Louisiana Geological Survey

The Value Of Geologic Maps

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Introduction

A *geologic* map is one that depicts the distributions of rock types, formations, and geologic features such as faults, according to their particular characteristics and geologic ages. The making of geologic maps involves the gathering of information about the properties of different rock and sediment occurrences—especially their composition and texture—and rendering their configurations, strata, and structure in map format, as illustrated by Figure 1. Geologists produce these geologic maps in order to portray the geology researched in different areas and to reconstruct and better understand the areas' geologic histories. But, because of their numerous derivative applications, the maps, once made, can have far-reaching value to many other people.

Geologic mapping makes use of topographic information, aerial photography and other types of imagery, soil survey information, and observations and documentation made in the course of field work. The field work may target specific aspects of previous mapping, if such exists, that is subsequently identified as having interpretive problems. Previous work covering the area is, in any case, reviewed and evaluated and used as a framework within which to conduct the new investigation where appropriate.

Support investigations may also be conducted. For example, interpretive problems in selected areas may be addressed by drilling boreholes or by subjecting borehole and surface samples to various specialized tests. Information thus gathered in the study area is fitted to the published topographic maps covering it, which are used as a base. The work often also includes consultation with other geologists who have experience and expertise germane to the problems encountered in the study area.

Ultimately, the geologic mapping effort is a joint one involving geologists, cartographers, geographic information systems (GIS) specialists, and other technical personnel, as well as the necessary administrative support personnel—plus potentially all these people's counterparts, with whom they interact, in the agency that funds the work.

With time, newer and more detailed mapping may reveal areas with potential for improvement. Some years after an area was originally mapped, it may be ripe for revisitation and complete remapping for improvement of detail and of consistency with more recent mapping done in surrounding areas.

Socioeconomic Benefits

The effort and expense required to make geologic maps are justified by their socioeconomic value, which derives from their multiple uses and applications in a variety of contexts. The distribution of geologic map units may be important to assessing coastal erosion and land loss, flood hazards, unstable-soil hazards, ground-water resource development and contamination potential; protection strategies for aquifer-recharge areas and for regions susceptible to ground-water pollution and soil erosion; and suitability of areas for waste disposal, aggregate-and mineral-resource potential, and location of residential areas.

Thus accurate, up-to-date geologic maps are essential for planning by a host of agencies and industries concerned with such issues. The socioeconomic value of new geologic maps relative to their predecessors derives in part from the added detail that provides clearer delineation of map units in these types of derivative applications. Figure 2 shows where detailed geologic mapping of Louisiana parishes has been done since the Louisiana Geological Survey's founding in 1934.

Commercial Value

Geologic maps not only lend themselves to a multitude of timely uses but are an essential starting point for a host of other, more specialized investigations. Impressive financial returns on the investments

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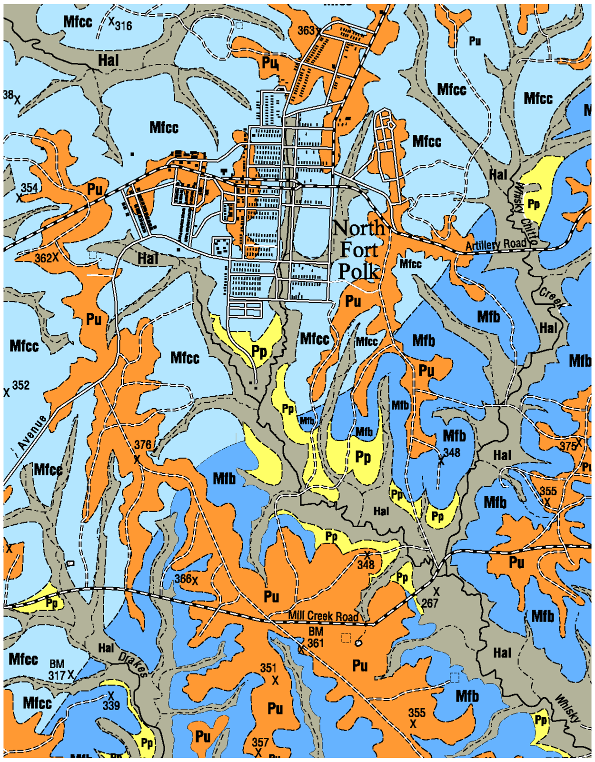

