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Creation of Data Specification for Geospatial Information in Albania on the Theme: "Geology"

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Abstract: The development of technology and the demands of groups of interest for standardized digital geospatial information are increasing daily. The necessity for referred geospatial information, according to a Referencing Coordinating System and European Standards, through a national GIS (Geographic Information System) system, requires a decision making of national and institutional importance. ASIG (State Authority for Geospatial Information) is the institution that administrates, implements, and maintains the NSDI (National Spatial Data Infrastructure). It is calculated that 80% of decision-making by public or private institutions uses geospatial data with a well-organized structure that enables efficiency. Thus, standardization of geospatial data by topic is one of the main objectives of implementing the NSDI in Albania. This is a complex task for the standard and the harmonization of geospatial data, which can be a good opportunity for professional awareness. This study shows in detail the methodology for the creation and implementation of data specification for geospatial information in Albania on the theme: Geology, adoption of the technical specification of the INSPIRE directive as well as the importance of ASIG as an institution that builds and maintains NSDI in Albania.

Key words: Geospatial data, GIS, ASIG, INSPIRE, NSDI.

1. Introduction

Geoinformation today appears as a key element in decision-making, data exchange and communication processes. Increasing of life demands and technology development has contributed to making the elements of geoinformation compulsory in a modern society. The current country development stage requires high-quality geospatial information [1, 2], optimum resource management, and efficient definition of solutions that will ensure sustainable development. Geospatial information involved in a common infrastructure provides many opportunities to improve public services while at the same time eliminating duplication of data and inconsistency. The ASIG (State Authority for Geospatial Information) has begun its activity to establish the Geospatial Data Infrastructure in Albania, in line with all European initiatives and trends. The purpose of the strategy is to create the most appropriate infrastructure, providing support for a sustainable development accompanied with economic growth and efficient services. ASIG is committed to carrying out the lead role in developing the strategy and implementation plan related to it which is responsible for the creation of the NSDI's (National Spatial Data Infrastructure's) National Geospatial Data Infrastructure which represents an integrated geospatial data system that enables users to identify and use geospatial information obtained from various sources at local and national level inclusively. ASIG's main role is leadership, development and promotion of joint infrastructure and a genuine cooperation approach with responsible public authorities and other stakeholders.

ASIG is responsible for the establishment of the State Standards for the Technical Specifications of

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Geospatial Information in Albania for each of the themes defined in the law [3], in accordance with European standards (INSPIRE Directive), concrete case topics: Geology where geospatial technical standards for the creation of NSDI, the topic Geology in Albania has been adapted to the technical specifications [4], of the relevant topic in the INSPIRE Directive. Standards should be created for the following fields: metadata, in this field the directive defines the standards on how metadata should be [5]. This standard is unique and applicable to all institutions or third parties that will implement this directive and specification of data-standards for technical specifications of data set out the basic rules of implementation of the NSDI in Albania with the purpose of its use by public authorities responsible for collecting the processing and updating of geospatial information, to achieve a unified and accurate understanding of geospatial data and services, in order to realize their interoperability. These standards are defined for all geoinformation topics [3] in accordance with the INSPIRE Directive.

2. Material

INSPIRE data specification for the theme geology is based on the infrastructures for spatial information that are created and maintained by the Member States. To support the establishment of a European infrastructure, Implementing Rules addressing the following components of the infrastructure have been specified: metadata, interoperability of spatial data sets and spatial data services, network services, data and service sharing, and monitoring and reporting procedures [6]. In the INSPIRE context geology could be seen as a reference data theme as it provides information for several themes [7]: mineral resources, natural risk zones, soil, energy resources, and it has a specific relationship with one of the most important natural resources, water, through groundwater bodies contained in aquifers. Geomorphology describes the earth’s present-day surface, and the processes creating its geometry. Geological data are used in various domains requiring knowledge of the surface and underground geological environment: detecting geo-hazards; ensuring the safe disposal of wastes, nuclear wastes, carbon capture and storage; ensuring the safe construction of buildings; providing information for environmental planning; providing information for natural resources exploration; vulnerability of the underground to contamination; providing indicators for climatic change; providing construction material and minerals. For groundwater and aquifers uses are: water supply (water abstraction); groundwater resources (water availability); providing base flow for rivers, wetlands; protecting ecosystems dependent on groundwater; groundwater quality and quantity assessment; transboundary groundwater management.

