ENGIE DELIVERABLE 1.5

ENGIE ACTION PLAN

Summary:
This report presents data that were collected and assessed during ENGIE WP1 Programming. The report concludes in a mobilisation action plan comprising three key messages that will guide the project in the implementation of actions.

Authors:
Kristina Johansson
Samuel Heimann
Maria Johansson
Eugenia Segerstedt

Luleå University of Technology

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1 EXECUTIVE SUMMARY

The project 'ENGIE – Encouraging Girls to Study Geosciences and Engineering' aims to interest girls aged 13-18 in studying geosciences and related engineering disciplines. As career decisions are generally made during this period, the impact of the project is expected to contribute to improving the gender balance within these disciplines.

ENGIE is being implemented through the cooperation of 26 institutions. The partnership involves three universities (University of Miskolc, Luleå University of Technology and University of Zagreb), two research centres (La Palma Research Centre and the National Research Council of Italy) and a European-level professional organisation (The European Federation of Geologists, EFG) with 26 national member geological associations. Twenty of EFG's national associations are participating in project implementation as linked third parties, thereby extending the activities of the project to more than 20 European countries.

This report presents data that were collected and analysed during the first ENGIE WP1 Programming. The results are based on the following:

1) The assessment of statistical data on the representation of women in geoscience education and professions and the results of previous studies related to best practices for teaching STEM and gender perspectives on geoscience education and professions

2) The assessment of new empirical studies using questionnaires administered to secondary school students, teachers and women in geoscience professions; interviews with academic leaders; and one international workshop and a series of national workshops with leading women geoscientists.

Drawing on this data, the report concludes in mobilisation action plan consisting of strategies for achieving gender equality in education, employment and workplaces within geoscience and mining-oriented working environments. The plan takes the form of a number of key messages that will guide the implementation of the project:

- Changing circumstances not individuals
- Challenging rather than reproducing inequalities
- Taking variations into account

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2 INTRODUCTON

2.1 THE ENGIE PROJECT

The project 'ENGIE – Encouraging Girls to Study Geosciences and Engineering' aims to interest girls aged 13-18 in studying geosciences and related engineering disciplines. As career decisions are generally made during this period, the impact of the project is expected to contribute to improving the gender balance within these disciplines.

ENGIE is being implemented through the cooperation of 26 institutions. The partnership involves three universities (University of Miskolc, Luleå University of Technology and University of Zagreb), two research centres (La Palma Research Centre and the National Research Council of Italy) and a European-level professional organisation (The European Federation of Geologists, EFG) with 26 national member geological associations. Twenty of EFG's national associations are participating in project implementation as linked third parties, thereby extending the activities of the project to more than 20 European countries.

Through the project, an awareness-raising strategy is being developed, and an international stakeholder collaboration network will be established for the implementation of a set of concrete actions that will include family science events, outdoor programmes, school science clubs, mine visits, mentoring programmes, international student conferences, publication and award opportunities, summer courses for science teachers and the production of educational materials. These actions are being carried out in more than twenty countries throughout Europe and will be enhanced by an active social media presence.

2.2 ABOUT THE ACTION PLAN

This report presents a mobilisation action plan consisting of strategies for achieving gender equality in education, employment and workplaces within geoscience and mining-oriented working environments. The plan takes the form of a number of key messages that will guide the implementation of the project. The key messages, presented in more detail in the final section, are:

- Changing circumstances not individuals
- Challenging rather than reproducing inequalities
- Taking variations into account

The action plan and its key messages draw on data that were collected and analysed during the first ENGIE work package, titled Programming. These results are based on:

1) The assessment of statistical data on the representation of women in geoscience education and professions and the results of previous studies related to best

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practices for teaching STEM and gender perspectives on geoscience education and professions

2) The assessment of new empirical studies using questionnaires administered to secondary school students, teachers and women in geoscience professions; interviews with academic leaders; and one international workshop and a series of national workshops with leading women geoscientists.

2.3 OUTLINE OF THE MAIN CONCEPTS

This section briefly describes some of the central concepts and themes that are relevant to the discussion of gender in relation to work, education and organisations. This section first introduces the concepts of gender, sex, and sex category in relation to the social world of work and organisations. The next section discusses gender equality and some of the various strategies commonly used to reduce inequality. Lastly, gender in organisations and how organisations are gendered, not least within geoscience and geoengineering, are discussed.

2.3.1 The concept of gender

The first necessary distinction relates to individual in organisations (worker/student) and the concept of gender itself. Gender is often regarded as synonymous with the term *sex*, meaning the biological sex of a person, which is a distinction often based on a person's genitals, internal re-productive organs and/or hormones. The simplification of sex/gender is often used in everyday speech and tends to promote assumptions that gender, i.e., being a "girl" or a "boy", is something that is "naturally" given – in other words, that gender correlates with sex. We are thus expected to think, dress and act in accordance with our biological sex.

However, how we think, dress and act are not dependent on biological factors but are psychological and social products that are developed in relation to our social surroundings. As an example, being "a girl" in Stockholm, Sweden, in 2020 means something different than being "a girl" in Helsinki, Finland, in 1960. How "a girl" or "a boy" is supposed to think, dress and act differs depending on the historical, cultural and social context. While "a girl" in Helsinki in 1960 might think that she would like to start a family, become a housewife and dress in colourfully patterned dresses, her modern equivalent in Stockholm might think that dresses are unpractical and that a career in science and partnership with Stina could be her future. This example illustrates, albeit crudely, how concepts of gender change over time and how the construct of gender is closely related to how we shape our identities and ideas about what our possibilities are and of how our lives should be. Gender should therefore be understood as "a classification that societies construct to exaggerate the differences between females and males and to maintain sex inequality" (Reskin & Padavic 1994:3). Gender is a social construct that divides and

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emphasises differences between the sexes, making these differences seem part of a biologically determined state of affairs.

When we reject the idea that sex equals gender, then our focus must be directed towards "how" and "why" gender differences manifest themselves. According to West & Zimmerman (1987), gender differences are produced and maintained through socialisation, the action of social institutions and interactions among people. In their view, rather than an inherent property of individuals, gender should be regarded as "an emergent feature of social situations: both as an outcome of, and a rationale for various social arrangements and as a means of legitimating one of the most fundamental divisions of society" (1987:126). Gender is thus something that is constructed outside of the individual. As part of our socialisation into society, we are assigned a *sex category* to which we are expected to adhere. Usually, the sex category is assigned in accordance with the socially agreed-upon criteria of biological sex. Gender, in turn, becomes the activity of managing the social expectations related to the given sex category, i.e., of "doing" gender rather than of "being" a certain gender.

By behaving and acting in accordance with the social expectations related to our gender, we are able to pass as "men" and "women". If we divert from these norms, then we are subjected to corrective behaviour from our social surroundings. These corrections can be subtle, as when the phrase "your hair looks good *today*" is directed towards a woman with the meaning that she usually does not pay enough attention to her appearance – something that is normatively expected of a person belonging to the sex category "woman". However, corrective behaviour can also be more direct, such as asking a woman in her late twenties "*when* are you planning on having children?" rather than asking *if* or simply not asking about children at all. The family is one of the social institutions in which gender comes to the fore and in which the expectations about certain gendered roles between "men" and "women" are evident and easily identified, which is perhaps most apparent in the gendered names of parents: the *mother* and the *father*, each of which are ascribed certain characteristics regarding their expected performance in relation to the child's upbringing.

These gendered divisions, the segregation of male and female spheres, are also carried into other social areas. Aside from the family, one social institution that has drawn considerable interest from scholars interested in gender is work and working life. Where we work, and with what, is often related, to a large extent, to gendered processes in our societies. For example, Sweden is often regarded as one of the most gender-equal societies in the world, but its labour market is profoundly segregated in terms of gender. Men are overrepresented in private-sector professions, while women predominantly work in the public sector. One might say that "men" in Sweden predominantly produce "goods" (in manufacturing and other industries) while women produce "the good" (in childcare, healthcare and education). This situation can also be interpreted as the manifestation of the gendered relations of the family, with women as the "carers" and

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men as the "providers", in working life. Moreover, women's work is generally less valued and has worse working conditions and lower wages than men's work. While women in the European context are better educated than men (45% of women have a tertiary education in the EU 27, compared to 34% of men), they still earn almost 15% less than men, and they do not receive the same access as men to the labour market (Eurostat 2020).

2.3.2 Gender (in)equality

How are we to understand the reasons behind the concept and reality of gender inequality? Once again, taking gender as meaning something that we do, rather than are, we can begin to discern the concept of gender equality as a question of power and resources distributed in accordance with gender attributions. In the European context, we have a long history of male domination within almost all spheres of life, from the family (as "head" of the household) to work, education, culture and political life. In fact, women have, for long periods, been excluded from almost all positions of power and influence, not least within education and the labour market.

The 20th century has seen improvement in women's rights, but there are still significant differences between men and women in terms of wealth distribution and access to power and influence. This is, of course, a generalisation made to underline the argument and to illustrate the structural problem of gender inequality. There are women in powerful positions and who are in control of considerable amounts of wealth. Moreover, numerous other factors influence power relations that intersect with gender and affect the positions of women and men, such as class, age, ethnicity, religion, and sexuality. Although our main concern is gender, it is important to recognise "the way power has clustered around certain categories and is exercised against others" (Crenshaw 1991:1296-1297). The power invested in the "white, Western, and middle-class man" is one such cluster, and the social construct of this entity has material outcomes (such as economic wealth and physical wellbeing). The main point is that gender is a factor in how resources are divided in a society and that women are given less power to influence this distribution than men.

The political struggle for gender equality has therefore argued for a redistribution of power and influence from men to women. This redistribution, in turn, has been shaped by different strategies to shift such power to women. Judith Squires discusses three main strategies and their characteristics in relation to the evolution of the women's liberation movement after the Second World War. The initial demands of women were for *equal opportunity* and inclusion in all societal spheres on the same terms as men. This strategy focuses on gender neutrality and equal treatment and seeks to open up positions to both women and men. The second strategy, *positive action*, seeks to upgrade women and characteristics perceived as feminine, in part through the reversal of discriminatory practices and the redistribution of resources (such as targets for the number of women in company boards or other positions of power). The third strategy is *mainstreaming*, which aims to transform the processes that reproduce inequality. Through a focus on processes (such as decision procedures in government), mainstreaming can be a

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transformative strategy that challenges rather than reproduces or merely compensates for gender norms and power structures, the latter being a critique that is often directed at the previous two strategies (Squires 2005).

Mainstreaming is the current main strategy being implemented within government organisations and public institutions in Europe (European Commission 2020). Although mainstreaming can be a transformative strategy if it manages to penetrate and transform the processes that reproduce inequality, it also risks being subsumed into bureaucratic machinery in which the transformative force is dampened by a lack of gender analysis. Carol Bacchi (2009) has referred to this risk as the question "What is the problem represented to be?" In Bacchi's understanding of policy-driven institutional change, the importance of defining the problem is instrumental in the process of not reproducing its causes. In relation to mainstreaming, this approach means that transformative change in processes must be accompanied by an analysis of the type of problem that the particular process is contributing to creating or solving. As an example, if the problem of women's unequal wages is represented as a question of lower productivity due to maternity leave, then the process that can right the inequality is directed towards women's reproductive capacity, meaning that only women who do not have children will have the opportunity to earn an equal wage. In contrast, if the problem of women's unequal wages is represented instead as a question of women's unpaid labour, then the process of correcting the problem will more likely be directed towards the functioning of the labour market and the normative division of labour between men and women (Bacchi 2009). Bacchi's critical approach to policy further stresses the need for processes that are inclusive both in terms of who is allowed to participate in the process (in terms of class, gender, ethnicity, age, etc.) and in how the idea of mainstreaming is framed, i.e., if it focusses only on gender or allows for a diversity of positions of marginalisation to be incorporated into the strategy (Bacchi & Eveline 2009). It is through such an inclusive and critical approach that we argue that a possible transformation towards equality is possible.

2.3.3 Gender and organisations

Inequality is not only visible in the family or in society at large but is also a profound problem in most organisations and workplaces. A common understanding of gender in working life is that men and women create working cultures that are positive or negative in relation to gender equality. This understanding of gender in organisations tends to conceive of gender as something carried into organisations by employees, leaving the organisations and their structures and processes as something of a neutral "carte blanche", ready to be filled with either positive or negative cultures. Such an understanding risks placing the responsibility for the reproduction of inequality on the persons in the organisation rather than seeing the organisation itself as part of the problem (Kanter 1977). Another way of understanding gender in organisations would be to think of organisations themselves as gendered and of gender as a part of the organisational logic that affects its process and structures (Acker 1990). The sociologist

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Joan Acker has created a theoretical frame for understanding the gendering of organisations. In Acker's theory, a gendered organisation means that "advantage and disadvantage, exploitation and control, action and emotion, meaning and identity, are patterned through and in terms of a distinction between male and female, masculine and feminine" (1990:146).

According to Acker, organisations are gendered through five interacting processes, of which the first is the divisions along the lines of gender. These divisions can encompass labour, power and the behaviour allowed for men and women. Most organisations have clear divisions of power, with men usually dominating the top positions. Work organisations are often organised according to a physical separation between men and women, for example, with women in administrative jobs and men in technical jobs. The second process regards the construction of symbols that are made visible through language and images. These symbols reinforce, explain or express the gendered divisions of an organisation. A common symbol is the top executive, who often presents an image of forceful masculinity. The third process relates to the interactions between men and women, men and men, and women and women within an organisation. These interactions include the patterns that enact dominance and submission and are often made visible in everyday work, for example, in who is listened to in a meeting or who interrupts a conversation or plays a supportive role to a colleague. The fourth process is related to individual identity and the individual's adjustment to and understanding of the gendered structure of the organisation. This process is carried out in relation to the aforementioned processes and encompasses the choice of work, use of language, clothing, etc. in accordance with the gendered structure of the organisation. Finally, the fifth process involves how "gender is implicated in the fundamental, ongoing process of creating and conceptualizing social structures" (Acker 1990:147). In this process, gender is a constitutive element in organisational logic, i.e., in the underlying assumptions and practices that form the structure of work organisations. Gender should not be regarded as something that is added on afterwards but as something that undergirds the organisational logic and takes material form in the shape of written work rules, contracts, wage criteria and job evaluations.

The study of gender in organisations is often also the study of the gender inequality of organisations. As mentioned, power structures are not limited to the effects of gender but are related to a wide variety of social categorisations that influence the hierarchy and access to power in organisations.

Acker calls these power structures "inequality regimes" that consist of "loosely interrelated practices, processes, actions, and meanings that result in and maintain class, gender and racial inequalities within particular organisations" (Acker 2006:443). This theoretical understanding of inequality in organisations emphasises an intersectional approach in which social identities overlap and create compounding experiences of discrimination (Crenshaw 1991). These social identities can relate to sexual orientation, disabilities,

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religion, age or geographic roots, but for Acker, it is especially important to relate inequality regimes to gender, ethnicity and class. These three markers of identity are central in understanding the stratification and working conditions in many organisations, not least in relation to geoscience and geoengineering.

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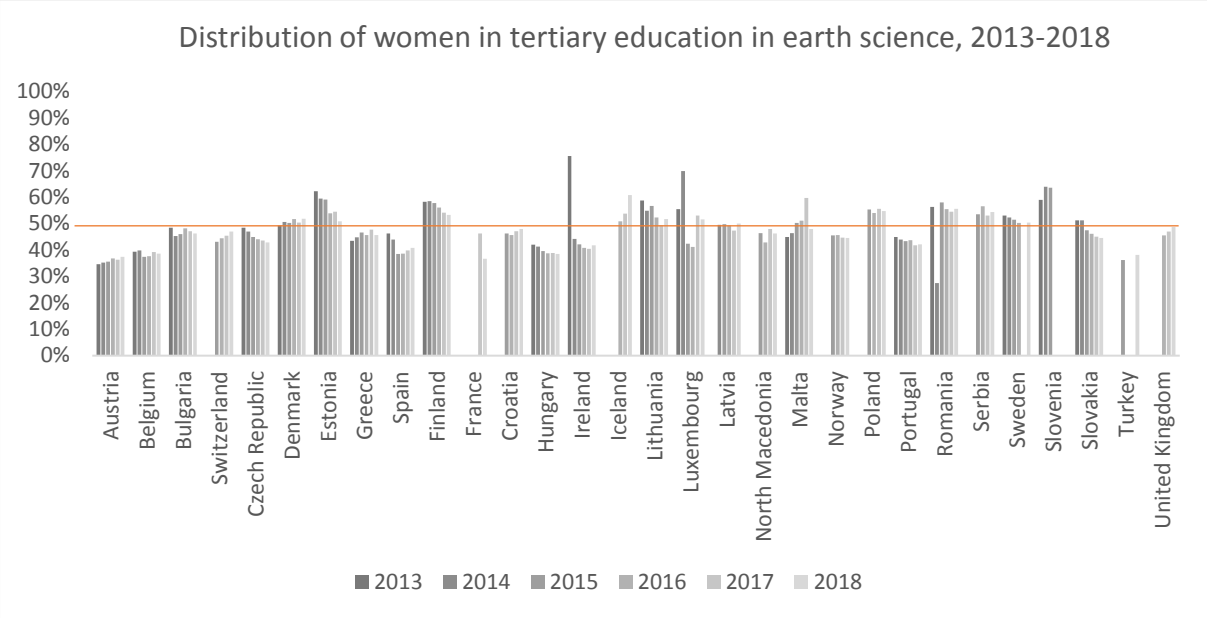
3 REVIEW OF DATA AND RESEARCH ON EDUCATION, EMPLOYMENT AND TEACHING

3.1 DATA ON TERTIARY EDUCATION

The proportion of women in STEM education in Europe is lower than that in many other fields. In addition, the proportion of women is much lower in higher academic positions. For example, 39% of doctoral graduates are women, yet women account for only 15% of academic grade-A positions (European Commission 2018). The gender distribution also tends to differ in various subfields within geoscience. In the following, the gender distributions in the subfields of earth science, environmental sciences and geo- and mining engineering are further explored (for a deeper analysis, see Johansson et al. 2020). Of these three subfields, **earth science** has the most equal gender distribution (Figure 1). In most countries, this field is composed of between 40% and 60% women. The distribution of women generally follows the same pattern in individual countries over time. Some countries, however, are either moving slightly towards a gender-equal distribution (see Estonia, Lithuania and Switzerland) or farther away from it (see the Czech Republic and Iceland).

Figure 1: Distribution of women in tertiary education in earth science, 2013-2018



(Source: Eurostat's online database, dataset educ_uoe_enrt03, downloaded from EIGE)

Of the investigated subfields, the proportion of women is highest in the **environmental sciences** (Figure 2), where women account for more than 60% of the total students in several countries. Like the timeline for earth science, it seems that countries largely follow

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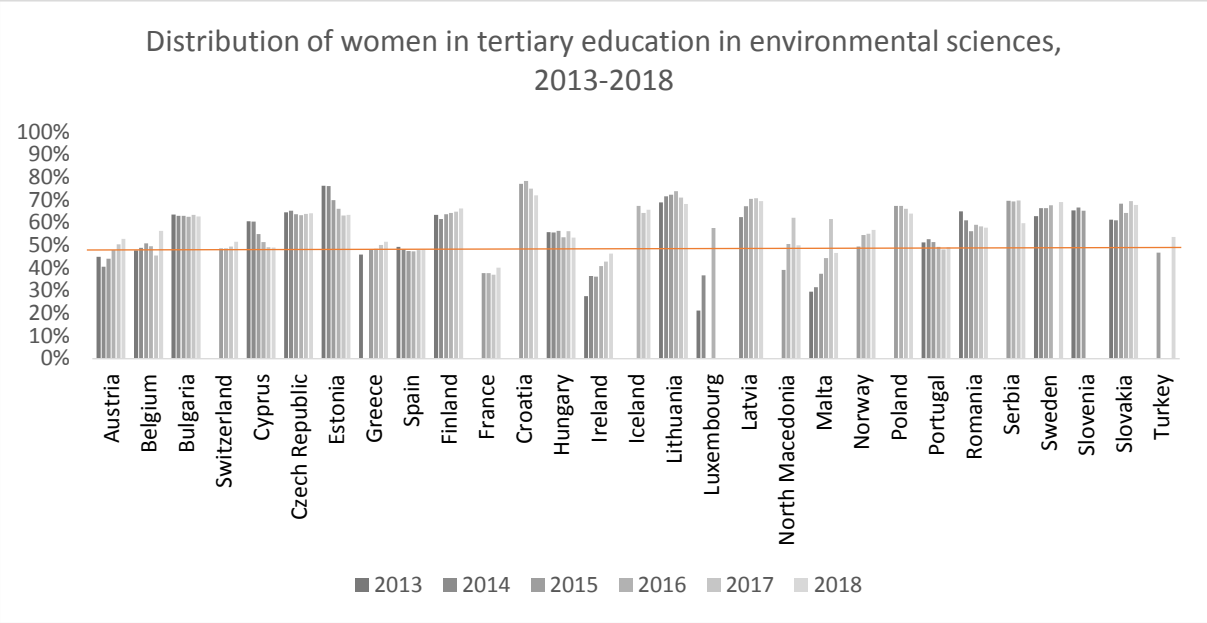
the same pattern over time in the environmental sciences, which indicates that it will continue to be a female-dominated subfield. In contrast, Cyprus, Estonia, Austria and Ireland became more gender equal across the timeline. France stands out because of the lower proportion of women over time compared to the other countries, with the proportion of women remaining at approximately 40%, although data for some years are missing.

