Guidelines for writing a master's thesis and other written final projects in geology and geophysics

UNIVERSITY OF HELSINKI
FACULTY OF SCIENCE
MASTER'S PROGRAMME IN GEOLOGY AND GEOPHYSICS

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1. WHAT IS A THESIS?

An academic degree always includes a written thesis. As part of their advanced studies, master's level students write a thesis of 30 cr in scope. Likewise, a bachelor's degree includes a thesis, the scope of which is 6 cr. The master's thesis demonstrates the student's ability to independently perform work in their field and report on their research. The aim is not to produce ground-breaking new research results nor does a thesis need to create new research avenues. In geology and geophysics, the master's thesis is often based on independently conducted research either in the field or in the laboratory, which means that the process includes much more than just writing. A bachelor's thesis may also be based on original material, even though they usually tend to be based on a literature review.

The purpose of these guidelines is to help students of geology and geophysics successfully navigate the technical issues related to the writing of the thesis. The guidelines do not discuss the actual research or the creative part of the writing. The former topic is addressed in thesis supervision and, in terms of the latter, there are numerous guides to thesis writing, which do also discuss the technical finalisation of the thesis. It is worthwhile acquainting yourself with these books and handouts (e.g., Bates 1988, Hakala 1999, Kinnunen and Löytty 1999, Haapala 2001, Gustavii 2008).

Finalisation instructions, from referencing conventions to fonts, vary according to discipline and department. Likewise, the formatting and structuring of manuscripts vary from one scientific publication series to another and they always need to be checked by referring to the instructions to contributors section of each journal. There is not just one correct method. The instructions provided by these guidelines apply to theses written in the Master's Programme in Geology and Geophysics of the Department of Geosciences and Geography of the University of Helsinki and, when applicable, to bachelor's theses and other written assignments in the bachelor's programme. These guidelines must be followed because they greatly facilitate both the writing and reading as well as the examination of theses.

It is good to remember that theses always have supervisors. With them, you can discuss the application of these guidelines with regard to your thesis. In addition to the

supervision of the actual research and the technical issues related to the writing, the supervisor gives advice on issues related to the production of good academic text.

2. GENERAL GUIDELINES

The thesis demonstrates the student's capacity for scientific thinking, competence in the relevant research methods, familiarity with the topic of the thesis, as well as the student's ability in academic communication. The presentation method must be precise and clear. Long, complex and ambiguous sentences must be avoided. The aim should be to write for the reader and make reading easy and pleasant. Scientific terms must be used consistently and accurately. They must comply with the latest edition of the *Glossary of Geology* published by the American Geological Institute. Instead of Finnish or Swedish, the thesis may also be written in English (the UK or US variant); but, for example, in Finnish text Anglicisms should be avoided both in sentence structure and in unestablished translations of terms.

Whenever possible, the thesis should use SI units and negative exponents instead of a slash (not m/s but m s-1). In theses written in Finnish or Swedish, numbers are divided by a decimal comma, whereas a decimal point is used in English text. Scientific names of organisms should be *italicised* starting from the genus.

The layout of the thesis must be flawless. The graded thesis is entered as a PDF file in the University of Helsinki's thesis database HELDA using the online publication tool of the E-thesis service. This will take place at the latest on the day when the approval of the thesis is presented for inclusion on the agenda of the master's degree programme board. The storage of the electronic version will be checked when the documents are submitted. The storage form and more detailed instructions pertaining to electronic storage are available on the website of the E-thesis service. Ouriginal plagiarism detection (formerly Urkund) is a compulsory stage before a master's thesis can be submitted for approval at a meeting of the master's degree programme board. The author submits the thesis to the primary supervisor's Ouriginal analysis address following the instructions on the Ouriginal website while simultaneously submitting the completed thesis to supervisors

for grading. If the student so wishes, they can have bound copies of the thesis made for themselves in accordance with the old model (see section 4.4).

Instructions on submitting the thesis for approval are available on the Instructions for Students website.
https://studies.helsinki.fi/instructions/article/thesis-and-maturity-test-masters-and-licentiates-programmes

3. STRUCTURE AND PARTS OF A THESIS

3.1. General

The structure of the thesis has to be logical and comply with the usual structure of a research article in natural sciences. To begin with, it proceeds from the general (scientific discussion on which the research is based) to the detailed (your own research questions, material and results) while expanding the investigation again to the general level at the end (your own conclusions as part of a more extensive discussion). In geology and geophysics, master's theses usually include the following parts:

Title
Abstract
Contents
Introduction
Geologic setting or background
Materials
Methods
Results
Discussion
Conclusions
Acknowledgements
References
Appendices

A bachelor's thesis can follow the same structure but, for example, a thesis based on a literature review can follow it as applicable. The heading of the section *Geologic setting or background* may also be changed if needed (see section 3.6).

3.2. Title

The title of the thesis must be succinct. However, it must describe the content of the thesis as comprehensively as possible. The title of regional studies must include the location in a sufficiently unambiguous manner (e.g., municipality or region in addition to the name of the area studied).

3.3. Abstract

The abstract is an important part of the thesis and it is written last. It is a short, independent description of the content of the thesis. When preparing the abstract, it is assumed that the readers have a general understanding of the topic. It briefly summarises the research and its most important results so that readers can understand the essential content of the thesis without having to go through the actual thesis. The abstract must include the topic of the research, area and purpose, methods used, key research results, and conclusions based on the results as well as possible suggestions for further measures. The abstract must also be written in full sentences, not as a list of subheadings. No abbreviations are used in the abstract. The text must only use established terms. The abstract must not contain references or quotations. An independent abstract does not contain information or claims that have not been presented in the thesis. An abstract must be informative and must not be written in the style: "the thesis discusses ... proves ... investigates ... studies ..."

