

THE AMERICAN UPPER ORDOVICIAN STANDARD. XVI.
UTILITY OF CLASTIC-RATIO VALUES TO DISTINGUISH
KOPE AND FAIRVIEW FORMATIONS,
HAMILTON COUNTY, OHIO^{1, 2}

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ABSTRACT

The result of a Mann-Whitney U-test indicates that clastic-ratio values for the Kope Formation are stochastically greater than are those for the Fairview Formation in eastern Hamilton County, Ohio. The use of the clastic-ratio as an inferential statistic when applied to these formations is justified.

INTRODUCTION

Clastic-ratio values as defined by Weiss *et al.* (1965, p. 8) have been used by Weiss and Sweet (1964), Weiss *et al.* (1965), Ford (1967), and Osborne (1968) to describe and lithologically correlate strata assigned to the typical Cincinnati Series in southwestern Ohio. Inasmuch as Osborne (1970) demonstrated the high degree of sedimentological similarity between the Kope and Fairview Formations in eastern Hamilton County, Ohio, the geologic utility of the clastic-ratio as a descriptive and especially as an inferential statistic when applied to these formations is subject to question. The purpose of this paper is to perform an appropriate statistical test to determine whether or not there is a significant stochastic difference between clastic-ratio values typical of the Kope Formation and those typical of the Fairview Formation in this area. Clastic-ratio values computed for 1111 intervals (each three feet thick) from 46 stratigraphic sections in eastern Hamilton County form the basis for this study.

PROCEDURE AND RESULTS

There are at least two statistical tests which might be used to accomplish this comparison of clastic-ratio values. The more powerful of these two tests is the parametric Student t-test. The following assumptions must be satisfied before confidence can be placed in any probability statement obtained by a t-test (Siegel, 1956): (1) the observations must be independent, (2) the variable involved must have been measured in at least an interval scale, (3) the observations must be drawn from normally distributed populations, and (4) the populations must have the same variance, or in some special cases they must have a known ratio of variances.

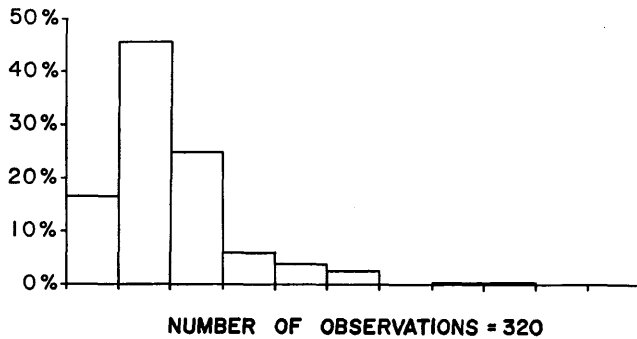
Although requisites (1) and (2) are satisfied in this case, examination of Figure 1 indicates that the observations are probably not drawn from normally distributed populations, and examination of Table 1 indicates that the variances cannot be considered to be even approximately equal. The mathematical assumptions for a t-test are obviously not satisfied; therefore this test is inappropriate for a meaningful solution.

The Mann-Whitney U-test (Siegel, 1956) is a nonparametric alternative to the t-test, provided at least ordinal measurement has been attained. The power-efficiency of the U-test approaches 95.5 percent as the sample size increases (Mood, 1954), which makes the U-test among the most powerful of the nonparametric

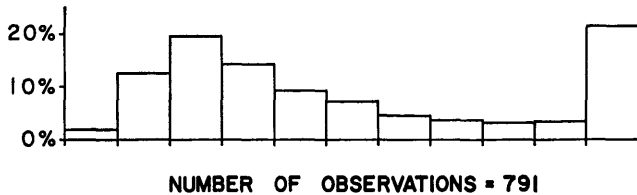
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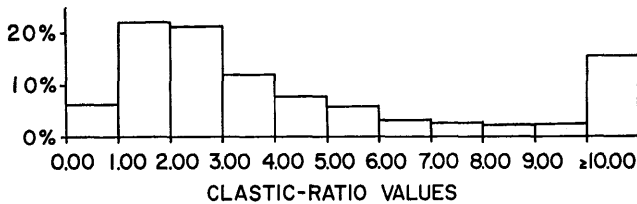
tests. The rationale and computational procedure for the Mann-Whitney U-test are explicitly discussed in Siegel (1956, p. 116-127), therefore these aspects of the U-test are not presented in this paper.



FAIRVIEW FORMATION



KOPE FORMATION



KOPE AND FAIRVIEW FORMATIONS

FIGURE 1. Histograms showing clastic-ratio values for the Kope and Fairview Formations in eastern Hamilton County, Ohio.

The null hypothesis (H_0) for this study is that the clastic-ratio values for the Kope and Fairview Formations are equal. The alternative hypothesis (H_1) is that the clastic-ratio values for the Kope are stochastically larger than are those for the Fairview Formation. The sample sizes for the Kope and Fairview Formations are 791 and 320 respectively, and the significance level (α) equals 0.05. The obtained value for z equals 18.48, which has an associated one-tailed probability of $<<0.001$. Therefore H_0 is rejected in favor of H_1 at the five-percent significance

level. This test strongly suggests that the clastic-ratio values for the Kope are indeed stochastically greater than are those for the Fairview in eastern Hamilton County, Ohio.

TABLE 1
Summary Statistics

Lithologic Unit	Number of Observations	Arithmetic Mean	Variance	Standard Error of Mean
Fairview Fm.	320	1.92	1.35	0.06
Kope Fm.	791	12.60	563.59	0.84
Total	1111	9.52	424.77	0.62

CONCLUSION

The use of the clastic-ratio as a descriptive statistic has been shown by Weiss and Sweet (1964), Weiss *et al.* (1965), Ford (1967), and Osborne (1968) to be geologically meaningful when applied to strata assigned to the Kope and Fairview Formations in southwestern Ohio. The present study suggests that the clastic-ratio values for the Kope Formation are stochastically greater than are those for the Fairview Formation, and the use of the clastic-ratio as an inferential statistic when applied to these lithic units is statistically justified. Although the Mann-Whitney U-test has not been widely used in geological literature, the utility of the U-test as an alternative to the Student t-test is demonstrated.

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REFERENCES CITED

- Ford, J. P. 1967. Cincinnati geology in southwest Hamilton County, Ohio. *Am. Assoc. Petroleum Geologists Bull.* 51: 918-936.
- Mood, A. M. 1954. On the asymptotic efficiency of certain non-parametric two-sample tests. *Ann. Math. Statist.* 25: 514-522.
- Osborne, R. H. 1968. American Upper Ordovician Standard. IX. Bedrock geology of eastern Hamilton County, Ohio. *Am. Assoc. Petroleum Geologists Bull.* 52: 2137-2152.
- . 1970. The American Upper Ordovician Standard. XII. Time-trend analysis of Cincinnati calcarenites, Hamilton County, Ohio. *Jour. Geology* 78: 363-371.
- Siegel, Sidney. 1956. *Nonparametric statistics for the behavioral sciences.* McGraw-Hill Book Co., New York. 312 p.
- Weiss, M. P., and W. C. Sweet. 1964. Kope Formation (Upper Ordovician): Ohio and Kentucky. *Science* 145: 1296-1302.
- Weiss, M. P., W. R. Edwards, C. E. Norman, and E. R. Sharp. 1965. The American Upper Ordovician Standard. VII. Stratigraphy and petrology of the Cynthiana and Eden Formations of the Ohio Valley. *Geol. Soc. Am. Spec. Paper* 81. 76 p.