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Defining bone movement in archaeological stratigraphy: a plea for clarity

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Abstract

In this paper a terminology for the description of the movement of animal bone in archaeological stratigraphy is proposed and discussed. It is suggested that the terms 're-deposition' and 'residuality' are adopted to describe movement of bone from earlier to later levels, and 'intrusion' and 'contamination' to describe movement from later to earlier levels. While 're-deposition' and 'intrusion' generically indicate movement of bones between different places and layers, 'residuality' and 'contamination' more specifically imply that the bones were found in a phase that was different from the one they were originally deposited in. Consequently, while 're-deposition' and 'intrusion' describe actual physical events, 'residuality' and 'contamination' represent analytical constructs, entirely dependent on the way archaeological phasing is designed. It is suggested that, whether such terminology is adopted or not, zooarchaeologists should be more explicit about the meaning of the concepts they use to describe animal bone movement, and that they also make them as relevant as possible to broader archaeological concerns, rather than merely borrowing from the palaeontological tradition.

Keywords

Animal bone, taphonomy, re-deposition, residuality, intrusion, contamination

Introduction and definitions

Animal bones found during excavations were the subject of a long history of taphonomic modifications, beginning at the moment they were initially deposited up to the time of their recovery. Such modifications can potentially alter the physical and chemical nature of the bone tissue but may also lead to movement of the bones. This can be very variable in its nature, including horizontal transportation of the bones from one area of the site to the other, vertical movement through the archaeological stratigraphy, as well as a combination of these phenomena.

This paper is concerned with the way we *define* such movements of animal bones and, particularly, with an analysis of the taphonomic implications that are associated with the application of such definitions. In other words, the paper is not so much concerned with the provision of the ultimate definitions, but rather with a reflection on the nature of the phenomena that such definitions imply, and their use for archaeological interpretation.

The four terms mentioned below represent useful concepts in zooarchaeology (and beyond), but they can benefit from clarification. In the rest of this paper the following definitions will be used, clarified and discussed (key terms in italics):

- Re-deposited bone: Found in a *place* different from the location of the bone initial *burial*

- Residual bone: Found in a *phase* that is *later* than the one the bone originally belonged to

- Intrusive bone: Found in a stratigraphic *layer* that accumulated *earlier* than the one the bone originally belonged to.

- Contaminant bone: Found in a *phase* that is *earlier* than the one the bone originally belonged to.

What is the problem?

A clarification of the taphonomic history of a bone assemblage is essential for archaeological interpretation. Although initial studies in taphonomy date back to the 19th century (Stiner 2008), Efremov (1940) is generally credited as the first scholar to have defined and described the term, and he did so in the context of palaeontological studies. He proposed the creation of "a new branch of palaeontology" (Efremov 1940, 85), which is mainly concerned with the study of the process of embedding vertebrate remains in the geological record. In his much quoted definition he states that "the chief problem of this branch of science is the study of the transition (in all of its details) of animal remains from the biosphere to the lithosphere". Eventually he proposed to call this new branch of science 'taphonomy'. Efremov's definition is fairly vague and has been subjected to various interpretations, critically reviewed by Lyman (2010). There are some indications in Efremov's paper that he regarded the taphonomic process to begin with the living organism (for instance through his reference to the relevance of palaeopathological studies to taphonomy), and inclusive of the stage between death and burial. This stage is crucial in archaeology as it includes both animal and human-induced modifications of the bones (gnawing, butchery, cooking, etc.), which are obviously of archaeological interest, and are sometimes defined as 'biostratinomy' (Gifford 1981, 367). This paper is, however, only concerned with the later biostratinomic stages (between discard and burial), but especially with post-burial phenomena, in palaeontology generally defined as 'diagenesis' (Efremov 1940, 84).

To understand what kind of movements bones have been subjected to since their initial deposition is essential in order to interpret the evidence in its appropriate chronological and spatial context. It is not uncommon in zooarchaeology to see assemblages interpreted as if they represented frozen moments of the past – almost in a Pompeii style – but the reality is often more complex.

Activity areas, for instance, can only be identified as such if there is direct evidence that the bones were uncovered in the same place where they had primarily been discarded, an uncommon situation in archaeology.

