The American Upper Ordovician Standard. XVI, Utility of Clastic-Ratio Values to Distinguish Kope and Fairview Formations, Hamilton County, Ohio

Osborne, Robert H.
THE AMERICAN UPPER ORDOVICIAN STANDARD. XVI.
UTILITY OF CLASTIC-RATIO VALUES TO DISTINGUISH
KOPE AND FAIRVIEW FORMATIONS,
HAMILTON COUNTY, OHIO

ROBERT H. OSBORNE
Department of Geological Sciences, University of Southern California,
Los Angeles, California 90007

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 Cincinnatian 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
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.

![Histograms showing clastic-ratio values for the Kope and Fairview Formations in eastern Hamilton County, Ohio.](image)

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 ($\alpha$) 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>
<thead>
<tr>
<th>Lithologic Unit</th>
<th>Number of Observations</th>
<th>Arithmetic Mean</th>
<th>Variance</th>
<th>Standard Error of Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fairview Fm.</td>
<td>320</td>
<td>1.92</td>
<td>1.35</td>
<td>0.06</td>
</tr>
<tr>
<td>Kope Fm.</td>
<td>791</td>
<td>12.60</td>
<td>563.59</td>
<td>0.84</td>
</tr>
<tr>
<td>Total</td>
<td>1111</td>
<td>9.52</td>
<td>424.77</td>
<td>0.62</td>
</tr>
</tbody>
</table>

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.

ACKNOWLEDGEMENTS

This work was partially supported by a grant from the National Science Foundation (GP-479) administered by Malcolm P. Weiss and W. C. Sweet.

REFERENCES CITED


