

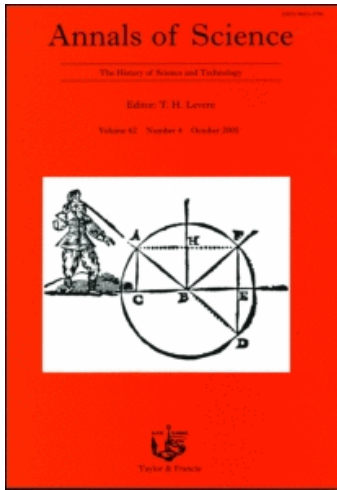
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A Mere Shadow of an Institution: the Unhappy Story of the Portuguese Geological Survey (PGS) in the Period Between the Two World Wars

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A Mere Shadow of an Institution: the Unhappy Story of the Portuguese Geological Survey (PGS) in the Period Between the Two World Wars

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Summary

In the period between the two World Wars, the Portuguese Geological Survey (*Serviços Geológicos de Portugal*: PGS) was legally dependent on the General Directorate of Mines and Geological Survey (*Direcção Geral de Minas e Serviços Geológicos*: GDMGS). Portugal was then living through troubled times, and the PGS struggled with financial problems and a lack of technical personnel. This situation did not allow the PGS to work properly as a scientific institution, and achieve its main function: the making and publication of geological maps and research papers.

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1. Introduction

The present organisation of the Geological Survey is highly inefficient and unable to meet the demands of this kind of work, which requires a degree of autonomy and almost unlimited independence and a considerable number of competent and specialised personnel... [T]he Geological Survey has thus become a mere technical Office.¹

¹ Jorge M. de Oliveira Simões, 'Os Serviços Geológicos em Portugal', *Comunicações dos Serviços Geológicos de Portugal*, 14 (1923), 30.

The present paper discusses the history of the Portuguese Geological Survey (*Serviços Geológicos de Portugal*: PGS) in the period between the two World Wars and can be regarded as a sequel to the paper by Ana Carneiro on the history of the Survey in the nineteenth century, previously published in *Annals of Science*.²

In 1918, the PGS was reorganized as a part of the new General Directorate of Mines and Geological Survey (*Direcção Geral de Minas e Serviços Geológicos*: GDMGS), at a time when Portugal was facing financial and political difficulties, and there was considerable social unrest. The young Republican regime, established in 1910, had to deal with the consequences of the First World War, and its position was insecure. A military *coup d'état* was soon to occur, and a dictatorial regime, known as the New State (*Estado Novo*), emerged.

Little has been written about the history of the PGS in the period between the two World Wars. However, there has been a general feeling that it was marked by the scientific decline of the institution.³ The historical investigation described here not only corroborates that view but also helps to explain the reasons underlying that decline which had its roots in the previous century. The successive restructurings of the PGS in the last decades of the nineteenth century and early twentieth century led to a more complex organization and a loss of autonomy resulting from the close association established between the PGS and the country's mining interests. These circumstances conspired to cause difficulties pertaining to human and material resources within the PGS. However, during most part of the nineteenth century and contrary to what happened during the period covered by this investigation, the PGS fulfilled its role as a scientific institution by carrying out scientific work and publishing geological maps.

It was not until the PGS became legally dependent on the DGMSG that its functions were seriously undermined, the institution becoming unable to fulfil its principal remit: the geological reconnaissance of the country and the publication of geological maps. The reorganization of 1918 did not provide the Survey with sufficient institutional autonomy, stability, and the resources needed to pursue its work properly. Subsequently, the 'dance' of the DGMSG from one Ministry to another, together with the lack of human, material, and financial means, was a clear manifestation of the Portuguese State's indifference to geological issues in the 1920s and to any contribution that the PGS might have made to the national economy. In a period during which similar institutions elsewhere devoted much of their scientific activity to surveying and researching mineral resources,⁴ the fact of the matter was that, incongruously, geological research and mapping were not among the PGS's priorities, despite its links to the mining interests of the State. The particular

² Ana Carneiro, 'Outside Government Science, "Not a Single Tiny Bone to Cheer Us Up!" The Geological Survey of Portugal (1857–1908), the Involvement of Common Men, and the Reaction of Civil Society to Geological Research', *Annals of Science*, 62 (2005), 141–204.

³ For this opinion, see J. Simões (note 1), 30; Fernando M. Moitinho de Almeida e António B. Carvalhosa, 'Breve história dos Serviços Geológicos em Portugal', *Comunicações dos Serviços Geológicos de Portugal*, 63 (1974), 239–65 (249 and 250); João M. Cotelos Neiva, 'Comissões e Serviços Geológicos e Carta Geológica de Portugal', *Boletim de Minas*, 35 (1998), 391–9 (395).

⁴ To know how other Geological Surveys dealt with the question of mineral resources in the period between the two World Wars, see H.E. Wilson, *Down to Earth* (Edinburgh, 1985), 20, 21, 38, and 39; Mary C. Rabbitt, *United States Geological Survey: a History of Public Lands, Federal Science and Mapping Policy, and Development of Mineral Resources in the United States*, 3 volumes (Washington, DC, 1979–1986), volume 3, 22, 27 and 28; C. Vodden, '150 years in the history of the Geological Survey of Canada', *Episodes*, 2 (1992), 99–110 (104 and 105).

circumstances that surrounded the PGS in the years between the two World Wars conspired to prevent it from engaging systematically in geological fieldwork. The publication of geological maps and research papers was reduced, and the general level of productivity was low. Thus, what we are considering here was anything but a 'success story' in the history of geology.

2. Early days of the Portuguese Geological Survey (PGS)

In most European countries, national geological surveys were created well after the emergence of mining schools, the formation of myriad geological and palaeontological collections, scientific societies, and the compilation of geological maps of specific areas.⁵ By the first half of the nineteenth century, many institutions, both private and official, became committed to the study of geology, thus producing what can be referred to as a geological culture.⁶ However, as Carneiro argued, in Portugal, a country situated at the 'periphery' of Europe, such circumstances did not apply.⁷ Apart from the work of a privileged elite, science was, in broad terms, unfamiliar to the 'man in the street'. Up to the middle of the century, the geological knowledge of the country was the work of a few foreign scientists who, for various reasons, lived in, or sporadically came to, Portugal. There were no portable topographic survey instruments or good-quality topographic maps on which to enter geological data. There were no reference collections or geological maps of other countries, and few specialized geological books.⁸ Geology teaching in universities, per se, was only a brief and introductory experience, based on a natural-historical perspective, in which individual student investigations and research had no place at all.⁹

Since Portuguese civil society proved incapable of generating any sort of interest in science in general, and geology in particular, the most convenient path for its implementation was through State intervention, as Carneiro has shown.¹⁰ It must be stressed that for the whole of the nineteenth century and up to the beginning of the twentieth century, Portuguese geology did not exist outside the sphere of the State.

