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Ecosym-Regolith Classification

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ECOSYM - Regolith Classification[1]

by

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ABSTRACT

Regolith is the predominantly loose, fragmented, poorly consolidated surficial material overlying coherent bedrock.

Regolith Classification is based on structure and the formative processes responsible for the surficial material. Emphasis is placed on the materials involved and the processes which transport, shape and redistribute these materials. Regolith classification is designed to classify or "define" discrete points. Information that describes or "defines" each point does not depend on the characteristics or "definitions" of adjacent classified points, nor does it have an intrinsic spatial character.

Regolith classification has four hierarchical levels which yield increasingly more detailed information on a classified point. The highest, most generalized level is the ORDER. After ORDER, are CLASS, TYPE and LOCALE. Each level is divided into elements which classify regolith into distinctive units. For example, ORDER level has the following units: EROSION ORDER, DEPOSITION ORDER, and RESIDUAL ORDER. Thickness and vertical composition of regolith can provide additional information to the classification of material exposed at the Earth's surface. Conditional series describes thickness and vertical composition as applied at any hierarchical level.

Mapping is accomplished through a defined mapping rule which combines the contiguous classified points using the descriptions or "definitions" of discrete points. The map scale and/or hierarchical level is chosen on the basis of management, economic, and political goals, and existing information.

CONTENTS

Table and Figures

INTRODUCTION

Regolith is a general term for the predominantly loose, fragmented, poorly consolidated surficial material that overlies more coherent bedrock. Regolith may be residual or transported, have a variable character, and include weathered rock debris, colluvium, alluvium, glacial drift, eolian deposits, volcanic ejecta, peat, buried soils, and local cemented horizons that resemble bedrock (Gary et al. 1972). Its upper portion is considered to be soil. The nature of regolith can be evaluated in terms of the material itself, and the geologic processes of weathering, erosion, transportation, and deposition that formed the regolith. These characteristics, singly or in concert, will provide most of the information for management decisions that involve regolith.

Regolith Classification Usage

The Regolith Classification is based on structure and the formative processes. Management needs may draw information from different levels of the classification hierarchy depending upon the specific constraints of the problem. The three types of problems possible in a management question involve either actions, outcomes, or places. All three types of problems commonly require information about the regolith. As intended for all ECOSYM classifications, elements of the Regolith Classification may be combined with individual elements from other component classifications to define points with specific sets of characteristics. This combination may involve elements at the same or different hierarchical levels. Additionally, the more detailed levels of the Regolith Classification may be aggregated to form broad inventories of regolith.

REVIEW OF EARLIER WORK

The term regolith was proposed by G. P. Merrill (1897). Regolith was defined as the total thickness of unconsolidated material on the surface of the Earth's crust. Merrill recognized transported regolith (e.g., colluvium, alluvium, glacial) and _in situ_ regolith such as residual and cumulative (peaty) deposits (Fairbridge 1968). Regolith is sometimes referred to formally as "mantle." Currently this usage is avoided to prevent confusion with the same name as applied to the zone between the Earth's core and the crust (Fairbridge 1968).

Other terms are applied to regolith in other countries (head, growan, grouan) or to connote particular origin or characteristics (grus, geest,) (Fairbridge 1968). The term regolith is approximately equivalent to the term soil as used by engineers. Pedologists however restrict soil to the upper portion of the regolith profile (Bloom 1969).

Some geomorphologists use the concept of a weathering profile instead of regolith. A weathering profile is the succession of layers in unconsolidated surface material produced by prolonged weathering; where well developed it consists of surface soil, chemically decomposed layer, leached and oxidized layer, and unaltered material (AGI 1976). This emphasizes the chemical and physical processes changing the nature of the regolith material without highlighting the material's origin. In many cases, the weathering profile may not include the entire thickness of regolith present at a site. Weathering profiles are especially used in studies of the material changes or formative processes (Ruhe 1975).

Classification of regolith however, has been more commonly used in the context of geomorphology, i.e., in dealing with landscape features.

But we distinguish between a classification of geomorphic features which is useful in descriptive geology and the classification of regolith material which we employ here.

There are four basic geomorphic classification approaches which were evaluated in our search for a regolith classification. These are:

(1) Interpretive classifications that employ "explanatory" descriptions of large regions based on similar kinds and patterns of major landforms due primarily to similar geologic factors and processes. The processes, in turn, are greatly influenced by climate of the region. Some authors have proposed the concept of "morphogenetic regions" based largely on climate (Budel 1963, Peltier 1950, Leopold, Wolaman and Miller 1964, Garner 1974).

(2) Parametric classifications that employ quantitative descriptions of areas of any size based on empirical measurements of specific parameters (Kesseli 1946, 1950, 1954, Hammond 1954, 1957, 1958, 1962, 1964, 1965, Wood and Snell, 1957, 1959, 1960).

(3) Genetic classifications that delineate individual landforms, generally large-scale, on the bases of distinctive morphology and origin (processes). Textbooks on geomorphology are commonly organized on the basis of specific processes and the landforms they create (Thornbury 1969, Easterbrook 1969, Bloom 1969, Tuttle 1970, Ruhe 1975).

(4) Classifications that integrate several properties of landscapes, such as landforms, vegetation, and soils for the purpose of recognizing repetitive patterns well suited for particular uses (Mabbutt and Stewart 1963, Aitchison and Grant 1967, Hackett and McComas 1969, Wertz and Arnold 1973, Bailey 1974).

