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A Controversial Management Process: From the Remnants of the Uranium Mining Industry to Their Qualification as Radioactive Waste – The Case of France

Philippe Brunet
Université d'Evry, Evry
Centre Pierre Naville
France

1. Introduction

The analysis of environmental issues inevitably requires the contribution of an array of scientific disciplines. The experimental sciences, whose goal is the knowledge of natural phenomena, cannot aspire, alone, to resolve the problems raised by interactions between human societies and nature. Nor can the social sciences claim any monopoly thereto. This is particularly true of our industrial societies, which ceaselessly produce what Ulrich Beck calls “latent induced effects” (1986) which engender long term environmental and health hazards. Their understanding is always belated. It is very often achieved by expertise in experimental sciences, intersecting with the wisdom of common sense, social mobilisations, and the weight of prevailing social norms (Wynne, 1997). Their extent and lastingness accordingly result from the combination of two factors, one being determined by the other. One factor include the limits, at any time, to the knowledge and predictions that they make possible, in terms of the future trend of a given industrial process ; other factor, the social relationships of production and reproduction whereby this industrial process is implemented by relying on the prior art, but also on prevalent beliefs and ideologies.

These social relationships also produce social values and norms. Under the impact of the rapport between capital and labour, they sustain the subdivisions inherent in any process of industrial production and in its organisation between experts and laymen, producers and consumers, particularly via legitimating arguments (Braverman, 1975). The sociological analysis of environmental issues requires an understanding of the dynamic of these social relationships through the examination of their tensions and conflicts which, very often, are crystallised in these dialectical forms. It must be considered as complementary to the analysis of the nature sciences, without one ever substituting for the other. It is in this perspective that we propose to analyse the production process of the uranium industry, a vital link in the production of nuclear energy. We shall focus particularly on its remnants. We shall show that the qualification of radioactive waste which henceforth attaches to them results from practices of the players within changing configurations, to varying degrees conflictual. The challenge concerns the hegemony of legitimacy to *say* and to *do* with regard

to their management. This perspective accordingly implies carrying out a long range analysis to grasp their evolution.

This chapter is divided into two parts. The first describes the emergence of the problematics, in which science, technology, politics and standards are combined in a scheme of specific production relationships. It dwells on the early decades of the atomic complex, to grasp its various structural components and, ultimately, to understand the function of the radioactive waste qualification process. The second part expands the analysis of this mechanism over the long term, based on the case of France. The focus is then directed at the least known productive segment of the nuclear complex, the uranium mining industry, and on its repercussions in terms of waste.

2. Science, politics and standards concerned with radioactive waste: A new horizon

By virtue of its history, and its underlying scientific knowledge and techniques, the atomic industry, later called the nuclear industry, is linked with the state of war. This is why no doubt more than any other, this industry has been ambivalent since its inception. It is oriented towards destruction as well as production (Naville, 1977). This attribute is especially pronounced as the structure becomes recursive. Indeed, the earliest large atomic facilities that went on stream in the USA, the USSR, Great Britain and France, were plants simultaneously generating plutonium and electricity for military and civilian uses (Barillot and Davis, 1994). Similarly, the environmental and health hazards associated with the concept of energy generation were precisely the “arguments”, amply demonstrated in practice, of its capacity to destroy at a hitherto unsuspected scale. This finding became the background for the many descriptions, popularisations and justifications of the new industry (Ducrocq, 1948; Martin, 1956; Goldschmidt, 1962), giving rise to many consequences that we shall examine in turn, and globally. First, the control of this industry was directly assumed by the States and associations thereof, in peacetime and wartime alike. Second, its technological and strategic sophistication generated an intensive and tight interpenetration of different professional worlds: scientific, military, industrial and political. This tense closed world reflected the elitist, in other words, non-democratic, relationship that became established for decisions pertaining to this industry. And finally, its ambivalence marked an associated process: the qualification of “radioactive waste”. The narrow perimeter in which it was long contained caused the slowness of its development, and also, in exchange, the deep democratic penetration that it received.

2.1 The atomic and nuclear industry: A matter for States at the planetary scale

After the Second World War, the atomic industry developed essentially in obedience to geostrategic and military objectives. A differentiation set in between States according to whether or not they possessed the atomic weapon and its uranium fuel. This cleavage was not exclusively of a technical or economic nature. It was also political, and had two outcomes. States owning atomic weapons sought to hamper the access of other candidate states to the possession of the industrial process. It hence ordered and crystallised the global ranking of the military powers. This situation still prevails today. For example, the sanctions imposed against Iran since 2006 by the UN Security Council, claimed justification in the fact

that these countries had tried or were trying to possess a military nuclear industry (IAEA, 2006). It also fostered a policy of secrecy which was gradually relaxed to facilitate civilian industrial applications.

This unprecedented situation betokened a new relationship between science, industry and politics, with an implication of international controls. The sharing of the world in fact established new geostrategic relations between East and West. Its equilibrium depended on the resources available to each camp to develop the industrial process. Before the war, the Belgian mines of Upper Katanga enjoyed a monopoly of radium production. The importance gained by uranium as a fuel then encouraged the USA to control its production. Despite the discoveries in Canada and Czechoslovakia, uranium was held to be a rare ore (Ducrocq, 1948). Thus, wishing to maintain a lead, which it wrongly believed to be significant in terms of the technology and the uranium raw material, the USA tried to impose its point of view, which only Great Britain and Canada accepted. Faced with the refusal of the USSR, which controlled Czech uranium, the USA decided to maintain its lead by practising a policy of secrecy (Goldschmidt, 1962). Indeed, in late July 1946, a law was passed organising and governing atomic energy in the USA (the *MacMahon Bill*). All the problems of atomic energy, from ore to nuclear fuel, plants included, fell under its authority. Secrecy was maintained, and its violation decreed a capital crime. Finally, the new Bill enshrined isolationism: collaboration with other countries was subject to Congressional approval. This is why from 1946 to July 1954, when the law was first relaxed, even collaboration with English speaking countries was suspended (Goldschmidt, 1962). This policy of secrecy became the international norm. In September 1949, the Russians showed the American that they no longer held exclusive sway. The battle for power and technological sophistication was then joined on a new project based on the thermonuclear reaction, leading to the hydrogen bomb, a thousand times more powerful than the A bomb. At the same time, in 1952, Great Britain broke into the closed club of the atomic countries, followed by France in 1960. This policy of secrecy contained its contradictions. Thus, from the 1950s, the US proposed the Baruch plan to the United Nations (Goldschmidt, 1987). It offered to relinquish atomic secrecy provided that an international agency took charge of the ownership of the uranium mines, atomic materials, and the running of fuel production plants and power reactors. The USSR was opposed and demanded that the USA destroy its arsenal and terminate the arms race. The American proposal was doomed to failure. Certainly, it foreshadowed the various UN regulatory agencies that were progressively set up in the atomic field. This necessity stemmed from the ambivalence of its industry. In terms of destruction, the UN Security Council contained the five foremost historic atomic powers as permanent members¹. They therefore “monitored” the balance of global forces under the sign of secrecy and mutual mistrust. In terms of production, civilian industrial development could not durably be a subject issue. This conflict was partly resolved at the first international conference in Geneva in 1955, *Atoms for Peace*. The disparateness of its participants and the scheduling of its deliberations (first, states and after Scientists) were symptomatic of its social intricacy and hierarchy, which promoted the existence of the industry, born in the USA in 1943.

