The Development of Popular Science Portal “Living Earth: Geological Perspective”

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Abstract

The study describes an approach for creation of popular-science internet-resource “Living Earth: Geological Perspective”. The internet-resource being developed is aimed to popularize modern geological knowledge by providing popular science multimedia content and tools for interactive interaction with it. The internet-resource is intended for wide range of Internet users. In the same time the whole information represented on it should be contemporary, scientifically verified, valid and actual. Important aspects of the portal are the simplicity of material representation and attractiveness for users of the modern “digital” community.

1 Introduction

Science popularization, “translation” of specialized knowledges into language of untrained listener, is one of the most important tasks of science popularizer. The task of the science popularizer is to transform difficult scientific data into interesting and understandable information for most of the people [Sam07, Obz17].

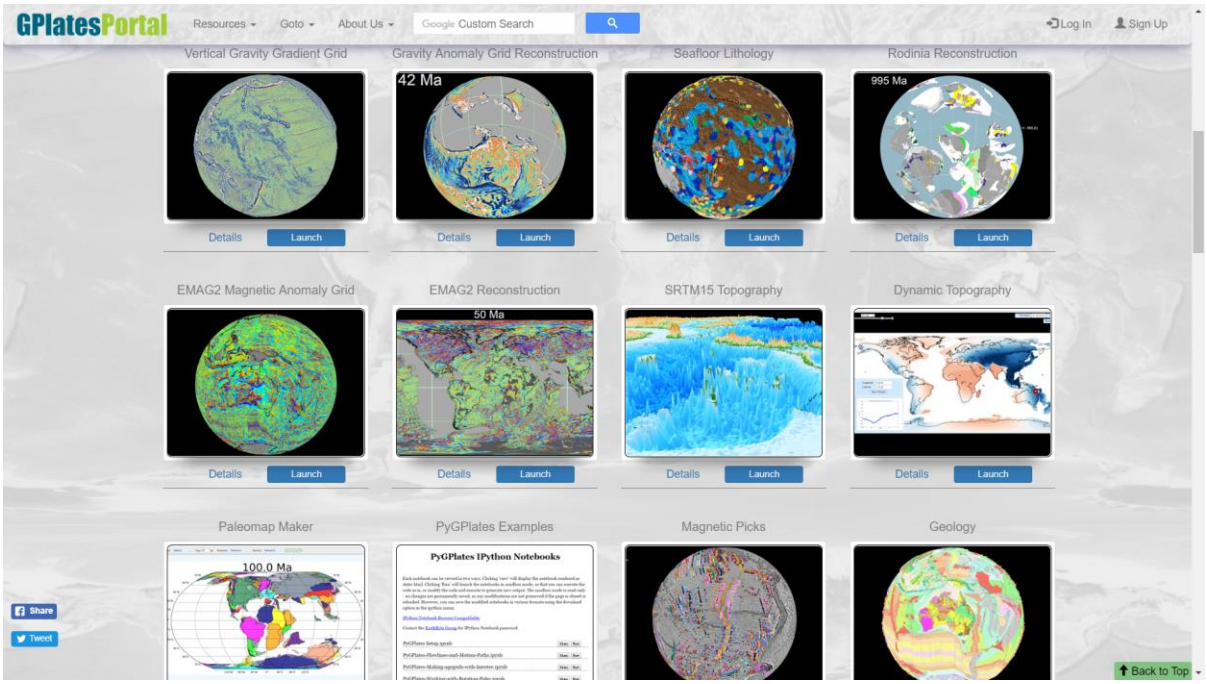

Figure 1: The main page of active foreign popular science resource dedicated to certain aspects of the geology of the Earth – GplatesPortal

The most effective means of science popularization are media, scientific-popular lectures, magazines, books, TV shows, radio and films. In the modern world the Internet provides great opportunities and the latest technologies for scientific popularization among the widest segments of the population, including youth [Mak13, Zhu18].

