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Bringing Geological Mapping into the Digital Era—A Finnish Case

By Niina Ahtonen, Hannu Idman, Esa Kauniskangas, Jarmo Kohonen, Jyrki Kokkonen, Jouni Luukas, Jukka-Pekka Palmu, and Jouni Vuollo

Geological Survey of Finland
P.O. Box 96, FI-02151, Espoo, Finland
Telephone: (+358) 2055030
Fax: (+358) 2055012
email: *firstname.surname@gtk.fi*

Introduction

The Geological Survey of Finland (GTK), like most long-established geological surveys, is in the process of renewing its mapping strategies. The revolution in information technology, pressures for greater responsiveness to customer groups, and the push for greater organizational efficiency are the main drivers behind this process. Web-based approaches also increase the importance of being able to query and exchange geoscientific information internationally.

The largest issues to be tackled in the renewal process relate to data models and architecture, data capture and acquisition, as well as dissemination and delivery of information. The process occupies considerable resources and demands a wide variety of skills. To date, GTK has expended some 200 man-years just on digitizing legacy data. Moreover, even with careful planning, the process has not been straightforward. The original plan of centralized storage based on an ESRI Geodatabase data structure (Oracle-ArcSDE platform) has been revised. We now divide the databases into spatial (Oracle-ArcSDE) and aspatial parts (e.g. geological unit register with attribute data in relational databases).

The present focus is on careful analyses of work flows to modernize our mapping processes, finalizing national data models for Precambrian and Quaternary geology, and reworking the data structures accordingly. Designing seamless map databases for the entire country and map products at scales of 1:1 million and 1:200,000 are underway.

Moving from Paper to Digital

Over the past 10 years, GTK has digitized all fundamental datasets (surficial and bedrock geology data, exploration, aggregate resources, peat resources, etc.) and transferred existing digital data into the new databases. Our databases currently contain a vast amount of observation points, vector/raster maps, and exploration datasets that include claim reports, drilling sites, and report maps.

By organizing these data according to in-house standards, we are in a position to provide extensive web-based services such as maps, index-based services from different kinds of point and polygon data, and archived reports. The quick-and-dirty approach to digitization has preserved rich bodies of geological information that might otherwise be lost, but it has hardly brought us closer to our ultimate goal of services based on fully harmonized datasets. However, a lot of legacy information is still in its original formats awaiting further revision, digitization, and harmonization. The planning of the future operations needs balancing of partly conflicting aspects: the ultimate goal of completely harmonized datasets seems too remote, whereas a simple bulk digitizing of materials without any revision of the content does not enable high-quality information services.

GTK´s vision of being a national geoinformation centre necessitates finding ways to make numeric datasets accessible, relevant, and easy to use. Interoperability in Europe (the EU’s INSPIRE directive; *http://www.inspire-geoportal.eu/*)

and global collaboration (OneGeology; *http://onegeology.org/*) requires normative conceptual data models, classification systems, and common geological terminology. For this purpose, GTK is beginning a transition to harmonized databases, governed largely by the recommendations of the INSPIRE directive and technical specifications in the emerging data-transfer standard GeoSciML (*http://www.geosciml.org/*). International networking, e.g. with the IUGS-CGI [*http://www.cgi-iugs.org/*], NADM [*http://nadm-geo.org/*], and GeoSciML teams, plays a significant role in the harmonization process.

Architecture and Databases

GTK's original plan, dating back a decade, featured centralized storage based entirely on an ESRI Geodatabase data structure (Oracle-ArcSDE platform). In recent years, the architecture was divided into spatial (Oracle-ArcSDE) and aspatial parts (Oracle, but not SDE). The present situation is illustrated in Figures 1 and 2.

The motivation for a divided architecture came from the plan of GeoScience Victoria of Australia (GSA) for their map database solution. The primary plan of GSA was to store everything in an ESRI Geodatabase, but after their evaluation process, a combination of RDBMS and GIS technology was selected (see in detail Simons and others, 2005).

