PRELIMINARY CORE PREPARATION FOR SPECIAL CORE ANALYSIS-GUIDELINES

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ABSTRACT

The application of core analysis to provide data for reservoir evaluation is not a new science but has seen continued research activity over along period.

Core analysis is complex containing many stages between the reservoir and the final measurements and interpretation. To ensure the data produced is valid, every step along this phase must be handled with equal attention.

Recently developed techniques of measuring certain special core analysis of rock formation are being perfected. The objective of this paper is to provide information that will be of practical value to geologists and engineers involved with preliminary core preparation program. Following is a guideline for preliminary special core preparation.

The step by step outline presented below is a suggested guideline and, most certainly, modifications and/or changes may be made. However, this guideline has been found to be very successful for laboratory works.

I. INTRODUCTION

When the coring program is still in the planning stage, it is wise to consult a representative of the testing laboratory to discuss preliminary core preparation techniques and testing requirements. Core analysis testing is usually devided into two sections, a conventional core analysis (CORAL) and a special core analysis (SCAL).

The data obtained from the routine core analysis, also called the basic data, are used by petroleum engineers to determine volume relationships and flow characteristics of the reservoir and are necessary for special core analysis tests. The special core analysis complements the basic data, and furnishes information that allows calculation of static fluid distribution as well as dynamic flow performance of a well of reservoir.

The following is to furnish you the considerations for a coordinated data gathering program of the satisfactory technic currently in use for preliminary core preparation guideline.

At the first indication that engineers and geologists are interested in initiating core analysis tests, made to convince them they need core analysis, certain basic information is required as follows:

a) - What types of reservoir are they looking at ?
- Is it a gas, condensate, oil producer or some combination ?
- If oil, is it saturated or undersaturated ?
- Is it a gas storage project or a water reservoir?

b) - What is the geology of the reservoir ?
- Is it a carbonate section, a sand stone section, a sequence of multiple volcanic section, a deltaic sequence of multiple sandshale layers or an evaporite deposit (salt, gypsum anhydrite, etc.) ?

c) - Is the area virgin or have previous studies been made in that basin, reservoir or formation ?

d) - Is the reservoir section thick (how thick) or multiple thin layers ?

e) - What is the maximum closure of the reservoir (maximum height above the oil water contact ?)

f) - What mineral logical information is available about the reservoir rock ?
- Does it contain clays ?
- Have x-ray diffraction studies been performed to identify any clays ?
- Has there been any indication of swelling clays ?
- Is there any evidence of dolomitation?
- Any evidence of potentially soluble gypsum in the formation ?
- Geological information should be collected as much as possible.

g) - What is the degree of consolidation of the reservoir rock ? (Unconsolidated loose, soft, friable, firm or hard)
- What type of coring is planned, rubber sleeve, conventional or pressure ?
- What type of coring fluid will be used ?

h) - What are the production plans for the reservoir ?
- Is primary production about to commence or already in process ? Are secondary or tertiary production procedures planned ?
- Is water or gas injection projected?
- If water injection is planned where will the water come from ?

i) - What are reservoir conditions of temperature and pressure ?

j) - What type of crude is present, that is, what is the pour point, wax content, gravity, etc. ?
- Have any analysis been performed on the crude to determine its characteristics ?

k) - What indications are there as to the wettability of the reservoir rock ?

l) - What specific problems areas exists if any and/ or what specific tests does the company have in mind ?

m) - What is the salinity of the formation and any potential injection brines ?
- Have full chemical analysis of the brines been performed and are the results available ?

After considering the above information, it is up to geologists, engineers or managers to make recommendations. Such recommendation should include insisting upon sufficient core being provided.

It is also generally necessary to enlighten the company about the significance of receiving fresh, preserved, unweathered samples and the advantages of performing tests upon fresh rather than restored state samples.

It is recommended that the geologist or engineer should strongly urge the manager to make available the entire core to permit the testing laboratory to make sample selections. Of course, all selections will be made in conjunction with the laboratory representatives.

If the company specifies only a limited number of samples for analysis and from specific depths, than the testing laboratory is extremely restricted with regard to the quantity of samples available, the possibility of conducting concurrent tests and the ability to make significant interpretations of the data. In the following recommendations it will be assumed that the best possible technique is followed.

