# A Revolution in Applied Geophysics in Brazil (1930-1960)*

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## Abstract

Imported technology and the efforts of professionals with foreign companies radically changed the use of geophysics for petroleum exploration in Brazil in the mid-Twentieth Century. From 1920 new "drilling geophysics" technologies rapidly resulted in more accurate identification of prime drilling targets and the discovery of significant oil fields. In 1930, the demand for oil in Brazil contributed to the federal government's investment in new geophysical techniques and methods (applied geophysics) to locate oil fields with more precision. Within six years, the Mineral Production Development Survey (Serviço de Fomento da Produção Mineral – SFPM) had acquired sufficient equipment to perform geophysical exploration with magnetic, gravimetric, electrical, seismic, and radioactivity methods. However, some equipment did not meet the requirements for Brazilian field work, even though it had been designed in Rio de Janeiro by technicians of a predecessor institution. Beginning in the 1930s, the National Oil Council (Conselho Nacional do Petróleo – CNP) contracted with North American companies such as United Geophysical Co. S.A., Geophysical Services Inc., DeGolyer & MacNaughton Co., and Exploration Surveys Inc., to apply a variety of geophysical methods in Brazil. In 1955, the Petrobras Exploration Department invested in local seismic, gravimetric and geological mapping teams. Headed by North American geologist Walter Karl Link (1902-1982), they also invested in the day's best available geophysical exploration technologies, mainly refraction seismic. The combined efforts of Brazilians and North Americans were critical to the development of new techniques and the discovery of new oil fields.

## Introduction

In the XIX century, world's oil drilling frequently resulted from a tactile approach and some luck to find and locate it. In the XX century, when "petroleum geologists began to rationalize and codify prospecting, Everette L. DeGolyer (1886-1956), one of the most influential geologists of his time, noted: "it takes luck to find oil" (Frehner, 2011). Even in an era of scientific and technological discoveries, a combination of ability and luck was still necessary. This combination expressed the knowledge acquired throughout time and place, mainly from local geological studies, and the sagacity to use the available technology to find oil.

Until 1920, geology provided some hints regarding anticlines and salt domes to be surveyed, found, and drilled for the search of oil deposits (Mau and Edmundson, 2015). After this decade, the new geophysical techniques and methods (that is, applied geophysics) complemented and expanded current surveying practices, helping to locate with more precision the targets for drilling. The contribution of the so-called "exploration geophysics" rapidly spread itself and resulted in the discovery of large oil deposits, mainly along the North American Gulf Coast, in Texas, in Mexico, and in other places around the world. Its technological development and the continuous innovation became the basis for oil exploration during the XX century onward (Frehner, 2016).

Brazil experienced the consequences of this process in the period analyzed here (1930-1960), being dependent on the importation of technology to explore oil: as an example, we could mention North American drilling probes and services of companies hired to research oil. The country still needed professionals, and new techniques to be specifically applied to the geology of Brazilian territory. In this period, the joint work between Brazilians and foreigners was also relevant for the discovery of new oil wells in Brazilian territory. Therefore, this work aims to discuss a revolution in applied Geophysics in Brazil between 1930 and 1960 (Figure 1).

## Using Geophysics in Brazil

In 1929, the Ministry of Agriculture designated a commission of professionals, mostly linked to the Serviço Geológico e Mineralógico do Brasil – SGMB (Geological and Mineralogical Survey of Brazil), for a six-month trip to the United States. The tour aimed at investigating and searching for solutions for some industrial problems faced by Brazil, with particular attention to the "exploitation methods of lead and zinc deposits, metallurgical treatment applied to these minerals, and the process of silver recovery in it" (Moraes, 1930).

In 1930, after their return, engineer Luciano Jacques Moraes (1896-1968) published a report about the visit. Moraes devoted a whole chapter to the geophysical process of surveying and insisted upon the necessity of applying geophysics in Brazil. Chapter IV of the report, entitled Processos Geofisicos de Prospecção (Geophysical Processes of Surveying), presented data related to financial costs, technical teams, and geophysical tools, and counted on the contribution of the geophysicist Mark Cyril Malamphy (1902-?). They suggested the application of geophysical methods as soon as possible and, as already mentioned, the creation of a complete geophysical department within the SGMB.

In 1933, Mark Malamphy was officially hired to work in the SGMB. Malamphy's work also encompassed instruction and training of several SGMB engineers, with whom he should perform magnetic and gravimetric activities in some Brazilian states, as was done. In 1936, the Serviço de Fomento da Produção Mineral - SFPM (Mineral Production Development Survey), an institution that replaced the former SGMB, already counted sufficient instruments and equipment capable of performing geophysical exploration through magnetic, gravimetric, electric, seismic, and radioactivity methods.

