REPORT ON THE TWENTIETH INTERNATIONAL GEOLOGICAL CONGRESS and A VISIT TO THE UNITED STATES

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INTRODUCTION

In 1956 I had the opportunity to attend the Twentieth International Geological Congress in Mexico as one of the official delegates of the Bureau of Mineral Resources, Geology and Geophysics, and also to act as the delegate of the Geological Society of Australia.

After the Congress I visited several Geological Institutions in U.S.A. with the intention of gathering first-hand knowledge of Cambrian fossils described in the literature and preserved in the Museums in U.S.A.

I departed from Sydney on the 27th of August, and returned home on the 9th November, the trip lasting altogether seventy-eight days.

The time was used as follows:-

Aug. 27 - Sept. 2 pre-Congress excursion in north-western Mexico (province of Sonora).

Sep. 2 - Sept.11 Congress in Mexico City.

Sep. 12 - Oct. 15 in Washington, U.S. National Museum, studying Cambrian fossils in the collections of the U.S. Geological Survey and the Smithsonian Institution.

Oct. 16 - 20 visit to the University of Cincinnati.

It was arranged that my official visit to U.S.A. should terminate on the 21st. October. To extend the visit, I was allowed to spend the time from the 21st October until the 9th November as my annual leave. A part of it was still used in pursuit of various problems of Cambrian geology and palaeontology, including a visit to the University of Wisconsin, and to the branch of U.S. Geological Survey in Denver (Colorado).

During my stay in Washington I also visited the Universities of Columbia, Princeton, Yale and Johns Hopkins, but could not afford to visit Harvard; the time was running short and the collections of the U.S. National Museum are large indeed.

I was invited to give lectures in all the Universities mentioned except for the Columbia University. Additionally I gave lectures in the University of Cincinnati, of Wisconsin, and in the Palaeontological Association in Washington. The total number of lectures were nine. The topics presented were :

1) Cambrian Stratigraphy and correlation;

2) Palaeogeography of the Cambrian in Australia;

3) The meaning of Stratigraphy and correlation;

4) Anatomy of the Cambrian Trilobite Redlichia.

2. THE CONGRESS

2. Some numbers

The total number of registered members was 4,039; the number of members present in Mexico City was 2,525. Absenteeism among members presenting papers was estimated of about 20%; on some sessions, however, it exceeded 50%. A certain disorganisation of the program resulted, because papers were not read at the appointed time and many were read by title only. One of the main reasons of absenteeism was "turista" - an infection of the digestive apparatus.

The presentation of papers was conducted in (a) fifteen sections, (b) five symposia, and (c) thirteen commissions and committees, the total number of divisions being thirty-three; eight days (3rd - 8th Sept., and 10-11th Sept.), were dedicated to the sessions.

The number of papers presented (read, or read only by title) was about 1,060.

The number of nations represented on the Congress exceeded ninety; nearly half of the total number of participants arrived from U.S.A. The Soviet Union was represented by fifty-seven geologists and five technical persons.

My participation

Because of reasons mentioned above I could not attend all the meetings and discussions according to my original intentions.

I attended; (1) section No.12 "Genesis of ancient and modern reefs (bioherms and biostromes)", and was in the chair at the second session of this section; (2) Symposium III, The Palaeogeography and the base of the Cambrian System (two sessions). It was conducted by the International Commission on Stratigraphy. (3) International Commission on Stratigraphy, three sessions. (4) Informal discussions arranged by the students of the Cambrian System, as a preamble for the symposium; (5) an informal meeting of Russian and American geologists on problems of exchange of scientific literature; (6) Excursion (before the Congress) to Sonora (Palaeozoic rocks).

Additionally, I attended presentation of selected papers in other sections; it was however, impossible to pick the right ones, because the programs were usually changed.

Information on items 1, 4, and 6 is given separately below. Item 5 (the meeting of Russian and American geologists on problems of exchange of scientific literature), as a non-geological matter, is summarized in an appendix, at the end of this report.

3. SECTION 12. GENESIS OF ANCIENT AND MODERN REEFS

Nine papers should have been read, according to the program; seven were presented. An outstanding contribution was - "Influence of Marine Bottom Communities on the Depositional Environment of Sediments", by R.N. Ginsburg and H.A. Lowenstam (U.S.A.). Observations by skin diving, supplemented by experiments and mapping of the sea floor, were presented. "The best known fossil examples of community influence on depositional environment are algae stromatolithes and organic reefs". Mats and carpets of modern algae, when covered by a layer of sand of some millimeters in thickness, grow through that layer within a few hours . (Laminated limestone and dolomite may have been formed in this manner, without producing "reef structures", or even recognisable biostromes; but absence of organic structure is no evidence that all such rocks are organic "reefs").

Numerous conversations and disputes on the topic of reefs followed during the congress, and later in United States, with geologists of the U.S. Geological Survey and in universities visited.

