Maiella, an oil massif in the Central Apennines ridge of Italy: exploration, production and innovation in the oil fields of Abruzzo across the nineteenth and twentieth centuries

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Abstract: This article aims to present selected episodes of the scientific and entrepreneurial activities realized in the Majella oil district, Abruzzo, central Italy, between the 1830s and the 1940s. Majella had an important role in the early process of modernization of the Italian oil industry. As we will see, the application of science and technology in the wellsite, a pioneering integrated production model, unexpected environmental constraints and the longevity of the business made Abruzzo into a benchmark. Between 1864 and 1865, the pattern of the secular and unchanged local manufacturing of bitumen, based on human labour and the manual harvesting of the mineral from natural outcrops, was outdone by two new conditions: the study of subsoil and the utilization of mechanical drilling. These early records of paid oil consultancies and the utilization of steam power were followed by the impressive, but short and illusory, peak in production never recorded before. In the following decades, the Majella district was very active and drew the attention of several international operators, in spite of the declining production of crude – compensated for by the yield of bitumen and shales – and the unstoppable rising of the Emilian Apennine ridge in the provinces of Pavia, Piacenza and Parma. From the early 1900s, foreign companies gradually reduced investment in new exploration in Maiella, where the core production was now bitumen and asphalts rather than oil and, by the 1920s, most of the industry was controlled by government authorities and local business. The advent of Fascism in the 1930s saw Maiella become a stronghold of the autarchy's policies; later, the improvised and inefficient national fuel planning of Italy at the start of the Second World War saw Abruzzo's oil and bitumen supplies become a strategic resource. The Maiella district has the longest production history in Italy and today geoscientists are surveying and interpreting the geology of the area with a new perspective.

Geological setting and petroleum system of the area

Our research focuses on the central Abruzzo areas of Tocco Casauria (Fig. 1), between the Apennine chain front to the west and the Maiella Mountain to the east, close to the villages of Roccamorice and Lettomanoppello. Geologically, the Maiella Mountain is a NNW–SSE anticline located in the Central Apennines, formed during the Middle–Late Pliocene (Ghisetti & Vezzani 2002): it records a carbonate succession from the Lower Cretaceous to the Miocene, topped by siliciclastic sediments of Messinian–early Pleistocene age (Donzelli 1968; Crescenti *et al.* 1969).

From the petroleum geology perspective, the NW sector of the Maiella structure is particularly interesting due to the numerous oil seepages detectable at surface, mainly associated with the high-porosity carbonate reservoirs of the Bolognano Formation (Oligo-Miocene), but locally also to the Santo Spirito Formation and the Orfento Formation carbonates (Paleocene–Oligocene and Upper Cretaceous in age, respectively) (Brandano *et al.* 2013; Scrocca *et al.* 2013). Evidence of oil occurrences is found over a wide area of more than 20 km^2, mainly between 400 and 1000 m in altitude, with some exceptional oil seeps found above 2000 m (Ferraris 1942).

The nearby Tocco Casauria area is, instead, located about 10 km west of the Maiella Mountain, at the front of the Apenninic chain, within the deformation belt at the frontal thrust of the Morrone Mountain. In this area, the same Bolognano reservoirs known to crop out in the Maiella Mountain have been successfully proven by wells to be oil bearing in the near subsurface. Indeed, a few kilometres NW of the Tocco da Casauria village, a stable natural water spring,

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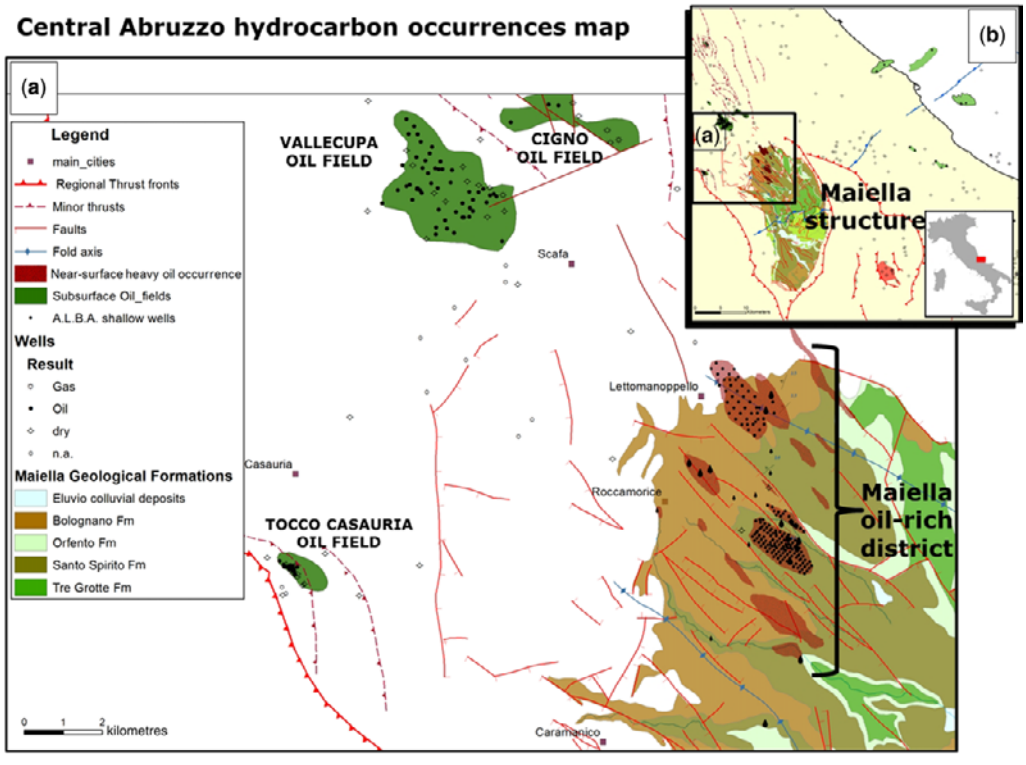


Fig. 1. Map of hydrocarbon occurrences in central Abruzzo, both in the subsurface (in green) and in the near-surface (in brown), including the bitumen/asphalt-rich outcrops of the NW flank of the Maiella Mountain and the Tocco Casauria 'oil district'. Surface geology and main tectonic elements are reported (Vezzani & Ghisetti 1998; VIDEPI Project 2012). Oil occurrences are mostly present within the Oligo-Miocene 'Bolognano Formation' reservoirs, both at surface and in the subsurface, but also in the 'Santo Spirito' Formation and 'Orfento' Formation carbonates (Paleocene–Oligocene and Upper Cretaceous in age, respectively).

containing important quantities of oil, has been known since historical times to emerge and flow into the 'Little Arollo River': this unique 'oil spring' has been interpreted as the spectacular result and evidence of a local hydrogeological drainage pattern of an aquifer crossing the shallow near-surface oil accumulations.

It is important to note that the same reservoirs in the region have also been successfully explored in the subsurface by more recent and modern exploration efforts and deep drilling, especially in the 1980s and 1990s, resulting in a few mid-sized oil discoveries and production fields, such as Tocco Casauria itself, and the Vallecupa and Cigno oil fields, today depleted and abandoned.

These hydrocarbon occurrences have generally been associated with Late Triassic–Early Jurassic (Liassic) carbonate source rocks (Mattavelli & Novelli 1990; Zappaterra 1994; Cazzini *et al.* 2015), while hydrocarbon migration is suggested to have been associated with the main fault systems and fractured corridors within the carbonate succession (Brandano *et al.* 2013; Cazzini *et al.* 2015).

The hydrocarbons found in the study area have generally been classified as heavy oil, in the subsurface, and bitumen/asphalt along the outcrops at surface: from historical photographic evidence (Fig. 2), oil discovered in the shallow subsurface by mining tunnels below the Maiella NW flank did still show a viscosity that can be estimated to be about 4°–8° API by visual comparison with fluid samples. Even today, at surface, when summer temperatures are above about 20°C, bitumen is able to flow from the rock's matrix porosity and fractures.

Notes on the pre-industrial history of the Abruzzo oil provinces up to the 1850s

The historical use of bitumen in Abruzzo was documented for the first time in 1868, close to the village of Lettomanoppello in the locality called Pignatara. Following an archaeological campaign, a workshop for the purification of asphalt dating from Roman times was discovered. Among the remains of several

Fig. 2. Viscous bitumen natural flow in a mine tunnel (courtesy of Lettomanoppello City Hall). Estimated 4°–8° API crude oil by visual comparison with fluid samples.

clay vases containing asphalt, archaeologists found a rectangular loaf of bitumen (35 × 26 × 10 cm (length × width × thickness)) on which was engraved 'ALONI.C.F.ARN.SAGITTAE'. This inscription allowed the artefact to be dated back to about the first century BC (the Ancient Rome Period) (Toppi 2017), and to attribute the ownership of the workshop to a man named Alone Sagitta from the Arniense Tribe (descendant of the old pre-Roman Marrucini), who probably were also the owners of the mine at Pignatara. The finding confirmed the mining of the product, its packaging and its commercialization; and that the Romans were trading bitumen from Maiella as much as the more famous oils from Sicily described by classical authors (Zambra 1869; Massimi *et al.* 2002; Novelli & Sella 2009).

The exploitation and utilization of the bitumen and asphalts of Maiella, near Lettomanoppello and Tocco Casauria, has been reported since the early Middle Ages. In the twelfth century, it was traded with the Republic of Amalfi, where it was used to caulk the ships (Anon 1182; Trapani 2003).

Flavio Biondo da Forlì (1392–63), historian and humanist of the Renaissance period, in his last work *Italiam illustratam* [*Italy Illustrated*], which was published posthumously in 1482, mentions the 'fons olei Petronici perennins scatent' ('the perennial source of oil that flows'), down the hill of the castle in Località Cantalupo (this settlement, now disappeared, was located between the village of Musellaro in the municipality of Bolognano and the municipality of Tocco da Casauria, in the province of Pescara). He refers to the 'Oleum Petronicum' (Medieval Latin, which can be translated as 'rock oil') collected from the spring by the German and Hungarian travellers who appreciated the medical properties of the oil; it was a valuable commodity (Biondo 1482).

Scipione Mazzella's (1586) *Descrizione del Regno di Napoli* [*Description of the Kingdom of*

Naples] (Fig. 3) reports on the 'mine of pitch … that resembles bitumen, but it finds more applications as pitch' (p. 93).

In 1551, Leandro Alberti in his *Descrittione di tutta l'Italia* [*Description of the Whole of Italy*] talks about a liqueur substance named 'Oglio Petronico' and renowned for its medical properties (Alberti 1551).

Cristoforo Scanello in the *Cronica o ver compendio dell'antiqua regione et provintia del Abruzzo* [*Chronicle* (or *Compendium*) *of the Ancient Region and Province of Abruzzo*], published in 1568, talks about an 'oil given by the Lord' a remedy for every infirmity and called 'Olio Petronico' (Scanello 1568).

The observations from these natural philosophers and geographers, together with many other sources from 1500 to 1800, give us two important pieces of information: first, oils were a mineral resource consistently available over the last two millennia; and, secondly, that heavy oils, asphalts and bitumen were an abundant resource, processed on a large scale, but commercialized in a local/regional range. The more valuable light fractions were scarce, gathered in limited quantities and traded along longer routes (Trapani 2003).

