Map Database for Surficial Materials in the Conterminous United States

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Contents

Introduction 1

Purpose 1

General Distribution of Surficial Material Types 2

Methodology for Compiling the Map 2

Caveats 3

Summary 5

Acknowledgments 5

References and Map Compilation Sources 5

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Introduction

The Earth's bedrock is overlain in many places by a loosely compacted and mostly unconsolidated blanket of sediments in which soils commonly are developed. These sediments generally were eroded from underlying rock and then were transported and deposited. In places, they exceed 1,000 ft (330 m) in thickness. Where the sediment blanket is absent, bedrock is either exposed or has been weathered to produce a residual soil. For the conterminous United States, a map by Soller and Reheis (2004, scale 1:5,000,000; *http://pubs.usgs.gov/of/2003/of03-275/*) shows these sediments and the weathered, residual material; for ease of discussion, these are referred to as "surficial materials." That map was produced as a PDF file, from an Adobe Illustrator-formatted version of the provisional GIS database. The provisional GIS files were further processed without modifying the content of the published map, and are here published.

Purpose

A detailed understanding of the Earth's blanket of sediment and weathered bedrock is critical to our society, because nearly all human activities occur on or within these materials. Homeowners, communities, and governments can make improved decisions about hazard, resource, and environmental issues, when they understand the nature of surficial materials and how they vary from place to place. For example, are the surficial materials upon which a home is built stable enough to resist subsidence or lateral movement during an earthquake? Do these materials support a ground water resource adequate for new homes? Can they adequately filter contaminants and protect buried aquifers both in underlying sediments and in bedrock? Are they suitable for development of a new wetland? Where can we find materials suitable for aggregate?

The U.S. Geological Survey (USGS) National Cooperative Geologic Mapping Program (NCGMP) works with the State geological surveys to identify priority areas for mapping surficial materials (for example, in areas of complex and poorly understood deposits of various sediment types, where metropolitan areas are experiencing rapid growth). To help establish these priorities, a quickly prepared, modern, synoptic overview of the geology was needed. The Soller and Reheis (2004) map was made in response to that need and provides an overview of current knowledge of the composition and distribution of surficial materials in the conterminous United States (the map covers only the conterminous U.S., because similar geologic information in digital form was not readily available for Alaska and Hawaii). Before its publication, the best available map had been a highly generalized depiction at 1:7,500,000 scale (about 120 miles to the inch), prepared for the USGS National Atlas (Hunt, 1979).

The Soller and Reheis map was compiled at a slightly more detailed scale (about 80 miles to the inch) than Hunt's map and used digital methods, which enabled rapid incorporation of the variety of available source maps. State-scale geologic maps from the western United States were brought directly into the map, without expending the time needed to resolve interpretive differences among them. Therefore, abrupt changes in surficial materials are indicated along many State boundaries. This, of course, is an artifact of the compilation technique and a limitation on its utility. However, this approach supports the basic premise of the map—to provide an overview of surficial materials and to identify areas where additional work may be needed to resolve scientific issues that can, in turn, lead to improved mapping.

General Distribution of Surficial Material Types

Surficial materials can be classified according to their age, texture, composition, and environment of deposition or formation. The environment of deposition is particularly helpful in understanding differences among these materials. For example, the texture, internal structure, and thickness of materials transported and deposited by glaciers are markedly different from residual materials developed in place, in bedrock. A highly generalized graphical depiction of the sediment texture and depositional environment of map units is shown as figure 1 in Soller and Reheis (2004).

