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The morphology of Se[0] nanoparticles formed from biological reduction of selenate

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Selenium is a Group 16 chalcogen with atomic number 34, just below S on the periodic table. It is an element of interest in environments receiving industrial effluents with elevated levels of soluble Se, usually in the form of selenate (SeO42-). One example of where Se is a concern is the Elk Valley in eastern British Columbia where there are five large steelmaking coal mines. Selenate is highly soluble and thereby very mobile, resulting in transport of Se from coal mines into downstream ecosystems where it is transformed and enters the food chain through bioaccumulation. This could lead to concentrations of Se reaching toxic levels in fish and birds, for instance. To mitigate Se release from coal mining, active and passive bioreactors are used to remove Se from mine-influenced water (MIW) based on specific microorganisms that metabolize Se from soluble to insoluble forms. The preferred biological mechanism is reduction of selenate to elemental Se0 nano particles (SeNP). To better understand where these SeNPs are formed in proximity to the bacteria, their morphology and size, which are important for managing Se bioreactor sludge, we ran bench-scale chemostat bioreactors with selenate reducing bacteria from the mine environment. During treatment of simulated MIW under different conditions, coupons were used to collect biofilms. These were examined under scanning electron microscopy with energy dispersive spectroscopy. Two different forms of Se nanoparticles were observed, spherical colloids and nano-wires, depending on the carbon (C) to Se mass ratio in the bioreactor feed. SeNP nanoparticles were mostly attached to extra polymeric substances (EPS) produced by the bacteria. Spherical colloids ranged in size from 30 – 100 nm depending on the conditions. This suggests that operating conditions of the active and passive bioreactors, and the composition of the MIW, might result in different forms of SeNPs. The stability of these SeNP bioreactor sludges needs to be studied further to improve management of Se bioreactor residues.