LANDTYPE ASSOCIATIONS

OF THE

NORTHERN REGION,

A FIRST APPROXIMATION

COMPILED BY

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PURPOSE OF THE LANDTYPE ASSOCIATION MAPPING

The purpose was to create a 1:100,000 map based upon landforms and geologic materials (bedrock and surficial materials) that provides continuous coverage for all Forest Service lands throughout northern Idaho, Montana, North Dakota and the northwest corner of South Dakota. Some areas of other ownership are included. Accompanying the map are map unit descriptions and attribute information. The mapping was prepared using a uniform legend for the entire region.

Landtype associations (LTAs) can be developed for a variety of interpretive purposes. The present LTAS were developed for landscape level biophysical stratification to characterize watershed properties important to management. The use of landforms and geologic materials as differentia is based on the assumption that these are the two variables which can be mapped consistently at the landscape level that most closely predict significant changes in inherent watershed, stream and riparian properties. Stratification of the landscape based on these criteria assumes the LTAs will contain predictable ranges in stream density, erosion properties, and stream and valley-bottom width and gradient attributes.

These landtype associations further refine the characterization of landscapes from subsections into units that describe similarities in landforms, their dominant formative processes, and underlying parent materials.

The display of mapped information is by no means inclusive of all known categories, nor (due to the mapping scale) is it site specific. The incorporation of a conceptual ecological hierarchy into geo-referenced delineations requires many interpretive iterations-each a more refined scale and level of resolution. The results of this collective project reflect our first attempt to translate on-the-ground knowledge into the landtype association level of the ecological mapping hierarchy.

This landtype association project has been divided into two parts. The present document, Part 1, consists of the maps and descriptions of the landforms and geologic materials, and associated characteristics of the project area. Part 2, which is planned for FY97, will consist of the development and documentation of interpretations for this map theme.

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MAJOR GEOMORPHIC SETTINGS OF THE NORTHERN REGION

The landtype associations that were mapped occur across a large complex landscape which includes both portions of the Rocky Mountains and the Great Plains. While the focus of this report is on the mapping of landtype associations it is useful to first obtain a "big picture" perspective of the geomorphic units that are distinct at the regional scale. The following sixteen units have been delineated (Figure X)

Pryor Mountains
Yellowstone Volcanic Plateau.
Beartooth Plateau
Non Glaciated Plains
Northern Glaciated Plains
Rocky Mountain/Beartooth Front
Central Montana Island Mountains
Southwest Montana Mountains and Valleys
Alpine Glaciated Metasedimentary Mountains
Continental Glaciated Mountains
Metasedimentary Mountains
Columbia River Basalts
Idaho Batholith Uplands

Idaho Canyon Lands
Badlands
Deltaic Plains

Listed below are descriptions of these units. The emphasis is on the geomorphic and geologic processes which have created the areas and the landforms and materials which occur there.

Pryors Mountains

The Pryors are the northern nose of the Bighorn mountains of Wyoming. They are cut off by the antecedent gorge of the Bighorn River. Structures are similar block faulting in a broad gentle uplift with minimal deformation on top with steeply dipping sediments draped up the sides. There is an east-west fault that divides the Pryors into two styles of landscape. To the North the Cretaceous sediments are exposed in rolling hills of bentonitic shales with some areas of badlands while to the south the massive Paleozoic limestones dominate the landscapes with high cliffs and large steep walled canyons.

Yellowstone Volcanic Plateau

The Yellowstone Volcanic plateau is a complex landscape shaped by glaciation and 3 main rock types. The ash-dominated volcanics give a rolling rounded landform with few outcrops. Where oversteepened by glaciation or erosion they are very slide prone and indeed there are numerous very large slides in this material. The flow dominated volcanics are rockier and in many areas very susceptible to glacial plucking in the cirques resulting in large amphitheater -like cirques at drainage heads. The Archean rocks preserve the "ice just melted look" the best resulting in rugged, spectacular landscapes with numerous horns and aretes

Beartooth Plateau

This landscape is defined by fault blocks that raise it to the highest average landscape elevation in the region. The core is very resistant old rocks dated at 4 billion years. There are a few places where the overlying sedimentary rocks can still be seen. There are large areas in the southwest where ash dominated volcanics cover these old rocks. A special case is the Stillwater Complex which outcrops along the northern front. This is a layered intrusive body of unusually mafic rocks that host the only US platinum group metal mines. Joint control of drainages and lakes at intersections is very dominant in the portions underlain by crystalline rocks. Many of these were enlarged in spectacular fashion by glaciation. Indeed a few small glaciers remain in this landscape. Grasshopper Glacier indicates that as late as 300 years ago there were swarms of locusts at this elevation in late summer. Another feature of note are the various "plateaus" or high elevation erosional surfaces preserved. These large broad ridgetops at high altitude show examples of most types of glacial and periglacial landforms. Till and talus are very abundant. The horns and cirques in this very resistant terrain give it a raw just exposed appearance that is fresh from the last ice age.

Non Glaciated Plains

The Nonglaciated Plains is the northern Great Plains south of the areas that were glaciated with low relief and gently rolling grasslands. The bedrock is Cretaceous marine shale and Tertiary fluvial sediments with some large sandstone units scattered through it. The other major component for soils is loess with lesser areas dominated by lag gravel deposits. Many of the benches are fragments of former landscape surfaces topped by these gravels. The clinker beds or "scoria" from burnt coal seams form colorful resistant beds in the Tertiary outcrops.

Northern Glaciated Plains

This is part of the northern Great Plains , large expanses of prairie with scattered highlands extending above the landscape. It was overrun by continental glaciers and covered with glacial drift to depths of up to 100 feet. The glacial drift is a mixture of clay to boulder size material. The ice also left the distinctive pot and kettle topography of rolling hills with ponds and lakes. Ice damming of the major rivers also created areas of lacustrine and delta sediments. The drift is the parent material for many of the soils and is markedly different than the Cretaceous marine shales on the rest of the prairie. Both the Glaciated and Nonglaciated Plains landscapes share commonality in having areas with a large loess component in some soils and the lag gravel remnants of former landscape surfaces on ridge tops and benches.

Rocky Mountain/Beartooth Front

The uplift and thrust faulting that created the mountains resulted in steeply dipping faults along the edges that face the prairies. This pushed up the overlying sedimentary rocks into steep dip slopes. In places this was too steep and large slabs of this rock telescoped by sliding into the low spots in a series of thrust faults. This pile of over thrust and wrinkled rocks are theMountain Fronts. Near the mountains the sedimentary rocks drape up against the uplifted mountains in steep flatirons on the noses of ridges. Farther out the landscape becomes more gentle and rolling or becomes a series of hogbacks parallel to the mountains. The valleys contain large amounts of outwash gravel often displayed in multiple terraces that give insight into climatic change and hydrologic variation of the last 10,000 years.