These observations, merged with information available for the other Italian oil regions, show how at the turn of the nineteenth century the 'geography' of the oil resources in Italy was already outlined for the generation of explorers to come. Northern Italy offered lighter and more valuable


DESCRITTIONE
DEL REGNO
DI NAPOLI.
NELLA QVALE S'HA PIENA CONTEZZA, COSI' DEL Sito d'esso, de' nomi delle Prouintie antiche, e moderne, de' costumi de' Popoli, delle qualità de' Paesi, e de gli huomini famosi che l'hanno illustrato; come de' Monti, de' Mari, de' Fiumi, de' Laghi, de' Bagni, delle Minere, e d'altre cose marauigliose, che vi sono.
Con la nota de' Fuochi, dell' Impositioni, de' Donatiui, e dell' entrate che ha il Rè.
Et vi si fa mentione de i Rè, con la loro vita, & effigie, che l'han dominato, de' loro titoli, dell'Incoronatione, e del lor modo di scriuere à diuersi Prencipi: de' Pontefici: e de' Cardinali che vi nacquero, e de' Vicerè stati ui, e de gli Arciuescouati, Vescouati, e delle Famiglie Nobili, che vi sono.
Co' Nomi de i Baroni, e loro Arme, e'l diuisamento delle lor Corone; e con vn preambolo de i Rè di Gierusalem, ove si dechiara perche i Rè di Napoli habbiano quel titolo.
Con la Tauola copiosissima, & altre cose notabili, che nella prima Impressione non erano.
DI SCIPIONE MAZZELLA NAPOLITANO.
CON PRIVILEGIO
PER ANNI DIECI.
IN NAPOLI, Ad istanza di Gio. Battista Cappello. M.DCI.

Fig. 3. *Descrizione del Regno di Napoli* by Scipione Mazzella (1586).

oils; and central and southern Italy were promising sites for the heavy oil industry – and it is not a coincidence that the historical literature often reports the contiguity of sulphur deposits and seepages of black oils (Tenore 1828; Pilla 1841).

In the early nineteenth century, asphalts were still being dug from shallow mines and bitumen was still collected from the land seepages or skimmed from the waters of creeks. The first was mostly used to pave streets, the latter as insulation in construction; oil was not officially acknowledged in the pharmaceutical industry but the locals were still using it for the same secular medical purposes (Huguenet & Frojo 1856).

Nothing changed in the *modus operandi* of local manufacture until the publication of the observations completed in the 1830s by Baron Giuseppe Nicola Durini (1765–45) on the local sulphur and oils. He was a land owner educated in law, and a science enthusiast affiliated to the Società Reale delle Scienze in Napoli [Royal Society of Sciences in Naples]. With the latter, he published in 1837 the pamphlet *Industria dello zolfo e bitume in Abruzzo Citeriore* [*The Bitumen and Sulphur Industry in the Abruzzo Citeriore*]. Durini's analysis is halfway between the natural sciences and an assessment on the potential of the land resources, which results in the first monographic study ever completed on the bitumen of the area (Verlengia 1956). Durini studied the physical proprieties of the bitumen filtered from the limestones and the clays along the beds of creeks between the Maiella Massif and the Morrone Mountain. He observed the relationship between the rainy season and the increasing flakes of bitumen flowing up into the waters of the Arollo Creek; he hypothesized that the mineral rose from deeper and abundant subterraneous deposits because of the circulation of the waters; he estimated that every year the equivalent of 130 barrels of oil were carried away by the stream. To prevent this waste, Durini proposed building a series of filtering pools into the bed of the smaller creeks to take advantage of the downwards inclination of the river course. He thought that forcing the water into a descending collection point, where wood sticks would form a rudimental filtering grid, would supply enough mineral to be used for heating and illumination. Durini promoted the mineral oil of Maiella as an old resource that belonged to modernity, for which the real potential was still to be unveiled. He completed the pamphlets with general notes on the organic origin of oil, showing his familiarity with the recently established term 'hydrocarbons' (Durini 1837; Anon 1845).

The first local businessman to test Durini's theory was Silvestro Petrini (1812–1912). Between 1840 and 1844, Petrini identified the possible asphalt mines on the western side of Maiella in the districts of Lettomanoppello and San Valentino. He built a small plant to process the mineral, and to produce bitumen and pitch. Heavy oils were mined in the traditional way; no information is available about the existence of possible shafts hand dug to collect oil. The venture was successful and the business took off very well until 1848, when Petrini fell into disgrace for political reasons. The family was isolated and forced to abandon the plant, which shortly after was pillaged (Petrini 1911; Novelli & Sella 2009).

The inception of the modern oil industry in the Maiella district, 1863–70

The illumination system in Italy was based on three fuels: rendered vegetable oils used by the lower classes; gas obtained from lignites, pitch and coal (which also gave a limited yield of dark oils), which was used for homes and public illuminations in urban centres; and, in a more minor way, gas and oils produced by the retorting of shale rocks. Whilst the vegetable, cheap and low-quality oils were abundant, Italy had negligible coal deposits in its boundaries and was dependent on foreign supplies. Coal was quite cheap per volume unit, but had high transport costs: in the harbour of Genoa, in NW Italy, the same quality of coal could cost twice as much as that in Cardiff in the UK. The shale deposits were small and poor in quality, and the Italian shale industry was not well developed (Bardini 1998).

In 1861, the first bulk of refined oils for lamps imported from the USA arrived and were rapidly adopted into the European markets, Italy included. The cheap price and the quality of the product gained the trust of the users, as much as the interest of entrepreneurs who saw in petroleum and its derivatives a lucrative business. Obviously, oil was not a job for everyone. Although the industry in Italy was characterized by a chronic lack of investment capital, it was not so difficult to find investors but much more so to find the operators (Gerali & Gregory 2017).

Between 1864 and 1870, the Maiella oil district – a wide area that includes the villages of Abbateggio, Manoppello, Lettomanopello, Bolognano, San Valentino, Roccamorice, Scafa and, the most important, Tocco Casauria – entered officially into the history of the modern Italian oil industry thanks to two outsider 'wildcatters', but who were not totally unrelated to the business (Fig. 4). The surface evidence of an active petroleum system in the region, represented by the Tocco Casauria oil springs and by the numerous oil seeps along the NW flank of the Maiella Mountain, triggered new interest in the region in the early 1860s. At Tocco Casauria, the oil springs that first attracted the interest of new investors were circumscribed between the two branches of the Arollo Creek, named 'Piccolo' (Little) Arollo and 'Grande' (Big) Arollo which were separated

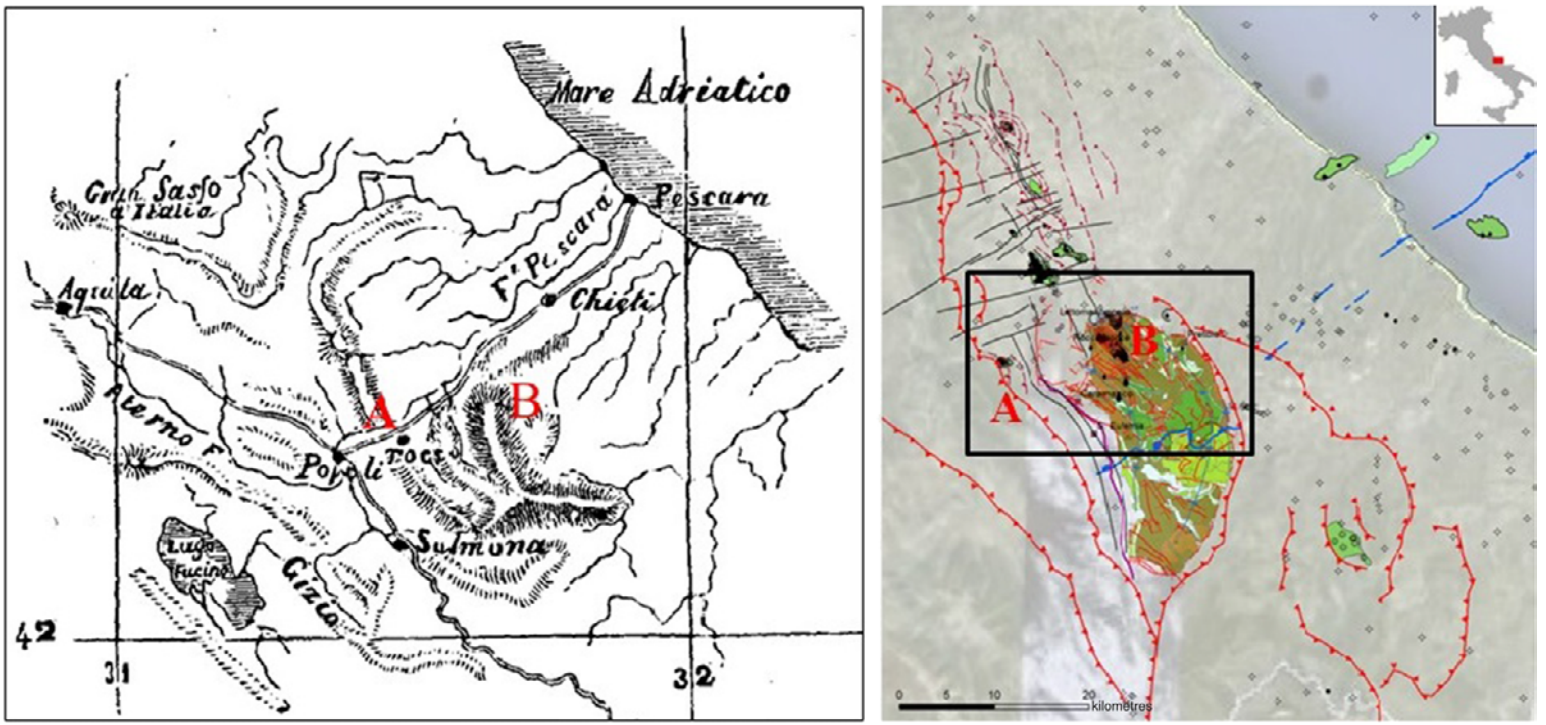


Fig. 4. Yesterday and today: A is the Tocco Casauria 'oil spring' area and B is the Maiella Mountain, where oil seepages occur over extended portions of land.

Fig. 5. Tocco Casauria, and the Grande Arollo and the Piccolo Arollo creeks.

by a rocky slope called 'Colle d'oro' ('Golden Hill') (Gerali 2013) (Fig. 5).

Enterpreneurs and geologists in Abruzzo

The inception of mass production in Tocco Casauria commenced in early 1863. The brothers Maurizio and Giuseppe Laschi from Vicenza, NE Italy, together with Siro Trovati and Vittorio Calabi from Milano, founded the Società Laschi e Trovati and acquired the rights of exploitation of lands in the proximity of the Little Arollo – the small outcrop of oil included in the area was known as the 'Spring of the City', because it was owned by the municipal authorities (Fig. 6). The Laschi brothers in Vicenza owned the mining company Società Vicentina Montanistica, as well as a refinery. Since 1839, they had been in the business of gas distillation from lignites and shale rocks, but the poor quality of the mineral produced in some of their mines (e.g. the Monteviale and the Calverina in the proximity of Vicenza) was jeopardizing company interests (Errera 1870; Stoppani 1876). The brothers Laschi travelled almost 600 km to find an alternative fuel to blend and enrich lignites and shales. But, little was done since they arrived in the area of the Little Arollo (Stoppani 1866*a*, *b*).

