# KANSAS GEOLOGICAL SURVEY
# OPEN-FILE REPORT ND-17

## GENERAL INSTRUCTIONS FOR DETAILED EXAMINATIONOF WELL CORES AND CUTTINGS OF KANSAS BASEMENT ROCKS

by

**F. F. Langford**

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Since there will be a number of people working on this project spread over a period of years, it is very important that data be gathered, and above all recorded, systematically in order to prevent duplication of work because people cannot understand what former workers have accomplished. The three basic items of a piece of data that must be available before the data can be considered valid are, 1) the material available, and its reliability, 2) the type of research done and the name of the person doing the research and, 3) finally the results of the research. Only when all three of these items are available can the research be truly useable by subsequent workers.

The validity of any scientific measurement depends more or less on the way in which it was made, and to compare two measurements each in different ways may result in comparing the methods of measurement rather than the quantities measured. Thus is a standard procedure of processing the well data is adopted and carried out, then the work done by different people should be suitable for comparison. In other words, where a standard process both of record keeping and of investigation is adopted it means that even if the workers change the new people can pick up where the others left off rather than having to re-do all the earlier work. One must guard against the system becoming out of date, and thus preventing the acquisition of significant data.

In order to make the information gathered useful to other people, it is vitally important that at all times there must be a clean distinction between what was observed

and what was inferred. Facts, that is a record of things actually observed, are of value forever. Inferences are of value only so long as the theory on which they are based is valid. For example, suppose a sample is observed to consist of clear colorless grains which are positively identified as quartz. If it is recorded that the sample consists of quartz this is an observation, and as such anyone can use it. If however it is recorded that the sample is quartzite this is an inference, because what was actually seen were quartz grains not quartzite. It is possible that the quartz grains in this sample came from granite in which the feldspars are largely altered to clay thus the record of this well showing quartzite may be wrong. If at a later date someone consults this record and sees only the word quartzite, he has to relog the well in order to find out how this inference "quartzite" was made. If on the other hand he sees the record which says the sample consisted mainly of quartz grains, he can see how the inference "quartzite" was made, and even though he knows that the inference was wrong, the work giving the true observations is still valid.

The following schemes are designed as much as possible to keep the observer aware of the difference between observation and inference, and to encourage him to keep them seperate.

The system proposed here is based on three part file system which consists of the following 3 sections:

a. Summary sheet which summarizes both the information obtained and the progress of the investigation. — Cards

b. Primary examination section, which gives all the information obtainable from hand-specimen and binocular examination.

c. Detailed examination section which records the information gained from thin sections, phase studies, etc.

The reason for separating b and c is that too often the tendency is to take a core, give it cursory look, hack off some pieces, and send them off for thin sectioning. The core is then returned to its box and forgotten. Such a procedure is wrong, the primary examination of that core is the most important step of all, because it determines the validity of all subsequent work.

Each of these parts is not a separate and exclusive body. It should often be necessary to check back and forth between various phases of the investigation. For example, after thin sections of chips have been examined, it may be necessary to go back and make corrections to the sample log, in order to bring it into accordance with the new information gained from the tin section.

The Summary Sheet. This sheet serves as an abbreviated presentation of the datas obtained from the well, as a record of the progress of the investigation of the samples and as a check list on what material should be available in case some of the file is mislaid.

The first item of information that must be recorded are what can be called the pedigree, the name, location, driller of the well, owner, sample interval, type of sample, and number of samples etc. Other obvious items, but ones that are commonly neglected are, source of the material, where it is customarily kept and who is the custodian, what other information is available and where. If there is a list of the datas available, for example E logs, RA logs, drillers logs, etc., for each well from which samples have been processed, and if this list is kept on file it saves much subsequent searching. This data is largely kept on index cards rather than on the summary sheet.

## The Primary Examination

This part of the study is called primary not only because it should be done first, but also because it is the most important part of the study and is too often neglected. This primary examination consists mainly of the megascopic examination of cores, and binocular examination of cuttings although to do some of the latter may require intensive study of the rocks and minerals under the petrographic microscope.

