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Perceiving gendered organizations: positions, power, and gender in geoscience

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Abstract

This article explores inequality in European geoscience organizations through the perspective of geoscience women professionals and their perception of gendered positions in academia and industry. Male dominance in geoscience organizations has previously been demonstrated within US and Canadian organizations, often in relation to gender inequality in STEM subjects and rarely in relation to the specific ideals and practices that shape geoscience. The current study contributes a European context, as well as a comparative approach to gendered positions in the organizational contexts of academia and industry. Using participatory research methods and visualization techniques, the study collected 42 organizational maps of academic and industry organizations in 16 European countries. The results reveal perceptions of gender inequality in academic and industrial geoscience organizations through women's limited access to positions of power, i.e. women geoscience professionals perceived underrepresentation in senior management positions in industry and in senior positions in academic organizations. Within the growing demand for geoscience expertise in the green transition, the results raise questions about what the perceived structures of gender inequality mean in relation to sustainable employment and good working conditions in European geoscience.

Keywords: Organization; Geoscience; Gender; Power; Positions

1. Introduction

This article explores inequality in European geoscience organizations through the perspective of geoscience women professionals. The study is framed by a shift in direction and prospects for many geoscience organizations as the green transition gains momentum within a European context. The European Green Deal leads to major investment in organizations central to geoscience professions. To accommodate the financial needs of the green transition, the European Union (EU) 2021-2027 budget reserve 30% of its assets for climate and environmental funding and the EU recovery fund devotes 37% of its assets to climate action [Speck et al., 2023]. Geologists and Earth Science professionals are highly involved in the process, not least through the Critical Raw Materials Act (CRMA)[1] which establishes a framework for a sustainable and secure supply of critical raw materials within the EU [European Council, 2024]. The green transition may also imply a shift in geoscience employment, away from extractive industries and toward environmental and sustainable work in low carbon geoenergy, subsurface energy storage and waste storage [Gardiner et al., 2023]. According to the O*NET Green Economy occupational classification, the transition will lead to a higher demand of geological expertise (such as geothermal technicians and production managers) as well as identifying Geoscientists (except Hydrologists and Geographers) as a "green enhanced skill occupation"[2]. The European Federation of Geologists (EFG) reports low and decreasing unemployment (2.4%) in their 2023 Employment survey of geologists working in Europe [EFG, 2023]. In the national context of Sweden, geoscience intensive industries are expanding, with the mining industry expected to add 12,000 new jobs in currently planned mining operations associated with the green transition [Hagman et al., 2023]. For geoscientists in Europe, the green transition shapes the organizations they work in, as well as their employment prospects. Yet we know very little about the employment structure of the organizations themselves, their hierarchies, working conditions and distribution of geoscience professionals within a European context [EFG, personal communication, 21 March 2024; EuroGeoSurveys, personal communication, 29 March 2024].

Research on geoscience organizations in the US and Canada indicate substantial organizational inequalities in relation to gender, ethnicity and disabilities [Ranganathan et al., 2021; Mattheis et al., 2022], inequalities that seem to be entrenched and continuously reproduced in both academia and industry [Williams et al., 2012; Holmes et al., 2015; Berhe et al., 2022]. Furthermore, studies indicate that these inequalities, in terms of access to resources and positions of influence, impede

[1] https://single-market-economy.ec.europa.eu/sectors/raw-materials/areas-specific-interest/critical-raw-materials/critical-raw-materials-act_en (accessed 16 March 2025).
[2] See O*NET, Green Jobs (database): https://www.onetcenter.org/ (accessed 16 March 2025).

research and practice involving environmental sustainability and climate change [Natcher et al., 2020; Mogk, 2021]. A general conclusion seems to be that organizations shaped by inequality are less capable of harvesting the skills and competencies necessary to address the challenges the green transition implies [Mogk, 2021]. As indicated by Elliot [2015], the green transition relies on specialized skills and competencies framed within the discourse of "green jobs", and the demand has implications for employment for both "new" and established occupations. While "green jobs" are framed within an economic agenda of transition toward environmentally sustainable and "greener" operational and technological solutions for capitalist production [Goods, 2014; Hoffman and Paulsen, 2020], the term should also be subjected to ethical considerations regarding the type and duration of "green" jobs, as well as how these jobs are organized in terms of sustainable employment, adequate reimbursement and good working conditions [Elliot, 2015]. The current development in geoscience intensive industries and research organizations, and previous research on inequalities within a US and Canadian context, therefore, call into question how European geoscience jobs are affected by inequality and how the organizations are perceived by the people working within them.

While geological work may be a "key profession" in the green transition, we know that employers of geologists and geoscientists currently struggle to meet some of the criteria posed by Elliot [2015] regarding sustainable employment, adequate reimbursement and good working conditions, especially in relation to gender and the position of women in geoscience organizations [Williams et al., 2012; Marín-Spiotta et al., 2020; Heimann and Johansson, 2024]. As Williams et al. [2012] have shown, the individualization of assessment of worker's performance, increased reliance on self-managed teams and job insecurity in professional organizations, risk reproducing patterns of gender inequality within geoscience organizations in relation to women's employment and career opportunities [Williams, 2019]. Gender-biased assessment and evaluation of geoscience workers have been demonstrated in both academia and industry [Moss-Racusin et al., 2012; Williams et al., 2012]. Furthermore, the working conditions of women in geoscience organizations are contextualized as "hostile environments" [Marín-Spiotta et al., 2020] and "chilly" climates [Holmes et al., 2008] where women are subjected to harassment, bullying, sexism and organizational constraints in terms of gender-biased recruitment and assessment processes as well as conditioned access to networks and collaborations [Pico et al., 2020; Mattheis et al., 2022; Heimann and Johansson, 2024]. Subsequently, terms such as 'glass ceilings' and 'leaky pipelines' have been used to describe how women are subjected to stalled career trajectories and exit-inducing practices in geoscience organizations [Holmes et al., 2015; Agee and Li, 2018; Marín Spiotta et al., 2020; Ranganathan et al., 2021].

The dominance of men in geoscience professions, and in positions of power within geoscience organizations, has been demonstrated in geological societies [Kernen et al., 2023], academic organizations [Holmes et al., 2008; Van Den Brink and Stobbe, 2009; Popp et al., 2019] and industry [Miller, 2004; Williams et al., 2012; Williams, 2019]. Van Den Brink and Stobbe [2009] conclude that the prevailing ideal of the (geo)"scientist" is a man, characterized by "his" physical strength, endurance, and willingness to "get his hands dirty". In relation to geoscientists working within industry and academia, the literature seems to indicate a gendered divide in terms of working conditions, career opportunities and sustainable employment. Yet, the studies that explicitly focus on gender and organizations within European geoscience are few and do not describe, nor explore, how gender inequality is experienced in terms of gendered jobs and hierarchies of academic and industry organizations [Heimann and Johansson, 2024].

Given the context of the presumed expansion of new "green jobs" in European geoscience, the transformative process that the "green transition" indicates and the ethical implications it entails in terms of fair working conditions, the aim of this study is to describe and explore how gender inequality manifests in two types of European geoscience organizations: academic geoscience departments and geoscience intensive industries. The questions asked are 1) what positions are women and men perceived to occupy in the organizations, and 2) how these (gendered) positions are perceived in terms of hierarchy and level of influence (power). The study makes use of an explorative methodological approach to chart organizational gender inequality using participatory research methods and visualization techniques. Engaging women geoscientists active in European geoscience, the study explores gendered organizations in relation to professional positions and hierarchy, arguing for the specific position of the gendered professional in attempts to discern how gender inequality manifests in organizations [Acker, 2006; Anderson et al., 2021].

The article is structured as follows: previous research on gender inequality in geoscience organizations and theoretical implications; description of the design of the study as well as its methodological implications and limitations; followed by the results. In the concluding section, the findings are discussed in relation to theoretical implications and the relevant literature.

2. Geoscience and gender

Studying geoscience organizations and occupations requires acknowledgment of the diversity of the field, its various disciplines (such as geology, hydrology, pedology, and glaciology) and its practice in a wide range of industrial sectors

(such as mining, oil and gas extraction, construction, agriculture, and forestry). The varied contexts differ in the representation of men and women, and there are further differences in relation to national contexts [Holmes et al., 2008, 2015; Nentwich, 2010; Blackburn, 2017; Ranganathan et al., 2021] and specific organizations and industries [Williams et al., 2012; Popp et al., 2019]. Academic and industrial geoscience organizations are different in character, displaying varying forms of organizations and hierarchies, as well as differences in how gendered structures and processes shape the working life of the organizational members [Williams et al., 2012; Zippel and Ferree, 2019]. Even so, there are interconnections between the two types of organizations, i.e. geoscience students become geoscience professionals in both academic and industry contexts, and academia and industry are interrelated actors through cooperative partnerships in research and development. These interrelated processes shape the gendered structures of the organizations, and, despite the heterogeneity of the field, there are strong arguments for a specific gendered culture within geoscience, ie. shared values and ideals constructing and reproducing gendered work [Padavic and Reskin, 2002], that shape occupations, organizations, and their hierarchies and positions as gendered [Van Den Brink and Stobbe, 2009; Williams et al., 2012; Heimann and Johansson, 2024].

