**Chapter 26**

# Globes on the Web – The Technical Background and the First Items of the Virtual Globes Museum

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## Abstract

The "Virtual Globes Museum" project has several aims. It preserves globes for the future and provides an opportunity of examining rare globes without the risk of doing any harm to them. It also can help in globe-restoring as the restoration work can be done on the virtual copy of a globe.

The first part of the paper will present possible solutions to the problem of interactive digital globe publishing on the Internet. It describes the processing method of the two possible source materials: globe prints and photographs. The visualization of results is realized in two different ways. The first one is a 3D virtual world created by using the VRML language. The second one is a special "globe layer" in KML, which can be used in the Google Earth software. The advantages and disadvantages of each solution are also examined.

The second part of the paper will introduce the most interesting items of the museum.

**Keywords:** virtual globe, 3D visualization, globe museum

## 26.1 Introduction

Globes are really multipurpose objects. They can be used as educational tools, as ornaments or simply to prevent table-clothes from being swept by the wind. Everybody likes looking at them and spinning them around. The desire of touching the globe is even greater for old ones. The librarians or museologists, however, try to keep their precious spheres untouched in order to lengthen their lifetime as long as they can. The Virtual Globes Museum can be a cure to this conflict as visitors can do anything with the exhibited items without causing any harm to them.

Until the end of the 1980's, when the technical development swept away the traditional globe production technology, the globes of Cartographia (the monopolistic company of Hungarian cartography during the communist time) were very popular not only in the Eastern Block, but throughout Europe. The original aim of the project was only to archive the remaining objects of the Hungarian globe production until they are in good condition.

After examining the possibilities, several new, realizable aims were identified:

- The capacity of an average PC and the usual bandwidth of the Internet connection nowadays make it possible to publish three-dimensional objects on the web. One of the tasks is to develop easily publishable 3D globe models.

- Developing and presenting the method of digital virtual globe restoration on a specified globe in order to free the restoration process of any risks.
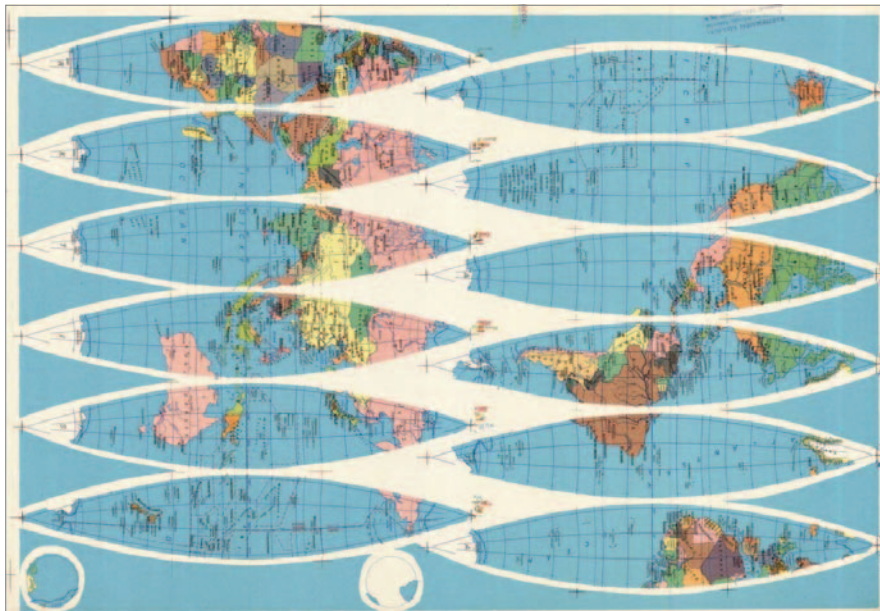


**Fig. 26.1.**   Globe print

- Producing new (thematic) globes (Márton 1975).
- As the authors have found a lot of interesting globes apart from those of Cartographia, it was decided to process all the globes that are somehow related to Hungary (either they were produced or can be found in Hungary).

