'THOSE KNIGHTS IN SHINING ARMOR': PUBLIC INTERVENTION ON BEHALF OF GEOLOGY AND GEOLOGISTS IN PORTUGAL DURING THE DICTATORSHIP (1940–1960)

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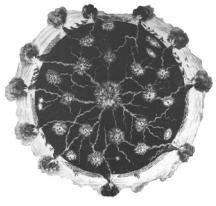

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ABSTRACT

This paper addresses the public intervention on behalf of geology and geologists made by members of the geological community in Portugal, from the 1940s through the 1960s, when the country was living under a dictatorship known as the *Estado Novo*. Three men stood out during this intervention: Mendes Correia (1888–1960), Carrington da Costa (1891–1982) and Carlos Teixeira (1910–1982). The content and form of their oral and written discourses, their intended audiences, and their scientific and institutional career paths are analyzed. One of the main themes of the discourses was the vindication of a professional space for geology in Portuguese society, a circumstance that led to a confrontation with a widely acknowledged techno-scientific professional group: engineers. This paper demonstrates that the public intervention in favor of geology and geologists was part of a broader process of the Portuguese geological community asserting its scientific and social importance.

Keywords: Public intervention, geological community, professionalization, dictatorship, Portugal. doi10.17704/1944-6178-36.1.142

1. INTRODUCTION

In 1979, Carlos Teixeira (1910–1982), a full professor of geology at the Faculty of Sciences of the University of Lisbon, claimed that in the 1940s there were only four or five individuals in Portugal who were truly engaged in geological practice (Teixeira 1984, pp. 46–47). Those claims were clearly exaggerated; there were not many geologists in the country at the time but they surely exceeded the half a dozen individuals recognized by Teixeira, a circumstance that he deliberately ignored. Teixeira's claims were built on a rhetoric that still echoes from the time of the public intervention on behalf of geology and geologists that took place from the 1940s to the 1960s. During that interval, members of the nascent Portuguese geological community, including Teixeira himself, publicly advocated for the scientific and social recognition of geology and geologists.

This public intervention consisted of the production of oral and written discourses with specific rhetorical features intended to render arguments persuasive to distinct audiences. One of main themes of these discourses was the vindication of a professional space for geologists in Portuguese society. In order to attain this goal, members of the geological community had to convince their public(s) that geologists were the only ones who had the right knowledge and skills to perform certain type of studies and tasks. However, while doing so, a confrontation with engineers arose. Engineers, a techno-scientific professional group widely acknowledged in Portuguese society, were the first to practice geology according to international standards back in the second half of the nineteenth century, when geology emerged within the State apparatus with the establishment of the national geological survey. In the 1940s, the geological community began to argue that engineers had abrogated the professional space of geologists, and that this circumstance hindered the recognition of geology both as a scientific discipline and as a profession.

Public discourse on science has already received considerable attention in historical and social studies of science, and is considered crucial in the construction and maintenance of science's boundaries (Gieryn 1983; Stichweh 2003), and in supporting scientific activity by

rulers, politicians, decision makers, and the public in general (Macleod and Macleod 1977; MacLeod and Collins 1981; Agar 2012). Public discourse is also necessary for securing social and economic status for scientists (Barton 1998), among others. The body of rhetoric, argument, and polemic intrinsic to this type of discourse was named public science by Turner and those responsible for it were named public scientists (Turner 1980). Public scientists, rather than contributing to the circulation of scientific knowledge as such, try to persuade the public(s) that science is crucial in supporting social, political, and even religious goals and values, and is therefore worthy of public attention and encouragement, and that it deserves adequate funding. Public science involves the lobbying of non-scientific elites such as governments, and as a consequence, governments may ascribe particular importance to questions that only scientists are able to address through their knowledge and expertise. Public discourse on science also helps to ascertain the position of scientists in relation to other social or intellectual groups, and contributes to the construction/consolidation of scientists' identities (Turner 1980).

Barton analyzed the public discourse of Victorian 'men of science' to unveil the ways they represented themselves and how these representations concurred to shape their identities as members of a scientific community in a time when the professionalization of British science was a major issue (Barton 2003). The present paper has no intention to discuss in depth the process of professionalization in science. However, and relying on Barton's careful approach, it is necessary to consider some aspects of the subject because the process of constituting a professional realm for geologists is addressed in the case study here considered. The professionalization of science shows many idiosyncrasies, and does not conform to most theoretical frameworks concerning the constitution of other professions. Thus, authors like Morrell and Golisnki urged historians of science to abandon the 'essentialist' sociological approach in the study of professions and professionalization in order to better acknowledge that the emergence of scientific professions greatly depended on the type of scientific discipline and its local historical circumstances (Morrell 1990; Golisnki 1998). Morrell contended that professionalization in science need not be perceived as a (teleological) goal but rather as a strategy deployed by certain occupational groups seeking higher social status, additional funds, and control over the working conditions of their members (Morrell 1990). As for Golinski, he recommended that historians of science abandon all models of professionalization and focus instead on disciplines in their local settings (Golinski 1998).

This paper analyses the public intervention on behalf of geology and geologists conducted by members of the geological community in Portugal from the 1940s to the 1960s. The study of this public intervention focuses on the oral and written discourses. The content and form of the discourses, the scientific and institutional career paths of the actors involved, and their intended audiences are analyzed. The analysis of discursive rhetorical devices is loosely inspired by Aristotle's means of persuasion: *logos*, *pathos* and *ethos*. In the first, the discourse resorts to argumentation that is built upon reason and knowledge; in the second, persuasion is achieved by stirring the audience's emotions; and finally, in the third, persuasive rhetorical devices rest mainly on the character of the author (Mesquita 2005, pp. 21–25 and 33–35).[1]

It will be argued that the public intervention in the period under consideration was part of the broader process of professional assertion by the geological community in Portugal, with emphasis being put on the vindication of a professional realm for geologists. Thus, this paper also sheds some light on the professionalization of geology in a particular context where geologists were in conflict with engineers.

