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PRELIMINARY SOIL CLASSIFICATION MAP OF SOUTHWESTERN U.S. AND MEXICO FROM SPACE PHOTOGRAPHY

by

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PRELIMINARY SOIL CLASSIFICATION MAP OF SOUTHWESTERN U.S. AND MEXICO FROM SPACE PHOTOGRAPHY

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Introduction

The enclosed map, at a scale of 1:3,000,000 was compiled from a mosaic of rectified black and white reproductions of space photographs from the Gemini IV and V missions. Unrectified color prints were used first to determine soils colors as portrayed by the photographs, and their distribution. Rectified black and white prints at a scale of 1:250,000 were also used to plot detailed information on topographic base maps at the same scale. This information was then transferred to the small scale mosaic. Most information contained therein is based on many years of field experience in the U.S. portion of the map. Field checking is planned for the coming spring field season, especially in portions of Mexico where previous work has not been done.

The map will serve as a basis of comparison for future photographic space missions, such as Apollo 502, which is planned to provide a continuous strip of overlapping, vertical looking, color photography of the southern United States.

The materials accompanying the soils map include 1) a detailed map explanation of major soils groups used in classification; 2) a diagram showing the distribution of major soil types in relation to altitude; 3) an example of some of the detailed work that has been done in the area; 4) a soil profile and 5) some basic definitions for non-soil scientists.

Knowledge of the distribution of soil types is fundamental to land use planning, agricultural development and irrigation systems. From this preliminary investigation it appears that improved space color photography will play an important role in development of small scale maps for regional investigations of this type.

Some basic definitions (for non-soil scientists)

A soil profile usually is comprised of several horizons arranged vertically above one another. The A and B horizons are the ones where biotic activity and weathering is greatest. They comprise the solum, which is the chief part of the soil profile as far as soil scientists are concerned. The A horizon is characterized by maximum eluviation of colloidal clay. In humid areas it is the richest in organic matter, but in desert areas this horizon is low in organic matter and hence light-colored. Well drained desert soils typically have less than 0.6% of organic matter. The B horizon is characterized by maximum accumulation of clay minerals and hydrolyzates of iron (and also of Mn and Al), partly by illuviation from the A horizon but mainly because of *in situ* weathering of mincerals such as feldspars and mafics. If there is appreciable colloidal clay in the B horizon (discernible by feel and by hand lens), this horizon is said to be "textural" or "argillic". Lesser degree of weathering, lacking discernible colloidal clay development by showing yellowish brown to red staining of soil particles by iron hydrolyzates, now also is designated as B horizon.

The C horizon is considered to be unconsolidated or poorly consolidated material (which may or may not be parent material for the B horizon) that is below any marked influence of biotic activity. However, soil scientists include accumulations of calcium carbonate that result from pedogenesis and in semiarid and arid climates occur in the upper part of the C horizon, as part of this horizon, designating them as Cca horizon. These are the caliches of the arid regions of western North America. Soil scientists refer to a horizon of calcium carbonate accumulation as a calcic horizon.

Although normally most or all of the carbonate accumulation is in the C Horizon; sometimes carbonate also has accumulated in the lower part of (or even throughout) the B horizon; such cases are designated as Bca horizons.

The so-called typical soil profile is one that shows evidence of considerable biotic activity and weathering--enough to have developed definite A and B horizons. Some soils, however, lack the A and/or B horizons. Unconsolidated material such as alluvium or eolian sand that is so young as to lack a discernible weathering profile but has enough evidence of bioti activity to have an A horizon may be designated as A-C profile; if it lacks any discernible influence of vegetation, it is merely C horizon throughout, without either A or B horizons.

The chief soil-forming factors are time, climate, vegetation (and othe biotic agencies), topography (mainly slope), and parent material. Climate and time are particularly important.

Great soil groups are very broad assemblages of soils based on the tendency of soils over wide areas with similar climatic conditions to become generally similar in their profile characteristics. About 40 great soil groups are now recognized in the U. S.