Figure 2: Distribution of women in tertiary education in environmental sciences, 2013-2018



(Source: Eurostat's online database, dataset educ_uoe_enrt03, downloaded from EIGE)

Contrary to the environmental sciences, the **geo- and mining engineering field** is heavily male dominated (Figure 3). Although data are missing from several European countries, it is clear that the proportion of women in the field is significantly lower than that in earth science and the environmental sciences. The proportion of women in 2018 is not higher than 45% (Slovakia) in any country, and in most countries, the proportion of women is less than 40%. As in the two other studied subfields, the pattern is consistent in most countries. However, there are less data available in the geo- and mining engineering field. It is possible that the increase of women in this field in Romania, from 14% in 2013 to 24% in 2018, might indicate a changing pattern in that country.

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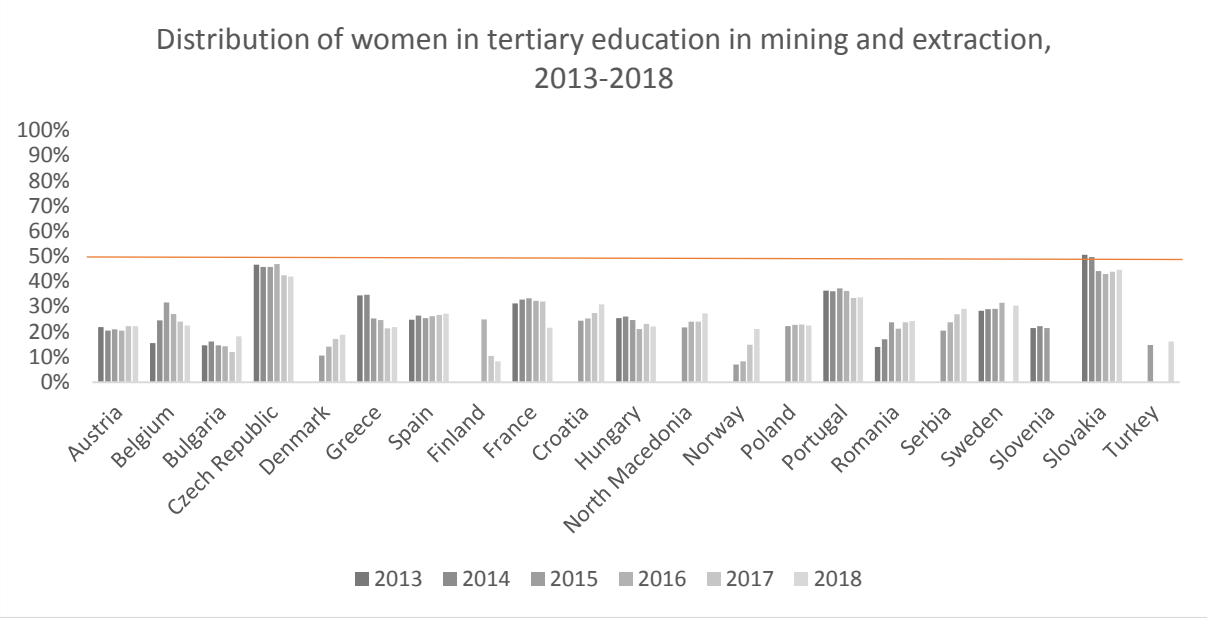
Figure 3: Distribution of women in tertiary education in geo- and mining engineering, 2013-2018



(Source: Eurostat's online database, dataset educ_uoe_enrt03, downloaded from EIGE)

In sum, the data on the gender distribution in tertiary education in earth science, environmental sciences and geo- and mining engineering show that the proportion of women varies based on subfield and, to some extent, among countries. For example, the proportion of women tends to be higher in some countries (see Slovakia, Estonia and the Czech Republic) and lower in others (see France). The subfield field of earth science is somewhat balanced in terms of the gender distribution, while there is a higher proportion of women than men in the environmental sciences. In the geo- and mining engineering field, the proportion of women is significantly lower in comparison to the other investigated subfields. In addition, the data indicate that when a pattern is established, concerning both the gender distribution in different subfields as well as in different countries, it usually continues over several years.

3.2 DATA ON EMPLOYMENT

This chapter describe the gender distribution in geoscience and geo-engineering professions in Europe on employment. However, is it´s difficult to draw conclusions from the limited data available. Data from an American context indicates that women educated in the field of geoscience, to a larger extent than men, work in a non-science engineering occupation (see American Geosciences Institute, 2020). In the European context, EFG has initiated a yearly survey with the potential to contribute with important information on the horizontal and vertical distribution of women in the field. So far, however, the results from the survey is have not been analysed according to gender (see The European Federation of Geologists 2018, 2019).

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It is difficult to find statistics on where female geoscientists in Europe work. However, data from the American context might serve as an inspiration for European stakeholders. For example, the American Geosciences Institute (AGI) presents short "data briefs", called *AGI Geoscience Currents*, based on national surveys and national data on a range of topics that are easily accessible to the public on their website. Sample topics include Diversity in the Geosciences, U.S. Female Geoscience Enrolments Show Variability in 2017, Highest Degree Fields of Geoscientists (2010-2017), Occupations of Terminal Geoscience Degree Recipients (2010-2017) and Participation of Women in the Geoscience Profession. In *AGI Geoscience Currents: Participation of Women in the Geoscience Profession*, it is reported that in the US, 11% of women with geoscience degrees worked in that field in 2017 compared to 23% for men. Moreover, 18% of women with such degrees worked in other science and engineering occupations, while the percentage of men was 31%. Notably, 57% of such women worked in a non-science and engineering occupation, which represents a steady increase from 40% in 2010. By comparison, the proportion of men in such occupations is 31%, which represents a small increase from 28% in 2010 (American Geosciences Institute 2020).

In the European context, the European Federation of Geologists (EFG) has conducted surveys since 2018 that ask about geoscientists' employment. The objective of the survey is to analyse the labour market in Europe for geologists, including where geologists work and whether their current job is related to their education, to find information about where job opportunities exist in the field and to provide information that can support improvements in geoscience education. The first survey, conducted in 2018, surveyed 740 participants, of whom 28% were women. However, the distribution of women was not separate from the distribution of men in the presentation of the results. Over half had a master's degree, and almost a third had a PhD. The results showed that more than half (54%) worked in the private sector, 23% in the public sector, and 13% were self-employed. The rest were retired or unemployed. Geoscientists were mobile, and 12% of the participants worked outside Europe. However, that rate is declining. The participants were active in different areas within geoscience. Slightly more than half (52%) were active in the minerals sector, 32% in environmental geology, 25% in hydrology, 20% in geotechnics, 18% in oil and gas and 16% in academia. According to EFG's report, one in five participants had changed fields within the last five years. Furthermore, the results showed that many of the participants who had changed their field worked in the oil and gas sector, academia or the mineral exploration and mining sector (The European Federation of Geologists 2018), although more details were not provided.

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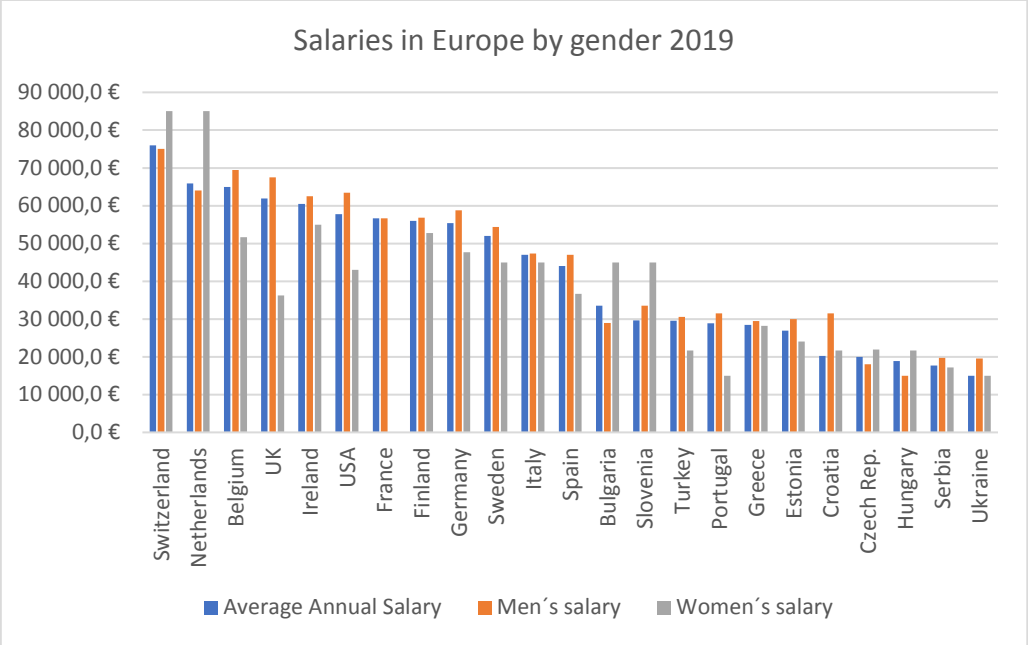
Figure 4: Salaries in geoscience by gender 2019



Source: EFG Employment Survey 2019

In the survey conducted in 2019, EFG received 694 responses, 31% of which were from women. In this survey, salary information was divided by gender. As shown in Figure 4, the average salaries in geoscience tended to be higher in Western Europe than in Eastern Europe. Furthermore, both senior positions with higher salaries and junior positions, which tend to have lower salaries, were included in the data (The European Federation of Geologists 2019). Men's salaries generally aligned with the column "average salary" in most countries, whereas women's salaries seemed more often to be either higher (Switzerland, the Netherlands, Bulgaria and Slovenia) or lower (Belgium, UK and Portugal) than the "average salary".

It is it´s difficult to draw conclusions from the limited data available about the gender distribution in geoscience and geoengineering professions in Europe. Data from the American context indicates that women educated in the field of geoscience, to a larger extent than men, work in a non-science engineering occupation (see American Geosciences Institute 2020). In the European context, EFG has initiated a yearly survey with the potential to contribute with important information on the horizontal and vertical distribution of women in the field. To date, however, the results from the survey is have not been analysed according to gender (see The European Federation of Geologists 2018, 2019).

3.3 REVIEW OF RESEARCH ON GENDER IN GEO-SCIENCE

The majority of research concerning gender in the field of geoscience focusses on the subject area as a part of STEM (Blackburn 2017) and primarily concerns the context of

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academia in the US and Canada (Holmes et al. 2008, Marín-Spiotta et al. 2020, Nentwich 2010). STEM, an acronym for Science, Technology, Engineering and Mathematics, comprises fields of science that are largely male dominated and are subject to extensive research regarding the question of gender equality and the underrepresentation of women in STEM education as well as in STEM academic careers (Blackburn 2017).

Research on gender in STEM has led to a number of different "themes" of explanations for the underrepresentation of women, ranging from individual to cultural and organisational (Blackburn 2017). Some of these themes can be regarded as societal and therefore generally shared by all fields of science, such as wage disparities between men and women (Nentwich 2010, Moss-Racusin et al. 2012); unequal distribution of parental leave and domestic work (Beddoes & Pawley 2014, Myers 2015); or unconscious bias in relation to gender stereotypes (Dutt et al. 2016, Eaton et al. 2020, Moss-Racusin et al. 2012). Some themes are more specific to STEM and can be described as related to the gendered patterns of educational and professional choice (Diekman et al. 2017, Heilbronner 2009, Le and Robbins 2016); the phenomenon of the "leaky pipeline" (women leaving careers in STEM)(Goulden et al. 2014); specific professional requirements in STEM disciplines, such as mobility for postdocs (Dutt et al. 2016) or fieldwork (Bracken and Mawdsley 2004); or specific organisational cultures that are detrimental to women by demonstrating an open male bias in terms of sexism (O´Brien et al. 2014), gendered career pathways (Carrigan, Quinn, and Riskin 2011) and scientific ideals in accordance with hegemonic masculinity (Van den Brink & Stobbe 2009). Due to the wide variety of disciplines in STEM, a relevant critique is the need to seek explanations for gender disparities within the different subdisciplines rather than searching for meta-explanations that are applicable to all.

As subfields in STEM, studies of gender in geoscience and geoengineering can be considered deserving of the same critique in relation to the various gender disparities prevalent within their respective disciplines. Geoscience encompasses diverse disciplines, such as geology, hydrology, paedology and glaciology, and the field is closely related to other scientific disciplines, not least through the use of tools from physics, chemistry, mathematics, geography and biology.[1] As shown in the previous section [3.1], the various disciplines also differ in their representation of men and women, and there are further differences concerning national contexts. Due to the internal variations of the field, research on gender in geoscience and geoengineering can therefore be said to focus either on specific case studies of how gender relations and gender disparities are constructed within a cultural or organisational context (for an extensive overview, see Marín-Spiotta et al. 2020) or on more descriptive meta-studies showing where gendered patterns of stratification occur within the scientific field (Holmes et al. 2008, Macfarlane &

1 https://www.usgs.gov/science-support/osqi/youth-education-science/what-geoscience 2020-10-22

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Luzzadder-Beach 1998, Nentwich 2010). Among the latter, Holmes (et al. 2008) investigates the gender imbalance in US geoscience academia, showing how the relatively equal proportions of men and women entering into geoscience education gradually shifts into a male-dominated field farther along the academic career path. Of students receiving a master's degree, 45% are women, while the number of women receiving their PhD (34%) and subsequently entering into academic professions at ranks such as associate professor (26%) or assistant professor (14%) is significantly lower. The percentage of full professors who are women is only 8% (Holmes 2008:79). A similar pyramidal distribution is evident in geoscience in Canada (Nentwich 2010:131) and among the EU-28 within the field of science and engineering (European Commission 2018:117).

The reason for this "leakage" of women from geoscience academia has been one of the main questions guiding research on women in the geosciences. Van den Brink & Stobbe (2009), interviewing women students in a male-dominated geoscience department, show that visibility (as a woman) can be negative in a context dominated by hegemonic masculinity. The prevailing ideal of the "scientist" in the geoscience department is male, characterised by "his" physical strength, endurance and willingness to "get his hands dirty". To "pass" within such a context, many women students choose to adopt masculine ideals, avoiding feminine clothes and other outward expressions of femininity. Not adapting to the masculine ideal incurs the risk of being identified as "a woman" and therefore as someone who does not truly belong to the field. Masculine ideals, and organisational cultures that adhere to them, are a recurring explanation for why women experience gender bias in geoscience (Popp et al. 2019, Marín-Spiotta et al. 2020). Bias against women in geoscience has been established within recruitment processes (Dutt et al. 2016), journal referee invitations (Lerback & Hanson 2017), collaborative networks (Natcher et al. 2020) and in the general perception of the working environment (Popp et al. 2019).

Constructing women as "the other" in geoscience can also be interpreted through the structural factors of professional organisations. In relation to US academia, Holmes (et al. 2008) question the career path leading to tenured positions and how this period of the career coincides with parental leave, leading to women losing the time necessary to be considered as meriting tenure (see also Macfarlane et al. 1998). Academia as a "greedy organisation" that often demands unregulated and long hours, which is a factor that leads to women experiencing "insufficiency", a feeling of being torn between the demands of family and professional life (Popp et al. 2019). Similar organisational factors are evident in Williams' (et al. 2012) study of geoscientists in the oil and gas industry. Interviewing women geoscientists and conducting observations in workplace meetings, Williams and colleagues show how corporate career models reproduce gendered structures and male domination. Through restricted access to networks, arbitrary evaluation criteria and minority positions in work teams, women are systematically placed in less-favourable positions than their male colleagues.

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Organisational bias against women can also be described as the experience of a hostile environment (Marín-Spiotta et al. 2020) or "chilly" climate (Holmes et al. 2008). A hostile environment is, according to Marín-Spiotta, an environment that goes beyond bias; in such environments, "[h]arassment, bullying, microaggressions, sexism, racism, homophobia, transphobia, etc., are prevalent in academia" (2020:119). The acknowledgement of hostile environments also highlights that other minorities suffer in positions that are vulnerable to majority aggressions and that intersectional approaches are necessary to diversify the experiences of women in relation to sexuality, class, age, disability, ethnicity, etc. In the geosciences, the prevalence of hostile environments has been shown in relation to fieldwork, a context in which the ideal of the geoscientist as a white, heterosexual, able-bodied man is highly prevalent, making those who deviate from this ideal both apparent and comparatively alienated (Atchison and Libarkin 2016).

In sum, a review of research on gender in the geosciences describes a field that faces significant challenges in relation to both cultural and structural factors that affect gender equality. The literature shows a prevalence for gender bias, gendered career pathways, and gendered organisational hierarchies and working conditions that expose women geoscientists to hostile environments. However, research on gender in the geosciences is limited and primarily concerns the academic contexts of the US and Canada. There are few studies on gendered working conditions in European geoscience subdisciplines or in specific national and organisational contexts.

3.4 INTERNATIONAL BEST PRACTICE REPORT ON TEACHING STEM

In ENGIE deliverable 1.4 "International best practice report on teaching STEM", Guiliani (2020) reports on successful initiatives and best practices implemented to increase the interest of both girls and boys in the area of STEM and comments on the adaptability of such initiatives to a geoscience or a geoengineering context. In the deliverable, more than seventy initiatives and projects at national as well as EU levels are reviewed. These initiatives and projects were selected through extensive web searches and based on the project partners' own experience. The initiatives and programs were then organised in the following categories: Theoretical concepts that underlie best practices for STEM teaching; programs and projects for schools and the general public; and initiatives/actions aimed at girls and women.

Guiliani (2020) concludes that it is important that teaching be "repeated, engaging, and intellectually stimulating" to make boys and girls interested in geoscience. The conclusions are divided into five themes:

1) *Avoid any kind of gender bias.* The importance of the inclusion of both girls and boys is highlighted, which also entails that teachers and students need to have knowledge about gender equality. Further, involving both families and the general public in different events is reported to be a way to facilitate change.

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In addition, collaborations between teachers and other stakeholders in national networks are reported to maintain quality in school projects.

2) *Presentation of positive examples provided by both successful researchers/women and peers.* Role models providing positive examples of how they succeeded in the area are reported to be of great significance for students, particularly if they work in male-dominated industries. Furthermore, the mentoring of younger students by older students is reported to be successful. It is suggested that videos/reports posted in or gathered from social media can be beneficial.

3) *Focus on active learning strategies and hands-on activities*. It is highly recommended that students be involved in active learning experiences in which they receive first-person experience of the job. These experiences are shown to increase students' interest in the area over the long term.

4) *Organisation of activities and use of new/updated technologies and approaches.* The fourth theme emphasises the importance of organising fieldtrips, classroom education and after-school programs in ways that have previously proven to be successful. In addition, information technologies adapted to teaching, the use of a language understandable by many and tools that are recognisable by the audience are also advisable.

5) *Empowering students through the exposure to science.* To encourage further engagement in students who are interested in geoscience, it is helpful to let them take part in real scientific work and/or let them be involved in planning activities and events. Scientific competitions with prizes can also empower students. These events can take place online, which is beneficial, for example, in times of social distancing.

For a deeper analysis of best practices, see Guiliani (2020).

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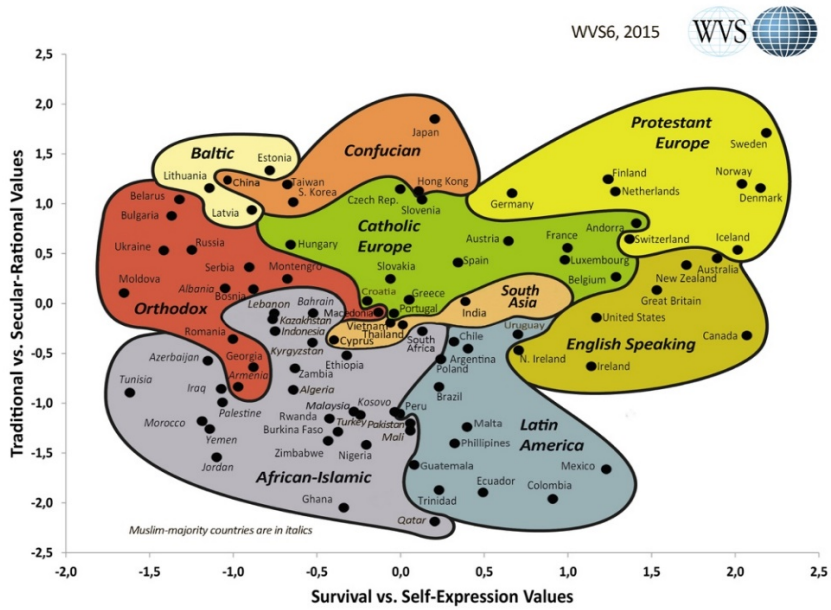
4 QUESTIONNAIRE FOR SECONDARY SCHOOL STUDENTS

This chapter presents the results of the survey analysis among school students in Europe conducted in 2020 from the point of view of factors that affect gender patterns in geosciences. The results are analysed using World Values Survey Cultural Map with sociological inspiration from Inglehart (1971).