This case study is all the more significant as Portugal was then living under a dictatorship, the *Estado Novo*. Some authors have defended the position that the advancement of science and technology is far greater in democracies than in dictatorial regimes, due to intellectual freedom and low levels of political and ideological control. Already in dictatorships, the influence of ideology would make science and technology more politicized and distorted. However,

[1] For different aspects concerning the use of rhetoric in science, see, for example Schuster and Yeo (1986), Gross (1990), and Pera (1994).

contemporary historical and social studies of science have shown that there is no such thing as 'good science' and 'bad science' depending on the type of political regime considered (Goméz, Balmer and Canales 2015). Democracies are not immune to state intervention in science, and it is possible to point to significant developments in science and technology under dictatorships (Szöllosösi-Janze 2001; Graham 2004; Saraiva and Wise 2010). All things considered, this paper could also provide insight into the relationship between science and politics in a dictatorial regime.

2. GEOLOGY IN PORTUGAL

In the late eighteenth and first half of the nineteenth centuries, the Earth came under empirical scrutiny. Scholars and naturalists from a variety of scientific fields—geotheory, geognosy, mineralogy, and physical geography—and practical men associated with mining, engaged in studies and debates about the planet's origin and history, and its physical processes. The new science of geology began to emerge from the intersection of all these fields of knowledge, combining the practice of geological fieldwork with work in the museum and laboratory, and disparate theories about the Earth. The emergence of geology was also coeval with nationalism and the creation of modern European nation states. Geological maps, which were one of the ultimate expressions of geological practice and research, took on a symbolic character regarding territorial expansion and control. In this context, it was possible to persuade many governments to create public institutions—in particular geological surveys and schools—that permitted the establishment and development of geology, thus creating the conditions for its scientific and professional legitimacy (Laudan 1987; Guntau 1996; Knell 2000; Vai and Cavazza 2003; Corsi 2003 and 2004; Rudwick 2005 and 2008).

In Portugal, however, the situation was different. During the first decades of the nineteenth century, the mineralogical and geognostic knowledge of the country relied primarily on the occasional work of a few locals, foreign visitors, and *estrangeirados*, that is, men who were trained abroad and/or became part of international scientific networks. Geological and paleontological collections in the country were scarce, there were no mining schools, and the practice of fieldwork associated with geological mapping was virtually nonexistent. With few exceptions, the aristocracy and the bourgeoisie did not seem to have a special interest in the practice of the natural sciences, thus preventing the establishment of a truly 'geological culture' (Knell 2000) in the country (Carneiro 2005; Carneiro and Mota 2007; Carneiro and Leitão 2009).

2.1 Engineers and the Geological Survey

Within this context, geology initially emerged in Portugal in 1857, in a state institutional setting, with the creation of a national geological survey (Carneiro 2005; Carneiro and Mota 2007; Carneiro and Leitão 2009). Other European countries, such as France and Great Britain, already possessed similar institutions, and others would soon create them, like Italy (Oldroyd 1996). The establishment of the Portuguese Geological Survey was closely associated with the construction of the liberal state, which followed the establishment of the constitutional monarchy. The construction of the liberal state included development policies implemented during the 1850s and 1860s, in a period known in Portuguese history as *Regeneração* (Regeneration). The importance of public works for the modernization of the economy, and the association between ideas of progress and the introduction of technical objects and systems, was particularly significant during this period (Matos et Diogo 2009).

The Survey's first leaders and higher ranking technical staff were predominantly military engineers. However, Portuguese military engineers did not have the kind of geological education provided by mining schools such as those of Spain, Italy, Germany or France. Instead they completed their education in the Army School, following the completion of preparatory scientific courses in one of the schools of higher education then existing in the country, such as the University of Coimbra, the Polytechnic School of Lisbon, or the Polytechnic Academy of Oporto.

The syllabi of these educational institutions included some rudimentary geological subjects but students did not get a comprehensive geological training that allowed them to engage in future geological research or a geologically related profession. The training they received primarily focused on the description and classification of minerals, rocks, and fossils according to a utilitarian natural history approach, together with some mention of mining. It was book-based instruction that relied on foreign textbooks, and students did not engage in geological fieldwork (Antunes 1989; Ferreira 1998; Mota 2015). As a means of making up for the deficiencies of Portuguese higher education, some of the newly educated military engineers completed their training abroad, a practice that would endure for a great part of the nineteenth century (Matos 2012). Self-education and apprenticeship also played an important role in the geological education of those who were appointed to the Survey. In spite of these limitations, military engineers were the only candidates at the time who could perform the investigations required by the Survey. They had the knowledge and skills to survey topography, to use and make maps, and to master fieldwork equipment and instruments, such as compasses and theodolites, thus it was easy for them to switch-over from planning military exercises to planning geological fieldwork (Carneiro 2005; Carneiro and Mota 2007; Carneiro and Leitão 2009).

During the second half of the nineteenth century, engineers took advantage of the favorable political context, and presented themselves as key players in the technical, economic, and social progress of the country. Following their transition from the military to the civil sphere, engineers implemented various mechanisms in order to have their profession recognized and to ensure jobs within the State apparatus. As a result, engineers gained an unprecedented importance in political power structures. Meanwhile, they constructed and made use of a hegemonic discourse in which the economic and social progress of the country went hand in hand with the implementation of development policies with a techno-scientific basis, with emphasis on the construction of public works and the railway in particular (Diogo 1994; Matos and Diogo 2009; Macedo 2012; Pereira 2012; Marçal 2016).

In the Portuguese Geological Survey, engineers consolidated their position. Despite a series of administrative, financial and logistical difficulties, the Survey was able to deal with adversity and attain its goals, namely the production and publication of geological maps (Carneiro 2005; Carneiro and Mota 2007; Carneiro and Leitão 2009). This period came to be considered the 'golden age' of geology in Portugal.

Over time, however, most engineers were recruited from within state careers, regardless of their knowledge of geology or their competence in geological surveying and mapping. For them, the Geological Survey was just one more step in their careers as civil servants. This situation was largely a consequence of the Survey never having functioned as a school for the training of those involved in geological practice, despite how it was first envisaged. All considered, at the beginning of the twentieth century, the institution that introduced geological practice according to international standards in Portugal went through a phase of scientific decline which would last a couple of decades (Carneiro and Mota 2007).

2.2. The early days of a geological community

At the beginning of the twentieth century, geology in Portugal was practiced by a small number of disparate individuals with different scientific and social backgrounds. Some of these individuals were engineers, others were professors and teachers with an academic degree in natural history, a few were naturalists, and others were field assistants.[2] The majority of the people engaged in geology worked in state-funded institutions, such as universities and other schools of higher education, and in the Geological Survey. There were few opportunities to

[2] This circumstance was not particular to Portugal; see Yanni (2005). For example, in Britain, there were gentlemen who approached geological fieldwork from a romantic perspective; professors in academia who claimed that geology should be pursued because it 'broadened the mind' and not for its practical applications; engineers; metallurgists; and miners.

engage in geological work in the private sector, one of the main reasons being the incipient state of the national mining industry. In fact, apart from state-sponsored professions such as professor, teacher, or engineer, free market scientific professions were quite rare in the country.[3] Science courses in the universities were above all preparatory to a degree in engineering, medicine or pharmacy, which granted professional titles and hence permitted access to professions with an acknowledged status in Portuguese society.