The abstract is written on a form available on the Instructions for Students website https://guide.student.helsinki.fi/fi/node/392?degree_programme_code=MH50_011.
The headings of the abstract form are provided in three languages: Finnish, Swedish and English. Include in your thesis forms for the different language versions. It is recommended that you also draw up an abstract in English. If you are a native Finn and

have written your thesis in English, it is recommended that you also draw up an abstract in Finnish. The thesis abstract also serves as a maturity test for the degree. If you have not completed a maturity test for your first-cycle degree (e.g., a BSc degree completed abroad), the maturity test must be completed in the language used in your school education (native language of your upper secondary school studies). The abstract constitutes page 1 of your thesis, but the page number should not be shown on this page. Other issues related to the thesis layout are discussed in section 4.

3.4. Contents

The contents page provides readers with an overall understanding of the content of the thesis. It contains the headings with related page numbers as well as appendices. If there are many second-level subheadings (see section 4.2), they can be left out of the contents list. Since the contents list needs to be compact, a slightly smaller font size than that in the actual text can be used. However, the type of font needs to be the same as in the headings within the text.

3.5. Introduction

The main function of the introduction is to present a clearly articulated research hypothesis or question that your thesis aims to answer. In addition, you must disclose what you plan to do to test the hypothesis or answer your research question. Scientific research – which is what a thesis, at its best, is – must be linked with existing research-based knowledge. The introduction states the aim of the thesis, provides grounds for the choice of topic and presents what is known about the subject matter based on prior research. It may also highlight the significance of the problem studied, the practical benefits derived from research, the application of new methods as well as a niche or unexplored topic within the field of research. The key prior research results are referred to but there is no need to present an extensive and detailed list of them in this context.

The introduction briefly summarises the prior research about the topic and research area. If your research is related to a certain geographical area, this area must be described

insofar as it may affect the interpretation of the results. In geology and geophysics, a more detailed description of the research area is often presented in the section *Geologic setting or background* and the area may also be specified in this context.

The introduction also provides a general outline of the methods used. They are not discussed in detail in this context because that is done in the *Method* section. Instead, only the approaches are set out (e.g., diatom analysis, seismic exploration, sedimentology). It is often a good idea to refer to the prior research that shows that the selected methods are well suited to the current task.

3.6. Geologic setting or background

Depending on the subject matter of the thesis, the content of this section may vary widely and its content and titling should be discussed with the thesis supervisor. It is often based on literature and it may present, for example, the overall geological features of the research target and the surrounding area or, say, the current or ancient climate conditions in the research area. In this connection, it is also possible to present a geological map based on prior research demonstrating the geological features pertinent to the thesis, as well as the location of the research target. In some cases, it is possible to already include in this map material derived from the research conducted for the thesis.

3.7. Materials

The *Materials* and *Methods* sections may be presented as one whole or they can be divided into two parts as is the case in these guidelines.

Research material comprises observations, samples and numerical information gathered during research. The material may also include observation material previously collected by others or derived from databases, which will now be reprocessed in the current research.

This section clarifies the use of material used in the thesis, its collection, and the documentation of the samples. Reference to prior research is made when needed. The origin of the material must be presented clearly so that it is possible for other researchers to access the same material when needed based on this description. The documentation and numbering of samples as well as a sample point map and coordinates are also necessary, when applicable, in order to give readers an accurate understanding of the scope of the research and the representativeness of the material. With regard to museum samples, the location of the collection and the catalogue numbers of the samples must be given.

3.8. Methods

Research methods (e.g., chemical, geophysical and statistical) must be presented to a sufficient degree. The aim is that other researchers and students can understand the principles of the research process and can duplicate the research based on the references and information provided. It is also important that the author shows that they understand the principles of the methods they use. A short mention or reference to a description published elsewhere is sufficient for a customary method, but new or unusual methods must be explained in more detail.

It is recommended that the methods are presented in an order which allows the presentation of the results later in the same order. The methods and analysis locations (laboratories) of chemical analyses can be included as information in the tables presenting the results of analyses.

When describing the research methods, it is not necessary to write a detailed 'recipe book' but to present the methods only insofar as the information provided can affect the evaluation of the suitability of the methods and the reliability of the results. A careful, detailed method description is required when the method used is new, under development or a test performed on a prior method. For example, the type and settings of a device are disclosed but its general operating principle is not presented. However, sample extractions and dilutions for analysis are described (e.g., aqua regia extraction, fiftyfold dilution), but the actual operation of the device is not explained.

When the statistical analysis and possible modelling and simulations for the thesis have been completed with software or a programming language that enables the running of an analysis from a command script (e.g., Python, R, Matlab, Julia), it is recommended that the script is included as an appendix to the thesis. This will allow the analysis to be duplicated and its reliability to be assessed.

3.9. Results

The thesis section *Results* presents the results of the research as text, tables and images. When presenting the results, it is especially important to write precise and logical text. Clear causal links can already be presented at this stage to clarify the aim of the research and the significance of the results for later conclusions. Likewise, it is recommended that results that are contrary to expectations or otherwise negative are presented at this stage. However, you should avoid expressing opinions or assumptions in this section.

The content of the section presenting the results may vary according to the topic of the research. If the thesis includes geological mapping, a petrographical description of rock varieties, for example, can be presented here or as a separate *Description of rock varieties* or *Petrography* section. The description may resemble the rock variety description on a bedrock map but it needs to be more detailed. However, you should not describe obvious features. For example, there is no need to mention that quartz is optically uniaxial. On the other hand, you should mention when quartz exhibits undulose extinction, especially if this is only true of certain rock varieties in the area. The resulting map is presented either in this section or at the end of the thesis as an appendix.

