DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

TABLE 3. Physical Properties and Engineering Characteristics of Weathered Material of Igneous and Metamorphic Bedrock, Fairfax County, Virginia

B. Derived from metamorphic rocks. (Typically has saprolite and weathered rock with flat, platy fragments.)

Open File 79-1221
(Table 3B of 3B)

| Surface Materials Map Unit | Surface Materials Map Symbol | Bedrock Map Symbol | Parent Bedrock and Structure | Weathering Profile |
|---|---|---|---|---|
| Hornfels | 7d | E | Thermally metamorphosed shale, siltstone, sandstone, and conglomerate; entirely recrystallized adjacent to diabase, and gradually decreasing in metamorphic grade away from diabase. Altered zone commonly extends 100-300 m from contact with diabase, and may extend 1000-1500 m. Rocks often gray, green, or mauve. Arkosic sandstones may be altered to rocks granite-like in appearance, and siltstone and shale may be altered to massive, fine-grained rocks, often spotted with epidote and other mineral species (hematite, malachite, etc.). Metamorphosed rocks retain layering and bedding, and are stronger and tougher than parent rock. Sheets, joints, and fractures variable, and may be highly fractured at various orientations near contact, with breaks spaced as close as 2.5-5 cm apart. | Weathering profile generally similar to sedimentary rock from which derived, except the depth of weathering usually decreases significantly as the diabase contact is approached. B-horizon (or residuum) can be very clay-rich and up to 1.3 m thick, but generally is a much thinner sandy clay. Beneath this horizon the weathered rock often has many platy fragments. Depth to unweathered rock averages about 1. 5 m, but can vary from 0-5 m. |
| Phyllite | 7e | A | Rocks include phyllite, metasiltstone, schistose phyllite, and phyllitic slate. Has some quartz veins and pods. Compressive strength of rocks highly variable, depends on rock type. Structures vary from foliated to fissile, locally schistose, locally thin- to thick-bedded (few centimeters to meters thick). Steeply dipping foliation and cleavage are the dominant planar elements. Where fissile, rock splits along 0.2-0.5 cm thick planes. Shear zones and joints commonly parallel to foliation. Cross joints vary in spacing and development, commonly closely spaced. Fan joints common at apexes of folds. Rocks typically break into elongate blocks. Locally, complex types of structures and parent rocks commonly change abruptly laterally, perpendicular to bedding. | Near the surface typically a silt with some clay, micaceous at places, commonly with many hard rock slivers, chips, and fragments. Saprolite of this texture varies from 0 to at least 10 m deep, and is possibly much deeper. Saprolite varies from medium consistency to stronger, and typically has many slightly opened parting planes, locally with abundant quartz fragments. Depth to unweathered rock varies from 0-30 m, averaging about 10 m. Depth of saprolite and depth to unweathered rock greatest on hilltops. Rock outcrops most common on very steep slopes, in stream valleys, and near major streams. Saprolite consistency and saprolite/weathered rock contact can be highly variable at a given site. |
| Gneiss, Schist, and Metagraywacke | 7f | { Gneiss, D / Schist, B / Metagraywacke, C } (Boundaries between each of these rock associations are on the map "Preliminary Bedrock Map of Fairfax County, Va.", Drake and Froelich, 1977.) | Includes massive to well foliated rocks, in well defined thin to thick beds 1 cm to many meters thick. Rocks include schistose gneiss, granofels, impure quartzite, metagraywacke, pelitic schist, mica schist, phyllonite, and veins and pods of quartz. Gneissic rocks and granofels (Gneiss association) may include large blocks of exotic rocks, commonly larger than house-size. Included blocks may have physical properties differing greatly from adjacent rock. Gneiss is typically jointed, with steeply dipping joints commonly at least 1 m apart. Also typically has sub-horizontal joints and some joints at random orientations. Joints commonly offset slightly 0.25-1 cm. Has widespread weak shear zones parallel to foliation, especially near Fall Zone, 1 cm-1 m thick and continuous for great distances. Also has many aplite dikes, 1 cm- 1 m thick, sometimes highly shattered. Schist and Metagraywacke associations, typically interbedded, have planar elements such as bedding and foliation much better developed than Gneiss. For Schist and Metagraywacke, dominant planar element is commonly metamorphic foliation, usually steeply dipping. Has many small isoclinal folds, and many shear zones parallel to foliation, with the shear zones usually being highly micaceous and 1 cm - 1 m thick. Shear zones typically have strong material but multiple parting surfaces. Joints commonly irregular and at many orientations, and locally intensely developed, but can be 1 m or more apart.<br><br>Locally, types of structures and parent rocks commonly change abruptly in plan view for Gneiss, Schist, and Metagraywacke. Veins and pods of quartz common, 0.5 cm - 0.3 m thick. | Saprolite is typically a highly micaceous silt with some sand and clay, massive to containing many parting planes. Massive saprolite forms on massive rocks, with parting planes developing on highly foliated bedrock. Parting planes can be open slightly near ground surface. Thickness of saprolite varies from 0 to at least 20 m, and consistency varies from medium to stronger. Saprolite commonly at least 7-10 m thick, being deeper away from main streams. Physical properties typically change rather erratically vertically and laterally (based on SPT data). Depth to unweathered rock ranges from 0-50 m, averaging about 15 m. Depth of saprolite and weathered rock greatest on hilltops. Saprolite/weathered rock contact can be highly variable locally; in steeply dipping beds of mica schist and quartzite, contact can vary vertically up to 10 m within horizontal distances of 0.7 m because of highly variable weathering susceptibilities. |

