REPORT OF THE REGIONAL MEETING ROCKY MOUNTAIN SECTION AMERICAN SOCIETY OF PHOTOGRAMMETRY

Laurence Brundall, General Chairman

A regional meeting of the newly-formed Rocky Mountain Section was held in Denver on October 3 and 4, 1949. Registration for the meeting was 250.

OUTLINE OF THE PROGRAM

MONDAY MORNING, OCTOBER 3, 1949

1. Registration
2. Opening remarks: R. O. Davis, President, Rocky Mountain Section.
3. Facilities and Functions of Lowry Field Photo School: Lawrence J. Bourrie, Lowry Field.
4. University Instruction in Photogeology: Professor Benjamin Tator, Louisiana State University.
5. Use of Aerial Photography in General Geology: Dr. Charles B. Read, United States Geological Survey, Albuquerque, New Mexico.
6. Discussion Forum: *Education in Photogrammetry and Photogeology.*
   Moderator: Laurence Brundall, Geophoto Services, Denver.
   Panel Members: Professor Benjamin Tator, Louisiana State University; Professor Sherman Wengerd, University of New Mexico; Professor William S. Levings, Colorado School of Mines.

MONDAY AFTERNOON

Inspection of Lowry Field photographic facilites

MONDAY EVENING

1. Color movies of Rocky Mountain scenery and mining operations.
2. Three dimensional slides of photogrammetric equipment shown by Captain O. S. Reading.

TUESDAY MORNING, OCTOBER 4, 1949.

Chairman: Philip McCurdy, U. S. Naval Hydrographic Office.

1. Petroleum Geology: A. R. Wasem, Geophoto Services, Denver.
2. Photo-interpretation for Engineering Sites and Materials: Jean E. Hittle, Bureau of Reclamation, Denver.
3. Practical Applications of Photogrammetry in Land and Soil Classification as used by the Bureau of Land Management: Douglas E. Henriques, Bureau of Land Management, Salt Lake City.
4. Aerial Photography in Soil Conservation: Alva C. Blakey, Soil Conservation Service, Albuquerque, New Mexico.
5. Applications of Photogrammetry in Cadastral Surveying: Arthur W. Brown, Bureau of Land Management, Salt Lake City.

TUESDAY AFTERNOON

1. Discussion Forum: Trends and Needs in Photogeology and Photo-interpretation.
   Moderator: Roger Rhoades, Bureau of Reclamation, Denver.
   Panel Members: Professor H. T. U. Smith, University of Kansas; Charles B. Read, U. S. Geological Survey; A. R. Wasem, Geophoto Services.
2. Inspection of Photogrammetric Facilities, U. S. Geological Survey, Topographic Branch.

TUESDAY EVENING

Informal Dance and Cocktail Party.

WEDNESDAY

Sightseeing trip to mountains.

CONVENTION COMMITTEE CHAIRMEN

General	Laurence Brundall
Program	Roger Rhoades
Hotels	M. A. Walker
Arrangements	Ray Grazier
Registration	E. J. Mundine
Entertainment	J. V. Meldrum
Transportation	E. J. Coon
Field Trips	T. V. Cummins
Membership	R. F. Thurrell
Publicity	R. F. Maffey

Officers of Rocky Mountain Section

R. O. Davis	President
A. J. McNair	Vice-President
M. A. Walker	Secretary-Treasurer

EDUCATION IN PHOTOGRAMMETRY AND PHOTOGEOLOGY—DISCUSSION FORUM*

Panel Members: Sherman Wengerd, University of New Mexico; W. S. Levings, Colorado School of Mines; Benjamin Tator, Louisiana State University.

Meeting Chairman: R. O. Davis, U. S. Geological Survey.

Davis: This forum is in discussion form, entitled "Education in Photogrammetry and Photogeology." Laurence Brundall of Geophoto Services in Denver will be the moderator.

Brundall: I will introduce the members of the panel. Professor Tator has already been introduced and we've heard his excellent paper;† the others are Professor Levings, of the Colorado School of Mines; and Professor Wengerd of the University of New Mexico. "Education in Photogrammetry and Photogeology" is certainly something in which we are all interested. Those who are in commercial work are interested in having geologists who can turn out accurate photogeological maps. Therefore, it is a most important function in any University course of geology today.

