員のメンタリング制度と取り入れるのはよいことであろう。若い教員は専攻学科の将来を担う重要な構成メンバーであるが、研究や教育での悩みも多い。各助教に２名程度のメンターをつけて援助してはどうだろうか？

(3) 国際性

この専攻では外国人（及び女性）の教員、学生が非常に少ない。のみならず、外国人

学生の数は年ごとに減少している。この傾向は日本の他の大学に比べても東京大学のこの専攻で顕著であり、これは国際化の流れに反しており改善が必要であろう。

外国人学生の少ない原因の一つとして、各研究グループや教員のホームページが英語で準備されていない例が多い点が挙げられる。現在では、殆どの学生は各大学のホームページをみて応募するのであるから、英語でのホームページを各教員が作る（充実させる）ことで留学生の減少傾向を改善する一つの手段になるであろう。また、化学科で行われているような、英語での授業も取り入れる必要があるのではないだろうか。

一方で、本専攻からの海外への学生や研究者の派遣（国際学会や短期研修など）に関しては積極的に行われてきた。ただし、もっと長期的な意味での海外進出は限られている。たとえば本専攻から海外へ出てポスドクとして研究したり、海外研究機関で活躍したりする人の数は少ない。

(4) 組織と運営

組織と運営に関しては、人事の問題が最も重要である。世界をリードすべき大学にとって重要なのは、一にも二にも世界的な研究者を揃えることである。そのためには、公平で開いた人事を行い、広く、優秀な研究者を採用し、適切な昇進人事を行うことである。

まず、最近、本専攻から何人かの世界的に評価の高い教員が抜け出ていったことが送られてきた資料から分かる。これは専攻の研究、教育を高い水準に維持するために憂慮すべきことである。優秀な教員を維持するには適切な昇進の方法を確立することとよい研究環境の整備が必要である。

また、人事に関しては、５つの研究グループのそれぞれが特定の数のポジションを「所有」するのではなく、専攻全体としてある数のポジションを持つべきであろう。そのポジションを各グループでどう配分するかは学問の進展に対応して専攻全体で検討し、変化させていくべきで、固定すべきではない。現状では各大講座に特定の人数が配分されているように見えるがこれでは学問の進展に対応できない。大講座と人事の強い結びつきは絶つべきである。このような、ポジションの配分を専攻全体で議論することにより、この専攻が将来の地球惑星科学をどのように変えていこうとしていくのかを示す「青写真」ができるであろう。このようなブレーンストーミングはこの専攻でもすでにおこなわれているようであるが、特にポジションの再配分も含めた実質的な議論が必要であろう。

開けた人事に関してのもう一つの問題は、この専攻の教員の出身校の約８割が東大であるという事実である。これは研究、教育の停滞化を招く危険のある、非常に憂慮すべきことである。同様に女性教員の数も世界的水準から見て少ない。

人事などの重要な案件の運営に関して、専攻長の権限、任期等を再検討すべきである。専攻長の任期が１年から２年になったのはよいことであるが、２年というのもまだ短すぎると思われる。専攻長により多くの権限を持たせ、任期を３年等に延期することを提言する。例えば、専攻長は上記のような人事問題、専攻の将来計画等の議論などでリーダーシップをとるべきである。問題があきらかになれば担当すべき委員会を組織し、その問題の検討をさせる。専攻長の活動を支えるグループとして、各大講座からの代表からなる諮問会議（advisory committee）を作り、また、専攻長の活動を助けるために専攻長裁量経費

をもうけるのもよいことであろう。

評価委員は、この専攻全体として色々な分野間の交流が欠けているという印象を持った。例えば週 1 回の専攻全体のコロキウム（これには専攻外からの研究者も呼ぶ）や、分野横断的な発表会等を試みてはどうだろうか。若手を中心に萌芽的な試みがあると理解しているが、是非推進していって欲しい。

日本の大学では「法人化」等によって政府からの経済的支援が減り、大学の運営に困難を来しているという声をよく聞く。とくに、技術職員の数の減少は、実験系、観測系の研究を推進していく上での大きな障害になっている。 大型機器維持管理等を担う専任の技術職員の慢性的な不足は、日常的な教育、研究活動に支障を来すと懸念される。

(5) 社会貢献

社会貢献に関しては、環境問題や地震災害問題などで多くの教員が対外的活動を行っている。また各種のアウトリーチ活動にも積極的に貢献していることは評価できる。

IV. Prior review in writing

1. Items for Written Review (English)

Items for Written Review:

FY 2012 External Review on Department of Earth and Planetary Science, Graduate School of Science, The University of Tokyo

12/17/2012

1. Academic researches of respective fields:
   A) Are the academic researches (research fields that each committee member of the review specializes in) of the department competitive at an international/national level?
   B) Will future research developments lead science in respective fields?
   C) Are there any other problems on researches?
   D) How should we improve the problems, if any, described in A) to C)?

2. Research system of the entire department:
   A) Are the research fields that the entire department promotes appropriate considering the size of the department?
   B) Does the ‘group’-based research system have any problem? (Here, ‘group’ implies each of the core groups: See page 8 of the document for the entire department.)
   C) How should we improve the problems, if any, described in A) and/or B)?

3. Education in Undergraduate and Graduate Programs:
   A) Has the department been successful in student education expected of the department?
   B) If not, what are the problems?
   C) Are the curriculums of the graduate programs appropriate?
   D) Is the undergraduate educational system composed of two programs appropriate?
   E) Are the curriculums of the two undergraduate programs appropriate?
   F) Are there any other problems on education?
   G) How should we improve the problems, if any, described in A) to F)?

4. Internationality of the department:
   A) Is the department regarded as an international center of research and education?
   B) Does the department have enough international communication in researches and education?
   C) Are there any other problems on internationality?
   D) How should we improve the problems, if any, described in A) to C)?

5. Organization and operation of the department:
   A) Are the numbers of the faculty and staff appropriate compared to the number of the students?
   B) Is the framework of ‘group’ appropriate in the department operation? (Here, ‘group’

implies each of the core groups: See page 8 of the document for the entire department.)

C) Is the personnel appointment process appropriate?

D) Is the authority of the head of the department appropriate?

E) Is the operational system in which the faculty members take roles in one/two-year shifts appropriate?

F) Are there any other problems on organizational operation?

G) How should we improve the problems, if any, described in A) to F)?

6. Social contribution of the department:

A) Does each department member adequately contribute to society?

B) What kind of social contribution activities should be further advanced?

