

COMMISSION 17: THE MOON (LA LUNE)

Reports of Meetings, 20, 24, 25 and 26 August 1970

PRESIDENT: A. Dollfus.

SECRETARY: J. O'Keefe.

First Session: Business Meeting

The first meeting was held in the large Chemistry Theater of Sussex University, Falmer. It was called to order at 14:15 with the President, A. Dollfus in the chair.

Dollfus announced the death of A. I. Lebedinsky, Vice-President of the Commission, and of J. H. Focas. He appointed a secretary for the session: Dr J. O'Keefe.

Professor Millman was invited to inform about the special session scheduled about the Moon at the Montreal Colloquium (Canada) on 22–29 August 1972. IAU is co-organizer.

Then, Dollfus reported on the enormous increase of complexity in the work of the Commission over the past 3 years as the programmes of lunar study and exploration have been realized. To cope with this problem, it was decided, as a result of extensive correspondence and discussions with members, to organize 3 working groups:

(a) Lunar nomenclature: D. H. Menzel (Chairman), M. Minnaert, B. H. Levin and A. Dollfus (ex officio).

(b) Figure and Motion of the Moon: Chairman Th. Weimer. This group has been working since 1968; it has recently had new members added, mostly interested in lasers.

(c) Geology and Geophysics of the Moon: Chairman G. Fielder. This group is under organization.

The President then asked for comments and advices about this organization of the Commission in three Working Groups. Discussion dealt with the question of putting a laser group in with Figure and Motion. B. Levin and J. O'Keefe commented that the mathematical skills of the senior men interested in Figure and Motion were essential to getting scientific information out of the laser data.

Dollfus then noted that in our times the lunar problems have come to interest unions other than IAU, notably IGGU, URSI, IUGS, IAVCEI, IUCSTP and COSPAR. President Heckmann, visiting the meeting, introduced the General Secretary Perek. Perek noted that consideration is being given to forming an International Council on the Moon, under ICSU. For Dollfus, such a commission would have one member from each Union; its goal should be coordination; the work in the several fields should be done by the Unions themselves. The International Committee on the Moon could presumably meet at the time of the meetings of the Unions involved.

Dollfus raised the question whether NASA or Akademiya Nauk of USSR would be represented, since they are significant contributors to the new technologies. Perek replied that only International Unions would be represented on the lunar commissions.

Returning to the organization of Commission 17, Dollfus then put forward names of a new president, 2 vice-presidents and the organizing committee.

The proposal was unanimously adopted.

Several members were of the opinion that a petrologist should be added. The question of adding Anders to the list was put forward and carefully considered. Levin pointed out that we must ask Anders. Dollfus remarked that it might be possible to give the composition of the Committee to the General Secretary only on the 25th after the 3rd session of the Committee; Perek remarked, in reply to a question, that new members can be added to the Organizing Committee between Assemblies if this is found suitable.

Second Session: Working Group 1: 'Lunar Nomenclature'

The session opened at 16:07 in the same room with the President, A. Dollfus, in the Chair. A telegram was prepared to Professor Minnaert as follows: 'Professeur Minnaert: Commission 17 vous a confié sa présidence, vous exprime ses chaleureuses félicitations, et souhaite votre prompt rétablissement'. The telegram being approved, Dollfus turned the meeting over to Menzel, chairman of Working Group I, who presented the proposed scheme of nomenclature for the far side of the Moon. The proposals are following the principles of guidelines previously adopted by IAU. Names, biographies and coordinates have been established. Six living Soviet cosmonauts and six living U.S. astronauts are exceptionally included. Lists of names are provided, and ACIC prepared maps at the 1:10000000 scale allocating the proposed names. These documents are distributed. They will be complemented by a guide to the pronunciation of the names. Minnaert is working on this problem; it must necessarily be approximate because of the many sounds involved in all the languages. There are to be phonetic transcriptions into French and English.

Moore moved acceptance for the general spirit of the report; motion seconded. A 'resolution' will be proposed for adoption by the full IAU General Assembly.

