SEDIMENTARY ANALYSIS OF DRILL CUTTINGS FROM THE VANCE WELL, DELAWARE COUNTY, OHIO

WILLARD D. PYE[1]

The Chester L. Wise, et al, Herman E. Vance, No. 1, is located on Lot 11, Sec. 3, Orange Township, Delaware County, Ohio. This location is on the east side of the Olentangy River approximately 14 miles north of Columbus and 10 miles south of Delaware. Drilling commenced in September, 1934, and was completed in May, 1937, the entire hole being drilled by cable tool. The well started in the Ohio shale of Devonian age and bottomed at a total depth of 4291 feet in crystalline rocks of pre-Cambrian age. Despite the fact that the well was a dry hole, it is of importance because of the information it has yielded as to the subsurface stratigraphy of that part of Ohio. A detailed study of the drill cuttings from the Vance well has already been published.[2]

The total amount of material available for disaggregation and analysis was small, averaging only about 100 grams, and consisted of chips and sand brought up by the bailer from the indicated depths. Although some contamination of the cuttings undoubtedly occurred due to material being knocked off the upper walls of the hole during drilling operations, nevertheless, the analyses of the samples probably rather closely represent the formation being drilled.

The samples were taken at depths of 3435, 3440, and 3445 feet[3] and represent a Cambrian sandstone, possible just above the Jordan.[4] A gas-bearing brine was found at 3550 feet, just below the lowest sample.

The samples were all very uniform in appearance and consisted of a fine-grained, friable, fairly porous, yellowish-gray calcareous to dolomitic sandstone. The main cementing material was dolomitic calcite with some iron. In the coarse chips from the cuttings the carbonate is present as a cement binding the sand grains together; in the finer cuttings where the rock has been broken down into its individual mineral grain components, the carbonate cement is found as a fine powder. The original sand grains are rounded to well rounded and possess a fairly high degree of sphericity.

METHODS OF ANALYSIS AND DATA

Since it was obvious from microscopic examination that much of the "sand" was from the carbonate cement, one fraction of each sample was boiled for ten minutes in dilute hydrochloric acid to remove the carbonates, and in stannous chloride to clean the grains of iron oxide coatings so as to facilitate later mineral identification.

Table I gives the results of the mechanical analyses of both the untreated and acid treated samples. Sieving was by hand and lasted for 30 minutes. As this is longer than has recently become the standard practice for making sedimentary analyses, the final results probably were controlled to some extent by the largest opening in each sieve.

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[1]Now with the Texas Company, Box 167, U. S. A. C., Logan, Utah.

[2]W. Stout and C. A. Lamey, "Paleozoic and Pre-Cambrian Rocks of the Vance Well, Delaware County, Ohio," *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 24, (1940), pp. 672–692.

[3]The samples were secured by Dr. G. D. Hubbard from Dr. W. Stout, State Geologist of Ohio. Acknowledgment is made to Messrs. A. J. Wallace and R. Mallory for supplemental information on the 3440 and 3445 foot samples.

[4]W. Stout and C. A. Lamey, *op. cit.*, pp. 672–692.

TABLE I

SIEVE ANALYSIS

DEPTH	3435 FEET	3440 FEET		3445 FEET	
Sieve Size (mm.)	Untreated %	Untreated %	Acid Treated %	Untreated %	Acid Treated %
1.000 – 0.495	trace	....	....	....	....
0.495 – 0.246	2.3	6.4	2.4	2.1	3.3
0.246 – 0.124	23.8	24.7	25.2	20.8	32.8
0.124 – 0.061	37.5	42.1	53.7	48.3	51.2
0.061 – Pan	36.4	26.8	18.7	28.8	12.7
Total	100.0	100.0	100.0	100.0	100.0
Mean Size	0.085	0.096	0.096	0.086	0.108
Standard Deviation	0.56	0.55	0.62	0.61	0.62
Per cent sample into solution by acid	64.1*	....	....	....	....
	62.2†	....	60.9	....	41.3

*Different sample than the one sieved.
†Sample used for chemical analysis of cements.

