



PETROLEUM IN THE SPANISH IBERIAN PENINSULA

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Abstract. The main events of the history of petroleum in Spain are the following: 1) The mining concession of petroleum named *El Progreso* is the first one in Spain and occurred only seven years after Edwin Drake (1819-1880) drilled the first oil well in Pennsylvania. 2) The first survey of oil production in Spain, well known as the *Tejón* borehole, was conducted by the Sondeos de Huidobro Company in 1900, in Huidobro (Burgos), and reached 501 m of depth. 3) In 1964 CAMPSA and AMOSPAIN found petroleum in the Ayoluengo field (Burgos), with a borehole of 1,349 m of depth. This was the first and only petroleum field in the continental Spain in this zone. The Ayoluengo petroleum field has been active during 35 years. In this paper we will review the history of petroleum in peninsular Spain.

1. INTRODUCTION

It has been historically known the existence of several oil evidences of solid, liquid and gaseous seeps in Spain. These evidences have guided the identification of areas that are favorable for the research of petroleum deposits.

With the discovery of some oil fields in the USA (1859), the search for this substance in Spain began. Thus, Ríos (1949) established three stages: 1) 1860-1918: based on improvisation, drilling boreholes and studies made no shortage of findings; 2) 1918-1939: with the major intervention of the Geological Survey of Spain and other Government agencies in the investigation; 3) Since 1939: with an ordering of investigations and use of more effective methods and tools, which led to the discovery of the oil field of Ayoluengo in Burgos (Northern Spain) (1964).

2. HISTORICAL EVIDENCES OF PETROLEUM

Evidences of oil have been mainly observed in the Basque-Cantabrian basin, but also in the Ebro basin, the Iberian Chain flanks, Andalusia, etc. The most significant ones are described below:

According to geographer Al-Udri (1003-1085), asphalt was extracted from the bituminous slates located near Sigüenza, Guadalajara (Vallvé Bermejo, 1996), which was similar to black fish-like bitumen or naphtha. We will no longer hear about this exploitation until the nineteenth century -i.e. in 1873 a bituminous shale

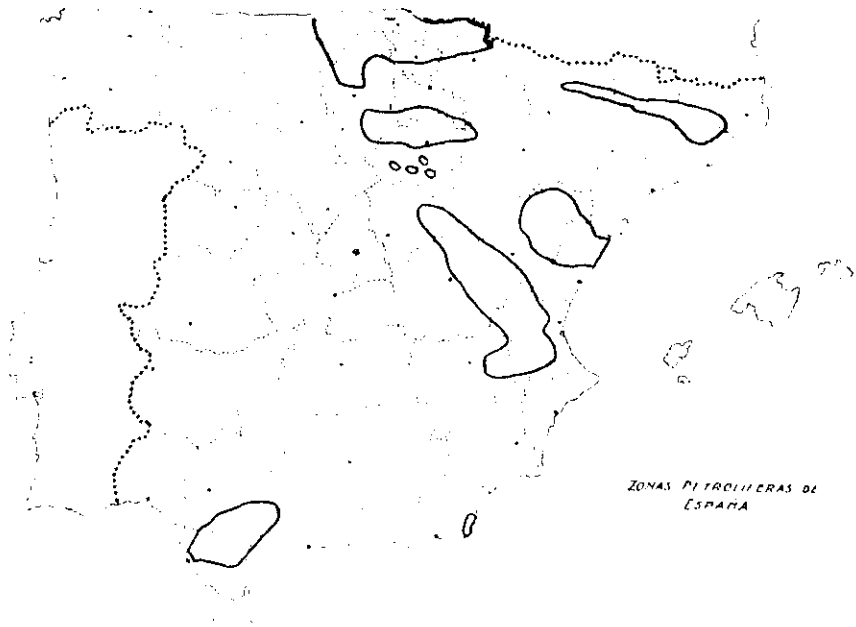


Figure 1. Map of favourable oil zones (Dupuy de Lôme, 1937).

mine called *La Fotogénica*, located south of the mill *La Raposera*, with 18 possessions, owned by Marcelino Franco, was registered (*Boletín Oficial de la Provincia de Guadalajara*, 9-V-1873). Later on, some other nearby concessions were also registered. They were called: *Por Si Acaso*, *San Adame*, *San Rafael*, *El Porvenir*, *Las Marianas*, and *Elisita*; but they had little success. In the volume of 1885 of the *Revista Minera* (p. 96) there is information about the oil mines of Sigüenza.

The Spanish Mining Statistics of 1860 (*Revista Minera*, 1862) mentioned the exploitation of asphalt from Maeztu (Álava, Northern Spain), whose extraction dates from the seventeenth and eighteenth centuries. The *San Ildefonso* mining concession was obtained in 1863. In the second half of the nineteenth century and the beginning of the twentieth century two dozens of concessions were requested in this area, emphasizing the creation of the Society of Asphalt from Maeztu in 1892. This exploitation has lasted until the present days.