In September 1864, the Società Vicentina Montanistica hired Abbot Antonio Stoppani (1824–91) to survey the company land. He was a leading scholar in Italy and was also well known in Europe (Fig. 7), and considered by many to be the 'father' of geology in Italy. At this time, he was also working at the University of Pavia and is credited as being the first Italian scholar author of a comprehensive essay on petroleum geology (Stoppani 1864; Zanoni 2014). Stoppani visited the lands of the company for a few weeks and then concluded that the only way to obtain enough petroleum to haul to the refinery in Vicenza and make a profit was to drill using the then 'modern' technologies to a depth of 90 m. He then explained the presence of the bitumen in the creek: he theorized that the waters in the subsoil passed through a 'pocket' of bitumen that was wiped out in different quantities depending on the pressure of the stream. The Società Vicentina Montanistica did not immediately follow the recommendation of the geologist. However, in late 1865, after months of manual digging, at a depth of 32 m, enough oil

Fig. 6. Maurizio Laschi.

emerged to persuade the Società to purchase drilling machinery from the Degousée–Laurent company in France, the leader in Europe in the drilling of artesian waters (Degousée & Laurent 1861, 1868).

The main machine was a drilling-by-percussion system working with hollow rigid rods and a free-fall (sliding) chisel. This machine was similar to the Kind and Fabian systems used to drill artesian wells (the latter was already utilized in precedence in the oil fields of Bobrka and Galicia in the Austro-Hungarian Empire). In principle, and depending on the conditions of operation (e.g. moving the walking beam by means of human labour or steam engine), it involved a greater outlay of capital and staff than manila rope-drilling (better known as the American system, or American standard). In return, it was guaranteed to keep to the vertical of the hole better in soft soils, to maintain the stability of the well walls and to achieve a larger hole, which could range up to 1 m in diameter (Degousée & Laurent 1861, 1868; Neuburger *et al.* 1901). The derrick was set up to drill the first well for the Società by the end of 1865. Unfortunately, the limited set of data available does not allow us to establish with any precision how much oil was produced from those wells (the only definite reference tells of about 14 tons of oil being collected in December 1866) and its influence on the total yield from the Maiella fields (Stoppani 1866*b*).

Fig. 7. Antonio Stoppani (Lecco 1824–Milano 1891).

However, it is known that the production enabled the Società to stay in business until 1870, before having to close (Fig. 8).

In the spring of 1864, the concession for the exploration rights around the Grande Arollo creek was granted to Carlo Ribighini, the owner of the Ancona branch of the Suisse company Blumer & Jenny. Ribighini was an entrepreneur who came from a wealthy family known in Ancona. He was administering a naval trade house and observed the increasing turnover of US-refined oil passing through the docks of Ancona harbour. He was also in touch with the US Consulate in Ancona (where a year later he was also appointed as Vice-Consul), which helped him to realize the magnitude of the oil business. Ribighini himself wrote that the real purpose of his venture in Tocco Casauria was to find crude oil.

The land to which Ribighini had been granted rights had never been of interest to the inhabitants of the village: the bitumen harvested from the stream of the Big Arollo was not dense and, therefore, more

I PETROLII IN ITALIA.

PARTE PRIMA:

IL PETROLIO NEGLI ABRUZZI.

Le industrie native e le industrie importate, 1. — Influenza dell'elemento morale nell' industria, 2. — Speranze per l' Italia, 3. — Un nuovo ramo d' industria mineraria, 4. — Programma dell' autore, 5. — Esistenza de' petrolii in Italia, 6. — Zone petroleifere, 7. — Un viaggio a Tocco, 8. — La valle del Pescara, 9. — Sollevamento dell'Abruzzo citeriore, 10. — Abbondanze de' bitumi, 11. — Sviluppo e singolarità del travertino, 12. — Antichi efflussi di petrolio, 13. — La sorgente petroleifera del commune, 14. — Come se ne conobbe l'esistenza, 15. — Primitivi apparati, 16. — Sgorghi spontanei, 17. — Manovre de' Toccolani, 18. — Deplorabile spreco, 19. — Caratteri del petrolio di Tocco, 20. — Una seconda sorgente petroleifera, 21. — Emanazioni gazose e metamorfismo, 22. — Sorgente degli Anconitani, 23. — Primo pozzo d'assaggio, 24. — Sgorghi invernali, 25. — Una leggenda che conduce ad una scoperta, 26. — Un esperimento fortunato, 27. — Fortuna degli Anconitani, 28. — Spiegazione del fenomeno principale, 29. — Spiegazioni di alcuni accessorii, 30. — Fatto relativo all'ossidazione de' petrolii, 31. — Pronostici, 32. — Migliori apparati intorno alla sorgente del commune, 33. — Il primo traforo, 34. — Comparsa del petrolio, 35. — Traforo artesiano, 36. — Prosperi successi, 37. — Estensione della zona petroleifera, 38. — Indizi nella provincia di Teramo, 39. — Altri nella provincia d'Ascoli, 40. — Avvenire di quelle popolazioni, 41. — Il progresso già installato nel commune di Tocco, 42. —

1. L'agricoltura e l'industria sono le figlie primogenite del suolo, e queste le madri delle grandi società civili. Un popolo stanziato sopra suolo infecondo, sopra una terra nelle cui viscere natura non nascose quelli che gli antichi poeti chiamarono tesori di Pluto, attende da estranie contrade il pane di che nutrirsi e gli strumenti più necessari alla vita: questo popolo vivrà nomade, disperso come le tribù erranti nelle sconfinate lande del Sahara; anzi non avrebbe nemmeno ragione di essere, se esistesse assolutamente una regione arida ed infeconda. È un fatto invece che le ricchezze del suolo crearono, generalmente parlando, i popoli industriali. Gli abitatori dell' Hartz, della Sassonia, della Slesia, divennero popoli metallurgici, perchè ricche di miniere trovarono le loro contrade; e se l' Inghilterra tien lo scettro nell' industria siderurgica, gli è anche vero che non ha che a rimovere le sue zolle per ritrovare annualmente i suoi 10 milioni di tonnelate di minerali di ferro e accanto ad esse i suoi 90 milioni di tonnelate di carbon fossile per ridurli in ghisa (1).

(1) La cifra di 90 milioni di tonnelate di carbon fossile prodotte annualmente dall' Inghilterra, risultò dall'ultima *Esposizione internazionale* del 1862, come si legge nella *Relazione* or ora pubblicata in Torino dal prof. I. Cocchi.

Fig. 8. *Petroli in Italia – Abruzzo* (Stoppani 1866*a*).

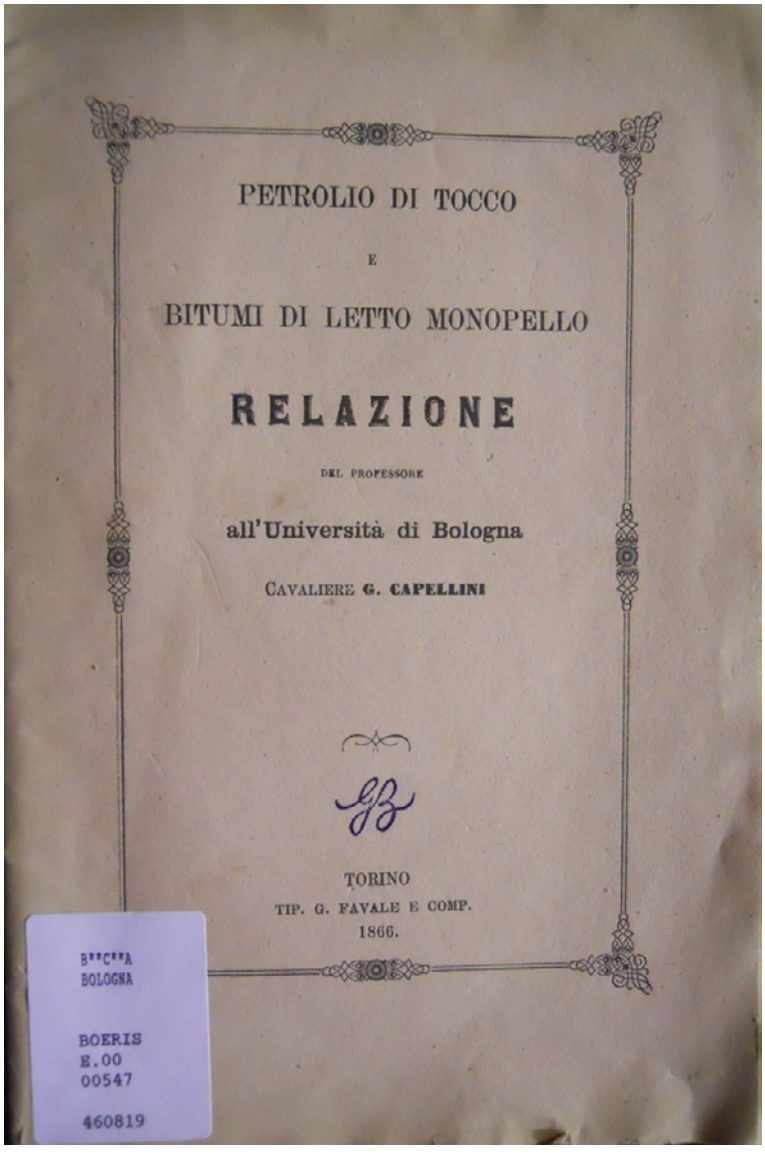
difficult to filter and collect from the water with the old method of the descending pools used until then. Ribighini suspected that he was not looking at common bitumen; instead, he believed that he had found the mineral he was looking for to start implementing his ambitious plan. Before proceeding, he decided to invest some money in chemical analyses, and sent some samples to be tested in laboratories in Trieste (NE Italy, at that time it was included in the Austrian Empire) and Marseille in France. The results were positive, and at the end of the summer of 1864 he started to dig manually shallow wells

close to the seepages and on the banks of the Grande Arollo creek. Ribighini concluded the year of 1864 by harvesting little more than 3 tons, a pretty miserable quantity of light bitumen filtering the waters of the creek; but the hunt for the 'big' deposit was a failure.

Ribighini heard about the geologist who had been hired on the other side of the Colle d'oro, on Little Arollo. The two companies were pursuing the same business just a few hundred metres from each other, but they were working with 'fair play'. As we have seen, the interests of the companies were different and there was no real conflict of interests; no other large operators were involved in the vicinity and the pressure – or, better, the rush – for oil was low. The only real competitor to contain and overtake was the refined oils (both for home and industrial uses) from the USA. Since 1861, the affordable and good imported oil had gained a greater share of the national fuel market every year, and, subsequently, it was depleting the chances of a successful start-up for the small national firms, such as Blumer & Jenny and the Società Laschi e Trovati.

Ribighini decided in late 1864, on the advice of other engineers, to write to Giovanni Capellini (1833–22), Professor of Geology and Palaeontology at the University of Bologna (Fig. 9), who had previous experience of oil fields. Between 1861 and 1864, Capellini had worked on the palaeontology of the oil regions of Emilia, in northern Italy; he had visited the oil fields of Pennsylvania in the USA; and in 1864 he was the consultant geologist to a British firm in Walacchia, Romania (Gerali & Gregory 2017). Ribighini questioned the nature of the subsoil, and whether it was possible to gauge the size of the deposit and foresee its productivity. Ribighini was

Fig. 9. Giovanni Capellini (1833–1922).


PETROLIO DI TOCCO

E

BITUMI DI LETTO MONOPELLO

RELAZIONE

DEL PROFESSORE

all'Università di Bologna

CAVALIERE G. CAPELLINI

TORINO

TIP. G. FAVALE E COMP.

1866.

Fig. 10. The report of Capellini on Tocco Casauria oil and Lettomanopello asphalts.

looking for exactly the same answer as that sought by today's oil companies: to know how valuable the oil pool could be before investing too much capital. Capellini answered with frank scepticism, maintaining that the samples received were too heavy and were not of competitive oil that could be refined to fuel for lamps, and it was not possible for him to travel to Abruzzo in such a short time (Accademia Lunigianese di Scienze, Personal Archive of Giovanni Capellini, Box XIX, Folder O, papers 1–3; Biblioteca Archiginnasio, Manuscript Section, Fondo 'Giovanni Capellini', Box CXVIII, Folder 4, papers 1–3).