The survey of students' attitudes towards their studies, careers in geosciences and gender issues was conducted within the framework of ENGIE (see the earlier baseline assessment, Johansson 2020) among students from 21 European countries with replies from 4906 students. Due to differences in number of replies per country and selection method, the decision was made to aggregate the analysis and presentation of the results to allow for the grouping of European counties by context. Based on the latest World Values Survey Cultural Map (2015), the participating countries were divided into the following categories: Catholic Europe, Protestant Europe, Orthodox Europe, Islamic Europe and Baltic Europe. This division places countries on a cultural map according to the replies that identify their position on survival versus self-expression values as well as traditional versus secular-rational values. Due to the similarities in the gender division in geoscience education in tertiary education, as well as reasons of cultural proximity in line with the worldview survey, the United Kingdom was grouped with Protestant rather than Catholic countries[2].



[2] Category divisions: **Catholic**: Croatia, Czech Republic, Greece, Hungary, Italy, Poland, Portugal, Slovenia, Spain. **Orthodox**: Bulgaria, Romania, Serbia, Ukraine. **Protestant:** Finland, Sweden, Germany, Netherlands, UK. **Islamic**: Turkey. **Baltic**: Estonia.

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- **Traditional values** emphasise the importance of religion, parent-child ties, deference to authority and traditional family values. People who embrace these values also reject divorce, abortion, euthanasia and suicide. These societies have high levels of national pride and a nationalistic outlook.

- **Secular-rational values** have preferences opposite to traditional values. These societies place less emphasis on religion, traditional family values and authority. Divorce, abortion, euthanasia and suicide are seen as relatively acceptable.

- **Survival values** emphasise economic and physical security. This worldview is linked with a relatively ethnocentric outlook and low levels of trust and tolerance.

- **Self-expression values** place high priority on environmental protection; display a growing tolerance of foreigners, gays and lesbians and gender equality; and show rising demands for participation in decision-making in economic and political life.

As Protestant countries stand out in this classification as prioritising secular-rational and self-expression values, Protestant Europe is used as a reference category. The hypothesis behind this choice is based on the classification as well as on statistics and studies that show a relatively high degree of gender equality in geoscience education in those countries; therefore, the comparison to this category should be illustrative.

In this section, the analysis of the following aspects of the data on students is presented. Plans for further education, reasons behind the choice of studies, and knowledge and information among students about the field of geosciences as well as plans to work in geosciences are analysed with descriptive statistics. Logistics regression is used to analyse the probability of choosing university/tertiary studies, of choosing tertiary education within natural sciences/technologies, and of choosing a career within geoscience.

4.1 HIGHER-EDUCATION PLANNING BY BOYS AND GIRLS

Figure **5** illustrates the gender distribution, in percentages, in planning for higher education for the social contexts described above. The analysis shows that among responding students, girls have a higher ambition to continue with university/tertiary studies compared to boys, except in Islamic Europe, where the proportion is higher among boys. Eight of 10 students plan to continue their studies, and students in Islamic Europe plan to continue their studies to an even higher extent than respondents from other contexts in the sample, while students in Protestant Europe plan to continue their studies to a lower extent than respondents from other contexts.

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Figure 5: Context, gender and planning for higher education (percent)

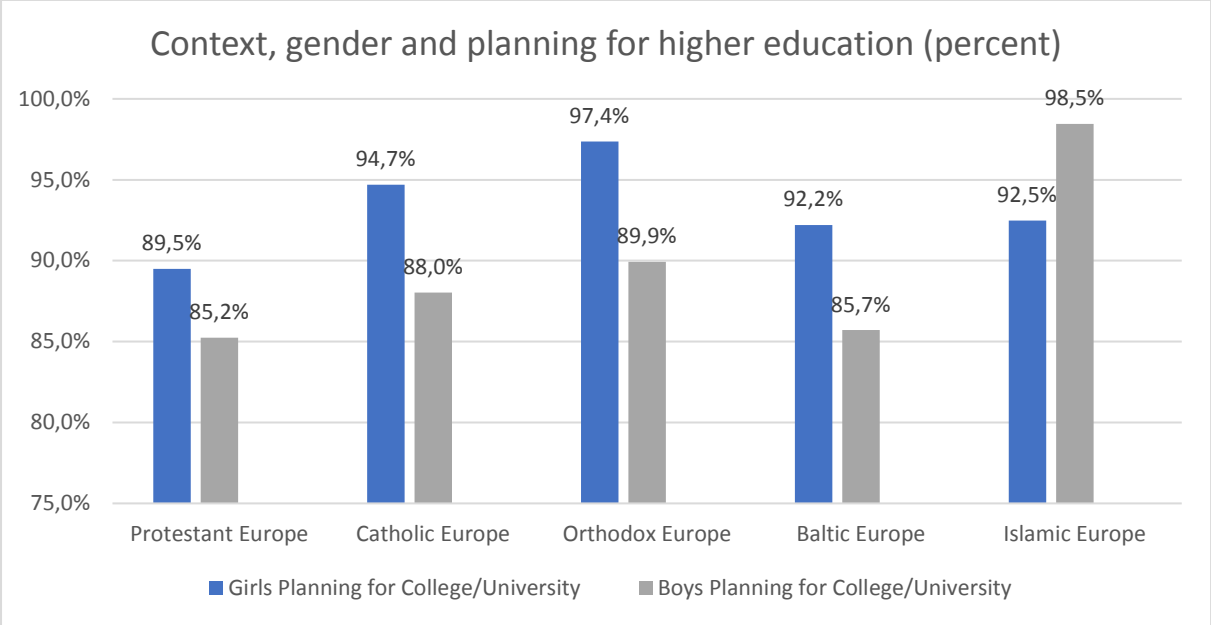

Figure 6: Context, gender and area of study (percent)

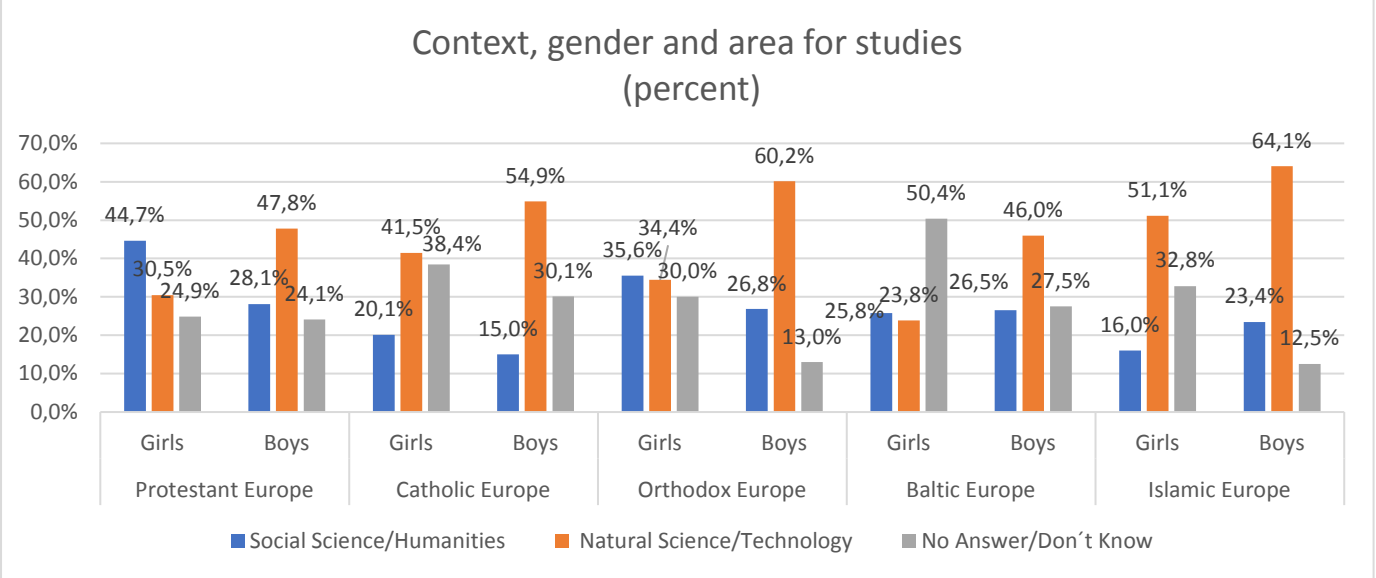

Figure 6 shows the differences in preferences for the area of future study between boys and girls in different European cultural contexts. There are visual differences in girls' and boys' plans for their future area of study. More boys than girls are planning to study natural sciences and technology, while more girls than boys are planning studies in the fields of humanities and social sciences, and these differences hold across all the cultural contexts. The gender differences between girls and boys in terms of interest in studying

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natural sciences and technology are greatest in the Orthodox Europe and Baltic Europe contexts, while for the humanities and social sciences, the gender gap seems to be the largest in Protestant Europe.

Figure 7: Context, gender and reason for studying natural sciences/technology (percent)

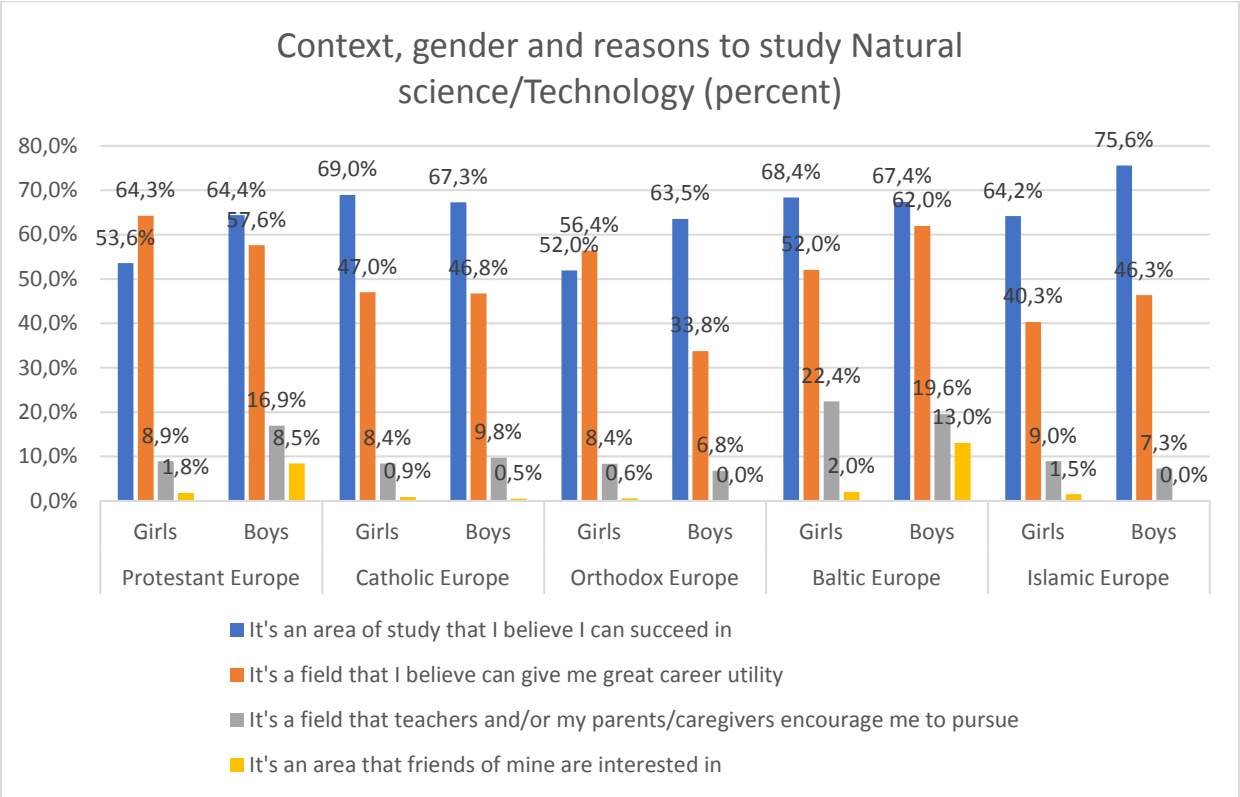

Figure 7 shows the differences in how responding boys and girls want to continue with their studies in natural sciences and technology and their self-esteem regarding their ability to do so. According to this data, boys tend to have a higher belief that they can succeed in studies of natural sciences and technology than girls, except for in the Catholic European and Baltic European cultural contexts. More girls than boys, however, tend to think that studies in natural sciences and technology lead to better career possibilities, except for in Baltic and Islamic Europe. NB: Percentages are based on the replies of the students who are planning to study natural sciences and technology in the future.

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Figure 8: Context, gender and reason for studying social sciences/humanities (percent)

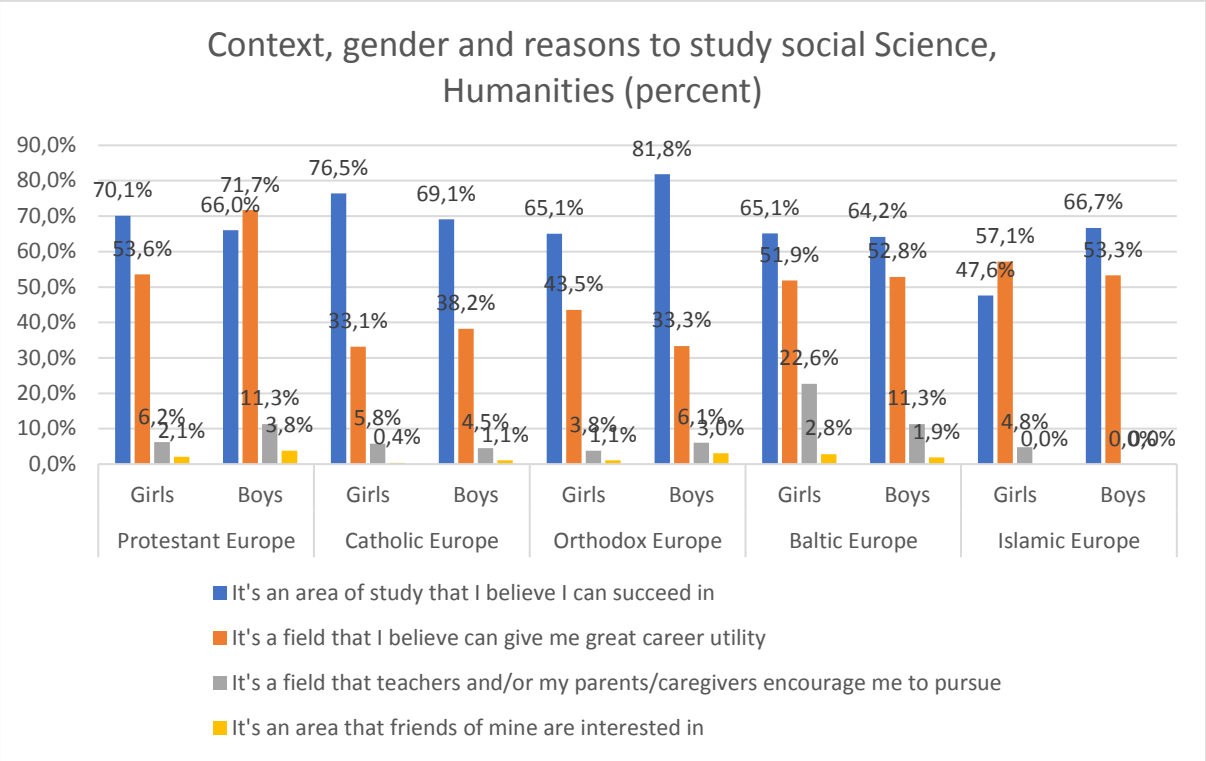

Figure **8** illustrates the reasons offered by boys and girls in different European cultural contexts concerning the choice of social sciences and humanities for future studies. The percentages are based on the replies of the students who answered that they are planning a career within those disciplines. There is a visible gender difference in the replies, as well as within the field of natural sciences and technology. The results are thought nearly opposite of those illustrated in figure 7. More girls than boys answered that they expect to succeed with their future education, except for in the cultural contexts of Baltic Europe and Orthodox Europe. More boys than girls, however, responded that they expect their education within the social sciences and humanities to offer them better career prospects, except for respondents in the Orthodox and Islamic European contexts.

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4.2 INTEREST AND FAMILIARITY WITH GEOSCIENCE AMONG BOYS AND GIRLS

Figure 9: Context, gender and familiarity with geoscience (percent)

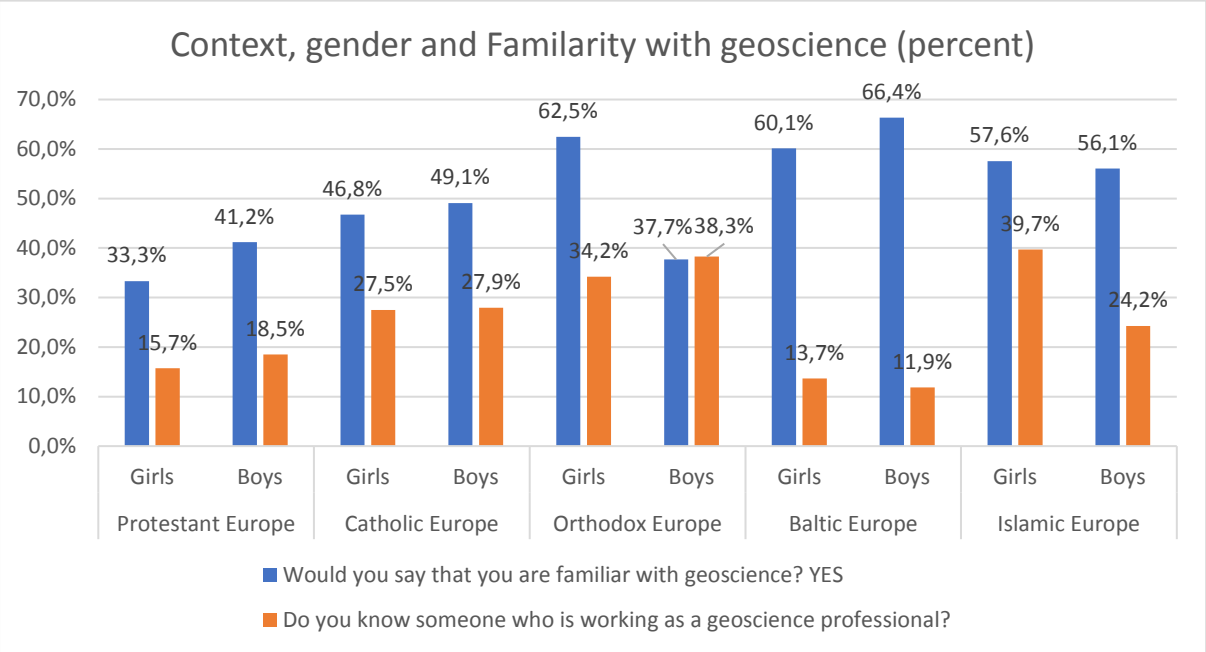

Figure 9 illustrates the familiarity with geosciences among girls and boys in different European cultural contexts. In general, boys replied more often that they are familiar with geosciences to a somewhat larger extent than girls, except for the contexts of Orthodox and Islamic Europe. Familiarity with geosciences can, to some extent, be explained by knowing someone who works within the field of geosciences. Girls and boys in Baltic Europe seem to be the most likely among all the cultural contexts to consider themselves familiar with geosciences.

