# Surficial Map Criteria: Linkage of Landform, Material, Process and Time

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## SURFICIAL MAP CRITERIA
### Methodology

The mapping protocol is based on similar schemes employed by the Maine Geological Survey (1986) and Kite (1994). These guidelines are designed to address the fluvial, colluvial, and karst features of the unglaciated Appalachians. The purpose of this map protocol is to: (1) provide an expanded, yet flexible, surficial map format for use in 7.5-minute quadrangle mapping, (2) provide a uniform approach to surficial mapping techniques in a field program that includes workers from various backgrounds, (3) provide a map-based data collection format that lends itself to geographic information systems, and (4) provide an approach to surficial mapping that is meaningful to planners, educators, consultants, and other user groups.

Three types of surficial map criteria are recognized for the central Appalachians (Taylor and others, 1996). These include: Type I - polygonal map units associated with landforms and surficial deposits; Type II - discrete surface features not associated with surficial deposits; and Type III - observational features associated with data collection and field mapping (Table 5-2). Type I units include landforms and deposits that result from *in-situ* weathering, mass wasting, fluvial processes, catastrophic slope failure, and periglacial activity. Type II units include surface features associated with karst processes, slope failure, surface hydrology, and anthropogenic activity. Type III features include reference points, test pits, and soil borings used for data collection. Type I mapping criteria employ a four-fold scheme in which units are delineated on the basis of age, origin, landform, and material. Unit polygons are coded with labels, patterns, or color to signify the four-fold designation. “Age” refers to the age of the material; “origin” refers to the primary surficial process responsible for deposition of the unit; “landform” refers to the topographic occurrence of the unit; and “material” refers to the texture of unconsolidated deposits or lithology of exposed bedrock. Type II and III criteria are mapped as two-dimensional surface features without reference to material or age.

The systematic nature of the map protocol is amenable to a checklist approach in recording field data (Table 5-2). The map feature is first identified as a Type I, II, or III element. A checklist format facilitates objective classification by the field worker. If a three-dimensional surfical deposit is encountered, then the Type I criteria are systematically examined, and the map feature is assigned age, origin, landform, and material identifiers. Additional map data include heights of surfaces above active channel, associated vegetation, and relative-age observations.

The optimum scale for surficial map preparation is largely determined by the intended use of the final product (Kite and others, 1998). Surficial geology maps can only be made for large areas in reasonable amounts of time if unit contacts can be derived from topographic and air photo interpretation, based on ground truth (Jacobson, unpublished report). A scale of 1:24,000 works well for large fluvial landforms, but is inadequate for portraying most landforms produced by small streams or colluvial processes. A 1:10,000 scale is optimal for mesoscale landforms such as point bars, floodplains, terraces, debris fans, and boulder streams (Kite and others, 1998). Larger map scales are prerequisites for detailed reconstruction of processes at flood and debris-flow impacted sites (Wells and Harvey, 1987; Ohmori and Shimazu, 1994; Cenderelli and Kite, 1998). The 1:24,000 scale is the preferred mode for many mapping projects at the state and federal level; however, much process-oriented detail is lost due to generalization of map units. A 1:9,600 scale has proven quite effective for the delineation of process-landform associations in small (<60 $km^2$) mountain watersheds associated with this study (Taylor, Chapters 2, 3, 4; this volume).

## LANDFORM

Large-scale, bedrock-dominated landforms characterize the erosional landscape of the central Appalachians. Hack (1960, 1975) emphasized the importance of dynamic equilibrium in this region, where fluvial-dominated surface processes are in delicate equilibrium with bedrock structure and resistance to erosion. Bedrock-dominated landforms are generally evident from topographic maps, but the geometry of the overlying surficial deposit is not (Kite, 1994). The landform component presented in Table 5-2 addresses both the landscape feature (e.g. ridge) and overlying deposit geometry (e.g. residual veneer, <2 meters thick).

Large-scale landform units are classified into hillslope and valley-bottom features. Hillslopes are characterized by gradients contoured to valley-bottoms, servicing drainage and transport of surficial materials. These larger-scale landform units are comprised of smaller, mesoscale features delineated at the outcrop level and from contour patterns.

### Hillslope Regime

Hack and Goodlett (1960) provided a framework for classification of hillslope elements in the central Appalachians. Many researchers outside the region recognize the importance of this seminal work (Marcus, 1980; Pierson, 1980; Dietrich and Dorn, 1984; Dietrich and others, 1986; Reneau and others, 1989; Montgomery and Dietrich, 1989). Following the approach of Hack and Goodlett (1960), hillslope landforms are subdivided into ridges, side slopes, hollows, and noses (Table 5-2, Figure 5-1, Figure 5-2). Ridges are upper-elevation areas in which contours are closed, acting as the primary divides between drainage basins. Side slopes represent open hillslope areas with approximately straight contour patterns. Hollows are defined as upland stream heads in which contours are concave outward in a down-slope direction. Tsukamoto (1973) coined the term "zero-order basin" to signify convergent slopes located above perennial first-order streams. For expediency in topographic-based mapping, hollows as defined here include the zero-order portion of the hillslope, as well as part of the first-order tributary with open-channel flow (after Mills, 1981). Hollows serve as the primary conduits for routing runoff and colluvium to higher order tributaries, and can occupy greater than 50% of total watershed area (Marcus, 1980). Noses represent divides between hollows in which contours are convex outward in a down-slope direction. Hack and Goodlett (1960) originally defined footslopes as transitional areas between side slopes and valley-bottom channels. For purposes of organization, the footslope environment is included within the discussion of valley-bottom landforms.