Geological information provides basic knowledge about the physical properties and composition of the geologic materials (rocks and sediments) outcropping at the lands surface and forming the underground, and about their structure and their age [7]. It also provides knowledge about aquifers, i.e. subsurface units of rocks or sediments of sufficient porosity and permeability to allow either a significant flow of groundwater or the abstraction of significant quantities of groundwater. Knowledge about landforms is also provided. The main product delivered by geologists for the users is a geological map which is the result of an interpretation of the observations and measurements made on rocks and sediments, on and under the surface. Because the rocks forming the subsurface are visible or accessible only on very small parts of the surface, the outcrops, geologists must interpret these observations and measurements to group rocks in geologic units, and to connect other information observed locally to identify the general geological structure. Boreholes are another important source of information for interpreting the subsurface geology. These can provide a stratigraphic and lithological log, analogous to a vertical geological map, and can also be used to gather samples and make measurements of various properties at depth. All this information is interpreted to make geological maps. The landforms (geomorphologic features) are often indicated on general geological maps, and are detailed on specific, applied geomorphological maps. Geology characterized according to composition and structure includes bedrock, aquifers and geomorphology [8].

3. Methods

The geological data model contains [9]: geologic features with geologic events, geologic units, geologic structures and geomorphologic features. The geometry of these features is described in Mapped Features and is included in geological maps and profiles in the form of points, lines and polygons. Mapped Features and Boreholes can be bundled in Collections, Thematic Class for reclassifying Geologic Features as some thematic class for thematic maps, the lithology of rock units, the processes of Geologic Events and their environments and ages, the types of Shear Displacement Structures and Folds, Borehole details, such as location and purpose.

The types to be used for the exchange and classification of spatial objects from data sets related to the spatial data theme "Geology" are defined in the following application schemas:

Geology application schemas provide basic geological, hydrogeological and geophysical knowledge on an area, with an agreed set of attributes. The application schemas specify requirements on the properties of each spatial object including its multiplicity, domain of valid values, constraints, etc..

4. Application Schema Geology and UML Overview

Fig. 1 shows only the spatial object types and their relationships. It does not include data types and code-lists [10]. The properties are not visible but are shown in Fig. 2, which describe the main parts of the geology data model.

Mapped Feature and *Geologic Feature* are central classes (spatial object types) in the model. A *Mapped Feature* provides a spatial representation of a *Geologic Feature*. The *specification* association from *Mapped Feature* to *Geologic Feature* allows only one Geologic Feature to be represented by any Mapped Feature. As well as standard geological maps the model allows the description of thematic maps using the *theme Class* association to *Thematic Class*. A thematic map in this context can be considered as a reclassification of the Geologic Unit in terms of some thematic property, for example reclassifying Geologic Units in terms of their susceptibility to compaction or their potential as a source of aggregate. A theme should have a name and be constrained by a codelist of class values for that theme but as each theme will have different classes, and it is likely different classification systems will have been used by different data providers, it is not possible to mandate any particular codelist of theme class values in the specification. The abstract *Geologic Feature* class represents a conceptual geological feature that is hypothesized to exist coherently in the world and includes as sub-types of the main information classes in the model. The implemented Geologic Feature instance acts as the "description package". There are three sub-types of *Geologic Feature* in the data model: *Geologic Unit*, *Geologic Structure and Geomorphologic Feature*. A *Geologic Event* is defined as an identifiable event during which one or more geological processes act to modify geological entities. Geological age is modelled using *Geologic Ev*ent the age of some geological event occurring. A *Geologic Event* should have a specified geologic age and process and may have a specified environment. The *Geologic History* association from *Geologic Feature* to *Geologic Event* describes a sequence of one or more Geologic Events which together describe the age or geologic history of the Geologic Feature. Commonly Geologic Features will have a geologic history comprising only one Geologic Event, which represents the formation of the Geologic Feature.