Central Montana Island Mountains

The Central Montana Island Mountains occur as widely separated uplifts sticking up above the surrounding prairie and isolated by it. The mountains are of varied types including volcanic piles with an intrusion in the middle to uplifted sediments with an intrusion in the middle. The higher elevations have been glaciated.

Southwest Montana Mountains and Valleys

The dominant feature of this landscape are mountains separated by large valleys filled with gravel. Large basins dominate the lower elevations. The mountains are complex landforms that include a number of rock types and histories including batholiths and alpine glaciation. The valleys or basins are similar in being broad areas filled with Tertiary sediment and Quaternary gravels. They are commonly linked to other basins along shared rivers and are separated from other basins and landscapes by a gorge. The mountains have some general similarities. The mountains are sedimentary piles that are uplifted and faulted, with a granitic intrusion in the core areas. A wide variety of lithologies and ages are thus exposed by erosion. The higher elevations have been alpine glaciated.

Alpine Glaciated Metasedimentary Mountains

The parent Metadeiment Mountain landscape is modified by pervasive alpine glaciation to make this landscape. Large U-shaped valleys with extensive rock outcrop run up to rugged cirques surrounded by craggy shattered peaks. Talus is aboundant on slopes along with till, outwash and moraines in the valleys. The deposits of periglacial processes are widespread. Lakes from mechanisms such as pot and kettle, damming by moraine, mass movement, or talus ramparts , and cirque lakes are common.

Continental Glaciated Belt Mountains

This landscape is made distinctive by the rounding of landforms by continental glaciation. This scoured the ridgetops and depositied till on the sideslopes and valley bottoms. These deposits are often 50 to 100 feet thick. Some characteristics remain from the parent Belt Basin landscape but these are heavily modified by glacial action and the addition of till and glacial lake sediments in lower areas. Most of this area retains the mantle of loess and ash on top of the glacial material. The valley deposits are various mixes of till, moraine, outwash and lake deposits reflecting their recent history of ice damming, diversion, flooding, stagnant or receding ice features such as pot and kettle, and some unique features from catastrophic lake releases, jokulhaups.

Metasedimentary Mountains

The Belt rocks are lightly metamorphosed quartzite and argillite that are resistant to weathering. In some areas thick carbonate units of dirty limestone and limestone cemented sediments are also present in the middle and near the bottom. The characteristic landforms are large steep slopes in an incised landscape of V shaped valleys. The loess/ash is typically missing or greatly reduced on the lower slopes. Talus is common on the lower slopes often extending up to rock outcrop on valley sides. On the northerly aspects the talus often extends upslope and goes under vegetative cover. The larger valleys show evidence of modification by damming from ice, lake sediments then the resulting erosion and redeposition from catastrophic draining of the lake. Long stretches of canyons have been stripped to bedrock to about 1000 feet up the valley sides leaving very rocky slopes dominated by talus and outcrop. Soils are largely mixtures of colluvium and loess, and thin in these areas. likewise large areas of the valley bottoms are lakebeds. The outwash gravels from these events make up the "bowling ball" acquifers that are unique in their water transmission rates and susceptibility to contamination. The major river of the area follows the Lewis and Clark line, the major structural feature. Tributary valleys correspond generally with secondary structural orientations defined by the edges of the overthrust plates.

Columbia River Basalts

This landscape is the result of the Columbia River Basalts flooding pre-existing terrain to about 3400 feet in elevation. The basalts filled drainage basins, overtopped low ridges, and isolated mountain tops. This produced low relief plateaus and rolling hills dotted with steptoes, the tops of the previous mountains.

The eastern edges of the flooded uplands in Idaho are a mix of lacustrine and stream deposits lying upon and interbedded with the basalt flows. Most of these edge flows are invasive basalts that were formed by the denser basalt invading the soft, wet sediments that form the interbeds. The interbeds are not continuous layers. They are isolated pockets formed by the damming of ancestral rivers as the basalt flowed up valley. Some were formed by overbank muds, some are lake and pond deposits, and some are channel deposits of sand and gravel. Topographically, the interbeds are expressed by esplanades, slope breaks or gentle benches, among the cliffs that mark the basalt flows along the canyons. Where the Big Canyon landscapes cut through this landscape the basalts are very unstable and susceptible to all forms of mass wasting.

Idaho Batholith Uplands

The granitics with their distinctive influence on hydrology, soils, and landforms define it. It is a large contiguous uplifted area characterized by large rounded mountain masses and basin areas with little rock outcrop. Soils are derived from gruss and loess/ash. This landscape is deeply cut by the Big Canyon landscape. Where it is cut by the big canyons the loess and ash component of soils is typically missing. Another variation is glaciation occurs at higher elevations. The glacially scoured areas have the typical glacial valley shapes with exposed rock in the walls. Ridgetops can be either sharp and rocky or gentle wide forms dominated by periglacial processes.

Idaho Canyon Lands

This landscape is dominated by the deep entrenchment of the major trunk streams into uplifted highlands. This landscape penetrates deeply into a number of other landscapes with these large canyons causing rapid changes in a number of ecolologic variables. Steep high relief breaks and narrow valley bottoms are characteristic. The loess/ash components of soils are typically missing from these high energy slopes. This landscape slices through a number of rock types with litle regard for lithologic variations emphasizing the overpowering nature of the process of downcutting in these landscapes. A variety of mass wasting processes are active in this landscape. Where the Big Canyons cut through the Basalt Flooded Uplands very large slides and failures are common.

Badlands

The Badlands are areas of thinnly bedded shales and sandstones. They occur in the plains areas and are areas of accelerated erosion. The factors common to these areas are alternating beds of softer and harder materials with the softer material being impervious material such as clay, near horizontal bedding, and high density intricate drainage patterns. The larger areas have high internal relief but the landform is cut into the surrounding plains or plateau areas. They are a good example of a self-enhancing feedback mechanism.

Deltaic Plains

This is the Sheyenne Delta created where the Sheyenne River emptied into Lake

Agassiz, one of the large glacially dammed lakes. This landscape is a mix of the delta and the recent modification of these loose sandy sediments into a dune field by wind action.

THE MAPPING

How the mapping was done: The landtype associations were produced in two ways. Where landtype mapping was completed for a Forest, the landtypes were combined based upon similarities in landforms and geologic materials to create landtype associations using a Geographic Information System. Where landtype mapping was not complete, the LTAs were delineated manually on 1:100,000 USGS metric topographic maps using available information.

