ISSN: 2688-8645

Implication of Grain Size Analysis Method in Pedo-geology

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Abstract

In pedo-geology, the granularity analysis data is mainly used for sediment transportation mechanism, hydrodynamic conditions, and restoration of sedimentary environment, and occasionally can also be applied to the restoration of diagenetic environment. At present, the main methods are formula calculation and plate method. The formula calculation method is to calculate some unique grain size parameters through the probability accumulation curve. Through the interval range or discriminant formula of these grain size parameters, the transportation mechanism, hydrodynamic conditions and deposition environment to which the sample belongs are determined. The plate method is to determine the transport mechanism, hydrodynamic conditions and deposition environment of the sample according to the curve shape or distribution position of the grain size data on a specific plate. With the improvement of the theory of geology and the development of geophysics and geochemistry, the application of grain size analysis in practice is becoming more and more extensive and more perfect. The interpretation formulas and diagrams of the sedimentary environment through grain size analysis should be gradually updated, Multidisciplinary intersections jointly restore the sedimentary environment.

Keywords

Grain size analysis; Pedo-geology; Depositional environment.

1. Introduction

Granularity is an important structural feature of sediments and the basis of its classification and naming. Granularity data is also widely used to judge the sedimentary environment and analyze the sediment transport process [1-3]. Since 1957, Folk and Ward proposed grain size parameter calculation formulas and simple sedimentary environment judgment standards [1, 2], the use of these grain size parameters to determine sedimentary environment research has emerged in large numbers, the most typical is Sahu based on these grain sizes in 1964 The parameters establish the discriminant formulas and diagrams of different deposition environments [3]. The same classic is that in 1969, Visher applied a cumulative curve of grain size probability values to establish a typical model of the sedimentary environment [4]. With the development of disciplines and the progress of methods, many scholars have also questioned the classic calculation formulas and templates in the past, and proposed

ISSN: 2688-8645

corresponding new methods [5-9]. For these new and old methods and application examples, this article summarizes.

2. Folk Grain Size Calculation Formula and Typical Sedimentary Environment Grain Size Characteristics

Folk and Ward (1957, 1966) obtained the Grain diameter at a certain cumulative percentage on the grain size accumulation curve, and then calculated parameters such as average grain size MZ, standard deviation σ1, skewness SK1, and kurtosis KG [1, 2].

The environmental characteristics of sedimentary sand were analyzed using the combined characteristics of grain size parameters, as shown in Table 1 [1, 2].

Table 1. Grain-size characteristics of several common depositional types

Depositional type	character				
	Curve shape	Skewness	Kurtosis	Sorting	Grain size
Channel sand	multimodal asymmetric curve	Mainly positive	low	bad~middle	coarse
Beach sand	Single peak symmetric normal curve	Symmetry, occasionally negative skewness	Middle-little sharp	well	↓
Dune sand	Single peak curve, asymmetric curve	Mainly positive	midlle	Very well	
Aeolian sand	Bimodal curve asymmetry	Mainly positive	sharp	Well	fine

3. Sahu Granularity Discriminant Formula and Causes Graphic

Sahu (1964) based on Folk and Ward's grain size parameter calculation formula, made a large number of statistics on modern clastic sediments (turbidite using core data), and used mathematical analysis methods to find the discriminant formulas for various sedimentary environments (Table 2) [3]. And drawing on logarithmic coordinate paper, it is found that different depositional environments have obvious boundaries on the drawing. The application of this diagram can roughly distinguish the sediments of turbidity currents, deltas, shallow seas, beaches and aeolian environments.

Table 2. Sahu discriminant formula for depositional environment

Depositional model	Discriminant formula	Discrimination value	Function average
Aeolian and beach sand	Y=-3.568MZ+3.7016σ12-2.0766SK1+3.1135KG	Y<-2.7411 Y>-2.7411	`Y=-3.0793 `Y=-1.7824
Beach and shallow sea	Y=15.6543MZ+65.7091σ12+18.1071K1+18.5043KG	Y<65.3650 Y>65.3650	`Y=51.9536 `Y=104.7536
shallow sea and river (delta)	Y=0.2852MZ-8.7604σ12-4.8932SK1+0.0482KG	Y<-7.4190 Y>-7.4190	`Y=-5.3167 `Y=-10.4418
river (delta) and turbidity	Y =0.7215MZ-0.4030σ12+6.7322SK1+5.2927KG	Y<9.8433 Y>9.8433	`Y=10.7115 `Y=7.9791

ISSN: 2688-8645

4. Paleoenvironment and Paleoclimate Restoration Model

Shi-Yong Yu (2016) believes that the traditional grain size parameter analysis methods and illustrations are not sufficient to characterize the complex sedimentary environment and climate [5]. Shi-Yong Yu used a multi-level Bayesian terminal simulation analysis method to dissect the granularity data, and established a new paleoenvironment and paleoclimatic discriminant model called BEMMA model [5].