#### *Deposit Geometry*

Regolith geometry is an important consideration with respect to the style and magnitude of processes that operate. Dietrich and Dunne (1978) noted the importance of colluvial thickness and root penetration depth in controlling hillslope stability.  As such, there is a strong tendency for regolith to thin on noses and thicken in convergent hollows (Reneau and Dietrich, 1987). Jacobson (unpublished report) suggested that these landform-thickness relationships are prevalent in the central Appalachians and topographic form is a guiding factor in determining depth to bedrock.

The map protocol outlined in Table 5-2 includes criteria for recognizing the thickness of regolith on larger-scale, hillslope landforms.  The terms "veneer" and "blanket" are applied to regolith thicknesses less than 2 meters and greater than 2 meters, respectively.  Landforms with no regolith cover are mapped as "bedrock".  Thus, hillslope landforms and deposit geometry provide a three-dimensional characterization of the surficial environment.  Using the landform-thickness relationships discussed above, Type I hillslope elements may include "nose veneer", "side-slope veneer", "hollow blanket", or "nose bedrock".

### **Valley Bottom Regime**

Valley bottoms represent lower elevation areas adjacent to stream channels.  This zone is further subdivided into channels, floodplains, terraces, fans, and aprons (Figure 5-2; Figure 5-3). The channel is the zone occupied by open streamflow and includes the channel bed, depositional bar, and active-channel bank (Osterkamp and Hupp, 1984).  Channel alluvium is subject to active reworking by streamflow for significant periods of the year, with negligible vegetative growth.

The floodplain is a low-lying surface adjacent to the channel that is inundated once every one to three years (Osterkamp and Hupp, 1984; Wolman and Leopold, 1957).  In the central Appalachians, floodplain heights range from less than 1 meter (Taylor and Kite, 1999) to greater than 10 meters (Schultz and others, 1990) above channel grade, depending on size of the watershed.

Terraces are defined as elevated alluvial surfaces that are inundated by flood waters at a frequency less than that of the floodplain.  The higher the terrace elevation above the channel, the less likely the occurrence of inundation, with the highest surfaces abandoned completely. Elongate terrace treads are commonly disconnected and unpaired, characterized by areas of anomalously flat topography.  Low-level terraces are common in small Appalachian watersheds ($<60$ $km^2$) and range in heights from 2 to 8 meters above channel grade (Taylor and Kite, 1998). Strath terraces on larger drainage systems range up to 100 meters above mean river level (Mills, 1986; Jacobson and others, 1988; Schultz and others, 1990; Erikson and Harbor, 1998).  The terrace map designations in Table 5-2 are labeled with a modifier to signify surface height above the active channel (e.g. T1 = 2 to 4 m, T2 = 6 to 8 m, *etc.*).  The height identification method precludes the need for obtaining chronologies prior to mapping terrace surfaces; however, flexibility in the protocol permits precise age assignment if data are available.

Although not as dramatic as in the southwestern United States, fan deposits are a common occurrence in the central Appalachians (see Kochel, 1990 for a review).  In smaller-scale watersheds, poorly-sorted debris fans occur at the junctions of lower and higher order tributaries (Taylor, 1998).  Similar types of deposits are described as "debris cones" elsewhere in the literature (Wells and Harvey, 1987; Kellerhals and Church, 1990).  Larger-scale, more complexly organized fans are found in piedmont areas of the Blue Ridge, where lateral erosion provides greater accommodation space for fan growth and preservation (Kochel, 1990; Whittecar and Duffy, 1992; Mills and Allison, 1995b).  Fans may become laterally and vertically incised to form abandoned fan terraces, with surfaces elevated well above the active channel floor (Mills, 1983; Whittecar and Duffy, 1992). Fan terrace surfaces range in height from 3 to 15 meters AMRL in small watersheds (Taylor, 1998), and greater than 20 meters in larger-scale fan environments (Mills and Allison, 1995a). Similar to terrace levels described above, fan surfaces are mapped according to height above channel grade (e.g. F = at grade, F1 = 2 to 4 m, F2 = 4 to 6 m, *etc*.; Figure 5-3). Large fans coalesce to form bajadas on the western slopes of the Blue Ridge (Whittecar and Duffy, 1992).