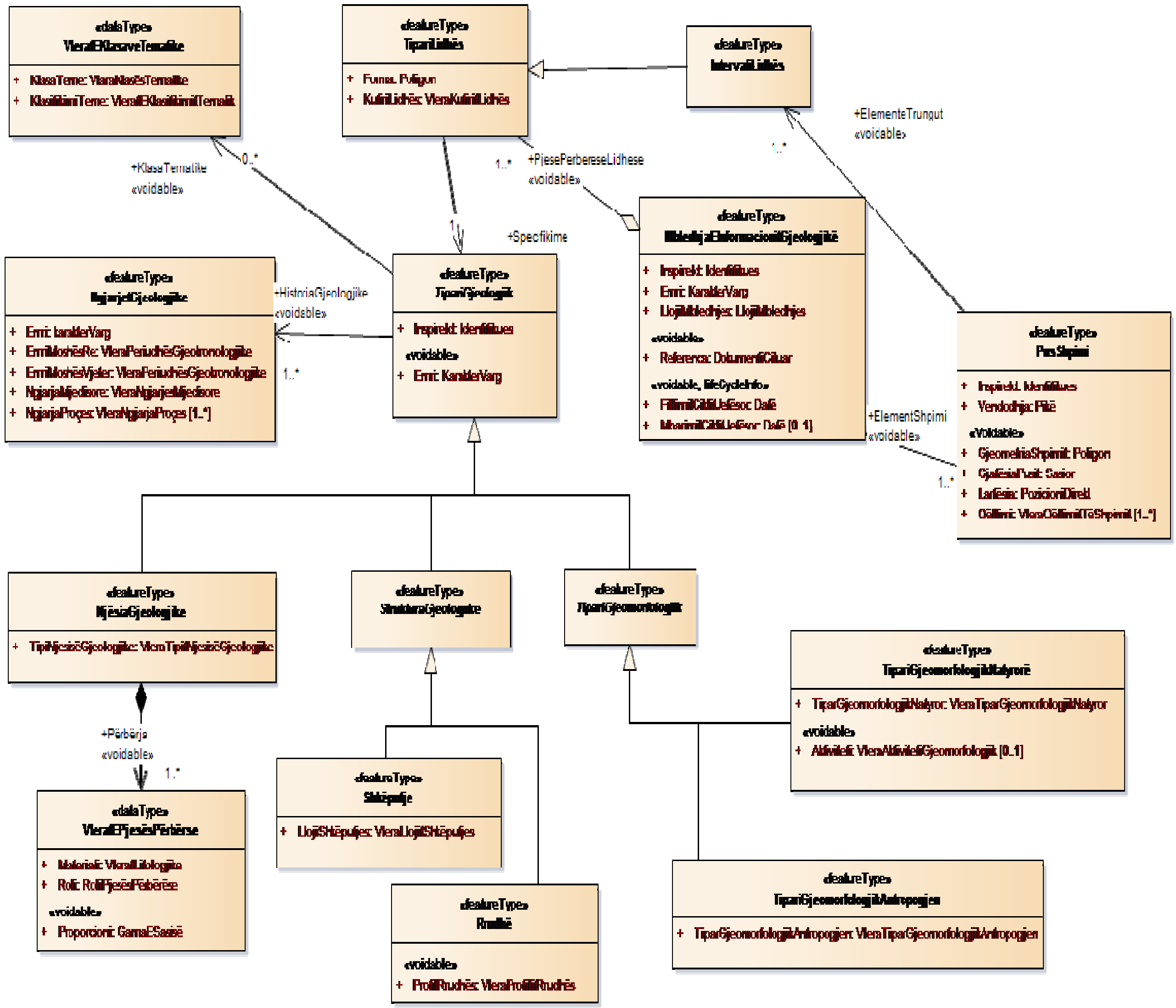

Fig. 1 UML class diagram: overview of the geology application schema.