¹ The list of five permanent members was approved in 1946, long before they became atomic powers. However, the correlation is striking, and the sign of a suite in the state power ranking.

2.2 The atomic and nuclear industry, a heterogeneous and closed visage

Its starting point was the *Manhattan Project*. This project was its parent-formula. It associated four different types of social actors, not without some tension: State (for political decisions), Industry (the *Du Pont* company engineers for the practical organisation of the industrial process at Oak Ridge, Tennessee), Scientists (for their investigations), and the Military (for their responsibility in management and control) (N'diaye, 1998). Subsequent industrial developments, each inserted into their specific national frameworks, were differentiated from this initial wartime model. But, with it, they shared the principle of ambivalence between destruction and production, of the disparateness of the social actors, and finally, the closure of this new productive world sustained by the policy of secrecy. The French model was no exception.

Certainly, for no science other than nuclear physics, was the era of its fundamental and theoretical questions and that of its practical applications so intermingled, jump-starting the production of destructive bombs. This unprecedented situation was marked by contradictions and internal tensions, particularly the ambiguous attitudes of the scientists (Martin, 1956). In August 1939, Einstein sent a letter, co-signed by other physicists, to US President Roosevelt, to alert him to the risk of some day finding Nazi Germany in possession of the atom bomb. He decided to move swiftly. This act triggered a process of decisions culminating in the *Manhattan Project* in 1942, in other words, the production of the bomb. It is estimated that 75 000 to 150 000 people were mobilised, particularly in the Oak Ridge plant, until the explosion of the first bomb in New Mexico (Goldschmidt, 1962; N'Diaye, 1998). The scientists, with the army and the industry, were joined under the aegis of the political authority. This created some ambiguity in the attitudes of the scientists in three respects. On the one hand, while nothing in the atomic field could be done without them, its future was beyond their control. On the other, the practical and ideological underpinnings of their professional integrity were denied. This applied to unrestricted access to information and its exchange in the name of priority over the policy of secrecy, and disinterestedness in the name of limited commitment. They tried morally to resolve this contradictory positioning in many ways: through justification, through guilt, or even by engaging in peace movements like *Pugwash* and the *Stockholm Appeal* (Oppenheimer, 1955; Joliot-Curie, 1963; Einstein, 1979).

Similarly, the first international conference in Geneva in 1955, *Atoms for Peace*, which brought together seventy-two countries, tried to resolve the internal contradiction of the atomic complex internationally. It partly relaxed the policy of secrecy and thereby met the desires of the scientists. It made possible the recursiveness of destruction towards production. It timidly addressed the latent induced effects of radioactivity on human health. Its deliberations nevertheless reflected the ambivalence of the atomic complex and the ranking of its players. First, the governments of the atomic countries (USA, Great Britain, USSR and France) held a week-long meeting in July; followed by the scientists and industrialists for twelve days on the civilian applications of the atom. No other social or associative force was invited to the discussion table, confining the issues exclusively in the hands of the experts and political decision makers.

These ingredients of the atomic complex could be found in the French formula, delayed and with specific characteristics. In October 1945, Commissariat à l'Energie Atomique (CEA) was

created under the unchallenged authority of Frédéric Joliot-Curie². Its programme was that of atomic science and its civilian applications. The problem of fuel remained to be solved. The CEA had a limited stock of heavy water and uranium in a context of a uranium embargo. France accordingly launched a prospecting programme:

“Dig everywhere without second thoughts. Have no qualms about your prospecting methods. Besides, if I could, I would send out 2000 prospectors throughout France! They would systematically scour the soil with a Geiger counter, from the Pas-de-Calais to the Pyrenees! Not a single clue of uranium could elude me!”

This was Joliot-Curie’s exhortation to the first class of uranium prospectors trained from December 1945 (Paucard, 1994). Until 1950, when Joliot-Curie was dismissed for political and geostrategic reasons, and even beyond, scientists resisted government pressures concerning the assigned objectives. The challenge was the atom bomb and the military presence in the CEA. But, progressively, through the Fifties, the CEA industrialised, militarised and finally escaped the control of the scientists, now more relevant to the initial model promoted by the U.S. So, By government decree in 1951, the CEA was led by a director and no longer by a scientist. In 1955, the government created the consultative commission for the Production of Energy of Nuclear Origin (PEON commission). It is reporting to the government and tasked with supplying justified opinions on decisions to be taken. Also, the government named a military man to direct the CEA’s general design office: in 1958 this office became the CEA’s Directorate of Military Applications (DAM), charged with setting up France’s nuclear weapons programme. After much procrastination, the French government decided to build the atom bomb. The return of General De Gaulle to power in 1958 accelerated the process. Symptomatically, the CEA’s director general, P. Guillaumat, was appointed minister of the Armed Forces by de Gaulle in his new Government. Two years later, in 1960, France exploded a bomb in the Algerian Sahara for the first time. In doing so, it joined the club of the four world nuclear powers. It thus marked a crucial step of its scientific, technological and geostrategic history in its quest for international “radiance” (Hecht, 1997).

