

Introduction

Today's reading involves an article of ~1000 words in the prestigious journal *Nature Geoscience* by S. Self and R. Gertisser, 2015, <http://ezproxy.library.ubc.ca/login?url=https://www-nature-com.ezproxy.library.ubc.ca/articles/ngeo2403> ² For free access and to download this article from the UBC Library, you will need your CWL. Data cited in this article will be briefly examined.

Finally, data from Figures comparing volcanoes from another article, in the Journal of Geophysical Research by Chaochao, G. et al., 2006,

http://digitalcommons.library.umaine.edu/cgi/viewcontent.cgi?article=1097&context=ers_facpub, will be examined without requiring you to read any of it.

After completing this assignment, you should be able to:

1. Describe the kinds of data or observations that help estimate recurrence intervals and ejecta volumes of past very large volcanic eruptions.
2. Justify the need for further research regarding very large volcanic eruptions by referring to difficulties of obtaining data or observations described in the previous goal.
3. Examine and interpret data in a citation, without worrying about details of the entire cited article.
4. Obtain various details about any volcano on Earth, from a database of Earth's volcanoes.
5. Characterize this scientific reading in terms of its type, reliability of sources and the authors' intent.
6. Characterize the claims made by authors in terms of arguments and various types of supporting evidence.

Instructions

1. FIRST, skim all the questions in this Worksheet (see next page) to find out what to expect.
2. DOWNLOAD the article *Nature Geoscience* by S. Self and R. Gertisser, 2015 here: <http://ezproxy.library.ubc.ca/login?url=https://www-nature-com.ezproxy.library.ubc.ca/articles/ngeo2403>
3. Then write your answers to the Worksheet questions during or after reading the article.
4. AFTER you have answered all the Worksheet questions, write the Reading Assignment Quiz. All the questions in this Quiz will be taken from the questions in this Worksheet!
 - a. There is a time limit to complete the Reading Assignment Quiz, so you MUST do the reading and complete the Worksheet BEFORE starting the Quiz;
 - b. The questions on the Quiz are automatically graded versions of SELECTED Worksheet questions, which will include fill-in-the-blank, multiple choice, ordering/ranking, and True/False question types;
 - c. Each student will get a slightly different set of questions.
 - d. The worksheet itself does not have to be turned in! Writing the Reading Assignment Quiz is what we consider as "turning in" your homework.
5. **Important notes**
 - a. **Regarding EOSC 114 Homework from past terms:** This reading assignment AND the questions for the Reading Assignment Quiz are *different from* EOSC 114 homework from past terms¹.
 - b. THE MOST COMMON ERROR in the Reading Assignment Quiz is not reading the questions in the Quiz carefully. The order in which questions are posed in the Quiz may differ from the worksheet, the answer options are randomized, AND each student gets a different **subset** of questions. Please write your Quiz carefully, with your worksheet beside you.
 - c. Working with peers on homework is OK, but copying the work of others is cheating and will not help you succeed. Read [UBC's Students Code of Conduct](http://www.calendar.ubc.ca/vancouver/index.cfm?tree=3,54,111,959) and our strict rules regarding academic integrity at <http://www.calendar.ubc.ca/vancouver/index.cfm?tree=3,54,111,959>.
 - d. Note there may be one or more questions about this assignment in future Quizzes or Final Exam.

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² "Tying down eruption risk". Self, S. and R. Gertisser, *Nature Geoscience*, 04/2015, Volume 8, Issue 4