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Figure 10: Context, gender and attractiveness of geoscience (percent)

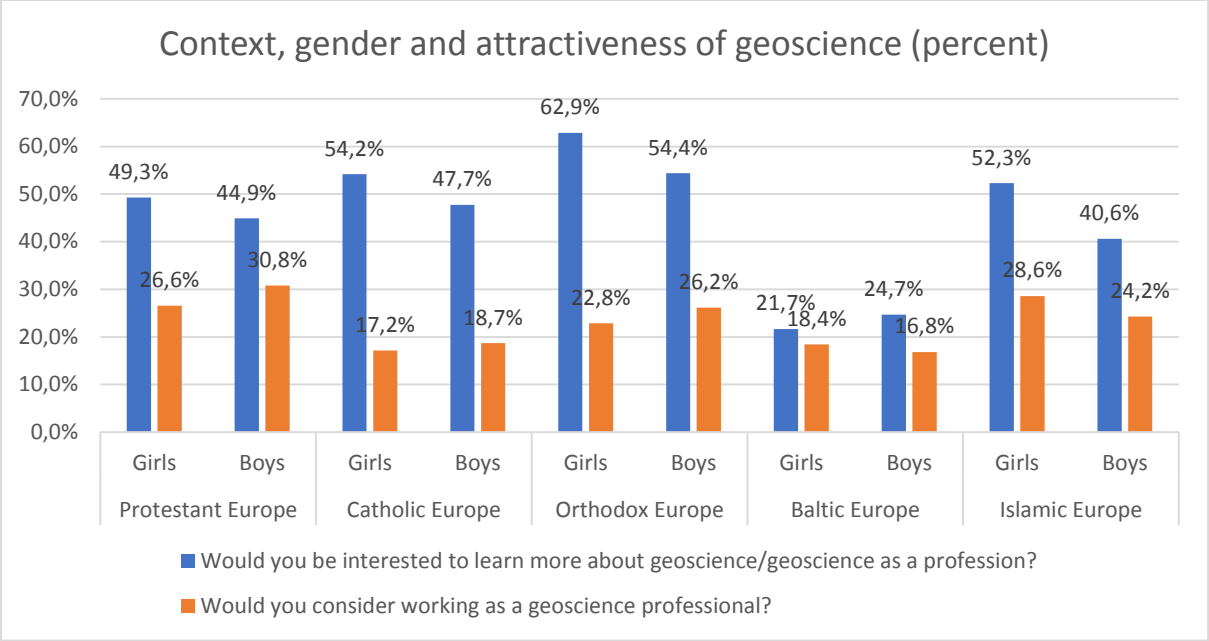

Figure 10 illustrates the attractiveness of geoscience for boys and girls in different European cultural contexts. Generally, interest in geoscience seem to be higher among girls than boys, except for in Baltic Europe, where the interest in geoscience is the lowest among all the cultural contexts. Regarding the consideration of a career in geoscience, the gender differences in responses appear to be the opposite, i.e., more boys than girls express a willingness to work within the field of geoscience in the future, except for in Baltic and Islamic Europe, where girls' interest in working in geoscience in the future is higher than that of boys.

Logistics regression analysis is further presented in relation to the following: 1. Considering university studies, 2. choosing natural sciences and technology, and 3. working within the geosciences. All the probabilities for independent variables are shown in relation to the dependent variable. The combination of the effects can be calculated using probability calculations, but those are not presented here. The significant odds are marked with ***.

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Table 1: Planning for university: multivariate regression analysis.

Planning for University	Log Odds	Exp B
Context; Protestant Europe (ref)		
Catholic Europe	0.643***	1.903
Orthodox Europe	0.544***	1.724
Baltic Europe	0.107 ns	1.113
Islamic Europe	0.735***	2.087
Gender; Nonbinary (ref)		
Girl	1.504***	4.503
Boy	0.782***	2.188
Parents have university degree/Have no degree (ref)	1.181***	3.260
Familiar with geoscience/Not familiar (ref)	0.267*	1.306
Do you know someone who is working as a geoscience professional? Don't know anyone who does (Ref)	0.170 ns	1.186
Constant	-0.103	
Nagelkerke R2	0.099	

Table **1** illustrates the results of multivariate regression analysis of the variables explaining planning for university studies. The multivariate analysis of the plans for higher education shows that students in Protestant and Baltic Europe are the least likely to plan for their university studies compared to other European cultural contexts. Planning for university studies is most common in the Catholic and Islamic European cultural contexts, in which the odds of pursuing university studies are double those of the Protestant context. The probability that girls will plan for university studies is double that of boys. Female gender is the strongest explanatory factor in this regression model. The second strongest factor is having parents with a university degree compared to parents without a university degree. This variable is considered to be a measurement of social class, which plays an important role in choices to pursue further studies. Having knowledge about geoscience and knowing someone working within the field are other factors that increase the probability of considering university studies. Overall, according to these results, gender and class background are the strongest predicting factors for choosing university studies.

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Table 2: Planning for studies in natural sciences and technology: multivariate regression analysis.

Planning for NT	Log Odds	Exp B
Context; Protestant Europe (ref) **Catholic Europe** **Orthodox Europe** **Baltic Europe** **Islamic Europe**	 0,459*** 0.222* -0.321** 0.807***	 1.583 1.249, 0.725 2.241
Gender; Nonbinary (ref) **Girl** **Boy**	 -0.160 ns 0.421*	 0.851 1.524
Parents have university degree/Have no degree (ref)	0.396***	1.872
Familiar with geoscience/Not familiar (ref)	0.391***	1.579
Do you know someone who is working as a geoscience professional? Don't know anyone who does (Ref)	0.110 ns	1.117
Constant	-1161	
Nagelkerke R2	0.067	

Table 2 shows the results of the multivariate regression analysis of the factors that influence the probability of pursuing an education in natural sciences and technology in the future. The analysis shows that students in the Catholic, Orthodox and Islamic European contexts are more likely to consider studying natural sciences and technology than students in the Protestant and Baltic European contexts. Boys have a higher probability of choosing an education within natural sciences and technology than girls. Having parents with a university degree nearly doubles the probability of choosing higher education in this field compared to students without college-educated parents. Having knowledge about geosciences also increases the probability of pursuing education in natural sciences and technology. Gender and parents' educational level seem to be the most influential factors on the choice to pursue education in natural sciences and technology.

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Table 3: Planning for a career in geosciences: multivariate regression analysis.

Planning for a career in geosciences	Log Odds	Exp B
Context; Protestant Europe (ref)		
Catholic Europe	-0.873***	0.418
Orthodox Europe	-0.551***	0.576
Baltic Europe	-0.914***	0.400
Islamic Europe	-0.401**	0.670
Gender; Nonbinary (ref)		
Girl	-0.329 ns	0.720
Boy	-0.242 ns	0.785
Parents have university degree/Have no degree (ref)	-0.230**	0.795
Familiar with geoscience/Not familiar (ref)	1.165***	3.207
Do you know someone who is working as a geoscience professional? Don't know anyone who does (Ref)	0.556***	1.743
Constant	-1.085	
Nagelkerke R2	0.120	

Table 3 illustrates the results of the multivariate regression analysis of the factors that influence planning for a career in geosciences. The results of this analysis are of special interest. Students in Protestant Europe are the most likely among all the cultural contexts to consider a career in geosciences. This model shows no significant differences between girls' and boys' preferences. Having parents with a university degree lowers the probability of considering a career in geosciences, whereas knowing someone working within geosciences increases the probability of considering this career. Having knowledge about geosciences has the strongest positive effect on considering a career in geosciences in this model.

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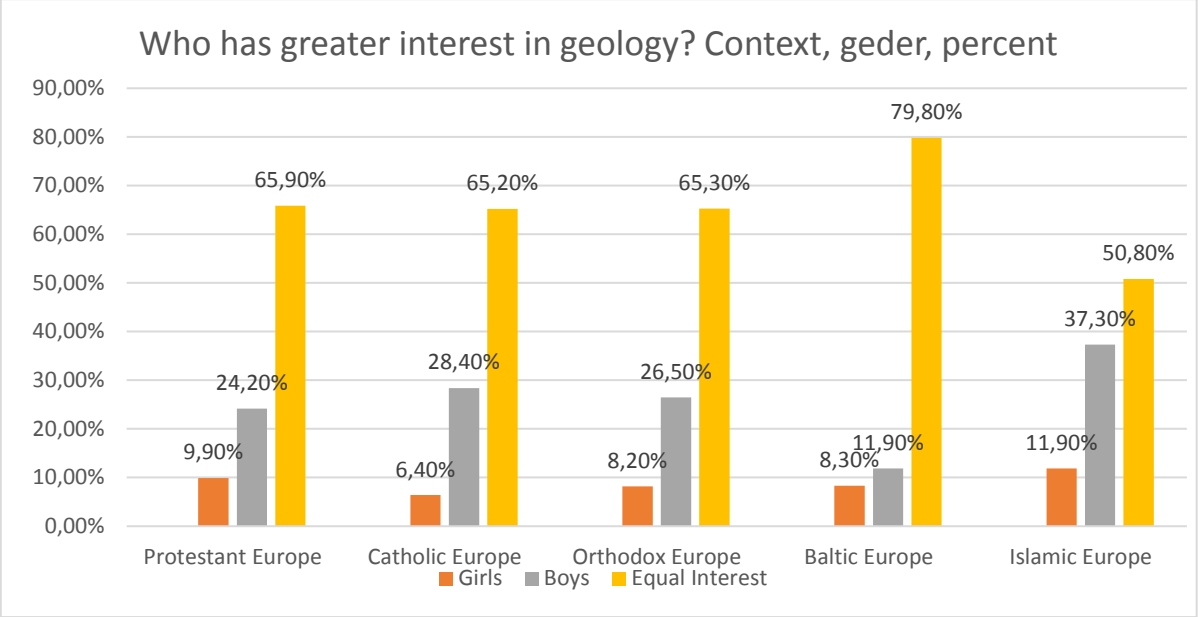
5 QUESTIONNAIRE FOR TEACHERS

The survey of teachers' attitudes towards gender issues in geosciences was conducted within the framework of ENGIE (see earlier baseline assessment, Johansson 2020) among secondary-education teachers in 2020 in 20[3] European countries. A total of 774 teachers responded to the survey. As the number of replies per country and differences in the selection method affected the survey, the decision was made to aggregate the analysis and presentation of the results to allow the grouping of European countries by context. The participating countries were divided into the following categories: Catholic Europe, Protestant Europe, Orthodox Europe, Islamic Europe and Baltic Europe. For more information on the theoretical basis for these categories, see section 3 on students and geosciences.

Due to similarities in the gender divisions within geoscience education in tertiary education, as well as reasons of cultural proximity in line with the worldview survey, the United Kingdom was grouped with Protestant rather than Catholic countries.[4]

5.1 ON BOYS' AND GIRLS' ATTITUDES TOWARDS GEOSCIENCE

Figure 11: Who has greater interest in geology? Context, gender, percent



[3] Full list: Bulgaria, Croatia, Czech Republic, Estonia, Finland, France, Germany, Greece, Hungary, Italy, Netherlands, Poland, Portugal, Romania, Serbia, Slovenia, Spain, Turkey, UK, Ukraine

[4] Division into categories. **Catholic**: Croatia, Czech Republic, Greece, Hungary, Italy, Poland, Portugal, Slovenia, Spain. **Orthodox**: Bulgaria, Romania, Serbia, Ukraine. **Protestant:** Finland, Germany, Netherlands, UK. **Islamic**: Turkey. **Baltic**: Estonia.

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Figure 11 illustrates how teachers view boys' and girls' interest in geology. The results show that the most common response is that such interest is equally high among girls and boys. In all the cultural contexts, the responses indicate that more teachers believe that boys are more interested in the subject than are girls.

Figure 12: Who takes a more active part in geology-related learning activities? (questions, notes)

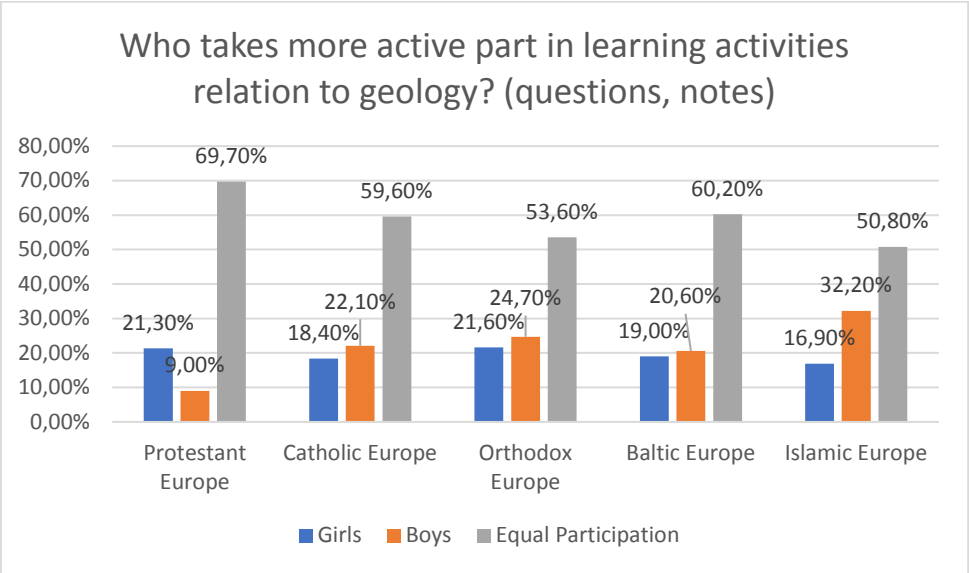

Figure 12 illustrates how teachers view boys' and girls' participation in geology-related learning activities. The majority of teachers in all the contexts see equal activity with no notable gender differences. Although girls in Protestant countries are considered more active than boys and boys in Islamic countries are seen as more active than girls, the most popular answer in those contexts remains that the participation of boys and girls is equal.

Figure 13 illustrates the involvement of boys and girls in compulsory and optional school activities that can encourage their interest in geoscience professions. Overall, most teachers in all the contexts observe equal participation and involvement. A partial exception to this result is Islamic Europe, where more teachers think more boys than girls participate in such activities; nonetheless, more than 60% of the respondents from Islamic Europe observed equal participation.

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Figure 13: Who is more involved in activities that can encourage interest in geosciences professions?

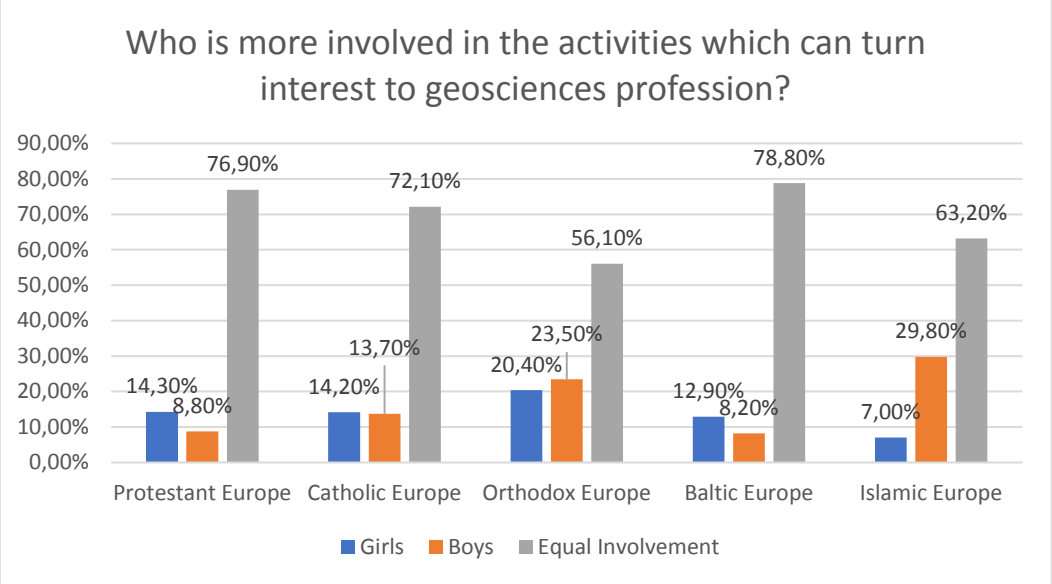

Figure 14: Whose scores are better on geology-related tests?

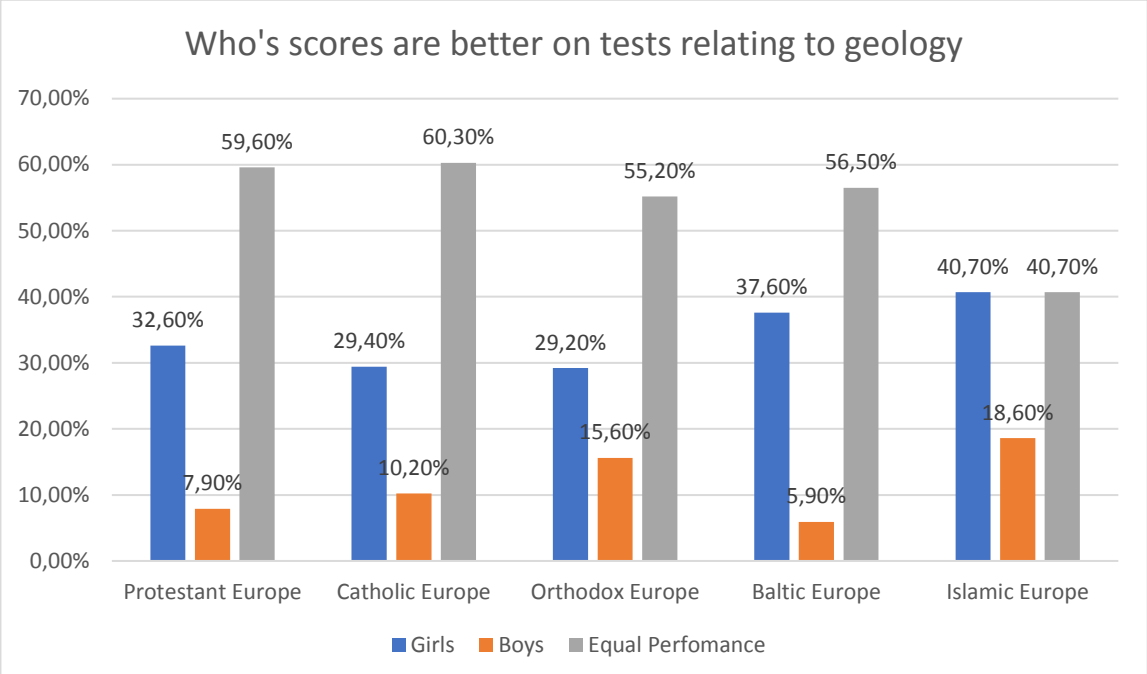

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Figure 14 shows teachers' views on the respective merit of boys' and girls' scores on geology tests. The results show that teachers find students to be equally good at those tests (the most popular answer) or that girls earn higher scores (the second most popular answer). Given that these same respondents consider boys to be somewhat more interested in the subject, the question arises of why this is so if they consider girls to perform better on tests. This view might be a reproduction of a gender stereotype.

5.2 ON WOMEN'S UNDERREPRESENTATION IN GEOSCIENCE

Teachers tend to be seen as important agents of change when it comes to addressing and changing gender imbalances in education. As teachers' actions (or no actions) are likely to be guided by their own perceptions of the potential problems at hand, the questionnaire also included questions surveying teacher' views on women's underrepresentation in geoscience. Hence, while teachers are not likely to have insights on the actual barriers to girls in geoscience, it is nevertheless important to understand how teachers perceive these barriers.