Today there are plenty of internet resources related to science including resources aimed at science popularization. Such resources mainly consist of regularly updated news feeds combining information in various fields of science (*http://www.ebizmba.com/articles/science-websites*). But, most often, they do not provide the opportunity to interact with the resource in an interactive form. There is one example of modern interactive portal related to geology of the Earth – Australian portal "GPlatesPortal" (*http://portal.gplates.org*). The advantage of this resource is a visual way of popular science information representation (Figure 1). Among the shortcomings can be noted a large amount of scientific data about the Earth, poorly understood by an uninitiated user.

The main goal of the Museum project is popularization of modern geological knowledges by presenting it on the internet portal, in museum exhibitions and at traveling museum exhibitions using modern information technologies. It has a conception of dynamic time as a basis. The conception provides interaction with information of the portal both in time and space. The most important aspects of the Portal being created are friendly interface, interactivity, virtual reality, modern ways of visualization of different types of information, ease of information representation and computer attractiveness for users of modern "digital" society.

2 Project "Living Earth: Geological Perspective"

To create the internet resource in 2018 there were started works on development and creation of Scientific-popular portal "Living Earth: Geological Perspective".

The portal consists of thematic volumes: "Time", "3D-Earth" and "Information layers" (Figure 2). Each module provides a way of interaction with it using timeline and space. The complex developed includes a 3D-model of the Earth, a dynamic time model and also a multilayered GIS-system with function of different thematic information visualization. As an information content the modern scientific publications and modern development in the field of geology are used. The modern scientific achievements in lithospheric plates movements reconstruction, volcano researches, geological sections and other geological materials are also used.

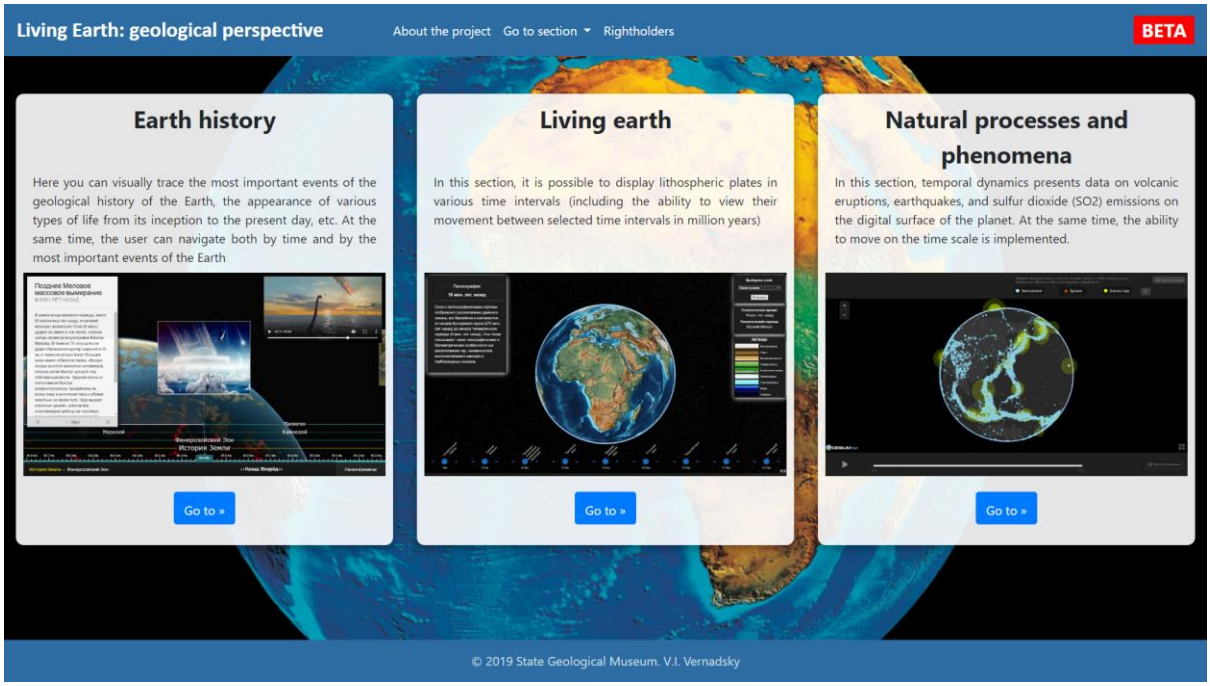

Figure 2: The main page of the Portal "Living Earth: Geological Perspective"