Step 1: Processes and predictions

- What is the location of Tambora, Sumbawa Island, Indonesia? Enter the nearest **whole number values with no decimals** for LATITUDE _____ degrees North, and for LONGITUDE _____ degrees East. Use a negative number if latitude is South of the equator or if longitude is west of the meridian.
- This major eruption occurred in the year _____
- How many years ago was this eruption prior to the article's publication (2015) _____?
- The article said the number of fatalities was probably [*similar to* / *smaller than* / *greater than*] the actual number of fatalities (choose one).
- What was the rough number of _____ direct fatalities quoted?
- What is the plate-tectonic setting of the Mount Tambora volcano? Look this up by searching the internet.
- near a tectonic spreading center
 - a continent-continent collision zone
 - on the over-riding plate above a subduction zone
 - on the subducting plate just before it starts being pulled down under the over-riding plate.
 - in the middle of a continental plate
 - in the middle of an oceanic plate
- What is the plate-tectonic setting of the Santorini volcano in Greece? Look this up by searching the internet.
- near a tectonic spreading center
 - a continent-continent collision zone
 - on the over-riding plate above a subduction zone
 - on the subducting plate just before it starts being pulled down under the over-riding plate.
 - in the middle of a continental plate
 - in the middle of an oceanic plate
- All these statements refer to real difficulties associated with understanding very large volcanic eruptions. Which one represents the most fundamental or comprehensive (overarching) difficulty with estimating **recurrence interval**?
- locations of submarine volcanic caldera may be hard to identify
 - large volcanic eruption events are rare
 - the size of calderas may be the result of several eruptions
 - thorough geochronological analysis of eruption deposits is rare
 - not all volcanoes emit enough sulphur to cause acidity spikes in ice cores
 - detecting eruption events in ice cores does not yield an origin or source of the event
 - erupted ash or pumice may become dispersed or redistributed by various processes during eruption
- How long ago does the article say these very large eruptions occurred? Roughly:
- Kikai: _____ years ago
 - Santorini: _____ years ago
 - Samalas: _____ years ago
- Search Google images for “_____ caldera”, where _____ is each of the volcanoes named below, to find out whether the caldera would be collecting seawater (i.e. is connected to the ocean) or freshwater (i.e. is not connected to the ocean).
- Kikai _____
 - Santorini _____
 - Samalas _____

- Traces of eruptions found in ice cores are important clues to past eruptions. However, what crucial information is NOT clearly provided by these traces?
 - date of the eruption causing the traces found in the core
 - whether or not eruptions contained sulphur
 - whether a particular eruption occurred before or after another known eruption detected in the same ice core
 - which volcano generated the traces found in the ice core
 - whether the eruption was large enough to introduce material into the stratosphere
- What 3 factors will have some influence on whether ash will show up in an ice core; pick three of the six only.
 - amount of erupted material
 - recurrence interval
 - volume of sulphur emitted
 - dispersal pattern of erupted material
 - extent of core sample area
 - acidity of ice layer
- This course addresses the following four aspects of natural hazards. Which one of these does this article concentrate on the MOST?
 - anticipating consequences
 - identifying appropriate mitigation strategies
 - describing geological processes
 - predicting time/place of hazardous events
- Which of these four aspects listed above does this article concentrate on the LEAST?
 - anticipating consequences
 - identifying appropriate mitigation strategies
 - describing geological processes
 - predicting time/place of hazardous events

Step 2: Characterizing the article

Information about any field of expertise can be obtained from many sources, with various degrees of reliability. Since this will be the only science course taken by some students, it includes learning goals related to recognizing and using various types of scientific communications, arguments, evidence, assumptions, and so on.

In this section we consider the author's intentions, the types of sources used to support their arguments or "story", and how evidence was used in those arguments. Please Review "primary", "secondary" and "tertiary" sources at: <http://scwrl.ubc.ca/student-resources/finding-identifying-and-citing-sources/identifying-different-types-of-sources/>.

- For each "characteristic" of the article we've read select either **TRUE** or **FALSE**. (On the Reading Assignment Quiz, read each question carefully to ensure you are answering the question correctly as questions in the Quiz may be listed in a different order than in this Worksheet.)
 - **TRUE / FALSE** Our article was written by the author(s) mainly to present their own previously unpublished new developments or discoveries.
 - **TRUE / FALSE** The central message of our paper was based predominantly on work already presented in earlier publications or other forms of communication.
 - **TRUE / FALSE** Our reading is mainly targeting a general non-scientific audience (consider the type of journal).
 - **TRUE / FALSE** The content in our reading is presented in a non-technical manner, **without** presenting a complete "chain of evidence" using formal references and citations.
 - **TRUE / FALSE** This article is published in a peer reviewed journal (disregarding comments from an editor).