Colluvial aprons lie at the base of the hillslope and represent a zone transitional to the valley-bottom regime ("footslope" deposits of Hack and Goodlett, 1960). Aprons typically display a gentler gradient than the adjacent side slopes, and are commonly underlain by mass-wasting deposits. Lateral erosion of aprons by valley-bottom channels results in development of a steep scarp, with the apron surface appearing as an irregular, unpaired terrace.

### **Miscellaneous Landforms**

Several Appalachian landforms represent mappable variations of the primary hillslope and valley-bottom features described above (Table 5-2). Miscellaneous hillslope features include boulder streams (Potter and Moss, 1968), boulder fields (Clark and Torbett, 1987), talus slopes (Whittecar and Ryter, 1992), patterned ground (Clark, 1968; Clark and Ciolkosz, 1988); rock-block slides (Schultz and Southworth, 1989), debris-slide scars (Clark, 1984; Mills and others, 1987), and debris-flow tracks (Clark, 1984; Mills and others, 1987). Miscellaneous valley-bottom landforms include lobes (Cenderelli and Kite, 1998), levees (Hack and Goodlett, 1960), oxbows, hummocky topography, and deltas. Type II karst features include cave openings, sinks, solution pinnacles, blind valleys, swallows, and karst springs (Davies, 1958; Schultz and others, 1990; Kite and others, 1995). Anthropogenically disturbed lands are mapped as "excavated", "fill", or "disturbed ground".

## MATERIALS AND ORIGIN (PROCESS)

Table 5-2 summarizes the materials and origin criteria. Material refers primarily to the texture of surficial deposits overlying bedrock. Kite (1994) recommended use of the USDA textural classification for grain sizes less than 2 mm, since soil surveys are a common starting point for most surficial geologists. The Wentworth scale is recommended for clasts larger than 2 mm as the USDA designations lack geomorphically significant detail. Bedrock exposure is an important component of the geomorphic system and is included as a materials unit. The origin criteria refer to the dominant processes resulting in the surficial deposit. Process interpretations are based largely on facies and landform analysis, and by comparison with deposits of a known origin. The process identifiers are not applied to bedrock map polygons.

Similar to landforms, surficial material is also divided into hillslope and valley-bottom facies. Hillslope deposits include colluvium and residuum, while valley-bottom deposits include channel alluvium, floodplain alluvium, terrace sediments, fan deposits, and apron deposits.

### **Hillslope Deposits**

Colluvium and residuum are the most widespread surficial deposits in the central

Appalachians (Mills and Delcourt, 1991). Both facies are comprised primarily of gravel diamicton in which framework clasts are set in a matrix of loamy sand, silt, and clay. Parent lithology is the primary influence on clast composition and texture. The term "regolith" encompasses all weathered and transported sediment at the earth's surface. "Colluvium" is applied to regolith that has been transported and deposited by diffusive mass-wasting processes (Mills and Delcourt, 1991). These processes are gravity driven and include slope wash, creep, frost heave, tree throw, and bioturbation. Under conditions of significant down-slope transport, the clast composition of colluvial sediments may differ significantly from that of the underlying bedrock (Mills, 1981). "Residuum" by definition contains the *in-situ* products of bedrock weathering. Clast composition represents parent bedrock lithology, with little or no transport (Mills, 1988). Hillslope colluvium and residuum most commonly form depositional veneers on bedrock, with thicknesses less than two meters. Residual veneers develop on ridge crests and noses with gentle slope gradients. Colluvial veneers occur on steeper side slopes.

Based on landform-deposit relationships, hillslope colluvium is subdivided into side-slope / nose facies (Qc1) and hollow facies (Qc2; Table 5-2). Many researchers have recognized the importance of hollows with respect to hillslope sediment routing and hydrologic processes (Hack and Goodlett, 1960; Williams and Guy, 1973; Dietrich and Dunne, 1978; Anderson and Burt, 1978; Pierson, 1980; Dietrich and Dorn, 1984; Marron, 1985; Hayes, 1985; Reneau and Dietrich, 1987; Tsukamoto and Minematsu, 1987; Crozier and others, 1990; Dietrich and others, 1995). Local topographic curvature determines whether material transport follows flow paths that are divergent (noses), convergent (hollows), or parallel (side slopes) (Hack and Goodlett, 1960; Reneau and others, 1989). Reneau and others (1984) concluded that thick deposits of hollow colluvium are important sources of debris flow and constitute a mappable geologic hazard. Hollow colluvium accumulates by diffusive mass-wasting processes. Debris slides are initiated during high-intensity precipitation events, in which positive pore pressures develop and critical shear strength is exceeded (Anderson and Burt, 1978; Pierson, 1980). The lower the bedrock permeability compared to that of hollow colluvium, the less stable the hillslope (Dietrich and others, 1995). Debris slides rapidly transform into debris flows as they mobilize into higher-order tributaries (Costa, 1984). Dietrich and Dunne (1978) noted the importance of regolith thickness with respect to slope failure, as thicker colluvium reduces the probability of root penetration to bedrock, lowering net effective shear strength. Therefore, the recurrence interval for episodic debris flow depends on the rate of colluviation, and the return time for triggering rainfall events (Costa and Jarrett, 1981). The rate of colluvial transport in turn, is directly proportional to the slope gradient (Dietrich and others, 1995). These hollow models are partially validated by flood-damage assessments in the central Appalachians. Williams and Guy (1971) noted that during the 1969 Nelson County debris flow event in Virginia, 85% of debris slides originated in preexisting hillslope depressions. Hack and Goodlett (1960) made a similar observation for 1949 slope failures in the Little River basin of Augusta County, Virginia. Thus, hillslope hollows represent a geomorphically significant element of the Appalachian landscape and special consideration is warranted in surficial mapping schemes.

