Final report of the working group on the establishment of protocols for the sampling and analysis of human bones and the conservation of samples (PAOHCE)

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This document is the English translation of the report presenting the conclusions of discussions between members of the PAOHCE working group.

The group was formed in 2019 by the French Ministry of Culture at the request of the national scientific community and the services responsible for monitoring archaeological operations in France.

This report is intended to contribute to the definition of good practices for the sampling and analysis, under the best possible conditions, of human bones discovered during archaeological operations in France, and to the implementation of French administrative procedures to ensure the optimal management and monitoring of sampling and analysis requests.

These procedures will be distributed to the French state archaeological services in charge of reviewing such cases.

The members of the working group wanted their report to be translated so that their thoughts and research, and their resulting suggestions, can be distributed more widely and so that the international scientific community, which is faced with the same questions, can use the report to help establish its own practices and procedures.

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Introduction

The increasing involvement of disciplines from the fields of physics, chemistry, or biology in the analysis of archaeological materials is enabling significant advances in our understanding of the past. However, in contrast to more traditional studies, this often involves invasive analysis that cannot be performed without destroying the material in question. Demand is now so high that it poses a risk to the remains themselves. Although this trend affects all archaeological finds to an extent, anthropobiological remains are an extreme case, both because of the number of analyses they undergo and because of their unique status.

Stimulated by fierce competition between laboratories, analyses of human bones are currently proliferating: paleogenetic analyses are receiving the most media coverage, but the category also includes isotopic, proteomic, and radiometric analyses. The benefits of these approaches are indisputable, and they are considerably enriching our view of ancient societies. Ancient human remains, whatever their origin, thus offer great potential for exploitation.

As a result, those in charge of such remains, whether agents of the Ministry of Culture or directors of archaeological operations or other institutions (particularly museums and university laboratories), are receiving an increasing number of requests to make bones available for analysis.

These requests primarily raise ethical and legal questions, but also questions about how to manage a finite and non-renewable resource. The way in which remains are conserved, including the products used to collect them and prepare them for study and the conditions in which they are stored, has a non-negligeable effect on the feasibility and quality of analysis. Finally, samples are often requested without revisiting excavation contexts and without taking archaeological questions into account.

Besides these questions, it is vital, in the current context of increased demand for the use of this archaeological resource, for a framework to be put in place to standardize access requests and improve the process by which they are reviewed and monitored. This framework will define clear, nationally applicable criteria for the initial compilation of research project files, as well as for the subsequent publication of data and results.

There is a significant gap between institutional research conducted in an international context and the evaluation of archaeological research projects by the regional archaeological research commissions (CTRAs; commissions territoriales de la recherche archéologique), whose members lack training and expertise. This report will provide guidelines for reviewing these files, which are not the usual subject matter of the commissions.

These questions are certainly not unrelated to the resistance within the French archaeological community to this promising field of study. It now seems necessary to find a balance between promoting this kind of research and protecting archaeological heritage. In an attempt to establish protocols and rules governing this use of anthropobiological remains, the Archaeology division at the Ministry of Culture (part of the Heritage department of the Directorate-General for Heritage and Architecture) formed a working group (list on page 2) made up of various specialists from the research community (anthropologists, archaeologists, paleogeneticists, ‘isotopists’, and other experts, research managers or managers of anthropobiological remains). The present document is the result of the working group’s efforts.

This report presents the conclusions of discussions between members of the working group on the establishment of protocols for the sampling and analysis of human bones and the conservation of samples (PAOHCE). The group was formed in 2019 by the Archaeology division at the request of

the scientific community and the regional archaeology services (SRA; services régionaux d'archéologie).

It starts with a comprehensive discussion of the concept of anthropobiological remains found during archaeological activities—from bones to DNA molecules or isotopes—before turning in chapter two to the ethical and legal issues surrounding the sampling, conservation, and use of such remains.

The third chapter presents the working group's reflections on the different types of analysis that can be performed, their requirements in terms of bone elements, and their limitations. It also touches on the collection of such remains and the specific constraints that must be taken into account throughout the archaeological process—from field collection through to the permanent conservation of remains and samples.

The fourth chapter deals with the scientific use of anthropobiological remains and, in this context, with the implementation and constitution of a research project, its scientific evaluation, and the presentation of its results.

The report concludes with a list of suggestions on how to sample and analyse human bones and conserve samples in such a way as to ensure optimum use and conservation of the resource.

1. The concept of anthropobiological remains: From bone to molecule

In France, anthropobiological remains (ABRs) found during archaeological activities can be defined as human remains brought to light during an archaeological operation ordered or authorized by the state, or discovered by chance, and which have been declared to the regional archaeology service (SRA) or to the Département des recherches archéologiques subaquatiques et sous-marines (DRASSM) (Department of Underwater Archaeological Research) as stipulated by book V of the Code du patrimoine (Heritage Code). In that sense, they can be classed as archaeological heritage elements, along with movable archaeological objects (artefacts, ecofacts, maritime cultural assets) and displaced immovable archaeological features, such as removed mosaics and murals or dismantled architectural elements.

What constitutes archaeological heritage is very broadly defined by article L. 510-1 of the Code du patrimoine:

'*Archaeological heritage elements consist of all remains, objects, and other traces of the existence of humanity, including the context in which they are found, the conservation and study of which, particularly via excavations or discoveries, allow us to trace the development of the history of humanity and its relationship with the natural environment.*'

Article 1-III of the decree of 7 February 2022 defining archaeological scientific data and the conditions for their proper conservation[1] gives a precise definition of anthropobiological remains:

'*Anthropobiological remains are human remains brought to light during an archaeological operation ordered or authorized by the state, or discovered by chance, and which have been declared to the regional archaeology service or to the Department of Underwater Archaeological Research as stipulated by book V of the Code du patrimoine.*

They consist of isolated or articulated human bones found in funerary structures, sediment layers, or backfill, regardless of the type of funerary treatment or the treatment of skeletal remains; as well as any mummified tissue, residual skin appendages, or calcified objects. Anthropobiological remains also include samples taken from skeletal remains, 'para-osteological remains', any elements that must be removed at the same time as the bones, and samples of sediment taken from around the bones.'

Samples taken from the remains of a dead person are not legally different to any other human remains: in the context of a scientific study, samples from human remains, and any residues left after the treatment/study/analysis of such samples, are considered as human remains in their own right.

[1] Decree of 7 February 2022 defining archaeological scientific data and the conditions for their proper conservation, NOR: MIC2137542A, published in JORF no. 0034 on 10 February 2022.

2. Ethical and legal aspects relating to the sampling, conservation, and use of anthropobiological remains

Before beginning, it should be noted that the following reflections do not apply to human remains conserved in museum collections, which fall under the regime of public ownership of movable objects.

2.1 Legal framework applicable to anthropobiological remains discovered in archaeological contexts

2.1.1. The status of anthropobiological remains in the Code du patrimoine

None of the laws concerning archaeology address the question of anthropobiological remains, whether it be the law of 1941,[2] known as the 'Carcopino law', those of 2001[3] and 2003[4] on preventive archaeology, or the law of 2016 on creative freedom, architecture, and heritage,[5] which made far-reaching changes to the ownership status of movable archaeological objects.

Nevertheless, the decree of 16 September 2004 on standards for the identification, inventory, classification, and packaging of scientific evidence and movable objects found in archaeological surveys and (preventive) excavations did attempt to determine the legal status of anthropobiological remains without actually naming them explicitly. The decree created the category of natural and biological materials. Although they are not defined in the decree, these materials consist of everything other than movable archaeological objects, in other words anything that is not an object transformed by human activity: anthropobiological remains are by definition natural and biological materials. They are, therefore, not movable archaeological objects, and the legal status of movable archaeological objects as defined in book V of the Code du patrimoine does not apply to them.

2.1.2. Turning to the Code civil

As the Code du patrimoine does not establish the status of anthropobiological remains, we must turn to other legislative frameworks that are applicable to human remains, and specifically to the provisions of the Code civil, to find clauses that can help to define the legal status of anthropobiological remains:

- Article 16-1 of the Code civil: '*Everyone has the right to respect for their body. The human body is inviolable. The human body, its elements, and its products may not form the subject of a patrimonial right.*'
- Article 16-1-1 of the Code civil: '*The respect due to the human body does not end with death. The remains of dead people, including the ashes of those whose bodies have been cremated, must be treated with respect, dignity, and decency.*'

Initially established in the bioethics law[6] of 1994 to enable the defence, by a specific individual, of the rights attached to their person, the principle of respect for the human body has been established in case law more broadly as the protection of the human being in general and as enabling a community of human beings to cite lack of respect for human dignity in support of their claims.

[2] Law of 27 September 1941 on the regulation of archaeological excavations, known as the 'Carcopino law' after its author, ratified by an order of 13 September 1945.
[3] Law 2001-44 of 17 January 2001 on preventive archaeology.
[4] Law 2003-707 of 1 August 2003.
[5] Law 2016-925 of 7 July 2016 on creative freedom, architecture, and heritage, known as the 'LCAP law'.
[6] Law 94-653 of 29 July 1994 on respect for the human body.

The prohibition against exercising a patrimonial right over parts of the human body must be understood as a prohibition against trading in such elements or deriving any financial profit therefrom. It applies equally to the person attempting to exercise such a right and to any third parties.

In any case, the prohibition against exercising a patrimonial right does not in itself amount to a prohibition, in the name of respect for human dignity, against any appropriation of human remains.

Insert: The status of the remains of soldiers from recent global conflicts

The remains of soldiers are covered by book V of the Code des pensions militaires d'invalidité et des victimes de guerre (Code Relating to Military Disability Pensions and Victims of War) and by agreements with the other countries who took part in these conflicts.

As a result, any soldiers' remains discovered during archaeological operations must be declared to the departmental branch of the Office national des anciens combattants et victimes de guerre (ONACVG) (National Office for Veterans and Victims of War), a public institution run by the Ministry of the Armed Forces, in the department where the operation is being conducted.

The archaeologists can normally remove the body in the presence of the relevant departmental branch of the ONACVG, to whom they hand over the remains and any associated movable archaeological objects. This procedure is, however, dealt with on a case-by-case basis, because it depends on the nationality of the soldier and the agreements concluded with different countries.

Scientific study of the remains (DNA, isotopic, or other types of analysis) and movable archaeological objects is subject to authorization by the country concerned. That country may refuse to authorize any study or analyses.

Following the study, if authorized, the remains and any residues are returned to the ONACVG. When the remains have been identified, any associated military and personal effects are returned at the same time as the remains. They cannot be conserved in the same way as other movable archaeological objects discovered during archaeological operations.

A Ministry of the Armed Forces/Ministry of Culture joint protocol on principles and procedures for the discovery of the remains of soldiers killed in action was signed in 2021 and sent to the regional archaeology service at the relevant regional directorate of cultural affairs/directorate of cultural affairs (DRAC/DAC-SRA) and to the DRASSM (Appendix 1).

2.2. Ethical recommendations regarding the conservation, study, and research of anthropobiological remains found in archaeological operations

The absence of a clearly defined legal status in the Code du patrimoine, together with the existence of a corpus of legal regulations approaching the question of human remains from the perspective of human dignity, particularly in the Code civil, means that anyone responsible for the conservation of anthropobiological remains found during archaeological activities must take an ethical approach to their management.

Ethics can be defined as 'a set of values guiding social and professional behaviours and inspired by deontological […] or legal rules' (Cornu, 2016). Professional ethics refers to the set of ethical principles and rules (code of ethics, charter of ethics) that govern and guide a professional activity.

Archaeologists, whose research depletes the resources they investigate and study, must reflect on the ethics of their practice in order to ensure sustainable exploitation of and access to these resources for future generations.

State custody of anthropobiological remains found during archaeological activities is not exempt from this reflection, in that it must ensure proper conservation for future generations while also allowing the scientific community to carry out research on the remains—research that is the ultimate justification for their conservation.

A balance must, therefore, be found between preserving such remains and making them available for research involving handling, analysis, and invasive or even destructive sampling, all without infringing on the principle of human dignity.

Respect for human dignity is a principle of constitutional value recognized by the Constitutional Council in a decision of 27 July 1994 (decision no. 94-343/344 DC of 27 July 1994, Bioethics Laws). For the Council of State, 'respect for the dignity of the human person is one of the foundations of public order' (CE, Ass., 27 October 1995, Commune of Morsang-sur-Orge, no. 136727).

As a result, archaeologists must ensure respect for this principle when handling anthropobiological remains.

2.2.1. Remains as study and research objects

Anthropobiological remains found during archaeological activities are as important an object of study as the other elements of the excavation, all of which contribute to reconstructing the history of a site and of humanity. Archaeologists study them in the same way as other movable archaeological remains, although their nature demands special attention.

Anthropobiological remains found during archaeological activities can be conserved and studied:

- Archaeological fieldwork involving human remains has a firm legal basis: the opening of ancient graves for the purpose of historical or archaeological research or study is not punishable by law as long as it does not involve any insult or lack of respect for the buried individual.

  Article 225-17 of the Code pénal, which defines the crime of violation or desecration of a grave, does not apply to people acting in the context of an authorized excavation as long as the archaeological activity is legally justified, pursuant to article 122-4 of the Code pénal: '*A person who performs an act prescribed or authorized by legislative or regulatory provisions is not criminally liable. A person who performs an act ordered by a lawful authority is not criminally liable, unless the action is manifestly unlawful*.'

- Furthermore, it could be added that the crime of violating graves and desecrating corpses is not relevant here because of the nature of archaeological research practice: a crime presupposes an intention to damage the respect due to the dead, and there is no such intention behind archaeological activities duly authorized and supervised by state services.

From a legal perspective, the state can authorize studies and analyses of these remains, including destructive analyses, if they are scientifically justified. When reviewing study requests, therefore,

the expected scientific benefit must be weighed against the loss or degradation of the remains concerned.

2.2.2. Remains in light of the principle of respect due to the human body

The provisions of the Code civil (article 16-1 and following—see § 2.1.2) do not make any distinction based on the age of the human remains discovered in archaeological contexts. They thus apply equally to all human remains regardless of their age.

Nevertheless, the way human remains are perceived and approached for study may change as the distance between the world of the living and the dead increases: the more time passes, the more the human body is reified, losing its legal personality. The loss of kinship ties or collective memory means the remains can be handled without arousing an emotional response from society.

It is these two factors—the application of norms of positive law and changing social perceptions—that determine the ethical duty of archaeological actors.

This ethical duty regarding the management and conservation of human remains is expressly mentioned in memorandum 2007-007 of 26 April 2007, which established the ethical charter for heritage conservators (state civil service and regional civil service) and other scientific coordinators of museums in France applying article L. 442-8 of section II (Collections) of the Code du patrimoine: '*human remains are studied, conserved, and presented in line with professional norms and with respect for human dignity*' (II.1.E). Nevertheless, the scope of this memorandum was restricted solely to the scientific coordinators of museums in France. It can, however, be used as inspiration in other heritage fields.

Studies of anthropobiological remains found during archaeological activities must be adapted in view of several factors:

First, the capacity of the archaeological community to identify the remains of the individuals concerned. Ethics recommends that professional practices are informed by the guidelines applicable to identified remains. It is important to consider the possibility of the existence of heirs. It is sometimes possible to identify the individual whose remains are being studied, and so potentially to find heirs (or beneficiaries). Outside certain specific fields (e.g., the archaeology of global conflicts, which is regulated by a specific area of law, see insert on page 9), such cases are very rare but must still be taken into account. This reality must also consider the legal provisions governing the rights of heirs.

In civil law, the status of heir is transferred indefinitely to direct descendants and up to the sixth generation for collateral relatives.

In funeral law, when a death occurs, the funeral arrangements are handled by 'the person qualified to provide for the funeral', in other words anyone who, thanks to their stable and long-term relationship with the deceased, is capable of expressing the latter's will, or in the absence of such will, to take the necessary decisions for organizing the funeral.

Heirs have rights over the personal effects associated with the identified remains, but not necessarily the right to decide what to do with the remains. The generational gap means they are not always deemed to be qualified to provide for the funeral. From an ethical perspective, however, it should be recommended that any descendants be informed about possible future studies to be carried out on the anthropobiological remains as well as about their results.

Second, ethical considerations also dictate a need to take into account the reaction of concerned communities (whether ethnic, religious, etc.) to the discovery and study of anthropobiological remains. Archaeologists are increasingly confronted by external opinions that may be hostile to their work. The National Museum of Natural History (MNHN) has examined the question of how to study and exhibit human remains and developed recommendations to that end (Bianquis et al., 2020).

Alain Froment[7] offers the following recommendations: '*Those in charge of collections must listen attentively to communities' requests; at the same time, they must act to maintain, as conservatively as possible, the integrity of the heritage they have received, which has been built up patiently and with considerable effort, and which they must pass on to future generations.*'

When dealing with these requests, the first step is to distinguish between requests from direct descendants (see above) and requests from communities with other motivations.

- Requests for the restitution of human remains from religious, memorial, or ethnic communities should not be approved if the deceased individuals or groups have no heirs or beneficiaries.
- Communities concerned with human remains that have a link or relationship (particularly a memorial one) to their ancestors should be involved by giving them access to the remains and allowing them to carry out ritual ceremonies, where applicable, or engage in any practices that bear a meaning within their ontological framework, without necessarily going as far as restitution and/or reburial of the remains, unless the scientific benefit of conserving them has not been proven (after complete documentation and sampling) or in light of specific local circumstances that must be dealt with by civil society or relevant institutions. Communities should also be involved and encouraged to take an interest in scientific study, particularly through professional training and teaching that respects their own sociocultural frameworks.

2.2.3. The impact of international conventions (Declaration of Helsinki, Nagoya Protocol)

The ethics of human research are embodied in adherence to international conventions, which may, however, seem to be of limited applicability to samples taken from anthropobiological remains found during archaeological activities.

The Declaration of Helsinki,[8] adopted in 1964 and amended several times since then, sets out the ethical principles applicable to medical research involving human beings. It is not, however, directly applicable to the present topic, in that it concerns research on living humans.

The Nagoya Protocol[9] on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from Their Utilization is an international agreement on biodiversity. It was adopted by the tenth meeting of the Conference of the Parties to the UN Convention on Biological Diversity on 29 October 2010 in Nagoya, Japan, and entered into force on 12 October 2014. It seeks to ensure the fair and equitable sharing of the benefits arising from the utilization of genetic resources from 'plants, animals, bacteria or other organisms for commercial, research or other purposes'. It thus regulates the use of environmental genetic resources.

[7] Director of research at the IRD, formerly responsible for the anatomical collections at the Musée de l'Homme.
[8] https://www.wma.net/fr/policies-post/declaration-dhelsinki-de-lamm-principes-ethiques-applicables-a-la-recherche-medicale-impliquant-des-etres-humains/
[9] https://www.cbd.int/abs/doc/protocol/nagoya-protocol-fr.pdf

Researchers studying subjects that fall under the scope of the Nagoya Protocol are obliged to declare their research projects (aims, methods, species studied, protocols for obtaining samples, dissemination of data and results, partnerships and data sharing, feedback to communities, etc.) and to obtain specific authorization from the institutions responsible for ensuring proper application of the Nagoya Protocol.

The scope of the Nagoya Protocol does not, strictly speaking, include human genetic data.

Nevertheless, research on anthropobiological remains found during archaeological activities could at least partially fall under the scope of the protocol if the planned analyses involve 'metagenomics' or environmental genetics (rather than the human genome specifically).

Such studies of human remains could be useful for understanding an individual's overall health or reconstructing the genetic history of human pathologies and their spatial and temporal distribution.