In spite of the discouraging words from the geologist, Ribighini moved forward with his plans and during 1865 he achieved interesting results. He built a small refinery in Porto Recanati, a coastal town only few miles away, which was close to larger towns where the product was sold. The business was doing well, and he invested in new mining concessions in the close areas of Roccamorice and Lettomanopello. Finally, he found a way to reach a few

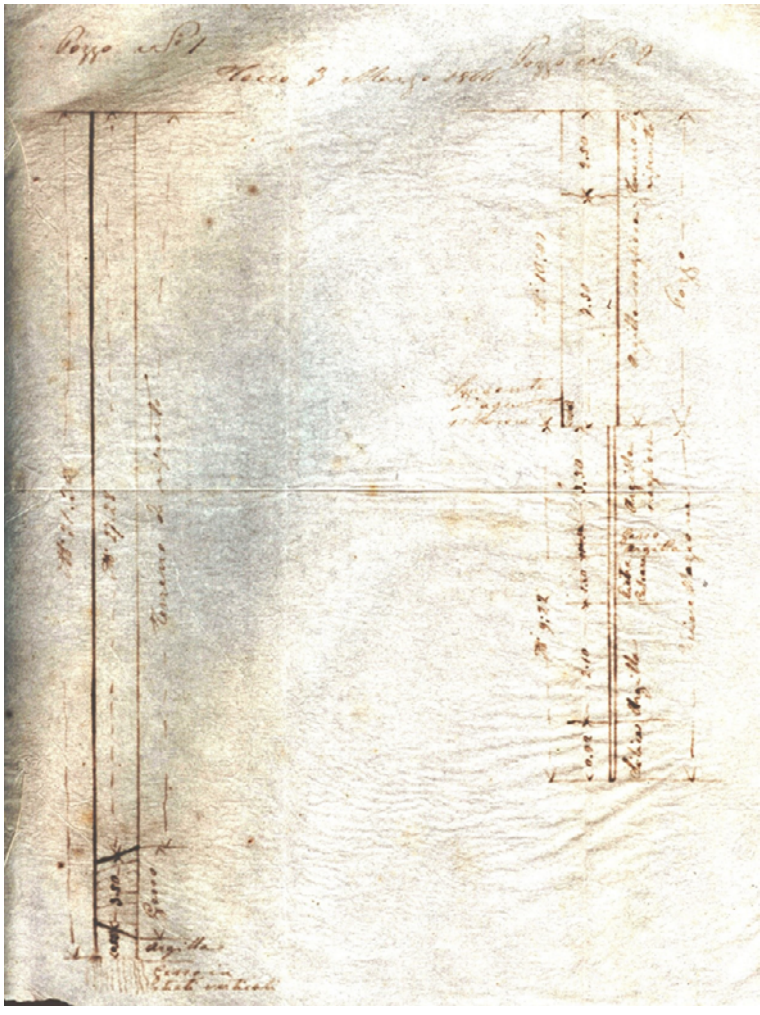


Fig. 11. 3 March 1866: a section of the rocks crossed during the drilling of wells 1 and 2 by Ribighini using French drilling machinery.

metres down in the ground to the cavern source of the bitumen that was discharged into the creek and, thanks to a system of artificial channels, he managed to increase productivity dramatically. The highest peak of production recorded in Ribighini's concession land was some 800 tons in November 1865. The amount of oil sent to Porto Recanati was exceeding the capacity of the plant, and it had an even greater expectation for the following year. He found a former sugar refinery that had been abandoned since 1859 in the nearby city of Grottammare, in the province of Ascoli Piceno, and purchased it with the plan of setting up a larger refining plant.

In January 1866, Ribighini wrote again to Capellini with the firm intention of convincing him to come in Tocco Casauria to locate finally the real oil deposit, and not just halfway pockets embedded in-between meandering siphons (known also as a Tantalus Cup) and a creek (Gerali 2013).

Capellini accepted the offer and completed the field survey in early 1866 (Capellini 1866), confirming to Ribighini that the main oil deposit could be reached by digging down further to a greater depth, using modern drilling mechanical machinery, right in the proximity of the Colle d'oro and the creek (Fig. 10). He then concluded his task by locating on the map where to drill two exploratory wells and suggested hiring the mine engineer Leopoldo Ferretti to be in charge the operation. Ribighini then ordered French drilling machines, just as his neighbours had the year before. The derrick was set up few months later and the first well of Blumer

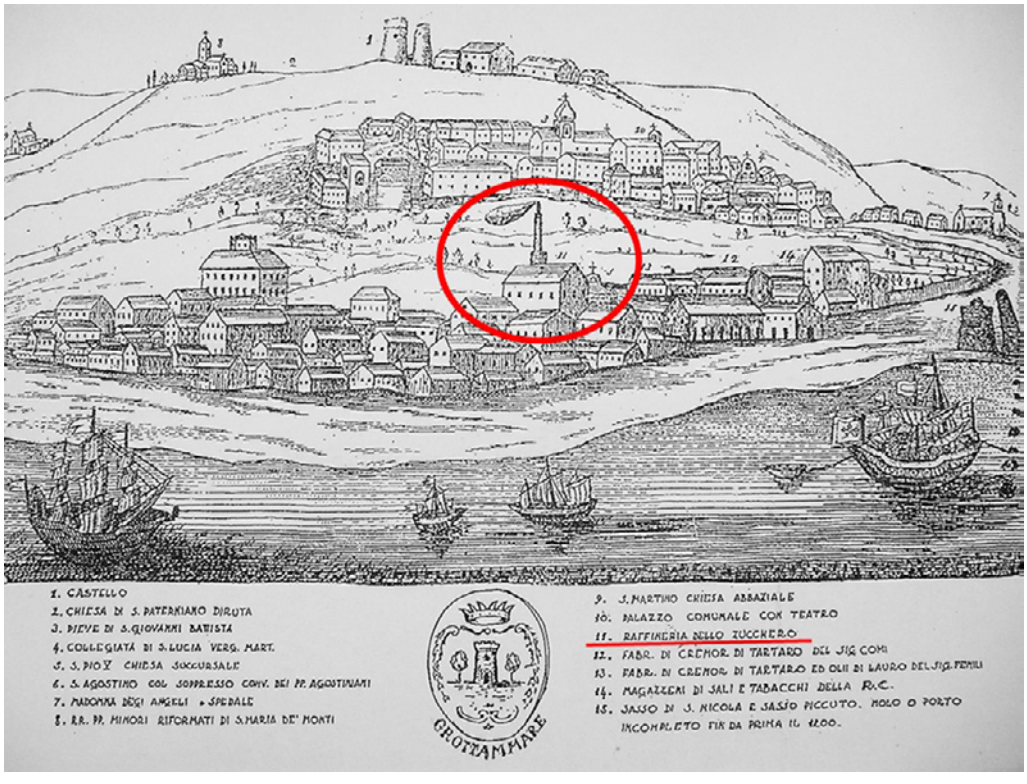


Fig. 12. The refinery at Grottammare, circled in red.

& Jenny reached 60 m, with a yield of up to 500 kg of oil per day. The company ended 1866 with about 300 tons of oil coming from two wells, named the Colle d'oro and De Gasperi (Accademia Lunigianese di Scienze, Personal Archive of Giovanni Capellini, Box XIX, Folder O, papers 4 and 5) (Fig. 11).

The petroleum produced in the Tocco fields was collected in barrels containing 151 l, hauled onto carriages and taken to the refinery in Grottammare (Fig. 12). From 1866, Ribighini decided to utilize the smaller facility in Porto Recanati to refine only the bitumens from the mines in Lettomanopello in the Maiella area, where productivity was quite consistent. The refinery produced a lot of fuel oil and asphalts, and small quantities of lamp oil. The latter was the real target product for Ribighini, who was looking to refine it in larger quantities at the Grottammare plant. In 1867, he successfully introduced a lamp oil branded as 'Toccolina' onto the market; he presented it at the Paris 'Exposition Universelle' – together with the Società Laschi e Trovati – and visited the municipal authorities of numerous cities to propose that his oils be used to fuel the public illumination systems (Biblioteca Archiginnasio, Box CXVIII, Folder 4, papers 1–3).

The same year, Ribighini and his chief engineer Leopoldo Ferretti started to advertise a new mining venture, and to gather capital to establish the Società Anonima Abruzzese dei Minerali della Maiella (SAM) (Anonymous Abruzzese Company for the Minerals of the Maiella). The SAM was the first company in Maiella to be financed by selling shares to the public (Fig. 13).

The SAM was officially constituted by notary on June 1868 in Chieti. Then, in the following July, the government authorities acknowledged and approved the statute. Unfortunately, at the same time, the project of Ribighini and Ferretti was jeopardized by a sudden depletion of production in Tocco, and a halt to the operation in the refinery at Grottammare. The smoke, the sulphur emissions and the acres of fumes generated by the refining process troubled the neighbourhood. The continuous protests by the residents forced the city hall to suspend all activities. The SAM ended 1868 by producing just 30 tons of crude, which was only 10% of the mineral produced just 3 years earlier; it ceased its activities in 1869, and Ribighini continued to run only the asphalt business between Lettomanopello and Porto Recanati.


N. 817

SOCIETÀ ANONIMA ABRUZZESE

DEI

MINERALI DELLA MAJELLA

CERTIFICATO INTERINALE

L' Azionista Sig. Germano Cugini

ha pagato pel primo versamento dell' Azione assunta

Lire Italiane Cinquanta.

Chieti 31 Dicembre 1867

Il Consiglio d' Amministrazione

Fig. 13. Stock of the Società Anonima Abruzzese dei Minerali della Maiella, 1867.

The operations of Laschi, Trovati and Calabi (1863–70), and Blumer & Jenny (1864–67) – the latter merged shortly after into the Società Anonima Abruzzere dei Minerali della Maiella (1867–69) – had a central role in the development of oil exploration, production and refining in the area. They are acknowledged to have led the production of oil in Italy at their time, and to have turned a spotlight on Maiella in the European oil panorama. Other operators had commercial interests in the region, like the French firm Asphaltene, founded by Augusto D'Aygesvives, and the Compagnia del Gas della Cittá di Chieti (the Gas Company of the City of Chieti), the public illumination company of the nearby town (Massimi *et al.* 2002; Novelli & Sella 2009). Their primary interest was not to search for oil, but mostly to mine for asphalts and bitumens, and to run a local business. These companies all together gave the momentum to the newborn sector and contributed dramatically to shaping what in the following years was defined as the 'Maiella oil district'.

Fig. 14. Compagnie Italo-Française du Pétrole d'Italie.

The fall and the rising of the Maiella oil district, 1870–1900

In 1870, the oil sector in Maiella could be associated with the metaphor of the phoenix. From the ashes of the businesses of the national small investors, it rose as an international oil district made up of foreign

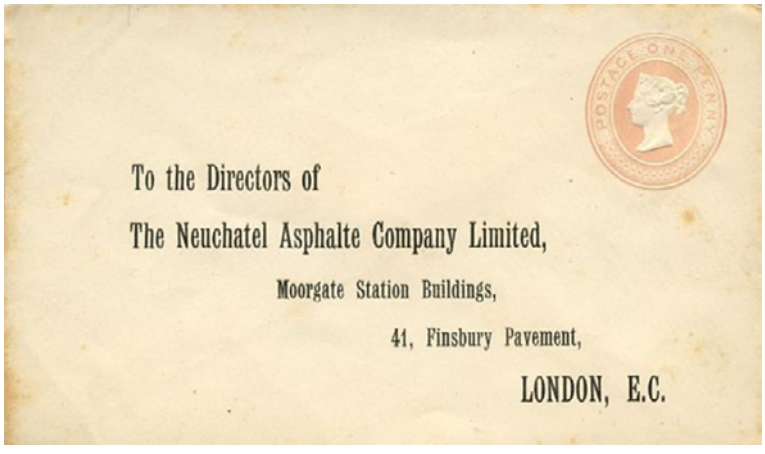


Fig. 15. The Neuchâtel Asphalte Company Ltd.

companies. These new players brought capital and know-how; revitalized old concessions and discovered new mines; invested in mechanization, and the construction of roads and facilities; and made Maiella a point of reference in the geography of the heavy oils in Europe.