No attempt was made in the sessions of section 12 to summarize principles, concepts and nomenclature pertaining to the main topic: "Genesis of Ancient and Modern Reefs". My own comment, therefore, is given below.

The paramount interest in "reefs" is a practical one and connected with oil prospecting. Accordingly, an otherwise not explained local thickening of limestone or dolomite is "reef", and a chance of oil concentration.

Many geologists apply the term "reef" for any limestone or dolomite containing visible amounts of corals, or pleosponges, or algae, even where no thickening of the formation is apparent in connection with the distribution of the "reef-building organisms".

On the excursion to Sonora, a Cambrian dolomite rich in Girvanella was regarded as a "reef". Girvanella (algae) occurs as loose "pebbles". They are never attached to a firm substratum or attached one to another. When living the Girvanella bodies were of a spongy texture, of a relatively small mass and large volume and could be easily transported and sorted by current and wave. Consequently "reefs" of Girvanella are a biological and mechanical impossibility.

Laminated limestone and dolomite without a partition in bedding and, therefore massive in appearance are also often called "reefs". The lamination is postulated to be "algal", although no organic structure is preserved. The algal origin is a possibility, of course; the other possibility is local accumulation of calcareous and dolomitic detritus derived from pre-existing sediments, including reefs.

Related to the problem of the "laminated limestones" is the mode of origin of the Guadaloupe Mountains reef. I have not seen it in the field, but I have taken part in several discussions of the problem. A most interesting discussion was held in Denver, U.S. Geological Survey, Fuels Branch, with Dr. Teichert and co-workers.

Rock samples located on air photographs and thin sections from the Guadaloupe Reef were examined. Fossil fragments are present in abundance as visible in slides, but no reef-forming organisms could be seen. El Capitan and the rest are "reef without reef-forming organisms", and algae and sponges are suspected as reef-builders. However, it is also possible that masses of detrital calcareous material may have been "poured" into the sea in volumes too great to be redistributed by currents. Thus, a "local thickening of limestone" was created by inorganic forces and, possibly, by co-operation of organisms that are not sufficiently preserved to be evaluated properly. This, of course, is my own attitude and should be regarded as a statement of the existence of a problem only.

A popular approach is to regard the reefs as "mounds on the sea floor", or better, "mounds of the sea floor", because the surface of the mound is also "sea floor". This is, of course, only an incomplete definition, supplementing the phrase: "local thickening of limestone".

Preston E. Cloud, Jr. (A.P.G. 1952, Vol.36, pp.2125-2179) prefers to use the general term "organic reef" instead of "reef" which may be also of an inorganic origin. Following Lowenstam, Cloud defines "organic reefs in terms of fundamental biologic potentials of the organisms responsible for them rather than in terms of the present day appearance of the structures". "These potentials are the ability to erect rigid topographic structures by frame-building, sediment retention, and binding, and to create a wave-resistant structure". It is not essential for an organic reef to act in effect as a wave-breaking structure; essential is the "potential" to act in such a manner, when the zone of waves has been reached.

The term "reef complex" covers the organic and

inorganic aspects of reefs.

Cloud's and Lowenstam's ideas may be developed further, by introducing the concept of the maintenance of the structure by organisms against the destructive forces of the waves and the creation of a dynamic equilibrium.

To conclude, organic reefs are the manifestation of the ability of organisms to build topographical structures against the force of gravity and the mechanical forces of water, and to maintain such structures by new growths replacing the loss of material inflicted by waves and currents.

4. INTERNATIONAL COMMISSION ON STRATIGRAPHY

The "Agenda" below contains the items discussed:

A G E N D A

Meeting of Subcommission on Stratigraphic Terminology
Saturday, September 8, 1956 at 9 a.m.

Room Q-1, Congress Building, Mexico City

1. Introduction by President of Commission on Stratigraphy.
2. Introductory remarks by Secretary of Subcommission.
3. Roll-call of members.
4. Reports on activities of national or local organizations dealing with stratigraphic terminology.
5. Discussion of contributions published subsequent to Algiers Congress.
6. Discussion of replies to first questionnaire (Circular No.2).
7. Discussion of replies to second questionnaire (Circular No.5).
8. Further program of Subcommission.
9. Report and recommendations to Commission.
10. Other business.

At Item 3 (Roll-call of members) I explained to the chairman, that I am not a member; but being a delegate of the Bureau of Mineral Resources and the Geological Society of Australia, (and not of the University of Sydney as it is printed in the "Directario de Delegados") I am ready to act as a proxy of the Chief Geologist, Dr. N.H. Fisher, in explaining such questions as may arise in connexion with the Stratigraphic terminology etc. At Item 4 (reports on activities of national or local organisations dealing with stratigraphic terminology), I was asked to tell about activity in Australia. I reported (1) that the Australian Standing Committee on Stratigraphic Nomenclature was transferred from ANZAAS to the Geological Society; (2) that the second edition of the "Code" was published in 1956; (3) that the new edition differs by arrangement of articles and simplification, omitting some philosophical definitions; (4) that the "code" is constructed to co-ordinate the field work of geologists especially in mapping of rock units. In reply, Dr. Hedberg said that it is desirable to provide all members with a copy of the

Australian code.