Although regolith has been an attribute in some of these approaches, it has not formed the basis for the classification effort. All these approaches are designed to identify landforms or describe the shape and changes on the Earth's surface. As a general rule, regolith is specifically used where it supplies pertinent information to distinguish similar landforms or different formative processes. Therefore, regolith has been employed where it is a definitive attribute of the landform and ignored where it yields no distinguishing characteristic. The goals of traditional geomorphic classification are different from the regolith classification goal of classifying the unconsolidated material covering the surface of the Earth.

REGOLITH CLASSIFICATION

General Statement

Regolith Classification, like other ECOSYM components is designed to classify or "define" discrete points. Information that describes or "defines" each point does not depend on the characteristics or "definitions" of adjacent classified points. The factors used do not have an intrinsic spatial character, and exclude elements not pertinent or intrinsic to the component classification. Emphasis is placed on the materials involved and the processes which transport, shape and redistribute these materials. To produce a component map at the scale and/or hierarchical level chosen, a formal mapping rule is derived using the descriptions or "definitions" of discrete points.

The Regolith Classification has the following four hierarchical levels:

1. ORDER
    2. CLASS
        3. TYPE
            4. LOCALE

The four hierarchical levels of the classification are discussed sequentially below. Terms in this classification are defined in the Glossary at the end of this report.

Orders

Orders are the highest, most generalized information unit (Table 1). There are three orders in the Regolith Classification:

1. EROSION ORDER
2. DEPOSITION ORDER
3. RESIDUAL ORDER

Regolith material classified under the erosion order is being actively influenced by some erosional process. This order is of minor importance in classifying regolith material since the material is being actively removed and does not accumulate. Erosional processes, however, are very important in forming the physical landscape but this is a different question from classifying regolith material. The deposition order includes material which was produced from its original source (e.g., bedrock) at some other place and has been transported and deposited at its present location. Material classified under the residual order results from an in situ physical disintegration and chemical decomposition of rock material. There is net increase in the amount of regolith and certain attributes are derived from the source material.

Classes

Nine classes are established for the EROSION ORDER, nine for the DEPOSITION ORDER, and three for the RESIDUAL ORDER (Table 1). In the first two orders, the classes specify the geologic processes (EROSION ORDER) or the deposits (regolith) formed by the processes (DEPOSITION ORDER). Classes of the RESIDUAL ORDER reflect especially effective weathering, either chemical or mechanical, and special conditions (saturated, poorly oxygenated) conducive to the *in situ* accumulation of organic products. As proposed, all classes are sub-divided into types; additional types or subdivisions may prove feasible and necessary for special studies.

Material in most classes of the EROSION ORDER is being produced at rates rapid by human standards, and hence deserve close attention because of potential damage to man-made structures and loss of life. The glacial class forms a major exception, and hazards from this and the Cryonival eolian ground-water, aquatic, and explosion classes are largely localized and therefore readily identified in most cases.

Classes of the DEPOSITION ORDER reflect the character of material in deposits which has been derived from the operating process. For example, stratification (layering) and sorting are common in deposits of the ejecta, alluvium, eluvium, terraqueous, and aqueous classes. In contrast, deposits of three classes, colluvium, drift, and niveal, commonly lack stratification, and are characterized by a large range of particle sizes, from clay to cobbles and boulders. Sand or smaller sizes predominate in most deposits of the eluvium and aqueous classes, whereas fine gravel, sand, and smaller sizes generally predominante in deposits of the alluvium class away from mountains.

Classes of the RESIDUAL ORDER will be limited to points where no erosion and deposition has occurred to significantly modify the regolith formed by weathering *in situ*. Generally, these classes will be restricted to flat terrain. Locally, regolith of these classes can be unusually extensive, commercially valuable, or form a potential hazard.

Types

The nine classes of the EROSION ORDER are divided into eighteen types, based on the specific mechanisms of each class of erosion (Table 1). Although intended to be thorough, the list is not exhaustive, and other types should be added where needed. No subtypes are listed, although, where desirable, they can be added (e.g., erosional aquatic currents can result from tidal forces, wind, differences in densities of water masses, and perhaps other causes). Identification of points as to erosional type can be accomplished using large-scale, black-and-white aerial photographs. Field checking will be required to confirm some and to identify certain types.

The nine classes of the DEPOSITION ORDER are divided into twenty-two types (Table 1). Physical and chemical characteristics of the deposited material form the basis of these subdivisions. The characteristics include, but are not restricted to, composition, grain sizes, sorting, permeability, absence or presence (and thickness) of stratification, related sedimentary structures, vertical and horizontal changes in all these properties, thickness, and the mechanics of emplacement. It is intended that many of these properties, singly or in aggregate, will be recognizable on large-scale, black-and-white aerial photographs.

For example, in till, a large range in grain size, poor sorting, and poor stratification predominate. Hence, an important distinction is made for better sorted and stratified material deposited by meltwater in contact with the ice (ice-contact type). In glaciated terrain, these deposits are valuable for constructional materials, placement of roads, and other types should be added where needed. No subtypes are listed, although, where desirable, they can be added (e.g., erosional aquatic currents can result from tidal forces, wind, differences in densities of water masses, and perhaps other causes). Identification of points as to erosional type can be accomplished using large-scale, black-and-white aerial photographs. Field checking will be required to confirm some and to identify certain types.

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In the case of colluvium, regolith material is typically poorly sorted and unstratified, so that the mechanics of deformation during emplacement (fall-slide/slip-flow) are used to characterize types.

In fluids such as air and water, weight and settling velocity are related to grain size. Current velocity and turbulance, which fluctuate, also affect the settling velocity and mode of transport (traction, intermittent suspension, viscous suspension, colloidal suspension). Thus, within the classes of alluvium, aqueous, and most ejecta and eluvium, grains of different sizes are segregated (sorted) into separate deposits and stratified. As a result, grain size, sorting, and sedimentary structures are important characteristics in indentification of such deposits of regolith material. Grain size (with sorting implied and mode of transport determined from sedimentary structures) affords the best overall characterization of most of these regolith accumulations, and so has been used to designate most of the types in these four classes.