⁵ For the history of other European Geological Surveys, see H. Wilson (note 4); M. Rabbitt (note 4); C. Vodden (note 4); Gordon L.H. Davies, *North from the Hook: 150 Years of the Geological Survey of Ireland* (Dublin, 1995); John S. Flett, *The First Hundred Years of the Geological Survey of Great Britain* (London, 1937); Edward Bailey, *Geological Survey of Great Britain* (London, 1952); Pietro Corsi, 'The Italian Geological Survey: the Early History of a Divided Community', in *Four Centuries of the Word 'Geology'*, edited by G.B. Vai, and W. Cavazza (Bologna, 2003), 271–321; Martin Guntau, 'The History of the Origins of the Prussian Geological Survey in Berlin (1873)', *History of Technology*, 5 (1988), 51–58; E. Dudich, 'A central European Survey in a changing society: 125 years of the Hungarian Geological Survey', *Episodes*, 4 (1994), 111–13; Francisco Javier Ayala-Carcedo, *Historia de los Mapas Geológicos de España* (Madrid, 1999); Oldroyd, D., and McKenna, G., 'Conditions of Employment and Work Practices in the Early Years of the Geological Survey of Great Britain', *Earth Sciences History*, 24 (2005), 197–223.

⁶ The concept of 'geological culture' is outlined in Simon Knell, *The Culture of English Geology, 1815–1851: a Science Revealed Through its Collecting* (Aldershot, 2000) and Martin J.S. Rudwick, *The Great Devonian Controversy: the Shaping of Scientific Knowledge among Gentleman Specialists* (Chicago, 1985).

⁷ A. Carneiro (note 2), 141–204.

⁸ A. Carneiro (note 2), 148 and Vanda Leitão, *Assentar a Primeira Pedra: as Primeiras Comissões Geológicas Portuguesas* (1848–1868), unpublished Ph.D. dissertation, New University of Lisbon, Lisbon, 2004, 45.

⁹ The teaching of geological matters in Portuguese universities was analysed by Martim R. Portugal Ferreira, *200 Anos de Mineralogia e Arte de Minas: desde a Faculdade de Filosofia (1772) até à Faculdade de Ciências e Tecnologia (1972)* (Coimbra, Faculdade de Ciências e Tecnologia da Universidade de Coimbra, 1998) and Miguel T. Antunes, 'Sobre a História do Ensino da Geologia em Portugal', *Comunicações dos Serviços Geológicos de Portugal*, 75 (1989), 122–70.

¹⁰ A. Carneiro (note 2), 143.

Thus, geology emerged in Portugal as a State science, following the establishment of the PGS on 18 August 1857 as a special section of the Kingdom's Directorate of Geodesic, Chorographic, Hydrographical and Geological Works, which was part of the Ministry of Public Works, Trade, and Industry (MPW).¹¹ Both the Geological Survey and the Geodesic Directorate represented the 'territorial imperative' in Portugal, so characteristic of the nineteenth century.¹² The PGS established geological surveying as a substantial scientific project, carefully devised and planned, with specific goals, based on systematic fieldwork and adopting working methods and strategies analogous to those of other similar European institutions, particularly the French Geological Survey.¹³

In December 1869, the Geodesic Directorate was reorganized to become the Directorate for Geodesic, Topographic, and Geological Works. It encompassed six sections, the fifth being the PGS. During this period, the PGS staff grew in number to include members linked to academia, but, as in the preceding years, military engineers, mining engineers, and mining technicians predominated.¹⁴ In 1886, the PGS was separated from the Geodesic Directorate and came under the jurisdiction of the General Directorate for Public Works and Mines, effecting a formal association with the State's mining interests. The staff was reduced, and all technical personnel had to be recruited solely among mining engineers working in the MPW. It was with this reorganization that field assistants were recognized for the first time as civil servants, and consequently could become permanent staff members of the Survey.¹⁵ Up to the first decade of the twentieth century, the PGS went through several other reorganizations and was confronted with severe political demands, prejudice, and conflicting interests. In 1892, it acquired a more autonomous status with three main lines of work being formally recognized: mineralogy, palaeontology, and archaeology. It should be noticed that this organization did not formally reflect the importance of cartography. The prevalence of engineers between the technical personnel continued to be overwhelming.¹⁶ In 1899, further changes occurred, and again in 1901, when the PGS turned into a more complicated and bureaucratic structure, composed of three distinct bodies: a Consultative Committee, an Executive Committee, and the Staff. Representatives from institutions for higher education were present in the Consultative Committee. This situation could have contributed to a closer relationship between these schools and the PGS; however, that did not happen.¹⁷

¹¹ A. Carneiro (note 2), 144–6; V. Leitão (note 8), 61–5 and 73–85. Between 1848 and 1858, an early geological survey (*Comissão Geológica e Mineralógica*) was established in the context of Royal Academy of Sciences of Lisbon existed, which was directed by the French engineer Charles Bonnet (1816–1867). However, the outcome of this first survey was poor: it was understaffed, its tasks were too wide-ranging, and Bonnet failed to comply with his duties. V. Leitão (note 8), 86–97.

¹² David Oldroyd, *Thinking about the Earth: A History of Ideas in Geology* (London, 1996), 108–30.

¹³ A. Carneiro (note 2), 146; V. Leitão (note 8), 79. V. Leitão and A. Carneiro argued that the Ministry of Public Works, Trade, and Industry acted as a 'centre of calculation' in Latour's sense, was composed of a multitude of subsidiary 'centres' devoted to the compilation and recompilation of various kinds of data, and had the purpose of converting the accumulating knowledge into 'inscriptions' and material structures. In this context, the PGS was therefore a 'centre of calculation' within the Geodesic Directorate, and more generally in the MPW bureaucratic apparatus. A. Carneiro (note 2), 145 and V. Leitão (note 8), 325–34 and 365–69. For the concept of 'centre of calculation', see Bruno Latour, *Science in Action. How to Follow Scientist and Engineers through Society* (Milton Keynes, 1987).

¹⁴ A. Carneiro (note 2), 157.

¹⁵ A. Carneiro (note 2), 168.

¹⁶ A. Carneiro (note 2), 170.

¹⁷ A. Carneiro (note 2), 175–8.

Despite all the changes, a considerable amount of work was achieved, and a significant number of maps were published prior to the First World War. Between 1862 and 1868, the PGS published several sheets of a geological map on the scale 1:100 000. In 1867, at the Paris Exhibition, it presented a first water-colour version, in two sheets, of the general geological map of Portugal on the scale of 1:500 000. This map was subsequently released on two different occasions: first, in 1876, a small number of copies were printed for display at the Philadelphia Exhibition. In 1877, it was reprinted with minor corrections to the 1876 version. In 1899, a second and more accurate version of this map was published, earning a gold medal in the Paris Exhibition of 1900. Other geological, tectonic, and hypsometric maps were released during the nineteenth century and the first decade of the twentieth. Beside cartography, the PGS also published a significant number of geological, palaeontological, and archaeological papers and memoirs, and engaged in work on applied geology, especially geologically informed technical evaluations of mines, and hydrogeological reports.¹⁸

Little is known about the PGS's history in the years between 1908 and 1918.¹⁹ Nevertheless, it seems that the death or retirement of its most distinguished geologists and the institution's deficient organization gave rise to a period in which the quantity and quality of the geological work produced decreased substantially. Geological cartography was relegated to a secondary position, and the links between geology and mining were stressed. The PGS financial difficulties increased, and almost all the staff positions were occupied by mining engineers or mining technicians.²⁰ The next two decades were an extension and deepening of the PGS's decline as a scientific institution.