Boulder streams and boulder fields are a common occurrence in the central Appalachians, and represent a mappable subset of colluvium. Boulder streams are elongate in the down-slope direction and tend to armor low-order tributaries. They are recognized by a prominent bouldery surface cover, with negligible amounts of finer-grained, interstitial sediment (Mills and Delcourt, 1991). Boulder fields are similar in character, but occur along straight side slopes and display an equant or irregular shape. Boulder streams and fields likely form by a combination of sliding, creep, and slopewash winnowing. It is plausible that better developed boulder streams are the products of periglacial processes during Pleistocene glacial climates (Clark and Torbett, 1987; Mills, 1988; Mills and Delcourt, 1991; Whittecar and Ryter, 1992). Supporting evidence is provided by numerous occurrences of patterned ground throughout the central Appalachians, documenting the widespread nature of periglacial conditions south of the glacial limit (Clark and Ciolkosz, 1988). The minimum elevation of patterned ground increases with decreasing latitude, from 600 meters along the glacial border to 1500 meters in more southerly latitudes (~35$^{o}$ N; Mills and Delcourt, 1991). Geo-botanical analysis of modern forest cover in Virginia suggests that some boulder fields are active under present-day climate conditions (Hupp, 1983).

### Valley-Bottom Deposits

Valley-bottom facies are comprised primarily of coarse gravel with various admixtures of loam, sand, and silt. These deposits are associated with channels, floodplains, terraces, fans, and aprons. Cobble- to boulder-dominated channels are common in steep mountain watersheds. Channel alluvium is typically clast supported, moderately sorted, and imbricated due to deposition by turbulent streamflow.

Floodplains and terraces are similarly comprised of coarse gravel deposits with loamy interbeds. Fabrics range from matrix- to clast-supported. Evidence for frequent floodplain inundation includes scour-and-chute topography, disturbed vegetation, and fresh slackwater deposits. Higher terrace surfaces display stabilized vegetation and are elevated well above flood-discharge level. Distinguishing between low terrace and floodplain is problematic because both surfaces are irregular. (Leopold and others, 1964). Osterkamp and Hupp (1984 ) argued that vegetative patterns are the most reliable criteria for distinguishing between the two. Floodplains and terraces are the products of fluvial incision, lateral channel migration, and overbank aggradation (Leopold and others, 1964; Nanson, 1986).

Fan deposits in sandstone landscapes of the central Appalachians are cobble- to boulder-rich, massive to crudely stratified, with either matrix- or clast-supported fabrics. Matrix fractions are in the silty to sandy loam class. Debris-fan deposits occur at tributary junctions as a result of flow expansion and decreased stream power (Taylor, Chapter 6, this volume). More sand-dominated, braided-fluvial fans are located on the western flanks of the Virginia Blue Ridge (Kochel and Johnson, 1984). Debris fan exposures reveal a complex internal stratigraphy with inset facies relationships (Kite, 1987; Tharp, unpublished data; Figure 5-4). Most of the higher fan terraces are dissected and covered with a colluvial veneer. Fans in the central Appalachians are the products of a combination of debris flow, hyperconcentrated flow, and normal streamflow (Mills, 1982; Kochel, 1990). The debris flows derived from sandstone regolith are noncohesive, resulting in poorly-sorted diamictons with crude internal stratification. Clast-supported and imbricated gravels result from fully turbulent streamflow (after Smith, 1986). Footslope aprons are similar in texture and occurrence, but they lack a well-defined point source. Aprons are the result of mass-wasting processes, such as slide, creep, and slope wash.

