Chapter 6

NON-DESTRUCTIVE GAMMA-RAY SPECTROMETRY OF THE SCLADINA NEANDERTAL MANDIBLE (SCLA 4A-1)

Yuji YOKOYAMA & Christophe FALGUÈRES

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1. Introduction

During the early 1980s, developments in the field of gamma-ray spectrometry allowed the observation of long half-life natural radionuclides such as uranium (^{238}U, ^{234}U), thorium (^{230}Th) and protactinium (^{231}Pa; Yokoyama & Nguyen, 1980). This new technique does not require prior chemical treatment of the sample, which is highly advantageous for studying rare and valuable objects. This technique was applied for the first time in the field of prehistory on the fossilized human remains from Caune de l'Arago (Yokoyama & Nguyen, 1981). Later, other human fossils were dated with this method. These include crania, notably that of Biache-Saint-Vaast; numerous mandibles, such as Fate in Italy and Atapuerca in Spain; long bones, such as the femur from the Venosa site in Italy; and an ilium from the Prince Cave, also in Italy, Qafzeh 6 skull, Israel and recently Ngandong calvaria, Indonesia (Yokoyama et al., 1988, 1997, 2008; Yokoyama, 1989).

This paper presents the results obtained in 1994 from non-destructive gamma-ray spectrometry applied to a the right hemimandible Scla 4A-1 of the Neandertal child found during the 1993 archaeological excavations at Scladina Cave.

2. Methods

The gamma-ray spectrometry method is based on radioactive disequilibrium of uranium series. During permineralization at the beginning of the fossilization process, bones readily absorb dissolved trace elements, such as uranium, from groundwater. As a consequence, fossilized bones may contain a variable amount of uranium (from 1 to 300 ppm). However, during the early phase of fossilization, bones do not take up uranium descendants such as thorium (^{230}Th) and protactinium (^{231}Pa), since these nuclides are insoluble in water. As time passes, these two nuclides grow from their parents decay respectively ^{234}U and ^{235}U. Measuring the ^{230}Th/^{234}U (or ^{231}Pa/^{235}U) ratio therefore yields the date of the sample. Details about these methods (U-Th and U-Pa) have been well described (Ku, 1976, Ivanovich et al., 1992, Bourdon et al., 2003). Gamma-ray spectrometry is not only applicable to bones and teeth, but also to antlers, reindeer palms, mammoth ivory, shells, and corals.

The Scladina sample was placed on a low background, high purity ORTEC germanium detector (GeHP) connected to a computer controlled by a microanalyzer. The detector had a relative effectiveness of 25% and a resolution of 0.7 keV at 63 keV. ^{234}U and ^{230}Th activities were determined from gamma rays directly emitted by these nuclides at 53.3 keV and 120.9 keV for ^{234}U, and at 67.7 keV for ^{230}Th. ^{238}U was determined from its direct daughter, ^{234}Th, at 63.3, 92.4, and 92.8 keV. Determination of ^{231}Pa activity is obtained from those of its daughters, ^{227}Th, ^{223}Ra, and ^{219}Rn.

3. Results and discussion

The Neandertal remains were found in Sedimentary Complex 4A. The mandible weighs 30.18 g and was counted during 91 effective days because the level of uranium in the mandible is low (Table 1) and did not allow the calculation of a date from the ^{231}Pa/^{235}U ratio. The age obtained via the ^{230}Th/^{234}U ratio presents an important error range due to the measurement difficulty of ^{234}U which is superimposed with ^{214}Pb at 53.2 KeV. The low level of ^{232}Th in the sample (the ^{230}Th/^{232}Th ratio is equal to 22) indicates correcting the age on the basis of exogenous thorium is not necessary. The age obtained reveals that the child lived at least 100,000 years ago.

U content (ppm)	2.6 ± 0.26
^{234}U / ^{238}U	2.2 ± 0.35
^{230}Th / ^{234}U	0.75 ± 0.12
^{230}Th / ^{232}Th	22 ± 2.2
Age EU (ka)	127 +46 / −32 ka BP

Table 1. Measured uranium content, isotopic ratios, and age of the Scladina mandible within 1 standard deviation of the mean.

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