There are other virtual globe projects. János Balázs had made a digital version from Waldseemüller's globe (Török and Balázs 2008), but the content is not the original: only the coastlines were redrawn by graphic software and some names were put onto it. The result is an animation, which does not let the user interact.

Another project is Andreas Riedl's "hyperglobe" (Riedl 2000, 2003). This shows several ways of globe visualization. With Florian Hruby and Irmgard Plank he created the digital copy of Mercator's globe by using photographs (Hruby et al 2006). Although the processing method was quite similar to the one described here later, there are some differences: they georeferenced smaller areas and used different software for it. They also examined alternative display technologies for better visualization (Hruby et al 2005).

The largest difference between these projects and that of the present authors is that in the Virtual Globes Museum project several globes are shown in their current, real state. There is a searchable background database, which contains detailed datasheets for each globe. The models are fully interactive, and visitors can spin the globes around, zoom in and out.

## 26.2  Source materials

The first problem when making a digital globe is the question of sources. As three-dimensional scanners are not widespread these days, it is difficult to get a digital image of a globe's surface.

The biggest help here is the unmounted globe prints (Figure 26.1), if they are available. In most cases they or at least the pilot prints of globes were found. These sheets can be easily scanned by a traditional scanner.

There are − especially manuscript or illuminated (hand-painted) − globes, however, for which there are no prints. In these cases, several photographs have to be taken of the globes. The photoshots need special conditions (Figure 26.2). The position of the camera and the globe has to be fixed, but rotating the globe around its center to any direction must be possible. These restrictions are required in order to assure the same lighting conditions for each photo. There must be specially arranged lamps, and also the exclusion of any outer light. And at last but not least, an expert photographer is needed.

Figure 26.3 shows what happens when the conditions are not perfect. The authors had the opportunity to make a photo series of a globe in a library, but did not have

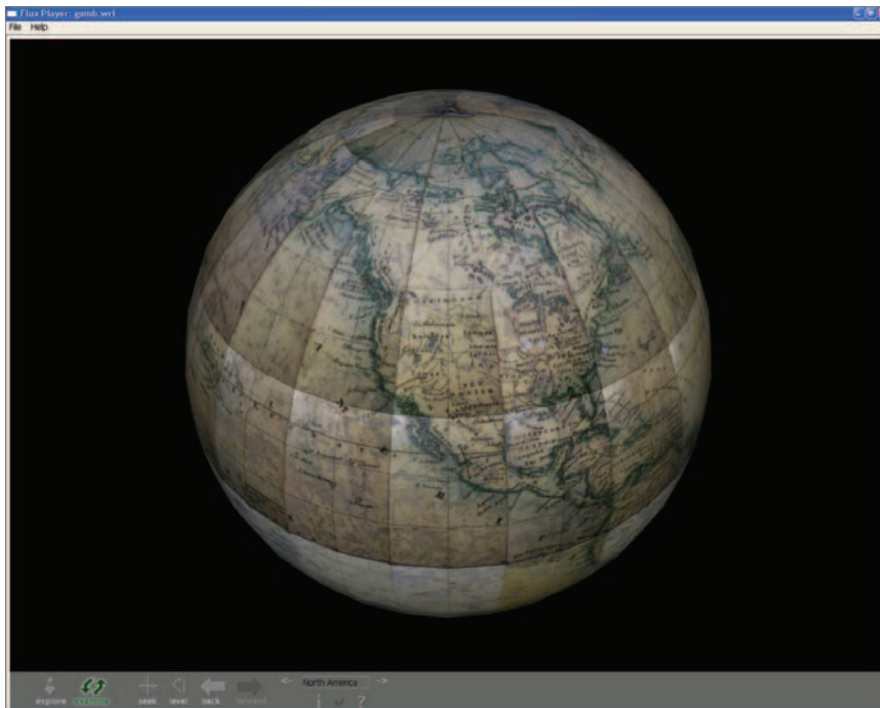**Fig. 26.2.**   Photographing a globe needs special equipment and conditions



**Fig. 26.3.**   Tone differences caused by insufficient photographing conditions

**Fig. 26.4.** Moire effect appearing due to the interference of the sampling grid and the printing raster

the required equipment as they were just visiting a conference abroad. Without special lighting and a photographer, they managed to take all the photos, but the resulting quality of the digital globe is rather poor.

