

# What is the significance of the materials of Upper Paleolithic Era artifacts across Europe?

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## Introduction

The Upper Paleolithic Era is marked by the creation and usage of personal ornaments, visual art, projectile weaponry, and objects made using fire among *Homo sapiens* (Shea et al., 2014). Expanding upon our understanding of this time period, archaeologists have gathered data on the materials used to make these personal objects and tools, the study of which is heavily impacted by preservation of the objects within the archaeological record. This report explores the following questions using data from Dutkiewicz et al. (2020), in response to these lines of inquiry: What materials were symbolic pieces most commonly made out of, and how did the chosen material affect their preservation level?

## Data

```
library(tidyverse)

my_data <- read.csv("signBase_Version1.0.csv")
```

```
# clean the data
my_data_clean <-
my_data <- read.csv("signBase_Version1.0.csv")
```

```
# inline r code
how_many_countries <- nrow(my_data_clean)

how_many_objects <-
my_data %>%
  pull(`object_type`) %>%
  unique() %>%
  length()

how_many_materials <-
my_data %>%
  pull(`material`) %>%
  unique() %>%
  length()
```

The artifacts in this data set were collected from 531 countries, while 23 types of objects were excavated consisting of 15 different types of articles (Dutkiewicz et al., 2020).

```

library(rcarbon)
library(ggbeeswarm)
library(cowplot)

signbase_full <- read_csv("signBase_Version1.0.csv")

# clean up and separate the radiocarbon age data so we can use it
signbase_years <-
  signbase_full %>%
  drop_na(date_bp_max_min) %>%
  mutate(date_bp_max_min = str_replace_all(date_bp_max_min, "\\+\\|\\-\\-", "\\±")) %>%
  mutate(date_bp_max_min = str_replace_all(date_bp_max_min, "\\+", "\\±")) %>%
  separate(date_bp_max_min,
           sep = " - ",
           c("date_bp_max", "date_bp_min"),
           remove = FALSE) %>%
  mutate(date_bp_max = ifelse(str_detect(date_bp_max, "\\|/"),
                             str_extract(date_bp_max, ".*(?=\\|/)",
                             date_bp_max)) %>%
  mutate(date_bp_min = ifelse(str_detect(date_bp_min, "\\|/"),
                             str_extract(date_bp_min, ".*(?=\\|/)",
                             date_bp_min)) %>%

  separate(date_bp_max,
           sep = "±",
           c("date_bp_max_age",
             "date_bp_max_error")) %>%
  separate(date_bp_min,
           sep = "±",
           c("date_bp_min_age",
             "date_bp_min_error")) %>%
  drop_na(date_bp_max_age,
          date_bp_max_error) %>%
  mutate(date_bp_max_age = parse_number(date_bp_max_age),
         date_bp_max_error = parse_number(date_bp_max_error))

signbase_years_cal <-
  calibrate(signbase_years$date_bp_max_age,
           signbase_years$date_bp_max_error,
           ids = signbase_years$object_id,
           verbose = FALSE) %>%

  summary() %>%
  tibble() %>%
  left_join(signbase_full,
           join_by("DateID" == "object_id"))

```

## Exploratory Data Visualization

```
library(rnaturalearth)
library(ggrepel)

# import the data
signbase <- read_csv("signBase_Version1.0.csv")

# prepare simple features objects for a base map of the coastlines
# and country boundaries of Europe
world <- ne_countries(scale = "medium", returnclass = "sf")
Europe <- world[which(world$continent == "Europe"),]

# make a map of the signbase sites
ggplot() +
  geom_sf(data = Europe) +
  coord_sf(xlim = c(-10,30),
           ylim = c(35,53),
           expand = FALSE) +
  geom_jitter(data = signbase,
             aes(x = longitude,
                y = latitude,
                color = preservation)) +
  # add labels for the site names
  geom_text_repel(data = signbase %>%
                 distinct(site_name,
                          .keep_all = TRUE),
                 aes(x = longitude ,
                    y = latitude,
                    label = site_name),
                 max.overlaps = 100,
                 size = 2) +
  theme_minimal()
```