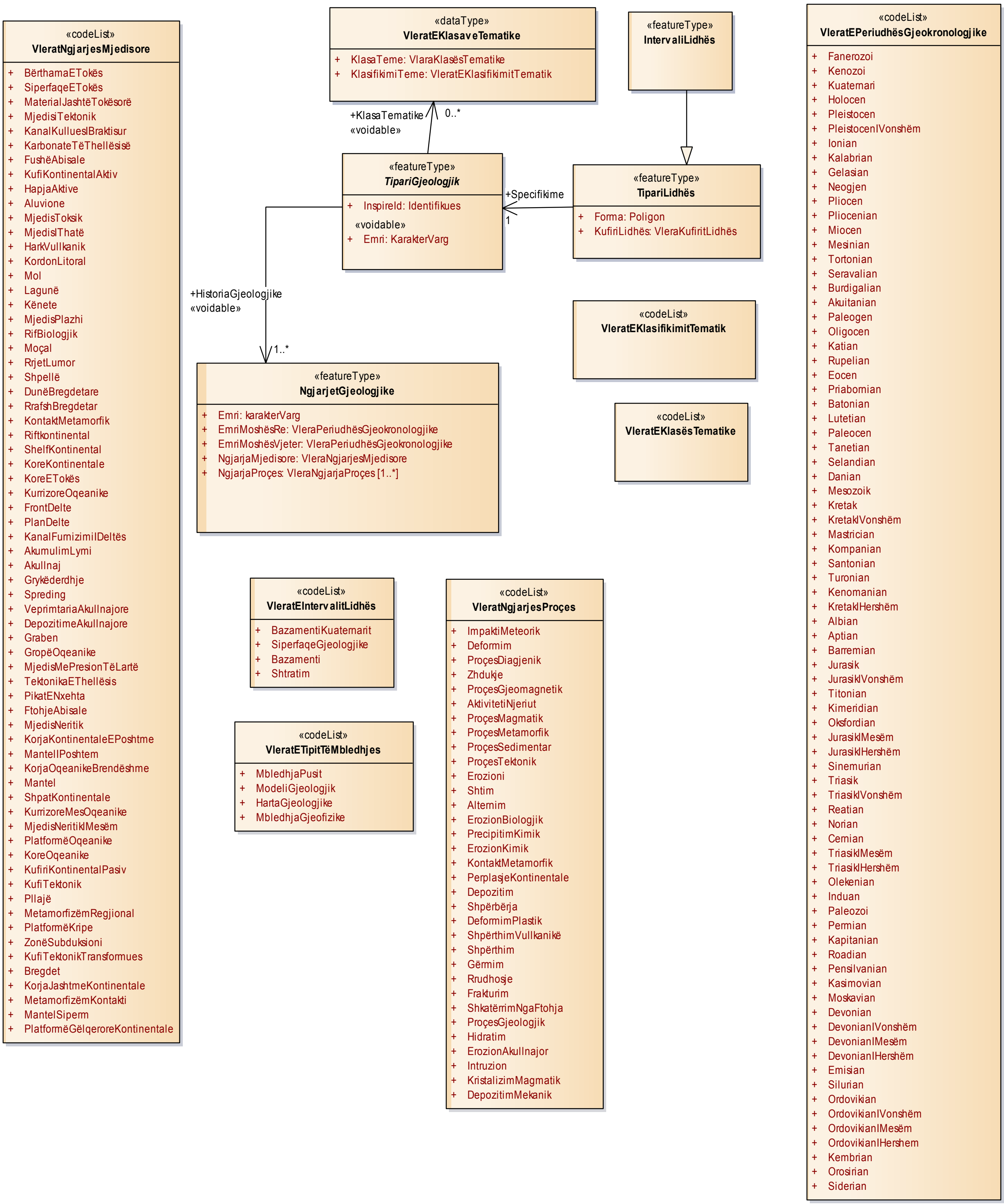

Fig. 2 UML class diagram: geologic feature, mapped feature, geologic event, thematic class.

