GML-based Strategic Approach and Its Application for Geo-scientific Infrastructure Building

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Abstract: GIS became increasingly important in information-oriented society as social indirect capital and many GIS data are developed. To use these data effectively standard format that enables easy to transport and store is needed. For this purpose, OGC developed GML based on XML as web standard format of geographical information. In this study, web based mapping with respect to digital geologic map and gravity anomaly map was accomplished using GML. While, styling methods were implemented in XSLT to make the visualizing suitable for the character of each layer, so it is possible to make dynamic maps in the SVG. GML-base map produced in this study can be transferred and represented without loss of the meaning and degrading on the web.
Keywords: Geo-scientific data, Digital geological map, GML, SVG map

1. Introduction

Digital geologic layers formatted in GIS (Geographic Information System) data were produced and distributed by KIGAM (Korea Institute of Geoscience and Mineral Resources). However, in actual application with them, currently there are few analyses integrated with geo-scientific data. It is due to shortage of application schema or modeling guideline that unify and analyze data of different structure.

Currently data share in real GIS project commercial data format such as Shp or DXF has been used. These data depend on GIS software, so transformation process is needed to share and analyze [1].

International trend for GIS data is format development that enables to share data on the web, and OGC (Open GIS Consortium) proposed GML (Geographic Markup Language) based on XML (Extensible Markup Language) as the web standard format of geographical information [2].

GML provide easy-to-understand encodings of spatial information and spatial relationships, including those defined by the OGC Simple Features model and a means of encoding spatial information for both data transport and data storage, especially in a wide-area Internet context. Also it provide a set common geographic modeling objects to enable interoperability of independently-developed applications, so much time and efforts wasted on manipulating and reformatting data between different computer platforms and applications significantly were reduced.

In this study, data model to represent Korean digital geologic map and gravity anomaly map was designed and geological application schema for encoding them to GML was developed.

2. Process

Entire process of this study is divided into two part, UML (Unified Modeling Language) modeling and GML encoding as shown Fig.1. Modeling is selection of class that need to be represented and defining properties and relation between the classes. To represent geological information validate to the model, it is necessary that XML schema describes structure of data, GML encoding, and graphical rendering. All of the procedures are based on XML.

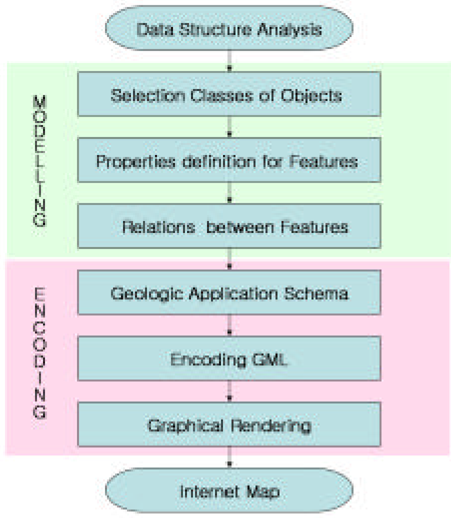

Fig. 1 Flow chart about entire process

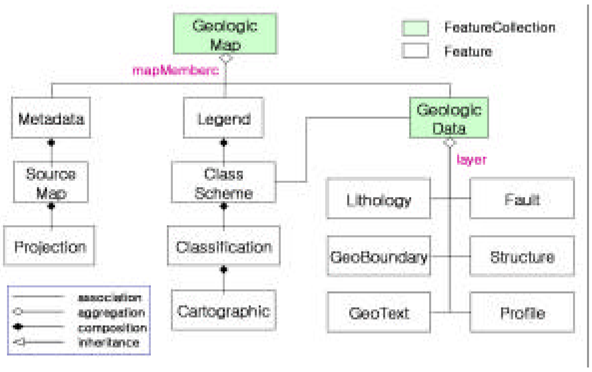

Fig. 2 Geologic map data model

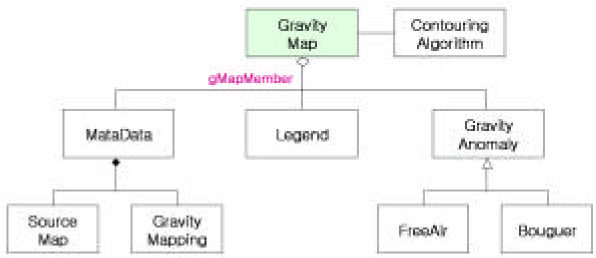

Fig. 3 Gravity anomaly map data model

1) Data modeling

In UML class is set of objects that have common attributes, operations and relations, is represented to square. Data model for geologic map and gravity data are shown in Fig.2, Fig.3 respectively. In this study, geologic map model is referenced USGS (U.S. Geological Survey)'s geologic map data model and KIGAM's digital geologic map production rule [3], [4].