2.3 The atomic and nuclear industry: Qualifying waste and measuring risks

The concerns that initiated the “radioactive waste” qualification process were present from the outset of the atomic complex, in forms both extensive and unstable. However, they fit into a matrix in which the development of atomic weapons and the corresponding secrecy policies predominated³. They were directed towards radioactive materials in use as well as those already used and non-reusable, insofar as they all incurred health hazards. The scientists, engineers and experts, associated with nuclear facilities, investigated and controlled this qualification process. They set up a system of standards and practices to which the governments adhered. Over the long term, this framework stiffened in a context of pressures. This was because a shift in the reference threshold of health and environmental hazards was observed, correlated with a deep public sensitivity, organised or not. In this

² He was Nobel co-laureate in 1935 with his wife, Irène, for the discovery of artificial radioactivity. During the German Occupation, F. Joliot-Curie secretly joined the Communist party.

³ An example, among many others, is the circulation of books aimed at the public for protection against the atomic radiation from a bomb. They were generally written by the military. (Gibrin, 1953)

respect, the radioactive waste qualification process was characterised by a democratic penetration that affected the entire nuclear complex.

Without any doubt, the starting point of this process was located in a twofold prolongation. One was the international meetings between experts of the new industry, which became institutionalised, either under the UN or in the form of inter-State treaties in the Fifties (Goldschmidt, 1987)⁴. The aim was to standardize practices to conform to the development of peaceful applications of nuclear energy. It was also a symptom of the public response. In fact, the weight of the military industry and its meshing with the civilian industry limited the quality of available knowledge, the social relationship to this knowledge, and the transparency of the information (Barillot and Davis, 1994). Let us examine these various aspects through three examples in France.

The multiplication of thermonuclear bomb tests came under strong criticism from some of the atomic scientists, who mobilised internationally. Soil contamination by radioactive fallout was condemned with the health hazards associated with the food chain. For example, Linus Pauling, Nobel laureate, in an international conference of conscientious objectors in Germany in June 1959, declared:

“The government leader who issues the order to explode an experimental atom bomb must realise that it simultaneously condemns 15 000 children yet unborn to suffer serious physical or spiritual handicaps and to have a painful and miserable existence” [press article in *Echo du Centre*, 2 July 1959].

This topic was a pressing concern in the Fifties in France. It was expressed in the political and peaceful battles against atomic weapons. It also raised public awareness about the problems raised by radioactivity. A split accordingly occurred between the good and bad users of the atom, depending on whether they derived respectively from civilian or military applications (Joliot-Curie, 1963). Public attention to the health risks engendered by radioactivity was therefore structured differentially. Notwithstanding this, it forced the CEA to install devices to record the radioactivity produced by this fallout across the country.

Another pressing topic was the dumping at sea of radioactive waste. This method, common to the atomic countries, applied the principle of dilution (Quéneudec, 1965). It was part of an initial presumption of the growth of industrial capitalism. Nature’s power of absorption is infinite (Beck, 1986). In October 1960, French press reports that the CEA is planning, in its own words, an experiment to submerge 6 500 drums of low level radioactive waste in the Mediterranean Sea [*Echo du Centre*, October 12, 1960]. In actual fact, from the onset of the Fifties and in secret, the CEA was already implementing the dilution principle by dumping waste into the rivers. The publicity shed on this project sparked a strong reaction from the population concerned: elected officials as well as scientists, biologists and oceanographers in particular, demanded that the Government shelve the experiment. The Minister for Atomic Energy had to explain matters before the Parliament:

⁴ Without claiming to be complete, examples include UNSCEAR created in 1955 by the UN. Its role was to assess the levels and the effects of exposure to radioactivity. The IAEA, created in 1957 by the UN also, promoted the peaceful uses of nuclear energy. EURATOM, created in 1957 by Europe, was a body that coordinated research programmes on nuclear energy and accompanied the growth of the civilian nuclear industry.

“We must therefore calm the fears of French opinion by making it understand that, in a century of progress, its vague terrors are no more reasonable than those of our ancestors upon the advent of the railway, of electricity, and of cars. It is a national duty, because it conditions the development of atomic energy in France [...]. We, who are most familiar with the details of the problem, who bear the responsibility, not only to weigh the risks, for ourselves and for our children, with objectivity, but also to inform, have this honour or liberating the men and women of France from their vague and senseless fears, and of restoring their trust” [*Official Bulletin*, Senate, session of 3 November 1960, p. 1435].

Finally, a challenge emerged in France, concerning the health detriment of the radioactivity used in medicine. A teacher, J. Pignero, took the initiative. In 1962 he created the Association against Radiological Hazard (ACDR) to react against the compulsory radiological examinations for schoolchildren. Previously, in 1957, the reading of a popular science magazine alerted him to the risks incurred by the children⁵. The association published a bulletin, *Le danger radiologique* (Radiological hazard) and acted to defend the few teachers who refused the imposition of these examinations on the children. In 1966, the ACDR was converted to the APRI (Association for the Protection of Ionising Radiation) in order to extend the associative battle to the civilian and military industry branches. This appears to have been the first organised opposition to the nuclear industry in France (Prendiville, 1993).

These various forms of public engagement implied an extension and a dissemination of the critical questionings on the subject of the risks of radioactivity, more or less independently of the institutional experts. This extension revealed the instability in identifying the threshold between the benefits and detriments, because science alone could not tell all (Beck, 1986). Thus, a normally positive health use of radioactivity (X-ray examinations) could be challenged for its danger. Moreover, since the diversity of the uses was condensed into a risk bearing aggregate, stretching from the military industry to medical practices, it was not so much the problematics of waste that prevailed in these first challenges, as that of the potential hazard of any radioactive material. It took root in particular in the detachment of some of the scientists from the reassuring and faultless discourse of the atomic institution. Yet its public range remained limited by the small audience of the associative movements that relayed it on, apart from the more political movements focused on the rejection of the bomb. This is why these criticisms did not truly destabilise or delegitimise the power to say and to do of the players of the atomic complex, who generated most of the knowledge and the justifications of this industry.

