



Map by Fletcher et. al., GSA Publications

**Position Summary.** To improve the scientific basis for public and private natural resource and land-use decisions, the Geological Society of America (GSA) supports comprehensive geologic mapping on local, state, and national scales and advocates increased public investments for current state and national geologic mapping programs.

This position statement provides a communication tool that (1) summarizes the consensus views of GSA regarding the importance of geologic mapping for natural resource and land-use decision making; (2) encourages partnerships among government, academia, and industry to share mapping expertise and technology; (3) promotes the development of digital data and maps in readily accessible and useable forms; and (4) encourages educational institutions and funding agencies to value and reward the teaching of geologic mapping skills.

## CONCLUSIONS AND RECOMMENDATIONS

GSA adopts this statement as a reflection of its commitment to the following actions:

- Public investments and enhanced partnerships**—Within the priorities of local, state, and national government, increased programmatic and financial investments are needed to adequately support the development, publication, accessibility, and use of geologic maps. Programmatic emphasis for mapping can be enhanced through developing partnerships among local, state, and federal agencies, educators, and scientists in the public and private sectors. Increased public investments in the geosciences should include geologic mapping as a critical component. For example, continued increases in funding for the U.S. Geological Survey’s National Cooperative Geologic Mapping Program (NCGMP) are essential; this program has been a productive and cost-effective partnership with state geological surveys and universities to produce geologic maps and train students in geologic mapping.
- Digital formats and access**—It is essential to produce geologic maps and related publications in digital formats so that information can be readily available to regional and urban planners, decision makers, industry, and the public. Digital formats would include previously published scanned maps available as PDFs. However, users are now demanding interoperable databases with rich content that allows them to view maps, produce cross sections and 3D geologic models, and also have the ability to construct their own customized derivative products. GIS and 3D geomodelling are critical for development of actionable geologic databases, which include (1) adoption of standards for encoding geologic map information; (2) adaptation of geologic mapping and geologic map publication to the possibilities presented by digital technology, including the publication of digital and scientifically attributed map databases; (3) seamless maps (e.g., matching map edges) across jurisdictions; and (4) optimization of online accessibility and delivery of geologic map data.
- Value of teaching mapping skills**—Teaching geologic mapping skills and methodology is important and deserves the full support and recognition of academic institutions and departments. In all these teaching pursuits, accessibility should be

emphasized. Geoscientists should engage students in geologic-mapping activities to the maximum extent practicable and strongly support teaching of geologic mapping, digital map compilation skills (including GIS and 3D modelling), interpretation of geologic maps, and development of derivative or interpretive maps. They should also support the offering and funding of geologic field mapping courses and other educational initiatives that provide financial support to equip and engage students in geologic mapping as well as to publish the resulting geologic maps. Academic and government institutions should fully recognize the scholarship and scientific merit, as well as the economic and societal value, inherent in the development of geologic maps as they evaluate individuals for tenure and promotion.

## RATIONALE

Geologic maps portray interpretive, 3D views of rock, sediment, and soil units. They are often based on hundreds to thousands of observations of outcrops, drill-core, water-well and engineering boring logs, and geophysical profiles that, once assembled, depict the distribution and age relationships of units within a given map area. The preparation of geologic maps is a fundamental skill unique to the science of geology. Maps provide information on Earth's structure, processes, environments of deposition, and features both at and below Earth's surface. They offer foundational data for mineral, energy, and water resources. Geologic maps can also show how the physical environment has been impacted by human activity. Our understanding of issues important to society, such as natural hazards, climate change, economic development, sustainability, and management of soil and water resources is grounded in geologic maps.

Geologic maps provide a context for testing scientific theories, hypotheses, and models. They stimulate scientific thinking and promote further development of geologic methods and techniques. Biologic, climatologic, hydrologic, and other scientific data often must be considered in the context of the geologic framework provided by mapping at appropriate scales, yielding increased understanding and encouraging further multidisciplinary scientific investigations. Geologic maps are also valuable teaching tools in the earth sciences.