On 5 October 1910, the liberal monarchy was overthrown and the *Primeira República* (First Republic) established. The new republican regime regarded science to be essential to achieve well-being and social transformation, following the distinctive positivist and materialist ideas of the last decades of the previous century, which permeated the Portuguese elites. Republican governments introduced major reforms in science education with the aim of placing scientific research at the core of Portuguese universities, and paved the way to the creation of the Board for National Education in 1929. This was the first public institution in charge of designing and funding a national scientific policy (Fitas *et al.* 2012).

On 28 May 1926, the *Primeira República* ended abruptly with a *coup d'état*. A military dictatorship followed until the implementation of the *Estado Novo* (New State) in 1933, a totalitarian regime that lasted for about forty years. The new regime imposed restrictions and controlled many aspects of Portuguese life at a collective and personal level. For example, only a single political party was permitted, freedom of speech and association was restricted, and a political police was created. From an economic point of view, the *Estado Novo* advocated self-sufficiency but, in the 1940s, some of its supporters began showing their interest in changing the economic structure of the country by fostering industrialization and implementing development policies.

At first, scientific activity during the *Estado Novo* basically relied on institutions and research programs dating back to the *Primeira República* (Fitas *et al*. 2012).[4] Regarding geology, educational reforms promoted by the republican regime led to its establishment as an autonomous discipline in the universities. There was no degree in geology but geological courses were part of the *curriculum* of a degree in natural history, and were also contemplated in some engineering degrees. With time, more and more students decided to enroll in natural history, the research in natural sciences increased, and the first PhDs dedicated to geology were completed in the 1930s. It was therefore possible to ensure the production, reproduction, and circulation of geological knowledge in academia for the first time. A growing self-consciousness among individuals belonging to academic circles who were engaged in geological practice led them to envisage the establishment of a geological community effectively articulated and socially recognized. In 1940, the Geological Society of Portugal was created, well after the Geological Society of London (1807), the Société Géologique de France (1830) or the Società Geologica Italiana (1881) but much earlier than the Sociedad Geológica de España (1985) for instance.

3. PUBLIC INTERVENTION ON BEHALF OF GEOLOGY AND GEOLOGISTS (1940-1960)

During the 1940s, members of the Geological Society began to publicly advocate for geology and geologists. Three actors emerged as the most emblematic in this process: João Carrington Simões da Costa (1891–1982), António Augusto Esteves Mendes Correia (1888–1960), and Carlos Teixeira. They had close relationships, first as professor/master and student, and subsequently as

[3] According to McClelland (2010), the distinction between free professions and state-service professions must be taken into account in the professionalization of science, with the first serving private clients in a free market. Law and medicine are examples of the first; teachers and civil servants are example of the latter.

[4] Continuity and stability in the scientific community can be also found after fascism rose to power in Mussolini's Italy. In Spain, on the contrary, purging was ideological and intense during Franco's regime and a new scientific community was formed via the criterion of their affection to the dictatorship (Goméz, Balmer and Canales 2015).

colleagues, but above all they were friends and shared common values and views concerning scientific practice.

3.1 João Carrington Simões da Costa: Defending geology from within

In November 1940, Carrington da Costa attended the Congress of the History of Portuguese Scientific Activity where he delivered a talk dedicated to the current status of geology in Portugal. The Congress took place in Coimbra, and was a high point among the many scientific and academic meetings organized in the context of the Exhibition of the Portuguese World. The Exhibition took place between June and December 1940, and was meant to celebrate the eighth centenary of the foundation of Portugal in 1140, and the third centenary of its independence from Spain in 1640. This exhibition was the most important political and cultural event of the *Estado Novo*, a major act of nationalist-imperialist propaganda, and a vehicle for the diffusion and legitimization of the dictatorship's ideology and values. In the Congress of the History of Portuguese Scientific Activity, the regime sought for scientific legitimization for its political agenda with the history of science serving ideological purposes (Ramos do Ó 1997; Acciaiuoli 1998; Almeida 2005). In turn, scientists and members of academia like Carrington da Costa used the Congress as a unique opportunity to foster their own agendas.

The attitude of scientists towards dictatorships can be diverse but usually they strive to accommodate to the regime's conditions in a quest for survival,[5] adjusting their own scientific agendas to the ruling ideology and values (Goméz, Balmer and Canales 2015). During the *Estado Novo*, most Portuguese scientists, independently of their political leanings, enrolled in the dictatorship's scientific endeavors, and adapted their practice to new opportunities with the intent of showing their usefulness. Scientific projects that lined up with issues of autarky and empire were especially suited to reverberate on the regime's agenda (Saraiva 2009).[6]

Carrington da Costa was a full professor in the Faculty of Sciences of the University of Porto, and the first director of the Geological Society of Portugal. Following a degree in natural history, he worked, from 1928 to 1936, as a naturalist in the Mineralogical and Geological Museum of the same Faculty. A republican and a freemason,[7] he fought in France during the First World War, where he was made a prisoner by the German troops in the La Lys battle in April 1918. Carrington da Costa accumulated various positions during the republican regime: he was adjunct to the Ministry of War, head of cabinet of the Ministries of Agriculture and Education, and governor of Braga, the second largest city in northern Portugal. Despite his allegiance to the *Primeira República*, Carrington da Costa, also held various significant positions in state-led scientific institutions during the *Estado Novo*. For example, he was a member of the Board for Nuclear Power from the time of its creation in 1954. Prior to this appointment, he had taken part in the Provisional Commission for Atomic Energy where he was vice-president of the Commission of Nuclear Studies, and in charge of its Mineralogical and Geological Research Centre. In 1955, Carrington da Costa became president of the Board for Overseas Research where he created two laboratories devoted to mineralogical, petrological and paleontological research (Teixeira 1962).