The "Time" module is a pass-through module of the Portal. By interacting with it, it is possible to view the most important events of the geological history of the Earth. Each event in this module has an ability to show

more detailed information including text and multimedia content in a form of interactive pop-up cards. The transition from one time period or event to another is accompanied by smooth animation.

During interaction with “3D-Earth” module user has an ability to find different geological artefacts, cross-sections, 3D objects (e.g. volcanos), lithospheric plates in different time intervals, including an ability of their movement overview within different time intervals. When artefact is selected the user can obtain a reliable information about it, including short description, image and video. The user can also track the artefact position within the time together with lithospheric plates movement starting from its discovery position ant till its dating time. This block also includes a mechanism of smooth animation of lithospheric plates movement.

Module “Information layers” represents an original multilayered GIS-system. The module has an ability of thematic materials and its combinations view: “Geodynamics”, “Stratigraphic and paleontology”, “Minerology”, “Natural resources”, “Relief”, “Biosphere”, “Atmosphere and climate”, “Hydrosphere”. It also has an ability to show geological artefacts based on digital cover of the planet using such filters as location, geological time period, artefact or event type and artefact layer type. The mode of detailed overview of selected artefact is also available. In that mode user has an ability to get all available information about the artefact in a simple visual form. It is necessary to notice an ability to switch between “Time” and “3D-Earth” modules during different artefacts and events overview.

3 Main information sections of the Portal

3.1 “Earth history” section

In this section the most important events in geological history of the Earth are available. Appearance of different life forms from their origin till nowadays. The user has navigation both by time and by the most important events of the Earth: life genesis, appearance of amphibians, appearance of dinosaurs, ice ages etc. For each event it is possible to obtain more detailed information, including textual, graphical and multimedia content in a form of interactive pop-up cards (Figure 3). The transition from one time period or event to another is accompanied by smooth animation.