In such cases, this kind of research would seem to fall under the scope of the Nagoya Protocol. One of the working group's recommendations is to require researchers who want to take samples from ABRs for the purpose of studying metagenomic diversity (if this is explicitly mentioned as one of their aims in their request for access to the ABRs) to ensure that their project complies with the Nagoya Protocol.

2.3. Recommendations and charter of ethics for handling anthropobiological remains in the care of the state[10]

2.3.1. Recommendations of the Archaeology division at the Ministry of Culture regarding the status of anthropobiological remains

In the absence of a specific legislative framework for anthropobiological remains found during archaeological activities, the provisions of the decree of 2004 on standards for the identification, inventory, classification, and packaging of scientific evidence and movable objects found in archaeological surveys and (preventive) excavations, as well as the abovementioned articles of the Code civil, have been used by the Archaeology division at the Ministry of Culture to define recommendations for the attention of the regional archaeology services and the DRASSM, which are responsible for the scientific and technical monitoring of archaeological operations carried out in French territory. These recommendations are as follows:

- Anthropobiological remains can be classed as archaeological heritage elements as defined in article L.510-1 of the Code du patrimoine, without being considered as movable archaeological objects. As a result, the articles concerning the regime of ownership of archaeological heritage and the rules on the conservation, selection, and study of archaeological heritage are not applicable to them;
- Articles 16-1 and 16-1-1 of the Code civil apply to all archaeological actors at all stages of the archaeological process;
- Anthropobiological remains cannot be considered as private property;
- Anthropobiological remains are placed under the care of the state, or of a local or regional authority under the scientific and technical supervision of the state, unless they have already been integrated into public collections in national or regional museums;

[10] Anthropobiological remains in the care of the state: anthropobiological remains deposited at the end of an archaeological operation and conserved in a permanent conservation institution. This does not include anthropobiological remains found in archaeological operations that are still ongoing or remains held in collections in French museums.

- The state can authorize studies and analyses, including destructive ones, if they are scientifically justified; it can place the ABRs on deposit in an institution so that they can be conserved in the same place as the movable archaeological objects discovered during the same operation; it can lend them for an exhibition or store them in a museum with a view to further use.

2.3.2. Agreement for the provision of anthropobiological remains to researchers

The provision of patrimonialized anthropobiological remains (i.e., remains found during an archaeological operation prior to the access request) to a researcher is subject to a provision agreement between the state (DRAC-DAC/SRA-DRASSM) and the researcher in charge of the research project. The research project must have been authorized by the regional prefect in line with articles L.531-1 and R.531-1 of the Code du patrimoine, following a template developed by the Archaeology division and annexed to this report.

This does not exclude the possibility of studying anthropobiological remains as part of the preventive archaeology operation during which they were discovered, as long as the project specifications drafted by the regional archaeology service provide for such an eventuality and it is arranged by the operator's scientific intervention project, which guarantees that the scientific intervention project has been evaluated by the CTRA.

In this case, the regional archaeology service works with the person in charge of the operation to determine the study specifications. The service must also be kept informed of any movement of the remains for study purposes.

2.3.3. Charter of ethics

Based on these legal and ethical considerations, the working group recommends that ethical charters or protocols be put in place to help those responsible for anthropobiological remains to make the appropriate arrangements for their conservation in specially adapted spaces, access, study, and the dissemination of results. These tools should also enable the researchers and laboratories requesting access for study purposes to understand the principles and rules that guide them.

The establishment of such protocols should make it possible to answer the following questions:

- Why have studies and samples been authorized? The aim here is to check the purpose of the sampling against the scientific objective of the requester.
- What can be studied? Is it appropriate to restrict authorized studies? If so, to what extent? Recommendations should be informed by the fact that human remains cannot be treated as private property or used for commercial purposes.
- Who is taking the sample and who is conducting the study?
- Where and how will samples be taken from the human remains?
- When is the appropriate time to take samples?
- Who must be kept informed of these studies and samples, and how should the data be fed back?
- What happens to any leftover material or residues from sampling, and how are they conserved? Should/can everything be conserved?

On this last question, from an ethical perspective, it might be interesting to draw a parallel with the system by which local or regional authorities manage burial plots, which allows human remains to be moved in certain circumstances when plots have ceased to be maintained. The provisions of the Code

général des collectivités territoriales (CGCT) (General Code for Local and Regional Authorities) concerning the reclamation of burial plots are set out in article L.2223-17: '*When, after a period of thirty years, a plot has ceased to be maintained, the mayor may issue a statement to the public and the families concerned to the effect that the plot is in a state of neglect.*

If, three years after this statement has been duly issued, the plot is still in a state of neglect, the mayor may refer the matter to the municipal council, which must decide whether the plot can be reclaimed.

If so, the mayor may issue a decree declaring that the land allocated to the plot will be reclaimed by the municipality.'

The provisions of the CGCT allow municipalities, which are responsible for maintaining cemeteries, to reclaim plots by virtue of the mayor's policing powers, and to transfer the associated human remains to mass graves without thereby committing an affront to human dignity or acting contrary to public order in the eyes of the legislator.

Although suggestions about what should be done with residues and leftover material can be made in a charter of ethics, the provisions of the CGCT discussed here nevertheless show that the implementation of such suggestions, insofar as they would lead to the destruction of human remains, should invite reflection by the public authorities on whether a legislative framework would be appropriate, given the sensitivity of the matter.

Elements for defining an ethical protocol are presented in the following chapters.

3. From field collection to analysis request

3.1. The different types of analysis

3.1.1. Invasive vs. non-invasive analysis

Material finds from archaeological excavations are by nature irreplaceable. Any destruction is final. This basic fact does not a priori rule out any study, but it does affect it.

It is customary to make a distinction between invasive and non-invasive analysis, in other words between studies involving irreversible modification of the initial object and studies that can be repeated indefinitely. Although analyses that completely destroy skeletal material should clearly be considered invasive, in general this dichotomy is too strict.

Besides the unavoidable impact of any handling of ABRs—which is one of the most frequent causes of deterioration—it is also important to think carefully about analyses that are generally considered to have no effect. How far should studies involving imaging (radiography, scans, accelerators) be considered as having no effect on the remains?

Either way, the fact that the anthropobiological remains have been analysed, and the type and number of analyses performed, must be recorded in the inventory of the operation report or in the management database of the institution conserving the remains.

3.1.2. Destructive analysis

Physicochemical and biological analysis of anthropobiological remains properly started with radiocarbon dating. While coal was the first material used for absolute dating, developments in methodology and in archaeological questions have led to a preference for human remains in many contexts. Although the scientific benefits have been remarkable, a considerable amount of material has been sacrificed. Before the widespread use of accelerators for analysis, around 300 to 400 g of bone was needed to obtain a sufficient quantity of collagen, meaning the destruction of half a skeleton or more. Although the scientific use of archaeological heritage elements is the primary justification for their conservation, the emergence in the 1990s of new fields of research involving dietary isotopes has led to a review of overly short-term perceptions of ABR analyses.

The growing use of nuclear physics, organic chemistry, and molecular biology in the study of ancient human remains is creating new possibilities for the study of ancient populations. The corollary of this is, of course, increased demand for analysable raw materials (bones or teeth). The rapid development of these techniques also obliges us to imagine that others, some already embryonic and others still undreamt of, will be developed in the future. Having learnt from the experience of radiocarbon dating, it seems essential to save some material for future research, irrespective of the ethical considerations that compel us to preserve these remains.

There are currently many methods that can be used to obtain highly complementary data about fossil remains: dating (radiocarbon or carbon-14), species identification and evolutionary information (ZooMS, paleogenomics, paleoepigenetics), migration (isotopic analysis, paleogenomics), life history and pathologies (paleogenomics, paleomicrobiology, paleohistology, isotopic analysis), diet (microremains, proteomic and metagenomic analysis of dental calculus, isotopic analysis), or histology (study of internal bone structure, cementochronology). Although the number of such analyses is growing, considered individually they are fortunately becoming less and less destructive.

Methodological advances in certain methods, particularly carbon-14 dating, are reducing the amount of material that must be sampled. Compared to the several grams of bone still being used in the 1990s, it is now possible to perform analyses using between 100 mg and 1 g of material (Fewlass et al., 2017; 2019) and to check the collagen content of a bone before analysis in order to avoid needlessly destroying unsuitable bones (Sponheimer et al., 2019).

Moreover, once the collagen has been extracted from a bone for radiocarbon analysis, that extract can also be used for other isotopic or proteomic analyses. A single sample can thus provide a huge amount of information. Table 1 shows the methods that can be combined when analysing a collagen extract taken from 500 mg to 1 g of bone (Table 1).

Method	Purpose of analysis	Advantage	Disadvantage	Cost per sample	Need to analyse a whole corpus of associated fauna	Part sampled	Amount of collagen sampled	Amount of bone needed (depends on condition)
Radiocarbon	Date the sample directly	Direct dating, very reliable method that can also be used on burnt bones	Expensive and long waiting list	300–500 euros	No	Collagen from a bone or tooth, or mineral fraction of the bone in the case of burnt bones	3 mg	100 mg–1 g
Carbon and nitrogen isotopes in collagen as a whole	Diet	Quick, cheap	Need to analyse associated herbivores and carnivores	20 euros	Yes	Collagen from a bone or tooth	0.5–1 mg	100 mg–500 mg
Carbon and nitrogen isotopes in amino acids	Very precise information about diet	Very precise information about trophic level, not many specimens needed	Complicated and expensive, still not much comparative data	Over 300 euros	Partial	Collagen from a bone or tooth	3 mg	100 mg–1 g
Sulphur isotopes	Mobility/fish consumption	Cheap, recent developments mean it can be used as a good tracer of provenance	Difficult to implement	25 euros	Partial	Collagen from a bone or tooth	8 mg	300 mg–1 g
ZooMS	Phylogenetic identification	Quick, cheap	Cannot always get to species level	Under 100 euros	No	Collagen from a bone or tooth	Residue from the bag or tube that contained the sample	<100 mg

Table 1: Isotopic and biochemical methods that can be combined on a single collagen extract from a bone or tooth.

Methods for the isotopic analysis of dental enamel have proliferated since the development of mass spectrometry in the 1990s. Although many are still in development, there is already a whole range of analyses that can be used to obtain information about diet, mobility, length of breastfeeding, ecology, and diagenesis (Table 2). Each of these analyses still requires a separate sample, but efforts are currently underway to combine protocols and separate different elements from a single extract of dental enamel. Moreover, in many cases the material analysed can be obtained by means of laser ablation, which causes only minimal destruction.

Type of analysis	Purpose of analysis	Advantage	Disadvantage	Laboratories carrying out these analyses for archaeological projects in France		Part sampled	Amount sampled
Zinc isotopes $\delta^{66}Zn$	Diet/breastfeeding	Less affected by mobility than other tracers, good information about trophic level and breastfeeding	Susceptible to contamination in the lab	Géosciences Environnement Toulouse (GET)	Yes	Enamel	Between 2 and 20 mg depending on the species
Carbon isotopes $\delta^{13}C$	Ecology	Very well-known tracer, can distinguish between folivores and grazers in certain environments	Can be impacted by diagenesis	MNHN, LGL-ENS Lyon	Yes	Enamel	0.4–8 mg depending on the lab
Oxygen isotopes $\delta^{18}O$	Climate, mobility, temperature, seasonality	Very well-known tracer	More complicated to implement if you want to avoid the risk of diagenesis	MNHN, LGL-ENS Lyon	Yes	Enamel	0.4–8 mg depending on the lab
Calcium isotopes $\delta^{44}Ca$	Diet/ecology/breastfeeding	Very small quantities of enamel needed	Affected by mobility	LGL-ENS Lyon	Yes	Enamel or bone	1 mg <
Stable strontium isotopes $\delta^{88}Sr$	Diet/ecology	Can be purified and analysed at the same time as radiogenic strontium	Still in development/not much comparative data	GET/LGL-ENS Lyon	Yes	Enamel	Between 2 and 20 mg depending on the species
Radiogenic strontium isotopes $^{87}Sr/^{86}Sr$	Mobility	Can be purified and analysed at the same time as stable strontium	Rarely permits conclusions about exact provenance	Numerous	Yes	Enamel	Between 4 and 20 mg depending on the species
Magnesium isotopes $\delta^{25}Mg$	Diet?	Seems to provide information that complements Ca and Zn	Affected by mobility	LGL-ENS Lyon	Yes	Enamel	1 mg
Trace element ratios (Sr/Ca, Ba/Ca)	Diet	Easy to analyse, no chemical separation	Does not always separate food groups well	Very numerous	Yes	Enamel	1 mg <

Table 2: Isotopic and elemental analyses that can be performed on dental enamel (the list of laboratories dates from 2021).

Similarly, genetic analyses require increasingly fewer anthropobiological remains: although several hundred mg of powdered bone was required a few years ago, improvements to protocols mean it is now possible to extract just 10–40 mg of material. Moreover, although the petrous portions of temporal bones are still the preferred remains for studying genomic DNA, an increasing number of paleogenetic analyses are now performed on atypical substrates like dental calculus or sediments (Table 3).

Analysis objective	DNA targeted	Part sampled	Amount of material required
Determining biological sex	Genomic DNA	Bone (e.g., petrous) or tooth root	10–100 mg
Determining kinship relations	Genomic DNA	Bone (e.g., petrous) or tooth root	10–100 mg
Population genetics	Genomic DNA	Bone (e.g., petrous) or tooth root	10–100 mg
Mitochondrial haplogroups	Mitochondrial DNA	Bone (e.g., petrous) or tooth root	10–100 mg
Y haplogroups	Genomic DNA	Bone (e.g., petrous) or tooth root	10–100 mg
Pathogens	Microbial DNA	Dental pulp cavity or pieces of bone with or near lesions	10–100 mg
Phenotype identification	Genomic DNA	Bone (e.g., petrous) or tooth root	10–100 mg
Oral microbiome	Microbial DNA	Calculus or specific tissue	1–100 mg
Scraps of food	Eukaryotic DNA	Calculus or specific tissue	1–100 mg

Table 3: Genetic analyses that can be performed depending on the quality of the data.

Destruction for analysis itself is no longer the principal risk: ultimately only a tiny quantity is used. Nevertheless, a much larger bone fragment or complete tooth must be sent to the laboratory for sampling. If the specimen is not returned to the conservation institution and is no longer available for future studies (which is the current norm), the fragment or tooth itself can be considered effectively destroyed.

3.1.3. Which bone/skeletal tissue for which analysis?

Bones and teeth are the most frequently available and analysed anthropobiological materials. More rarely, and in specific contexts, hair, nails, or soft tissue can also be analysed (mummies, embalmed tissue, or tissue preserved by natural mummification).

Bone and dental tissue follow different growth processes. While bone is constantly being renewed, the signals recorded by a tooth correspond to the period when it was formed. Analysis of dental tissue is, therefore, preferred for research questions related to childhood (diet, mobility), while analysis of bone collagen can provide information about the final years of an individual's life (between 10–15 years for an adult, when using the compact part of the long bones) (Table 4).

For research questions focused on the overall analysis of dietary patterns, the ideal is to target one tissue (bone tissue) from each individual in a cohort that is as numerically representative as possible so as to achieve statistically admissible samples.

By contrast, an intra-individual approach is preferred for tracking dietary changes throughout an individual's life. This may involve analysing several tissues, for example bone and dental tissue, to investigate changes between childhood and death. It is also possible to perform sequential analyses along the growth axes of enamel or dentine (depending on the chemical element being analysed). All teeth can be analysed. The most appropriate tooth depends on the life period in which researchers want to track isotopic changes.

Target tissue	Signal recorded	Research question addressed	
Bone		**Individual analysis (1 analysis/individual)**	**Intra-individual analysis (several analyses/individual)**
Compact bone (e.g., femur, tibia, humerus)	Average signal = last years of life (around 15 years for an adult, less for an individual who was still growing)	Diet/mobility/environment over a long period	To follow the life history of individuals (in utero/birth until death)
Spongy bone (e.g., ribs, epiphyses)	Average signal = shorter recording time than in compact bone; signal is closer to death	Diet/mobility/environment over a shorter but not precisely determinable period	
Tooth		**Individual analysis (several analyses/tooth)**	
Enamel, dentine, cementum, secondary dentine	Growth and physiology specific to each tooth and each dental tissue	Diet/mobility from birth to the end of adolescence/beginning of adulthood. Maternal diet, breastfeeding, weaning, physiological impact of stress and growth, detection of 'social ages'.	

Table 4: Research questions addressed by isotopic analyses of dental and bone organic material (collagen) (C, N, S).

Genomic material is the same in all the body's tissues. For paleogenetic analyses, therefore, any tissue can be used under similar conditions. Generally, the sample is taken from the most compact and least altered bone, which is the least likely to be affected by environmental contamination. This is why most analyses are performed on the petrous part of the temporal bone or, if that is not available, on tooth roots. Nevertheless, this does not apply to studies of bacterial DNA. In that case, the part of the skeleton in contact with the microorganism (for primary lesions) is preferred: dental calculus, dental pulp, altered tissue, or bone in contact with blood vessels in the case of septicaemia.

3.2. Constraints on studies, and the specific case of paleogenetics

3.2.1. Treatments during archaeological operations: A possible hindrance

Under normal conditions, archaeological remains, including anthropobiological remains, are handled with bare hands, from the field to the laboratory. Archaeological remains are sometimes in such poor or fragmented condition that special excavation protocols must be followed for extracting them from the ground. In extreme cases, chemical treatments may be used at the excavation site to enable the extraction of an object that would otherwise disintegrate completely on extraction.

When studying objects after an excavation, cleaning treatments are used to ensure their surface features are visible. The scientific coordinator of the operation is responsible for ensuring the material collected is in a suitable condition for study (article L.546-1 [11] of the Code du patrimoine). 'Macroscopic' biological anthropology studies need remains in the best possible condition. Except in certain specific cases, observations are much easier when bones resemble the original anatomical piece as closely as possible: an entire bone can be measured, its morphology assessed, its details recorded and located. Nevertheless, it is essential that fracture planes are free of any 'foreign' material. It has long been a requirement for gluing to be reversible; it is essentially an illusion, and none of the products used to assemble fragments are completely neutral. Depending on the type of deposit, but particularly when the skeletal and dental remains of several skeletons are mixed together or when dealing with scattered human remains, researchers often indicate a reference code and write the inventory number directly on the pieces to avoid any confusion.

[11] Article L.546-1 of the Code du patrimoine: '*During any archaeological operation, the operation director, under the scientific and technical supervision of the state, ensures that archaeological finds are conserved and takes the necessary measures to prepare them for study. He or she entrusts preventive and curative conservation operations to qualified staff who perform them under the scientific and technical supervision of the state.*'

These interventions have consequences for subsequent analyses. They may make certain types of analysis more difficult or even impossible, as shown in the table below (Table 5):

	Direct contact	Indirect contact	Consequences
Paraloid B72 or Primal or Acryl 33 (acrylics)	X		May form complexes with DNA that can affect purification
Cyclododecane	X		Does not interact with DNA but can affect purification
Acetone or ethyl alcohol	X		Risk of contaminants being introduced into the bone
Polyurethane foam spray (if applicable)		X	Unknown
Plaster or plaster strips		X	Unknown
Water	X		To be avoided because it can: - dissolve the DNA bound to the bone mineral - contaminate the bone with exogenous DNA
Gauze, tarlatan, lightweight Japanese paper	X		None if new
Paper towel	X		None if new
Cling film, aluminium foil	X		None if new
Cotton	X		None if new
Adhesive tape		X	Risk of glue being transferred into the bone
Paintbrushes	X		Transfer of materials if not sterile
Brushes	X		Transfer of materials if not sterile
Small excavation tools	X		Transfer of materials if not sterile
Wooden rods	X		Single use
Blower bulbs		X	Unknown
Vaporiser		X	To be avoided (risk of contamination)
Small plastic dustpan		X	Transfer of materials if not sterile
Metal and/or rigid wooden plates		X	Not a problem if the bone has been wrapped in a previously unused minigrip or paper bag
Pliable packaging material (air pouches, polystyrene bead pouches, bubble wrap, and foam)		X	Not a problem if the bone has been wrapped in a previously unused minigrip or paper bag
Minigrip/paper bag			None if new
Boxes (wide and flat; wide and deep; small padded wooden box)		X	Not a problem if the bone has been wrapped in a previously unused minigrip or paper bag
Small boxes if applicable		X	Not a problem if the bone has been wrapped in a previously unused minigrip or paper bag
Styron, Tyvek, or polyester labels		X	Rigid labels should be inserted into a new minigrip bag before putting into the bag containing the associated ABRs in order to avoid transferring volatile ink components.