II. INITIAL LABORATORY ACTIVITY

For the purposes of this discussion, it will be assumed that the entire cored interval has been made available to the testing laboratory in a preserved state. In the event that preselected samples, either preserved or unpreserved, have been submitted for analysis, the same general principles, with one or two qualifications, will be applied. When the core first arrives at the testing laboratory, certain basic decisions have to be made :

a) What size of samples should be tested, 1" , 1 1/2" or full diameter ?

b) What type of lubricant should be used for drilling (water, air, kerosene or liquid nitrogen) ?

c) What type, if any, of mounting medium will be required ?

Full diameter samples are only tested if the formation contains fractures or is very heterogeneous as in the case of some reefal limestone. The decisions whether to use 1" or 1 1/2" diameter samples depend upon the type of test, (some core holder are only available in one size) the quantity and diameter of core are available as well as upon accuracy. The larger of the sample, the less is any potential error, since most special core analysis calculations are based upon pore volume which is a small number.

It is desirable to obtain a length to area ratio as large as possible. On the metric scale, a ratio approaching one is optimal. Usually attempts are made to use plug about 7.5 centimetres long. Type of lubricant will depend upon the core lithology and the type of test required, as shown in the Table 1.

Mounting can currently be performed with three mediums, hysol epoxy, heat shrinkable tubing and lead jackets (tooth paste tube). Selection will depend upon the tests planned and the state of rock consolidation can be summarized in the Table 2.

With these decisions made, the core can be opened and sampled.

Table 1
Type of lubricant and test required

Rock type	With No swelling clays suspected	With swelling clay suspected	For fresh or wettability tests
Hard-rock	Water	Kerosene	Kerosene
Friable-rock	Air	Air	Liquid N_2
Soft-rock or unconsolidated rock	Liquid N_2	Liquid N_2	Liquid N_2

Table 2
Summarised type of medium and sample state

Mounting medium	Sample state	Requirement	Limitations
Hysol Epoxy to 1" - 1 1/2" diameter.	Insufficient material to drilled or too friable to drilled and has been hand-shaped	Must know PV and BV before mounting, so-that sample must be extracted and dried.	None
Heat shrinkable tubing to 1" or 1 1/2" diameter.	Air drilled because too friable for liquid drilling	Must know PV and dimension before mounting, core must be extracted and dried.	None
Lead-jacket to 1" -1 1/2" diameter.	Soft or unconsolidated material.	Must perform all tests in Triaxial core holder.	Cannot perform electrical properties or porous plate cell capillary pressure.

III. LABORATORY TREATMENT

In general, the geologists and petroleum engineer will require routine conventional core analysis measurements to be performed first. Then it is a simple matter to drill an additional plug for possible special core analysis use at the same time that the routine plug is drilled.

These extra plugs should be wrapped in saran wrap and foil and stored away until required. If kerosene was used as a bit lubricant, the extra plugs should Be stored, submerged in kerosene until required.

The next preparation of rock works should be done in three phases as follow :

Phase (I) will be an evaluation of core analysis procedures followed by Phase (II) which will be the routine core analysis and this in turn followed by Phase (III) which will be the special core analysis.

Assuming that the cores are cut into lengths suitable for shipment and then sent to the laboratory facilities, Phase (I) would be initiated.

This Phase would first consist of running a core-gamma log on the sample to be used to compare with the downhole gamma log to tie together core and log depths.

The core gamma-ray surface log will determine prior any testing will be commenced. Initially the whole core segment will remove from each box without opening the preservation materials, then they will be laid out on the rolling belt beginning from the BOTTOM to the TOP of the core, respectively.

The data will show the peak intensities of radioactive material in the rock samples. This log would then serve as a sampling tool for work to follow.

Phase II will be an evaluation of core analysis. Core from selected intervals would be taken and analysis techniques would be evaluated so as to eliminate or minimize dehydration of clay during future work.

These evaluation tests would include routine core analysis technique, permeability, porosity, fluid saturation tests, thin section to define mineral present, X-ray diffraction tests as back up for the thin section works and Scanning Electron Microscope works for identification of clay type present, etc.