## 26.3  Image processing

Once we have the digital images, we have to georeference them. It is quite easy for the unmounted prints, because their projection is known: Cassini projection (known as Cassini-Soldner by GIS applications) for the segments and Azimuthal Equidistant for the polar caps. The control points of the georeference can be the intersections of the geographic grid.

Georeferencing the photos is slightly more difficult. If the globe photo is treated as a map, its projection is Tilted Perspective (Snyder 1987), which is not known by any GIS program. However, if the centre of the globe is on the optical axis, it is a Vertical Near-Side Perspective projection. Knowing the name of the projection is far not enough as it has several parameters: the longitude and latitude of its

central point and the relative height of the perspective point. In order to solve this problem, a program had been developed which uses the Downhill Simplex method (also called Nelder-Mead method) (Nelder & Mead 1965) to find the optimum of these values by using the given control points, which are again the intersections of grid lines; for celestial globes, some stars whose coordinates can be determined can serve as control points.

After georeferencing, a projection transformation of these images to Plate Carrée is applied. The reason is that in this projection the images can be easily assembled into one image. Attention must be paid to the Moiré effects that can appear during resampling the images in the new projection (Figure 26.4). This effect can be prevented by using a Moiré filter.

## 26.4  The ways of visualizing the globes

The first idea to visualize the globes was to use VRML language (Virtual Reality Modeling Language) (Carey & Bell 1997). A spherical object was developed that consists of six surfaces. There are two polar caps and four geographical quadrangles
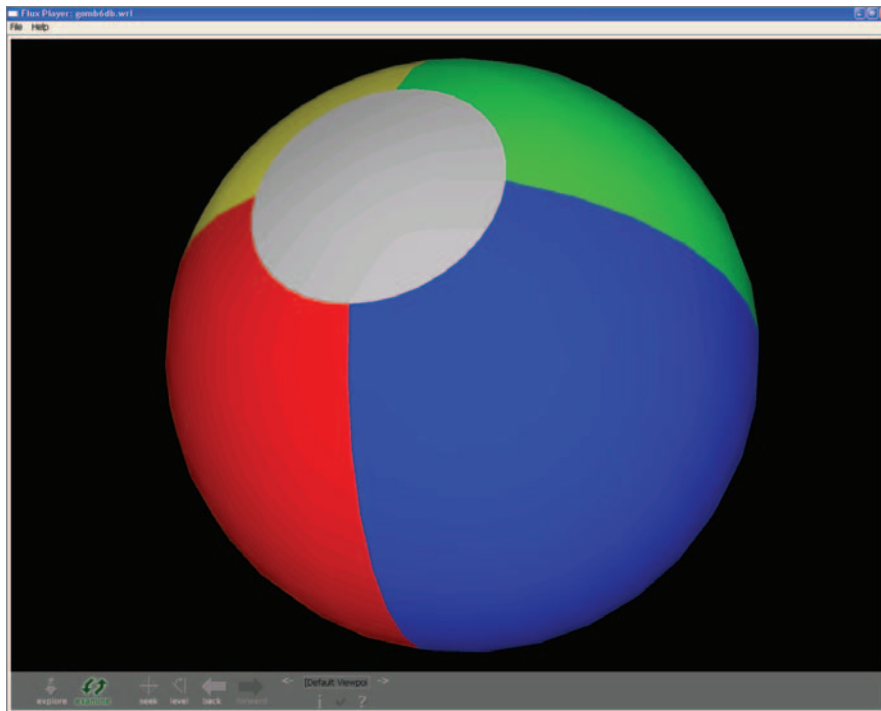


**Fig. 26.5.**   The self-defined sphere built up of six surfaces (here with boundary latitudes of 70°)

around the equatorial areas (Figure 26.5). Each surface has its own texture. The textures of the polar caps are in Azimuthal Equidistant projection, while the others in Plate Carrée. Some pre-defined viewpoints are also added: one for each continent and for the poles.