Amalio Maestre e Ibáñez (1812-1872) in the "Descripción física y geológica de la provincia de Santander" (1864) noted the existence of mineral oils, previously studied by the mining engineer Cirilo Tornos (1828-1865). He was sent to Santander in 1859, where he remained until he became inspector of mines in the island of Santo Domingo in 1864. According to Maffei and Rúa de Figueroa (1872), "In this province he noticed the abundance of bituminous slates that were completely abandoned and began the study of their use and benefit". Also, in 1876 José González Lasala studied the bituminous oils of the Burgos and Santander Provinces (Mazarrasa and Luna, 1923).

Asphalt linked to the Wealdean sandstones of Fuentetoba (Soria), whose exploitation by underground mining began around 1850 (Dupuy de Lôme, 1937), was also recorded. When King Alfonso XIII inaugurated the Numantine Museum (1919), he received distilled gasoline for his car obtained from these bituminous sediments (*La Vanguardia Española*, 25-VII-1954). Gaya Nuño (1965) noted that the oil from Fuentetoba was also

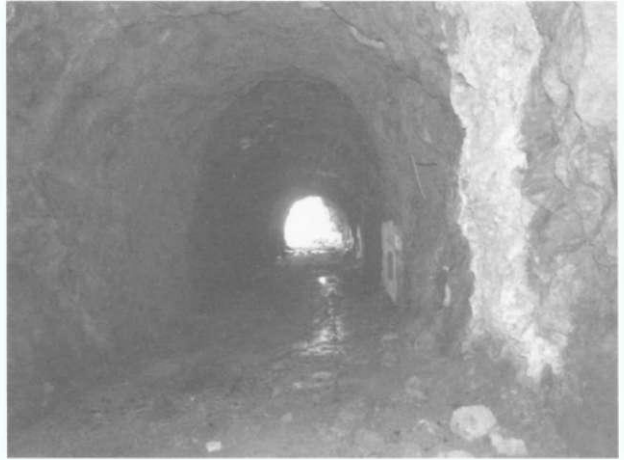


Figure 2. Book of the oil mines in Sigüenza

Figure 3. Asphalts from Maeztu (Álava, Northern Spain) in 1971.

used to illuminate the city of Soria. The Spanish government drilled a 400 m borehole between 1928 and 1929 in the PicoFrentes anticline, which cut diverse asphalt beds (Dupuy de Lome, 1937). Also, during the Second Republic, several surveys in the Sierra de Fuentes were made and 13 beds of tar sands were cut (ABC, 7-II-1935).

In Riutort (Barcelona) bituminous marls were exploited since 1898. French-born Jules Clavez and Philippe Petit, belonging to the Riutort Mining Company, extracted 500 tons of asphalt by means of underground mining between 1905 and 1917. Nowadays, this mine has been transformed into a museum (www.minadepetroli.com). Other oil evidences in Catalonia are those of Boixols, Abella de la Conca and Sallent de Montanisell (Lérida), San Julián de Vallfogona, Castellfullit de la Roca, San Lorenzo de la Muga, and Oix (Gerona).

In the Aragón region, the main historical evidences were located in the Bigornia Range (Zaragoza), Loarre (Huesca), and Albalate del Arzobispo, Ariño and Oliete (Teruel); in the Valencia region, Ribesalbes (Castellón) was the most important one, whereas in the Castilla-La Mancha region, the most significant evidences were observed along the whole Cuenca province, and in Barajas de Melo. In Andalucía, the main evidences appear in the Provinces of Cádiz and Sevilla (Dupuy de Lôme, 1937).

In the report of the president of the Mining Council, José María de Madariaga (1917), the oil evidences in Cádiz and Sevilla were noted by Solvay (Hevia, 2001), and also the tar sands of Fuentetoba and Cidones (Soria), the tar sands of Puerto del Escudo (Santander), the sands and bituminous limestones of Maeztu (Spain), and the discovery of oil in Barreda (Santander). Evidently, there were more evidences, but the abovementioned were the most significant ones.

3. THE FIRST CONCESSIONS AND THE FIRST BOREHOLES

The first survey of oil production in Spain (but without any economic benefit), known as the *Tejón* borehole, was conducted by the Sondeos de Huidobro Company in 1900, in Huidobro (Burgos), and reached 501 m of depth (Ayala, 2007). In the late nineteenth century a 40 m borehole was already drilled (Dupuy de Lôme, 1937).