Routine core analysis data should be obtained on each foot of core. If the core is well consolidated and homogeneous, the analysis is usually done on 1 inch diameter and 1 to 3 inches long plug samples drilled from the whole core pieces. However, if the core is heterogeneous, a 1 inch diameter plug sample will not adequately represent the whole core piece.

Routine analysis of heterogeneous core such as stratified sandstone and vuggy carbonates should be done on whole core pieces.

If plug samples are taken from a vuggy carbonate, a thin-walled, diamond-tipped core drill should be used. Thick-walled core drills frequently break the plug sample resulting in samples too small to represent the whole core piece. The samples break at the vugs, therefore, the vug porosity is not included and the porosity is under estimated.

Full diameter analysis requires the entire core for testing, routine core analysis requires about four inches per foot and special analysis requires another six to eight inches per foot. In the later case testing is not usually performed on every foot of a core but on the representative samples covering range of permeability and porosity.

Phase III will be an evaluation of special core analysis.

Since the identity of these special samples is not known until the whole section has been tested and the data reviewed, the best course of action is to preserve all potential special test samples. It is a matter of personal choice whether the geologist or engineer select the samples for special core analysis at the rig or preserves the entire core and leaves the selection to the laboratory analyst. If selection is performed at the wellsite, care must be taken to provide sufficient rock for the required analysis.

When a special core analysis study is projected, all core remnant, after sampling, should be correctly oriented, labelled and represerved. This is so that fresh material will still be available if it is required at a later date.

The company should be discouraged from proceeding with slabbing and stratigraphic, environmental, paleontological or geochemical studies until all special core analysis are complete, unless adequate alternative material is available. The availability of additional fresh rock is stressed because many special core analyses tests take months to complete. If an error in procedure occurs or sample fails, then a substitute must be found.

On completion of conventional core analysis , the petroleum engineer or geologist must evaluate the basic data,

Porosity, permeability and grain density values should be carefully checked against the actual test plugs and the lithological descriptions. If any errors are apparent, they must be corrected before proceeding farther.

When the manager is satisfied that porosity and permeability results are accurate, sample selections which are representative of the full range of porosity, permeability and lithology present should be made in accordance with the following statistical technique, as discussed in the next section.

IV. SELECTION OF PLUGS SAMPLE FOR SPECIAL CORE ANALYSIS

The reservoir engineer is frequently faced with the task of deciding which plugs from a core should be selected for a special core analysis. This is often done arbitrarily, with the result that the measurements taken do not adequately represent the reservoir rock. Even more frequently, some loose direction, such as "take one plug every fifty feet" is given to the laboratory performing the core analysis. Consequently, special core measurements are taken which are unrepresentative of the reservoir rock being studied.

A. *Statistical Plugs Selection Method*

Statistical techniques exist by which the engineer may select samples for special core analysis which will be truly representative of the reservoir being investigated.

First, conventional core analysis is performed on the core, porosity and permeability data are generated.

The reservoir engineer and geologist then separate these data into lithologic units. For limestone would mean sorting the data into reefal and lagoonal facies, and for a sandstone reservoir might mean sorting the data into channel and bar sands.

This must be done prior to selecting sample for special core analysis for any analysis of conventional core data, because properties of the reservoir rock are dependent upon which lithologic unit it occurs in.

Trying to obtain representative rock property data from a sample set includes different lithologies which are not possible. Consequently, prior to sample selection for special core analysis :

* Perform conventional core analysis,
* Separate the conventional core analysis data by lithologic unit.

After the conventional core analysis data have been sorted by lithologic unit, statistical techniques may be applied to the data from each individual lithologic unit to select representative sample for the special core analysis.

As a general rule, the porosity and permeability of rocks exhibit normal and log-normal distributions, respectively.