When the French government decided in 1975 to build a large nuclear power capability to contend with the oil energy crisis, this situation had barely changed. The social criticism of the atomic industry remained very discreet. It is true that the spectre of atomic war had receded and that a political consensus had emerged in France in favour of possession of nuclear weapons. As an emblem of this process, the French communist left, which long argued against nuclear weapons, finally came round to the idea that its possession by France was a guarantee of its independence. This caused a significant weakening of social mobilisation. And it is without any real debate in the parliament that the decision of this

⁵ According to testimony obtained by letter dated 25 July 1999.

new nuclear energy plan was taken, because in this case also, the political consensus existed to legitimise the energy independence of France. And yet, it is at the meeting point of the various criticisms that an anti-nuclear movement was taking structural shape in France, with varying strength according to location. This movement was not only heterogeneous in its composition, but also in its arguments and its highly diversified methods of combat. Thus we find three types of critical (Brunet, 2004a; 2006b). First, critics levelled by scientists who organise and popularise for the public the problems raised by the deployment of this energy industry in France. This is the case of Group of Scientists for Information on Nuclear Energy (GSIEN). This group was founded by scientists, particularly nuclear physicists, after the “appeal of the 400” published by the daily *Le Monde* in February 1975. A total of 400 scientists of the CNRS, the College du France and the universities were concerned about the risks incurred by the French nuclear power programme and asked the population to reject the installation of power plants as long as any doubts subsisted. They criticised the secrecy surrounding the nuclear industry. GSIEN published a journal *La Gazette du Nucléaire* which played a considerable role in checks and balances and hence in the democratic penetration of the nuclear industry. This journal was circulated to a nascent antinuclear movement. In this sense, GSIEN was the first independent associative expert. In second, the critics in which the nuclear power programme is assimilated with the installation of a police state ordering an overwhelming consumption disrespectful of nature. This type of critical, more political, was essentially levelled by libertarian and ecological movements as an extension of the criticism of capitalist production and consumption in 1968. Finally, we find the critical type “nimby”⁶. It is truly from this period that the problematics of radioactive waste began to take shape. The inquiry by a journalist among members of the PEON commission in this period was symptomatic of this slow movement. To the question of “waste?” he received the answer: “It is not a current problem. The storage of these wastes today raises no difficulties; they only occupy a few square metres. It will become a substantial problem in the year 2000”. (Simonnot, 1978). This issue was essentially centred on the production of industrial facilities qualified as nuclear, in other words, their fuels and wastes and releases. The uranium ore industry remained on the sidelines of this nascent problematics. Accordingly, its associated remnants are difficult to “recognise” as radioactive waste. This is precisely what we shall examine in the second part, covering the long term.

3. From the remnants of the uranium mining industry to the qualification of radioactive waste

We have seen that for geostrategic reasons, the context of national reticence and secrecy surrounding the development of the atomic industry internationally after the Second World War compelled France to take steps to assert its independence. Evidence of this is the creation of The CEA in 1945. And in setting up this new industry, uranium procurement became the CEA’s top priority. The first class of prospectors was operational in late 1945. From the outset, an ever growing series of survey missions crisscrossed France, focusing on granitic formations. Some were already known from radium mining. This is the case of small deposits known before the war and located on the eastern margin of the Massif Central. As to the remainder, prospecting missions were spread over a vast area forming a V

⁶ Nimby: the acronym means “not in my backyard”. It is intended to reflect a refusal by future residents, not of this industry as a whole, but of observing the installation of a risky industrial facility nearby.

from Brittany to the Morvan and passing through the Massif Central. Others, like the Limousin, were prospected for the first time. In this region, some twenty kilometres north of the city of Limoges, the richest uranium shows in France and the most promising in terms of quantity were discovered in late 1948 (Paucard, 1992). They allowed the industrial mining of uranium ore and, from the late Fifties, chemical treatment to produce *yellow cake*. The outcome was an industrial configuration which lasted half a century and caused an upheaval in this small rural region, formerly dedicated to agriculture. Like any mining industry, the production of uranium led to the buildup of overburden and tailings. Three successive periods can be distinguished to understand how these tailings were transformed into radioactive waste. They corresponded to different social configurations in which the legitimacy of statement and action tended towards their qualification. Whereas the tailings were treated routinely in the early period, and only raised questions in the second, the analysis of the third period reveals a conflictual context, with growing, permanent, expert and multifaceted vigilance with regard to their management as radioactive waste.

3.1 The good old days of uranium: The era of arrangements and convertible industrial remnants

The first configuration, the *good old days of uranium*, lasted about twenty-five years, from 1949 to 1973. It reflected an industrial mining scheme in which the tailings were treated as harmless. As for any mining practice at the time, they were either returned to the environment, or were used for other purposes. The monopoly of knowledge and power over them belonged to the CEA. It alone analysed, guided decisions and set the standards. The knowledge of these tailings was therefore severely restricted by such practices, especially since the mining industry was dissociated from the nuclear industry. Ultimately, risk is intrinsic to mining activity. Only the environment is risk-free.

Because of its duration, this industrial configuration was a structuring factor. It displayed many features. First, it was localised, limited to a few communes of the Monts d'Ambazac. Second, it was closed in on itself. The few kilometres distance from the city of Limoges were a virtual barrier separating the rural and urban worlds. Their links were limited to traditional trading between countryside and city. Besides, this small rural region was the water reservoir of the city of Limoges⁷. This configuration was also dominated by the CEA's mining division, made up of mining engineers and geologists. So, the job organisation of mining production is doubly structured by a geological department, in charge of prospecting, of measuring ore assays, and a mining department which extracts the ore. The Mining Division corresponds to the company which, in addition to these two major technical departments, contains an equipment maintenance and management department and an administrative department. And a significant number of the mine workers were former farmers or their offspring. Moreover, after the discoveries of large uranium deposits, the CEA supplemented the ore mining process with on-site treatment in a plant built in 1957 in the commune of Bessines. For economic reasons relating to the low concentration of the ore, the CEA quickly decided to concentrate the uranium ore chemically on-site. The product obtained was a paste called yellow cake, which had a uranium content of about

⁷ Since the 19th Century, the City of Limoges has installed reservoirs in the form of ponds, for its water supply.

90%. This cake was then sent to plants in southern France to undergo final treatment to fabricate nuclear fuel by purification and enrichment. Before the Bessines factory went on stream, the CEA transported and processed the ore from Limoges in the Paris area, to the Bouchet factory.