Great soil groups are divided into families, and families into soil series.

Pedocals are formed in semiarid to arid climates and are distinguished by an accumulation of alkaline-earth (Ca and/or Mg) carbonates in the lower part, or even throughout, the soil profile. (Such an accumulation is called a calcic horizon (cca and/or Bca horizon).

Pedalfers are formed in relatively humid climates, are characterized by an accumulation of clay minerals and/or hydrolyzates of Fe, Mn, and Al in the B horizon, and by the absence of an accumulation of alkaline-earth carbonates in or below the B horizon. In other words, pedocals have a calcic horizon, and pedalfers do not have a calcic horizon.

Zonal soils are those that have well-developed soil characteristics and have been produced under normal conditions--their parent material is well drained and not of extreme texture or chemical composition. They reflect the influence (for sufficient time) of the active factors of soil genesis--climate and living organisms, chiefly vegetation.

Intrazonal soils have more or less well-developed characteristics that reflect some local factor of relief, drainage, or parent material that overbalances the normal effect of climate and vegetation.

Azonal soils are those that are too young to have developed genetic horizons; their parent material remains practically unchanged by the active factors of soil genesis.

Map Explanation

Note: The great soil groups listed below under each map unit are those generally recognized by the leading soil scientists in the U. S. (except for Red Earths, see footnote). The dominant or characteristic great soil groups in each association are underlined; the subordinate great soil groups are not underlined.

B Group

Strongly developed desertic pedocal soils on intermontane-basin uplands underlain by poorly consolidated sediments (mainly gravel of alluvial fans and pediments) of middle Quaternary to late Tertiary age. The typical soil profile (Red Desert and Reddish Brown great soil groups) consists of a thin, light reddish A horizon, a moderately dark red to reddish brown clayey B horizon, and a strongly developed Cca (caliche) horizon which is nearly white, commonly is cemented, and 2-1/2 to 8 feet thick. Surface gravels in old desert pavement areas have a dark-colored "desert varnish". Within this group are local inclusions of younger, less developed soils in places where the older soils have been removed by erosion--for example, along the sides of gullys and stream valleys.

B1 Red Desert, Reddish Brown, or Red Earth* (in northeastern Baja California and northwestern Sonora only); Calcisol, Lithosol, Regosol, Alluvial soil.

B2 Calcisol, Lithosol, Regosol, Red Desert or Reddish Brown, Alluvial. This unit comprises areas that have undergone considerable erosion (enough

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*/ Red Earths are exceedingly arid, warm-climate soils, that are red and generally calcareous throughout their profile, without differentiation into distinct, separate B and calcic horizons. They have not been recognized in the U. S.

to generally remove the B horizons of the older, strongly developed soils, leaving the more resistant Cca horizon relatively intact, to form Calcisols). (Calcisols have only a thin A horizon, if any, and a strongly developed Cca horizon; they lack a B horizon.) Dissected areas of this unit have a large percentage of Lithosols and/or Regosols.

C Group

(present only in Texas)

Strongly developed pedocal soils of the uplands of the Southern Great Plains, generally developed on poorly consolidated sediments of middle Quaternary to late Tertiary age. The typical soil profile (Reddish Chestnut) consists of a medium to dark gray A horizon, a moderately deep reddish brown or brown-red clayey B horizon, and a strongly developed Cca (caliche) horizon which is nearly white and 3 to 8 or more feet thick. Areas where the B horizon generally has been eroded, leaving the Cca horizon, are designated as those dominated by Calcisols.

C1 Reddish Chestnut; Calcisol, Lithosol, Rockland, Alluvial.

C2 Calcisol, Lithosol, Rockland, Regosol, Reddish Chestnut.

D Group

Sand dune areas, ranging from those devoid of soil-profile development (active dunes to those with moderate to strong soil-profile development (stabilized dunes).

