

## 3D GEO-MODELS SHARING ON THE WEBSITE BASED ON GEOSCI ML STANDARD

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### ABSTRACT

3D geological models become increasingly important and popular recently. But it is too difficult to share the models because of different models come from different modeling software. It is urgent to solve the problem for the unification of data management. Based on it, the paper explains basic construction and architecture if GeoSciML to discuss how to take advantage of this standard and define a whole geological model, such as drill model or a geological section model. The models provide the foundation to the 3D geological models sharing on the website. Meanwhile, by using of the new technology of Html5 and WebGL, 3D geological models can be shard in spite of different data formats. So it becomes impossible for us to use the geological models in different fields by the method.

**Keywords:** *WebGL, Web Sharing, GeoSciML, 3D Geological Model*

### 1. INTRODUCTION

Along with the development of network and 3D GIS technology, geological information also began to be digital and visual. Due to the virtual visualization of geological information, workers from different fields can communicate with each other expediently. Meanwhile, standard specifications from various geology professions make it possible that geological data in our country can be controlled together, which adapts to our high-speed urban construction. So 3D Geological Mapping and Modeling is becoming an important content of geological survey work and a significant method of result expression of geological survey results.

Domestic and international geology survey institutions, scientific research groups and enterprises carry forward the relevant theory research, software and hardware support technologies and tools development and so on. They were engaged to make the geology survey data service as a part of national spatial data integrated strategy on basis of continuous accumulation about digital information resources. For instance, the United States Geological Survey put forward the complex spatial modeling or simulation in its 2007-2017 ten years science strategy, which realizes multidimensional data integration to provide scientific and decision support for the policy makers and resource managements. It also makes underground 3D geological format be an important goal of Geological mapping plan from 2007 to 2012[1].

Australia geological survey AGSO has been starting 3D geological modeling and visualization research since 1999, whose goal is to build Australia geological online seamless data integration for the comprehensive analysis, interpretation and communication of geological information[2]. British land adjustment bureau BGS published 2000-Beyond strategic plan in 1999, and its important strategic plan is to establish the 3D geological framework list, and then it developed Digital Geological Spatial Model DGSM project from 2000 to 2005[3]. Our country has been beginning the national geological mapping plan argumentation since the “eleventh five-year plan”, and put forward to start 3D geological mapping and data sharing plan in “twelve five-year plan” planning. In terms of 3D geological modeling, different methods and software tools have different advantages and disadvantages, so it may need to use kinds of modeling tools for the same institution or project. Due to the lack of exchange standard, it is not convenient to realize the geological model sharing of different methods or modeling tools. It is similar to the early 2D multi-source heterogeneous data integration and it is one of the important problems need to be solved.

Therefore, it is particularly urgent to establish a uniform 3D model data format to realize the exchanging and sharing of 3D geology model data between different industries. To do this, the data model association constructed by geological information management and application committee, which belongs to the international earth science association, develops Geology Science

Markup Language Standard (GeoSciML). It utilizes the GeoSciML standard to define the complete geological data model so that 3D geological model data formats can be uniformed, and it becomes possible of 3D geological data sharing on website.

## 2. BASIC COMPOSITION AND SYSTEM STRUCTURE OF 3D GEOLOGICAL MODEL BASED ON GEOSCI ML STANDARD

GeoSciML is a kind of Geography Markup Language (GML) application in the field of geology profession, which is based on XML, supporting the exchange of geological information[4]. Developed over XMML (eXploration and Mining Markup Language)[5] and NADMCL (North America Data Model)[6], it is a kind of information encoding and exchange standard for geology areas. GeoSciML is also a specific application of GML standard published by OGC (Open Geospatial Consortium)[7]. It follows OGC WFS (Web Feature Service)[8] standard, supporting geology survey information sharing service under circumstance of distributed computer. So far, it mainly stipulates the representative encoding standard of geological exploration data, such as drilling, geological map, formation model, geological structure and so on[9], and it is expanding to the areas of earth chemistry and geophysical. GeoSciML is care of geology concept and the definition and description of its data structure.

GeoSciML is an ideal data model of geological information sharing, which has CGI and IUGS standard exchange format as same as OGC standard, and it can commendably solve the defect of data format exchange and direct reading sharing model anciently. In addition, it supports the expansion of new type and professional data.

### 2.1 Geosciml System Structure

According to the UML, GeoSciML standard can be divided into seven parts, namely Geologic-Features, GeologicUnits, Geologic-Structures, EarthMaterials, SamplingFeatures, ValueTypes, and Vocabularies. GeologicFeatures is the core content, which derived several GeologicaUnits and GeologicStructures. GeologicUnits defines every field's semantic by means of Vocabularies, and on the basis of sampling information provided by SamplingFeatures, GeologicStructures confirms structure information, and then combining with GeologicStructures and GeologicaUnits

information, it shows visualization information through EarthMaterials and describes specific geological information by ValueTypes.