2.1. The gendered culture of geoscience

Holmes et al. [2015] describe the gendered culture of geoscience and the subsequent subordination of women in relation to the barriers women face on the individual, interactional and institutional levels and the various expressions of gender bias that overlap them. On the level of individual barriers, women in geoscience occupations describe being questioned in relation to their abilities and skills (such as math capabilities, physical stamina), being more inclined toward family than career, and/or lacking the assertiveness necessary to negotiate or ask for mentorship [Miller, 2004; Faulkner, 2009a; Heimann and Johansson, 2024]. The interactional barriers arise from implicit bias, micro-aggressions and discrimination, assumptions about gender that limit women's opportunities in relation to field-work, or expectations that define women as more suitable for work in laboratories or performing nurturing tasks, such as caring for the well-being of co-workers [Nentwich, 2010; De Welde and Laursen, 2011; Marín-Spiotta et al., 2020; Thun, 2020]. Institutional barriers are gendered organizational structures consisting of policies, formal and informal practices and processes of geoscience organizations [Acker, 1990], as well as the institutional framework that surrounds those organizations in terms of labour regulations, access to daycare facilities, parental leave provisions (governmental

and/or corporate) and the division of reproductive work in households [Acker, 2006; Pactwa, 2019; Zippel and Ferree, 2019; Thun, 2020]. In part, institutional barriers are continuously made visible by the ongoing discussion on the lack of support for women in geoscience, especially at crucial career stages, highlighting the gendered (masculine) organizational logic of academia [Holmes et al. 2015; Bernstein, 2024]. These barriers are also prevalent in other STEM subjects (Science, Technology, Engineering and Mathematics) and the analytical levels form a theoretical framework of how women's underrepresentation in STEM can be understood and challenged [Sattari and Sandefur, 2019; Beck et al., 2022]. In addition to Holmes et al. [2015] framework of barriers, the culture of gender inequality in geoscience is manifested in symbols and practices that are particular to the subject, rather than shared by other STEM subjects. These specific symbols and practices are reproduced through organizational socialization of gender norms, where the masculine ideal of geoscience is made evident in the symbol of the able-bodied male and the physical requirements and attire of field work. As Van Den Brink and Stobbe [2009] demonstrate, the othering of those who deviate from the ideal leads to an in/visibility paradox, making women visible as "othered" yet invisible as geoscientists in terms of competence and abilities. The masculine and homosocial character of geoscience professions, and especially the geological profession, can in turn be related to historical factors of male dominance, legislative and organizational policy practices restricting women from field-work and the exclusion of women from practicing in geoscience-intense industries, such as mining [Nentwich, 2010; Pactwa, 2019; Marín-Spiotta et al., 2020].

2.2. Gendered ideals and organizations

Organizational hierarchies and the co-construction of gender and power are embedded in the gendered culture of geoscience through gendered ideals and various forms of gender bias that reproduce gendered job hierarchies, work and work tasks [Acker, 2006; Heimann and Johansson, 2024]. Gendered work in geoscience is framed by the pervasive ideal of the geoscientist as a man, emphasizing physical strength, stamina and connection to the rock and soil of the subject [Van Den Brink and Stobbe, 2009; Bleijenbergh et al., 2013]. The ideal further frames who is regarded as "other" within geoscience organizations, shaping processes of inclusion and exclusion that are inclusive toward white, heterosexual, able-bodied, middle-class men, while excluding women, non-binary, gay, lesbian, persons with disabilities and non-whites [Mattheis et al., 2022; Heimann and Johansson, 2024]. The ideal of the male geoscientist [Acker, 1990; Bleijenbergh et al., 2013] is foremost visible in relation to positions of influence and power in geoscience organizations, positions

predominantly inhabited by men [Miller, 2004; Nentwich, 2010; Williams et al., 2012; Ranganathan et al., 2021] and in relation to positions and experiences of those who are othered, i.e. women and other subordinated minority positions (including men who do not adhere to the ideal), and their relative scarcity in positions of power. The hierarchical distribution of gender in geoscience academia (in the US and Canada) displays a structure of male dominance in the most influential positions, such as professors and heads of departments, whereas women are to a greater extent positioned in entry level and mid-level positions of teaching and research, and within administrative positions [Holmes et al., 2008; Nentwich, 2010; Ranganathan et al., 2021]. In a study of 62 higher education institutions in the US, ~27% of tenured and tenure-track faculty in the Geosciences are women, within a range of 46% as assistant professors, 34% as associate professors and 19% as full professors [Ranganathan et al., 2021]. In comparison, women are more prevalent in positions of precarity, ie. non-tenured and short-term academic contracts, making up ~40% of US geoscience non-tenure track lecturer and instructor positions [Wilson, 2017; cf. Mattheis et al., 2022; Doerr, 2024].

In geoscience industries, such as mining organizations, similar hierarchical patterns of gender distribution in positions of power are evident. Mining and other extractive industries remain predominantly male-dominated, with men holding top positions and comprising the majority of the workforce [Moraka, 2015; Perks and Schulz, 2020; Heimann et al., 2023]. Women account for less than 30% of the skilled workforce in the mining sector. At the executive level of mining companies, women are even more underrepresented. Among the top 100 global listed mining companies, only 16 have more than one female director [Perks and Schulz, 2020]. Moraka [2015] demonstrates that women on the boards of mining companies are typically assigned peripheral and advisory roles in areas such as law, environmental aspects, and HR, while men dominate “core” positions related to production and corporate governance [cf. PwC, 2013; Perks and Schulz, 2020; Mkhatshwa and Genc, 2022]. Women working as geoscience experts in mining have been found to navigate the masculine ideals of their organizations through strategies of doing gender [West and Zimmerman, 1987], eg. by assuming gendered positions of “mother” or “sister” that do not threaten male dominance [Musonda, 2020] or by performing masculinity to gain visibility and claim authenticity as geoscience professionals [Miller, 2004; Faulkner, 2009a,b; Heimann and Johansson, 2024].

Women’s experiences of work within geoscience organizations (academic and industrial) indicate positions of subordination in terms of power, describing working life as “hard work”, meaning that work efforts are directed toward navigating positions of subordination to counter the effects of exclusionary practices [Heimann and Johansson, 2024]. This gendered workload consists of managing preconceptions

of family responsibilities, sexual availability, physical abilities, and perceptions of professional competence – the necessity to "prove" skills and knowledge – as well as gaining access to networks and arenas of decision-making (formal and informal) [Faulkner, 2009a,b; Williams et al., 2012; Bridges et al., 2023]. The "hard work" of women in geoscience stand in contrast to those men who, in adherence to the ideal, serve as the image of "authentic" professionals [Faulkner, 2009b], can be expected to prioritize work over family, and are expected to participate and contribute to the networks and processes of decision-making in geoscience organizations.

2.3. Hierarchies and organizational myths

The gendered ideal of the geoscientist and the hierarchical (and vertical) distribution of gendered work (and positions of power) in geoscience organizations are reproduced through processes of gender bias in academia and industry [Williams et al., 2012; Marín-Spiotta et al., 2020]. As extensively demonstrated within the academic context, gender bias affects recruitment to entry-level and top positions, influences access to social, material and economic resources, and shapes the opportunities for advancement in academic geoscience organizations [Moss-Racusin et al., 2012; Dutt et al., 2016; Lerback and Hanson, 2017; Marín-Spiotta et al., 2020]. In addition, the reproduction of gender inequality within academic institutions is legitimized through the organizational myth of meritocracy. As argued by Amis et al. [2020, p.218] organizational myths are "the widely shared cultural ideals and rationalized beliefs about how organizations ought to operate". As a persistent myth in academia, meritocracy legitimizes the current (patriarchal) order through the organizational principle of individual advancement and reward being based on capabilities and performance, rather than seniority, gender, ethnicity, etc. Even though extensive research shows that meritocratic systems are flawed, in terms of gender, class and racial bias [Faulkner, 2009a,b; Śliwa et al., 2022], the myth prevails and continues to legitimise organizational processes that reproduce inequality [Amis et al., 2020]. Similar processes seem to be prevalent in industry organizations yet work within a different context of organizational practices and processes. As Williams et al. [2012] demonstrate, the transformation of many modern organizations has restructured the processes of assessment and managerial control, as well as how job descriptions are formulated. The transformation has shifted responsibility from employers in terms of providing well defined job descriptions and assessment processes, leaving individual workers in a more precarious position in terms of having to navigate career maps and networks to manage their careers and future opportunities. While industry organizations to some extent adhere to the

same organizational myth of meritocracy, career trajectories and opportunities for individual workers are further guided by myths of "efficiency" and "positive globalization", meaning that organizational practices that affect workers opportunities, such as the availability of flexible working hours, parental leave and reimbursement practices, are legitimized through paradigms of efficiency and global market forces [Amis et al., 2020]. As work organizations are constructed in relation to the ideal of the male worker [Acker, 1990], the inefficiency of workers with family responsibilities (reproductive work) becomes apparent [Thun, 2020].

As demonstrated by previous research, the work of geoscience professionals may be understood as permeated by gendered structures where women are subordinated through biased processes of recruitment and assessment, hostile climates and compensatory work requirements. In both academic and industry organizations, "gender neutral" myths of meritocracy and efficiency serve to legitimize gender inequality. Exploring how women geoscientists perceive gender in relation to positions of work and power is subsequently a way to make visible how gender shapes the hierarchies of work in geoscience organizations.