According to the Spanish Mining Statistics in 1866 (*Revista Minera* 1868, 19, pp. 728-729), in this area



Figure 4. Oil mine of Riutort, Alto Bergadá, Barcelona.

there was something like crude oil inside the *La Borrega* mine, "The waters that seep through the ground and run along the sandstone layers that constitute it, drag a certain amount of mineral oil". For this reason, the mining concession called *El Progreso* began to operate. According to Pascual Madoz (1847), these copper mines were opened in the eighteenth century, and they were re-opened in 1841 by the company *La Iberia*, which named the mine *La Borrega*. In 1858 two other mines related to the same substance were opened, under the names of *Aristóteles y Convertida*. The concession of *El Progreso* is the first one in Spain and occurred only 7 years after Edwin Drake (1819-1880) drilled the first oil well in Pennsylvania. As indicated in the Mining Statistics, "...there is a new industry that may be of incalculable future for the country". In 1872 an attempt to distill the tar sands in the area was performed, operated by a hole dug on the north side of Peña Redonda (Dupuy de Lome, 1937).

Curiously, after the demarcation of *El Progreso*, a newspaper from Madrid called *La Gaceta de Madrid* (September 3rd, 1867), containing what it was published in the *Diario de Barcelona*, provided "news on the discovery and exploitation of a mineral oil called petroleum". Details on the opening of the first well in Pennsylvania by Drake were also given.

According to Gavala (1916), in 1860 there was an attempt to extract oil out of bituminous slates from the Grazalema Range. The presence of oil in the sulphur mines of Conil (Cádiz) was mentioned in 1894. In 1895 oil appeared when drilling a water well in the area of Jerez de la Frontera. In 1906 oil and ozokerite were found in the area of Villamartín. In 1907 gaseous emissions were observed near a farmhouse of Santo Domingo, close to Jerez, and a concession for oil was requested. In 1908 gas emissions were also observed in the fountain of Pambauco, west of Lebrija, next to the Guadalquivir River marshes, and the Oil Company of Pambauco was created (See *Revista Minera Metalúrgica y de la Ingeniería*, 1910, 345). Soon, after a host of foreign engineers (Marshall, Petit, Leblanc) and national ones (Mallada, Velázquez and others), studied this area, boreholes were drilled in

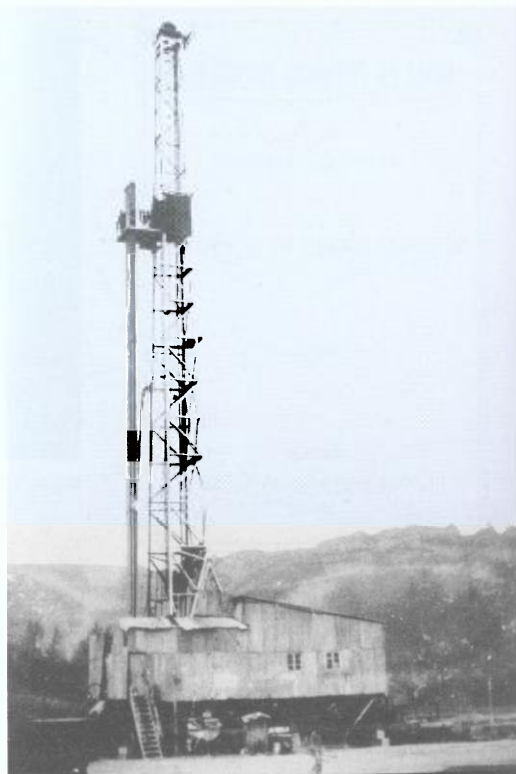


Figure 5. Zamanzas borehole (Libro conmemorativo de CAMPSA, 1928-1958).



Figure 6. In 1937 or 1938, and during three years, the borehole of Chinchilla was drilled. Later, in the 1950s, another borehole was drilled (www.chinchillademonetaragon.com).



Figure 7. Zumaya borehole (Archivo General de Guipúzcoa Guipuzcoaco Artxibo Orokorra_OA06785).

the 1920's, believing that under the Triassic surrounding the Demanda Range (Burgos) Permian materials were located, sediments that were oil productive in other parts of Europe, boreholes were drilled by a Swedish company in Palazuelos de la Sierra and Salguero of Juarros, with negative results" (Ayala, 2007).

Villamartín and Bornos (Cadiz), as well as several ones were drilled in Lebrija (Sevilla). Gavala thought that the source rocks were the clays with evaporite meterils of Triassic age, but the scarce of oil in these rocks made everybody aware of the possible existence of oil deposits in reservoir rocks of the area.

During those years, interest arose on the Basque-Cantabrian basin, where there were well known oil evidences, generally located in the continental facies of Purbeck or Weald. For this reason, some boreholes such as the Salvatierra one (Álava, Northern Spain), conducted by the Geological Survey of Spain in 1915, were drilled.

