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Multidisciplinary characterisation of raw materials used for "ghiara" mortars from the historical city centre of Catania (Eastern Sicily, Southern Italy): insights into their genesis

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This work deals with new data on the raw materials used for the production of typical *ghiara* mortars, widely employed in historical buildings of Catania downtown (Eastern Sicily, Southern Italy). *Ghiara* aggregates are interpreted as the product of thermal transformation of soils rich in organic matter as a consequence of heating induced by the flowing lavas of Mt. Etna volcano on them. This process changes the original brown colour of the soil to reddish nuances.

Aim of this study is a multidisciplinary investigation of such raw materials by comparing various *ghiara* samples from different ancient quarries located in areas covered by historic lava flows (both in the historic centre and the periphery of Catania) with a still-preserved, unburied and unburnt, volcanic soil profile presumably correlated with those affected by transformation.

Relevant information about the compositional, physical, petrographic and mineralogical features is provided, mainly on the weathering degree, the patterns that affect the primary components and the newly-formed phases. This allows the acquisition of new elements on the *ghiara* genesis and its physical-chemical formation conditions. Several analytical techniques were used to characterise both the *ghiara* and soil samples from the same profile.

Major and trace element patterns of *ghiara* and soil samples are very similar, supporting the hypothesis that the studied soil really represents the parent material of *ghiara* unaffected by the lava flow-induced transformation. Plagioclase, pyroxene and quartz grains of *ghiara* samples exhibit important corrosion features, often coupled with Si-Al and Si amorphous phases as well as Fe-oxides/hydroxides. Conversely, primary minerals are fairly fresh within the soil. The clay mineralogy of soil horizons consists of illite and kaolinite phyllosilicates (along with halloysite-7Å in one sample), whereas *ghiara* includes illite and hematite and/or goethite. Organic matter occurs in significant amounts within the soil, ranging between 1.6 and 5 wt%, whereas it is absent in *ghiara* samples. All these data support the idea that *ghiara* materials derive from the burning of soils at temperatures estimated in the range of about 550-900 ˚C, since illite is preserved whereas kaolinite collapses from soil to *ghiara* specimens. Such temperatures are also able to promote a fast and complete loss of soil organic matter, severe corrosion of all the primary minerals (quartz included) and re-precipitation of amorphous phases, widespread oxidation of iron forms. These features suggest a paramount role of circulating fluids, presumably enriched in CO_2 released from organic matter heating and degradation.