Deposits in the aqueous class are divided into coarse, mixed, and fine types. Deposits of the coarse type are chiefly sand. These deposits are valuable for constructional materials, placement of roads, and building sites due to their excellent sorting, high permeability, common raised topographic position, and good drainage. Many coarse aqueous deposits are linear in distribution, along shorelines and exhibit distinctly lighter tones on aerial photos than finer-grained deposits. The mixed type contains both sand and mud, either intimately mixed, or as irregular sandy areas and muddy areas with sandy channel fills (e.g., some estuaries and tidal flats). Again, light tones characterize the sandy deposits on aerial photography. Deposits of the fine type are dark-toned and have typically flat surfaces prior to dissection.

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Terraqueous deposits form at the Earth's surface only in special circumstances and usually are localized. Depositional effects of organisms are subdivided into a human-mechanical type and a nonhuman type. Identification of human-mechanical type regolith is important in areas subject to mining activities.

The three classes of the RESIDUAL ORDER generally reflect the special circumstances under which residual regolith forms. Although these types will appear in restricted areas, their presence will be important to some management situations. For example, the freeze-thaw class could provide an approximation of areas subject to intensive frost heaving if still active. This regolith information would be important in slope stability studies.

Locale

Classification of locale within the hierarchy ties the abstract designation of the higher classification levels to specific conditions at a representative site. This aspect of the regolith classification is equivalent to the pedon description for a particular soil series in Soil Taxonomy or the community level in the ECOSYM Community Type vegetation classification.

This concept is used in geology to specify stratigraphic units. Bedrock is usually assigned a unit name and described at a representative site called a type locality. Tephra deposits with distinctive mineral assemblages have been designated by descriptions at representative deposits. Certain tephra units at Mt. Rainier National Park are classified in this manner. Similarly, glacial units in the Rocky Mountains and Sierra Nevada are indentified as stratigraphic units corresponding to described deposits at a particular location. The Temple Lake moraines are till deposits described at the Temple Lake area in the Wind River Mountains of Wyoming. Traditional practice, in geology, has been to use these site descriptions to indicate time-correlative rock and surficial units. In some cases, the specific site description establishes certain distinctive chemical and physical attributes of the unit.

The locale level of the regolith classification differs from traditional geologic useage by being restricted to a description of the chemical and physical attributes of the unit. Locale is not used to suggest or indicate time-correlative relationships. A locale is based on a specific description of chemical and physical attributes of a depositional or residual type at designated location. Erosional types are not classified at the locale level due to a lack of variation within material upon which the description would be based.

Conditional Series

The thickness and vertical composition of regolith provides important information for management purposes. Conditional series is a means for vertical description of classified points regardless of the hierarchical level.

- I. ORDER ⟶ CONDITIONAL SERIES
  - A. CLASS ⟶ CONDITIONAL SERIES
    - 1. TYPE ⟶ CONDITIONAL SERIES
      - a. LOCALE ⟶ CONDITIONAL SERIES

The parameters included in a conditional series designation indicate total thickness of regolith, thickness of individual layers, identification of regolith, and vertical arrangement. Total thickness is, by definition of regolith, the vertical extent from the land surface down to bedrock. This is measured in meters and written as the first part of a conditional series designation, e.g.:

45

Each distinctive regolith layer is identified beginning at the land surface. Identifiers are one to four character alphanumeric codes. The number of characters increases as the hierarchical level of classification increases in resolution. At the highest level (ORDER), only a single character is used (R-RESIDUAL, D-DEPOSITION). At the class level, a second character is added using the capital letter for the appropriate class in Table 1. Classification, at the level, adds a third character. This character is the number for the identified type under the appropriate order and class. The fourth character is used when the locale is known. The locale designation is governed by the numeric code assigned from the master locale listing. It is added to the rest of the identifier and proceeded by a hyphen.

45 DF2-3

The example above can be desiphered as: total depth 45 meters, Deposition Order (D), Eluvium Class (F), Silt Type (2), and Smart Ash Locale (-3).

Each layer thickness is measured from the land surface or bottom of the previous layer to the top of the next distinctive layer. The layer thickness is placed in parenthesis after the identifier and is used when more than one layer is recognized in a regolith profile.

As different layers are identified, they are indicated by separating their identifiers and thicknesses from the preceeding, upper layer identifier using a slash. Identifiers separated by slashes are used until the total regolith thickness is described.

32 DC1 (12)/DDL (20)

If layers are too numerous or otherwise complicated, a conditional series complex is formed. A complex is designated by a plus sign between the identifiers of each distinctive material. The thickness of the total material is in parenthesis rather than the thickness of the individual layer

32 DC1 (12) + DB2(20)

Conditional series maps may be made at any hierarchical level appropriate to the purposes of the manager. Gathering of these data will require extensive drilling and associated field work. In the long term, the framework provided by the conditional series will provide a means of storing and organizing detailed and highly useful information.

IMPLIMENTATION PROCEDURES

Methodology

Application of the Regolith Classification to a management area will follow standard geologic procedures except for the use of a different mapping rule.

First, the area of study, scale, and specific objectives should be defined insofar as possible. Time available, budget, facilities, and personnel should be determined at the outset, and may control or place limitations on the first three factors.