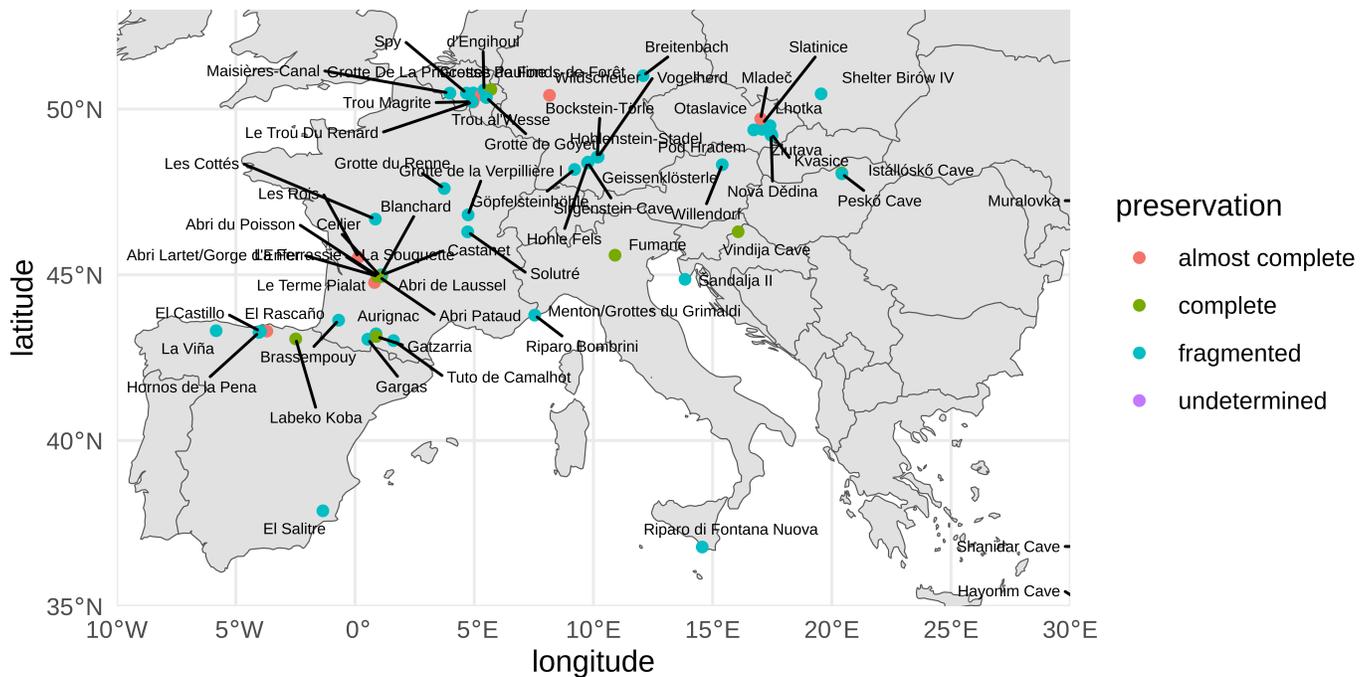


Figure 1: Isabella Hankins: Map of mobile object preservation levels and location.

[Figure 1](#) maps the preservation levels of each mobile object and the location it was discovered. Notably, fragmented (blue) objects were discovered frequently across Europe, while “complete” and “almost complete” objects were less common. There is no strong visual correlation between region and preservation level (Dutkiewicz et al., 2020).

```
# Load the data
signbase_full <- read_csv("signBase_Version1.0.csv")

# Create a summary table to calculate counts for each combination of material and object
summary_data <- signbase_full %>%
  group_by(material, object_type) %>%
  summarize(count = n(), .groups = "drop")

# Plot the summarized data
ggplot(summary_data, aes(x = material, y = count, fill = object_type)) +
  geom_col() +
  labs(
    x = "Material",
    y = "Count",
    fill = "Object Type",
    title = "Relationship Between Tool and Material"
```

```
) +
theme_minimal() +
theme(axis.text.x = element_text(angle = 45, hjust = 1))
```