D1 Regosols (eolian sand, quartzose); soil development ranges from nil to strongly developed Red Earth, Red Desert, or Reddish-Brown soil.

D2 Regosols (eolian sand, gypsiferous, no soil development) (active dunes in White Sands, New Mexico area).

D3 Regosols (eolian sand, gypsiferous, moderate to strong Reddish Brown soil development) (late to middle Quaternary stabilized dunes adjoining White Sands, New Mexico area).

L Group

Late Quaternary sediments of lowland areas, with little or no soil-profile development.

L1 Alluvial soils. Unconsolidated gravel, sand, and silt of stream flood-plains low terraces, and young alluvial fans.

L2 Alluvial soils. Unconsolidated silt, clay, and local sand on subaerial portion of the Colorado River Delta. Local inclusions of Solonchak (salt-affected) soils.

L3 Regosols (Unconsolidated marine sediments). Sand, local silt and gravel along coast of Gulf of California; also silt and clay, local sand, on outer portion of Colorado River delta; Solonchak (salt-affected) soils occur locally.

L4 Regosols (Playa and late Quaternary pluvial lake sediments). Unconsolidated gravel and sand in shore zones of former pluvial lakes, and silt and clay (and Solonchak soils locally) in the lake-bottom areas.

M Group

Hill, mountain, or other upland areas characterized principally by a high percentage of rock outcrops (Rockland) and/or talus and other colluvial deposits with slight or no soil development (Lithosols). Local patches of zonal soils at sites with gentle local relief.

The 1,000 to 6,500-foot rise of the higher mountain ranges above the desert basins of the Basin and Range Province causes sufficient increase in precipitation and lowering of temperature to permit development of zonal soils that are characteristic of less arid and cooler climates, in the areas that are not dominated by rock outcrops and Lithosols. These soil changes are here divided into two soil-association zones that lie at successively higher altitudes above the desert mountain zone (map unit M1). (1) Unit M2, the intermediate zone, has Western Brown Forest soils as the characteristic zonal soil type in lower parts of its altitude range, and Reddish-Brown pedalfer soils (which do not fit into any presently recognized great soil group) at higher altitudes. Both these great soil groups have medium to dark gray A horizons and brown B horizons that may or not be slightly clayey. The Reddish Brown pedalfer soils lack a calcic horizon but the Western Brown Forest soils have a slightly to moderately developed Cca horizon; thus the latter great soil group is transitional between the desert pedocal and the mountain pedalfer soils. In this region the pedocal-pedalfer boundary ranges in altitude from 4,000 to 6,000 feet, depending upon local climate, parent material, age of the soil, etc. (2) Unit M3, the upper unit, is characterized by Brown Podzolic, Gray-Brown Podzolic, Gray Wooded, and Prairie (Brunizem) soils. These soils do not have a calcic horizon and their sola (A and B horizons) are neutral to somewhat acid.

M1 Rock outcrops (Rockland), Lithosol; local Red Desert, Reddish Brown, or Red Earth (in northeastern Baja California and northwestern Sonora).

M2 Rockland, Lithosol; local Western Brown Forest, Reddish-Brown pedalfer, and Prairie (Brunizem).

M3 Rockland, Lithosol; local Brown Podzolic, Gray-Brown Podzolic, Gray Wooded, Prairie (Brunizem).

Figure 1. SOIL CLASSIFICATION MAP
(from northeastern Baja California eastward along U.S.-Mexico border to central Texas)

Scale approx. 1:3,000,000

Prepared from Gemini IV and V color photography

Jan. 1968 by R. B. Morrison, U.S.G.S.