Presented to a large audience, consisting not only of members of the Portuguese academic and scientific communities but also of the regime's *elite* as a whole, Carrington da Costa's presentation to the Congress of the History of Portuguese Scientific Activity, which was

[5] Other attitudes might be: defensive isolation around professional values, resistance to some policies, collaboration while maintaining a certain independence, commitment and opposition to the regime (Goméz, Balmer and Canales 2015).

[6] Some Portuguese authors adopt a different position and stress the difficulties in pursuing scientific activities during the *Estado Novo* and the exposure of members of the scientific community to political persecution (Gaspar *et al.* 2009).

[7] http://madrugada.no.sapo.pt/os_principios.htm accessed on 15 September 2015.

published two years later in the journal of the Faculty of Sciences of Porto,[8] was a long and comprehensive review of *his* history of geology in Portugal. His summary of the history of geology of Portugal was the foundation on which he based his outline of what geological practice should be in the future, as well as its institutional framework. At the same time, he also forecasted the framework of geological practice in the country. He drew special attention to the past, present, and future contributions of the Geological Survey, but universities were given a leading role in the future of Portuguese geology. The exposition also illustrated that one of the tasks into which the geological community was then putting more effort was the prevention of individuals with no appropriate knowledge and skills from practicing geology.

In 1943, Carrington da Costa focused on the geology of Portuguese overseas territories in a paper entitled '*Problemas de geologia colonial*' ('Problems in colonial geology') published in the official journal of the Geological Society.[9] Once again, the author provided the readers with an historical account, this time of the development of geological knowledge in the colonies. Carrington da Costa emphasized the need to deepen the economic relationship between mainland Portugal and the Portuguese African colonies, focusing on the exploitation of natural resources, and he deplored the state's neglect of colonial geology. Until then, the production of geological knowledge about the African colonies had been left to a small number of individuals who occasionally engaged in geological research. As a result, geologic knowledge of the colonies was inconsistent and uncoordinated. To counter this situation, Carrington da Costa suggested the creation of a public institution that could ensure "unity and sequence"[10] to geological research and surveying in overseas territories. He urged the collaboration between the Geological Survey and the Colonial School in the training of geologists and field assistants intended to work in overseas territories, thus foreseeing the possibility of future positions for them in the colonial administration. Finally, Carrington da Costa drew attention to the need of organizing international commissions aimed at solving geological discrepancies in border regions, and deplored the absence of a colonial museum, "worthy of the greatness of our empire".[11]

Carrington da Costa's audience was chiefly composed of members of the academic/scientific community; thus, he used communication channels that had an institutional character to deliver his message: a scientific/academic meeting, an academic journal published by the University of Porto, and the official journal of the Geological Society, which was meant to be read not only by geologists but also by the academic/scientific community at large. His discourse was clearly structured, resorted to arguments based on academic knowledge, and was filled with scientific, historical and even literary references. Occasionally, Carrington da Costa used geological language, that is 'esoteric' geological terms, certainly with the purpose of showing that geology is a field of particular scientific expertise that cannot be mastered by anyone, but that he was among those who could. His rhetoric rested mainly on argumentation, and on his credibility as an academic and a member of the scientific community. Exceptions occurred when Carrington da Costa called upon feelings of glory and pride concerning the Portuguese colonial empire; then his discourse took on a more emotional dimension.

8 Costa, João Carrington da. 1942. Do Conhecimento Geológico de Portugal Continental. *Anais da Faculdade de Ciências do Porto* 27, offprint.

9 Costa, João Carrington da. 1943. Problemas Geológicos Coloniais. *Boletim da Sociedade Geológica de Portugal* 2, 55–76.

10 Costa, João Carrington da. 1943. Problemas Geológicos Coloniais. *Boletim da Sociedade Geológica de Portugal* 2, offprint, 72.

11 Costa, João Carrington da. 1943. Problemas Geológicos Coloniais. *Boletim da Sociedade Geológica de Portugal* 2, offprint, 76.

3.2 Mendes Correia: An 'outpost' in the defense of geology

During the 1940s, members of both the National Assembly and the Corporative Chamber[12] showed concern for the current situation of geology in Portugal, in particular the almost complete absence of geological mapping. In their view, it was imperative to increase the completion and publication of geological maps, as they were important instruments to the development of economic sectors such as agriculture, mining, and public works.[13] These arguments in favor of geological mapping emerged more or less at the same time that some supporters of the dictatorship lobbied for an acceleration of the country's industrialization process, which, it was argued, should mainly rest on the advance of science and technology. This circumstance was no different from other southern countries that also experienced or were living under dictatorial regimes, such as Italy and Spain, which regarded science and technology as being crucial to their general development (Goméz, Balmer and Canales 2015).

Mendes Correia was one of the members of the National Assembly who distinguished himself by advocating that the economic and social development of Portugal could no longer be separated from scientific teaching and research, because these were preconditions to the survey and study of national natural resources, in particular minerals.[14]

Mendes Correia had graduated in medicine in the Medical and Surgical School of Porto in 1911, and completed a PhD in natural history at the University of Porto in 1921, where he taught, from 1911 to 1936. Despite his scientific research being devoted mainly to anthropology, ethnology, and archaeology, he became full professor of geological sciences in the Faculty of Sciences of the University of Porto in 1926. He was Carrington da Costa's professor of geology when the latter was studying natural history in the same Faculty. Later, in 1928, they became colleagues when Carrington da Costa was appointed naturalist to the Faculty's museum. In 1936, Mendes Correia became full professor of biological sciences, but he left academia to become the Mayor of Porto.[15] Mendes Correia then held other prominent political positions during the *Estado Novo*. For example, he was member of the Corporative Chamber between 1936 and 1942, and of the National Assembly between 1945 and 1957. His early political leanings seem to have been quite liberal as in his youth he was associated with *Renascença Portuguesa* (Portuguese Renaissance), an intellectual movement with nationalist republican leanings, and he collaborated with *Seara Nova*, a journal with political and pedagogical aims that was first published in 1921 and later engaged in ideological opposition to the dictatorship. While a university student, Mendes Correia had been a colleague and friend of individuals who became preeminent political and scientific figures during the *Primeira República* (Matos 2012).

Mendes Correia chose to intervene on various occasions at the main forum of the Portuguese political system. He used his oratory skills to stand up for geology and geologists in the National Assembly, particularly during the 1950s. He usually referred to geology in the wider context of scientific teaching and research, and frequently resorted to arguments concerning the relationship between geology and the social and economic development of the country. On one occasion, he engaged in raising awareness of the state of near paralysis faced by the Geological Survey, which prevented the institution from adequately performing its primary task: geological

12 The National Assembly and the Corporate Chamber were the synthesis of national representation during the Estado Novo. The first had a legislative function but seldom exercised its power. The second had a consulting character and was created by the Estado Novo in accordance with the corporative ideas held by the dictatorship.