Levings: The Department of Geology at the Colorado School of Mines is obviously very much interested in the use of aerial photographs as an assistant technique in teaching geology, and as an important tool for the professional geologist in carrying out field studies. Up until about four years ago, however, scant attention was paid to the value of aerial photos in modern geologic investigations. Continually mounting evidence of their utility, emphasized in part by

* At Regional Meeting of Rocky Mountain Section, Denver, Colo., Oct. 3, 1949.

† See page 603.

TOP ROW: Left—Forum on Education in Photogeology, L to R—Laurence Brundall, Sherman Wengerd, William S. Levings, Benjamin Tator; Right—Inspection trip through U. S. G. S. Topographic Branch

MIDDLE ROW: L to R—Robert O. Davis, Col. Helk (Denmark), A. W. Brown

BOTTOM ROW: L to R—Lawrence Bourrie, Charles Reed, A. R. Wasem

the war, and partly by technical publications, directed attention to the necessity of more or less systematic training.

The questions naturally arose: What kind of instructions should be given? How should it be taught? A limiting factor in this regard was the difficulty in incorporating one or more new courses in an already crowded curriculum. The outcome was the establishment of a one-semester course at the senior level, consisting of a one-hour lecture and two-hour laboratory devoted almost entirely to photo-interpretation. As time passed, our methods of presentation have

changed. Much more emphasis is being placed on applications, both in the making of maps and in the interpretation and plotting of geology. One of the reasons for this change of attitude may be attributed to the constantly increasing number of graduate students. Many of these choose thesis problems in unmapped areas, and they are consequently faced with the necessity of constructing a base map with limited ground control. We are also influenced in this regard by the attitude of the student himself, who as a rule is definitely impressed with the advantages of photos in map making. This is understandable in view of the fact that at Mines we are teaching engineering students almost exclusively.

Aerial photos are now being used in several courses. Photos showing typical drainage patterns, land forms, and structures were used for the first time last year in supplementing topographic map studies in the Freshman laboratory, and with gratifying results. Interest in what many of us know can easily become a drab study was noticeably quickened. The element of detective work seems to carry a special appeal at this level. Another successful experiment was the substitution of an air flight over the Continental Divide in place of one of the field trips customarily taken. This proved to be so popular that the practice will be continued in the future and, in all probability, extended to other classes as well.

In order to expedite the summer geological field work, a new policy was put into effect last year at Mines which consisted essentially of instructing Juniors throughout the whole school year, in the elements of field mapping. Emphasis is being placed on surface mapping during the first semester, underground mapping during the second. As one of their tasks, the students are required to make a geological map of a limited area along the pre-Cambrian contact near the vicinity of Golden, using a quadrangle sheet as the base and the Brunton compass and air photos as auxiliaries. In this way, the student soon comes to appreciate the relative ease of locating himself and of placing formation boundaries on the aerial photo as compared with topographic maps. Two lectures are devoted in this course to elementary characteristics of photos. The six weeks' summer field course following the Junior year includes regional study of the structural geology, stratigraphy, and geomorphology, and the economic geology of the Canyon City embayment. Specific areas are mapped in detail, both on aerial photographs and topographic maps. Instruction during the Senior year includes class room work consisting of one hour lecture and two hours laboratory, and is a geology option. Several field trips are taken during which on-the-spot identification is made of questionable photo details. In addition, during the Senior course, selective photos showing the structure, stratigraphy, and physiographic features of typed areas are closely associated with corresponding topographic and geologic maps.

From a broad point of view, one of our main objectives is to master the interpretation to the extent that as one authority has expressed it, "Comes to recognize differences in things that appear similar and similarities in things that appear different." This, of course, is a tall order and an ideal not usually obtained. Another aim concerns the ability of the students to construct maps and field data using methods such as radial line plots to transfer the photo detail to base maps; tracing planimetric detail with the Kail Radial Line Plotter, and tracing contours and contacts on an overlay under the stereoscope, and so on. We feel, too, that more or less familiarity with the capabilities of such equipment as the KEK contour plotter is desirable.

These subjects that I have mentioned imply preliminary basic training in certain phases of geology and elementary photogrammetry. In this connection, we use the excellent text book by Professor Smith, to set the pattern for our teaching. Inspection of the facilities at the Topographic Branch at the Federal Center and Lowry Field never fails to receive a stamp of hearty approval from

the group. In fact, we feel particularly fortunate in having these agencies so near by, and I must add we are appreciative of the many courtesies extended by them.