Table 5: List of tools and products that most commonly come into contact with remains being removed or treated in the laboratory after excavation.

While it is easy to plan the least invasive measures when it is known before the operation that there will be skeletal remains to analyse, problems arise when the importance of the remains is not correctly assessed during excavation or when no such analysis was anticipated.

The treatments the ABRs have undergone and, if applicable, which parts of the remains were treated must be recorded in the operation's final inventory and in the inventory of the conservation institution so that analysts can decide whether prior treatments are compatible with their planned study method or, if necessary, suggest ways to remove any contamination beforehand. A form can be drawn up including the above list of possible contaminants and a photograph or description of the parts that were treated. These forms correspond to the treatment forms commonly used by conservators and restorers; they are a key part of the documentation of the object and its conservation condition beyond the research question addressed by the analyses. Although this type of form is frequently filled in during consolidation in the field, this is less commonly done in the post-excavation period, particularly during the cleaning stage.

The elements to be included in the form will be defined in the decree on standards for the content, presentation, and dissemination of operation reports, which is currently being drafted by the Archaeology division (see Appendix 2).

3.2.2. Environmental contamination

Bioarchaeological materials are subject to taphonomic processes from the moment they are buried, leading to the quantitative and qualitative degradation of mineral and organic fractions as well as interactions with exogenous elements (trace elements, metals, natural organic matter, environmental DNA).

Trace elements can be affected by contamination from the laboratory or the person handling the samples. This was the case with lead for a long time (until the development of unleaded petrol) and is currently a particular risk with zinc, which is present in the nitrile and latex gloves used to protect researchers from acids in the preparation room.

Degradation of the organic fraction (collagen) and the mineral fraction (bioapatite) in bones can be identified using several indicators obtained during preparation of the fractions (yield) and when measuring the targeted elements.

3.2.3. Difficulties encountered during paleogenetic analysis

The DNA preserved in the bones and teeth of individuals from the past is highly degraded and, in most cases, present in very small quantities: the determining factors are the age of the sample, the environmental conditions (temperature, pH, humidity) in which it was preserved, and the conditions in which it is kept after excavation.

The opportunity to perform DNA analysis may be lost (reduction in the number and quality of analysable molecules) due to contamination by other DNA molecules (exogenous DNA) or by molecules that can inhibit biochemical reactions (PCR inhibitors), or as a result of the degradation of the DNA molecules themselves (fragmentation, sequence alteration).

The burial of skeletal remains in the ground leads to contamination from the genetic material of the flora and fauna in the ground, which can constitute more than 99% of the DNA extracted and have a major impact on the cost of research projects. The growing use of the petrous part of the temporal bone, which is less porous and so less susceptible to contamination, reflects the difficulties caused by this exogenous DNA in paleogenetic studies. Laboratory methods have also been used to increase the proportion of endogenous DNA: capture technologies enable the targeted recovery of areas of interest in the genome. Their efficiency significantly reduces the cost of sequencing, and they are indispensable for the analysis of remains with very low rates of endogenous DNA. Nevertheless, these approaches introduce analytical biases with consequences that are still being assessed. Moreover, the sequences they produce cannot be reanalysed in view of other research questions or advances in our understanding of genomes.

Contamination by DNA from the same species as the target (or a closely related species) is difficult to eliminate retrospectively; the danger when analysing ABRs, therefore, is contamination from anyone who has been in contact with the remains. For that reason, contact must be kept to an absolute minimum from archaeological excavation through to sequencing.

3.2.4. Excavation protocol for ABRs destined for paleogenetic analysis

- Problems posed by contamination (Table 6)

DNA contamination during excavation is limited to the surface of the sample, except in the presence of water and humidity, because water can penetrate the bone and carry DNA molecules inside it. DNA contamination is thus more of a concern for remains from which surface DNA is taken (cementum from tooth roots) than remains from which DNA is taken from further in (dense fraction surrounding the cochlea in the petrous bone).

Generally speaking, the best way to eliminate DNA molecules from the surface of the material is to clean it using bleach (freshly prepared aqueous sodium hypochlorite solution [for example 0.65%]) before rinsing it with 70% ethanol and drying it to minimize surface corrosion.

To help paleogeneticists and other molecular analysts adapt their decontamination and/or analysis protocols, it is strongly recommended that any measures taken (or not) in the field are documented: whether gloves were worn, what type of gloves (latex, vinyl, nitrile, powdered or not), whether masks were worn, the use of glue, whether the remains were cleaned, etc.

Source of contamination (risk)	Risk-prevention measures
Environmental DNA	The ground in which the remains are buried contains numerous microorganisms whose DNA can penetrate into the sample before excavation. It is not possible to prevent this intrinsic source of exogenous DNA in the field. Washing the sample with water does not eliminate this exogenous DNA; in fact, it further contaminates the sample and degrades the molecules. Washing with water should be avoided.
DNA from excavators (+++)	Any direct (bare hands) or indirect (saliva, nasal mucus, sweat, object that has been in contact with skin) contact with the remains is a major source of surface contamination. To avoid this surface contamination, excavators should wear new gloves, frequently disinfected with bleach, and a mask. Subsequent contamination can be limited by keeping the sample in a tightly sealed (if there is no humidity) container (box or bag) until it reaches the analysis laboratory or its conservation location. Invisible contamination is more difficult to prevent than visible contamination (hair). Although excavators are recommended to wear a hygiene cap, it is less important than wearing a mask and frequently disinfected or new gloves.
Transferred DNA (+)	Modern DNA already present on a surface can be accidentally transferred onto the remains (indirect contamination). This type of DNA transfer can be limited by avoiding any contact between the remains and an object (glove, tool, bag, etc.) that has previously been in contact with skin. If gloves touch skin or an everyday object (tool, phone, bottle, camera), they must be disinfected immediately with bleach. The bags or containers in which remains are placed must be new or cleaned with bleach. Another example: if the bones must be placed on a table to be studied, clean the table with a paper towel soaked in bleach before putting the remains on it, or place them on a piece of new aluminium foil.
DNA from other remains	The risk of DNA contamination from one remain to another (direct contact between the bones of two individuals, use of the same tool to excavate two individuals) is relatively low in a dry environment. Nevertheless, gloves and tools should be cleaned between working on different individuals (wipe with a bleach-soaked cloth). If remains have been identified as belonging to two different individuals, they must be kept in separate bags or containers (new or cleaned with bleach). Warning: if samples are taken using microsaw tools (Dremel, circular saw, etc.), the powder produced poses a strong risk of contaminating another sample, and the tool could also act as a contaminant if it is not properly cleaned. **This type of activity should not be carried out in the field** (except in very specific cases, by trained personnel) but in a laboratory specializing in ancient DNA.
Other contaminants and inhibitors (+++)	Any product applied to the remains (glue, varnish, ink, etc.) can contaminate the samples and/or inhibit processes carried out in the laboratory. The use of such products must therefore be avoided as far as possible and documented when unavoidable. Some gloves are powdered: this powder inhibits PCR and may prevent biochemical reactions on the sample. It is imperative to use non-powdered gloves.

Table 6: Measures to avoid contamination.

- Degradation of molecules (Table 7)

Anatomical piece or sample	Recommendation
Petrous bone	The density of the portion surrounding the cochlea helps to preserve DNA. The risk of post-excavation contamination and degradation is relatively low **as long as the bone is kept whole** and the cochlea is not exposed. If the cranium is intact, it must remain so. If the temporal bone is fragmented, the petrous can be placed in a new bag (minigrip or paper). Gloves should ideally be worn to handle the bone; if not, this should be documented. Keep the anatomical piece at a stable temperature < 20°C and relative humidity between 45 and 55%.
Teeth	Teeth are a very valuable substrate for studies of human DNA (using cementum), paleomicrobiological studies (using the pulp cavity or calculus), paleoproteomic studies (dentine and calculus), and isotopic studies (enamel and dentine). If teeth are still in place in the mandible or maxilla, they must be **left in place** until they reach the analysis laboratory. If the teeth are loose, place them in a new bag (minigrip or paper). It is important **not to touch the teeth** with bare hands (risk of DNA contamination) or with gloves (risk of contamination from zinc, which interferes with certain isotopic analyses). Use metal tongs that have been cleaned with bleach or new tongs. If the tooth has been touched, this must be documented so the laboratory staff can adapt their protocol. It is important **not to clean the teeth** and to leave all traces of calculus in place. If an identifiable fragment of calculus comes away from the tooth, place it in a separate bag with a note indicating which part of which tooth it came from. Keep teeth at a stable temperature < 20°C and a relative humidity between 45 and 55%, and keep them out of UV light, especially if they are loose.
Small bones	Recent studies (Sirak et al., 2020, Genome Research) have shown that small bones are a very good reservoir of DNA that give comparable results to the petrous bone. When they are found during excavations, they should be placed in a new bag **without cleaning them.** Keep small bones at a stable temperature < 20°C and a relative humidity between 45 and 55% and keep them out of UV light.
Pathological lesions	Studies of ancient pathogens (paleomicrobiology) can be performed on bone lesions indicative of infection (tuberculosis, leprosy, syphilis, etc.). Likewise, some calculus or other calcified tissues can be used in paleogenetics. Samples **should not be washed**, and lesions **should not be touched** with bare hands or with tools that have not been previously cleaned with bleach. Keep samples at a stable temperature < 20°C and a relative humidity between 45 and 55% and keep them out of UV light.
Coproliths	Coproliths are a source of human and microbial DNA. Samples **should not be washed or touched** with bare hands or with tools that have not been previously cleaned with bleach. Keep coproliths at a stable temperature < 20°C and a relative humidity between 45 and 55% and keep them out of UV light.
Mummified tissue, including hair	Mummified tissues have been used successfully, particularly in paleopathogenic studies (for example concerning smallpox). Hair is a very good reservoir of human DNA. Mummified tissues in very cold environments (permafrost, glacier) must be **kept frozen** with no rupture of the cold chain. Mummified tissues in temperate or warm environments should be kept at a stable temperature and above all in a **dry environment**. Gloves must be worn in all cases and samples must be kept out of UV light.
Burnt bones or teeth	Burnt remains generally contain little usable DNA. Nevertheless, promising methods are being developed in forensic medicine. As a precaution, if the scarcity of the remains or the importance of the context makes it plausible that the bone fragments will be used for paleogenetic research in the future, samples **should not be washed or touched** with bare hands or with tools that have not been previously cleaned with bleach. Keep burnt bones at a stable temperature < 20°C and a relative humidity between 45 and 55% and keep them out of UV light.
Sediment	Sediment should be removed using **tools cleaned with bleach**, placed in **sterile laboratory containers** (for example Eppendorf tubes), and kept **cold** (ideally in a freezer, or, failing that, a refrigerator). These samples should be studied soon after excavation.
Other bones	Other bone pieces are less useful for paleogenetic analysis. Nevertheless, they might be of interest to pilot studies or if they are the only remains belonging to certain individuals, and they are frequently used in isotopic analysis. In such cases, bones with areas of denser compact bone are preferable. If the scarcity of the remains or the importance of the context makes it plausible that the bone fragments will be used for paleogenetic research in the future, samples **should not be washed or touched** with bare hands or with tools that have not been previously cleaned with bleach. Keep the remains at a stable temperature < 20°C and a relative humidity between 45 and 55% and keep them out of UV light.
Artefacts and geological materials	Although these cases are still the exception, certain artefacts or geological materials can be atypical sources of ancient DNA (human or microbial), such as chewing gums or calcite deposits. They should therefore be collected and conserved with the same amount of care as the aforementioned anthropobiological remains. New atypical sources of ancient DNA may be identified in the future.

Table 7: Recommendations for handling and conserving different anatomical pieces or samples.

The principal factors leading to degradation of DNA molecules are temperature (+++), humidity (++), and UV radiation (+). These factors must be taken into account when deciding how to store and transport samples.

High temperatures and temperature fluctuations increase degradation and must be avoided at all costs (do not keep samples in car boots or portacabins in direct sunlight).

Remains should be kept at a cool, stable temperature as far as possible (refrigerator, air-conditioned room, cellar, even a cave can be ideal!). Refrigerators are not recommended for long-term storage: the sample must be kept well aerated to prevent the development of bacteria or mould. Continuous freezing (-20°C) is the best solution and should be preferred when possible, but it is not feasible in many archaeological operations for technical reasons. In some cases, because of the scarcity, age, or context of the remains, freezing is strongly recommended (e.g., remains from the Upper Paleolithic) or essential (excavations in permafrost, glaciers). In such cases, it is essential to avoid temperature fluctuations due to ruptures in the cold chain, particularly when samples are being transported.

Water causes the hydrolysis and so the fragmentation of molecules, as well as encouraging the growth of bacteria and fungi that damage DNA. Samples should not be washed with water or kept in very humid environments. Plastic bags (minigrip) should not be closed unless samples are totally dry.

UV light degrades DNA molecules. Samples should therefore not be left in direct sunlight. This does not have a significant impact on DNA in the petrous bone because the paleogeneticist will take sub-samples from the interior of the bone (rather than the surface, as with dental cementum).

- Anticipation of future analyses

At the present time, these kinds of precautions only concern excavations where it is planned from the outset for finds to be used for paleogenetic analysis. Given that French archaeologists discover the remains of several thousand individuals every year, the number of such operations is relatively low. Nevertheless, it seems likely that as paleogenetic studies become more advanced and widespread, and as the relative cost of analysis decreases, paleogenetic analysis will, in the medium term, be used on a far greater number of remains. It goes without saying that a lack of sufficient new finds will make it necessary to use finds from excavations that were not carried out with paleogenetic analysis in mind. This is already the case for periods that produce limited amounts of ABRs: the Paleolithic, Mesolithic, and often the Neolithic.

In light of protocols put in place by paleogenetics laboratories, in order to optimize analysis success rates and to reduce costs, it seems reasonable to consider that any human skeleton found in an archaeological context may be analysed at some point. The chances that such an analysis will be successful should, therefore, be maximized.

Current archaeological practices are fairly far from paleogenetics protocols. When analyses are going to be performed during the archaeological operation, the scientific coordinator of the preventive operation or the licence-holder of the planned operation must consult anthropologists and paleogeneticists as soon as any anthropobiological remains are found in order to decide which remains should be prioritized in order to answer the targeted questions.

When no analysis is planned during the operation, bone pieces must still be removed in such a way as to enable future analysis. The collection and handling of ABRs for study must not

compromise the success of future analyses. The above recommendations should, therefore, be followed.

The working group explored the question of whether archaeological practices could be brought into line with the very strict protocols of paleogeneticists. This could be envisaged along the following lines:

- Archaeological practices could evolve to come as close as possible to analysts' expectations, although it will never be possible to transform an archaeological site or a post-excavation study room into a cleanroom;
- The suggested protocols would be applied but only to a small part of the skeleton, which would be selected when the skeleton is identified in the field. Even still, there is no consensus about this option. Is it appropriate to break up skeletons in the field before they have undergone anthropological analysis? Analyses of anthropobiological remains are just one of the tools of archaeological research. Moreover, DNA analysis has been successfully performed even on bones that have been handled and kept at room temperature. Nevertheless, the preservation of DNA varies depending on which part of the bone it is taken from, and handling remains a major contaminating factor;
- Paleogeneticists should also be encouraged to continue to develop protocols to eliminate surface contamination (UV treatment or bleach, sequential extraction).

Fieldwork and post-excavation studies must take all the scientific issues into account. Anthropobiological remains cannot be regarded as sacrosanct or broken up solely for the purpose of paleogenetic research. Because the amount of material required for analysis is relatively low, it seems feasible to combine paleogeneticists' recommendations with archaeological and anthropological imperatives for operations where anthropobiological remains are found. This factor must be included in the specifications of operations thought likely to produce anthropobiological remains (see appendix 5).

3.3. Preservation measures before destruction

3.3.1. What information should be preserved, and for what purpose?

It is an archaeological truism that excavation amounts to the implicit destruction of the deposit, and so of its original document. To mitigate this drawback, the discipline has developed and continues to refine a wide range of recording methods. Given that isotopic or paleogenetic analysis involves the at least partial destruction of anthropobiological remains, can this destruction be compensated for, and if so, how?

To the extent that the destroyed part is irreplaceable, the first option is to ensure that all information that might be useful for archaeological and anthropological study has been recorded. A second option when selecting samples that will be destroyed is to choose an object that resembles another object collected during the operation and ultimately stored in the conservation institution, and to carry out at least a macroscopic comparison of the two objects. Finally, discussions between archaeologists, anthropologists, and analysts should determine whether additional measures are necessary.

If it seems necessary to make a very detailed record of the remains, for example by using medical imaging techniques, the choice of sample can be considered beforehand. Unless it is impossible to select an equivalent object for analysis, an object considered to be exceptional should probably not be chosen for sampling.

In addition to saving information for scientific purposes, information about an object, or a copy of the object, might be useful for museum collections or with a view to some other further use. In such cases, the project specifications will be defined in line with this goal.

3.3.2. Theoretical possibilities and practical means, developments

Several preservation measures are already available, each of which has its own advantages and disadvantages (Table 8).

Method	Advantages	Disadvantages
Photography	Quick and easy. Often sufficient when working with collections comprising numerous remains. Simple to store photo files.	No preservation of internal structure, particularly for the petrous part of the temporal bone or dental or bone microstructures.
Macro photography	High-precision and high-quality photographs.	Availability of suitable hardware and software (suitable camera and lens). Only possible for small bone pieces. No preservation of the internal structure of remains.
Photogrammetry or surface scans	Enables a 3D view of the piece. More accurate than classic photography. Moulds can be made using 3D digital models.	Requires expertise and a suitable camera and software. Preserves digital data, but not very much.
3D micro scans Micro-CT	Preserves the internal structure, which is important for the petrous part of the temporal bone (which can help to determine genetic sex) or for the study of dental microstructures or bones. Marginal impact on DNA if the radiation dose is less than 200 Gy (µCT) and the bone is dry. Reasonably affordable (around 150 euros per skull-size piece with a resolution of 100 µm, or one or several human teeth with a resolution of 20 µm). 3D moulds can be made using scanners, less time-consuming than traditional moulds.	Degrades DNA if the radiation dose is above 200 Gy (synchrotron). Data cannot be used without imaging expertise and access to suitable software. Scanners produce a large amount of data that must be stored on a server.
Moulding	Can create an accurate replica of the piece (tooth or petrous).	Access to 3D printing: costs approximately 100–150 euros for a skull or 10–15 euros for a tooth.

Table 8: Measures for preserving information or mitigating loss when ABRs are destroyed.

It is important to discuss the capacity and sustainability of structures used to manage digital data (servers required). Currently, the very large files produced by the specialized software used to process these kinds of analysis cannot be stored long-term in the state's permanent conservation institutions. If there is no plan to use the data, there is no point investing human and material resources in storing them for unknown purposes.