Between this industry and the population, a shared positive vision emerged of its production within a set of arrangements. Uranium ore, an element of an acted nature, became the new wealth of this area and the symbol of its revival. It became a positive heritage. This situation did not discount the “drawbacks” engendered by the proximity of the mine to the villages: collapses of cultivated land, wastewater dumping into the fields, deafening noises and dust clouds from the mine sites. Yet formulated as such, they did not bring into question the mining industry and its vocation for the inhabitants: as the driver of local economic development. Depending on their characteristics, these drawbacks were dealt with under individualised arrangements on an individual case basis, or collectively. Thus, for example, the collective problem of access to water could be solved by its handling by the mining division. Indeed, when the mining division was installed in the Fifties, a collective water supply did not exist, and water was drawn from individual wells. Very often, mining operations intersected the springs and dried up the wells. The mining division then took charge of the collective water supply. In exchange, these arrangements served to reinforce its domination over the area. Thus when the mediation of the mayors was required to address collective drawbacks, the negotiations always took place in the office of the director of the mining division, a venue that was deeply symbolic of the exercise of this unchallenged domination.

As for the treatment of the remains from the industrial process, it was completely unmarked. Two types of waste coexisted: overburden from ore extraction, and mill tailings from chemical treatment. The first were the rock containing the ore, whose economic value was below the assay. Considered as routine and harmless, they were used as backfill for road building projects, or to plug a mine. Part of it was also used in individual arrangements. The latter were present as soon as the Bessines factory became operational. In the form of reddish wet sand, they represented an approximately equivalent mass to the crushed ore. Indeed, in terms of mass, given the very low uranium concentration in the rock, yellow cake represents an infinitesimal part of the total mass of ore treated, about 2 to 5 ppm depending on each case. They were handled in two ways. The first was burial in the excavations of the open pit mines. Thus like the overburden, they were “returned to nature” without any further action. A second, in very small quantities and less frequent was disseminated across the region for masonry. So, examples are not rare of individuals residing on the mining zone who used these residues, some to make a floor slab for a home, build a workshop, obviously unaware of the radioactive hazard associated with the very high radon emanations released by the radioactivity remaining in these residues. This raised no problem: the radioactive composition was considered close to zero because the chemical treatment was supposed to extract all the uranium.

In actual fact, the only recognised risks were contained within the strict limits of the production process. Exposure to these risks concerned the miners, especially the workers. Some of these risks fell into the very broad class of mining operations: cave-ins, silica inhalation. Others were classed as radioactive risks. From the mid-Fifties, a more sophisticated vigilance, taken over by the CEA, was exercised over the work of the miners,

with the installation of mine aeration systems and radioactivity measurements, both collective and individual. The chief hazard identified was radon. It was discharged to the exterior by the ventilation systems. A dosimetric measurement system was set up at the same time. In 1951, the CEA formed an inspection body, the Radiation Protection Department (SPR) reporting directly to the High-Commissioner for the mining sector. A methodology and a metrology were then set up (Bernhard & al, 1992).

3.2 Nuclear discord: The mining industry, a link of the nuclear industry

The second period, the era of *nuclear discord*, began in the mid-Seventies and ended twenty years later when Compagnie générale des matières nucléaires (COGEMA) announced the indefinite suspension of uranium mining in the Limousin. This period reflected a new industrial configuration, more open and intense than the previous one, with sharp tensions. The construction of a major nuclear power capability in France demanded much higher uranium output than in the past. At the same time, criticism of the government decision roiled across France. It impacted uranium mining, henceforth considered an inseparable component of the nuclear industry. Uranium was no longer acknowledged to be the only positive asset. And tentatively, the issue of waste materialised.

The government decision in 1974 to schedule the construction of nuclear power plants had two major consequences for the CEA's mining sector. One concerned its organisation. To streamline the new energy sector founded on the nuclear industry, the government decided to split off all operations associated with the nuclear fuel cycle from the CEA, ranging from mining to waste reprocessing. It created a subsidiary in 1976 for the purpose, named COGEMA. The second consequence was the transformation of the local industrial configuration in the Limousin. Annual uranium production had to be doubled. This goal implied fresh prospecting and new mine sites. The mining division therefore expanded its operating perimeter and went on a hiring spree. A number of comparative figures can provide an idea of the transformation of the mining division in a few short years. In 1973, it produced 590 tonnes of uranium; in 1980, 1002 tonnes of uranium for 620,300 tonnes of ore extracted. At the same time, its area of occupancy rose from 350 to 1300 hectares, divided into 3300 registered plots. Its workforce also grew from 650 in 1975 to 1000 in 1980. The new mine workers were outsiders. The industrial configuration which, until then, was closed in upon itself, opened up. But the extension of its activities henceforth became a problem for a large segment of the population, farmers and others, who discovered and attempted to legitimise environmental issues with local officials and administrative authorities. The words "pollution", "nature protection", "environmental problems" became current, in opposition to the earlier popularisation. These words come from the new environmentalist vocabulary used by the national associations of conservation and environmental scientists. They are then taken over by the State when it created, in 1973, the first environment ministry in France. (Charvolin, 1997). Local officials passed the word on to COGEMA's mining division and the State authorities. The texture of the individual arrangements which hitherto cemented this configuration disintegrated. Conflicts broke out, essentially collective. Some inhabitants of the mining zone set up owners' and environmental conservation associations. Antinuclear groups were also formed, especially in Limoges. They decried the risks of radioactive pollution of the water catchment basins of their city by mining operations. These conflicts were emblematic of the way in which environmental

problems generated by the uranium industry and the solutions made thereto were posed from then on. They also helped to grasp the conditions of the emerging issue of radioactive waste.