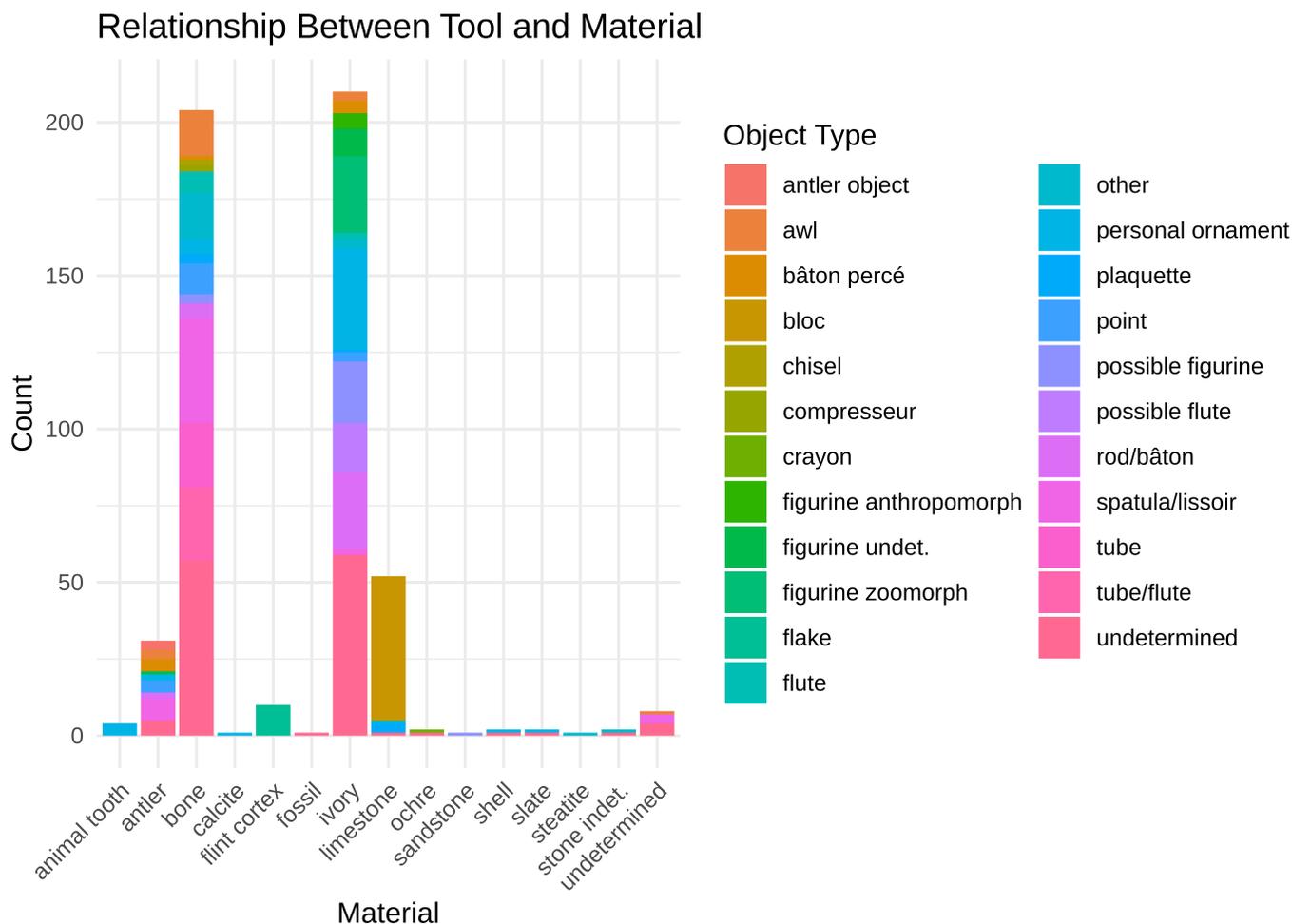


Figure 2: Lily Miller: Frequency of object materials and object type.

[Figure 2](#) depicts sampled objects by frequency, material, and type. Bone and ivory are overwhelmingly the most frequently found object materials, followed by limestone, then antler. Objects made of bone were most frequently categorized as tube/flute, tube, and spatula/lissoir, among objects that were classifiable; objects made of ivory were most frequently categorized as figurines, personal ornaments, and rod/baton, among objects that were classifiable (Dutkiewicz et al., 2020).

```
signbase_clean <-
signbase_years_cal %>%
  select(MedianBP,
         material,
         object_type,
         preservation)

summary_data <- signbase_full %>%
  group_by(preservation, material) %>%
  summarize(count = n(), .groups = "drop")
```

```
ggplot(summary_data, aes(x = preservation, y = count, fill = material)) +
  geom_col() +
  labs(
    x = "Preservation State",
    y = "Count",
    fill = "Material",
    title = "Relationship Between Fragmentation Status and Material"
  ) +
  theme_minimal() +
  theme(axis.text.x = element_text(angle = 10, hjust = 0.5))
```