The numerical research results are presented briefly and clearly, for example, as tables, charts or drawings. Short tables may be embedded in the text in this section but large-scale tables presenting measurements are best included as appendices. Extremely large tables should be included as electronic appendices (e.g. CSV or txt files). It is possible to present results also using video-files. All the electronic appendices (tables, videos, models) should be shared with the geology and geophysics education coordinator, who will share them with the degree programme board and send them to the library, where

they are stored in the E-thesis along with the thesis. Also the electronic appendices of the bachelor thesis should be sent to the education coordinator. If possible, large tables of measurements can also be stored in an open data repository, such as the European Pollen Database, PANGAEA or Zenodo. In this case, a precise reference must be given to the material in the database. It is always recommended that you consult your supervisor about the presentation of measurement results, since it is not always possible to present detailed results in a thesis.

The results are not interpreted at this stage, but they can be summarised and illustrated, for example, with the help of averages, dispersion, distribution and various graphic tools, such as maps and diagrams. The text presents the pertinent features of the results in a logical order while not repeating all that is included in the images. In order to maintain the attention of readers, this information needs to presented in as interesting and succinct a manner as possible. Consequently, it is recommended that you do not utilise the style "XRF analysis results are presented in Table 3, which shows that ..." but go straight to the point: "As shown in Table 3 ...". You must ensure that the order of presentation of the results in the text matches that in the tables and graphs. It is usually a good idea to present the results in the same order as the analysis methods.

Instructions on the explanations and formatting of tables, images and drawings are available in section 4.3.

3.10. Discussion

The discussion of the results is the most important part of the thesis, in which the aim is to take a wide-ranging look at the thesis results. The discussion section also expands the scope by looking at results as part of the scientific discussion from which the research questions stem. The discussion should always be balanced, in-depth, and efficiently utilise the material. The discussion of the results evaluates how accurate and significant the results are. They are compared with results of prior research and a well-grounded claim (interpretation) about the reasons for the results is presented. The aims of the thesis presented in the *Introduction* must also be kept in mind and questions raised therein must be answered. The reliability, accuracy and significance of the results are assessed

critically with reference to research published by others, if applicable research has been conducted. You should avoid overly positive claims about the validity of the conclusions.

You can divide the discussion section by theme or topic and use your own descriptive headings. It is usual to present your own results first and then compare them to the results of other research, before finally moving on to the interpretation. The discussion of the results in theses can be started with assessing sources of error especially if they have obviously affected the reliability of the results. When comparing the thesis results with prior research, it is necessary to acquaint yourself with the source material, since this is the only way to assess the reliability of the results.

The aim of the discussion of the results is not simply to repeat the things presented in the results section. All of the details of the thesis should not be discussed either. Tables and images are referred to insofar they are relevant to the grounds of the argument presented or the discussion. Negative results or results contradictory to prior research should not be hidden; instead, you should try to explain them or admit that it is impossible to do so. If there is a need, you can criticise prior research, but this should not take the form of a personal attack. You must particularly make sure that you describe and cite the work of other researchers absolutely accurately.

Statistical and other modelling methods are used when needed to assess results and find causal relationships. If statistical analysis goes beyond calculating a few correlation coefficients, the methods and software used must be mentioned in the *Method* section. The material of the thesis and the evidence obtained from it are woven into as logical an interpretation as possible. Observations are usually better explained through one or two, rather than multiple, hypotheses. If there is speculation in the discussion, you must clearly express where it starts and ends.

3.11. Conclusions

The *Conclusions* section is of special importance to the thesis. In it, the student shows that they are able to utilise the research they have conducted, to make conclusions based on it that move research forward and to present the results in summarised manner. This section presents the most important results in a succinct, precise, clear and unambiguous way. This is not the place for discussing how the results were achieved, referring to other research or presenting new information. Results are interpreted here in a way that corresponds to the questions posed in the *Introduction*. It is also possible to give general recommendations about further research avenues. The conclusions must not contain points that have not been justified in the earlier content of the thesis. When drawing conclusions, you should be especially careful to ensure their validity, since unfounded or insufficiently grounded conclusions will have a negative effect on the thesis as a whole.

3.12. Acknowledgements

Acknowledgements are part of the responsible conduct of research, since very few research projects are completed by an individual alone and research also entails collaborating with colleagues. You should, for example, thank the funder of the research as well as those who have helped you conduct the research (e.g., supervisors, laboratory staff and official partners). Here too, it is recommended that excessive praise and exaggeration are avoided.

3.13. References

The list of references only includes the publications you refer to in the main text. For all publications, information that is as detailed as possible is provided so that they can be accurately and easily identified. Key information includes author(s), publication year, name, publisher, place of publication and number of pages. If the text referred to is an article, you must disclose – in addition to the name(s) of the author(s) and the year of publication – the name of the publication series, the number of the publication (volume and number) as well as the page numbers of the article.

The Preparing a list of references section gives you detailed advice and examples of what kinds of citation practices are followed when preparing reference lists for theses in the Master's Programme in Geology and Geophysics.

4. THESIS LAYOUT

4.1. Template and accessibility of the thesis

The thesis layout must comply with the format presented in the thesis template, when applicable. The template is available on the Instructions for Students website.
https://studies.helsinki.fi/instructions/article/thesis-and-maturity-test-masters-and-licentiates-programmes
The template provides a ready format that complies with these guidelines.

Since the completed thesis will be stored as a PDF file in the University of Helsinki's thesis database HELDA, attention must be paid to ensuring its *accessibility*. Accessibility means the consideration of human diversity in digital services. In other words, it corresponds to accessibility in the physical world. A more detailed description of accessibility and its importance and instructions on how to prepare a PDF file are available on the Instructions for Students website.
https://studies.helsinki.fi/instructions/article/accessibility-what-all-students-should-know

4.2. Text and layout

The thesis is laid out on A4 pages. A margin of 3.5cm is reserved on the left side for possible binding. The right margin is narrower at 2.5cm. The top and bottom margins on the page are also 2.5cm. Slight deviation from these margins is tolerated if this means that the last line of a paragraph can be fitted on the same page as the rest of the paragraph. The lines are justified at both the left and right margins and the words at the end of the lines on the right can be hyphenated if seen fit.