13 "Contas Gerais do Estado de 1940, parecer da comissão encarregue de apreciar as contas públicas do ano de 1940", *Diário das Sessões da Assembleia Nacional*, Suplemento ao nº 124, 12 de Fevereiro de 1942, p. 64.

14 Among others: Intervention of Mendes Correia in the Portuguese National Assembly, *Diário das Sessões da Assembleia Nacional*, 21 March 1946, pp. 883–884; Intervention of Mendes Correia in the Portuguese National Assembly, *Diário das Sessões da Assembleia Nacional*, 28 February 1951, pp. 423–426; Intervention of Mendes Correia in the Portuguese National Assembly, *Diário das Sessões da Assembleia Nacional*, 28 April 1955, pp. 904–908.

15 Payment sheets of the Faculty of Sciences of the University of Porto, volumes 37, 38, 39, 40 e 41, 1934−1936, Historical Archive of the University of Porto.

mapping.[16] In another intervention, he deplored the reduced number of Portuguese geologists, advocated their important role in society, and the benefits that geology could bring to the economic and social development of the country: "[there are] half a dozen employed geologists, most with no prospects to improve their professional situation . . .".[17] He was certainly referring to the low professional status of geologists in the Survey, where state engineers, by relying on their privileged position, prevented geologists from joining the institution on a permanent basis. Mendes Correia also drew attention to the lack of geologists in other public institutions, and to the negative consequences resulting from the fact that most geological tasks ended up being performed by others who did not possess the required competence:

> . . . we are regrettably missing out on expert advice in certain public services with a loss of efficiency in those same services . . . in the Laboratory of Civil Engineering there is not a single geologist and the solution of landslides is in the hands of others . . . Geologists would be useful in such cases and what happens in this domain also happens in others.[18]

A striking feature in Mendes Correia's speeches was the way he managed to convey a message that in many aspects was critical regarding certain decisions taken by the dictatorship. For instance, Mendes Correia once upheld that the country's productivity would increase if the Portuguese population had higher living standards, and that this could only be achieved if the government invested in education and scientific research. These were bold claims that Mendes Correia tempered by almost shamelessly praising Salazar's achievements, and by assigning the blame of economic measures that he considered defective to experts in the government that, however, he did not name.

Mendes Correia used an almost colloquial language in his speeches, his discourse being colored by popular expressions, exclamations, and punctuation that rendered it lively and paced. However, his discourse was by no means less precise, and sound arguments drawn from his experience as a politician were often mobilized to justify his claims. Like Carrington da Costa, the rhetoric in Mendes Correia's discourse relied both on argumentation and the author's status as an experienced politician, but the role played by emotion was greater, with Mendes Correia trying to win the audience by inducing an emotional state through his oratory skills.

3.3 Carlos Teixeira: A 'crusade' on behalf of geology

Mendes Correia and Carrington da Costa's interventions were definitely aimed at institutional audiences. Nonetheless, the general public also had to be won over to the cause of geology; that was when the press came to be used.[19]

In Portugal, during the final years of the liberal monarchy and the *Primeira República*, newspapers became an important source of information, even to people who were unable to read but were willing to join in public places to listen to others reading.[20] Newspapers played an important role as mass educators and agents of social transformation spreading ideas of modernity and progress (Tengarrinha 2006). With the establishment of the *Estado Novo*, the press became a powerful tool to indoctrinate, control and subdue the Portuguese population, in particular those with basic levels of literacy. Newspapers were subjected to censorship by the

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16 Intervention of Mendes Correia in the Portuguese National Assembly, *Diário das Sessões da Assembleia Nacional*, 15 December 1950, p. 175.

17 Intervention of Mendes Correia in the Portuguese National Assembly, *Diário das Sessões da Assembleia Nacional*, 3 April 1952, p. 663.

18 Intervention of Mendes Correia in the Portuguese National Assembly, *Diário das Sessões da Assembleia Nacional*, 28 April 1955, p. 906.

19 For the communication of science in Portuguese newspapers, see Simões *et al*. (2012).

20 In 1878, 79% of the Portuguese people over six years did not know how to read. Most of them lived in the countryside with agriculture being the country's main economic activity (Ramos 1988).

regime officials but they also engaged in 'self-censorship'. For example, directors, editors and authors refrained from writing and publishing anything that could be targeted by the censors and lead to harsher forms of repression (Rodrigues 1980; Azevedo 1999; Gomes 2006).

On 30 May 1947, an article entitled '*Geologia pura, geologia aplicada*' ('Pure geology, applied geology') was released on the front page of the daily newspaper *Diário Popular*. The article was devoted to different aspects of geology and conveyed the idea that this was "the most fascinating of all sciences" and the impossibility of distinguishing between "pure and applied geology". But the article also drew attention to more down-to-earth aspects of geological practice in Portugal, namely the difficult situation faced by the Geological Survey. The author claimed that the institution could do little because of its "deficient and outmoded" organization and shortness of staff, geologists in particular, and argued that the Survey had been almost completely "neglected by its leadership", namely mining engineers. He also criticized the Service for Mining Development, a scientific and technical state institution created in 1939, and directed by mining engineers whose contempt for geology had severe consequences for many public works that were developed throughout the country.[21]

The article was written by Carlos Teixeira, an assistant professor of geological sciences in the Faculty of Sciences of the University of Lisbon. Teixeira began his academic career as a non-paid assistant professor in the Faculty of Sciences of the University of Porto in 1933, after completing a degree in natural history. He had been a student of both Mendes Correia and Carrington da Costa, and prior to engaging in an academic career dedicated to geology, he joined the research school in anthropology that Mendes Correia had created and headed at the University of Porto. In 1936, Teixeira replaced Carrington da Costa as a naturalist in the Museum, a position he held until 1946. Teixeira then moved to Lisbon, and in the course of the 1950s and 1960s, he became the leader of a research school in geology at the University of Lisbon. Teixeira held significant scientific positions during the *Estado Novo*. He was scientific advisor to the Board for Nuclear Power, and a member of the Board for Overseas Research where he headed the Laboratory of Petrological and Paleontological Studies. As a scientific collaborator of the Survey, Teixeira authored and co-authored many geological maps (Gonçalves 1976).