By contrast, storing a physical copy of the destroyed piece in conservation institutions is a realistic short-term goal. With the guarantee that the surface scanner will not hamper the analysis, a 3D print of the selected bone or tooth should soon become possible before any analysis. This copy, paid for by the research project, would be returned to the conservation institution.

4. The scientific use of anthropobiological remains

One current difficulty facing researchers is the lack of standardized procedures and the impression that decisions vary from one operation or region to another. It is important to remember that the state (DRAC-DAC/SRA and DRASSM), because of its responsibility for archaeological heritage and so for anthropobiological remains, is the only entity with the power to authorize studies or analyses, especially when the latter are invasive. Even in the context of an ongoing operation under the scientific authority of a preventive or planned operation coordinator, the state must approve any analysis not anticipated in the operation instructions or authorization and in the scientific specifications.

This authorization must be obtained whether the research project only involves analysis or whether it is part of a broader scientific programme, such as a collective research project.

The provision of anthropobiological remains and/or samples of the same is subject to a signed agreement between the state and the research project lead (see § 4.3 below).

Scientific use is a four-stage process:

- Appointment of the research project lead;
- Scientific assessment of the project;
- Monitoring of the research project;
- Delivery of results.

4.1. The research project: Responsibility and design

4.1.1. Responsibility for the research project

Responsibility for the project must be assumed by a named individual who is affiliated with or permanently employed by a recognized institution (an établissement public à caractère scientifique et technologique [EPST] [Public Scientific and Technical Research Establishment], university, or similar). Because many research projects run over a long time, a student cannot be named as the project lead while completing a thesis or postdoctorate, even if they are identified as the person who actually takes the samples and produces and/or analyses the data and are acknowledged as the intellectual owner of these aspects.[12] Likewise, the institution itself or its legal representative cannot lead the project: the project lead must be scientifically involved in the project.

The project lead is the person who signs both the research project sent to the relevant regional archaeology service and the agreement to provide anthropobiological remains for analysis (Appendix 3). They are responsible for conducting the project properly and making sure all members of the project team respect the rules set out in the agreement. The project lead is also responsible for using samples within the strict framework of the authorization and approval negotiated with the Ministry of Culture. The role also involves coordinating the circulation of information to the various teams and to the people involved and named in the initial request.

In a research project dealing with metagenomic diversity, the project lead must guarantee that the project complies with the Nagoya Protocol and that all necessary steps have been taken to that end (see § 2.2.3). Any changes to the orientation or schedule of the research project must be submitted in

[12] Moreover, the fact that the scientific supervisor of doctoral or post-doctoral students is listed as the last author in publications underlines students' lack of autonomy in these studies.

advance to the regional archaeology service, which will decide how to deal with the change: new approval of the research project or amendment to the provision agreement.

Insert: Support for national research institutions and collaborative projects. Towards calls for projects?

National research institutions likely to undertake projects (particularly in paleogenetics) dealing with anthropobiological remains found in archaeological operations in French territory are often in competition with international research organizations with much larger budgets. In the long run, this situation poses the risk of the isolation or marginalization of national laboratories committed to scientific questions of interest to archaeologists and paleoanthropologists in French research units.

To help maintain a research landscape that can meet archaeologists' needs, the Archaeology division of the Ministry of Culture could issue calls for projects for the study and analysis of corpora of anthropobiological remains of particular interest to science. These calls for projects could encourage initiatives involving collaborative projects, in other words cooperation between several national structures bringing together researchers from different institutions and laboratories specializing in the analysis of anthropobiological remains. These projects combining several analytical approaches would also facilitate the pooling of samples and so increase the benefits derived from the sampled material and results.

The creation of overarching research infrastructures by the CNRS and its partners (Ministry of Higher Education, Research, and Innovation, Ministry of Culture, etc.) could make it possible to bring together different teams and laboratories at the national or international level so as to be able to set up and carry out ambitious projects that are currently out of reach for any of the French teams working individually on these questions. The Ministry of Culture could make contact with its various institutional partners in order to discuss setting up this type of infrastructure in our field.

4.1.2. Research project design

The drafting of the application is an essential part of formalization that helps to ensure project feasibility, in particular regarding the location and availability of samples and the approval of the institutions concerned. The content of the application should respond to the project evaluation criteria listed in § 4.2.4.

The research project must include a detailed inventory of all anthropobiological remains concerned.

4.2. Scientific evaluation of the research project

Any research project involving archaeological heritage elements must be sent to the regional archaeology service (or DRASSM) to obtain authorization and access to the objects.

In the specific case of anthropobiological remains, because of their nature and possible rarity, it seems essential for research projects to be assessed by the regional archaeological research commission (CTRA; commission territoriale de la Recherche archéologique) with jurisdiction over the region (or one of the regions, for larger projects) where the remains were found.

4.2.1. The regional archaeological research commission

When making scientific decisions, the regional archaeology services rely on the opinions given by the CTRAs,[13] which are composed of members representing all the national archaeology bodies as well as the different chronological periods and specialities.

For very specific fields, they regularly call on external experts. This is the case for disciplines like anthropology, paleometallurgy, geoarchaeology, or bioarchaeology. It is also the case for research fields that are rarely represented by competent experts in the CTRAs, like landscape archaeology, underwater archaeology, or the archaeology of modern conflicts. Some CTRAs have recently drawn up lists of external experts who can be called on for occasional advice to complement the opinions of the CTRA members.

The CTRAs meet at very regular intervals (once a month or every six weeks) and do not, therefore, significantly delay the archaeological operations or research projects they assess.

4.2.2. Types of project requiring special expertise

At present, the CTRAs are not normally consulted regarding fields that use innovative and/or extremely specialized techniques, especially when those techniques are not part of archaeological 'routine', such as paleogenetic or isotopic analyses. By contrast, external advice is not normally sought when assessing the suitability of a project using carbon-14 dating techniques, which are well known among the whole archaeological community.

Ideally, this expertise should be consulted in all projects involving the invasive analysis of human bones, regardless of the number of analyses or the amount of material required.

When the impact on the resource is minimal, the SRA assesses whether to solicit the CTRA's advice. When the CTRA receives simple requests for advice, it chooses whether or not to ask an external expert to judge the project's suitability. External expertise must be solicited for projects with a clear impact on the resource, whether because of the number of analyses or the rarity or heritage value of the remains, or because there are questions surrounding the scientific issues.

4.2.3. The expertise in question

Therefore, to help the CTRA respond to these emerging research questions and requests, several researchers with knowledge of the disciplines in question should be appointed to form a national college of experts from which one or several opinions can be solicited for each project, in addition to the opinion given as normal by a member of the CTRA. It would appear difficult for a single expert to be able to offer an opinion on projects involving a range of different methods of analysis. In addition to the disciplines in question, the expertise must also take into account the state of the resource, in other words how depleted the collection is at the time of the application and how depleted it is likely to be after the project is completed. A college of experts is, therefore, the best option.

Moreover, in a field where scientific competition is intense and there are not many laboratories, it is objectively impossible to find a 'neutral' researcher, and the definition of standard criteria for evaluating analysis protocols may be hampered by divergent views regarding said protocols. These

[13] For the DRASSM, these opinions are provided by the Commission des opérations sous-marines (COSM) (Commission of Underwater Operations), which is a sub-commission of the Conseil national de la recherche archéologique (CNRA) (National Archaeological Research Council).

differences of opinion, which are completely normal in a rapidly developing subdiscipline, nonetheless represent an obstacle for decision-making bodies. The problem of competition seems to be more marked in the field of paleogenetics (although its existence is undeniable in other areas as well). In paleogenetics in particular, an arrangement could be possible whereby all the French laboratories (four at the present time) are represented in the college of experts.[14]

On that basis, the working group recommends that the Ministry of Culture draw up a national list of around ten external experts designated for the duration of the CTRA's mandate, which is four years, renewable once. These experts would be chosen preferably from French laboratories; the list could also include specialists in disciplines studying animals or living organisms, as well as foreign researchers. To familiarize them with how the CTRAs work, these external experts would be invited to participate directly in CTRA meetings, either in person or remotely.

The established procedure for specialists commissioned by the CTRA could easily be adapted to ABRs. The expert would give an overall opinion on the quality of the project, focusing particularly on the methodological aspects:

- Is the planned research question relevant?
- Is the chosen method suitable for answering the research question?
- Does the analysis method comply with current standards?
- Does the extraction method compromise the performance of future analyses?
- Are the proposed arrangements and schedule for making the results available to the research community satisfactory?

The external expert sends their written opinion to the CTRA, which then drafts a collegial opinion following its normal procedure, taking into account the specific knowledge of each of its members as well as information about the history of the application: any past issues, the overall feasibility of the project (access to study objects, agreement of researchers involved, budget and funding, etc.), the heritage value of the anthropobiological remains being analysed, etc.

Insert: Confidentiality regarding research projects

The members of the CTRA are not permitted to discuss projects outside the commission. They have a duty of confidentiality regarding the commission's debates.

In the case of a college of external experts, these experts must be chosen so as to avoid any conflicts of interest. All external experts must be reminded that they are subject to the same ethical rules as members of the CTRA.

Moreover, it must be stipulated that once the minutes of the session have been approved, the CTRA's collegial opinion is an administrative document that can be sent to the project lead and any third parties who request it, subject to the conditions of the Code des relations entre le public et l'administration (CRPA) (Code of Relations Between the Public and the Administration).

[14] Insofar as an animal collection may give rise to the same questions, it seems logical not to limit this procedure to human bones alone. In this case, the committee of experts could be consulted if needed on request by the CTRAs. This would be a national committee of experts in skeletal remains more generally.

4.2.4. Criteria for evaluating research projects

There are five generally accepted aspects to be evaluated :

- The research question and, if applicable, the involvement of the scientific coordinator of the operation in the development of the question;
- The compatibility of methods and objectives;
- Whether the benefit outweighs the resource loss;
- The ability of the institution and/or project lead to complete the work;
- The delivery of the data.

These five criteria are generally the most important in the a priori or a posteriori evaluation of any state-authorized archaeological excavation.

When evaluating samples taken for analysis, however, samples could be graded according to impact as part of the evaluation process. For analyses that do not target a specific anatomical part and that are well represented for the period or geographical area in question (typically the case for radiocarbon dating), it does not seem necessary to undertake a specific prior evaluation. By contrast, it is useful to remember which anatomical parts should be avoided for this type of analysis (teeth, petrous bones, etc.) in order to preserve this limited resource.

Regarding samples taken from anatomical parts or specimens that are poorly represented anatomically or are rare archaeologically, the five points listed above must be considered as a priority.

- <u>Research question</u>
    - Contextualization of the project (including review of existing studies on the same subject)
    - Aims
    - Contribution of the expected results
- <u>Methods</u>
    - Sampling methods
    - Description of analysis and data processing methods (summary with bibliography if methods have been published elsewhere, detailed description if they are new or modified)
- <u>Benefits vs. resource loss</u>
    - Representation of the targeted anatomical part in the collection, taking into account the different contexts and periods at the site
    - Representation by context, region, or period in the case of rare remains
- <u>Skills of project leads</u>
    - Nature of the institution and the equipment, commitment of the institution holding the ABRs while analysis is ongoing
    - CV of the project lead
    - Guarantee that the project is funded. If the laboratory performs analysis at its own cost, a letter of commitment is required. In the case of external funding that has not yet been acquired, conditional authorization can be given.
- <u>Delivery of data</u>
    - Format in which the data will be delivered
    - Project lead’s commitments regarding delivery deadlines and formats as well as access rights
    - Commitment to return unused samples as planned in the draft agreement on the provision of ABRs

Although there is, unsurprisingly, a general consensus about the titles of the five points, there is some debate about their exact content. The loss/benefit ratio weighs the research question against the irreplaceable nature of the material consumed by the analysis. From this point of view, a method that is well proven but does not exploit all the informative potential of the sample may seem most suitable. This type of question is as relevant for the different levels of ancient DNA analysis (mitochondrial DNA, positions of interest, entire genome, etc.) as for isotopic analysis (research focused on one, several, or a wide range of atoms found within a single collagen extract). The condition of the resource must be borne in mind, with the most exhaustive treatment of a sample only required if it is justified by the research question.

4.3. Provision agreement and timeframes

After the CTRA has issued its opinion on the research project and the SRA has authorized it, the project lead must sign an agreement with the state (DRAC/DAC/DRASSM), which is responsible for managing anthropobiological remains found during archaeological activities, regarding the provision of the remains needed for the study (see template in Appendix 3). When the research project deals with ABRs held by several SRAs, each SRA must give authorization, and an agreement must be signed with each of the relevant SRAs.

It should be noted that this agreement is not required when the analyses were foreseen in the operation specifications or in the authorization request for planned operations. Nevertheless, in the case of planned analyses, the operator, the scientific coordinator of the operation, or the licence-holder of the planned operation must sign a contract with the analysis laboratory stipulating how the analysis is to be performed, the results delivered, and the remains returned.

4.3.1. Content of the provision agreement

The agreement will record, in particular:

- DRAC/DAC-DRASSM's commitment to provide the anthropobiological remains listed in the research project's inventory, as well as the reports of the operations they came from and any other information needed to carry out the research;
- The authorization by the SRA or the DRASSM allowing the project lead to take samples for analysis in accordance with the CTRA's opinion;
- The project lead's recognition that they have only a temporary and non-exclusive right to use the ABRs in order to perform the analyses planned as part of the research project. The project lead will under no circumstances become the owner of the anthropobiological remains provided or of the samples taken;
- The project lead's commitment to update DRAC/DAC-DRASSM regularly regarding the progress of the study;
- The duration of the agreement;
- What will be done with the by-products and results;
- The responsibilities of each party.

4.3.2. Timeframes

Authorization for analysis (and so for sampling) is given on the basis of the research project presented and is justified in light of the funerary/chronological/geographical context and the biological parameters associated with the ABRs, all of which will change over time as the research progresses. As a result, an authorization given at a moment T is subject to the timeframes of research, which may vary from one project to another.

When dealing with invasive analyses, which by nature concern a non-renewable resource which will, in some cases, have been treated according to specific standards from the moment it was removed in the field, cautious management is essential: two competing projects cannot be completed simultaneously using the same material.

On another level, the human and financial investment required for certain analysis projects also justifies the granting of a set period of time to analyse the resource. Approval for a project thus entails a form of exclusivity for the scientific use of the samples within the framework set out in the provision agreement signed with the state. This exclusivity must not be unlimited or unmonitored. It is subject to several timeframes:

- Access to the resource

As things stand, projects, particularly those involving paleogenetics, are only rarely funded by research laboratories themselves (although new forms of service delivery may be developed in the near future). Funding normally comes from calls for projects (issued by regional organizations, foundations, the Agence nationale de la recherche [ANR] [National Research Agency], the European Research Council [ERC], etc.). It is reasonable to assume that funding will not be confirmed without a guarantee that the evidence base exists, in other words that the resources are available. Conversely, the state cannot commit to sacrifice samples to a project without a guarantee that it will be successfully completed, which requires funding.

For analysis projects, the first agreement is conditional. It provides exclusive access to the samples on condition that the project is proven to be practically feasible within one year. If funding is not obtained in the first year, a simplified procedure can be used to request an extension of the prior agreement by one year upon production of solid justification and a guarantee that the project will be resubmitted for financing the following year. Moreover, a new application must be submitted to the Archaeology division at the Ministry of Culture.

- Preliminary analyses

Although some methods have by now become routine, others are still in the exploratory phase, with results not guaranteed at every stage of the analysis. Some projects could benefit from authorization for a trial year in which to begin studies on part of the corpus, with authorization for the full study dependent on the results obtained during the first year. If the initial application does not go into sufficient detail about the risks at each stage, the CTRA could suggest a trial year that would be enshrined in the ABR provision agreement.

In the case of ancient DNA, the screening stage is both essential and quick (it evaluates the percentage of endogenous DNA, the fragment length expressed in base pairs, and the level of clonality). Depending on the resources allocated to the project, an interim report would have to be submitted to the state no later than a year after the beginning of the analysis. On the basis of this report there would be a discussion of project feasibility and any changes to be made to the protocol (choice of new samples, trying new laboratory procedures, stopping the project, etc.).

- Rollout of the project up to publication (Table 9).

The project is subject to two separate timeframes: first, the period during which no other rival projects can request access to the same resource[15]; second, the deadline for publishing results. It seems impossible to suggest a one-size-fits-all time period. Project size, which is often linked to how much funding is obtained, is an essential parameter.

Nevertheless, it seems sensible to restrict initial authorization of an analysis to no more than three years (except in specific circumstances to be defined and set out in the research project), at which point the application to the SRA should be updated, duly justified, and motivated by scientific and not just economic considerations (partial or total non-funding of the project or submission to pending funding decisions). **Moreover, the moratorium on samples should not exceed the time needed to publish the first results.**

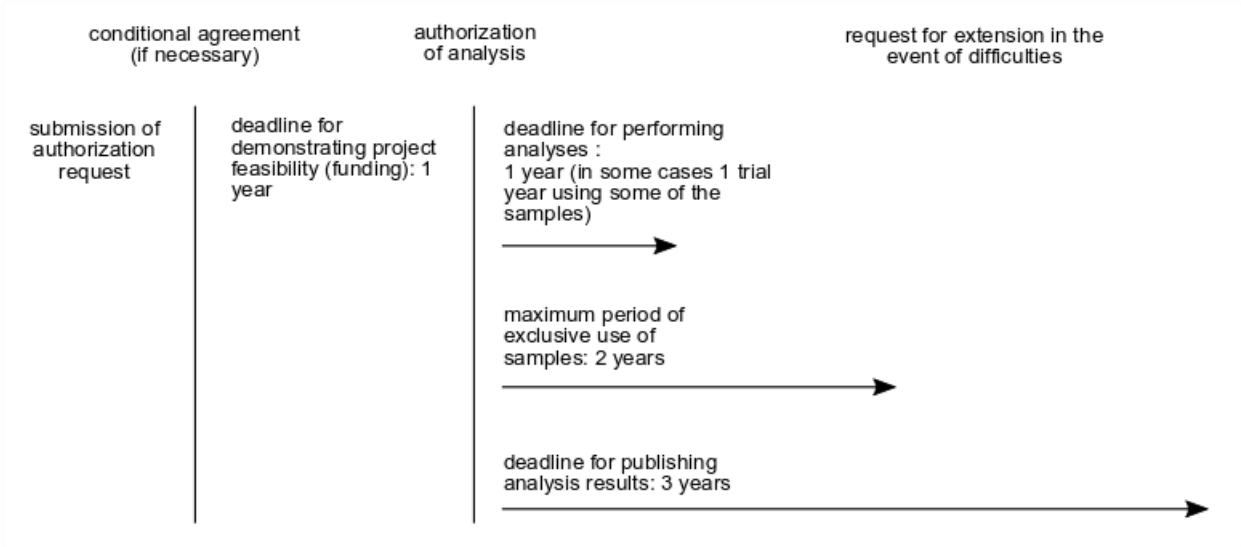

Table 9: Suggested analysis timeline.

Insert: Information about project progress

As things stand, it is often difficult, if not impossible, to obtain information about the progress and monitoring of ongoing research (especially internationally, where there is significant turnover among students and researchers responsible for analysis at sampled sites).

Agreements signed between project leads and the state must, therefore, include an obligation to provide the SRA with an annual progress report detailing the analyses carried out, the results obtained, and the longevity of the funding required to continue the research project.

These reports must be of a reasonable size and detail so that they can be produced effectively without requiring excessive administrative work on the part of the research project leads.

This would improve monitoring and communication between the parties, with the SRA entitled to request additional information in the case of difficulties, and if necessary and justified, even revoke the study and sampling authorization.