Spacing in normal text is 1.5 and the font size is 12. The font is Times New Roman, Times or, if needed, some other similar serif font (such as the one used in this text).

Paragraphs are separated by an empty line (not by indenting). Two empty lines are left in front of the main heading and the first-level subheading on a page (see below) followed by one empty line, but before a second-level subheading there is only one empty line. Enough space must be left above and below pictures to ensure that they are distinguishable from the text. This, together with the extra space in front of headings, can be done using the appropriate function of the word processing software.

Pages are numbered sequentially and the page numbers are centred at the top of the page. The numbering starts from the Abstract, which is therefore page 1 of the thesis. The table of contents starts on page 2. Page numbers are not shown on the abstract and table of contents pages.

4.3. Headings and table of contents

The adequate use of subheadings makes the thesis easier to read, but you should avoid using too many subheadings. At most, three heading levels are used in theses. The headings are numbered and written as follows:

1. BOLD UPPER CASE LETTERS (main heading)

1.2. Bold lower case letters (first-level subheading)

1.2.3. Italicised normal text (second-level subheading)

You must pay attention to ensure that each heading level is consistent throughout. It is also worthwhile to use the numbering and table of contents creation functions of the word processing software. Various reference, spellcheck and hyphenation software may also greatly facilitate the finalisation of the text.

4.4. Figures and tables

Figures and tables are used to illustrate the information presented in the research. For example, tables are used to present the results of chemical analyses performed as part of the research for the thesis. Graphic presentations are a good way to present key results in an easy-to-understand manner, making interpreting them easier. Tables usually present numerical information, but it is also possible, for example, to draw up a table for the purpose of explicating the conclusions wherein the key results of the topics studied are presented verbally and, if needed, numerically. With the exception of summary tables, one table should not include very different types of information.

Tables and figures must also be informative and understandable on their own when removed from their textual context. They are supplemented with a short description (figure or table caption) presenting their key content. The caption is written under the figure and above the table. It is recommended that as in the actual tables, the font used for the captions is the same as in the main text, with font size 9.

The descriptions need to be comprehensive enough to allow readers to understand the content of the figure or table without having to read the actual text. However, captions should not be too long but include only the key elements needed to make the figure in question understandable. If a figure or table is borrowed from another publication, the reference is given in this description. Moreover, if the original figure has been edited, the figure caption must contain information about this [e.g., adapted from Saarikoski (2017), based on Saarikoski (2017)]. The name of the photographer and the location are mentioned for photographs. Since copyrighted material may not be used in theses without permission (e.g., various photographs, drawings and maps), the use rights of such images must always be checked from the owner of the rights, which is often the publisher. Use rights of images are usually listed on the website of the publisher (e.g., GTK and Elsevier). For maps and photographs, the scale must also be mentioned. For maps, this is best done using a map scale and for photographs with an inserted scale bar, compass or pen. In maps, an arrow pointing north and the coordinates must also be displayed. In exposure images, it is good practice to indicate the position of the photograph with a north arrow or in some other way in the direction of north. In tables, the meaning of each column and row is explained and units of measurement comply with the SI system. The

element content is usually expressed in weight percentages or parts per million (ppm). Figures and tables are numbered sequentially in Arabic numbers, both separately. All references in the text must be done in this order and consistently. Each figure and table is placed within the text in an appropriate place after it has been referred to for the first time in the text. An individual image may comprise several sub-images (e.g., figures 2.A and 2.B). If images are grouped in series comprising several images, this must be taken into account when writing the text.

One image or table must not contain too much information. Images must be clear and the text and symbols within them must be clearly distinguishable. The absolute minimum size limit of the final text and symbols in images is 1mm but 1.5mm is preferred. It is recommended that drawings are done in a uniform style and using one software package and with the same line thicknesses, fonts and font sizes for the same objects throughout. When preparing images, it should be taken into account that they may be made smaller for their final size. In order to avoid symbols and letters being too small as well as lines being too narrow, it is recommended that the preparing of images is started by turning raw versions into proofs. Text can be placed within images horizontally or vertically and sometimes diagonally, but upside-down text is not allowed. References to figures, tables and appendices are written starting with capital letters, e.g.,: “Variances in potassium content are presented in Table 1 and Figure 3. Significant differences in sodium content were observed (Appendix 2).”

It is recommended that tables are designed leaving plenty of space and with clear headings. As a rule, variables are given in columns to ensure that numerical values in the columns are of the same magnitude. However, this is not compulsory as the practice followed depends on the requirements of the economical use of space. Vertical lines are not used but horizontal lines are used, for example, under the top heading. You can either import tables from other programmes to the word processing programme or create them in that programme. The fonts of imported tables or figures must conform to those in the other figures and tables. If a table contains abbreviations or symbols, these must be explained in the footnotes to the table.

Examples of figure captions and referencing when using an original image (Figure 1) and when using an edited image (Figure 2). Figure 3 is an example of the original and edited map.