TABLE II

PIPETTE ANALYSIS OF SAMPLE FROM 3445 FOOT DEPTH
(Untreated by acid)

Size (mm.)	Per Cent	Per Cent of Total Size Distribution
1/16 – 1/32	40.9	11.8
1/32 – 1/64	40.9	11.8
1/64 – 1/128	11.7	3.4
Less than 1/128	6.5	1.8
Greater than 1/16 (from Table I)	....	71.2
Total	100.0	100.0

TABLE III

MINERALOGY OF SAMPLE FROM 3440 FOOT DEPTH

Minerals	Untreated Sample %	Acid Treated Sample %
Iron stained quartz	35	79
Opaques (Magnetite and Limonite)	5	10
Biotite	1	4
Muscovite	1	3
Garnet (pink and red)	1	3
Hornblende	1	1
Tourmaline	1	..
Opaque and semi-opaque iron carbonates	40	..
Calcite and Dolomite	15	..

The material from the non-acid treated sample caught on the pan during the sieving of the 3445 foot depth sample was boiled in a solution carrying 0.5 grams of sodium carbonate and then diluted to 1000 cc. for pipette analysis. The results are presented in Table II. How much of this distribution was due to carbonate cement fragments was not determined.

The mineralogy of the samples is given below and is based upon both heavy mineral and thin section analyses.

Sample from 3435 foot depth: The cement binding the sand grains together consists of carbonate with minor amounts of iron oxide. Some post-depositional pyrite is also present. No silica cement is evident. Magnetite makes up fully fifty per cent of the heavy minerals; pyrite, limonite, and leucoxene make up minor amounts. The non-opaque heavy minerals are freshly broken (during drilling?) pink garnet, rounded topaz grains with many inclusions, and well rounded olive-green zircons. The dominant detrital light mineral is quartz, which may be clear or filled with inclusions. Acid feldspar is present but not common. The very abundant carbonate cement is all recrystallized and shows no evidence of a detrital origin.

Sample from 3440 foot depth: See Table III.

Sample from 3445 foot depth: Iron-stained quartz makes up most of the detrital minerals. Zircons, garnet, flourite, hematite, magnetite, leucoxene, and pyrite are present in small amounts. Magnetite makes up over 40 per cent of the heavy minerals with the other ore minerals making up most of the rest. Fragments of well crystallized carbonate cement are very common in the light fraction.

Chemical Analysis of Sample from 3435 Foot Depth: After a sample from the 3435 foot depth was leached with hydrochloric acid, it was found that a total of 62 per cent had gone into solution. This solution was analyzed for calcium, magnesium, and iron percentages. Although undoubtedly other elements for which no tests were made were present in minor amounts, the following were calculated to have made up all of the material that was dissolved by the acid:

$CaCO_3$ 57%
$MgCO_3$ 23%
$FeCO_3$ and Fe_2O_3 ..... 20%

(Note: Some of the iron probably came from small amounts of the magnetite and other iron minerals going into solution during the acid treatment.)

CONCLUSIONS

The formation is a highly dolomitic, calcareous, fine-grained sandstone with considerable iron carbonate and oxide. Silica cement is nil. The insoluble portion is dominantly made up of fine quartz sand with very little feldspar. Small amounts of heavy minerals are present. Of these, magnetite and the other opaque ore minerals predominate.

The degree of sorting coupled with the presence of well rounded zircon and topaz grains would indicate probably at least a second cycle of erosion for some of the sand. Not enough evidence was available to determine whether the sand was (1) deposited under aeolian conditions with later carbonate cementation by ground water, or (2) deposited under near shore, clear water conditions with no major streams entering the sea in the general vicinity, and a low lying, probably peneplaned, land-mass making up the coastal area. Either case would give a clean, well sorted, medium fine, calcareous sandstone deposit. The latter probably represents the conditions of deposition unless the formation is a combination of the two, being an aeolian sand reworked and deposited under the above outlined marine conditions.