Second, a literature review and examination should be made of published or open-file maps of bedrock geology, surficial geology, and environmental-geology features. Bibliographies of the U. S. Geological Survey and reports of appropriate federal, state, and county surveys, bureaus, or divisions would provide an initial set of literature citations. Additional relevant material from the published abstracts of Ph.D. dissertations and established keyword computer-serarch facilities such as the GEOREF service of the American Geological Institute. Geologists and other scientists in teaching institutions, industry, and private consulting can be invaluable in finding pertinent local information.

Third, while the analysis of literature and maps proceeds, a reconnaissance examination should be made of topographic maps and aerial photographs of the study area, at scales appropriate to the study. If needed, a brief field reconnaissance should be undertaken to verify preliminary interpretations, to identify critical areas that will require detailed study, and to assess such logistics as accessibility and locations of sites for field camps (if needed). A preliminary field reconnaissance generally is desirable, but may not be feasible due to limitations of time, season, or budget. A flight over the area can provide a useful overview and invaluable low-angle-oblique, color and infrared aerial photographs.

Fourth, it is crucial to re-evaluate the overall situation with the perspectives gained from the preliminary steps outlined above. Final decisions should be made on: (1) the exact location of the area or areas to be classified and mapped; (2) the scale of the final maps; (3) the specific purposes for which the information will be used; and, finally (4) which parts (i.e., orders) of the classification will be used, and at what hierarchical levels.

Fifth, the area should be classified and mapped at the required level of resolution by interpretation of vertical aerial photos and/or by detailed field work. The latter is time consuming and expensive. Except for detailed studies of limited areas or of complex areas, detailed field work should seldom be necessary in preparation of the initial map.

Sixth, a field check of any aerial-photo map should be made. Typical sites with good access should be chosen to verify interpreted orders, classes, or types believed to be unambiguous. Steep slopes with obscuring vegetation, other obscured areas on the aerial photographs, and areas affected by man, fire, freak storms, overgrazing, etc., since the photos were taken should be checked for possible erosion or deposition. Areas of difficult interpretation should be divided into groups, and representatives of each group should be field checked. Most problem areas probably will fall into the DEPOSITION ORDER, partly because it usually will be mapped at the more detailed levles, and partly because unambiguous interpretation from aerial photographs is more difficult than for the two other orders. Outcrops of poorly competent bedrock, especially shales, also cause problems, especially where surrounded by regolith.

Seventh, at this point, detailed field studies may be deemed necessary at selected sites where potentially valuable resources are known or most likely, or where significant human impact is expected, etc. Such a decision would be based on the information already gathered and its evaluation, especially by comparison with information gathered under other ECOSYM component classifications and stored in computers by means of geographic coordinates.

Classifying

Classification is the identification of points throughout the study area. Management goals, economic and political factors, and previous mapping will be involved in establishing the hierarchical level of the classification as it is applied. Once the hierarchical level is established, the study methodology provides the framework for classifying the regolith.

There are several guidelines used in classifying regolith. First, standard geologic evidence is used to determine the classification name for a particular point. For example, the presence of rills will indicate:

I. EROSION ORDER

A. FLUVIAL CLASS

1. RILL TYPE

Depositional and residual regolith will be distinguished on the geologic evidence suggested by the definition for the particular classification element. Second, the classification is based on the dominant, active factors resulting in the regolith at a point. If an area is glacially eroded, as in a cirque, but is currently being eroded by mass wasting and/or fluvial processes, classification names would reflect the appropriate fluvial or mass wasting designations. In another case, a stream may be incised in a till type deposit. The presence of rills and a stream channel would result in using fluvial erosion names for points with this evidence. Till type would be applied to the points without this evidence.

Mapping

Mapping classified points will require drawing boundaries around the similar adjacent points to delineate map units. As with most mapping units, some inclusion of dissimilar points will result. A mapping rule is then established to govern the percentage of dissimilar points allowable in a unit. This rule influences the resulting boundaries of the map units. As an example, three types of points are classified in an area (Figure 1). The identical, contiguous points are enclosed by boundaries to form map units (Figure 2). It should be noted that several points in the T map unit and the G map unit are inclusions allowed under the mapping rule for this area.

Translation of these maps into other forms may be accomplished with additional information where the new map might be more appropriate for some special useage. As mentioned earlier, the combining of spatial and plan view data with regolith map units could produce a genetic geomorphic map of landforms. Other maps could be produced from conditional series map at different hierarchical levels. Where thickness data were available, an isopachous map (equal thickness) could be compiled showing the thickness distribution of regolith cover.

Table 1. - Regolith Classification: Hierarchy of Orders, Classes and Types.

I. EROSION ORDER
- A. Explosion Class
  - 1. Eruption Type
  - 2. Impact Type
- B. Mass Wasting Class
  - 1. Subsidency/Compaction Type
  - 2. Tear-Away Type
- C. Fluvial Class
  - 1. Rill Type
  - 2. Channelled Type
  - 3. Unchannelled Type
- D. Glacial Class
  - 1. Grinding (Scour) Type
  - 2. Plucking Type
- E. Cryonival Class
  - 1. Nivation Type
- F. Eolian Class
  - 1. Sandblast Type
  - 2. Deflation Type
- G. Ground-Water Class
  - 1. Collapse Type
- H. Aquatic Class
  - 1. Wave Type
  - 2. Current Type
  - 3. Surface-Ice Type
- I. Living Class
  - 1. Excavation Type
  - 2. Surface-Disturbance Type

