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Standard Guide for Displaying the Results of Chemical Analyses of Groundwater for Major Ions and Trace Elements—Trilinear Diagrams for Two or More Analyses¹

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1. Scope

1.1 This guide covers the category of water analysis diagrams that use two-dimensional trilinear graphs as a technique for displaying the common chemical components from two or more complete analyses of natural groundwater (see Section 3) on a single diagram. This category includes not only trilinear-shaped diagrams but also the diamond- or parallelogram-, rectangular-, or square-shaped graphs that have trilinear subdivisions.

1.2 This guide is the first of several documents to inform professionals in the field of hydrology with the traditional graphical methods available to display groundwater chemistry.

NOTE 1—Subsequent guides are planned that will describe the other categories of diagrams that have been developed to display groundwater chemical analyses.

(1) A guide for diagrams based on data analytical calculations will include those categories of water analysis graphs in which one analysis is plotted on each diagram (for example, the pattern, bar, radial, and circle diagrams).

(2) A guide for statistical diagrams will include those categories of water analysis graphs in which multiple analyses are analyzed statistically and the results plotted on the diagram (for example, the box, etc.).

1.3 Numerous methods have been developed to display the ions dissolved in water on trilinear diagrams. These diagrams are valuable as a means of interpreting the physical and chemical mechanisms controlling the composition of water.

1.4 The most commonly used trilinear methods were developed by Hill (1-3),² Langelier and Ludwig (4), Piper (5, 6), and Durov (7-13). These techniques are proven systems for interpreting the origin of the ions in natural groundwater and for facilitating the comparison of results from a large number of analyses.

NOTE 2—The use of trade names in this guide is for identification

¹ This guide is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.21 on Groundwater and Vadose Zone Investigations.

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² The boldface numbers in parentheses refer to the list of references at the end of this guide.

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1.5 *This guide offers an organized collection of information or a series of options and does not recommend a specific course of action. This document cannot replace education or experience and should be used in conjunction with professional judgment. Not all aspects of this guide may be applicable in all circumstances. This ASTM standard is not intended to represent or replace the standard of care by which the adequacy of a given professional service must be judged, nor should this document be applied without consideration of a project's many unique aspects. The word "Standard" in the title of this document means only that the document has been approved through the ASTM consensus process.*

2. Referenced Documents

2.1 ASTM Standards:³

D596 Guide for Reporting Results of Analysis of Water
D653 Terminology Relating to Soil, Rock, and Contained Fluids

D1129 Terminology Relating to Water

3. Terminology

3.1 Definitions:

3.1.1 Except as listed as follows, all definitions are in accordance with Terminology D653.

3.1.2 *anion*—an ion that moves or would move toward an anode; the term is thus nearly always synonymous with *negative ion*.

3.1.3 *cation*—an ion that moves or would move toward a cathode; the term is thus nearly always synonymous with *positive ion*.

3.1.4 *equivalent per million (epm)*—for water chemistry, an equivalent weight unit expressed in English terms and also expressed as milligram-equivalent per kilogram. When the concentration of an ion, expressed in parts per million (ppm),

³ For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.