In 1873, the early pioneer Silvestro Petrini, no longer a victim of political purges, co-founded with his new British partners the Anglo-Italian Mineral Oils and Bitumen Company, established in London. He opened mines in Scafa, San Valentino and Roccamorice (both close to Lettomanopello) in the Maiella area to extract and refine oil from asphaltic rocks. The Scafa plant was made up of several buildings and halls: two mills, a crushing plant, a foundry, a refinery, a press department, workshops, warehouses and offices. The choice of Scafa was mainly due to the nearby presence of the Pescara–Sulmona railway, then extended towards Rome and Isernia, and the Pescara and Lavino rivers (Petrini 1911; Massimi *et al*. 2002). In 1879, the French Asphaltene company is reported to have still been in business at Lettomanopello. In 1880, a new Italian outsider company Crocco e Giampietro is recorded, but little is known about the extent of its business. The same year, in the local railway hub of Piano d'Orta, close to Bolognano, a refinery with a capacity of ten of tons per day was built by Vittorio Croizat, an entrepreneur from the NW region of Piedmont who was already active in the public illumination business

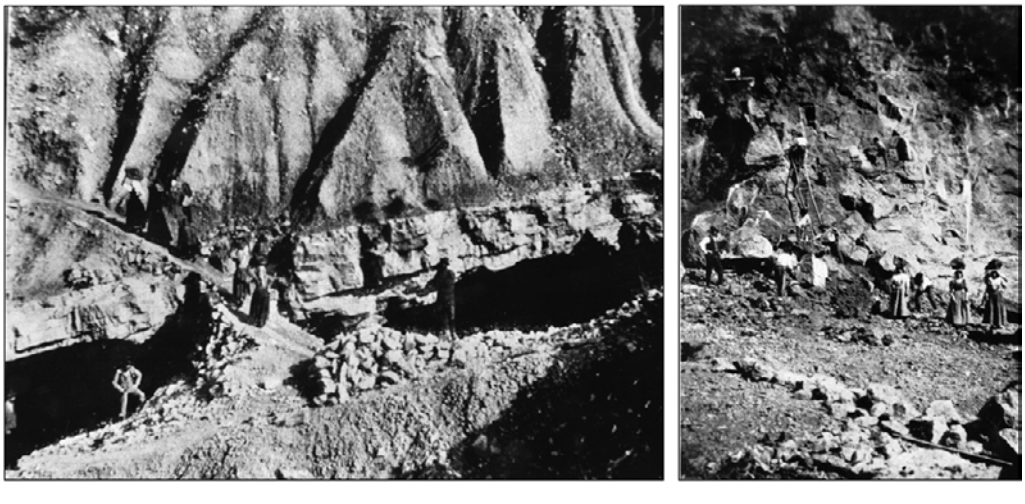


Fig. 16. Photographs of the *in situ* exploitation carried out at surface in the Maiella oil district.

Fig. 17. (**a**) The 'furnace' used to extract bitumen by heating, from the Acquafredda mine and (**b**) the Fonticelli mine, along the NW flank of the Maiella Mountain. (**c**) Loading of mules for transportation out of the 'S. Spirito mine tunnel' (REH 1911); and (**d**) asphalt hauling using mules (REH 1911).

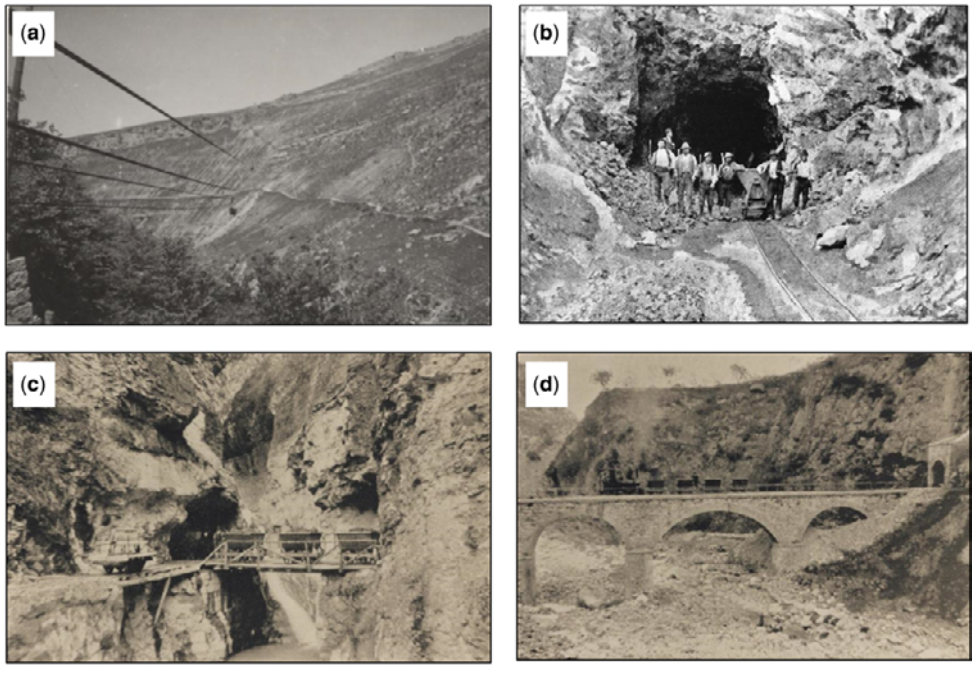


Fig. 18. (**a**) Cableway system across the valley; (**b**) miners at the Santo Spirito mine entrance; (**c**) railway entry point in the 'Pilone' mine system (1903); and (**d**) 48 m three-arch railbridge built across the Lavinio River.

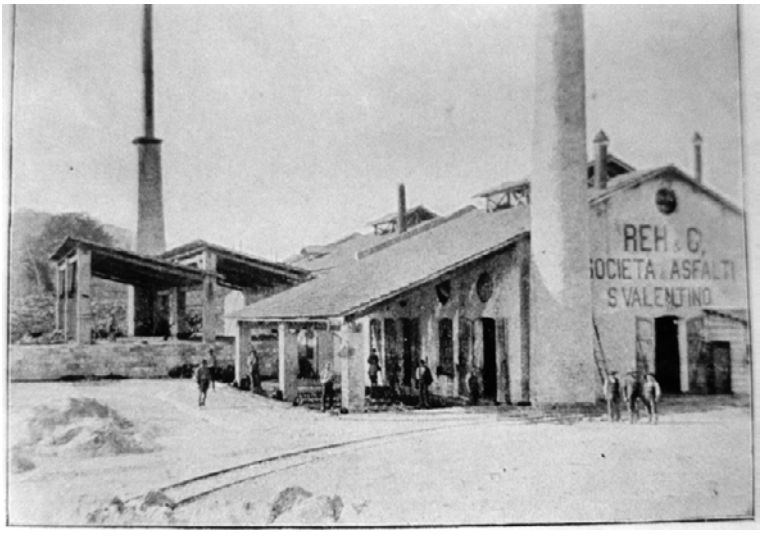


Fig. 19. The REH plant in the San Valentino, Scafa locality.

(Ministero di Agricoltura, Industria e Commercio 1895). In 1881, Giuseppe Laschi still had some properties in the area. He was co-founder in Paris of the Compagnie Francaise pour l'exploitation des sources petroliferes de l'Italie et de leurs produits. The Compagnie purchased all the assets of the former Anglo-Italian Mineral Oils and Bitumen Company from the British firm Claseen. Apparently, the British associates of Petrini, the chief investors, had arranged to cut Petrini out of the business pretty arbitrarily and changed the name of the company. However, the venture of Claseen had a short life. In the same period, the Compagnie Francaise–Italienne du petrole de Italie also entered the district (Novelli & Sella 2009; Zanoni 2014) (Fig. 14).

The turnover of companies was high, and the quantity of mineral produced varied every year. In 1883, the production of crude oil recorded was 125 tons. Between 1889 and 1893 (in this period the production of crude had fallen to just 12 tons, while the mining of asphalts and bitumen was sky rocketing), two companies arrived in the district that in the years to come would give new momentum to the development of the Maiella oil industry. The first to join was the German company REH & Ci. Società di Asfalti San Valentino, founded in Berlin

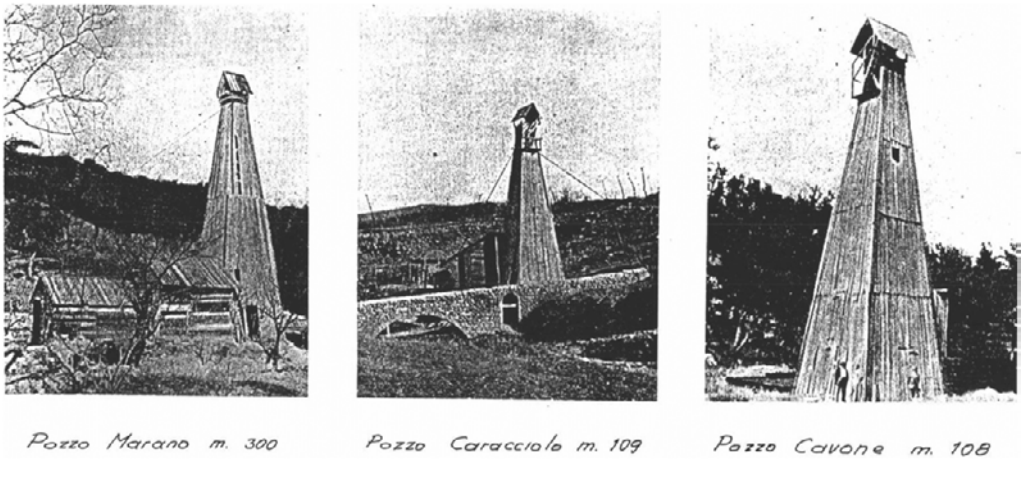


Fig. 20. Photographs of first wells drilled in the area in the late 1800s.