Improvements on details were then proposed. Arthur objected that the name Sven Hedin had been assigned to a crater on the back side, but for some years, work of the British Astronomical Association had referred to a crater Hedin on the front; there will be confusion in the literature. Menzel pointed out that the designation Hedin was not in IAU Official Blagg and Mueller list.

Koziel remarked that the name Banachiewicz had been moved, also Lamark, Riemann, Rayleigh and some others. There were names given from photographs taken of the Moon's limb; when more nearly vertical photos became available, it appeared that they represented rather poorly-defined craters.

Arthur then objected to naming one crater inside another. In particular, where letters are added, it will be difficult to decide whether these should be after the inner or the outer crater. In particular, he pointed out Krylov and Ingalls inside Korolev. A similar case with Apollo and with Das which is inside Galois.

O'Keefe pointed out that most of these problems involve the large farside craters of dimensions as large as front side maria, for which the Soviets had proposed the name thalassoids. He pointed out that front-side maria do not control the assignment of letters to craters.

Arthur then proposed that the names of these large craters be designated by parentheses in the lists, as a guide to cartographers, but not to letter smaller craters after them.

Whitford asked that the biographical list include another Russell beside H. N. Russell; Menzel accepted.

The report of the Committee on nomenclature as amended was then unanimously accepted.

Menzel then remarked that the Soviets have suggested that crater chains be named after Institutes, these being designated by their initials; for example, the rocket research institute, RNEE. The Working Group remarked that there was not enough data to make a decision; and that it should be referred to a new committee for the interim period.

Menzel then asked whether there should be a pronunciation guide. Markowitz felt that it would be useless; the sense of the meeting was, however, that the pronunciation guide should be prepared.

The session of Working Group I on 'Nomenclature' is adjourned.

Then, the President, A. Dollfus, announced that an additional working session is scheduled at 19:45, in the same room, about the problem of coordination in Laser studies. Attendance is for IAU Members, or others, directly interested in the Laser problems.

Special Working Session on Laser Study of the Moon

A. Dollfus, Chairman, described the widespread interest in the use of lasers with retroreflectors on the Moon; he read a COSPAR resolution appointing a working party to work on the problem:

“*Decision No. 7* proposed by the COSPAR Executive Council on the proposal of Working Group 1 – (Leningrad, May 1970).

COSPAR,

noting with satisfaction that the lunar laser experiment has been successful in its initial phase, but *recognizing* that the scientific value of the experiment will be fully realized only under the following conditions:

- (1) when several retroreflectors are widely distributed on the lunar surface;
- (2) when there are as many terrestrial observing stations as practicable, well distributed geographically, with at least one station in the southern hemisphere.
- (3) when the data are made available to the scientific community;

urges space agencies launching lunar landing spacecrafts to place on the lunar surface more optical retroreflectors, some of which should be large enough to be used easily with one-meter telescopes,

encourages all countries to develop and build lunar laser ranging systems and to participate in the observations, and

establishes a working party of Working Group 1 on lunar laser ranging under the chairmanship of Dr C. C. Alley (U.S.A.) in order to initiate international coordination and data exchange in this field”.

J. Kovalevsky then read a proposed IAU resolution supporting this working party, to be submitted to IAU Commission 4:

“Proposed IAU resolution (draft to be submitted to IAU Commission involved):

IAU,

realizing that the potential scientific value of lunar laser experiment would be highly enhanced if international cooperation in the observations and prompt data exchange is achieved by all groups active in the field,

and *noting* that a working party was appointed by COSPAR (Decision No. 7, 1970) under the chairmanship of C. O. Alley in order to initiate such coordination,

endorses the formation of this working party and requests that it reports on its activities to the relevant IAU Commissions 4, 17 and 19.

The Kovalevsky resolution was then extensively discussed. Dollfus pointed out that although COSPAR is well-adapted to promote the measurements, the IAU is deeply involved for scientific utilization. In the discussion it became clear that a major role is likely to be played by the Commission 17 astronomers interested in the librations of the Moon; D. Y. Martynov emphasized the names of A. A. Nefediev, K. Koziel and Th. Weimer.