Most of the session was spent in discussing the great diversity of the answers to the "Circulars" (questionnaires) of the Sub-commission on Stratigraphic Terminology. It became apparent that a general agreement cannot be attained especially in matters of nomenclature and concepts of rock-units. The German and English geologists regard rock units as useless; the French and Belgian geologists seemingly do not understand satisfactorily what are formations in American and Australian usage, and are operating with "facies". Even among American geologists a diversity of opinion is evident. To reach some agreement, I think one must try beforehand to define matter to be named, and afterwards to agree upon a universal system of nomenclature. It is essential that one and the same term should not be applied to cover different concepts. This stage was not reached during discussions.

5. SYMPOSIUM III. PALAEOGRAPHY AND THE BASE OF THE CAMBRIAN SYSTEM

The published first volume of the Symposium (in two parts) was exhibited. Part one contains papers on the Cambrian System of Europe, Africa, and Asia; part two - of Australia and the Americas. The Australian part contains about 275 pages. Dr. J. Rodgers, the Editor, remarked that the Australian part alone is complete and covers all aspects of the Cambrian of the whole of the Continent. A second volume is in preparation, with about 25 - 30 articles that arrived too late to be published in the first volume.

Several papers were presented. The main topic under discussion was the problem of the Base of the Cambrian System and of the Palaeozoic. Two mutually opposed solutions were discussed. Some proposed that the terms "Cambrian" and "Palaeozoic" should be applied to all rocks conformable with the Cambrian and resting below the lowermost known Olenellus-fauna. The reasons are (1) similarity in lithological setting, (2) unity of inorganic history, and (3) the arbitrary nature of the concept of the Lower Cambrian Series.

The others proposed to retain the present status, that is, the Lower Cambrian Series (Georgian or Vaucobian) be the lowermost division of the Palaeozoic, and the rocks and events before that time shall have another designation. O. Schindewolf (Germany) defended this scheme from a biological aspect. The passage from Precambrian to Cambrian marks a major break in the history of life, more important than any other break known. I myself, and in agreement with O. Schindewolf, added some more arguments: (1) the similarity in the lithological setting is of no importance; dissimilarities should be accounted for. The similarity refers only to clastic sediments. Absence of evaporites of the halite-gypsum suite, absence of glauconite, and predominance of dolomite in late Precambrian rocks, are important dissimilarities. The "unity of inorganic history" refers to the unity of the whole of the geological history of the globe, and is obvious on all "boundaries" of systems in areas of continuous sedimentation. For example, is it reasonable to apply the name "Cretaceous" to all rocks below and as far as continuity of sedimentation is observable?

The "arbitrary nature" of the base of the Cambrian is no exception: all "boundaries" between the divisions of the geological scale are "arbitrary" in a similar way. System boundaries are not defined by diastrophisms, but by fossils. Diastrophisms mean breaks in the record, and the intervals are dated by fossils. "Areas of unconformities are surrounded by regions of conformity". All geologists present are operating with "systems" and many of the participants of the meeting seemingly assume that systems have been established as rock

divisions between unconformities. But universal unconformities are unknown, and all attempts to revise the geological scale on a diastrophistic basis have failed. The Palaeozoic Systems each are established by R. T. Murchison as "grand orders of life with an appointed span", clearly on a biological basis. Since Darwin, however, we know that only one "system of life" exists, against the stand of Murchison and Sedgwick, who "vehemently maintained the immutability of species". The system boundaries believed to be matters of creation and extermination remain arbitrary by selection of actually existing and verifiable biological criteria.

Extension of the terms Cambrian and Palaeozoic might provide some Precambrian unfossiliferous sequences with respectable names. Limitless extension, however, would render the references "Cambrian" and "Palaeozoic" quite meaningless, and obliterate the results of a century of research. Chiefs of surveys and of private companies in future might not be satisfied when an expert referred some matter to the "Palaeozoic". Which Palaeozoic, the more precise, or the new extended ?, or the "extension" itself ? - would be the query.

Systems (and their subdivisions) are defined on three aspects: (1) each on its own merits, and especially on the basis of their fossil lists; (2) by difference against the system above; (3) by difference against the system below. It has been suggested that the Cambrian System is defined somewhat incompletely against the rocks below. But actually - there is the "great break", of the passage from Precambrian to the Cambrian with its diagnostic fossils, that satisfies the third condition of the definition of a system.