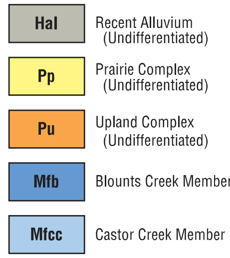

Figure 1. Portion of a geologic map of the Fort Polk area where sediments of Eocene, Oligocene, Miocene, Plio-Pleistocene, and Holocene age crop out. The sediments shown range from Middle Miocene through Holocene, spanning a time interval of approximately 15 million years. (Geology by David J. Hinds [1998], cartography Mary Lee Eggart).

made in geologic mapping have been documented in other states[1] through both present economic benefits and avoidance of future financial loss. *Direct benefits* include oil and gas field discoveries, as well as development of nonfuel mineral and ground-water resources. *Avoidance of future costs* is derived from the early identification of natural hazards, and the optimal site location and design of structures and facilities based on such knowledge.

The National Cooperative Geologic Mapping Program was authorized by Congress in 1992 to support the goal of eventually mapping the geology of the entire United States at the scale of 7.5-minute quadrangles. In Kentucky, the first state to completely map its geology at this scale, benefits were estimated to exceed costs by 50 to 1 on a $21 million investment over the life of the program[2] (1960 to 1978).

Potential Applications

The geologic mapping applications mentioned above have value for addressing needs specific to many current problems in Louisiana. A critical problem in our state is coastal land loss; geologic maps provide basic information applicable to the guidance of development in Louisiana's coastal zone. Detailed mapping in the coastal zone and the lower Mississippi River flood plain can provide information about the distributions of permeable and impermeable sediments and of surface faults, which is crucial in the effort to rationally plan the permitting of activities in the coastal zone in ways that minimize the threat of land loss.

Geologic mapping can, in places, resolve sediment and landform combinations characteristic of different environments of deposition—such as former stream courses, meander belts, natural levees, and backswamps—with characteristic physical properties that have important consequences in engineering applications.

Knowledge of the distribution of such characteristics is essential to the determination of constraints for optimally locating industrial facilities. This includes the conscientious location of waste-treatment facilities relative to the recharge zones of aquifers that are important sources of drinking water, such as the Chicot aquifer, which is the principal source of ground water for 13 parishes in southwestern Louisiana.

The investigation and mapping of the geology in a particular area can have important implications if it is a large urban center. For example, socioeconomic value of geologic mapping in the Baton Rouge area, which includes the capital seat of the state and is impacted by active faults, derives from the implications of geology for urban development (environmental-geologic applications), for ground-water protection (containment of potential contaminants), and for developing strategies for fault-hazard risk assessment and damage reduction.

The surface faults, though they do not produce detectable earthquakes, are known to be active because of the cumulative damage done to structures built on and near certain fault segments over periods of years and decades. Detailed mapping of the faults provides a framework useful for formulating and evaluating such strategies for constructing structures within areas that overlap the fault-line scarps.

In summary, geologic mapping has myriad applications specific to timely needs in Louisiana, including:

- A variety of uses in conjunction with the assessment of the quality, quantity, and distribution of ground water and surface water, and the prevention and mitigation of their contamination.
- Safe and optimal location of industrial and commercial facilities, including waste repositories.
- Monitoring and assessment of coastal land loss.
- Assessment and mitigation of natural hazards (in Louisiana, principally flooding and landslides).
- A variety of uses relating to mineral resources—specifically to their exploration, the mapping of their distribution, the economics of their exploitation and development, and their management.