3. Method

The present study is based on workshop data collected within the ENGIE project, a European educational and research project focused on gender in the geosciences. The project provided access to national geological organizations and institutions across Europe within which 16 national workshops were conducted. The workshops had a twofold aim: (1) to discuss gender equality and gendered barriers within geoscience organizations through discussion questions and propositions provided by the project, and (2) to conduct an organizational mapping of gendered positions in geoscience organizations, which provided the data for the presented study. Guided by participatory action research methodology [Chevalier and Buckles, 2019], the workshops were designed to be carried out independently, without the authors' presence, by national geology organizations associated with the European Federation of Geologists (EFG). Following a template provided by the author, the workshop results were documented by the participants and collected as part of the research material within the ENGIE project.

The workshops were conducted during autumn and winter of 2020 and were affected by the COVID-19 pandemic and the various mitigating responses and restrictions deployed in Europe. Subsequently, the workshops were designed to be conducted on-line (ie., through Zoom), although some workshops were carried out in physical meetings (with distancing applied and according to national regulations). During the

workshops, participants were instructed by a workshop template developed by the author (see Figure 1) and asked to choose an organization they were familiar with and to illustrate the organizational structure using professional positions in a hierarchically ordered organizational template. As a guide, some professional positions were given as examples (such as CEO, Professor, Geologist) but the participants were encouraged to identify professional positions independently, given their knowledge and experience of the organizations. During the mapping, the participants were asked to position the various professional positions within the organization according to their level of power and status, thereby producing a subjective hierarchical view of the organization. In the following, they were instructed to designate gender to the various positions based on their approximation of whether the position was dominated by men, women or neutral, i.e., could not be described as neither male nor female dominated. While gender should be understood as a continuous accomplishment achieved in interaction and within institutional arenas, the theoretical frame of gender in geoscience, as well as how gender tends to be conceptualized and perceived as binary in organizations, makes a dichotomized scale more viable within the context of the study [West and Zimmerman, 1987; Acker, 1990].

In total 57 organizational charts were collected. The average workshop group documented two to three organizations. Three groups provided between six and nine organizational charts. The organizations charted varied with four predominant groups identified as: Industrial organizations within extraction and construction (n = 18); Academic organizations (n = 24); Museums in the field of science (n = 4); and Governmental organizations of geological surveys (n = 8). Three out of the 57 organizational charts were excluded from the study due to non-compliance with the workshop instructions (such as not using the template provided or adhering to instructions). Two organizational groups (museums and geological surveys) were excluded from the study as the type of organizations charted were only represented in eight out of 16 national contexts. In total, 42 organizational maps were included, containing 18 industry organizations and 24 academic organizations (Figure 2). The organizations contained 547 unique positions across the organizations, each designated by professional occupation (see Table 2), position of power (central-periphery position) and gendered profile (masculine, feminine, neutral). The 18 industry organizations were dominated by industries in the extraction industry (predominantly mining) and the 24 academic organizations were all academic departments in the field of geoscience with a majority specialized in geology. In all, 113 geoscience professionals participated in workshops conducted by national geology organizations in 16 European countries[3].

[3] A majority of the national workshops were organized in southern and eastern European countries (10), and six national workshops were organized in central, northern and western Europe.

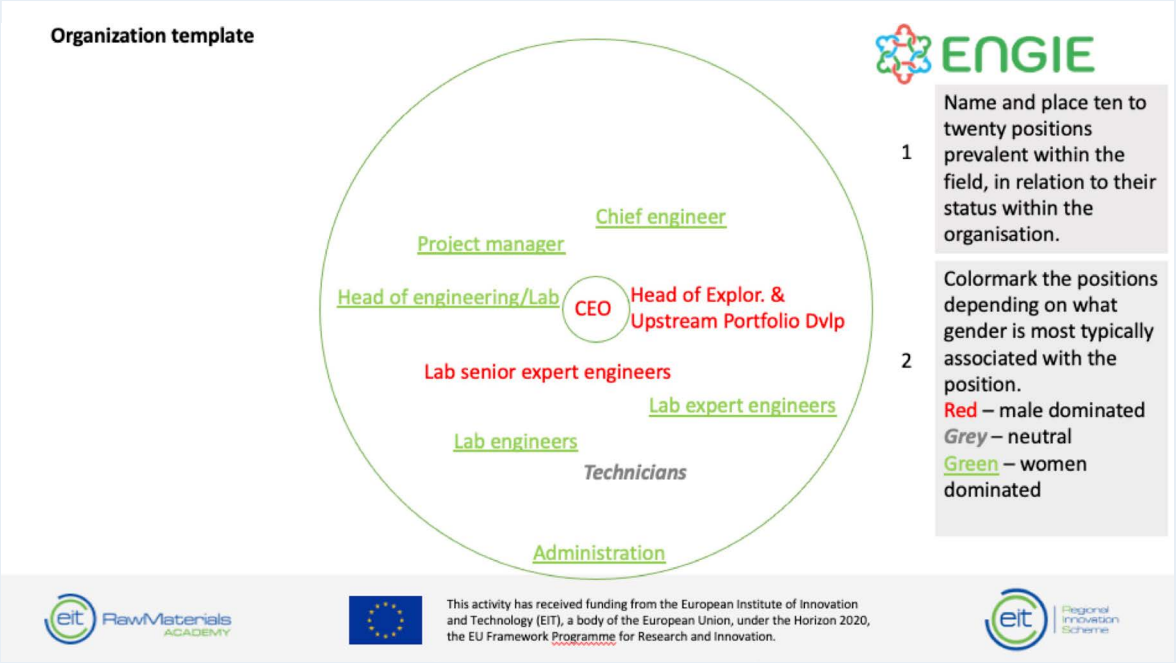


Figure 1. *Organizational template – data sample.*

3.1. Study design

The design of the study was motivated by practical reasons and theoretical assumptions. As organizational data describing positions and gender in geoscience in a European context is not readily available, nor possible to obtain given the frame and resources of the project, the workshops provided the opportunity for a sampling of perceived organizational structure in terms of professional positions, hierarchy and gender. The design of the mapping was therefore constructed in relation to three premises. First, the data gathered is exploratory and positioned from below [Harding, 1986] within a participatory action research framework [Chevalier and Buckles, 2019]. In comparison with personnel data gathered by organizations, the study data provides the perspective of the employee, and more specifically, the perspective of women geoscientists who work, or used to work, within the organizations in question. As such, the data should be regarded as a representation of situated knowledge, i.e., the knowledge produced in the workshops, and further interpreted in the research process, is socially situated as experienced by women

in male-dominated geoscience organizations, and further interpreted within a feminist theoretical framework [Haraway, 1988]. The mapping of organizations is within this design "partial" as only a minority group within the organizational collective is given the opportunity to describe their perceptions. Yet, it is through the perception and experience of the subordinated that we might better see the effects of inequality [Harding, 1986] and through their participation gain the knowledge required for change [Chevalier and Buckles, 2019].

The second premise of the design is the acknowledgment of professional positionality and the specific view such a position entails [Anderson et al., 2021]. Professional organizations are generally comprised of different occupations, positioned in various areas and across hierarchical levels of organizations. As such, occupational perspectives differ in relation to position and what and whom is within their gaze, and how hierarchies are experienced. As Anderson et al. [2021] demonstrate, organizations have multiple hierarchies, and some professions, such as university administrators, might primarily relate their organizational experiences in relation to the subhierarchy of university administration, rather than the hierarchy of academic faculty. As an academic profession, geoscientists are primarily part of the academic faculty, and their perception of hierarchy and gendered positions can be assumed to relate primarily to the structure of the academic faculty hierarchy. In comparison, geoscientists in industry are positioned as a profession among others (engineers, miners, administrators, technicians) and incorporated into the hierarchies and subhierarchies of their respective organizations. Such a position can be assumed to shape the perception of the organization in relation to the area one is working within, as well as the collaborations and career developments available.

Third, the design of the organizational mapping (Figure 1) is constructed in relation to the professional practice, tacit knowledge, and skills of geoscientists, especially geologists [Polanyi, 1998]. By asking the participants to visualize positions and hierarchy in their organization through an abstract template, the design relates to the practice of visualizing rock formation and mineral deposits through abstract templates while simultaneously adhering to the inductive method used in geology [Osmond, 1978]. In doing so, the template design seeks to bridge methodological boundaries between sociological organizational studies and geological practice [cf. Osmond, 1978].

3.2. Data coding and analysis

The collected data was manually coded with each organizational template (Figure 1) coded according to the type of organization (academic or industry) and the

various professional positions it contained (Table 1). The positions were coded based on the type of work (e.g., geologist), gender (e.g., male) and positional power. Since power is a relative and contextual variable, it is interpreted here as a position's spatial relation to the centre (i.e., high power) of an organization, with positions of less power positioned further away from the centre. Following the distribution of positions and avoiding a binary scale (power – no power), the positions were coded as either high power (close to or in the centre), medium power (close to or in the middle strata of the organization), or low power (peripheral in relation to the circular boundary). For example, each position is coded individually within each organizational chart; a position can be coded as 'Chief Financial Officer, masculine, high power' in one organizational context and as 'Chief Financial Officer, masculine, low power' in another, depending on the positioning of the 'Chief Financial Officer' in the organizational chart. The professional/occupational positions are grouped into 8 categories, with four belonging to academic organizations and four to industry (see Table 2). The categories are grouped according to profession and organizational level and are estimated to be approximations of the organizational hierarchy in the respective organizations. The data was coded and analyzed using SPSS crosstabulation of key variables and visualized in figures and tables using Microsoft Excel.