3. Creation of the General Directorate of Mines and Geological Survey (GDMGS) in 1918

The GDMGS was created on 14 July 1918, under the jurisdiction of the Ministry of Labour and Social Welfare.²¹ For the first time in Portugal, the country's geological survey was given a permanent status, and at the same time, its institutional links to the mining interests of the State became closer than ever, in a relationship that would last for a long time.

The legislation was published when Portugal was going through one of its most complex and troubled historical periods. The First Republic was facing difficult times, and the country was beset by violence, political instability, and economic and financial difficulties. There was a climate of virtual civil war with plots taking place from time to time. Governments often lasted only a few days. The participation of Portugal in the First World War had pernicious economical consequences, which exacerbated the social conflicts. In 1918, a charismatic member of the military forces attempted to install a totalitarian regime, but it did not last for long. Subsequently, the life of the Portuguese Republic became even more difficult, and on 28 May 1926, a military *coup d'état* occurred, leading to a military dictatorship that preceded the

¹⁸ A. Carneiro (note 2), 147–80.

¹⁹ No research has yet been carried out on this period of time. The main sources for information are J. Simões (note 1) and F. Almeida and A. Carvalhosa (note 3).

²⁰ J. Simões (note 1), 20 and F. Almeida and A. Carvalhosa (note 3), 240.

²¹ Decree 4 641, 14 July 1918, 1290.

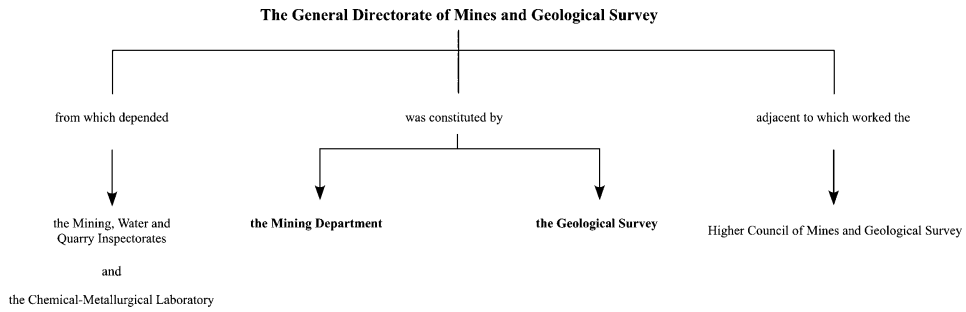


Figure 1. Organization of the General Directorate of Mines and Geological Survey as established by decree 4:641 of 14 July 1918.

Estado Novo ('New State'), the dictatorship installed in Portugal in 1933 and under which the country lived for more than forty years.²²

At the beginning of the twentieth century, Portugal was a country with archaic economic and social structures, backward agriculture, and a rudimentary industrial fabric. The mining industry was underdeveloped, due to, among other things, the inadequate transport network, the absence of capital and specialized personnel, and the lack of initiative of Portuguese entrepreneurs. However, during the First World War and the early 1920s, there was an increase in mining activity. The State showed some interest in the development of this area of industry, especially coal surveying and exploration, an interest due, in large measure, to the military situation in the period between 1914 and 1918.²³

The GDMGS was in charge of mining, quarrying, mineral waters, and geological, chemical, and metallurgical services. It was constituted by the Mining Department and the Geological Survey and several other services the Mining, Mineral, Water and Quarry Inspectorates and the Chemical–Metallurgical Laboratory that were dependent on it. The Higher Council of Mines and Geological Survey (*Conselho Superior de Minas e Serviços Geológicos*: HCMGS), a consultative body composed of university professors, PGS engineers, and representatives of public services, was also linked to the GDMGS and provided advice on matters pertaining to its work (Figure 1).²⁴

The PGS's principal aims and tasks were²⁵:

- to promote geological, petrographical, and palaeontological studies;
- to survey the country in order to produce geological maps; and
- to carry out geological studies applied to mining, agriculture, and hydrology.

²² Joaquim V. Serrão, *História de Portugal*, 11 volumes (Lisbon, 1989), XI; José A. França, *Os Anos Vinte em Portugal, Estudos de Factos Socio-culturais* (Lisbon, 1992); Joaquim V. Serrão and António H. Oliveira Marques (eds), *Nova História de Portugal*, 11 volumes (Lisbon, 1991), XI.

²³ Manuel V. Cabral, *Portugal na Alvorada do Século XX* (Lisbon, 1979); K.C. Schwartzman, 'Instabilidade Democrática nos Países Semiperiféricos. A Primeira República Portuguesa', in *O Estado Novo—das Origens ao Fim da Autarcia (1926–1959)*, 2 volumes, edited by António da C. Pinto (Lisbon, Editorial Fragmentos, 1987), I, 25–40; F. Medeiros, *A Sociedade e a Economia Portuguesas nas Origens do Salazarismo* (Lisbon, 1978); Sacuntala de Miranda, 'Crise Económica, Industrialização e Autarcia na Década de 30', in *O Estado Novo? das Origens ao Fim da Autarcia (1926–1959)*, 2 volumes, edited by António da C. Pinto (Lisbon, 1987), I, 41–65.

²⁴ As indicated in note 21, 1292.

²⁵ As indicated in note 21, 1292.

Table 1. PGS technical personnel working in the institution in 1920 and 1935.

PGS technical personnel	Number of elements foreseen by law 4:641	Number of elements actually working in 1920	Number of elements actually working in 1935
Engineers	3	2	3 ^a
Mining technicians	2	1	0
Field assistants	2	4	3
Draughtsmen	1	1	1
Museum curators	1	1	1
Photographers	1	1	1
Laboratory assistants ^b	2	2	0

Notes:^a A geologist occupied one of the engineers' positions.^b This position was extinguished in 1928.

In themselves, these remits were entirely appropriate.

In June each year, the PGS had to present a report to the GDMGS Director, setting out the work proposed for the following year. The proposal had to be approved by the GDMGS Director and the HCMGS, and then submitted to the Secretary of State, who decided what kind of work should be done.²⁶ But on 25 November 1925, the Ministry of Works and Social Welfare was suspended, and the GDMGS was transferred to the Ministry of Communications and Trade, which was considered to be more suitable to its purposes.²⁷ In July 1932, there was a reorganization of some of the State services, and the Ministry of Communications and Trade was divided in two: the Ministry of Public Works and Communications and the Ministry of Trade, Industry, and Agriculture. The GDMGS became part of the latter, but its structure and *modus operandi* remained the same.²⁸

4. PGS technical personnel

The restructuring of 1918 stipulated that the PGS should have the following technical personnel: three engineers, two mining technicians, two field assistants, two laboratory assistants, one museum curator, one draughtsman, and one photographer. This was clearly insufficient to meet its commitments. The PGS leadership was given to the oldest mining engineer working in the institution, suggesting that years of service were more important than competence.²⁹ Table 1 shows the distribution of the PGS technical personnel in 1920 and 1935.