## AGE

Dating of surficial deposits in the Appalachians is problematic, and persists as an elusive facet of geomorphic study. Geo-botanical evidence provides an important dating tool for historic deposits (Osterkamp and others, 1995); however, the ages of older landforms are poorly constrained. Radiocarbon techniques are of limited value due to poor preservation of organic matter and many older deposits are beyond the range of application (Mills, 1986; Mills and Delcourt, 1991). Thermoluminescence (Shafer, 1988), magnetostratigraphic (Jacobson and others, 1988; Springer and others, 1997), and cosmogenic isotope (Pavich and others, 1985; Granger and others, 1997; Ries and others, 1998) techniques provide results holding some promise; however, they have not yet been widely applied in the Appalachians. In addition, costly absolute dating techniques add greatly to mapping budgets, which are chronically underfunded and typically limited to field expenses. Relative-age dating techniques were utilized in several studies (Mills, 1988; Whittecar and Duffy, 1992; Mills and Allison, 1995b), although the discontinuous nature of surficial deposits makes stratigraphic correlation difficult. Pollen stratigraphy is applicable in upland bogs and on the Coastal Plain (Delcourt and Delcourt, 1986), but application in colluvial environments has not been tested. Mills (1988) concluded that a continuum of relative ages exists for many deposits with no discrete mappable groups. Hence, a traditional stratigraphy-based mapping scheme is largely not applicable due to poor resolution of surficial chronologies (Kite, 1994).

Table 5-2 provides criteria for assigning ages to surficial map units. Grouping deposits by age is often arbitrary and speculative at best. Historic channel and debris-flow deposits are mapped with certainty as "Late Holocene"; however, many older deposits are typically assigned an age of "Quaternary-undifferentiated". Despite the problematic uncertainties of surficial chronologies in the central Appalachians, the map protocol is flexible and offers precise age identification when data permit. Since the mapping scheme incorporates the four-fold criteria system described above, the need for formal stratigraphic nomenclature is largely unnecessary.

# Table 5-2. Surficial Map Criteria for the Central Appalachians (after Kite, 1994).

**A. Type I Criteria: Age, Origin, Landform, Material.**

**1. Age of Surficial Material**

H = Holocene (< 10,000 years old)
W = Wisconsin (ca. 89 to 10 ka)
I = Illinoian
P = Pleistocene Undifferentiated
EP = Early Pleistocene
MPl= Middle Pleistocene
LP = Late Pleistocene
Q = Quaternary Undifferentiated
CZ = Cenozoic Undifferentiated

**2. Origin / Surficial Process**

A. Hillslope
- r = residuum (in situ regolith)
- c = colluvium (mass wasting)
- ds = debris slide
- rf = rock fall or topple

B. Valley Bottom
- a = stream alluvium (normal flow)
- hcf = hyperconcentrated flow
- df = debris flow
- sw = slackwater deposition

C. Lacustrine
- l = lacustrine deposit, undiff.
- lb = lake-bottom deposit
- ld = lacustrine deltaic

D. Other
- g = glaciofluvial, undifferentiated
- go = glacial outwash
- e = eolian
- co = collapse (solution)
- cr = cryoturbation
- x = anthropogenic disturbance
- f = artificial fill
- rk = bedrock (process n/a)

**3. Landform Units**

A. Hillslope
- n = nose
- sl = side slope
- h = hollow
- veneer = < 2m of regolith
- blanket = > 2 m of regolith
- bf = boulder field
- bs = boulder stream
- pg = patterned ground
- tls = talus deposits

**3. Landform Units (Cont.)**

B. Valley Bottom
- ch = channel
- fp = floodplain (RI </= 2-3 yr)
- t = terrace (t1, t2 …tn; height AMRL)
- f = fan
- f-t = fan terrace (f1, f2 …fn; height AMRL)
- a = apron (footslope deposit)
- lo = lobe
- lv = levee
- ox = oxbow, abandoned channel

C. Other
- ft = flow track (debris flows)
- hm = hummocky topography
- rb = rock-block slide deposits
- x = excavated, fill, disturbed ground
- d = delta
- du = dune

**4. Material (Composition and Texture)**

- b = boulders (>256 mm; clast supported)
- c = cobbles (64-256 mm; clast supported)
- p = pebbles (4-64 mm; clast supported)
- g = gravel (>2 mm; clast supported)
- sg = mixed sand and gravel
- s = sand (0.05-2.0 mm)
- st = silt (0.002-0.05 mm)
- cy = clay (<0.002 mm)
- l = loam (mix of sand, silt, clay)
- d = diamicton undifferentiated
- bbd = very bouldery diamicton
- bd = bouldery diamicton
- cd = cobbly diamicton
- pd = pebbly diamicton
- ds = sandy matrix diamicton
- dt = silty matrix diamicton
- dy = clayey-matrix diamicton
- rk = bedrock (modify with lithology)
- rs = rotten stone, saprolite
- tr = travertine
- tu = tufa
- ma = marl
- og = organic-rich sediment
- w = water
- u = unkown

**B. Type II Criteria: 2-D Surface Features**

1. Karst
- bv = blind valley
- ca = cave (human entry)
- Active cave passage
- Abandoned cave passage
- dv = dry valley
- kw = karst window
- sk = sinkhole (doline)
- skst = sinking stream
- ks = karst spring

2. Hillslope
- hs = headscar
- ds = debris-slide scar
- ls = landslide scar undifferentiated
- rs = rotational slide (slump) scar
- ts = translational slide scar
- rb = rock-block slide scar
- tc = terracettes