Positions in Academic Organizations	Feminine	Masculine	Neutral	Total
Head of Faculty (A1)	1	22	2	25
Professor (A2)	3	36	8	47
Associate professor (A2)	4	5	5	14
Assistant professor (A2)	3	4	6	13
Department Director (A1)	7	21	6	34
Secretary (A4)	2	1	0	3
Administrative Staff (A4)	21	3	6	30
PhD-position (A3)	4	7	10	21
Teaching position (unspec) (A2)	4	4	10	18
Researcher (unspec) (A2)	7	11	17	35
Deputy Dean (A1)	6	4	0	10
Faculty Chairman (A1)	0	3	1	4
Deputy Faculty Chairman (A1)	3	2	0	5
Provost (A1)	0	1	1	2
Technical staff (A4)	5	3	10	18
Deputy Department Director (A1)	1	1	0	2
Students (excluded)	0	0	5	5
Academic organizations Total	*71*	*128*	*87*	*286*

Positions in Industry Organizations	Feminine	Masculine	Neutral	Total
CEO (I1)	1	17	0	18
HR Manager (I1)	7	2	5	14
Chief Financial Officer (CFO) (I1)	3	7	0	10
Head of Engineering (I1)	0	7	1	8
Head of Exploration (I1)	1	9	0	10
Head of Mining Operations (I1)	0	6	0	6
Chief engineer (I2)	1	6	2	9
Chief Geologist (I2)	2	9	4	15
Environmental sustainability Officer (I3)	6	1	2	9
Head of Sales (I1)	0	5	1	6
Administrative Manager (I1)	14	18	2	34
Geologist engineer (I3)	1	4	4	9
Engineer (unspec) (I3)	1	4	8	13
Mining engineer (I3)	0	3	1	4
Laboratory Engineer (I3)	3	1	2	6
Miner (I4)	0	3	0	3
Technician (I4)	2	5	6	13
Project Manager (I2)	2	3	1	6
Head of department/division (I2)	8	22	2	32
Administrative position (I4)	6	3	4	13
Board Chairman (I1)	0	2	0	2
Environmental health and safety officer (I3)	0	1	1	2
Geologist (I3)	0	2	3	5
Industry organizations Total	*58*	*140*	*49*	*247*
Total	*129*	*268*	*136*	*533*

Table 1. *Frequency of Professional positions in Academy and Industry Organizations as distributed within feminine, masculine and neutral positions*

Organization	Grouped Category	Examples of included professions (see Table 1 for full coding specifications)
Academic organizations	Academic Management (A1)	Head/Deputy of Faculty/department/division
	Teaching and Research positions (A2)	Associate Professor, Professor, Assistant Professor, Researcher, Teacher
	PhD-students (A3)	PhD-students
	Administrative and Technical Staff (A4)	Technical Staff, Administrative Staff, Secretaries and other administrative positions

Organization	Grouped Category	Examples of included professions (see Table 1 for full coding specifications)
Industry Organizations	Senior Management (I1)	CEO, VP, Chairman, Head of Engineering/Exploration/ Operations/Sales
	Mid-level Management (I2)	Head of Department/division, Chief Engineer/Geologist, Project Manager
	Expert Positions (I3)	Geologist, Engineer, Environmental Sustainability Officer
	Administrative and Technical Staff (I4)	Technician, Administrator, Miner

Table 2. *Coding of grouped categories in academic and industry organizations.*

3.3. Study limitations

While the organizations and professional positions are illustrations of places of work within academia and industry, their rendering is a subjective interpretation, as perceived by the workshop participants. Furthermore, the limited number of organizations, their non-representative selection and their distribution across 16 countries mean that no further generalization can be claimed aside from the apparent coherence in the gendered character of the organizations. In relation to a European geoscience landscape of work organizations, the study omits museums, geological surveys, consultancies and NGOs (to name a few), organizational contexts where gender patterns might differ compared with industry and academia [Almstedt Valldor and Halldén, 2023]. Another limitation relates to the comparability of different types of organizations and organizational levels. The coding of the data according to organizational hierarchy presents a challenge in relation to the organizational structure of universities versus industry organizations. Since geological faculties/ departments are subdivisions of a larger university organization, they do not have the same administrative management level as many industry organizations or the level of power and resources a CEO or industry board might have. The power ascribed to various positions should be valued in relation to the specific organizational context as expressed by workshop participants, not as levels of power comparable between organizations. Another difference is the role of senior experts (professors) within universities and the relative status and power of department and faculty leaders within a collegial academic system. These factors and subsequent methodological challenges are further discussed below (see discussion).

4. Results

The results are presented in two parts. First, aggregated results of academic and industry organizations are presented in relation to the distribution of positions and gender. These results present the overall perception of how the participants perceive their organizations in terms of which occupational positions are regarded as feminine or masculine, as well as where neutral positions are to be found. Second, aggregated data is presented on how perceptions of power shape the distribution of occupational positions and perceived gender.

4.1. Position and gender in academy and industry

The results from the modelling workshop display academia and industry as two distinctly different types of organizations, yet with some similarities in relation to gender distribution. Academic organizations (Figure 2) are, on the aggregate level,

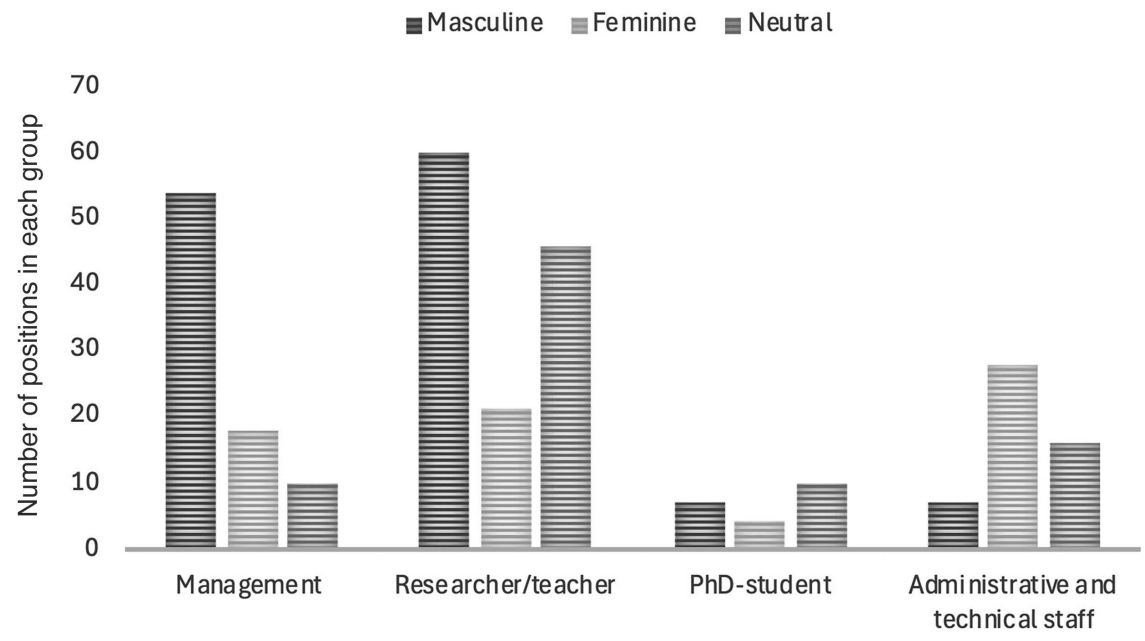


Figure 2. *Distribution of gender in academic occupational categories.*

perceived as dominated by masculine positions in both teaching/research positions and management. Within management positions, *Head of Faculty* and *Department Director* are foremost designated as masculine. Feminine positions in management are predominantly perceived to be deputy positions and directors at the department level. The management positions designated as neutral, perceived as neither feminine nor masculine, are comparatively few, yet are prevalent in positions such as *Head of Faculty* and *Department director*. Masculine positions are most dominant in management positions, followed by positions in research and teaching. Within PhD positions, masculine positions are not perceived as dominant, and within administrative and technical positions, the masculine positions are even fewer in comparison. Feminine positions are almost equally distributed in the categories of management, researcher/teacher and PhD-students, while feminine positions dominate the category of administrative and technical staff [Anderson et al., 2021]. Neutral positions are most prevalent within the categories of researcher/teacher and PhD-students. A substantial part of administrative and technical positions is also regarded as gender neutral, while management holds comparatively few neutral positions.