GeologicFeatures: A MappedFeature can be viewed as an event, like a polygon, it is unknown when it is under true geologic environment, so the same geological features have different MappedFeature, but every MappedFeature can only represent a GeologicFeature.

Its indispensable attribute is goal for a GeologicFeature and shows that GeologicFeature is a concrete or standardized description. It records map features and geologic features' attributes through various observation methods. For example, a MappedFeature may be obtained by observation, while the standard GeologicFeature is summarized by the observed data.

Each MappedFeature is related to SamplingFrame, which shows that these data is obtained in a certain space reference system. The relationship between geological characteristics can be described by GeologicFeatureRelation.

In GeoSciML specification, abstract data type — GeologicFeature and its subclasses (including GeologicUnit, GeologicStructure) is used to express kinds of geologic concept and object. GeologicFeature defines geologic features' requirements, such as observation method, observation information and so on, allowing recording the relationship between its feature and other features through GeologicFeatureRelation, and via MappedFeature, it records its feature's space form in specific map environment, such as specific scale and data precision conditions. At the same time, MappedFeature is pictured as a specific performance of GeologicFeature under particular observation conditions. Different conditions are corresponding to the specific performance of different features. So a GeologicFeature object can be associated with several MappedFeature objects. Besides, MappedFeatur also allows its samplingFrame members to record the specific observation conditions when obtains attribute value, especially space sampling conditions.

GeologicUnits: GeologicUnit is an abstract geological unit, integrity and accuracy exist under the hypothesis circumstance, only linked to GeologicFeature can space attribute be effective. In GeoSciML specification, it mainly refers to the stratum or rock bodies. This kind of geological objects in space have clear geological boundaries. In the field of geology, geological boundary is especially important which reveals the position of stratum or rock boundary, reflecting the contact relationship and geological structure characteristics

between geological objects. Meanwhile, internal parts of formation or rock mass distribute different attribute fields, and attribute characteristics reveal the distributed situation of geological object's physical and chemical properties. So the expression and generation method of general geological model has two kinds: boundary model and attribute model(or voxel model).

Using the concept of Contact, we can define the standard of geological space classification as the following:

(1) Follow the principle of "meet pay will be break" for the same type geometry objects.

(2) Based on the partition of feature attributes and dividing geologic unit in accordance with the consistency geologic vocabularies of up geological boundary and down geological boundary is called "geological semantic consistency" principle.

In order to express the position relationship between GeologicFeature better, according to the 3D space division, it mainly defines Z+, X-, Y+, and the Exterior is upper, on the contrary, it is Bottom.

Show as figure 1, GeologicUnit A and B use the same GeologicBoundary a3, defining the relationship between GeologicUnit Unit-A and GeologicBoundary Contact-a3 is that this GeologicUnit is located in the left side of GeologicBoundary, and this GeologicBoundary's "up" is GeologicUnit Unit-A. In GeoSciML specification, first we need to identify GeologicUnit's ID, and then ensure the relationship between GeologicUnit and GeologicBoundary, in addition, utilize relateFeature member to associate with the GeologicBoundary which is related to it.

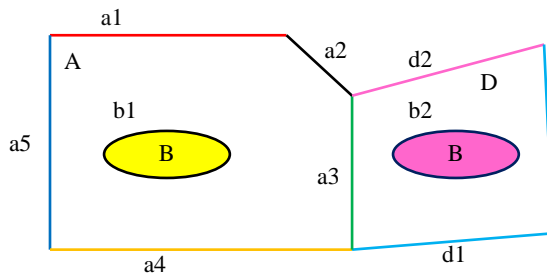


Figure 1: Geological Space Division Schematic Diagram

**GeologicStructures:** GeologicStructure mainly records the shape in the earth's crust, which is left by the deformation and deflection of rock crustal movement, such as fold, fault, joint, kinds of planar or linear structure and crystal crystallization direction, internal structure and composition change, etc. In GeoSciML specification, this part defines various type of geological structure on the basis of

GeologicStructure class, respectively is Shear-DisplacementStructure class, Contact class, Linertion class, NonDirectionalStructure class, Foliation class, FoldSystem class. Shear-DisplacementStructure class is used to record fault data, including the displacement of fault fluctuation geological sliding and separate value. According to the sampling information delivered by Sampling-Feature class, GeologicStructure class utilizes its subclass to estimate this geology model's structure type, and then writes down the geology model data by its corresponding class.

**SamplingFeatures:** This part records the representative sampling data selected from goal geologic body. In GeoSciML specification, SamplingFeature class records the sampling data on the basis of SurveryProcedure class, Sampling-FeatureRelation class, Observation class and Any-Feature class. And it is divided into SamplingPoint class, Specimen class and SpatiallyExtensiveSamplingFeature class. Besides, in accordance with the recorded data of SpatiallyExtensiveSamplingFeature class, it can get sampling curve and write down the detailed drilling information and color in Borehole class.