[15] For 'complementary' projects, like pathogenic DNA analysis during a project on human DNA, or isotopes while samples are being analysed for human DNA, different laboratories could collaborate on the same resource.

4.4. Delivery of results

4.4.1. Content of the analysis report

The results of any analyses performed during excavations, targeted surveys, or collective research programmes (PCRs) must be presented in the operation report. Standards for the presentation of archaeological operation reports are set out in the decree of 27 September 2004, which is currently being revised. This decree makes a number of points regarding samples and analysis. The operation report must describe 'the protocols for the recording and processing (…) of samples' and indicate 'any ongoing additional studies and analyses whose results are pending, including expected completion dates'. Specialized analyses must be 'correlated with the excavation results' (article 5). The current revisions to the decree also stipulate that the report must include the inventory of anthropobiological remains (future version of the decree on the composition of the operation report) and of samples (the future version of the decree specifies 'samples for inspection and analysis that have been or will be studied') (article 7). Finally, the results of these analyses must be submitted at the same time as the rest of the archaeological scientific data (article 7).

Analyses performed after the archaeological scientific data have been submitted to the state, whether they were initiated during the operation or after it by another scientific team, must be described in an analysis report at the end of the studies. This report can be submitted following the first publication, in other words after the analyses have been completed. It should be noted that any report becomes an administrative document upon submission to the state and can be communicated to third parties on request.

The overall organization of the analysis report must follow the same lines as that of the archaeological operation reports, which comprise three sections: the first presents the administrative, technical, and scientific data related to the operation; the second describes the operation and its results in detail; and the third presents the inventories of scientific data pertaining to the operation.

The elements that may feature in these three sections in the analysis report are as follows:

- 1st section:
- Administrative information about the operation(s) the samples come from: the nature, reference details (reference numbers of the operation, archaeological entity if known, and instruction decree or authorization; the year fieldwork took place; and the person responsible for the operation), as well as location (department, town, address) of the operation; a copy of the CTRA opinion; a copy of the analysis authorization from the SRA; copies of the provision agreement(s);
- Information about the remains: reference details (inventory number, recording unit), nature, condition (initial condition and condition after sampling), storage location;
- Information about sampling: sample number (or if applicable the number allocated in the report), condition after analysis (destroyed or not, returned or not, any residues), storage location of residues and by-products;
- Information about the study/analysis: contributors (organizational chart of the scientific team, associated laboratories), length, how results will be published (DOI or bibliographical reference if already published, draft publication if still ongoing).
- 2nd section:
- Review of study objectives;
- Analysis protocols used;
- Sample documentation (if the sample was not documented in the operation report);
- Presentation of results, including negative results.

- 3rd section:

- This section should include the raw data, a link to access them online, or information about where they are stored, as well as an inventory of documentation submitted (images, data files, etc.) in accordance with the inventory rules for archaeological documentation in the report decree. There should also be a consideration of the interoperability formats in which the digital data will be submitted;
- Inventory of sampling or analysis residues that follows the structure of the corresponding inventories in the report decree, including information about their nature, location, and condition.

4.4.2. Publication and communication of results

While the publication of results is what justifies carrying out research in any area, in the case of ABRs it is also an essential part of good management. A destroyed sample can never be re-analysed. It is vitally important that later studies do not have to duplicate work that has already been done—all the more so when the resource no longer exists. Publications normally report positive results; only rarely is unfruitful research described in the literature. With ABRs, analyses can easily run into insurmountable problems due to the current state of protocols: no collagen, no usable DNA. Project reports must include negative results about sampled ABRs, indicating which protocols were followed. There is no point in successive projects continuing futilely in the destruction of archaeological material without genuine improvement of experimental protocols.

Like any scientific production in the field of archaeology, previous studies can be reused in various ways. In a general synthesis, it is primarily the conclusions of particular studies that are relevant. In a more critical approach, these conclusions themselves may be called into question. Sometimes the re-evaluation of the documents produced in a publication can lead to the reformulation of hypotheses. Materials found in an excavation can be re-examined, sometimes performing analyses that were impossible when the original study took place. But the excavation cannot be repeated, the plan reinvented, or the sections redrawn. In any case, it is essential for archaeological scientific data to allow the greatest possible objectivity.

In physicochemical or biological analyses, the ‘raw’ data are generated primarily by computer. These data cannot be used by a non-specialist. Given the quantity of digital data, it seems unrealistic for the Ministry of Culture to save them. They are normally saved by the laboratory that produced them and by specific databases. Once the resulting study has been published, these documents must be accessible, subject to state approval and always indicating the laboratory that produced them.

Given the financial, human, and intellectual investment inherent in the production of data, teams who have worked to produce them must have legitimate, exclusive use rights to them before publication. The great majority of organizations funding French, European, and international research require a data management plan to be drawn up and submitted for the projects they fund. The way in which data are published is an important part of this deliverable, following the principle that research should be ‘as open as possible, as closed as necessary’. Publications of genetic data are thus obliged to store so-called ‘raw’ data in a publicly accessible database that can be accessed using a code indicated in the article.

Insert: The typology of so-called 'raw' data in relation to the different types of analysis

In paleogenomics, so-called 'raw' data refers to sequencing data, generally in the *.fastq* format, corresponding to all the DNA sequences generated from a DNA bank, as well as their quality scores. In certain cases, only data in the *.bam* format are stored in databanks. These are sequences aligned with the human reference genome. In this case, *.bam* files do not contain microbial sequences, which are evidence of possible pathogenic contamination and may be dealt with in a separate publication.

For isotopic ratios in collagen (C, N, and S), the raw data are:

- The quantity of material extracted,
- The collagen extraction yields,
- The percentages of the elements: %C, %N, and %S (used to calculate the C/N, C/S, and N/S atomic ratios),
- The isotopic ratios ($\delta^{13}C$, $\delta^{15}N$, $\delta^{34}S$) of the samples,
- The isotopic ratios compared to international standards and each laboratory's own internal standards (essential for verifying the stability of the measurements).

For the quantity of material and the yields, the availability of data depends on the protocol used. Isotopic data from standards and duplicate samples are now required to be presented in an appendix to published papers. These data are used particularly for calculating measurement uncertainty (see Szpak et al., 2017).

For carbon-14 dating of collagen, depending on the dating laboratory, the raw data can be:

- The collagen extraction yields
- The percentages of the elements: %C, %N
- The $\delta^{13}C$ isotopic ratio of the sample (different from the $\delta^{13}C$ measured by AMS, which is used to correct the dating).

4.4.3. Management of residues or sampling by-products

Thanks to the ongoing optimization of tools and methods, an ever-decreasing amount of material is required for each analysis. Nevertheless, the initial management of the resource does not enable a significant reduction in the size of the sample taken. Fractions of material taken from dentine or cementum are sufficient for isotopic or paleogenetic analysis, and several different analyses can be performed on the same sample. But the sample used is generally an entire tooth, or in other cases a large bone fragment. When several analyses are performed in succession, with no coordination or synchronization, the ABRs are thus sampled repeatedly, with no regard for the amount of material actually required. Currently, unused portions of the bone fragment or tooth are still only returned after analysis in exceptional cases.[16] **This situation must be reversed. The residue must be returned to the anthropobiological remains from the operation and, in the case of pieces sampled in the field and stored according to a specific protocol, these conditions must be maintained** (Table 10).

Analysis is not performed directly on bone or tooth fragments but on extracts taken from them. It goes without saying that it is impossible to predict the actual yield of material for analysis (collagen or DNA) from any given fragment. The objective being to acquire at least as much material as is

[16] Most contracts between the scientific coordinator of the sample and the analysis laboratory do not currently specify this. Ad hoc requests can lead laboratories to return unused parts, but archaeologists and anthropologists generally consider the fragment sent for analysis as having been totally destroyed. Finally, in the case of services (e.g., radiocarbon dating), the fees do not factor in return costs.

needed for analysis, there will logically be a surplus in most cases. In addition to the time required for extraction, this part of the ABR must be able to be reused. Thus, as long as the extraction protocol used is clearly documented, extracts of collagen, DNA (and DNA libraries), and bioapatite should be usable for multiple analyses without needing to take further samples. Because it is difficult to store extracts in archaeological collections, the storage of extracts in the laboratories that produced them—which is currently the norm regardless of the regulatory framework—should become a formal requirement. Subsequent projects that use the extracts would have to indicate their origin in some way so as to comply with intellectual property rules concerning the work that produced the samples.

One problem is the lack of information about the long-term conservation of these extracts at different stages of their processing and analysis (particularly for sub-products of isotopic analyses). Insofar as responsibility for conservation remains with the state, it is possible to envisage a small exploratory project, conducted jointly with an analysis laboratory, to evaluate how a set of test samples fares over the long term.

It does not currently seem possible, whether for financial reasons or because of a lack of standard or test protocols, to try to conserve all the products not consumed at the different stages of analysis. Nevertheless, we must not close the door on future progress in this area in fields where the technology is evolving very quickly.

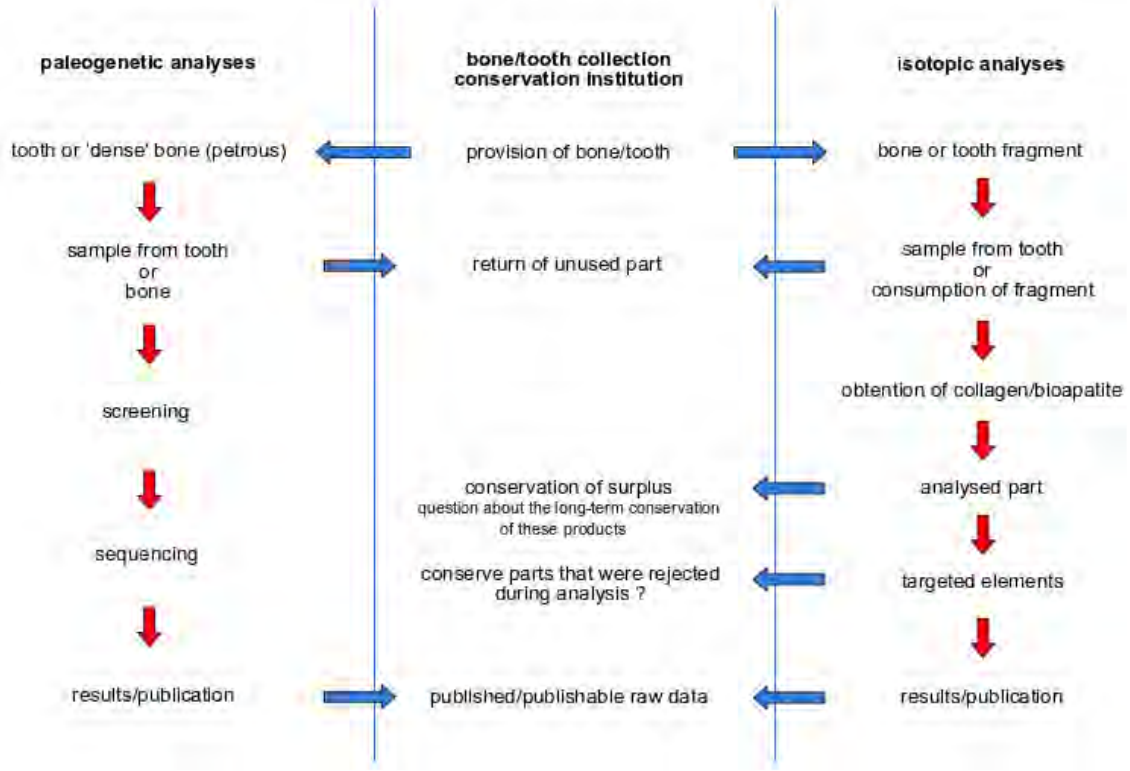

Table 10: Returning and conserving the products and sub-products of analyses.

4.4.4. Documentation of analyses in the archaeological data management inventory

When analyses have been performed on anthropobiological remains and/or fragments have been sampled for analysis, these interventions should be documented in the conservation institution's inventory. This would make it possible later:

- To find out whether the object has been analysed and to see any results (and in the case of non-destructive analyses, to access any fragments still being conserved);
- To understand that the absence of a particular element is due to this analysis and not because it was not found during excavation.

The data that should be included are set out in Appendix 2.

5. By way of conclusion: Summary and suggestions

At a time when our discipline is going through significant changes thanks to the constant evolution of research, the members of the working group tried to elucidate the principal challenges and consequences of this type of research for the study and conservation of anthropobiological remains found during archaeological activities: the scientific use, preservation, proper conservation, and responsible, well-thought-out management of the resource. The result was a debate between disciplines that have hitherto not tended to be in dialogue with each other.

In particular, this dialogue should encourage interaction between 'analysts', anthropologists, and archaeologists at a time when new and innovative analytical methods are rapidly emerging.

The performance of analyses using known and routine methods risks creating pressure from high demand, even though the quantity of material sampled from anthropobiological remains is generally decreasing.

The working group's reflections led to the following proposals, which should be shared with the whole scientific community involved[17] in these types of research, and primarily with the Conseil national de la recherche archéologique (CNRA) (National Archaeological Research Council):

- Disseminating the recommendations of the Archaeology division of the Ministry of Culture regarding the status of anthropobiological remains discovered and studied during an archaeological operation;
- Drafting an information sheet listing which actions should be taken and avoided during the operation, as well as the proper conservation conditions for ensuring the scientific community has access to anthropobiological remains that have suffered as little damage as possible and are likely to enable optimal analysis in the medium and long term;
- Drafting an information sheet presenting the benefits of each analysis method and the technical details of sampling procedures, updated as and when new analysis methods are developed;
- Making the scientific community aware of the fact that this resource is not renewable, that it may be rare in certain contexts, that carrying out studies leads to a loss of information, and that destruction is irreversible;
- Prior submission to DRAC-DAC/SRA or DRASSM of every research project led by a clearly identified person who is permanently affiliated with a recognized institution;
- Evaluation of the submitted project, like any other archaeological research project, by the regional archaeological research commission (CTRA), which can call on one or more external experts selected from a national list drawn up by the Ministry of Culture following the suggestions of the CNRA;
- Authorization of the research project by DRAC-DAC/SRA or DRASSM in line with the opinion of the CTRA/COSM;
- Provision of anthropobiological remains and/or samples via an agreement between the project lead and the state service responsible for conserving the anthropobiological remains and/or samples (DRAC-DAC/SRA or DRASSM);
- Stipulating the study timeline and an obligation to submit the research project's data and results to scientific and technical monitoring by DRAC-DAC/SRA or DRASSM;

[17] CTRA experts, SRAs, preventive archaeology operators, regional authorities' services, CNRS, MNHN, INSERM, museums, research laboratories, students, associations, groups, and French learned societies (SAP, SPF, GPLF, GAAF, RIGMA, CTHS, etc.).

- Presentation of the number and nature of research projects assessed by the CTRA in the CTRA's annual report to the CNRA;
- Performance of long-term conservation experiments on samples of residues or by-products in order to determine conservation recommendations;
- Establishment by the Director General for Heritage and Architecture of a mission at the Heritage Inspectorate, Archaeology College, to carry out a summary assessment of the studies and analyses undertaken, the results obtained, the processes used, and any difficulties encountered at the end of a trial period of four to five years, a period sufficient to enable the finalization of studies and the submission of reports from the first research projects authorized.

Following discussions with the scientific community, a summary presenting the approaches adopted will be drafted by the coordinators of the PAOHCE working group and sent to the director of the Archaeology division. This document will serve as the foundation for a set of guidelines sent by the Director General for Heritage and Architecture to the state services (DRAC-DAC/SRA and DRASSM) responsible for the conservation of anthropobiological remains and/or samples and for the scientific and technical supervision of archaeological studies.

In order to ensure that future exchanges with the different actors in the scientific community are fruitful, the PAOHCE working group recommends using the network made up of its twenty-odd members to facilitate effective communication of its suggestions, but also to provide methodological oversight with the implementation of its recommendations, to keep an up-to-date list of the institutions capable of performing the analysis methods, and to help the CNRA establish and update the national list of experts available for consultation by the CTRAs/COSMs.

List of appendices

- Appendix 1: Ministry of the Armed Forces/Ministry of Culture joint protocol on ‘principles and procedures for the discovery of the remains of soldiers killed in action’
- Appendix 2: Extract from the reference framework in the decree report *[currently being revised, working document]*
- Appendix 3: Template for an agreement between a DRAC/DAC and a researcher to provide anthropobiological remains for the purpose of analysis
- Appendix 4: Template form for monitoring anthropobiological remains from excavation in the field to analysis and the identification of residues and by-products
- Appendix 5: Recommendations for scientific specifications for an operation involving analysis of ABRs

Glossary

Artefact/ecofact: in archaeology, an artefact is a movable object that has been modified by human activity, while an ecofact is a movable object from the animal, vegetable, or mineral kingdom.

Bioapatite: calcium phosphate, the principal component of the mineral fraction of skeletal tissue (bone, enamel, dentine). Most of the elements of interest in bioarcheology are measured from this fraction, except nitrogen and sulphur.

Capture: experimental method that uses the affinity between a specific probe and DNA to increase the proportion of targeted DNA relative to the total DNA in an extract. The targeted DNA may be a set of genomic positions of interest, a full chromosome, or an entire genome.

Cementochronology: method for estimating age at death that involves microscopic observation of the number of dental cementum layers in a cross-section of a tooth root.

Cochlea: found in the petrous part of the temporal bone, it is a spiral-shaped inner ear canal.

Code du patrimoine: set of legal texts concerning the protection of French cultural heritage. The Code du patrimoine is divided into seven books. Book I deals with provisions that apply to all cultural heritage, book II with archives, book III with libraries, book IV with museums, book V with archaeology, book VI with historical monuments, noteworthy heritage sites, and architectural quality, and book VII with France's overseas territories.

Collagen: protein found in most animal tissues. It represents 90% of the organic fraction of bone (about 30% of the total bone) and gradually disappears after death. Less susceptible to contamination than the mineral fraction, collagen is used in numerous biochemical analyses.

DNA (pathogenic DNA, DNA from calculus): biological macromolecule found in all living organisms and certain viruses. It contains information transmitted from one generation to the next that determines the physical characteristics of an individual. DNA consists of an ordered sequence of nucleotides (A, T, C, or G) that form chromosomes. The sequence formed is specific to a species or an individual and can evolve over generations by means of mutation.

Epigenetics: the study of reversible modifications that do not change the gene sequence and which can be transmitted during cell division and affect how genes are expressed.

Genome: the complete set of genetic information in an organism, found in each of its cells in the form of a set of chromosomes. In mammals, the genome is made up of the nuclear genome (in the nucleus) and the mitochondrial genome (in mitochondria).

Isotopic analyses: a generic term referring to studies that use mass spectrometry to measure the isotopic ratios (counting the mass of elements with heavy and light isotopes) of bioarchaeological materials. The principal elements studied are traditional isotopes (C, N, S, O), radiogenic strontium (Sr) isotopes, and non-traditional isotopes (Ca, Fe, Cu, Zn).

Life history: analysis of life history traits is used in demography to gain information about the different social or biological stages in an individual's life. These traits include size at birth, growth pattern, age at maturity, offspring, age- and size-dependent reproductive investments, age- and size-dependent mortality, lifespan, etc.

Mass spectrometry: a physical analysis technique used to detect and identify molecules of interest by measuring their mass. For example, the isotopes of an element ($^{15}N/^{14}N$ or $^{13}C/^{12}C$) are separated and counted. The result is recorded using δ notation and expressed in per mille (‰) so that very small variations between the two isotopes can be detected.

Metagenomics: the study of all DNA fragments in a complex ecosystem, without prior separation of the species it contains. This method reveals the taxonomic richness of the sample as well as its functional content (presence of genes associated with different functions).