This is illustrated in Figure 1. If rather than permeability, the logarithm of permeability is considered, this will also exhibit a normal distribution. (These distributions are the reasons why porosity is plotted versus the log of per-

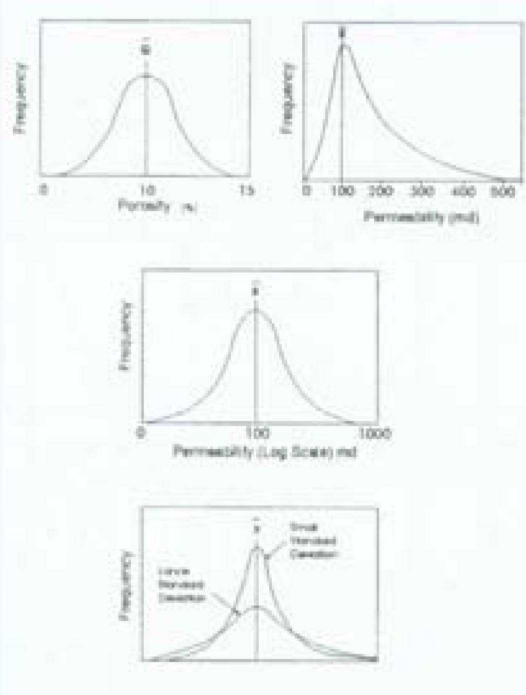

Figure 1
The normal and log normal distributions

meability to obtain porosity/permeability correlations).

A normal distribution is characterized by two parameters:

- the mean, which locates the apex of the distribution,
- the standard deviation, which describes the stepness of the curve.

Conversely, a distribution having a large standard deviation will tend to be rather flat. It should be noted that normal distributions are symmetric about the mean. For a normal distribution, the standard deviation also describes the percent of the data set which lie within the curve, at a certain distance from the mean.

For any normal distribution, 68 % of the data set lies within plus and minus one standard deviation from the mean. This is shown on Figure 2.

The shaded on the insert represents the area for number of samples between vertical two lines drawn equidistant from the mean. Since the total area under the curve represents all samples in the set, if the shaded area is devided by the total area under the curve, this will yield the percent of the data contained within the vertical lines.

As noted above, if these lines are drawn at plus and minus one standard deviation from the mean, 68 % of the data set will lie within them. If drawn at plus and minus two standard deviation from the mean, 95 % of the data will lie between them, and if drawn at plus and minus three standard deviations from the mean, 99.8 % of the data set will lie between them.

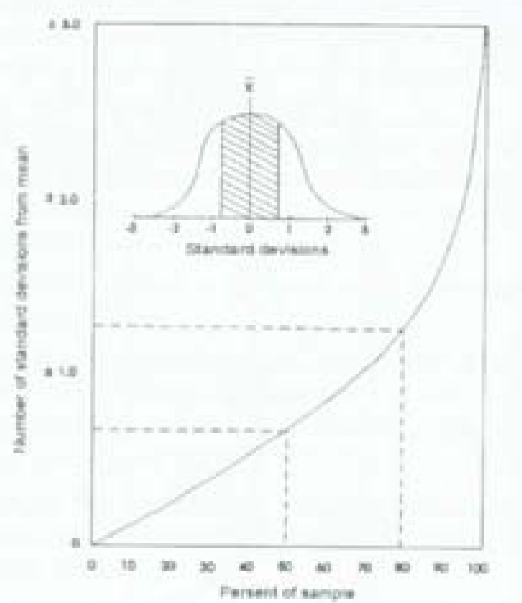

Figure 2

Percent of sample under normal curve enclosed by N standard deviations from the mean

This relationship is shown graphically on Figure 2. Where the percentage of the data set contained between limits at certain number of standard deviations from the mean is shown. It is apparent from this figure that to obtain sample representative of fifty percent of a data set, sampling limits should be set at about plus and minus 0.7 standard deviations from the mean. From this graph, it is also apparent how a statistical technique may be used to select core plugs for special core analysis.

Suppose plugs are to be selected on the basis of porosity alone: from routine core analysis, the mean porosity of all the plugs is known, and the standard deviation of the porosity may be easily calculated.

To describe the data set correctly, fifty percent of plugs should be selected within plus and minus 0.68 standard deviations of the mean porosity, an additional thirty percent between (plus 0.68 to 1.26) and (minus 0.68 to 1.26) standard deviations of the mean porosity; and remaining 20 % of plug for analysis beyond plus and minus 1.26 standard deviations from the mean. This is best understood when considered numerically. Suppose a set of porosity data has a mean porosity of 10 % and a standard deviation of one porosity percent.