**Vocabularies and EarthMaterials:** Vocabularies define each field of GeologicUnits. In GeoSciML specification, on the basis of geology definition, this module searches various dictionary definitions through vocabulary relationship and control relationship of every field. Finally geological fields can be obtained and the fields semantics can be determined.

**ValueTypes:** ValueTypes is to specifically describe all the information above. This module is used to make the geological model shape through CGI standard class.

### 3. USING GEOSCI ML STANDARD TO REALIZE 3D GEOLOGICAL MODEL NETWORK SHARING AND PUBLISHING

The development of network technology causes great changes during our daily life, especially after XML and GML technology appearing, 3D geologic model network sharing technical level has been greatly improved. Now geology information sharing methods is constructed on basis of XML and GML[10]. Although directly using XML and GML to establish geology model can solve numbers of problems, many matters also need to be settled. So this chapter introduces how to make use of GeoSciML standard to define complete geologic

data model and discusses the network publishing of 3D geologic model based on Html5 and WebGL.

### 3.1 Using Geosciml Standard Define Complete Geological Data Model

Data models established by various geological data acquisitions are different. According to this point, GeoSciML standard develops several standards to regulate the writing of eXtended Markup Language, which is called XML. XML is a kind of structured markup language developed by World Wide Web Consortium (W3C) for adapting the development of network to describe complex information. Using XML to express knowledge and transfer data, it is not only across the platform, but also across the space, more across the equipment. XML data and the performance of separation can be carriers of different terminal exchange information [11].

Geological map is the graphical expression result of geological model, drilling can be regarded as linear geological model, describing the distribution law of formation along the borehole trajectory. Traditional profile and geological plan is a plane geological model, which can describe formation's plane distribution low and geological structure along the plane of linear track and so on. Geological model in 3D environment is 3D geological model (Model3D), in order to use virtual reality way to express the geology information visually.

Drill Model: In XML files, firstly, we use drill represent borehole, and then statement quoted namespace and schema file. It utilizes Metadata, GeoStyles, ReferencedModel, gmml:GeoLayer to record borehole data. In details, Metadata illustrates its Metadata information, and what GeoStyles records is model's visual information, and ReferencedModel is used to store drill's geometry and attribute information, finally, gmml:GeoLayer tag is to determine corresponding relation between feature class and practical parameters. The ReferencedModel and GeoStyle are the main parts of XML.

In GeoSytle label, on the basis of stratigraphic information, it records every formation's visual information, and uses filter tag to filtrate the specific attribute information in Rule tag, only when the attribute information is right can call the X3DMaterial label in Rule tag. X3DMaterial tag mainly stores its visual information, including AmbientIntensity, Shininess, DiffuseColor, EmissiverColor, SpecularColor, and Transparency, which is recorded by RGB format.

In ReferencedModel label, we can make use of GeoFeatureClass tag to store drill's geometric set (ID for mark) and its topological relationship (ID for stratum). According to the requirement of Schema model, Mark GeoFeatureClass records all drill model's point coordinates of each layer in member label, which is for every formation model's attribute information record; stratum GeoFeatureClass is used to mark the points recorded in mark GeoFeatureClass, according to the topological relations of different formations, geology map can be divided into several Geo-MappedFeature models to store different relations. In every GeoMappedFeature label, it takes advantage of shape tag to record this formation model's geometry information and ensure points' dimensions and number to obtain line features in posList attribute, but because drill is regular linear model, so each period only needs two point coordinates.

Geo-section Model: In XML files, it uses section to mean profile. The most difference between profile and borehole is that GeoFeatureClass tag's ID number changes, in stratum GeoFeatureClass, because drill model is considered as regular linear model, so the point record is simple, but the section is made up of numbers of section lines, so that when records the section's geometry information, it in fact is to record each section line's coordinate information. Not likes drill model, section lines are no rules, so in order to reduce the error as little as possible, it needs to be divided as more as possible. When recording the information of each section line, we should make sure point's number to describe section lines in the attribute of poList tag. Meanwhile, the adjacency relation between it and its surrounding formation model is recorded in relatedFeature label. In addition, there is no mark GeoFeatureClass in section model, which is transformed into GeoBoundary GeoFeatureClass. This GeoFeatureClass mainly records attribute information of section and increase fault node to store fault information. Figure 2 shows the section models and drill models.