J. Rösch argued for COSPAR-IAU working groups at the same level. On the other hand, A. H. Cook pointed out that AIG, AISPEI, and especially IGGU are interested in the problem. P. J. Melchior urged that we avoid a multiplicity of committees on the same subject. G. P. Kuiper felt that IAU should speak with one voice.

The possibility of a separate IAU working group with one or two members from each of the interested Commissions was discussed, with perhaps more representatives from Commission 17 because of their stronger interest.

It was decided that there was not enough information to permit a decision; Dollfus was to contact Perek; Rösch to see some of the other Commission members. An additional meeting for delegates of IAU Commissions involved is scheduled on August 24, at 20:45 at the Dome Amphitheater. Meeting adjourned near 19:30.

Additional Meeting on Laser

Present: A. Dollfus, C. O. Alley, J. A. O’Keefe, B. Guinot, K. Koziel, J. Kovalevsky, J. Rösch. Dollfus pointed out that there were two possibilities:

- (a) At minimum, an IAU Group with representatives from each of the Commissions involved.
- (b) At maximum, a mixed COSPAR-IAU group working on the whole thing.

Kovalevsky remarked that de Jager feels that only one group should coordinate efforts. De Jager suggests that IAU representatives be added to the COSPAR party. IGGU may do likewise. The Chairman of this joint working group would be in a position to ask for meeting either from COSPAR or from IAU during an Assembly of either organization.

It was the sense of the meeting that IAU should send representatives to make a joint working party. Names suggested:

Commission 4	To be decided
Commission 7	W. J. Eckert
Commission 9	J. Rösch
Commission 17	K. Koziel, W. H. Michael, J. Rösch
Commission 19	P. J. Melchior
Commission 31	B. Guinot

Kovalevsky's proposed resolution to support COSPAR was amended to indicate support for coordination of analytical studies as well as observations and exchange of data. Final wording of the resolution was left to Dollfus and Kovalevsky. Adjourned 22:00.

Kovalevsky and Dollfus then worked on the wording and drafted the following proposal, submitted to the General Secretary on August 25, morning:

RESOLUTION DE LA COMMISSION 17
APPUYEE PAR LA COMMISSION 4
PROPOSEE POUR LE COMITE EXECUTIF

“L'Union Astronomique Internationale,

consciente que l'importance scientifique des déterminations de distance de la Lune par laser se trouverait grandement valorisée par une collaboration internationale concernant les observations et les développements théoriques ainsi que par des échanges rapides des données à réaliser entre les différentes équipes engagées dans ce domaine,

et *considérant* qu'un groupe a été constitué par le COSPAR (décision No. 7, 1970) dans le but d'assurer cette coordination,

estime appropriée la formation de ce groupe.

Afin de renforcer la coopération internationale et la liaison entre les unions scientifique l'UAI *propose* que des représentants des commissions suivantes:

- 4 (Ephémérides)
- 7 (Mécanique Céleste)
- 9 (Instruments Astronomiques)
- 17 (La Lune)
- 19 (Rotation de la Terre)
- 31 (Temps)

soient nommés dans ce groupe et qu'ils rendent compte de ses travaux à l'UAI.”

RESOLUTION FROM COMMISSION 17
SUPPORTED BY COMMISSION 4
PREPARED FOR THE EXECUTIVE COMMITTEE

“The International Astronomical Union,

Realizing that the potential scientific value of lunar laser ranging experiments would be highly enhanced if international cooperation in the observations and theoretical developments, as well as prompt data exchange are achieved by all groups active in the field,

and *noting* that a working party was appointed by COSPAR (decision No. 7, 1970) in order to initiate such coordination,

welcomes the formation of this working party.

In order to strengthen international and interunion cooperation,

IAU *suggests* that representatives of the following commissions:

- 4 (Ephemerides)
- 7 (Celestial Mechanics)
- 9 (Astronomical Instruments)
- 17 (The Moon)
- 19 (Rotation of the Earth) and
- 31 (Time)

be appointed to the working party and report about its activity to IAU."