All the permanent technical personnel were civil servants belonging to the GDMGS. At least one of the engineers working in the PGS was to come from the Corps of Mining Engineers and Geological Surveying (*Corpo de Engenharia de Minas e Serviços Geológicos*: CMEGS); the others could be recruited either from the engineers working at the Ministry of Public Works or from 'geologists proper'. It is obvious that the GDMGS recruitment policies were identical to those of the nineteenth century: almost all the technical personnel had to be engineers or mining

²⁶ As indicated in note 21, 1303.²⁷ Decree 11 267, 25 November 1925, 1620.²⁸ As indicated in note 27, 1620.²⁹ As indicated in note 21, 1297.

technicians. The mining technicians, who had diplomas from a technical institute, assisted the engineers in their technical work (they had diplomas from a technical institute). The field assistants had no specific formal qualifications, and their role was to assist engineers and mining technicians in fieldwork campaigns.³⁰

Table 1 shows that, in practice, the number of staff members prescribed in the legislation was never reached, since there were always some vacancies in the technical staff. In 1920, for example, they were one engineer and one mining technician short. However, there were two additional field assistants—a less expensive provision. In 1935, the numbers were almost the same, but there were still some vacancies: now all three positions of engineers were filled, but there were no mining technicians and the number of field assistants decreased. The geologist occupying one of the positions that should have been allocated to an engineer was not a permanent member of the staff. The position of laboratory assistant was extinguished in 1928.³¹

In February 1928, the position of ‘collaborator’ was officially established. At the same time, the legislation recognized that the PGS work should be developed and accelerated in order to provide a wider contribution to the mining industry, agriculture, and other fields where geological studies were considered relevant. It also recognized that the PGS was underfunded and understaffed, but the State claimed (probably correctly) that it was in no position to raise the PGS budget. In order to alleviate this situation, it was decreed that all professors of geology working in Portuguese universities and technical schools, or any suitable individual engaged in geological studies, could be appointed as PGS ‘collaborators’.³²

5. Money issues: the PGS budget

There is ample evidence that during the period under analysis, the PGS went through financial difficulties. Artur Guilherme Rodrigues Cohen (1877—1961), a mining engineer, was appointed Director in 1922. He held this position until 1935, when he retired.³³ While working in the PGS, Cohen did little geological fieldwork and failed to publish a single piece of research, spending most of his time on bureaucratic and administrative work. Between 1928 and 1932, he wrote several letters to the GDMGS Director, saying that the PGS annual budgets were insufficient and that the institution could not survive with its constant lack of financial and human resources.³⁴

As the PGS was administratively and financially dependent on the GDMGS, its budget came from the State budget, which was allocated annually to the GDMGS, whose Director determined the amount to be made available to the PGS. The latter could not even decide on payments for ordinary expenses, such as the acquisition of scientific books or the expenses associated with the printing of its journal. Even the

³⁰ When comparing the PGS staff with that of one of the best-studied geological surveys, the Geological Survey of Great Britain, two differences stand out: the PGS staff was dominated by one group of civil servants, the engineers and its members had a low level of specialization. Oldroyd and McKenna (note 5), table 3, 207.

³¹ Decree 15 018, 11 February 1928, 307.

³² As indicated in note 31, 307.

³³ *Verbo Enciclopédia Luso-Brasileira da Cultura*, 29 volumes (Lisbon, 1967), V, 859 and 860.

³⁴ Official Letter No. 2, 16 January 1928; Official Letter No. 3, 17 January 1926.

most insignificant purchases had to be sanctioned by the GDMGS director.³⁵ A more detailed view of the PGS financial problems is given in Table 2.³⁶

The requests made by Cohen in 1930–1931 to increase the PGS budget had little success. He proposed more than a doubling of almost all budget items and requested that the amount allocated to fieldwork be tripled, but to no avail. Cohen justified his requests mainly on account of the need to speed up the production of the Portuguese 1:100 000 geological maps.³⁷

However, as Table 2 shows, despite the increase in the PGS budget in 1930–1931 in comparison with the previous year, it lagged behind expectations. For instance, for ‘publicity and propaganda’ (which was associated with the publication of scientific work), the sum allocated remained the same, and the money that allowed the PGS technical personnel to carry out fieldwork (the item listed as ‘living allowances’) was increased by only 5000 Portuguese escudos.³⁸

In the following year, 1931–1932, only ‘transportation’ increased by 1000 escudos; all the other items were allocated the usual amounts, and the ‘living allowances’ were actually reduced. Despite failing in his attempts at obtaining more funds, Cohen did not give up, and he renewed his requests in 1932–1933. Cohen tried to make his point by setting forth arguments that might appeal to the people in charge of the GDMGS and in the Ministry: that the economy of a country had much to profit from the PGS work because geological studies could be used in engineering and mining works, which were the basis of the Portuguese economic recovery.³⁹

6. Daily routine in the PGS

The PGS technical personnel spent much of their time giving geological advice to other public institutions, and assisting the GDMGS when requested. The PGS made hydrogeological studies for the Ministry of Agriculture⁴⁰ and for some city councils,⁴¹ and undertook other kinds of geological studies related to building construction and public works.⁴² Often, other State services requested the assistance of the technical personnel of the PGS, and consequently they spent much of their time working for other public institutions. For instance, Romão de Matos (1880–1979), one of the field assistants, worked ten days every month for the Ministry of Agriculture in 1918⁴³ and was seconded again in 1930.⁴⁴ Another of the field assistants, Manuel de Matos (1894–1971), was requested to carry out work on behalf of the Portuguese Fuels Institute in 1933.⁴⁵

³⁵ Books of Official Letters for 1918–1935. When it came to money issues, the difference between the PGS chief and the Director of the Geological Survey of Great Britain was enormous, with the latter being able to dispose disburse money in a much more independent manner; see Oldroyd and McKenna (note 5).

³⁶ Budget Sheets for 1930–1931; Official Letter No. 24, 29 March 1930; Official Letter No. 11, 14 March 1932.

³⁷ Official Letter No. 24, 29 March 1930; Official Letter No. 11, 14 March 1932.

³⁸ In 1926, ninety-five Portuguese escudos were equivalent to one English pound in gold.

³⁹ Official Letter No. 11, 14 March 1932.

⁴⁰ Books of Official Letters for 1918–1935.

⁴¹ Books of Official Letters for 1918–1935.

⁴² Official Letter No. ?, 12 April 1928.

⁴³ Official Letter No. 21, 7 September 1918.

⁴⁴ Official Letter No. ?, 18 December 1930.

⁴⁵ Official Letter No. ?, 11 January 1933.

Table 2. Money requested and given to the PGS between 1929 and 1932.

	Amount of money given to the PGS	Amount of money requested by the PGS	Amount of money given to the PGS	Amount of money given to the PGS	Amount of money requested by the PGS
Budget items	1929–1930	1930–1931	1930–1931	1931–1932	1932–1933
Living allowances ^a	10 000 PTE ^c	30 000 PTE	15 000 PTE	10 000 PTE	30 000 PTE
Transportation ^a	6500 PTE	18 000 PTE	85 000 PTE	95 000 PTE	15 000 PTE
Publicity and pro-paganda ^b	20 000 PTE	50 000 PTE	20 000 PTE	20 000 PTE	50 000 PTE
Unspecified items	10 000 PTE	20 000 PTE	10 000 PTE	10 000 PTE	20 000 PTE

Notes:

^a This item was related to geological fieldwork.

^b This item was related to making and publishing scientific work, namely geological maps.

^c PTE: Portuguese escudos.



Figure 2. View of the PGS Museum (PGS Archives, date unknown).