(Get writeup from Cathy on GIS work)

Map Unit Differentia: Ecological mapping projects commonly have some landscape components that are used to delineate units on maps, and others that are used to describe what is there. Those that are used to draw the lines are referred to as the differentiating criteria. For this mapping, landforms and geologic materials were the differentiating criteria. The landform groups and geologic material groups that were used in the mapping are described in following sections.

The other components that are described for each map unit, but were not used to delineate them are called the accessory characteristics. The accessory characteristics for this mapping were: elevation range, slope range, average annual precipitation, surface and subsoil textures and rock fragment contents, soil taxa and potential vegetation.

General Discussion of Landform Groups

Seventeen major landform groups were used for the LTA mapping. These are described below using the following criteria:

1) Primary landforms
2) Process of development
3) Slope gradient range and typical
4) Surface shape
5) Associated landforms

Valleys: The primary landforms included in this unit are: floodplains, terraces, benches, and alluvial basins. These landforms were formed by recent streams or by glacial meltwater. A variety of water-deposited sediments occur. These deposits vary from poorly sorted and stratified to well sorted and stratified. Some dune deposits also occur. These units typically have straight or convex slopes that range in gradient from 0 to 30 percent. This unit also contains narrow terrace escarpments which can be much steeper. The surface shape typically is mostly level to very gently rolling. Associated landforms include both glaciated and unglaciated mountains slopes and gently to moderately sloping hills.

Breaks: The primary landforms included in this unit are breaks and escarpments. These generally have straight slopes in excess of 60 percent, with a slope range from 50 to greater than 100 percent. Breaks typically have abrupt changes to gentler slopes with the adjacent landforms. These landforms have developed by tectonic activity and/or rapid stream downcutting processes. In some places they have been modified by glacial action. Associated landforms include mountain slopes and ridges and alluvial valley bottoms.

Steep mountain slopes: (this group may be combined with one of the others). Unglaciated mountain slopes of high relief. In general, an elevational change of greater than 800 feet is common to these units. Slope gradients are greater than 40 percent.

Steep glaciated lands: The primary landforms included in this unit include: cirque headwalls, glacial troughwalls, alpine ridges and cirque basins. These landforms are predominantly formed by alpine glacial erosion processes but include areas of glacial deposition. Due to the scale of the mapping and the close physical association of these landforms, they are all combined into a single map unit. Cirque headwalls and glacial troughs typically have straight or concave slopes that range in gradient from 50 to greater than 100 percent. Alpine ridges have convex slopes that range in gradient from 10 to 40 percent. Cirque basins are typically bowl-shaped landforms with gradients from 0 to 30 percent.

The dominant slope gradient within this map unit is 45 to 70 percent. Associated landforms include gentle to moderately sloping glaciated lands, frost churned ridges, and valley bottoms. This steep glaciated map unit has characteristics similar to the gentle to moderately sloping glaciated land produced by continental glaciation; however that unit typically has more subdued topography and occurs at lower elevations. This unit also includes broad, ice-cap ridges having less than 40 percent slopes and equal amounts of subdued glacial erosion and deposition.

Gently to moderately sloping glaciated lands: The primary landforms include glacial moraines, glaciated mountain slopes, and glaciated mountain ridetops. These landforms represent depositional and erosional surfaces formed mostly by continental glaciation with some areas modifed by alpine glaciers. These surfaces have subdued relief with rolling topography. They are a combination of eroded, convex ridges, glacial deposits on slightly concave valley sideslopes, and deep glacial deposits on valley floors. The dominant gradient is 15 to 50 percent. Associated landforms include gentle to moderately sloping frost churned ridges and sideslopes, steep glaciated lands, and glacial outwash and glacial lacustrine alluvial landforms.

Mountain slopes and ridges: The primary landforms are ridges and sideslopes that have formed by fluvial and colluvial processes. The ridges are generally convex and the sideslopes are straight. Slope gradients generally range from 20 to 65 percent with 35 to 60 percent being dominant. There is a variety of weathering classes. Infrequent small nivational basins are included. Associated landforms are valley bottoms, and steep glaciated lands where alpine glaciers have been active at higher elevations. Some broader ridges may also occur where frost action has occurred.

Mountain ridge tops: The mountain ridge top is a broad convex landform that commonly occurs above mountain slopes and adjacent to steep glaciated lands. They have formed mainly by physical weathering and periglacial frost-churning. They are usualy undissected. Slope gradients are less than 50 percent but are dominantly 5 to 40 percent. As mapped, these landforms can include small areas of weak glacial erosion and deposition. The geologic materials commonly have a high rock fragment content which has been loosened and mixed by frost action and other weathering processes. Rock outcrops are infrequent.

Gently to moderately sloping low relief hills: This group consists primarily of low relief hills (less than 100 meters) with lesser amounts of alluvial fans, terrace remnants and colluvial slopes. These landforms are the result of shallow stream dissection of deeply weathered surfaces. They are frequently protected from deep dissection by nick points. Slope gradients are generally less than 45 percent with a typical range of 20 to 40 percent. Surface shape consists of simple to complex slopes of all shapes. Associated landforms are recent terraces and fans, hills and mountain slopes, deep frost churned ridges and slopes.

Mass wasting and colluvial landforms: The dominant landforms are rotational and translational failures. Included are a variety of types of failures, such as debris avalanches, slumps and deep mantle failures. Slope gradients for the translational failures are generally greater than 50 percent and most commonly occur on the steep mountain sideslope units, either glaciated or unglaciated. Rotational failures generally occur on lower slope gradients on the gently to moderately sloping mountain sideslope units, either glaciated or unglaciated. The associated landforms, in addition to the mountain sideslope units, are ridge tops at higher elevations and valley bottoms at lower elevations. Because of their generally small size many of these occur as inclusions in the other landform groups.

Rolling plains: The primary landforms in this unit include hills, and swales. These landforms are formed by fluvial and colluvial processes, and by chemical and physical weathering. The surfaces are level to steep with slopes usually less than 45 percent. Associate landforms include valleys, floodplains, badlands and breaklands.

Dissected plains: The primary landforms in this unit include hills, swales and drainageways. These landforms are formed by fluvial and colluvial processes, and by chemical and physical weathering. The surfaces are level to steep with slopes usually less than 45 percent. Associate landforms include valleys, floodplains, badlands and breaklands.

Glaciated rolling plains: The primary landforms in this unit include plains, hills , hummocks and swales. Thee landforms are formed by deposition of flacial till from continental glaciation. The surfaces are level to steep with slopes usually less than 45 percent. Associated landforms include rolling and dissected plains near the boundary of the continental glaciation.

Glaciated dissected plains: The primary landforms in this unit include plains, hills , hummocks and swales. Thee landforms are formed by deposition of flacial till from continental glaciation. The surfaces are level to steep with slopes usually less than 45 percent. Associated landforms include rolling and dissected plains near the boundary of the continental glaciation.