Third Session: Working Group 2 'Figure et mouvements de la Lune'

A. Dollfus announced that the papers on laser results would be postponed to the 26th. He then turned the chair over to Menzel, for additional comments about the lunar nomenclature.

Menzel announced that Working Group 1, Lunar Nomenclature, had now completed some minor revisions resulting from the discussion on August 20. The craters Pingré, Krylov, Ingalls, Bobone, Tereshkova, Hagen, Chappel, and Das had been relocated; most of these changes removed craters from the interior of other craters. It is believed that the latter problem is now solved, so that there is no need for the proposed use of parentheses to designate very large craters to prevent their use to sub-letter the small nearby craters.

Menzel stated that three small maria near Mare Orientale had been renamed as 'Lacus', namely Lacus Veris, Lacus Aestatis and Lacus Autumnae.

A number of mountain ranges are found not to be clearly identifiable and are removed: Montes Doerfel, D'Alembert, Leibnitz, Hercynii, Sovieticii.

C. de Jager has agreed to print the revised list in *Space Science Reviews*.

The revised list was unanimously adopted by voice vote.

Dollfus then presented for the full Commission a report on the laser working session discussions reported above.

He then proposed for approval the above-reported resolution. Resolution adopted.

Dollfus then announced that those members of Commission 17 or others interested in the problem of coordination for geological, geophysical and lunar samples analyses would meet for a working session at 18:00.

He then presented a list of proposed new members of Commission 17. It is not always possible, at this stage, to decide if the names on the list will correspond to 'IAU members' or to 'consultant members'. Such attribution depends on IAU by-laws and will be decided by the Executive Committee. The list of names proposed is: Alley, C. O. – Anders, E. – Baldwin, R. – Brunk, W. E. – Carder, R. – Cook, A. H. – Ewing, M. – Gast, P. – Gavrilov, Z. A. – Hagfors, T. – Hunt, M. – Lipsky, U. N. – Michael, W. H. – Moutsoulas, M. – Orszag, A. G. – Runcorn, S. – Shapiro, I. I. – Sonett, C. B. – Van Flandern, T. L., and the chairman of COSPAR W.G. 7 'Moon and Planets' (presently A. D. Kuzmin).

Such a number of new appointed members is realistic on account of the existence of three working groups, the status of Consultant, and the fact that previous Commission Members are no longer active in the field.

Five additional names were proposed by the Commission, during the discussion:

- D. H. Eckhardt
- J. Guest
- L. P. Morrison
- W. Sjogren
- R. Wildley

The list was accepted.

To the names of the Organizing Committee were then added E. Anders and P. Millman, the

latter because of a conference soon to be held on the subject of the Moon at Ottawa.

Then the session of Working Group 2: 'Figure et mouvements de la Lune' was open. Th. Weimer, Chairman of W.G. 2, then spoke on the purpose and goal of Working Group 2. He proposed to report scientifically each year on work in this field, after the manner of the old IAU Draft Report. Koziel felt that an annual report was too often; but the sense of the meeting was that the volume of new work would require an annual report.

Furthermore, bibliographical lists will continue to be prepared. Three lists were already circulated in 1969–70.

The definition of the field covered by the Working Group was discussed, in view of avoiding overlaps with other IAU Commissions, namely Celestial Mechanics. A new title was proposed for the Working Group, adequately indicating its scientific field:

'Figure, rotation et position observée de la Lune'.

Then comes the *scientific session of the Working Group 2*:

First Part – Chairman: K. Koziel.

R. F. Hall: Preliminary Results of the Moon Camera.

S. Chapront: Progrès dans la construction des éphémérides de la Lune.

T. C. Van Flandern: The Motion of the Moon from Occultations.

F. M. McBain-Sadler: Results of Occultations.

I. I. Shapiro: Comparison of Radar Data and Meridian-Circle Observations.

Second Part – Chairman: A. Mikhailov.