7. Please point out freely any other problems that should be improved.

2. 書面評価項目（日本語）

2012 年度東京大学理学系研究科地球惑星科学専攻外部評価書面審査評価項目

2012/12/17

１．各分野の学術研究について

① 専攻の学術研究（各委員がわかる分野について）は当該分野の国際的レベルに対しどのようなものであるか，国際的あるいは国内的に期待されるレベルにあるか？

② 今後の研究の展開は分野の先頭を拓くものであるか

③ そのほか，研究についての問題点

④ ①–③で問題がある場合、どのように改善すべきか

２．専攻全体の研究体制について

① 専攻全体で現在展開している分野は，専攻の規模から見て適切であるか

② 講座を基礎とする研究体制に問題はないか

③ ①–②で問題がある場合、どのように改善すべきか

３．学部と大学院教育について

① 本専攻に期待される大学院生の育成ができているかどうか

② そうでないと思われる場合，問題は何か

③ 大学院カリキュラムは適切かどうか

④ ２学科で構成される学部教育体制は適切かどうか

⑤ ２つの学科のカリキュラムは適切かどうか

⑥ そのほか，教育についての問題点

⑦ ①–⑥で問題がある場合、どのように改善すべきか

４．専攻の国際性について

① 国際的な拠点として認識されているかどうか
② 研究教育において国際的な交流が十分行われているかどうか
③ そのほか，国際性についての問題点
④ ①–③で問題がある場合、どのように改善すべきか

５．専攻の組織と運営について
① 学生数に対する教員数、職員数は適切か
② 専攻運営において講座という枠組みは適切かどうか
③ 人事の決定方法は適切かどうか
④ 専攻長の権限は適切かどうか
⑤ 役割を 2 年～１年交代で分担する運営体制は適切かどうか
⑥ そのほか，組織運営についての問題点
⑦ ①–⑥で問題がある場合、どのように改善すべきか

６．専攻の社会貢献について
① 専攻メンバーは適切に社会貢献を果たしているか
② 一層果たすべき社会貢献はどのようなことか

７．その他改善すべき事があったら自由に記入ください

3. Review reports

(1) Kelvin Richards, University of Hawaii, USA

1. Academic researches of respective fields:

Atmospheric and Oceanic Science Group:

A) Are the academic researches of the department competitive at an international/national level?

All faculty members have published numerous papers in leading international journals, garnered significant amounts of research funds, presented their work at international meetings and contributed to the educational mission of the Department. All (with the exception of Miura) contribute to the national and international academic communities through membership of committees and acting as editors or co-editors of journals. Yes, they are competitive at the national and international level.

B) Will future research developments lead science in respective fields?

All faculty have impressive future plans for research that will make significant contributions to the science. There is no statement as to who will head the Ocean-Atmosphere Material Circulation Physics group. Sato and Koike mention future plans that are relevant. There is no statement as to who will be involved with respect to the ocean. This is an area that potential brings a number of faculty members together.

C) Are there any other problems on researches?

None

D) How should we improve the problems, if any, described in A) to C)?

There needs to be clearer statement as to how the Ocean-Atmosphere Material Circulation Physics group will achieve their objectives, and who will be involved. There appears to be little cross-group activity. I encourage faculty to consider ways in which their joint strengths can be utilized. There is no statement as to what steps are being taken to replace the vacancy left by Prof. Yamagata.

2. Research system of the entire department:

A) Are the research fields that the entire department promotes appropriate considering the size of the department?

The Department's policy is to cover as wide a range of research areas as possible. Given the breadth of the science areas this means that individual research areas are headed by a single faculty. This breadth gives greater choice to students in the educational programs, but it also means the continued reputation of the Department in a given area is very dependent on individual faculty, and the retention of those faculty.

B) Does the 'group'-based research system have any problem?

Grouping science areas is natural, particularly given the diverse nature of the research areas covered by the Department. The existence of the groups can, however, introduce barriers to cross-fertilization of ideas and a "group mentality" rather than seeking a broader vision for the Department. The diagram on page 8 of the self-assessment shows overlaps between the various groups with Earth and Planetary System Science providing a connection between the other 4 groups. Conceptually this is fine, but I have the impression from the written material that there is very little overlap in practice of the research of the various groups. Even within the individual groups collaborative work between individual faculty appears to be limited.

C) How should we improve the problems, if any, described in A) and/or B)?

I strongly encourage the Department to formulate its "grand design" as articulated on p78 of the self-assessment. There needs to be a statement of where the Department wants to be in 5 or more years time. This will help enormously in deciding on strategic new appointments.

3. Education in Undergraduate and Graduate Programs:

A) Has the department been successful in student education expected of the department?

As I do not know what is expected of the Department in terms of student education it is difficult to judge how successful it has been. Based on the results of student questionnaires, and the career/education paths of undergraduates the undergraduate programs appear to be healthy, and graduating good and satisfied students (although I am a little baffled by the distinction between "good" and "just right"). It is noted that the vast majority of UG students continue on in the EPS graduate school so I presume the Department is satisfied with their performance.

The mix of career pathways for Masters students appears to be healthy, although there is no indication of what percentage follow careers related to their degree. The vast majority of doctoral students continue as a postdoc, so again the quality of the students leaving the program must be satisfactory for them to remain in academia. How successful the Department ultimately is, however, can only be judged by what happens to these people after doing a postdoc. No information is given. The GCOE program is invaluable in providing not only funds to employ doctoral students, but also funds to allow students to attend conferences and for English courses.

B) If not, what are the problems?

The decrease in the number of enrolled doctoral students is worrisome. As stated this is related to available funds, but is also dependent on good students wanting to pursue a doctorate. The fall in the latter is not confined to EPS. The Department should continue to look for ways to fund graduate students and explore ways of advertising their graduate program to students outside EPS and the University of Tokyo.

C) Are the curriculums of the graduate programs appropriate?

The Department offers a vast number of graduate courses. The mix of basic and advanced courses is good for both the diversity of incoming students, and the varied career/education pathways of students. There is no statement, however, as to what are the course requirements. Are students affiliated with a given Science group required to complete certain groupings of courses? If not perhaps consideration should be put to defining required or desirable sets of courses. How are students advised as to what courses he/she should take?

D) Is the undergraduate educational system composed of two programs appropriate?

Yes. Having the two programs allows the Department to tailor the curriculum of each to cater for students with quite different educational desires.

E) Are the curriculums of the two undergraduate programs appropriate?

As with the graduate programs there is no statement as to what courses students are required to do. Are the “six crucial experiments” for the Physics program compulsory? It would be good to have at least one experiment that relates to Atmospheric and Oceanic Science.

F) Are there any other problems on education?