However, some equipment did not fit the requirements for Brazilian territory sometimes. Even in difficulties, Mark Malamphy and his team applied different geophysical methods, such as magnetic, magnetic and gravimetric, electrical resistivity, in various Brazilian states. These efforts did not exclusively emphasize oil prospecting but were thought to contribute to the study of other topics like quakes (seismic movements) and mineral deposits, with a stronger focus on gold exploration too. Although Mark Malamphy's contract in Brazil finished in

1936, the geophysical work continued through Brazilian hands from 1937 onwards and, in the following years, in partnership with foreign companies, predominantly North Americans. In this period, magnetic profiles, studies with Torsion Balance and seismographs were performed (Abreu, 1948).

## Geophysics and the North American Companies

In Brazil, two federal acts changed the trajectory of oil politics and economics, both in the national and international levels. The first one, dated 29 April 1938, created the Conselho Nacional do Petróleo – CNP (National Council of Oil), and the second, 03 October 1953, created Petrobras. This company began its activities in 1954, gradually aggregating the CNP's structure (and absorbing its problems), until the subsequent closure of the Council. From the existence of Petrobras onwards, the rights over Brazilian oil became a federal monopoly. Petrobras and CNP played a central role in implementing geophysics in Brazil.

In 1939, the CNP initially contracted with the North American company United Geophysical Co. S.A., from Pasadena, California, specialized in seismic survey. The United Geophysical Co. committed to bringing Brazil the most modern equipment and an experienced team of specialized technicians. For that reason, it may be considered an economical and technical exchange between North Americans and Brazilians (Mais um grande, 1940). Previous geophysical works executed by the United Geophysical Co. contributed to the discovery of oil in Brazil on 21 January 1939 in Recôncavo Baiano, Bahia State, Brazil (Paiva apud Oliveira, 1940). The work of the United Geophysical Co. with Petrobras continued for years.

Another North American company that also operated in Brazil was the Geophysical Service Inc., who used refraction and reflection seismic methods to find oil. It is important to highlight that the company kept the partnership with Petrobras for decades. To complement the services performed by the two companies mentioned above and to promote the search and exploitation of oil in the country, the CNP hired, in 1944, the famous North American company DeGolyer and MacNaughton, from Dallas, Texas, as a consultant to guide oil survey (Oliveira, 1955). Subsequently, following the suggestions given by the DeGolyer & MacNaughton Co., the CNP contracted another company linked to geophysics, the Exploration Surveys Inc., from Dallas, Texas, to perform gravimetric studies.

In 1954, when Petrobras' activities began under Federal, state monopoly, the company focused on building up a Department of Exploration – DEPEX –, which depended less on imported technology, aimed at developing its own know-how. In the same year, to organize and structure this department, the company hired the North American geologist Walter Karl Link (1902-1982) as the Superintendent-in-Chief, one of the most important positions in the Brazilian oil industry at that moment (Peyerl, 2017).

Link began his work by hiring and assembling a large group of foreign and Brazilian professionals. In February 1956, the Department of Exploration had District geologists, field geologists, and geophysicist interpreters (Peyerl et.al, 2016). Thus, Walter Link erected an ambitious exploration program (Dias and Quaglino, 1993), with an organizational structure based on the North American industry, which was essential to change the course of exploration in Brazil. He invested in seismic, gravimetric and geological mapping teams to the locals (Peyerl et.al, 2016). However, unfortunately, some points where perhaps not possible to find oil and could not be explored because it could not reach the necessary depth.

Link also opted to invest in the best available technology of those times to find oil, mainly geophysical ones, seismic of refraction for example, emphasizing that "the evolution of the tools could reverse" Brazil's current situation related to unearthing new exploration points (Milani et.al., 2000). Walter Link also insisted upon the idea of directing the studies towards the Brazilian continental shelf. However, it would have to "wait for the development of more advanced seismic technology for surveys and more powerful computers for processing the geophysical data" (Gall, 2011).

## Conclusions

The strong Brazilian interest in finding oil and thus to become a huge producer encouraged the country to invest in exploratory oil research. Frequently, scientific institutions followed international standards, hired foreign specialists, and adapted new institutional models from the Northern hemisphere. In the particular case of the oil industry, North Americans, in a joint work with Brazilians, helped to upgrade the pursuit of new techniques and oil fields.