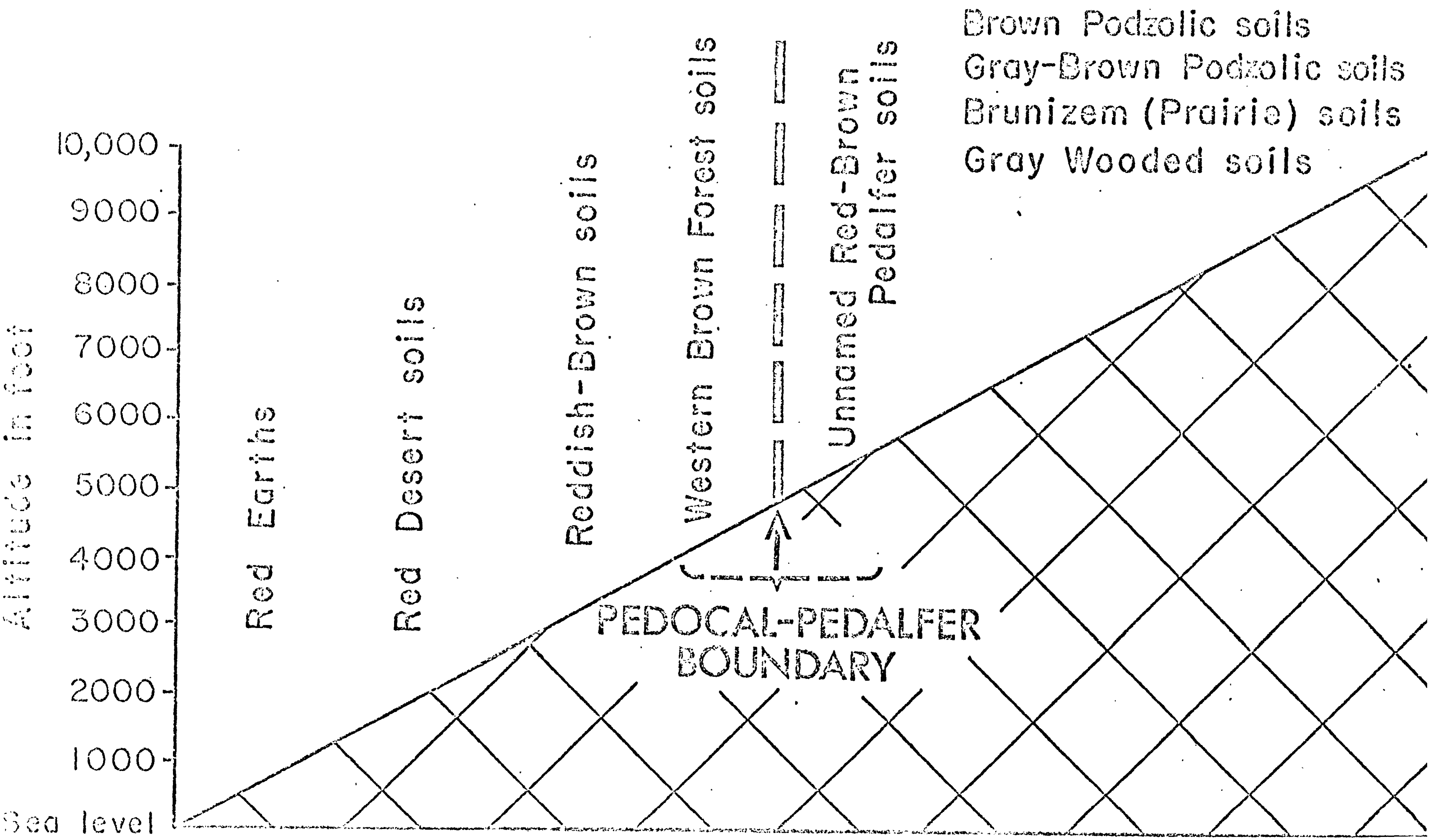

Figure 2. DIAGRAM SHOWING CHANGES IN ZONAL SOILS WITH ALTITUDE, FROM DESERT TO MOUNTAIN TOP, IN SOUTHERN ARIZONA AND SOUTHERN NEW MEXICO