II. DEPOSITION ORDER
- A. Ejecta Class
  - 1. Tephra (Ash) Type
  - 2. Breccia Type
- B. Colluvium Class
  - 1. Slide-Slip Type
  - 2. Flow Type
  - 3. Fall-Talus Type
- C. Alluvium Class
  - 1. Vertical-Accretion Type
  - 2. Lateral-Accretion Type
  - 3. Mudflow-Debrisflow Type
- D. Drift Class
  - 1. Till Type
  - 2. Ice-Contact Type
- E. Niveal Class
  - 1. Geliflruction Type
  - 2. Rock Glacier/ Protalus Ramparts Type
- F. Eluvium Class
  - 1. Sand Type
  - 2. Silt Type
  - 3. Clay Type
- G. Terraqueous Class
  - 1. Hot Springs Type
  - 2. Vadose Type
  - 3. Salina Type
- H. Aqueous Class
  - 1. Coarse Type
  - 2. Mixed Type
  - 3. Fine Type
- I. Organism Class
  - 1. Human-Mechanical Type
  - 2. Nonhuman Type

III. RESIDUAL ORDER
- A. Mineral Soil Class
  - 1. Physical-Residuum Type
  - 2. Chemical-Residuum Type
- B. Freeze-Thaw Class
  - 1. Patterned-Ground Type
  - 2. Frost/Mound Type
- C. Organic Class
  - 1. Peat Type
  - 2. Bog-Ore Type

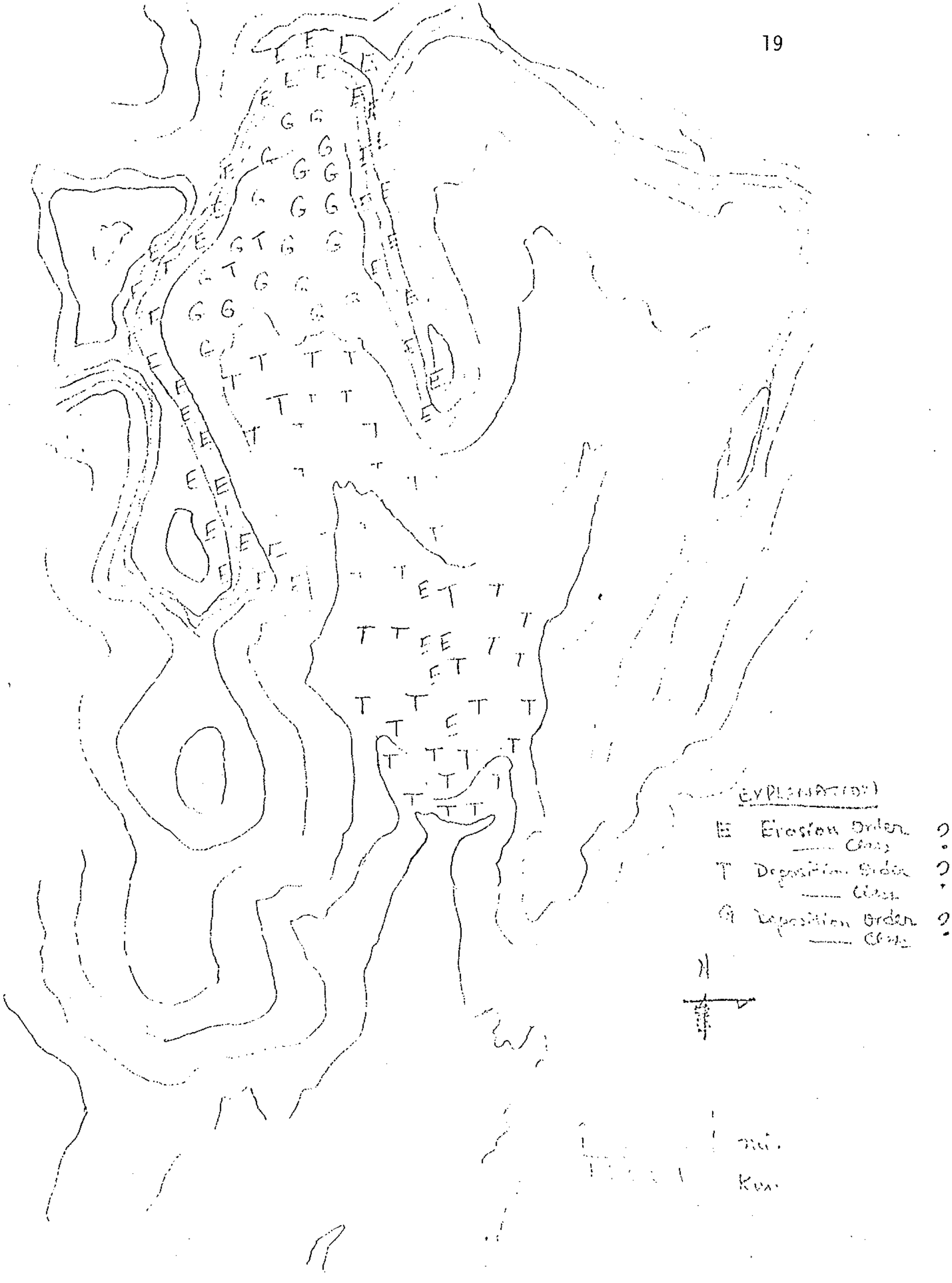
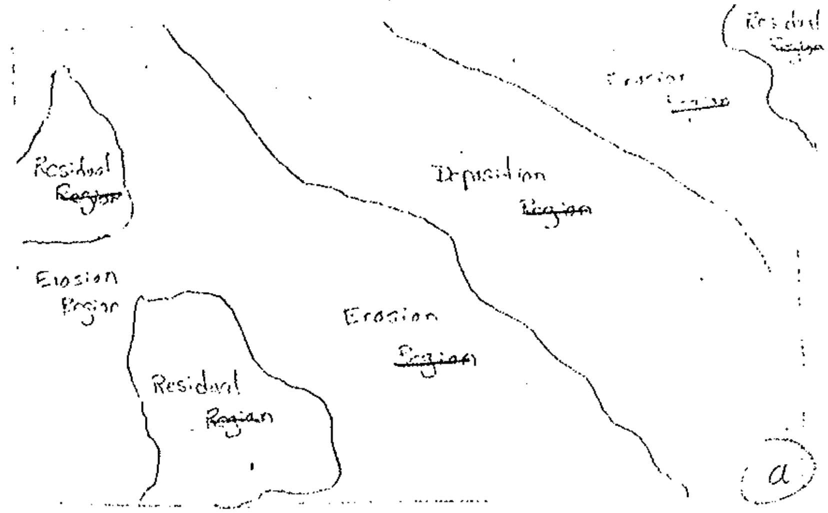
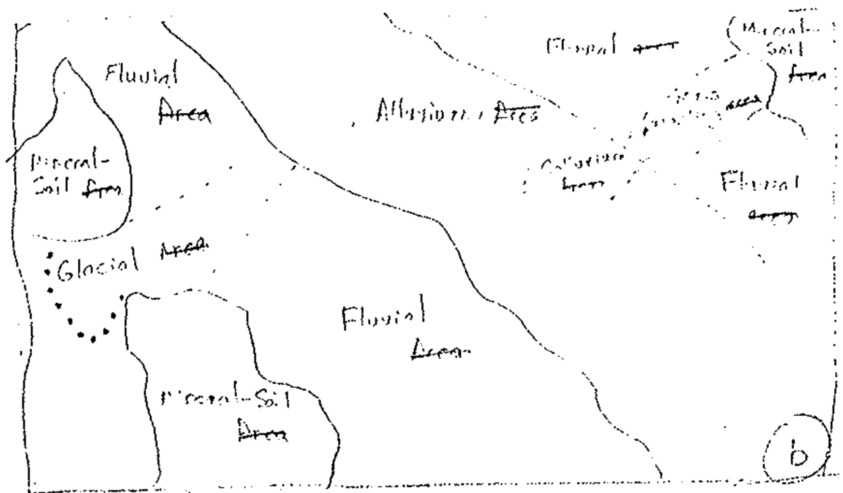