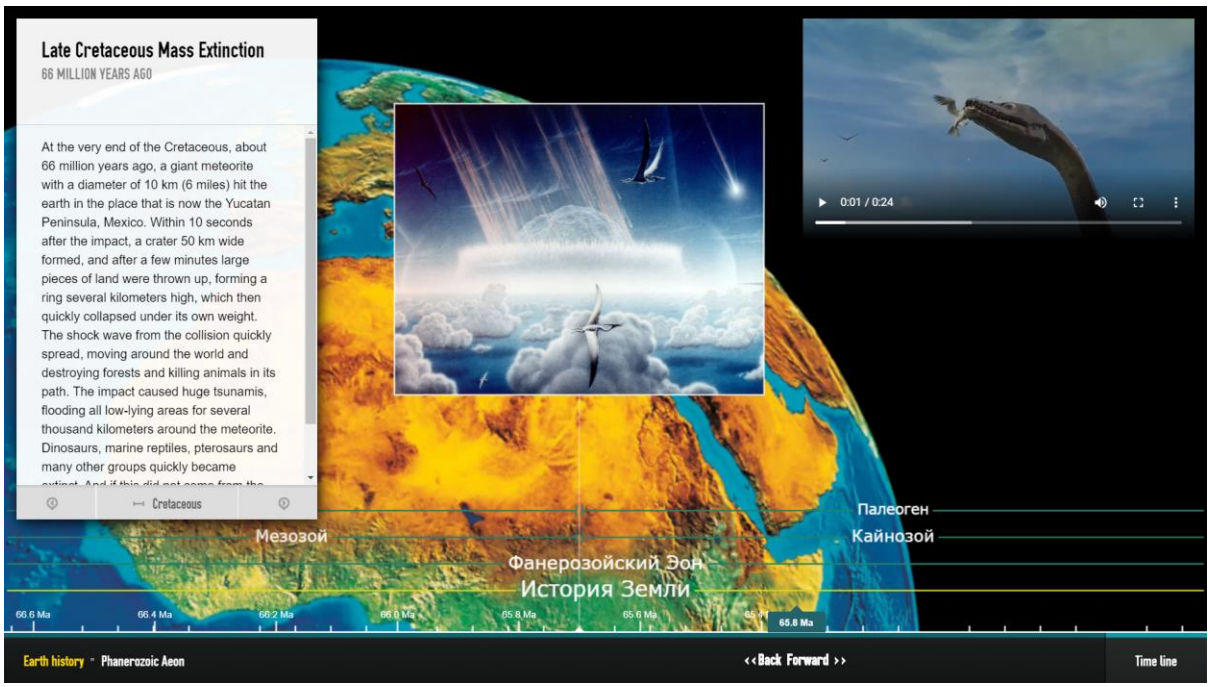

Figure 3: Entrance page of the Earth History section with the main control elements and multimedia content

3.2 “Living Earth” section

This section of the Portal provides an ability to visualize movement of lithospheric plates in different time intervals (Figure 4) and to visualize geo-position of different geological artefacts, cross-sections, geological 3D-objects. User can get various information about the artefact being selected including short description, image

and video. The selected artefact can be tracked both in time and space on the surface of the Earth, including its location on the lithospheric plate.

3.3 “Nature processes and events” section

The section includes data of volcanos eruptions, earthquakes and dioxide sulfide pollutions (SO_2) on the basis of digital Earth cover (Figure 5) with timeline controller ability. The detailed overview of selected event or object is available. There is available an animation speed controller. The section has a brief user guide and legends description for all types of events.