The upper limit of the Cambrian System was discussed with lesser participation. The main contributor was Stubblefield (British Geological Survey). It is the custom of this Survey to regard the Tremadocian as a division of the Upper Cambrian, whereas everywhere else the Tremadocian is accepted as the lowermost division of the Ordovician. Difficulties exist in England and Wales in establishing the lower limit of the Tremadocian in the field, because the particular rocks are not fossiliferous enough. However the appearance of Dictyonema flabelliforme marks sufficiently the beginning of the Tremadocian, and enough fossils are known to extend the correlation of the Tremadocian Series.

6. INFORMAL DISCUSSIONS ARRANGED BY THE STUDENTS OF THE CAMBRIAN SYSTEM, as A PREAMBLE FOR THE SYMPOSIUM

Participants were: Ch.Lochman-Balk, W.C. Bell, B.F. Howell, F. Rasetti, J.L. Wilson, all from U.S.A.; R. Endo, Japan; myself (Australia); and J.C. Troelsen (Denmark). Problems of inter-continental correlation of the Cambrian, mainly on Australian evidence were discussed. It was accepted that the Leiopyge laevigata zone is the top division of the Middle Cambrian, and that the Upper Cambrian starts with the Agnostus pisiformis zone. It was, however, impossible to convince the majority that the American correlate of the latter is the "Cedaria-Cedarina" fauna, a classical interpretation already introduced by Ch.D.Walcott, and adhered to in the "Correlation of the Cambrian Formations of North America" (B.F. Howell and the Cambrian Sub-committee, 1944, Bull. Geol. Soc. Am., Vol.55, p.993-1003). An extremely aberrant correlation was subdequently published by Ch.Lochman (Journal of Palaeontology, Vol.30, No.3 1956), as a variant of a correlation by J.L. Wilson (J.P. Vol.28, No.3, 1954). Wilson recently changed his stand to a variant approaching the classical correlation (J.P. Vol.30, No.4, 1956), and is publishing one more variant (personal communication).

The informal discussions lasted two days and a great amount of useful information on details and minor problems was exchanged.

7. EXCURSION IN SONORA

(Comment on the American interpretation of rock-units.)

I took part in a six-day excursion in north-western Sonora to inspect the Palaeozoic and Mesozoic succession, and, particularly, the recently discovered and very well described (geologically and palaeontologically) Lower and Middle Cambrian rocks of Caborca. G.A. Cooper (U.S. National Museum) was in charge of the scientific part, the rest was the care of Dr. A.R.V. Arellano, Instituto Geologico de Mexico. Outcrops of rocks of the following six systems were visited: (1) Cretaceous, (2) Triassic (marine), (3) Permian, (4) Lower Carboniferous, (5) Devonian, and (6) Cambrian.

The Sonoran sequence was deformed by a late Cretaceous or early Tertiary orogeny, and intruded by granites. Subsequently a wide-spread volcanic activity covered tens of thousands of square miles with lavas and pyroclastics. Lead-zinc, gold, and antimony mineralization is connected with the deforming orogeny.

The appearance of the rocks and their fauna generally follows the pattern observed in the adjacent parts of U.S.A. The Cambrian is actually the extension of the Rocky Mountains Province and is faunistically distinct from the Cambrian of Australia.

The rock units of the Cambrian of Caborca in Sonora were established by G.A. Cooper and Arellano in 1952. The American modern and "formal" usage has been applied by G.A. Cooper. The criteria are lithology and to some extent morphological manifestation of the rocks, e.g. cliffs, ridges, valleys. One-rock formations are named by the rock (El Tren dolomite is in effect a dolomite, 1,600 feet thick; Cerro Prieto limestone is a massive limestone, 300 feet thick); two or more rock formations are called formations (Proveedora formation consists of quartzite and slate, altogether 700 feet thick). This procedure and nomenclature corresponds to the Australian rules of Stratigraphic Nomenclature.

The lithic subdivision of the Cambrian of Caborca is, however, a simple case, because the formations are tectonically disrupted, and the interformational boundaries cannot be viewed in one and the same section at once. A certain tendency to "adapt" a boundary is apparent, i.e. to have the fossil zones coinciding somehow with such a selected boundary. Thus, the Cerro Prieto is described as a limestone with Girvanella. It rests on the Buelna formation, which is mostly limestone with trilobites and Girvanella. The boundary between the two formations is selected immediately above the uppermost trilobite-bearing bed. Both the formations are lithologically distinct; the Cerro Prieto is a massive limestone, the Buelna is bedded. These distinctions, however, are not "immediately apparent" in the field when one looks for the boundary between two Girvanella-bearing limestones. It may be argued that a part of the trilobite-bearing Buelna is lithologically similar to the Cerro Prieto. I myself as a visitor, accept the first solution involving the help of trilobites for matters of convenience. The described boundary is regarded as the Lower/Middle Cambrian boundary.

It appears to me that in U.S.A. and especially in the practice of the United States Geological Survey, it is customary to select boundaries of formations to coincide with series and

system boundaries. In spite of similar lithology on both sides of such a boundary diverse names for the so resulting "rock units" were given. Behind it is the traditional belief that system boundaries mostly are, and series boundaries within a system probably are, "breaks." However, I was unable to obtain a clear picture of the matter. Anyway, in conversation I had to assure them that in Australia geologists do not change the names of their formations when passing across a system, or a state boundary.