Glacial lacustrine plains: Refers to the Sheyenne Delta fromed during the Pleistocene ephoch by deposition of the sediments at the mouth of the Sheyene River as it discharged into Glacial Lake Agassiz which filled the Red River Valley of North Dakota and Minnesota. The deltaic deposits consist of very fine to fine grained sand, a transition zone of interveded siot and sand and silt and clay. After the glacier receeded and Glacial Lake Agassiz subsided, the sand delta left by the glacial meltwaters was readily susceptible to erosion, especially wind erosion. These sands were blown and moved by the wind into dunelike topography.

Badlands: The primary landforms in this unit include hills, drainageways, and knobs. Thee landforms have formed as a result of erosinal processes on sedimentary deposits. Badlands are rough, narrowly and steeply gullied topogaphy where soft shale and sanstone are widely exposed as a result of eroin caused by infrequent heavy showers on saresely vegetated landscapes. Runoff is very rapid and permeability is very slow. Little true soil development has taken place and erosion is active. The surface is sloping to steep. Slope gradients range from 5 to greater than 45 percent. Associated landforms include rolling and dissected plains, and valleys.

Plateaus and buttes: The primary landforms in this unit include the nearly flat tops of the plateaus and buttes, and the breaks and escarpments which descend from their to the surrounding lowlands. These landforms have developed by erosion and /or uplift. Associated landforms include rolling and dissected plains, and badlands.

Eroded uplands: The primary landforms include ridges, plateau remnants, hills and drainges. These landforms were formed by erosion by streams.

General Discussion of Geologic Groups:

Twelve geologic material groups were used for the landtype association mapping These groups are briefly summarized below:

Schist and Gneiss: This includes all schists and gneisses in the Region regardless of age or origin. It includes the Archean basement (about 2.8 billion years old) exposed in the Beartooths, the metamorphosed Belt rocks of zone 3 (described in the Belt section which follows) and the rocks which occur in the Western Idaho Suture Zone (WISZ).

Belt: The Belt Supergroup is the bedrock of about 65% of the Northern Region. Because of its complex history these rocks assume a wide variety of lithologies and appearances. Many of these are here described under other categories, such as calc-silicates, WISZ, schists and gneisses depending upon their metamorphic grade. For this document, Belt is defined as that portion of the Belt lithology that is dominated by alternating thin beds of argillite, siltite and quartzite. It includes thick carbonate units at the bottom and in the middle. It also includes large dark colored intrusives shot in along along bedding planes. This occurs most comonly in the lower, older rocks.

The region is divided into three zones based on metamorphic grade.

In the extreme east is zone one from the Little Belts east and northward. This is the least metamorphosed area of the Belt basin with the rocks being only slightly altered and much more like sedimentary rocks.

Zone two makes up the bulk of the region extending to the Idaho line near Missoula to Coeur d'Alene and northward. In this zone the rocks are harder. Slaty cleavage shows but they are still recognizable as sediments.

Zone three extends to near Orofino, Idaho where it merges into the Western Idaho Suture Zone (WISZ) explained below. These rocks are where sediments begin to turn into schist and gneiss and become increasingly hard to recognize as sediments. These are depicted on Figure __. Belt time spans the period of 2.2 billion to about 850 million years ago.

Western Idaho Suture Zone (WISZ): This is a zone of intensely metamorphosed rocks that started as Belt or granitics and are now gneisses and schists. While this was going on the rocks were mechanically abused as well resulting in a weak broken material, subject to deep chemical weathering, shot through with planes of failure and making erosive weathering products, such as grus or fine micaceous sand. The old term for this was Border Zone when it was thought the result of intrusion of the Idaho Batholith. The change to WISZ reflects a newer understanding that this is the collision zone where Washington and Oregon docked when they were added to the Idaho coast in addition to the effects of the batholith.

Quartzite: Refers to the Flathead Formation where it is a quartzite, and the Quadrant Formation. The Flathead lies atop the Belt rocks on a regional scale unconformity. It is early Cambrian in age spanning the time 570 to 550 million years. The Quadrant is Pennsylvanian (about 4000' above the Flathead) spanning 320 to 290 million years. Both formations have blocky outcrops and make for low fertility, excessively drained sites. They both tend to be resistant ridge formers and knickpoints in the landscape.

Sandstone and Shale: Refers to all sedimentary strata above the Cambrian not dominated by carbonates, or large quartzite units. This does not include the unindurated Tertiary Sediments. These are the less resistant clastics that underlie rounded hills or are swales in the landscape. Some of the larger sandstones are ridge formers and moderately resistant. These span from 600 million to 1.7 million years.

Carbonates: Refers to all carbonates, including dolomites, above the Cambrian. The most prominent formations are paleozoic in age including Cambrian Meagher and Pilgrim Formations, and the Devonian aged Three Forks Formation. The largest is the Mississippian Madison Group. These units tend to be resistant ridgeformers. This position in the landscape allows the chemically reactive erosion products to move downslope with gravity, mixing with and adding lime to all the soils below them. Structurally controlled drainages and stable drainageways are features of landscapes in these units. Water chemistry is dominated by carbonate influence. Karst and dramatic water loss from perennial steams is common as are large volume springs. Many thermal springs originate from these formations.

Granitics: Refers to all light colored intrusive rocks of any age. The bulk of these are in the Idaho, Boulder and Kaniksu Batholiths along with related intrusives. Most of these masses date from late Cretaceous to early Tertiary (70 to 55 million). Important properties stem from the fact that they occur as large homogenous masses of equagranular rock made up of minerals with different properties. In moist regimes exposed to soil acids they are very reactive to chemical weathering, while in dry or nonacid regimes are very resistant. This leads to landforms at the ends of the spectrum being made of the same material. Where soil and vegatatively covered, it makes weak, gentle, rounded landforms and is erosive, while where bare is resistant, fresh, and rugged. This also affects the nature of sediments produced. The weathering product grus is equagranular, noncohesive, and very erodible and is primarily in the medium to coarse sand range. Fresh material makes cobbles and boulders that persist and are resistant in running water.

To maintain uniformity between forests in mapping granitic weathering classes, the system developed by Clayton and Arnold (1972) is used and should be consulted for more information. A brief summary of weathering classes defined in this publication is given below. These definitions should be used in describing the granitic materials.