Teixeira's second article, '*A geologia e os trabalhos públicos*' ('Geology and public works'), was also published in *Diário Popular* that same year, on 28 October, on pages 7 and 9. Teixeira criticized the recent reform of a technical public institution, the Hydraulic Services, which did not provide positions for geologists. He mentioned the Survey again, which in his view had a "more theoretical than real existence", and asked the government to renew the institution. Once again mining engineers were criticized, as they were held responsible both for the reduction of the number of geologists initially allocated to the Service for Mining Development, and for their low status as they were considered "auxiliary personnel".[22]

In February 1948, Teixeira wrote another article for *Diário Popular*, which was again published on the front page: '*Duas conferências oportunas*' ('Two timely lectures'). The way in which the Service for Mining Development carried out drilling campaigns was criticized. The scientific and technical requirements involved in this procedure justified in Teixeira's view the urgent need to enroll geologists in the campaigns, otherwise it would be like "throwing money out the window".[23]

Diário Popular was a popular evening daily newspaper published in Lisbon that managed to be as politically and economically independent as possible (Tengarrinha 2006).[24] It did not have a specific page or space allocated to science, but Teixeira was able to publish two of his articles on the front page. Even if the content of his articles might not be perceived as particularly threatening to the regime, Teixeira ran a greater risk to see them 'mutilated' by censorship, given

[21] Teixeira, Carlos. 'Geologia pura, Geologia aplicada'. *Diário Popular*, 30 May 1947.
[22] Teixeira, Carlos. 'A Geologia e os trabalhos públicos'. *Diário Popular*, 28 October 1947.
[23] Teixeira, Carlos. 'Duas conferências oportunas'. *Diário Popular*, 5 February 1948.
[24] In the 1970s, the Portuguese dictatorship suspected that *Diário Popular* had some left-wingers in its editorial board (Caetano 1974).

the relative independence of *Diário Popular*. The articles, in addition, expressed criticism towards a powerful professional corporation, the engineers, and the dictatorship was built up on a delicate balance and compromise; conflict was definitely not welcome. In any event, Teixeira published his first two articles on the first page of a popular daily newspaper making it more likely to attract a large number of readers and therefore to draw their attention to the articles' contents.[25]

Four years later, an article entitled '*Um sector que precisa de reorganização urgente: os Serviços Geológicos*' ('A public service that needs immediate reorganization: the Geological Survey') was published on the front page of the newspaper *O Debate*. This time, Teixeira's approach was somewhat different: he avoided harsh criticism towards mining engineers, their work and the Service for Mining Development, blaming instead the Survey's own complex organization for its shortcomings.[26]

Despite Teixeira's milder approach, Luís Acciaiuoli (1888—1958), a mining engineer belonging to the State Mining Board, reacted quite harshly. In his article '*Os Serviços Geológicos têm cumprido honrosamente*' ('The Geological Survey has served honorably'), published on the front page of the same newspaper, he accused Teixeira of conducting a campaign against the Survey for his own benefit. Acciaiuoli argued that Teixeira wanted the Survey to be replaced by a new institution where he would be the leader, and free to exercise his tyranny. Other professional, scientific and personal criticisms followed, and near the end of the article Acciaiuoli devoted a few critical words to the Geological Society of Portugal, although without naming it: "there is a society which should be only scientific . . . but it is also engaged in manoeuvres for immediate profit of some".[27]

Teixeira's reaction to Acciaiuoli's article entitled '*Geologia, geólogos e Serviços Geológicos*' ('Geology, geologists and the Geological Survey') was published on 6 November 1952, on pages 3 and 8 of *O Debate*. He reiterated his opinion and views, and tried to contradict Acciaiuoli's accusations: "I am no one's enemy, much less of mining engineers . . . I am only against the fact that any diploma is enough for someone to be called a geologist". He vehemently condemned those who conducted geological research and tasks without proper training or that "deny geologists their place but are ready to take advantage of their work".[28] At the end of the article, a footnote from the newspaper's editorial board stated that as the bone of contention had been "diverted from the realm of principles to become a personal matter", *O Debate* decided to put an end to the subject.

It is hard to understand why Teixeira published the articles in *O Debate*, a conservative and nationalistic weekly newspaper created and owned by right wing monarchists that was certainly not widely read. If knowing how readers appropriate the contents of newspapers is a difficult and complex issue, this becomes an even more challenging enterprise when dealing with a dictatorship where freedom of expression was severely constrained. The possibility that Teixeira could not continue to publish in *Diário Popular* due to questions of censorship cannot be disregarded. In fact, his last article in the newspaper only found a place on an inside page mixed with a variety of other news, from bullfighting to the latest novelties in show business. The situation must have been identical in the case of *O Debate* where Teixeira's articles also ceased to be published after the acrimonious discussion with Acciaiuoli.

Newspaper articles were not the only public interventions by Teixeira concerning the defense of geology and geologists. In fact, throughout his life, Teixeira rarely missed an opportunity to speak or write on the subject, as shown by his academic and scientific publications, oral presentations and newspaper articles. When Teixeira came upon those who

[25] In fact, the two articles published on the front page of *Diário Popular* only displayed the title and a few lines; the remaining text was in the newspaper inside pages. On the importance of 'form' presented by scientific topics in newspapers, see Papanelopoulou *et al*. (2009) and Simões *et al*. (2009).

[26] Teixeira, Carlos. 'Um sector que precisa de reorganização urgente: o dos Serviços Geológicos'. *O Debate*, 7 August 1952.

[27] Acciaiuoli, Luís. 'Os Serviços Geológicos têm cumprido honrosamente'. *O Debate*, 4 September 1952.

[28] Teixeira, Carlos. 'Geologia, geólogos e Serviços Geológicos'. *O Debate*, 6 November 1952.

practiced geology without proper knowledge and skills, especially engineers, he did not hesitate to target them. Just like Carrington da Costa and Mendes Correia, he claimed that engineers had taken the places of geologists in various sectors of Portuguese society, thus explaining the poor status of geology in the country.[29]

While Mendes Correia and Carrington da Costa had to comply with the stricter rules and conventions of institutional settings and publication outlets, Teixeira published his articles in newspapers, where the use of vocabulary and expressions was not so constrained. This circumstance allowed Teixeira to address the public with fewer language constraints, especially when engineers were targeted. In those cases, his discourse was sometimes aggressive, as if he had taken on the 'dirty part of the job' in the defense of geologists.