| Surface Materials Map Unit | Unified Soil Classification of Saprolite and B-Horizon 1/ | Total Unit Weight (kilograms force per cubic meter) | Drainage and Natural Moisture Characteristics: Surface Drainage | Drainage and Natural Moisture Characteristics: Internal Drainage and Natural Moisture | Suitability as Compacted Material | Excavation Properties | Erodibility | Shear Strength and Compressibility Characteristics | Allowable Bearing Pressure (kilograms force per square centimeter) | Slope Stability | Road Performance Characteristics |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Hornfels | B-horizon: CH, MH-CH, ML-CL, CL<br>saprolite (or residuum): ML, ML-CL | 1750 and higher, generally increasing with depth to unweathered rock. | Moderately well drained to poorly drained, depending largely on clay content of residuum. | Permeability generally low to very low in B-horizon, and low to medium in residuum. After rainy season, water approaching ground surface commonly perched above contact of weathered-unweathered rock. | Highly variable, but commonly marginally suitable, especially where very clay-rich or where there are many rock fragments. | Saprolite (residuum) easy with light power equipment; weathered rock can be difficult to excavate with power equipment. Generally increasingly difficult to excavate with power equipment as diabase contact is approached. | Generally not highly susceptible, except where clay content is low. | Clays medium to stiff, silts stronger. Effective friction angle of fine-grained materials probably greater than 20 degrees, even for clays; coarse-grained effective friction angle much higher. Compressibility highly variable, with medium stiff clays susceptible to significant compression under moderate loads. | 1 or greater for shallow footings above unweathered rock. Should investigate for highly plastic, swelling clays and erosion tubes. | Highly variable, depending on degree of alteration and parent rock; sometimes more fractured than parent rock requiring flatter slopes than for unaltered condition, and sometimes more massive than parent rock. | Perched water near ground surface and presence of plastic clays commonly result in poor performance. |
| Phyllite | saprolite: ML, SM, (ML-CL) | 1300 and higher, lowest in saprolite immediately beneath B-horizon, generally increasing gradually with depth from saprolite to unweathered rock. | Normally well drained to very well drained, except at toes of slopes where ground is flat lying. | Permeability throughout weathered profile typically medium; possibly higher. Water collects at contact of weathered-unweathered rock. Natural moisture content of saprolite near ground surface commonly 10 percent less than plastic limit, with degree of saturation increasing with depth. Plastic limit of silty soil near surface averages about 25 percent. | Generally good source of fill, but compaction very sensitive to moisture content. Highly micaceous soils especially sensitive to compaction control. Wet soils easily dried. Soils compacted with Standard Proctor specifications suitable for homes and light two-story structures. | Saprolite at ground surface on hill tops generally easy to excavate with light power equipment, to depths at least 2-3 m. Increasingly difficult with increasing depth. Occasional quartzite beds and quartz veins, requiring blasting. | Highly susceptible, especially where micaceous and whenever remolded. | Medium or stronger consistency beneath soil disturbed by roots and other organic activity, or by frost action (rarely greater than 1.7 m), and beneath shallow covering of colluvium (map unit Colluvium and Lag Gravel). Strength increases gradually with depth, commonly to stiff consistency at depth of 7 m.<br>Peak effective friction angle commonly ranges from about 25 to 35 degrees; residual effective friction angle ranges from about 20 to 25 degrees, possibly less in sheared zones. Preconsolidation stress commonly slightly greater than existing overburden at top of saprolite, but increases rapidly with increasing depth. Soils commonly extremely compressible in virgin portion of consolidation curve, and highly compressible at loadings less than preconsolidation stress. | Commonly 1 to 2 for spread footings embedded to shallow depths into saprolite; typically increases rapidly with increasing depth. | Temporary vertical excavations in saprolite commonly stable to depths of at least 2 m, but presence of parting planes, shear zones, and aplite dikes makes cuts unstable at unpredictable localities. Permanent long slopes rarely unstable at angles less than 27 to 30 degrees in saprolite, weathered rock, or unweathered rock; stability depends almost entirely on presence of defects such as joints and shear zones. Unweathered rock usually stable at much higher angles. | Soils generally well drained internally, but silty, micaceous soils are extremely susceptible to frost heaving and softening where surface drainage is poor. Can be stabilized with cement. |
| Gneiss, Schist, and Metagraywacke | saprolite: ML, SM, (MH) | Same as above. | Same as above. | Same as above, except natural moisture content of saprolite near ground surface commonly 5 to 10 percent less than plastic limit. | Same as above. | Same as above. | Same as above. | Same as above, except peak effective friction angle of dikes containing highly plastic clays probably about 20 degrees. | Same as above. | Same as above. | Same as above. |

1 Soils in parentheses are present in secondary amounts.