> **Unweathered:** This corresponds to class 1 being fresh unweathered material. It is most common in glacially scoured landscapes where it has been protected from vegetation by slope, altitude, or running water. Cracks are fresh and sharp, it rings when hit with a hammer, and crystals are sharp and fresh including the black mica.
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> **Weakly weathered:** This corresponds to Classes 2 and 3. It represents the first stages of weathering including features like weak iron stains emanating from the black mica, and the feldspars turning from fresh white or transparent to a cloudy white condition. It gives a duller sound when struck with a hammer.
>
> **Moderately weathered:** This corresponds to classes 4 and 5 including material that spalls (crumbles) and gives a dull thud when hammered. This material requires a hammer to break and does not generally go directly to grus.
>
> **Highly weathered:** This corresponds to classes 6 and 7. This covers materials that extend from that which goes directly to grus and can be broken by hand, up to material where feldspars have gone to clay and material that is plastic when wet.

Volcanics: Refers to all extrusive rocks regardless of age or composition. The region is bimodal having a lot of lava with minimal silica in it (basalt), containing little ash, scoria or welded material in far ranging flows, or having a lot of ashy welded rocks with abundant silica with short trashy flows intermixed. This leads to the two class definitions:

Basalt dominated: These are the great flood basalts of the Columbia River Plateau. They typically have the flat upper surface of a fluid lava flow. They are deeply dissected by the main trunk streams forming the characteristic stepped breaks controlled by resistant flows. These units also include paleosols and gravel interbeds that are locally important in controlling stability and groundwater. The resistant beds are nickpoints in many drainages. These rocks are alkaline and the groundwater and surface water reflect this. They are Miocene (17 million to 8 million years) in age.

Intermediate composition (andesite-rhyolite) dominated: These rocks are piles of siliceous volcanic rocks that fell out of the air or slid down the sides and were welded into rock by their remaining heat, mixed with lava flows, mudflows, mass failures, and ash falls. They tend toward rounded gentle landforms until flow or solidly welded material approaches 50% of the pile. These act as resistant units. The ash typically weathers rapidly to clays. These layers greatly affect stability and act as aquatards for perched aquifers and determine seep horizons. Slumps and landslides are common, even pervasive in many landscapes of these rocks.

Calc-Silicates: These are the mid-Belt carbonates (Middle Wallace Formation of the Belt Supergroup) where they have been subjected to metamorphism such that little carbonate remains. In the case of these rocks that were dirty carbonates, the carbonate has reacted with the dirt to become calcium aluminum, or calcium magnesium silicates. There are often zones of schist or gneissic rocks included.

Loose Sediments: This refers to all unindurated material. This is Quaternary to Recent material spanning the last 1.7 million years. This material tends to be bimodal, either predominantly coarse or fine.

Fine grained: (<.25 mm or <60 mesh) This is predominantly sediment deposited in ponded water (lacustrine sediments) or wind deposited ash and loess. The largest expanses are from lakes ponded by ice during the ice ages, or mass failure dams in smaller drainages. This includes fine colluvial material or mass failures in any of this fine grained material.

Coarse grained: (>.25 mm or >60 mesh) This includes coarse material deposited by modern streams, glacial meltwater, glacial till and wind deposited sand. Also included are gravity deposits, such as talus or mass failure in coarse materials. An unusual occurrence is that of coarse delta deposits into Lake Missoula in western Montana.

THE MAP LEGEND

The strategy used in this mapping project was to define the broad landform groups and broad geologic material groups that would be mapped throughout the Region. The differences between these groups as they occur throughout the region were described in the map unit descriptions which were written on a

Section basis.

The 17 landform groups and the 12 geologic materials groups were combined to produce 77 landtype associations for the Northern Region. These were mapped and described for each Section. Where the same LTA occurs in more than one Section and has the same accessory characteristics, one MUD was prepared for multiple Sections. A total of 260 map unit descriptions were prepared for all LTAs in all Sections.

Listed below is the legend which was used for the landtype association mapping. It is organized with the first subdivision on landform and the second on geologic material. The number given is the LTA number. For the convenience of the user the appendix contains a second version of the legend which is arranged by geologic material first and landform second.

Rolling plains

1	shales, siltstones and sandstones

Glaciated rolling plains

2	shales, siltstones and sandstones

Dissected plains

3	shales, siltstones and sandstones

Glaciated dissected plains

4	shales, siltstones and sandstones

Badlands

5	shales, siltstones and sandstones

Eroded uplands

6	volcanic tuffs, shales and sandstones

Plateaus and buttes

7	shales, siltstones and sandstones

Glacial lacustrine plains

8	glacial lake deltaic deposits
9	sandhills and sand dunes

Valleys

10	Recent alluvial deposits, coarse
11	lacustrine deposits
12	outwash and extensive non-glacial alluvial deposits
13	fine glacial sediments on terraces and alluvial fans
14	Recent alluvial deposits, fine
16	old terraces and recent flood plains

Breaks

20	Belts
21	granitics, highly weathered
22	granitics, weakly weathered
23	schists and gneisses
24	volcanics

25	sandstones and shales
26	gneiss, quartzite, hard schist, moderately weathered
27	volcanics, basalt
	limestone
28	Belt (dissected Breaks)
29	quartzites and calc-silicates

Steep mountain slopes

32	granitics, moderately weathered
34	volcanics
36	sandstones and shales
37	carbonates

Steep glaciated lands

35	weak alpine glaciation, calci-silicates and quartzites
39	gneiss, schists and associated metamorphics
40	Belt
41	granitic
42	volcanics
43	carbonates
44	sandstone and shales
45	weak alpine glaciation, granitics
46	alpine troughs and troughwalls, granitics
47	alpine troughs and troughwalls, belts
48	gneiss, quartzite, hard schist, moderately weathered (Western Idaho Suture Zone)

Gently to moderately sloping glaciated lands

50	Belts
51	granitics
52	schists
53	sandstones and shales
54	volcanics
56	carbonates
57	gneiss, quartzite, hard schist, moderately weathered
58	highly weathered Belt till

Mountain slopes and ridges

17	loess
59	gneiss, quartzite, hard schist, moderately weathered (Western Idaho Suture Zone)
60	Belt
61	granitics, highly weathered
62	granitics, weakly weathered
63	schists, gneisses and associated metamorphics
64	volcanics
65	
66	quartzites, calci-silicates and carbonates (west side)
	carbonates, Paleozoics and younger (east side)
67	weathered quartzites
68	sandstones and shales
69	pediment, mixed geology

Mountain ridge tops

70	Belts
71	granitics, highly weathered
72	granitics, weakly weathered
73	volcanics
74	sandstones/shales
75	calc-silicates
77	gneiss, quartzite, hard schist, moderately weathered

Gently to moderately sloping low relief hills

80	Belts
81	granitics, highly weathered
82	volcanics
83	fine to very fine loose sediments
84	schists
85	gneiss, quartzite, hard schist, moderately weathered

Mass wasting and colluvial lands

90	mass wasting, both translational and rotational, (Includes both surficial and deep bedrock mass failures)
91	slumps (includes landslides and landflows)
92	colluvial deposits, mixed geology

Water

99	lakes

THE NATIONAL HIERARCHY OF ECOLOGICAL UNITS

This LTA mapping report refers to several levels of the National Hierarchy of Ecological Units (ECOMAP 1993): Sections, Subsections, Landtype Associations and Landtypes. To help the reader understand these levels the following is an excerpt from the 1993 paper. Readers wanting more information and the references for the paper should consult that document.