The importance of the preliminary study stems from two aspects. First it is the major study of the distribution of the rock types. Later work may refine details of the composition and character of the rocks, but the important questions of how and where they occur is resolved only by looking at the core and cuttings. Some decisions of the type of rock present can only be made in the hand specimen; a common example is the differentiation of granite and arkose. Secondly, it is on the basis of this primary examination that material is selected for further examination. Thus the validity of all the detailed work in the end depends upon the primary examination.

Another important feature of the primary examination is that it offers the best opportunity to put together and compare the several different types of information commonly available. For example cores and cuttings should never be examined without having the various types of logs that are available right at hand to compare with the rock as the examination proceeds. This is especially necessary where long continuous cores are available. They should be compared inch by inch with any corresponding logs or cuttings.

The primary examination generally falls into four phases; assessment of the quality of the samples, the description of the material, which should contain only

observations as far as possible, the interpretation of these descriptions, and the selection of material for further study.

The first item to consider when examining the material of the well is the character of the material present. Too often on a logged hole there is no way to find this out without going and looking at the actual material. It is not enough to merely say that the sample from such and such well consists of a cored interval from 5100 to 5200 feet because it is almost standard to find that the entire core now existing consists of one 6 inch piece.

In the case of cores we want to know how much core, what diameter, and the intervals actually represented. Also important is the condition of the core; is it badly broken and mixed up or one long piece or what?

In the case of cuttings, we want to know the interval covered, frequency of the sampling, size of the samples and type of cuttings i.e. rotary or churn drill. Also important is the condition, have they been properly bagged and labeled or are they probably all mixed up?

Since the cores and cuttings require different methods of study it is advisable to consider them separately. However, what is said regarding the selection of core samples for thin sectioning also applies to a large extent to selection of material for further analysis from cuttings.

Examination of Cores, Procedure.

The examination of cores is pretty straight forward. Lay the cores out in serial order, wash them, examine them foot by foot and describe what you see. Although the above sounds so easy the proper examination of cores is a pains-taking, tedious and often boring procedure. Yet it is vital that it be done well.

The very first job, to lay out the core in its proper order is not always easy and sometimes impossible. Be sure to record any problems that arise in trying to put them in order, because it may be important later when something seems wrong or unusual about the cores.

The next step is to wash the cores. Oddly enough this seems an obvious procedure where the cores are dirty, yet it is not uncommon to find people struggling along logging dirty core. Aside from making the work harder it often makes it useless. Even where the core is clean, it must be examined wet because wetting the core permits one to see features on the cut surfaces. Some prefer to examine the core dry first and then wet it.

In describing rocks of the core give first, the interval over which the particular rock occurs, then the name of the rock, the attitude of any structures (with respect to the core axis, and measured with a protractor) and finally a description of the rock. Where two rock types are in contact be sure to describe the nature of the contact. Weathered zones should be fully described.

After logging the core samples for more detai led study (thin sections etc) should be taken. This selection of material for further study should be made with care. Care to record the particulars of why that material was chosen. Most material for thin section is generally selected in one of three ways. First, it is selected because there is some particular feature that one wants to examine. Second, it is selected because one piece looks pretty much like another and this one is convenient. Third, the specimen is selected at random. If the core or cuttings were not logged or washed chances are that the specimen was selected at random regardless of the apparent care exercised. If no description is made of the whole core or cuttings which includes a record of the selection of the specimen,

then the reason for selecting this rock to thin section or otherwise examine is forgotten, and it soon becomes only a thin section from so and so. The first method which seems so scientific can, if one is not careful, lead into the trap, that we will have lots of thin sections of all the odd features, and practically nothing on the garden variety rock in which we are really interested. Surprisingly, the second method has relatively little to condem it and usually produces good material.

In the case of selecting material for thin section be sure to record the attitude of the final thin section. If this is not done it makes it difficult if one wants later to do a petrofabric analysis. In core specimens no azimuth can be recorded, however the section with respect to the core axis and with respect to megascopic structures should be recorded. Petrographic analysis may prove to be useful in establishing fields of equivalent structural symmetry.

The material selected should be separately described and the following items should be noted which are basically answers to the question "what does this material represent?".

