

## Methodological Benefits of a GIS Map: The Example of the Eldgjá Eruption of the Late 930s CE and the Reliability of Historical Documents

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On 22 July 1893, the geologist Thorvaldur Thoroddsen went riding through the countryside of southern Iceland. He came across an enormous fissure, which tore through the terrain in a straight line. What Thoroddsen discovered on that day was Eldgjá—a 75 km long volcanic fissure caused by a major eruption some time in the past. Thoroddsen assumed that the eruption took place around the year 950. In 1917, the geographer Karl Sapper dated the Eldgjá eruption to between 930 and 950. Since then, studies from the natural sciences have dated the event to 934, 938, and 939 (with a tolerance of  $\pm 2-4$  years), and argued for multiple eruptions between 934 and 939 or continuing volcanic activity from spring 939 to autumn 940. Due to the greater level of detail given in some historical documents (e.g., day and hour), written evidence was sometimes used to calibrate the dating in the studies mentioned. Eldgjá represents one of the most significant volcanic events of the last 1,200 years in Iceland. Did this eruption affect European society?



Fig. 1. The Eldgjá Fissure, Iceland.

Photograph by indigoMood.

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In documents referring to the tenth century, the eruption seems to have had tremendous repercussions. As many as 28 medieval documents report remarkable events such as harsh winters, or unusual celestial phenomena such

as solar eclipses, comets, or a blood-red sun, as well as floods, animal mortalities, and famines in many parts of Europe between 939 and 942. On the whole, this collection of early medieval documents may be evidence of volcanic-induced impacts. Climate cooling effects or remarkable celestial phenomena, such as a reddish sky due to volcanic aerosols in the atmosphere, could explain the historical accounts (for comprehensive explanations concerning volcanic forcing, see Schmincke below).

For an environmental historian, these fascinating correlations raise new questions: How reliable is the information given in the texts? How "close" were the medieval chroniclers to the time they wrote about? Did they just copy information from an earlier date or did they observe the events with their own eyes?

Environmental historians seek to understand the interrelation between nature and culture. As the natural sciences have identified the Eldgjá eruption and demarcated a possible time frame for the event, the historical sciences can now study the cultural consequences. The value of most historical documents, however, is ambiguous. Due to the peculiarity of medieval historiography and the historical traditions of the different manuscripts, uncertainties are considerable. In the case of Eldgjá, this means evaluating the quality of the historical data and reviewing the traditions of all the 28 documents—a frustrating piece of work. Most of the chronicles rely on each other—and sometimes even their names are hard to distinguish from one another (e.g., *Annales Leodienses*, *Annales Lobienses*, *Annales Sancti Iacobi Leodiensis minores*—all from present-day Belgium).

Preliminary results of this research were presented at the VICS meeting (Volcanic Impacts on Climate and Society) in January 2018 in Arizona. One of the main methodological questions prior to the meeting was how the value of the historical data and its interdependency could be visualized comprehensibly. The solution was to create a GIS (Geographic Information System) map because more information can be attached to a single pin compared to a regular map. A pin on the map was used to mark the location of origin of each manuscript. Then, the original text and an English translation were added to the pin as well as further information, such as details about the traditions, the reliability of some information mentioned in the text, links to critical editions and—if available—digital reproductions of the medieval manuscript (see Figure 2; a video link will help you to understand how to use the GIS map). The aim of creating a GIS map was to overcome disciplinary boundaries. Scholars from outside the field of historical sciences can easily distinguish between original, independent information or later texts that depend on chronologically earlier material. By examining the various reports on the map it is also possible to develop an understanding of the challenges historical sources pose. Various aspects that need to be considered when working with historical material, such as issues of chronology and tradition or the *causa scribendi* of medieval authors, are presented on the map and can be considered in future studies when historical data is combined with findings from the natural sciences.

Fig. 2. Interactive GIS map created by S. Ebert (2018), also available at <https://arcg.is/1CLOS>. Red pins indicate documents from the tenth century, blue pins indicate documents from a later date. The map provides further information about the value and reliability of the historical data as well as the chronological and regional scope of the events. A tutorial is available [here](#).

The results of the analysis on the GIS map provide quite a different picture from the initial impression: only 11 out of the 28 documents were written in the tenth century and a harsh winter was reported only in Saxony, the Lake Constance area, and Ireland. The hardships from 939 to 942 seem to have been caused by multiple factors. The Eldgjá eruption was probably one factor among others; the ongoing research for my PhD project will analyze this eruption and other possible impacts more accurately. Meanwhile, the GIS map may serve as an example of the limitations, but also of the methodological potential of historical data in environmental studies.

### Further readings:

- Kostick, Conor, and Francis Ludlow. "The Dating of Volcanic Events and Their Impact upon European Society, 400–800 CE." *PCA* 5 (2015): 7–30.
- McCormick, Michael, Paul Edward Dutton, and Paul A. Mayewski. "Volcanoes and the Climate Forcing of Carolingian Europe, A.D. 750–950." *Speculum* 82 (2007): 865–95.
- Oppenheimer, Clive, et al. "The Eldgjá Eruption: Timing, Long-Range Impacts and Influence on the Christianisation of Iceland." *Climatic Change* 147 (2018): 369–81. doi:10.1007/s10584-018-2171-9 .
- Sapper, Karl. *Katalog der geschichtlichen Vulkanausbrüche*. Schriften der Wissenschaftlichen Gesellschaft in Straßburg 27. Strassburg: Trübner, 1917.
- Schmincke, Hans U. *Vulkanismus*. 4th ed. Darmstadt: Primus, 2014.
- Thordarson, T., et al. "New Estimates of Sulfur Degassing and Atmospheric Mass-Loading by the 934 AD Eldgjá Eruption, Iceland." *Journal of Volcanology and Geothermal Research* 108 (2001): 33–54. doi:10.1016/S0377-0273(00)00277-8 .
- Thoroddsen, Thorvaldur. *Die Geschichte der isländischen Vulkane: Nach einem hinterlassenen Manuskript*. Det Kongelige Danske Videnskabernes Selskabs skrifter 9. Copenhagen: A. F. Høst & Son, 1925.

### Related links:

- Clark, Brandon. "Blood in the Water: A Digital History Project on the Geography of Pontiac's War, 1763." *Arcadia* 2018. <https://doi.org/10.5282/rcc/8460>
- Ebert, Stephan. "Vulkane in der Umweltgeschichte oder das Problem der 'Euphorie der Erkenntnis.'" <http://mittelalter.hypotheses.org/7685>.
- Hohensinner, Severin. "The Struggle with the River: Vienna and the Danube from 1500 to the Present." *Arcadia* 2012. <https://doi.org/10.5282/rcc/4959>
- Website of the VICS working group (Volcanic Impacts on Climate and Society) <http://www.pages-igbp.org/ini/wg/ocean2k/161-initiatives/working-group/vics/1290-vics>

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Environment & Society Portal, Arcadia

### Websites linked in this text:

- <https://arcg.is/1CLOS>
- <https://youtu.be/PvVKn6TxUgc>

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**Websites linked in image captions:**

- <https://flic.kr/p/ospMGL>