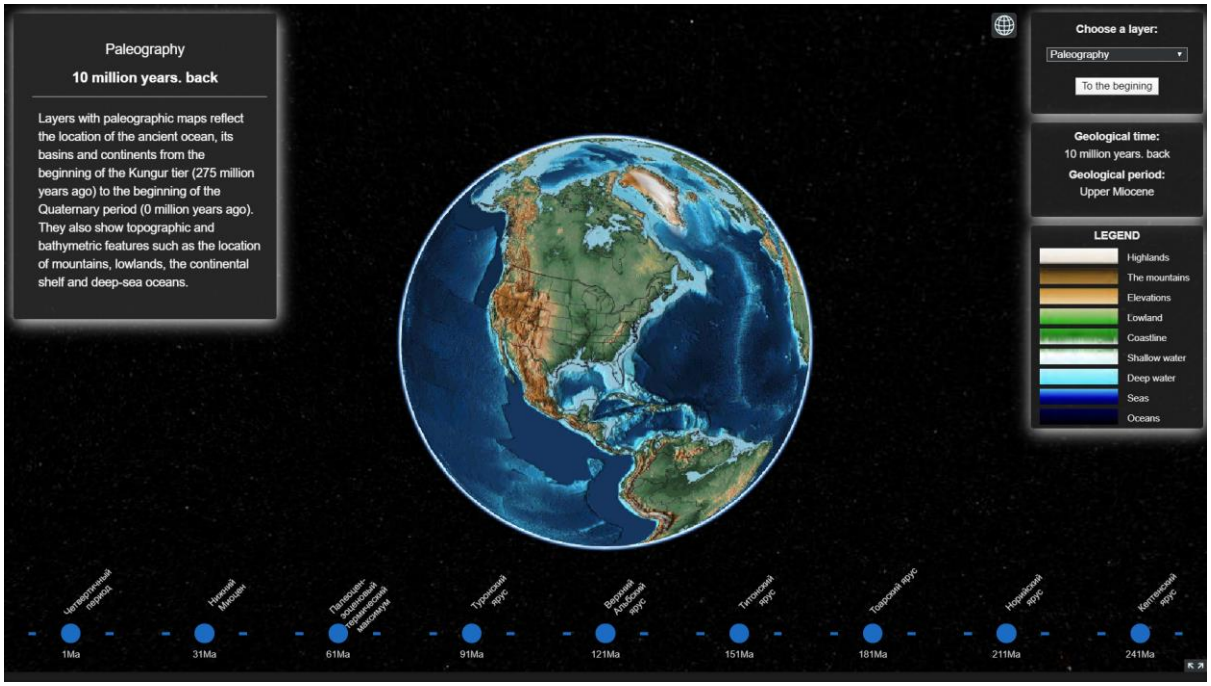

Figure 4: Entrance page of the Living Earth section with controls and information blocks

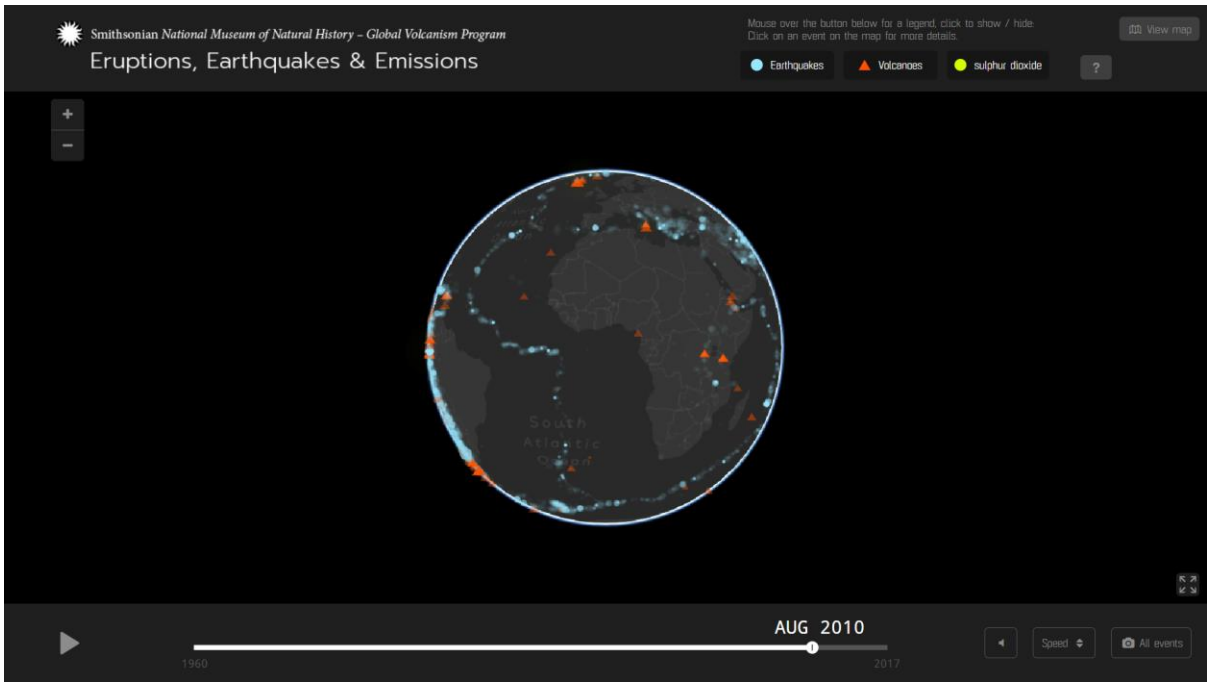

Figure 5: General view of the interface of the section "Natural processes and phenomena"

4 Technological and program solutions used

The Portal is based both on developed solutions and modified free 3rd party software. Most of the blocks are implemented to work on the client side in browsers with automatic loading and buffering of various multimedia information.