Some quotations from literature may serve as illustrations of how formation boundaries are selected.

In United States Geological Survey Professional Papers 276, p.18, it is stated that the "Hamburg Dolomite is both Middle and Late Cambrian in age". Consequently this formation retains its name on both sides of a series boundary within a system. In the same paper, p.20, the authors "propose the name Windfall Formation for the rocks of Cambrian age below", as distinct from the Ordovician "Pogonip" above. The new Windfall was previously a part of the "Pogonip", but the selected lithologic boundary still apparently does not coincide precisely with the palaeontologic boundary between the Cambrian and Ordovician; "a fauna with elements of the highest Cambrian continues upwards about twenty feet into the Pogonip"; and, finally, "the faunal and lithologic evidence indicates strongly that there is a gradational contact at Eureka between the Cambrian and Ordovician sedimentary rocks", "and the deposition continued without interruption from one system to another"; but this "is in contrast with the unconformity reported in the areas to the east"; thus, the systems are still separated by a break.

The procedure in establishing the Windfall Formation was; (1) to establish first the boundary of two systems on palaeontological evidence; (2) to find a "fairly easily recognized" and "mappable" lithologic boundary as near as possible to the systemic boundary, e.g. a marker bed within otherwise similar rocks; (3) to name the rocks below, and the rocks above that boundary by different names.

The Pogonip is a group of Ordovician formations. The lowermost formation of the group is the Goodwin Limestone. The authors of the Professional Paper No.276 apologise (p.26) for not being "consistent in their solution of (the) conflict between lithologic and palaeontologic evidence in regard to the base of the Goodwin" (against the Cambrian Windfall).

To conclude, in U.S. some formations are discovered, and some are made for convenience, and some are made to fit the major boundaries of the geological scale.

I had no chance to learn what is actually meant by the term "member" in the U.S.A. It seems, however, that in folded regions, as the Rocky Mountains are, members are distinct rock units considered to be too insignificant for separate mapping. Recognition of "members" simplifies the description of a formation without introducing too much detail into the "bulk" description. It is, however, customary to map members as formations and "elevate" them when the scale of the map warrants it, and when the members are lithologically recognizable within the area.

The term "member" is sometimes used to overcome the difficulties of formal nomenclature. For example, a member can be named after a creek, but a formation is preferably named after a river, a canyon, or mountain; creeks are numerous, but geographical features "of importance" are not always available for naming. Of course, it is no strict rule; moreover, a member with a creek name retains that name when "elevated in rank".

Large formations in America, subdivided completely into members, correspond to groups in Australian usage.

Formations can be degraded to the lower rank of members of a compound formation, when the lithological distinctions between the contiguous rock units are considered insignificant and their contacts are diffuse.

Degradation is enforced upon formations having contacts that "intergrade laterally, crossing faunal zones". Such contacts are "climbing" or "rising", and rock units in such lateral contact are members of a single formation. Consequently, formations are believed to be rock units in strict superposition with boundaries parallel to "fossil zones".

I think that in U.S.A. members are lithologically distinct portions of compound formations; members intergrade laterally with other members, or with the "bulk lithology" of the formation; the intergrading should be visible in the field or be established palaeontologically.

Members are also prominent portions of distinct lithology within a formation, and in super-position with other parts of the same formation, or with another formation. Such members are usually elevated to the formation rank.

8. EXCURSIONS IN OHIO

(Comment on another interpretation of what are rock-units.)

During my stay in U.S.A. I had a chance to see the Ordovician sequence in Ohio (Cincinnati uplift) on excursion in three consecutive days. The Ordovician rocks in Ohio were deposited in an epicontinental sea, are horizontal, and each of the numerous subdivisions is of small thickness. Thus, members are anything between 15 and 120 feet thick; no formation is thicker than 250 feet. As curiosities in the local nomenclature should be mentioned, e.g., that the Liberty formation consists of a single member, the Liberty, and the Elkhorn formation consists of its only member, the Elkhorn.

The rocks are marl, calcareous shale, and platy limestone, all interbedded and recurrent. Most of the sequence is "over"-fossiliferous, the fossils are perfectly preserved and most of them are properly described. I think over 500 named species are known to occur in the Cincinnatian.

The smallest subdivisions are termed members, and some of them are visibly rock units of a single lithology, as e.g. the Economy Shale of the Latonia or Eden formation. Another example is the Bellevue limestone of the McMillan formation, which in its turn is the upper part of the Maysville, to use a name of wider popularity. The designation of the Maysville is, perhaps also formation; Maysville is the Upper Division of a "sub-series".

