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A NEW ROUNDNESS SCALE FOR SEDIMENTARY PARTICLES[1]

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ABSTRACT

A new roundness scale is proposed. This scale is defined by six roundness classes. Two sets of clay models were prepared to characterize each roundness class. One set shows a high sphericity, the other a low sphericity. Photographs of these models are used to determine the roundness of a particle by comparison.

The roundness of a particle depends upon the sharpness of the edges and corners. It is independent of the shape. Roundness is a physical property of all sediments, and needs to be described. Where fossils are absent from a sedimentary layer it may prove useful in determining environment of deposition. Roundness gives us some idea of the distance traveled by a particle prior to its deposition, and may also indicate tectonic disturbances. It is probable that roundness may be of some use in the correlation of beds. In order to evaluate the validity of such ideas an accurate method of determining roundness must be adopted using a statistically operable roundness scale. For convenience the method should also be rapid.

Hakon Wadell's method for determining the roundness of a particle (Wadell, 1935) involves dividing the average of the radii of the corners of the grain image by the radius of the maximum inscribed circle. This method is the most accurate yet proposed, but it is far too slow to be used in studying sediments on a large scale.

Russell and Taylor (1937) placed particles in classes based on comparison with photographs of type grains. They presented five grade terms. The class limits for the grade terms are referred to the Wadell method. Sediments are usually assigned by estimation using as criteria the amount of wear of corners and edges. The terms and their corresponding mid-points and class limits are given in Table I. Their class limits were not systematically chosen and the arithmetic means of the intervals were used as mid-points. These values do not provide the smaller subdivisions that are needed in the lower values. Practice has shown that the eye can more readily distinguish differences of roundness when the roundness values are low.

Pettijohn (1949) has modified the ar-

TABLE I.—*Roundness grades*

Grade term	Russell and Taylor		Pettijohn	
	Class Limits	Arithmetic Mid-Point	Class Limits	Geometric Mid-Point
Angular	0 to 0.15	0.075	0 to 0.15	0.125
Subangular	0.15 to 0.30	0.225	0.15 to 0.25	0.200
Subrounded	0.30 to 0.50	0.400	0.25 to 0.40	0.315
Rounded	0.50 to 0.70	0.600	0.40 to 0.60	0.500
Well rounded	0.70 to 1.00	0.850	0.60 to 1.00	0.800

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TABLE II.—*Roundness grades*

Grade Terms	Class Intervals	Geometric Means
Very angular	0.12–0.17	.14
Angular	0.17–0.25	.21
Subangular	0.25–0.35	.30
Subrounded	0.35–0.49	.41
Rounded	0.49–0.70	.59
Well rounded	0.70–1.00	.84

rangement by using a "geometric" scale, and has rounded off the class limits in order to facilitate memory. (See Table I.) Even this "geometric" scale does not provide small enough divisions in the lower roundness values. Pettijohn differs from Russell and Taylor in that he groups particles into classes by using silhouettes rather than photographs for comparison. The comparison characterizes a three dimensional particle by a two dimensional reference although the three dimensional aspect of small particles is easily observed under the microscope by raising and lowering the focal plane through the full thickness of the particle. A more complete picture of the roundness of a particle is obtained in this manner.

Krumbein (1941) relied entirely on visual comparison of the individual grains with silhouettes to arrive at an average roundness value for the samples. He proposed no class limits, but presented silhouettes for nine different roundness values. This method is rather slow and somewhat tedious. Since his roundness values are very close together, it is often difficult to decide which roundness value to assign to a particle.

If another descriptive term, *Very Angular*, were added to Pettijohn's and Russell and Taylor's set of roundness terms, there would be six roundness classes, and this addition would provide an additional division of the lower classes. As is usual, the addition of another class interval would permit hitherto obscured differences to be revealed by the statistical analysis, and would, perhaps, afford a better interpretation of the history of sediments.

The interval from 1.00 to 0.12 has been divided into six intervals in such a way that the ratio of the upper limit to the lower limit of any interval is 0.7. The characteristic point of each interval is the geometric mean of the class limits. The values appear in Table II. The values given have been rounded off to the nearest hundredth. This scale provides the required increasingly fine divisions at the lower end of the scale. It increases the number of classes which permits a better appraisal of variability and it does away with what is basically an infinite open interval from 0.00 to 0.15 present in the older "geometric" classification. It has been our experience that, with the exception of crystals, particle roundness less

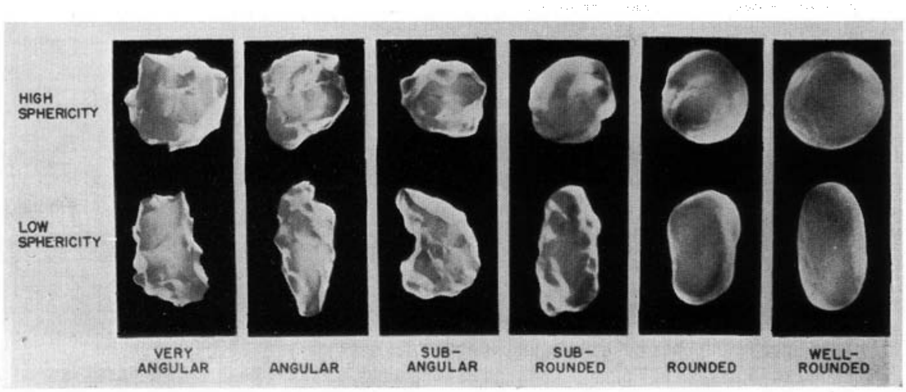

FIG. 1.—Roundness scale.

than 0.12 is not differentiated. The extension of the notion of roundness as defined by Wadell to a crystal is a purely conceptual matter. It is our contention that crystals are not a uniform part of the domain to which the concept of roundness is validly applicable. By deleting crystals and by terminating the division at a point below which observation does not go we have secured a partition into classes that is subject to valid statistical operation.

Figure 1 illustrates particles which fall very near the geometric means of the six class intervals. The particles were modeled from clay to make possible the addition of certain details in the shape, sphericity, and roundness of the particles. Photographs of particles and actual quartz grains whose roundness values were determined using the Wadell method were used as references for the models. Each roundness class is illustrated with two particles, one with a fairly high sphericity, and one with a rather low sphericity. Modeling of the clay and photography of the models was done by Mrs. Josephine B. Thoms.

In determining the roundness of a sample, each particle is assigned to one of the classes depending on the photograph with which it most nearly compares. Fifty or more grains are thus classified by comparison with the photographs. An average roundness for the sample is determined by multiplying the number of particles in each class by the geometric mean of that class and dividing the sum of the products by the total number of particles counted. This method has been used in laboratory work and found to be at least as accurate as other methods proposed.

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REFERENCES

KRUMBEIN, W. C. (1941) Measurement and geological significance of shape and roundness of sedimentary particles: Jour. Sedimentary Petrology, vol. 11, pp. 64–72.

PETTIJOHN, F. J. (1949) Sedimentary Rocks, Harper and Brothers, New York.

RUSSELL, R. D. and TAYLOR, R. E. (1937) Roundness and shape of Mississippi River sands. Jour. Geology, vol. 45, pp. 225–267.

WADELL, HAKON (1935) Volume, shape and roundness of quartz particles: Journal of Geology, vol. 43, pp. 250–280.