As a basis for the "Living Earth" section the open js-library Cesium v1.58 is used (https://cesiumjs.org/refdoc). The library is intended for creation of 3d globes and 2d-maps in web-browsers. Cesium uses WebGL for hardware accelerated graphics. The library is cross platform and is aimed to dynamic data visualization (http://gis-lab.info/docs/osgeo/ru/overview/cesium_overview.html).

The basic features of Cesium used in museum Project are: visualization of layers on the basis of WMS standard, visualization of vector data in GeoJSON format and 3D-models visualization. Cesium has an ability for visualizing big amount of different geometric primitives (lines, polygones, object, labels etc.) and to use standard widgets for timeline control, layers selection and zooming. Cesium allows to visualize information in the form of 3D globe, 2D and 2.5D maps.

The basic program solution for "Earth History" section is a geological Timeline on the basis of ChronoZoom project from Microsoft (*https://www.microsoft.com/en-us/research/project/chronozoom*). The project has been modified by Lane Olson, a member of the University of Alberta (Canada) (*https://d396qusza40orc.cloudfront.net/dino101/timescale/timescale.html*). This scale has further modifications by the authors of the Portal. The main feature of the Scale is its "endless" scalability and the ability to describe events located at great distance in time (billions of years). The Scale uses data in json format for visualization. The data is downloaded from the server by a request. Each event or artefact on the Scale is a unique label with detailed description. The description includes: a card with text description, image of the event/artefact and pop-up video. The description appears when the event is selected.

The user can switch between labels on the Scale using forward/backward arrows or pop-up menu located in the right corner and also using mouse scrolling.

The module developed by the Smithsonian Institution [Glo16] is used as the basic software solution for the section "Natural processes and phenomena". It is intended for dynamic visualization of natural processes in time. This module is based on the CESIUM javascript library and uses its API to synchronize the timeline and displayed content on the main screen of the user interface.

