Grain Counting Strategies for a More Accurate Assessment of Soil Mineralogy

Danielle M. Balduff and Martin C. Rabenhorst

According to Soil Taxonomy (Soil Survey Staff, 2006), the mineralogical placement of soils in loamy (coarse-loamy, fine-loamy, coarse-silty, and fine-silty) or sandy families is tied to the composition of the 0.02- to 2-mm soil fraction. In practice, rarely is the quantitative mineralogical composition of the full 0.02- to 2-mm fraction ever actually determined. This is largely due to the complicated and involved nature of the combination of analytical techniques and interpretations required for a quantitative determination. At a minimum, this would involve X-ray diffraction, which is only a semiquantitative estimate of the mineralogical components, and total elemental analysis and may also involve others such as differential scanning calorimetry or some other thermal technique (Burt, 2004). Therefore, the mineralogical composition of these soils is usually estimated using simpler techniques such as grain counting (Burt, 2004).

There are several grain mount counting techniques that may be utilized, but the different techniques do not yield the same results. The Fleet method (Fleet, 1926) requires the identification and counting of all the grains on a slide. However, this method provides a number percentage that cannot be converted to an area, volume, or weight percentage without additional information about the size and shape of the individual grains (Galehouse, 1971). The ribbon method (Van der Plas, 1962) is similar to the Fleet method, except that only grains in representative bands are identified and counted. It is necessary for the bands to be randomly arranged over the slide since it is impossible to get a completely random distribution of the grains (Galehouse, 1971). The line method is commonly used due to the ease of keeping track of the minerals that have been identified and counted (Drees and Ransom, 1994). In this method all grains that intersect the microscope crosshairs during a linear transect across the slide are counted. This method provides a number frequency that is biased because larger grains are more likely to be encountered than small grains. However, the number frequency does not imply a volume percentage and cannot be converted to weight percentages. The differences between the number percentage provided by the ribbon counting method and number frequency by the line counting method can be minimized by mounting grains in limited size intervals (Galehouse, 1971).

Basic statistics informs us that the number of grains counted during the number of grains counted the probable percentage error decreases (Fig. 1). For example, a sample found by counting 300 grains will have a counting error (probable percentage error) of ±3.39%, whereas by counting 1600 grains the counting error (probable percentage error) will be ±1.47%. The grain counting techniques (beyond being able to identify that a relationship between grain counts and volume or weight percentages could not be obtained because the relationship depends on the grain shape, size, cleavage, density, and the counting method used. Although converting grain counts to weight estimates is impractical, grain counts can be used for mineralogical analysis of the soils.

Basic statistics informs us that the number of grains counted the probable percentage error decreases (Fig. 1). For example, a sample found by counting 300 grains will have a counting error (probable percentage error) of ±3.39%, whereas by counting 1600 grains the counting error (probable percentage error) will be ±1.47%. The grain counting techniques (beyond being able to identify that a relationship between grain counts and volume or weight percentages could not be obtained because the relationship depends on the grain shape, size, cleavage, density, and the counting method used. Although converting grain counts to weight estimates is impractical, grain counts can be used for mineralogical analysis of the soils.