A. A. Nefediev: Constants of Libration from Heliometer Observations at Kasan.

K. Koziel: Cracow Selenodetical Works.

I. V. Gavrillov: Comparison of some Selenodetic Coordinates.

Z. Kopal and M. Moutsoulas: Results from the Manchester Team on Star-Calibrated Lunar Photographs.

D. W. G. Arthur: Selenographic and Selenodetic Results with Apollo Photographs.

P. Gottlieb: Recent Results in Lunar Gravity Fine Structure.

Special Working Session on Geology, Geophysics and lunar samples analysis

A. Dollfus opened the meeting by remarking that the NASA Meeting on lunar samples at Houston was in many respects admirable. However, there were very few astronomers at the meeting. He considered that astronomers must play a role in the analysis at the next step, for interpretations of the data, and be asked for ideas.

B. Levin remarked that IGGU is organizing a geological congress in Moscow, which will include a symposium on the figure and motion of the Moon. He remarked that it is the function of Working Group 3 to use these data for studies of e.g. the thermal history of the Moon.

B. Levin and J. A. O'Keefe both agree on the point that interpretation of the data, including lunar sample results, is what is now needed.

B. Levin, R. J. Fryer, W. E. Elston then discussed the difficulty of translating geological nomenclature so as to make it comprehensible to astronomers.

W. E. Elston brought forward the point that there should be some expression of opinion from the IAU concerning the value of the lunar landings and the need for future work, especially to explore the highlands.

A long discussion followed on the kind of action an IAU Commission can undertake to stimulate the lunar space programmes, to orientate its goal in scientifically useful directions and to coordinate the scientific interpretation of the results.

The argument often put forward is that direct exploration of the Moon represents a major step towards the basic problem of the origin and evolution of the Solar System. But it was clearly stressed by the group that such an argument was never clearly explicated in details. Of major importance should be a report, prepared by a group of specialists of the Commission, detailing the scientific approaches involved, previews of the successive scientific steps and the results expected, and the

overall limitations. Members of the audience willing to cooperate were: Baldwin, Dollfus, Elston, Levin, O'Keefe, Runcorn, Strom.

Furthermore, as immediate action, a resolution expressing the needs of lunar scientists for further exploration should be drafted.

A small group (B. Levin, R. B. Baldwin, R. G. Strom and K. Runcorn) was appointed to prepare a resolution for IAU, expressing these ideas.

The resolution prepared reads as follows:

Commission 17: RESOLUTION

“The IAU expresses its conviction of the great scientific importance of the preliminary physical measurements made in the environment of the Moon and on its surface, and of the collection and analysis of samples returned from the surface, especially in relation to the advance of our knowledge of the origin and evolution of the Earth, the Moon and the whole Solar System.

The IAU strongly hopes that continued programmes will be developed in which a sufficient minimum of sampling sites are included so that conclusions can be drawn about the Moon as a whole. In particular, the IAU stresses the importance of sampling the highlands, and of some special areas which are critical for the understanding of the processes which have shaped the Moon and even the Solar System as a whole.

The IAU recognizes the value to member states of contributions to the scientific exploration of the Moon made from the international scientific community, and expresses the hope that international cooperation in this field will continue to expand.”

Fourth Session: Working Group 3 ‘Geology and Geophysics of the Moon’

This session was opened at 14:15. Gold’s paper was called, out of order, on ‘Present Information concerning the Lunar Surface’.

Next, information was given about the working session of previous night on geology, geophysics and lunar samples analysis.

The resolution prepared at the issue of this session was brought forward and was passed.

Dollfus reported that the group decided to prepare a report indicating the conclusions from the astronomic standpoint to be obtained from the direct exploration and returned lunar samples. Volunteers being asked for, the committee was composed of R. Baldwin, A. Dollfus, W. E. Elston, B. Levin, J. O’Keefe, K. Runcorn and R. G. Strom. Furthermore, E. Anders could be approached to join the group, G. Fielder, chairman of W.G. 3, has agreed to chair the group.