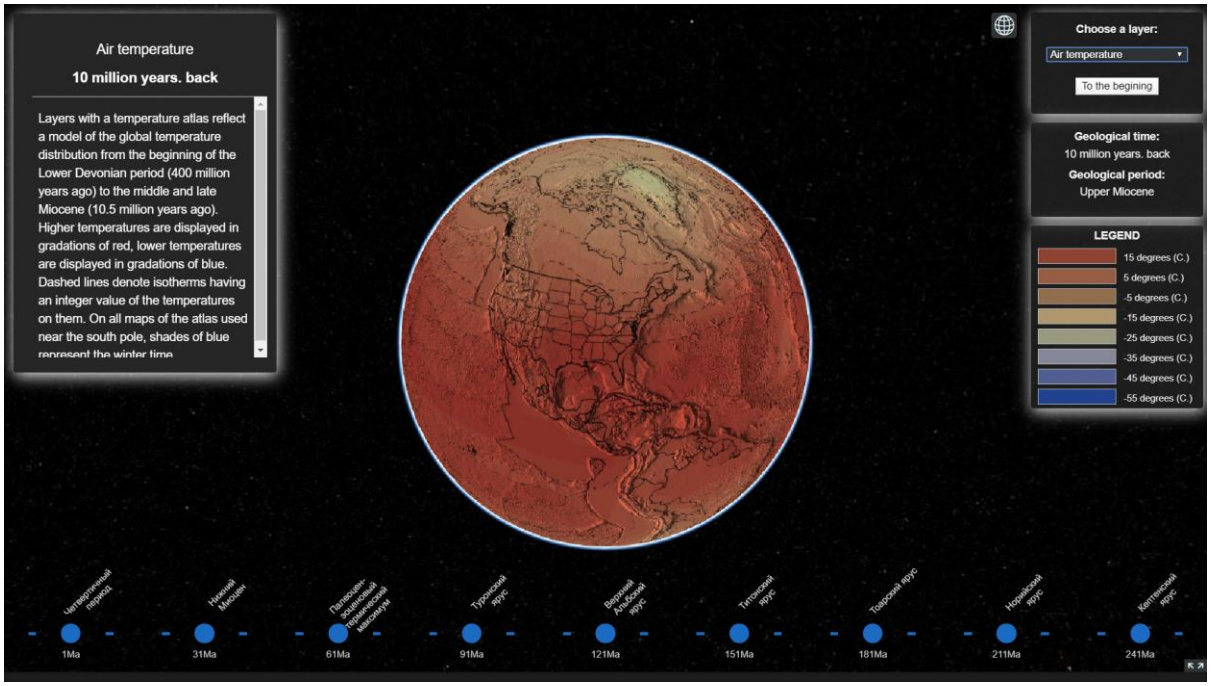

Figure 6: Atmospheric temperature information layer with description and legend [Sco16]

5 Used scientific popular data

The content of the Portal is based on modern scientific publications and solutions in different branches of geology: paleontology, geodynamic, magmatism, sedimentation and relief, hydrosphere, atmosphere and

climate, biosphere, minerals. Recent scientific achievements in lithospheric plates movement reconstruction are used. Additionally, the accumulated scientific material of the Museum is involved [Che18]. The material represents collections of geological artifacts, excavations and various geological reference objects discovered in Russia and abroad.

5.1 Earth geology data

Modern scientific achievements in the field of lithospheric plates movements reconstruction, 3D-relief and climate are used as basic information layers. The results of world-class scientific works of American geologist Christopher Scotese [Sco17] are one of the basic data sources. These data most accurately and in detail reflect the nature and process of changes in various layers of the Earth's surface at the scale of geological time.

5.1.1 Paleography

One of the basic layers used in 3D-Earth section is a paleogeographic atlas (Sco16). Paleogeographic maps shows location of ancient ocean, its basins and continents. They also show such topographical and bathymetric features as location of mountains, valleys, continental shelf and deep oceans.

5.1.2 Temperature atlas

The temperature atlas is based on the model of global temperature distribution from the beginning of Cambrian period (542 Ma) to the middle and late Miocene (10.5 Ma) (Figure 6). Higher temperatures are shown in gradations of red, lower temperatures are shown in gradations of blue. Dash lines shows isotherms with digital values in Celsius. On all maps of the atlas near the south pole, shades of blue color show the winter time [Sco14a].

5.1.3 Precipitation atlas

The precipitation atlas of the Phanerozoic aeon was created based on a model of the average annual distribution of precipitation over the period from the Cambrian period (542 Ma) to the middle/late Miocene (10.5 Ma) (Figure 7). Light-blue squared areas show value of precipitations. Zones indicated by gradations of green are regions where precipitation is superior to evaporation. Land areas of brown and dark brown indicate places where evaporation exceeds precipitation [Sco14b].