3. Other
- wf = water fall
- w = water, lake, reservoir
- Spring
- wt = wetland, undifferentiated
- wh = wetland, heath
- wm = wetland, marsh
- ws = swamp
- quarry (with highwall)
- gravel pit
- deep mine opening
- strip mine (with highwall)
- mine subsidence zone
- rc = rock city
- Scarp
- Meander scroll on floodplain
- Lacustrine strandline

**C. Type III Criteria: - Data Reference Points**

- Sandwhich symbols showing stratigraphy
- Depth to bedrock (drilling or seismic data)
- Minimum depth to bedrock (log data)
- Test hole / boring
- Well
- RE = refusal (in test boring)
- Hand-auger hole, shovel hole,
- Fossil locality
- Paleocurrent direction
- Observation Point

## Hillslope Units after Hack and Goodlett (1960)

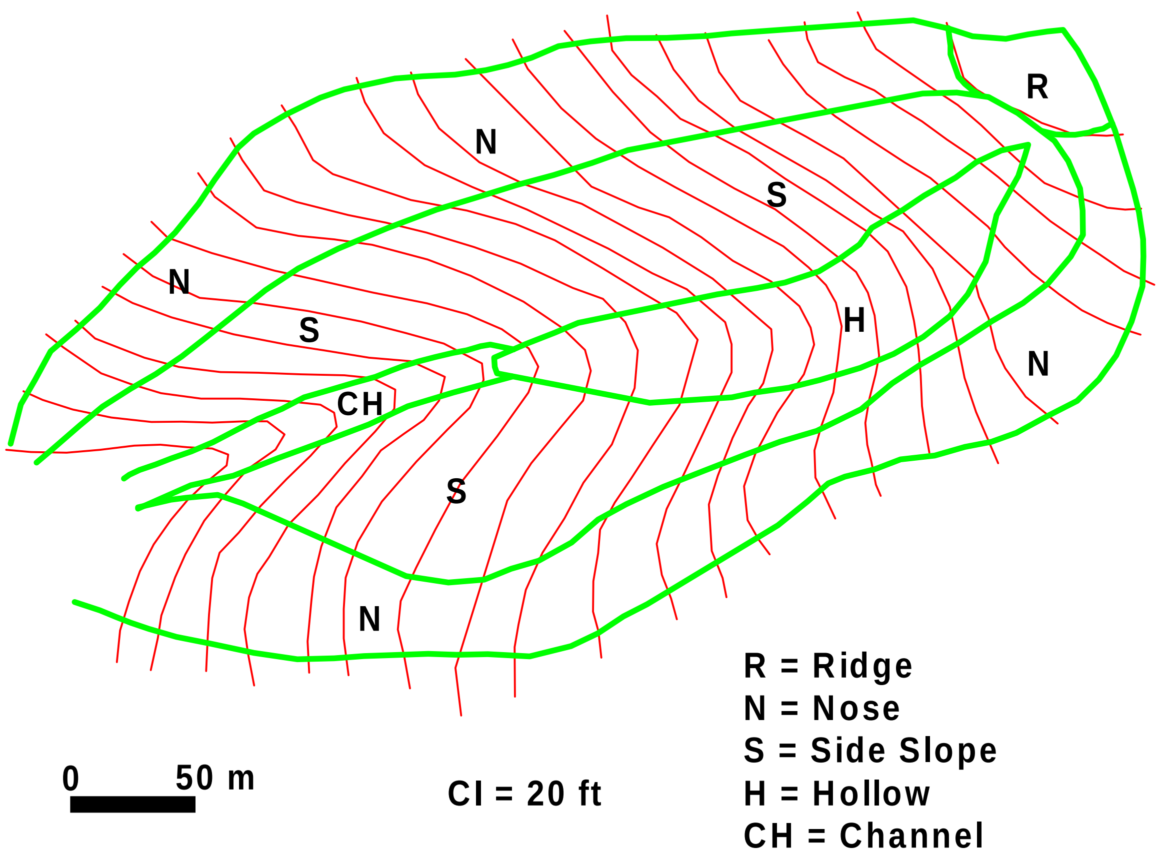


Figure 5-1. Hillslope landform elements after Hack and Goodlett (1960). Net transport flow paths are divergent on nose, covergent in hollows, and parallel on side slopes (Reneau and others, 1989). Noses represent drainage divides between zero- to first-order tributaries. Ridge crests serve as drainage divides between higher-order watersheds.