In addition to these tasks, the PGS technical personnel spent much time on administrative and bureaucratic work. It had insufficient clerical staff, and the Director was in charge of almost all the official correspondence, which was considerable, inasmuch as the institution exchanged all sorts of scientific publications with other geologic surveys, scientific societies, and universities, both in Portugal and abroad. Most of this service was channelled through the National Library. However, public entities like city councils, schools, ministries, and even individuals, also requested the PGS to send them scientific publications and maps, this task being carried out by the technical personnel.⁴⁶ The technical personnel also had to prepare fossil, mineral, and rock collections—a task that was carried out in the PGS museum (Figure 2)—because the institution had to respond to numerous requests from various public and private institutions and also individuals.⁴⁷

In order to meet such requests, the PGS technical personnel were left with little time to carry out their primary scientific work. In fact, the evidence points to the fact that the PGS technical personnel did not do *any* relevant geological survey work in the field between 1918 and 1928! Only then did the PGS begin to survey some parts of the Portuguese territory, as shown in Figure 2.⁴⁸

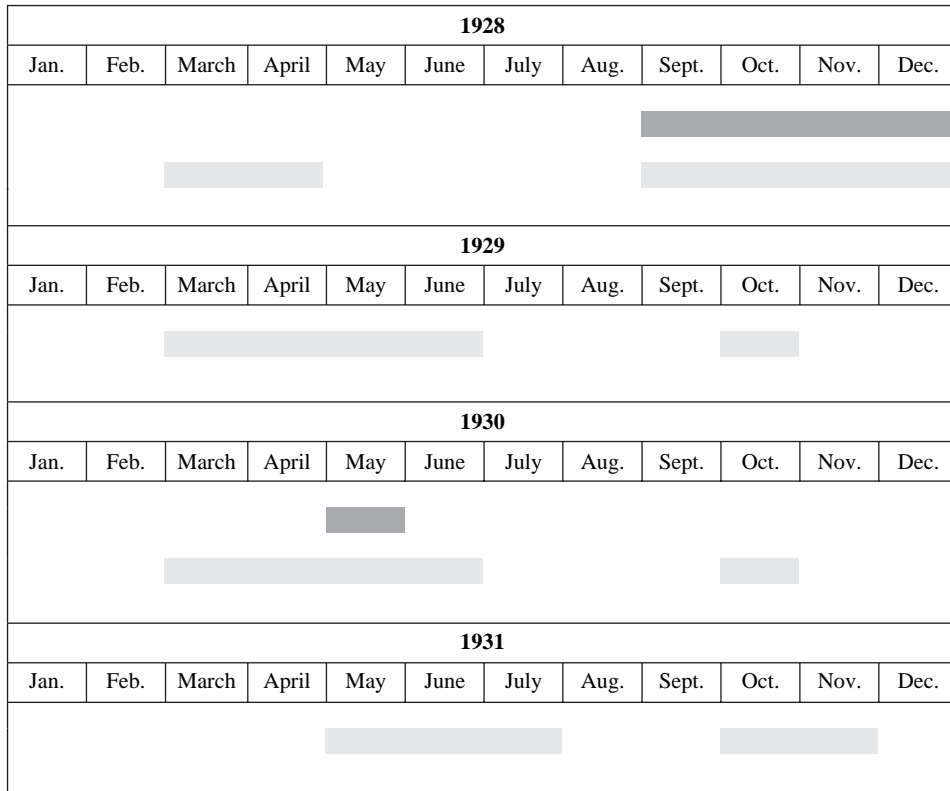
Most fieldwork was carried out in Lisbon and its surroundings, though it was intended to compile a new geological map of Portugal. Fieldwork was carried out during most of the year except for winter and the hottest summer months. It is also evident from Figure 3 that most of the fieldwork was done by the field assistants. But since the last decades of the nineteenth century, the experienced field assistants working in the PGS had been able to proceed on their own with geological fieldwork; sometimes, they were even called ‘practical geologists’.⁴⁹

⁴⁶ Books of Official Letters for 1918–1935.

⁴⁷ Books of Official Letters for 1918–1935. When comparing the daily routine of the PGS with that of the Geological Survey of Great Britain, for instance, there is no information that the latter had to deal with such bureaucratic work; Oldroyd and McKenna (note 5).

⁴⁸ Payment Sheets for 1918–1935; Books of official letters for 1918–1935.

⁴⁹ A. Carneiro (note 2), 143–4.




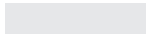
 PGS engineers
 PGS field assistants

Figure 3. Fieldwork carried out by the PGS technical personnel between 1928 and 1931.

An exception in what concerns engineers was Francisco Luís Pereira de Sousa (1870–1931) (Figure 4), a military engineer who was appointed to the PGS because he liked geology and had some expertise in the area. He worked for the institution until 1928 but was then forced to leave, owing to incompatibilities between his position as a civil servant at the PGS and other professional commitments, namely his professorship at the University of Lisbon. Even so, Pereira de Sousa’s geological research and mapping was a major contribution to the PGS output in this period.⁵⁰

⁵⁰ Jorge M. de Oliveira Simões, ‘Biografia de Geólogos Portugueses—Francisco Luís Pereira de Sousa (1870–1931)’, *Comunicações dos Serviços Geológicos de Portugal*, 17 (1931), 3–11; António A.O. Machado e Costa, ‘O Professor Dr. Francisco Luís Pereira de Sousa, 1870–1931’, *Boletim do Museu de Mineralogia e Geologia da Universidade de Lisboa*, 2 (1933), 2–14; J. Simões (note 1), 99; F. Almeida and A. Carvalhosa (note 3), 259.



Figure 4. Photograph of Francisco Luís Pereira de Sousa (taken from: Jorge M. de Oliveira Simões 'Biografia de geólogos portugueses Francisco Luís Pereira de Sousa (1870—1931)', *Comunicações dos Serviços Geológicos de Portugal*, 16 (1931), 3).

Pereira de Sousa carried out fieldwork in southern Portugal, especially in the provinces of Alentejo and Algarve, until he left the PGS.⁵¹ Some of this fieldwork was related to the production of a geological map of the Algarve on the scale of 1:50 000.⁵² Occasionally, other engineers working in the PGS and collaborators became involved; however, most of the work was left to field assistants. Fieldwork during these years resulted in the publication of one of the sheets of the Geological Map of Lisbon and Surrounds in the scale 1:50 000 (1935), but this was the only geological map published by the PGS between 1918 and 1935.

7. PGS scientific productivity

Concerning other PGS scientific publications, the results were little better, as shown in Table 3.

⁵¹ Alentejo and Algarve are the southern provinces of Portuguese mainland, and their geology is very diverse. The age of the rock formations goes from the Paleozoic to the Cenozoic Eras comprising sedimentary, metamorphic, and igneous rocks.

⁵² Official Letter No. 11, 24 March 1932.

Table 3. *CSGP* volumes published between 1918 and 1935.

Years	<i>CSGP</i> volumes published between 1918 and 1935
1918	–
1919–1922	Volume 13
1923	Volume 14
1924	Volume 15
1925 and 1926	–
1927–1930	Volume 16
1931	Volume 17
1932	Volume 18
1933	Volume 19
1934–1937	–
1938	Volume 20 ^a

Notes:

^a This volume was issued in 1934.