To obtain a representative set of samples from this set for special core analysis, 50 % of the samples should have a porosity between 9.3 % and 10.7 % , 30 % should be taken from the porosity ranges 8.7 % to 9.31 and 10.7 % to 11.3 % , and the remaining 20 % should have porosities less than 8.7 % or greater than 11.3 % . Thus, if it was decided to select 20 plugs from this data set for special core analysis, they would be selected as follows :

Porosity, %	Number of plugs
<8.7	2
8.7 - 9.3	3
9.3 - 10.7	10
10.7 - 11.3	3
>11.3	2

B. Procedure of Application Statistical Technique

For normal special core analysis, it is necessary to define not only the porosity ranges from which the samples should be taken, but also the permeability ranges. This will be considered by means of an example, but may be summarized as :

- prepare histogram of porosity and log permeability
- calculate the mean porosity, and mean permeability
- calculate the standard deviation of porosity ($S\phi$) and permeability (Sk)

- calculate sampling limits at 0.68 Sk, 1.26 Sk and 0.68 Sφ, 1.26 Sφ
- crossplot porosity and log permeability
- overlay sampling limits on crossplot
- select sample as follows :

< -1.26		10%
-1.26 to -0.67		15%
-0.68 to +0.68		50%
0.68 to 1.26		15%
> 1.26		10%

Table 3

Porosity and permeability data

DEPTH	,%	LOG k	k,MD	DEPTH	,%	LOG k	k,MD
9000	7.5	1.77	58.9	9041	9.3	2.14	138.0
9001	11.2	2.45	281.8	9042	8.5	1.84	69.2
9002	10.0	2.15	141.3	9043	10.7	2.28	190.6
9003	11.8	2.43	269.2	9044	8.0	1.77	58.9
9004	8.8	2.12	131.8	9045	10.6	2.41	257.0
9005	11.1	2.47	295.1	9046	12.0	2.61	407.4
9006	8.5	1.97	93.3	9047	9.1	1.97	93.3
9007	8.2	1.97	85.1	9048	10.1	2.20	158.5
9008	10.9	2.40	251.2	9049	10.3	2.21	162.2
9009	8.5	1.93	85.1	9050	10.9	2.36	229.1
9010	9.4	2.02	104.7	9051	10.0	2.20	158.5
9011	9.1	2.07	117.5	9052	12.7	2.68	478.6
9012	11.8	2.56	363.1	9053	10.7	2.28	190.6
9013	10.3	2.31	204.2	9054	11.2	2.45	281.8
9014	10.2	2.15	141.3	9055	9.8	2.07	117.5
9015	13.3	2.82	660.7	9056	8.3	1.83	67.6
9016	9.8	2.16	144.5	9057	9.8	2.17	147.9
9017	10.6	2.38	239.9	9058	8.9	2.05	112.2
9018	9.2	2.12	131.8	9059	10.6	2.42	263.0
9019	10.2	2.31	204.2	9060	7.9	1.71	51.3
9020	11.5	2.53	338.8	9061	11.7	2.47	295.1
9021	10.9	2.47	295.1	9062	8.5	1.83	67.6
9022	10.3	2.20	158.5	9063	9.4	2.18	151.4
9023	5.7*	1.42*	26.3	9064	11.9	2.60	398.1
9024	10.8	2.46	288.4	9065	9.1	2.06	114.8
9025	7.7	1.72	52.5	9066	10.0	2.28	190.6
9026	9.4	2.13	134.9	9067	9.0	2.09	123.0
9027	12.1	2.63	426.6	9068	10.2	2.27	186.2
9028	10.0	2.27	186.2	9069	8.7	1.91	81.2
9029	10.7	2.32	208.9	9070	9.5	2.08	120.2
9030	10.4	2.22	166.0	9071	10.9	2.42	263.0
9031	6.7	1.62	41.7	9072	14.2*	3.09	1230.*
9032	11.1	2.41	257.0	9073	9.4	1.99	97.72
9033	8.8	1.92	83.2	9074	9.3	2.05	112.2
9034	8.7	1.89	77.6	9075	7.2	1.55	35.5
9035	9.7	2.19	154.9	9076	9.8	2.11	128.8
9036	10.2	2.30	199.5	9077	10.5	2.38	240.0
9037	9.8	2.11	128.8	9078	12.3	2.62	416.9
9038	10.1	2.26	181.9	9079	10.4	2.27	186.2
9039	8.8						
9040	9.0						

V. CASE STUDY: SELECTION OF PLUGS FOR SCAL

Given data: CORAL has been performed on 80 feet core samples (Depth 9100-9179 ft.), plug samples were taken every foot. The data to be analyzed are shown on Table 3.