The boundaries between the formations and of the members are thin marker-beds of distinct lithology or, more often, beds abundant in easily recognizable fossil species. Thus, the base of the Bellevue is the "Shingled Rafinesquina zone", the only one in the whole sequence; the Economy Shale has a basal contact against a limestone, and starts with a Triarthrus fauna (the Fulton beds); the Fairview (platy limestone and marl interbedded) ends above against the "Shingled Rafinesquina zone", and has its lower contact against the Resserella zone (topmost Eden). Resserella, a brachiopod, is actually present everywhere abundantly in that zone and can be recognized as a marker in mapping.

Higher subdivisions in current use are series, subseries, groups, stages. Cincinnatian geologists and amateurs are able without much hesitation to recognize the rock specimens taken from any place and any part of the sequence. They are guided by the lithology and the general aspect of the fossils in the rock specimen; some specimens are identified by absence of fossils. Whatever the stratigraphic units of the Cincinnatian may be - they are readily recognizable and mappable in the field, within the wide region of the uplift: in Ohio, Kentucky, and Indiana.

The following definition of the concept "formation" as applied in this region can be deduced: formations are regional sheets of sediments separated one from another by lithologically conspicuous thin marker beds, or by such beds as can be identified from an accumulation of remains of a species or genus, or by readily recognizable changes in faunal assemblages at the boundaries, or by all three criteria.

By Australian measure the whole Cincinnatian would be a single formation with several distinct marker beds and members separated one from another by the "bulk lithology" of the formation.

The examples discussed above reflect strictly the nomenclature developed in Ohio. The same geographical names are valid also in Kentucky and Indiana, but some have different designations. Thus, Maysville and Eden are groups, but Latonia (= Eden) remains a formation. It looks strange, but is reasonable, because parts of the sequence covered with its geographical name remain the same, boundaries are not shifted ("re-defined"). Instead of displacing boundaries new names were introduced, and the "new units" were correlated with the priority scale.

Such was my first impression after the first excursion. However, I think that after having spent a field season in Cincinnati I would be able to appreciate the "pure stratigraphy" of the Cincinnatian geology, and, applying it, I should be able to map the units, to study the palaeogeography and the history, and to present the details of the structure in any reasonable scale.

The Cincinnatian stratigraphy is a refined achievment of scholars, and capable of being applied in practice as well.

E.O. Ulrich, R.S. Bassler, Ch.Schuchert, J. Bridge, and some more equally brilliant men became geologists, stratigraphers, palaeontologists in Cincinnati.

9. STUDY IN THE UNITED STATES NATIONAL MUSEUM

(Problems of Cambrian Correlation and Palaeontology.)

I shall explain first why a study of foreign fossils is necessary for better understanding of the Australian Cambrian fauna and palaeogeography.

A belief prevails in the literature that the Cambrian marine provinces were isolated, that they contain diverse fossils, and that, consequently, a reasonable correlation between the provinces cannot be established. Contrary to such a belief, the Australian Cambrian faunas contain a number of genera and species previously known from other provinces of the world. Thus, it seems that the study of Australian Cambrian fossils may provide the key for a world-wide and adequate correlation of rocks and events of the Cambrian Period, as is already indicated in the "Symposium".

Accurate correlation can be made only with properly determined fossils. Most of the Australian Cambrian fossils are, however, not yet described. To describe them the knowledge of fossils already described as Cambrian elsewhere is necessary. A great many Cambrian fossils have been described from the United States and Canada and are kept in the National Museum in Washington. In the same Museum is stored the largest and most complete collection of Cambrian fossils from China, and the Museum is in possession of specimens of most of Cambrian fossils from all other parts of the world. Washington is the best place for the study of Cambrian palaeontology.

It is unfortunate that a great number of fossils have been in the past described inadequately; and the published descriptions and illustrations are often inadequate for any palaeontological and stratigraphical conclusions. The student is compelled to visit Museums abroad and to study the actual material to overcome some of the difficulties. The material, however, is so extensive that in a short time only a fraction of it can be studied.

The following quotations may serve to illustrate how insufficient some descriptions are (Ch. Resser, Cambrian System (Restricted) of the Southern Appalachians, Geol.Soc. Am. Special Paper No.16, 1938, 110 pages, 16 plates; about 270 species are described.)

(1) "Dresbachia appalachia, n.sp. It is possible that the Alabama and Virginia specimens constitute separate species but since they are much alike they are put together. The libragenes are abundant, but the cranidia are rare. Compared with D.amata, the genotype - D.appalachia - differs in minor details".

(2) "Kingstonia alia, n. sp. This differs from its associate K.tumida in being flatter".

Palaeontologically such "descriptions" are useless. To evaluate the stratigraphical significance, the specimens must be studied in the U.S. National Museum, where thousands of other, potentially important, fossils are kept. Of course, some fossils are better described, but only few can be identified satisfactorily from the descriptions without inspecting the actual types.

The examples above are taken at random. They refer to lower Upper Cambrian fossils; deposits of a similar age and faunas were recently discovered in Australia.