The PGS's geological journal *Comunicações dos Serviços Geológicos de Portugal* (*CSGP*) was published but irregularly. The first volume for our period was No. 13 (1919–1922). Volumes 14 and 15 were published in 1923 and 1924, respectively, and the next three years, 1925, 1926, and 1927, only yielded one volume (16). Volume 17 covered the period 1928–1931, and in the next two years two more volumes were published: 18 (1932) and 19 (1933). Volume 20 was officially published only in 1938, though it was in fact issued earlier in 1934.

Table 4 shows the number of papers according to scientific domain published in each of the *CSGP* volumes and the percentage of papers published in all the *CSGP* volumes, according to scientific field.

As expected, the number of papers increased when the *CSGP* volumes covered more than one year. In this case, the papers also presented a wider range of scientific topics. The fields with the largest number of papers were palaeontology, anthropology, and archaeology. Local geology and history of the PGS came next, followed by stratigraphy and petrography/petrology. Mineralogy and tectonics had only two papers each and all the other domains, geodynamics, seismology, hydrogeology, geochemistry and paleogeography, only one each. Papers devoted to mineralogy and petrography/petrology appeared only from Volume 16 onwards. The number of papers dealing with non-geological scientific domains, in particular archaeology and anthropology, increased with time: one in Volume 16; five in Volume 17 (50% of the papers), and five again in Volume 19 (more than 70% of the papers). As the number of papers on archaeology and anthropology increased, the number of geological papers decreased. The PGS technical personnel and/or collaborators did not author the great majority of the papers published in the *CSGP*. Only three PGS engineers contributed papers: Pereira de Sousa, Amílcar de Jesus, and Oliveira Simões.

Jorge de Macedo de Oliveira Simões (1889–?) was an engineer of the Ministry of Public Works who worked for the PGS. He also had a degree in Natural Sciences and taught in secondary schools.⁵³ He seems only to have published obituaries and articles on the past accomplishments of the institution.

⁵³ J. Simões (note 1), 49; F. Almeida and A. Carvalhosa (note 3), 250.

Table 4. Number of papers according to scientific speciality in each of the *CSGP* volumes and percentage of papers according to scientific speciality published in all the *CSGP* volumes.

<i>CSGP</i> volumes	A	B	C	D	E	F	G	H	I	J	K	L	M	N
No. 13	1	2	2	0	0	0	1	1	1	0	0	0	0	0
No. 14	1	1	0	1	0	0	0	0	0	0	0	0	0	0
No. 15	1	1	2	0	0	0	0	0	0	1	0	1	0	0
No. 16	0	0	0	1	1	1	0	0	0	0	0	0	1	0
No. 17	1	0	1	0	2	0	0	0	0	0	1	0	2	3
No. 18	0	0	0	1	0	0	0	0	0	0	0	0	0	0
No. 19	0	0	0	0	1	0	1	0	0	0	0	0	2	3
No. 20	0	1	1	1	0	0	0	0	0	0	0	0	0	1
Total	4	5	6	4	4	1	2	1	1	1	1	1	5	7
Total (%)	9	12	14	9	9	2	5	2	2	2	2	2	12	16

Notes:

A: History of the PGS; B: Stratigraphy; C: Palaeontology; D: Local Geology; E: Petrography/Petrology; F: Mineralogy; G: Tectonics; H: Geodynamic; I: Seismology; J: Hydrogeology; K: Geochemistry; L: Paleogeography; M: Archaeology; N: Paleoanthropology.

Pereira de Sousa's publications were eclectic. He published on stratigraphy, palaeontology, petrography, and seismology. Regarding stratigraphy and palaeontology, his papers focused on the geological study of the Algarve, which was intended to be used in compiling a geological map of that province on the scale 1:50 000. The only paper on seismology published in the *CSGP* during this period of time was written by Pereira de Sousa and was part of his extensive interests in this field. He published other papers and a series of monographs on the 1755 Lisbon Earthquake *O Terramoto do 1º de Novembro de 1755 em Portugal e um Estudo Demográfico*⁵⁴ but never finished this project because he died unexpectedly in 1931.

The few papers written by Amílcar Mário de Jesus (1895–1960) (Figure 5) were the only ones published in the *CSGP* that focused on mineralogy and petrology. He had a degree in Natural Sciences and was also a mining engineer. He began to work in the PGS in 1929 and stayed there for a couple of years. In 1931, when he left the PGS, he became a 'collaborator' of the institution.⁵⁵ Amílcar de Jesus was one of the few Portuguese geologists who gave particular attention to mineralogy and petrology, but the amount of his published work was only modest.

Between 1918 and 1939, the PGS also published a couple of memoirs: the previously mentioned work by Pereira de Sousa devoted to the 1755 Lisbon Earthquake; and one on the tectonics of the submarine valleys near the Portuguese coast⁵⁶ by one of the PGS 'collaborators', Carlos Bento Freire de Andrade (1893–1956).

⁵⁴ Francisco Luís Pereira de Sousa, *O Terramoto do 1º de Novembro de 1755 em Portugal e um Estudo Demográfico*, 4 volumes (Lisbon, 1919–1932).

⁵⁵ Décio Thadeu, 'Prof. Amílcar Mário de Jesus', *Boletim da Sociedade Geológica de Portugal*, 13 (1958–1960), 309–11; F. Almeida and A. Carvalhosa (note 3), 259 and 260; Luís Aires-Barros, 'O Culto da Geologia: Breve Resenha Histórica sobre a Contribuição dos Engenheiros de Minas Portugueses', *Boletim de Minas*, 36 (1999), 103–10 (105 and 107); *Verbo Enciclopédia Luso-Brasileira da Cultura*, 29 vols. (Lisbon, 1973), XIV, 217.

⁵⁶ Carlos Freire de Andrade, *Os Vales Submarinos Portugueses e o Diastrofismo das Berlengas e da Estremadura* (Lisbon, 1937–1938).



Amílcar Mário de Jesus

Figure 5. Photograph of Amílcar Mário de Jesus (taken from: Décio Thadeu, 'Prof. Amílcar Mário de Jesus', *Boletim da Sociedade Geológica de Portugal*, 13 (1958–1960), 309).

Pereira de Sousa's work on the Lisbon Earthquake was issued in four volumes (the first and second volumes in 1919, the third in 1928, and the last one in 1932) and was a substantial piece of work. It is worth noting that this study does not derive from Pereira de Sousa's working position at the PGS. It is likely that Pereira de Sousa decided to engage in such research because his career prospects and expectations at the PGS could not be fulfilled satisfactorily. As the study of the 1755 Lisbon earthquake did not require significant financial and logistic means, which the PGS could not have met, and seismology had little expression in Portugal, this topic might have seemed to Pereira de Sousa most convenient and worth pursuing. He assembled the information about the earthquake from different historical sources including the famous questionnaire that Marquês de Pombal the Portuguese Prime-minister in 1755 sent to parishes all over the country. As to the cause of the earthquake, Pereira de Sousa followed and adapted the tectonic theories introduced by Eduard Suess (1831–1914) in the late nineteenth century and subsequently developed by French geologists. Pereira de Sousa's study of the Lisbon earthquake became a landmark in the study of Portuguese seismology.⁵⁷

Freire de Andrade, a mining engineer who studied in England, worked as a naturalist at the Geological Museum of the University of Lisbon. In 1929, he became a PGS 'collaborator', and it was in this capacity that the institution published some of his geological studies. The memoir on the tectonics of submarine valleys was an important topic in the context of Portuguese geology. Tectonics was an area of specialization that did not have many followers in Portugal, where geology was still a

⁵⁷ Carneiro, A., and Mota, T., 'Francisco Luiz Pereira de Sousa (1870–1931): 1755, um terramoto para uma vida', paper delivered at the international interdisciplinary Meeting *O Terramoto de 1755: Impactos Históricos*, Lisbon, 4–5 November, 2005.

generalist science. Just like Pereira de Sousa's study on the Lisbon Earthquake, Freire de Andrade's research on tectonics, though published under the auspices of the PGS, had no direct relation to its activity.