Wengerd: My discussion of this situation might be entitled, "The Geologist and the Aerial Photograph." Mr. Tator mentioned a point to the effect that students are not adequately prepared for a course in photogeology, at the level at which we should like to give it. That level is one in which they have had geomorphology and structural geology, and experience in field geology. The point which Mr. Read mentioned that I want to talk about was the philosophy of the aerial photographs. To the students in geology, the aerial photographs are something romantic, but to those of us who have had some training in use of photographs, they represent a lot of hard work.

The interest in photogrammetry as it applies to geology at the University of New Mexico is very great. I wish to warn you that I have no real solution for the problems of training photogeologists. I don't think we train photogeologists: I think the emphasis will fall on training in the recognition of the shortcomings and the values of photographs, which necessitates training in photogrammetric engineering. I do not agree with some of the statements made in some of the previous talks that photogrammetric engineering is difficult. It is not difficult; it is only because the geologist is afraid of quantities, not qualities, and it is a matter of taking some time. I believe it is possible to take students early in their careers and teach them the rudiments of photogrammetric engineering. It is not possible to teach them photogeology, as we know it now, prior to the graduate level. In our own course, which I would like to describe briefly, we have only one lecture and three hours of laboratory per week. Early in my own training, I began to make up a prospectus for an excellent course for training of geologists in photogrammetric engineering and photogeology. The outline was something like 15 sheets long. I sent a copy of it to Dr. H. T. U. Smith and promptly received a nice reply and a note that it was probably a little too long. Then I started teaching the two-hour course at the University of New Mexico. The same difficulty that Dr. Levings has mentioned is evident there. We are not able to give our entire geological curriculum and squeeze in the number of courses we might have in photogeology; so I taught this course and completed only one page and one-half of my 15 page outline. In our own case we treat the theoretical characteristics of photographs so that the students realize that photographs are not orthographic projections, but are perspective views and that there are errors attendant thereto. We touch on simple photogrammetric computations, and, in this connection, I might mention that we use Dr. Smith's book. I don't use the entire book because it is impossible to pound into some of these students' heads all of the material that Dr. Smith has in his fine book. We go out in the field and we check the areas mapped on the photos, so that the students can see the relationship of the geology in the field to that of the photograph. That is, of course, an excellent method of teaching, but it requires a prerequisite of trigonometric surveying and structural geology. I now realize that it should also require geomorphology. The course is followed by a field course taught by Dr. Vincent Kelley in which photographs are used in conjunction with field mapping. In this, the students get practice in the utilization of the stereoscope in the field. In the case of advanced instrumental work, we are very fortunate. We do not own the advanced instruments, but Mr. C. B. Read of the U. S. Geological Survey has them, so we send our students over there for part-time employment. Many of the advanced students he makes into what I call "photogrammetrists." The class also takes tours through that office, and we will be taking more in the future.

The purpose of photogrammetric and photogeologic training is to utilize

one of the best tools we have in geologic mapping. It is not to train photogrammetric engineers, but it is necessary to learn some photogrammetric engineering. I found in teaching this two-hour course for the first time, that we have too little time to do photogeology. Hence, beyond elementary photogrammetric constructions, the Junior level course is not practical and we must turn the students over to a man like Mr. C. B. Read for the more advanced work on the specialized instruments. It has taken two years to put this course into curriculum; it will take me three more to get a graduate course where actual photogeologic techniques can be taught. The geologic applications of the photographs are very important. The training in the initial course must, therefore, be aimed at the philosophy of the aerial photographs. What are their limitations? Can you take a photograph, for example, and match it with another photograph, draw a contact, make an overlay and come out with a geologic map? Of course you can't. There are too many photogrammetric corrections to be made. I could mention a number of geologists who, knowing nothing about aerials, will trace the contact up and down hills, and then lay the photograph out on the table, and lay a tracing cloth over it; when he ends up, he has a map in which the contacts do not jibe. He wonders why; it is because he doesn't know the principles of photogrammetric engineering. Once a man gets enough training to recognize the value of aerial photographs, he is either an executive, or he is too busy to utilize them as they should be utilized. I believe then that two courses should be taught for geologists; one similar to our two-hour course in which you only familiarize yourself with general interpretation and with all photogrammetric computations. This is technically a course in engineering, and it is not taught in the University of New Mexico engineering curriculum. Therefore, I have to teach it in geology. The second course should be an advanced course for graduate students, in which they do nothing but interpretation and check it with field work. As for devising new methods, we are also taking our geomorphology classes on aerial trips and I am insisting that many of our geologists learn to fly. That insistence isn't successful, of course, but I get about 20 per cent of them into airplanes and they learn to fly and they begin to realize that the photograph is something you should treat as a tool, both in the engineering and interpretative sense.