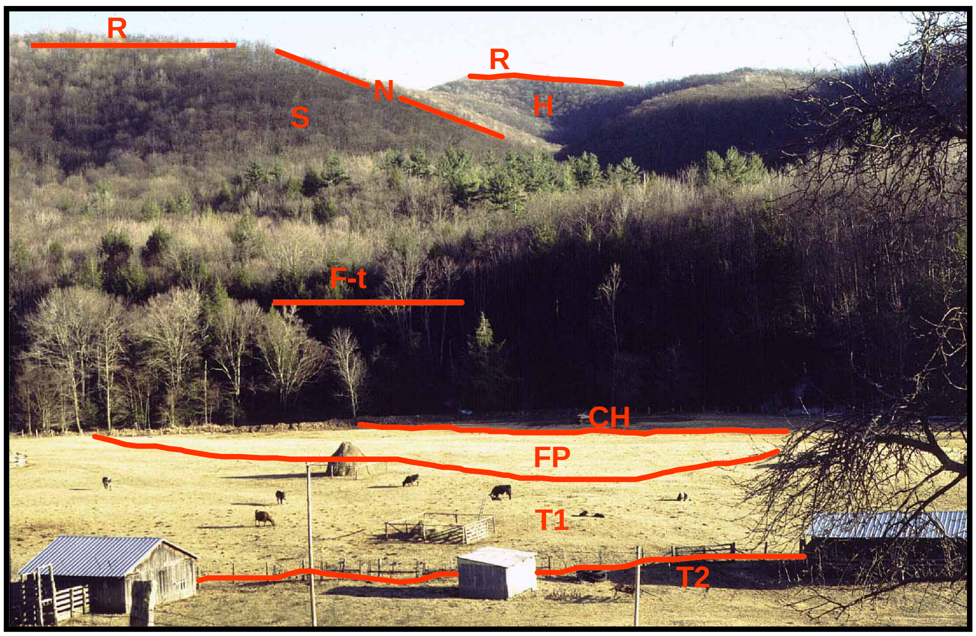


Figure 5-2. Principal landform elements recognized in the unglaciated, humid-mountainous landscape of the central Appalachians. Label identification is as follows: R = ridge, N = nose, S = side slope, H = hollow, CH = channel, FP = floodplain, T1 = low terrace, T2 = intermediate terrace, F-t = Fan terrace. Photograph is from the North Fork basin, Pocahontas County, West Virginia. See text for discussion.