The First World War stimulated the search of oil resources and especially the application for concessions. Because of this, many oil companies were incorporated. A brochure of Sánchez de Toca (1917) entitled "The oil as a main product for our national economy", notes the emerging suggestions in favor of oil exploration and exploitation of national oil, as well as those for creating a state monopoly in the distribution sector. In 1920 the Geological Survey of Spain sent several geologists to visit the major oil-producing countries, to acquire some knowledge on the matter (Ríos, 1949). Also, foreign geologists such as Faison Dixon, who worked in the Gastain borehole (1923), came to Spain. Until then, boreholes did not exceeded 700 m of depth and the evidences found were scarce. But, in the 1920's boreholes deeper than 1,000 m began to be drilled, such as Ahedo (Burgos), Gastain (Navarra) and Ajo (Santander), along with shallower ones. Until the Spanish Civil War (1936-1939), a total of 11,000 m were drilled. Numerous indications were cut, but none of the boreholes were productive. At this time, a scheduled survey with geological criteria was performed (searching for structures and/or formations) and the first geophysical surveys were also carried out, such as that of the Geological Survey of Spain in the area of Garrucha, Almería (1932). However, certain geological knowledge was lacking, and "in

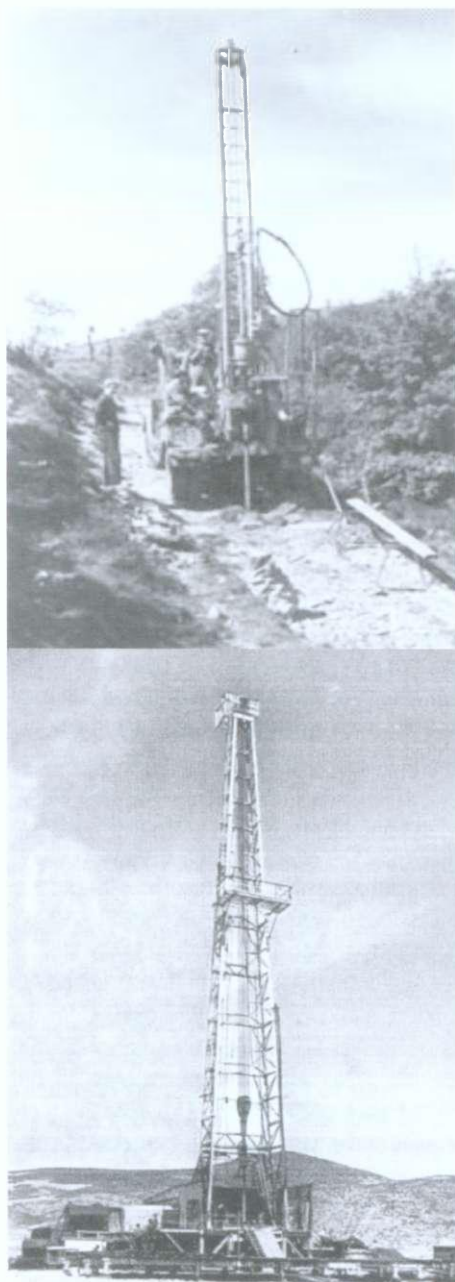


Figure 8. CIEPSA borehole in the Basque-Cantabrian Basin (Archivo Territorio Histórico de Álava-DAF-SCH-13760), and drilling rig of ADARO Company (*Industria Minera*, 1968).

In Table 1, we provide a list with the first main boreholes drilled in Spain (Mallada, 1910, Gavala, 1916, Dupuy de Lôme, 1937, *ABC* 1-Sep-1926, García Portero, 2004, López Peña, 2005, *La Vanguardia* 26-Sep-2006, Baquedano, 2007).

The company named Compañía Arrendataria del Monopolio de Petróleos Sociedad Anónima (CAMPSA) -founded in 1927 after the Law of Petroleum Monopoly of June 28th, 1927, was approved by the dictatorship of Miguel Primo de Rivera- was the first devoted to the petroleum industry in Spain. CAMPSA assumes a monopoly on the importation, processing, storage and distribution of oil, but not on the research and production areas (although these areas were also considered when it was founded). In 1937, during the Spanish Civil War, one of the parties (the Nationals) created a Survey section (belonging to the Department of Industry). However, it is not until the end of the Spanish Civil war that CAMPSA found evidences of petroleum in borehole N° 7 from the Zamanzas valley (Burgos), of 2,177 m of depth.

Until the foundation of CAMPSA, Shell and Standard Oil companies controlled the whole Spanish market and 80% of the global market. The strong economic interests led the USA and Britain to work hard in the destabilization and eventual overthrow of Primo de Rivera's dictatorship, founder of the Spanish monopoly on petroleum (<http://es.wikipedia.org/wiki/CAMPSA>).

4. OIL AFTER THE SPANISH CIVIL WAR

During the Civil War, three boreholes began to be bore, but drilling was interrupted by military activities. From these boreholes, only the one located in Tremp (Lérida) was finished, reaching 1,700 m of depth (Ríos, 1949). In the Hall containing the Library of the Republic (Salamanca Archive Series) there are several technical reports on the Isona boreholes, in addition to reports on the oil possibilities of the Tremp basin in 1937. We do not know if Ríos (1949) considered in this group the borehole of Chinchilla (Albacete), which reached more than 600 m of depth.