The National Hierarchical Framework of Ecological Units is a regionalization, classification and mapping system that provides a systematic method for classifying and mapping areas of the Earth based on associations of ecological factors at different geographic scales.

Ecological types are classified and ecological units are mapped based on associations of those biotic and environmental factors that directly affect or indirectly express energy, moisture, and nutrient gradients which regulate the structure and function of ecosystems. These factors include climate, physiography, water, soils, air, hydrology, and potential natural communities.

Ecological units delimit areas of different biological and physical potentials. Ecological unit maps can be coupled with inventories of existing vegetation, air quality, aquatic systems, wildlife, and human elements to characterize complexes of life and environment, or ecosystems.

Ecological Unit Design

The primary purpose for delineating ecological units is to display land and water areas at different levels of resolution that have similar capabilities and potentials for management. Ecological Units are designed to exhibit similar patterns in: (1) potential natural communities, (2) soils, (3) hydrologic function, (4) landform and topography, (5) lithology, (6) climate, (7) air quality and (8) natural processes for cycling plant biomass and nutrients (e.g. succession, productivity, fire regimes).

Climate, as modified by topography, is the dominant criteria at the upper levels of the hierarchy. Other factors, such as geomorphic process, soils and potential natural communities take on equal or greater importance than climate at lower levels.

An ecological type is a category of land having a unique combination of potential natural community, soil, landscape features, and climate; and differing from other ecological types in its ability to produce vegetation and respond to management. An ecological unit is a mapped landscape unit designed to meet management objectives, comprised of one or more ecological types. Ecological map units are differentiated and designed by multiple components including climate, physiography, landform, soils, water, and potential natural communities.

Underlying principles

Ecosystems exist at many spatial scales, from the global ecosphere down to regions of microbial activity. The level of discernible detail, the number of factors comprising ecosystems, and the number of variables used to characterize these factors progressively increase at finer scales. Hence the data and analysis requirements, and investments for ecosystem classification and mapping also increase for finer scaled activities.

The structure and function of ecosystems are largely regulated along energy, moisture, nutrient, and disturbance gradients. These gradients are affected by climate, physiography, soils, hydrology, flora, and fauna. And while the association of these factors is all important in defining ecosystems, all factors are not equally important at all spatial scales. At coarse scales, the important factors are largely abiotic, while at finer scales both biotic and abiotic factors are important. Ecosystems are conceptualized as occurring in a nested geographic arrangement, with many smaller ecosystems embedded in larger ones.

At global, continental, and regional scales, ecosystem patterns correspond with climatic regions, which change mainly due to latitudinal, orographic, and maritime influences . Within climatic regions, physiography or landforms modify macroclimate, and affect the movement of organisms, the flow and orientation of watersheds, and the frequency and spatial pattern of disturbance by fire and wind. Within climatic-physiographic regions, water, plants, animals, soils, and topography interact to form ecosystems at Land Unit scales.

Classification Framework

The following is an overview of the differentiating criteria used in the development of the ecological units.

Ecoregion Scale At the Ecoregion scale, ecological units are recognized by differences in global, continental, and regional climatic regimes and gross physiography. The basic assumption is that climate governs energy and moisture gradients, thereby acting as the primary control over more localized ecosystems. Three levels of Ecoregions are identified in the hierarchy:

Domains Subcontinental divisions of broad climatic similarity, such as lands that have dry climates, which are affected by latitude and global atmospheric conditions. For example, climate of the Polar Domain is controlled by arctic air masses, which create cold, dry environments where summers are short. In contrast, the climate of the Humid Tropical Domain is influenced by equatorial air masses and there is no winter season. Domains are also characterized by broad differences in annual precipitation, evapotranspiration, potential natural communities, and biologically significant drainage systems. The four Domains are named according to the principal climatic descriptive features: Polar, Dry, Humid Temperate, and Humid Tropical.

Divisions Subdivisions of a Domain determined by isolating areas of definite vegetational affinities (prairie or forest) that fall within the same regional climate. Divisions are delineated according to: (a) the amount of water deficit (which subdivides the Dry Domain into semi-arid, steppe, or arid desert, and (b) the winter temperatures, which have an important influence on biological and physical processes and the duration of any snow cover. This temperature factor is the basis of distinction between temperate and tropical/subtropical dry regions. Divisions are named for the main climatic regions they delineate, such as Temperate Steppe, and Temperate Steppe Mountains.

Provinces Subdivisions of a Division that correspond to broad vegetation regions, which conform to climatic subzones controlled primarily by continental weather patterns such as length of dry season and duration of cold temperatures. Provinces are also characterized by similar soil orders. The climatic subzones are evident as extensive areas of similar potential natural communities. Provinces are named typically using a binomial system consisting of a geographic location and vegetative type such as Great Plains Steppe.

Highland areas that exhibit altitudinal vegetational zonation and that have the climatic regime (seasonality of energy and moisture) of adjacent lowlands are classified as Provinces. The climatic regime of the surrounding lowlands can be used to infer the climate of the highlands. For example, in the Mediterranean Division along the Pacific Coast, the seasonal pattern of precipitation is the same for the lowlands and highlands except that the mountains receive about twice the quantity. These provinces are named for the lower elevation and upper elevation (subnival) belts, e.g. Northern Rocky Mountain Forest-Steppe-Coniferous Forest-Alpine Meadows.

Subregion Scale Subregions are characterized by combinations of climate, geomorphic process, topography, and stratigraphy that influence moisture availability and exposure to radiant solar energy, which in turn directly control hydrologic function, soil-forming processes, and potential plant community distributions. Sections and Subsections are the two ecological units mapped at this scale.

Section Broad areas of similar geomorphic process, stratigraphy, geologic origin, drainage networks, topography, and regional climate. Such areas are often inferred by relating geologic maps to potential natural vegetation "series" groupings. Boundaries of some Sections approximate geomorphic provinces as recognized by geologists. Section names generally describe the predominant physiographic feature upon which the ecological unit delineation is based, such as Idaho Batholith, Yellowstone Highlands and Northern Rockies.

Subsections Smaller areas of Sections with similar surficial geology, lithology, geomorphic process, soil groups, subregional climate, and potential natural communities. Names of Subsections are usually derived from geologic features, such as Upper Yellowstone Valley, Montana Glaciated Plains, and Clearwater Mountains and Breaks.