Figure 15: Viewing underrepresentation as a problem that needs addressing

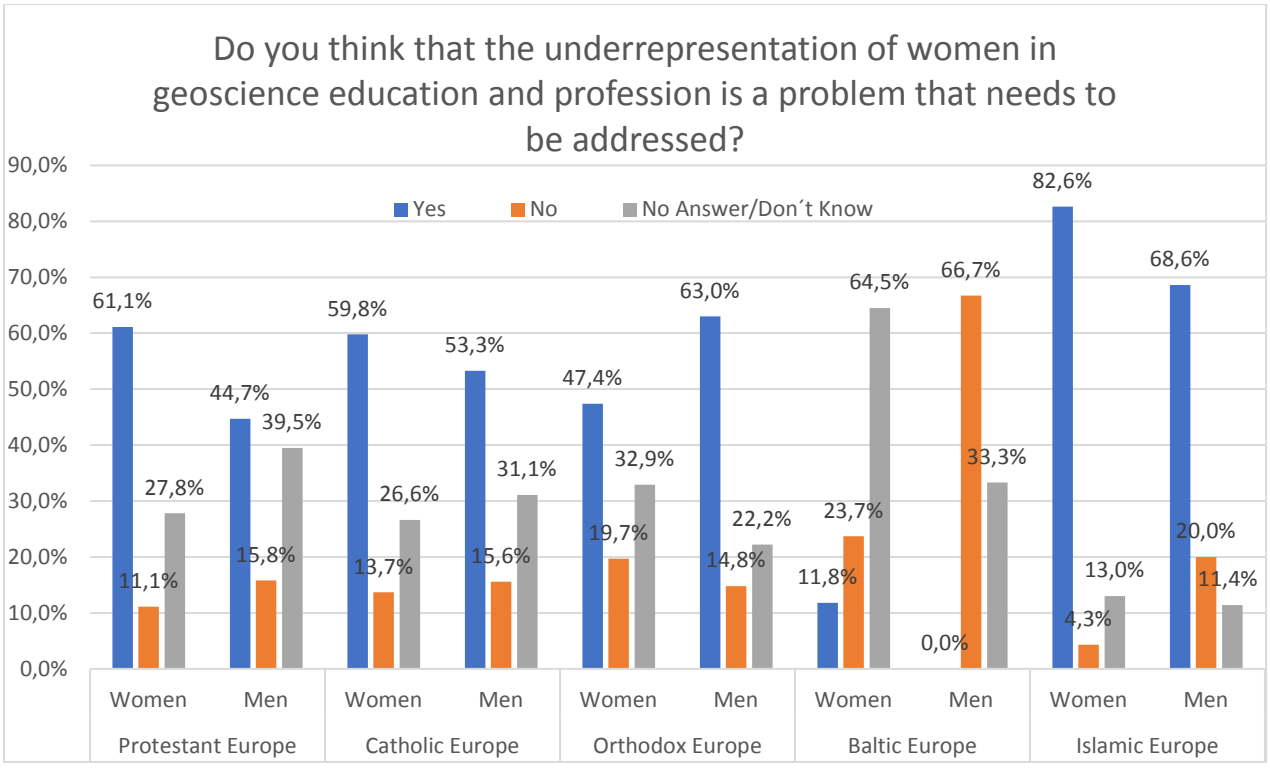

Figure 15 shows that the majority of male and female teachers in the Protestant, Catholic and Orthodox European contexts find gender imbalance to be a problem that needs to be addressed. Male teachers in the Baltic European context tend not to see the issue as a

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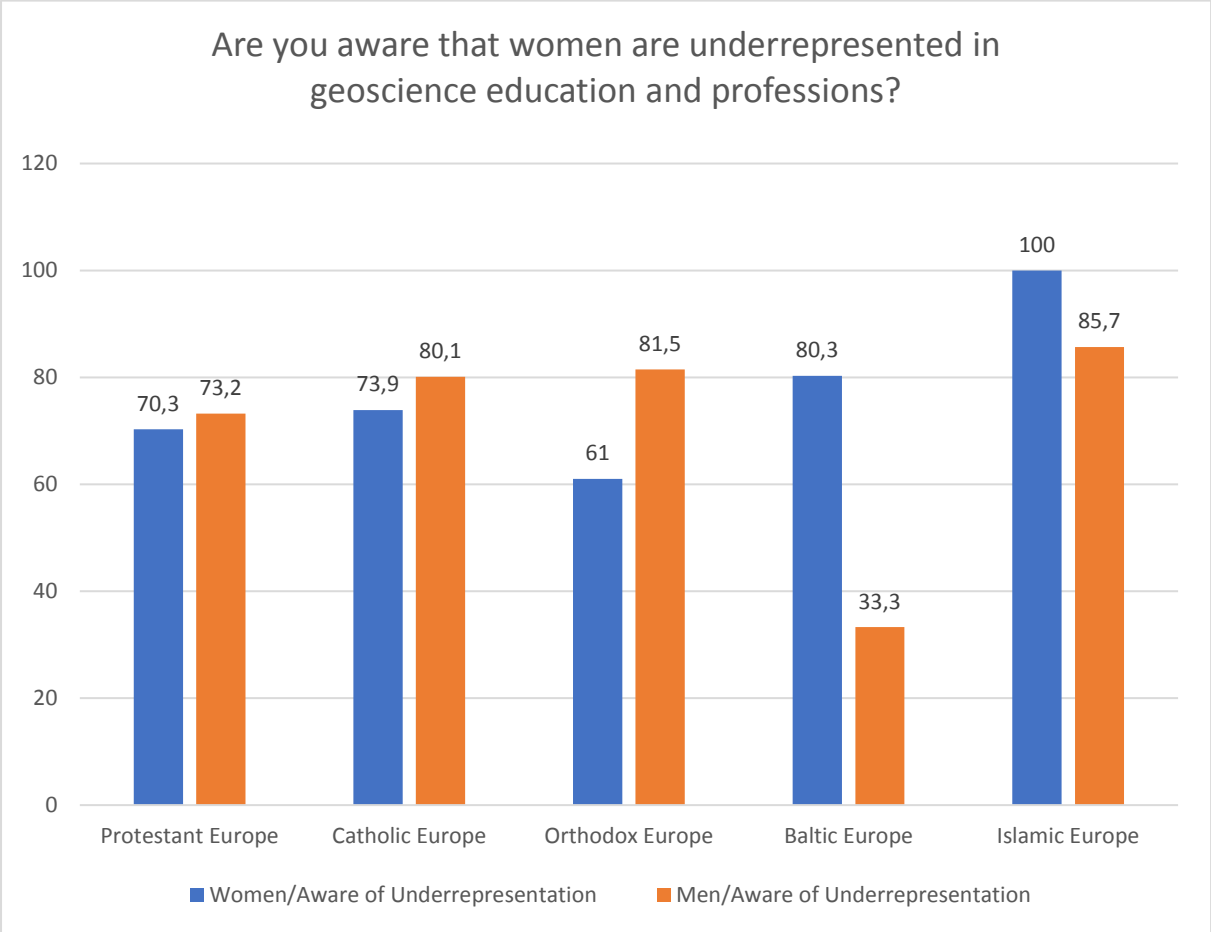
problem that needs to be solved, and women in the Baltic European context are more likely to respond that they do not know or do not see it as a problem. In the Islamic European context, the majority of men and women tend to see the imbalance as a problem that needs solving.

Figure 16: Awareness of underrepresentation of women in geosciences among teachers



Awareness of the underrepresentation of women in geosciences seems to be high in all the European cultural contexts, as illustrated in figure 16. Nevertheless, it is possible that this high level of similarity in answers is partly explained by the form and phrasing of the question. Certain gender differences, such as the higher awareness among women in Baltic and Islamic Europe, should be analysed with caution, as fewer men than women replied in Islamic Europe and too few male respondents replied in Baltic Europe.

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Figure 17: Teachers' views on barriers to girls in geosciences

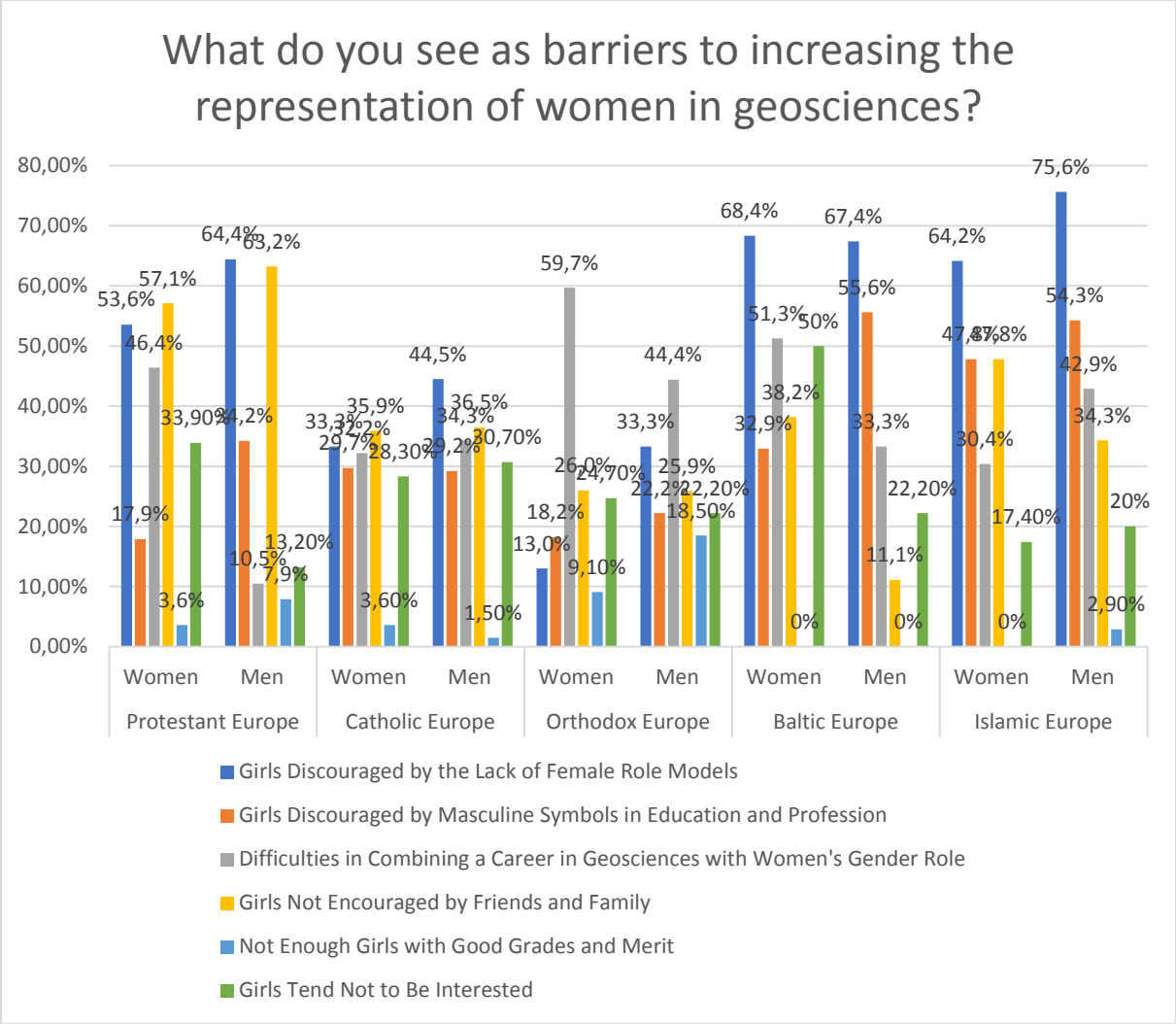

Figure 17 represents teachers' views on barriers to girls in geosciences. The figure aims to show the relationships among attitudes towards these barriers among teachers. For example, the role model explanation seems to be popular overall, but not in the Orthodox European context nor for female teachers in the Catholic European context. The least popular explanation among respondents of all genders and contexts is the lack of girls with sufficiently high grades and merit. The information is further divided into two categories in the following tables: one presents the barriers concerning gender roles at the societal level and the other presents the barriers related to the individual girls' merit, interests and background.

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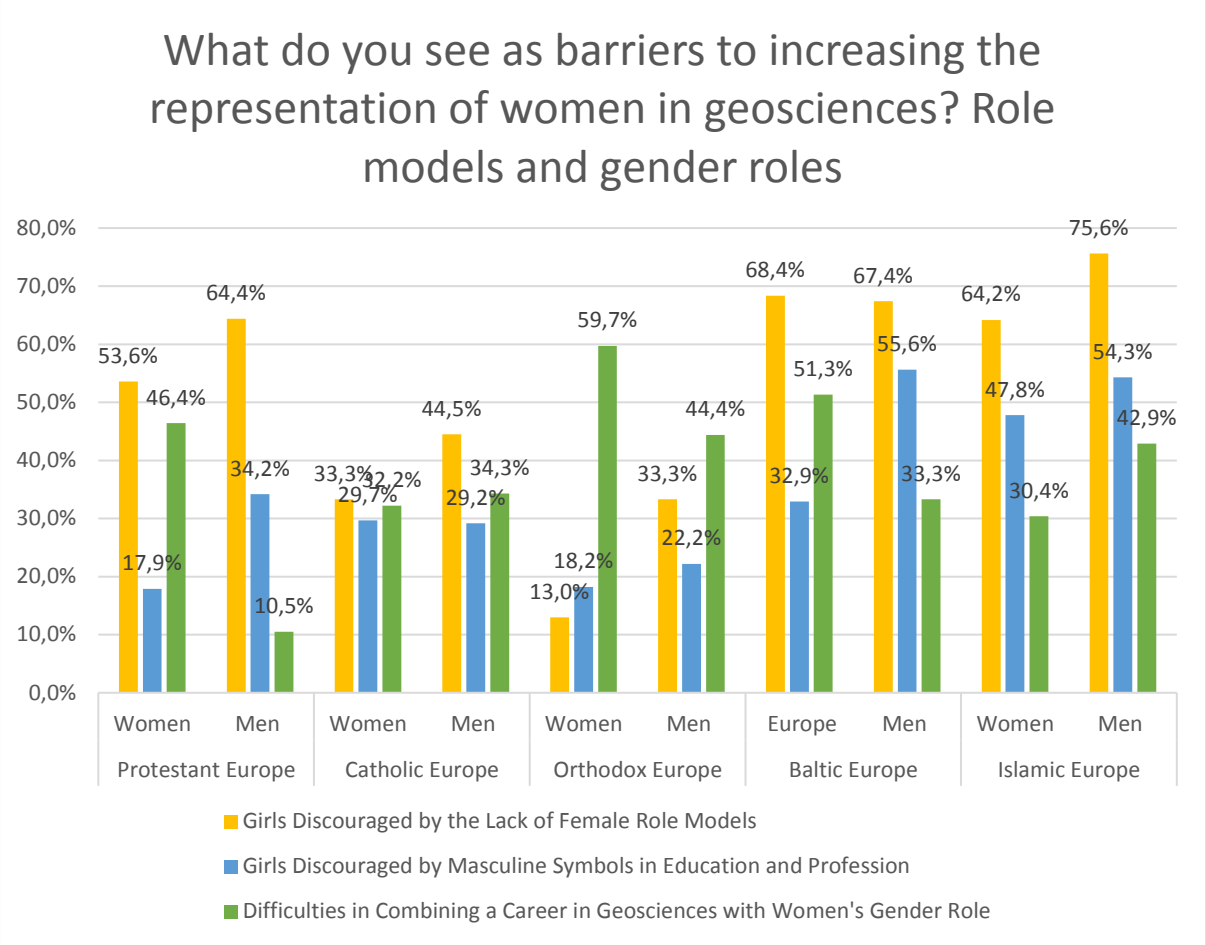
Figure 18: Teachers' views on barriers to girls in geosciences: gender roles in society



Teachers in several European contexts (except for Orthodox Europe) view the lack of female role models as a barrier to girls in the geosciences, as illustrated in figure 18. The majority of responding teachers in most contexts, except for Islamic Europe and men in Baltic Europe, do not see the discouragement posed by masculine field-related symbols as a barrier for girls. Replies regarding the difficulty of combining a career in geosciences with women's gender role are of special interest. In Orthodox, Baltic, and especially Protestant countries, this barrier is more visible for female teachers than male teachers. This barrier is a popular explanation for gender imbalances in geosciences in the Orthodox, Baltic and Islamic European contexts. Our interpretation of these results is that, in these contexts, teachers observe barriers to women in geoscience work, probably at the organisational level, that make it difficult for women to combine a geoscience career with their prescribed gender role. Further exploration of what barriers (likely organisational) are more often encountered and recognised by women than men, as shown by these results, is recommended.

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Figure 19: Teachers' views on barriers to girls in geosciences: girls' interest, merit and background

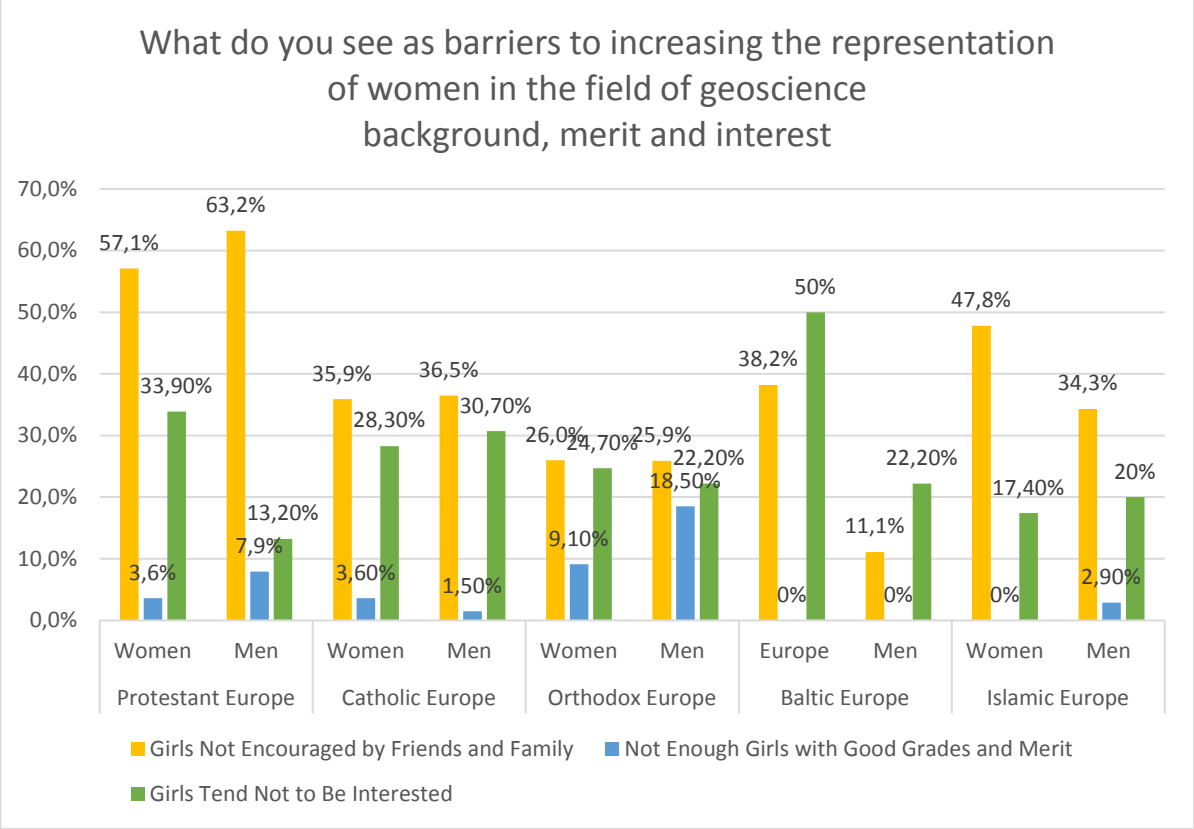

Figure 19 illustrates teachers' views on barriers for girls in geosciences in relation to their individual merit, interests and encouragement. As mentioned earlier, girls' insufficient merit or grades is the least popular explanation among teachers. Lack of encouragement from family is a more popular explanation in several contexts. We interpret this result as related to the class factors identified in students' replies. As the student results show, having parents with a university degree is an important factor in students' choice of education and career, and we interpret this result as related to class rather than to individual encouragement. Teachers' views on the lack of interest among girls as a barrier vary widely, but this explanation is generally not popular, except for women in Protestant and Baltic European contexts.

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6 QUESTIONNAIRE FOR WOMEN PROFESSIONALS

The survey "Women in geoscience and geoengineering" contained questions related to working life experiences and initial study/career choices of women professionals in geoscience and geoengineering. This survey was distributed through ENGIE linked third-party (LTP) networks, primarily through national geoscience associations, and was directed to their members. Although the project primarily focussed on Europe, the distribution of the survey extended beyond the European context, illustrating the globalised working conditions of geoscience professionals. A total of 204 responses were collected, with a majority from women working in industry (103), followed by women in science and education (71). The remaining responses were divided between professionals in the public sector (8), NGOs (7), students (8) and persons no longer working in geoscience (6).

Due to the survey distribution method, there can be no argument for a representative selection of respondents, nor for any claim of generalisability of the results. Rather, the survey results should be regarded as expressions of the subjective experience of women in geoscience. Although these results are not representative of all women in geoscience, they do represent a substantial amount of experience from both industry and academia. Within these experiences, we seek shared themes and topics as well as unique understandings of what it is like to work in geoscience as "a woman". The themes and topics visible in the material are treated as shared references and ways of making sense of the profession and working life. They are collected, discussed and reviewed in relation to previous research.

6.1 MOTIVES FOR CHOOSING GEOSCIENCE OR GEOENGINEERING

There are many reasons why a person would choose a certain profession or career, and these reasons cannot always be considered in isolation, especially not within the qualitative frame of the current survey. Instead, this research offers the possibility to discern a range of themes within the material. A person may describe her choice of career within one theme or several and through numerous variations.

A common but difficult theme to analyse is the concept of "interest". Having "an interest" in geoscience from an early age is a recurring response among our participants. Among the constructs of "nature," individuals might have "an interest" in rocks or landscape formations. What this "interest" in geoscience means is difficult to discern without the possibility of asking additional, specific follow-up questions. Here, we might have to conclude that an interest can be understood as something that entices curiosity and prompts a longing to understand and gather knowledge on a particular subject.

When I was a child, I was inspired by the rocks in the village I lived in.

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Some respondents see their interest in geoscience as innate, having always been there, while others indicate factors that prompted them to indulge in it. These factors are usually encouragement by persons who were close to them as a child or as a young adult, often a parent, another relative or a teacher. Having someone show them different geoscience phenomena and explain nature was, to many respondents, key in their stories of why they became geoscientists.

> *I owe my schoolteacher for my profession. She gave us open lessons in nature and took us hiking in the region. We studied the rocks and minerals of our region. She instilled in us a natural scientific knowledge.*

A second theme can be considered a question of emotional motivation. These respondents often emphasise a love of nature and being in the outdoors. Many tell stories of how they, as children, discovered an emotional connection with the outdoors (hiking or camping with family). This emotion led them to seek a career in which they would be able to be outdoors and in nature. These stories can be understood as embedded within a class narrative of possible occupations, partly due to the socioeconomic factors that influence the type of holiday experience available to individuals and partly in relation to the prevalence of nonacademic occupations that provide access to the outdoors.

> *I really enjoyed physical geography at school and decided to read geology. I wanted to work in an industry where I could be the tomboy I have always been and one that would provide variety.*

Emotional motivation may also lie within a narrative of finding a place in which one can express oneself and the person one tries to be. As the quote shows, the respondent chose a career in geology because it would allow her to be a “tomboy”, i.e., to avoid the gendered role of a “girl” or “woman” in professional life and instead find a profession in which she could adhere to more masculine ideals.