Microremains: waste trapped in dental calculus (pollens, phytoliths, etc.).

mtDNA – human mitochondrial genome: the human mitochondrial genome is the genetic material of mitochondria specific to the human species. This genome is of particular interest in population genetics and evolutionary theory because it is only transmitted from mothers to offspring and so enables the reconstruction of female lineages.

Paleogenetics: the study of ancient DNA that displays signs of degradation caused by taphonomic processes.

Positions of interest: variable position in the genome carrying information of phylogenetic, populational, or phenotypic interest.

Preparation for study: all direct interventions (preventive or curative conservation) required for the scientific study of movable archaeological objects, not including any restoration work that prevents future study of the object.

Proteomics: the study of all the proteins in an organism, a biological fluid, a tissue, a cell, or even a cellular compartment.

Radiocarbon (carbon-14): the radioactive isotope of carbon. Interaction with the atmosphere, which has a constant proportion of radiocarbon, stops when an organism dies, leading to the slow and measurable disappearance of this isotope. It is the most commonly used absolute dating tool in archaeology.

Trace elements: commonly present in the environment, in our food, and in all living organisms in low concentrations (trace amounts, concentration of <1 g.kg-1), trace elements comprise several families: the ‘essential’ elements (Cu, Zn, Fe, Mg, Cr…), metals (Pb, Hg, Cu…), and non-metallic elements (Ar, F).

ZooMS: a recent analysis method that identifies the family (genus or species) to which non-diagnostic skeletal elements belong. It uses mass spectrometry to analyse the peptide sequences found in the protein collagen. Less expensive than DNA analysis, its use is increasing in bioarchaeology.

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APPENDIX 1 : protocole conjoint ministère des Armées/ministère de la Culture sur la « Découverte de restes humains de militaires tués au combat. Principes et procédures » accompagnant la circulaire signée par les directeurs généraux des deux ministères du 14 septembre 2021

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RÉPUBLIQUE FRANÇAISE

Paris le 14 SEP. 2021

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Direction des patrimoines,
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Note

à

Mesdames et Messieurs les Préfets

OBJET : **Découverte de restes humains de militaires tués au combat.**

ANNEXE : Principes et procédures à mettre en œuvre.

Plusieurs événements récents, de même que le percement du canal Seine-Nord Europe et la réalisation des aménagements connexes, qui constitue l'un des plus grands projets conduits en France ces dernières décennies, ont conduit nos départements ministériels à préparer le document en annexe.

Celui-ci rappelle, lorsque des restes humains de militaires tués au combat sont découverts, les textes législatifs et réglementaires qui sont applicables ainsi que les procédures à mettre en œuvre. Il précise également le rôle respectif des services concernés et la répartition de leurs compétences. Ces principes concernent tant le champ patrimonial que le respect dû aux soldats « morts pour la France » et les droits de leurs proches.

Nous vous invitons à tenir nos services informés de toute difficulté rencontrée dans la mise en œuvre des dispositions prescrites.

Pour la ministre des Armées
et par délégation,
Le Directeur des patrimoines,
de la mémoire et des archives

CGA Sylvain MATTIUCCI

Pour la ministre de la Culture
et par délégation,
Le Directeur général des patrimoines
et de l'architecture

Jean-François HEBERT

Découverte de restes humains de militaires tués au combat
Principes et procédures

I. Principes généraux

La loi consacre le principe du respect du corps humain. Cette obligation de respect ne cesse pas après la mort. Les restes des personnes décédées (ossements et autres vestiges anthropobiologiques du corps humain, biens personnels...) doivent être traités avec respect, dignité et décence (article 16-1-1 du Code civil, CC).

Toute atteinte portée au respect dû aux morts est passible des sanctions pénales prévues aux articles 225-17 et 225-18-1 du Code pénal (CP).

Ces sanctions (cumulant l'amende et l'emprisonnement) répriment la violation de sépulture et l'atteinte aux cadavres. Elles s'appliquent notamment aux recherches de restes humains effectuées sur un terrain sans autorisation de l'État, quel que soit le propriétaire du dit terrain. Par ailleurs, les articles L. 544-1 et suivants du Code du patrimoine punissent les mêmes agissements effectués en vue de la recherche d'objets ou de monuments.

Ces principes se retrouvent dans les mesures qui sont prévues par la loi en cas de découverte de corps sur la voie publique :

- l'auteur de la découverte doit en informer immédiatement les autorités (maire, police, gendarmerie) ;
- l'officier d'état civil localement compétent informe sans délai le procureur de la République, afin que celui-ci puisse prendre les réquisitions nécessaires aux fins d'établir l'identité du défunt, en application de l'article 87 du CC ;
- aux termes de l'article 74 du code de procédure pénale (CPP), qui fixe la conduite à adopter et l'identité des autorités compétentes en cas de découverte d'un cadavre, « qu'il s'agisse ou non d'une mort violente », l'officier de police judiciaire qui en est avisé informe le procureur et se rend sur les lieux pour procéder aux premières constatations. Le corps du défunt est mis à la disposition de l'autorité judiciaire et est destiné à être restitué à la famille si l'identification aboutit.

Toutefois, si des éléments matériels indiquent que l'on est en présence de restes humains de militaires tués au combat, d'autres dispositions, celles relatives aux corps des combattants « morts pour la France » (MPF), s'ajoutent aux dispositions relatives aux obligations de respect, de décence et de dignité évoquées ci-dessus et impliquent la compétence des services du ministère des armées.

II. Compétence générale du ministère des armées

Les recherches officielles par les autorités françaises de corps de militaires tués à la guerre sur le territoire français ont été interrompues en 1935, s'agissant de la Première Guerre mondiale, et n'ont pas duré au-delà de 1952 pour la Seconde Guerre mondiale.

Ainsi, actuellement, hormis lors d'opérations de fouilles menées par des organismes étrangers habilités ayant obtenu une autorisation du service régional d'archéologie de la direction régionale des affaires culturelles (DRAC/SRA), les découvertes de corps de militaires ont le plus souvent un caractère fortuit, y compris lorsqu'elles interviennent à l'occasion d'opérations de diagnostics ou de fouilles préventives prescrites par le préfet de région - DRAC préalablement à des travaux d'aménagement, dès lors que l'objectif de la recherche qui les ont dictées ne consiste pas dans l'étude de restes humains.

La gestion de la découverte de restes humains sur les anciens champs de bataille est de la compétence du ministère des armées. Sur le territoire métropolitain, ainsi qu'en Algérie et au Maroc, la mise en œuvre de cette compétence est déléguée à un établissement public administratif, l'Office national des anciens combattants et victimes de guerre (ONAC VG), avec le concours d'autres services de l'État en tant que de besoin. Elle est exercée dans les départements et collectivités d'outre-mer (DOM-COM) par les directions du commissariat et, dans les pays autres que l'Algérie et le Maroc, par les ambassades (cf. III-C infra).

A – Fondement juridique

Tout corps revêtu d'effets militaires découvert sur un ancien champ de bataille ou présentant des caractéristiques ou/ou un environnement constituant un faisceau d'indices à valeur probatoire est présumé, jusqu'à preuve du contraire et *a fortiori* s'il est identifié comme tel, être celui d'un militaire tombé au cours de l'un des conflits qui se sont déroulés sur le territoire national (Guerre franco-prussienne de 1870-1871, Première et Seconde Guerres mondiales) ou à l'étranger (guerres napoléoniennes, guerres de décolonisation ...).

Ce corps a vocation à reposer dans l'un des lieux de sépulture spécialement aménagés à cette fin par la puissance publique. En effet, l'article L522-1 du Code des pensions militaires d'invalidité et des victimes de guerre (CPMIVG) dispose que les militaires morts pour la France en activité de service au cours d'opérations de guerre sont inhumés à titre perpétuel dans les nécropoles ou les carrés spéciaux des cimetières communaux, l'entretien et la garde de leurs sépultures étant à la charge de l'État (art. L522-6). Toutefois, l'article L521-1 du CPMIVG prévoit que les proches du défunt, dont la liste est fixée par l'article L 521-2, ont droit à la restitution et au transport aux frais de l'État du corps de ces combattants.

Afin de préserver la dignité de leur sépulture, les restes humains de militaires tués avant 1915, date d'instauration de la mention MPF, font l'objet d'un traitement analogue et adapté aux circonstances.

Au sein du ministère des armées, chargé des questions relatives aux anciens combattants, c'est la direction des patrimoines, de la mémoire et des archives (DPMA) qui est responsable du pilotage et de la coordination de ce sujet, en vertu de l'arrêté du 30 décembre 2020 fixant les attributions et l'organisation de la DPMA.

B – La mise en œuvre de cette compétence est confiée à l'ONAC-VG

L'article L611-3 du CPMIVG prévoit que l'ONAC-VG assure la mise en œuvre de l'entretien, de la rénovation, et de la valorisation des sépultures de guerre. Cette compétence s'exerce en France métropolitaine, en Algérie et au Maroc. Dans les départements, régions et collectivités d'outre-mer, des procédures analogues sont mises en œuvre par les directions du commissariat outre-mer du ministère des armées.

En cas de découverte de corps de militaires, les services de l'ONAC-VG doivent être informés dans les plus brefs délais, soit par l'auteur de la découverte, soit par les autorités que celui-ci a saisies (gendarmerie, mairie). Ils sont en effet seuls habilités à :

- prendre en charge les restes humains découverts ;
- prendre toute mesure appropriée pour leur préservation ;
- diligenter, s'ils jugent la chose possible, toute enquête nécessaire pour parvenir à leur identification si celle-ci n'est pas obtenue par l'examen des pièces trouvées sur les corps.

Si des éléments permettent de déterminer qu'il s'agit d'un militaire ressortissant d'un pays étranger qui entretient des cimetières sur le territoire français en vertu d'accords internationaux (pays du Commonwealth, Allemagne, États-Unis d'Amérique, Italie), l'ONAC-VG remet les restes humains et les biens personnels du défunt à l'organisme concerné, qui décide du lieu d'inhumation et se charge d'y procéder.

S'il s'agit d'un militaire français, deux procédures sont possibles.

Si le corps n'est pas identifiable, l'ONAC-VG choisit immédiatement le lieu de sépulture le plus approprié, conformément à l'article R522-4 du CPMIVG, à proximité de l'endroit où le soldat est tombé pour la patrie.

Si le corps a pu être identifié, l'ONAC-VG décide de son entreposage provisoire dans le dépositoire le plus proche et entreprend les recherches en vue de retrouver la famille afin :

- de lui permettre d'exercer son choix de demander la restitution du corps ou de préférer son inhumation en sépulture perpétuelle conformément à l'article R522-1 du CPMIVG ;
- de lui restituer, le cas échéant, les biens personnels du défunt.

Il appartient donc à l'ONAC-VG de mener les investigations nécessaires pour parvenir à localiser les familles et prendre contact avec elles, par tous les moyens utiles.

Le droit à la restitution des corps de militaires est une mesure dérogatoire, ouverte par voie législative en juillet 1920, après la Première Guerre mondiale, pour répondre à la demande pressante des familles. Ce droit est frappé de forclusion depuis le 1er mai 1921 pour la Première Guerre mondiale, depuis le 1er décembre 1948 pour la Seconde. Néanmoins, cette forclusion est suspendue provisoirement dans les cas de découverte tardive de corps, comme le prévoit l'article R521-2 du CPMIVG : la famille dispose alors de trois mois, après avoir reçu notification de l'identification du corps, pour présenter sa demande de restitution.

Enfin, l'ONAC-VG organise, sous l'autorité du représentant de l'État, les cérémonies d'hommage éventuelles et prend les dispositions nécessaires à l'accueil des familles qui viendraient à se faire connaître.

L'ONAC-VG tient la DPMA informée de toute découverte de corps et des démarches consécutives.

III. La contribution d'autres services de l'État

D'autres services de l'État sont amenés à intervenir en cas de découverte de corps de militaires.

A- Le ministère de la Justice

Il a ici un rôle – limité – en matière d'état civil. Le rôle des services judiciaires (procureur de la République, service de gendarmerie agissant comme tel) consiste à constater le décès et s'assurer qu'il s'agit bien d'un soldat tué au combat.

Il n'y a pas lieu d'établir un acte de décès dans les cas de l'espèce. En effet, les militaires concernés ont été portés disparus et leur décès a été constaté, dans les délais, par voie de jugement déclaratif, en application de l'article 88 du CC.

B- Le ministère de la Culture

Les services régionaux de l'archéologie (SRA) des DRAC sont des services déconcentrés du ministère de la culture, chargés de mettre en œuvre la politique nationale en matière d'archéologie en région. Dans le domaine public maritime, cette mission est assurée par un service à compétence nationale, le Département des recherches archéologiques subaquatiques et sous-marines (DRASSM) basé à Marseille. Les opérations archéologiques préventives prescrites et contrôlées par les SRA et le DRASSM sont réalisées par des opérateurs habilités ou agréés par le ministère de la culture.

En effet, l'essor de l'archéologie des grands conflits contemporains au cours des dernières décennies a progressivement conduit les différentes institutions concernées à réfléchir à la prise en charge des corps de militaires, inhumés ou non, découverts dans le cadre des opérations archéologiques. Grâce aux méthodes et techniques minutieuses de fouille mises en œuvre et aux indices collectés, ces recherches apportent une contribution importante à l'histoire des conflits et favorisent l'identification des restes humains découverts.

Du fait de la prise de conscience que les découvertes de corps de combattants des conflits contemporains, qui relevaient auparavant exclusivement de l'état civil, peuvent présenter un intérêt d'un point de vue historique et archéologique, ces services sont également concernés par ces opérations.

1) Il convient de préciser que les DRAC ne sont pas systématiquement impliquées en cas de découvertes de corps sur les anciens champs de bataille. Il existe à cet effet, pour ce qui concerne les restes humains des militaires tombés lors des conflits contemporains, une législation spécifique, toujours en vigueur (cf. supra).

Cependant, si le code du patrimoine ne prévoit pas de régime spécifique aux restes humains, l'article L510-1 du Code du patrimoine définit d'une manière inclusive les éléments du patrimoine archéologique comme *« tous les vestiges, biens et autres traces de l'existence de l'humanité, y compris le contexte dans lequel ils s'inscrivent, dont la sauvegarde et l'étude, notamment par des fouilles ou des découvertes, permettent de retracer le développement de l'histoire de l'humanité et de sa relation avec l'environnement naturel »*. Ainsi, les vestiges anthropobiologiques mis au jour en contexte archéologique (découverte fortuite expertisée par le SRA, opérations archéologiques prescrites ou autorisées par le SRA) font partie des éléments du patrimoine archéologique, au même titre que les biens archéologiques mobiliers (artefacts, écofacts, biens culturels maritimes).

2) Par conséquent, la coopération des services de l'ONAC-VG et des DRAC peut s'établir de la façon suivante, qui prend en compte de manière équilibrée les impératifs de leurs missions respectives :

- Par un appui de la DRAC à l'ONAC-VG lorsque des découvertes fortuites de corps de militaires ont lieu sur des sites protégés ou dans le cadre d'une opération archéologique prescrite et contrôlée par la DRAC pour d'autres raisons que la recherche de corps de militaires (archéologie préventive notamment). En pareil cas, les opérateurs d'archéologie doivent, par l'intermédiaire des DRAC, informer l'ONAC-VG et peuvent proposer de conserver les corps ainsi que les biens personnels et l'équipement du soldat afin de pratiquer les études nécessaires. L'ONAC-VG délivre alors une autorisation de conservation temporaire des corps, des biens et des équipements les accompagnant qui mentionne les délais d'études. En ce cas, la DRAC communique à l'ONAC-VG l'identité des soldats dès qu'ils ont été identifiés, sans attendre la fin des délais d'études, afin que les recherches d'état civil puissent être engagées par le bureau de l'état civil militaire de l'ONAC-VG. Ces recherches achevées, les restes humains, les biens et équipements doivent être remis à l'ONAC-VG ou au service étranger compétent, aux fins d'inhumation ou de restitution à la famille du défunt, charge à la

DRAC de prendre en compte les frais inhérents à ces restitutions à l'ONAC-VG ou au service étranger compétent.

- Les DRAC peuvent également être amenées à prescrire des fouilles préventives ou autoriser des fouilles programmées en cas de suspicion de la présence de restes humains en nombre sur une zone déterminée (zone de tranchées importantes, de combats intensifs, de cimetières provisoires) ou de recherches sur des sites d'intérêt scientifique avéré. C'est à la DRAC territorialement compétente (après avis de la commission territoriale de la recherche archéologique CTRA) qu'il appartient de juger de l'opportunité pour la recherche scientifique de telles décisions, qui relèvent de la politique publique de l'archéologie. Les DRAC doivent informer l'ONAC-VG des décisions prises et lorsque des découvertes de corps de militaires ont lieu, elles peuvent proposer de conserver les corps ainsi que les biens personnels et l'équipement du soldat afin de pratiquer les études nécessaires. L'ONAC-VG délivre alors une autorisation de conservation temporaire des corps, des biens et des équipements les accompagnant qui mentionne les délais d'études. En ce cas, la DRAC communique à l'ONAC-VG l'identité des soldats dès qu'ils ont été identifiés, sans attendre la fin des délais d'études, afin que les recherches d'état civil puissent être engagées par le bureau de l'état civil militaire de l'ONAC-VG. Ces recherches achevées, les restes humains, les biens et équipements doivent être remis à l'ONAC-VG ou au service étranger compétent, aux fins d'inhumation ou de restitution à la famille du défunt, charge à la DRAC de prendre en compte les frais inhérents à ces restitutions à l'ONAC-VG ou au service étranger compétent.

  En particulier, à l'occasion de projets de travaux, lorsque des diagnostics archéologiques prescrits et effectués sous le contrôle scientifique et technique de la DRAC permettent la découverte de vestiges structurés liés aux conflits contemporains et pouvant receler des restes humains de militaires, fosses communes et cimetières provisoires, des fouilles archéologiques préventives peuvent être réalisées dans un deuxième temps, selon un cahier des charges scientifique émis par la DRAC, après examen pour avis de la commission territoriale de la recherche archéologique (CTRA). Ce dispositif permet d'exhumer les restes humains, biens et équipements les accompagnant, de recueillir le maximum d'indices, de favoriser leur identification et ainsi de minimiser les risques de découvertes fortuites lors des terrassements ultérieurs.

- Le cas échéant, notamment en cas de découverte fortuite, par un appui technique des DRAC dans les opérations d'exhumation des corps de militaires, pour lesquelles les services archéologiques ont une compétence reconnue, propre à préserver l'intégrité de restes humains. Dans le cadre de leur mission scientifique et en sus de l'étude de l'environnement des corps découverts (tranchées, abris, bâtiments militaires, etc.), les DRAC peuvent être amenées à procéder à certaines observations sur les corps eux-mêmes, ainsi que les biens et équipements les accompagnant avant de les remettre à l'ONAC-VG ou au service étranger compétent aux fins d'inhumation ou de restitution à la famille du défunt. Toutefois, cet appui technique reste conditionné à la possibilité de mobiliser les moyens et aux capacités d'intervention dont disposent les opérateurs archéologiques dans le cadre de leurs missions respectives.

Les données obtenues lors de ces observations peuvent être de nature à améliorer la connaissance dans différents domaines, dont celui de l'anthropologie funéraire. Ces études doivent être menées en tenant compte des exigences de respect, de décence et de dignité qui incombent en l'espèce et, notamment, de manière à ne pas allonger excessivement le délai de mise à disposition des corps préalablement à leur restitution aux familles ou à leur inhumation en sépulture perpétuelle.