A conflict about the definition of the situation broke out on two levels with the mining division. Faced with the industrial breakthrough, these new associative players, pursuing their favourite themes, became spokesmen of a nature and of a living framework that deserved protection, and/or radical critics of a risky energy policy generating very long term waste. In the former case, the associative arguments drew on sensitive past experience: the noise generated by mining, the drying up of the springs, the degradation of the landscape, were criticised. Water and landscapes were defended as common heritage of an abused nature (Dorst, 1965) and as a positive asset whose use was jeopardised by pollution and other industrial detriments. In the latter case, the scientific and critical arguments of the GSIEN (Gsien, 1977) concerning the nuclear industry were mobilised. Appropriated by the antinuclear associations, they were disseminated among the population of Limoges, so that the conflict around the risk of radioactive pollution of drinking water that crystallised in autumn 1979 was acknowledged to be a problem by the municipality and the Prefect, the representative of the State. The confrontation found legitimacy in areas which were no longer those of the mining division but those of the State. In the negotiations initiated in the presence of local officials, while the State obliged COGEMA to protect the water resources of the city from industrial releases, the director of the mining division nevertheless continued to deny the problem. At a joint meeting chaired by the Prefect and attended by the Mayor of Limoges and the director of the mining division, the latter offered an answer:

“Yes, Prefect, we agree in principle, but provided that it is the prefectural authority that issues the demand, and that it is perfectly clear that it is not a problem of pollution that needs settling, but a problem of psychological damage. In other words, the crowd psychology needs to be corrected.” [Prefecture of the Haute-Vienne, "Radioactivity of waters supplying the city of Limoges." - Proceedings of the briefing of 08/10/79. Mimeographed].

At the same time, the State and the nuclear establishment were denounced for their habit of withholding information about radioactivity monitoring measurements. Short of a suspension of the nuclear power programme, which remained its ultimate target – this locally implied suspending the inauguration of new mine operations and the shutdown or slowdown of those incurring a risk for the environment or for the population – the local antinuclear movement defends two others claims. The first is more intensive monitoring of the radioactivity of drinking water and publication of the data. The second is the creation of an enquiry commission to conduct an epidemiological survey by independent bodies.

It is in the tumult of this conflict that the nature protection and antinuclear associations also alerted the public to practices they considered dubious. These included waste dumping at night in an open pit mine by COGEMA. The CEA, which closed its uranium concentration plant in the Paris area to the Bouchet factory, decided to transfer the tailings to the Limousin. The arguments volunteered to justify this practice was their harmlessness and the fact that having originated in the Limousin, they were merely going back to where they came from. The answer offered by the Prefect of the Haute-Vienne in 1979 to a worried local official:

“[...] At that time, there was no treatment plant on the spot and the ore was sent by lorry to the Paris area, to the Bouchet factory installed by the CEA. The treatment of the ore led to the production of a few thousand tonnes of sterile, just like the sterile at the Bessines factory: these harmless materials are now returning. It is almost like going back home.” [press article in *Le Populaire*, 15 février 1979]

The semantics were ingenuous: to qualify mine tailings as “overburden” meant to treat them as any routine form of residue. Their “problem” was nonexistent, and their sole admissible identity was the one attributed by COGEMA. This identity implied an ignorance of the radioactive composition of these residues, and denied the existence of any risk. The associations lacked the means to counter these assertions. Their criticism was limited to inflating the challenge to this industry by arguments targeting waste, which contributed to its disqualification. It sustained a powerful tension between the positive and negative aspects of the industry. Yet too many economic and social challenges precluded its full and unchallenged legitimacy. This is why the issue of radioactive waste from the mining industry was not identified during this period, although emerging details tended in that direction.

3.3 Nuclear uncertainty: Managing and qualifying the remnants

The third and final period, of *nuclear uncertainty*, began in 1988 with the announcement of the speedy termination of industrial activity. The social configuration, hitherto centred on industrial operations, and the problems raised by uranium production, were progressively transformed into a solidly environmental configuration that would never end. From uranium as *acted nature*, its remnants were considered *acting nature*. Indeed the radioactive waste qualification process applied to the residues now entailed permanent vigilance and accompaniment. A priori, it's almost impossible to fix the term because the respective time scales for men and radioactivity emitted by these wastes are immeasurable. This situation resulted from the nuclear establishment's progressive loss of hegemony of statement and action with regard to these remnants (Brunet, 2004b). Its weakness had three causes. First, it originates the strengthening of the expertise of the antinuclear movement in France with the emergence of the associative expert, who scientifically challenged the arguments of the nuclear establishment. Second, the local public authorities, no longer anticipating any positive spinoffs from the industry, were vulnerable to the arguments of the associations. Finally, thirdly, the nationwide nuclear establishment was forced into reform, given its relative failure to propose an operationalisation of the comprehensive management of all radioactive waste, high and low level alike. A correlation therefore existed between this weakness, the obvious shift in acceptable standards on radioactive waste management, and the stigmatising image projected by the recognition of the remnants as radioactive waste. Nevertheless, the environmental configuration remained subject to regulatory practice.

With the onset of the Nineties, the mining industry declined and collapsed in late 1995. COGEMA's decision in 1988 to stop any further mining in France had its economic underpinnings: to mine only profitable orebodies. The low price of uranium on the world market made Limousin ore expensive compared to those of Canada and Africa. Despite the very intense but dispersed labour unrest, the mine workers and their unions had to give in, and they quickly disappeared from the social landscape. While the local political officials favoured the resumption of mining, others, urban political officials, promoted the idea of a

“green” Limousin for the mining area, oriented towards housing and tourism. The construction of expressways between Limoges and Monts d’Ambazac shortened the distances and many citydwellers came to live there. At the same time, in the late Nineties, the inauguration of a leisure facility on St Pardoux Lake made it a relaxation centre for the population of Limoges and for the tourists. That is why these urban political officials formulated a twofold demand, non-negotiable for them: that COGEMA should finance a conversion plan for the mining territory, and that it clean up the traces left by fifty years of uranium mining.

Yet when mining operations ended, more than twenty million tonnes of residues generated by the industrial process remained on the old mining territory, stored in open pit mines. Added to this mass were wastes of all types, already present or anticipated. The industrial logic of burial for many long years had been fully implemented. Thus, empty drums that previously contained radioactive substances and originated directly from COGEMA and CEA industrial facilities, were regularly dumped in thousands in the mine pits. And in the guise of a conversion project, COGEMA planned to set up an interim storage facility for 200 000 tonnes of depleted uranium produced by the fuel enrichment cycle. All these factors tended to project a negative and stigmatising image on the region, one of a “nuclear dustbin”. The unfair tradeoff that triggered it contributed to a dual upheaval symbolic and political. Symbolic, when the uranium converted to residues was no longer considered a positive asset, but became a negative legacy. Political, when the radioactive, economic, environmental and health hazards harboured by this negative legacy, whether real or imaginary, soon spread and tended to convert the officials to the position defended by the environmentalist associations. The industrial configuration blurred and vanished, leaving in its place an environmental configuration in which COGEMA, the elected officials, State representatives, associations and experts were the players. The experts then played a central role in the dynamic of this configuration. They compiled and assessed the controversial knowledge about the remnants, given the turmoil that governed the way in which the questions were asked and answered. This knowledge, no doubt unstable, was nevertheless sufficient to qualify and to manage the remnants.