Runcorn pointed out that a conference on the Moon will be held in Newcastle-upon-Tyne by April 1971, with the support of IAU; he proposed to take this opportunity to discuss the contents of the report. Accordingly, the schedules will be to have the draft ready for March 31, 1971.

Fielder then presented a report on the functions of Working Group 3. He was concerned over the problem of coping with the enormous and very varied information coming in; obviously the Commission must be concerned with the analysis of this mass of information. He proposed a basic plan for an overall committee on the Moon, with representatives of NASA, AGU, IUGS and other international unions. The programme was criticized as sinking in a mass of Union formalities and was tabled.

Fryer then brought forward a request that Commission 17 supports the *Catalog of Terrestrial Crateriform Structures* to be prepared for the sake of astronomical needs. Specimens were already prepared as Part I: *Canada* and Part II: *Indonesia*. This could be a Commission 17 report.

W. Elston, however, objected that the report would duplicate other catalogs such as N. v. Padang’s *Catalog of Active Volcanoes*. He pointed out that there are hundreds of thousands of such structures; the job would be monstrous and would strain the available resources. Fryer clarified that the purpose is not at all to be exhaustive, but only to make available to the discipline of Astronomy pre-existing documents of the geological literature. Money would not be requested from IAU.

Elston indicated that the Geological Survey of Canada has a similar project in work.

Levin feels we should not get involved too much with this kind of problem.

Dollfus was of the opinion that although other catalogs exist, they are not in the form in which astronomers want it. The adaptation will be helpful and still a manageable task.

On Levin's motion, the committee expressed its gratitude to Titulaer and Fryer for the work which they have accomplished.

Miss Middlehurst then presented her paper: The International Group of Lunar Transient Phenomena Observers.

Next came the scientific session, chaired in the first part by B. Levin, and in the second part by G. Fielder, as follows:

Scientific Papers

C. O. Alley: Laser Reflections on the Moon.

P. L. Bender: Lunar Ephemeris and Laser Experiments.

M. Hunt: A Lunar Laser Optical Ranging Experiment.

A. G. Orszag and O. Calame: Télémétrie laser en France.

S. K. Runcorn: Ancient Magnetic Field and Convection inside the Moon.

P. Gottlieb: Mass Anomalies.

V. S. Safronov: Mascons and Isostasy.

R. Baldwin: The Flux of Meteoritic Particles throughout Geologic History.

J. E. Geake: Optical Properties of Lunar Samples.

A. G. Kisliakov: Note, due to V.S. Troitskii, on the Lunar Thermal Behaviour.

J. O'Keefe: Implications of the Chemical Composition of the Moon for the Question of Its Origin.

SPECIAL MEETING OF WORKING GROUP 2: 'FIGURE, ROTATION ET POSITIONS OBSERVÉES DE LA LUNE'

Before the end of the General Assembly, some members of W.G.2 met again, to study with Th. Weimer a proposal from D. Bender on the need for more laser-cataphotes on the Moon. They concluded the following statement:

"Le groupe de travail 'Figure, rotation et positions observées de la Lune' de la Commission 17 de l'UAI,

– *considérant* qu'il serait utile de disposer de deux à trois grands cataphotes et de six à dix petits pour étudier avec soin la libration de la Lune et pour faire une triangulation de sa surface destinée à fournir un canevas précis pour les futurs travaux sélénodésiques et cartographiques,

– *formule* le voeu que les expéditions futures sur la Lune déposent de tels cataphotes en des endroits choisis en accord avec les astronomes intéressés."

"The working group 'Figure, rotation et positions observées de la Lune' of Commission 17 of the IAU,

– *considering* that, for a careful study of the Moon's libration and the establishment of a triangulation on its surface to have a precise net of fundamental points for the coming selenodesic and cartographic work, it would be useful to have two or three great cube corner panels and six to ten smaller ones on the Moon's surface,

– *expresses* the wish that the forthcoming Lunar expeditions shall put such panels on places chosen with the agreement of the interested astronomers."