Figure 1. Migmatite from Saaremaa island in Estonia. (Sepp 2005, CC BY-SA 3.0)

Figure 2. Migmatite from Saaremaa island in Estonia. Light leucosome and dark melanosome are indicated in the image. The image has been cropped from the original image. Adapted from Sepp (2005). CC BY-SA 3.0

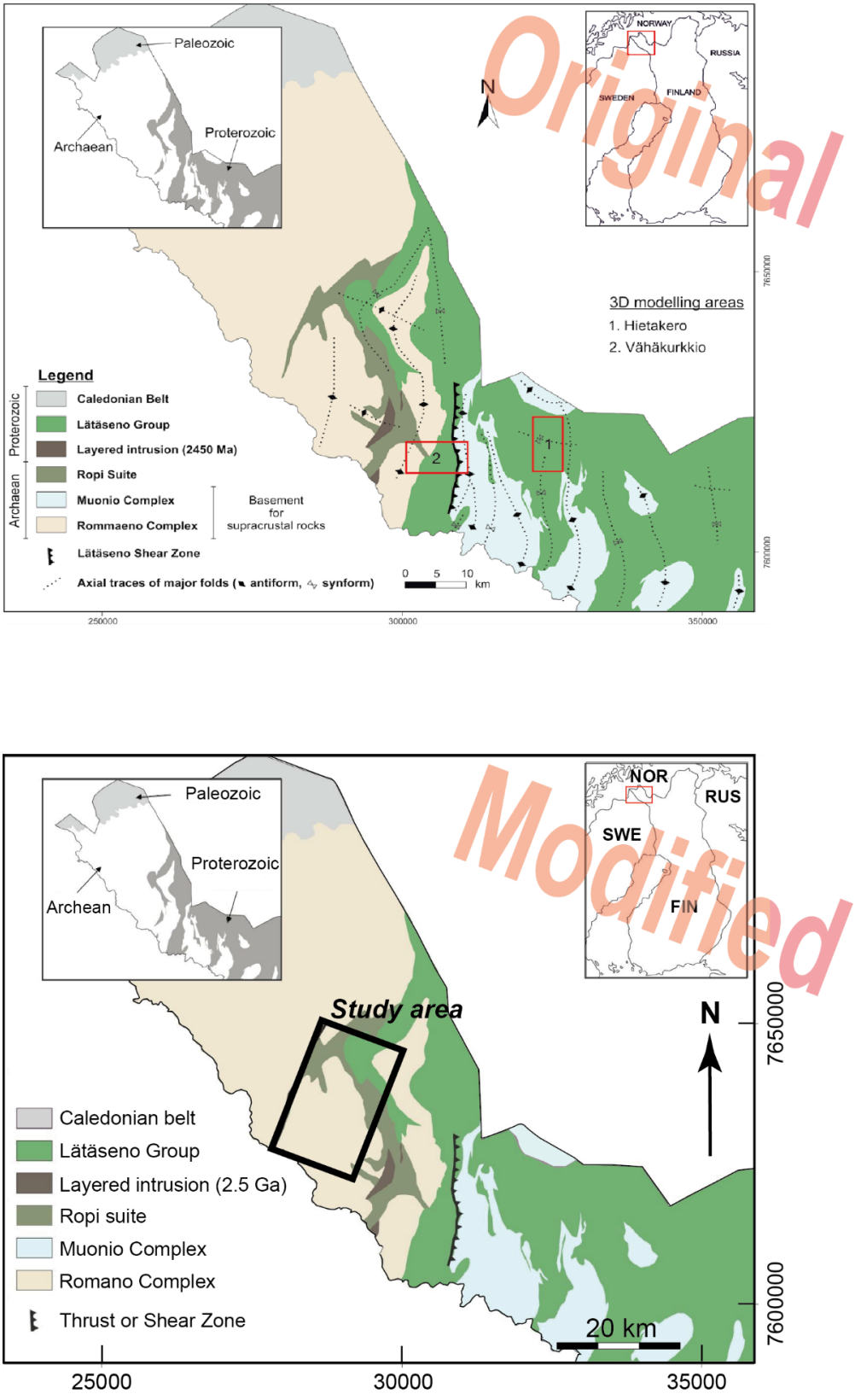

Figure 3. An example of the original and edited map. The reference to the original image should be "Karinen et al. 2015" and the lower edited image "adapted from Karinen et al. (2015)".

4.5. Cover

Students can, if they wish, have a bound copy of the thesis made for themselves. Kumpula Student Services (kumpula-student@helsinki.fi) will provide you with some addresses for bookbinders, the thesis number and any additional information you might need for binding. When binding copies for other collaboration partners, supervisors or libraries, such as the library of the Geological Survey of Finland, it is recommended that the copies follow the same appearance: dark grey buckram covers with the name of the thesis printed in the middle with upper case letters and the name of the author in the lower right hand corner. The back of the bound book has the first and last name of the author at the top and the thesis number and year at the bottom. If the name of the thesis is too long for technical reasons related to printing, it may be replaced with the text MASTER'S THESIS.

5. REFERENCING CONVENTIONS

5.1. General

The aim of references is to link the thesis author's research results to existing knowledge. They are a way for the author to tell readers what other books, articles or sources can provide further information on the subject matter. The versatile use of various sources demonstrates expertise in the field and the ability to engage in academic argumentation. Therefore, it is recommended that paragraph-level citations are avoided. Such citations are placed at the end of the paragraph and they are linked to number of sentences above the citation.

According to the Harvard system followed in the theses of the Master's Programme in Geology and Geophysics, text citations placed in the main text as well as figure and table descriptions contain the name(s) of the author(s) of the source publication and the year of publication as presented in section 5.2. The complete information for each book or other source is presented in a separate list of references. This information needs to be comprehensive enough so that, based on it, readers can check the accuracy of a citation presented in the thesis or acquire the publication referred to for themselves. It is absolutely

crucial that all citations presented in the text, tables and figures can be found in the list of references. A citation must be indicated both in connection with a direct and paraphrased quote. Reference must be made to the original publication, or first-hand source; references to second-hand sources are permitted only in special cases. In other words, for example, if Lahermo (1996) has claimed that moraines in Finland contain 2.5ppm of nickel and there is a reference following this claim (Koljonen 1990), you must find Koljonen's work from 1990 and check what it says about the matter. Under no circumstances should you refer only to Lahermo (1996). On the other hand, if the reference is to Koljonen (1990), the accuracy of the citation must be checked from the original source. If it is totally impossible to get hold of the original publication, the citation is done as follows:

· *Hazen (1911, according to Fetter1994) says that … … … …*
· *… .. … .. …(Hazen 1911, according to Fetter 1994).*

During the master's level course Conducting Scientific Research (GEOM_1003), students draw up a template usable with the EndNote software, which will format citations as well as the list of references in the manner described in these guidelines. It is also possible to create corresponding templates with other reference management software (e.g., free source code software Zotero). In fact, it is recommended that a reference management software package is always used to add references and draw up a list of references.