The map shows broad, regional differences in the nature of materials at land surface. In the Atlantic and Gulf coastal zones, clayey to sandy materials have been deposited in beach, lagoonal, nearshore, and related environments. Inland, broad areas especially in the southern, central, and western parts of the Nation are covered by thin residual materials weathered from the underlying bedrock and "mass-movement" (landslide and hillside creep) sediments mostly derived from residual materials that have been slightly transported downslope and redeposited. In many places, the residual and mass-movement materials are patchy or absent and bedrock is exposed, especially on hillslopes. For large areas of the midwest, these and other materials are blanketed by windblown sediments, especially on the uplands. Coarse- to fine-grained alluvial and lake sediments are commonly found in major river valleys throughout the Nation, in low-lying areas of glacial-age lakes (for example, surrounding the Great Salt Lake, Utah), and in internally drained valleys in the Great Basin of the western U.S. In the northeast and north-central United States, glacial ice caused the accumulation of extensive and thick deposits (in places exceeding 1,000 ft) of till and associated glacial lake and stream sediments; these materials support a rich agricultural and industrial infrastructure.

Methodology for Compiling the Map

The map compilation of Soller and Reheis (2004) began with an inventory of available source maps. Selected maps met the following criteria: they were statewide or larger in area, showed surficial materials at land surface (or could be interpreted to derive such information), and were Geographic Information System (GIS) files in an ESRI file format. For the conterminous U.S. east of long 102° W., a 1:2,500,000-scale recompilation (Fullerton and others, written commun.) of the "Quaternary Geologic Atlas of the United States" series (U.S. Geological Survey, Map I-1420, scale 1:1,000,000) was used. That recompilation contained more than 150 different types of surficial materials. For the conterminous U.S. west of long

102° W., published statewide geologic maps, mostly at 1:500,000 scale, were used (see “References and Map Compilation Sources,” below). Those maps emphasize the bedrock geology, although they also show some of the major unconsolidated units such as alluvium in major river valleys and large deposits of lake sediment. Significant interpretation, therefore, was required to identify the appropriate residual surficial material developed in each mapped bedrock unit.

The disparity in information content among source maps argued for a broad classification with few units. Soller and Reheis began with a simple classification based on that of the British Geological Survey (McMillan and Powell, 1999). For the eastern source map (Fullerton and others, written commun.), each of the 150 map unit descriptions were interpreted and manually parsed into various attribute fields in a spreadsheet. Attributes included unit name, dominant sediment texture, geologic age, environment of deposition, and thickness. After using these attributes to classify the map units, the map was displayed and evaluated and, iteratively, a revised classification emerged that adequately displayed and highlighted the broad variations in surficial materials. This classification emphasizes sediment texture and depositional environment.

Parsing into database fields the sediment texture and depositional environment was especially challenging because the map unit descriptions were in many cases quite lengthy and complex and contained information about several different surficial material types. For example, in southwestern North Dakota a unit on a source map is named "Loamy disintegration residuum, sheetwash alluvium, and colluvium on sandstone, siltstone, mudstone, claystone, shale, and lignite"—this map unit contains three different major types of surficial material and a variety of bedrock lithologies that provide sources for the surficial material. Soller and Reheis classified the unit as "Mostly residual materials developed in bedrock, with lesser sheetwash alluvial sediments."

For each source map in the western part of the Nation, unconsolidated units were assigned to the appropriate category in our classification, and bedrock units were assigned to the surficial materials category most appropriate to their rock composition; for example, a sedimentary rock unit predominantly comprised of limestone was assigned to the category "Residual materials developed in limestone and other carbonate rocks." These source maps then were appended into a single digital map file of the western states, and additional source information for lake and eolian deposits was added.

Sediment thickness estimates were derived from various sources. For the glaciated area and adjacent alluvial valleys mostly in the eastern part of the map, thickness contours from Soller and Packard (1998) were generalized. Elsewhere in the east, sediment thicknesses were derived from the source map unit descriptions. In the west, sediment thicknesses were obtained from source maps and also by generalizing from locally known unit thicknesses.

Caveats

This map database is a highly generalized depiction of surficial materials for the conterminous United States. It is intended solely as an overview of existing knowledge, as an educational tool, and as a guide to support discussions on where additional geologic mapping might be needed. Because of its generalized unit descriptions, regional scale, and incomplete integration across the map area (as discussed below), this map is not intended for use in decisionmaking at the local, site-specific level nor for display at scales more detailed than that of the source map compilation (1:5,000,000).

