Using a Laser Particle Counter to Enhance Sedimentology Laboratory Exercises

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Introduction

Particle-size distribution of sediment samples has been used for many years to help determine environment of deposition. Traditionally, the size determination of fine-grained materials has been done by either the pipette or hydrometer method, both of which are tedious, time consuming, and of questionable accuracy (see Swift and others, 1972). With the development of the laser particle counter, however, it has become possible to quickly and accurately determine the size distribution of mixtures of particles with diameters in the range of 1 to 100 microns (that is, silt and clay). Furthermore, relatively small samples suspended in any clear liquid can be analyzed, and the analysis is non-destructive. This means that samples of, for example, flocculated clay particles in their natural waters can be analyzed without separating them from the water in which they were found and without subjecting them to various harsh deflocculating treatments. The purpose of this paper is to describe a laboratory exercise that makes use of this new technology.

Principles and Operation of Spectrex Laser Particle Counter

The Spectrex laser particle counter described herein utilizes an optical scanning technique. A laser beam is passed through a sample under analysis, and a particle is detected when it passes through the sensitive zone of the beam. Part of the incident beam is scattered by the particle and a photoelectric cell detects that portion of the light reflected in the near forward angle, 6 to 19 degrees from the direct light path. The resulting electrical pulse (generated by the scattered light) is analyzed by an electronic detection unit. An abnormal pulse can be caused by (1) a particle outside the focus area "sensitive zone" of the laser beam or (2) a particle in the sensitive area which does not pass completely through the laser beam. Any abnormal pulse is ignored by the detector.

Particle concentration must be kept to less than 1000 particles/milliliter (by dilution if necessary) so that only one particle at a time is detected by the counter. If the laser beam strikes more than one particle at the same time, the counter will interpret the resulting signal as having come from a single large particle, rather than two smaller ones, thereby skewing the results. The counter provides a size distribution per milliliter of water in 30 seconds and displays the results as a 32-channel particle count. The first 16 channels range from zero to 16 (in one-micron intervals, see Figure 1) and the last 16 channels from 16 to 97 microns in five-micron intervals. In addition, a "threshold dial" can be set to a specific particle size and the unit will then count only particles at or greater than that size. The particle counter is calibrated by using sealed standards of known particle-size distribution and concentration that are provided by the manufacturer.

Previous studies (for example, Agrawal and Riley, 1984;, McCave and others, 1986; Singer and others, 1988) other laser particle counters and compared the Spectrex counter to other instruments used to determine grain-size distributions.

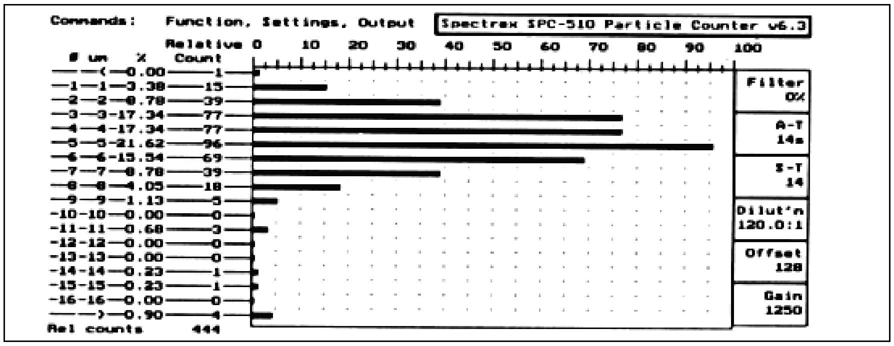

Figure 1. Printout of a sediment size distribution in the form of a histogram. The histogram is based on the relative number of particle counts. The percent distribution is given for each size interval in the columns to the left of the graph. Additional printout information, not shown here, includes a histogram of percent for each phi size, a cumulative frequency percent plot, and certain statistical parameters, such as mean, skewness and kurtosis.

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