A third theme concerns respondents who are ideologically motivated. These respondents emphasise that protecting the environment and wanting to help people were major factors in why they chose a career in geoscience. Recurring stories within this theme include wanting to fight climate change and to be able solve problems in relation to environmental protection, to take better care of the earth’s resources and to help people who are at risk because of climate change or environmental hazards. These respondents can be seen as ideologically motivated since they are guided by values and ethical considerations in relation to their occupational choice.

There are also stories of women who encounter a geoscience subject by accident or by “pure luck”, for example, by taking an odd course at university or by finding a summer job that led them into the field. These stories often come with a reflection on geoscience being something that was previously unknown, something that one needed to “discover” to

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understand that it was a possible career. These stories can be understood as belonging to women who had no close social relationships with persons who were invested in a geoscience profession nor an inspiring teacher who could introduce them to the subject. These stories also illustrate the relative marginalisation of geoscience and geoengineering professions in education, media and popular culture, especially in comparison with highly visible occupations such as medical doctors, schoolteachers or police officers.

A final reflection regarding the question of "why a geoscience career?" would be to ponder the lack of replies that, otherwise, would be common when asking questions on educational and professional choice (cf. Gerber &Cheung 2008). Such replies could include the search for status and economic gain, i.e., a respectable profession with a high salary. These sorts of motivations are not found in the survey material. Rather, there are reflections on the relatively low status of geoscience professions as "dirty", "muddy" and uncomfortable in terms of their travel requirements and fieldwork. Moreover, choosing to work in geoscience for financial reasons is hardly mentioned at all. That status and financial matters receive relatively little attention from respondents is interesting and might indicate that the respondents themselves already adhere to a relatively stable and financially secure position in terms of class.

6.2 EXPERIENCES OF GENDERED WORKING LIFE AND GENDER INEQUALITY

Descriptions relating to experiences of gendered working life and gender inequality show a great variation concerning when and how gender is perceived to matter or not. On the one hand, many respondents describe not seeing gender as an issue in their everyday work. They describe their workplaces as neutral sites in which "it doesn't matter if you are a woman or a man, what matters is if you do your job". Some respondents say that they have never experienced anything negative in relation to being a woman in geoscience, and some say that being a woman in geoscience has only brought positive experiences. On the other hand, these narratives are often interrupted by reflections on unequal pay or remembrances of a workplace they left because of misogynist behaviour, as if the questions the survey asks prompt the respondents to reflect upon experiences related to gender equality. Many reflections begin with a story of a working life undisturbed by inequality, only for respondents to later state that they make less money than their male colleagues. This indicate some ambivalence associated with having to explain a minority position in the context of inequality, a possible unwillingness to be regarded as disadvantaged. One respondent's reflection on her position might serve as an illustration:

> *Mostly I wouldn't say I've noticed a difference, but often it can be male dominated and you might be the only female in the room. I often find this empowering, an opportunity to stand out and put ideas forward.*

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In this case, the situation of being the only female in the room leads to a feeling of empowerment and the possibility to take advantage of being unique in terms of gender. Nonetheless, the quote also points to male domination and the respondent's position as a minority. This position is ambivalent because the possible empowerment lies in the majority's willingness to listen.

A large number of respondents offer more direct accounts of the disadvantages of being a woman in geoscience and geoengineering. These cannot be interpreted as ambivalent and instead describe situations in which being a woman stands in a stark, negative contrast to a male-dominated environment; of being the only woman in the room, at a conference or in a client meeting; of difficulties being listened to, taken seriously or regarded as competent; and of being belittled, sexually objectified or of being mistaken for an administrative assistant when in reality the respondent was the keynote speaker or the project manager.

> *Many times, nothing is expected of me or people don't immediately assume that I am knowledgeable or successful. Unless they know me by name, then the story is different.*

The quote could be interpreted as a reflection from the majority's viewpoint, which reflects the labelling of a woman according to a gendered organisational stereotype of being an administrative or other assistant or an HR operative. She is grouped into a powerless collective and, as such, made anonymous and unimportant. It is only through the majority's knowledge of her person that she can claim knowledge or status. Such accounts of being stereotyped and diminished because of gender are numerous, and the respondents are fairly consistent in describing a world that is dominated by men, especially older white men. That geoscience organisations often are dominated by men is visible through the respondents' descriptions of men in top positions, of men constituting the majority in meetings and committees and of the male worker being the norm to which women must relate. There are numerous mentions of "the old boys club" or variations thereof, along with direct references to the problem of misogyny being dependent on the "old white men", who are perceived as carriers of both organisational culture and status. Of course, there are differences and variations in how geoscience organisations are described, but organisations dominated by women or characterised as gender balanced are always the exception to the rule. However, there are differences in descriptions of organisational culture among different sorts of geoscience organisations, especially between academic organisations and industry organisations in the raw materials sector.

6.2.1 Gender bias in academia

While geoscience academia usually is described as male dominated at "the top", the overall working conditions for women are often depicted as reasonable, with a relatively large number of women working in geoscience departments and attending educational

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programs. There is rarely open animosity towards women, but neither are there equal opportunities for women and men nor for women of colour. Academia can be viewed as a male domain in which women work and are able to succeed. Moreover, women encounter challenges in terms of parenthood and the expectation that motherhood will lead to their neglect of the demands of the academic profession, inability to devote the long hours necessary, and lack of availability to complete research projects because of maternity leave.

> *I didn't think about my gender at the beginning of my career. It wasn't something that I considered to be a disadvantage or something that differentiated me from my colleagues. It only became something I was aware of when I came back from maternity leave. I personally feel it has been a difficult discipline to progress my career as a geologist and a mother.*

In many geoscientists' experiences, it is the expectations directed towards them as women that are most challenging, rather than the actual challenges of managing an academic career, irrespective of whether they have or even want children. These gendered expectations of their colleagues and professors lead women academics to receive fewer opportunities and, potentially, to carry greater teaching and administrative responsibilities instead of conducting research. To compensate for the lower expectations, women have to work harder to prove their worth, often feeling that they are more competent but less valued than their male peers.

> *I felt that I would have to work harder than a male colleague and hide any personal (or family) issue.*

The experience expressed in this quote is a recurring narrative regarding the working conditions of women in academia (De Welde & Laursen 2011). The importance of not allowing one's personal (or family) life to get in the way of professional accomplishments is often expressed as a matter of course that is unrelated to organisational pressures, gendered domestic work chores or family situation. Women in geoscience thus tend to encounter an organisation that is both shaped by a masculine culture and greedy in its nature, expecting them both to adhere to its cultural values and to prioritise their work above everything else in life.

6.2.2 Hostile working environment in industry

Descriptions of the raw material sector tend to tell a different but related story. First, fewer women in this sector describe their workplace as gender equal or gender balanced. Second, these respondents offer consistent descriptions of a working life culture in which women are questioned as less knowledgeable than their male colleagues, are frequently given administrative tasks or are expected to be subservient to men, and must prove their

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competence to be accepted. Some industry organisations can thus be said to have a masculine culture in which women's presence is actively questioned and challenged.

> *I have worked in mining and heavy civil industries for the past 9 years. In that time, I have spent a considerable amount of time on project sites, including deep hard rock mines, open pit mines, tunnel projects, and smaller pipeline and trenchless projects. At very few (if any) sites I have worked at have I had the opportunity to not be reminded [of]/experience being a woman.*

The respondent tells of a workplace in which she is always visible and stands out as something other than her male co-workers. Women speak of worksites as places where they are catcalled, subjected to wolf whistles and crude jokes or are surrounded by pin-up photos in barracks and workspaces. There is often is a challenge to their presence or professional competence and a questioning of their physical strength, their willingness to "get in the mud" or their competence in handling heavy machinery or understanding technical talk. These challenges can be viewed as tests to determine whether they are able to cope with and adapt to a masculine working culture (Reskin & Padavic 1994). Some women describe how they are willing to endure these tests and prove their "worth", while others choose to leave organisations that do not actively work to change cultures that are hostile to women. In these male-dominated organisations, women also describe themselves as having to represent all women by proving themselves so as not to let other women down.

> *It can be lonely. It can also feel like the reputation of all women rests on your shoulders. It can also be empowering.*

This feeling of accountability for other women puts additional pressure on an already precarious minority position. To fail to prove oneself in a masculine environment could lead to further reinforcement of prevalent gender stereotypes and of stories about "women who cannot cope". However, the vulnerability of the position can also be reinterpreted, as in the quote above, such that the feeling of being a representative of a collective (all women) leads to empowerment.

6.3 BARRIERS THAT PREVENT GIRLS FROM STUDYING GEOSCIENCE OR GEOENGINEERING

The survey of geoscience professionals explicitly asked about the main barriers that prevent girls from studying geoscience or geoengineering. This question relates to the entire educational process, from preschool to university, and the respondents tended to formulate an answer to the question in relation to their own educational background and educational context, emphasising the condition of geoscience in the national curriculum in various countries. As a result, the barriers discussed vary due to national educational

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context and personal experiences. Moreover, the answers from respondents who have had access to, and completed, a geoscience education might diverge from those of persons who have encountered a barrier that prevented them from choosing or completing a geoscience education. Due to the limited scope of our study, we are not able to compare possible differences. The barriers discussed herein are those that are described as prevalent within an educational context as guided by the survey question. A number of barriers outside of the educational context are identified, some of which have been briefly discussed above, such as wage disparities and masculine working cultures and two that will be more extensively discussed: parenthood and gender-biased recruitment.

6.3.1 Barriers in primary and secondary education

One common issue discussed as a barrier is the national educational context and the lack of geoscience subjects in the curricula of primary and secondary education. Geoscience subjects, such as geology, are seldom taught independently but are rather incorporated into other subjects, such as geography or natural science. Many respondents argue that a more prominent role for geoscience subjects in primary and secondary education would increase interest among girls (and probably also boys). The lack of a specialised geoscience curricula might be considered a barrier for those groups of students who will not encounter geoscience outside of the educational system, i.e., students who do not have family or social relations to introduce them to the field. Apart from countries where the curricula differ between boys and girls – a circumstance apparent in some of the respondents' experience (in the 1970s) – this barrier does not seem to be particularly gendered. Rather, it is how that geoscience subjects are taught that is gendered, together with the expectations vested in who might be interested in the subject.

> *It doesn't fit with gender norms for girls to be interested in dirt, and rocks, and math and the like…utter nonsense obviously, but it can be discouraging for teenage girls who just want to fit in.*

The expectation that boys are more inclined to study geoscience is expressed both as a possible barrier in school and as an expectation reproduced by many respondents themselves. As the quote above highlights, to "fit in" also means to be the right kind of "girl". Geoscience is regarded as a "dirty" subject in which one must "get muddy with the boys" and spend one's time in harsh outdoor conditions. The stereotypical "geoscientist" does not fit well with the stereotypical "girl", who is expected to value her clean appearance and prefer less-physical activities than going on expeditions for rock samples. These gendered stereotypes are further entrenched within STEM in relation to boys' inclinations towards math and the ideal of the nerd (Reskin & Padavic 1994). Several respondents express concern that gendered stereotypes are reflected in how geoscience is taught in school, particularly through the encouragement of girls to develop other

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interests. These reflections seem to be confirmed in research regarding gendered educational choice (cf. Smyth & Darmody 2009).

6.3.2 Masculine culture as a barrier in university and working life

In addition to the lack of education in geoscience subjects and the cultural context affecting the educational choices regarded as acceptable for girls and boys, the survey respondents indicate barriers outside of primary and secondary educational institutions. These barriers can, roughly, be divided into two categories: university education and working life. The latter relates to issues of the organisational culture within geoscience and geoengineering organisations, such as the prevalence of macho masculinity, sexual harassment, wage disparities, bias against women and lack of family-friendly work policies. These aspects of geoscience organisations have been discussed more extensively in relation to the experiences of being a woman in geoscience. For now, it may be sufficient to summarise and conclude that the working conditions for women in geoscience, in terms of culture, are often challenging, a circumstance that might be considered a barrier, especially in relation to the disparity between the number of women who attain a geoscience degree and the number of women who work as geoscientists in industry. The cultural factor might also be relevant in geoscience university education since it is here that many students first come into contact with the industry and the working culture, especially through their first fieldwork experiences.

6.3.3 Fieldwork as both a barrier and an inspiration to women

Descriptions of fieldwork varied in the material, ranging from respondents seeing it as one of the benefits of geoscience, to other respondents seeing fieldwork as a barrier to women. Many respondents do not seem to mind fieldwork, instead viewing it as one of the advantages of the job and, for many, a good experience during their education. There are examples of women students being told by teachers that they could not attend certain fieldwork expeditions because they were women and lacked the necessary physical strength. Such experiences of overt misogynist treatment occur and pose an obvious barrier to women gaining the experience they need for a professional life in geoscience. However, it seems that most respondents regard gender stereotypes relating to women's participation in educational fieldwork as a thing of the past, at least in the European context. This view might depend on an overall wish for progress and relative distance in terms of years since they themselves participated in fieldwork, or it might be a relevant observation about factual circumstances. Either way, it seems as if fieldwork remains an activity that upholds certain masculine ideals relating to adventure and physical strength, ideals that might deter both women and men.

Alongside positive descriptions of fieldwork were respondents consider the working conditions of fieldwork to be a barrier, both in terms of what sort of "girl" is expected to enjoy the dirt and primitive living conditions and in terms of the realisation that a certain

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masculine ideal is present. Fieldwork is often described as a masculine environment with high demands on physical endurance and perseverance, as well as an activity that can be exclusionary in practice, lacking housing and hygiene facilities for women.

I think mothers and parents struggle with the fieldwork associated with our field.

The respondents also highlight the expectations of others regarding what geoscience fieldwork and how it is viewed as unsuitable for girls. Here, it might not only be the physical hardship that is an issue but also moral aspects and questions of sexual propriety, a notion of wanting to protect girls from being in "the wild" surrounded by boys. There are also experiences of fieldwork being something outside of a purely educational or professional setting.

Fieldwork still comes with a bit of a drinking culture that has often made me feel uncomfortable.

The social aspects of living in close quarters with one's fellow colleagues or students can be a trying experience, especially when there is alcohol involved. Sexual invitations occur, and there is a risk of having to fend off unwanted attention or having to deal with intoxicated colleagues or students. Being in a minority position places these women at further risk of being ostracised or deemed socially deviant.

[I] feel out of place and not accommodated in fieldwork quite often.

The feeling of not truly fitting in is a recurring narrative and has also been the focus of other research, not least in relation to being "visible" as a minority (Van den Brink & Stobbe 2008). One aspect that increases the feeling of being "out of place" is the occurrence of exclusionary practices, both overt and subtle. Examples of overt exclusionary practices might be offensive language or sexual objectification, while more subtle practices can be a lack of bathroom facilities or no separate sleeping arrangements for women. Another is a prevalence of macho masculinity and the valuation of physical rather than cognitive capabilities.

6.3.4 Parenthood as a barrier to equal career opportunities

While parenthood does not necessarily have to be classified as a barrier to women's participation in geoscience, it should be seen as a possible factor in why women choose to leave geoscience professions (Macfarlane & Luzzadder-Beach 1998). Just as the prevalence of harassment and misogynist working cultures will cause women to leave (Marín-Spiotta et al. 2020), an overwhelmingly recurring theme is the question of parenthood and what happens in a woman's career when she either has children or is expected to.

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I was told by a female colleague "if you have a second child it would be career suicide!"

Working life in geoscience, in both academia and industry, does not seem to be willing to adapt to the demands to members of a workforce who give birth to children nor to parents who want to combine a career with a family life. It seems clear that industry has adapted ideals where long working hours with long periods of travel or field expeditions is the norm and that employees who cannot, even periodically, adhere to that norm, are of lesser value. A recurring issue is the expectation among employers that women in their thirties will have children and, further, will be the children's primary caregiver, thereby needing to take time off for childcare. The respondents share numerous experiences of being passed over for promotion or given lower pay or less interesting work assignments due to their employers expecting them to prioritise family. The discriminatory practice of assuming women to be less dedicated employees than men seems to be common and might function as a self-fulfilling prophecy in terms of the retention of women employees, as well as the low number of women in senior positions in both industry and the academy. It should perhaps be stressed that the expectation of the employer, built into the organisational culture, is that women are mothers first and employees second, regardless of whether they have children. It might also be relevant to note that the respondents often describe how they navigated these expectations to be able to continue their careers in geoscience. Some chose to change their employer or transfer to another sector, while others made sure that their employer knew about the arrangements in their private lives to reassure employers that their family would not affect their work.

I didn't think about my gender at the beginning of my career. It wasn't something that I considered to be a disadvantage or something that differentiated me from my colleagues. It only became something I was aware of when I came back from maternity leave. I personally feel it has been a difficult discipline to progress my career as a geologist and a mother. It is something I have had to work very hard to overcome barriers.

The above quote illustrates how motherhood affects a woman's career, even within an organisation that she, before maternity, experienced as gender equal. Having children leads to a clash between the organisation's demands on its workers and the workers' expectations of their employer. While workers expect to be treated equally in terms of gender, the organisation expects workers to perform according to an ideal shaped by the idea of the worker as male (Acker 1990). For women, the organisational bias against them becomes evident once they have children. The respondents explain how they, at first, had to work harder than men to prove their worth and establish themselves in the organisation. Then, when they are established, many have children and once more experience the need to defend their position as equal to their male colleagues. This

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recurring questioning of women's productiveness occurs as a result of organisational bias against women based on assumptions about gendered roles and responsibilities in relation to children and family life.

6.3.5 Barriers due to bias in recruitment practices

Gender bias in geoscience organisations is also evident in terms of recruitment. The respondents describe how they have struggled with employers' perception of who a geoscientist might be in terms of gender. One respondent, who finished her MSc in 2017, describes one of her first interviews after graduation:

> *I remember one of the recruiters saying: "I don't care about the professional background or race or sexual preference: I just want someone who's a male"*

Such blatant examples of homosocial recruitment practices might be rare, but they still serve as extreme examples of a mindset that seems prevalent within some geoscience organisations. It might also be important to note that this interview took place fairly recently, not in some "murky past". Numerous respondents who are now in senior positions within industry and academy express the belief that the misogynist behaviour they encountered in the beginning of their career is now a thing of the past. However, one might also consider that seniority in a profession also leads to a status that might prevent one from being subjected to misogynistic behaviour, thereby leading to a belief that things have improved. Whether the levels of misogynistic behaviour have decreased, there are still examples of barriers against women even at the top organisational levels. One respondent expressed such barriers as follows:

> *The biggest obstacle for women is the deeply ingrained institutional resistance to the promotion of women to the executive level or boards of companies.*

Not only are there few women at the executive level, those who have managed to reach a top position are often regarded as tokens who are touted as examples of progress in terms of gender equality (Kanter 1977). Moreover, even if these women have achieved a position of power and influence in the organisation, it does not mean that they will be advocates for women's rights.

> *I do not see many people like me at the moment (mid-career with children). Many of my counterparts are no longer actively employed in the industry as it is hard to return to meaningful work after a career break and fitting it around family commitments. This is a massive loss to all. Higher up the food chain, women are underrepresented, and many wear battle scars, which does not always make them pro-women.*

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As this respondent implies, being a woman at the top does not mean that one has gotten there without considerable effort. Coming from a minority position and reaching a position of authority can be a struggle that leaves "battle scars", experiences that one might not want repeated. To invest oneself in a struggle for women's rights could mean that opening oneself up to further struggles and further "battle scars". At worst, it could mean risking the position these women have struggled so hard to attain.

6.3.6 The lack of role models as an invisible barrier

Most respondents seem to agree that a barrier in achieving greater representation of women in geoscience is the lack of role models. Without enough women in visible, established and senior positions, women students and young professionals might not realise that it is possible to have a successful career in geoscience. The need to establish more visible role models is suggested as a solution to a wide variety of problems, including increasing interest in geoscience among girls in primary education; increasing girls' awareness of different subfields of geoscience; increasing the number of women students in geoengineering; and increasing women's representation in the oil and gas industry, academia and in other areas. One respondent offers a general explanation of the need for role models:

> *I think that geoscience has a predominantly male face at this moment. If we could show the female face, which definitely exists, a bit more, it might help girls to overcome doubts about their ability, skills, etc.*

That the perceived face of geoscience is gendered as male is confirmed in other studies (Marín-Spiotta 2020). Masculine gender norms constitute the face of STEM in general (Dancy et al. 2020). Some research indicates that role models can be relevant to help a minority believe that they have a place within an institutional setting (Holmes et al. 2008, De Welde & Laursen 2011, Popp et al. 2019). However, other research indicates that it might be harmful to women's careers to emphasise their visibility as women in a male-dominated environment (Van Den Bring & Stobbe 2009).

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7 INTERNATIONAL WORKSHOP WITH LEADING WOMEN

The ENGIE project organised an online International Workshop with Invited Women Experts in September 2020. The main objective of the workshop was to identify the motivators for and barriers to empowering young women to become geoscientists and geoengineers. The workshop was initially planned as a physical meeting, but due to the COVID-19 pandemic, it was moved online and conducted via Zoom. The workshop gathered 18 women professionals who were well established within their respective field of geoscience, in both industry and academia. During the workshop, they were given the opportunity to present and discuss their experiences of working life, particularly the situation for women within geoscience and geoengineering. The workshop was recorded and transcribed for further analysis.