In 1937 a section devoted to prospection was created within CAMPSA Company, and the area between Pamplona (Navarra) and the Puerto del Escudo (Santander), an area with many evidences, began to be explored.

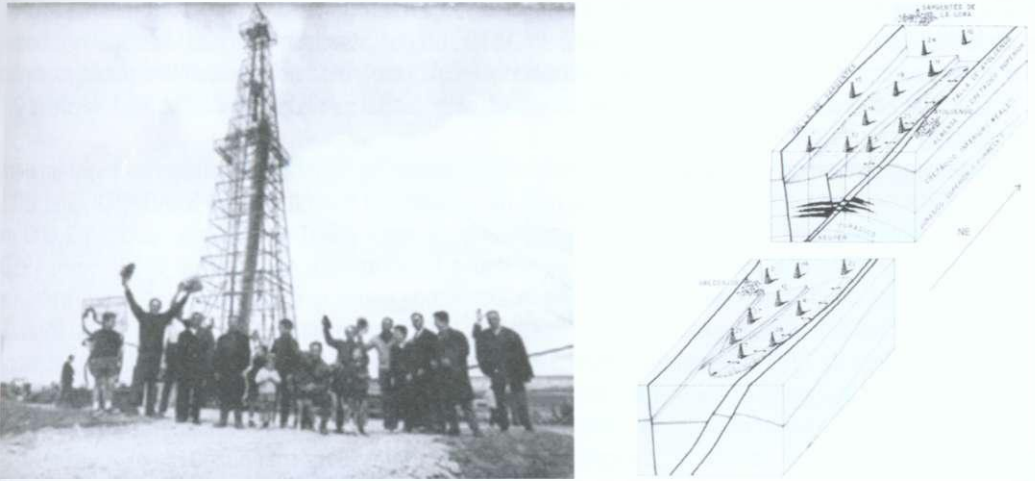


Figure 9. Oil discovery in Ayoluengo (1964) (*La Vanguardia Española y ABC Sevilla* 9-Junio-1964). Scheme of the Ayoluengo oil field (Hevia, 1998)

Site	Year	Company	Depth	
1.-Huidobro (Bu)	1900	Soc. de Sondeos de Huidobro	501	+
2.-Utrera (S)	1910		600	
3.-Salvatierra (Vi)	1911	El Estado (IGE)	200	
4.-Villamartín (Ca)	1915	El Estado (IGE)	377	
5.-Lebrija (Se)		Cía. Petrolífera de Pambauco	300	+
6.-Condado Treviño (Bu)			641/200	
7.-Polanco (S)		Solvay	700	+
8.-El Robredo-Ahedo (Bu)	1922		1010	+
9.-Elorrio (Bi)	1923		600	
10.-Leva (Bu)			600	+
11.-Gastain (Na)	1923	Soc. Petrolera-Iberoamericana (con la participación Interocean Oil C° de New York)	1660	+
12.-Aras (Na)			700	
13.-Jaizquibel (SS)	1923		615	
14.-Tona (B)	1929		700	
15.-Ajo (S)	1926-27	Soc. Petrolera-Iberoamericana	1200	
16.-Bornos (Ca)	1928-29	El Estado	500	
17.-Fuentoba (So)	1928-29	El Estado	398	+
18.-Ronda (Ma)	1932-34	Copropiedad Petróleos de Ronda	500	

Table 1. First main boreholes drilled in Spain.

The petroleum company Compañía de Investigación y Explotaciones Petrolíferas (CIEPSA), founded in 1940, discovered gas near Vitoria (Álava) in 1959. CIEPSA was subsidiary of the Spanish Company of Petroleum (Compañía Española de Petróleos-CEPSA), the first main petroleum public company in Spain (incorporated in 1929). CIEPSA was created with capital provided by CEPSA and Vacuum Oil Spain (Socony Vacuum Oil).

A systematic exploration of large areas of territory was performed by Spanish and foreign geologist (mainly Germans and Americans) under CAMPSA and the national company of mining research's (ADARO) -and later on CIEPSA- command. CIEPSA provided equipment capable to reach 2,500 m of depth, reaching 2,000 m in Oliana (Lérida) in the late 1940's. In 20 years more than 61,000 m were drilled (Ríos, 1959). Since 1950 Schlumberger tests begun to be performed (logging in exploration wells) in the boreholes of Peña Ortún, La Marina, Boltaña and San Lorenzo de La Parrilla. Also, CIEPSA found natural gas in Castillo, near Vitoria (Álava), in 1959. From 1963 to 1981 this fuel was extracted for the first time in Spain, drawing 33 Mm³ that were transported through a pipeline of about 4 km long to diverse factories: BH (bicycles) and Esmaltes San Ignacio. CIEPSA also reached 5,000 m of depth in 1960 in a borehole conducted in Santa Cruz de Campezo, with a machine imported from USA, whose value exceeded 31 million pesetas (Baquedano, 2007).