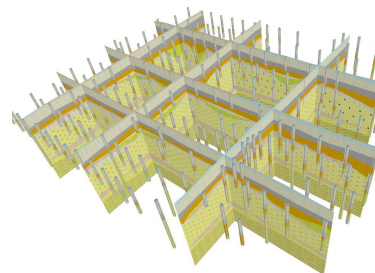


Figure 2: Sample Of Sections And Drills Model

3D geo-model: Usually, fault information and geological model is in a XML file. In GeoStyle, it adds FaultStyle model to record kinds of fault's visual information. Because fault is expressed by 2D plane in XML, so fault is divided into several triangles, and then establishes coordinate index, finally, these triangles will be put together by the topological relationship between each geological unit and geological boundary. In ReferencedModel tag, fault information exists alone in a fault feature class, in this feature class, fault's ID is read by ShearDisplacementStructure label, and use relate-Feature to ensure the topological relationship between each unit and its adjacent units. Mark GeoFeaturClass records geometry information of all geological geometry information and fault section's geometry information. Vertex tag stores every triangle's vertex coordinates and sets index number, and increases triangle tag to ensure the index number of vertex coordinate of each triangle and matches index to each triangle for that stratum can be easy to know topological relationship between every surface of geologic body and fault section. Figure 3 shows the 3D geological structural model. Next paragraph will explain how to describe these models by GeoSciML language.

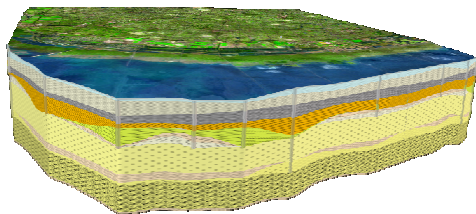


Figure 3: Sample Of 3D Geological Structural Model

### 3.2 Web Publishing Of 3D Geological Model Based On Htm15 And Webgl

The development of network makes web sharing of 3D geological model inevitable. Now the preliminary idea is to transfer uniform 3D geological data model to data organization layer through cyberspace data access interface. According to the information of distinguish model types represented by each node in XML, push the handled 3D geological model to the graphics card via WebGL to realize visualization of 3D geologic model, showed as figure 4.

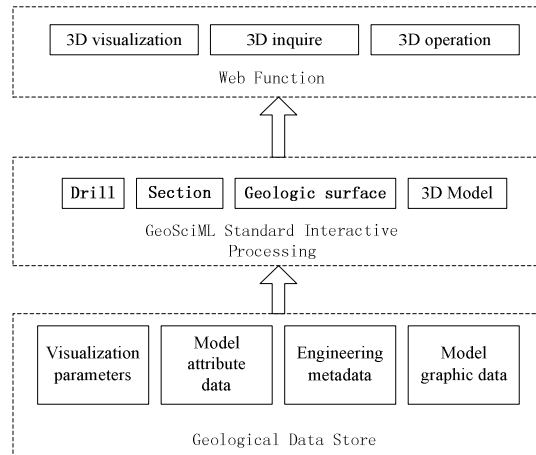


Figure 4: Preliminary Technical Schema Of 3D Geologic Model's Network Publishing

Html5 generalized addressed is a technology portfolio including HTML, CSS and JavaScript. Html5 has two main characteristics. Firstly, it strengthens the performance capabilities of the web page. Secondly, it adds the function of the web applications, such as local database. The new canvas tag achieves page display of the 2D model without plugin, establishing the foundation for visualization of network without plug of 3D model. Through the hardware accelerated 3D rendering provided by WebGL3D drafting standards, developers can make use of the graphics in the browser very smooth display of 3D geological model.

The WebGL frame widely used at present mainly has Oak3D developed by Oak3D Team and three.js WebGL third-party libraries. The Principle of WebGL is to send various information of model to graphics via vertex shaders and fragment shaders to display a variety of model on a web page without plug. In the WebGL rendering pipeline, the point and texture information of the 3D model is written in JavaScript, and then pass the array object and attribute values to the vertex shader. For what passed to the vertex shader are Uniform variables, in the vertex shader, it needs to be transform into Varying variable to pass rasterization of element's assembly to the fragment shader, at last, process fragment and put figure to the video card.

## 4. CONCLUSION

The current version of GeoSciML standard is GeoSciML3.0, which greatly improves the geological information sharing technology level. It makes up for the data format conversion and reading the defects by the sharing model directly.



GeoSciML has the XML documents and defines the complete data model for 3D geological model of network sharing, laying the foundation to solve the problem of data model disunity in each field. GeoSciML standard originates from geological data and the exchange and sharing demand of geological data and map in the 2D conditions, so in order to achieve 3D model of visualization, it is insufficient to support the 3D geological model and it still needs other standards to regulate XML documents. In addition, the Meta WebGL technology is realized successfully in Firefox and Chrome browser, but since most graphics and graphics driver in the design are not considered safety which is completed by the operating system, and will product great hidden danger to the browser, because the browser thinks WebGL can be executed safely, which would make the scripts get crossing domain execution authority, even get access to local file permissions. The network of 3D geological model network release technology remains to be improved.

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