Another solution is displaying the globe in Google Earth. This software lets us stretch images to geographical quadrangles. If the images are in an equirectangular projection, they will be mapped correctly onto the globe. The only limit is that images larger than 2048*2048 pixels will have their size being reduced. This problem can be solved by using several smaller images instead of a large one. In this case, a KMZ file has to be created. This file is a zipped archive consisting of a KML file describing the position of the images and the image files themselves (Google 2008).

## 26.5  Samples from the museum

Willem Jansszon Blaeu's pair of globes (Figures 26.6 and 26.7) from the Cistercian Abbey of Zirc were amongst the first items processed by the authors. The globes were recently restored, so now they are in a very good state in spite of their age of more than 350 years. Due to the large size of the globes, the resolution of the on-line versions is limited, but researchers who wish to study them in details can reach the high-resolution models at the authors' Department.

The models of these globes were made by taking a photo series. As the celestial globe does not have a proper geographic grid, the colour tone differences appear sharply on the assembled picture at the adjacent edges of different photos. (If there were a grid line outlining the parts, this difference would not be so much eye-catching.)

A facsimile atlas of Coronelli's globe prints is kept in the National Széchényi Library,  and the authors had the opportunity to process it. These prints are monochrome. In Coronelli's time it was possible to order globes with different quality of illumination (hand-painting) or without any (this was the cheapest option). The globes shown in the museum are of course of the latter kind (Figure 26.8).

There are prints of terrestrial and celestial globes of several different sizes in this atlas. The smallest globes have a diameter of less than 10 cm, and the biggest ones are larger than 1 meter.