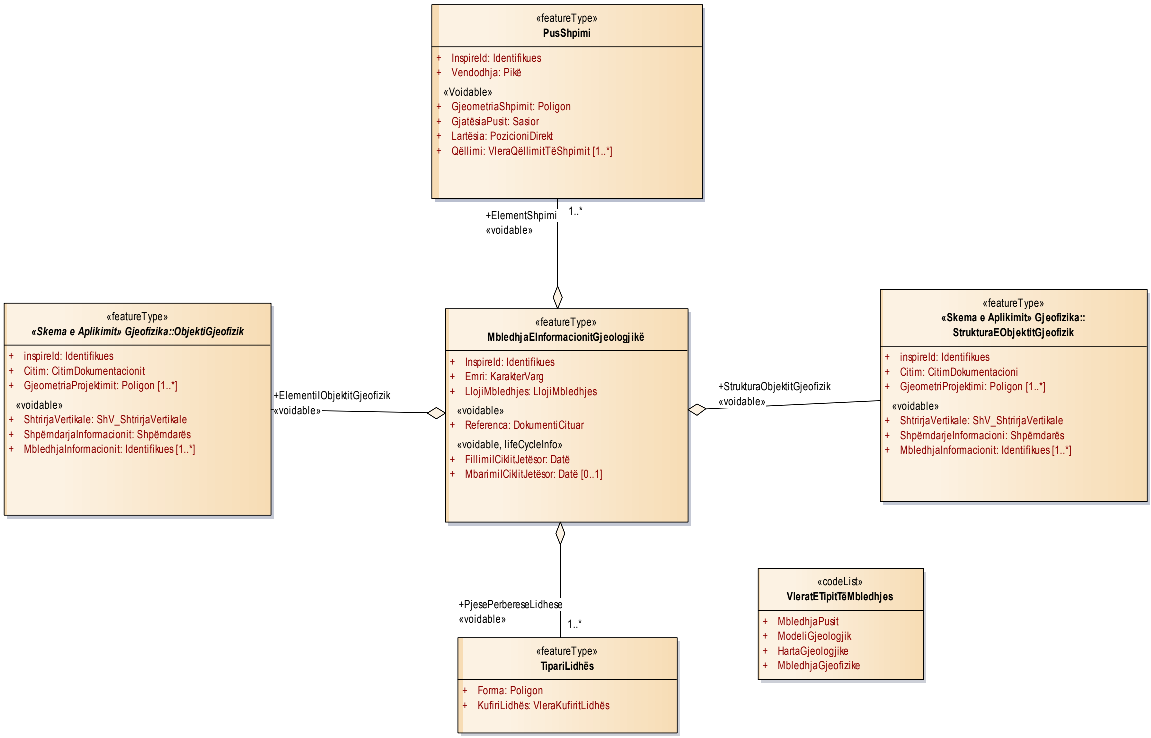

Fig. 3 UML class diagram: geologic collection.

A *Geologic Collection* is a named or identifiable group of geological or geophysical objects. As per Fig. 3, Geologic objects are commonly grouped into collections such as geological maps, thematic maps, groups of geophysical measurements or models of the same type etc., which are familiar to many user communities. The Geologic Collection class allows the delivery of a package of objects that go to make up one of these familiar collections.

Geologic Unit represents a body of material in the earth whose complete and precise extent is inferred to exist as per Fig. 4. Spatial properties are only available through association with a *Mapped Feature*.

The *composition* association from *Geologic Unit* to *Composition Part* allows the lithological description of the Geologic Unit. The composition of a Geologic Unit can be made up of several Composition Parts, for example where there are lithologically distinct components interbedded.

Geologic Structure is defined in Fig. 5 as a configuration of matter in the earth based on describable inhomogeneity, pattern, or fracture in an Earth Material. The identity of a Geologic Structure is independent of the material that is the substrate for the structure. The two types of Geologic Structure in the data model are Shear Displacement Structure and Fold. *Shear Displacement Structure* includes all brittle to ductile style structures along which displacement has occurred, from a simple, single "planar" brittle (fault) or ductile surface to a fault system comprised of tens of strands of both brittle and ductile nature. *Fold* describes one or more systematically curved layers, surfaces, or lines in a rock body. A fold denotes a structure formed by the deformation of a Geologic Feature to form a structure that may be described by the translation of an abstract line (the fold axis) along some curvilinear path (the fold profile).