Tator: The question of the academic approach to photogeology varies, of course, with circumstance. Unfortunately, I am teaching school in the swamps of Louisiana, and one has difficulty there finding, locally at least, outcrops to study in teaching general geology. I should like very much to bring the stereoscope into the beginning of geologic courses. I have not yet done this for several reasons; one is a Freshman course of several hundred students which requires a great deal of equipment, and the other is the inability to find places in the nearby country where we can check photographs of our immediate area against the ground details. Aerial flights which would almost be a necessity for us have not been practical in our area.

It is my belief that there should be a division of function in science and that a geologist is a geologist, although he can become proficient in certain photogrammetric techniques. Here, again, I must admit that my students show no capability along those lines. They are Juniors for the most part and, as a matter of fact, half of them are petroleum engineers who have a completely inadequate geologic background. There is almost no way, in my opinion, at the moment in college curriculum, to properly teach photogeology. As I mentioned, after a geologist is a geologist, he can become a photogeologist, but I don't think he will ever become a photogrammetric engineer. I believe that he can learn certain of the techniques, and perhaps after he has worked in the field for years, he becomes capable of handling the more advanced techniques. I believe that people

working for Bob Davis at the Geological Survey should be trained photogrammetric engineers, not civil engineers, nor any other kind of engineers. So the geologist should be only a geologist.

Perhaps the problem requires a complete renovation of our geologic curriculum. I believe we must face the fact; I think we cannot teach photogeology in the present capacity. We can attempt it and can turn out people later on with experience who may become experts in their field.

I am a little bit amazed that certain elements consider the photogeologic map to be completely inaccurate. There is no such thing, fundamentally, as a photogeologic map. It is a field map; it is a new method which saves about 60 per cent in time and effort; and it is extremely valuable. I know, for example, we wouldn't be teaching a course in photogeology in the Louisiana State if it weren't for the requirement of the oil companies; they want it and they want even the poor students we turn out. We turn out a few good ones too. Three or four in a class of 70 I consider worth-while in the present circumstances; the rest of them are just learning a few techniques which they may or may not ever use.

We all realize the problem lies beyond us. I believe in pushing college curriculum in the proper direction, at least in geologic training. An important factor is the elimination of a lot of non-essentials which are important to the advanced photogeologists, but only confuse the average undergraduate.

Brundall: Speaking from the purely commercial point of view, I should like to state the type of qualifications we require that we think would fit a geologist to be a photogeologist.

I agree with Dr. Tator that you are not necessarily training people to be photogeologists; you are training them to be geologists. The photogeological part of it is just an adjunct; it's doing something a little different to achieve the same end in view. A photogeologist in reality is just a field geologist; the making of maps is the end result.

Again, I agree with Dr. Tator that this is not especially different from the type of map that the geologist would make by going out and doing the whole work on the ground. It depends on the type of accuracy needed, and that would depend on whether you are doing very long range reconnaissance work of a regional nature; whether you are doing detailed reconnaissance work; or whether you are doing detailed structural contouring. These types of maps can be made by doing most of the work on aerial photographs, and I cannot agree with the statement that these maps are not necessarily accurate. In many cases we prepare maps that are inaccurate in the locations of some features, but those are for areas in which the extra cost is not justified to go in and make more accurate position control. If you're working in an area of 100,000 square miles in South America, when you tie in a stream intersection or a mountain top, it doesn't have to be down to the nearest 100 feet; in fact, we feel pretty good if we get to the nearest mile. For certain areas in the Rocky Mountains where you're doing detailed work in a small area and the map will be used for leasing or for development work, it is entirely possible to make the map quite accurate by photogrammetric methods.