It is therefore important for us to investigate bone movement and to use a terminology associated with it that is clear and, ideally, widely used. The current situation is, however, unsatisfactory, not only because multiple terminologies are adopted but also due to a widespread confusion regarding which processes are implied by the used concepts. Among the terms defined above, common is the confusion between 're-deposition' and 'residuality', to the extent that 'residuality' in not even conceived of as a separate concept in some scholarly traditions (details below), with the inevitable confusion that such omission generates.

The impetus behind this paper derives mainly from an urge to introduce the concept of 'residuality' to the core of discussions about bone taphonomic histories, and raise awareness of its important interpretive value in archaeology. This concept, however, cannot properly be discussed without an evaluation of the associated terms: 're-deposition', 'intrusion' and 'contamination'.

The zooarchaeological literature has, surprisingly, neglected the issue, with 'residuality' (or any similar process given with a different name) not even mentioned in the major zooarchaeology textbooks (e.g. Klein and Cruz-Uribe 1984; Davis 1987; O'Connor 2000; Reitz and Wing 2008), not even those particularly focused on taphonomy (Schiffer 1987; Lyman 1994). The issue is briefly touched upon in O'Connor's (2003, 87-88) handbook for the study of urban animal bone assemblages but, significantly, the work takes for granted that the adopted terms (re-deposition, residuality, etc.) do not require explanation. This is an assumption probably made – perhaps too hastily - on the basis of the familiarity of these concepts to British archaeologists. In recent guidelines to the study of animal bones published by English Heritage (2014, 18-19) 'residuality' is mentioned, but only in terms of the fact that it needs to be evaluated before an 'assessment' of an animal bone assemblage is carried out. The term is neither explained nor discussed. A plea for references about residuality, published on the email discussion list ZOOARCH (ZOOARCH archives 28.09.2001 https://www.jiscmail.ac.uk/cgi-bin/webadmin?A0=ZOOARCH), produced little response. Discussion in the same outlet a few years later (ZOOARCH archives 27.09.2006) highlighted the fact that the term, or indeed the concept, is not used in the American literature, as confirmed by a trawl of the literature and feedback received on the occasion of the oral presentation of this paper at the ICAZ 2014 conference in San Rafael (Argentina).

In contrast to its poor coverage in the academic literature, the concept of 'residuality' is well known to field archaeologists and frequently used by zooarchaeologists – particularly in Britain – working on developer-funded projects. English Heritage guidelines to the Management of Archaeological Projects (English Heritage 1991, 17) insist on the need to evaluate 'residuality' to assess stratigraphic integrity and, therefore, the research potential of an assemblage. This of course applies to all types of archaeological finds, rather than just animal bones. The issue has received some occasional attention in the archaeobotanical literature (Green and Lockyear 1993) and more substantially so in ceramic studies (Evans and Millett 1992; Vince 1995). The latter is not surprising, as artefacts that can be more easily dated than bones, such as pottery, are more likely to be spotted when found in the 'wrong' stratigraphic phase. This may occasionally be the case for animal bones - for instance the occurrence of the bone of a certain species found in a stratigraphic phase dated to a period when the species was regarded to have been long extinct – but it does bear the rather obvious risk of a circular argument.

There can be little question that a clarification of the concept and its discussion at an international level should be beneficial for the refinement of our terminologies and the creation of a vocabulary of animal bone movement across archaeological stratigraphies that is better understood by all. To achieve this objective it is necessary to go back to the definitions provided above and discuss in greater detail how and why these different concepts should be treated distinctively.

Differences between re-deposition and residuality

To investigate the concepts of re-deposition and residuality further, it may be useful to consider some hypothetical examples (Fig.1). Let us assume a certain archaeological stratigraphy and that a bone became originally deposited in a context within Layer G. Contemporaneous or almost

contemporaneous human digging activity may lead to movement of soil that causes this bone to be moved from its original location to pit F. The archaeologists will not find the bone in its original location, thus the bone may be regarded to have been 're-deposited'. It is important here to note that, although the bone is found in a different place from its initial deposition, it is still attributable to the same phase.

