Bacteria can travel from one continent to another in atmospheric dust particles

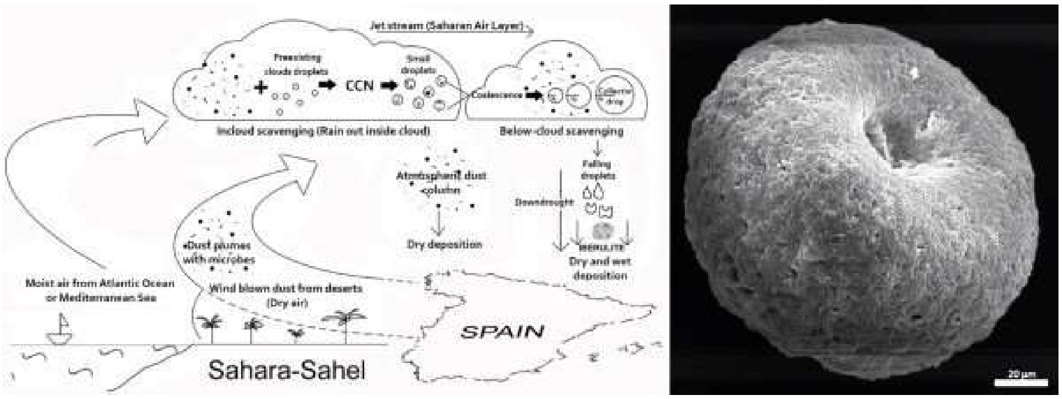

Figure 1. Sequence of iberulite formation in the atmosphere with bacterial involvement (left) and the appearance of an iberulite under electron microscopy (right). Credit: Atmospheric Research

Researchers from the University of Granada (UGR) have discovered that some microorganisms, such as bacteria, can travel from one continent to another 'hidden' in atmospheric dust.

Scientists from the UGR's Department of Edaphology and Agricultural Chemistry, Department of Applied Physics, and Center for Scientific Instrumentation have deciphered the enigma of the inter-continental transport of microorganisms via iberulites ('giant' atmospheric particles potentially inhalable by humans) and atmospheric dust, with the consequent risk of disease transmission that this implies.

Iberulites are giant polymineralic atmospheric bioaerosols, measuring on average one hundred microns approximately (although they can reach up to 250 µm). They travel across continents, defying the laws of gravity and transporting live microorganisms (acting rather like a launch vehicle). They were discovered in 2008 by researchers from the Department of Edaphology and Agricultural Chemistry of the UGR and the Andalusian Institute for Agricultural and Fisheries Research and Training (IFAPA).

NASA made the discovery public on its website in October of that year. But it is not until now that the UGR's multidisciplinary scientific team has revealed the mechanism by which bacteria are involved in the genesis and formation of atmospheric iberulites.

The researchers analyzed atmospheric dust deposits found in the city of Granada, the composition of which is heterogeneous comprising predominantly clay, quartz, and carbonate minerals and, to a lesser degree, iron oxides. In addition to this mineral component, a biological component was found in this dust: bacteria, diatoms, planktonic organisms, and even brochosomes (microscopic granules secreted by insects such as grasshoppers). The dust originated from the Sahara Desert (north-northeast Africa) and local/regional soils. Atmospheric interactions between these two components and clouds produce the iberulites (polymineralic bioaggregates), whose composition has now, for the first time, been studied.

To characterize the iberulites and solve the mystery of their existence and formation, the researchers analyzed their mineral composition, elemental composition, size of atmospheric dust, and the air mass origin for this particular region, as well as the atmospheric formation mechanisms involving bacteria.

They found that, in broad terms, iberulites originate in the troposphere as a result of various hydrodynamic processes that enable interaction to take place between dust grains, microorganisms of that dust that rise from Saharan soils (which act as condensation nuclei), and water-vapor molecules from clouds. The droplet of water formed in these condensation nuclei agglutinates dust particles of different sizes in its interior together with bacteria in suspension.

During the trajectory taken by the droplet through the air, a series of gravitational forces create a coherent structure inside, producing a wall or external covering (micro-laminate or clay rind) while, inside, the mineral particles are arranged in an orderly pattern (the smallest on the outside and the largest at the center of the iberulite).

Giant aerosols

At the same time, due to hydrodynamic forces, a vortex is created at the north pole of the increasingly complex droplet of water, which is what lends these giant aerosols their characteristic appearance. This is the basic structure of the iberulite, which enables it to react with other atmospheric components, leaving behind a reliable trace of the places through which it has passed.

Alberto Molinero García, a researcher at the Department of Edaphology and Agricultural Chemistry at the UGR and one of the authors of this study, explains:

"Bacteria can survive in iberulites because these provide a nutritious medium, a microhabitat rich in nutrients, and they protect the bacteria from ultraviolet radiation. This is demonstrated by the bacterial polymeric exudates that, rather like mucilaginous mucus, act as a 'glue' between the mineral particles, preventing their disaggregation and increasing their resistance to fragility in the turbulent phenomena of the atmosphere."

This enables the iberulites and microorganisms to travel great inter-continental distances on atmospheric currents such as the Saharan Air Layer (SAL). In atmospheric transport, the iberulite is in contact with a reactive medium—the atmosphere—where interactions take place with the gases naturally present, such as nitrogen and sulfur compounds.

A worldwide phenomenon

The UGR researcher points out that iberulites are not exclusive to this region of Spain: they may exist throughout the world, primarily in those regions where dust is carried in from desert regions.

"They have been found in Saudi Arabia, Volgograd (Russia), and possibly in the far-eastern part of China, Japan, Korea, and also in the U.S.," says Molinero. The new aerosols identified in Granada derive from the Sahara, which is a powerful emitter of atmospheric dust (it is estimated that the Sahara sends between 400 and 700 million tons of dust around the world per year).

This dust, together with the iberulites and the bacteria incorporated by the different atmospheric currents, can reach as far as the Amazon, the Caribbean, or the Himalayas. However, the dust coming into the Mediterranean is characterized by having followed a specific and well-known atmospheric trajectory.

Using all the data they have gathered, the UGR scientists will model the inhalation of the microscopic particles smaller than 10 microns (PM10) of which iberulites consist, as well as their penetration into the respiratory tract and the destination of the bacteria that are transported.