5.2. Text citation instructions and examples

In theses written for the Master's Programme in Geology and Geophysics, a text citation is indicated with the name of the author and publication year with a single space without a comma; for example (*Nenonen 1998*). In order to make the work of the thesis examiner and readers easier, sometimes also the page(s) from which the citation originates should be mentioned. This applies to exceptionally long articles and in particular books that are not collections of separate articles. In the following, the *examples* have been *italicised*, in theses they are written normally. If a citation is presented only in one sentence, the reference is added to the end, beginning or middle of the sentence as follows:

· *The metavulcanites in Lake Pielavesi and Lake Tohmajärvi are … (Ekdahl and Pekkarinen 1986).*
· *According to Lipponen (1997) ....*
· *Katainen and Kanerva (2003) have stated that ….*
· *These values, compared with the results of Vanhanen et al. (1989, 1992) are ....*
· *Sounding model curves were calculated on the basis of one-dimensional sandwich model based formulae presented by Kunetz (1975) and*
Falkendorf (1975) with software created by Halonen
(1988).

In natural sciences, as in other fields of exact sciences, fact-based referencing is dominant with the emphasis on the content of the matter presented, such as exact research-based information. In fact-based referencing, the text reference is placed in brackets at the end of the sentence. An author-based reference is used when an interpretation of the source or a subjective view is emphasised. Author-based referencing plays a key role in scientific argumentation, for example, when comparing different research results and presenting a critique of the source. In author-based referencing, the source is usually presented at the start of the sentence utilising referring verbs, such as "suggests", "states" or "emphasises".

If the source cited has two authors, they are both referred to and their names are separated with the conjunction "and" (in Finnish-language theses "ja" and in Swedish-language theses "och"; when applicable, this also applies to other guidelines pertaining to references).

· *… (Salonen and Korkka-Niemi 1998).*

If the work cited has more than two authors, only the first one is given and the rest are replaced with "et al.".

· *…. (Virtanen et al. 1996).*
· *According to Lahtinen et al. (2002) ….*

If a certain aspect has been pointed out by more than one researcher or research group in a number of articles, the correct way to refer to it is by presenting them in date order starting from the oldest and separating them with commas as below:

· *Lake Kirkkojärvi has become eutrophic in the last 50 years (Mäkelä et al. 1998, Mustonen 1999).*
· *The eutrophication of Lake Kirkkojärvi has been caused by … (Mustonen 1998, 2001).*

However, if in a corresponding situation a given author has several articles, these are presented consecutively as follows:

· *Lake Sakarajärvi has become significantly purer in recent years (Pyykkönen 1998, 2003, Pekkala 2001)*

If an aspect has been studied very widely or it has been noted in numerous studies, some of the references may be replaced with the expression "etc.". In this case, the thesis author has to choose the most important publications referring to the matter.

· *Fly-ash particle dating has been found to be a good method of dating lake sediments (Kauppila 1995, Itkonen 1999, Valpola 2000, etc.).*

If several aspects presented by various researchers are introduced in one sentence, they must all be referred to separately in the following manner:

· *Methods for restoring lakes may include intensive fishing (Särki 1995), clay blankets (Saverikko 1998) or using gypsum (Varjo 2000).*

If the text refers to several publications by the same author published in the same year, the references are distinguished from each other by using lower case letters as in the example below:

· *The bedrock comprises komatiites, basalts, and … (Räsänen 1987a, b).*

If the list of references starts with several individuals with the same last name and reference is made to their books that have been published in the same year, they are distinguished by the first name initial as follows:

· *The massive sulfide ores in Southern Finland originate from … (K. Mäkelä 1990, U. Mäkelä 1990).*

As a rule, you should aim to rely on printed sources. However, personal communications (discussions, lectures, letters) are allowed and they are mentioned in the text but not in the list of references. In this case, the reference comprises the name and the year and, if needed, the place of employment and the title of the person referred to as follows:

· *… (Professor Kalervo Rankama, University of Helsinki, verbal communication 1973)*
· *… (Markku Rask, personal communication 1974).*

If a cited work has no author, the reference is to the publisher.

· … *(Ekono 1996).*

An anonymous author may also be expressed in the following manner:

· … *(Anonymous 1999).*

If the reference is to an organisation whose name is not too long, the full name is used in the first reference. In later references, the name may be abbreviated. However, remember to include the abbreviation in the first reference, for example as follows:

- *(Geological Survey of Finland, abbrev. GTK, 2000).*

The abbreviation is used especially when a long name is repeated dozens of times in the text. However, in the case of a few mentions, there is no reason to use an abbreviation. The unabbreviated name is used in the list of references. A work that is unfinished must not be referred to. A publication that is in the process of being printed is referred to as “in print”.

- (*Penttilä in print*)

Electronic works may be referred to in the same way as printed sources. In this case, too, the references must conform to the list of references.

- Normally, the reference is to the author (*Lahti 1996*).
- If the author is unknown, the reference is to the editor or the party maintaining the website (*Parker 1995*).
- In the case of an organisation's official document, the reference is to the organisation (*Helsinki Polytechnic* 1995).