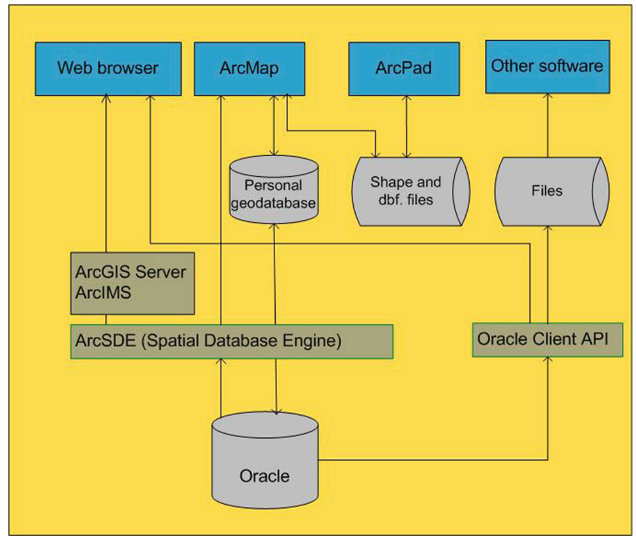

Figure 1. GTK´s data architecture is based on a centralized Oracle database and ESRI's ArcGIS software family. ArcMap and ArcGIS server (running on Web browser) are the main client software products. Large georeferenced raster images are served with IWS-software (ERDAS ER Mapper). Web Map Service (WMS) and Web Feature Service (WFS) interfaces are also available.

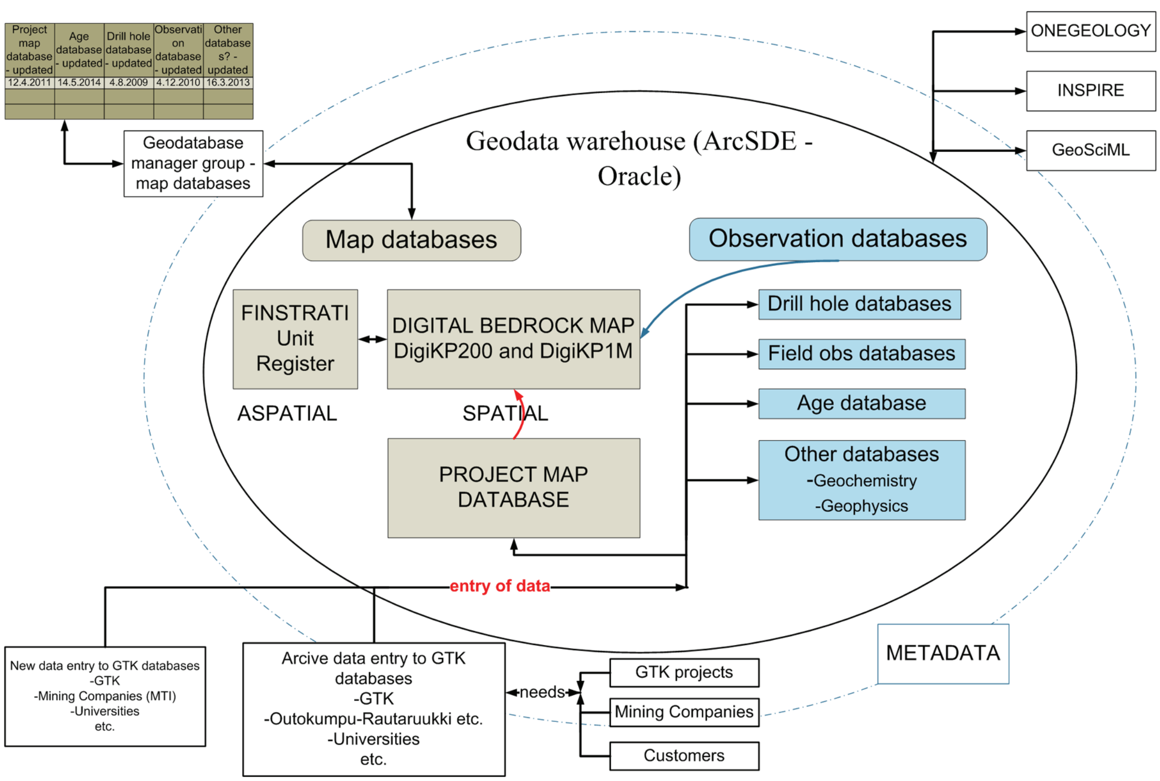

Figure 2. GTK's database structure for bedrock data. New data and maps – from archives and field – will be stored in observation and map databases that are used to design harmonized seamless geology map databases at 1:200,000 and 1:1 million scales linked to the aspatial unit register.