- The main purpose or context for this reading is to _____. (Hint: consider where or how it was published.)
- offer social commentary to any reader
 - provide news for the general public
 - explain some scientific matters to the general public
 - provide information for a person or organization who requested it
 - present and discuss recommendations about scientific priorities in the peer-reviewed literature
 - communicate new scientific methods, procedures or discoveries to experts in the subject
- Now, based on your choices above and the summary about source types referred to above, what kind of reference is our article best described as?
- primary
 - secondary
 - tertiary
- What types of sources were used by the author(s)? Select **TRUE** or **FALSE**.
- **TRUE / FALSE** One or more citations of primary or secondary sources were included in a reference list.
 - **TRUE / FALSE** A bibliography including resources NOT cited in the article was included.
 - **TRUE / FALSE** One or more citations of tertiary sources (including textbooks, encyclopaedias, etc.) were included in a reference list.
 - **TRUE / FALSE** One or more direct quotes from named experts were used by this author to support or justify arguments.
 - **TRUE / FALSE** Work of experts was referenced in the writing but not cited in a reference list.
 - **TRUE / FALSE** One or more direct quotes from non-experts were used as sources by this author.
- What writing strategies were used in this article? Select **TRUE** or **FALSE**.
- **TRUE / FALSE** Assertions and arguments supported by evidence based on observations, measurements or experiments done by scientists other than the author(s).
 - **TRUE / FALSE** Assertions and arguments supported by evidence based on scientific observations, measurements or experiments done by the author(s).
 - **TRUE / FALSE** Narrative or personal stories.
 - **TRUE / FALSE** Targeted human emotion.
 - **TRUE / FALSE** Descriptions of “aesthetic” aspects like scenes, views and impressions.
 - **TRUE / FALSE** Identified at least some uncertainties, incomplete aspects or needs for further work.
- An essential characteristic of scientific writing is that authors will make (or state) claims and support those claims using arguments. Each argument will consist of logic and reasoning that depends upon reproducible observations, evidence and data.
- What is the most reasonable way of describing each of the following statements paraphrased from our article?
Choose from options i to iv.
- i. an observation or quantity measured with instruments
 - ii. a result based on calculations using parameters and assumptions that could be varied to yield a range of values
 - iii. a conclusion, theory or ‘understanding’ that is well established, based on a variety of consistent observations and/or experiments and logical inferences
 - iv. a suggested explanation that was (or is) not well established by a variety of observations or experiments
- _____ *“The event was the most disastrous volcanic eruption in recent history.”*
 - _____ *“Recent estimates of the volume of magma erupted from Tambora during the April 1815 event range from 30 - 50 km³”*
 - _____ *“Ice-core evidence for a giant eruption at this time has been available since the 1990s.”*