Two types of expert faced off within this environmental configuration: the establishment expert and the establishing expert (Bonnet, 2006a): the first largely came from the nuclear establishment itself. This period of the late Nineties witnessed the generalised treatment as a problematic issue of all radioactive waste and, as a corollary, a transformation of the institutions which possessed and produced the expertise of the State in this field. We cannot expand further on this issue in this chapter. However, it is clear that the progressive inclusion of the remnants of the uranium industry in the issue of all radioactive waste facilitated the process of its qualification. This transformation stemmed from processes of differentiation and independence. For example, the French National Radioactive Waste Management Agency (ANDRA) was created from a CEA Department. In 1981, with the passage of the first French bill on the nuclear industry specifically and exclusively addressing radioactive waste management, ANDRA became independent of the CEA. This transformation impacted the radioactive waste management policy, the nuclear facility safety policy, and the health and environmental safety policy of the population. The French State did not succeed in resolving the management of high and medium level nuclear waste. Underground storage alternatives were vigorously challenged by the public and the

antinuclear groups. From this point of view, the antinuclear groups did not conceal their strategy. One of the routes for securing the shutdown of the nuclear industry in France was to demonstrate the “intestinal blockage” of the system. This strategy consisted in focusing public attention on the waste. Insofar as no transfer solution was accepted by the potential host population (deep burial, underground storage with possible rehandling), the wastes remained where they were generated and ultimately cluttered the area. Added to the establishment expert, arguing by differentiation, were the university laboratories which assumed a role in offering expertise, in which the monopoly of the nuclear establishment disappeared.

During the same period, and at the same time, the associative players transformed themselves into the typical ideal figure of the *associative expert*, with features specific to the Limousin. This figure assumed two forms. On the one hand, it inspired the local environmental defence associations and antinuclear groups, who together created the Limousin anti-waste coordination (CLADE) in 1992. This flexible federative organisation focused exclusively on the “remnants” of the mining industry. Its essential demand was the conduct of a radiological investigation which, independently of the nuclear establishment, could assess the environmental and health hazards incurred by these harmful remnants. The prize was the definitive qualification of these remnants as radioactive wastes. It adjusted its practices to this outcome. Thus, without awaiting the independent investigation that it demanded from the authorities, it concentrated on the burden of proof that bedevilled it and forced it to mobilise science to prove the existence of dangers to health. On the other hand, this associative expert figure also engaged the Commission for Independent Research and Information on Radioactivity (CRII-RAD), an associative radioactivity measurement laboratory. CRII-RAD is a non-profit association created in 1986 to counter the statements of the authorities and experts of the nuclear establishment, who, after Chernobyl Nuclear Power Plant explosion, argued that the radioactive cloud had “stopped” at the French border, and that there had been no significant radioactive fallout on the national territory. This association enjoys the original privilege of having founded a laboratory for measuring the radioactivity that is independent of the state and nuclear authorities, with a nationwide audience. It is therefore at the junction of the activities of the local association, which relentlessly denounced the potentially polluted locations, took samples in suspect places of the old mining zone by observing the procedures recommended by the CRII-RAD and those of the associative laboratory which analysed and interpreted the results, that this associative expert unveiled its reality as a player and, progressively, imposed a new and critical viewpoint on the remnants (Brunet, 2006c). There is therefore an important qualitative change in the practice of associative expertise. Without the GSIEN having disappeared from the associative landscape, the investigation of the antinuclear movement no longer relied exclusively on a critique of the documents produced by the nuclear establishment, but on independent evidence produced in the laboratory. This is one of the reasons why COGEMA, the experts of the nuclear establishment and the authorities were compelled to re-examine the knowledge and management of these “remnants” and to recognise them as radioactive waste.

Firstly, the associative expert forced COGEMA, via the State, to take more restrictive protective measures in its winding-up operations. But above all, with the support of the local authorities, it succeeded in imposing the satisfaction of its central claim: the setting up

of an independent investigation of all the mine sites. The Prefect decided in fact to set up a Local Information Commission (CLI). This commission aims to provide information “on the risks incurred by ionising radiation pertaining to the activity of the uranium site”⁸. The composition of the CLI serves to gather together in a single place all the players in this environmental issue: the services of the State, the operator, the eco-environmental and antinuclear associations, local authorities and the experts. This decision is also the translation of many reports produced or under preparation of the State Services and also of the Parliamentary Office for Assessing Scientific and Technological Choices (OPECST) on the mining residues that have supported this qualification (Ministère de l’Environnement, 1991, 1993 ; OPECST, 1992). Thus, mining residues were definitively classed in the category of radioactive waste, which implied a need for management and the establishment of new standards. It is in this new setting of institutionalised consultation that a radiological investigation of the mine zone was decreed.

To allay suspicion, the investigation was funded by the local authorities and took the form of a joint investigation between the CRII-RAD and COGEMA laboratories. The definition of the measurement plan and its implementation lay at the heart of the conflict on the most appropriate definition of the situation. It is therefore not surprising that it was the subject of lengthy and difficult negotiations between the players of the CLI. And when in 1994, the results had to be interpreted by comparing the measurements of the two laboratories, the players of the environmental configuration were unable to agree, leading to the breakup of the CLI. The investigation, all the way to the assessment, clashed on two conflicts of interpretation which prevented settling the argument between the associative movement and COGEMA. First, in this mining area, how the part of the so-called natural radioactivity and that provided by industrial activities? This question evidenced an attempt to establish COGEMA’s liability. And besides, is the risk assessed at the source, within the boundaries of the mining sites, or is it, according to the regulations in force, assessed in the environment, outside these boundaries? In the former case, waste monitoring was a public matter; and the second, it remained a private affair, the domain of COGEMA, because access to the source remained prohibited. Thus, while everybody agreed that the results of the two laboratories were identical. But for the associative movement, they offered evidence of the existence of risks which must be neutralised at the source, whereas for COGEMA, they confirmed the absence of any danger to human health and justified his self-inspection.