Direct quotations are not recommended but they may serve a purpose if paraphrasing distorts the issue or crucially changes it. Direct quotations are placed within the text in quotation marks. You should avoid long quotations and make sure that the context remains correct. If a quotation is in a different language than the thesis, it is recommended that it be translated. In this case, it must be clearly indicated that the quotation is a translation and the name of the translator must be mentioned. If part of the quotation is left out, this is indicated with an ellipsis. An example:

- *Heikkinen (1990) has written about modelling methods of direct current and induced polarisation measurements, for example, in the following way: "Numerical methods are best suited to the modelling of measurements of direct current and induced polarisation. Of these, differential equation methods are suited to modelling two-dimensional structures that are complex with regard to their cross section. ... Efficient three-dimensional modelling requires the use of integral equations or hybrid methods."*

6. PREPARING A LIST OF REFERENCES

6.1. General guidelines

The aim of the list of references is to help identify and locate a publication. The source literature to which the thesis refers is presented at the end of the thesis as a list of

references comprising reference information that is as complete as possible. It provides the bibliographic information on the references mentioned in the text so that finding and identifying all the sources is guaranteed. This allows readers to both check the accuracy of the passage in the thesis that is based on a reference and acquire the said publication for themselves. The key information includes the name(s) of the author(s), the year of publication (indicated immediately after the author's name), information related to the publication forum and the number of pages. Works not referred to in the thesis are not listed in references and, correspondingly, any reference listed must be found in the main body of the text. It is recommended that the list of references is drawn up using reference management software (see section 5.1.), which ensures that the references are included and formatted correctly in the list of references.

As a rule, information for references is taken from the title or description page of the publication in question. It is presented in the same form as in the original publication, with the exception that only the initials (separated with full stops) of the author's name are included. If a publication has two authors, their names are separated with the conjunction "and". If there are more than two authors, their names are separated with commas, except before the last author when "and" is used. The year of publication is indicated immediately after the name of the author. For books, the year of publication is the year of publication of the first edition. If there is more than one edition, the year of publication of the edition used is indicated as well as the number of the edition.

In the case of an article published in a scientific journal, the words in the title are written in lower case except for the proper names that are written with an initial capital letter. Upper case letters are used in the names of books, publication series, conference publications, compiled works and publishers' names in accordance with how they have been used in the title page of the original work.

If the publication forum is a book or other single work, the publisher, the place of publication location and number of pages are also indicated. If the publisher has more than one location, the first will suffice. In the case of a compilation, the name(s) of the editor(s) of the book, the name of the book, the place of publication and the page numbers of the article in question are indicated. In the case of an article in an academic journal, the whole unabbreviated name of the publication series, the number (volume) of the

publication as well as the page numbers of the article in question must be indicated. The volume of a single journal is usually not mentioned. If the page numbering of each volume starts afresh, the volume number must be followed in brackets by the number of the journal, for example, ... 7 (2), 13-32. For an unpublished thesis the thesis level (e.g., BSc thesis or master's thesis), the department that has approved the thesis or the degree programme and the university as well as the number of pages must be indicated. When referring to a map, the name of the author or editor, the year of publication, the name of the map, the publisher and the place of publication are mentioned.

The number of possible appendices to the reference is indicated after the number of pages if there are many of them and if they constitute an essential part of the publication. The number of reference maps is always mentioned.

Electronic documents, such as e-publications, are referred to in the same way as printed publications. If a reference has a DOI (Digital Object Identifier), this should be added after the reference (see example in the list of references). When referring to internet addresses, the author of the text must be mentioned in addition to the full address, if it is known, and the date when the information was accessed. If the website does not spell out the author of the text, the party maintaining the website is indicated (e.g., Finnish Environment Institute, or SYKE, if the abbreviation is in use). The url address of the website is not in itself an accurate enough reference. It is also recommended that a printout of the page is taken on the day it is accessed for the thesis author's records. A reference to an internet address is alphabetised in the list of references based on the author or, if the author is unknown, the party maintaining the website. It is recommended that web-based sources that have not been reviewed in advance in accordance with scientific practice are avoided or approached with an extremely critical eye.

In the list of references, a reference to each publication starts on its own line. Line spacing is 1, font size is 11 and indentation is 0.5cm; however, the first line of each publication is not indented; that is to say, hanging indentation is used.

In the list of references, published or unpublished literature used as a source of the thesis is alphabetised according to the author's last name, or in the case of several authors, the last name of the first author. However, remember to alphabetise the list according to the

language used in the thesis. Consequently, for example, the letters ä and å are alphabetised as a in an English-language thesis.

Works published by the same individual in different years are listed in the order of the publication year from the oldest to the newest. Works published by the same author(s) in the same year are listed in alphabetical order using lower case letters. The order is based on the order in which the works are referred to in the text (the work referred to first is indicated with an a, the second with a b, etc.), for example, thus:
Aaltonen, P. 1996
Aaltonen, P. 1997a
Aaltonen, P. 1997b

However, the publications of a single author are listed so that first are the works written alone by the author in the order of publication, followed by publications co-authored with one other individual and, finally, publications co-authored with two or more individuals. If the number of authors is the same, the alphabetical order based on the second author's name is followed.
Prefixes related to last names are given in front of the name either written together or separately from the name as per the original publication. If the prefix is abbreviated, the place of the article is determined alphabetically based on how the prefix is written in its unabbreviated form. Of the most common abbreviations, Mc and M' mean the prefix Mac. Prefixes not belonging to the last name are mentioned last after the name and written in the form used in the publication.

Geer, G. de
Heide, S. van der
Knorring, O. von
The abbreviation Jr. is added after the name and separated with a comma as follows:
Avery, G., Jr.

If the name of an author has not been provided for a cited publication and the reference is to the publisher, the publication will be alphabetised according to the publisher's name (e.g., *Ekono* 1996). If the word 'anonymous' is used for the author of a cited publication, the publication is alphabetised according to that word.