Geologic maps and their subsequent derivative products have immense economic and societal value to the nation and its security. Numerous economic studies of geologic mapping all show a positive benefit-to-cost ratio for the mapping activity, spanning from 4:1 to >100:1 (Berg et al., 2019). Geologic maps are particularly useful when in standardized digital format and accessible online. They support our ability to locate and develop vital mineral, energy, and water resources; assess and protect groundwater quality; safely site solid and hazardous waste disposal facilities; construct, restore, maintain, and protect sensitive ecosystems; and identify and prepare for such natural hazards as earthquakes, volcanic eruptions, landslides, sinkholes, collapsible swelling soils, and land subsidence. Geologic maps enhance our ability to identify health hazards; to site and build the nation's infrastructure of roads and highways, railroads, pipelines, utilities, dams and locks, buildings, and foundations (ground conditions and ease of excavation are critical considerations dependent on geologic variability); and to make more informed land-use and planning decisions to meet societal needs. Geologic maps have proven to be essential elements for informing many policy decisions of federal, state, and local agencies.

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## ABOUT THE GEOLOGICAL SOCIETY OF AMERICA

The Geological Society of America (GSA) (<https://www.geosociety.org>) unites a diverse community of geoscientists in a common purpose to study the mysteries of our planet (and beyond) and share scientific findings. Members and friends around the world, from academia, government, and industry, participate in GSA meetings, publications, and programs at all career levels, to foster professional excellence. GSA values and supports inclusion through cooperative research, public dialogue on earth issues, science education, and the application of geoscience in the service of humankind. Inquiries about GSA or this position statement should be directed to GSA's Director for Geoscience Policy, Kasey S. White, at +1-202-669-0466 or [kwhite@geosociety.org](mailto:kwhite@geosociety.org).

## OPPORTUNITIES FOR GSA AND ITS MEMBERS TO HELP IMPLEMENT RECOMMENDATIONS

To facilitate implementation of the goals of this Position Statement, GSA recommends the following actions:

- We should seek opportunities to effectively communicate the value of geologic mapping to international, national, state, tribal, and local legislative bodies and government agencies, private developers, economic development corporations, professional land-use planners, chambers of commerce, and other local decision makers. GSA members are encouraged to work with print, electronic, and broadcast media in promoting the value of science-based approaches, such as geologic mapping, for addressing critical resource and land-use issues.
- We should seek opportunities to engage representatives of industry, colleges and universities, and public decision-making entities to foster financial support for geologic mapping partnerships. If possible, it is beneficial to provide potential industry, academic, and public decision makers with local examples of geologic maps contributing vital information to a resource, land-use planning, or decision-making effort.
- We should emphasize how the geoscientific information might have prevented or lessened the effect of a costly adverse land-use activity or reduced devastating consequences of a natural disaster. In particular, geologic mapping provides prior knowledge of site conditions and, therefore, can reduce over- and under-bidding for construction projects and overall project delays and associated costs.
- We should seek opportunities to effectively communicate the value of geologic mapping to community groups, including town hall meetings. The public must be able to respond in an informed manner to resource and land-use decision making that may directly affect their community's health, safety, resilience, welfare, and personal property. There is a growing need for the public to be educated about the value of geologic mapping in identifying the geographic extent and thickness of geologic units at both the land surface and at depth, which in turn provides valuable insights regarding water and mineral resource availability. As above, it is beneficial to provide decision makers with local examples of how geologic mapping has either contributed to resource land-use planning efforts or its lack has resulted in costly adverse land-use activities or devastating consequences of a natural disaster.
- Considerable expertise and resources are available to members through GSA's Geology and Public Policy Committee, GSA's Geology and Society Division, and GSA's Director for Geoscience Policy in Washington, D.C. GSA can provide members with readily accessible print, online, and personnel resources to support geoscientists' communications with decision makers regarding the value of geologic mapping.
- GSA can raise awareness of the value of geologic mapping by publishing geologic maps, databases, and associated articles and by encouraging members to propose geologic mapping sessions, workshops, short courses, and field trips at annual and sectional GSA meetings.

### REFERENCES

1. United States Geological Survey (USGS) National Cooperative Geologic Mapping Program (NCGMP), [www.usgs.gov/programs/national-cooperative-geologic-mapping-program](http://www.usgs.gov/programs/national-cooperative-geologic-mapping-program).
2. USGS National Map Database (NGMDB), [ngmdb.usgs.gov/ngmdb/ngmdb\\_home.html](http://ngmdb.usgs.gov/ngmdb/ngmdb_home.html).
3. Links to U.S. state geological surveys can be found through the Association of American State Geologists, [www.stategeologists.org](http://www.stategeologists.org).
4. Berg, R.C., K.E. MacCormack, and Russell, H.A.J., 2019, Chapter 4: Benefit-cost analysis for building 3D maps and models, *in* 2019 synopsis of current three-dimensional geological mapping and modelling in geological survey organizations: Alberta Energy Regulator/Alberta Geological Survey AER/AGS Special Report 112, p. 19–23.