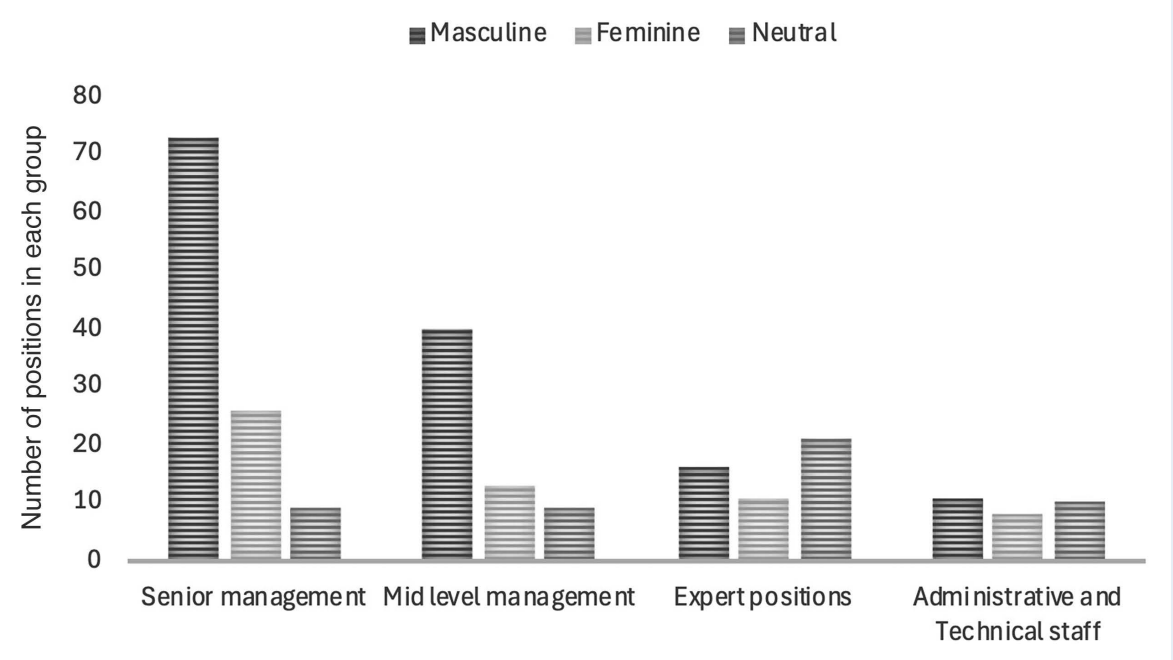


Figure 3. *Distribution of gender in industry occupational categories.*

Industry organizations (Figure 3) are perceived at an aggregate level as being dominated by masculine positions in Senior and Mid-level management. Within Senior management, positions such as *CEO*, *CFO* and *Head of Engineering/Exploration/ Mining Operations* are predominantly regarded as masculine. Feminine positions in Senior management are predominantly perceived to be "supportive" management functions such as *HR-manager*, *Head of administration* and *CFO* [Moraka, 2015]. Neutral positions in Senior management are few yet primarily perceived to be in similar "supportive" functions such as HR and administration. Mid-level management, which includes positions such as *Head of Department/Division*, *Chief Engineer/Geologist* and *Project Manager*, is perceived as less segregated with feminine and neutral positions dispersed among various professional positions. Expert positions are largely considered gender neutral, with exceptions such as *Mining Engineer* (predominantly masculine) and *Environmental Sustainability Officer* (predominantly feminine). Within administrative and technical positions, administration is predominantly regarded as holding feminine positions while technical positions are designated as masculine.

Similarities between the organizational types are primarily visible in relation to the senior levels of the organizations and the apparent dominance of masculine positions within management in academia and industry. Similarities in perceived gender distribution are also evident when comparing non-management positions, where gender-neutral positions and feminine positions are perceived as more prevalent. The aggregated data of academia and industry indicate similarities in the perceived gender structure of hierarchical positions and occupations, aligning with previous research on gendered hierarchies and job segregation in a US and Canadian context, particularly in Academic organizations (Holmes et al., 2015; Perks and Schulz, 2020; Anderson et al., 2021).

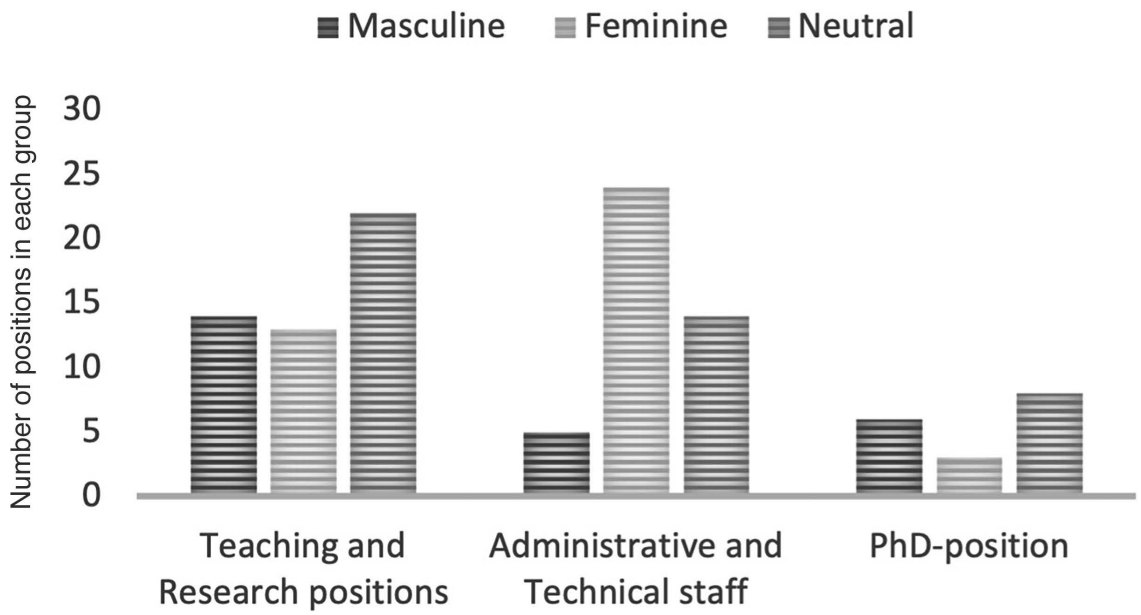
4.2. Gender and distribution of power

In addition to marking a position as gendered, participants were asked to orient each position in relation to power, visually represented in relation to the centre-periphery of the organizational boundaries. In the following, results are presented for academic and industry organizations following the three levels of power, i.e. low (peripheral position), medium (middle strata) and high (centred).

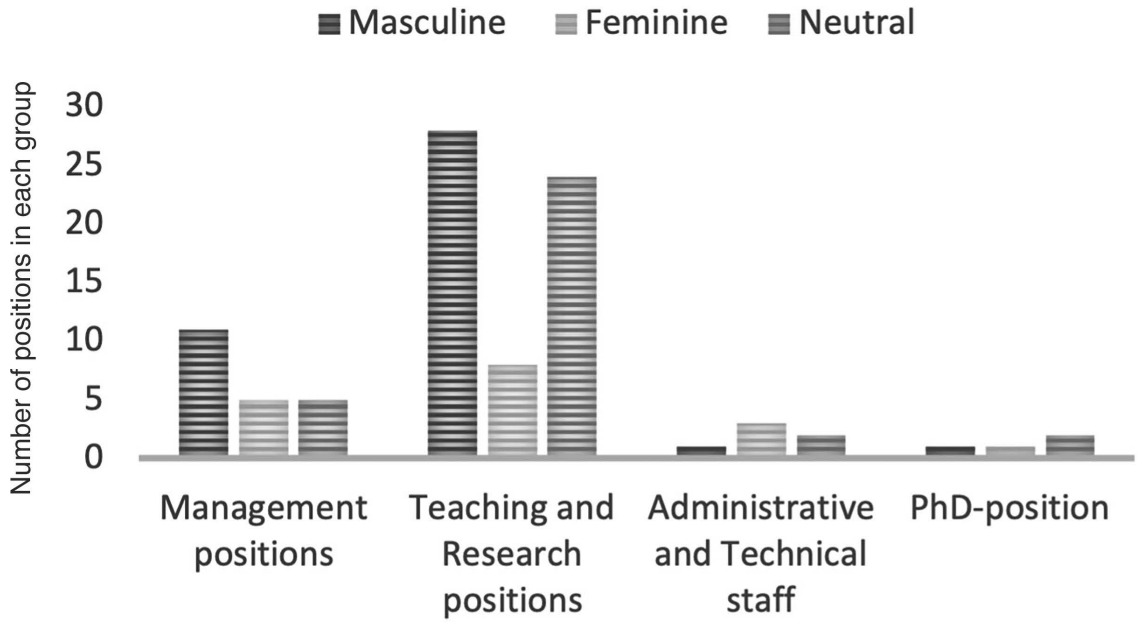
Figure 4 displays the distribution in Academic organizations of perceived gender and positions in relation to low (4A), medium (4B) and high power (4C). Figure 5 displays the distribution of gender and power among professors. Positions of perceived low power (4A) are predominantly perceived to be unspecified (e.g. non-tenured) positions

in teaching and research, as well as administrative/technical and PhD positions. These positions are to a comparatively large extent regarded as gendered feminine

A: Distribution of gender in academic positions perceived as low power.



B: Distribution of gender in academic positions perceived as medium power.