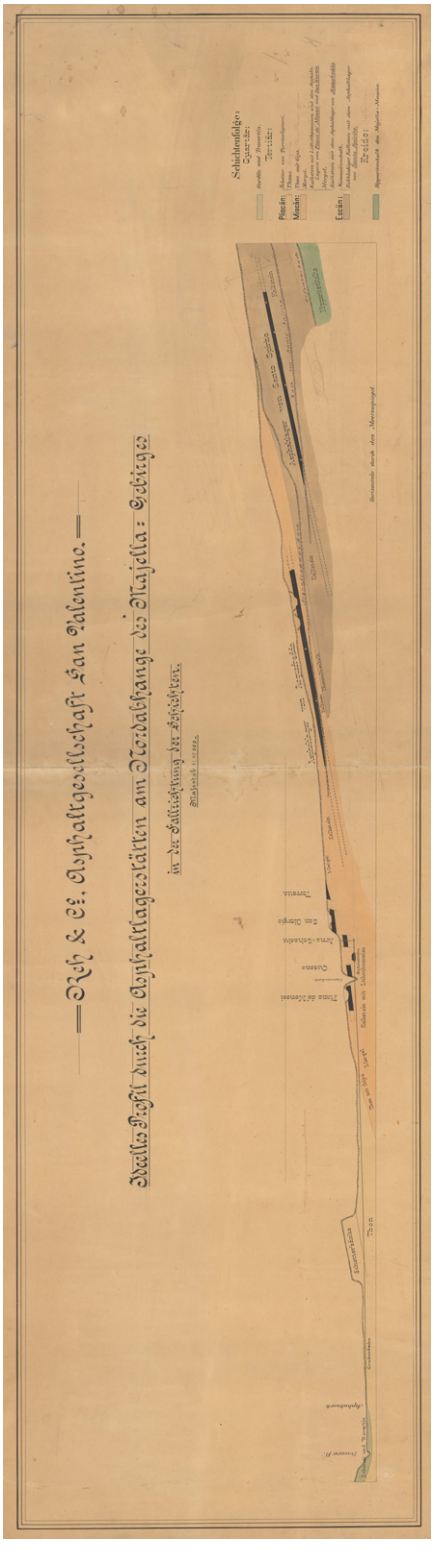


Fig. 21. NW–SE geo-mining original section (ink and watercolour) by the REH company, showing some of the key bitumen-rich intervals exploited at the beginning of the 1900s along the NW flank of the Maiella Mountain.

in 1888 by Adolf Reh; the second was the Neuchâtel Asphalte Company (Giavarini 2011), a British mining company working in the field of asphalt in Europe, established in 1873 (Fig. 15). Both companies established their main facilities in the town of San Valentino, which was close to the railway yard of Scafa. The increasing mining activities required numerous labourers from nearby regions, and Scafa soon became a 'workers village' with 113 inhabitants in 1894 (in 1948 the village would be appointed as an autonomous municipality) (Felice 1990*a*, *b*; De Luca *et al.* 1998). In 1893–94, the Neuchâtel Asphalte Company purchased mining concessions for bitumen mining from firms in difficulty, and started up five new mines in the territories of the municipalities of Abbateggio, Lettomanoppello, Manoppello and Roccamorice (Benegiamo 2012) (Fig. 15). A few years later, the bitumen and asphalt exploitation scenario of Maiella was completed by the French company Società Lyonnaise in 1896, and the German company Valle Romana Asphalte Minendi Lipsia in 1908.

The turn of the new century and the process of industrial transformation across the 'Maiella oil district'

Initially, bitumen and asphalt production in the Maiella district was obtained through *in situ* exploitation activities carried out at surface, from the hydrocarbon-rich reservoirs cropping out along the flank of the mountain (Fig. 16). The bitumen was mainly used for illumination purposes and impermeabilization, while asphalts were used mainly to produce bricks. The workers (including women and children) used to mine and fragment the bitumen-rich rock so that it could be heated in order to extract the bitumen (Fig. 17a, b); transportation was frequently carried out using women and mules (Fig. 17c, d).

With time, a more complex and articulated mining system was created (Colecchia & Agostini 2014), which delivered employment to hundreds of workers in the Maiella area, between the villages of Lettomanoppello, Roccamorice and San Valentino: the exploitation system was extended further, with tunnels, pits and several mines being excavated. Also, as a consequence of all these efforts, by the early 1900s the Maiella area had become the second largest oil district in Italy and an important oil province for future investment in exploration activities. It was defined as the 'Polo minerario della Maiella' (the Maiella oil district), with several production sites over an area of more than 20 km, reported to be active for asphalt and bitumen production; this will eventually deliver an annual production of

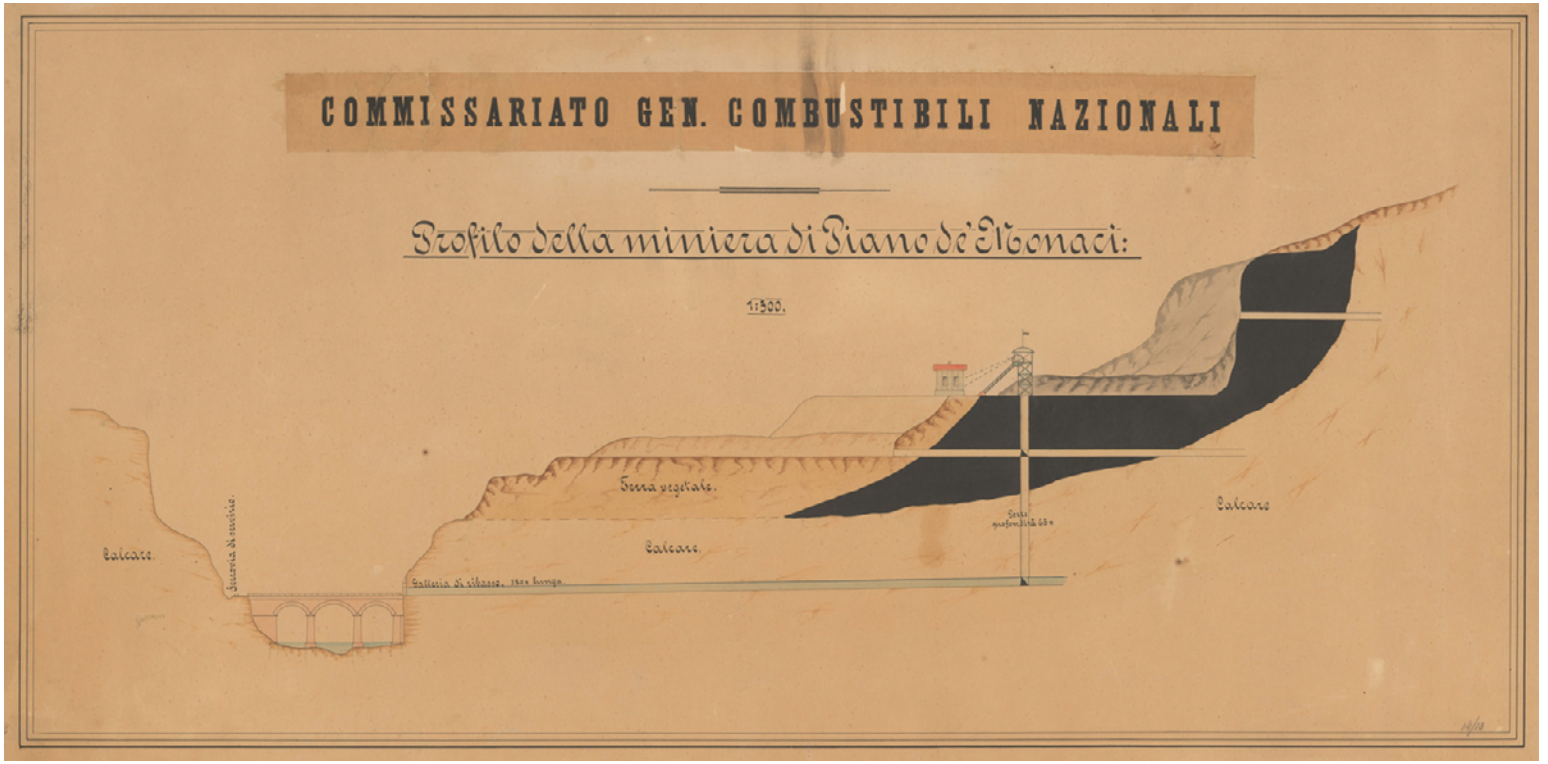


Fig. 22. North–south geo-mining section (ink and watercolour) originally by the REH company showing the gradual 'Italianization' of the mine labels. The section shows the mining system active at the 'Piano de Monaci' mine. The bitumen-rich rocks were displaced along the pit and taken out through carts, across the 'Lavinio' River to the left of the drawing. The same bridge is shown in Figure 18d (courtesy of S.A.M.A. – Italcementi).

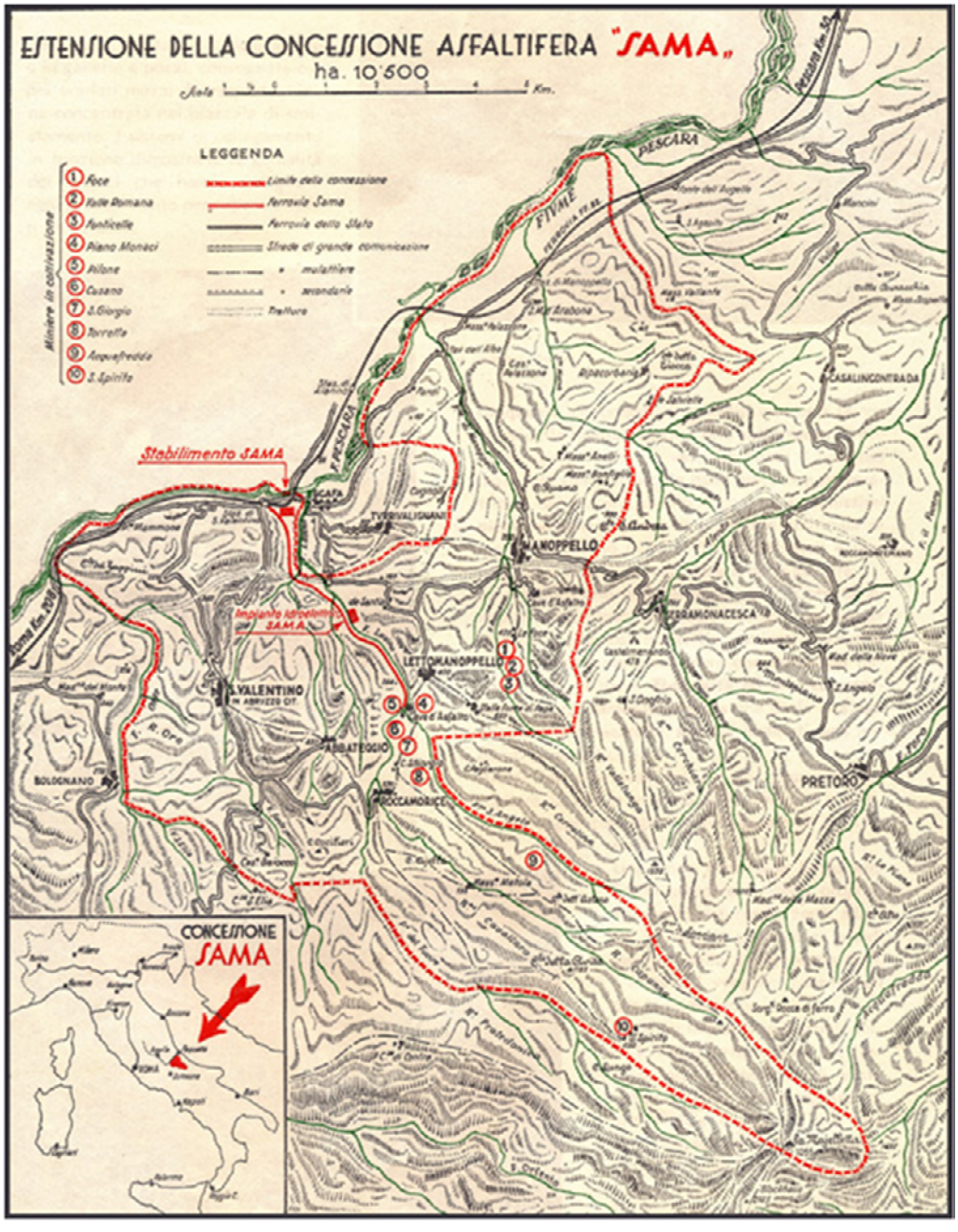


Fig. 23. Map of the S.A.M.A. concession for asphalt and bitumen exploitation (1919–29) (courtesy of the Eni Archives).

more than 20 000 tons of bitumen that would be exported all around the world, covering about 40% of the Italian national production (Ministero di Agricoltura, Industria, e Commercio 1908).

