Functional Variability in the Late Upper Palaeolithic of North-Western Europe. A Traceological Approach

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Early on, functional interpretations about prehistoric tools illustrated one of the main concerns in archaeological research, and such relevance led to the development of functional analysis techniques. Established by Semenov's (1964) systematic research, use-wear and residue analysis focus on the observation, identification, and interpretation of different diagnostic physical alterations made on the active areas and edges of tools used by human populations (e.g., hunting projectiles, domestic tools, and/or residue traces) (see, e.g., Fullagar and Matherson 2013). Therefore, during the last few decades, functional studies, experimental tests, use-wear, and residue analysis, have been seen in archaeological research as fundamental proxies for the reconstruction of prehistoric technology and human socio-cultural behavior and organization (e.g., Anderson-Gerfaud et al. 1993; Grace 1996; Longo et al. 2005; Odell 2004; Plisson 1985; Stafford and Stafford 1993).

This book, *Functional Variability in the Late Upper Palaeolithic of North-Western Europe. A Traceological Approach* by Katsuhiro Sano focuses on the functional interpretation of lithic assemblages in order to understand the organization, variability, and utilization strategies of these industries and to recognize occupation-settlement and ecological behavioral patterns of hunter-gatherers during the Magdalenian of north-western Europe. From my perspective, the present book is organized in five main sections: (1) introduction and theoretical background (Chapter I), (2) methods and techniques (Chapters II and III), (3) data from traceological analysis of the Magdalenian lithic assemblages (Chapter IV), (4) a conclusive and wider discussion of the results about functional variability in the regional Magdalenian (Chapter V), and (5) the appendices.

The introduction chapter is divided into four main topics. It describes the (1) research theoretical background, (2) main goals and key questions, (3) geographic and chronological framework of the research, and (4) methods and techniques. The main research questions and goals are clear and well-defined by the author in the introduction section, emphasizing the importance of traceological analysis of the lithic assemblages of three important sites as a proxy to interpret functional variability and organization in the Late Upper Paleolithic of north-western Europe. In this chapter, the theoretical framework describes the settlement-subsistence model defined for the Magdalenian occupation in north-western Europe. Based on several decades of research, the author highlights a model for human settlement during the Magdalenian that distinguishes two classes of sites situated in two different geographic territories that, although complementary, are associated with different occupation functionality. However, from this model the author emphasizes three main open key questions: (1) "were any other activities other than lithic artifact production performed at the quarry-workshops", (2) does use-wear analysis show evidence of hunting activities at cave sites, and (3) how diverse and which activities were conducted at the so-called "base camps".

In this scenario, based on the interpretation of human activities at the sites, the author argues that research should explore two complementary questions: (a) the relationship between sites, and, (b) revision of the traditional model for human settlement-subsistence behavior during the Magdalenian in this territory. Thus, in order to test this hypothesis and reply to those questions, the author, based on traditional techno-typological data of the lithic industries, proposes a traceological approach to the lithic industries as a proxy for understanding and interpreting lithic variability and site function during the Magdalenian in this region. Also in this chapter, from the theoretical framework, the author introduces a short state of the art of traceology studies in archaeological research, discussing the key techniques, concepts, and definitions of the discipline. This section has excellent schematic illustration for the formation processes, both natural and cultural, of the diversity of wear traces in lithic artifacts (Figures 4, 5 and 6).

Although introduced in the previous chapter, as mentioned above, in Chapter II (Methods of Traceology, page 27), the author individually describes the methodological background for the formation processes of all types of wear traces (i.e., fractures, edge damage, striations, rounding, and polish) observed on lithic tools. From my perspective, this chapter is well balanced and comprises an important methodological and experimental reference and database for traceological research. In this section, experimental work is presented as an important technique to test the association of different contexts and processes (i.e., geological, production, use, depositional and post-depositional, and excavation and/or post-excavation) and the formation processes of all different categories and types of wear

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traces. Here the author provides excellent images, illustrations and schemas to demonstrate all categories and variables mentioned in the text. Besides the identification of all classes of wear traces, quantification also is addressed in order to distinguish different categories, according to all predictable dependent and independent variables associated with the formation processes (e.g., polish formation process), including movement, duration, worked material, etc. This chapter also includes a section regarding the methodological procedures that the author used for sampling Magdalenian lithic assemblages for traceological analysis in this study. Sampling included lithic assemblages of the archaeological sites of Eyserheide, Bois Laiterie Cave, and Gonnersdorf K-II. From these three assemblages, the analyzed sample includes only flint tools. Besides sampling, cleaning procedures are described, as well as all methodological approaches used for microscopic and photography identification of wear traces and functional interpretation of lithic tools.