An interesting item is Alois Höfler's truncated sky globe for students (Figure 26.9). This globe showed only the celestial areas visible from Germany, so its southern pole is missing. Unfortunately, no existing copy of this globe is known to the authors, as only a set of prints is kept in the maproom of the authors' Department.
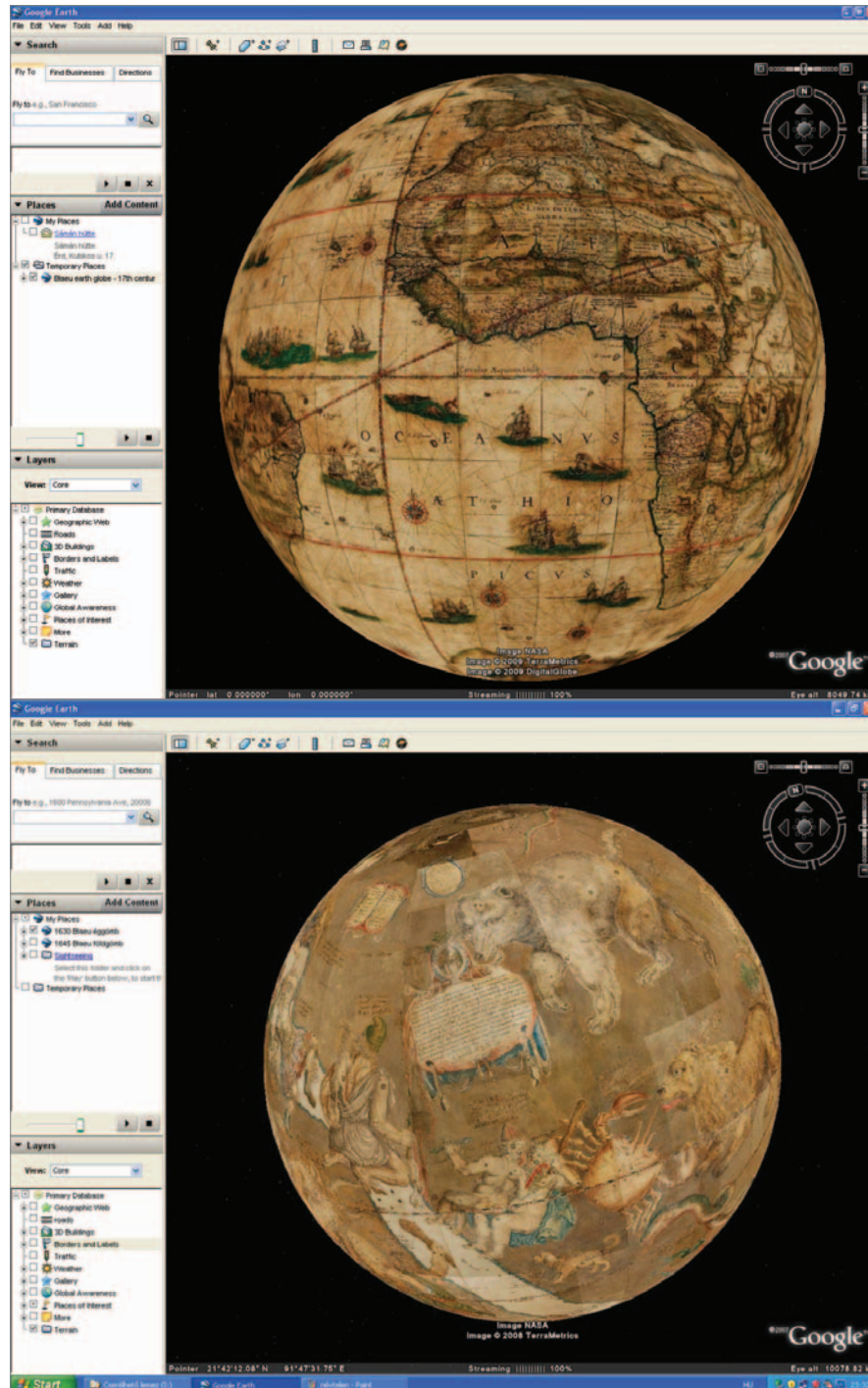
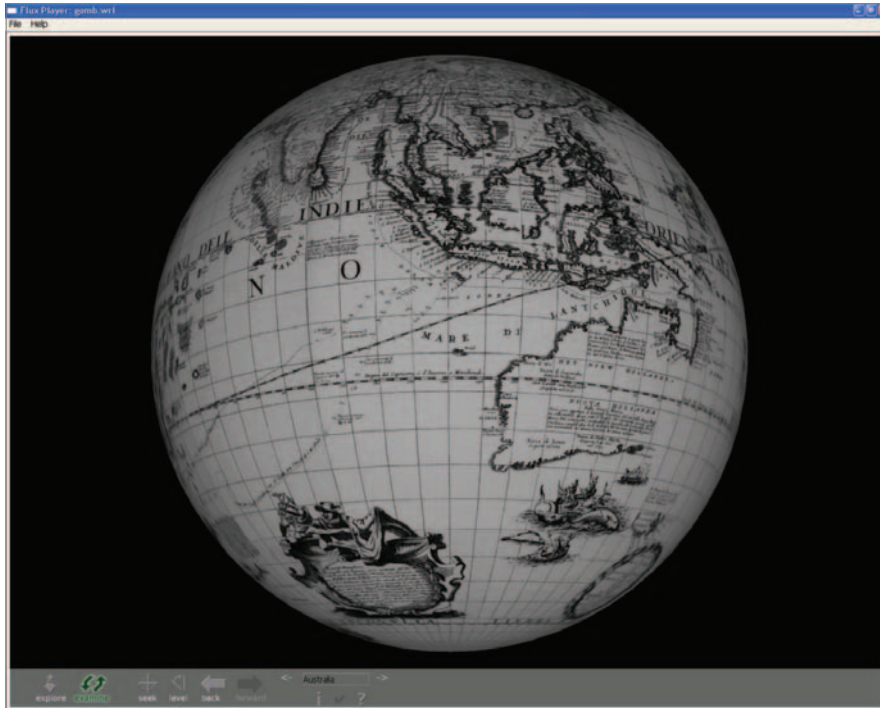**Fig. 26.6. and 26.7.**   The 68 cm diameter terrestrial globe of Blaeu in Google Earth