3.4 Continuing tensions between expertise, democracy and social norms

The democratic trial seemed powerless to withstand the ordeal of scientific controversy. Precisely because the scientific controversy extends continuously beyond the narrow issues of Science. These were constantly articulated in terms of social norms: an environmental hazard or a health risk always includes more than just scientific data (Beck, 1986). Both reflect essentially normative points of view drawing not only on scientific reasoning but also on social reasoning. Since it is around this model, initiated by the incomplete experiment of the CLI, that two-track *ad hoc* procedures for consultation and negotiation punctuated every new problem posed by *acting nature*. It brings together the elected officials, State Administration, COGEMA and the experts, which reached the public domain in line with

⁸ Prefectoral decision of 7 January 1992.

the action model promoted by the associative expert. Moreover the action model was completed by a legal expertise of the associative movement. All the actions of COGEMA and of the State on radioactive waste management are the subject of closely attentive legal monitoring by the local associative movement. In other words, the recognised legitimacy of the environmental issue by expert knowledge, failed in setting up truly permanent systems for consultation and negotiation, that is to say political. Only *acting nature*, via the spokesmen experts, who claimed to be its interpreters, conditioned its frequency, intensity and scale.

It follows that AREVA Company, formerly COGEMA⁹, like any mine producer, wanted to leave Limousin for good after the industrial sites had been redeveloped, and not rehabilitated as this company suggests (Bavoux & Guiollard, 1998). It was forced to remain on the spot. In recent years, the State should take its place for a strictly indeterminate period. Its task was precisely to “contain” this set of remnants now qualified as “radioactive waste” and to meet the standards whose level of acceptability ceaselessly became more restrictive. In other words, while the nuclear establishment was planning to “return these wastes to nature”, according to its own terminology, to forget about them, they now became, probably for an unlimited period, the subject of increasingly intensive monitoring, which forced it to remain nearby. This obligation of surveillance and retention was not simply that. AREVA NC and the State are resistant to this because it represents a cost to both economic and symbolic. More the cost of monitoring work grows, less the industry shows that it was profitable. Similarly, more problems appear, less engineering, over the long term, shows its ability to solve them. It’s in fact ceaselessly updated by the vigilance of the associative movement. This monitoring is therefore fragile. Indeed, it is largely contingent on the capacity of the movements coming from society to exercise this control which, necessarily, remains discontinuous. The militant capacities of the associative movement are very fragile (Brunet, 2004c; 2006b). More generally, above and beyond the issues of radioactive waste, this situation raises the question of the role of public, the associative movements and experts in a renewed technical democracy. In this context, certainly, the State should reconsider the submission of general interest for the sole benefit of short-term economic, which denies the existence of waste and problems. It needs also to recognize and take account of public engagement in its attention to the commons with their coloration positive or negative, as are the radioactive waste. In the same times, the public must recognize all the commons that are part of the same story. This is certainly one of the most important political challenges of the future of our industrial societies.

4. Conclusion

The socio-historical analysis of an industry helps to understand the place that gradually take its waste. In France, in its productive phase, the uranium industry lasted about fifty years. In fact it has no end. Three periods were able to be identified. Each has a very different relationship to his remains. Their succession shows a progressive visibility and legitimacy of his remains to the characterization of radioactive waste. The first period, which lasts nearly twenty five years, shows that the remains do not exist. Either they are “returned to nature,” either they are used for other purposes. Uranium is considered by all actors as a common

⁹ COGEMA changed its name in 2001 and is now called AREVA NC.

unchallenged. Account only the nature acted. The second period corresponds to a strong growth of the mining industry. This one is disputed because it disrupts the natural environment. Two commons are then in opposition. Water and uranium, respectively, correspond to urban and rural social worlds different. In addition, by the action of anti-nuclear groups, the uranium industry becomes an integral part of the nuclear industry. Their challenge is only to delegitimize the reassuring speech experts from the State and the operator (CEA and COGEMA) about the environmental and health risks associated with radioactivity, affecting the water. However, this challenge is limited because it based solely on the data produced by the nuclear institution itself. Also, in this context of strong activity, industrial remains are hardly questioned. The third period, which has no end, starts when the industrial decline and the operator informs of the imminent closure of the mines. From that moment, the remains are real issues and the problem of radioactive waste emerges. It develops in a context of strong challenges that mobilize elected urban and antinuclear groups against the state and the operator. Uranium as common fades along with its industry. Only exist remnants that become problematic. It then becomes necessary to identify, qualify as radioactive waste, measure and evaluate them in terms of environmental and health risks. Antinuclear associations have acquired a capacity to produce data themselves through the figure of the associative expert. But conflicts over these activities can not diminish for two reasons. The democratic machinery around these radioactive wastes is limited and fragile. And also the actors for the most part unaware of the history of the industrial process in its entirety, including the production of its common, positive and negative. Despite appearances, our society built on the basis of science and technology, is fundamentally a political society.

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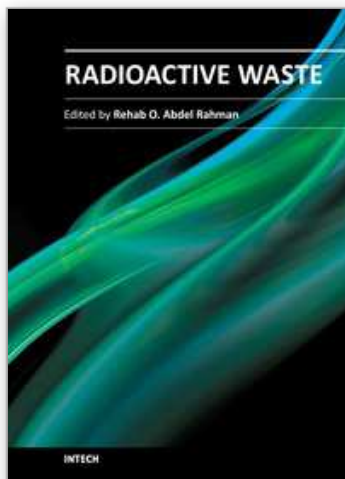
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The safe management of nuclear and radioactive wastes is a subject that has recently received considerable recognition due to the huge volume of accumulative wastes and the increased public awareness of the hazards of these wastes. This book aims to cover the practice and research efforts that are currently conducted to deal with the technical difficulties in different radioactive waste management activities and to introduce to the non-technical factors that can affect the management practice. The collective contribution of esteemed international experts has covered the science and technology of different management activities. The authors have introduced to the management system, illustrate how old management practices and radioactive accident can affect the environment and summarize the knowledge gained from current management practice and results of research efforts for using some innovative technologies in both pre-disposal and disposal activities.

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Unit 405, Office Block, Hotel Equatorial Shanghai
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Phone: +86-21-62489820
Fax: +86-21-62489821

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