During the past few decades, research on functional studies focused on the development of different methods and techniques. According to the author, more recently, research has been focusing particularly on "*special issues*," such as (1) hafting and prehensile wear analysis, (2) residue analysis, (3) diagnostic impact fractures (DIF), commonly interpreted as evidence of projectiles used in hunting activities, and (4) perforating tools. Such topics are explored in Chapter III, containing a brief description, state of the art, and definition of these wear traces and techniques of functional analysis. In my opinion, one of the most interesting aspects of this chapter is the experimental program used to analyze the formation processes of the different fractures. As clearly mentioned by the author, traditionally, experimental studies focused only on the formation of impact fractures, conducting several experimental scenarios for their formation, and naturally ignored all the other possible accidental fractures that may have occurred during knapping or due to post-depositional processes. The author made a clear effort to compare accidental fractures with projectile impact fractures. Processes such as dropping the lithic artifact, blank production (knapping), additional configuration and/or retouching, and trampling were tested and compared with the so-called typical diagnostic impact fractures and associated polish and striations. The results are clear and well-described including, once again, several excellent schematic illustrations that compare the different fractures and formation processes (e.g., Figures 78, 79 and 84). Evidence for perforating is also explored; experimental tests were conducted using different materials, such as leather/hide, hard organic materials (e.g., bone, antler, and ivory) and ornamental bead (e.g., shell, teeth, and stone). Results are presented according to the association of distinct perforating wear traces and worked materials, including great description and illustrations.

Chapter IV refers to the traceological analysis of the lithic assemblages of the three Magdalenian sites: Eyserheide, Bois Laiterie Cave, and Gonnersdorf. In this section each archaeological site is presented in three subdivisions: (1) introduction, including a brief outline of the site location, chronostratigraphic record, and historical background, (2) materials and results of the traceological analysis, and (3) discussion and interpretation of site function, including tool function and spatial distribution and organization.

After the analysis and results presentation, Chapter V offers final discussion and conclusions. In this chapter, based on the main research questions, results are interpreted, discussed, and organized into three main topics: (1) lithic utilization strategies, (2) intra-site spatial organization, and (3) functional variability of the lithic industries during the local Magdalenian. In the first topic, the author compares the results from traceological analysis of the lithic assemblages from the three Magdalenian sites and discusses techno-typological variability and utilization strategies. In my opinion, the effort that the author makes on combining technology, typology and functional data for the interpretation of lithic tool utilization, such as endscrapers, burins, and splintered pieces, showing that this multidisciplinary approach is fundamental to understand lithic variability, organization, and economization is interesting.

Spatial analysis focuses on the association of the distribution of lithic function and anthropic features, such as hearths, in order to infer intra-site spatial organization of the human occupation. Results show interesting aspects. On the one hand, data show that the association between hearths and projectile armatures is likely typical and has been confirmed at other Magdalenian sites. On the other hand, other activities such as hide processing and butchering took place in peripheral areas outside the hearths' perimeters. Another interesting aspect is the dichotomy between production and utilization areas. While the production and maintenance of tools such as burins, projectiles, and endscrapers tends to be made around the hearths, their utilization took place outside these areas.

Lithic functional variability during the Magdalenian is addressed in the third topic. Here the author presents and combines data from traceological analysis from the three archaeological sites. Results show that all three sites had different functional occupations. While Gonersdorf does not show evidence for a specialized task occupation, since different activities were performed at the site, Bois Laiterie Cave is clearly identified as a hunting station, marked by a high frequency of projectiles (backed tools with diagnostic impact fractures), and Eyserheide is associated with blank production and organic material working. These results clearly indicate, as the author mentions, the presence of differently specialized sites (logistic and residential) that characterized settlement-subsistence human behavior during the Magdalenian.

In sum, from my perspective, this book by Sano illustrates one of the main important questions that have been discussed during the last decade, the combination of different approaches to study lithic industries, such as technology, typology, and functional analysis (e.g., Evans et al. 2014). This pluridisciplinary approach is fundamental to recognize lithic utilization strategies and infer human technological, cultural, and social behavior (e.g., Marreiros

et al. in press). This approach is excellently presented in Sano's work exploring the main goals and key questions and proving to be crucial to recognizing site functionality and identifying settlement and mobility patterns of Magdalenian hunter-gatherers in north-western Europe.

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