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**Title:** **Atomic Force Microscopy Nanomechanics for the Detection of Microplastics in Ground Water: Study Case from Dasha River, Shenzhen, Guangdong.**

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A collage of images of bacteria

Description automatically generatedMicroplastic pollution is a severe environmental issue with potential impacts on human health. Despite the worldwide diffusion of plastic debris in the environment, the effective characterization of microplastics (MPs) in groundwater is still under debate. During the seepage processes throughout the aquifers, subsoils have the capacity to block the larger MPs particles, while the finer fragments are difficult to detect with the standard techniques. Here, we propose a new protocol based on multifrequency Atomic Force Microscopy (AFM) and fluorescence methods, to detect and quantify plastic particles from microscale down to nanoscale according to their nanomechanical properties. The proposed methodology was tested on reconstituted MPs to distinguish potential false-positive detection of MPs in natural samples. Subsequently, our protocol was applied on urban groundwater sampled in Dasha river within an Asian megacity (Shenzhen, China). MPs were detected and characterized in three groundwater samples. This methodology represents an advancement in the mechanical characterization of MPs that can circulate in the aquifers but are difficult to detect via traditional analytical methods.