Under the Decree of December 12th, 1952, oil research was declared of national interest and was supervised by the National Institute of Industry (INI), which could engage association with other entities. All reserves found along Spain, except those areas with existing permits or concessions, are also considered as a national property.

In 1950 George Cramer visited the Navarra region and found geological similarities with the State of Colorado (USA); then he decided to invest in oil in the Ebro basin. For this purpose, Valdebro was established in

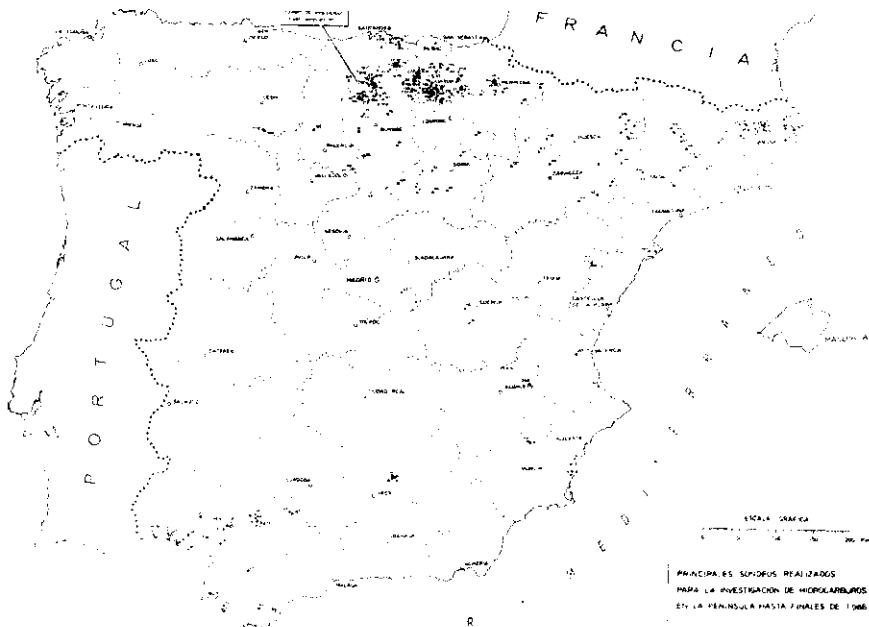


Figure 10. Location of major oil boreholes in Spain (Ríos, 1968). Most of them are located in the Basque-Cantabrian basin.

1953, a consortium formed by the National Institute of Industry (ADARO) and several USA companies (General American Oil Co. of Texas, Tyler Delta Drilling Co., and GSI). After the seismic survey of the subsurface geological structures, the Marcilla-1 borehole was drilled, reaching 3, 415m, but with negative results.

Some of the main boreholes drilled after the Spanish Civil War (Ríos, 1958) are listed in Table 2.

Site	Year	Company	Depth	
1.-Zumaya (SS)	1940	CAMPESA		
2.-Tudanca (Bu)	1941	CAMPESA	445	
3.-Valle Zamanzas-1 (Bu)	1942	CAMPESA	602	+
4.-Valle Zamanzas-2 (Bu)	1944	CAMPESA	820	+
5.-Valle Zamanzas-3 (Bu)	1945	CAMPESA	860	+
6.-Oliana (L)	1947-48	CIEPSA	2223	¿?
7.-Chiclana (Ca)	1947-49	ADARO	747	+
8.-Peña Ortún (Bu)	1947-50	CAMPESA	1246	+
9.-Burgo de Osma (So)	1949-50	CIEPSA	2212	
10.-La Marina (A)	1950-51	CIEPSA	1610	
11.-Dobro (Bu)	1951	CAMPESA	1221	
12.-Rojales (A)	1952	CIEPSA	1552	
13.-Villanueva de Ramplay (Bu)	1952-53	CAMPESA	2177	+
14.-Boltaña (Hu)	1952-54	CIEPSA	2124	
15.-Baena (J)	1953	ADARO	410	+
16.-Marcilla (Na)	1953	Valdebro	3415	
17.-Baeza/Bailén (J)	1953-54	ADARO (3 sondeos)		+
18.-Delica (Bi)	1953-54	CAMPESA	358	
19.-Castilfrío (So)	1954	Valdebro	2400	
20.-Zúñiga (Vi)	1954	CIEPSA-Socony Vacuum Oil	2050	+
21.-Chiclana (Ca)	1954-56	ADARO	1033	+
22.-Apodaca (Bi)	1955	CIEPSA	2535	
23.-S. Lorenzo de la Parrilla (Cu)	1955	Valdebro	2580	
24.-Iglesias (Bu)	1955-56	Valdebro	2180	
25.-Puigreig (B)	1956	Valdebro	3192	
26.-Bornos-Villamartín (Ca)	1956	Valdebro	3027	
27.-Leva (Bu)	1956	CAMPESA	580	+
28.-Matienzo (S)	1956	Valdebro	1950	
29.-Laño (Bu)	1956-57	CIEPSA	3501	+
30.-Alda (Na)	1956-57	CIEPSA	3540	+
31.-Almarchal (Ca)	1956-57	Valdebro	3045	+