[1] *The best documented example is Kentucky, the state that is most comprehensively mapped at 1:24,000, which is the scale of 7.5-minute quadrangles.*

[2] *Smath (1988)*

Role of the Louisiana Geological Survey

The Louisiana Geological Survey is responsible for investigating the geology of the state and disseminating the knowledge acquired through its investigations via published reports and maps. Aspects of the geology mentioned above in connection with the manifest derivative applications of geologic maps relate primarily to the geologic occurrence of energy and mineral resources and of natural hazards.

Nonrenewable resources largely comprise minerals in the broadest sense of the term. Identification, exploitation, and management of such resources, and identification and mitigation of natural hazards, depend on geologic maps. The well-being of any state is based to a considerable degree on the resource base that supports its population, and on its ability to safeguard its populace against known hazards; hence, accurate and up-to-date geologic maps are essential to that well-being.

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Contacts

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Additional Web Sites:

http://www.usgs.gov/

http://ngmdb.usgs.gov/

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http://ncgmp.usgs.gov/ngmdbproject/standards/metadata/metaWG.html

http://www.fgdc.gov/metadata/metadata.html

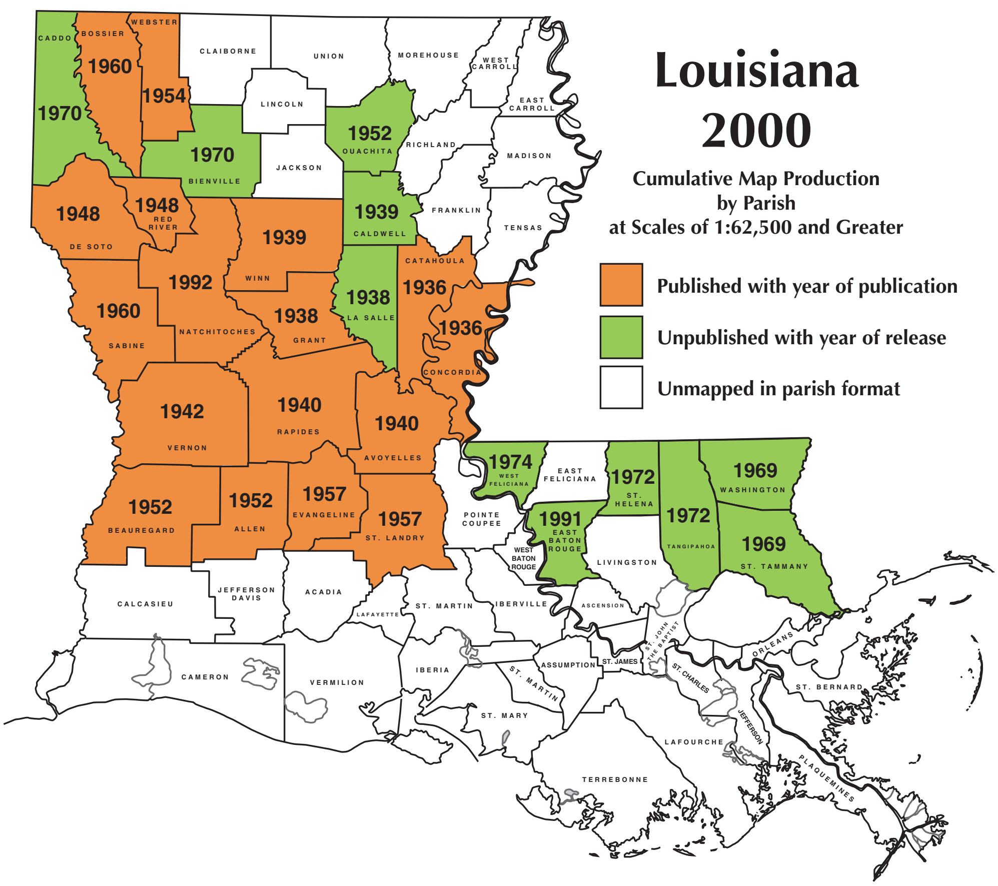

Figure 2. Parishes in Louisiana for which detailed geologic maps (those done at scales of 1:62,500 or larger) have been made, with dates (redrawn and adapted from McCulloh 1992). Those in the unpublished category comprise portions of masters' theses, doctoral dissertations, and open-file reports. Of a total of 64 parishes, 28 have been geologically mapped in detail.