EXPLANATION
E Erosion Order ?
____ Class
T Deposition Order ?
____ Class
G Deposition Order ?
____ Class
N
mi.
Km

Fig. 1

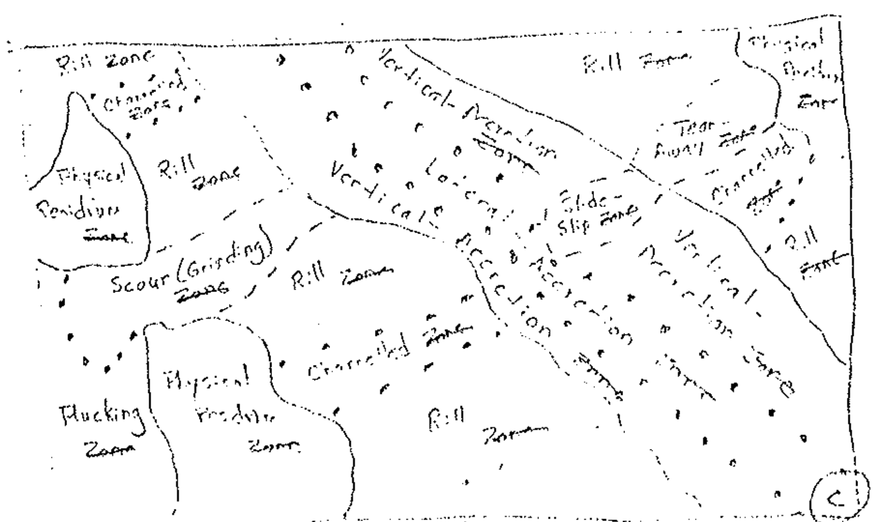
Fig. 2



ORDER MAP



CLASS MAP



TYPE Map

Fig. 3

Scale

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GLOSSARY

ALLUVIUM CLASS	Regolith that consists of clay, silt, sand, gravel, or similar unconsolidated detrital material deposited by a stream or other body of running water as a sorted or semisorted sediment in the bed of the stream or on its floodplain or delta, or as a cone or fan at the base of a mountain slope.
AQUATIC CLASS	Regolith formed and associated with erosion by bodies of water.
AQUEOUS CLASS	Regolith consistency of sorted and stratified clay, silt, sand, and gravel that was deposited into a body of water.
BOG ORE TYPE	Regolith consisting of chiefly hydrous oxides such as iron and manganese with associated plant debris, clay, and clastic material. Some poor stratification may be present. Deposition is accomplished by precipitation and oxidizing action of algae, iron bacteria, or other microorganisms.
BRECCIA TYPE	Regolith composed of deposited angular pyroclastic rocks that are .2mm in diameter or larger and that may or may not have a matrix.
CHANNELLED TYPE	Regolith formed and associated with erosion in which material is removed by water flowing in well-defined channels.
CHEMICAL-RESIDUUM TYPE	Regolith consisting of fine grained material resistant to chemical changes, such as quartz and some clay minerals, produced by chemical weathering.
CLAY TYPE	Regolith consisting almost exclusively of rock or mineral fragments or detrital particles having diameters less than 1/256 mm (4 microns) with probable stratification.
COARSE TYPE	Regolith consisting of gravel and coarse sand which is sorted and stratified by currents and/or waves in a body of water.
COLLAPSE TYPE	Regolith formed and associated with ground-water erosion where soluble material has been partly or wholly removed by solution, thereby allowing the overlying material to settle and become fragmented.
COLLUVIUM CLASS	Regolith that is a loose, heterogeneous, and incoherent mass of soil material or rock fragments deposited chiefly by mass wasting.