The aim of the workshop was to provide a forum for joint learning among women experts to reach a deeper understanding of the motivators for and barriers to the empowerment of girls to become the geoscientists of tomorrow. After an initial presentation on the ENGIE project and an introduction of the participating experts, the main group was divided into four separate working groups. Each group was asked to focus on a framing issue and attempt to discern its current status and possible solutions to any identified problems related to the issue. The four framing issues were:

- Mapping the representation of men and women in geoscience-related professions
- Exploring the existence of gender bias in geoscience-related professions
- Identifying the barriers to empowering girls
- Identifying the motivators for empowering girls

Each group had approximately 45 minutes to discuss and problematise their framing issue. They were then reunited to present their results to the larger group and join in a joint discussion with the aim of defining solutions to identified problems. A summary of each group's presentation is provided here, together with a summary of the suggested solutions.

7.1 MAPPING THE REPRESENTATION OF MEN AND WOMEN

Geoscience is male dominated, both in industry and in academia, but there are variations. The group discussed differences in women's representation in different countries and fields, concluding that there has been a shift towards a more equal distribution of women in geoscience education and, to some extent, in industry. Generally, men still dominate the top positions in science and industry, filling the majority of positions as professors, CEOs or chairmen of boards. The male-dominated top also means that men are more visible in positions of influence, usually filling the role of keynote speakers or corporate representatives in various venues. This vertical distribution of men and women seems to be changing but at such a slow pace that it will take a considerable amount of time before industry is close to an equal gender distribution.

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A second aspect of representation discussed was the horizontal distribution of men and women within geoscience organisations. The group concluded that women tend to be clustered in other areas than men, often in roles supporting men. HR and managerial support areas within organisations are seen as dominated by women, while women are relatively rare in areas concerning exploratory mining or the "hard" areas of geoscience (i.e., relating to rocks). In one country (Poland), women are entirely excluded from underground work. Apart from the traditionally gendered organisational domains, the group also concluded that women often are multiprofessionals, meaning that many women occupy professional positions in which they use multiple competences, such as combining management or marketing skills with expertise in geology. As multiprofessionals, women access domains that are seen as peripheral to the organisational core. As such, they can act as links between industry and other areas, such as environmental organisations and alternative markets for industry products. These peripheral functions and multiple competences are seldom given a high status within the organisations themselves but are often regarded as important from a societal perspective.

7.2 EXPLORING THE EXISTENCE OF GENDER BIAS

The group discussion confirmed the prevalence of gender bias within geoscience organisations and working life. Many of the women experts had themselves experienced situations in which both overt and more subtle forms of gender bias had affected them. Some forms of bias were related to general societal belief structures regarding women's role in the workforce and had affected them in their deliberations regarding education and profession. Some had experienced a questioning attitude towards them as women when choosing a long course of university studies to become geoscience professionals. One professional's family expressed the attitude that women did not need a university education since they would become mothers and, as such, responsible for their family and home and thus would no longer have the time for a career. While this questioning of women's educational aspirations might be on the decline, the idea of women as the primary caregiver in family life was still experienced as an important form of bias in professional life. According to the experts, many organisations still view motherhood as an interference with professional commitment and engagement. The expectations that women will become mothers and that mothers will perform worse than their male colleagues hamper women's careers. These expectations also place extra stress on women, who must work harder to prove their worth to the organisation.

Women in geoscience professions also frequently encounter the assumption that they occupy a supportive role rather than being managers or experts in their field. One expert described her experience at a conference where she was mistaken for an administrative assistant, even though she was the coordinator of a large EU project and played an important role in the conference. Had she been a man, she believed, this assumption would not have been made. The experts also described experiences of having their merit

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and status downplayed. One professor was often referred to by students by her first name, suggesting a familiarity they did not show in their relation to her male colleagues, who were always referred to as "professor". Other examples include women's professional achievements being ascribed to men or to women's top-level positions being credited to their personal connections rather than their competence. One woman in a senior position stated that she was seen as a "token", a woman given a position of status but lacking actual power; her top-level position had been created to make the company look more gender equal. Such tokenism could also be a problem in everyday working situations. As one expert described, she had once turned down an offer to participate in a recruitment committee when she found out that she had been invited to participate not because they needed her professional opinion but because a committee without a single woman would have "looked bad". Her story offers insight into the fact that the industry understands that there is a problem with gender inequality, but that their understanding of the problem sometimes does not go further than providing a token woman as a solution.

7.3 IDENTIFYING THE BARRIERS TO EMPOWERING GIRLS

Examples of factors preventing and discouraging girls from developing a career in geo-related professions were prevalent in all four groups. The group that was assigned a focus on barriers identified a wide range of obstacles to women entering a geoscience profession. One of the main barriers was the stereotype of the sector as heavily invested in industries that are detrimental to environmental protection. The view that geoscience is related to the petroleum and mining industry is seen as something that might interfere with young women's interest in a future career in the sector. The group emphasised the necessity to "change the narrative" and explain the importance of geoscience in creating environmentally friendly energy solutions as well as sustainable mining operations. The perception of geoscience as environmentally unfriendly may also be associated with it being a "dirty" industry in which the grime, harsh weather conditions and necessary physical endurance make it a profession that clashes with gender stereotypes of what attracts girls' interest. The experts expressed worries about parents and teachers perpetuating the stereotype of geoscience as an unsuitable occupation for women and further guiding girls into professions that reproduce, rather than challenge, stereotypical gender roles.

To counter these barriers, the experts suggested outreach initiatives from the industry with the aim of changing the perception of geoscience. One aspect of such initiatives would be to show the types of jobs available in the industry, that not all jobs necessitate fieldwork carried out in harsh conditions and that there are successful women in fieldwork as well. Another aspect would be to show that there are jobs in the industry and that it is moving into sustainable fields of energy and raw material resources. The transformation of geo-related industry is necessary to address the challenges of global warming and environmental challenges, and the industry needs to communicate this

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change to attract the next generation of geoscientists. The experts encourage the ENGIE project to contribute to changing this narrative.

The experts also suggested outreach activities for both teachers and young women. Teachers need to learn more about geoscience and how to conduct fieldtrips and bring students out into nature. Courses for teachers are suggested as one way the industry can overcome this barrier, along with more resources to bring students into nature. Not being exposed to nature and the outdoors as a child or young adult is of concern to the experts, many of whom learned to appreciate geoscience through growing up in the countryside or spending time in nature with their family as a child. If children do not have the social circumstances that will introduce them to nature, then it is crucial that schools fill that void and make this introduction to awaken young women's interest in and curiosity about geoscience.

Finally, one of the main barriers discussed is the lack of women role models in the geosciences. The experts concluded that more women role models are necessary to show the wide variety of professions and careers available in geoscience and geoengineering. Women role models can make themselves available as mentors and guides in the industry, as well as visiting schools and making public appearances, to show young girls that they have a place in geoscience. The experts believe that a larger visibility of women within the industry will lead to an increase in girls who attempt a career in geoscience.

7.4 IDENTIFYING THE MOTIVATORS FOR EMPOWERING GIRLS

The fourth group discussion focused on questions of motivators and support structures for increasing the number of girls in geoscience. As in the discussion on barriers, the group underlined the importance of early exposure to types of careers in geoscience as well as girls' involvement in outdoor activities. Geo-related industry should engage in outreach events aimed at schools, universities and families to create a wider knowledge of the field and its occupational opportunities. Outdoor activities at an early age are seen as important, not least to minority groups and urban youth who otherwise would have limited opportunities to "discover nature". Geo-related industry and interest groups could work together with other groups involved in nature activities, such as scout organisations, nature guides and adventure holiday organisers. Such activities could also be arranged through philanthropic support from the industry to reach other disadvantaged groups, such as persons with disabilities, that may have restricted access to nature. Showing that the threshold for access can be lowered increases the possibility of drawing greater interest in geoscience subjects and related activities. In addition to the traditional outreach activities focussed on experiencing nature, the experts stressed the need to adapt to a new generation and its reliance on digital platforms. The increased presence of geo-related organisations on digital platforms that attract young girls might be one way to reach out to those who otherwise would remain unaware of geoscience opportunities.

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Once an interest in geoscience has been awakened, it has to be sustained and further encouraged. The group suggested that mentoring young girls might be one way of retaining their interest. Different mentoring schemes are available, but both students mentoring younger pupils and established professionals mentoring students and young professionals might be appropriate motivators. There is also the possibility of encouraging informal mentoring, not least through encouraging women within geoscience to support and guide students and new colleagues, to engage in outreach activities, and to advocate the geoscience profession to girls. As in the former group, the need for active role models is stressed as vital to empower girls to become geoscientists.

7.5 SUGGESTED SOLUTIONS

The joint discussion gave rise to a number of solutions and suggested priorities, some of which are given extensive attention above, such as the need for role models, outreach programs for young girls and connection to the social and environmental aspects of geoengineering to change the industry narrative. Changing the gendered preconceptions about geoscience professions is important to create a more equal gender distribution across the field. These recommendations are paired with an overarching suggestion of working towards organisational change in the industry. Such a change should focus on fostering an inclusive working culture and preventing women from leaving academia and industry. The so-called leaky pipeline is a challenge to both industry and academia, and one of the causes of this leakage is the situation for women who have children or are treated as if they will have children when they reach their thirties. The sudden change in career progression that many women experience in their thirties coincides with geoscience employers expecting them to prioritise family over working life. This expectation, together with insufficient actions taken to support young parents in their career, causes women's careers to stagnate.

A second aspect of organisational change is related to other forms of gender bias, such as the questioning of women's competence and working skills prevalent in "male" work domains, the objectification of women as sexual objects and the wage disparities prevalent in the sector, to name a few. The experts stressed the need to work with men in the industry and, especially to focus on actions in "traditional" parts of the industry, where change is slow. A focus on organisational culture and masculine attitudes throughout the industry is necessary for women to feel welcome. One suggestion is to further support mobility between sectors, thereby creating an influx of alternative experiences and ideas into more conservative parts of the industry. One suggested parallel element of such an effort is to further develop and build upon existing networks focused on supporting women within geoscience, both in terms of creating forums for women to share their experiences but also in creating more business networks for women. Access to professional networks that are particular to specific areas of geoscience expertise are necessary to create a level playing ground for both women and men.

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8 NATIONAL WORKSHOP WITH WOMEN EXPERTS

To capitalise on the experience of women professionals in geoscience, ENGIE Linked Third Parties conducted a series of workshops in October and November of 2020. The aims of these workshops were to provide a forum for discussion and joint learning among women professionals to reach a deeper understanding of how gender affects working life in geoengineering and geoscience. Through developing a better understanding of the conditions of working life, the project hoped to develop strategies and activities that will increase the interest of girls and women in the field as well as their abilities to enter working life with the appropriate knowledge and skills.

The workshop target group was professionals working in geoscience or geoengineering, either in academia or in industry/commercial organisations. The workshops were primarily conducted with a mix of professionals from both academia and industry. Participants were selected and invited by the project LTPs. Ten workshops with 74 participants were conducted by LTPs in Spain, Turkey, Poland, Portugal, Bulgaria, the Czech Republic, Slovenia, Hungary, Croatia and Ukraine. Due to the restrictions imposed by the COVID-19 pandemic, some of the workshops were conducted via Zoom. To help coordinate the workshops, all the LTPs were given a template prepared by LTU that consisted of a PowerPoint that structured the workshop into two parts, as well as a guide with instructions for the workshop leader. The two parts of the workshop were constructed to discuss different aspects of gender equality in organisations. The first part, called Mapping the representation of men and women, aimed at describing and further discussing horizontal and vertical gender distribution in geoscience organisations. The second part, called Discussions on gender and working life, discussed gendered aspects of working life in geoscience that had emerged in previous workshops and surveys. The workshop was designed to last for two hours, with one hour assigned for each part. All the workshops were documented using the form provided in the PowerPoint. A short summary of the results and major points of interest is presented here.

8.1 PART 1: MAPPING THE REPRESENTATION OF MEN AND WOMEN

The discussion on representation centred around an exercise constructed to visualise horizontal and vertical gender segregation in organisations. The participants were asked to position various professional positions within an organisation according to their level of power and status, thereby producing a subjective hierarchical view of the organisation. When the participants had finished mapping the organisation, often a geoscience academic department or company, they were asked to gender the various positions by asking themselves if they thought of the positions as usually filled by male or female colleagues. As an example, one would expect the CEO of a company to be male but the HR administrator to be female.

The result of the mapping was a total of 33 different organisational maps consisting of the following types of geoscience organisations (number of organisations):

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- Public organisation – Academia (12)
- Public organisation – Government geoscience and/or environmental agency (3)
- Public organisation – Geological survey (4)
- Public organisation – Natural history museum (2)
- Private organisation – Mining company (10)
- Private organisation – Geoscience laboratory (1)
- Private organisation – Oil and gas company (1)

To determine the similarities and differences among these organisations, the following presentation of the results is discussed in relation to the vertical and horizontal distributions of gendered positions. A vertical distribution means that there is a hierarchy within organisations, often with a president or CEO at the top, followed by managerial positions and then by employees in different departments. This hierarchy is gendered in relation to the gender ascribed to the various positions and the persons who hold the positions. As an example, the position of CEO is usually characterised as male even though the person currently holding the position does not necessarily have to be male. In the workshop, the participants were asked to consider the former, although there are examples of charts where the positions seem to have been interpreted as the latter.[5] A horizontal distribution describes the segmentation of gendered occupational fields within an organisation (cf. Reskin & Padavic 1994:51). While an organisation may be "gender equal" in numerical terms, with women and men each occupying 50% of positions, it may nonetheless be a gender-segregated workplace in which men hold professional positions characterised as "masculine", such as technician, while women are employed in "feminine" positions, such as administrative positions. It is important to note that horizontal segregation does not have to be physical segregation: women and men may share the same workspace but be predominantly assigned different work spheres (technical tasks/administrative tasks).

8.1.1 Vertical distribution

The gendered vertical distribution of the organisations can be divided into three main categories: heavily male dominated, male dominated, and diverse/neutral. Almost all the geoscience organisations examined here have top positions assigned as male dominated. Of the 33 organisations mapped, only four have top positions where women are assigned as the director or equivalent. Of these four organisations, one is a museum, one is a public geological survey and one is an academic organisation. The fourth is a private mining company in which the top positions are shared by a male chairman of the board and a woman general director, who is marked as temporary. The remaining 29 organisations all have top positions designated as male. Since the top positions are so clearly male

[5] Although it might not pose a concern for this descriptive analysis, the question of what is actually being depicted (an idea or an observation) might lead to interpretative problems later on. This question also highlights the difficulty of arranging a workshop but not being able to lead it or be present to explain concepts.

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dominated, it is difficult to discern any differences or variations other than the possible suggestion that public institutions seem to have a slightly higher chance of somewhat more diversity at the top. In contrast, for middle management and senior professional levels, there are more discernible differences among organisations, especially between public and private organisations. Many academic and other public organisations have a large proportion of women in management positions and as professors. There are also private organisations in which women are positioned close to the centre of power, although these are few. The organisations designated as heavily male dominated (11) have very few women close to the centre of power (often just one or, in larger organisations, a few). Most of these are private industry with connections to mining, exploration and geoengineering, although there are a couple of academic organisations in this category as well. The majority of organisations belong in the category of male dominated (17), which can be described as having a majority of men in dominant positions, while a few organisations are diverse/neutral (5), meaning that the balance of influence between men and women in the organisation seems to be in the range of 40/60. These organisations are public (academic, museum or geological survey), except for one mining company.

8.1.2 Horizontal distribution

The gendered horizontal distribution is possibly more heterogenous and more difficult to compare across the diverse types of organisations present in the material. Possible approaches are a horizontal approach to managerial positions, a sorting of positions generally classified as male or female, and inquiring whether there are any geoscience positions that could be understood in terms of being gendered. Managerial positions reflect several typical gendered patterns regarding the types of areas that women and men are positioned to manage. While men are often expected to lead organisations and workgroups (as head of department or similar), women are expected to lead in areas designated as female, often areas that are considered to be social, caring or supportive of the main area of expertise in the organisation (be it mining or research). Such patterns are discernible in the organisations (especially in private industry) considered here, where women often tend to hold positions as HR manager, head of finances or commercial manager. There are similar gendered horizontal patterns in relation to men, who dominate in positions designated as head of engineering (chief engineer) or head of exploration. Moreover, patterns are evident within the positions that are generally classified as male or female. These positions suggest that many of the organisations are characterised by traditional patriarchal structures in which men “lead” and women “support”. Women are, almost without exception, described as being administrators, administrative assistants or support staff. Such patterns are also visible in academia, with positions such as laboratory assistant and administrator designated as female. Traditionally masculine occupations are also visible, with positions such as technician, driver or miner being the prime examples. As for the question on gendered geoscience positions, there are clusters of positions designated as male, especially in industry. These positions often have to do with mining or extraction, such as exploration and drilling

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engineers or, regarding academia, involve particular subfields of geology, such as geological engineering, structural geology or geophysics. There are also tendencies towards certain areas being more feminine, or at least somewhat less masculinised, such as geochemistry or palaeontology, that could serve as a preliminary guide to further studies on gendered positions in geoscience.

8.2 PART 2: DISCUSSION ON GENDER AND WORKING LIFE

The aim of the second part of the workshop was for the participants to engage in a discussion of four themes relating to gender in geoscience. The themes were selected based on the results of previously conducted surveys in ENGIE as well as existing research, and each theme was illustrated by a statement. The statements were formulated to express an opinion, and the participants in the workshop were asked to engage in an open discussion without necessarily deciding on whether they agreed with the statement. They were also informed that they were not expected to reach a consensus and that each participant was entitled to her opinion and understanding of the statement. The first theme was fieldwork, selected in relation to both positive and negative field experiences expressed in the survey of geoscience professionals. The second statement was related to parenthood and was based on the experiences of women professionals handling employers and colleagues' expectations regarding their fulfilment of a traditional ideal of motherhood. Third was a statement relating to gendered work assignments and the possibility of women being assigned additional administrative burden compared to men. Last, the participants discussed a statement on the working conditions for women in relation to workload and the need to "work harder than men" to reach a comparable level of acceptance and recognition. Each statement is presented below, together with a brief summary of the documented reflections from the workshops.

8.2.1 Statement 1 – fieldwork

"Fieldwork is crucial for a career in geoscience, but the organisation and culture out in the field make conducting fieldwork more accessible for men than women."

This statement was met with discussion and opposing views in the workshops. While most participants seem to agree that fieldwork is an important part of geoscience, there are a variety of perspectives on whether women are disadvantaged. A few participants clearly state that they do not consider women disadvantaged in the field, explaining the statement as an expression of stereotyping women or that, based on their own experience and their employer, they do not see fieldwork as a challenge for women. These women relate their argument to their own branch of geoscience and their own experience, making it clear that they also regard geoscience as diverse in terms of fieldwork. As an example, one participant from the oil and gas industry does not see fieldwork in her field as comparable to fieldwork in "hard" or "rock" geology, framing it as

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"they have a problem, but we (I) do not". Another geoscientist expresses her view that "when outdoors, the earth knows no difference between man and woman", thus placing the statement in another context than the purely social, relating to the earth itself as an agent indifferent to gender. It is also in relation to this sphere of the physical, the strains and demands of fieldwork, that participants express an essentialist view as to why women and men are not equally equipped for fieldwork. Women are understood to lack the necessary physical strength, while men help women by carrying the "extra weight". One participant puts it plainly: "a woman physically cannot carry as many rocks as a man", a statement that in itself expresses a stereotype that should be problematised and further contextualised. One possible question would be to ask whether all men always carry all the rock they themselves have collected, etc. However, this rather traditional way of seeing gender as directly manifested in a strong masculine body or a weak(er) feminine body also has a possible connection with the participants who agree on physical differences but do not see them as legitimising inequality in the field. Here, there is a discussion about progress, both in cultural terms and in technical terms. In relation to culture, the argument is that organisations and employers have changed and become more inclusive of women in the field. As for the technical argument, there is a perception that technical development will increasingly lead to a decreased dependence on physical strength and endurance during long fieldtrips. Instead, technological advances will make fieldtrips more accessible, both in terms of physical requirements and of social expectations, for example, when technology makes sampling easier and faster, thereby reducing time in the field. Women's perceived obligation to family is a social expectation that many participants claim poses a barrier to women participating in the field on equal terms with men. Because of "family", women are not as able to travel to distant places or be away for long periods, which is given as a reason why employers and colleagues prefer male geoscientists in the field, who are seen as more flexible and easier to accommodate. The heterogeneous reasoning is also visible in relation to the organisation of fieldtrips, where women can be regarded as "deviant" geoscientists who require separate hygiene facilities or sleeping arrangements or need protection from "wild dogs" or "local people".