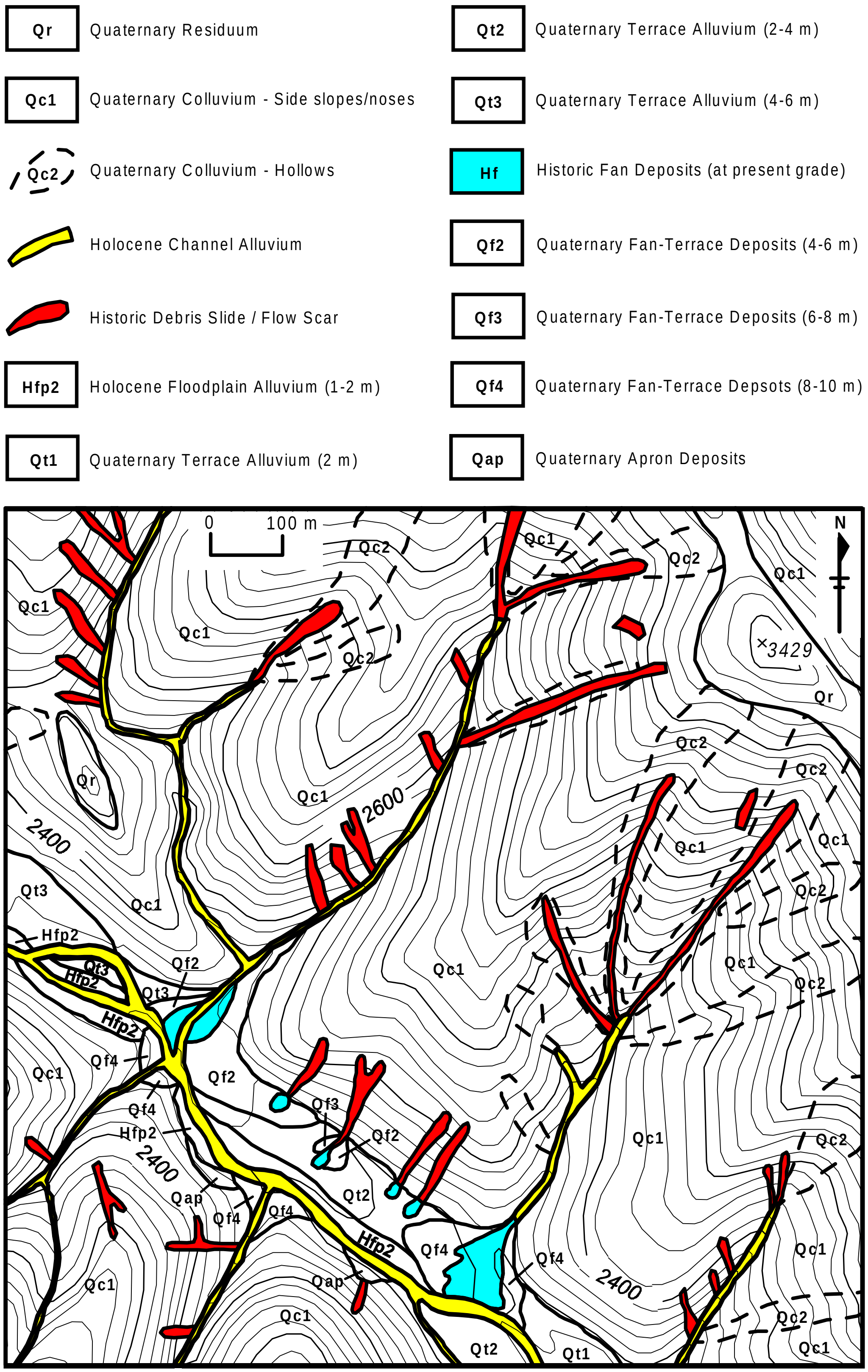


Figure 5-7. Portion of the surficial geology map for the Little River area, Augusta County, Virginia. Features were originally mapped at a scale of 1:9,600 (Taylor and Kite, 1998). Refer to Table 5-3 for an expanded explanation of map units. Contour interval = 40 ft.

Table 5-3. Example Application of Surficial Map Criteria at the Little River Basin, Augusta County, VA.

| Map Unit Label | Map Unit Description | Age | Origin (Process) | Landform | Material (Texture) | Four-Fold Identifier | Comments |
|---|---|---|---|---|---|---|---|
| Qr | Quaternary Residuum | Quaternary (Undiff.) | Residuum | Ridge-Veneer | Cobble- to Boulder-Diamicton with Silty Loam Matrix | (Q,r,r-v,c-bdt-l) | Predominantly associated with ridge crests supported by the Pocono Formation. |
| Qc1 | Quaternary Colluvium (Side Slopes) | Quaternary (Undiff.) | Colluvium | Nose-Side Slope Veneer | Cobble- to Boulder-Diamicton with Silty Loam Matrix | (Q,c1,n/s-v,c-bdtl) | Predominantly associated with side slopes underlain by the Hampshire Formation. Includes the Hazleton and Hazleton-Lehew soils series (Hockman and others, 1979). |
| Qc2 | Quaternary Colluvium (Hollows) | Quaternary (Undiff.) | Colluvium | Hollow Veneer | Cobble- to Boulder-Diamicton with Silty Loam Matrix | (Q,c2,h-v,c-bdt-l) | Predominantly associated with zero- to first-order hollows underlain by the Hampshire Formation. |
| Qbf | Quaternary Boulder Field | Quaternary (Undiff.) | Colluvium (periglacial?) | Boulder Field | Cobbles and Boulders | (Q,c,bf,c-b) | Equant to irregularly shaped side slopes covered by greater than 80% cobbles and boulders. Commonly interpreted as the product of Pleistocene periglacial slope processes. |
| Qbs | Quaternary Boulder Stream | Quaternary (Undiff.) | Colluvium (periglacial?) | Boulder Stream | Cobbles and Boulders | (Q,c,bs,c-b) | Elongate valley-bottom areas covered by greater than 80% cobbles and boulders. Commonly interpreted as the product of Pleistocene periglacial slope processes. |
| Hch | Holocene Channel Alluvium | Holocene | Alluvium | Channel and Narrow Floodplain | Cobbles-Boulders and Pebbly Loam (rounded to subrounded) | (H,a,ch,c-b-pl) | Fluvial channel deposits associated with first- to sixth-order streams. Unit includes channel alluvium and portions of adjacent floodplain too small to map at the given scale. |
| Hfp1 | Holocene Floodplain Alluvium (0.5 to 1.0 m surface) | Holocene | Alluvium | Floodplain | Cobbles-Boulders and Pebbly Loam (rounded to subrounded) | (H,a,fp1,c-b-pl) | Floodplain alluvium associated with second- to sixth-order streams. Unit includes low-lying surfaces 0.5 to 1.0 m above present channel grade with a flood recurrence interval of approximately 3 to 5 years. |
| Hfp2 | Holocene Floodplain Alluvium (1.0 to 2.0 m surface) | Holocene | Alluvium | Floodplain | Cobbles-Boulders and Pebbly Loam (rounded to subrounded) | (H,a,fp2,c-b-pl) | Floodplain alluvium associated with second- to sixth-order streams. Unit includes low-lying surfaces 1.0 to 2.0 m above present channel grade with a flood recurrence interval of approximately 3 to 5 years. |
| Hfp2A | Holocene Floodplain Alluvium (1.0 to 2.0 m surface) | Holocene | Alluvium | Floodplain | Sandy Loam | (H,a,fp2A,s-l) | Sandy slack-water deposits upstream from Hearthstone Lake. Unit includes low-lying surfaces 1.0-2.0 m above present channel grade with a flood recurrence interval of approximately 3 to 5 years. Buried root flares common. |