Table 2. Main boreholes drilled after the Spanish Civil War (Ríos, 1958).

Until 1956 one or two oil research boreholes were performed per year, maximum three. From this year on to 1961 the number of boreholes drilled reached 11-13 per year, a number that increased after 1962 due to the Oil Law of 1958.

5. THE OIL LAW OF 1958 AND THE DISCOVERY OF OIL IN BURGOS

On December 26th, 1958, the Law on Legal Regime of Research and Exploitation of Hydrocarbons was approved. This is the first time oil was regulated independently of mining activities (this law would be complementary to the Mining Law of July 19th, 1944). The regulation implementing this Law was approved under the Decree of June 12th, 1959. This legislation strengthens the country's presence, thinking on the domestic supply, even though the international blockade of the United Nations to Francisco Franco's dictatorship (1950) had ended and agreements with the USA military bases (1953) had been signed. The main changes were that Spain opened to foreign capital (Chevron, Texaco, and other companies started to invest in our country) and holders of exploration permits had the obligation of conducting a minimum of activities.

In 1963 CAMPSA and AMOSPAIN (subsidiary of Standard Oil and Texaco) discovered gas in the Ayoluengo field (Valdeajos, Burgos) and, a little bit later (July 6th, 1964), oil was extracted from Ayoluengo 1 borehole of 1,349 m of depth. This was the first and only petroleum field in continental Spain.

Later, the extension of the petroleum field was delimited through 32 boreholes, a small site (10Km²) with 2Mtons. At the beginning productions of 1000 barrels/day were reached, but it progressively diminished to 300/350 barrels/day in the 1970's and activity ceased in 2000, despite the attempts of increasing production by drilling new boreholes (up to 53). This was a small field, fragmented (associated to sandstones arranged in palaeochannels of the Purbeck facies) and with a bad quality petroleum. Because of that, petroleum was not refined but directly used as fuel in the glass industry, such as VICASA (Cantabria) and other from the Basque Country.

Later on, CAMPSA and AMOSPAIN found small petroleum fields in the vicinity of Ayoluengo: Tozo, Huidobro, and Hontomin (Hevia Cargas, 1989 y *La Vanguardia Española*, 26-Sep-68). Following CAMPSA's actions, other companies (Chevron, REPSOL, Northern Petroleum, and Ascent Production) began to investigate in this zone.

Thus, the Ayoluengo petroleum field has been active during 35 years. In 2002 the Spanish Society for the Preservation of the Geological and Mining Heritage (SEDPGYM) proposed its transformation into a Petroleum Museum. This initiative has been assumed by the City Council and will include rooms devoted to geology, research and production of oil fields (*El Correo Gallego* 20-Jul-2008). The other petroleum field located in the surroundings that bore certain interest (Hontomin, in Jurassic limestones) will be used as a Technology Development Site for the sequestration of 100,000 tons of CO₂.

Gas was found in Serrablo (Huesca, Spanish Pyrenees) and was extracted from 1984 to 1990, when the oil field located in the Guadalquivir marshland began operations.

Studies on Spanish territories —such as the case of Guinea and Sahara, and the “off-shore” sites— will be considered on subsequent studies.

6. CONCLUSIONS

The first survey of oil production in Spain, well known as Tejón borehole, was conducted by the Sociedad de Sondeos de Huidobro in 1900, in Huidobro (Burgos). The concession of El Progreso is the first one in Spain and

appear only 7 years after Edwin Drake (1819-1880) drilled the first oil well in Pennsylvania. At the beginning of the 20th century the Basque-Cantabrian Basin become of interest, where different petroleum seeps appeared, usually located in continental facies, and the mining permissions were numerous, mainly after the 1st World War.

The company named "Compañía Arrendataria del Monopolio de Petróleos Sociedad Anónima" (CAMPESA) was the first devoted to petroleum industry, founded in 1927 after the Law of Petroleum Monopoly, of 28 June 1927, was approved.

In 1963 CAMPESA and AMOSPAIN (subsidiary of Standard Oil and Texaco) found gas in the Ayoluengo field (Valdeajos, Burgos). This was the first and only one petroleum field in continental Spain. At the beginning, productions of 1000 barrels/day were reached, that progressively diminished and ceased in 2000.

