Application of New Techniques for Soil and Geological Particle Size Analysis

1. Definition of Particle Size

The size of a particle is called particle size, which is often designated as the average diameter of the particle. But in terms of particle diameter, its physical meaning is very different. Particles have the following five definitions in sedimentology:

(1) Sieve diameter: the smallest square pore size through which particles can pass [1].

(2) Stokes diameter: equivalent diameter corresponding to the diameter of a sphere with the same final settling velocity as the particle undergoing laminar flow in a fluid of the same density and viscosity [4].

(3) Apparent diameter: The diameter measured from a given point of view of the particle. Generally determine the longest or shortest diameter.

(4) Volume-equivalent sphere diameter: The diameter of a homogeneous spherical particle with the same volume as the measured particle. The particle diameter measured by the laser method is the volume-equivalent sphere diameter.
2. Techniques and Methods for Soil and Geological Particle Size Analysis

(1) Sieving method: The sieving method is the main method for analyzing fine gravel and sand. Usually, 50 g of the sample will be sieved on a sieve shaker for about 10 minutes, and then grading and weighing will be finished. Sieving method just requires a simple device, but it is not suitable for analysis of silt and clay particles.

(2) Laser diffraction method: The laser diffraction method is an effective and efficient method for determining particle size, which was developed in the 1970s. It has the advantages of high accuracy, fast speed, and simple operation [2].

(3) Image analysis method: The image analysis method is to collect the particle images under the microscope and transmit the images into a computer. The measurement and processing of the two-dimensional particle image of the particles will be completed on the computer. With the advancement of imaging technology, this method is increasingly used for soil and geological particle analysis.

(4) Comprehensive method: For soil samples with wide distribution, it is generally analyzed by a combination of sieving and laser diffraction. The final particle size distribution report will be synthesized by a specified software. In the attached table, there is an analysis report of elastic rock particle size using sieving method and Bettersize particle size analyzer.
3. Applications of Particle Size Analysis

The particle size distribution of sediments is mainly affected by factors such as the transport medium, the transport pattern and the deposition environment. Therefore, by studying the particle size distribution of sediments, we can know the depositional environment of the sediments. The sediments can be divided into suspended load, saltation load and traction load according to different transport methods. The particle size of suspended load is generally below 0.1 mm. The saltation load is sand near the bottom of the riverbed with a particle size of 0.15 mm to 1.0 mm. And the traction load is coarse particles slid or rolled at the bottom of the river, whose grain size is generally greater than 1 mm. Sediment particle size distribution is a reflection of material source, hydrodynamic environment of the sedimentary area, transport capacity and transport route. On the basis of particle size analysis data, sediment types has been classified and named while the distribution regularities of different sediments obtained can be used to determine the hydrodynamic conditions of the sedimentary environment [3].

The laser particle size analyzers developed by Bettersize Instruments are characterized as being accurate measurement, wide measuring range, easy operation and fast measurement speed. The image particle size and particle shape analyzers can measure the particle size, aspect ratio, circularity and other indicators while saving the images of a single particle for easy reference and analysis, which meet the demands of various soil and sediment particle size measurement.

Bettersizer 2600 Laser Particle Size Analyzer

BeVision D2 Image Particle Size and Particle Shape Analyzer
Attached table: Sieving + Better size instrument particle size analysis report of clastic rock

**Particle Size Analysis Report of Clastic Rock**

<table>
<thead>
<tr>
<th>Well No.</th>
<th>Sample No</th>
<th>Date</th>
<th>Well Depth (M)</th>
<th>Original Sample No</th>
<th>Particle Size Interval (μm)</th>
<th>Particle Size Distribution (μm)</th>
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<td>2019-12-10</td>
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<tr>
<th>Particle Size Gradation</th>
<th>Frequency%</th>
<th>Cumulative%</th>
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<tbody>
<tr>
<td>Lower gravel</td>
<td>17.96</td>
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<td>Medium gravel</td>
<td>23.67</td>
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<td>Fine gravel</td>
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<td>Coarse grit</td>
<td>6.78</td>
<td>6.20</td>
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<tr>
<td>Fine grit</td>
<td>2.60</td>
<td>8.95</td>
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<td>Ultramate grit</td>
<td>0.95</td>
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<td>Coarse slite</td>
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<td>Fine slite</td>
<td>12.37</td>
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<td>Clay</td>
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<table>
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<tr>
<th>Particle Size Parameter</th>
<th>Average Value</th>
<th>Standard Deviation</th>
<th>Skewness</th>
<th>Peakedness</th>
<th>Sorting Coefficient</th>
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<td>1.13</td>
<td>0.95</td>
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<td>1.74</td>
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</table>

Nearing: clastic rock

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**Sample Particle Size Distribution**

![Sample Particle Size Distribution](image)
References:
(1) Liu Yifeng. Analysis and Application of Sedimentary Rock Granularity. Laboratory of Sedimentary Rock, Chengdu University of Geology, 1981, 21 ~ 23
(4) W. Pabst / E. Gregorová. Characterization of Particles and Particle Systems. 2007, 2~3