It is very desirable that doctoral students publish their work in leading international journals. The requirement that a doctoral needs a published first author paper, however, puts undue pressure on the student, the Department and in some cases reviewers. In many cases, particularly when involving fieldwork, it can take a long time to do the work and analyse the results. Publication can often take several months or longer for a manuscript to go through the review process. The Department should compile statistics as to whether or not the publication requirement significantly delays the graduation of a student.

G) How should we improve the problems, if any, described in A) to F)?

How does the Department itself assess if it is successful in student education? There is no statement as to what criteria are used. There is no statement as to what is done with the statistics

gathered on undergraduate courses and future pathways. How is such information used to improve the curriculum. What happens if a course consistently gets poor ratings? If it has not done so already the education committee should formulate policy on such matters. The introduction of an advisory system for undergraduates is to be applauded. There is no statement as to what advisory system is in place for graduate students in terms of student committees. The review in 2006 pointed to the desirability of determining the success of the Department in producing leading and influential scientists. Even a partial list would be useful, particularly those that have made a name outside academia.

4. Internationality of the department:

A) Is the department regarded as an international center of research and education?

Faculty publish in leading international journals, are members of international committees and have received a number of awards from international institutions.

B) Does the department have enough international communication in researches and education?

Funding students and junior faculty to visit oversees institutions, and hosting oversees visitors are excellent ways of ensuring good communication with the international community. The Department should continue to do so.

C) Are there any other problems on internationality?

D) How should we improve the problems, if any, described in A) to C)?

5. Organization and operation of the department:

A) Are the numbers of the faculty and staff appropriate compared to the number of the students?

In general the numbers appear to be about right. An increase in the number of doctoral students is desirable.

B) Is the framework of 'group' appropriate in the department operation?

Yes, provided there is proper communication across the groups.

C) Is the personnel appointment process appropriate?

Having a "grand design" will help in deciding on new appointments that best benefit the Department.

D) Is the authority of the head of the department appropriate?

No information is given as what authority the dead of department has.

E) Is the operational system in which the faculty members take roles in one/two-year shifts appropriate?

It is good to see the Department is moving to a two year tenure for the head of department.

F) Are there any other problems on organizational operation?

G) How should we improve the problems, if any, described in A) to F)?

6. Social contribution of the department:

A) Does each department member adequately contribute to society?

Most faculty engage in outreach activities. Some fields lend themselves to contributing to society more than others. The contribution to society should be judged from the Department as a whole rather than individuals. By their very nature the fields of Atmospheric and Oceanic Science and Solid Earth Science have the potential to contribute greatly and certain members of the Department do so. It would be a mistake however to insist that each faculty member does so more than is implicit in the basic science they do.

B) What kind of social contribution activities should be further advanced?

7. Please point out freely any other problems that should be improved

(2) Atsuhiro Nishida, Emeritus Professor, JAXA

１．学術研究について

云うまでもなく東京大学に「期待されるレベル」は「内外において最先端の研究活動を牽引する」レベルです。

論文引用数は全体として特に優れているとは言えませんが、このような指標に必ずしも反映されない先駆的な研究が行われていることを望みます。

２．研究体制について

2006 年の外部評価で指摘した「改善すべき点（１）」を再録します。

「専攻は戦略を持ってリーダーシップのとれる分野を判断し、選択的に研究を推進すべきである。」

３．学部と大学院教育について

博士前期課程、修士課程は「広い視野に立って精深な学識を授け、専攻分野における研究能力又はこれに加えて高度の専門性が求められる職業を担うための卓越した能力を培うこと」を目的しています。実際、修了者はかなりの割合で専攻分野の研究者とは異なる職業につくのですから、所属講座に関わる講義だけでなくより広い範囲の講義を聴講するよう奨励することが望まれます。教員の側も少なくとも 2－3 年は同一の講義を担当して講義の質を高める機会を持つことが望まれます。

４．国際性について

専門外なのでよく知りませんが、「個人資料」に見るところ浦辺教授の「アーキアン・パーク計画」は国際的拠点のスケールを持つ計画と思われます。

国際性の評価基準は海外の研究者との交流によって「どれだけを学んでいるか」だけでなく「どれだけ与えているか」ではないでしょうか。

７．その他

研究・教育活動の進展や社会的・国際的情勢の変化を受けて、いずれは東京大学並びにその理学部・理学系研究科についても見直しが行われるものと思われます。自己点検の視野を本専攻に閉じることなく、他専攻の業績に照らしても第一級と見做される水準を追求して行くことが必要と思います。

English translation:

1. Academic researches of respective fields:

Needless to say, 'the level expected of the University of Tokyo' is such that the university 'leads domestically and internationally cutting edge research activities.'

Although the number of papers cited is not outstanding as a whole, I hope that pioneering researches, which are not reflected in such index have been conducted.

2. Research system of the entire department:

I would like to restate my comment put forth at the external review in 2006:

'The department should make best efforts to identify the disciplines where critical advances are expected and encourage their development.'

3. Education in Undergraduate and Graduate Programs:

Educational objective of the master's program is 'to foster science engineers with broad perspective, deep expertise and to develop their research abilities in the fields of the department and exceptional abilities to carry out occupations which require extremely wide and firm knowledge.' As a matter of fact, many graduates with master's degree engage in jobs in different fields from the department, therefore it is recommended to encourage students to take a wide range of courses, not limited to the courses of their own groups. In addition, teachers should be assigned for the same courses for at least two or three years to improve the quality of each lecture.

4. Internationality of the department:

Although I don't know in detail since it is outside my field, 'the Archaean Park Project' of Professor Urabe seems to be a large-scaled project, which would make the department an international center of research.

I think that the evaluation standard for internationality should be 'how much one is giving,' not 'how much one is learning' through interaction with overseas researchers.

7. Other problems that should be improved:

The University of Tokyo and its School of Science will eventually be subject to re-examination, responding to the development of research and educational activities and changes in social and

international situations. It is necessary to have a broad view of self-inspection not limited to the department and to pursue the research standard considered to be first rank among the other departments.

(3) Bruce Fegley, Washington Univ., St. Louis, USA

1. Academic researches of respective fields:

A) Are the academic researches of the department competitive at an international/national level?

