The fulgurite of Torre de Moncorvo (Portugal): description and analysis of the glass

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Abstract: The fulgurite of Torre de Moncorvo (Portugal) was formed by lightning striking a small electricity pylon; it consists morphologically of a central cylinder with radial ramifications several metres long. It is largely composed of glass, with the remains of quartz crystals and neoformed cristobalite. This paper reports a textural and geochemical study of the lithologically different axial and radial facies identified in the fulgurite. The axial facies is formed of a dark, vitreous rock, shows a concoidal fracture, and has a central tube some 20 cm in width. The fulgurite shows a large quantity of small vesicles and partially melted quartz remains, along with fractured crystals of cristobalite and quartz. Analysis of this facies showed it to be composed of an aluminosilicate material with Na, K and Fe, formed from a granitic protolith and some allochthonous materials. Two types of glass were characterised, different from a textural and geochemical point of view, formed in two phases of incongruent melting. The radial facies are similar to their axial counterpart at the point of contact with the central cylinder, but these very vesicular, dark cylinders gradually take on different properties with distance from the axial facies. The chemistry of these branches indicates that they formed exclusively from native granitic material. The radial facies are made of the same types of glass as the axial facies, but cristobalite crystals have not been identified in this facies.

Key-words: fulgurite, lightning, glass, cristobalite.

1. Introduction

Glass is naturally formed by several processes like volcanic events (producing obsidian), meteorite strikes (forming impact breccias, impact glasses and tektites), burning coal (Cosca et al., 1989), pseudotachylytes (Ujiie et al., 2007) and lightning strikes (forming fulgurites). The existence of fulgurites has been known for many years (Darwin, 1839). The literature contains descriptions of their genesis and petrological studies (Hobbs, 1889; Petty, 1936; Kochemasov, 1985; Essene & Fisher, 1986). Recently the composition of gases trapped in the vesicles of a fulgurite in the Libyan desert was investigated to help reconstruct the palaeoecology of the area (Navarro-González et al., 2007). This background encouraged the present study of the Torre de Moncorvo (Portugal) fulgurite, numerous fragments of which are now held at the Museo Geominero (IGME) in Madrid.

The term fulgurite (from the Latin fulgur, lightning) is used to designate glassy rocks formed by atmospheric electrical discharges on soil or rock. Normally, fulgurites consist of a cylinder some centimetres in length, with a central canal; they are composed of glass produced by the melting of silicates. The internal part of the tube is usually shiny, while the outside is rough due to fragments of minerals and rocks that did not melt. The morphology of the fulgurite reflects the trajectory taken by the lightning as it penetrated the ground. Most of them form simple tubes but dendritic fulgurites have also been described.

The lightning that generated the Torre de Moncorvo fulgurite occurred on the 24 May 1998, striking the ground between the villages of Cabanas de Baixo and Foz do Sabor in the municipality of Torre de Moncorvo (northeastern Portugal, near the frontier with the Spanish province of Salamanca).

1.1. Formation characteristics

Fulgurites are formed when very powerful atmospheric electrical discharges strike the ground. These discharges can be induced by metallic columns or posts, through which they can find their way to the ground (Durgun & Karamanderesi, 1985). A lightning bolt is usually about 2–5 cm across, reaches a speed of 94,000 km/s, a temperature of 17,000–39,000 K, and has a peak current of some 10,000–30,000 A (Rakov & Uman, 2003). As the lightning enters the ground the latter experiences an enormous and instantaneous increase in temperature, in some cases causing it to melt. If the strike – which must be powerful – lasted several milliseconds, and minimum temperature of around