CRYONIVAL CLASS	Regolith formed and associated with erosion by the combined action of frost and snow.
CURRENT	A horizontal movement or continuous flow of water in a given direction with a more or less uniform velocity, producing a perceptible mass transport, set in motion by winds, waves, gravity, or differences in temperature and density, and of a permanent or seasonal nature.
CURRENT TYPE	Regolith formed and associated with erosion by currents in a body of water.
DEFLATION TYPE	Regolith formed and associated with the sorting out, lifting, and removal of loose, dry, fine-grained particles (clay and silt sizes) by the turbulent eddy action of the wind.
DEPOSITION ORDER	The regolith resulting from the laying, placing, or throwing down of any material; specifically, the constructive process of accumulation into beds, veins, or irregular masses of any kind of loose, solid, rock material by any natural agent.
DRIFT CLASS	Regolith consisting of clay, sand, gravel, or boulders deposited by a glacier directly or from meltwater. Stratification and sorting may or may not be present.
EJECTA CLASS	Regolith composed of glass, shock-metamorphased rock fragments, and other material thrown out of an explosion or impact site during formation.
ELUVIUM CLASS	Regolith consisting of fine soil or sand deposited by the wind.
EOLIAN CLASS	Regolith formed and associated with erosion by the wind.
EROSION ORDER	The regolith wholly the result of the general process or the group of processes whereby the earthy and rocky materials of the Earth's crust are loosened, dissolved, or worn away.
ERUPTION TYPE	Regolith formed and associated with erosion resulting from volcanic, thermal, chemical, or nuclear explosions.
EXCAVATION TYPE	Regolith formed and associated with the process of digging or blasting a cavity or channel.
EXPLOSION CLASS	Regolith formed and associated with depressions created by volcanic, thermal, chemical, or nuclear explosions or hypervelocity impact.

FALL-TALUS TYPE	Regolith deposit of rock fragments of any size or shape (usually coarse and angular) derived from and lying near the base of a cliff or very steep, rocky slope. Formed chiefly by gravitational falling, rolling, or sliding.
FINE TYPE	Regolith consisting of sand, silt, and clay which is sorted and stratified by currents and/or waves in a body of water.
FLOW TYPE	Regolith deposit consisting of an incoherent mass of earth, sant, or similar material which was deposited by a mass movement that exhibited a continuity of motion and a plastic or semi-fluid behavior resembling a viscous fluid.
FLUVIAL CLASS	Regolith formed and associated with overland flow whether channeled or unchanneled.
FREEZE-THAW CLASS	Regolith consisting of unconsolidated, unstratified rock material subjected to mechanical weathering by alternate or repeated cycles of freezing and thawing of water in pares, cracks, and other openings, usually at the surface.
FROST MOUND TYPE	Regolith consisting of a variety of grain sizes, with some sorting possible, caused by development of a subsurface ice core by frost heaving and/or hydrostatic pressure of interstitial water.
GELIFLUCTION TYPE	Regolith consisting of a mixture of earth material exhibiting little or no sorting or stratification due to the progressive and lateral flow responsible for the deposit.
GLACIAL CLASS	Regolith formed and associated with glacial erosion.
GLACIAL EROSION	The grinding, scouring, plucking, gouging, grooving, scratching, and polishing effected by the movement of glacial ice armed with rock fragments frozen into it, together with the erosive action of meltwater streams.
GRINDING (SCOUR) TYPE	Regolith formed and associated with abrasion by rock fragments embedded in a glacier and dragged along the bedrock floor.
GROUND-WATER CLASS	Regolith formed and associated with erosion by that part of the subsurface water that is the zone of saturation, including underground streams.

GULLY EROSION	Erosion of soil or soft rock material by running water that forms distinct, narrow channels that are larger and deeper than rills and that usually carry water only during and immediately after heavy rains or following the melting of ice or snow.
HOT-SPRINGS TYPE	Regolith consisting of mineral material precipitated from springs, usually hot or warm. Commonly, soluble minerals such as tufa or siliceous sinter.
HUMAN-MECHANICAL TYPE	Regolith consisting of rock particles or other detritus which may be sorted but probably not stratified, and deposited by man; e.g., mine spoils, landfills.
ICE-CONTACT TYPE	Regolith consisting of stratified, semi-sorted material deposited in contact with melting glacier ice, such as an esker, kame or kame terrace.
IMPACT TYPE	Regolith formed and associated with erosion resulting from hypervelocity impact of large objects such as meteors.
LATERAL-ACCRETION TYPE	Regolith consisting of stratified clay, silt, sant, or gravel deposited by outward or horizontal sedimentation; e.g., digging away the outer bank of a stream meander and building up of the inner bank to water level by deposition of material brought there by rolling or pushing along the bottom.
LIVING CLASS	Regolith formed and associated with erosion by man and other organisms.
MASS WASTING	A general term for the dislodgement and downslope transport of soil and rock material under direct application of gravitational body stresses. In contrast to other erosion processes, the debris removed by mass wasting processes is not carried within, on, or under another medium possessing contrasting properties. The mass strength properties of the material being transported depend on the interaction of the soil and rock particles with each other. It includes slow displacements such as creep and solifluction and rapid movements such as earthflows, rockslides, avalanches, and falls.
MASS WASTING CLASS	Regolith associated with the erosional site produced by either mass wasting or subsidence.