1. Is this material selected from the proper stratigraphic level? For example if a sample is considered as being representative of the basement granite, it is always possible that it may in fact represent granite wash. In some cases you can be sure it is true basement, in others not so sure, and it is again important that the degree of certainty should be written down.
2. In the material selected for further examination representative of the average underlying rock. Since the study is only beginning, we are concerned with delineating major features, we should not be concerned with

odd-ball rocks or rocks that are minor in amount. For example, consider an aplite dyke an inch or so wide in a core. While the study is in its infancy this dyke should be considered only as a fabric element of the rock in which it occurs, until such time as there is a reason to examine it as a rock type in itself. To select a sample containing the aplite dyke and not point out obviously that it represents less than 1% of the core may lead to a much distorted picture of type of rock present. Above all, the basement of Kansas is no place to begin the study of aplite dykes.

Examination of Cuttings, Procedure.

The following remarks pertain primarily to the examination of well cuttings obtained from the Precambrian section. The problems are somewhat idfferent to those concerning Paleozoic and younger rocks. Much more interpretation is required, and if not watched can make the whole description too subjective to be of much use. One should always be able to differentiate between what was actually seen, and what was concluded. The following procedure is designed to try and keep, as far as possible, conclusions and observations separate.

Outline of the Examination Procedure

1. Identify and learn to recognize all items present.
    a. Make a preliminary examination to select items
    b. Positively identify items
        i mineral grains by immersion
        ii rock fragments by immersion or by thin section
    c. Write an introduction to the log giving the results of a and b above

2. Log the samples.

   a. Learn to estimate quantities or establish counting technique

   b. Secure all other datas available on the well E logs, RA logs, etc.

   c. Log the samples to produce

      i) Litho percentage log

      ii) Commentaries on i above

3. Interpretation of the log with comments on

   a. identification of rocks and minerals

   b. accuracy and significance of litho percentage log, give

   c. your interpretation of the log, and

   d. compare with other wells nearby.

4. Select material for further study.

1. Identification of the Items.

The term item refers to each type of rock and each type of mineral that may be present in the cuttings. It seems obvious that one should be able to recognize all the items that are present in the sample, but it is not quite so obvious how to go about it. First make a preliminary examination of the suite of samples, and pick out representatives of each item. Be sure to indicate from whence these items came particularly where there were only a few grains present in the sample. Remember to count these items back into the samples when are are being logged in detail.

Mineral grains should be suitably crushed, mounted on epoxy and identified by immersion or other means. Rock chips should either be thin sectioned or crushed and mounted on epoxy and the constituent minerals identified by immersion methods. In both cases it is also wise to make up a slide or slides with the uncrushed material so that they will be available for comparison later on.

Write up the results of the above work as the introduction to the sample log. Be sure to indicate the slides made, and relate them by number to the material they contain and the sample from which they came. A very important part of these descriptions is an unequivocal description of the identifying features of each item. These features must be expressed so precisely that identifications can be made without error. One of the worst errors is to say an item has been given some name, say Regan quartzite because it looks like Regan quartzite. Such a sample looks like Regan quartzite because it has certain features, which the observer associates with the Regan quartzite. Therefore, it is these features which must be described as the definitive features of this item.

In naming the rock items, it will in many cases be necessary to use considerable subjective judgements as for example in discriminating between arkose, granite, and gneiss. Where this happens be sure to give the reason for your choice, even if it was done by tossing a coin. This will enable the reader to use the information even if he does not agree with the interpretation.

Often when logging a group of holes it will be possible to use items which have been identified in adjacent wells. When this is done, be sure to record in the introduction the precise source of the identification. This should include not only the name of the well, but the exact location in the report of that well, where the identification is given. A note should be made that you actually compared the identified material with the item being logged.

2. Making the Litholog.

Having described and learned to identify all the items present, the next job is to determine their abundance in the samples. This involves learning to measure the amounts present. There are two principal ways of doing it, by counting, or by estimation.

The latter is probably largely reserved for the experienced observer, and the discussion of this method will be limited to stating that estimations should be frequently and regularly checked by counting, at least at any 5th sample. Each log should contain a statement on the method used, and wherever checks are made on the accuracy of the estimation, the results of the checks should be included.

In terms of counting it is seldom practical to count every fragment present in the sample. However the whole sample should be searched and every item that is present should be recorded, even, and especially even, if there is only one grain present. For these minor or trace constituents it is often quite convenient to record the number of grains seen. The next step is to spread the sample out one grain thick, place the sample in a number of random positions, and count the items within the fields of view at each position until the desired numbers of grains have been counted, probably about 200 as a minimum. Record the values both as numbers counted and as percentages, or as percentages and note total number counted.