6.2. Examples of referring to literature

6.2.1. Reference to a book or other separate work

Didier, J. 1973. Granites and their Enclaves. Elsevier, Amsterdam, 393 p.

Hall, A. 1996. Igneous Petrology. 2nd edition. Longman, London, 551 p.

Papunen, H., Haapala, I. and Rouhunkoski, P. (eds.) 1986. Suomen malmigeologia: metalliset malmiesiintymät. The Geological Society of Finland, Helsinki, 317 p.

Tikkanen, T. 1986. Kasviplanktonopas. Suomen luonnonsuojelun tuki Oy, Helsinki, 278 p.

6.2.2. Reference to a chapter of a book or a separate work

Barbarin, B. 1991. Enclaves of the Mesozoic calc-alkaline granitoids of the Sierra Nevada Batholith, California. In Didier, J. and Barbarin, B. (eds.) Enclaves and Granite Petrology. Developments in Petrology 13. Elsevier, Amsterdam, 135-153.

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Hyvärinen, L. and Eskola, L. 1986. Malminetsintä. In Papunen, H., Haapala, I. and Rouhunkoski, P. (eds.) Suomen malmigeologia: metalliset malmiesiintymät. The Geological Society of Finland, Helsinki, 215-289.

6.2.3. Reference to a publication series

Haapala, I. 1977. Petrography and geochemistry of the Eurajoki stock; a rapakivi-granite complex with greisen-type mineralization in southwestern Finland. Geological Survey of Finland, Bulletin 286, 128 p.

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Tuttle, O.F. and Bowen, N.L. 1958. Origin of granite in the light of experimental studies in the system $NaAlSi_3O_8$-$KAlSi_3O_8$-SiO_2-H_2O. Geological Society of America, Memoir 74, 153 p.

6.2.4. Reference to an article in a publication series

Zellmer, G.F., Blake, S., Vance, D., Hawkesworth, C. and Turner, S. 1999. Plagioclase residence times at two island arc volcanoes (Kameni Islands, Santorini, and Soufriere, St. Vincent) determined by Sr diffusion systematics: Contributions to Mineralogy and Petrology, 136, 345-357, doi: 10.1007/s004100050543.

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Burnham, C.W. and Nekvasil, H. 1986. Equilibrium properties of granite pegmatite magmas. American Mineralogist 71, 239-263.

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6.2.5. Reference to a magazine article (e.g., in a scientific magazine)

Eerola, T. and Törnroos, R. 2000. Magmojen sekaantuminen svekofennisessä Soukkion kerroksellisessa gabro-graniittikompleksissa Mäntsälässä. Geologi 52, 132-140.

Pearce, J.A. 1996. Sources and settings of granitic rocks. Episodes 19, 120-125.

6.2.6. Reference to a summary or an article in an excursion guide

Dobnikar, M., Dolenec, T., Fioretti, A.M. and Bellini, G. 2000. The origin of plagioclase-mantled K-feldspar in porphyry rocks of Karavanke Granitic Massif (Slovenia). In Lukkari, S. and Haapala, I. (eds.) Rapakivi granites and associated mineralization. IGCP Project 373 Conference in Southern Finland, July 3-7, 2000. Excursion Guide and Abstracts, 36-37.

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6.2.7. Reference to a research or other report

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6.2.8. Reference to a map in a series of maps or a separate map

Haavisto-Hyvärinen, M., Sten, C.-G. and Kaija, J. 1990. Karisjärvi. Geological map of Finland 1: 20 000, soil map, sheet 2134 04. Geological Survey of Finland, Espoo

Härme, M. 1960. Turku. Geological map of Finland 1:400 000, bedrock map, sheet B1. Geological Survey of Finland, Espoo.

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6.2.9. Reference to a map sheet explanation

Härme, M. 1960. Turku. General geological maåp og Finland 1:400 000, rock tyoe map explanations, sheet B1. Geological Survey of Finland, Espoo. 78 p.

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6.2.10. Reference to an atlas

Koljonen, T. (ed.) 1992. Suomen geokemian atlas, Osa 2: Moreeni. Geological Survey of Finland, Espoo, 218 p., 11 map appendices

6.2.11. Reference to a thesis

Peltonen, P. 1995. Petrology, geochemistry and mineralogy of ultramafic rocks and associated Ni-Cu deposits in the Vammala belt, southwestern Finland. Geological Survey of Finland, Espoo, 108 p. doctoral thesis

Rautiainen, J. 2000. Arkeeisen kratonin reunalla esiintyvät intermediääriset juonet Iisalmen, Juankosken ja Siilinjärven alueilla. Master's thesis, University of Helsinki, Department of Geology, Department of Geology and Mineralogy, 60 p.

6.2.12. Reference to a website

Crawford, W.E. 2018. Rare-Earth Elements Discovered In Georgia Kaolin Mines, Study Finds. Accessed 9 January 2019. https://news.gsu.edu/2018/12/14/rare-earth-elements-discovered-in-georgia-kaolin-mines-study-finds/

Nuggetshooter 2004. Arizona gold deposits. Accessed 3 August 2004. http://www.nuggetshooter.com/articles/ArizGoldDeposits.html

7. GEOLOGICAL INFORMATION ONLINE

Efficient use of the library and databases is a precondition of a successful master's thesis. Consequently, it is worthwhile practising the use of these important tools for students and researchers, among the most important of which are the University of Helsinki's Helka, AGI's Georef and GTK's Fingeo databases. Google or some other internet browser may

take you to the required information surprisingly quickly, but in this case, it is extremely important to be critical about the sources.

The website of GTK's information services provides links to electronic geological publication series as well as an up-to-date list of publication series subscribed to by the library. You also have direct access from the University of Helsinki's intranet to an immense article database through the ScienceDirect service.

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