Fig.1 also presents a different potential scenario. That same bone is the subject of later disturbance, and digging caused by human activity led to it being moved to layer E. Clearly this bone can still be defined as having been 're-deposited', according to the definition provided above (it *is* found in a different place from its original deposition), but there is more to it than in the previous example. The bone is now in a different *phase,* with all the very important consequences for archaeological interpretation that this situation implies. This bone is, according to the definition above, 'residual'.

What becomes clear therefore is that a residual bone is also necessarily re-deposited, which is one way to say that residuality is one form of re-deposition. The opposite is, however, not the case – a re-deposited bone is not necessarily residual, as we have seen in the example above.

Dobney et al. (undated) have the merit of having tried to tackle the issue of residuality in zooarchaeology in their study of the animal bones from Lincoln (England). The problem, unfortunately, is that they tried to match residuality in pottery – as detected through the comparison of typologically-based ceramic chronologies and stratigraphy – with what they believed to be 'residuality ' in animal bones. As I pointed out at the time (Albarella 1998) they were, however, using measures of re-deposition (such as battering of the bones or degree of angularity of the fractures), to assess residuality. It is, therefore, not surprising that their evaluations of the degrees of 'residuality' in bones and pottery did not match each other at all. In a slightly later publication (Dobney et al. 1997) the problem is somewhat acknowledged, but the core issue remains unresolved and unclarified.

What is important to point out is that a bone can be re-deposited many times – with all the damage that generally follows – and still not be residual. One single re-deposition event may, however, be sufficient to make that bone residual – and this event may not necessarily lead to any particular evidence of battering on the bone. It is, therefore, essential that measures of re-deposition are *not* used to assess residuality, as this may lead to misleading results.

The nature of residuality

Residuality allows us to assess the chronological integrity of archaeological assemblages and as such it represents an important analytical category in archaeology. It is worth exploring further the nature of this concept by using a slightly different version of the example provided above. In the case presented in Fig.2 it is hypothesised that the bone originally deposited in layer G is re-deposited in pit F, exactly as in the first example (Fig.1). What has changed now is, however, the phasing of the site. The archaeologists have decided that there are sufficient differences between layer G and pit F to attribute them to distinct occupation levels, and split Phase 2 into two sub-phases. Consequently, the same bone that in the previous example was merely re-deposited, has now become residual, as it no longer belongs to the same phase as that of its initial deposition. It is important to pay attention to the fact that the actual physical event has not changed, but its interpretation has.

It should by now be clear that while re-deposition represents an *actual event* - bones are physically moved by agents such as scavengers, humans or various natural forces (water, soil, wind) – residuality is an *artefact* of archaeological interpretation, and it is dependent on the phasing established for a given site/assemblage. In other words, residuality can be considered to be a mere *analytical construct,* but not for this any less important in archaeological interpretation.

The extent to which residuality is dependent on our choice of analytical categories cannot be emphasised enough. Zooarchaeologists will be used to the fact that, in order to compromise between sufficient sample size and a reasonable chronological refinement, their data can be grouped in a variety of different ways. An example taken from later Prehistoric Greek chronology may help in clarifying the issue. A bone originally deposited in a late Helladic IIIA level but found in a late Helladic IIIB level *is* residual (note that the late Helladic is approximately equivalent to a late Bronze

Age). That same bone, however, will no longer be residual if the late Helladic, as a whole, is compared to the Geometric period (i.e. Iron Age).

There are also other potential variables that need considering. It is, for instance, possible that the zooarchaeologist will decide that, in terms of taxonomic quantification, it is possible to carry out a comparison between the Late Helladic IIIA and IIIB periods. For the reasons mentioned above such comparison will (detrimentally) be affected by the issue of residuality. It is, however, possible that in terms of, say, ageing and biometrical analysis, a decision will be made that the two late Helladic periods are combined to obtain a sufficient sample size, and are then compared as a single group with the Geometric period. The residuality of that particular bone will therefore cease to be an issue according to this type of analysis. Such situations are indeed very common in zooarchaeology and may benefit from a better, and more explicit, awareness of the processes involved.

The examples above should have already provided an answer to the frequently posed question of whether residual bones possess any heuristic value. The only possible answer to that question is that it depends on the analytical categories that we choose. Residuality, by complicating, if not obstructing, chronological attribution unquestionably diminishes the interpretive potential of archaeological bones. If sufficiently broad chronological groups are considered, the effect of residuality can, however, be overcome, in some cases even to the point that the issue becomes irrelevant to (some) archaeological interpretation.