In general, the breadth and depth of the Department of Earth and Planetary Science at the University of Tokyo is impressive and I think it is equivalent to the Department of Earth, Atmospheric & Planetary Sciences at MIT and the Division of Geological and Planetary Sciences at Caltech. Very few departments in the world can claim breadth spanning space physics (e.g., Prof. Hoshino), geophysical fluid dynamics (e.g., Professors Sato and Hibiya), terrestrial geosciences (e.g., Professors Geller, Kimura, and Qzawa), cosmochemistry (e.g., Professors Nagahara, Sugiura, Miyamoto, and Hiyagon), planetary science (e.g., Professors Abe, Iwagami, Ikoma, and Dr. Genda), and geobiology (e.g., Professors Urabe, Endo, and Murakami). Specifically, the faculty in the areas in which I work (cosmochemistry and planetary science) are well known internationally and have been competitive at an international level for many years. For example, Professor Abe has done seminal work on the early evolution of the Earth and other terrestrial planets and his models of an early steam atmosphere and of the effects of the Moon-forming giant impact have stimulated many subsequent papers by other scientists (myself included). His recent papers with Hashimoto on composition of the Earth's early atmosphere, with Genda on the effects of giant impacts on atmospheric loss, and by himself on the early magma ocean are at the forefront of work in this area. Professor Nagahara has done ground-breaking work in two areas. First, in meteoritics, and more specifically on the mineralogy of chondritic meteorites, especially her 1984 paper “Matrices of type 3 ordinary chondrites – primitive nebular records”, which remains important almost 30 years after its publication with 72 citations (Google Scholar) and 6 alone in 2012. Second, in basic geochemistry, specifically her work on vaporization of silicate minerals, in particular her work on olivine vaporization (a series of papers in top international journals with Ozawa, Kushiro, Mysen, and Young). This work is generally acknowledged as important for modeling the origin of chondrules in the solar nebula. I also find it important for modeling the vapor pressure of a peridotite magma ocean on the early Earth (e.g., see my chapter in press in the 2nd edition of “The Treatise on Geochemistry”, Elsevier, 2013). A third example is the work of Professor Sugiura, who has been internationally known for 30 years and is an expert in SIMS (ion microprobe work) and in rock magnetism.

B) Will future research developments lead science in respective fields?

Yes I found the proposed work described by several faculty in cosmochemistry and planetary sciences to be very interesting and potentially very important. The most important development and the one with the biggest potential payoff is the development of the Earth and Planetary System

Science Group. At present (28 Dec 2012) astronomers have discovered 854 extrasolar planets! This is amazing when one considers that the first extrasolar planet around a main sequence star (51 Peg b) was only discovered in 1995. Furthermore, recent observations show an increasing number of rocky extrasolar planets (CoRoT-7b, Kepler 10-b, 55 Cnc e), and an increasing number of spectroscopic measurements of atmospheric chemistry of extrasolar planets. A true Earth-like planet will undoubtedly be discovered in the near future and it is important to apply the methods developed in the earth & planetary sciences to the study of extrasolar planets. The University of Tokyo can be a leader in this area if they devote the necessary resources to the Earth and Planetary System Science Group.

C) Are there any other problems on researches?

The department is weak in geochemistry, as you already know.

D) How should we improve the problems, if any, described in A) to C)?

I recommend hiring faculty who span cosmochemistry and geochemistry. One of my colleagues in the McDonnell Center for the Space Sciences at Washington University (Research Professor Sachiko Amari) is one person in this area. Others also exist.

2. Research system of the entire department:

A) Are the research fields that the entire department promotes appropriate considering the size of the department?

As mentioned earlier, the breadth of the department is impressive (with the exception of the geochemistry "hole") and the Earth and Planetary System Science Group has the potential to be a world-leader in this area.

B) Does the 'group'-based research system have any problem?

I cannot tell this from the information provided to me.

C) How should we improve the problems, if any, described in A) and/or B)?

No comments

3. Education in Undergraduate and Graduate Programs:

I am not sure that I understand the educational programs of the department well enough to comment on this area. I was impressed by the breadth of courses offered, but at the same time I found some areas lacking, e.g., thermodynamics and phase equilibria. Perhaps this is already covered in some of your other courses and hence not needed as a specific course.

A) Has the department been successful in student education expected of the department?

B) If not, what are the problems?

C) Are the curriculums of the graduate programs appropriate?

D) Is the undergraduate educational system composed of two programs appropriate?

E) Are the curriculums of the two undergraduate programs appropriate?

F) Are there any other problems on education?

G) How should we improve the problems, if any, described in A) to F)?

4. Internationality of the department:

A) Is the department regarded as an international center of research and education?

Yes the department is well known internationally, but I think mainly for research and not so much for student education. I think this is not surprising because very few US students know any foreign language, let alone a difficult one such as Japanese, so there is little interest in sending students to Japan to study. Many faculty have international collaborations and host visitors from overseas, much more so than my own department at Washington University. I have no further comments in this area.

B) Does the department have enough international communication in researches and education?

C) Are there any other problems on internationality?

D) How should we improve the problems, if any, described in A) to C)?

5. Organization and operation of the department:

My only comment is that a two-year tenure as department chair is too short and this period should be extended to 4-5 years. I think it is difficult to make significant changes within the two year period of time and it is hard to get to know university administrators within this short period of time.

A) Are the numbers of the faculty and staff appropriate compared to the number of the students?

B) Is the framework of 'group' appropriate in the department operation?

C) Is the personnel appointment process appropriate?

D) Is the authority of the head of the department appropriate?

E) Is the operational system in which the faculty members take roles in one/two-year shifts appropriate?

F) Are there any other problems on organizational operation?

G) How should we improve the problems, if any, described in A) to F)?

6. Social contribution of the department:

Different faculty have different degrees of outreach activities and to some extent this is a function of the personality of each faculty member. I do not think that it is useful or appropriate to demand that faculty have some specified level of outreach activities. Hypothetically, if this were done, any faculty member whose personality is somewhat incompatible with these activities would probably do a poor job, which would reflect badly on the department. Several faculty, e.g., Professors Geller and Urabe (who is retiring) have been extremely active and successful in their social contributions.

A) Does each department member adequately contribute to society?

B) What kind of social contribution activities should be further advanced?

7. Please point out freely any other problems that should be improved.

I have no comments in this area. Overall I am extremely impressed with the progress made in the department over time.

(4) James Kasting, Penn State Univ., USA

1. Academic researches of respective fields:

A) Are the academic researches of the department competitive at an international/national level?

I will limit my comments here to the Earth and Planetary Systems (EPS) group, which is the closest to my own area of expertise. Prior to performing this review, I was familiar with the work of two EPS group members, Yutaka Abe and Hidenori Genda. Prof. Abe has long been considered one of the leaders in the field of atmospheric formation and evolution, having performed seminal work on the structure of impact-induced runaway greenhouse atmospheres. Prof. Genda is also known for his work on the effects of impacts in atmospheric removal. These two researchers, along with Prof. Ikoma, whom I haven't met, are part of a series of eminent Japanese researchers in the field of stellar and planetary evolution that dates back at least to Univ. of Tokyo graduate Chushiro Hayashi. American researchers have great respect for this tradition and for the influence of Japanese workers in this research area.