Lu and Vandenberghe (2001) used a combination of granularity parameters and radar graphic methods to explain the origin of the Red Clay in the Quaternary in northern China, and restored the ancient climate of the Quaternary Red Clay deposition period [11].

5. Visher Uses Probability Value Cumulative Curve to Distinguish Sedimentary Environment

Visher (1969) uses logarithmic coordinates to expand the effect of coarse and fine Grains in the cumulative grain size curve, and divides the cumulative curve into three parts, which represent the rolling component and jumping component of the sediment transport process And suspended components [4]. Visher also made a large number of statistics on the grain size probability curves of different deposition environments in modern times, and summarized the template of grain size probability curves of different deposition environments [4].

6. Conclusion

Granularity analysis is mainly used in sedimentology to restore sediment transport mechanism, hydrodynamic conditions and the restoration of sedimentary environment, and occasionally to the restoration of diagenetic environment. There are two methods for sediment transport mechanism, hydrodynamic conditions and restoration of sedimentary environment, one is formula calculation method, and the other is plate method. The formula calculation method is to calculate some unique grain size parameters through the probability accumulation curve. Through the interval range or discriminant formula of these grain size parameters, the transportation mechanism, hydrodynamic conditions and deposition environment to which the sample belongs are determined. Representative scholars of formula calculation method include Folk, Sahu, Simon j. Blott, Shi-Yong Yu, Vandenberghe and so on. The plate method is to determine the transport mechanism, hydrodynamic conditions and deposition environment of the sample according to the curve shape or distribution position of the grain size data on a specific plate. Representative scholars of plate method include Visher, Passega, Donghuai Sun and so on.

It is not enough to simply use granularity data to restore sediment transport mechanism, hydrodynamic conditions and sedimentary environment. Many scholars also comprehensively use geophysical and geochemical methods to comprehensively restore sediment transport mechanism, hydrodynamic conditions and sedimentary environment. Representative scholars include Liu jin, Ezquerro, etc.

With the improvement of geology theory and the development of geophysics and geochemistry, the application of grain size analysis in practice is becoming more and more extensive and more perfect. The interpretation formulas and diagrams of the sedimentary environment are gradually updated, and the sedimentary environment is restored through cross-disciplinary intervention. However, there are still the following points to be considered: (1) The interpretation formulas and plates of the sedimentary environment are based on empirical observation data, a large number of statistics of the characteristics of granularity data in the modern sedimentary environment, and inversion of the ancient sedimentary environment. However, the fundamental analysis of grain size data should be to explain the relationship

ISSN: 2688-8645

between Grain transportation and deposition process and grain size distribution from the perspective of physics, and then to explain the deposition environment according to Grain transportation and deposition process. Only in this way can we further analyze the relationship between the size distribution characteristics and the sedimentary environment. (2) The theory of sedimentary environment model and Grain diameter currently lacks a unified standard.

References

[1] Rl F, Wc W. Brazos river bar: a study in the significance of grain size parameters[J]. Journal of Sedimentary Petrology,1957(27):3-26.

[2] Rl F. A REVIEW OF GRAIN-SIZE PARAMETERS[J]. Sedimentology,1966,6:73-93.

[3] Sahu B K. Depositional mechanisms from the size analysis of clastic sediments[J]. Journal of sedimentary petrology,1964,34(1):73-83.

[4] Visher G S. grain size distributions and depositional processes[J]. Journal of sedimentary petrology,1969,39(3):1074-1106.

[5] Yu S, Colman S M, Li L. BEMMA: A Hierarchical Bayesian End-Member Modeling Analysis of Sediment Grain-Size Distributions[J]. Mathematical Geosciences,2016,48(6):723-741.

[6] Blott S J, Pye K. GRADISTAT: a grain size distribution and statistics package for the analysis of unconsolidated sediments[J]. Earth Surface Processes and Landforms,2001,26(11):1237-1248.

[7] Sun D, Bloemendal J, Rea D K, et al. Grain-size distribution function of polymodal sediments in hydraulic and aeolian environments, and numerical partitioning of the sedimentary components[J]. Sedimentary Geology,2002,152(3–4):263-277.

[8] Fredlund M D, Wilson G W, Fredlund D G. Use of the grain-size distribution for estimation of the soil-water characteristic curve[J]. Canadian Geotechnical Journal,2002,39(5):1103-1117.

[9] Weltje G J, Prins M A. Genetically meaningful decomposition of grain-size distributions[J]. Sedimentary Geology,2007,202(3):409-424.