Also, a "divided approach" was strongly supported by the decision of GTK to create seamless countrywide map databases of our Precambrian bedrock at 1:1 million and 1:200,000 scales (DigiBr 1M and DigiBr 200), on a geologic map unit basis. This meant jettisoning the purely lithological approach of the original plan. Guidelines and procedures for naming Precambrian units in Finland were drawn up largely following recommendations in the North American Stratigraphic Code (North American Commission on Stratigraphic Nomenclature, 2005). These guidelines have been used to design the geological unit register consisting of lithostratigraphic, lithodemic, and tectonostratigraphic units with attribute data in relational databases. This is illustrated in Figure 2.

Field Data Capture and Acquisition

Field data capture is important for GTK. Because data models used by GTK are complicated, GTK has focused software programming strongly on attribute editor development. Attribute editors are programmed on top of ArcGIS. In surficial deposit mapping and bedrock mapping, field data capture is done with portable tablet PCs (see our DMT poster for details [*http://ngmdb.usgs.gov/Info/dmt/docs/DMT08_Kokkonen.pdf*]). Base maps, geophysical maps, previously made observations, etc., are in digital format and can be manipulated with GIS software in the field. Bedrock and surficial deposit observations are stored using standard ArcMap tools and customized editors.

The database structure is complex. For example, the data model for bedrock observations covers sub-processes such as regional bedrock mapping, exploration, natural stone investigations, and urban geology for construction purposes.

Map Production and Delivery

GTK's Map Production Extension (Figure 3) is an information processing and cartographic editing system for geologic maps and map products. The system is not a data management tool, but rather specialized process software for map production and publishing. It is based on a double-server architecture, whereby end-users with Windows-based tools are connected to Unix-based database services. Product groups and different products are predefined in the system, as are the symbol sets, colors and annotations. Users are administered according to their roles in the process.

Data in the database server are managed by Oracle RDBMS and stored on Oracle-managed disks. ArcSDE connects the Oracle and GIS systems. The customer server architecture allows for sharing of information, centralized information management of controlled work, and processing of optimized information.

All original material is maintained in source databases. The source databases consist of GTK's Oracle – SDE database for geologic information and the National Land Survey's terrain database for base maps. The material from source databases is copied into a map database according to area delimitations of the product.

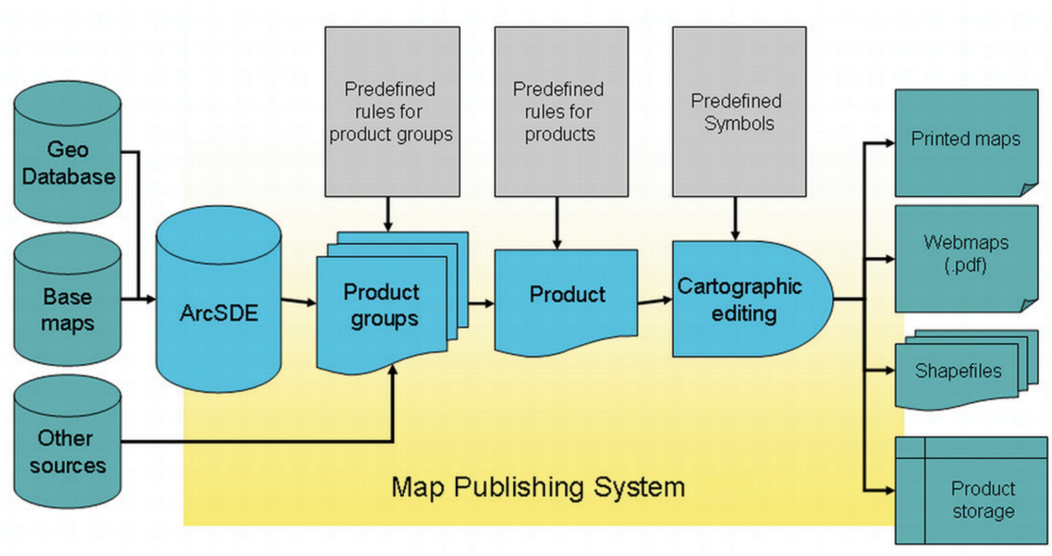

Figure 3. Map production extension used by GTK.