Having clarified that indicators of re-deposition should not be used to estimate residuality, the 'elephant in the room' remains the question of whether we have any way to measure residuality. This represents a complex issue, whose full discussion goes beyond the scope of this paper. It is sufficient here to say that, beyond using direct dating of the bones (e.g. through ^{14}C), the problem remains hitherto unresolved. In fact even radiocarbon dating can only help if the archaeological phases in question are sufficiently chronologically distinct for that difference to be identified by such a technique. The use of parallel evidence from commingled artefacts, such as pottery, can be useful, but it has its own problems (Evans and Millett 1992), such as the assumption that the degree of bone and pottery accumulation in different phases is consistently proportional. A full solution is unlikely to be ever found, but a mitigation of the problem will probably need to rely on the investigation of multiple lines of evidence, including artefacts, soils, taphonomic patterns, direct dating and the bones themselves.

The boundaries of re-deposition

To provide a more complete overview of the concepts under discussion, it is necessary to go back to an issue on which I have so far glossed over and that refers to my definition of 're-deposition'. At the beginning of this article emphasis was placed on the word 'burial', without this choice having been defended; however, this has important interpretive implications and requires further clarification.

It would have been conceivable to consider re-deposition as the movement of the bone from the place of first *discard,* rather than *burial*. Let us assume that some bones became accumulated on a rubbish tip in a given area of the site. A scavenger, such as a dog, starts interacting with them, chewing them and eventually moving them to another area of the site, where they become buried and eventually, after centuries or millennia, found by archaeologists. Should such bones be regarded as 're-deposited'? According to the definition provided in this paper the answer is 'no', as the bones were not yet buried, thus becoming easily accessible to scavengers (or even humans), who moved them around the site. If we had opted for the word 'discard' rather than 'burial' then the answer would be 'yes', as clearly the bones ended up in a place different from the one of the original discard.

The reason why I consider the concept of 'initial burial' more appropriate is that activities that occur more or less contemporaneously to the original use of the bone, should be regarded as 'primary', with the diagenetic history of the bone only beginning when this is buried. Dogs running around the settlement or people chucking down refuse from a rubbish tip to a ditch represent site activities that we should attempt to reconstruct and understand as behavioural patterns, rather than mere taphonomic biases. My definition of re-deposition is therefore in line with what Landon (1992, 356) chooses to call "tertiary deposition".

This choice has some important implications:

- Bones in articulation, as well as unfused diaphyses and epiphyses found together, can be regarded as indicators of primary deposit. After the death of an animal and the removal (or deterioration) of the flesh, tendons can keep bones together for weeks, if not months. During this period they can be moved around a site – for instance by scavengers – repeatedly, but if they are found in articulation only a limited amount of time will have passed between the death of the animal and the burial of the bone. Since articulation indicates that no further movement occurred after initial burial – which would have been inconsistent with them to be found in anatomical connection – they can be regarded as in primary deposit.
- Bones in primary deposit are not necessarily found in the exact spot where the human activity that led to their discard occurred (see also Schiffer 1987, 199-200). This has important implications for zooarchaeological interpretations of issues such as activity areas, household refuse, and the use of specific site features. We must be careful because even articulated bones can be found some distance away from the original place a certain animal had been slaughtered, butchered and/or consumed.

Intrusion and contamination

Most of the vertical bone movement discussed so far occurs from bottom to top, with earlier material infiltrating later sediments. It is, however, also known that bones can migrate in the opposite direction – from top to bottom – which means that material of later date will be found in stratigraphic layers that accumulated at earlier times. Such bone movement is rarely caused by human activities and more commonly occurs as a consequence of the fall of (generally small) material along fissures naturally occurring in the sediment, or as a consequence of the action of burrowing animals, such as moles, rabbits and badgers. The growth of plant roots, certainly trees, may also push bones towards earlier levels. As suggested in the Introduction, the occurrence of bone in earlier stratigraphic layers can be defined as 'intrusion'.