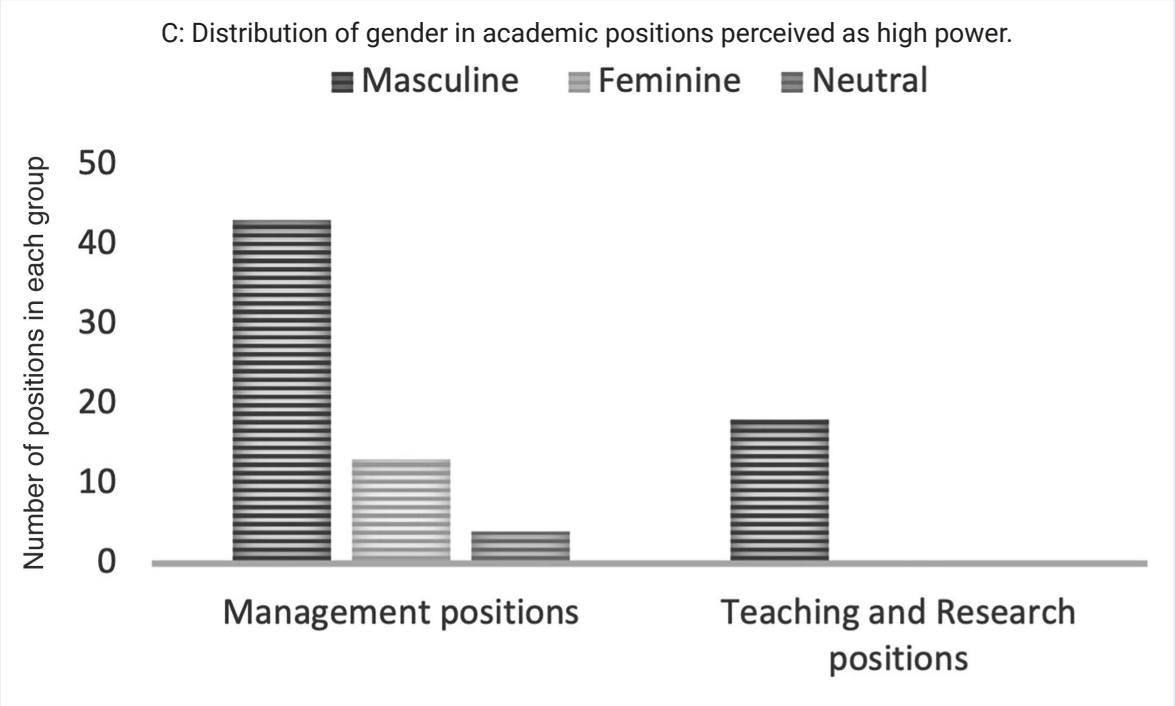


Figure 4. *Distribution of gender and power in academic positions.*

and neutral, although masculine positions are prevalent in the teaching/research and PhD categories. Positions of perceived medium power are foremost situated within the categories of teaching/researcher and management, the later dominated by masculine positions. Examining the category of Teachers and researchers perceived as medium power, the perceived gender of positions is predominantly masculine, yet contain a substantial proportion of neutral and feminine positions, predominantly within positions of *Researcher*, *Professor*, *Associate* and *Assistant professor*.

As shown in the distribution of gender and power in positions of (full) Professor (Figure 5), medium power positions contain feminine and neutral positions, while both low and high-power positions of professor are exclusively masculine. As shown in 4C, high power positions within the category Teaching and Research are perceived as exclusively masculine, containing positions of Professor and Assistant Professor. Management positions with high power are perceived as more diverse in relation to gender, yet dominated by masculine positions (predominantly *Head of Faculty* and

Department Director), while feminine positions are prevalent in "deputy" positions (*Deputy Dean* and *Deputy Faculty Chairman*) as well as *Department Director*.

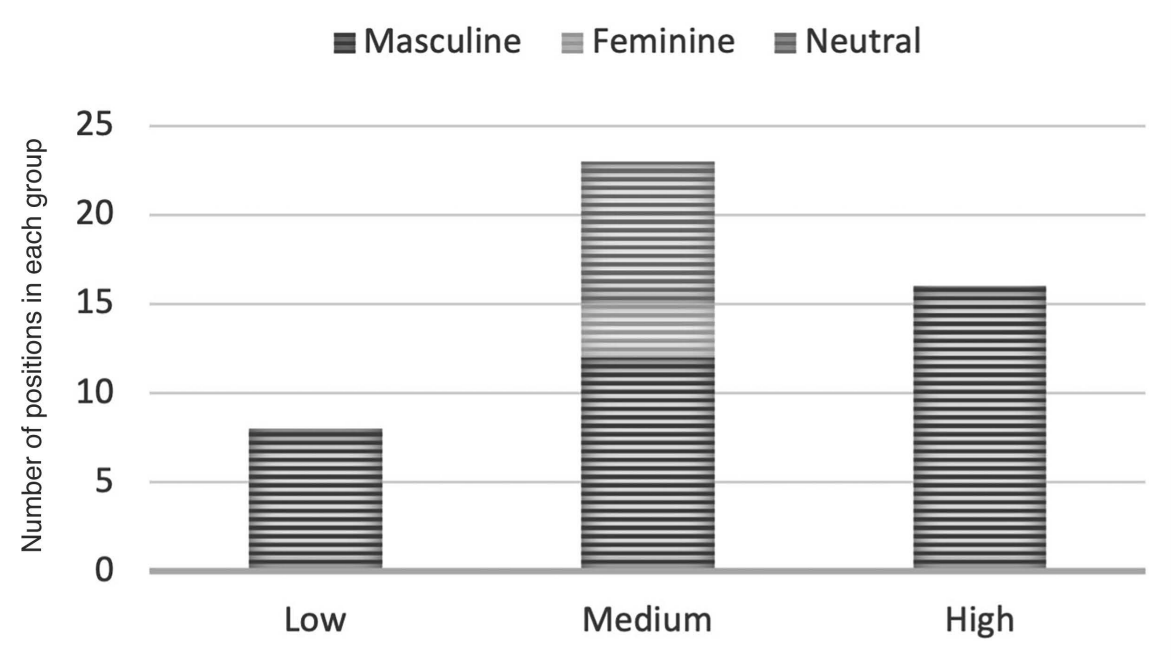
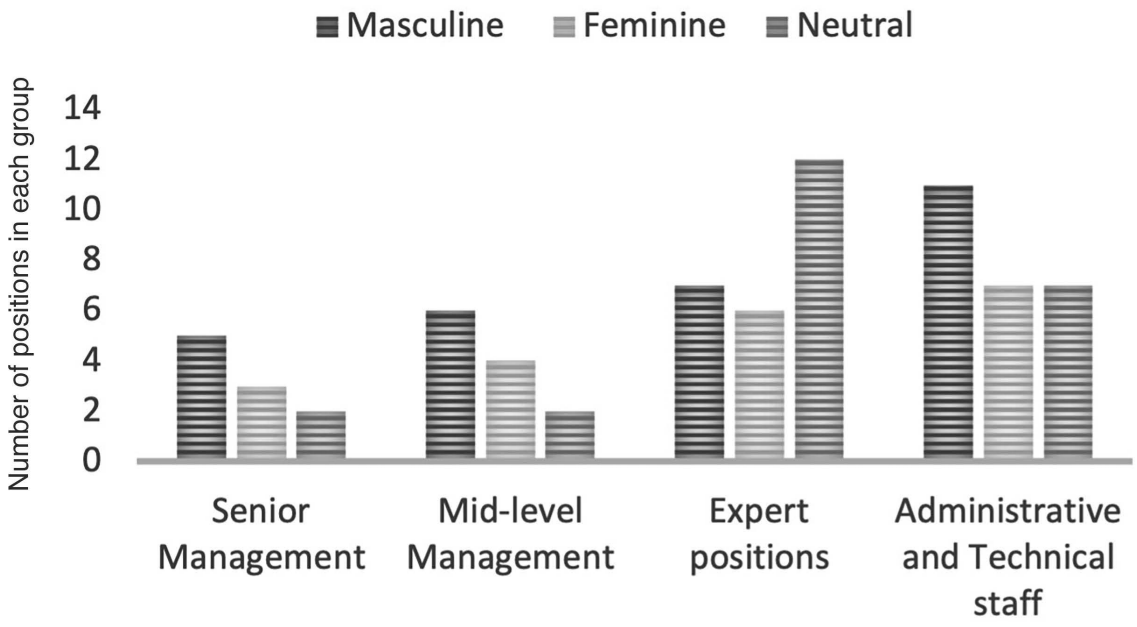


