The Soil Profile as an Aid to Range Management

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Too often our consideration of range maintenance or improvement stops short at the surface of the soil. We are concerned with what grows on the surface but not with the material in which it grows. For successful range management we need to know more about the character, composition, and present status of soils on our range lands. Information of this kind on agricultural lands has already become the basis for land classification, treatment, and use. Knowledge of the soil as it exists—of the soil profile—is no less important in classifying, treating, and using our western range lands.

Soil may be defined broadly as the natural medium for the growth of plants. To understand this natural medium fully, it is necessary to understand not only that soils differ from place to place, but how they differ. The more outstanding differences in soils may be easily observed when the soil layers are exposed in cross section, as in a freshly cut road ditch, a trench, or a pit. These exposed layers, which may be distinct or merely gradual blendings, are called horizons. The whole arrangement of the horizons, from top downward and extending into the parent material, is known as a soil profile.

The character and arrangement of these layers are determined by climate, vegetation, parent rock, relief, and time. The same set of these factors anywhere produces the same set of soil layers—the same soil. Thus soils occur in orderly, discoverable, and entirely reasonable patterns. The various layers may differ from each other in texture, structure, consistency, thickness, color, drainage, degree of acidity or alkalinity, and inherent fertility. It is, of course, the total effect that these layers have on soil moisture, plant food, and aeration that determines the relative inherent productive capacity of any soil.

Other things being equal, two soil profiles alike in all details will produce, or will be capable of supporting, the same kind and density of plants. It is also true that two soils having different profiles only rarely have the same productiveness for native or crop plants. This does not mean that the reason for this difference in plant growth can quickly be found in every instance. In some cases it remains obscure even under rather careful study. But the fact that differences in productivity are associated with distinct profile combinations is in itself important enough to be of great practical use.

Relating Profiles to Range Areas

Examination of soil profiles will, among other things, help the range manager determine which areas are basically different even though the present more or less depleted plant cover may be quite similar. This is especially important in areas where one general range type is found overlying several kinds of soil, each of which may have a significantly different response to management. Information and experience regarding land use can be more accurately extended from enclosures, study plots, pastures,
and other small sites to the larger areas to which they apply, if soil differences are carefully considered.

Some of the range and watershed study enclosures have wide application. They have been well placed on soil-cover complexes that represent relatively large areas. Others, which may also be well placed, have a more limited direct application because of their having been located on less extensive complexes. Obviously it is highly important to the range manager that he have a clear idea of just what areas are represented by each enclosure.

Occasionally sites for enclosures may be selected that tend to make the observer draw the wrong conclusions. For instance, an enclosure may be placed in an area having generally shallow soils and supporting one broad general range type throughout, but on a pocket of soil much deeper than the surrounding average (Fig. 1). If this happened, an observer could easily draw erroneous conclusions. It might appear that the vegetative difference inside and outside the enclosure was due entirely to the

improved management and that the entire area could be expected to give the same response under similar management. In reality, the response or growth made within the enclosure would be typical of only a small portion of the range type. Unsound interpretations of this sort can be held to a minimum if the soils are intelligently examined to insure proper placement of enclosures or other study areas.

**Characteristics of the Soil Profile**

Review of several hundred soil descriptions made in the Intermountain region on a wide variety of range lands has shown that three soil variables stand out over the rest as being particularly valuable for soil profile comparisons under any one broad range type. These are color, texture, and the thickness or depth of soil, which should be determined for each of the layers concerned. Although adequate for many valley soils,
though of great importance in most soils as far as productivity is concerned, assumes a secondary role in the kind of soil comparisons that we are concerned with here. Consistency, another important characteristic in many soils, seems to be more dependent on texture than on soil development. The sandy soils are loose or friable, the medium textures are usually friable or mellow, and the heavier textures tend toward the dense or tight side. One reason for this close correlation is that many of our range soils have been formed under conditions where parent materials and relief have overpowered the other soil factors. This has resulted in the formation of soil profiles in which the subsoils have not fully developed and which profiles are therefore relatively uncomplicated. This is in contrast to the more complicated soil profiles in which subsoil development has often compacted, cemented, or in other ways significantly affected the air, water, and root relationships of the subsoil material. However, it is important in field observations to note any such variation that may occur.

**Color**

The principal soil colors are black, gray, brown, red, and yellow. There may be combinations of these colors which may be further modified by the terms of light and dark. Soil color is one of the more important characteristics of the profile because of its indicator qualities. The darker colors generally indicate high quantities of organic matter but may also indicate certain minerals in the parent materials. Red colors may indicate either good drainage and aeration but more likely in the Intermountain region will be due to the color of the parent materials. Imperfectly drained soils are frequently mottled with gray, yellow, and brown at some depth below the surface. Variegated coloration, on the other hand, often occurs in parent materials which are not completely weathered. Regardless of the reason for the color patterns, it is obvious that in order for two soils to be comparable, the colors of the various soil layers should be similar.

**Texture**

The second important soil characteristic to observe is texture which refers to the relative size of the individual soil grains. In the laboratory, texture is the distribution of the gravel, sand, silt, and clay particles in a soil sample as determined by a mechanical analysis. In the field, texture is determined by feeling the moistened soil. Five broad textural classes commonly used are sands, sandy loams, loams, clay loams, and clays, each of which may be modified further by the terms gravelly or stony. In making a soil comparison, it is sufficient as far as textural determinations are concerned to decide merely whether the soil of the respective layers feels alike. If the examination is more thorough and a written profile description is desired, familiarity with the above textural classes is necessary.