In the 1950s, Petrobras began to invest massively in the establishment of research centers, and in the labor force. Specifically, in this case, it is worth noticing the creation, in 1955, of the Centro de Aperfeiçoamento e Pesquisa de Petróleo – CENAP (Center of Improvement and Oil Research), later replaced by the Centro de Pesquisas e Desenvolvimento – CENPES (Research and Development Center Leopoldo Américo Miguez de Mello) founded in 1963. At first, the CENAP promoted courses aimed at the training and professionalization of the workforce, as well as advanced technological exploratory researches directed to oil. On the other hand, CENPES operated more closely to the oil industry, performing mostly scientific and/or technological research – a somewhat different goal from CENAP, which is understandable if we keep in mind that, in 1963, Petrobras was already ten years old and faced new challenges for its expansion (Peyerl, 2017).

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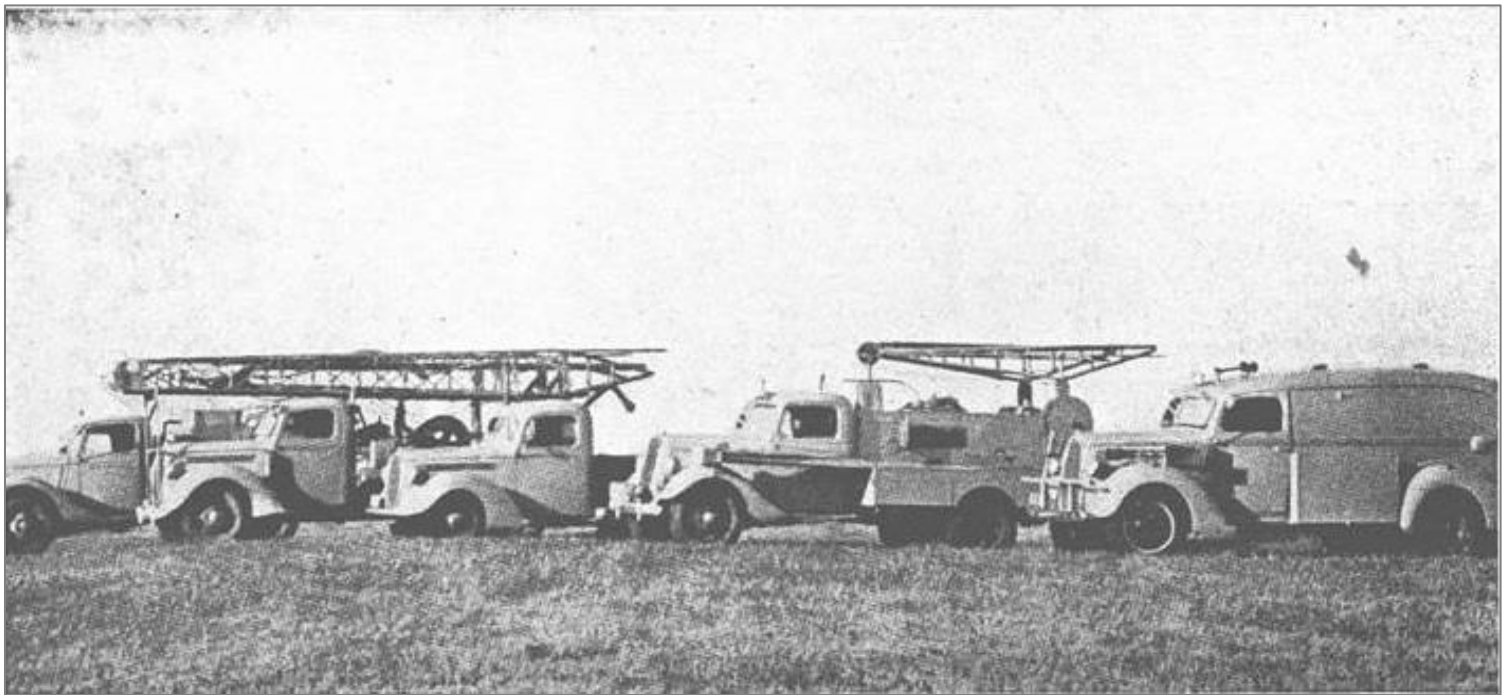

Figure 1. All the field equipment of reflection seismograph. From right to left: water tank, seismographic probe, topographer's truck, explosives car, and register truck (Eichelberger, Jr. and Oddone, 1941).