8. Geological mapping in the PGS

During the years covered by the present paper, despite many attempts by the PGS at obtaining the funds necessary to carry out fieldwork in order to compile and publish the 1:50 000 geological map of the Algarve, and a 1:100 000 geological map of Portugal, it never succeeded. In fact, none of these maps ever saw the light of day. All the fieldwork carried out by the technical personnel, and especially by the field assistants, seems to have been used for the only geological map released by the PGS between 1918 and 1935, i.e. one of the four aforementioned sheets of the Geological Map of Lisbon and Surrounds (1:50 000) (Figure 6).

This map represents the geological features of the region of Cascais, at the time a small village in the surroundings of Lisbon. The map was worked out from the fieldwork notes of the former PGS geologist, Paul Choffat (1849—1919). Since 1928, these notes were revised and completed by the PGS's field assistants and collaborators. The topographic background used in the map was produced by the Portuguese Geographical and Cadastral Institute, which also engraved and chromolithographed the map. The legend provides information about the type of igneous rocks, stratigraphy and palaeontological content of the sedimentary formations, and occurrence of geological structures such as faults. Information on

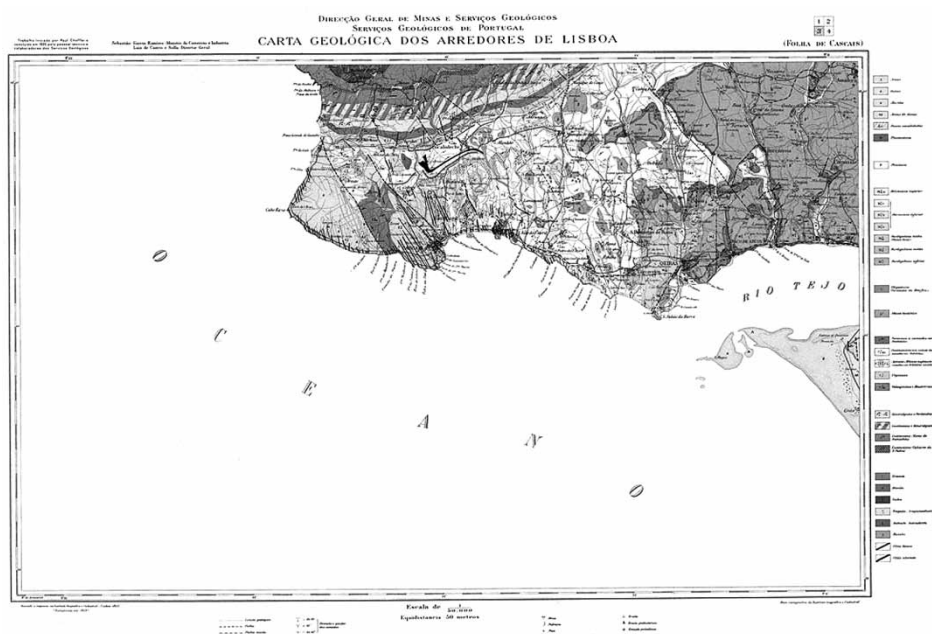


Figure 6. Sheet of the Cascais area of the Geological Map of Lisbon and Surrounds (1:50 000), (PGS historical archive).

the stratigraphy of the most recent sedimentary formations, in particular those belonging to the Oligocene, Pliocene, and Pleistocene Epochs, is quite vague.

Several other geological maps were made by the PGS staff, but they were never published as such, though they were included in papers published in the *CSGP*. These maps were of two sorts: either they resulted from fieldwork that was not yet completed, or they were maps on larger scales that the PGS did not intend to publish. However, by publishing these maps in the *CSGP*, the PGS was publicizing its work, and at the same time it made available scientific information. Table 5 presents the main characteristics of the maps published in the *CSGP*.

9. Conclusion

During the interwar period, the PGS was simply unable to carry out the geological surveying of Portugal and produce the appropriate maps and memoirs. Decree 4: 641, issued in 1918, removed most of the PGS autonomy, linking its purposes—or even subordinating them—to the GDMGS and to State mining interests. The GDMGS initial subordination to the Ministry of Labour and Social Welfare, and subsequently to the Ministry of Trade and Communications, followed by the Ministry of Trade and Industry, also reflected this situation. Despite keeping its name, the changes in its institutional setting had a common trait: all those Ministries had to deal with industrial issues, and notably the mining industry. This situation entailed the close dependence of the GSMGS, and therefore the PGS, on the industrial policies of the Government—a view shared by other authors who have written about the history of the PGS.⁵⁸ As usual, the people in charge of a public institution wanted it to have the greatest possible autonomy, as this provides the best position to ‘negotiate’ with the State when it requested funds, staff, or planning the work. Before 1918, various members of the PGS, especially its Directors, advocated and fought for the institution’s autonomy.⁵⁹ They thought this was the best way to run an institution with the PGS characteristics, as had happened in Britain. There, the autonomy of the Geological Survey had been strongly defended by its founder and first Director, Henry De la Beche,⁶⁰ and by his successor, Roderick Murchison.⁶¹

When comparing the PGS legal situation with that of similar institutions in other countries, we find that it was quite similar to the Italian situation, which had also a strong connection to the Corps of Mining Engineers. Quite different was the case

⁵⁸ J. Simões (note 1), 30; F. Almeida e A. Carvalhosa (note 3), 249 and 250; J. Neiva (note 3), 395; João Carrington da Costa, *Do Conhecimento Geológico de Portugal Continental* (Porto, 1942), 56; Carlos Teixeira, *Geólogos . . . para quê?!!!* (Lisbon, 1976), 5.

⁵⁹ Ana Carneiro, ‘The Travels of Nery Delgado (1835–1908) in the Context of the Portuguese Geological Survey’, *Comunicações do Instituto Geológico e Mineiro*, 88 (2001), 150–75; Ana Carneiro and Vanda Leitão, ‘Engineers at the Geological Survey of Portugal in the Nineteenth Century: Considerations on the Professionalisation of Geologists, in *Jogos de Identidade: os Engenheiros, a Formação e a Acção*, edited by Maria P. Diogo, A. Grelon, Irina Gouzevitch and Ana C. de Matos (in press).

