What favored (poly)saccharides preservation in sedimentary organic matter and aerosols?

Carbohydrates, also called sugars or saccharides, are organic compounds containing carbon, hydrogen, and oxygen in their molecule. Sugars can be classified as monosaccharides, disaccharides, oligosaccharides, and polysaccharides.

Carbohydrates are essential constituents of living biomass. They are present in cells of all organisms, starting from protists and finishing to vascular plants and mammals. In bacteria, carbohydrates account reached 20 to 40% of the dry weight, while in vascular plants, they can reach even 80% of the dry weight. Therefore, this group of organic compounds is the most common group on Earth. In living organisms, saccharides play various functions. Some of them (e.g., starch) are used for organisms as energy storage. Some others, like cellulose, hemicellulose, pectin, tannin, or chitin, are associated with cell walls, where they may provide protection and strength. Although carbohydrates are very common in living organisms, their occurrence in the geological record is rare.

The aim of the project is to understand the conditions under which carbohydrate preservation in sedimentary rocks is possible, taking into account their labile character. Our recent works show that monosaccharides, disaccharides and polysaccharides can be preserved in sedimentary rocks for hundreds of millions of years and be a significant constituent of rocks. Most recently, we have found remnants of hemicellulose in Cretaceous and Miocene xylites. Such a finding is unique in the worldwide geochemical data, but we should better understand the conditions under which these theoretically unstable compounds can survive in fossil material.

During the project, we plan to provide detailed molecular characteristics of Mesozoic and Cenozoic organic matter of diverse geological materials (fossil wood, lignites, organic-rich sedimentary rocks), focusing on the preservation of polar compounds and biomolecules. The main method used in saccharide detection will be gas chromatography coupled with mass spectrometry (GC/MS), with methanolysis as a perfect method of hemicellulose decomposition.

The second important aspect of the investigation will focus on carbohydrates' characteristics in the ambient air. We will characterize the occurrence of hemicellulose in aerosols and explain why it is highly degraded.

Implementing such a pioneer study would contribute to understanding the preservation potential of carbohydrates, which are still considered unstable in sedimentary organic matter diagenesis. We’ll try to explain what is the main factor controlling the preservation of carbohydrates in sediments and what processes lead to their destruction or conversion.