ANCIENT IRON SMELTING REVISITED BY MODERN TECHNIQUES: WHAT MAKES AN IRON ORE WORK?

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The art of ancient bloomery iron smelting caught the attention of many archaeometallurgists in the past decades, the findings of which have been summarized in several important works (TYLECOTE, 1992; PLEINER, 2000; REHDER, 2000). Despite these accomplishments, none have ever considered conducting a thorough study, spanning across several mineralogy-cally and chemically distinct ores, both pure and diluted by quartz sand, to infer on the precise range of chemical and/or mineralogical ore compositions which render an ore workable, taking into consideration the chemical and physical circumstances dictating the course of the smelting process. The enormous quantities of resources required, like sufficient charcoal, ore, wood and refractory clay for such an endeavour are in themselves self-explaining as to why such an extensive project did not take place until now.

In this contribution, we present the preliminary results of our long-term study (having started in the year 2012) using the results of XRF (X-Ray Fluorescence) data from the slag and ore samples obtained during more than 150 controlled smelting experiments. The results, albeit preliminary, clearly define the region of workable ores (without significant CaO contents) in the ternary system FeO-Al_2O_3-SiO_2. The compositions corresponding to 'workable' ore compositions cluster around the cotectic lines joining both eutectic points in the given ternary system. Such compositions have the lowest melting points, indicating that the key factor to a successful iron smelt is indeed that the slag remains sufficiently liquid during the entire smelt to be able to flow down from the region of the air inlet, liberating space for the incoming iron particles from the furnace shaft, while still partially coating the forming iron bloom, preventing its re-oxidation.

Ores with abundant CaO in the gangue form a separate cluster in the FeO-Al_2O_3-SiO_2 ternary scheme, since CaO in combination with the other gangue oxides leads to different more complex quarternary eutectic compositions. Regardless, the key factor governing the functionality of any particular ore seems to be independent of its mineral composition and defined entirely by its global chemistry, in accord with the findings of SAUDER & WILLIAMS (2002), which also emphasize the crucial role of a sufficiently fluid bloomery slag.

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