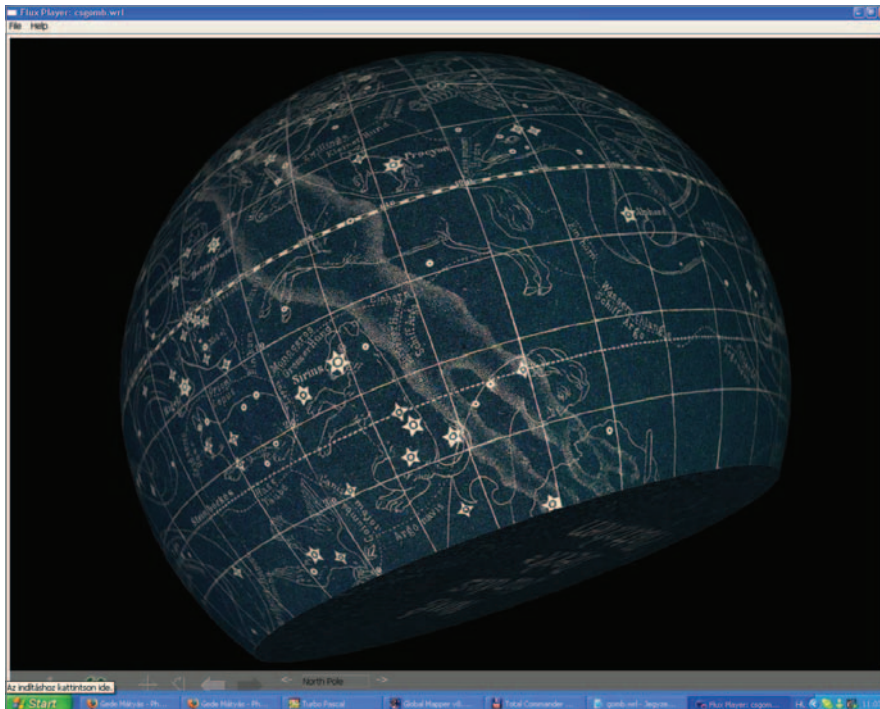**Fig. 26.8.**    A virtual globe created using a facsimile print of Coronelli