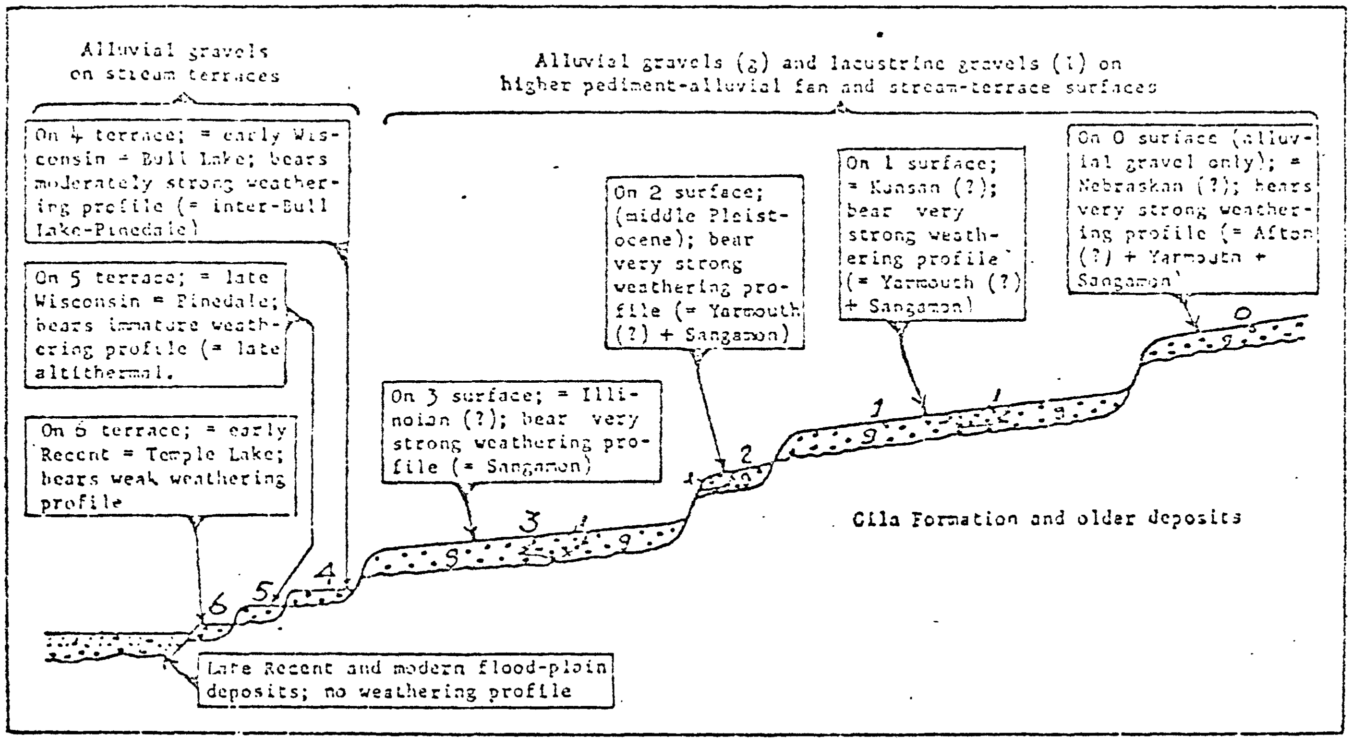

Figure 3. Quaternary surfaces and associated deposits and weathering profiles (geosols and paleosois) in Duncan Valley, Arizona-New Mexico (Morrison, 1965)*. The geomorphic and soil-stratigraphic relations shown are typical of the extra-montane areas of the western U. S. from the High Plains through the Basin and Range Province (subdivisions of one or more of the main surfaces may be present locally). The relict geosols on the 6, 5, 4, and 3 surfaces contrast with each other sufficiently in degree of development and profile characteristics so that they can be distinguished from one another and can be used as a means of age differentiation and local correlation of the surficial deposits and landforms. Differences in degree of development and profile characteristics between the Sangamon(?) geosol on the 3 surface and the Yarmouth(?) + paleosol on the 2 surface are locally, but not everywhere, sufficiently marked for these relict profiles to be a reliable means of differentiation and correlation. Diagnostic differences generally cannot be distinguished between the relict paleosols on the 2, 1, and 0 surfaces.