The following descriptions are offered for those desiring more detail. These have been adapted from California Agricultural Experiment Station Bulletin 556 (Storie, 1933).

**Sands.**—Sands are loose and granular. The individual grains can readily be seen and felt. Squeezed in the hand when dry the material will fall apart when the pressure is released. Squeezed when moist, it will crumble when touched, although fine sand and very fine sand have a certain amount of cohesion when moist.

**Sandy loams.**—Contain much sand but have enough silt and clay for coherence. Have a gritty feel and sand grains can be seen. Squeezed when dry will form a cast which will readily fall apart, but if
Squeezed when moist a cast can be formed that will bear careful handling without breaking.

Loams.—Even mixtures of different grades of sand, silt, and clay. Mellow, of somewhat gritty feel yet fairly smooth and rather plastic. Squeezed when dry they will form casts that will bear careful handling, while those formed by squeezing the moist soil can be handled rather freely without breaking.

Clay loams.—A clay loam in the field breaks into clods or lumps, which when dry are hard to break. When the moist soil is pinched between the thumb and finger it will form a thin “ribbon” that will break readily, barely sustaining its own weight. Moist soil is plastic and will form a cast that will bear much handling. When kneaded in the hand it does not crumble readily, but tends to work into a heavy compact mass.

Clays.—Dense and compact, forming very hard lumps or clods when dry. Composed of very fine particles which when wet stick together to make a very putty-like and plastic mass. When the moist soil is pinched out between the thumb and fingers it will form a long flexible “ribbon.”

Most of the textures with which we are concerned relate directly to the parent material. If these parent materials are high in clay, heavy-textured soils are produced, perhaps clay loams or clays. If the rocks are coarse grained the resulting soils are similarly coarse or sandy. For this reason soil classifications based solely on parent materials are in common use. Granitic soils, limestone soils, sandstone soils, and similar groups of soils often express textural grades as well as certain other soil characteristics, such as inherent fertility. They do not usually give any clues as to soil depth or drainage, for example. However, where the parent material can readily be determined it is advantageous to consider it whether the soil examination is merely a hasty field check or one of a more thorough nature.

There is hardly one best texture. Most heavy soils—those high in clay content—are capable of holding large amounts of water but much of it is unavailable to the plant because it is held too tightly. Sandy soils on the other hand allow too much water to drain away. In humid regions the very sandy soils are the most droughty; but under arid conditions these soils may be the least droughty. They allow the water that falls to infiltrate at a faster rate and then readily give water back to the plants. Under average conditions the medium-textured soils are usually the most efficient in releasing the moisture that they receive.

Depth

The third factor to be considered, and often one of the most important in comparing profiles, is depth. Of all the common characteristics that we use in evaluating mountain soils, this one perhaps means more by itself than any of the others. This is especially true when the term is qualified and used to mean depth of permeable soil and soil material. Shallow soils, regardless of how good the other characteristics may be, lack abundant capacity for water retention and root growth. This deficiency is vitally important from the point-of-view of adequate productive capacity and response to management.

A study made in the Wasatch Mountains of Utah disclosed interesting relations between soil depth and accelerated erosion (Olson, 1949). The deep soils (generally 4 to more than 6 feet of readily permeable soil and soil material over bedrock) were found covering 71 percent of the total area studied. Soils underlain by tight clay or bedrock at shallow depths (generally 6 to 18 inches of readily per-
meable soil) were found to cover 19 percent of the area with rock outcrops making up the remaining 10 percent. Eighty-five percent of the severe class of accelerated erosion mapped was found on these shallower soils which made up less than one-fifth of the total area studied.

The time necessary for restabilization of an eroded site under proper management will depend largely on the quality of the remaining soil profile in relation to the other environmental factors. Many of our shallow, inherently poor soils, along with those soils made poor through severe accelerated erosion, remain in poor condition for long periods even though complete protection from livestock grazing has been afforded them.

Most shallow sites have been stabilized in the past or they would not now have a soil profile developed on them. But under heavy use—-heavy for the site—they have in general broken down and become unstable. Recovery or restabilization has been notably slow in most instances observed. The deeper, more permeable soils, on the other hand, respond readily to improved management in a relatively short period of time.

In examining most soils, it is not necessary to expose the entire profile down to bedrock. Only with the shallower ones is this practical or necessary. The combined topsoil and subsoil layers of these profiles will generally be found within three, or possibly four, feet of the surface and in places within one or two feet. By contrast, the material in the substrata may extend to great depths, as for example valley alluvium. It is sufficient to expose only enough of this layer to determine its characteristics. Because many of the range soils are stony, a word of caution should be added: large stones can easily be misinterpreted as bedrock, so enough soil should be removed to make certain of the finding.

**Summary**

A range manager in the Intermountain West can more accurately apply the information obtained from enclosures, if he will consider three relatively simple characteristics of a soil profile—color, texture, and depth. Even when individual study plots are lacking, a range manager can make useful judgments of site potential if he understands these three simple characteristics. Moreover, once he begins to gain a field knowledge of soils, new applications for the information will continually appear. Selecting sites for reseeding, predicting forage yields, and appraising the on-site effects of accelerated erosion are some of the phases of range management that can be accomplished with greater assurance of success when soils and the soil profile are more fully understood.

**LITERATURE CITED**