All items should be included, even those regarded as cavings, (the one exception is steel bit fragments). It is entirely wrong to leave out one or more of the items because you think they are cavings. If you are wrong, or if someone disagrees with your idea of cavings, the hole will have to be relogged. The proper procedure is to record such items as "Shale 20% prob. cav." or to indicate in the introduction or interpretation that the shale fragments are considered cavings.

All this grain counting may look as if it will be extremely tedious and time consuming. It will be, but it should be remembered that most of these wells have less than 300 feet of Precambrian section, and it is not as if you were logging 5000 feet of hole every time.

As this work is being done, electric logs, drillers logs, etc. should be consulted to see if there is any correlation between the cuttings and this information. Any correlation or apparent lack of correlation should be noted in the comments with the lithopercentages.

Some observers like to log the samples without having the other logs available, in this way they hope to achieve independence of their observations. This philosophy is good in theory, but bad in practice, because if the sample log does not agree (the usual case) with the electric (or other) log, then the hole or parts of it has to be relogged to see that nothing was overlooked. If the sample log and other log agree very well, the samples usually have to be re-examined to explain this remarkable coincidence. An honest observation is an honest observation, regardless of the aids used in arriving at it.

3. Interpretation

All the work that has so far been done has supposedly been as objective as possible. The person who has logged the well is in the best position to interpret the results obtained above. This section is therefore the place to develop ideas and in fact it is very important that the logger try to reconstruct what he thinks are the conditions prevailing in the hole.

The least that he should do is to draw a stratigraphic section for the hole (or part logged) as he sees it, and should make comments upon how he derived it from the preceding information that he gathered. He should also make comparisons with any nearby holes that he has logged.

Comments on the accuracy and significance of any of the other work would be of value.

4. Select Material for Further Study.

Most of the remarks made regarding selection of material from cores applies here.

Detailed Examination

As presently envisaged the detailed examination comprises two parts - the thin section description and the phase analysis. Those specimens that are suitable for thin sectioning will have both parts done, others only the phase analysis fully or in part.

Before beginning the description of the thin section be sure you know why this particular bit of rock was selected for a thin section and how it was selected. This should have been recorded at the time the material was selected.

In writing the description either a paragraph form or a printed form will have to be chosen. Ultimately, the information will have to be put in the former. In writing these descriptions one should remember that he is not writing a masterpiece of literature, but a rock description, and the two are quite different

The major difference is, that in writing general prose, variation of style, arrangement and expression are essential to avoid monotony. On the other hand repetition of arrangement and expression are the essentials of good rock descriptions. No one can write a long series of rock descriptions so that a person will read them for enjoyment. The best one can hope to do is to make them bearable. This is done by arranging the information so that a person can look at any description, and find the information he wants, without having to read every word of it. For this reason a standard style and arrangement, repeated in every description is desirable.

In describing a rock it is best to give as quickly as possible, a general picture of the rock and then fill in the details. The first thing to give is the name of the rock, because this tells in one phrase more about it than can be done in a whole compound-complex sentence, especially when a few adjectives are added. For example - "a

medium grained pink biotite granite", at once gives a mental picture that can be enlarged upon later.

In general a formal rock description should be arranged as follows:

1. Introductory sentence - the pink biotite granite etc. to give the first picture.
2. A group of sentences enlarging on its general appearance, and then descriptions of structure, fabric and texture. This information is largely a combination of material gained from both hand specimen and thin section and the sources should be clearly indicated in connection with the datas they supplied.
3. The next item consists of a list of the minerals present, essential ones first followed by accessories and the secondary minerals last. Also listed with the minerals is the percentage, and a note should be included to indicate estimated or measured percentages. In the case of plagioclase it is also customary to indicate its composition.
4. The last section consists of descriptions of the actual minerals. For each mineral give 1) grain size (IN M.M.) 2) grain shape, 3) alteration and inclusions, and 4) estimated paragenetic relations where determinable. Where possible the actual composition of the species should be given. The composition of Olivine, Orthopyroxene and to some extent Clino pyroxene can be estimated from an estimated value of 2V from an optic axis figure. In the case of plagioclase extinction angles are never more

accurate than $\pm An_5$ and only when they are measured from a known orientation. Statistical zone methods should only be used as a last resort. For colored minerals the color and pleochroism should be described. Extinction angles are commonly given for amphiboles.