*Morrison, R. B., 1965, Geologic map of the Duncan and Canador Peak quadrangles, Arizona and New Mexico: U. S. Geol. Survey Misc. Geol. Inv. Map I-442.

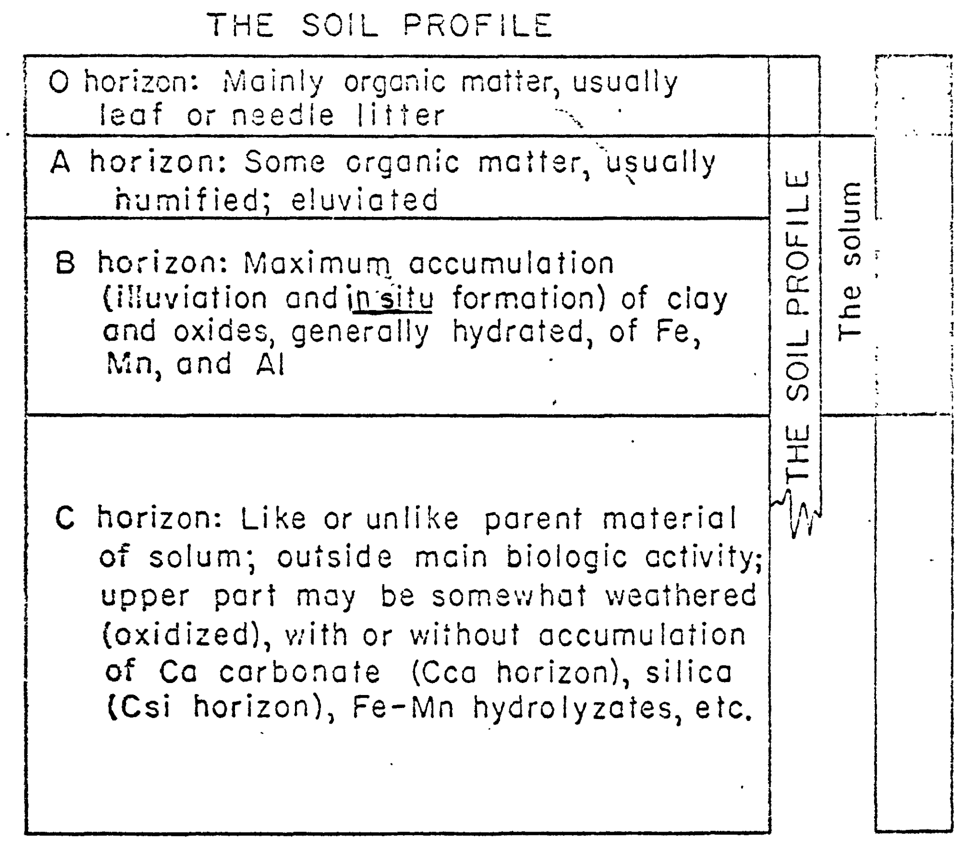
THE SOIL PROFILE
O horizon: Mainly organic matter, usually leaf or needle litter
A horizon: Some organic matter, usually humified; eluviated
B horizon: Maximum accumulation (illuviation and in situ formation) of clay and oxides, generally hydrated, of Fe, Mn, and Al
C horizon: Like or unlike parent material of solum; outside main biologic activity; upper part may be somewhat weathered (oxidized), with or without accumulation of Ca carbonate (Cca horizon), silica (Csi horizon), Fe-Mn hydrolyzates, etc.
THE SOIL PROFILE
The solum

Figure 4