I think the basic requirement in commercial work of the geologist, who is going to be doing photogeology, is a thorough background in field experience because actually all he is doing is field geology. He is doing it quicker and by looking with vertical plane rather than the oblique plane, but nevertheless all the interpretations that the photogeologist makes of the aerial photographs are in terms of what he would interpret to be on the ground. He has to transform the impression from looking at an aerial photograph to that which he might obtain by standing on a hill and looking at the outcrops. Therefore, if the man does not

have the background of field experience, he cannot turn out accurate photogeological work.

Sometimes I think that perhaps photogeology should not be given a separate treatment in University work as a course in photogeology, other than the preliminary work in stereoscopy, elementary height finding, radial plot work, mosaic layout, the simple types of photogrammetric work, etc. Perhaps the photogeological end of it should be tied in directly with the actual field mapping, and in course of geomorphological studies, and to use aerial photographs wherever necessary and advantageous in these courses.

The meeting is now open to general discussion.

B. C. Bellamy, Bellamy and Sons: I should like to ask about geological instruction prior to the work on the photographs. If students actually have had prior field experience would not this be valuable for them?

Levings: I think, Mr. Bellamy, your observations are sound. A first-hand acquaintanceship with an area in the field gives a certain degree of confidence in working the photos. Of course, at the same time, there are certain technical considerations that a student has to have in his background, in order to appreciate some of the inherent characteristics of these photographs.

Wengerd: Our own men usually have field geology at the same time that they are taking the first course in what we call geologic interpretation of aerial photographs. In addition, they are taking Dr. Kelley's field course, and they are required to go out and become familiar in an area that has already been mapped.

Tator: In regard to field experience, it is very fortunate that some schools are not capable of providing preliminary field work. My students rarely get field work before they have photogeology and this is very fortunate. They have a field course in Colorado; many of them take it before and many of them after they have had the photogeologic course.

In reference to the statement a moment ago concerning the use of geologic photographs in wide areas which one cannot visit, it should be pointed out that the present status of photogeologic mapping is mainly reconnaissance. The question of accuracy in reconnaissance mapping has always been bothersome to me because I have seen attempts made to measure true dip and strike in the field with a Brunton compass, and if the readings were within an accuracy of 5 degrees, they were considered quite adequate. I am told that with practice and knowledge of the photogrammetric functions of the photograph, it is possible to get to a point of estimation of dip to a value of one-half degree. That is very difficult to do with a Brunton compass. This information comes from people who are working in the profession, so you can accept or reject it as you please.

R. F. Thurrell, Geophoto Services: In reply to Dr. Tator's last remark, I should like to bring out one point which is quite important.

In the field, when a man is doing field work measuring with a Brunton compass, he is looking at a small area. Normally in photogeologic evaluation, when you're handling dips of three degrees or less, you're dealing with large areas of outcrop where you can see an expanse of three miles in a single view. This gives you a much greater perspective; you're seeing perhaps a much greater total difference in elevation than the man in the field; that is how you can actually come out with an accurate estimate; while in the field it's quite true that when the dips get down to one degree and less, you can't do much about it.

One other point that I should like to bring out in this discussion. Dr. Wengerd says he trains photogrammetric engineers and Dr. Tator says he likes to have them trained in the basic principles involved. Now I feel that right here we have the critical point in the relationship between photogeology and photogram-

metric engineering. A photogeologist, any geologist, with the present use of aerial photography should have some background information, some knowledge of the principles used by the photogrammetrist. There are times for everyone when new maps are not available. The person working with aerial photographs must have maps made from those photographs to be able to spot accurately the position of something he identifies on the photograph. With no such map, and even though the map he has was made in the field by the most up-to-date methods, there is not sufficient detail to get an accurate location; he must resolve back to photogrammetric methods to give a detailed plotting of that information. Now if you are doing reconnaissance work, I feel that it is perfectly reasonable for the geologist to be trained in making the radial line plots. Where he knows the tolerance to which he is working, he knows he has inaccuracies, and he and the person for whom he is doing the work accept these facts. However, if at the same time you are trying to turn out something very precise in detail from aerial photography, I feel that the job should again go back to the photogrammetrist. There is a division line, but it falls on the extent of the work, on the size of the area, and on the accuracy which is required. The photogeologist, any geologist, cannot be satisfactorily trained in photogrammetric engineering to know all the aspects of accuracy and the other factors involved.