Teixeira used colloquial language with the occasional use of exclamations, punctuation, and a handful of adjectives to render the discourse appealing to the reader. Even when he resorted to argumentation to state his case, the discourse had an obvious emotional tone and showed that he was not detached from the message he wished to convey; in fact, he was emotionally involved both when praising the virtues of geology and in criticizing engineers.

The interventions of Mendes Correia, Carrington da Costa and Teixeira shared common traits: geology and geologists occupied a minor status in Portugal; engineers held positions that should belong to geologists, especially in the Geological Survey; there were negative consequences to the prestige and opportunities for geologists because of both of these circumstances. The customary utilitarian approach of science, presented as having a key role in the social and economic development of the nation,[30] and the instrumentalization of feelings concerning the Portuguese colonial empire, were also used to reinforce the authors' arguments. Yet, those same interventions combined different modes of persuasion according to their intended audience. When addressing audiences within an institutional context, such as the National Assembly in the case of Mendes Correia and academia in the case of Carrington da Costa, the discourse preferably rested on argumentation (*logos*) and the author's credibility (*ethos*). While emotional rhetoric devices (*pathos*) were less prominent in Carrington da Costa's oral and written interventions, Mendes Correia tried to win the representatives of the nation by also appealing to emotion. As for Teixeira, his newspapers articles were intended to reach not only the general public but also engineers and mining engineers working in the Geological Survey. As a consequence, his discourse relied much more on *pathos*. Not only was the subject especially dear to him and the discourse less constrained, but an emotional tone could also render the message more appealing and effective to an audience generally unfamiliar with geology.

4. THE 'KNIGHTS IN SHINING ARMOR' OF PORTUGUESE GEOLOGY

The public interventions conducted by Mendes Correia, Carrington da Costa and Teixeira gain a wider dimension when one takes into consideration their scientific, professional, and even personal paths. They all left Porto and headed to Lisbon in the second half of the 1940s, and it was in the capital city that their professional, scientific and political careers reached their peak. In 1946, Mendes Correia took on the directorship of the Colonial School in Lisbon and became the president of the Board for Overseas Research. That same year, Carrington da Costa, who was

[29] Contention between engineers, especially mining engineers, and geologists also existed in other countries; Italy and its national geological survey in particular have been studied in detail by Pietro Corsi. In the beginning of the 1920s, mining engineers were in charge of the Italian survey, which was in a poor situation, with fieldwork and the production of geological mapping being neglected. As late as the 1920s, geologists from academia replaced mining engineers who directed the survey but their work was constantly subjected to criticism from engineers. In the 1930s, engineers regained the power in the Italian survey. By the end of the decade, the reputation of the institution was damaged since it did not fulfill its main aims: a geological map of the country and the assessment of mineral resources (Corsi 2004).

[30] Recurrent rhetorical emphasis placed by Mendes Correia, Carrington da Costa and Teixeira on the utilitarian aspects of geology is a good example of the primacy given to scientific knowledge regarding its applications or technical aspects. On questions regarding the relationship of 'pure science' and 'applied science', and on the relative supremacy of science and technology see, for instance, Ziman (1983), and more recently, Forman (2007).

already a member of the Board, was invited by Mendes Correia to head a geological expedition to Portuguese Guinea (now Guinea-Bissau). In 1955, Mendes Correia left the Board and Carrington da Costa succeeded him as the president, a position he kept until 1967. Meanwhile, Teixeira, who since 1946 was an assistant professor at the Faculty of Sciences of the University of Lisbonalso became a member of the Board, and shortly after he was appointed head of the Laboratory of Mineralogical, Petrological and Paleontological Studies created there by Carrington da Costa. He was also appointed to various posts on the Board for Nuclear Power, another public institution where Carrington da Costa held an important position. When Mendes Correia died in 1960, Teixeira took his place in the Academy of Sciences of Lisbon.

The relationship between Mendes Correia and Carrington da Costa seems to have been rooted in shared republican values, which might also have been embraced by Teixeira, first as their student, and afterwards while working with them in the Faculty of Sciences of the University of Porto. The influence of Mendes Correia and Carrington da Costa on Teixeira, however, becomes more obvious in his ideas on scientific education and research, especially when praising the role of university professors as researchers and leaders of research schools. Mendes Correia, in particular, had a key influence on Teixeira as the leader of a research school at the Institute of Anthropology of the University of Porto. In fact, he was Teixeira's role model when the latter created his own research school of geology in the Faculty of Sciences of the University of Lisbon in the late 1950s. Furthermore, a certain 'spiritual communion' seems to have strengthened Teixeira and Mendes Correia friendship, as they both shared the Catholic faith. As for Carrington da Costa, there is no doubt that he played a fundamental role in the advancement of Teixeira's career, notably with his appointments to the Boards for Overseas Research and Nuclear Power, which enabled Teixeira to build up his own scientific and professional prestige and hold significant institutional power.

Together, Mendes Correia, Carrington da Costa and Teixeira, acted as a kind of 'knights in shining armor' of Portuguese geology, engaging in what seems to have been a coordinated strategy of public intervention on behalf of geology and geologists. This was, in turn, part of the wider process of asserting the scientific and social identity of the still nascent geological community, with Mendes Correia, Carrington da Costa and Teixeira acting as spokesmen in the defense of the community's interests.

It was no coincidence that the public intervention by Carrington da Costa took place when the Portuguese Geological Society was being launched. His main purpose was to create an *esprit de corps* among those who practiced geology and had been dispersed until then within a myriad of scientific areas and occupations. Carrington da Costa used his intervention to (re)create a 'historical mythology' for geology, a key step in forging the identity of scientific disciplines and associated practicing communities (Graham *et al*. 1983; Laudan 1983; Nye 1993). He also sought to forge allegiances among his peers in the academic/scientific community in order to get the Society recognized as the actual and only representative of Portuguese geologists, and to put geology at the regime's service by emphasizing its utility to the nation's economy and to the colonization of overseas territories. The intervention of Carrington da Costa is thus inscribed in a strategy of accommodation to the regime. Scientists just like him who traditionally defend the position that science and technology are key factors in fostering the development of the country, usually end up taking this position in the face of dictatorships (Goméz, Balmer and Canales 2015).

