

## **Description of Additional Supplementary Files**

**File name:** Supplementary Data 1

**Description:** Exponential and power law equations characterizing the vesicle size distributions of samples from the Fontana Lapilli, Masaya Triple Layer and Etna eruptions.

**File name:** Supplementary Data 2

**Description:** Tortuosity, presented as the mean value and standard deviation for each sample.

**File name:** Supplementary Data 3

**Description:** Results of the sensitivity analysis, performed using the Masaya Triple Layer composition and initial conditions, for a conduit radius of 25 m, 10 m and 5 m.

**File name:** Supplementary Data 4

**Description:** Results of the sensitivity analysis using the Etna 122 BC composition and initial conditions.