Wengerd: If I stated that I am training photogrammetric engineers, I want to change that somewhat. It is a matter of quantity and time. What we are trying to do is to teach students the theory of error so that they can criticize the work of photogrammetric engineers in relation to their own geologic difficulties. In that I agree with Dr. Tator, it takes something like five to ten years to make a good photogrammetric engineer; Mr. Davis will back me up in that statement. For specific instruments, training may take two months or six months, as found out in the Navy during the war, but these men are not real photogrammetric engineers; instead, they are technicians. A good photogrammetric engineer is also well versed in the theoretical aspects of research in photogrammetric engineering.

Ted Abrams, Lansing, Michigan: The subject for the forum is photogrammetry and photogeology. So far it has been photogeology, and I should like to get back to where I think we ought to start. Photogrammetry can be divided into a lot of parts. For just a moment, I should like to divide it into three parts: elementary photogrammetry, photo technicians, and photogrammetric engineers as a profession. I think that in the curriculum of our colleges and universities, we should try to get aerial photographs and at least photo-interpretation used in many of the branches, and not just photogeology. It has been my experience across this country and around the world that in each of the universities, emphasis on photogrammetry is placed because some one person has a particular interest in this subject. In some college curricula photogrammetry is taught in the geography department while in others it may be taught in the agriculture department. In some curricula it is in civil engineering, and in other places it is in military science. I think that we should have it in all of those branches. I should like to see aerial photographs and some part of that science put into all of the various branches of engineering and even in some of the liberal arts studies such as planning surveys, etc.

H. T. U. Smith, University of Kansas: I don't have much to add to what the others have said except that they followed my own experience very closely. I envy Professor Levings and Professor Wengerd in having two such interesting areas in their backyards, to do field checking in. We feel the need of this checking but have to go a good deal farther to work. Our experience is parallel in that we all feel the need of photogrammetry along with photogeology; and our indi-

vidual courses are compromised with time and circumstances in that respect. I believe that one way of making more effective compromise is by streamlining our photogrammetry, and in that connection, we need more teaching aids. One thing that is particularly helpful will be more training films showing how the various operations are carried on; both those which we use as a preview, and the equipment such as a multiplex—an instrument which we cannot afford—so that the students can see how they work and what they are good for. I believe that stereoscopic lantern slides and the vectograph would be very important also in that connection. That is a field of teaching which I believe has been hardly touched.

At a meeting of the Geologic Society of America a few years ago, I saw a demonstration of vectograph lantern slide projection from the stereoscopic prints, which were extraordinarily impressive. The relief features showed up on the screen in front of a whole room as effectively as you see the relief in a single photo under a stereoscope. Of course, there is an economic limitation there; such slides are expensive, or at least the set-up for making the first one is expensive. If we had some way of assembling selected material which everybody is interested in using and could have vectograph prints made, we could distribute them at a reasonable cost. I am referring now to both pictures of instruments and of geological features to be used in teaching elementary geology. I believe that if we can develop these in full color for the geologist, there will be offered a very promising means of streamlining the teaching of both geology and of photogrammetry. I feel that one way in which the American Society of Photogrammetry can aid the teacher is by sponsoring the development of teaching aids of that sort.

Finally, one thing that I have found very helpful is the use of three-dimensional models to illustrate perspective geometry and other photogrammetric principles in an elementary way. We have had a few of those models made with a great deal of time and difficulty; pooling our efforts and with some agency like the Society making them available to everyone at a reasonable cost, would do a great deal towards streamlining our teaching in this respect.

Charles Read, Geological Survey: I should like to make one correction about dips in connection with field work. It's quite true that you cannot read dips very accurately with a Brunton compass when the dips get pretty low; however, it is equally true when the field geologist resorts to dip determinations in low-dip strata over a considerable area as it is when the man working in the office does. So, basically, their problem is the same. When it is necessary to secure a dip taking into account an area of three miles, the field geologist does it consistently. Beyond that, I should like to ask one question. This is a discussion about photogeology; I should like to hear a definition of photogeology. In other words, I raise the question, "Is there any such thing as photogeology?" How is it defined?

Brundall: I can give you my definition of photogeology. I believe that photogeology is the art of preparing a geologic map accomplished through the means of aerial photographic interpretation.