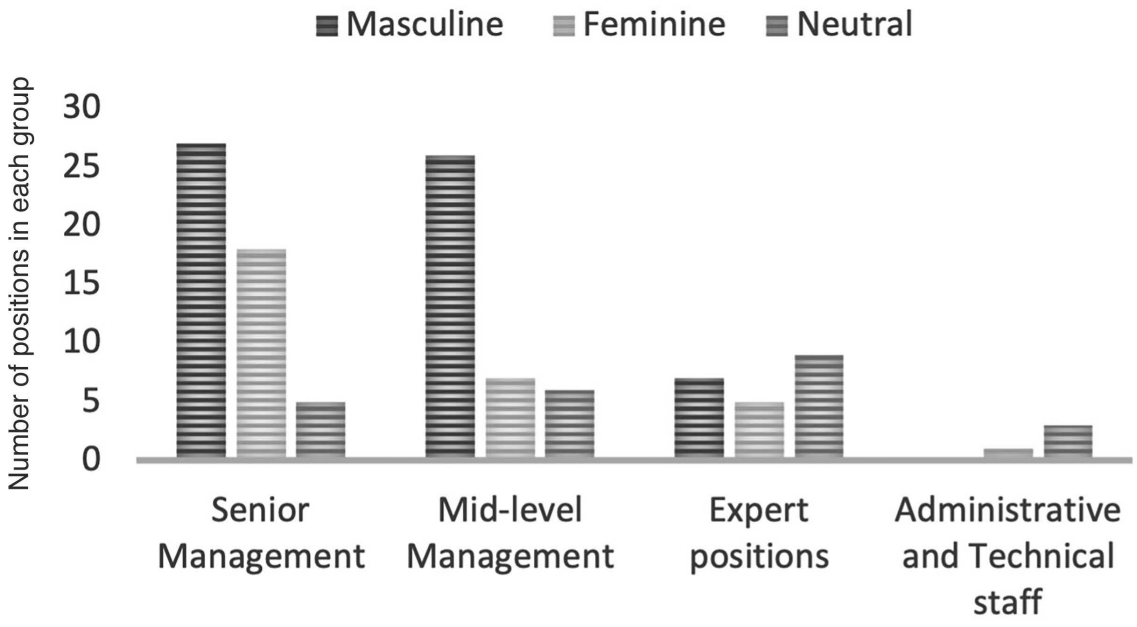
Figure 5. *Distribution of gender and power in positions of Professor.*

Figure 6 displays the perceived distribution of gender and positions in industry organizations in relation to low (6A), medium (6B) and high power (6C). Positions perceived as low power (6A) are predominantly prevalent within Expert positions and Administrative and Technical staff. The latter is dominated by masculine positions such as technicians, miners and administrative functions, while the feminine positions are primarily administrative, and neutral positions are both technical and administrative. Expert positions with low power (as shown in 6A) are, to a large extent, perceived as gender neutral, containing positions within engineering and geology, while feminine and masculine positions are dominated by positions of *Environmental Sustainability Officer* and *Engineer* respectively. In Mid-level management, feminine positions perceived as having low power are *Head of Department/Division*, while masculine positions are more evenly distributed among the grouped positions (see Table 2). Positions within Senior Management regarded as having low power are

A: Distribution of gender in industry positions perceived as low power.



B: Distribution of gender in industry positions perceived as medium power.



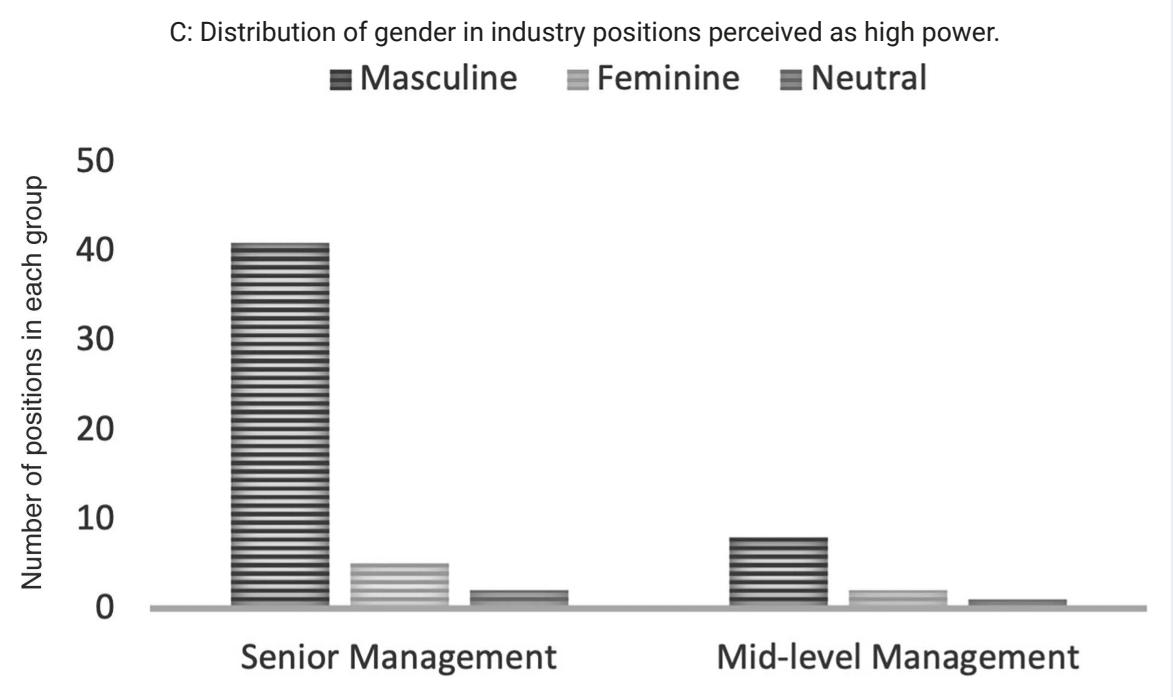


Figure 6. *Distribution of gender and power in industry positions.*

predominantly administrative (such as *CFO*, *Administrative Manager* and *Head of Sales*) with masculine, feminine and neutral positions dispersed, with the exception of the perceived masculine position of *Head of Engineering*.

Distribution of gender in industry positions perceived as having medium power (6B) is primarily concentrated in the two management categories. Expert positions with medium power are dominated by engineering positions (neutral and masculine) and *Environmental Sustainability Officers* (feminine). Within Mid-level Management of medium power masculine positions dominate (such as *Head of department/division*, as well as *Chief Engineer/Geologist*), while feminine and neutral positions are dispersed across positions. Senior Management positions perceived as having medium power are dominated by the position of *Administrative Manager*, perceived as both masculine and feminine, while positions related to production (such as *Head of Exploration*, *Engineering* and *Mining Operations*) are perceived as masculine.

Distribution of gender in industry positions perceived as having high power (6C) is almost exclusively masculine and is related to core management and production positions (such as *CEO*, *Head of Exploration* and *Engineering*) and the administrative

position of *CFO*. Feminine positions are predominantly administrative, and neutral positions are singularly dispersed. As shown in the categories Mid-level Management and Senior management in 6B and 6C, perceptions of positions as feminine and neutral steadily decrease in relation to the increase in the amount of power ascribed to the occupational position.

5. Discussion

The distribution of position and gender in geoscience organizations is interpreted here as a pattern of gendered positions, where the position is considered either masculine, feminine or neutral in relation to who is perceived as the "ideal" worker to fill said position [Acker, 1990]. When examining the aggregated positional categories (e.g., Management), the distinctly gendered character of their composition becomes apparent in relation to what positions women and men are perceived to occupy in the organizations. In the academic context, management positions can be understood as primarily perceived as masculine positions, whereas administrative positions can be characterized as feminized [Anderson et al., 2021]. While no area can be regarded as exclusively feminine, masculine, or neutral, it seems that the workshop participants perceive geoscience academia as hierarchically stratified in relation to gender, with masculine positions more prevalent at the top and feminine positions dominating administrative roles. Additionally, the overall distribution of feminine and masculine positions appears similar to the distribution of men and women in US geoscience academia [Holmes et al., 2015; Ranganathan et al., 2021]. While this similarity may be noted, direct comparison between perceived positions and statistical data of organizational employment structure is not methodologically feasible (in terms of what is measured), but the similarity might serve as an indicator of similar patterns of gendered structures in the academic organization.

Industry organizations display somewhat comparable results to academic organizations in relation to Senior and Mid-level management, both being dominated by masculine positions. However, the difference in organizational structure between industry and academia is also apparent, as the diverse professional structure and hierarchy of industry organizations differ from the collegial heterogeneity of academia. As such, industry management appears divided between positions related to core production processes (exploration, mining operations) and administrative support processes (administration, finances and sales) with masculine positions being firmly associated with the former and feminine (and some neutral) positions to the latter [Moraka, 2015]. Examining the category of Expert positions, similar patterns are discernible, with *Mining engineer* and *Environmental Sustainability Officer* being

perceived as masculine and feminine respectively. Yet these gendered positions seem to be "outliers" as expert positions predominantly are perceived as less gendered and often characterized as neutral. Within Administrative and technical positions, there is a pattern of technical and "blue-collar" positions as masculine and administrative positions as feminine. However, as further discussed below, the result suffers from comparatively few observations in the data.