Now I present some detail of my visit to U.S.A.

The time between 1st and 8th October was spent in visiting the Columbia, Yale, and Princeton Universities.

I spent altogether twenty-two days (2nd to 13th September, 9th - 15th October) working in the collections of Cambrian fossils of the United States National Museum, Washington D.C. Assistant Curator, Dr. A.R. Loeblich (Smithsonian Institution) and Dr. Reeside (United States Geological Survey) introduced me to the scientists working in the premises of the Museum. Actually all the invertebrate palaeontologists and a number of stratigraphers of the United States Geological Survey are accommodated there. All collections (American and overseas) are there at hand, and the complete literature of the world is available. It is a most efficient organization. Palaeontologists, when identifying or describing a fossil, must have knowledge of all already described fossils of the similar kind. The volume of such knowledge is very great, if compared with other geological sciences, which can be restricted regionally. In describing a rock, or a formation, the knowledge of all rocks or all formations of the world is not necessary. Considerations of a restricted

region or area and application of general principles of geology is sufficient. Consequently, concentration of palaeontological literature and material in one place means ultimate efficiency.

I had a desk, a binocular microscope, all tools necessary, and the complete Cambrian literature of the world in reach of my hand. A cabinet was available without drawers. I could assemble in this cabinet the drawers from the main collection with fossils to be examined, and change the drawers in the course of the study. A pass was given to me permitting the entry and stay in the laboratories even on Saturdays.

The room I used is the office and laboratory of Dr. Allison R. Palmer, palaeontologist of the United States Geological Survey; Dr. Palmer is in charge of the Cambrian palaeontology and stratigraphy in the Survey. The scope of the work he is doing is, consequently, smaller than my activity in the Bureau. In the same room the assistant of Dr. Palmer was working extracting and cleaning, numbering and registering Cambrian fossils.

I worked "side by side" with Dr. Palmer all the time, and we had much discussion and exchange of information concerning the Cambrian palaeontology, stratigraphy, correlation, and stratigraphy in general.

At lunch time in the same room several young palaeontologists (micro - and otherwise) came to visit us and general discussions in an organized manner were held. Dr. J. Brooks Knight, now retired, a most prominent invertebrate palaeontologist, joined us several times. The themes discussed were many; as examples may be mentioned: "Specialization and primitiveness"; "The value of (preconceived) ideas in geology and palaeontology"; "The meaning of stratigraphy".

I have also assisted in discussion of problems of the correlation of American and Baltic Ordovician and Lower Silurian (with Dr. H. Duncan and Dr. Berdan); of problems of ostracod taxonomy (with Dr. G. Sohn); and of gastropod taxonomy (with Dr. J.B. Knight, Dr. Yochelson and Dr. Rasetti, and several minor problems of lower Palaeozoic palaeontology and stratigraphy. I spent a full day in Johns Hopkins University (Baltimore) studying the collection of Cambrian trilobites from Canada, brought together and described by F. Rasetti. It was a privilege, and the experience I had I hope to use with advantage in my Australian research.

Dr. R.S. Bassler, the retired custodian of the geological and palaeontological division of the United States National Museum, introduced me into the exhibits of the Museum, and on a week-end into the geology of Washington. On a week-end excursion with Dr. R. Loeblich, I learned the geology of a part of the Virginian Appalachians.

The results of my learning of the Cambrian collections are recorded in numerous notes and references, arranged chronologically. They have to be digested and compared with the corresponding literature. Some important observations are mentioned below, as follows -

(1) I have studied practically all described species of Redlichia, most of their types, and several additional collections.

(2) I have studied all described material of Centropleurinae, and additionally a collection of fossils, from a Middle Cambrian Shale from Manuels Brook, Newfoundland, as an example of the "Centropleura fauna". This was a most welcome opportunity because I am working myself on similar faunas from Australia.

(3) I have studied practically all Cambrian fossils described from China, Manchuria, Himalayas, and Indo-China. I think that I may venture now to produce a correlation of South-East Asian and Australian Cambrian faunas, at least within the Middle Cambrian.

(4) In the "Cambrian Symposium" I committed myself to the statement that the genera and many species of agnostid trilobites are universal and that a world correlation of the Cambrian can be constructed with their aid. It is already substantiated by the Australian faunas, tied up with the European Acado - Baltic and American Atlantic regions by the occurrence of common species. For the American Appalachian and Pacific regions, however, this statement was a mere prediction, because in the literature no such agnostids are as yet described. Now it seems to me that in these regions agnostids occur that may amplify the correlation. I studied, of course, the large collections of agnostids in the United States National Museum, which contains practically the complete array of agnostids of the world, and large undescribed collections from U.S.A. The Conasauga shale (Appalachian region) and several localities in the Rocky Mountains actually contain sequences of agnostids of an Australian - Acado - Baltic aspect. Three forms Glyptagnostus, Pseudagnostus cyclopyge, and Homagnostus obesus (all of Upper Cambrian age) were already known to occur in these regions. Dr. A.R. Palmer is already studying the agnostid faunas from the Rocky Mountains "without prejudice and bias", and speaks of Baltic agnostids in the American Pacific realm. Thus the problem of the universality of the agnostids will be tested professionally by an American palaeontologist as well.

