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# The exploitation of copper sulphides and its implication on the organization of the economy during the Bronze Age

Céline Tomczyk<sup>1</sup>, Patrice BRUN<sup>2</sup>, Christophe Petit<sup>1</sup>

1: Université Paris 1 Panthéon-Sorbonne, ArScAn UMR7041, Archéologies Environnementales

2: Université Paris 1 Panthéon-Sorbonne, ArScAn UMR7041, TranSphères

contact: celine.tomczyk@univ-paris.1

## Introduction

The pyrometallurgy of copper successively underwent 2 technical innovations between the Neolithic and the Bronze Age :

- reductive fusion, allowing to extract copper from oxidized/carbonated minerals
- oxidation (roasting) which, carried out prior to the reductive melting, allows to exploit primary sulphide minerals.

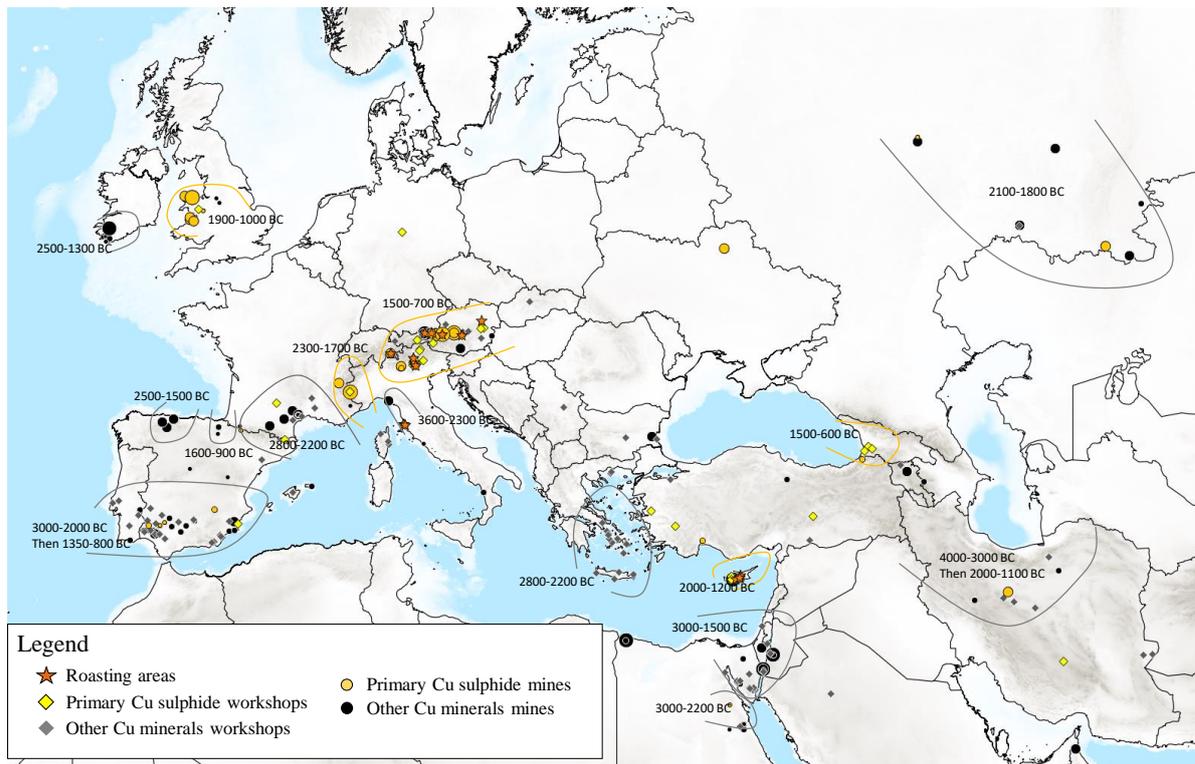
This study focuses on this second innovation: the metallurgy of primary copper sulphides **between 3500 and 800 BC** (time scale chosen to observe the appearance and durability of this pyrometallurgy in Europe and the Middle East).

## Methodology

A database of all **mines** and **pyrometallurgy workshops** for which the associated copper mineral type is known was created via the existing literature. 170 mines and 157 workshops were identified of which :

- **83 primary copper sulphides exploitations** were isolated

Exploitations of fahlores (Cu-As±Sb sulphides) were discounted because although they can be roasted, they can also be worked by simple reductive fusion. The same applies to co-smelting cases where the primary sulphides are smelt with copper oxides or carbonates by reduction alone.



Location of copper mines and pyrometallurgy workshops and main operating periods of the major mining regions

## "Specialized" regions?

In the Bronze Age:

1/ The innovation of primary Cu sulphides exploitation was concentrated in **large production regions**: Austrian Tyrol, Wales, Cyprus and southern Georgia.

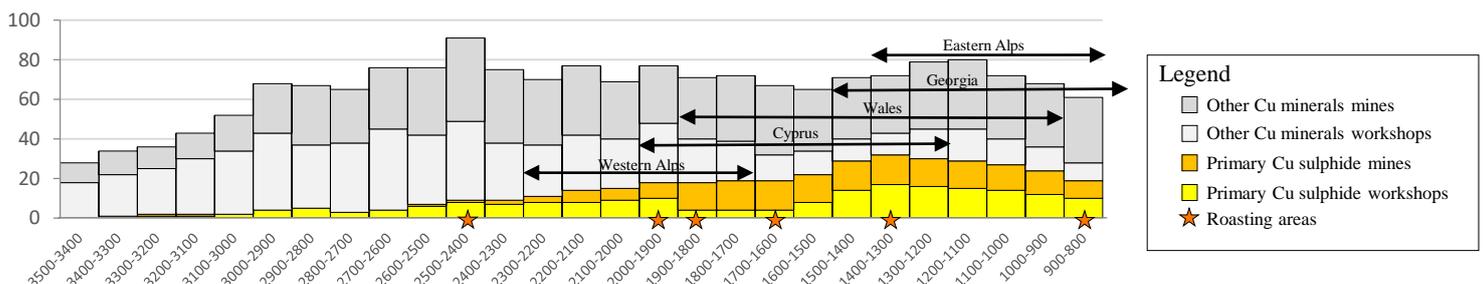
2/ Other regions such as the Iberian Peninsula or the Levant continued to practice a metallurgy based on the reduction of Cu carbonates, perhaps in relation to their local abundance.

3/ Primary Cu sulphides have a low impurity content and are therefore ideally suited for the production of high-purity copper ingots. It is thus possible to correlate the generalization of the extraction of Cu sulphides with the generalization of bronze.

## The generalisation of primary Cu sulphides exploitation

It possible to specify the dates of appearance and generalization of the oxidation metallurgy of simple copper sulphides:

- chalcopyrite-type copper sulphides start to be exploited as early as the second half of the III<sup>rd</sup> millennium BC
- primary Cu sulphide exploitation gradually increases from the beginning of the II<sup>nd</sup> millennium BC and becomes widespread in the second half of the II<sup>nd</sup> millennium BC



Evolution of the number of mines recorded between 3.500 and 800 BC in Europe and the Middle East. The number of mines is not necessarily representative of production as the size of primary copper sulphide mines is generally important