Landscape Scale At the Landscape scale, ecological units are defined by general topography, geomorphic process, surficial geology, soil and potential natural community patterns and local climate. These factors affect biotic distributions, hydrologic function, natural disturbance regimes and general land use. Local landform patterns become apparent at this level in the hierarchy, and differences among units are usually obvious to on-the-ground observers. At this level, terrestrial features and processes may also have a strong influence on ecological characteristics of aquatic habitats. Landtype Association ecological units represent this scale in the hierarchy.

Landtype Associations Groupings of Landtypes or subdivisions of Subsections based upon similarities in geomorphic process, geologic rock types, soil complexes, stream types, lakes, wetlands, and series, subseries, or plant association vegetation communities. Repeatable patterns of soil complexes and plant communities are useful in delineating map units at this level. Names of Landtype Associations as mapped by the Northern Region are combinations of landforms and geologic materials, such as Steep Glaciated Lands, Granitics.

Land Unit Scale At the basic Land Unit scale, ecological units are designed and mapped in the field based on properties of local topography, rock types, soils, and vegetation. These factors influence the structure and composition of plant communities, hydrologic function, and basic land capability. Landtypes and Landtype Phases are the ecological units mapped at this scale.

Landtypes Subdivisions of Landtype Associations or groupings of Landtype Phases based on similarities in soils, landform, rock type, geomorphic process and plant associations. Land surface form that influences hydrologic function (e.g., drainage density, dissection relief) is often used to delineate different landtypes in mountainous terrain.

ORGANIZATION OF LANDTYPE ASSOCIATION INFORMATION

After the mapping was complete, the question became how to present and analyze it. When the spatial pattern of LTAs was compared to the Section and Subsection Maps of the Northern Region, the strongest relationships of LTAs were with Subsections. Since Subsections and LTAs are closer in the hierarchy it is not surprising that there is a stronger relationship.

The presentation and analysis of landtype associations in this publication will use both Sections and Subsections. There is a need for a small number of large land units to use for general cataloging of the Landtype Association information. The Sections work well for this purpose since there are only 15 for the Northern Region. The data on the abundance and distribution of LTAs within Sections is best understood by summarizing the data by Subsections. Thus, while the LTAs were mapped independently of Sections and Subsections, both these levels will be used to help the reader understand the occurrance and distribution of LTAs within the Northern Region.

Preparing the map unit descriptions on a Section basis meant that when the same LTA occurred in more than one Section, a separate MUD was prepared for each of them. Later during correlation each of them were compared to see which were similar and which were dissimilar. Some LTAs occur in more than one Section, while some Sections will have very different versions of the same landform/geologic material group because of differences in climate and potential vegetation.

Some of the landform/geologic material groups occur across very large areas and have many differences in accessory characteristics (soils, climate, potential vegetation). It was very difficult to develop a single concise definition of each LTA because of all the variability and exceptions that had to be considered. Thus the strategy was to use a general definition for each LTA (landform groups and geologic material groups described earlier in the document) and then to talk about the differences on a Section by Section basis in those map unit descriptions.

Table XX shows the distribution of LTAs by Section throughout the Region.

The map unit descriptions for the landtype associations are presented in the following chapters. Preceeding the map unit descriptions for each Section is a map showing the location of that Section within the Region, a photograph showing typical landscapes, tables showing the distribution of LTAs by Subsection, a short discussion.

SECTION 331A PALOUSE PRAIRIE

This Section occurs in west central Idaho and includes portions of the Columbia River Basalts and Idaho Canyonlands Major Geomorphic Settings.

MAP SHOWING LOCATION OF SECTION 331A WITHIN THE NORTHERN REGION

PHOTOGRAPH OF TYPICAL LANDSCAPE

TABLE SHOWING DISTRIBUTION OF LTAS BY SUBSECTION

DISCUSSION OF PATTERN AND ABUNDANCE OF LTAS

331A LTA64 STEEP MOUNTAIN SLOPES AND RIDGES, VOLCANICS

Location: This unit is located along streams and rivers, and adjacent to basalt plateaus in west central Idaho in the Clearwater River Basin.

Map Unit Setting and General Characteristics

Differentiating characteristics: This map unit is colluvial mountain slopes and is usually is adjacent to steam breaklands or plateaus. Parent materials are poorly to moderately weathered Columbia River basalt.

Accessory Characteristics: The primary soils are moderately deep to deep loams and cobbly loams. The vegetation is a mosaic of grassland and coniferous forest. Mean annual precipitation ranges from 12 to 35 inches (30 to 89 cms). The elevation range is 700 to 5800 feet (275 to 1700 meters). The dominant slopes have gradients of 35 to 50 percent.

This unit is moderately dissected by streams, with the dominant stream pattern being parallel.

Landscape Components: This map unit consists of one component: mountain slopes.

Mountain slopes are formed in thin or mixed influenced loess, residuum and colluvium of basalt lithology. Slope gradients range from 35 to 50 percent. Soils on these landforms are moderately deep to deep, moderately developed cobbly loams and loams with very cobbly loamy or clayey substrata. These soils are classified as Ultic Argixerolls with Andeptic Cryoboralfs at higher elevations. Rock outcrop is less than 25 percent of the unit. The dominant potential natural vegetation at low elevations is bluebunch wheatgrass series, and at mid-elevations Douglas-fir and grand fir series.

Compiled by: Pat Green, Nez Perce NF

APPENDICES

ATTRIBUTE TABLES

Attributes
acres of ltas
number of polygons
others

GEOLOGIC MATERIAL/LANDFORM LEGEND

Earlier in this document the legend that was used for the mapping is given. It is displayed with landforms as the first separation, with geologic material being second. For the convenience of the user a second version is provided here that is arranged by geologic material first and landform second. This is the way the legend is listed on the 100k maps.