5. Add other details of significance.

6. Comments on the postulated relationship with other rocks or problems may be included.

Universal stage measurements of the 2Vs of potassic feldspar, pyroxenes, olivines are generally informative, and time permitting should be done. Extinction angle determinations on plagioclase grains can also best be done on the U stage.

Petrofabrics

An important feature that may aid both correlation and the tectonic interpretation is the fabric symmetry of the rock. This can be partially adduced in hand specimens from cores. Cuttings on the other hand give few structural data until they are thin sectioned and a petrofabric study is made. One difficulty with petrofabric studies from well samples is lack of orientation. Cores lack an azimuth (and often a top when they are not marked for top when they are retrieved from the core barrel) and cuttings are randomly oriented. However, a petrofabric diagram can give a fabric symmetry pattern which may permit correlation and in any event should be instructive. It may permit separations of Palaeozoic and Precambrian quartzites.

STATE OF OKLAHOMA
OKLAHOMA GEOLOGICAL SURVEY
UNIVERSITY OF OKLAHOMA
PHONE JEFFERSON 6-0900 EXTENSION 2081 OR 2082
NORMAN, OKLAHOMA

February 24, 1961

Mr. Daniel F. Merriam,
Kansas Geological Survey,
University of Kansas,
Lawrence, Kansas.

Dear Dan:

PC-36

Confirming our telephone conversation of yesterday afternoon, I am enclosing a sample from the Frankfort Oil Co. no. 1 Van Ausdel, SE NE NW sec. 31, T. 28 N., R. 20 E., Craig County, Oklahoma, completed Jan. 10, 1955, elevation D.F. 859, T.D. 2014. Top of basement rock under Cambrian Arbuckle is 1692 feet (-833), picked from excellent rotary rig cuttings and confirmed on the electric log. Basement rock is andesite from 1692-2014 R.D. Sample enclosed is normal rock for the hole, composite cuttings picked from 1715-1815 feet.

PC-19

Our best information on the hole I wrote you about is Wackerle no. 4 Hood, SE SW SE sec. 19, T. 28 N., R. 20 E., Craig Co., completed as a dry hole in December, 1954, elevation 838, T.D. 1590 feet. I have just finished running the samples, and I place the basement rock top at 1493 (-655), under Cambrian Arbuckle. The rock is andesite to 1590 T.D., and it is similar to that in the Van Ausdel well. The cuttings unfortunately are quite poor. Although I am having two thin sections made, I would appreciate seeing your slide when it is returned from being remounted.

Best wishes and many thanks.

Cordially,

William E. Ham,
Associate Director.

WEH/mer
enc.

March 3, 1961

Dr. Jonathan Halsey
Mobil Oil Company
Box 900
Dallas, Texas

Dear Dr. Halsey:

Enclosed you will find the last of the corrected galleys for the list of Precambrian wells drilled in Kansas. I am sorry that it has taken so long to send this material to you, but it has taken this much time to check the information. We are fairly sure now we have as complete a list that is possible to compile, and that the information on the list is reasonably accurate.

The Kansas Basement Rocks Committee is still actively functioning collecting information on the basement rocks. We have been given numerous sample and core material which is on file at the Survey and available for use by any interested Precambrian student. We are most anxious to obtain additional information and would appreciate any such that you have come across working on the national committee.

Virgil Cole and myself at the present time have almost completed a configuration map on the Precambrian basement in Kansas on a scale of 1:500,000. This map will be published by the Kansas Geological Survey and should be available for distribution sometime this summer. I will see that you receive copies when they are available. Inasmuch as Virgil has been appointed to the national committee, all of this information will be available to you through him. Please feel free to contact us at any time concerning anything we may do for you.

I am enclosing a list of publications of the Kansas Survey. If there is anything we may do to help you in your search for oil in the state of Kansas, please let us know.

With best regards,

Daniel F. Merriam
Geologist

DFM:ps
Encl. (2)
cc: Dr. Peter T. Flawn
Virgil B. Cole
Dr. William W. Hambleton
Paul L. Hilpman
Paul C. Franks