B) Will future research developments lead science in respective fields?

This depends partly on collaboration with other research agencies, especially JAXA. The field of exoplanets is now exploding in both the U.S. and Europe. It is being driven largely by ground-based radial velocity searches, which have found hundreds of exoplanets around nearby stars. NASA's Kepler mission has supplemented this by finding thousands of transiting exoplanets around somewhat more distant stars. The study of exoplanet atmospheres has now begun, and this is where EPS researchers can make an impact. The tools that they possess, namely, knowledge of the radiative and chemical structure of planetary atmospheres, are the same tools needed to interpret transit spectra of such atmospheres, which have now been obtained both from the ground and from NASA's Hubble and Spitzer Space Telescopes. NASA's JWST Space Telescope should provide much more detailed transit spectra if it flies in 2018, as currently planned. Beyond that, NASA's TPF (Terrestrial Planet Finder) space telescopes and ESA's Darwin space telescope (a thermal-infrared interferometer) should eventually provide visible and IR spectra of nearby non-transiting planets. Hiring more faculty like Prof. Ikoma, who work on exoplanet atmospheres, could allow EPS to become a major player in this field. But this would work even better if JAXA can be persuaded to either run its own exoplanet space missions or to collaborate with NASA and ESA on such missions.

C) Are there any other problems on researches?

To really be a major player in any field, including exoplanets, one needs data collectors as well as theorists. For the field of exoplanet atmospheres, this requires partners outside of University of Tokyo. For people working on the evolution of Earth's atmosphere, collaboration with geologists and geochemists can also be productive, because these researchers have data.

D) How should we improve the problems, if any, described in A) to C)?

(a) For exoplanets, encourage cooperation with JAXA, NASA, and ESA, as well as with

ground-based astronomers. Japan has an excellent ground-based SUBARU telescope in Hawaii. They are amongst the world's leaders in direct imaging of exoplanets.

(b) For the evolution of Earth's atmosphere, encourage cooperation with other Univ. of Tokyo faculty, particularly those in the Geosphere and Biosphere Science group.

2. Research system of the entire department:

A) Are the research fields that the entire department promotes appropriate considering the size of the department?

From my reading of your brochure, it seems that the biggest problem that the Department faces is that of downsizing. Several faculty positions have been lost over the past few years. While this is likely inevitable, given the ebbs and surges of national funding for science, it may force the Department to specialize in fewer areas than before. Picking these areas well is not an easy task, especially since we all have our own ideas about what types of science are most important. I am not sure that I have any more insight into this question than would someone from another field. From my own field of atmospheric/planetary evolution, I think that exoplanets and astrobiology are important. I like planetary science more, space and magnetospheric physics less. Solid Earth and earthquake-related issues, including tectonics, are a natural for U. Tokyo, given Japan's location on top of a major fault zone. Climate modeling may be a good field, especially if one can claim to have access to the very fastest supercomputers.

B) Does the 'group'-based research system have any problem?

I don't see any particular problems with this arrangement.

C) How should we improve the problems, if any, described in A) and/or B)?

Don't try to cover all fields if you don't have enough faculty members. Be sure to build expertise in a few of the most important ones. You yourselves are the best judges of what is most important.

3. Education in Undergraduate and Graduate Programs:

A) Has the department been successful in student education expected of the department?

I did not see any evident problems, but then I'm not really a very good critic on this topic.

B) If not, what are the problems?

See answer above.

C) Are the curriculums of the graduate programs appropriate?

Again, the programs look fine to me.

D) Is the undergraduate educational system composed of two programs appropriate?

Yes, this seems like a reasonable way to arrange things. Some students are always more mathematically oriented than others, no matter where you go.

E) Are the curriculums of the two undergraduate programs appropriate?

Yes.

F) Are there any other problems on education?

Not that I could see from reading your brochure.

G) How should we improve the problems, if any, described in A) to F)?

No comment.

4. Internationality of the department:

A) Is the department regarded as an international center of research and education?

Yes, as I pointed out above, Univ. of Tokyo is considered a leader in the area of planetary formation and evolution.

B) Does the department have enough international communication in research and education?

I think you are doing a good job.

C) Are there any other problems on internationality?

No.

D) How should we improve the problems, if any, described in A) to C)?

No comment.

5. Organization and operation of the department:

A) Are the numbers of the faculty and staff appropriate compared to the number of the students?

I cannot judge this myself. To me, the question is: Do the faculty have time to do their research in addition to performing their teaching duties? If the answer is 'no', then you have either too many students or too few faculty. On the other hand, if senior faculty are no longer involved in the teaching process, then you may have too many faculty members.

B) Is the framework of 'group' appropriate in the department operation?

This seems like a reasonable arrangement.

C) Is the personnel appointment process appropriate?

No problems identified.

D) Is the authority of the head of the department appropriate?

The switch from 1-year terms to 2-year terms is probably good. At Penn State, our Department Heads typically serve for 3 years or more (more if they enjoy it and are good at it).

E) Is the operational system in which the faculty members take roles in one/two-year shifts appropriate?

Longer terms will give you more expertise in this position. On the other hand, it tends to dampen one's research productivity. So, if you expect everyone to be at the forefront of their research fields, then short terms are necessary. At Penn State, we tend to let people do what they are good at. Some people are good administrators, some are good teachers, and some are good

researchers. You don't have to be able to do everything, assuming your department is large enough to allow such specialization.

F) Are there any other problems on organizational operation?

Not that I can see.

G) How should we improve the problems, if any, described in A) to F)?

No comment.

6. Social contribution of the department:

A) Does each department member adequately contribute to society?

Beauty, or value, is in the eye of the beholder, as we say in English. Basic research is often valuable in ways that are not obvious to those who are not familiar with it. If you are being accused of being irrelevant, your best defense is to try to educate the public about what you are doing. We call it "public outreach". NASA, in particular, is very good at it. NSF also places a lot of emphasis on outreach. As researchers, you have a responsibility to educate people about what you are doing. If you don't, they may decide it's not worthwhile.

B) What kind of social contribution activities should be further advanced?

Global warming is a serious environmental concern. All universities, especially those with strong atmospheric science programs, like Univ. of Tokyo, should conduct research on this topic and should educate their students and the public about the seriousness of this issue.

7. Please point out freely any other problems that should be improved.

No comment.