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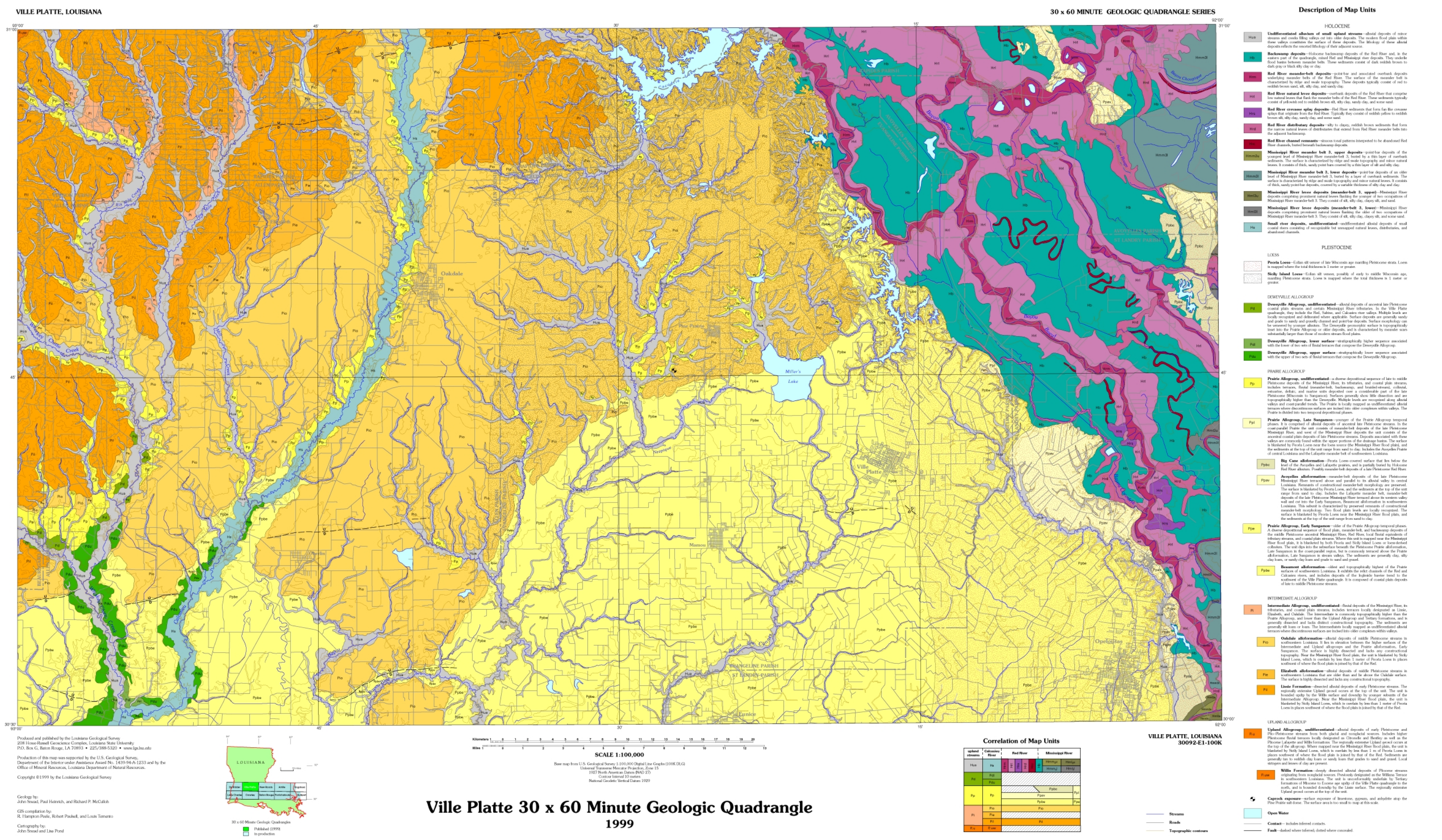

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