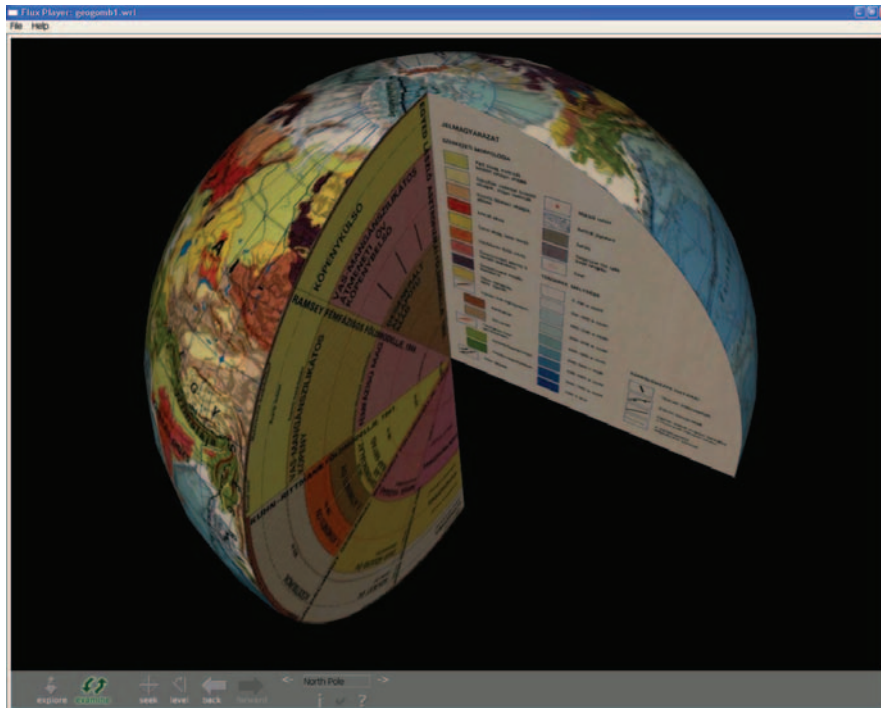**Fig. 26.9.**    Alois Höfler's truncated sky globe

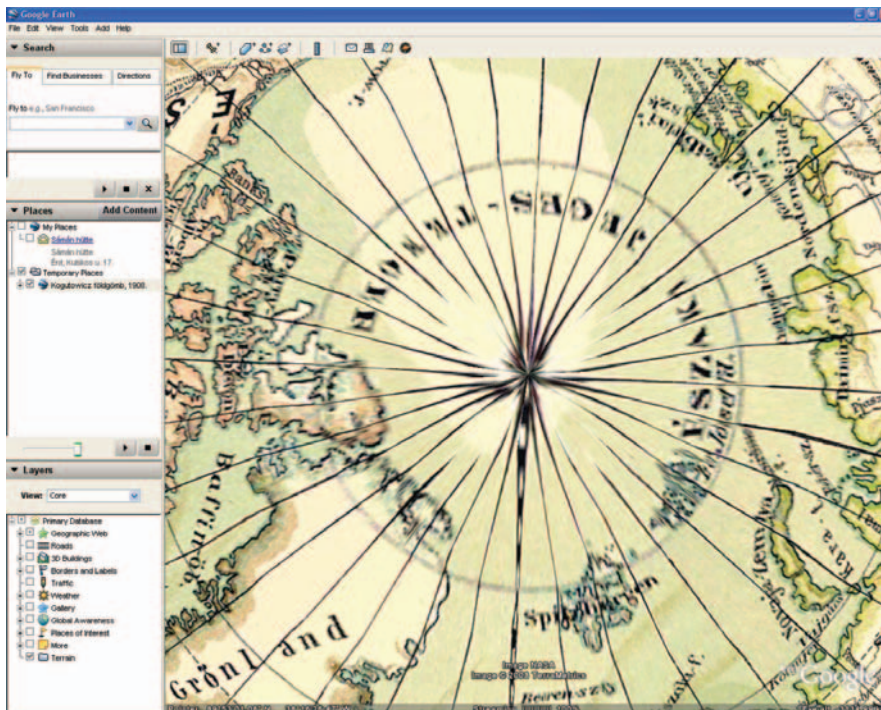**Fig. 26.10.**    The geophysical Earth-model in the virtual space



**Fig. 26.11.**    The visualization problem of polar regions in Google Earth

The shape of VRML globe models is not limited to the sphere only. The 3D versions of the detachable structural morphological Earth model of Cartographia were also created (Figure 26.10). This model consists of two parts, which together build up the whole sphere. The inner surfaces of the parts show different geophysical themes.

## 26.6 Feedbacks, Conclusions, Plans

The first feedbacks about the page were mostly positive. The only problem was that many visitors skipped the information page, where the software requirements are mentioned. They complained about the „malfunction" of the page – of course, one cannot watch the VRML model without installing the VRML plug-in. Therefore, the authors placed the notice of installing the appropriate software into the first paragraph of the information text.