(5) J. Casey Moore, Emeritus Professor, Univ. California, Santa Cruz, USA

My comments are based on a familiarity with Tokyo University based on being a member of an onsite review committee in 1999, a one month visit to the campus as a JSPS Fellow, interaction with members of the Solid Earth Science Group for the past two decades, and a reading of the current Self-Assessment.

Overall I am very impressed with your department. Since I was on a reviewing committee it has undergone a major regrouping of faculty and substantially changed its curriculum. The faculty members I know are outstanding both scientifically and personally. I have interacted with your graduate students and believe they are excellent. Your new building (as of 2006) is very functional. And, your program is raising increasing amounts of grant funding. Accordingly, from my perspective Earth and Planetary Sciences Department is doing well. To a certain degree my overview is superficial. I'm sure there are important issues that the visiting committee will recognize after being on site for several days. I wish you well in understanding and resolving

problems that surface during this review.

1. Academic research of respective fields:

My field is structural geology and tectonics.

A) Is the academic research of the department competitive at an international/national level?

Yes, very clearly so. I have followed the work of Gaku Kimura since about 1995. Kimura has led a group that has greatly advanced the study of paleoseismology in the Shimanto complex. Importantly he and his group have developed a number of indicators of high velocity slip that have allowed recognition of past earthquakes. In North America we have utilized this approach to further extend the realm of paleoseismology. Moreover, Kimura has been a leader in the NanTroSEIZE drilling project off the Kii Peninsula. In addition to his much-cited work, Gaku commonly come to major scientific meetings in the US, often as an invited speaker, and has hosted a number of US scientists as JSPS Fellows at Tokyo University. He is also a major organizer (principal investigator) of the Kaname project that focuses on super deep drilling in subduction zones.

Recently I was on CHIKYU Exp 343 with Jun Kameda. While Jun is Junior scientist and I am not as familiar with his work, his publication list is very impressive. He has cleverly taken a background in mineral physics and is now applying it to substantial geological problems associated with subduction zones. Though I know their work less well, the interests of Ide, Geller and Tanaka fit well with Kimura and Kameda and I could imagine how students could benefit from interaction with the people mentioned above and being exposed to their diverse scientific approaches.

B) Will future research developments lead science in respective fields?

This depends on the direction that the program takes. However, the stated emphasis on subduction zones, volcanic arcs and backarcs provides intellectual challenges that are scientifically fundamental, and also of great significance to the well-being of the Japanese people. Japan, in comparison to the US, focuses a lot of resources on understanding natural hazards. Harnessing these resources to study both the fundamental and applied problems of these natural hazards can continue the keep your department at the forefront of the aforementioned fields of investigation.

C) Are there any other problems in research?

I foresee no major problems as long as the department maintains a reasonable area of intellectual focus in each group and recruits outstanding faculty that support these focus areas.

D) How should we improve the problems, if any, described in A) to C)?

2. Research system of the entire department:

A) Are the research fields that the entire department promotes appropriate considering the size of the department?

In comparison the departmental structure I saw in the 1999 review, the current organization is very modern and broadly similar to that adopted by the best programs in the US. However, the

organizational structure is very broad and requires developing focus areas for each group of science fields. That is, your groups probably can't be great at everything, and if they try to do so, risk being average over a broad range of fields. I would recommend selecting areas and developing superlative competence in these specialties. This has happened in the tectonics, geophysics, and structural geology areas of the Solid Earth Science Group as mentioned in 1), above. I cannot judge the work in other groups, but other program reviewers may provide opinions.

B) Does the 'group'-based research system have any problems?

As mentioned above, the danger is being spread too broadly over too many fields. With 51 faculty, the current groups can all be excellent at some parts of their stated group objectives, but probably not all.

C) How should we improve the problems, if any, described in A) and/or B)?

Having and keeping focus in the groups will require great care in hiring faculty that will integrate well with existing people. Developing a new focus in a group may require multiple hires in a similar area of specialty. Because faculty turnover is slow this is a long-term solution. However, the numerous pending retirements of faculty (Self –Assessment p. 78) should provide an opportunity to refocus some of the academic core groups. Choosing areas to develop within the groups can be directed by the problems most relevant to modern Japan. This should not be hard because Japan is a relative small area with a host of strong geologic influences affecting the people: earthquakes, tsunamis, volcanoes, atmospheric processes (typhoons), sea level change. I am not suggesting that the department become a program of applied earth science, rather that your research objectives (listed on page 8 of the self study) can be linked to issues that your government and people really care about.

Although a focus of research groups on areas of great public concern is desirable, this is obviously not possible for all groups (e.g. Space and Planetary Science Group) or for all faculty within research groups. Such groups, and people, can achieve notoriety by being really excellent at what they do, and by being incorporated in highly visible research projects.

3. Education in Undergraduate and Graduate Programs:

A) Has the department been successful in student education expected of the department?

The department is to be complimented for the revision of its curriculum, a hard task under any circumstances. The list of courses appears to cover a great range of topics that exceeds what is typical of what most US universities can provide, due to our more limited faculty size. Certainly the students at the University of Tokyo have a wide range of options for instruction. A high percentage of the students rate the courses as "Just Right" to "Excellent" during the review period. It appears that a majority of the students are satisfied with the quality of instruction. It is impossible to give a more detailed reply without being on-site and talking with students and faculty.

B) If not, what are the problems?

C) Are the curriculums of the graduate programs appropriate?

Yes, as with the undergraduate curriculum, there seems to be a large choice of courses.

D) Is the undergraduate educational system composed of two programs appropriate?

Yes. I believe fewer course paths with a large degree of flexibility within each is good. This appears to be the case with the two programs outlined in the Self-Assessment

E) Are the curriculums of the two undergraduate programs appropriate?

Yes, see 3A above.

F) Are there any other problems on education?

At my university the declining number of graduate students would be a problem. Our university administration provides more financial support for the whole campus, in part, depending on the number of graduate students. Good graduate students are very effective in assisting in developing a thriving research program. Also, having a critical mass of good graduate students allows them to teach each other, providing support for the supervising faculty member.

G) How should we improve the problems, if any, described in A) to F)?

Regarding the issue of declining number of graduate students, especially those from the Tokyo University program: In the US it is considered better, and many programs it is required, to accept Ph.D. students only from other universities. It is considered better for the student to be exposed to a diversity of scientific thought that comes from changing educational and research programs after receiving their undergraduate degree or master's degree. Based on this perspective, would it be possible to recruit more Ph.D. students from outside Tokyo University? This may be completely wrong given your educational traditions, but it a path we would pursue at the University of California.

4. Internationality of the department:

A) Is the department regarded as an international center of research and education?