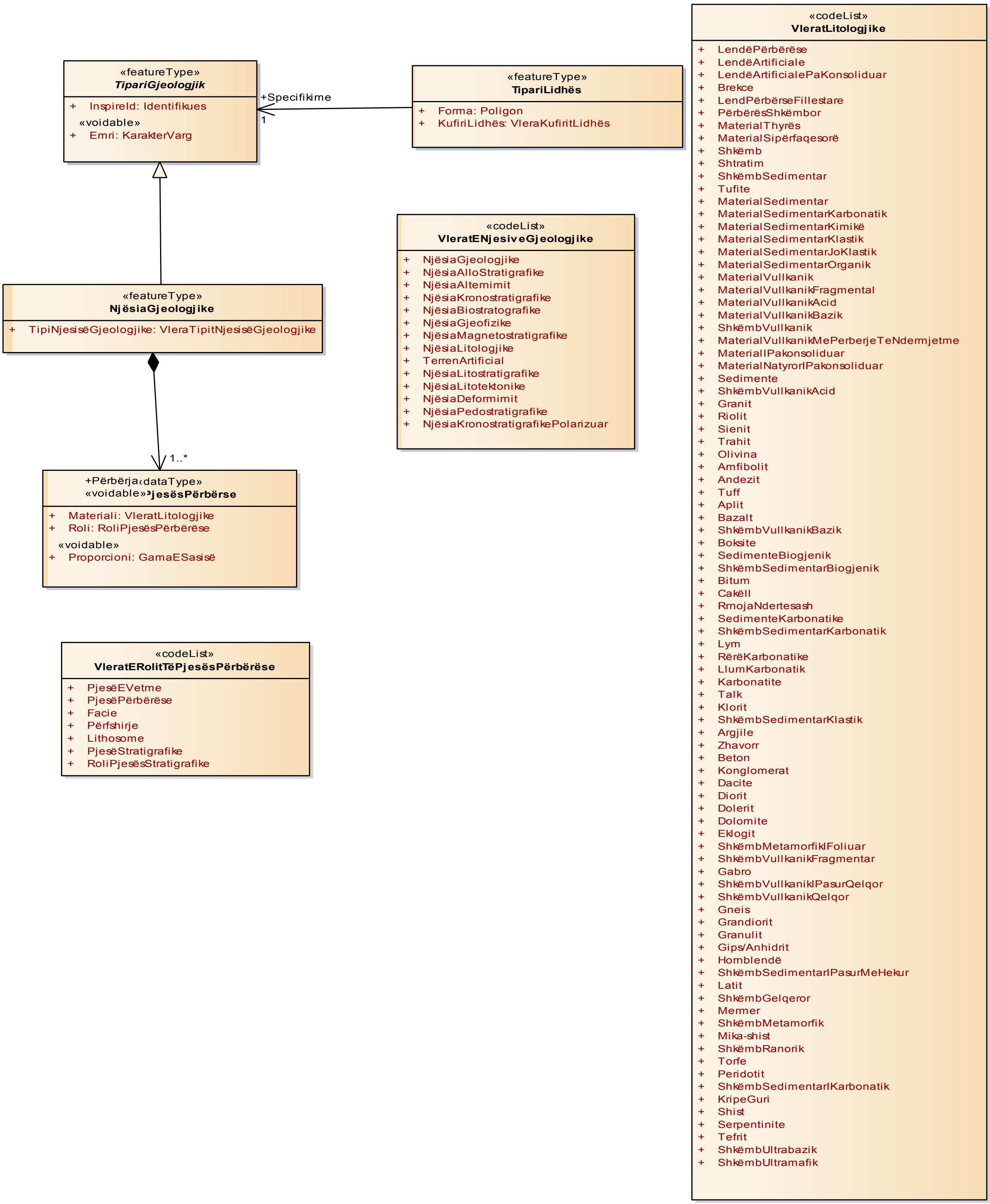

Fig. 4 UML class diagram: geologic unit.