CAMPESA and AMOSPAIN found later small petroleum fields in the vicinity of Ayoluengo: Tozo, Huidobro and Hontomin. After CAMPESA, other companies (Chevron, REPSOL, Northern Petroleum and Ascent Production) began to investigate in this zone.

Thus, the Ayoluengo petroleum field has been active during 35 years. In 2002 the SEDPGYM proposed its transformation into a Petroleum Museum. The other petroleum field with certain interest in the surroundings (Hontomin, in Jurassic limestones) will be used as Technology Development Site for the sequestration of 100.000 t of CO₂.

REFERENCES

- Ayala Carcedo, F.J. 2007. Minería Industrial (El petróleo y el uranio). In: SIEMCALSA (ed.), *La Minería en Castilla y León*. Junta de Castilla y León (SIEMCALSA), Valladolid, 82-83
- Baquedano, K. 2007. *La búsqueda del petróleo en Álava*. Eusko Ikastunza, San Sebastián, 111 pp.
- Dupuy de Lôme, E. (1937). Las investigaciones de petróleo en España. *Boletín del Instituto Geológico y Minero de España*. T. LIV, 4-73.
- Gavala, J. 1916. Regiones petrolíferas de Andalucía. *Boletín de la Comisión del Mapa Geológico de España*, XXXVII, 27-211.
- García Portero, J. 2004. *La exploración para hidrocarburos en el País Vasco*. Ente Vasco de la Energía, Bilbao, 8 pp.
- Hevia Cangas, F. 1989. Aprovechamiento de los Hidrocarburos datos históricos. *Historia de la Geología*. Real Academia de Ciencias Exactas Físicas y Naturales. Madrid, 309-337.
- Hevia Cangas, F. 2001. El petróleo. In: Ayala Carcedo, F.J. (ed.), *Historia de la Tecnología en España*. Valatenea, Barcelona, Tomo I, 213-218.
- López Peña, C. 2005. *Memorias de un tiempo pasado 1907 (Ahedo de las Pueblas)-1982 (Madrid) de Andrés Peña Varona*, 134 pp. ahedodelaspueblas.com/documentos/memoriasAPenaVarona.pdf
- Mallada, L. 1910. Yacimientos de petróleo y azufre de la provincia de Cádiz. *Revista Minera, Metalúrgica y de la Ingeniería*, LXI 25-28 and 41-42.
- Maestre, A. 1864. *Descripción física y geológica de la provincia de Santander*. Imp. Gamayo, Madrid, 127 pp.
- Maffei, E. and Rúa de Figueroa, R. 1872. "Apuntes para una biblioteca española de libros, folletos y artículos, impresos y manuscritos, relativos al conocimiento y explotación de las riquezas minerales y a las ciencias auxiliares." Imprenta J. M. Lapuente, Madrid. Reedited in *La Minería Hispánica e Iberoamericana*. Cátedra de San Isidro. León II, 531 pp & III, 695 pp.
- Mazarrasa, L. 1923. Estudio de las sustancias bituminosas de la provincia de Santander. *Boletín Oficial de Minas*, VII (75), 3-41.

- Nuño, G. 1965. *El santero de San Saturio*. Espasa-Calpe, Madrid, 163 pp.
- Querol, R. 1971. La estratigrafía española y sus posibilidades petrolíferas. *Industria Minera*, 121, 29-70.
- Ríos, J.M. 1949. Las investigaciones de petróleo en España. *Notas y Comunicaciones del Instituto Geológico y Minero de España*, 119, 354-374.
- Ríos, J.M. 1958. Posibilidades petrolíferas del subsuelo español en su relación con el origen del petróleo y sus condiciones de yacimiento. *Notas y Comunicaciones del Instituto Geológico y Minero de España*, 50, 1-46.
- Ríos, J.M. 1958. Relación de los principales sondeos para investigación de petróleos llevados a cabo en España desde 1939. *Notas y Comunicaciones del Instituto Geológico y Minero de España*, 50, 47-94.
- Ríos, J.M. 1968. Relación de las principales actividades para investigación de hidrocarburos llevadas a cabo durante 1967. *Industria Minera*, 94, 5-75.
- Sánchez de Toca, J. 1917. *El petróleo como artículo de primera necesidad para nuestra economía nacional*. Imprenta Isidro Perales, Madrid, 189 pp.
- Tornos, C. 1865. *Memoria sobre el beneficio de las sustancias bituminosas, presentada al Excmo. Sr. Ministro de Fomento*. Imprenta Nacional, Madrid, 56 pp.
- Vallvé Bermejo, J. 1996. La minería en Al-Andalus. *Actas de I Jornadas sobre Minería y Tecnología en la Edad Media Peninsular*. Fundación Hullera Vasco-Leonesa, Madrid, 56-64.