Yes, my colleagues have strong interactions with earth scientists at Tokyo University. Tokyo University faculty travel frequently to our major scientific meetings and workshops and we are welcomed in Japan for many meetings both reporting scientific results and planning new international scientific programs.

B) Does the department have enough international communication in research and education?

I am very impressed with your Global COE program that is promoting all kinds of exchanges. Additionally teaching scientific English in your curriculum is very impressive as is requiring your Ph.D. students to publish part of their theses in English. I personally benefited from a JSPS Fellowship at Tokyo University in 2006. Additionally, in 2006 one of Gaku Kimura's students, Asuka Yamaguchi, spent a month in the field in Alaska, with my students and me, studying rocks similar to the Shimanto Complex of Japan. I still interact frequently with Asuka and building that bridge through our mutual exchange was essential.

C) Are there any other problems on internationality?

I don't see problems and would urge your department to keep up its strong international outreach.

D) How should we improve the problems, if any, described in A) to C)?

5. Organization and operation of the department:

A) Are the numbers of the faculty and staff appropriate compared to the number of the students?

The number of faculty is appropriate as compared to the number of students overall. But this assumes that the numbers of students is about uniform between the groups. Preferential appointments of faculty could remedy imbalances in student to faculty ratios between groups.

The technical and administrative staffing seems low for the number of faculty. This, of course, depends on the distribution of effort of the part-time staff and who pays for them. If all the part-time staff are supported from grants, and the administrative and technical staff supported by the university, then the university-funded administrative and technical support should be increased.

B) Is the framework of 'group' appropriate in the department operation?

Yes this is appropriate, and as I suggested in 2A above, the groups should be allowed to evolve and reform as the faculty change and new "hot" scientific areas emerge.

C) Is the personnel appointment process appropriate?

Yes, as long at the committee of professors, that make the final decision, is composes of people form all groups, not just the group in which the appointment is being made. I understood this to be the case base on the information on page 6 of the Self-Assessment.

D) Is the authority of the head of the department appropriate?

I'm not sure based on the Self-Assessment, but in general the authority of the chair should be comparable to his or her responsibility. Too much responsibility with no authority will mean that the chair will be an ineffective leader.

E) Is the operational system in which the faculty members take roles in one/two-year shifts appropriate?

I believe a minimum term for the departmental chair should be three years. Two years is too short as it takes a year to learn the job. Longer terms for chairs of departmental committees would also be valuable in providing continuity.

F) Are there any other problems on organizational operation?

I don't see major problems. But, this is hard to answer, based only on the Self Assessment and would be better evaluated by people doing the onsite review.

G) How should we improve the problems, if any, described in A) to F)?

Regarding staffing, complain to the university administration and point out that your department has a sharply increasing amount of external funding that reflects well on Tokyo University. More funding means more administrative activity to spend that money and should be supported by the university. This argument would also apply to support needed for technical staff.

6. Social contribution of the department:

A) Does each department member adequately contribute to society?

Probably not, and the contributions of each member will never be the same or necessarily adequate. The real question is does the department as a whole contribute adequately to society? In the areas I'm familiar with in tectonics, geophysics, and structural geology the answer is yes. Even if parts of other groups do not contribute to society, they may provide a theoretical framework that the more applied programs can utilize in making a more visible contribution to society.

B) What kind of social contribution activities should be further advanced?

In hiring new faculty people could be selected if they directly contribute to societal problems or provide the framework for understanding them.

7. Please point out freely any other problems that should be improved.

None at this point, but I'm certain that the visiting committee may assist in this area.

(6) Judith McKenzie, Emeritus Professor, ETH, Switzerland

With this letter, I am responding to your request for a written external review of the Department of Earth and Planetary Science, Graduate School of Science, The University of Tokyo. I was a member of the external review committee who conducted an onsite visit in March 1999 before the department was established. I also submitted a written external review for the following evaluation held in 2006. Thus, I have read with great interest the documents for the current selfassessment and external review that I received from your office. I found the documents to be very informative, and I was brought up-to-date on recent developments in your Department. As my expertise relates primarily to that of the <Geosphere and Biosphere Science Group> and some aspects of the fields found within the <Earth and Planetary System Science Group>, my specific comments related to research topics will focus more in the direction of the former. However, I hope that I can also provide insight into the more general areas under the various headings that you sent, which are listed below.

1. Academic researches of respective fields:

A) Are the academic researches, of the department in line with my expertise, competitive at an international/national level?

The study of geosphere/biosphere interactions in modern and ancient systems is one of the most innovative topics in 21st century Earth Sciences. In line with this development, the academic research profile of the <Geosphere and Biosphere Science Group> has evolved in a very competitive and exciting direction, which emphasizes the rapidly advancing fields of geobiology and geomicrobiology. With the recent addition of 3 new faculty members in these general research fields (Endo, Suzuki and Tsuihiji), the competence of the faculty has been greatly expanded. It is interesting to note that these 3 individuals completed their graduate degrees outside of Japan, and,

thus, represent, in a sense, an internationalization of the faculty. Furthermore, the diverse research directions of the current 8 members of the <Geosphere and Biosphere Science Group> are very complementary and will allow for the continued development of state-of-the-art, groundbreaking research in the future.

B) Will future research developments lead science in respective fields?

Future research developments within the <Geosphere and Biosphere Science Group> are very promising, particularly considering the on-going and proposed collaboration with colleagues from JAMSTEC and AIST and through participation in the old and new IODPs and related deep-sea research expeditions. With the application of new high-resolution imaging technologies and molecular techniques, the potential for the future research of the Group to make significant achievements in the areas of biomineralization and nanotechnology are excellent.

C) Are there any other problems on researches?

It should be noted that a critical member of the Group, Prof. Urabe, will retire in 2013. It will be essential to immediately fill the gap his retirement will leave, as his expertise covers the important research areas of hydrothermal systems and the deep biosphere. The age distribution among the different faculty categories is good with a range between 38 to 61 years, excluding Prof. Urabe. It will be essential to continue this age trend, even more downwards, with additional hires.

D) How should we improve the problems, if any, described in A) to C)?

Not applicable.

2. Research system of the entire department:

A) Are the research fields that the entire department promotes appropriate considering the size of the department?

The research fields covered by the entire department are absolutely appropriate considering the essential requirements of the Japanese society related to natural hazards, climate change, energy requirements, ocean resources, etc. These needs dictate that research be conducted in a broad range of appropriate fields, which will effectively promote fundamental discoveries and educate the next generation of Earth scientists. Also, the national and international ranking of the University of Tokyo requires that research be conducted on a very high intellectual level using upto-date, advanced technologies.

