DETERMINATION OF ELECTROMETRIC PROPERTIES OF GROUND WATER BY A FIELD METHOD[1]

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The reaction, oxidation-reduction potential, and specific conductance of ground water exert pronounced influence on the distribution of vegetation on hydromorphic soils. These properties taken together express two major ecological conditions: degree of water oxygenation and supply of nutrient elements, particularly bases (Hartmann, 1928; Averell and McGrew, 1929; Laatsch, 1944).

As revealed by a study of organic soils in Wisconsin (Wilde *et al.*, 1950), stagnant bogs, characterized by an average reaction of pH 4.2, redox potential of —250 m.v., and specific conductance of 7.8 mhos $\times$ 10^5, support only struggling stands of black spruce and tamarack. Ground water of organic soils with slow but constant internal drainage showed average values of pH 6.1, redox potential —50 m.v., and specific conductance 25 mhos $\times$ 10^5; such soils support mixed stands of hardwoods and conifers which attain yields as high as 30 or 40 cords per acre. Alluvial soils, subirrigated by well-oxygenated ground water enriched in bases, are correlated with forest stands whose rate of growth at times exceeds that of most productive upland soils. The ground water of alluvial soils usually has a nearly neutral reaction, positive redox potential and specific conductance approaching 40 mhos $\times$ 10^5. However, the ground water of periodically inundated areas shows great variation in its composition, and therefore average values have questionable significance.

Another study (Wilde and Randall, 1950) detected that stands of aspen on siliceous soils owe their rapid growth to the fertilizing effect of hard water enriched in electrolytes by contact with lenses of lacustrine clay or other fertile substrata. In other instances, however, tree growth was found to be depressed by ground water carrying an excess of calcium and magnesium car-

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bonates. There is evidence that the chemical composition of ground water affects the activity of microorganisms, development of humus layers (Hesselman, 1910; Feher, 1933), and in turn, natural regeneration of selectively logged forest stands.

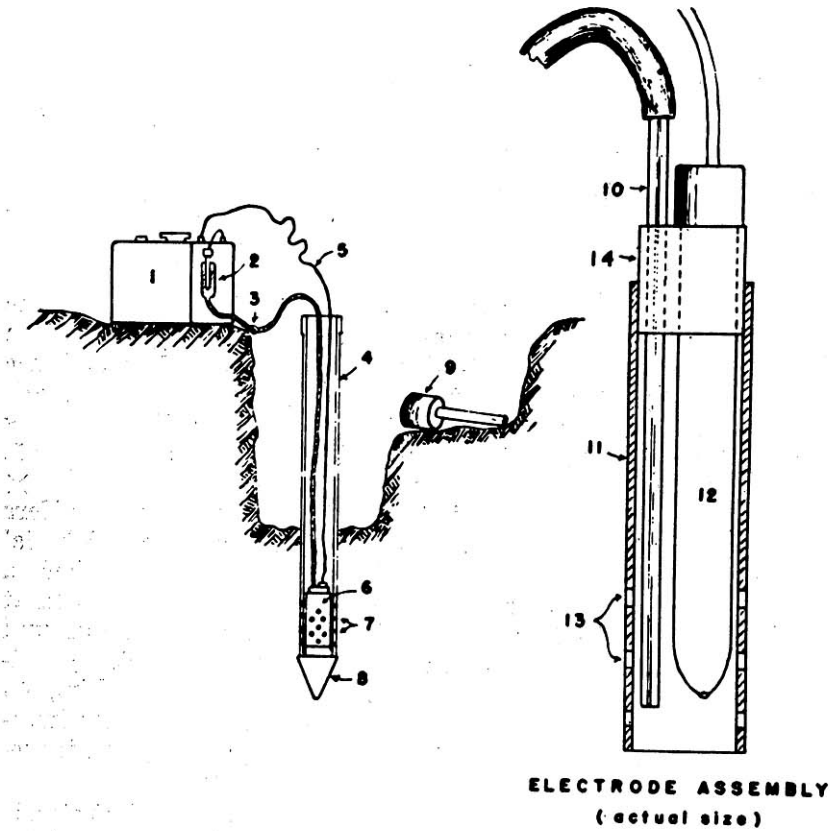

FIGURE 1. Portable apparatus for the determination of redox potential of soils *in situ* (schematic diagram): (1) potentiometer, (2) calomel half cell in reservoir with saturated KCl solution, (3) bead valve in ¼ inch Tygon tubing, (4) galvanized sampling pipe, length 3 feet, diameter 1 inch, (5) electrode lead, (6) electrode assembly, (7) 100-mesh screen openings, (8) removable steel point, (9) metal driving hammer, (10) glass capillary tube, (11) plastic insulating sheath, (12) platinum electrode, (13) water inlets, (14) fitted rubber stopper.

The technique of electrometric analysis of ground water is extremely simple and rapid. Unfortunately it is handicapped by difficulties in obtaining samples not contaminated with oxygen, as well as the preservation of samples in their original condition

during transportation. Therefore, an attempt was made to follow the technique used by Starkey and Wight (1946) in their study of corrosion of iron in soil, and to develop a direct electrometric method for analysis of ground water *in situ*. The procedure is reported in this paper.

The soil is excavated until slight seepage of ground water is evident. A galvanized-iron well point is tapped into the gley horizon with a driving hammer to a depth of 18 inches (Figure 1). The assembly of the platinum electrode and capillary tube of the KCl bridge is inserted into the well pipe. The calomel half cell is placed in a glass tube with saturated KCl solution. This is connected with the capillary tube to form a KCl bridge from the calomel half cell to the water, a device which precludes contamination of the cell by suspended colloids. The platinum electrode and calomel half cell are connected to a portable Beckman potentiometer, Model N–2 (Beckman Instruments, Inc.). Two drops of KCl, released by pinching the bead valve, assure a complete circuit. After allowing a few minutes for the system to reach equilibrium, the reading is taken. The pH value is obtained in a similar manner by substituting a glass electrode for the platinum electrode.

Before the determination of specific conductance, the temperature of the water is recorded by an ordinary thermometer. Then, a conductivity cell is inserted into the well pipe and connected to a portable Solu-Bridge (Industrial Instruments, Inc.). The scale of the bridge is set at the recorded temperature and the reading is taken. The entire analysis consumes not more than 15 minutes, not counting the time required for soil excavation.

The technique devised appears to provide not only simplification and acceleration of ground water analysis, but also greater accuracy of the results obtained. It is hoped that this method will find application in silviculture, soil drainage, irrigation practice, and artificial regulation of ground water.

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