From those data require 8 plug sample for SCAL study. Which eight samples should be selected ?

Solutions :

First, it is necessary to produce histogram of porosity and permeability so that their means and standard deviations may be calculated. Select the highest and lowest porosity and permeability values, and note the data by * code. Data are then sorted by class, and cumulated within each class to yield the frequency. Porosity data are shown in the Table 4.

Inspection of these data shown the approximately normal distribution of porosity and log permeability.

Table 4

Porosity data sorted by class

Porosity			
Class	Midpoint	Tally	Frequency
5.5-6.4	5.95	I	1
6.5-7.4	6.95	II	2
7.5-8.1	7.95	IIII I	6
8.5-9.4	8.95	IIII IIII IIII IIII I	21
9.5-10.4	9.95	IIII IIII IIII IIII III	23
10.5-11.4	10.95	IIII IIII IIII I	16
11.5-12.4	11.95	IIII III	8
12.5-13.4	12.95	II	2
13.5-14.4	13.95	I	1
			Σ = 80

Table 5

Permeability data sorted by class

Log permeability			
Class	Midpoint	Tally	Frequency
1.305-1.605	1.50	II	2
1.605-1.805	1.70	IIII	5
1.805-2.005	1.90	IIII IIII II	12
2.005-2.205	2.10	IIII IIII IIII IIII IIII	24
2.205-2.405	2.30	IIII IIII IIII I	16
2.405-2.605	2.50	IIII IIII IIII	15
2.605-2.805	2.70	III	3
2.805-3.005	2.90	I	1
3.005-3.205	3.10	I	1
			Σ = 80

Table 6
Values of the porosity variables

	Porosity			
Mid. Class	t	Frequency, f	ft	ft∆
5.95	-4	1	-4	16
6.95	-3	2	-6	18
7.95	-2	6	-12	24
8.95	-1	21	-21	21
9.95	0	23	0	0
10.95	1	16	16	16
11.95	2	8	16	32
12.95	3	2	6	18
13.95	4	1	4	16
Assumed mean xo = 9.257		Σf = 80	Σft = 1	Σft^2 = 161

Table 7
Calculated sampling limits data for porosity and permeability

Variable (x)	X-1.26S	X-0.68S	X	X+0.68S	X+1.26S
Porosity (%)	8.15	8.99	9.94	10.89	11.73
Log Permeability	1.82	2.00	2.20	2.40	2.58
Permeability (md)	66	100	158	251	380

After the data have been sorted by class, either by the reservoir engineer or by the core laboratory performing the conventional analysis, a frequency table, as shown below, may be constructed to calculate the mean and standard deviation of the data. The table is constructed in five column.

In the first column, enter the class midpoint, and in the third column the class frequency. The class midpoint having the highest frequency is then taken as the assumed value of the mean, Xo. Classes above and below the class are then assigned a number, t, sequentlly.

Classes having midpoints lower than the assumed value of the mean have negative value of t, and those with higher midpoint values have positive values of t. The class midpoint taken as the assumed value of the mean is assigned in zero volume for t.

Values of the variables ft (Column 2 x Column 3) and ft^2 {Column 2 x $(Column 3)^2$} are then calculated and summed.

If the class interval is defined as C, the volume of the mean, X, and the standard deviation for the variable may then be calculated. For the case shown, for porosity, the class internal, C, is 1.0.