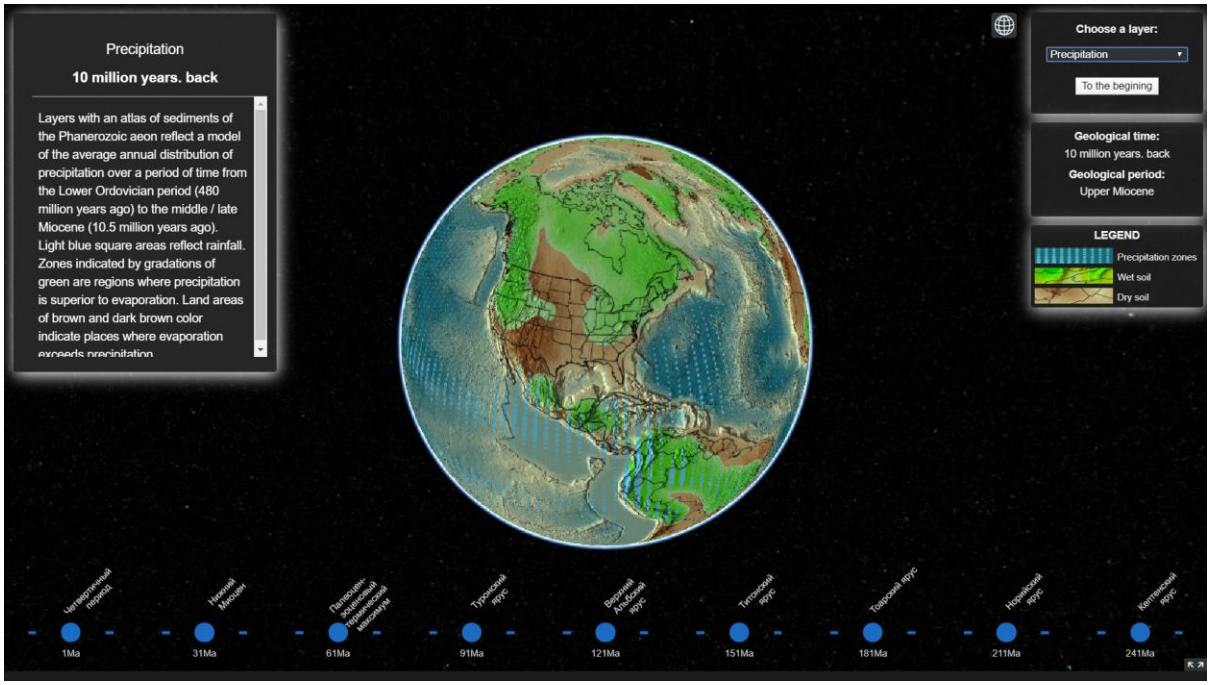

Figure 7: Precipitation information layer with description and legend [Sco16]

5.2 BBC film: “History of the Earth for 2 hours”

As an audio-visual accompaniment for the section “Earth History”, thematic fragments of the BBC film “Earth History” were used (*https://www.youtube.com/watch?v=8skl3ZifTpI&t=4225s*). This film was chosen because of professional compliance with the level of popular science knowledge, high-quality graphics and sound. Fragments from this film were selected in such a way as to most fully and in an accessible form reveal the description of the selected event/artifact.

5.3 Data of volcanic eruptions, earthquakes and sulfur dioxide (SO2) emissions

Volcanic eruption data provided by the Global Volcanism Program (GVP) of the Smithsonian Institute for Earth volcanology (*http://volcano.si.edu*). Research and documentation of volcanic activity under this program has been ongoing since 1968.

Earthquake data source is the US Geological Survey (USGS) earthquake directory (*https://earthquake.usgs.gov/fdsnws/event/1*). Sulfur dioxide data source – data received on the basis of satellite remote sensing: OMI (Ozon Monitoring Instrument), installed on the Aura satellite (*https://so2.gsfc.nasa.gov*), OMPS (Ozone Mapping and Profiler Suite), installed on the Suomi-NPP satellite and TROPIMI (TROPOspheric Monitoring Instrument), installed on the Sentinel-5P satellite. This data is available since 1978.

5.4 Popular science images on Earth geology

Media from open data sources were used to visual design of the Portal, including various resources on the geology of the Earth (GEOLOGY page, GeologyIn, MoviePilot).

6 Conclusion

The beta version of the museum’s Popular science Portal “Living Earth: Geological Perspective” at the current moment is available for testing and refinement to a wide range of users. The authors plan to use the Project within the Museum Program for development of continuous educational system for children and youth in the field of geology and environment management, education of ecological ideology, career guidance in mining and geological fields.

Specialized version of the Internet-resource is an information core for realization of museum exhibitions, including with use of regional and local collections. The use of this version for the organization of visiting thematic exhibitions, specialized expositions of school and local history museums is provided.

The project is being implemented at the State Geological Museum of V.I. Vernadsky, in the framework of the State Assignment No.0140-2019-0005 “Development of an information environment for integrating data from natural science museums and their processing services for Earth sciences”.

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