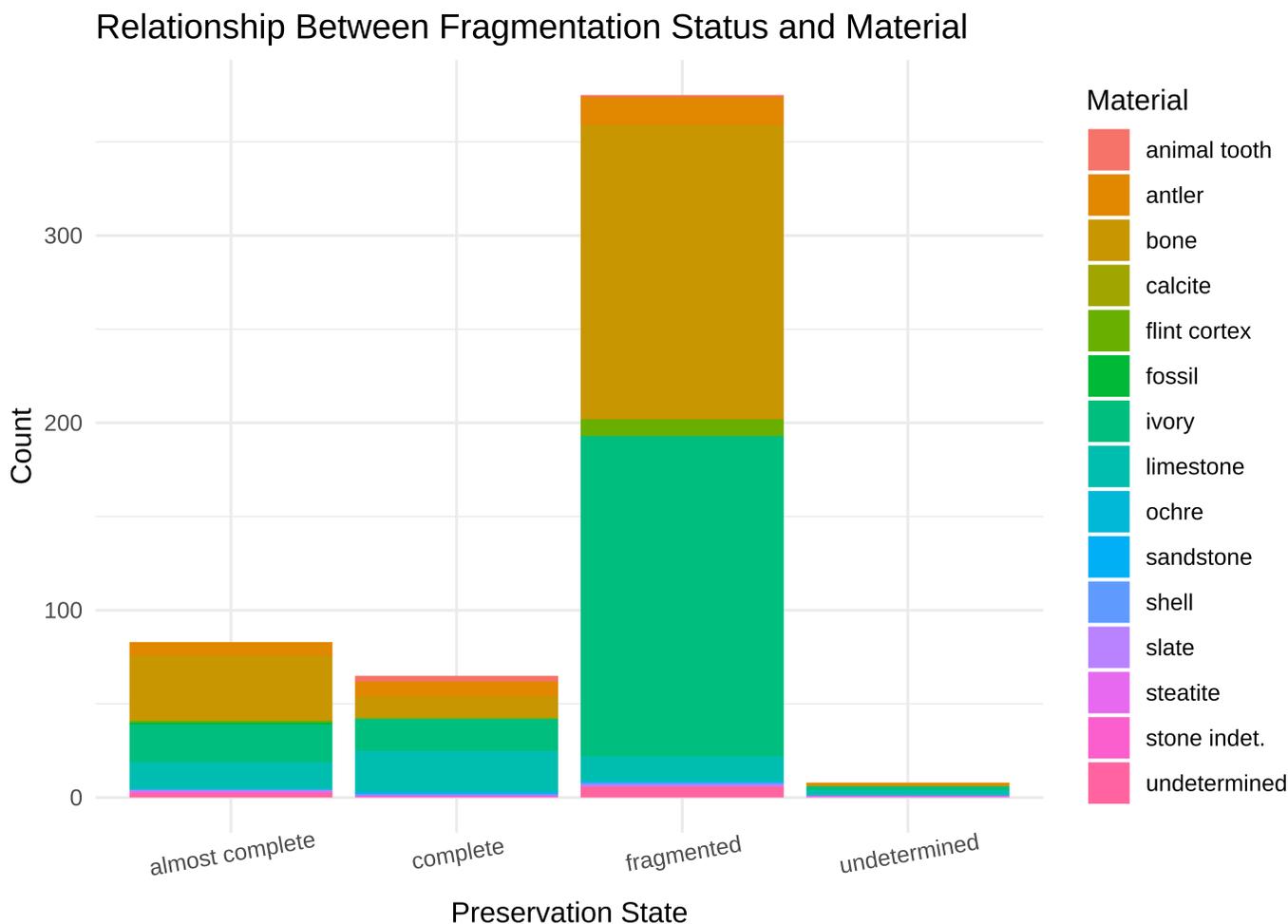


Figure 3: Angeline Nguyen-Phan: Here, we see how many of each material of artifact corresponds to the listed categories of fragmentation statuses.

[Figure 3](#) demonstrates that among almost complete and complete artifacts, the most common materials used were bone, ivory, and limestone. Ivory and bone also made up the largest majority of and had the greatest overall count within fragmented objects. Notably, very few objects made of other materials were excavated in complete or almost complete condition (Dutkiewicz et al., 2020).

```
signbase_clean <-
signbase_years_cal %>%
  select(MedianBP,
         material,
```

```

object_type,
preservation)

ggplot(signbase_clean) +
  aes(material,
        MedianBP) +
  geom_boxplot() +
  labs(
    title = "Relationship Between Materials and Age") +
  xlab("Material") +
  ylab("Age (Years BP)") +
  scale_x_discrete(drop = FALSE,
                   guide = guide_axis(n.dodge = 2),
                   name = "") +
  theme_minimal()

