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Subsurface laser scanning and photogrammetry in the Corona Lava Tube System, Lanzarote, Spain

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The Corona lava tube (Lanzarote, Canary Island, Spain) is one of the world's largest volcanic cave complex, with a total length of about 8km, comprising both dry and submerged sections. The 6 km long terrestrial portion of the tube is open to the surface through a series of skylights, in the local language called "jameos", that are aligned along the cave pathway. The underground passages are mainly sinuous, partly braided and multilevel, horizontal tunnels of variable width from 2m up to over 25m (5-7m on average), laying from few meters to a maximum of 30 meters from the surface. Although the first explorations and mapping campaigns of the lava tube have started already in the seventies, until now a clear view on the development and morphometry of this subterranean conduit was elusive. With three surveying campaigns carried out between February and November 2017, about 5 km of cave passages were mapped using a Leica P40 laser scanner. A total of 28 working days and over 440 scans were necessary to map this lava tube system, which is composed by different sections connected to each other through external collapses. The main path of the entire cave system was mapped with an unprecedented resolution of few centimetres, including the most relevant upper levels as the Jameos Cumplidos, the two tourist parts of the Cueva de Los Verdes and Jameos del Agua and the partly flooded part of Cueva de los Lagos.
The surveys realized inside the cave with the laser scanner were georeferenced on the surface through differential GPS, LIDAR (from the Spanish Geological Service) and photogrammetry data obtained through flights realized with unmanned aerial vehicles on the external collapses located along the cave path.
The dataset gathered by the detailed 3D model of the cave system have three main purposes: 1) create a virtual and analogic model of the cave to be used for outreach and didactic purposes in the touristic centre of Casa de Los Volcanes of the Lanzarote Geopark; 2) provide a detailed map of the tube and its relative depths from the surface, identifying critical zones for potential collapses, in order to allow local institutions to develop a protection plan for this subterranean environment in relationship to the actual different land use of the overlying surface; 3) provide to scientist quantitative morphometric data (volumes, morphologies, surface roughness, etc.) to develop detailed studies on the tube genesis and peculiar morphologies. These latter studies are on-going and will allow for the first time a detailed comparison between this exceptional example of terrestrial lava tube and similar features observed on the Moon and Mars.