8.2.2 Statement 2 – parenthood

> *"Employers know that many employees are parents and need to balance their priorities between their professional and private life. However, women are often expected to take a larger share of the responsibility in their private life, especially as mothers. This expectation negatively affects their career."*

There is a relative consensus across the workshops in agreeing with the statement. Women are seen as the primary caregivers in families, and this role is seen as detrimental to fulfilling the obligations needed for a successful career. Participants point to societal expectations of women as mothers, the lack of childcare and insufficient legal protection against discriminatory practices. Such institutional factors vary depending on the national

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context but seem to be a structural problem that affect most women. More precisely, the statement points to the responsibilities of employers, and some workshops thus shifted the discussion from societal factors to organisations. Participants describe being held back in their career because of maternity leave and having children. Some ascribe the responsibility for this situation to the employer and its perception that women with children are unable to handle a larger share of responsibilities. Some participants highlight the competitive culture (of academia), where there is little time for other things than work if one wishes to advance. A shared perspective is that women become mothers and that mothers, in turn, must find strategies to deal with a working life that is structured around work (and the male worker) rather than family and/or a social life. To achieve success while growing their family, participants stress the need for a supportive spouse, an extended family that can help with children and the willingness to work harder than men to prove that one, as a woman, is not inhibited by parenthood. One participant describes this situation as "damned if you do, damned if you don't" because women who do not have children are regarded as underachievers by employers and colleagues, regardless of the amount of time they put into their work. Their "free time" is less valued because they do not have children (and thus violate the expectation that women be mothers), and thus, their work is also less valued than that of their male colleagues. The discussion overall seems to confirm an underlying discourse of maternity being one of the main reasons for gender inequality at work, unfortunately shifting the perspective away from the employer's responsibility and instead directing it towards the women, the family and society at large.

8.2.3 Statement 3 – gendered work assignments

> *"Professional life includes many tasks that are less related to the profession as such. Even so, men tend to perform fewer administrative tasks than women, and men are allowed more time to work on specific tasks related to their profession."*

There are two parts in this statement that point to different aspects of gendered work. One is directed towards the administrative work often carried out by women, either as administrators or through the incorporation of administrative tasks into their daily work. The other relates to men being able to dedicate their work to specific tasks and thus to specialise effectively. The two aspects are visible in the discussion, although the latter aspect receives less attention. Men's privileged position is summed up as a matter of fact: Men "receive more management responsibilities" or "are not willing to perform administrative tasks". One participant describes a workplace where it is "common for men to perform the fieldwork and women to create the reports". This quote offers an extra dimension for what can be regarded as administrative work and raises questions regarding whose name is placed first on the report. Nevertheless, the main discussion relates to administration and the question of why women seem to take on the largest share of administrative tasks. On participant puts forward a hypothesis that, while women

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comprise the lion's share of administrators, the administrative tasks of the everyday jobs of geoscientists are fairly equally distributed due to new public management. Others note that the administrative burden seems to be increasing but that men (in academia) often solve this issue by hiring extra female help, while women researchers are left to deal with administrative tasks by themselves. Such a situation creates an obvious disadvantage for women in time-sensitive undertakings such as applying for research funding or publishing manuscripts. A similar observation arises in industry, where a participant disagrees with the statement but adds that "There are, of course, exceptions in the lower and middle management ranks, where individuals behave like the women engineers are their 'secretaries'". While men are "allowed" to ask for help and to believe that they are entitled to it, women who ask for support are regarded with suspicion. One participant describes that such a woman would be regarded as "lazy, comfortable, disorganised, even difficult". There are also examples of the administrative aptitude of women being internalised; women are described as being better writers, better at multitasking and better at organising. Even if such assumptions are true, however, it would be reasonable to expect such proficiencies to develop due to practice and diligence rather than gender, especially if women's male colleagues seem to avoid them.

8.2.4 Statement 4 – gendered workload

"Many women achieve top positions in geoscience and geoengineering. Women have to work harder than men to achieve the same position and level of acceptance in their organisation."

The phenomenon of women's aggregated workload is a recurring theme in previous surveys and is further confirmed by the workshop discussions, in which several related themes arise, some of which have already been mentioned in relation to previous statements. One such theme is women's unpaid domestic work, i.e., the extra workload carried out by women in relation to their children, their spouse and their extended family. This workload is mentioned in addition to the work referred to in the statement. The workshops predominantly discussed and affirmed the existence of this "hard work". While there are those who dissent, most participants seem to agree on women's need to work harder to compensate for the disadvantage of not being men. One participant expresses her experience as "Women need to work harder and need to achieve more than men to be equally acknowledged". The question of being equally acknowledged is a shift of focus towards the criteria for accomplishment and how these, if they are formulated, are evaluated. Moreover, even if there are clear criteria, this does not guarantee that the acknowledgement for fulfilling them will be equally distributed. In the experience of one geoscientist, this is the situation in academia, where women can "have dozens of publications, but they receive half of the appreciation that men receive, even if they work much more". Even so, there are those who do not agree with the statement and instead argue for a meritocratic system (in academia) and a belief that this system is free of bias. As one participant stated, "It doesn't matter the gender, it's more important how much

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he/she 'can show'". This quote puts forward the "end product" as a measure of achievement and unbiased evaluation, but the participant in question does not discuss the process, the work, leading up to the product. As shown above, most participants express their opinion that women do need to work harder, not least to manage work tasks (administrative) that men do not perform, and to perform better to reach the same level of acceptance as their male colleagues.

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9 INTERVIEWS WITH ACADEMIC LEADERS

The interview study with academic leaders is a part of WP1, task 1.2 Capitalising on experience. Within this task, further knowledge on working life conditions in geoscience is gathered and analysed in relation to ENGIE's goal and action plan. Capitalising on experience is performed by assessing current working life conditions and gender equality policies in geosciences organisations, both in industry and academia. In relation to the action plan, an interview study of the terms of academic professional careers and ideals within the geoscience/geoengineering community is conducted to enhance our understanding of gendered career paths and the frequently cited problems of "glass ceilings" and "leaky pipelines" regarding women's opportunities in academia. By investigating what ideals are reproduced within the geoscientific community, the study hopes to increase the understanding of how the field is gendered and how inequality is reproduced in academic organisations.

As has been shown in the literature review (3), neither industry nor academic geoscience professionals in Europe have been the subject of extensive research, and knowledge gaps exist. ENGIE has added some new knowledge through surveys of geoscience professionals (see section 6) and a policy study of gender equality in geoscience companies (Johansson 2020). The policy study was conducted in a selection of geo- and mining companies by investigating their policies towards gender equality. The findings suggest substantial variations in how industry organisations describe and promote gender equality but that business value is often an incentive to work towards equality (rather than achieving a good work environment or promoting equal rights for women and men). The study's main findings have been reported in ENGIE Deliverable 1.1 (Johansson 2020).

A selection of relevant respondents/participants in interviews within the field was performed by the ENGIE expert panel. The criteria for participants were devised by LTU with the assistance of ENGIE partners. The criteria for the selection of interviewees were as follows: geoscientist with a senior research leader/professor position in a geoscience or geoengineering department. A senior research leader should have a position as professor or equivalent. A total of nine interviewees were identified and contacted to inquire whether they would be willing to participate. All nine agreed to participate in the study. The participants were located in Croatia, Hungary and Sweden. All the interviews were conducted via Zoom, in English or Swedish, and lasted between 50 and 90 minutes. The interviews were guided by a semi-structured questionnaire following four themes: Interviewee background information, recruitment to research positions, career opportunities for geoscientists, and gender in geoscience. Of the nine interviewed, seven were men, and two were women. All had extensive experience as research leaders, but their current positions varied. Some held administrative/managerial positions within their research institutions, but most were occupied with teaching and research. All the interviews were recorded and will be transcribed for further analysis. To ensure the

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anonymity of the participants, their employers and organisational backgrounds will not be disclosed. Due to the timeframe of the study, only a preliminary analysis can be provided here.

9.1 DEMANDING WORKING CONDITIONS

The preliminary results of the interviews correlate with what has already been described regarding the results of the survey of geoscience professionals (see section 6). The respondents in the interviews discuss a profession that is highly competitive and demanding in terms of dedication and long working hours. A male professor states that the profession demands "hard physical work and intellectual work". In his experience, geology demands physical labour, fieldwork and travel, followed by long hours of analytical work. It is this combination that many respondents describe as attractive in their choice of profession, the possibility to go to new, often remote, places, as well as fulfilling their intellectual aspirations. This combination, together with the competitive nature of academia, can be said to construe one of the core circumstances in geoscience in relation to gender and gender equality. Based on the interviews, the demands of geoscience seem to include:

- fieldwork that involves travel and, often, long periods away from home. It may also involve rigorous physical demands as well as hostile environments.
- long working hours to compete with colleagues for funding and publications. Science is an international profession and so is the market one competes in.

As a result, successful geoscientists need to be able to prioritise their work over other prerogatives in life, such as family and interests outside of work. This does not necessarily mean that one cannot have a family or have other interests if one wants to be successful. Many respondents have families. However, there is also an emphasis on having a family that supports one's work and is willing to take care of the children when one is away on fieldwork or to accept long working hours. Such conditions do not necessarily mean that one must be male to succeed, but it definitely helps to be male in a culture where women perform the majority of the housework and are usually the primary caregivers in families. There is also a recurring story of the need for mutual understanding between spouses to make working life and social life function. This mutual understanding means that either one partner can have a successful career and one can take a primary interest in the household, or, if both want a career, they can either choose not to have children or to secure outside help for daycare and other obligations. The last option is dependent on either financial means or having an extended family that is available for assistance. In sum, and in accordance with previous research (Blackburn 2017), one might say that working conditions are rigged to function within a traditional family structure. However, as the female respondents emphasise, such conditions do not mean that one cannot have a successful career as a woman, one must simply navigate gendered barriers in both family and professional life.

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9.2 THE IMPORTANCE OF NETWORKS AND COLLABORATION

One of the main objectives of the interviews was to ask about what it takes to be successful, not only to examine the gendered barriers to success.[6] When discussing questions of success in geoscience, a recurring theme is the importance of networks and collaboration. Most of the interviewees are situated in relatively small research areas, with their own research interests shared by few close colleagues. There are therefore limited possibilities for collaboration within their own department or university. To be able to conduct the research they are interested in, they need to find collaborators, both for funding purposes and for research and technical expertise. Since geoscience is multidisciplinary, there is often a need to collaborate across disciplines to answer scientific questions. For funding, there is often a need to be close to industry, to share research objectives and to take a collaborative approach to projects. Several respondents' express concern regarding the difficulties in receiving research funding, both nationally and internationally. In one country, the researchers are concerned that the national research council no longer has any funding available for geoscience. As a result, they are dependent on international research funding, such as EIT, funding from industry, or collaborative approaches with other disciplines for which national funding is available.

The interviews suggest that researcher networking in both industry and academia is of great importance. To obtain research funding, researchers need to collaborate, but to be able to collaborate, one needs a network of people. How researchers find these people and create these networks are therefore of interest, not least in relation to gender. Several respondents describe research collaborations as springing from their networks in the form of invitations and offers they would not have received without prior connections. There are different ways to obtain access to networks, and there are many types of networks, both formal and informal. The formal way to obtain access to a network would be through a scientific institution, for example, through an invitation to collaborate in an international research project supported by a preexisting university network. Such invitations would be funnelled through official channels at the university and often land with a scientist with some prior knowledge of the research area. However, the interviews show that a more common entry path to research collaborations and projects seems to be initiated through informal processes. They could be initiated at a chance meeting at conferences or in other collaborative circumstances (such as expert meetings arranged by governmental bodies or industry projects). One respondent described how a long research collaboration and large international project all started with a friendly meeting at a conference. A chat with fellow male researcher between sessions led to a discovery

[6] There are problems with using concepts like "barriers" and "success factors", not least in relation to distinguishing them since "overcoming barriers is a success factor". Replies to questions regarding success/barriers easily become tautologies. However, such concepts are still of interest and useful in how they tend to connect to discourses of "success". Moreover, not all answers provided are tautologies.

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of a shared interest and, later, an invitation to join an application for research funding. Another respondent described how vital his connections with his former PhD students were for collaborative projects with industry. Many had left the department for industry jobs after completing their dissertations. Now, they are both instigators and reciprocators of research ideas and suggestions for collaborations between the professor's research team and various industry companies. The collaborative nature of geoscience was emphasised by the respondent, as was the need to maintain and develop good networks. His emphasis on the importance of networks is shared by many respondents, and no one described their research as a singular effort, nor was there a difference in emphasis on networks between the men and the two women in the study. All described the importance of networks and continuous collaboration to keep funding and publishing going. It was also obvious that those researchers who had left for an administrative position, such as dean or head of department, considered their chances of research collaborations and publications diminished.

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10 CONCLUSIONS AND KEY MESSAGES

This report presents data that were collected and analysed during the first ENGIE WP1 Programming. The results are based on the following:

1) The assessment of statistical data on the representation of women in geoscience education and professions and the results of previous studies related to best practices for teaching STEM and gender perspectives on geoscience education and professions

2) The assessment of new empirical studies using questionnaires administered to secondary school students, teachers and women in geoscience professions; interviews with academic leaders; and one international workshop and a series of national workshops with leading women geoscientists.

In this final chapter, the results are further analysed and presented as three overarching key messages or strategies that will guide the project in the implementation of actions. Similar to the analysis of each data source, the messages have been formulated in relation to the findings of previous research as well as the theoretical framework on gender, gender equality and gender in organizations.

Although the analysis in the chapter is divided into three messages, the messages are all interrelated and should be read and understood together. A common theme among the messages is the need to examine and critically reflect on the underlying assumptions and notions guiding activities, the potential effects of activities and the ways in which they contribute to or contradict the vision of ENGIE.

The key messages will have a practical role in the monitoring and assessment of continuous activities, as each organizer will be asked to reflect on how he or she has considered these strategies in the design and implementation of activities. To facilitate this, the key messages and their potential practical implications will be further outlined in forthcoming guidelines delivered in April 2021.

10.1 CHANGING CIRCUMSTANCES, NOT INDIVIDUALS

First, the problem at hand is not girls nor their behaviour and aspirations but the varying practices and processes that contribute to the existing gender imbalances in geoscience education and professions. The qualitative and quantitative data presented in this report suggest that professional ideals and values in geoscience tend to be constructed in relation to symbols, experiences and preconditions associated with men and masculinity. Furthermore, women professionals have to adapt and strategize in relation to this dominant masculine culture. Although variations in women's experiences exist, many of the women participating in ENGIE workshops and surveys describe situations where both overt and more subtle forms of gender bias have affected them. Women also described situations where others wrongfully assumed that they worked in a supportive role rather

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than being managers or experts in their field. The results thus indicate a need to shift the focus from the particularities of women's experiences in geoscience organizations and instead direct attention to the general working conditions in the geoscience field and the structures and cultures that reproduce male dominance.

Focusing on changing circumstances also draws attention to the limited role of geoscience in the curricula of primary and secondary education. One result from the ENGIE surveys is that many geoscientists enter the profession due to an introduction to the subject by family or other close social relations. This finding suggests that schools could play an important part by exposing students to geoscience when they might otherwise not be exposed in their social contexts. However, geoscience subjects, such as geology, are seldom taught independently but instead are incorporated into other subjects, such as geography or natural science. Changes to how geoscience is taught and the creation of a more prominent role for geoscience subjects in primary and secondary education are likely to increase interest in geoscience, especially among underrepresented groups.

A further recurring theme in the data is the need to promote alternative, perhaps more progressive and more sustainable, narratives of what geoscience is about. As shown in survey data, there is a tendency for people outside the field to perceive geoscience as related to environmentally damaging industries involved in oil, gas and mineral extraction, while geoscientists themselves would say that they aim to find the solution to many of the problems causing environmental damage, especially within the energy sector. In this way, recalibrating representations of geoscience in a way that emphasizes its social relevance in relation to, for example, climatic and ecological emergencies, has become necessary. Such a reimagining would enable ENGIE to communicate the ways in which geoscience matters for societal changes and the demands of the future in a way that does not reproduce stereotypical perceptions of what geoscience is about.

10.2 CHALLENGING RATHER THAN REPRODUCING INEQUALITIES

Second, changing circumstances to enable a more gender-balanced geoscience education and profession involves challenging rather than reproducing existing patterns of inequalities. Foremost, it is important to not address girls in ways that further perpetuate ideas about gender differences and the association of girls and women with assumed natural, ahistorical "feminine" interests, characteristics and aspirations. In addition to reproducing ideas about gender differences, activities that promote "geoscience for girls" or "women geoscientists" also imply that the terms "geoscience" and "geoscientists" without a gendered prefix refer to an activity and a profession that are for boys and men. In fact, the most successful strategy to promote gender equality is often to not explicitly target women or girls but to instead ensure that the activities are designed without gender bias and that they represent women at all levels.

The risk of reproducing existing inequalities makes the often-recurring need to promote women's role models a complicated matter. In the data presented in this report, the need

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to establish more visible role models is suggested as a solution to a wide variety of problems. While there is research that indicates that role models can be relevant in making minority individuals believe that they have a place in an institutional setting, there is also research that indicates that it might be harmful to women's careers to emphasize their visibility as women in a male-dominated environment. Adding the burden of promoting change and equality for women to an already exposed minority position is thus problematic. This approach also risks framing issues that relate to the practices and process that are inherent organizations as problems of individual women. To avoid this trap, it may be more beneficial to include women in the representation of geoscientists without explicitly promoting them foremost as women. Rather than emphasizing *women* geoscientists, it is more beneficial to place the emphasis on *geoscientists* who happen to be women.

The need to challenge existing inequalities goes beyond the issue of gender. For example, the existing literature and survey data collected from students indicate that social background seems to have a strong influence on the decision to study geoscience. Children with parents who have a higher education degree are more likely to consider geoscience, which suggests that children from less-educated households constitute an untapped group of potential aspirants. Designing and implementing outreach activities directed at girls/youths in a way that does not further add to patterns of social stratification is thus important. A practical example might be to ensure that field trips and other outdoor activities are arranged in a way that does not put extra financial strain on parents, with ENGIE providing all necessary materials, including outdoor clothing.

10.3 CONSIDERING VARIATIONS IN GENDER IMBALANCES

Third, changing the circumstances in a way that challenges existing inequalities calls for actions that consider the variations in gender imbalances across different fields and contexts related to geoscience professions and education.

Data on the gender distribution in geoscience tertiary education in Europe show that the representation of women varies across subfields and national contexts, which indicates that the conditions for increasing the number of women in geoscience education also vary. Earth science tends to have an equal gender distribution, whereas environmental science is more female dominated, and the geo-engineering and mining engineering field is more male dominated. Therefore, girls should be particularly encouraged to pursue education in the field of geo-engineering and mining engineering, and boys' interest in environmental science should be encouraged. The data also show that the gender imbalances in different subfields differ across countries. The proportion of women in geoscience tends to be higher in some countries, such as Slovakia, Estonia and the Czech Republic, and lower in other countries, such as France. Thus, the actions of ENGIE need to be flexible or adaptable in relation to the specific educational gender patterns of particular countries.

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An additional variation that relates to patterns in tertiary education concerns the differences in gender imbalances across different areas of geoscience organizations. The findings suggest that women tend to be clustered in different working areas than men, often in roles supporting men. There are also relatively few women in areas concerning exploration mining or the “hard” areas of geoscience (where “hard” refers to rocks). Rather than being associated with the core areas and professions of geoscience organizations, women often occupy roles requiring broad skills and multicompetences, such as combined management or marketing skills and expertise in geology. These roles are often regarded as important from a societal perspective and can be an opportunity for women to advance. At the same time, these roles are seldom given high status within organizations, especially in comparison to what are seen as core roles and roles that remain associated with men. Understanding how gender and the representation of men and women within geoscience organizations relate to the status, values and notions of the core/periphery in organizations is important. Without such an understanding, there is a risk of reproducing existing inequalities by continuing to push women to more peripheral, and already “feminized", parts of organizations while enabling the central and core professions of organizations to remain associated with men and certain forms of masculinity.

Variations have also been found in geoscience professions across public bodies, academia, the private sector and related career progressions. The analysis of experiences of women in this report suggests that while the academic field of geoscience is usually described as male dominated at “the top”, the overall working conditions for women tend to be depicted as reasonable, with a relatively large number of women working in geoscience departments and attending educational programs. The geoscience academic sector is rarely described as expressing open animosity towards women, but neither is it described in terms of the equal opportunities for women and men or for women of colour. Descriptions of the raw material sector are different to some extent, where fewer women describe their workplaces as gender equal or gender balanced; in addition, descriptions of the work life culture consistently note that women are questioned and seen as less knowledgeable than male colleagues, that women are frequently given administrative tasks or are expected to be subservient to men, and that women have to prove their competence in order to be accepted. However, variations do exist in descriptions of the industry, suggesting that there are some organizations that are less biased and more modern and inclusive. Identifying the more progressive organizations that employ geoscientists and positioning them as role models to promote change should be considered, not least in an attempt to shift the focus away from individuals and place the responsibility for solutions to gender inequality on employers and geoscience organizations.

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