Exploring how the gendered positions are perceived in terms of hierarchy and level of influence (power), the result in academic and industry organizations becomes more complex. In academic organizations, a rough pattern of low to high power professional categories emerges, where administrative, technical and PhD positions are primarily regarded as "low power", and Management positions are perceived as high power, while teaching and research positions stretch across the spectrum. In relation to gender, the dichotomy of masculine management positions "with power" and feminine administrative positions of "low power" is made apparent, mirroring the organizational logic of the academic "meritocratic" organization and the division between faculty and support functions [Anderson et al., 2021]. In academic management, the gendered power divide seems further evident in the overrepresentation of feminine "Deputy" positions and as *Head of Department* (rather than *Head of Faculty* which is perceived as masculine). Yet the explanatory strength of perceived position of power seems most evident in the category of Researchers and teachers. As demonstrated by numerous studies [Nentwich, 2010; Holmes et al., 2015; Ranganathan et al., 2021], US and Canadian academic geoscience organizations have an underrepresentation of professors who are women, and a hierarchical structure where women faculty aggregate in junior and mid-level academic positions. The results from the mapping workshops seem to indicate the perception of similar patterns in European academic geoscience organizations, with feminine and gender-neutral positions most prevalent in the low and medium power strata of faculty. As Ranganathan et al. [2021] demonstrate, the gendered difference between tenured and non-tenured faculty positions in the US academic system reproduces gender inequality and gendered precarity [Doerr, 2024]. While European academic geoscience organizations are diverse in relation to employment structure and recruitment practices and cannot be fully compared to the US system of tenure, there are similarities in relation to precarious positions, the prevalence of gendered "tasks", the greater administrative burden of women, and the prevalence of short-term contracts in teaching/research positions and PhD-positions [Bleijenbergh et al., 2013; Thun, 2020; Heimann and Johansson, 2024]. As such, the perception among workshop participants of differences in access to power, despite similar positions (such as positions as *Researcher*), and the gendered character of those differences, can be interpreted as a higher level of precarity in feminine

positions. In relation to the aggregated power accumulated in masculine positions, the difference deserves further study in relation to how power differences are reproduced, e.g., how gender bias is prevalent in assessment and recruitment procedures in European geoscience organizations [Moss-Racusin et al., 2012; Dutt et al., 2016; Marín-Spiotta et al., 2020]. As indicated, the gendered structure of power within geoscience academic organizations is perhaps most apparent in relation to Teaching and research positions with perceived high power being exclusively masculine (see Figure 4C) and in relation to the gendered dichotomy of feminine-masculine positions increasing in relation to increased power (and the subsequent decreasing of neutral positions). That said, the results also show that the position of (full) professor (see Figure 5) with low power is exclusively masculine, while feminine and neutral positions as professors are centered in the medium power strata. A possible explanation for the former is the hierarchical ordering of subjects within geoscience departments and the possibility that some less prestigious/financed areas are regarded as peripheral yet masculine. If so, the result may indicate that the prevalence of gendered subhierarchies in academia is not only a question of faculty and administration but also a question of social (gendered) stratification within scientific subjects [cf. Anderson et al., 2021].

Industry organizations as employers of geoscience professionals, are less well-documented in terms of gender inequality, especially regarding gendered hierarchies. Similar to academic organizations, there is a general pattern of low-to-high power occupational categories. Administrative and technical positions, as well as Expert positions, are primarily regarded as "low power", while Mid-level and Senior Management positions are perceived as high power. High power positions are perceived as distinctly masculine, while low power positions are perceived as more feminine or neutral. When examining the category of Expert positions (Figure 6A and 6B), which include positions such as *Geologist*, *Environmental Sustainability Officer* and *Geoengineer*, these positions are largely perceived as gender-neutral. However, there are some professional positions within this category that are perceived as gendered, such as *Environmental Sustainability Officer* (feminine) and *Engineer* (masculine) [cf. Faulkner, 2009a,b]. Geoscience positions, as well as other occupational positions in industry, tend to become more gendered (i.e., perceived as masculine or feminine) as more power is attributed to them. Consequently, neutral positions perceived as high power are rare. Instead, the gendered power structure of industry organizations appears to be divided into masculine managerial positions related to core production (*Head of Exploration/Operations*) and managerial control (*CEO*), and more feminine administrative managerial positions (*Administrative Manager*).

In comparing the gendered power structure of academic and industry organizations in relation to geoscience professional positions, the Expert positions in industry may

serve as a point of entry. Generally perceived as a neutral position, Expert positions in industry raise questions about the gendered structure of geoscience positions and what neutral positions might entail in relation to perceptions of professional hierarchies. In academia, the hierarchy of power and gender seem intricately entwined with the subject of geoscience as a professional scene, as the subject matter of geoscience, and the "meritocratic" organizational logic, frame the work they do and the positions that are available to them [cf. Acker, 1990; Amis et al., 2020]. An Expert position in the academic context can, in this regard, be either a postdoc or a professor, albeit the former has accrued deeper experience and knowledge, as well as possible resources and power. Within this process of "meritocratic" career progress, processes of gender bias and the ideal of the male geoscientist seem to reproduce an organizational power structure dominated by masculine positions [cf. Acker, 1990, 2006; Amis et al., 2020]. Drawing on previous research that demonstrates the individual, interactional and institutional barriers that women in STEM and geoscience face [Holmes et al., 2015; Sattari and Sandefur, 2019; Beck et al., 2022], and the particulars of gendered ideals and practices [Van Den Brink and Stobbe, 2009], academic geoscience organizations in Europe seem to share the gendered structures of their US and Canadian counterparts [Nentwich, 2010; Marín-Spiotta et al., 2020; Ranganathan et al., 2021]. In Industry, geoscience experts seem embedded in a different kind of hierarchy, one that is guided by a logic of industrial management, and where the skills and knowledge of geoscientists are important yet not dominant [Miller, 2004; Williams et al., 2012]. Their positions are to some extent hierarchically ordered in relation to expert knowledge, yet the organizational hierarchy is primarily legitimized through managerial principles of production and efficiency [cf. Amis et al., 2020]. In such a context, career progression toward more senior positions means entering the managerial level of the organizations into positions such as *Chief Geologist* and *Head of Exploration*. Since managerial positions in industry are perceived as masculine, especially in positions related to production, the career paths of women in industry might encounter different forms of gendered barriers than what is prevalent in academia. As Williams et al. [2012] show, neoliberal managerial practices might be one such barrier that, in relation to a masculine managerial ideal, serve to "other" women and make their work and competence less visible [Faulkner, 2009a,b; Heimann and Johansson, 2024].

From the perspective of applied method, and the attempt to bridge methodological boundaries between sociology and geology [Osmond, 1978], the study incorporates the ideal worker as situated within the perceptions of the research participants [Haraway, 1988; Acker, 1990]. It is therefore their situatedness as professionals within a university-educated, middle-class profession that guides their perception of the ideal, as it is framed through gendered positions of occupation and power.

Grounding the method in situated positions (of women geologists in geoscience organizations) also leads to a conditioned perspective on the organizations. As a result, the study tends to look "up" the organizational hierarchy, rather than toward those who perhaps have the least power in these organizations. Even if women geoscientists are subordinated in relation to masculine positions of power, they are also in a position of privilege, in terms of class, in relation to many of the workers within the organizations [Acker, 2006]. The relative (in)visibility of certain positions (such as PhD-students and miners) in the organizational maps demonstrates that the positionality of participants, as geoscience professionals, shapes their perception of the organizations and how they experience inequality [Anderson et al., 2021]. In relation to the choice of method, using visualization techniques familiar to geology and allowing the participants to designate the relevant positions, the study has enabled such a perspective. The methodological perspective also has theoretical implications in relation to how Acker's [1990] concept of the ideal worker can be understood. Deriving a perspective on organizations and an ideal through professional situatedness contributes to an understanding of how a certain group of employees perceives the gendered structures of an organization, and that their perception is situated in their professional and organizational context [Anderson et al., 2021].

The perceived gendered divide in positions of influence in industry and academia may have implications for how women geoscientists can contribute to the green transition. The masculine character of core production management positions in industry indicates limited influence for women over the industrial processes that shape the transition. Similarly, the perception that men occupy the most prestigious positions in academic organizations (such as professor or head of faculty) may put women in academia at a disadvantage in shaping and contributing to research and educational development relevant to the transition. In terms of recommendations, the study is based on the assumption that those who are subordinated are also the ones who perceive inequality most clearly [Harding, 1986]. Industrial and academic geoscience organizations should therefore acknowledge the perceived gender inequality in their organizations and make necessary changes. Relevant actions would be to chart and analyze their gendered structure of employment, systematically implement terms of sustainable, i.e. gender-equal, employment and ensure good working conditions regardless of gender or minority position [Elliot, 2015; Mogk, 2021].

6. Concluding remarks

As European geoscience organizations and geoscientists engage in the green transition, questions of sustainable employment, adequate reimbursement, and

good working conditions remain relevant [Elliot, 2015]. Previous studies have demonstrated how gender inequality permeates geological associations, academic careers in the US and Canadian Geoscience, as well as the work environments of both academics and industry professionals [Holmes et al., 2015; Doer, 2022; Kernen et al., 2023; Heimann and Johansson, 2024]. The current study contributes an organizational perspective in a European context, demonstrating how gender inequality is perceived in relation to positions of influence and power in academia and industry. The results indicate that academic and industrial geoscience organizations in a European context reproduce gender inequality through women's limited access to positions of power, i.e., women's underrepresentation in senior management of industry and senior academic positions. The difference in women's perceived access to, and perceived representation within, positions of power in Geoscience organizations raises questions as to who can contribute within the green transition and what the perceived structures of gender inequality mean in relation to sustainable employment and good working conditions in European geoscience [Mogk, 2021].

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