

Mineralogical characterization of the Seffner fulgurite, Florida: Insights into lightning-induced petrogenesis

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ABSTRACT

Fulgurites are glasses formed when electrical discharge hits a target material made of soil, sand, or rock. Due to their formation conditions, fulgurites inform how high-temperature processes and rapid quenching of rocks result in peculiar mineralogical assemblages characterized by the presence of reduced phases. Fulgurites can be either natural or artificial, with the latter occurring when the electrical discharge is not due to lightning but a downed power line. They are also anthropogenic if the target material is not completely natural, allowing for a wide range of temperatures and materials involved in their formation. Artificial and anthropogenic fulgurites are far less characterized than natural ones. In this work, we studied a fulgurite from Seffner, Florida, U.S.A., formed by the action of a downed power line. The fulgurite also contains a piece of a metal conductor, thus providing the interesting opportunity to characterize the interface between the metal and the silicatic portion of the sample. The Seffner fulgurite contains a huge variety of reduced phases, comprising metallic silicon, iron silicides, and Al-Fe-Si and Fe-Si-Ti compounds. The occurrence of iron silicides points to an environment rich in silicon and exposed to relatively low temperatures, as is typical in artificial fulgurites. Al-containing phases are found close to the metal conductor, suggesting that Al metal in the wire could play a major role in determining the mineralogy of the Seffner fulgurite and in driving the formation of reduced phases. Conversely, Fe-Si-Ti phases occur in the whole fulgurite fragment containing the metal conductor, suggesting the action of another source of reduction, most probably organic carbon. Notably, analysis of other portions of the fulgurite samples far from the metal conductor shows a minor presence of reduced phases, supporting the role of Al as a fundamental driver of the reduction.

Keywords: Seffner, fulgurite, iron silicides, silicon, phosphides, Al-bearing conductor, reduced phases