Comparing biogenic and abiotic magnetite for potential biotechnological applications

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Magnetite (Fe_3O_4) is a mixed valent Fe(II)-Fe(III) mineral that is readily found in the environment. It is considered to be an important mineral for its potential use in a wide range of applications including remediation of pollutants or in the medical industry for drug targeting or cancer treatment. Magnetite can be formed via a number of different pathways including biogenic mechanisms such as dissimilatory Fe(III)-reduction [1], microbial Fe(II)-oxidation [2], or via non-biogenic processes such as chemical synthesis [3], the weathering of igneous rocks, and metamorphic processes at elevated pressure and temperature [4]. Differences between how magnetite is formed can significantly affect its properties such as Fe(II)/Fe(III) stoichiometry, magnetic recoverability and particle size. These differences can in turn have dramatic effects on the bioavailability of magnetite to Fe-metabolizing bacteria [5] and on its potential reactivity towards environmental pollutants or use in other applications.

Here we compare and contrast the properties of different magnetite nanoparticles that have been produced through biogenic, synthetic and weathering processes. We have probed how different properties such as Fe(II)/Fe(III) ratio, magnetization and mineralogy are dependent upon their route of formation and crucially address how biotic vs. abiotic synthesis influences the bioavailability of the minerals to Fe-metabolizing bacteria and furthermore how these processes affect the reactivity of the magnetite towards chromium, which is often cited as a contaminant that can be treated with magnetite [6]. This work will help develop a better understanding of how biogenic or synthetic magnetite can be used in applications in the near to long term future.

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