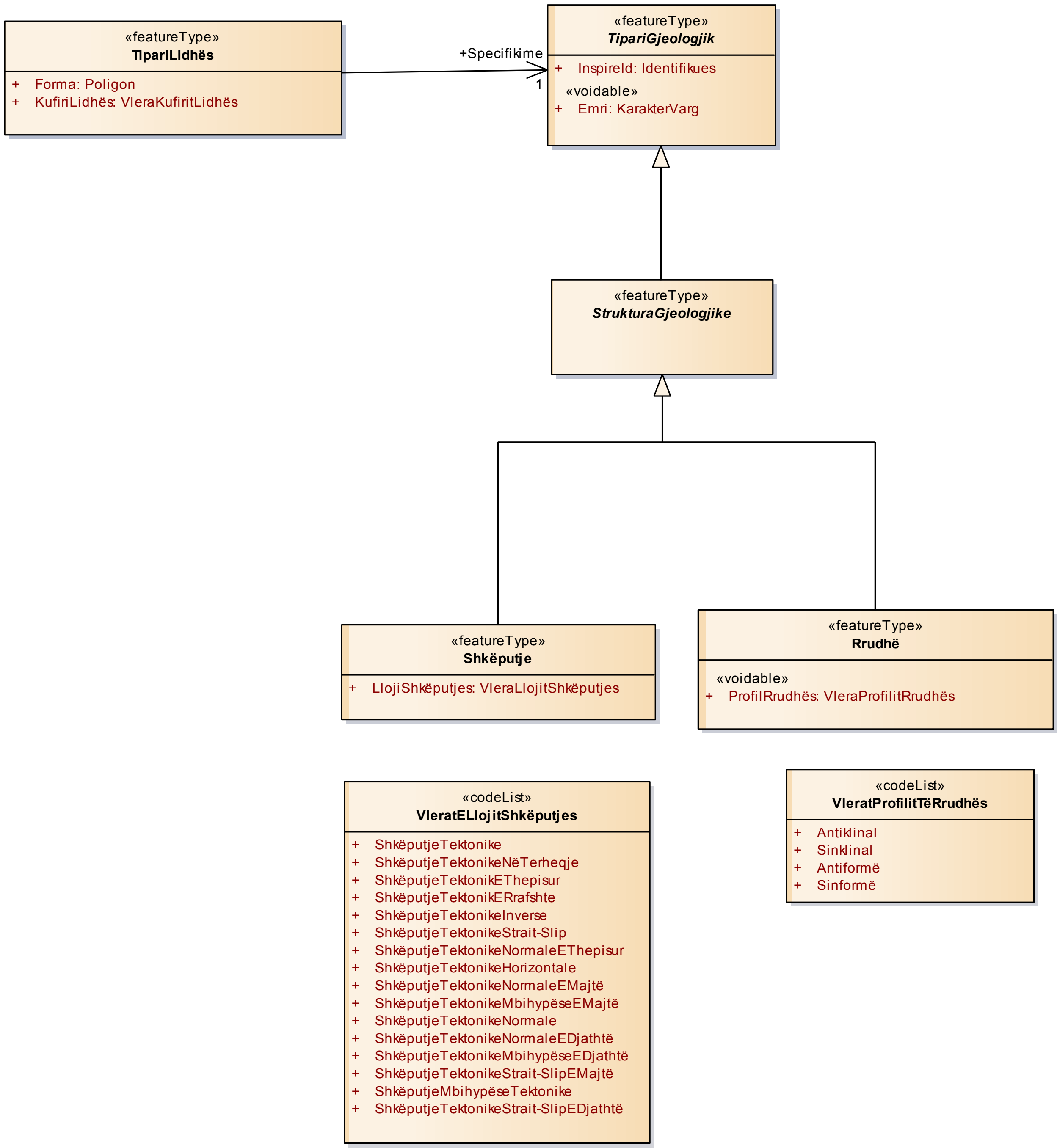

Fig. 5 UML class diagram: geologic structure.