C- Le ministère de l'Europe et des affaires étrangères

En cas de découverte à l'étranger (hors Algérie et Maroc) de corps de militaires français tués au combat, les postes diplomatiques sont habilités à prendre en charge les restes humains.

Dans les grandes lignes, les préconisations ci-dessus trouvent à s'appliquer.

En outre, les constatations d'état civil sont effectuées par les services consulaires, en lien avec la DPMA.

L'aspect funéraire (ré-inhumation dans le cimetière militaire français le plus proche ou transport pour restitution à la famille) est mis en œuvre par l'attaché de défense près l'ambassade, conformément aux instructions de la DPMA et en lien avec l'ONAC-VG qui a la charge de localiser et contacter les éventuels descendants pour connaître leur choix.

Lorsqu'il n'existe pas de cimetière militaire français dans le pays, le corps est rapatrié, soit pour être inhumé en sépulture perpétuelle dans une nécropole ou un carré militaire choisi en concertation entre la DPMA et l'ONAC-VG, le cas échéant en y associant la famille, soit pour être restitué à celle-ci.

Appendix 2: Extract from the reference framework in the decree report [currently being revised, working document]

Work document

Extrait du référentiel relatif à la structure du fichier normalisé de transmission des données scientifiques de l'archéologie (projet d'arrêté relatif aux normes de contenu, de présentation et de transmission du rapport d'opération)

7 - Vestiges anthropobiologiques

Cette feuille liste tous les vestiges anthropobiologiques prélevé en fonction des demandes de la prescription. Les vestiges anthropobiologiques sont classiquement inventoriés par unité d'enregistrement.

Chaque ligne d'inventaire doit être accompagnée d'une fiche de conservation de l'individu (fiche squelette éclaté ou cliché du patron). Cette fiche doit avoir une légende claire. La légende est à rappeler sur chacune des fiches de conservation.

Le catalogue des tombes doit faire l'objet d'une ligne dans la feuille 11 - documentation archéologique.

Le champ « matière » doit obligatoirement être renseigné par la donnée « organique » et le champ « classe » doit obligatoirement être renseigné par la donnée « vestiges anthropobiologiques ».

Les champs en *italique* sont des champs d'informations complémentaires qui ne sont pas obligatoires mais qu'il serait bon de renseigner si l'information a été recueillie au cours de l'opération.

Les autres champs sont à renseigner si la donnée est connue.

code_OA_NAT [texte]	Code complet de l'opération archéologique (n° de la région + n° d'ordre dans la région) généré par la base de données de gestion des opérations archéologiques du ministère de la Culture.
identifiant_VAB [texte]	Code du vestige anthropobiologique (squelette ou lot de restes) dans l'opération archéologique. Il s'agit généralement d'un numéro d'UE défini dans la feuille 4 - Unités d'Enregistrement. L'identifiant peut être numérique ou alphanumérique. Associé au code d'OA_NAT placé en préfixe, il forme le code d'inventaire de la donnée.
identifiant_UE [texte]	Code de l'UE désignant la sépulture d'où provient le squelette ou le lot de restes, défini dans la feuille 4 - Unités d'Enregistrement.

identifiant_prelevement [texte]	Code du prélèvement dont le vestige anthropobiologique est issu comme défini dans la feuille 8 – Prélèvement.
matière [texte]	« organique »
classe [texte]	« vestiges anthropobiologiques »
determination [texte]	Identification du squelette ou du lot de restes en fonction des usages du responsable de l'opération préventive, du titulaire de l'autorisation de l'opération programmée ou de l'archéo-anthropologue et de l'avancement des études. Exemples : squelette d'individu adulte en connexion // lot d'ossements en dépôt secondaire // dépôt épars // squelette d'immature // ...
identifiant_fiche_conservation_par_individu [texte]	*Code de la fiche de conservation de l'individu (fiche squelette éclaté) défini dans la feuille 11 - Documentation archéologique.* *Ce champ n'est pas obligatoire si les fiches ne sont pas numérotées individuellement ou si leur numéro reprend l'« identifiant_VAB » du squelette ou du lot de reste.*
numero_contenant [texte]	Numéro du contenant dans lequel se trouve le squelette ou le lot de restes au moment du versement à l'État. Ce numéro doit être unique dans l'opération tous types de vestiges confondus.
taille_contenant [texte]	Taille du contenant dans lequel se trouve le squelette ou le lot de reste au moment du versement à l'État sous la forme : largeur x profondeur x hauteur.
etat_etude [texte]	Ce champ permet d'indiquer si une étude a été menée sur le squelette ou le lot de restes. Valeur « oui » : le squelette ou le lot de restes a été étudié en tout ou partie Valeur « non » : le squelette ou le lot de restes n'a pas été étudié
nombre_element [texte]	Si la valeur « oui » est saisie dans le champ « etat_etude », ce champ permet d'indiquer le nombre de restes qui composent le lot, classés par type d'os, permettant d'identifier le nombre minimum d'individu du lot (NMI). Ce champ ne s'applique pas aux squelettes individualisés (information disponible sur la fiche de conservation de l'individu). Ce champ doit contenir à la suite le nombre de reste par type d'os selon la structure : « type d'os 1 : nombre »« »« & »« »« type d'os 2 : nombre »« »« & »« » … (exemple : tibia droit : 3 & tibia gauche : 2 & …).
potentiel_scientifique [texte]	Il s'agit d'indiquer ici si le squelette ou le lot a livré tout son potentiel scientifique lors de la phase d'étude et de rédaction du rapport de l'opération. Cela permettra à l'État d'identifier plus facilement les séries

	ou les éléments ostéologiques qu'il pourra mettre à la disposition de la communauté scientifique pour de nouvelles études. Valeur « non » : le squelette ou le lot a livré tout son potentiel scientifique lors de l'étude de phase d'étude et de rédaction du rapport de l'opération. Vide : le squelette ou le lot de restes n'a pas livréé tout son potentiel scientifique et peut faire l'objet de nouvelles études.
commentaire_potentiel_scientifique [texte]	*Zone de texte permettant d'expliciter le choix des vestiges anthropobiologiques identifiés dans le champ précédent.* *Ce champ n'est pas obligatoire*
alerte_sanitaire [texte]	Ce champ permet d'indiquer la présence de tissus mous, phanères, cheveux … conservés s'il y a lieu ou si le squelette ou le lot de restes a été mis au jour en contexte pollué.
informations_complementaires [texte]	*Description plus complète du squelette ou du lot de restes selon l'avancement des études. Champ pouvant regrouper les données de plusieurs champs de la/des base(s) de données utilisée(s) lors de l'opération sous la forme : « nom du champ »« »« : »« »« donnée saisie dans le champ »« »« & »« »« nom du champ »« »« : »« »« donnée saisie dans le champ »« »« & » …* *Ce champ permet aussi de donner toute information importante à connaître sur le squelette ou le lot de restes et qui ne peut pas être saisie dans un autre champ.*
lieu_de_conservation [texte]	Indication du lieu de conservation du squelette ou du lot s'il n'est pas physiquement remis à l'État

8 - Prélèvement

Cette feuille liste les prélèvements pour examens et analyses qui ont été étudiés lors de l'opération archéologique ou qui restent à étudier. Un prélèvement est l'acte de prélever une quantité n de sédiment à des fins d'études ou des morceaux d'un objet, et qui se justifie d'un point de vue scientifique.

Si le prélèvement a été étudié lors de la phase d'étude et de rédaction du rapport, quelques données suffisent pour conserver la trace de l'existence de ce prélèvement.

L'étude du prélèvement fournit de la documentation archéologique et peut révéler des composants qui constituent de nouveaux objets, lots d'objets (restes de microfaune, pollens …) ou vestiges anthropobiologiques (ossements spécifiques, dents, phanères ...) qui devront être inventoriés dans la feuille 6 - vestiges archéologiques mobiliers de l'opération ou dans la feuille 7 - vestiges anthropobiologiques de l'opération.

Si le prélèvement n'a pas été étudié lors de la phase d'étude et de rédaction du rapport, il pourra être versé à l'État après échange et validation dans le cadre du contrôle scientifique et technique. Dans ce cas, des données complémentaires doivent être associées à ce prélèvement dont la plus importante, la date de validité au-delà de laquelle le prélèvement ne peut plus être utilisé pour l'étude pour laquelle il a été fait. De même pour les prélèvements qui n'ont pas été détruits en totalité lors de l'étude.

Certains prélèvements de référence doivent être conservés de manière pérenne. Dans ce cas, la date de validité sera remplacée par le mot « pérenne » et le champ « condition de conservation » doit être renseigné avec précision.

Pour les prélèvements non étudiés ou non totalement détruits après étude, le code de l'OA, le numéro de contenant, la date de validité et les conditions de conservation doivent être obligatoirement noté sur le contenant.

Une copie des résultats d'étude du prélèvement est à transmettre à l'État avec l'ensemble des données scientifiques de l'opération.

Les champs en *italique* sont des champs d'informations complémentaires qui ne sont pas obligatoires, mais qu'il serait bon de renseigner si l'information a été recueillie au cours de l'opération.

Les autres champs sont à renseigner si la donnée est connue.

Il doit y avoir un seul prélèvement par ligne.

Données à transmettre pour tous les prélèvements :

code_OA_NAT [texte]	Code complet de l'opération archéologique (n° de la région + n° d'ordre dans la région) généré par la base de données de gestion des opérations archéologiques du ministère de la Culture.
identifiant_prelevement [texte]	Code permettant de désigner de manière unique le prélèvement dans l'opération archéologique. L'identifiant peut être numérique ou alphanumérique. Associé au code d'OA_NAT placé en préfixe, il forme le code d'inventaire de la donnée.
nature_prelevement [texte]	Nature du prélèvement. De quoi est/était constitué le prélèvement : charbon, sédiment, échantillons d'objets … Pour un prélèvement sur un objet ou un vestige anthropobiologique, il faut préciser en plus ici : - le type du vestige sur lequel le prélèvement a été fait (tesson de céramique vaisselle ; ossement ; dent ; phanères ou tissus mous pour les restes momifiés ; …) ; - la localisation précise impliquée pour les objets complets ou les pièces anatomiques (tibia droit, pyramide pétreuse droite, incisive centrale mandibule) ; - l'étendue ou la zone du prélèvement (tesson complet, fragment d'1 cm de la tige de la fibule, carottage fin, os complet, dent complète, surface articulaire supérieur du talus, fragment de diaphyse au niveau du tiers distal, zone pathologique …).
auteur_prelevement [texte]	Nom « » Prénom de la personne ayant effectuée le prélèvement.
objectif [texte]	Dans quel but le prélèvement a été effectué. Expliciter en quelques mots le protocole associé au prélèvement. Pour quel genre d'analyse ou d'étude a été fait ce prélèvement.

etat_final [texte]	État final du prélèvement après étude. Selon les termes de vocabulaire obligatoires : détruit / conservé en partie / conservé en totalité. Lorsque le terme « conservé en partie » est sélectionné, il faut donner le pourcentage restant. Lorsque le prélèvement n'est pas détruit en totalité, les champs des données complémentaires à transmettre « si le prélèvement est versé à l'État dans l'attente de son étude complète ou pour sa conservation pérenne (prélèvement de référence) » doivent être renseignés.
informations_complementaires [texte]	*Description plus complète du prélèvement.* *Ce champ n'est pas obligatoire.*

Données complémentaires à transmettre si le prélèvement est versé à l'État dans l'attente de son étude complète ou pour sa conservation pérenne (prélèvement de référence) :

date_validite_prelevement [texte]	Date (aaaa/mm) au-delà de laquelle le prélèvement, n'ayant pas été totalement détruit après analyse, ne peut plus être utilisé pour l'étude en vue de laquelle il a été fait. À partir de cette date le prélèvement pourra être jeté. Certains prélèvements de référence doivent être conservés de manière pérenne. Dans ce cas, la date de validité est remplacée par le mot « pérenne ».
condition_preservation [texte]	Comment doit être conservé le prélèvement : pièce sèche, milieu humide, pièce/contenant réfrigéré, sans contrainte particulière …
numero_contenant [texte]	Numéro(s) du ou des contenants dans le(s)quel(s) est stocké le prélèvement. S'il y a plusieurs contenants, séparer les numéros par « »« & »« ». Ce(s) numéro(s) doit/doivent être unique(s) dans l'opération tous types de vestiges confondus.
taille_contenant [texte]	Taille(s) du ou des contenant(s) dans le(s)quel(s) se trouve le prélèvement au moment du versement à l'État sous la forme : largeur x profondeur x hauteur ou litre. S'il y a plusieurs tailles, séparer les numéros par « »« & »« ».
poids_volume [nombre]	Poids ou volume du prélèvement.
unité_poids_volume [texte]	Unité de poids ou de volume dans laquelle est indiqué le poids ou le volume du prélèvement. Selon les termes de vocabulaire obligatoires : quintal / kilogramme / gramme ou litre / centilitre / millilitre.
lieu_de_conservation [texte]	Indication du lieu de conservation si le prélèvement n'est pas physiquement remis à l'État

9 - Liens prélèvement – UE, vestiges (vestiges mobiliers, immobiliers mobilisés et anthropobiologiques)

Cette feuille liste les liens qui peuvent exister entre un prélèvement et l'UE, l'objet ou le vestige anthropobiologique dans lequel le prélèvement a été fait.

Les champs *en italique* sont des champs d'informations complémentaires qui ne sont pas obligatoires, mais qu'il serait bon de renseigner si l'information a été recueillie au cours de l'opération.

Il doit y avoir une ligne par prélèvement quand il a été fait sur un objet ou un vestige anthropobiologique.

Il doit y avoir autant de ligne que d'UE présentent dans le prélèvement (donc un même prélèvement peut être documenté par plusieurs lignes).

code_OA_NAT : [texte]	Code complet de l'opération archéologique (n° de la région + n° d'ordre dans la région) généré par la base de données de gestion des opérations archéologiques du ministère de la Culture.
identifiant_prelevement [texte]	Code du prélèvement défini dans la feuille 8 – prélèvement
identifiant_UE [texte]	Code de l'UE défini à la feuille 4 - Unité d'enregistrement Si le prélèvement a été réalisé dans plusieurs UE, le lien à chaque UE doit être défini par une ligne
identifiant_objet-lot [texte]	Code de l'objet ou du lot d'objet défini dans la feuille 6 – Vestiges archéologiques mobiliers de l'opération.
identifiant_VAB [texte]	Code du squelette ou du lot de restes défini dans la feuille 7 – vestiges anthropobiologiques.
informations_complementaires	*Description plus complète sur le lien.* *Ce champ n'est pas obligatoire.*

10 - Étapes des traitements vestiges (vestiges mobiliers, immobiliers mobilisés et anthropobiologiques) et prélèvements

Cette feuille liste toutes les étapes de traitement que les vestiges mobiliers, les vestiges immobiliers mobilisés, les vestiges anthropobiologiques ou les prélèvements ont subies lors de l'opération archéologique, qu'ils soient conservés ou non.

Une étape de traitement est tout ce qui arrive à un vestige ou un prélèvement y compris les temps de stockage dans un lieu défini ou des mouvements.

Les étapes de traitements courantes qui doivent nécessairement être effectués (lavage, étude, conditionnement …) sont à saisir dans cette feuille, de même que toutes les étapes de traitements spécifiques (consolidation, stabilisation ...), marquage, étude spécialisée, et les mouvements, principalement vers divers lieux de stockage, ….

Lorsque plusieurs étapes de traitements sont liées et ont été effectuées sur une durée limitée dans un même lieu ou par une même personne, elless peuvent être considérées comme une seule étape de traitement. Exemple : lavage, comptage, conditionnement // nettoyage, consolidation, collage // …

Les étapes de traitement se suivent en continuité et permettent une traçabilité totale, jusqu'à parfois l'étape ultime qui peut-être le rejet ou la destruction de l'élément considéré (cas des analyses destructrices par exemple).

Pour les prélèvements cette feuille permet de détailler les études qui ont été effectuées sur les prélèvements lors de la phase d'étude et de rédaction du rapport.

Les champs en *italique* sont des champs d'informations complémentaires qui ne sont pas obligatoires, mais qu'il serait bon de renseigner si l'information a été recueillie au cours de l'opération.

Les autres champs sont à renseigner si la donnée est connue.

Il doit y avoir une seule étape de traitement par ligne. Un vestige ou un prélèvement peut avoir plusieurs étapes de traitement.

code_OA_NAT [texte]	Code complet de l'opération archéologique (n° de la région + n° d'ordre dans la région) généré par la base de données de gestion des opérations archéologiques du ministère de la Culture.
identifiant_objet-lot [texte]	Code de l'objet ou le lot d'objet défini dans la feuille 6 – Vestiges archéologiques mobiliers de l'opération.
identifiant_VAB [texte]	Code du squelette ou du lot de restes définie dans la feuille 7 – vestiges anthropobiologiques
identifiant_prelevement [texte]	Code du prélèvement défini dans la feuille 8 – prélèvement.
type_etape [texte]	Type d'étape de traitement ou de manipulation que le vestige ou le prélèvement a subi depuis sa mise au jour : lavage, consolidation, stabilisation, étude spécialisée, marquage, prélèvement pour datation, radiographie … Selon les termes de vocabulaire proposés et pouvant être complétés ; lavage / tamisage / flottation / stabilisation / consolidation / étude spécialisée / marquage / radiographie / datation / ... Tous les produits utilisés lors du traitement doivent être notés ainsi que leur concentration et toutes les informations pouvant être utiles aux interventions futures sur l'objet ou le lot. Exemple : lavage eau + alcool // marquage encre de Chine noire sur une couche de vernis // nettoyage : polarisation cathodique (electrolyte : sulfate de sodium à 2%), protection : vernis résine acrylique (Paraloïd B44) en solution dans l'acétone, cire microcristalline dans le white-spirit // nettoyage mécanique au scalpel, consolidation ponctuelle avec de la colle cyanoacrylate, collage avec de la colle cyanoacrylate // …

identifiant_rapport [texte]	Code qui est donné, dans la feuille 11 – documentation archéologique, au rapport lié au traitement effectué : étude spécialisée, datation …
date_debut_traitement *[date]*	*Date (aaaa/mm/jj) début du traitement.* *Cette information est importante pour les traitements de conservation curative, stabilisation … ou pour les études spécialisées comme les analyse C^{14}, ADN …* *Ce champ n'est pas obligatoire.*
date_fin_traitement *[date]*	*Date (aaaa/mm/jj) de fin du traitement s'il y a lieu.* *Cette information est importante pour les traitements de conservation curative, stabilisation … ou pour les études spécialisées comme les analyse C^{14}, ADN …* *Ce champ n'est pas obligatoire.*
lieu_traitement *[texte]*	*Lieu où a été effectué le traitement.* *Le lieu doit être identifié de manière unique : laboratoire XXX, laboratoire de datation de l'université de XXX ...* *Cette information est importante pour les traitements de conservation curative, stabilisation … ou pour les études spécialisées comme les analyse C^{14}, ADN …* *Ce champ n'est pas obligatoire.*
nom_responsable_traitement *[texte]*	*Nom « » Prénom du responsable du traitement* *Cette information est importante pour les traitements de conservation curative, stabilisation … ou pour les études spécialisées comme les analyse C^{14}, ADN …* *Ce champ n'est pas obligatoire.*
identifiant_lie_au_traitement *[texte]*	*S'il y a lieu, identifiant donné au vestige ou au prélèvement par le responsable du traitement pour la durée de celui-ci.* *Cette information est importante pour les traitements de conservation curative, stabilisation … ou pour les études spécialisées comme les analyse C^{14}, ADN …* *Ce champ n'est pas obligatoire*
informations_complementaires	*Description plus complète sur le lien.* *Ce champ n'est pas obligatoire.*

APPENDIX 3: Agreement to provide anthropobiological remains for the purpose of analysis

Institutions' logo

Agreement to provide anthropobiological remains for the purpose of analysis

BETWEEN:

The state, Ministry of Culture, represented by the prefect of XXX region, at [Regional Directorate of Cultural Affairs, Regional Archaeology Service],

Hereinafter referred to as the '**DRAC**'.