The overall effort was aimed at industrially produced bitumen (directly *in situ*) and asphalt-rich rocks, which, once treated in the factory, could produce asphalt powders, asphalt 'bricks' and refined

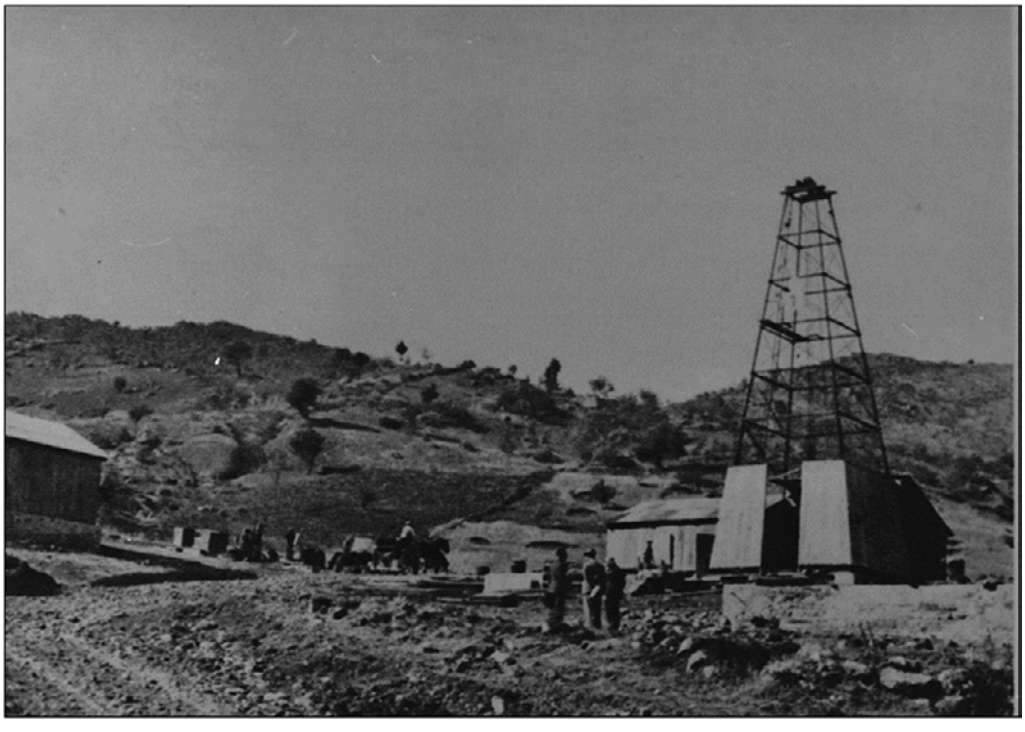


Fig. 24. Well Abbateggio-1 drilling derrick (1927).

bitumen (REH 1911), used as products for roads, pavements and the local cement industry.

These products were then exported either by railway or by ship, from the Ancona and Ortona harbours, mainly to Germany, but also to Egypt, Austria, Russia, South Africa, Holland, Denmark and the Americas (REH 1911). The German REH & Ci. and British Neuchâtel Asphalte companies were the key actors in the industrial transformation of the exploitation activity over these years. In 1903, a 6.5 km-long railway was built by REH to collect extracted material from the widespread system of cableways and mine carts that had been constructed (Fig. 18a, b). The material was then directed by rail (Fig. 18c, d) to the Scafa plant facility (Fig. 19), which was expanded by REH as the main logistical centre of collection and transformation of the extracted material, being well positioned close to the main roads, the railway national system and the Pescara River.

As seen, since early times the history of petroleum-related activities in the Maiella oil district was correlated with the ongoing parallel exploration activity in the Tocco da Casauria area, which was continuing with additional efforts to discover hydrocarbons in the subsurface. Unfortunately, only rare and fragmented documentation exists about the exploration and drilling efforts of that time, with only some wells being documented, such as the Arolla, Marano, Casa del Sergente, San Valentino, Piano d'Orta, Torre dei Passeri, Tre Croci, Caracciolo, Cavone and De Gasperis wells (Coppetti 1954): of these, a rare photographic record exists of the Marano, Caracciolo and Cavone wells (Fig. 20), thanks to E. Paparella, a very active businessman in these areas (Paparella 1928; Coppetti 1954; De Luca *et al.* 1998).

The economic interest over the bitumen-rich reservoirs also required the interest and attention of the scientific community, in particular of geologists who contributed to the understanding of the phenomena, evaluating the type, extension and quantity of hydrocarbon resources associated with the reservoirs (e.g. Giattini 1907). As a good example of the geological view over the extension of these bitumen-rich reservoirs, a geo-section from an original ink/watercolour drawing by REH is shown in Figure 21.

This interest, from both an economic and scientific point of view, is also demonstrated by the fact that, in 1913, a field seminar was organized by the Italian Geological Society over the area, associated with its annual congress held in the city of L'Aquila in September of that year (Verri 1913).

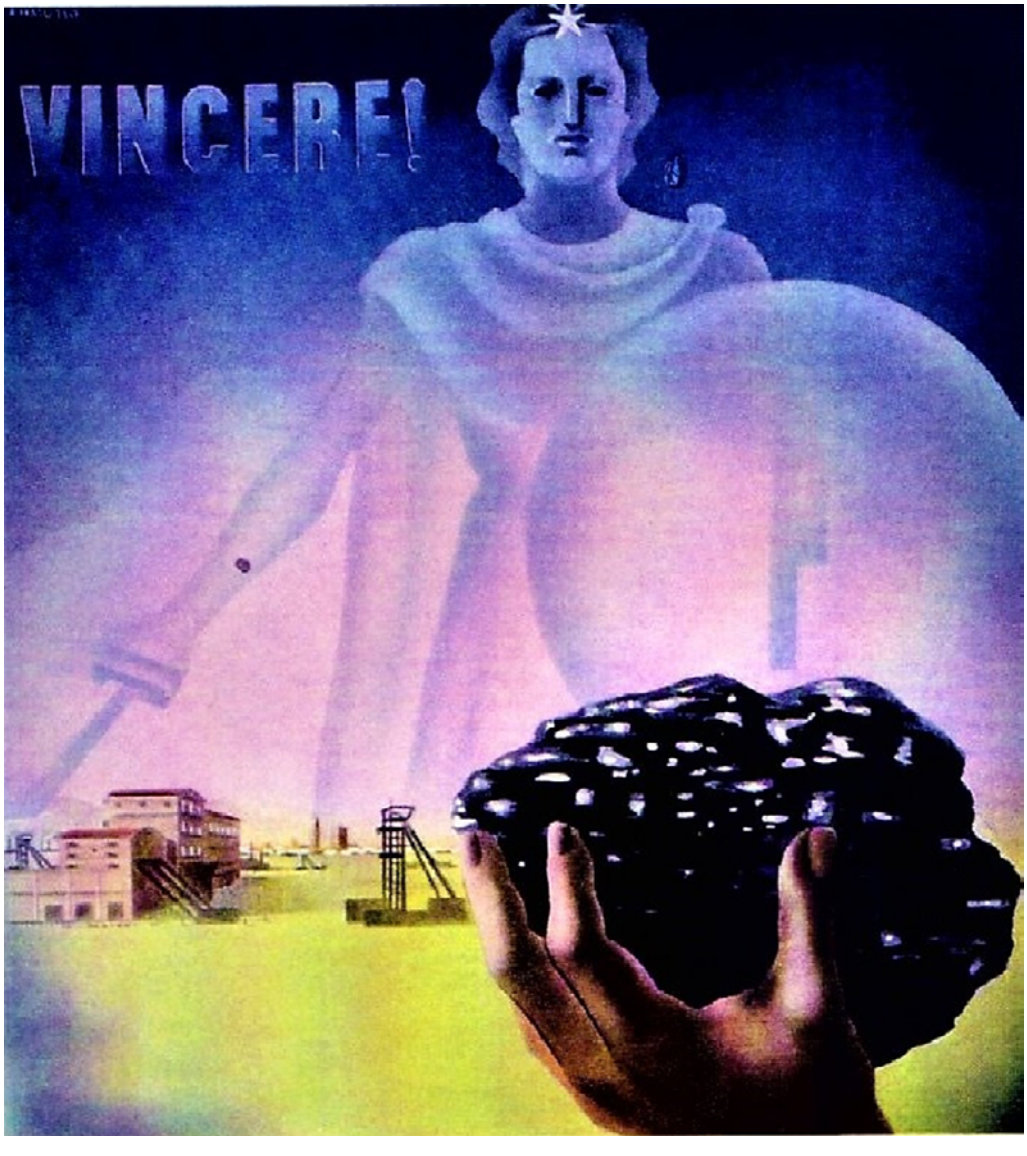


Fig. 25. Example of fascist regime propaganda (D'Ascanio 2013).

1917–18: the nationalization of the Abruzzo mining activities

On 21 May in 1918, following the declaration of war with Germany, the properties of German companies such as the REH were confiscated by the Italian government. This is reported in the mining activity official report of 1918 (Ministero dell'Agricoltura 1920), and well documented from the geo-mining section in Figure 22: in this drawing, the same REH style as seen in Figure 21 can be easily recognized, but with the names now all in Italian. This substitution and renaming action is particularly evident from the main label 'Commissariato Gen. Combustibili Nazionali', which was the authority that was entitled to the confiscated activities. As a consequence, in 1918, after many years in which the bitumen-extraction activity was dominated by foreign companies in this area, a new Italian company called S.A.M.A. (Società Abruzzese Miniere Asfaltiche) was created, to which most of the confiscated concession was then assigned (Giavarini 2011).