⁶⁰ Paul J. McCartney, *Henry De la Beche: Observations on an Observer* (Cardiff, 1977), 37; J. Morrell, ‘Science and Government: John Phillips (1800–1874) and the Early Ordnance Geological Survey of Britain’, in *Science, Politics and the Public Good: Essays in Honour of Margaret Gowing*, edited by N. Rupke (Oxford, 1988), 7 and 8; Tom Sharpe and Paul J. McCartney, *The Papers of H.T. De la Beche (1796–1855) in the National Museum of Wales* (Cardiff, Geological Series No. 17, 1998), preface and 8; H. Wilson (note 4), 8–11; Oldroyd and McKenna (note 5), 197–200.

⁶¹ Archibald Geikie, *Life of Sir Roderick I. Murchison* (London, 1875).

Table 5. Geological maps published in the *CSGP* between 1918 and 1935.

Name of the geological map	Major earthquakes in Portugal	Geological Map	Geological Map of the Mangualde Region
Paper where it was published	'Principais macrossismos em Portugal', <i>CSGP</i> , 13 (1919–1922)	'Aperçu sur le Carbonique de la rive droite du Guadiana', <i>CSGP</i> , 15 (1924)	'Pegmatites mangano-litíferas da região de Mangualde', <i>CSGP</i> , 19 (1933)
Authorship	Francisco Luís Pereira de Sousa	Francisco Luís Pereira de Sousa	Amílcar Mário de Jesus
Scale	1:2 250 000 cm	1:200 000 cm	1:50 000 cm
Geological map most important features	Printed in black, white and red; with legend	Printed in black, white and red; with litho-stratigraphical legend	Printed in black and white; with lithological legend

with the British and the American Geological Surveys, which were free to employ whomsoever they wanted.⁶²

It is worth noting that the PGS was on the one hand a public institution whose main task was the geological surveying of the country, and on the other hand a scientific institution that was required to produce geological knowledge. The first aspect was undoubtedly a State matter, but the second had to do with scientific practice, a much more problematic matter in terms of State concerns and interests. Consequently, the PGS's financial and material resources fluctuated according to the interests of the Portuguese Governments. Even if the connection of the PGS with the mining activity might have been thought to imply that the institution could rely on the State's support, in practice it did not work that way. The PGS struggled with countless material difficulties. One of its main problems was the lack of money for fieldwork, and the publication of scientific research. Both activities were drastically reduced, as well as the levels of scientific productivity.

But money was not the only reason for the PGS's low level of productivity. During this period, a major problem was the shortage of staff. The PGS technical personnel was insufficient to accomplish all the tasks that needed to be carried out, and running the PGS in accordance with the complicated civil service procedures took up much of its time. Additionally, both engineers and mining technicians did not seem suited to most of the geological tasks. It is possible that many of them had insufficient geological expertise, or had no experience and did not even like geological work. It was in fact an anomaly that the PGS should have had such a high proportion of staff not formally trained as geologists. But engineers and mining technicians found in the institution a place where they could secure a position and earn a living as civil servants rather than as geologists. There were few State institutions in Portugal where engineers could secure employment, especially in a country where the private sector was modest and did not see the need for specialized personnel.⁶³ In a note dating from 1919, Paiva Mourão, then Director of the PGS, wrote to the GDMGS director, saying that 'the PGS staff is composed of engineers... but they should not devote themselves to the PGS alone; rather they must be always ready to perform any technical service when needed'.⁶⁴

Also, when analysing the PGS written scientific work, it stands out that most of it was written by people *outside* the institution and that a significant number of research papers were *unrelated to geology*. As for the research papers written by the PGS technical personnel, for instance those written by Pereira de Sousa, they are rather eclectic. At a time when geology was becoming specialized, this situation was becoming quite anachronistic and reveals the state of this science in Portugal.

Regarding fieldwork, most of it was carried out by the PGS field assistants, who seem to have been the only heirs of the tradition inaugurated in Portugal by the PGS back in the nineteenth century.⁶⁵ In fact, it was they who kept this tradition alive while the institution waited for better days.

⁶² For the Italian case, see P. Corsi (note 5); for the American case, see H. Wilson (note 4).

⁶³ H.G. Botto, 'Engenheiros através do Diário do Governo?Compilação', *Técnica*, 27 (1936), 1–71; C.A. Sepúlveda, *História do Exército Português* (Lisbon, 1912); Maria P. Diogo, *A Construção de uma Identidade Profissional: A Associação dos Engenheiros Cívicos Portugueses, 1869–1937* (unpublished Ph.D. dissertation, New University of Lisbon, 1994).

⁶⁴ Written note from Paiva Mourão to the GDMGS Director, 28 August 1919.

⁶⁵ All the evidence points to the fact that the role of PGS field assistants in the institution has no comparison with that accomplished by field assistants of other national geological surveys.

The state of affairs at the PGS was, needless to say, associated with the situation of Portuguese geology as a whole in the early twentieth century. The practice of geology in Portugal had its own idiosyncrasies. Throughout the nineteenth century, there had never been a significant amateur tradition in the country as compared with Britain, for instance, and the professionalization of geologists occurred quite late: the Portuguese Geological Society (*Sociedade Geológica de Portugal*) was only formed in 1940. The title of 'geologist' was given to people who had not really been trained as such but who carried out geological tasks, especially within the frame of civil service. The majority were engineers who had a taste for geology, like Pereira de Sousa, but their knowledge of geological matters was only general and was far from the specialization, which took place in geology in other countries. In addition, the only working positions for someone with knowledge of geological matters was—beside the State—the private mining sector but only to a limited extent.⁶⁶

At the beginning of the twentieth century, the institutional landscape of Portuguese geology was much the same as that of the previous century. Geology was not taught in Portuguese universities, and there was nothing similar to a degree in geology. University curricula, which included lectures in mineralogy and geology were scarce and designed to be part of degrees such as philosophy, mathematics, and natural sciences. Only in 1930 was the Licentiate in Geological Sciences established in the Portuguese Universities (then Lisbon, Oporto, and Coimbra).⁶⁷ Technical institutes and the Military Academy in Lisbon were the other institutions where some topics in geological science were taught, but only to a limited extent.⁶⁸ Various Portuguese scientists maintained that the teaching of geology in higher education, in so far as it existed at all, was too bookish, framed in a natural-historical perspective, and was even opposed to fieldwork!⁶⁹

In the first decades of the twentieth century, then, the PGS reflected the deficiencies of Portuguese geology and Portuguese society in the wider context. Given this situation, between 1918 and 1935 the only thing the PGS could do was to manage its own survival as a public institution as best as it could. In those years, the PGS was little more than a shadow of a geological survey.

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⁶⁶ Most of the mining explorations in Portugal did not employ specialized personnel, and those that did were owned by foreigners who preferred to employ technical personnel from their own countries. António de Mello Nogueira, 'Elementos para o estudo da indústria mineira em Portugal nos anos de 1930 a 1939', *Boletim de Minas*, Ano de 1939 (1941), 3–23.

⁶⁷ M. Portugal Ferreira (note 9), 72.

⁶⁸ H. Botto (note 63), 26–34, 38–42 and table II.

⁶⁹ A. Machado e Costa (note 50); Orlando Ribeiro, 'Ernest Fleury e o Ensino da Geologia', *Boletim da Sociedade Geológica de Portugal*, 13 (1958–1960); António Celestino da Costa, *A Universidade Portuguesa e o Problema da sua Reforma* (Porto, 1918).

(IGM) for the raster version of the Cascais geological map. I also wish to thank the anonymous referees for their comments and suggestions.

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