The end products are various size and quality printouts, including Adobe PDF files (.pdf) and ESRI shapefiles (.shp).

Web Publishing

The GTK service model (Figure 4) is a portal, based on an ArcGIS Server 9.x for vector data and an ER Mapper Image Web Server for raster/matrix data. Basemaps are uploaded via a WMS interface developed by the National Land Survey and Karttakone Ltd. Geospatial data used in this service come from GTK's database or other sources.

The service should accommodate standard web browsers (basic users) or GIS software (advanced users). It will also work with Open Geospatial Consortium (OGC) interfaces. The Data Interoperability Extension built into the system allows downloading of data in a variety of formats (e.g. AutoCAD, Mapinfo, ESRI shapefiles). It is also possible to search spatial and areal information. Reports and other documents are readable or downloadable in Adobe PDF. Ordering services for printed documents, maps, and reports are included.

References

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Simons, B., Ritchie, A., Bibby, L., Callaway, G., Welch. S., and Miller, B., 2005, Designing and building an object-relational geoscientific database using the North American Conceptual Geology Map Data Model (NADM-C1) from an Australian perspective: Proceedings of IAMG'05: GIS and Spatial Analysis, v. 2, p. 929-934.

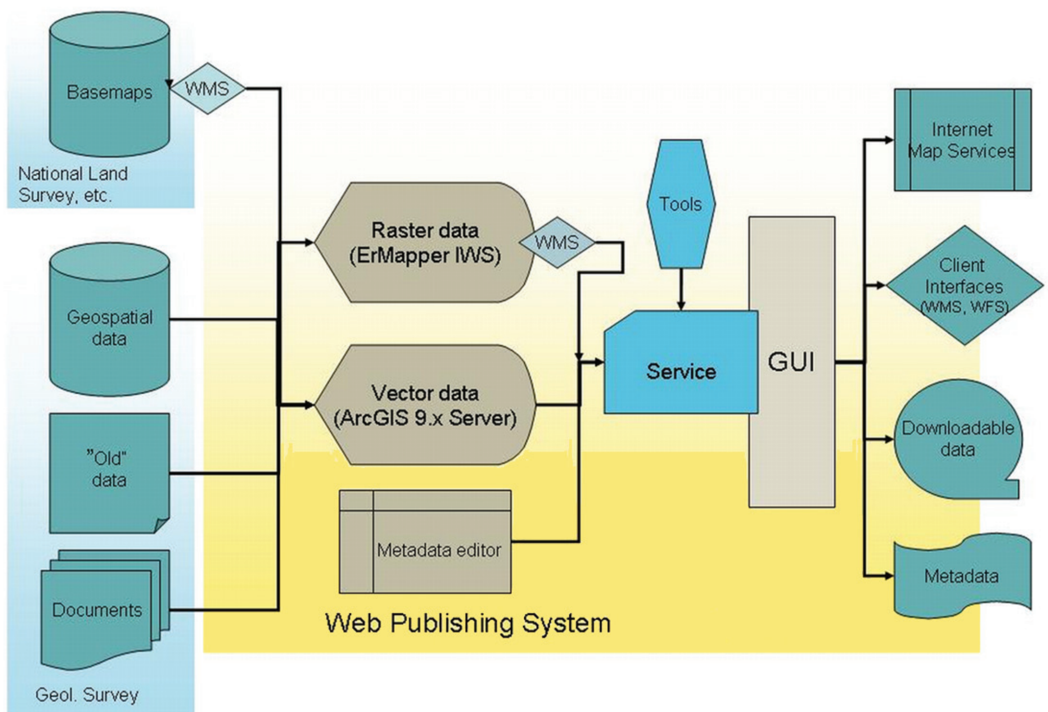

Figure 4. GTK´s Web service model. The Web Publishing System serves as GTK's portal.