Mendes Correia's speeches in the National Assembly were delivered approximately one decade later, and their main intention was to reassert a place for geology in the regime's political agenda. In particular his speeches were designed to get funds allocated to geological research by praising its role in the economic and social development of the country. Mendes Correia was a physician and it is likely that his public intervention was inspired by the strategies deployed by Portuguese doctors in the late nineteenth and the beginning of the twentieth centuries, especially during the republican regime. Those strategies were designed to promote the medical profession,

with doctors presenting themselves as an intellectual and scientific elite capable of influencing political decisions and contributing decisively to the effort to revert the 'decline' of the nation.[31]

Even if Carrington da Costa and Mendes Correia's interventions also addressed the question, it was in Teixeira's articles where the purpose of establishing a professional realm for geology was clearly presented. In order to meet this goal, Teixeira had to ascribe authority to geologists as experts in certain techno-scientific activities, such as drilling and geological mapping, thereby differentiating the field of expertise of geologists from that of engineers, whom geologists considered to have 'invaded their professional space'. At the same time, Teixeira also conveyed the idea that engineers, and in particular mining engineers, did not have the required expertise to conduct geological work, and that by preventing geologists from utilizing their expertise, engineers were putting the country's progress at risk.[32] In this context, the Survey was frequently invoked because it exemplified all of the problems that the members of the Portuguese geological community faced: in their view, it had been unduly 'colonized' by engineers, who, despite being responsible for carrying out geological studies and mapping, did not fully understand geologic principles nor properly endorsed geological knowledge. Furthermore, the few trained geologists working in the Survey had no permanent positions and earned lower salaries than the full-time engineers tasked with undertaking geological investigations.[33] If geologists could take control of the institution there would be tangible positive consequences for them but above all it would have a symbolic meaning as the Survey was considered the 'cradle' of Portuguese geology.

Nevertheless, it should be emphasized that when vindicating a professional space for geologists in their interventions, Mendes Correia, Carrington da Costa and Teixeira's always referred to positions in public institutions. There is no mention concerning the 'professionalization' of geology in a broader sense, namely in considering that geology should be recognized as a free market profession. As engineers already occupied most of the claimed positions in the state apparatus, a confrontation with them became inevitable. These circumstances shed some light on the process of professionalization of geology in Portugal, a country where historically the state has a preeminent role when compared to the private sector, showing that priority was given to the establishment of a professional realm for geology in public service.

5. CONCLUDING REMARKS

During the second half of the twentieth century, the panorama of geology in Portugal changed. From the 1950s onwards, the *Estado Novo* allocated funds for the production and publication of geological maps. The Geological Survey and other scientific institutions, such as the Board for Nuclear Power and the Board for Overseas Research, profited from the situation and were able to recruit a growing number of geologists. In 1964, a degree in geology containing the professional title of geologist was created in the universities of Lisbon, Porto and Coimbra. Research schools in geology were established in the three universities and the number of geologists steadily increased. Some of them followed an academic career, others were appointed to positions in public scientific institutions, and a few found jobs in the private sector.

Such changes were due to a series of intertwined factors that are hard to untangle and identify, or to ascertain the consequences, but they are all an expression of the process of assertion of geology in Portugal. It is difficult to determine the extent to which the public intervention of Mendes Correia, Carrington da Costa and Teixeira had a role in the process. Just

[31] Carneiro, Ana, Mota, Teresa Salomé, and Amaral, Isabel. Shaping doctors and society: a preliminary approach to the Portuguese Medical Press (1880–1926). In review for *Media History*, submitted on 17 September 2016.

[32] Teixeira's articles can be perceived as an example of 'boundary-work', contrasting the realm of a science-related profession to an engineering-related one (Gyerin 1983).

[33] Until 1954, geologists were not acknowledged as a permanent position in the staff of the Portuguese Geological Survey: they could only work in the institution under contract, could not be promoted, and their wages were equivalent to those of low rank engineers.

as in politics (Ulrich 2016), the 'knights in shining armor' of Portuguese geology used different persuasive rhetorical devices to render their message effective and get different responses from distinct audiences. However, only in the case of Teixeira's articles published in the daily press was it possible to get a reaction from mining engineers; all the other audiences seem to have remained mute.[34]

But besides the effectiveness of their intervention, what is worth emphasizing is the way in which Mendes Correia, Carrington da Costa and Teixeira managed to use the rather restricted and controlled 'public sphere' during the *Estado Novo* to convey their message. Part of this message was built on the praising of geology and geologists with emphasis being put on the vindication of a professional realm for the latter. The other part of the message comprised an 'attack' on engineers, and that was not an easy undertaking. Engineering occupied a privileged position and during the *Estado Nov*o engineers regained the power they had previously, during the liberal monarchy. They did so by contributing to the modernization of the country, especially through their involvement in civil works, which became emblematic symbols of the regime, and thus helped to maintain the balance and stability of the dictatorship (Lewis 2012; Diogo and Matos 2012).

Both geologists and engineers were willing to accommodate to the *Estado Novo* in order to serve their own agendas. On the other hand, the attitude of the regime towards the national scientific community, which did not suffer significant purges when the dictatorship was established, was both pragmatic and instrumental in general.[35] As the interventions analyzed in this paper show, elements of the scientific community even seemed to feel at ease to defend their ideas on scientific activity in Portugal, at least in the decades under consideration. Still, the *Estado Novo* was not particularly fond of dissenting voices that could somehow call into question the social *status quo* on which the dictatorship rested so the risk of Mendes Correia, Carrington da Costa and Teixeira's interventions being censured increased, something that might have actually happened.

In the end, even 'knights' have to comply with their rulers' commandments if they want to keep their 'shining armor' . . .

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ARCHIVES

Archival material mentioned in the footnotes can be found at the Historical Archive of the National Laboratory of Energy and Geology, Estrada da Portela, Bairro do Zambujal, Apartado 7586, Alfragide, 2610–999, Amadora, Portugal.

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[34] One of the main difficulties faced by historians working on the circulation of scientific knowledge is precisely to gather information about the responses of audiences.

[35] The relationship between the *Estado Novo* and the national scientific community seems to have a lot in common with Italy where scientists contributed to the project of autarkic economic development cherished by the fascist regime which in turn was looking for technological and scientific effectiveness (see Maiocchi 2015).
It should be noted, however, that any Portuguese scientists and academics suspected of having a relationship with the Communist Party, or with other movements opposed to the regime, such as anarchists, suffered retaliations (see Simões 2011).

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