The properties themselves are modeled in UML as associations, or as attributes, of the feature class. It is common for a property with a complex or highly structured type to be modeled as an association, while simple properties are typically class attributes. If the value of a property only exists in the presence of the feature, then it may use either a composition or be represented as an attribute. However, if the value of a property is loosely bound to the object and the property value is an object that might exist independently of the feature, then it must use an aggregation.

2) Encoding GML

In GML real-world phenomenon is represented to set of features. The state of a feature is defined by a set of properties, where each property can be thought of as a {name, type, value} triple. GML 2.0 provides support for building feature collections that can use the featureMember property to show containment of other features and/or feature collections. Geographic features are those with properties whose values may be geometry. The traditional 0, 1 and 2-deminsional spatial reference system are represented by points, line strings and polygons.

Each class shown data model is defined to feature or feature collection in GML. In Fig.2 root element that contains all of information is represented to Geologic Map feature collection, has Metadata, Legend, Geologic Data as mapMember inherited from featureMember. Metadata contains information about source map, projection, and organization and Legend give a description of classification schema of spatial objects and cartographic element. Geologic Data is feature collection that has several layers as feature member. Table 1 contains attributes and description of each class represented in Geologic Data model.

Data model of Gravity anomaly map is represented in Fig.3. Gravity Map is feature collection has Metadata, Legend, and Gravity Anomaly as gMapMember and associated with Contouring Algorithm. Gravity anomaly map is contour type showing anomaly range or distribution pattern without anomalous values. So algorithm method needs to be defined.

In this study, Korean geological map and gravity anomaly data were transformed to GML respectively

Table 1. Definition of the attributes in the GeologicData model

Attribute	Description	Type
Lithology		Feature
label	The abbreviation of stratigraphy	Text
stratigraphy	A stratigraphic classification	Text
chronology	Identifier for a specific age	Integer
rockType	Rock unit of all types	Text
remark	Additional information	Text
extentOf	Polygon property of Lithology	Polygon
GeoBoundary		Feature
boundType	Type of boundary	Integer
edgeOf	Polyline property of boundary	Polyline
GeoText		Feature
label	the abbreviation of stratigraphy	Text
position	Point property of GeoText	Point
Fault		Feature
desc	Identifier for type of fault	Integer
dip	The dip angle of fault	Integer
centerLineOf	Polyline property of Fault	polyline

3) Graphical Rendering

GML is concerned with the representation of geographic data content, so to draw a map it is necessary that transforming the GML into a graphical form such as SVG (Scalable Vector Graphics) that can be interpreted for graphical display in a web browser. Styling methods were implemented in XSLT (eXtensible Stylesheet Language for Transformations) to make the visualizing suitable for the character of each layer, so it is possible to make dynamic maps in the SVG on user's need. As shown in Fig.4 many different graphical representations might be generated from a single GML file. These different representations could include both different graphical formats and different symbolizations.

Because of SVG is based features, direct access to each feature and search and analysis of information on the image is possible. For example, click on part of map then information can be searched.

Spatial coordinates is transformed to image coordinates by specific rules, so maps having same extent can be placed same location. As displaying gravity anomaly map with geologic map covers same area, overlay analysis can be performed as in GIS software.

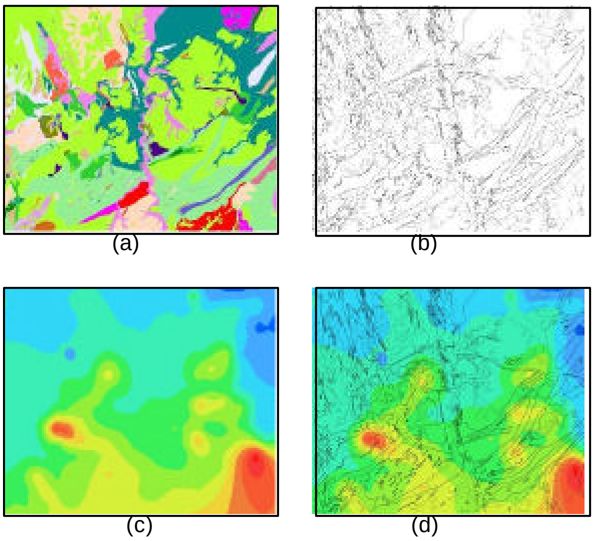

Fig.4 SVG map of lithology(a), geological boundary(b), free-air gravity anomaly(c), free-air anomaly with geological boundary(d)

3. Conclusion

GML is a new metadata standard in the geosciences that will increase the efficiency of the web by reducing network traffic and allowing intelligent searches, and will allow efficient movement of information between computer platforms and applications. In this study all process from GIS producing to analytical functions are accomplished without any proprietary software. Conclusively, it is thought that non-expert can search and analyze easily GIS spatial data on the web and that developed data can be applied effectively to synthetic analysis GIS data with geo-science data.

Reference

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