The mean porosity average is then defined by :

$$\bar{\phi} = \bar{X} = X_0 + C\frac{\sum ft}{\sum f}$$

$$= 9.95 + 1.0\,\frac{-1}{80} = 9.94\%$$

and the standard deviation, s, is defined by :

$$S = C\left[\frac{\sum ft^2}{\sum f} - \left(\frac{\sum ft}{\sum f}\right)^2\right]^{0.5}$$

$$= 1.0\left[\frac{161}{80} - \left(\frac{-1}{80}\right)^2\right]^{0.5} = 1.42$$

For this well the porosity is normally distributed, with a mean of 9.94 %, and a standard deviation of 1.42 porosity percent. In a similar fashion, it may be calculated that the log of permeability is also approximately normally distributed, with a mean log permeability value of 2.20 (equivalent to a geometric mean permeability of 158 md) and a standard deviation of 0.30 log cycles.

Knowing the mean, and standard deviation for both porosity and permeability, the sampling limits for each variable at about 0.68 and 1.26 standard deviations may be calculated.

A crossplot of porosity and log permeability may now be constructed (Figure 4) and the sampling limits superimposed on it. As noted previously, samples should be taken in the ratio 10/15/50/15/10 across the range of data values.

However, by the porosity/permeability crossplot, samples may be chosen to satisfy statistical sampling limits for both porosity and permeability simultaneously. This is achieved by drawing the horizontal sampling limits using the permeability sampling limits (as determined by the permeability standard deviation).

Since only 8 plugs are to be used for special core analysis, they can not be taken in the ratio 10/15/50/15/10. With 8 plugs, the most reasoanble data spread will be obtained by sampling in the ratio 1/1/4/1/1/.

The plugs selected will then be :

Depth	Porosity	Permeability
9175	7.2	35.5
9109	8.5	85.1
9165	9.3	114.8
9170	8.5	120.2
9151	10.0	158.5
9136	10.2	199.5
9105	11.1	295.1
9152	12.7	478.6

This set of samples has a geometric mean permeability of 144 md, and an average porosity of 9.8 %. Comparing this values with the geometric mean permeability (158 md) and the mean porosity (9.94 %) for the entire set of plug samples, it is found that the mean permeability of the samples selected for special core analysis differ by only 0.13 standard deviation, and the porosity by only 0.10 standard deviations. These plugs are thus highly representative of the data set from which they were taken.

If the approach of taking one sample every ten feet had been followed, the sample set for special core analysis would have had a mean porosity of 8.34 %, and geometric mean of permeability of 125 md. These values are -1.13 standard deviations from the mean porosity, and -0.34 standard deviation from the geometric mean permeability of the entire set of plug samples. Consequently, this sampling technique would not have yielded special core analysis data which were representative of the rock being studied.

If porosity and permeability data obtained from routine core analysis do not exhibit normal distributions, and the porosity/log permeability crossplot exhibit a "shotgun" character, this statistical sampling technique is not appropriate. In this case samples for special core analysis should be chosen randomly across the range of porosity and permeability values percent.

The samples should, however, be selected so that then porosity and geometric mean permeability of the special core analysis samples is the same as those the entire routine core analysis data set. In this case, it is appropriate to conduct more special core analysis than in the case where distinct correlations exist between porosity and permeability.

VI. CONCLUSIONS

1. The reliability of special core analysis data are dependent upon the quality of the sample tested, but also selection of the actual test sample in the laboratory.
2. If the core sample is well consolidated and homogeneous, the analysis can be done on 1-inch diameter and 1 to 3 inches long plug samples, however if the core sample is heterogeneous, it is recommended the analysis is done on full diameter core sample.
3. The accuracy of special core analysis data are dependent on selection of the test plug samples which are representative to the reservoir formation being studied.
4. The recommended of porosity and permeability data of plug samples are the conventional data, which are measured at the reservoir overburden pressure conditions.

REFERENCES

1. **Heaviside,J**. and **Salt,H.J**.,1988, "A Systematic Approach: The Key to Successful Core Analysis", *SPE*-18385.
2. **Keelan, D.K**., 1971, "A Critical Review of Core Analysis Techniques", *Petroleum Society of CIM Paper No. 7612.*
3. **Jenkins, R.E**. and **Koepf, E. H**., 1957, "An Evaluation of Sidewall Core Analysis Techniques", *Annual Meeting AIME* , Paper 788 G.
4. **Moroney, J.M**.,1976, *Facts from Figures.*
5. **N.N.**, 1960, *API Recommended Practice for Core Analysis Techniques*, API RP-40.□