```

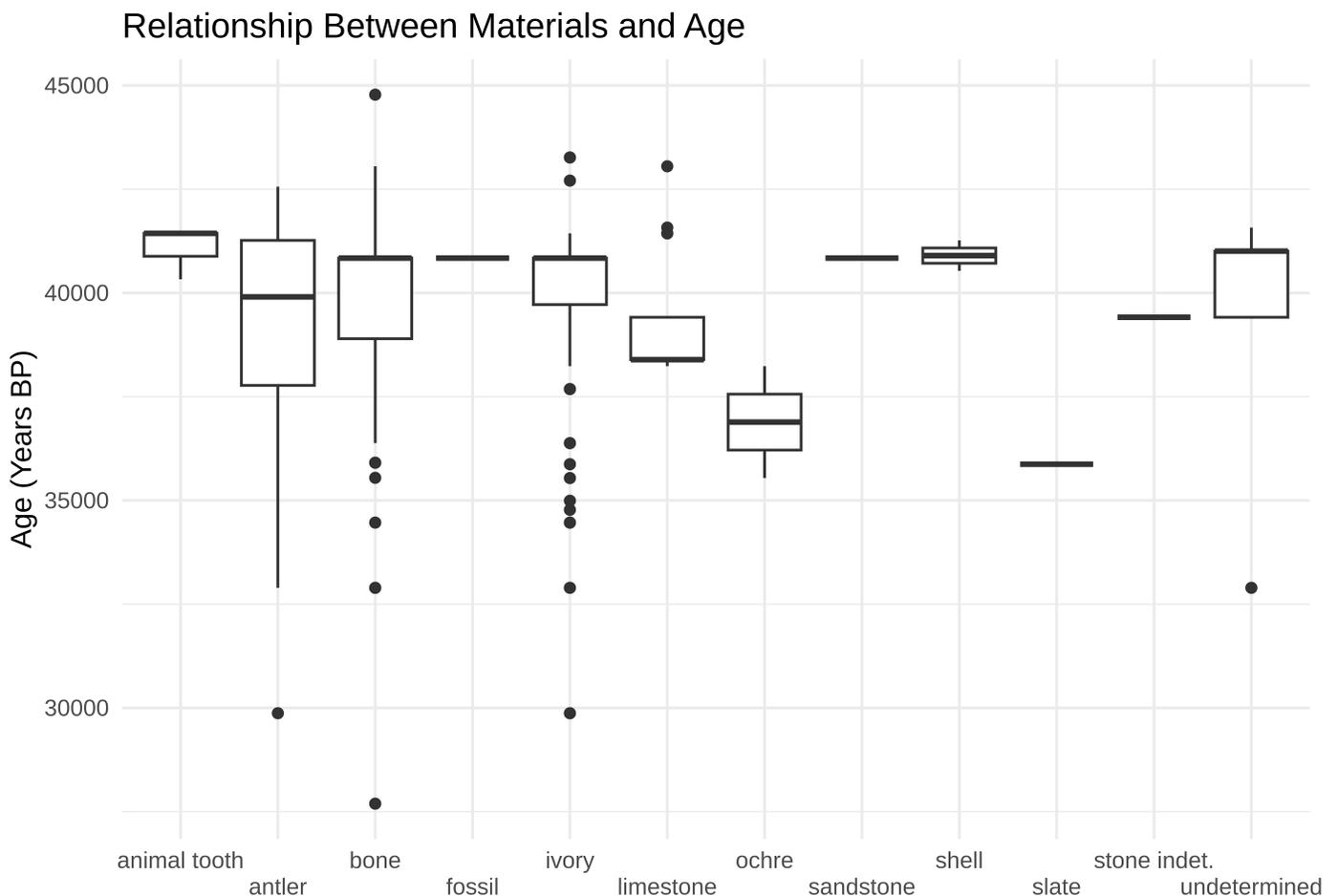


Figure 4: Hannan Fakhri: Boxplot showing the relationship between materials and their age

[Figure 4](#) shows the relationship between the types of materials used to make objects, and their age. It appears that ivory, bone, and antler were commonly used for a long period of time, with bone artifacts existing from between approx. 45000 to 30000 years before the year 1950 (Dutkiewicz et al., 2020).

## Conclusion

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Bone and ivory may have been commonly used for creating symbolic pieces. However, from this data set, it cannot be determined whether the abundance of ivory and bone objects were from a stronger preservation ability or from a higher frequency of creation (Dutkiewicz et al., 2020). In fact, many factors are capable of impacting bone preservation in the archaeological record: Orłowska (2024) notes the impacts of different plant roots on eroding bone objects. Further, this data does not support the notion that preservation levels are correlated with broad geographic location (Dutkiewicz et al., 2020). While it cannot be determined with this data whether higher frequencies of bone and ivory meant higher usage of these materials by early humans, greater availability, the shape, and the size of these materials could increase usage (Olsen, 2007). To conclude, Sanjuán et al. (2013) notes the cultural significance of materials in later human periods. In this case, ivory indicated social status and power in Southern Iberia during the Copper Age. While status and power may not have played a role in these humans' material culture at this point in time, it will become a critical piece of the human history and object creation.

## References

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