AND:

Mr./Ms. XXX, leader of the research project, at [name and address of the UMR or research laboratory]

Hereinafter referred to as the '**Researcher**'.

The **DRAC** and the **Researcher** are hereinafter referred to collectively as the '**Parties**'.

PREAMBLE:

The **DRAC** is responsible for the management and conservation of anthropobiological remains documented by an archaeological operation performed in its area of jurisdiction, hereinafter referred to as 'anthropobiological remains (**ABRs**)', which represent a non-renewable heritage resource that must be preserved.

For the purpose of the research project that is the subject of the authorization granted to Mr./Ms. XXX, a researcher at YYY, by the regional prefect on XX XX XXXX, which is attached to the present document (Appendix 1), the **Researcher** wishes to perform analyses on the ABRs discovered during the following archaeological operations: [list of relevant archaeological operations].

IT IS AGREED AND DETERMINED AS FOLLOWS:

Article 1 – Purpose of the Agreement

Under the terms of this Agreement, the **DRAC** commits to provide the **Researcher**, in line with the conditions set out in this Agreement, with the ABRs listed in Appendix 2, for a period of [note the number of months, the recommended length is one month] **months from the signing of this Agreement.**

A copy of the report(s) from the archaeological operation(s) associated with the ABRs is to be sent to the **Researcher**, as well as all necessary information required for the research work.

The **DRAC** authorizes the **Researcher** to take samples from the provided ABRs as required by the research project that is the subject of the aforementioned authorization (Appendix 1) attached to this document (Appendix 3).

Article 2 – Non-exclusivity of the provision

The ABRs mentioned in Article 1 are entrusted to the custody of the state, which guarantees their conservation from the time of their discovery.

The **Researcher** expressly acknowledges that this Agreement only grants them a temporary and non-exclusive right to use the ABRs for the purpose of the analyses anticipated in the research project mentioned in Article 1. Under no circumstances can this Agreement be interpreted as conferring upon the **Researcher**, expressly or tacitly, a right of ownership over the ABRs provided.

Article 3 – Conditions for the transportation and storage of the ABRs provided

The ABRs provided by the **DRAC** must be transported by the **Researcher** or by a specialized carrier [or secured package assessed in line with the nature and rarity of the remains] at the **Researcher**'s expense. The **Researcher** bears all risks associated with the transportation and storage of the ABRs.

Article 4 – Uses of the ABRs provided and ownership of the samples

The **Researcher** commits to use the ABRs only as required by the authorized research project. Any other use is subject to the prior written approval of the **DRAC**.

The ABRs cannot be handed over to third parties other than colleagues involved in the research project and working directly under the scientific authority of the **Researcher**. The **Researcher** commits to ensure all colleagues respect this Agreement.

Furthermore, given the specific nature of the ABRs, the **Researcher** undertakes to ensure particular attention is paid to the respect due to human remains when handling them and to only take samples that are strictly necessary for the performance of the planned analyses.

The **Researcher** expressly acknowledges that, given their specific nature, they have no material property rights over the samples from the ABRs that were taken for the purpose of the analyses.

Article 5 – Funding

The **Researcher** is personally responsible for obtaining the necessary funding to carry out the research project.

Article 6 – Obligation to inform

The **Researcher** commits to inform the **DRAC** periodically about the progress of the research. The **Parties** agree that this information will be provided [note the interval, the recommended interval is annually] **from the date on which this Agreement enters into force** in the form of a report

detailing any analyses that have been completed, the results obtained, and the longevity of the funding required for the research project.

Exchanges between the **Parties** conducted in fulfilment of the obligations set out in this Agreement are to be sent to [give the name and contact details of the person designated to monitor this Agreement at the SRA].

Article 7 – Duration

This Agreement is concluded for a duration of [note the number of years, the recommended length is 3 years] **years** from the date on which it is signed, which cannot take place until the funding mentioned in Article 5 has been obtained. Under no circumstances can it be renewed by tacit consent.

Article 8 – Return of the ABRs and treatment of by-products

Upon expiry of this Agreement, the **Researcher** commits to give the ABRs provided for the research project back to the **DRAC** by [note deadline for returning the ABRs].

Upon completion of the research project, the **Researcher** commits to inform the **DRAC** about any by-products created but not used during the project. The **Researcher** also commits to specify where they are stored so that other researchers can, where applicable, submit a request to use these by-products.

Article 9 – Guarantees and responsibilities

The **DRAC** gives no guarantee regarding the analytical potential of the ABRs provided and the samples taken therefrom.

The **Researcher** is solely responsible for all risk or damage arising from the execution of this Agreement, in particular when handling the ABRs and analysing the samples.

The **Researcher** remains responsible for the conservation of the ABRs for the duration of this Agreement in the event of total or partial destruction or damage due to natural causes or to a third party and, particularly, in the event of loss, theft, fire, flood, or gas explosion. The **Researcher** is bound by a best-efforts obligation and is only liable in the event of gross negligence or deliberate fault.

Article 10 – Results and publications

In addition to periodic reports on the progress of the research project, the **DRAC** is to be kept informed about the publication of data concerning the ABRs. A final report on the work carried out is to be submitted to the **DRAC**.

This report must contain three sections: the first section presents the administrative, technical, and scientific data relating to the operation; the second describes the operation and its results in detail; and the third presents the inventories of scientific data pertaining to the operation. The content of this analysis report is laid out in detail in Appendix 4. This report and any information

about the publication of data are to be submitted to the **DRAC** no later than [indicate the time allowed in letters and figures] months after the expiry or termination of this Agreement.

It should also be noted that this report constitutes an administrative document that can be shared with the public once it has been submitted to the Direction régionale des affaires culturelles de Normandie (Regional Directorate of Cultural Affairs of Normandy) or other competent services as stipulated in articles L.300-1 and following of the Code des relations entre le public et l'administration (CRPA) (Code of Relations Between the Public and the Administration).

Article 11 – Automatic termination

This Agreement terminates automatically on expiry of its term, or on completion of the research project if earlier.

This Agreement also terminates automatically if the **Researcher** does not obtain the funding needed to carry out the research project within a year from the provision of the remains. This period can be extended by one year at the **Researcher's** request upon production of solid justification and a commitment to obtain funding the following year.

Article 12 – Termination for breach

This Agreement can be terminated by the **DRAC** in the event that the **Researcher** fails to fulfil one or more of the obligations stipulated in one of its clauses.

This termination will take effect **two (2) months after the DRAC has sent a letter by registered mail** setting out the reasons for the termination, unless the **Researcher** fulfils the obligations or provides proof of an impediment constituting force majeure within this time period.

Nevertheless, if this Agreement is terminated because the research project authorization granted to the **Researcher** by the **DRAC** has been withdrawn, the termination will take effect immediately upon receipt by the **Researcher** of the letter sent by registered mail notifying them that authorization has been withdrawn.

Notwithstanding the exercise of this right of termination, the **Researcher** is under no circumstances exempted from fulfilling their contractual obligations until the termination takes effect.

Article 13 – Personal nature of the agreement

This Agreement is made personally with the **Researcher** and cannot be transferred to a third party under any circumstances.

Article 14 – Applicable law and jurisdiction

This Agreement is subject to French laws and regulations.

In the event of a dispute between the **Parties** regarding the execution of this Agreement which the **Parties** are unable to resolve amiably, the dispute will be referred to the competent French administrative jurisdictions.

Article 15 – Language of the agreement *(only for agreements with foreign co-contractors)*

This Agreement exists in a bilingual version, in French and English. In the event of any difficulty of interpretation, only the French version is valid. *[Negotiation possible for both versions to be valid]*

Signed at ….. on ……

In 2 original copies

Appendices:

- Appendix 1: Decree authorizing the **Researcher** to carry out the analysis project
- Appendix 2: List of ABRs covered by this Agreement
- Appendix 3: **Researcher's** research project
- Appendix 4: 'Decree report' defining the detailed content of the analysis report

APPENDIX 4: Template form for tracking anthropobiological remains from excavation in the field to analysis and the identification of residues and by-products

1 –Documentation of remains during the operation	
1.1 – Documentation of provenance	
Reference code of the operation (Code OA)	
Name of the region	
Name of the department	
Name of the municipality and site	
Type of operation	
No. of the operation decree	
Name of the scientific coordinator of the operation	
Affiliated institution of the scientific coordinator of the operation	
Date of the beginning and end of fieldwork	
1.2 – Documentation of anthropobiological remains	
ID number of the object	
ID number of the recording unit of provenance	
Categorization (type of bone)	
Information on cleaning: Has the object been cleaned? What with?	
Conservation recommendations	
Place where the object is stored	
Photograph before excavation	Photograph after excavation
1.3 – Documentation of conservation work (fill in separately for each instance)	
Date of the work	

Products used (identify solvents)	
Any material that came into contact with the object during the conservation work	
2. Documentation of the sample	
Date of sampling	
ID number of the sample	
Sampling protocol used	
Name and role (archaeologist, archaeoanthropologist, 'analyst', etc.) of the person who took the sample	
Any material that came into contact with the object during sampling	
Planned analyses	
Conservation recommendations	
3. Documentation of the analysis (if applicable, fill in separately for each analysis performed on the sample)	
3.1 – Administrative documentation of the analysis request and analysis site	
Name of the analysis requester	
Affiliated institution of the analysis requester	
Date and number of the SRA authorization	
Signing date of the agreement to provide anthropobiological remains for the purposes of analysis	
Name and address of the laboratory where the analysis will be performed (if different from the requester's affiliated institution)	
Name of the person who will perform the analysis if different from requester	
Start date	
If applicable, anticipated date for returning the sample	
Mode of packaging and wrapping	
3.2 - Documentation of analyses performed (fill in separately for each analysis)	
Type of analysis performed	

Treatment(s) performed on the sample	
Material(s) and/or method(s) used to carry out the analysis	
DOI of the article where results are presented and/or title and number of the analysis report	
Summary of the analysis result if unpublished (for negative results, explain why the analysis was unsuccessful)	
Access link(s) or archive call number for raw data	
Presence of residues (yes/no)	
Storage location of residues and other products that can be reused, indicating for what type of analysis	
Details about how residues and other products are stored	

Appendix 5: Recommendations for scientific specifications for an operation involving analysis of ABRs

L'application des préconisations du groupe de travail PAOHCE amènerait leur prise en compte dans les cahiers des charges d'opérations de fouilles préventives ou bien à titre de simples prescriptions adossées à une autorisation d'opération programmée.
De telles préconisations ne doivent bien sûr pas être systématiquement mises en œuvre. Leur intérêt doit être justifié au regard des données du diagnostic préalable à la fouille et des problématiques qu'il a fait émerger. Ces préconisations portent sur 7 points principaux :

1- Projet d'analyses et collaboration avec un laboratoire d'analyses spécialisé

1.1. Analyses paléogénétiques/isotopiques

Dans leur offre, l'opérateur et les laboratoires qu'il aura sollicités devront faire la démonstration de l'adéquation de leur projet avec le cahier des charges. A cet effet, il est recommandé d'encourager l'implication des spécialistes des laboratoires correspondant dès le montage du projet scientifique de l'opération.

Le projet d'intervention sur les VAB et plus précisément son protocole de prélèvement et d'analyses figureront dans le projet plus global d'opération présenté par l'opérateur/le responsable d'opération. Il paraît nécessaire que ce projet d'intervention comporte :

- L'identité du porteur de projet d'analyses (ADN, isotopes) ;
- La problématique particulière à ces analyses ;
- Le bilan perte de matière/bénéfice scientifique en tenant compte de la représentation des parties anatomiques ;
- Les aptitudes du ou des porteurs de projet ;
- La méthodologie employée et la quantité prélevée pour chaque échantillon ;
- Le nombre prévisionnel d'échantillons analysés et les régions anatomiques concernées (ces informations pourront donner lieu à des prescriptions complémentaires au cours de l'opération archéologique au vu des résultats produits) ;
- Les éventuelles mesures de sauvegarde des VAB en cas d'analyses destructives *(*selon les cas, photographies, macrophotographies, photogrammétrie, micro-scans 3D, moulages par imprimante 3D, …) ;
- Les modalités de restitution et de publication des données ;
- L'engagement du porteur de projet sur la restitution de la part des échantillons non utilisés.

Le protocole de prélèvement et d'analyses n'est pas unique : il pourra être adapté au corpus d'étude selon la rareté du matériel, les objectifs recherchés et les conditions de la fouille.
Dans le cas du préventif, à moins d'avoir une connaissance précise des teneurs en matière organique des os, il semble difficile de déterminer a priori le nombre d'analyses à programmer sur des sujets complexes impliquant des analyses multiples. Il est préférable de formuler des objectifs scientifiques précis dans le cahier des charges et d'examiner a posteriori si les propositions des opérateurs et labos répondent à ces attentes.
Le choix de l'équipe de recherche portant le projet d'analyses sera fait sur proposition de l'opérateur ou du responsable de l'opération et l'étude anthropologique devra être validée par le conservateur régional de l'archéologie (mais ce dernier point n'a pas lieu d'être précisé dans le cahier des charges).

1.2. Datations radiocarbone

Les datations par le radiocarbone devront être réalisées par un des laboratoires pratiquant l'intercomparaison (liste publiée par la revue Radiocarbon).

2- Convention de mise à disposition des VAB (hors préventif)

Il paraît utile de rappeler qu'une convention de mise à disposition des VAB serait mise en place, si nécessaire, entre la DRAC-SRA et le porteur de projet. Cette convention définirait les conditions générales d'utilisation des VAB : notamment durée de la mise à disposition, conditions de transport des échantillons, information de la DRAC-SRA de l'avancement des travaux, restitution des reliquats d'échantillons non utilisés et devenir des produits intermédiaires.

La mise en place de ce type de convention ne concernerait pas les analyses effectuées dans le cadre de fouilles préventives. Quelques points peuvent néanmoins être clairement précisés dans le cahier des charges (et par conséquent dans le projet scientifique et technique de l'opérateur) : l'engagement du laboratoire d'analyses sur la restitution des reliquats ou sur la diffusion des données brutes, éventuellement la durée de la mise à disposition des VAB pour analyses.

3- Mesures de précaution lors de la fouille et traitement des échantillons destinés à des analyses paléogénétiques

Il paraît nécessaire de vérifier que le protocole de fouille vise à l'optimisation des analyses effectuées sur les VAB. Celui-ci doit permettre de limiter au maximum les risques de contamination et de dégradation du potentiel analytique (notamment paléogénétique).

Pour les structures concernées par le programme de prélèvement pour analyse paléogénétique, il est en particulier demandé d'appliquer le protocole offrant le plus de garanties à ce sujet : utilisation par le fouilleur d'un masque, d'une charlotte et de gants ; nettoyage des outils et des gants à l'eau de javel chaque fois qu'ils ont touché leur corps ou celui d'une autre personne ou un objet (téléphone, seau, bouteille, etc.).
Une fois que l'os est dégagé du sédiment, il est recommandé de le mettre dans un sac en papier ou en plastique neuf, si possible avec une fraction du sédiment qui l'entourait et de le garder dans un endroit frais et sec, voire dans un réfrigérateur ou un congélateur. Il faut garder ouvert le sac en plastique pour éviter la prolifération de micro-organismes qui sont des agents de la destruction de l'ADN. Dans tous les cas, il est demandé de ne pas rompre la chaîne du froid lors du transfert vers le laboratoire d'analyse ou vers la structure d'étude ou de conservation.

Le protocole pourra varier dans le détail selon les préconisations du laboratoire d'analyse partenaire.

Aucun traitement des échantillons avant analyse microbiologique (lavage, imprégnation, collage) ne doit avoir lieu. Concernant les analyses isotopiques, seul le lavage à l'eau est autorisé.

4- Mesures pour la conservation des VAB durant le post-fouille

Durant le post-fouille, l'ensemble du matériel anthropologique, y compris celui ne donnant pas lieu à des analyses paléogénétiques, doit être conservé dans des conditions fraîches et sèches et sans variation de température.

5- Le prélèvement (tests, quantité maximale et partie anatomique)

Un point central de ces prescriptions concerne l'économie de la ressource osseuse. Les prélèvements doivent être effectués afin de minimiser le poids de matière osseuse prélevée et afin de préserver le potentiel des restes osseux pour de futures analyses (particulièrement celui des vestiges dentaires et des os pétreux).

Dans le cas d'analyses multiples et croisées (paléogénétiques/isotopiques/datations radiocarbone ou autres), on visera surtout (dans la mesure du possible) la mutualisation des prélèvements afin de limiter l'impact sur la ressource osseuse (le projet scientifique devant préciser les régions anatomiques concernées).

Dans le cas d'analyses paléogénétiques, des tests d'extraction du collagène et du séquençage de l'ADN seront entrepris le plus tôt possible, si possible dès le diagnostic ou, au plus tard, dans les premiers instants de la fouille, afin de cerner précisément la pertinence de la mise en œuvre de ces analyses.

Dans le cas de la réalisation d'une série de datations ^{14}C, les datations doivent porter préférentiellement sur les parties compactes d'os pairs (si possible phalanges) ou des côtes (on évitera le crâne et la mandibule). Les échantillons devront être répertoriés dans l'inventaire des restes osseux et examinés préalablement par un anthropologue afin d'éviter la destruction éventuelle de vestiges pathologiques.

6- Fiche d'inventaire et de suivi, diffusion des résultats

L'inventaire des VAB intégré au rapport d'opération (fiches de sépulture ou bien inventaire des pièces osseuses dans le cas d'un ensemble funéraire déconnecté) doit comporter un volet décrivant les traitements auxquels les ossements auront été exposés pendant et après la fouille, ainsi que la liste des prélèvements effectués. Les analyses engagées après la remise du rapport devront se référer à ces inventaires (le contenu détaillé de l'inventaire des VAB sera précisé par arrêté, projet en cours de refonte).

Un tableau récapitulatif présentera toutes les datations au radiocarbone et les fiches de laboratoire seront également présentées en annexe.

Cette documentation doit permettre par la suite :

— de savoir que le vestige a été l'objet d'une analyse et d'accéder à ses résultats (en cas d'analyse non destructive, d'accéder aux fragments encore conservés) ;

— de comprendre que l'absence d'un élément particulier est liée à cette analyse et non pas à une absence dès la fouille du fragment considéré.

— le cas échéant, la fiche de suivi indiquera la localisation des produits intermédiaires (notamment les reliquats de collagènes non utilisés) et stockés par le laboratoire d'analyses.

Les mesures issues des analyses devront être communiquées dans un format d'exploitation standard ou déposées sur une banque de données publique.

Il est également recommandé que le cahier des charges de l'opération précise la forme sous laquelle on souhaite que les données brutes soient transmises (données elles-mêmes ou lien à un site de stockage numérique).

7- Reliquats et surplus

L'existence de surplus d'échantillons ou de produits intermédiaires mérite d'être prise en compte dans le cahier des charges. Au terme de l'analyse, le laboratoire d'analyses doit éventuellement s'engager à restituer à la DRAC les VAB mis à disposition dans le cadre de son projet de recherche et non utilisés, conformément à la convention de mise à disposition évoquée ci-dessus et préconisée par le groupe de travail. A l'issue du projet de recherche, le Chercheur informe la DRAC des produits intermédiaires constitués, mais non utilisés dans le cadre du projet de recherches. Il en précisera le lieu de dépôt.