B) Does the 'group' –based research system have any problem?

The 'group'-based research system appears to be a very satisfactory and efficient method to promote a modern Earth science research and teaching program. It enables scientists to crosscut disciplinary boundaries, which were established in earlier times, and facilitates the development of new interdisciplinary research frontiers. Ideally, this 'group'-based approach does not erect new boundaries but remains flexible allowing for the development of new research fields and fruitful interactions.

C) How should we improve the problems, if any, described in A) and/or B)?

Not applicable.

3. Education in Undergraduate and Graduate Programs:

A) Has the department been successful in student education expected of the department?

The department offers a broad course program at all levels. The data indicate that most of the department's undergraduates will continue on into a Master's program, which offers them wider career choices afterwards. Furthermore, the Master's program offered by the department appears to be very attractive for students coming from other universities, who comprise 30 to 40 % of the total enrollment. The distribution of the Master's theses among the 5 research groups is quite equable in number and stable.

B) If not, what are the problems?

In contrast to the Master's program, there has been a steady decline in the number of PhD students entering the Doctoral program since 2006, which is notable and, perhaps, worrying. Although there has been a general overall decline in doctoral dissertations in all Groups, a relatively large decrease is observed in the Solid Earth Science Group. From the data presented, it appears that very few doctoral students enter the department's PhD program from external universities. This is surprising when compared with the significant number of external students entering the department's Master's program.

C) Are the curriculums of the graduate programs appropriate?

Yes.

D) Is the undergraduate educational system composed of two programs appropriate?

The division of the undergraduate educations system into two programs seems to be appropriate with approximately equal numbers of students entering into each one, as of 2012. However, there has been a significant decrease in the number of students in the Earth & Planetary Physics program from a high of 35 in 2010 to 23 in 2012, whereas the number of students in the Earth & Planetary Environmental Science program has remained at a relatively constant of between 18 and 22 since 2007. Does this reflect a general decrease in the number of students entering Earth science programs, which may then lead to decreased numbers entering the Master's program in the future?

E) Are the curriculums of the two undergraduate programs appropriate?

Yes.

F) Are there any other problems on education?

Is it sufficient to send only 10 doctoral students every year to international conferences? Perhaps, more should be attending on an annual basis, as it provides opportunities for them to present their research to an international audience and highlight the department's broad research program. Also, doctoral students act as good ambassadors to represent and promote their university.

G) How should we improve the problems, if any, described in A) to F)?

It may be possible to overcome the steady decline in the number of PhD students entering the Doctoral program since 2006 through the admission of applicants from other universities throughout

Japan and internationally. Encouraging doctoral students from outside the department to enter the doctoral program could be accomplished through a concerted international advertising campaign. Or, for example, showcasing the department with an academic booth in the Exhibit Hall of the 2013 AGU Fall Meeting in San Francisco, or at other international conferences? An internationalization of the doctoral student is an excellent way to improve the international profile of the department.

4. Internationality of the department:

A) Is the department regarded as an international center of research and education?

The department is well regarded as an international center of research and education.

B) Does the department have enough international communication in researches and education?

Although the members of the department have a high representation at international conferences, it might be advisable to recommend participation of all members in at least one international conference per year, if possible. The department's publication record in peer reviewed international journals is commendable and successfully reflects the productivity and efforts of the academic staff to communicate their research results to the international community. Also, the extensive contribution of department members to the editorships of international journals and to international societies and conferences is very noteworthy. The introduction of a program of international exchange activities has been very successful. The increased number of students and visitors coming to the department from abroad has surely raised the level of international communication in researches and education. Furthermore, the Overseas Internship Program, launched in FY 2009, has undoubtedly accomplished its goal of introducing young researchers to new research horizons and has inspired them to achieve broader research potentials. The large number of participants in the OIYR program at a selection of high quality international research institutions reflects the popularity and value of the experience.

Support of the OIYR program must be continued.

C) Are there any other problems on internationality?

The lack of internationality in the faculty remains a topic of concern, which needs to be somehow addressed.

D) How should we improve the problems, if any, described in A) to C)?

Because of language and cultural barriers, the difficulty of increasing the international character of the faculty is recognized. As mentioned previously under item 1A, offering academic positions in the department to Japanese nationals, who have completed their doctoral degrees or have had international post-doctoral positions abroad, is a possible way to increase the international research prospective of the department. Also, increasing the number of international doctoral students and post-doctoral fellows within the department is highly advisable.

5. Organization and operation of the department:

A) Are the numbers of the faculty and staff appropriate compared to the number of the students? Yes.

B) Is the framework of 'group' appropriate in the department operation?

Yes.

C) Is the personnel appointment process appropriate?

It was mentioned of page 16 of the review document that there has been a significant changeover in the faculty, partially through retirement, resulting in an increase of 17 new members and a decrease of 25 old members. With this high amount of personnel activity, care must be taken that possibilities remain for young scientists to enter the faculty as assistant professors, who are offered the potential to develop and advance within the department. Maintaining a balanced age distribution within the department among assistant, associate and full professors is essential for the continued healthy development of the department in both researches and education.

D) Is the authority of the head of the department appropriate?

Apparently, yes.

E) Is the operational system in which the faculty members take roles in one/two-year shifts appropriate?

Yes.

F) Are there any other problems on organizational operation?

None that is obvious.

G) How should we improve the problems, if any, describe in A) to F)?

6. Social contribution of the department:

A) Does each department member adequately contribute to society?

Members of the department appear to be quite involved in public outreach activities.

B) What kind of social contribution activities should be further advanced?

Perhaps, developing and promoting an Earth science program for public school teachers would provide them with material to encourage their students to contemplate the exciting possibilities of careers in Earth science. This may, in turn, help attract more young people to consider studying Earth sciences on the undergraduate level at the University of Tokyo.

7. Other problems:

Based on the documents that I received for this external review, it was not possible for me to evaluate the gender balance within the department with respect to either the academic staff or the student body, whether at the undergraduate, masters, PhD or post-doctoral levels. In my opinion this is an unfortunate omission from the document, as any progress made to improve the gender balance since the last review in 2006 remains uncertain.

In summary, after accessing the external review documents, I have a very positive impression of the recent accomplishments of the Department of Earth and Planetary Science, and foresee continued success with the development of the research and education programs within the 5 'group'-based concept. For the future prospective of the department, I found the information

provided under “current issues and future plans” to be very thoughtful and well addressed. I hope that my comments, which represent my own personal prospective after reading the compiled documentation, will be useful for your review and can be incorporated with those of other reviewers. Please do not hesitate to contact me if you have specific issues you would like for me to address