- Which one of these statements most clearly articulates the overarching claim of this article?
- People all over the world are likely to be impacted by single huge eruptions.
 - Better records of size and occurrence are needed to reliably forecast future large eruptions.
 - Magnitude 6 or more volcanoes can directly cause huge numbers of fatalities.
 - Identifying volcanism-induced acidity spikes in ice-core records combined with discovery of a relatively young caldera are two steps that led to discovery of the Kuwae super volcano.
 - Recurrence interval for very large eruptions can be estimated using statistical models.
- Was each of the following claims supported with arguments or discussions presented in this article? Choose: **YES** = *it was supported by arguments or discussions* or **NO** = *it was just stated*.
- **YES / NO** *"Tambora is probably the largest caldera-forming eruption of the last few centuries"*
 - **YES / NO** *"...estimates of the recurrence interval for Tambora-size eruptions range from 780 years for low-end approximations"*
- Arguments that support claims. For each of the following, choose **TRUE** if the statement given in italics is part of an argument that supports the corresponding claim (as paraphrased from the article). If not, choose **FALSE**.
- **TRUE / FALSE** The statement: *"...to see a large eruption in the ice-core record, large volumes of sulphur must have been emitted by the eruption"* is part of an argument that supports the claim: "...determining the recurrence time of catastrophic eruptions is difficult"
 - **TRUE / FALSE** The statement: *"Climate change is affecting our abilities to estimate size and recurrence intervals"* is part of an argument that supports the claim: "We need better records of size and occurrence if we are to predict future large eruptions more accurately."
- Estimating the volume of material erupted is challenging. Which of the following reasons contributing to this claim were discussed in the article?
- Select **YES** = was discussed in our article or **NO** = was NOT mentioned in our article
- **YES / NO** Eruptions may be so strong that solid material is blown into the atmosphere and carried away.
 - **YES / NO** The thickness of ash found in ice-core layers is poorly correlated with eruption volume.
- Estimating recurrence intervals for mega-volcanoes is challenging. Which of the following reasons contributing to this claim were discussed in the article?
- Select **YES** = was discussed in our article or **NO** = was NOT mentioned in our article
- **YES / NO** Mega volcanoes are rare.
 - **YES / NO** A lack of historically accurate information about locations and magnitude contributes to difficulties in estimating timing – i.e. recurrence intervals.
- Arguments supported by data. Was each of the following arguments supported by describing or citing data, methods, or people responsible for the information? Select **YES** = *data, methods or people were mentioned or referenced* or **NO** = *data, methods or people were neither mentioned nor referenced*. (HINT: use "search" in the article, to find each of these phrases.)
- **YES / NO** *"Only eruptions that emitted large volumes of sulphur will generate acidity layers in ice cores."*
 - **YES / NO** *"During eruptions, ash, pumice and hot gases can be ejected upwards into the atmosphere in an eruption column and outwards along the volcano flanks in the form of a pyroclastic flow."*
 - **YES / NO** *"...many more magnitude 6–7 eruptions may not be recognized in existing records"*

- Consider the various types of data mentioned in our article. What is the most reasonable way of describing each of the following statements paraphrased from our article? **Choose from options i to v.**
- i. measured with instruments of some sort
 - ii. observed – i.e. seen or noticed, not measured with instruments
 - iii. simulated, modelled or calculated
 - iv. gathered – i.e. needing to be collected from people, archives, records etc.
 - v. not really data
- _____ “number of deaths on Sumbawa and neighbouring islands”
 - _____ “areas of land covered in ash and pumice, or tephra”
 - _____ “magnitude of an eruption”
- Which of the following is a reason presented to support the claim that “single huge eruptions can impact people all over the world”?
- Sulphur gases leave layers of increased acidity in ice cores.
 - Global temperatures have been observed to drop following huge eruptions.
 - Erupted materials are seen to get re-distributed within only a few years after being ejected.
 - Calderas have been seen to fill, collapse or even coalesce with previous calderas.
 - Ash fall is known to occur not just adjacent to the eruption but far out to sea as well.

Step 3: Data – delving a little deeper into the scientific thinking that backs up the article’s claims

We read an article from the New Yorker for the previous Homework Reading Assignment. It mentioned sources but did not cite them formally. The present article does cite official peer reviewed, mostly primary references for details about reasons and evidence. We next explore this aspect briefly, but first, based on the paper we’ve just been looking at, let’s compare the Tambora and Kuwae eruptions.