Water deposited sediments
- 8 glacial lake deltaic deposits
- 10 Recent alluvial deposits, coarse
- 11 lacustrine deposits
- 12 outwash and extensive non-glacial alluvial deposits
- 13 fine glacial sediments on terraces and alluvial fans
- 14 Recent alluvial deposits, fine

wind deposited sediments
- 9 sandhills and sand dunes
- 17 loess

Belt
- 20 breaks
- 28 dissected breaks
- 40 steep glaciated slopes
- 47 alpine troughs and trough walls
- 50 gently to moderately sloping glaciated lands
- 60 mountain slopes and ridges
- 70 mountain ridge tops
- 80 gently to moderately sloping low relief hills

carbonates
- 27 breaks
- 37 steep mountain slopes
- 43 steep glaciated lands

granitics
- 21 highly weathered breaks
- 22 weakly weathered breaks
- 41 steep glaciated lands
- 45 weak alpine glaciation
- 46 alpine troughs and trough walls
- 51 gently to moderately sloping glaciated land
- 61 mountain slopes and ridges, highly weathered
- 62 mountain slopes and ridges, weakly weathered
- 71 mountain ridge tops, highly weathered
- 72 mountain ridge tops, weakly weathered
- 81 gently to moderately sloping low relief hills

volcanics
- 24 breaks
- 34 steep mountain slopes
- 42 steep glaciated lands
- 54 gently to moderately sloping glaciated land

64 mountain slopes and ridges
73 mountain ridge tops
82 gently to moderately sloping low relief hills

sandstones and shales
25 breaks
36 steep mountain slopes
44 steep glaciated land
53 gently to moderately sloping glaciated lands
65 mountain slopes and ridges
68 mountain slopes and ridges
74 mountain ridgetops, sandstones and shales
83 Tertiary sediments

shales, siltstones and sandstones
1 rolling plains
2 glaciated rolling plains
3 dissected plains
4 glaciated dissected plains
5 badlands
6 eroded uplands
7 plateaus and buttes

quartzites and calc-silicates
29 breaks
35 weak alpine glaciation
66 mountain slopes and ridges
67 mountain slopes and ridges, weathered quartzites)
75 mountain ridge tops

gneisses and schists
23 breaks, schist/gneisses
26 breaks
48 steep glaciated land
52 gently to moderately sloping glaciated land, schists
57 gently to moderately sloping glaciated land
59 mountain slopes and ridges
63 mountain slopes and ridges, schists and gneisses
77 mountain ridge tops
84 gently to moderately sloping low relief hills, schists
85 gently to moderately sloping low relief hills

Miscellaneous
69 pediment, mixed geology
90 mass wasting
91 slumps
92 colluvium
99 lakes

LIST OF COMMON AND SCIENTIFIC NAMES FOR VEGETATIVE SERIES USED IN THIS REPORT

bluebunch wheatgrass	Agropyron spicatum
big sagebrush	Artemesia tridentata
curlleaf mountain mahogany	Cercocarpus ledifolius
Douglas-fir	Pseudotsuga mensiesii
Engelmann spruce	Picea engelmannii
geyer willow	Salix geyeriana
grand fir	Abies grandis
Holm's Rocky Mountain Sedge	Carex scopulorum
Idaho fescue	Fextuca idahoensis
limber pine	Pinus flexilis
low sagebrush	Artemesia arbuscula
mountain big sage	
mountain hemlock	Tsuga mertensiana
Parry's rush	Junus parryi
ponderosa pine	Pinus ponderosa
rough fescue	Festuca scabrella
subalpine fir	Abies lasiocarpa
tufted hairgrass	Deschampsia caespitosa
water sedge	Carex aquatilis
western hemlock	Tsuga heterophylla
western redcedar	Thuja plicata
whitebark pine	Pinus albicaulis

Carex scirpoidea
Carex utriculata
Carex elynoides

Carex rupestris

GLOSSARY

The definitions listed below are taken from te following sources: 1) the Glossary of Landforms in the USDA Natuaral Resource Conservation Service National Soils Handbook, 2) the American Geological Institute's Dictionary of Geological Terms, and 3) the American Fisheries Society's Glossary of Stream habitat terms. Consult the reference section for complete citations.

alluvial: Pertaining to material or processes associated with transportation and/or subaerial deposition by concentrated running water.

alluvium: Unconsolidated clastic material deposited by running water, including gravel, sand, silt, clay and various mixtures of these.

badlands: A landscape which is intricately dissected and characterized by a very fine drainage network with high drainage densities and short, steep slopes with narrow interfluves. Badlands develop on surfaces with little or no vegetative cover, overlying unconsolidated or poorly cemented materials (clays, silts, or in some cases sandstones) sometimes with soluble minerals sucha s gypsum or halite.

cirque: Semicircular, concave, bowl-like area with steep face primarily resulting from erosive activity of a mountain glaciers.

colluvial: Pertaining to material or processes associated with transportation and/or deposition by mass movement (direct gravitational action) and local, unconcentrated runoff on sideslopes and/or at the base of slopes.

colluvium: Unconsolidated, unsorted earth material being transported or deposited on sideslopes and/or at the base of slopes by mass movement (e.g. direct gravitational action) and by local, unconcentrated runoff.

crystalline: Of, or pertaining to the nature of a crystal, having regular molecular structure. Contrasted with amorphous (without form)

ephemeral stream: A stream, or reach of a stream, that flows only in direct response to precipitation. It receives no protracted supply from melting snow or other source, and its channel is, at all times, above the water table.

fluvial: Of or pertaining to rivers; produced by river action.

frost churning (cryoturbation): A collective term used to describe all soil movemnts due to frost action, characterized by folded, broken and dislocated beds and lenses of unconsolidated deposits.

glaciofluvial deposits: Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and may occur in the form of outwash plains, valley trains, deltas, kames, eskers, and kame terraces.

Glaciolacustrine deposits: Material ranging from fine clay to sand derived from glaciers and deposited in glacial lakes by water originating mainly from the melting of glacial ice. Many are bedded or laminated with varves or rhythmites.

jokulhlaup: An Icelandic term for a glacial outburst flood, especially when an ice dam impounding a glacial lake greaks. Such breaks drainaged glacial Lake Missoula and created the Channeled Scablands in the Pacific Northwest.

loess: Fine-grained, wind-deposited material, dominantly of silt size.

outwash: Stratified detritus (chiefly sand and gravel) removed or "washed out" from a glacier by melt-water streams and deposited in front of or beyond the end moraine or the margin of an actve glacier. The coarser material is deposited nearer to the ice.

pediment: A gently sloping erosional surface developed at the foot of a receding hill or mountain slope. The surface may be essentially bare, exposing earth material that extends beneath adacent uplands; or it may be thinly mantled with alluvium and colluvium, ultimately in transit from upland front to basin or valley lowland.

residuum: Unconsolidated, weathered, or partly weathered mineral material that accumulates by disintegration of bedrock in place.

riparian: Pertaining to anything connected with or immediately adjacent to the banks of a stream or other body.

series: A group of habitat types having the same potential climax tree (shrub or grass) species.

till: Dominantly unsorted and unstratified drift, deposited by a glacier, and consisting of a heterogeneous mixture of clay, silt, sand, gravel, stones, and boulders.

weathering: All physical disintegration, chemical decomposition, and biologically induced changes in rocks or other deposits at or near the earth's surface by atmospheric or biologic agents or circulating surface waters with essentially no transport of the altered material. These changes result in disintegration and decomposition of the material.

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