Although 'intrusion' indicates the translocation of bones in a broadly opposite direction to re-deposition and residuality, it cannot be regarded as the mirror image of either, as the dynamics leading to it are generally different. What 'intrusion' shares with the other concepts is that the bones are not found in the place of initial burial or deposition and they end up being deposited in the 'wrong' layer, sometimes substantially so, as gravity may make the bones travel fairly rapidly across the stratigraphy.

Intrusive bones may or may not end up in an archaeological phase that is different from the one in which the animal they belonged to lived. However, provided that a corridor has been open through the stratigraphy, the likelihood for a bone to become deposited in an earlier phase appears to be high. Intrusive bones can be 'modern' but they may also be the consequence of movement from one archaeological phase to the other. When intrusive bones originate from animals that had died relatively recently they can sometimes be recognised as such due to their fresh appearance and their lack of substantial staining from the sediment minerals. In most other cases it is difficult, if not impossible, to spot intrusive bones, though the stratigraphic identification of animal burrows or heavily bio-turbated sediments can at least ring an alarm bell.

In the same way as the 'residual' category was distinguished within the more general concept of 're-deposition', it is useful to define a category within the concept of 'intrusion' that characterises a bone that has ended up in the wrong 'phase' and to which the same proviso discussed for residuality should apply. It is suggested that another term, often used in archaeology, that of 'contamination', is applied to intrusive bone found in a phase that is different from the one they originally belonged to. As in the case of residuality, intrusive bone will, or will not, be 'contaminant' according to the way the phasing of a site is arranged by the archaeologists. The fairly frequent occurrence of modern material in archaeological deposits suggests that contamination represents a common phenomenon, though it may be archaeologically undetectable if a bone has intruded from another archaeological layer.

Conclusions

It is proposed that a clearer and more explicit terminology is used to describe the vertical (and sometimes horizontal) movement of animal bones across archaeological stratigraphy. The following four terms are proposed:

- Re-deposition
- Residuality
- Intrusion
- Contamination.

The terms have been defined in the Introduction and their characteristics are summarised in Table 1.

	In a different place/layer	In a different phase	Bottom-up*	Top-down*
Re-deposition	X	(X)	X	
Residuality	X	X	X	
Intrusion	X	(X)		X
Contamination	X	X		X

Table 1

None of these terms are new in archaeology, but the purpose of this paper is to clarify their definition to facilitate wider and more consistent application. More important than the choice of certain terms is, however, the discussion behind their use. Though a common terminology can help communication, what is essential is to have a complete understanding of the questions that are being discussed and to develop a vocabulary that is adequate to describe them.

In the zooarchaeological context it is also important that the terminology, as well as its explanation, is adequate in dealing with real archaeological problems. Perhaps too often zooarchaeologists have adopted a vocabulary as well as an approach to taphonomy that is borrowed from palaeontology (e.g. Lyman 1994) and, as such, is not necessarily ideal in dealing with the problems and concerns of the archaeologist. Lyman (2010) is certainly right in advocating the need for archaeologists not to alter the original concept of taphonomy as defined by a palaeontologist (Efremov 1940) as such terminological confusion may also lead to a lack of analytical accountability. However, there is much more to taphonomy than its original definition, and archaeologists need to emphasise the components that are more appropriate to interpret their own body of evidence. The development of an approach that is more strictly archaeological can also be beneficial in improving the level of collaboration between field archaeologists and zooarchaeologists. It also has the potential of letting zooarchaeologists lead the way in providing the correct framework of reference to an issue that is significant well beyond the study of animal remains, and should indeed be of relevance to all archaeological materials.

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Captions

Table 1 A summary of the main characteristics of the concepts discussed in this paper and associated with bone movement across archaeological stratigraphy. Brackets indicate that those criteria do not always apply. *It needs to be noted that re-deposition and residuality may also occur through horizontal movement. Although it is here assumed that an archaeological stratigraphy will be vertical, human activity and tectonic movements may make it largely horizontal

Fig.1 A model of archaeological stratigraphy illustrating two potential movements of a bone from the area of its original deposition. The two possibilities lead to re-deposition (from G to F) or residuality (from G to E)

Fig.2 A similar model to the one illustrated in Fig.1, but in this case movement of the bone from G to F leads to residuality due to site re-phasing