Systems biology studies on the stress response of perchlorate, chlorate oxidative and nitrosative stress in *Desulfovibrio alaskensis* G20

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The chloroxyanions, perchlorate and chlorate, are potent inhibitors of sulfate-reducing bacteria, and as such are promising as treatments for biosouring in oil reservoirs. To understand the mechanism of inhibition, tagged transposon pools of the model sulfate-reducer, *Desulfovibrio alaskensis* G20 were stressed with the intermediates of respiratory perchlorate reduction: perchlorate, chlorate and oxygen.

The G20 mutant fitness profiles for (per)chlorate stress compared with other stressors such as nitrate, nitrite, nitric oxide and the reactive oxygen species hydrogen peroxide and hypochlorous acid reveal both overlapping and unique targets and mechanisms of resistance. Physiological, biochemical and transcriptomic studies were used to further define the cellular response to (per)chlorate. Taken together our results suggest that (per)chlorate toxicity appears to be a combination of oxidative stress alongside competitive inhibition of transport systems and enzymes involved in sulfate reduction. This work provides a starting point for developing new treatments to inhibit sulfate reduction in engineered ecosystems, including possible synergistic interactions between stressors.

Making Earth

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Our understanding of the steps involved in Earth formation have been transformed by huge improvements in the isotopic measurement techniques employed in geo/cosmochemistry. Modern techniques can: provide chronological precisions of well less than a million years on events happening over 4.5 billion years ago; allow the application of a wide variety of extinct radionuclides as chronometers and tracers that are sensitive to different key processes in planet formation and differentiation; and resolve isotopic variabililty in the Solar nebula that can provide clues to its structure and the origin of the building blocks of the terrestrial planets. The identification of an increasing number of stable isotope variations between meteorites and Earth has reopened the question of whether meteorites can be used to accurately infer the composition of the bulk-Earth. This basic compositional datum likely will have to come from direct measurement of Earth composition, for example the determination of bulk-Earth U and Th abundances via geoneutrinos. Improved chronological precision now allows clear resolution of many key steps involved in planet formation. Earth gained its characteristic depletion in volatile elements compared to chondritic meteorites within a few million years of Solar system formation. Ages for other events, however, must be interpreted in the context of a prolonged interval for Earth formation. For example, core formation on Earth is dated at 4.47-4.53 Ga, but this age range likely just reflects a mean age for a sequence of core forming events that occurred with each impact between a large planetesimal and the growing Earth. The last major impact into the growing Earth, likely the one responsible for Moon formation, appears to have occurred relatively late in Solar system history. The oldest reliably dated lunar crustal rocks give ages between 4.36 and 4.41 Ga, which overlap the I-Xe age of Earth's atmosphere, the U-Pb model age of Earth's mantle, the Sm-Nd and Lu-Hf model ages of the lunar mantle, and the oldest ages for zircons from western Australia and mafic metamorphic rocks from northern Quebec. Some Archean rocks derive from sources created in this early differentiation event, but mantle convection appears to have mixed away much of the evidence for this event in Earth's interior by 2.7 Ga. By ~4.4 Ga, Earth's surface and shallow interior had cooled to the point where liquid water was present on the surface and cycles of basaltic magmatism followed by hydration and remelting of the basalt to produce the felsic rocks typical of continental crust already had begun.

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