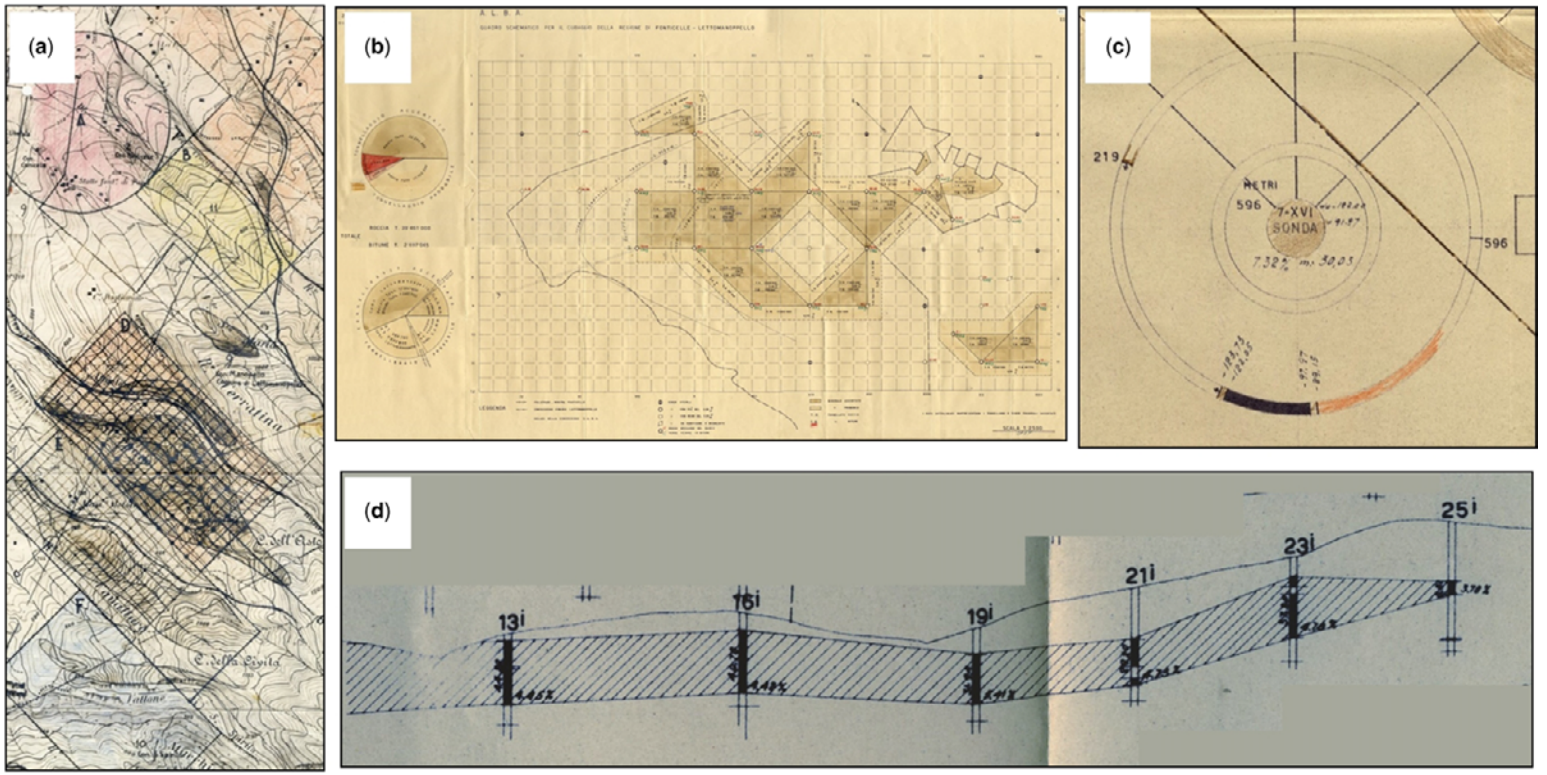


Fig. 26. Example of the A.L.B.A. documentation recovered from the Eni Historical Archive. (**a**) General map of the planned drilling activity over the some key areas along the NW flank of the Maiella Mountain. (**b**) Example of a summary map of the results of the drilling campaign aimed to evaluate bitumen presence and degree. (**c**) Example of a circular diagram used to summarize well information (the hydrocarbon-rich section drilled by this specific well is reported in black). (**d**) Example of a well correlation section showing the hydrocarbon-rich main interval across the Acqufredda area.

The S.A.M.A., which is still operating today, was particularly active in between the two world wars, when it was managing a good part of the existing complex mining and exploitation system (Fig. 23). By 1929, S.A.M.A. was reported to be employing about 950 workers, with the headquarters always in Scafa, at the main plant.

During the fascist period, Italy became in many regards a modern country, also from an oil and gas perspective, and in 1926 the Agip (Azienda Generale Italiana Petroli) company (today ENI S.p.A.) was founded. As a result, a new modern period of exploration and drilling was initiated, in particular with the drilling by Agip and other operators of the Abbateggio-1 (in 1927, reaching a total depth (TD) of 1168 m: ENI S.p.A. Associazione Pionieri e Veterani: http://www.pionierieni.it; (Fig. 24), Lavino-1 (in 1934, TD = 803 m) and Alanno-1 (in 1937, TD = 1185 m) wells, and the drilling of 25 wells in the Tocco Casauria field area between 1933 and 1943. Of these, 14 resulted in producing wells, while 11 others were considered to be uneconomic (Coppetti 1954).

1941–43: the need for national bitumen resources

Approaching 1941, to meet the needs from the industry close to and during the World War II period, a new important effort was dedicated to the exploitation of the bitumen and asphalt resources in the outcrops of the Maiella, and production was increased up to 1000 tons/year.

In 1941, in particular, a new company called A.L.B.A (Azienda Lavorazione Asfalti Bitumi) was created by the fascist regime (Lionel & Bertrand 1941; D'Ascanio 2013) to assess and evaluate bitumen/asphalt resources from the existing oil-rich outcrops known along the Italian Peninsula, mainly from the Sicily, Basilicata, Emilia Romagna and Abruzzi regions, this last one over the 'Bacino minerario asfaltifero abruzzese' ('Abruzzo asphalt-rich petroleum province').

The creation of A.L.B.A. (which also means 'sunrise' in Italian) has to be framed against the national war effort of the country to be as independent as possible from oil imports, and at the same time affirm self-sufficiency (autarky), which was also a top political value of the fascist regime (Fig. 25).

A.L.B.A., which was controlled by the Agip Italian oil company (nowadays ENI) and I.R.I., was assigned to assess the total volume of bitumen/asphalts that could be extracted from the NW flank of the Maiella: this resulted in an extensive geological and drilling campaign carried out between July 1941 and December 1942, with the drilling of about 200 'shallow' vertical wells (drilled using a rotary drilling approach), regularly spaced over grids of 100 × 100 m/200 × 200 m, and with total depths in the range of 80–250 m below surface (A.L.B.A. 1942, 1943). In our research, we were able to find an extensive database of reports, memos, letters and technical drawing from these activities, care of the Eni S.p.A. Historical Archive, some of which are shown in Figure 26.

The whole effort abruptly ended in early 1943, with the arrival of the war front and the retreating defence line from the Nazi army, and the whole site was abandoned for many years thereafter. Even if this attempt was unable to succeed, it did, indeed, represent the first effort to create a national and efficient approach to the development of a key resource, such as bitumen and asphalts (D'Ascanio 2013).

Conclusions

In the 1860s, petroleum in Abruzzo was synonymous with modernity. Many Romanian and Austro-Hungarian fields were a more advanced model of productivity, and this is undisputable. However, in the national contest, the early entrepreneurial protagonists of the 1865–68 boom were forerunners. Blumer & Jenny (later the SAM) can be considered to be the first Italian company operating with an 'integrated model', which included exploration, drilling, production, transportation, refining and retailing. This was a very special and uncommon situation to find, and not many companies at that time in Europe were able to set up and sustain such a complex structure. On the one hand, it was a very effective model: the liquid assets circulated into the company from one stage to another, without substantial external expenditure to third parties. On the other hand, it was a frail equilibrium: every problem in one of the 'ring' components of the productive chain could jeopardize the entire system, and generate losses even in the working sectors. Ribighini first experienced problems with the refinery and then with the yield of the well: the lack of availability of capital worsened the situation, and within about 1 year the company imploded.

A conclusive reflection goes to a historiographical issue that is still not clear in the history of the oil industry in Italy. Was the well dug in December 1865 by the Società Laschi e Trovati the first modern productive well drilled in Italy by means of mechanical equipment and powered by a steam engine? We can state with certainty that it was the first modern well drilled in the Maiella district and, most probably, it was the first – or one of the earliest – drilled by mean of a percussion system

Fig. 27. Pietra Prima – Opere da ammirare: 'Maiella madre di cultura' (Craftwork to admire: 'Maiella, mother of culture') by the sculptor Ettore Altieri.

in Italy (Stoppani 1866*b*; Ribighini & Ferretti 1867; Zanoni 2014).

Until in the late 1860s, the southern oil regions in Sicily and lower Lazio were producing primarily heavy oils, tar and asphalts, and the first tracks of modernization in those areas are documented in later decades. The land on the western slope of the Northern Apennines, included in the provinces of Parma, Piacenza and Pavia, had been known for their oil for centuries, but the documents found so far describe an antiquated industry poor in technology and scarce in production until the 1870s. However, Maiella in the 1860s represented the vanguard of the Italian oil industry in terms of organization, technologies and entrepreneurial organization (Jervis 1873; Magini 1977; Novelli & Sella 2009). This set of conditions was reflected during the period 1865–68, when national oil production was driven by the oil coming from Maiella. These conditions, we think, support our interpretation of the protagonists and the events that occurred in December 1865 close to the Piccolo Arollo Creek.

In Italy, several histories have been written, with which we do not necessarily agree, about the 'first modern oil well of Italy'. Since the 1950s, there have been quite a number of reports on numerous 'first discoveries' accomplished by different people in various places and over several years; absolute statements about 'game-changing' groundbreaking achievements; and improbable numbers of barrels produced. The history of the oil industry is a relatively new field of research. The early oil industry in Italy (1860–70) is still not well documented, and there is much work to be done by historians in the many small, local and badly preserved municipal archives. We are confident that other historians in the future will find further evidence and confirm our thesis (Squarzina 1958).

Maiella has been the most long-running modern oil district in Italy, and the only one that produced considerable quantities of crude, bitumen and asphalts together (Fig. 27). For almost 100 years, oil shaped the classes of skilled workers; created some of the wealth that distinguished eastern Abruzzo from other less fortunate regions of Italy; and contributed to the development of the industrial and civil infrastructure in the Abruzzo territory. The evidence still visible at surface – abandoned mines, pits, quarries and facility ruins currently studied by industrial archaeologists – are the witnesses to the cultural richness and historical relevance of the oil industry in the area, from both a geological and technological point of view. Finally, it would be desirable in the future to cultivate renewed interest and encourage a new

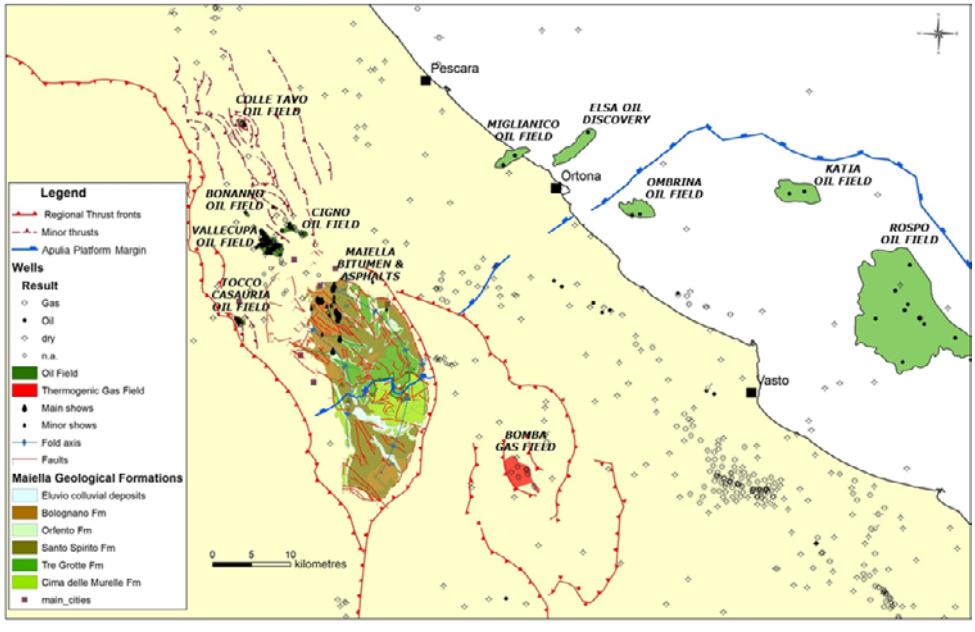


Fig. 28. Regional hydrocarbon occurrence map onshore Abruzzo and offshore the Adriatic Sea (central Italy). The surface geology and main tectonic elements are reported. The whole Maiella structure is represented (in colour), as well as the main Apennine-related compressive thrusts (in red) and the main oil fields discovered in the area (both onshore and offshore).

campaign of exploration in this region, where many opportunities remain to be discovered in the subsurface and others can be better investigated (Fig. 28).

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