5. Conclusions

This standard creates a structural model of data according to the directive INSPIRE and the referring system Geodetic Framework "KRGJSH2010", which provides collection and offers this information according to the article [3], "On the Organization and Functioning of the National Infrastructure of Geospatial Information in the Republic of Albania", Below in a systematic way and illustrated with the geological map of Tirana Fig. 6 is shown the way of harmonization of the existing data according to this standard. The term "data harmonization" means the conversion of the existing database of geospatial data

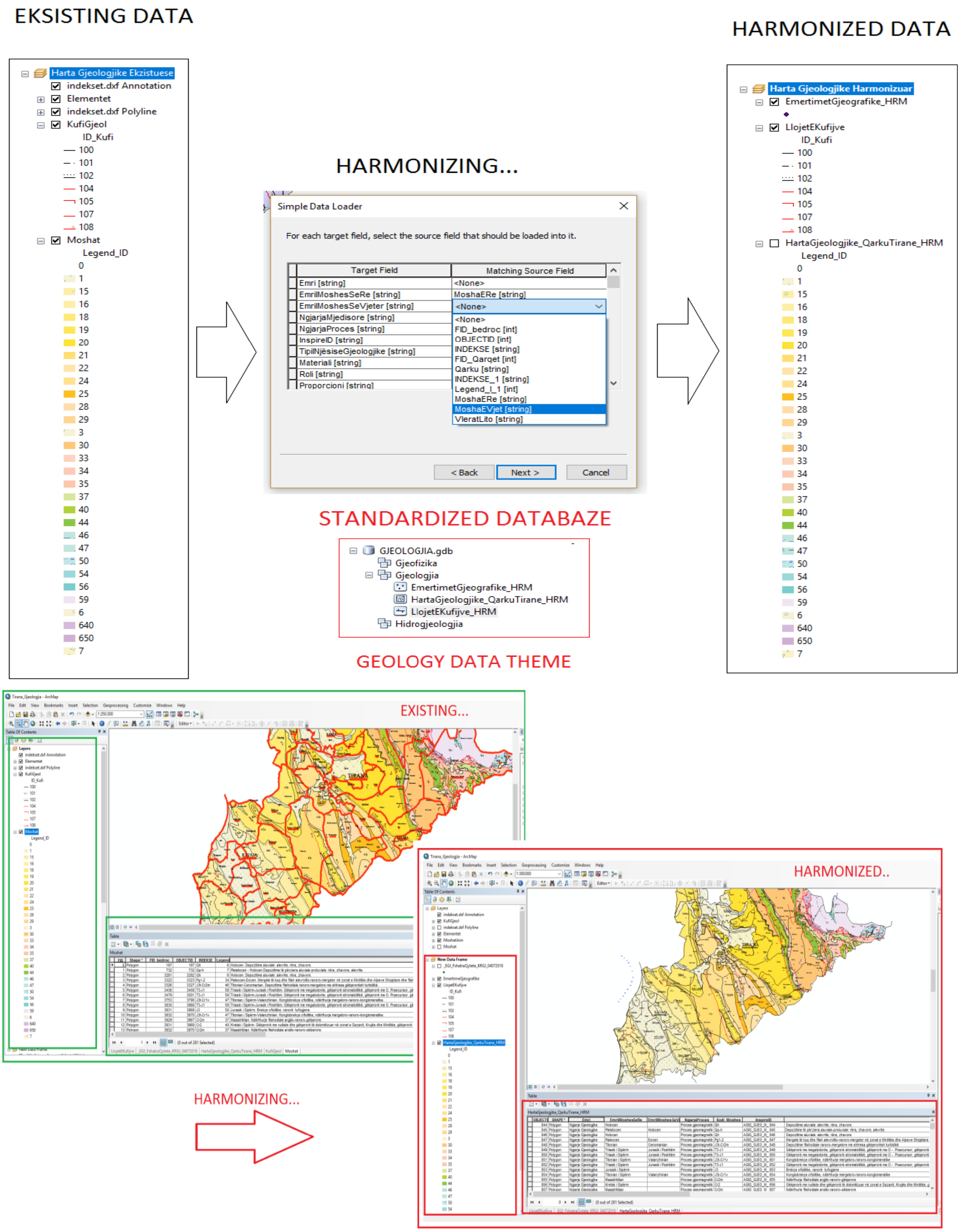

Fig. 6 Structural model of Geology Theme and data harmonization.

according to the database format specified in the standard with the respective topic as well as of data according to the standard.

References

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