MINERAL	Any naturally formed, inorganic material, i.e., a member of the mineral kingdom as opposed to the plant and animal kingdoms. A naturally occuring, usually inorganic, crystalline substance with characteristics physical and chemical properties that are due to its atomic arrangement.
MINERAL - SOIL CLASS	Regolith consisting almost wholly of mineral material derived in situ from bedrock through chemical and physical weathering.
MIXED TYPE	Regolith consisting of segregated masses of coarse and fine types intimately intermixed by depositional action in a body of water.
MUDFLOW - DEBRIS FLOW	Regolith consisting predominantly of fine grained material with some large rock fragments. Little or no stratification is present due to the sudden flow of the rock-water mass, usually resulting from cloudbursts or related phenomena.
NIVATION TYPE	Regolith formed and associated with erosion of rock or soil beneath a snowbank or snow patch and around its fluctuating margin, caused mainly by frost action.
NIVEAL CLASS	Regolith composed of coarse, angular rock fragments deposited by action of snow and intersititial ice, usually associated with extensive frost action.
NONHUMAN TYPE	Regolith consisting of rock or other detritus, usually as an unsorted, unstratified mass, and deposited by creatures other than man; e.g., guano.
ORGANIC CLASS	Regolith consisting of mineral material which is a residuum of organic matter or produced by chemical action by microorganisms.
ORGANISM CLASS	Regolith consisting of rock material with a wide size range which has been deposited by living creatures.
PATTERNED GROUND TYPE	Regolith consisting of a wide variety of particle sizes which may or may not be sorted by intensive frost action.
PEAT TYPE	Regolith consisting of unconsolidated, semicarbonized, plant remains.
PHYSICAL - RESIDUUM TYPE	Regolith consisting of sand and silt sized rock particles, similar in composition to the source bedrock, produced by mechanical weathering.

PLUCKING TYPE — Regolith formed and associated with glacial erosion by which sizeable rock fragments, such as blocks, are loosened, detached, and borne away from bedrock by the freezing of water along joints and stratification surfaces with resulting removal of rock as the ice advanced.

RESIDUAL ORDER — The regolith created as a residue formed by weathering in place.

RILL EROSION — The development of numerous, minute, closely spaced channels resulting from the uneven removal of surface soil by running water that is concentrated in streamlets of sufficient volume and velocity to generate cutting power.

RILL TYPE — Regolith formed and associated with rill and gully erosion.

ROCK GLACIER/PROTALUS RAMPART TYPE — Regolith consisting of a mass of poorly sorted angular boulders and fine material deposited by frost action of internal ice or an associated snowfield or patch.

SALINA TYPE — Regolith consisting of highly soluble salts such as sodium chloride, sodium carbonate, borax deposited by evaporation of water in the saturated surface soil after precipitation in an arid region.

SAND TYPE — Regolith consisting almost exclusively of rock or mineral fragments or detrital particles smaller than a granule and larger than a coarse silt grain, having a diameter in the range of 1/16 to 2mm with probable stratification.

SANDBLAST TYPE — Regolith formed and associated with erosion by windblown sand driven against an exposed rock surface.

SILT TYPE — Regolith consisting almost exclusively of rock or mineral fragments or detrital particles smaller than a very fine sand grain and larger than a coarse clay, having a diameter in the range of 1/256 to 1/16 mm. with probable stratification.

SLIDE-SLIP TYPE — Regolith deposited as a rock, sand, or earth material in an incoherent mass by a mass movement under shear stress along one or several surfaces that are either visible or may reasonably be inferred.

SUBSIDENCE — A local mass movement that involves principally the gradual downward settling or sinking of the solid Earth's surface with little or no horizontal motion and that does not occur along a free surface (not the result of a landslide or failure of a slope).

SUBSIDENCE/COMPACTION TYPE — Regolith formed and associated with erosion by subsidence and compaction, including man-induced circumstances.

SURFACE-DISTURBANCE TYPE — Regolith formed and associated with the mixing or partial removal of the soil surface by living things.

SURFACE-ICE TYPE — Regolith formed and associated with erosion by surface and shore-fast ice on a body of water.

TEAR-AWAY TYPE — Regolith formed and associated with the bare or relatively bare surface or niche left by the removal of earth material through landsliding.

TEPHRA (ASH) TYPE — Regolith composed of deposited fine pyroclastic material (under 4.0mm diameter; under 0.25 mm diameter for fine ash).

TERRAQUEOUS CLASS — Regolith consisting of mineral material derived fromwater that has penetrated the lithosphere.

TILL TYPE — Regolith consisting of a heterogeneous mixture of clay, sand, gravel, and boulders varying widely in size and shape. Generally unworted and unstratified as a result of direct deposition by glacial ice.

UNCHANNELLED TYPE — Regolith formed and associated with erosion in which their layers of surface material are gradually removed more or less evenly from an extensive area of gently sloping land by broad, continuous sheets of running water rather than by streams flowing in well-defined channels.

VADOSE TYPE — Regolith consisting of chemically precipitated, dense mineral material deposited by evaporation at the water table.

VERTICAL-ACCRETION TYPE — Regolith consisting of stratified fine grained material (clay, silt, fine sand) deposited by upward or vertical deposition; e.g., settling of sediment from suspension in a stream subject to overflow.

WAVE TYPE — Regolith formed and associated with erosion by an oscillatory movement of water (waves) manifested by an lternate rise and fall of a surface in or on a body of water.

WEATHERING — The destructive process or group of processes constituting that part of erosion whereby earthy and rocky materials on exposure to atmospheric agents at or near the Earth's surface are changed in character (color, texture, composition, firmness, or form), with little or no transport of the loosened or altered material; specifically the physical disintegration and chemical decomposition of rock that produce an _in-situ_ mantle of waste and prepare sediments for transportation.