(5) The experience with the Cambrian collections of the United States National Museum naturally necessitates amendment of some of the names of trilobites mentioned by me in the "Symposium" as occurring in Australia. For example, I am now convinced that the Chinese genera Lisania Walcott and Aojia Endo & Resser are synonymous. It seems also that forms believed to be species of the Manchurian genus Cropicephalina in Australia may belong to another undescribed genus. The faunas of the lower part of the O'Hara Shale (near Duchess, Queensland) which I termed as a "Cedaria fauna" (Appalachian), retains this stratigraphic position. But, besides some elements of the "Cedaria fauna without a Cedaria", I can recognize in it forms of the Upper Kushan stage (Shantung) believed to be indigenous Chinese fossils. All these amendments as well as such as may be discovered subsequently can be conveniently settled when I have the opportunity to actually describe the Australian faunas involved.

POSTSCRIPT

As a consequence of my visit to United States of America and discussions with American students of Cambrian palaeontology and geology problems were recognized, the solution of which demands international co-operation. A major problem is the correlation of the upper half of the Middle Cambrian and the lower half of the Upper Cambrian between America and Australia. Correspondence to clarify that correlation was started between the present writer, and the American authors Ch. Lochman, J.L. Wilson, F. Rasetti, and A. R. Palmer, and information, rubber casts of fossils, and opinions are exchanged. Everyone mentioned, including myself, has published one or even two or three versions of that correlation. Naturally only one of the versions might be the right one. The Australian evidence supports Ch. D. Walcott's classical idea that the Leiopyge laevigata fauna (the conventional top of the Middle Cambrian Series) is followed above by the Cedaria fauna, assumed to be the beginning of the Upper Cambrian. Ch. Lochman and J.L. Wilson have modified that scheme in various ways in a speculative manner. A.R. Palmer, however, collects fossils from measured sections and supplies facts supporting (in my opinion) Walcott's interpretation. The correspondence is not yet concluded.

APPENDIX.

(Informal Meeting of Russian and American Geologists to discuss problems of exchange of scientific literature)

About thirty American geologists mostly representing various universities were present. The convener on the American side was Professor R. Fairbridge. The Russian geologists were well represented, and their speaker was Professor T. Scherbakov. G. Chilingar (U.S.A.) acted as interpreter.

The American participants asked various questions, and Professor T. Scherbakov answered them all. It is enough to give here some of the answers:-

(1) The U.S.S.R. will continue to publish in Russian; in Russia all languages are read; why are the Americans not learning Russian?

(2) Individual authors in the Union are now allowed to exchange reprints and to correspond with foreigners.

(3) Foreign institutions in need of Russian publications should write to the Academy of Sciences in Moskow. The president of the Academy has the power to command all other publishing institutions; they will obey the orders and send the requested papers.

(4) To the best knowledge of Professor Scherbakov scientific institutions of the Union are getting everything published abroad. On their side no need exists for a specially organised exchange of publications, in excess of the existing exchange.

(5) On a page by page count the Union gets in exchange far less than it is able to give itself. But they are ready to accept several copies of a single foreign paper in exchange for a larger publication of theirs.

(6) Many papers are on sale and can be ordered commercially.

(7) Professor Scherbakov can give no promises, but he will investigate the situation in Moscow, and interested persons are invited to write him later on matters of exchange of papers.

Obik's comment: (not presented at the meeting):

The actual situation is more complicated. Russian scientific papers and books (not counting text-books etc.) are published in small numbers. The number of copies varies between 500 - 700 - 1,200, just enough to satisfy the universities' libraries and selected experts. Nothing remains, or only few copies are left for sending abroad. No means are available for foreigners to find out what is actually published in Russia; titles of periodicals and of publication series are changed without notice, some are discontinued, new ones are created, and all such information remains unattainable. Moreover, no copyright is acknowledged by the Government of the Union. Foreign books are translated and published in quantities and, of course, - everything is available in Russia.

A special instance is biological taxonomy, in my case, palaeontological taxonomy. Russian palaeontologists are publishing great quantities of new names of genera and species, and have also the habit to publish manuscript names and museum names without indicating that they are nomina nuda. Names published in a book of five hundred copies, which are distributed in Russia, are in effect "not published" according to the International Rules of Zoological Nomenclature. They are not

accessible for the public without an order and command from a superior, and delivery can be refused also.

No authority, however, exists to declare such nomenclature as being unpublished; a bulk decision cannot be made; each publication, even each single name, should be examined first.

Thus, the Russian palaeontological literature has succeeded in creating a formidable disorder in nomenclature.