- Compared to the Kuwae eruption, the Tambora eruption size was:
- larger
 - similar
 - smaller
 - unknown or not mentioned
- Compared to Kuwae’s caldera, the elevation of Tambora’s caldera rim is now:
- higher
 - similar
 - lower
 - unknown or not mentioned
- Compared to the Kuwae eruption, the Tambora eruption occurred:
- at a later date
 - within plus or minus 50 years
 - at an earlier date
 - at a date that is not known or was not given
- Compared to Tambora’s eruption, impacts on humans from Kuwae’s eruption were:
- larger
 - similar
 - smaller
 - unknown or not mentioned

To more clearly understand the ice core acidity data associated with Kuwae, we must find the corresponding article that was cited. Find this article here:

http://digitalcommons.library.umaine.edu/cgi/viewcontent.cgi?article=1097&context=ers_facpub³

BUT YOU DO NOT HAVE TO READ IT. WE WILL REFER TO THE FIGURES ONLY!

- Where did the ice samples come from? Use **Figures 1, 2, 3** and **4** to fill in the blanks with a NUMBER only. There were _____ sites/locations in the NORTHERN Hemisphere and _____ sites/locations in the SOUTHERN Hemisphere where ice cores were obtained. However, based on **Figures 3** and **4**, only _____ ice cores were used for analysis from the SOUTHERN Hemisphere and _____ were used from the NORTHERN Hemisphere.
- What is the horizontal axis for graphs in **Figure 3** and **4**?
 - Time (i.e. years)
 - Location (i.e. where in the hemisphere)
 - Acidity
 - Electrical conductivity
 - some other parameter
- Fill in the blanks with NUMBERS not words: **Figure 3** shows _____ ice cores from the SOUTHERN Hemisphere that contain records of “sulfate flux” (i.e. basically the amount of sulphur causing acidity), and _____ ice cores that provided records of “electrical conductivity” (increased conductivity also implies increased acidity). Of these ice core records, _____ appear to have spikes of greatly increased acidity at times directly related to some event that occurred between 1450 and 1455.

Figure 5 represents a compilation of many data sets to emphasize certain interpretations. The two parts give estimates of sulfate flux (i.e. acidity) based on either SOUTHERN (SH) or NORTHERN (NH) hemisphere data.

- What is the maximum number of years following Kuwae’s eruption for which greater than zero acidity of ice was found in either north or south locations?
 - less than 1 year
 - 1 year
 - 2 years
 - 3 years
 - 4 years
 - 5 or more years
- How did acidity of ice measured one year after eruption in the NORTHERN hemisphere compare to acidity of similarly aged ice in the SOUTHERN hemisphere?
 - more acidic
 - similarly acidic
 - less acidic
- Which of the two volcanoes made ice in the NORTHERN hemisphere the most acidic one year after its eruption? (Ignore “Kuwae adjusted” data.)
 - Kuwae
 - Tambora
 - Both caused similar acidity of ice

³ “The 1452 or 1453 A.D. Kuwae eruption signal derived from multiple ice core records: Greatest volcanic sulfate event of the past 700 years”. Chaochao, Gao et.al., **Journal of Geophysical Research**, VOL. 111, D12107, doi:10.1029/2005JD006710, 2006.

- How did acidity of ice following the Tambora eruption compare to acidity of ice following the Kuwae eruption?
- The Kuwae eruption caused ice to be **more** acid than did the Tambora eruption.
 - The Kuwae eruption caused ice to be **less** acid than did the Tambora eruption.
 - Acidity of ice following BOTH eruptions seems to be roughly similar.
 - Comparison depends upon the location of the ice.
 - Comparison depends upon the timing of samples following eruptions.

Hopefully this short look at one citation helps you recognize the distinction between **(a)** a scientific article that uses multiple sources to make an “over-arching” (comprehensive) argument versus **(b)** an article that goes into great depth regarding exactly what was learned from specific observations, experiments, analysis and/or logical discussions.

IMPORTANT REMINDERS:

The MOST COMMON ERROR made by students in the past is not reading questions on the Reading Assignment Quiz carefully. So, work on your Quiz with this completed worksheet beside you.

Remember our CLASS CODE OF CONDUCT, and UBC’s strict rules regarding academic integrity.

See <http://www.calendar.ubc.ca/vancouver/?tree=3,54,111,959>.