In the beginning there were only a few items in the museum. Later, as the number of the globes increased and the whole list exceeded the screen size, a simple search engine had been built in: now it is possible to search by diameter, language, type, date and place of publication etc.

One might ask why it is necessary to publish both models (the VRML and the KMZ). The answer is that each model has advantages and disadvantages, and it depends on the purpose of use which one to choose.

VRML models have a limited resolution. The size of their texture images cannot exceed 2048*2048 pixels. Even images just approaching this limit can cause problems for lower performance computers with insufficient memory resources. A good point for VRML is, however, that the polar regions are viewed correctly, which is a problem in Google Earth (Figure 26.11). In other words, if the poles are important, one might choose VRML.

The KMZ models can be easily combined with other contents of Google Earth, which makes it possible to compare the globe's content with the present conditions. For example, the changing borders in Africa or any other former colonial area, or the longitude measurement errors appearing in the coastlines of old globes. Another option is that a higher resolution can be reached with Google Earth than with VRML models on the same hardware.

One must consider these options before choosing model.

There are several plans for the future. The most important task is adding as many new items as possible. A huge task is the translation of the existing database entries into English and German, as the detailed data sheet is available only in Hungarian by this time. Luckily, there are two German students spending their practical semester at the Department, and they have started the German translation.

**Fig. 26.12.**   A sample area showing the current state of Perczel's globe
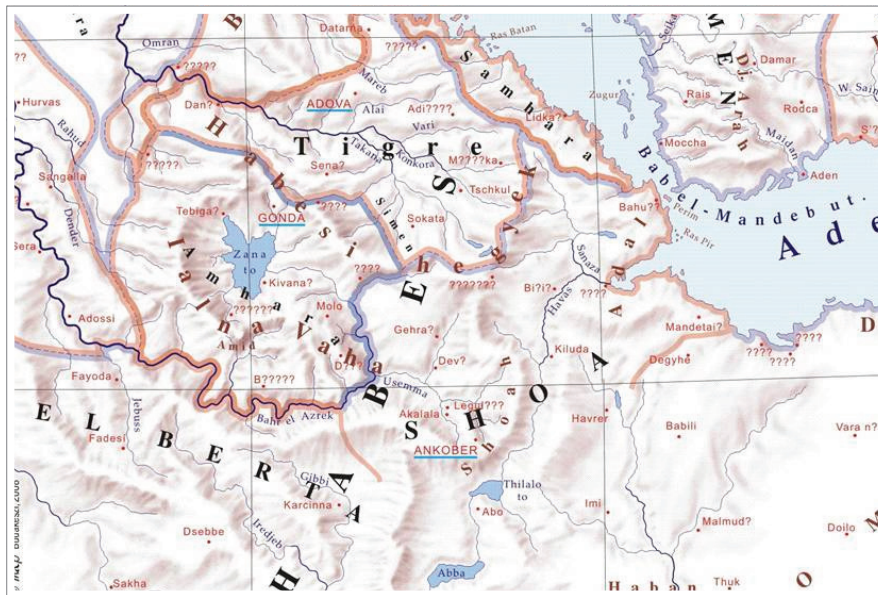


**Fig. 26.13.**   The digitally redrawn sample area

The authors plan to create the digital facsimile copy of Perczel's 132 cm diameter globe. This globe is in a very poor condition. The thick layer of shellac became dark yellowish and the originally red settlement names faded out and became prac-

tically illegible. What is more, the globe suffered severe damage during the storms of history. The plan is to create a digital model after taking a complete photo series of the globe and redrawing the whole surface in the virtual space. Figures 26.12 and 26.13 show the original and the redrawn content on a sample area. As this will be a huge project, the authors have started a course where students who would later join this work can learn the special techniques needed.

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