Many of the processes that create surficial materials (especially those involving wind or mass movement of materials) tend to vary over small distances, so the delineation of map areas large enough to be visible at the scale of this map (1 inch on the map equals about 80 miles on the ground) is highly problematic. To improve map legibility and comprehension, a classification system was required that assigned the many complex units on source maps into units much more broadly and simply defined.

In some cases, units on source maps could not be readily assigned to this classification. As an example, a particular geologic unit found mostly in the southeastern U.S. is a residual material that developed mostly in metamorphosed sedimentary rocks and, to a lesser extent, in sedimentary rocks. Rather than define a new map unit, Soller and Reheis decided to classify it as "Residual materials developed in sedimentary rocks" to distinguish it from "Residual materials formed in igneous and metamorphic rocks." As another example, the source map for New York and New Jersey classified a unit as "Ice-contact deposits and glacial lake deposits—A complex of ice-contact sand and gravel and glacial lake sediments." This unit could not readily be assigned in the classification to either a coarse- or a fine-grained unit. Therefore, Soller and Reheis decided to assign it to a genetically related unit, glacial till, whose texture ranges from coarse to fine. This decision certainly is imperfect and illustrates the difficulties in reinterpreting source map information.

A further challenge is presented where map units from different source maps abut. When compiling a map from numerous published sources, many instances occur where, especially along the edges of adjoining source maps, the materials are described and mapped in different ways. Normally, these inconsistencies can be resolved by additional field mapping or through discussions with the geologists who created the source maps, and this is an especially effective approach when mapping at a relatively detailed scale. Lacking such opportunities for resolution, units shown on adjacent source maps could not always be reconciled. Therefore, this map shows numerous instances where different map units meet along straight lines, commonly at state boundaries or lines of latitude. For example, in North Dakota, a map unit extends westward where it seems to correspond to a unit from the adjacent source map. However, on that adjacent map, the surficial materials were not shown; there, it must be assumed that the bedrock is exposed and has been weathered to produce residual materials. The residual materials that are inferred from that map are classified differently than the materials described on the map to the east, hence there appears to be a sharp discontinuity in surficial materials. Because this map is an overview, essentially a snapshot, of current knowledge that can be represented at a national scale, these inconsistencies are retained to indicate what is actually known about the materials and to indicate where additional mapping may be beneficial.

Regarding the thickness of these surficial materials, scant information at a regional or national scale is available, except within the glaciated area. In most places, this is not a significant problem, because these materials generally fall within our lower thickness category (<100 ft). However, for large expanses of alluvial and lacustrine materials (for example, in the Mississippi River Valley and the Platte River Valley and in internally drained valleys of the western United States), thicknesses may exceed 100 ft, even where not so indicated on the map.

In most places, especially in areas not covered by glacially deposited sediment, the uppermost material generally constitutes most (and in places all) of the total thickness of sediment overlying bedrock. However, where sediment is shown exceeding 100 ft in thickness, the surficial material mapped at land surface does not necessarily extend downward to bedrock. In many places the uppermost material may be only a few feet thick, but the total thickness of sediment overlying bedrock is much greater. This is especially common in the glaciated area where the peat or loess shown on the map is only a thin veneer that overlies a complex package of other surficial materials which, in places, exceeds 1,000 ft in thickness.

Summary

A detailed understanding of the Earth's blanket of sediment and weathered bedrock is critical to our society, because nearly all human activities occur on or within these materials. This level of understanding is now being gained through detailed mapping by the State geological surveys and the USGS. In support of that work, this map provides a rapid, preliminary regional compilation; it does not offer information useful for local decisions but instead serves to illustrate for educational and planning purposes the general nature and distribution of the Nation's surficial materials at land surface. Perhaps most significantly, the map is intended to highlight regional differences in the mapping of these materials. The compilers hope the map will, thereby, serve a useful purpose by helping to guide further mapping efforts.

Acknowledgments

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